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Novel Baseline Framework for Effective Monitoring of 6G-Enabled Internet-of-Vehicle

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Abstract

The facilitation of a high speed 6G network will boost the performance of data transmission in order to meet its dynamic communication demand with massive generation of data in Internet-of-Vehicle (IoV) environment. Adoption of existing methods towards 6G in IoV is significantly witnessed with loopholes and limitation related to lack of structurization of massively generated data considering practical grounds. This challenge is addressed in proposed study by introducing a novel baseline architecture where a layer-wise operation is carried out towards developing a sustainable communication model in IoV. The monitoring and sensing is carried out by sensing layer while computing layer facilitates short range communication system using Request For Comment (RFC) 7625 compliant of 6G communication. The study outcome shows that proposed scheme is capable of structuring traffic data from IoV environment and offers better control on delay and stabilized links on multiple test cases of channel capacities.

Keywords: 6G, Internet-of-Vehicle, RFC 7625, Monitoring, Traffic Data;

1 Introduction

The proposed study is meant to develop a communication model which is compliant of 6G wireless network with a peak data rate more than 1 Tb/s and claimed reduced latency of 10-100 μ s with higher mobility [1]. At the same time, Artificial intelligence is seen to increasingly use in various field of network; however, owing to the dependency of massive data and computing resources towards maximizing the usage of AI, it still finds highly challenging to be implemented in 6G which is 100 times faster than 5G [2]. Developing an Artificial Intelligence in 6G network is still feasible if a proper case study with formulation of all the constraint is carried out in mathematical modelling [3]; however, this is very less to be seen in existing approaches. 6G claims of offering a ubiquitous connecting environment e.g., Internet-of-Things. Therefore, the proposed study considers a use case of Internet-of-Vehicles, where the assessment environment of proposed

Artificial intelligence in 6G networks becomes feasible. The next section further highlights existing literatures and its issues. 6G is still in its nascent state of development which suffers limitation of 100% coverage, terahertz communication, optimizing spectrum, and challenges in incorporating Artificial intelligence for making smart network. Therefore, considering Internet-of-Vehicle (IoV), which is preferred target of 6G network system, the proposed scheme introduces a novel computational model which is capable of establishing a seamless connection among the vehicles in IoV considering majority of the practical constraints of 6G. The proposed model also contributes towards incorporating Artificial Intelligence in order to build up a predictive communication model over 6G compliant vehicles. Further, the study also contributes towards optimizing the learning framework using cloud computing for facilitating sustaining connection among vehicles using 6G networks. This section further illustrates about study background, research problem and proposed solution as follows:

1.1 Background

It is to be noted that core aim as well as vision of 6G network is to facilitate ultra-dense network with reduced latency and faster rate of data transmission especially required in Internet-of-Vehicle (IoV). While facilitation of artificial intelligence further accelerates the process of finding optimal connection ensuring seamless connection. However, this is quite a challenging task. There are various forms of existing studies carried out most recently towards this target. The work carried out by Basset et al. [4] have used various computational intelligence in order to optimize the connection between the vehicle and sink. The model is also appended with cross-over operator in order to carry out better convergence over 6G network. However, the limitation of this model is it has an extensive set of learning operation involved which could lead to intermittent link even in 6G network. The study carried out by Chen et al. [5] have used deep learning in order to facilitate autonomous driving in IoV using 6G. The model has used Markov chain to carry out prediction of system states in order to retain safer distance between two vehicles. The limitation of this model is it used stochastic network calculus for distance control without considering connectivity with other vehicles much. Similar direction of work is also witnessed in literature of Ergen et al. [6] who has introduced a decentralized edge architecture for consistent distribution of computational capacity using computational resources of the vehicles. The limitation of this model is it is a theoretical framework that has not been benchmarked.

Work carried out by Jiao et al. [7] have developed an intelligence access technology over 6G where power factor is used along with expectation maximization algorithm for communication purpose. The limitation is that the model targets resource allocation without considering complete topological information of vehicular network. Lv et al. [8] have developed a framework that ensure vehicular connectivity in 6G network with complete channel characteristics in IoV. The study limitation is massively generated data of vehicles is not utilized in this regard and it depends on training data entirely. The work of Nawaz et al. [9] have developed a model for connecting large set of vehicles in IoV using 6G networks especially focusing on non-coherent communication. The model limitation is that its specific rate of data transmission in dense network is not explored, which could

render 6G unutilized. The work carried out by Shrestha et al. [10] have carried out discussion of using 6G services over unmanned vehicular network using multi-layer parameters. The limitation of this study is that it doesn't highlight any tentative solution towards dealing with massive data rates from such forms of vehicles. The work carried out by Tang et al. [11] have discussed about contribution of machine learning approaches over 6G network, which is impressively elaborated about its perspective from various IoV application. Existing study has also work towards streaming services using blockchain in IoV in 6G as presented by Wang et al. [12]. The limitation of the model is that adoption of blockchain has been carried out without dealing with impending issues of blockchain. The work carried out by Xu et al. [13] have discussed about service migration in 6G over IoV emphasizing over energy factor. The limitation is this model it offers trade-off between speed and reliability of data transmission even using 6G as the migration technique is highly iterative.

Further studies using artificial intelligence has been carried out by Yang et al. [14] where different approaches have been reviewed in the context of application in 6G communication system. According to this study, there are massive advancement in such smart implementation required and it is still under development. The limitation of this study is that it doesn't offer direct indication or guideline for future adoption of artificial intelligence in 6G. Qi et al. [15] has used a case study of internet-of-things and has used deep learning approach for facilitating better form of communication with a target to improve a energy. Although, the outcome exhibits better performance but still it suffers limitation of inducing higher computational complexities without any form of benchmarking. The work carried out by Mishra and Tripathi [16] have presented a unique business model of artificial intelligence and machine learning considering a use case of various heavy application which will be more-or-less dependent on speedy networks. The model has exhibited better innovation in business model of intelligence; however, its limitation is that it is not assessed from the data transmission perspective and it is more inclined towards analytics. Consideration of communication factors are very essential as without this, it is challenging to initiate any form of modelling practices. Study in this direction has been carried out by Mahmood et al. [17] where various key indicators has been investigated e.g., low-powered devices, global connectivity, essential dependencies, security, and privacy, etc. The limitation of this work is that it doesn't brief out any specific mechanism for optimization of resources using these communication drivers. This lets to an open research question that what could be further mechanism towards harnessing the power of artificial intelligence on using over application to be using 6G network. It should be noted that studies towards using artificial intelligence is just a beginning and it has a long way to go.

1.2 Research Problem

The significant research problems are as follows:

- Not much extensive usage of novel and cost-effective artificial intelligence (even in form of machine learning) approaches is witnessed in 6G based IoV environment.

- There are various existing works e.g. [18]-[27] towards IoV but such studies are found to not consider managing of massively generated data in IoV.
- Identification of optimal resources in existing IoV based on 6G network is still in infancy stage which are majorly theoretical and un-benchmarked with narrowed test environment.

Therefore, the problem statement of the proposed study can be stated as “*It is challenging to design a 6G-based IoV environment which can effectively manage the massively generated data for rendering suitability in advanced analytical operation in future.*”

1.3. Proposed Solution

In continuation of our prior work [28], the core agenda of the proposed study is to construct a baseline architecture towards IoV that is supportive of the communication facilitation via 6G networks. As the study model is designed considering deployment of application in future using 6G, it is eventually anticipated to introduce a large number of data traffic too. Therefore, a systematic design implementation is required in order to evolve up with such challenging solution that can cater up complete communication demands related to IoV. Hence, a layer-based architectural scheme is designed to address this challenge as showcased in Fig.1.

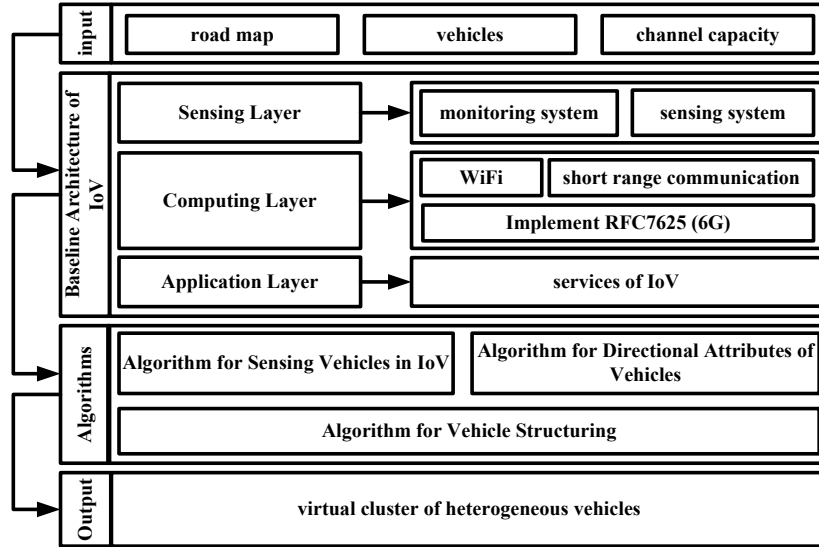


Fig.1 Schema of Methodology

A baseline architecture of IoV will be constructed considering sensing environment & control layer, computing layer, and application layer. The sensing layer will consist of model development of intelligent vehicle and driver mainly considering monitoring and sensing of vehicle as well as monitoring/control of information. The computing layer will

consist of deploying Wi-Fi, 6G using RFC7625, and also for short range communication. The application layer will consist of various services of IoV to be used for testing the proposed scheme. A simplified communication and network model will be constructed for IoV to initiate transmission of data along with constructing a matrix which retains all the features associated to transmission

Summarized Steps of Implementation: To develop a sensing layer which is capable of performing both environmental and control layer operation in IoV. The sensing layer will consist of implementing monitoring and sensing system for vehicles (both inbound and outbound). To develop a computing layer considering heterogeneous vehicular nodes over network and transport platform. To develop an extensive feature towards facilitating data analysis over cloud computing platform in IoV. To implement standard RFC7625 for deploying IoV architecture in its natural form. The outcome of final model will be anticipated to generate enough transactional data from its network model which can be subjected to predictive analysis in next objective implementation.

2 Method

The implementation of the proposed study is designed using analytical research methodology where the prime preference is offered towards introducing sensing and computing layer of proposed baseline architecture. The complete modelling is carried out using three different algorithms emphasizing towards sensing vehicle, analyzing direction of vehicle movement, and vehicle structuring. The study model also introduces an algorithm for sensing vehicles in IoV which is mainly used for initiating an effective monitoring and sensing system.

2.1 Algorithm for Sensing Vehicles in IoV

The algorithm takes the input of r_{map} (road map), g_{size} (grid size), cap (channel capacity), t_{veh} (total vehicles) that after processing yields an outcome of θ (sensed direction of vehicle). Following are the steps of algorithm:

Algorithm for Sensing Vehicles in IoV

Input: r_{map} (road map), g_{size} (grid size), cap (channel capacity), t_{veh} (total vehicles)

Output: θ (sensed direction of vehicle)

Start

1. $init\ g_{size},\ cap,\ Ptr$
1. $M(x,y) = f_1(r_{map})$
2. $N_{tr} \rightarrow f_2(Ptr * t_{veh})$
3. **For** $i = 1 : t_{veh}$
4. $idx \rightarrow f_3(x)$
5. $[x_c(i), y_c(i)] \leftarrow [x(idx), y(idx)]$
6. $\theta(i) \rightarrow f_4(b)$

7. **End**

End

The discussion of the algorithmic steps are as follows: After initializing the grid size (or deployment size), channel capacity cap , and total number of vehicles t_{veh} (Line-1), the algorithm implements a function $f_1(x)$ which is exclusively meant to read the colored map of the road r_{map} (Line-2). Complete image information of road map is obtained which is then stored in map matrix M with respect to each coordinate (x, y) of the road. The next part of algorithm implementation is towards computation of total number of transmitting vehicles N_{tr} using an explicit function $f_2(x)$ (Line-2). The empirical representation of this function is as follows:

$$f_2(x) = P_{tr} * \frac{t_{veh}}{100} \quad (1)$$

As per above expression (1), the function $f_2(x)$ takes the input variables for percentage of message propagation P_{tr} and total vehicle t_{veh} in order to compute the total number of transmitting vehicles. This mechanism is used for sensing the total number of vehicles in transmission zone of IoV environment (Line-2). For the next round of computation towards sensing layers, the algorithm considers all the vehicles t_{veh} (Line-3) followed by generating an arbitrary number of index idx using another explicit function $f_3(x)$ (Line-4). An empirical expression of this function is as follows:

$$f_3(x) = rand * length(x) \quad (2)$$

In the above expression (2), the variable x represents the x -coordinates of location of vehicle, which when subjected to function $f_3(x)$ yield a random index number idx that is used for tagging the sensed vehicles on lane system. Further, coordinates of the junctions (x_c, y_c) are obtained by accessing this random index idx from the matrix elements of x -coordinates of vehicle (Line-5). This assists in sensing all the incoming as well as outgoing vehicles from each lane as well as junctions system in IoV. In order to undertake more smart measures, the algorithm chooses to compute the direction θ for each vehicle (Line-6). For this purpose, a function $f_4(x)$ is designed that considers the input of a variable b that represents the matrix which stores all the coordinates of vehicles in junction. In order to discuss the operation of this function $f_4(x)$, the complete illustration is furnished towards the internal operation involved in the form of an algorithm.

2.2 Algorithm for Directional Attributes of Vehicles

According to this algorithm, the function $f_4(x)$ is designed to take the input of b matrix storing vehicle coordinates with respect to junction. The algorithm constructs an empty matrix for initialization of direction i.e., θ_{init} (Line-1); this is further followed up by constructing a logical condition to assess if the junction position of vehicles i.e., j_1 and j_2 doesn't matches and are found to be unique (Line-1), then the system allocates a different junction position j_2 for clearance (Line-3). However, owing to congestion or bottleneck condition, the sensing layer can also recommend the vehicle to switch on to different junction position (Line-7). Finally, the system performs the computation of direction θ by accessing initialized direction $\theta_{init \text{ matrix}}$ with respect to all the recently indexed idx elements. The steps are as follows:

Algorithm for Directional Attributes of Vehicles**Input:** b (vehicle coordinates with respect to junction), idx (arbitrary index of vehicle)**Output:** θ (direction of vehicle)**Start**

```

1. For  $\theta_{init}=[]$ 
2.   If  $b(j_1, j_2) == 1$ 
3.      $\theta_{init} = [\theta_{init}, j_2]$ 
4.   End
5.   Switch  $\theta$ 
6.     case  $j_1$ 
7.       direction to be avoided  $dav = j_3$  ( $j_1 | j_2 \neq j_3$ )
8.     End
9.   End
10.   $\theta = \theta_{init}(idx)$ 
11. End
End

```

2.3 Algorithm for Vehicle Structuring in Computing Layer

The next part of implementation is associated with structuring the vehicle in compliance with the computing layer of proposed baseline architecture. This layer of operation is responsible for offering a short range of communication using available network system which are mainly WiFi and 6G (RFC 7625). It should be noted that 6G doesn't bear a dedicated RFC for development; however, RFC 7625 relates to architecture development using IP/MPLS streams which are an essential part of implementation for vehicular network in IoV. The core idea of implementing baseline of this RFC is towards constructing a stratum network of vehicles that can be easily configured with the 6G services. For this purpose, the idea is to ensure that variables connecting the original road system deployed with various network and sensing devices should be able to sense and extract traffic related data over IP/MPLS stream and forward to some core network device or application layer in cloud. Hence, this algorithm is mainly towards developing a internal sensing and simplified computation over 6G services which are associated with syncing with vehicles and road system of an IoV. The benefit of this algorithm is towards its contribution of constructing a topology that facilitates seamless sensing of vehicles and exchange of message among the vehicles as well as vehicles to different other components present in IoV environment towards data propagation. The steps of algorithm are as follows:

Algorithm for Vehicle Structuring in Computing Layer**Input:** t_{veh} (total vehicle)**Output:** V_c (virtual cluster of heterogeneous vehicles)**Start**

```

1. For  $i=1:t_{veh}$ 
2.    $dz \rightarrow g_1(n_r, n_c)$ 
3.    $M_{lab} \rightarrow (j, g_r, g_c)$ 

```

```

4.   $V_{c(x,y)} \rightarrow g_2(br, bc)$ 
5.  For  $m=1:\text{length}(V_{c(x)})$ 
6.    For  $n=1:\text{length}(V_{c(y)})$ 
7.       $V_{c(x)}, V_{c(y)} = [\{V_{c(x)}, V_{c(y)}\} \{V_{cxs}, V_{cys}\}]$ 
8.    End
9.  End
10. End
End

```

According to this algorithm, all the total number of the vehicles t_{veh} is considered (Line-1) followed by assessment of the deployment zone dz using an explicit function $g_1(x)$ (Line-2). The computation of function $g_1(x)$ is carried out as follows:

$$g_1(x) = (g_r, g_c) \quad (3)$$

$$g_r = \frac{n_r}{g_{size}} \quad \& \quad g_c = \frac{n_c}{g_{size}}$$

From the above expression (3), it is now understood that computation of two new variables g_r and g_c is carried out by considering row and columnar elements (n_r, n_c) of actual roadmap points. The next operation is related to formation of a matrix label M_{lab} considering all vehicles j (or t_{veh}) along with inclusion of newly computed variables (g_r, g_c) from expression (3) as noted in Line-3. The next task is towards formation of a virtual cluster V_c with respect to position of vehicles (x, y) using an explicit function $g_2(x)$ (Line-4). The function generates the coordinates of virtual cluster V_c using (b_r, b_c) that represents the single hop link between position of vehicle in map area (n_r, n_c) and position of vehicle in grid area (g_r, g_c). This is one of the essential operations where the underlying operation of extracting the sensed information of vehicle is linked with the communication vector of network devices deployed in grid in order to sync the traffic information. Further, the algorithm considers complete information of a virtual cluster for all its considered location in map and further constructs a topology of virtual cluster (Line-5/6) that further organizes the complete number of vehicles running over the lane of the IoV (Line-7). All this information is required for structuring the vehicles with IoV system in order to perform a seamless sensing and monitoring over a short range of communication.

2.4 Algorithm for Generation of Traffic Data

The next work carried out towards the baseline architecture is associated with generation of traffic data. The algorithm takes the input of t_{veh} (total vehicles) that after processing yields a_{space} (available space). The steps of the algorithms are as follows:

Algorithm for generation of traffic data

Input: t_{veh} (total vehicles)

Output: a_{space} (available space)

Start

```

1. For  $i=1:t_{veh}$ 
2.   $m_p \rightarrow g_3(msg, e, n)$ 
3.   $d_m \leftarrow g_4(r_m, d, n)$ 
4.  If  $r_{cid} = c_{id}(r_{nid})$ 

```

```

5.   flag "node received msg"
6. End
7.    $a_{space} = cap - g_{mem}$ 
8.   For  $j=1:N_{cl}$ 
9.      $O_{flow} \rightarrow N_g - cap$ 
10.     $[v \ ix] \rightarrow \arg\max(a_{space})$ 
11.     $a_{space} = a_{space} - O_{flow}$ 
End

```

The novelty of this algorithm is that it offers an allocation of an encoded signal for all its IP/MPLS streams using an explicit function $g_3(x)$ giving an outcome of message pool m_p (Line-2). In order to perform encoding, the function $g_3(x)$ considers an input of message msg and two variables e and n which are extracted from simplified mathematical operations towards obtaining greatest common divisor for random number and $\Phi=(p-1)(q-1)$, where p and q represents two discrete prime numbers. Hence, after obtaining the input arguments, the function $g_3(x)$ performs decimal to binary operation in order to reduce the possible overhead of the message and generates an encoded traffic message m_p (Line-2). The next part of the process calls for deploying another $g_4(x)$ which is meant for performing decoding operation to generate decoded message d_m (Line-3). The input argument of function $g_4(x)$ is received message r_m obtained from message pool matrix m_p and two different variable d and n which are obtained using similar operation that has generated prior variables of e and n considering two prime numbers p and q . The next part of the operation calls for assessing the identity of receiver cluster r_{cid} and transmitter cluster c_{id} matches with respect to current cluster id r_{nid} (Line-4). In case of a match, the system generates the traffic message and is exchanged between two communicating nodes (Line-5). The next part of computation initiates with assessing available space a_{space} of a node to be allocated in one cluster obtained by subtracting group member node g_{mem} from capacity cap (Line-7). For all the number of clusters N_{cl} (Line-8), the scheme checks if the number of group member N_g is greater than the capacity cap . In positive case of this comparison, the system computed overflow O_{flow} by subtracting capacity cap from N_g (Line-9). This is further followed by obtaining the maximum possible space remaining in virtual cluster with higher available space denoted as v and its number as ix (Line-10). Finally, the algorithm also computes available space a_{space} on the basis of newly computed a_{space} and newly computed overflow O_{flow} (Line-11). Therefore, the accomplishment of this algorithm it can generate a traffic data by combining an interactive operation synced between sensing and computing layers.

3 Results and Analysis

The logic of the proposed study is scripted in MATLAB considering 600 Vehicular Nodes with 100x100 grid size and 15 Gbps channel capacity. The transmission range of the vehicular nodes are considered to be 120 meters while 1500 bytes of packets are

considered as size of data propagation. The vehicles are considered to be moving at 5-10 m/s velocity. The visual outcomes of simulation obtained are as follows:

Fig.2(a) and Fig.2(b) showcases the input of road map in MATLAB script followed by identification of sensed vehicles in sensing layer with respect to input of road map and sensed vehicle position in it respectively. Varied intersection points are also identified in this process along with position of various networking devices within IoV environment. The idea is towards using the proposed algorithm for an effective monitoring and control of the vehicular nodes in mobility conditions.



Fig. 2 Deployment of vehicular nodes in IoV environment in road map

Figure 3(a) showcases inter and intra cluster communication respectively where the complete sensing region is divided by various number of virtual clusters. All the node types are same within one cluster; however, they differ from another cluster, thereby forming a heterogeneous node management towards communication in IoV. A road side unit is located within every cluster where each communicating vehicles looking for information forwards the encoded message. The gateway node starts interacting with neighboring gateway node (Fig.3 (b)) in the process of syncing the source and destination node.

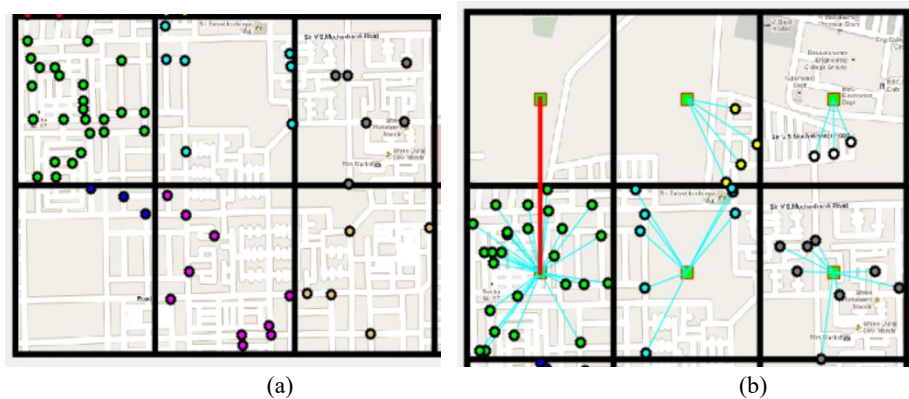


Fig. 3 Formation of Virtual Cluster for heterogeneous Node Sensing

For simplification, each gateway node exchanges a beacon after uniform interval of time which leads to reduce the process of searching for destination node by one gateway node. Further, the proposed system is assessed for investigating the impact on various channel capacity (= 5, 10, 15 Gbps) with respect to performance metric of delay and stabilized link as shown in Fig.4 and Fig.5. Adoption of delay parameter is considered as an effective 6G-based communication system in IoV is required to offer faster transmission rate while adoption of stabilized links is done towards evaluating the presence of reliable data transmission links among various vehicular nodes. Hence, delay and stabilized link are prominent performance parameters towards assessing the suitability of proposed baseline architecture of IoT.

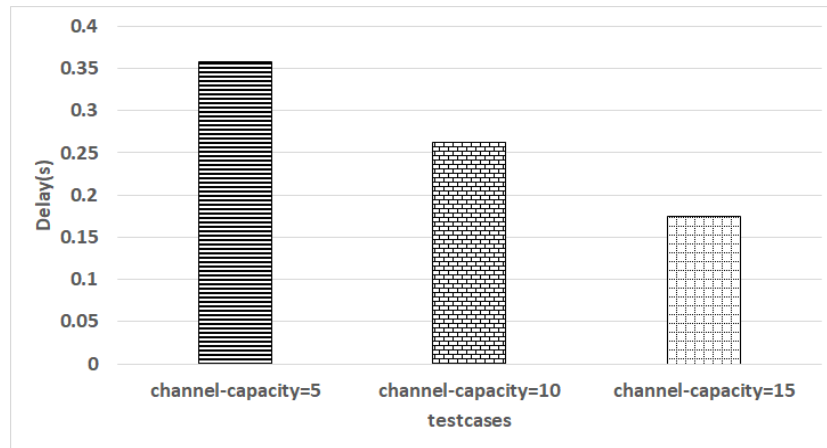


Fig. 4 Impact of variable channel capacity on delay

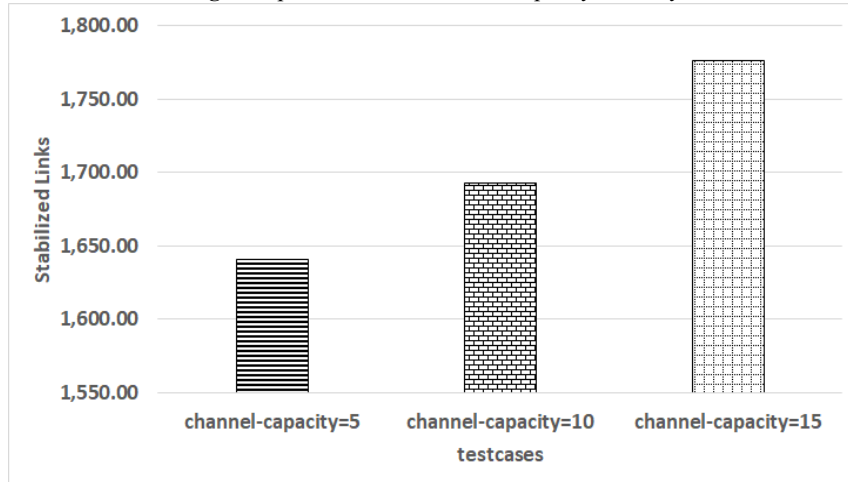


Fig. 5 Impact of variable channel capacity on Stabilized communication

Fig.4 showcase that proposed scheme offers delay reduction with the increase of channel capacity. However, an intermediate channel capacity (cap = 10Gbps) is sufficient for better delay control. Fig.5 showcase that proposed scheme offers higher number of stabilized communications for increased channel capacity. Stabilized communication is referred to as link associated between two communicating nodes with lower delay and optimal data transmission leading to lower resource consumption. The outcome states that proposed system is capable enough to perform seamless data transmission in highly organized form in an IoV environment. Hence, the architecture shows an effective capability towards managing dynamic and massive volumes of data transmission over 6G-based IoV environment.

4 Conclusion and Future Work

This paper has presented a discussion of a baseline architecture which is designed not only to generate a significant amount of traffic data in IoV but also towards an effective control of all the dynamic traffic information management as well. The contribution of the proposed study are as follows: i) The study model constructs a baseline architecture with more prominence towards sensing and computing layer in IoV, ii) The notion of implemented work is mainly to make an accountable sensing and monitoring system for vehicles when deployed in larger area of IoV simulation zone while 6G is deployed on it. iii) The study model uses short-range communication as well as standard RFC 7625 towards balancing the data transmission demand cost effectively over heterogeneous vehicular nodes, iv) the investigational study also assesses the proposed novel baseline architecture with real road map and numerically assessed with delay and stabilized links to find its suitability towards 6G implementation and advanced analytics. The outcomes have been assessed to prove its applicability on any practical traffic environment. The future work of the study will be towards developing an Artificial Intelligence model further to optimize the communication system in 6G-enabled IoV environment.

Declarations

Conflict of Interest: We wish to confirm that no known conflicts of interest are associated with this publication.

Ethical Approval: Not applicable

Authors Contribution: All the authors have contributed equally

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Availability of data and materials: Due to ethical concerns, supporting data cannot be made openly available

References

1. P. Porambage, G. Gür, D. P. M. Osorio, M. Liyanage, A. Gurtov and M. Ylianttila, "The Roadmap to 6G Security and Privacy," in *IEEE Open Journal of the Communications Society*, vol. 2, pp. 1094-1122, 2021, doi: 10.1109/OJCOMS.2021.3078081.
2. W. Hong et al., "The Role of Millimeter-Wave Technologies in 5G/6G Wireless Communications," in *IEEE Journal of Microwaves*, vol. 1, no. 1, pp. 101-122, Jan. 2021, doi: 10.1109/JMW.2020.3035541.
3. Y. Liu, X. Yuan, Z. Xiong, J. Kang, X. Wang and D. Niyato, "Federated learning for 6G communications: Challenges, methods, and future directions," in *China Communications*, vol. 17, no. 9, pp. 105-118, Sept. 2020, doi: 10.23919/JCC.2020.09.009.
4. M. Abdel-Basset, L. Abdel-Fatah, K. A. Eldrandaly and N. M. Abdel-Aziz, "Enhanced Computational Intelligence Algorithm for Coverage Optimization of 6G Non-Terrestrial Networks in 3D Space," in *IEEE Access*, vol. 9, pp. 70419-70429, 2021, doi: 10.1109/ACCESS.2021.3078585.
5. M. Abdel-Basset, L. Abdel-Fatah, K. A. Eldrandaly and N. M. Abdel-Aziz, "Enhanced Computational Intelligence Algorithm for Coverage Optimization of 6G Non-Terrestrial Networks in 3D Space," in *IEEE Access*, vol. 9, pp. 70419-70429, 2021, doi: 10.1109/ACCESS.2021.3078585.
6. M. Ergen et al., "Edge on Wheels With OMNIBUS Networking for 6G Technology," in *IEEE Access*, vol. 8, pp. 215928-215942, 2020, doi: 10.1109/ACCESS.2020.3038233.
7. J. Jiao, Y. He, S. Wu and Q. Zhang, "Intelligent Hybrid Nonorthogonal Multiple Access Relaying for Vehicular Networks in 6G," in *IEEE Internet of Things Journal*, vol. 8, no. 19, pp. 14773-14786, 1 Oct.1, 2021, doi: 10.1109/IIOT.2021.3071354.
8. Z. Lv, L. Qiao and I. You, "6G-Enabled Network in Box for Internet of Connected Vehicles," in *IEEE Transactions on Intelligent Transportation Systems*, vol. 22, no. 8, pp. 5275-5282, Aug. 2021, doi: 10.1109/TITS.2020.3034817.
9. S. J. Nawaz, S. K. Sharma, B. Mansoor, M. N. Patwary and N. M. Khan, "Non-Coherent and Backscatter Communications: Enabling Ultra-Massive Connectivity in 6G Wireless Networks," in *IEEE Access*, vol. 9, pp. 38144-38186, 2021, doi: 10.1109/ACCESS.2021.3061499.
10. R. Shrestha, R. Bajracharya and S. Kim, "6G Enabled Unmanned Aerial Vehicle Traffic Management: A Perspective," in *IEEE Access*, vol. 9, pp. 91119-91136, 2021, doi: 10.1109/ACCESS.2021.3092039.
11. F. Tang, Y. Kawamoto, N. Kato and J. Liu, "Future Intelligent and Secure Vehicular Network Toward 6G: Machine-Learning Approaches," in *Proceedings of the IEEE*, vol. 108, no. 2, pp. 292-307, Feb. 2020, doi: 10.1109/JPROC.2019.2954595.
12. Y. Wang, Y. Tian, X. Hei, L. Zhu and W. Ji, "A Novel IoV Block-Streaming Service Awareness and Trusted Verification Scheme in 6G," in *IEEE Transactions on Vehicular Technology*, vol. 70, no. 6, pp. 5197-5210, June 2021, doi: 10.1109/TVT.2021.3063783.
13. X. Xu, L. Yao, M. Bilal, S. Wan, F. Dai and K. -K. R. Choo, "Service migration across edge devices in 6G-enabled Internet of Vehicles networks," in *IEEE Internet of Things Journal*, doi: 10.1109/IIOT.2021.3089204.
14. Helin Yang, Arokiaswami Alphones, Zehui Xiong, Dusit Niyato, Jun Zhao, Kaishun Wu, "Artificial Intelligence-Enabled Intelligent 6G Networks", arXiv.org > cs > arXiv:1912.05744, 2019
15. Fei Qi, Wenjing Li, Peng Yu, Lei Feng & Fanqin Zhou, "Deep learning-based BackCom multiple beamforming for 6G UAV IoT networks", *EURASIP Journal on Wireless Communications and Networking*, Article number: 50, 2021
16. Shrutika Mishra & A. R. Tripathi, "AI business model: an integrative business approach", *Springer-Journal of Innovation and Entrepreneurship*, Article No.18, 2021
17. Nurul Huda Mahmood, Stefan Böcker, ...Pertti Seppänen, "Machine type communications: key drivers and enablers towards the 6G era", *Springer-EURASIP Journal on Wireless Communications and Networking*, Article No.134, 2021
18. W. Jiang, B. Han, M. A. Habibi and H. D. Schotten, "The Road Towards 6G: A Comprehensive Survey," in *IEEE Open Journal of the Communications Society*, vol. 2, pp. 334-366, 2021, doi: 10.1109/OJCOMS.2021.3057679.
19. H. Cheng, L. Bertizzolo, S. D'oro, J. Buczek, T. Melodia and E. S. Bentley, "Learning to Fly: A Distributed Deep Reinforcement Learning Framework for Software-Defined UAV Network Control," in *IEEE Open Journal of the Communications Society*, vol. 2, pp. 1486-1504, 2021, doi: 10.1109/OJCOMS.2021.3092690.

20. X. Yan, J. Zhang, H. Elahi, M. Jiang and H. Gao, "A Personalized Search Query Generating Method for Safety-Enhanced Vehicle-to-People Networks," in *IEEE Transactions on Vehicular Technology*, vol. 70, no. 6, pp. 5296-5307, June 2021, doi: 10.1109/TVT.2021.3075626.
21. H. Chang et al., "A Novel Nonstationary 6G UAV-to-Ground Wireless Channel Model With 3-D Arbitrary Trajectory Changes," in *IEEE Internet of Things Journal*, vol. 8, no. 12, pp. 9865-9877, 15 June 2021, doi: 10.1109/JIOT.2020.3018479.
22. A. Mahmoud, S. Muhaidat, P. C. Sofotasios, I. Abualhaol, O. A. Dobre and H. Yanikomeroglu, "Intelligent Reflecting Surfaces Assisted UAV Communications for IoT Networks: Performance Analysis," in *IEEE Transactions on Green Communications and Networking*, vol. 5, no. 3, pp. 1029-1040, Sept. 2021, doi: 10.1109/TGCN.2021.3068739.
23. S. Shen, C. Yu, K. Zhang and S. Ci, "Adaptive Artificial Intelligence for Resource-Constrained Connected Vehicles in Cybertwin-Driven 6G Network," in *IEEE Internet of Things Journal*, vol. 8, no. 22, pp. 16269-16278, 15 Nov. 2021, doi: 10.1109/JIOT.2021.3101231.
24. K. Lin, Y. Li, Q. Zhang and G. Fortino, "AI-Driven Collaborative Resource Allocation for Task Execution in 6G-Enabled Massive IoT," in *IEEE Internet of Things Journal*, vol. 8, no. 7, pp. 5264-5273, 1 April 2021, doi: 10.1109/JIOT.2021.3051031.
25. Z. Na, Y. Liu, J. Shi, C. Liu and Z. Gao, "UAV-Supported Clustered NOMA for 6G-Enabled Internet of Things: Trajectory Planning and Resource Allocation," in *IEEE Internet of Things Journal*, vol. 8, no. 20, pp. 15041-15048, 15 Oct. 2021, doi: 10.1109/JIOT.2020.3004432.
26. Z. Jia, M. Sheng, J. Li, D. Niyato and Z. Han, "LEO-Satellite-Assisted UAV: Joint Trajectory and Data Collection for Internet of Remote Things in 6G Aerial Access Networks," in *IEEE Internet of Things Journal*, vol. 8, no. 12, pp. 9814-9826, 15 June 2021, doi: 10.1109/JIOT.2020.3021255.
27. X. Zhang, J. Wang and H. V. Poor, "AoI-Driven Statistical Delay and Error-Rate Bounded QoS Provisioning for mURLLC Over UAV-Multimedia 6G Mobile Networks Using FBC," in *IEEE Journal on Selected Areas in Communications*, vol. 39, no. 11, pp. 3425-3443, Nov. 2021, doi: 10.1109/JSAC.2021.3088625.
28. M. Golla, V. K. Narasimhalah, and A. B. Puttappa, "Insights of 6G and artificial intelligence-based internet-of vehicle towards communication," *IAES Int. J. Artif. Intell. (IJ-AI)*, vol. 12, no. 4, pp. 1521-1533, 2023, Accessed: Nov. 29, 2023. DOI: <http://doi.org/10.11591/ijai.v12.i4.pp1521-1533>