Study of QoS Optimization Techniques in Internet of things-Driven Intelligent Transportation System

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***Abstract*—High mobility in ITS, particularly in V2V communication networks, provides for more coverage and faster assistanceto users and neighboring networks, but it also affects the overall system's performance owing to wireless channel fluctuations. Because of the high mobility of vehicles and heterogeneity of future IoT-based edge computing networks, obtaining better QoSduring multimedia transmission in V2V over future generation networks has become increasingly challenging. This paper makes the following contributions: provides a QoS-aware, green, sustain- able, reliable, and available (QGSRA) algorithm for V2V multimedia transmission across future IoT-driven edge computing networks, implements a novel QoS optimization strategy in V2V during multimedia transmission over IoT-based edge computing platforms, proposes QoS metrics such as greenness (i.e., energy efficiency), sustainability (i.e., less battery charge consumption), reliability (i.e., less packet loss ratio), and availability (i.e., more coverage) to analyze the performance of V2V networks. Ultimately, the proposed QGSRA method has been tested using large real-time vehicle datasets to show how it outperforms traditional techniques, making it a viable contender for multimedia transmission in V2V via self-adaptive edge computing systems.**

***Index Terms*—component, formatting, style, styling, insert**

I. Introduction

It is true that every sector from industry to healthcare has been fundamentally transformed. This can be owed tothe increasing importance of intelligent transportation systems which special reference to vehicle to vehicle communication. Though it has been observed that technological trends,on average, have made the lives of common citizens betterbut it is also evident that Quality of service (Qos) in terms of multimedia contents over smart phones etc, has been compromised due to high mobility of vehicles. In recent years the landscape of edge computing has been completely revolutionized, specifically multimedia streaming in V2V communication while optimizing the QoS in terms of greenness, sustainability, reliability, and availability. However, because ofthe dynamic nature of cars, there is increased RSSI loss and power dissipation, resulting in a shorter battery lifetime for IoT-based ITS, degrading the overall transportation system's quality from both the network and user viewpoints. In thecase of In-motion vehicular multimedia communication the key areas are video gaming, video reporting, mapping images for vehicular guidance and QoS/quality of experience (QoE) optimization. Furthermore, to provide an effective and equitable allocation of resources inside vehicular networks, edge computing technologies must be integrated to make users and drivers' lives easier.

II. Key research objective and contributions

The main objective of this paper is threefold and can be summarized as follows:

A quality of service (QoS) aware Green, Sustainable, Reliable, and Available (QGSRA) algorithm is presented. Which aids to support multimedia transmission ITSs over future generation networks such as edge computing. A QoS optimization scheme in V2V multimedia transmission over edge computing is also proposed Tuning performance criteria (i.e., greenness, sustainability, dependability, and availability) to expand network coverage and capacity in both urban and rural locations can improve network performance in terms of QoS. For the examination of the performance of vehicle to vehicle networks, a variety of quality of service criteria have been introduced.

III. QoS-Aware Green, Sustainable, Reliable, and Available Algorithm

Many challenges prevail when it comes to multimedia V2V communication over heterogeneous networks, the ones listed below are fundamental:

Development of QGSRA algorithm taking into consideration the dynamic nature of vehicles and the nature of emerging technologies. It is also deemed significantly important to propose better insight in the case of emergency/event-triggered cases during communication at remote areas. Consider the high mobility of vehicles (i.e., fluctuation in wireless channel) and heterogeneity, as well as the resource constrained (i.e., high power and battery charge drains, high packet loss ratio, and less coverage) nature of vehicular networks when optimizing QoS in V2V during multimedia communication over an edge computing platform.

In figure 1, a unique IoT-driven edge computing framework is proposed. This framework has 3 key layers and proves to be suitable for V2V multimedia communication.The functionality is explained as follows:

1. Cloud node in layer 1: Responsiblefor handling and monitoring the services and tasks performed

by the cloud.

2. Edge node in layer 2: Has several MEC (mobile edge computing) platforms, can manage and deliver the services from the cloud node to the edge of the network to assist users.
3. End node in layer 3 : This is mostly related to the users/networks to get their requirements in order to fulfill them To support the importance of QoS optimization, the QGSRA has been presented to reach a green, sustainable, reliable, and available V2V multimedia communication platform.

Further, the structure of the QGSRA algorithm has been explained in the figure 2 a. QGSRA algorithm has the following three main blocks: resource allocation, QoS optimization, and adaptation and tuning of parameters. Resource Allocation block: In an IoT driven edge computing system, the traditional methods are not efficient and are unable to meet the requirements imposed by V2V communication in this case. In this block, resources are allocated effectively. QoS optimization block: This block is further based on four layers: application, network, medium access control (MAC), and physical (PHY). Adaptation and tuning of parameters: This block tunes and adapts the parameters according to the particular requirementsof the vehicles during the quality of service optimization

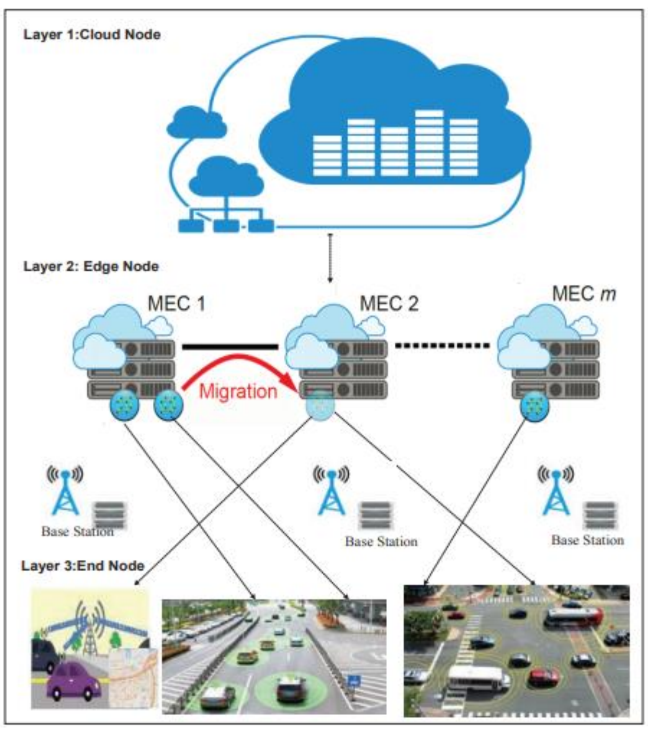


Figure 1. Framework of an intelligent transportation system.

Figure 2 b. displays the proposed QGRSA algorithm's pseudocode, which consists of two fundamental steps: The first step optimizes the power drain and battery lifetime in IoT-based ITS by computing energy and duty cycle at the PHY and MAC layers, respectively. The second step minimizes RSSI and packet loss to compute dependability and coverage at the network and application layers.

IV. Important results and findings

In this experiment a MATLAB based convex-optimization tool was used which supported a speed in the range of [60,120] kmph. In a V2V communication scenario, the RSSI valueof the wireless connection is employed as a crucial metricto offer clear insight into the performance of the ITS foreach transceiver. For a smart city setting using IoT-based ITS,the suggested QGSRA algorithm is compared to traditional approaches. To address vehicular coverage and computational needs in urban areas, reference techniques employed mixed integer linear programming to optimize the heuristic problem of implementation and cost of edge devices.

Figure 3 presents the relation between QoS optimization and vehicular nodes with high mobility. Explanation of the four figures is given as follows:

1. For the proposed QGSRA system and conventional approaches, the relationship between increasing the number of cars and the battery lifespan is shown in this graph. It is evident that the performance ofthe former is exceedingly better than the earlier approaches.
2. Demonstrates that the obtained energy-saving performance can be accomplished without degrading packet reception rate.
3. Exploits a linear trade-off between vehicle mobility and ITS performance; nevertheless, the proposed QGSRA improves on the prior competing methods' QoS optimization.
4. This figure demonstrates the tradeoff between vehicular nodes num- bers and the coverage ratio thereby confirming the proposed QGRSA algorithm promises wider coverage in comparison to the traditional approaches.

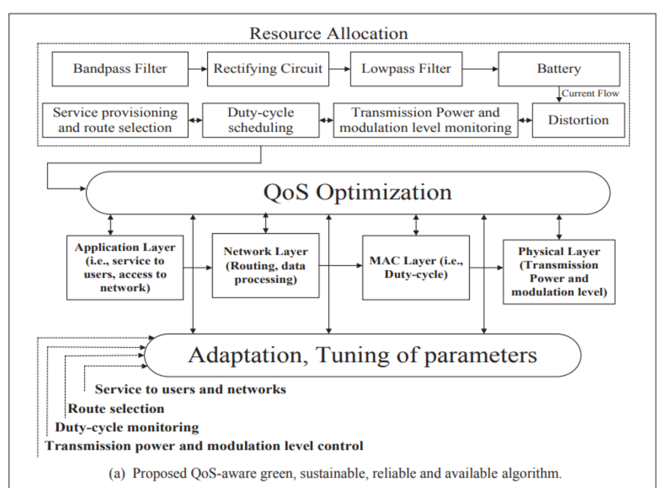


Figure 2a: Proposed QoS-aware green, sustainable, reliable and available algorithm

V. CHALLENGES AND PROPOSED SOLUTIONS FOR IOT-DRIVEN V2V COMMUNICATION

Some challenges are highlighted in this section, and few solutions are proposed to overcome them.

Initialization:
Define: $TP, Dc, RSSI_{th}, d, b, LT, HT, R_s, W, \sigma, TP_{max}$
Set: $QoS_{i,j}(t) \quad \min_{\{Dc,TP,RSSI\}} \quad f(d, Dc, TP, RSSI_{th}), \ \forall i \in b, \text{ and } j \in TP$

Event on $QoS(t)$ **do**
  for $i \leftarrow 1$ to b based on Table 1 **do**
    for $j \leftarrow 1$ to TP based on Table 1 **do**
      Compute $E_{total}(t) \leftarrow (E_{stat} + E_{mov} + E_{trans} = P_{stat} \times T_{stat} + P_{mov} \times T_{mov} + P_{trans} \times T_{trans})$
    end
  end
  if $(TP <= TP_{max} <= \sigma) \&\& (10m <= d <= 300m)$ based on Tables 1 and 2, then
    Compute $D_C \leftarrow \left(\frac{T_{mov}}{T_{total}} = \frac{\frac{W}{R_s \cdot b}}{T_{total}} = \frac{W}{R_s \cdot b \cdot T_{total}}\right)$
  elseif $(LT <= RSSI_{th}(d) <= HT)$ based on Table 1 then
    update $TP \leftarrow TP \pm \sigma$
  else update $RSSI_{th} \leftarrow RSSI \pm b$
  end
end

Figure 2b: Pseudocode of the proposed QGSRA algorithm

A. HIGH MOBILITY OF VEHICLES AND DATA RATE COMPATIBILITY

Vehicles' high speed and mobility allow them to respond quickly to critical/emergency situations, but they also use more power and battery charge, resulting in performance deterioration during multimedia V2V communication via IoT-driven edge computing networks. Solution: To design a specific QoS architecture over the edge computing platform, a combined power and bandwidth management method should be established, taking into account the dynamic nature of vehicular multimedia networks.

B. HETEROGENEITY AND INTEROPERABILITY

Future network technologies will create self-adaptive environments due to a lack of appropriate answers to interoperability and dynamicity challenges. There are more opportunitiesto deplete batteries and reduced reliability and coverage for automobiles in rural locations during multimedia communication due to the large volume of data, rapid movement, and different data/transmission speeds. This poses a great problemto the deployment of IoT. Proposed solution: For overcoming this problem we need a specific standard of the ITS to support vehicle to vehicle multimedia communications. It is critical to incorporate QoS optimization approaches as well as hybrid green, sustainable, and dependable techniques due to the significant role and compatibility of edge computing with vehicular networks.

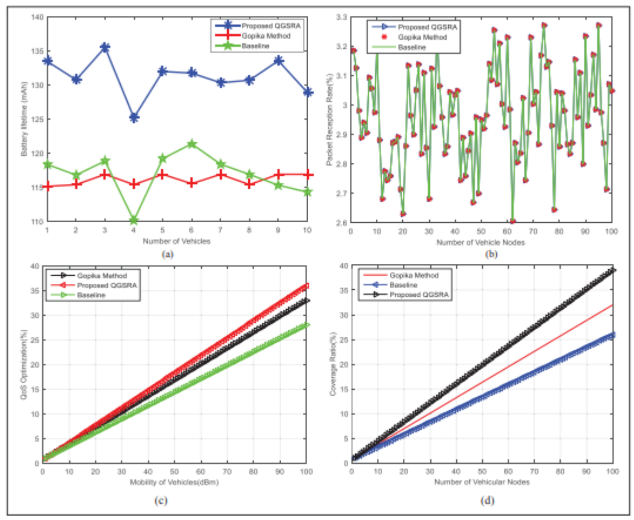
C. RESOURCE CONSTRAINED IOT-BASED ITS

One of the most difficult difficulties in IoT-based ITS platforms is effectively managing and monitoring the vast amounts of data generated by sensors, cameras, and the global positioning system (GPS). Furthermore, for emergency V2V communication, smooth and stable conveyance is critical. This entire procedure will have a direct impact on ITS QoS. Proposed solution: A joint transmission power and energy harvesting technique for QoS optimization in vehicular multimedia communication must be developed to overcome this difficulty.

D. LIMITED SPECTRUM AND HIGH CONGESTION

E.

A vast volume of data must be monitored and handled due to the fast growth of IoT-driven edge computing devices. Furthermore, owing to the restricted spectrum of edge-computing-based IoT devices, expanding the network to prevent congestion is difficult. As a result, smart spectrum management is one viable method for resolving this problem. In recent years, two well-known spectrum allocation strategies for edge computing networks, full duplex (FD) and cognitive radio (CR), have been suggested [13]. The main impact of such intelligent approaches on resource sharing in V2V networks is that they enable autonomous power and bandwidth allocation for a long-term and dependable platform.
Proposed solution: To improve network performance, it's critical to keep the RSSI stable and regulate mobility in high-speed vehicle networks.



F. *Figure 3: QoS optimization in V2V increasing the number of vehicles: a) battery lifetime, b) packet reception rate, c) QoS optimization, d) coverage*

VI. DISCUSSION THROUGH OTHER PAPERS

The research on edge computing is currently in a relatively early stage, and many challenges are yet to be solved [1]. In edge computing, different use cases utilize different architectures for the optimal support of end-users. Accordingly, one of the challenges for IoT systems based on edge computing is where to deploy the application components to achieve the desired system qualities. A number of studies have investigated and compared various deployment alternatives. It is concluded that edge computing reduces energy consumption, latency, and cost.

Further we know that cloud computing is a critical component of the Internet of Things, since it expands applications that generate large quantities of data and improves efficiency. To reduce the amount of load on the network, computations can also be done at the fog or edge. Researchers in [7] suggested a set of QoS measures that would allow customers to compare service providers (whether cloud, edge, or fog) using these quality indicators.

1. Scalability: It is defined in computing applications as the ability to produce maximum throughput in the shortest amount of time.
2. Dynamic Availability: It is a quality characteristic that indicates whether or not a system is available for use when it is needed under typical operating conditions.
3. Reliability: The better the reliability, the longer the programme operates smoothly over the rented cloud. End-users will prefer just those service providers who deliver the best QoS at the lowest cost.
4. Pricing: Only those service providers will be preferred by end-users who give best QoS with minimum cost
5. Response Time: The response time is the time it takes for a service to react to a request.
6. Capacity: Capacity is the amount of computer resources offered by the computing service provider that can be processed and evaluated by the computing programme.
7. Security and Privacy: For assessing the trustworthiness of computing services, certain security measures such as crypto algorithms and key management, physical security support, network security support, and data support are taken into account.
8. Customer Support Facility: It covers the type of facility, the response time, and the cost of delivering it to the users. Computing services with a dependable support system are often favoured.
9. User Feedback and Reviews: The availability, dependability, stability, transparency, and pricing of the services are described by the users' experience. The better the customer's experience, the higher the value of the service rating.

In a variety of fields, IoT networks provide a lot of promise for better cloud applications. The development made in the field of communication protocols for the lower network levels, notably physical, link, and network, has substantially aided data gathering by a wide variety of various sorts of devices during the last decade [8]. Furthermore, application layer protocols, which are commonly referred to as messaging protocols in the context of IoT, have a significant impact on data collection and exchange. In IoT systems, there are two types of messaging approaches with different levels of QoS provisioning: request/response protocols, which provide high reliability at the cost of increased latency, and broker-based publish/subscribe approaches, which are more promising for meeting latency requirements.

Nonetheless, given the huge variety and heterogeneous nature of IoT applications that cover a broad range of needs required by both data types and the settings in which these systems are implemented, several important issues are raised. Concerns concerning the 3Vs (volume, variety, and velocity) of IoT data being transferred are the most common. There are still certain limits to QoS support in common protocols.

QoS aids in the management of a system's capabilities and resources in order to deliver IoT services. It helps service providers to give users with clear visibility into their services, as well as their performance and usability.

With the growing demand for media technologies and a high degree of user satisfaction, it's critical to handle QoS and QoE requirements from both a system and end-user standpoint. The multimedia materials are classified as key performance indicators for QoS study by researchers in [2]. For evaluating the trade-off between user perception and QoS entities, a basic and efficient quality of experience analysis technique is devised [3-4]. Furthermore, they addressed the fact that standard network performance measures such as latency, jitter, and throughput do not adequately reflect the complete user perception level. However, the required aim can be accomplished by combining QoE and QoS parameters. In a similar vein, researchers in [5] suggest an energy-saving and QoS-evaluation system for healthcare and traditional wireless networks. They said that network performance may be assessed by accurately forecasting key elements such as throughput, latency, and jitter.

VII. FUTURE WORK

In the future the authors will create a wireless channel mobility management model in V2V in the near future to manage smart cities for mobile healthcare applications by monitoring user/network satisfaction in terms of QoE/QoS.

VIII. CONCLUSION

In conclusion, we discussed a QoS optimization framework, the innovative QGSRA algorithm, and a use case for pervasive healthcare in V2V over IoT-driven edge computing systems during multimedia transmission, that was proposed by the authors of the base paper. Because vehicles are more dynamic and share resources, it is critical to manage and monitor QoS from both a network and user standpoint. Clear, bright, and high-resolution images of individuals and networks are required in the considered use case of QoS optimizationfor pervasive healthcare. The proposed QGSRA algorithm is being explored as a candidate for multimedia communication in a V2V over edge computing platform in this regard. Furthermore, the proposed scheme was evaluated using real-time datasets, and its performance was compared to that of traditional competing approaches in terms of performance metrics like greenness, sustainability, dependability, and avail-ability. The collected findings show that the QGRSA techniqueis a viable candidate for improving QoS in V2V over edge computing networks during multimedia transmission.

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