HIGHLY SCALABLE AND EFFICIENT SCHEDULER FOR VSN BASED ON DIFFSERV GUARANTEES

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ABSTRACT *–Current WSN applications generate different types of traffic with various requirements such as delay-bounded, bandwidth and reliable data delivery. IEEE 802.15.4 is widely used as standard, for wireless sensor networks (WSNs).However, the behavior of CSMA/CA at heavy load reduces the throughput and energy consumption performances which require proposing MAC layer solutions for better efficiency. Quality-of-Service (QoS)-based mechanisms can improve efficiently the traffic delivery in wireless and mobile networks. Service scheduling and differentiation allow providing QoS support to the prioritized and categorized communication beside differentiates the traffic carried over the network based on certain criteria and forms several traffic classes in WSNs. This paper introduces new differentiated service approaches and tasks accomplished by scheduling disciplines and highlights the impact of these techniques on the QoS support in vehicular sensor networks.*

Index Terms—VSNs, QoS, differentiation, scheduling.

1. INTRODUCTION

Service differentiation is the most known and used model for Qos provisioning in all kind of wired and wireless networks. It forms several service classes and uses certain criteria to differentiate the services carried over the network. The MAC sub-layer processes differently each of these service classes by managing the resource sharing and tries to satisfy their requirements [1]. Thereby, service differentiation consists of two phases: (i) priority assignment, and (ii) differentiation between priority levels [2].

Queue scheduling disciplines are the vital instrument to accomplish QoS in packet networks as they directly controls packet delays, throughput and bandwidth utilization rate. Their primary goal is to process different service classes or flows of packets with different levels of priority in order to provide performance guarantees according to their requirements [3]. The higher priority service achieves relatively better performance since it is always served first [2].

A specific problem that arises as a result of the collected traffic diversity is how to differentiate and process them in a suitable way to their requirements. The traffic diversity, caused by the multidisciplinary supported application, is controlled by the roadside unit (or base station), so it introduces new requested capabilities. This creates a new set of challenges that need to be resolved by integrating new mechanisms able to (a) classify packets according to their types of service and (b) schedule them appropriately to their requirements.

The most implemented vehicular architecture incorporates roadside gateways used for proper data propagation and message relay boxes for collection, classification and scheduling messages. However, introducing QoS in VSNs is challenging, considering the high mobility of the VSN nodes which requires vehicle to vehicle (V2V) and vehicle to gateway (V2G) communication models in addition to differentiation and scheduling-based protocols [4].

Similar to the Distributed Coordination Function (DCF) defined in the IEEE 802.11, IEEE 802.15.4 defines a contention-based channel access mechanism called unslotted CSMA/CA channel access protocol. This protocol enables contending wireless sensors to access the shared channel without providing service differentiation at the MAC layer. This lack of providing service differentiation has hindered the development of service differentiation model for rate-sensitive applications. [5]

In this paper, we propose a suitable classifier/scheduler at the medium access control (MAC) layer to support different traffic with diverse QoS requirements in a dynamic environment. Therefore, a priority or weighted function is requested for each traffic admitted in the system and updated dynamically depending on the wireless channel quality, QoS satisfaction, and service classes. The proposed differentiation and scheduling model should provide the prescribed QoS guarantees, utilizes the wireless bandwidth efficiently and leads to low implementation complexity, flexibility, and scalability.

The rest of the paper is organized as follow: Section 2 introduces differentiation and scheduling for QoS support in VSNs. Section 3 provides a background and related work in vehicular sensor networks. Section 4 presents the proposed VSN architecture and communication models employed in this work. Section 5 evaluates the simulation results conducted with OPNET. Finally, section 6 concludes the paper.

2. BACKGROUND

Recently, there is a strong interest from researcher's in deploying WSNs in VSNs in many applications that involve constraints related to the traffic conditions and high mobility. Some research focus to enhance Quality of Service (QoS) in a vehicular sensor environment by integrating traffic differentiation and scheduling mechanisms in order to reduce the end-to-end delay, improve the throughput, enhance the bandwidth utilization rate and perform fast processing and delivery for urgent data traffic.

Diff-MAC is a QoS aware MAC protocol based on CSMA/CA access method to support hybrid prioritization and differentiated services. Diff-MAC integrates an effective service differentiation algorithm in order to increase the channel utilization and provide fair and fast data delivery. Diff-MAC is needed in WSN supporting QoS-constrained heterogeneous traffic such as multimedia applications. To provide QoS, Diff-MAC consists of (1) reducing the retransmission using fragmentation of the long frames into small manageable packets and transmitting them in form of burst, (2) decreasing collisions and minimizing the packet latencies by adjusting its contention window size as per traffic requirements and (3) providing fair and reliable data delivery among sensor nodes based on intra-queue prioritization feature [2].

[8] Proposed a service differentiation algorithm with slight modification on the protocol to enhance the achievement of slotted CSMA/CA for time-critical events. The service differentiation algorithms were particularly based on various parameters such as the macHinE, aMaxBE and the Contention Window (CW). They differently process the command and data frames since they are affected by high and low priority levels (service class), respectively. In other terms, different attributes have been defined and assigned for different service classes. This algorithm keeps slotted CSMA/CA in its original form and focuses on tuning related parameters effectively in keeping the criticality of messages. Some existing works [9,10,11] are interested in controlling over CW depending on the changes in the network status. In [9], the Sensing Back off Algorithm (SBA) has been addressed to maximize channel throughput with impartial access to shared channel. When packet collision occurs, it multiplies its back off interval by α while on a successful transmission, both sending and receiving wireless sensors multiply their back off interval by θ, and the others overhearing (sensing) a successful transmission decreases their back off intervals by β. α, θ and β are defined in [9]. However, on the basis of p-persistent CSMA/CA protocol, [10,11] addresses dynamic IEEE 802.11 wireless networks. Their approaches assume having a precise number of the active wireless sensors, to estimate the network state, while they do not consider QoS for real-time traffics.

Node-based scheduling and level based scheduling, proposed in [12], are two centralized heuristic scheduling algorithms. The first algorithm is inspired from the classical multi-hop scheduling using direct scheduling of the nodes given in an ad hoc mode. The second algorithm uses a routing tree to schedule the levels before scheduling the nodes. This algorithm is more suitable for wireless sensor networks since it supports many-to-one communication model. A node distribution across levels affects the performance of these algorithms.

In [13], the authors proposed at the MAC level a scheduling algorithm that is able to support assorted connections with different QoS necessities. At the physical (PHY) layer, each connection utilize an adaptive modulation and coding (AMC) scheme over wireless fading channels. The scheduling algorithm assigns a certain priority level based on the QoS requirements of each connection. Then, it adjusts dynamically the priority level according to the channel and service status.

In [14], the authors proposed scheduling algorithms that are able to guarantee better processing and delivery especially for data packets. These algorithms are namely the weighted hop scheduling algorithm with Dynamic Source Routing (DSR) and the weighted distance scheduling algorithm with Greedy Perimeter Stateless Routing (GPSR) where the scheduler lies above the MAC layer and between the routing agents. In this context, these algorithms affect the data packets with a higher weight in order to reduce the number of hops (or geographic distances) towards their destinations and optimize significantly the average delay without any additional control packet exchange. They demonstrate that the average delay reduces as the movement of nodes rises. The conventional scheduling is considered which is typically used in mobile ad hoc networks.

3. Proposed VSN Architecture and Communication Model

Current WSN applications generate different types of traffic with various requirements such as delay-bounded, bandwidth and reliable data delivery. Consequently, Quality of- Service (QoS)-based mechanisms can improve efficiently the traffic delivery in WSNs. This work introduces new differentiated service approaches and tasks accomplished by scheduling disciplines and highlighting the impact of these techniques on the QoS support in mobile sensor networks.

3.1. VSN Architecture

Vehicular sensor networks (VSNs) is a technology where sensors are deployed in the road side and in the vehicles to sense various urban phenomenon's and transmit information for vehicular traffic control and monitoring. VSNs have different characteristic from traditional sensor network in terms of computational, power supply, memory storage and reliability. Moreover, vehicular sensor network has a much more dynamic topology since the vehicle sensors are moving in a random fashion where the communication links can often become unreliable. This dynamic nature of VSN affects several characteristic properties, such as routing, MAC level protocols and physical hardware [15].

The roads are divided into S virtual segments with the different length. On each road segment, there are two road side units located at the both ends of the segment, as shown in figure 1.Theroad side unit (or sink node) is responsible to gather data from all sensor nodes in its segment, aggregate them based on differentiation and scheduling mechanisms, and send the result to the coordinator (or control room).

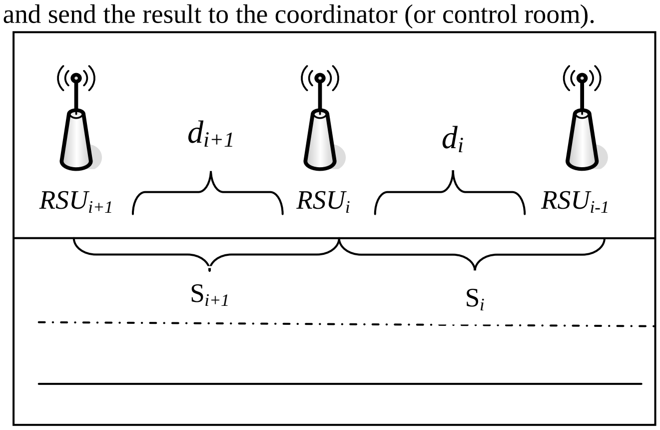


Figure 1. Road segmentation.

3.2. Communication Models

There are three types of communicating nodes in the proposed vehicular architecture: Sensor nodes, routers (or road side unit (RSU)) and coordinator.

- Sensor nodes: are mobile end-devices collecting events from their environments and transmitting them when passing closer to the routers (RSUs). A vehicular-to-infrastructure (V2I) communication model is to be established for data exchange between the sensor node (vehicle) and infrastructure (RSU).
- Routers: are considered as road side unit fixed at the border of the roads and responsible to route the data sent

by the sensor nodes. These routers are connected together via an infrastructure-to-infrastructure (I2I) communication model [15].

- Coordinator: is the master device (or control room) responsible of governing the whole network.

In this work, we consider one way straight highway with length L. We assume that corners, turns, merging or exits are not considered in our proposed highway model. But, the proposed system can be used in any type of road model. We assume that each vehicle is equipped with a sensor device responsible for detecting environmental events and communicating them to the nearest RSU. Vehicles are moving in a constant speed within a road segment delimited by two RSUs (or routers) placed at the segment borders. After propagating the distances d_1, d_2 and d_3, the vehicles may wait for a constant time period due to the road signals. Multiple scenarios have been proposed for performance evaluation, including several events, vehicle densities and various types of traffic [16].

4. PROPOSED DIFFERENTIATION AND SCHEDULING MECHANISM

The main Goals of this paper consist of supporting Quality of Service (QoS) in a vehicular sensor environment by integrating traffic differentiation and scheduling mechanisms. These latter allow to reduce the end-to-end delay, improve the throughput, enhance the bandwidth utilization rate and perform fast processing and delivery for urgent data traffic. Grade of service is one of crucial part of QoS in mobile communications which involves outage probability and blocking probability and scheduling starvation. Various mechanisms such as mobility management, fair scheduling, radio resource management, channel-dependent scheduling etc. are affected to measure the above said performance measures. The proposed solution includes the use of specific roadside gateways used for proper data propagation and message relay boxes for collection, classification and scheduling messages. Moreover, the inclusion of Quality-of-Service (QoS) in VSNs is challenging, considering the high mobility of the VSN nodes.

In this research work, a suitable scheduling scheme among various scheduler schemes is selected at the medium access control (MAC) layer for multiple connections with diverse QoS requirements. Therefore, a priority or weighted function is requested for each connection admitted in the system and updated dynamically depending on the wireless channel quality, QoS satisfaction, and service priority across layers. The proposed scheduling model should provide the prescribed QoS guarantees and utilizes the wireless bandwidth efficiently while enjoying low implementation complexity, flexibility, and scalability.

4.1. Differentiation in VSN

The first step for supporting quality of service in vehicular sensor networks consists of including differentiation mechanism in the MAC layer, since several types of events with different significance and severity may happen in the roads. Moreover, other non-related road traffic is to be supported by the sensor network such as pollution control, urban application etc.

The differentiation mechanism will not retransmit packets as they arrive but it allows:

- Collecting and classifying data from cars and other neighbor platforms,
- Marking and storing data in different queues characterized with different priority levels.

4.2. Scheduling in VSN

As a second step, the goal is to process different traffic classes or flows of packets with a variable level of priority in order to provide performance guarantees for a range of traffic types. Queue scheduling in packet networks is an important mechanism to achieve Quality-of-Service (QoS) as it directly controls packet delays, throughput and bandwidth utilization rate. In addition, VSN is considered as a limited resource network (computation, storage and bandwidth) which require adoptive algorithms to provide a differentiated band width fairness and delay among queues on each Road Side Unit (RSU) [3,17].

Scheduling algorithms serve as an imperative segment in any communication network to fulfill the QoS requirements. The design is especially challenged by the limited capacity and dynamic channel status that are inherent in wireless communication systems. Our main objectives are:

- Efficient Bandwidth utilization: Efficient data transfer capacity is the most important in the architecture design. The algorithm must use the channel productively.
- QoS Requirements: Our architecture should support different applications to exploit better QoS to support delay-sensitive applications. The long-term throughput should be guaranteed for all connections when the sufficient bandwidth is provided.
- Fairness: The scheduling architecture should allocate available resource fairly across connections. The fairness should be provided for both short term and long term.
- Scalability: The scheduling architecture should operate efficiently as the number of connections or users sharing the channel increases.
- Delay Guarantee: It will provide delay guarantees for UGS and rtPS flows. And it also decreases the packet loss rate [18].

4.3. Differentiation and Scheduling Module

There are many different queue-scheduling disciplines, each attempting to find the correct balance between complexity, control, and fairness. [21,22] describe a number of popular queue scheduling disciplines: first-in-first-out queuing (FIFO), priority queuing (PQ), fair queuing (FQ), weighted fair queuing (WFQ), weighted round-robin queuing (WRR) and deficit weighted round robin queuing (DWRR).

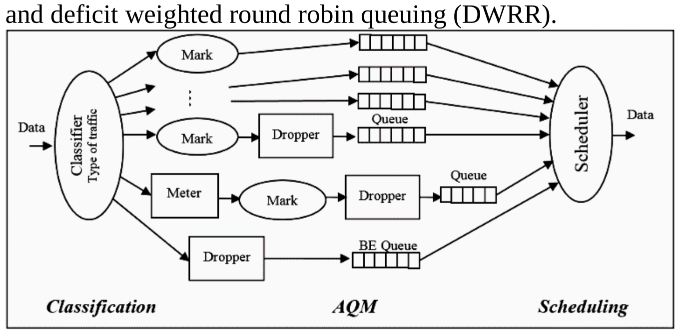


Figure 2. Differentiation and scheduling structure module.

With Weighted Round Robin (WRR), packets from different flows are queued in separate queues and the scheduler polls each queue in a cyclic manner in proportion to a weight pre-assigned to each queue (Fig.2). The Deficit Round Robin (DRR) scheduler handles variable packet sizes without knowing the mean packet size of each flow in advance [19]. DRR provides near-perfect throughput fairness and flow isolation at low implementation cost. The DWRR scheduler provides unfair bandwidth allocation where different queues are allocated a different quantum value using a proportionally weighted function [20].

In the vehicular sensor network, we proposed implementing in the RSU a differentiation and scheduling module for QoS support (Fig.2). This module includes various processes organized according to the type of traffic received from several types of sensors. These processes consist of classifying packets into a small number of aggregated flows or classes that provide different levels of service for different classes. Our differentiation model achieves packet classification, traffic shaping, and traffic policing and queuing (Fig.2). It needs queuing technology like priority queuing (PQ) and WFQ, which buffers and dispatches congested packets to accomplish queue management. A packet dropping module similar to WRED (weighted random early detection) is being used for certain type of traffic.

Table 1. Application Traffic Parameters.

Parameter	Emergency	Audio	Best Effort	Non Real Time	Video
Packet Size (bit)	512	512	1024	1500	2500
Traffic gen Model	uniform	uniform	uniform	Poisson	Poisson
Start Time	uniform	Uniform	exponent	Poisson	Poisson
Stop Time	Infinity				
Destination	All Routers				

Each vehicle in the system is equipped with a vehicle sensor system to provide vehicle's information request to the RSU. For real time scenario, we cannot bind a single vehicle to use or stick with single application as shown in Figure 3. So in real time scenario, vehicles are allowed to use multiple applications at particular moment. All the traffic received from the vehicles will be classified according to the application requests. All the requests are maintained in separate stack/buffer for service differentiation purposes. The traffic has been differentiated into 5 Data Types such as Audio, Video, Emergency, Best effort and Non-Real Time. For thorough testing the proposed scheme has been applied on packets of different parameters as shown in Tabel 1. Multiple scenarios are simulated concurrently and compared. The comparison includes the following statistics: end-to-end delay, medium access delay, load and throughput.

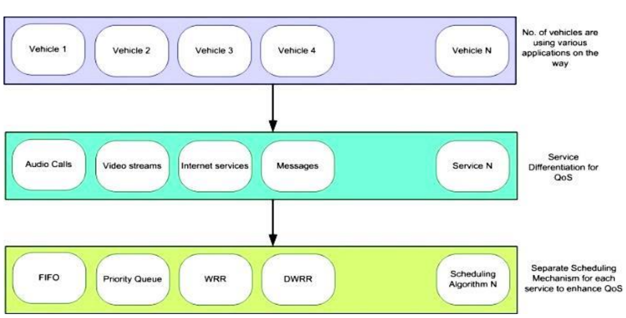


Figure 3. Service differentiation and scheduling.

5. SIMULATION AND PERFORMANCE EVALUATION

5.1. Simulation Environment and Parameters

This work has been simulated using OPNET on 6 lanes with 8 Coordinators and 16 Routers maintained within 10 km road length. For simplicity, straight roads are considered and turns, corners and exits are omitted in our proposed high-way model. Each vehicle in the system is assumed to be equipped with a vehicle sensor system to send vehicle's information request to the RSU. The traffic has been classified into 5 data types such as Audio, Video, SMS, Email and Internet. For thorough testing the proposed scheme has been applied on packets of different sizes such as 500, 1024, 1500, 2500 bits as shown in Table 1.

We assume that vehicles are running on the road with constant driving behaviors, such as lane change, acceleration, and overtaking, deceleration. Vehicles are moving in constant speed and moving in their lane. After the distance d_1, d_2, d_3 is reached, the vehicle may wait for constant time period for signals on the road. Multiple scenarios are simulated concurrently and compared.

The comparison includes the following statistics: end-to end delay, media access delay, load and throughput. In this scenario, DWRR, WRR, priority queue and FIFO scheduling mechanisms are considered. The number and type of ZigBee nodes in all scheduling mechanisms are similar.

Table 2. Simulation Parameters.

Parameters	Value
Transmit Power	0.05
Transmit band	2.4 GHz
Max. routers	16
Max. coordinators	8
Packet reception-power threshold	-85dB
Packet Size (bit)	512, 1024, 1500, 2500
Channel Sensing duration	0.1 µs
Vehicle speed	60 Km/h
Vehicle density	200

The simulation phase considers six trajectories traveled by the mobile nodes as shown in Fig.4. The mobile node starts transmitting their data once passing inside the router coverage area. Fig. 5 shows the network structure employed with different scenarios for simulation using OPNET Modeler.

5.2. Performance Metrics

In our study, we are interested in assessing the performance in terms of the following metrics: End-to-end delay, media access delay, data traffic received, data traffic sent and throughput. In the following, we define all metrics being considered.

Data Traffic Sent. is defined as the total number of data bits delivered by the source per unit of time.

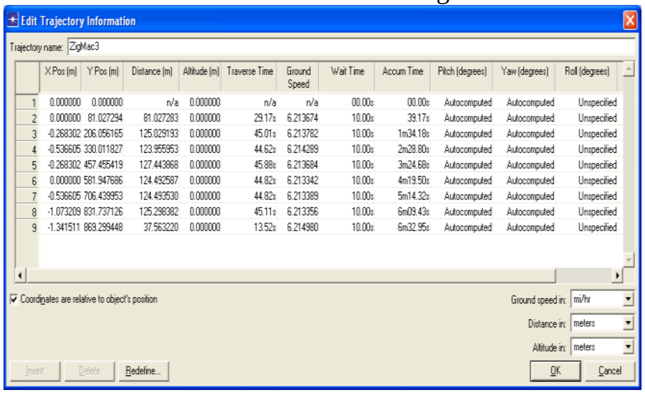
Data Traffic Received. can be expressed as the number of data bits received per unit of time.

Medium Access Delay. is considered as an important factor measuring the QoS offered by a wireless network. It includes the queuing and contention delays from when a data packet is delivered to the MAC level till its delivery with success.

End-to-End Delay. is a measurement of the network delay on a packet. It measures the time interval between when a message is queued for transmission at the physical layer until the last bit is received at the receiving node.

*Delay***.** is measured when packets of data take more time than expected to reach destination

*Throughput***.** is the actual amount of data transmitted correctly starting from the source to the destination within a given time. The throughput is quantified with various factors including packet collisions, interference, barrier between nodes and the differentiation and scheduling mechanisms.



Edit Trajectory Information

Trajectory name: ZigMac3

	X Pos (m)	Y Pos (m)	Distance (m)	Altitude (m)	Traverse Time	Ground Speed	Wait Time	Accum Time	Pitch (degrees)	Yaw (degrees)	Roll (degrees)
1	0.000000	0.000000	n/a	0.000000	n/a	n/a	00.00s	00.00s	Autocomputed	Autocomputed	Unspecified
2	0.000000	81.027294	81.027283	0.000000	29.17s	6.213674	10.00s	39.17s	Autocomputed	Autocomputed	Unspecified
3	-0.268302	206.056165	125.029193	0.000000	45.01s	6.213782	10.00s	1m34.18s	Autocomputed	Autocomputed	Unspecified
4	-0.536605	330.011827	123.955953	0.000000	44.62s	6.214289	10.00s	2m28.80s	Autocomputed	Autocomputed	Unspecified
5	-0.268302	457.455419	127.443868	0.000000	45.88s	6.213684	10.00s	3m24.68s	Autocomputed	Autocomputed	Unspecified
6	0.000000	581.947686	124.492587	0.000000	44.82s	6.213342	10.00s	4m19.50s	Autocomputed	Autocomputed	Unspecified
7	-0.536605	706.439953	124.493530	0.000000	44.82s	6.213389	10.00s	5m14.32s	Autocomputed	Autocomputed	Unspecified
8	-1.073209	831.737126	125.298382	0.000000	45.11s	6.213356	10.00s	6m09.43s	Autocomputed	Autocomputed	Unspecified
9	-1.341511	869.299448	37.563220	0.000000	13.52s	6.214980	10.00s	6m32.95s	Autocomputed	Autocomputed	Unspecified

Coordinates are relative to object's position

Ground speed in: mi/hr

Distance in: meters

Altitude in: meters

Insert Delete Redefine... OK Cancel

Figure 4. Trajectory information.

5.3. Performance Evaluation

5.3.1. Data Traffic Sent

Data traffic sent is expressed as the total number of bits sent from source to destination per time unit. Data traffic sent includes all data bits irrespective whether these bits reach the destination or not. Fig. 6 indicates the data traffic sent for FIFO, HPF, WRR and DWRR scheduling modules and maximum data is sent in case of DWRR scheduling scheme as the packets which are held back those exceed from the packet length for the next round of scheduler. DWRR scheduling scheme can handle variable packet size without knowledge of their mean size. It achieves a better generalized processor sharing (GPS) approximation without prior knowledge of mean packet size of each connection. Also it has been noticed that data traffic sent is low in FIFO scheduling scheme as it organizes data relative to time and does not perform manipulation of data on the basis of prioritization. Moreover, it processes queue by ordering data in first come first serve behavior, where each packet leaves the queue in order they come.

5.3.2. Data Traffic Received

Fig. 7 depicts the data traffic received for the FIFO, HPF, WRR and DWRR scheduling techniques respectively in vehicular sensor network. As result, the data traffic received is maximum in case of WRR scheduling scheme because each packet flow or connection has its own packet queue in a network interface card. WRR serves an amount of packets for every nonempty queue.

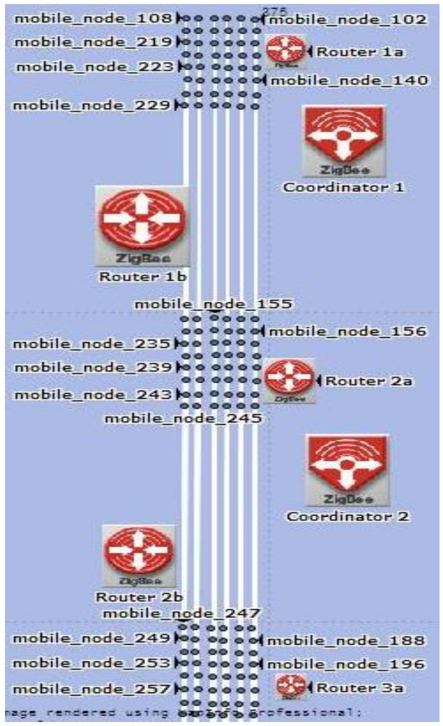


Figure 5. Vehicular Sensor network simulation architecture.

Figure 6. Data Traffic Sent in VSN.

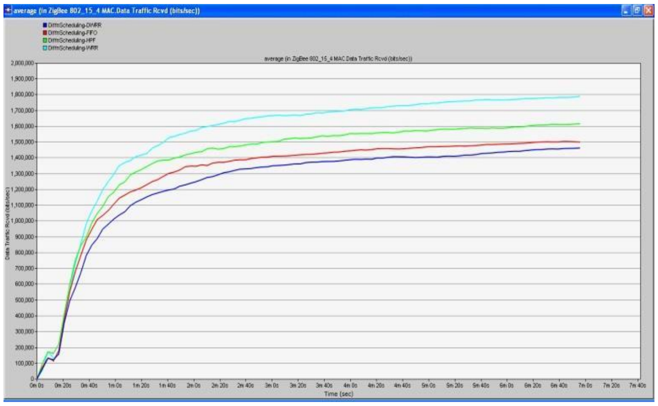


Figure 7. Data Traffic Received in VSN.

Moreover, the data traffic received is slightly low for DWRR scheduling scheme as packets are held back those exceed from the packet length for the next round of scheduler. Those packets exceeds from packet length can be calculated by subtracting maximum packet size number from packet length. Although, DWRR scheduling scheme can handle variable packet size without knowledge of their mean size.

5.3.3. Media Access Delay

To analyze the performance of various scheduling algorithms in providing QoS to users of vehicular sensor network, the medium access delay is considered as an important factor. It is measured as the total of queuing and contention delays. This delay is calculated for each frame. During the evaluation of media access delay with FIFO, HPF, WRR and DWRR with various scenarios having the same Physical and MAC parameters are tested and we found the results shows that FIFO has minimum medium access delay as in Fig 8,while WRR has maximum medium access delay. On the other hand, DWRR and HPF have almost similar results. The overall medium access delay is low and within 0.0015 sec to 0.0090 sec range.

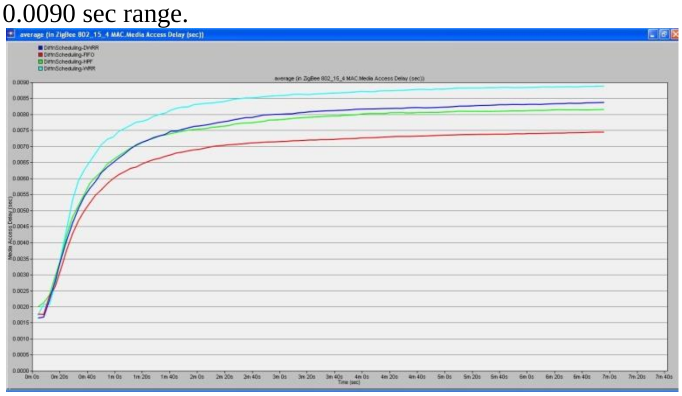


Figure 8. Medium access delay in VSN.

To analyze the performance of various scheduling algorithms in providing QoS to users of vehicular sensor network, the medium access delay is considered as an important factor. It is measured as the total of queuing and contention delays. This delay is calculated for each frame. During the evaluation of media access delay with FIFO, HPF, WRR and DWRR with various scenarios having the same Physical and MAC parameters are tested and we found the results shows that FIFO has minimum medium access delay while WRR has maximum medium access delay. On the other hand, DWRR and HPF have almost similar results.

5.3.4. End-to-End Delay

End-to-End delay (sec) can be defined as total delay between creation and reception of application packets generated by nodes. Fig.9 shows the end-to-end delay through the network using FIFO, WRR, DWRR, and HPF scheduling mechanisms under the same scenario. Various types of traffic (Audio, Video, SMS, Email and Internet) have been generated and processed in this vehicular sensor network. As result, WRR and DWRR mechanisms have less end-to-end delay compared to FIFO mechanism. Overall, the differences in delay between the various schemes are very less, and it ranges from 0.014 Sec to 0.025 sec. In current scenario, WRR has minimum end-to-end delay while FIFO has maximum end-to-end delay due to its scheduling scheme.

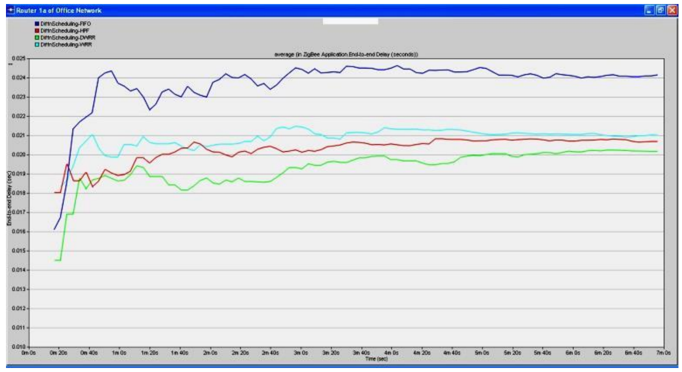


Figure 9. End-to-end delay in VSN using various scheduling techniques.

Delay is measured when packets of data take more time than expected to reach destination. Fig. 10 shows the measurement for overall global delay for FIFO, HPF, WRR and DWRR scheduling schemes. Multiple factors contribute to delay such as network congestion and packet processing at each link till the final destination is reached. Their effects can be minimized by selecting a proper scheduling scheme. It is observed that DWRR and WRR have approximately similar maximum values. Whereas delay is minimum in case of FIFO scheduling scheme

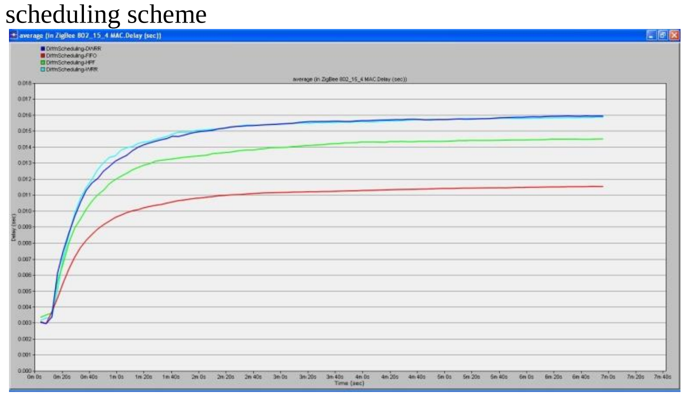


Figure 10. Packet Delay in VSN.

5.3.5. Throughput

Throughput is the actual amount of data transmitted correctly starting from the source to the destination within a given time. It is very important to analyze this QoS metric due to the increasing number of users of wireless medium which can lead to increasing rate of collision and interference. The throughput is quantified with various factors including packet collisions, barrier between nodes and the differentiation and scheduling mechanism used.

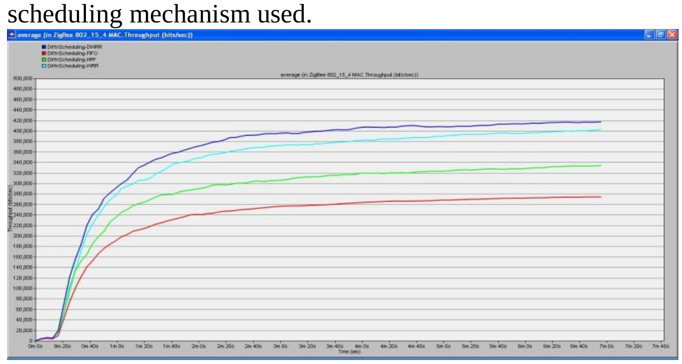


Figure 11. Throughput achieved by various scheduling techniques.

Figure 11 shows that the DWRR scheduling mechanism achieves the maximum throughput. WRR has second highest throughput level while FIFO scheduling mechanism has the lowest throughput. We can observe that there is clear difference in throughput of all scheduling schemes. The results for FIFO lies around 250,000 bps while DWRR and WRR perform around 400,000 bps this result indicates that DWRR and WRR perform well in terms of throughput.

6. CONCLUSION

This work introduces new differentiated service approaches and tasks accomplished by scheduling disciplines and highlights the impact of these techniques on the QoS support in mobile sensor networks. We compared the use of different quality control algorithms for prioritizing and scheduling of traffic received from vehicles in ZigBee environment. On the basis of our measurements and results, we presented that DWRR and WRR have increased QoS by decreasing the collision, packet drop rate and delay. This research can be further extended by implementing existing modern priority and scheduling mechanism or by presenting innovative new algorithm for particular scenario of vehicular sensor networks.

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REFERENCES

1. Feng Xia, Ruonan Hao, Yang Cao, and Lei Xue “A Survey of Adaptive and Real-Time Protocols Based on IEEE 802.15.4” International Journal of Distributed Sensor Networks, 2011.
2. M. Aykut Yigitel, Ozlem Durmaz Incel, Cem Ersoy, “QoS-aware MAC protocols for wireless sensor networks: A survey” The International Journal of Computer and Telecommunications Networking, 2011.
3. K. McLaughlin, D. Burns, C. Toal, C. Mc Killen, S. Sezer, Fully hardware based WFQ architecture for high-speed QoS packet scheduling, Integration, the VLSI Journal, Elsevier, vol. 45(1), 2012.
4. Vladimir Atanasovski “Vehicular Sensor Networks: General Aspects and Implementation Issues “Springer, Aspects of Wireless Sensor Networks, 2011.
5. Yan Zhou. “Performance Research of the IEEE 802.15. 4 Protocol in Wireless sensor networks”, 2006 2nd IEEE/ ASME International Conference on Mechatronics and Embedded Systems and Applications, 2006.
6. B. Nefzi, Y.Q. Song, "QoS for wireless sensor networks: Enabling service differentiation at the MAC sub-layer using CoSenS", Ad Hoc Networks, vol. 10, no. 4, 2012, pp.680-695.
7. T. Zhang, L. Chen, D. Chen, and L. Xie, “EEFF: A Cross-Layer Designed Energy Efficient Fast Forwarding Protocol for Wireless Sensor Networks”, In proc of IEEE Wireless Communications and Networking Conference (WCNC), pp. 1-6, 2009.
8. A. Koubaa, M. Alves, B. Nefzi, and Y.Q. Song, “Improving the IEEE 802.15.4 Slotted CSMA/CA MAC for Time-Critical Events in Wireless Sensor Networks”, Workshop on Real Time Networks (RTN), vol.6, 2006.
9. Z.J. Haas and J. Deng, “On Optimizing the Backoff Interval for Random Access Schemes”, IEEE IEEE Transactions on Communications, vol. 51, no.12, pp. 2081-2090, 2003.
10. F. Cali, M. Conti, and E. Gregori, “IEEE 802.11 Protocol: Design and Performance Evaluation of an Adaptive Backoff Mechanism”, IEEE Journal on Selected Areas in Communications, vol. 18, no.9, pp. 1774-1786, 2000.
11. F. Calì, M. Conti, E. Gregori, “Performance Modeling of an Enhanced IEEE 802.11 Protocol”, In Proceedings of IFIP ATM, vol.99, 1999.
12. S.C. Ergen and P. Varaiya, “TDMA scheduling algorithms for wireless sensor networks”, Wireless Networks, vol. 16, no. 4, 2010, pp.985-997.
13. Q. Liu, X. Wang, and G.B. Giannakis, “A Cross-Layer Scheduling Algorithm with QoS Support in Wireless Networks”, IEEE transaction on vehicular technology, vol.55, no.3, pp.839-847, 2006.
14. B.G. Chun and M. Baker, “Evaluation of Packet Scheduling Algorithms in Mobile Ad Hoc Networks”, ACM SIGMOBILE Mobile Computing and communications Review, vol. 6, no. 3, pp. 36-49, 2002.
15. Ridha Ouni, Mohammad Zuheir Hourani, efficient data harvesting for inelastic traffic in vehicular sensor networks, Science international journal, 24 (1), 13-19, 2012.
16. Ranran Ding and Qing-An Zeng, “A Clustering-based Multi-channel Vehicle-to-Vehicle (V2V) Communication System”, First international conference on ubiquitous and future networks, 2009.
17. TeckMeng Lim, Bu Sung Lee, Chai Kiat Yeo, “Weighted deficit earliest departure first scheduling”, Elsevier, Computer Communications (28), 2005, pp 1711–1720.
18. Laias, Elmabruk M. “Performance Analysis and Enhancement of QoS Framework for Fixed WiMAX Networks. Design, analysis and evaluation of 802.16 Point-to-Multipoint (PMP) Quality of Service Framework based on uplink scheduler and call admission control analysis.”, University of Bradford, 2010.
19. M. Shreedhar and G. Varghese, Efficient fair queuing using Deficit Round Robin, IEEE/ACM Trans. Netw. 4 (1996) 375-385.
20. R. Ouni, J. Bhar, K. Torki, A new scheduling protocol design based on deficit weighted round robin for QoS support in IP networks, Journal of Circuits, Systems, and Computers, Vol. 22, No. 3, 2013, 1350012 (21 pages).

22. Supporting differentiated service classes: Queue scheduling disciplines, white paper chuck semeria, marketing engineer. Part number 200020-001, December 2001.

23. L. Le, J. Aikat, K. Jeffay and F. D. Smith, The effects of active queue management on web performance, in SIGCOMM'03, Germany, 25-29 August 2003, pp. 265-276.

24. M. Z. Hourani, R. Ouni, N. Hussain, Novel Data Harvesting Scheme for Efficient Data Aggregation, ICW2941, WORLDCOMP'11, USA. 2011.