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# Dynamic Scheduling Algorithm based on NOMA Access and Priority Assignment for V2X communications

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**Abstract:** Nowadays, heterogeneous and stringent requirements for the fifth generation (5G) mobile communication system are imposed to adapt with the fast growing usage of the mobile equipment including connected vehicles and rapid development of IoT. As a consequence, the limitation and inefficient using of the spectrum becomes a major problem to meet the demand of mobile broadband, extreme capacity and high throughput. Thus, to handle the challenges of access collisions, the scarcity of spectral efficiency due to the limited bandwidth and massive connectivity, non-orthogonal multiple access (NOMA) schemes have been introduced as a potential solution for 5G wireless networks. Accordingly, this paper presents a new optimal scheduling algorithm for V2X connections called Dynamic Scheduling Algorithm based on NOMA and Priority Assignment for vehicular Networks (DSA-PA-NOMA), which improves performances in terms of Quality of Service (QoS), throughput and bit error rate (BER). The proposed algorithm consider the traffic classification imposed by V2X exigency and taking into account the channel conditions of Vehicular User Equipment (VUE) expressed by the Signal-to-Interference-plus-Noise Ratio (SINR) value.

*Keywords:* 5G, Massive connectivity, Scheduling algorithm, Traffic classification, Throughput, BER.

## 1. INTRODUCTION

Vehicle-to-everything (V2X) has been proposed as a promising concept for the fifth generation (5G) mobile communication system to enable vehicles to communicate, cooperate and exchange information with each other and beyond. It supports diverse vehicular communication modes including vehicle-to-vehicle (V2V), vehicle-to-pedestrian (V2P), and vehicle-to-infrastructure/network (V2I/N) in order to improve traffic safety, efficiency and other services such as comfort and infotainment, Song Li et al. (2018).

As an orthogonal multiple access (OMA)-based system, the widely deployed Long Term Evolution (LTE) networks are being considered as a very promising design for supporting V2X communications which can be achieves large cell coverage, controllable latency and high throughput. However, LTE-V2X have not been fully and efficiently using the limited spectrum resource causing to serious congestion problems in a dense network. To handle the challenges of the scarcity of spectral efficiency due to the limited bandwidth, access collisions and massive connectivity of the conventional OMA systems, applying new techniques and methods to improve spectral efficiency in 5G is very important, Liang Chen et al. (2019).

NOMA is one of the upcoming physical layer communication technique and promising multiple access technologies paving the path to the development of the 5G cellular communication systems. By exploiting non-orthogonal resource allocation, NOMA multiplexes multiple users into one subcarrier to transmit information on the same frequency resource at the same time with different power levels. In addition, NOMA provides enhancements not only in terms of the large connectivity requirements, but also for the high data rate, spectral efficiency, low latency, communication's range and high reliability for V2X environment, Boya Di et al. (2017b).

In fact, radio resource management (RRM) becomes a key design aspect to enable V2X communications. For this reason, the RRM is one of the most important tasks of the eNodeB MAC layer which is the key issue to insure efficient exploitation of the available radio resources including especially interference management and resource allocation. Even in future 5G, resource allocation mechanism needs to be carefully designed to maximize the radio resource efficiency, to satisfy the different demands of QoS requirements and the target throughput for V2X links corresponding to their supported services.

In this work, we propose a new algorithm called Dynamic Scheduling Algorithm based on NOMA with Priority Assignment for LTE-V2X Vehicular Networks that aims to optimize the use of very limited available resources, to maximize cell throughput by taking into account traffic classification, the values of the SINR of vehicular users and to ensure fairness between the different VUE classes such as safety traffic (ST) and Non safety one (N-ST). The performance of the proposed approach was compared with the relaying scheme assisted by conventional OMA. The rest of this work is organized as follows in section II, we present a different scheduling algorithm being proposed in the literature and related works reviews. In section III, we explain the proposed algorithm and we describe his different steps in the section IV. Some simulation results and performances evaluations of the proposed scheduler are analyzed in section V. Section VI, synthesis the proposed algorithm and we conclude our work in Section VII.

## 2. RELATED WORK

The management of radio resources for V2X has been addressed in several articles and research work such as:

Jianhua He et al. (2018) proposed and evaluated several statistic models for power allocation strategies and user scheduling algorithms with their design objectives of minimizing algorithm computational complexity, QoS guarantee and maintaining a good network performance in terms of throughput and user fairness. Then, they choose round-robin (RR) and proportional fairness (PF) scheduling in their study as a joint design of scheduling and NOMA algorithms, in order to analyzed the impact of power allocation for joint NOMA and RR scheduling algorithm and to developed an optimization solution for joint PF scheduling and NOMA algorithms which satisfy the requirement of QoS. However, this algorithm does not consider the traffic classifications and the V2X communications links.

Chen Chen et al. (2018) designed an effective interference hypergraph-based resource allocation (IHG-RA) scheme with cluster coloring algorithm for NOMA-integrated V2X communications with complicated interference. Its main optimization objective was to maximize the network sum rate. In order to minimize the interference caused by NOMA and to achieve efficient radio resource allocation they constructed an interference hypergraph to model the complicated interference scenario. After, In addition, based on the constructed interference hypergraph, the RB assigned to the communication groups or the cluster by using an IHG-RA scheme with cluster coloring algorithm with low computational complexity. The limitations of this scheduler are does not consider the traffic classifications, fairness between users and Qos requirement.

Hanyu Zheng et al. (2018), investigated the resource allocation problem for NOMA-enabled V2X communications and designed a novel scheduling algorithm named NOMA-enabled V2X system resource allocation (NVRA) algorithm for both CUEs and VUEs adopted in a downlink NOMA enabled V2X network. This approach decoupled into three stages: power allocation for CUEs, power control and SC assignment for VUE pairs and SC assignment and user clustering for CUEs, in order to obtain a joint solution that yields to satisfy the fairness and variety requirements of CUEs for data service by considering the weighted max-min rate fairness, to maximize the high capacity demand of V2I links and to guarantee the reliability of V2V links by imposing the minimum SINR requirements on the optimization problem. However, this scheduler does not consider the traffic classifications.

Shengjie Guo et al. (2018) developped a joint power and sub-carrier allocation scheme for NOMA systems with imperfect channel estimation expressed by channel state information (CSI) feedback, to improve the energy efficiency and the ergodic capacities of V2I links and reliability requirements of V2V links. To simplify and decouple the joint power and radio resources assignment problem, they designed a cascaded Hungarian channel assignment algorithm. However, this approach does not consider the traffic classifications and does not provide means to prioritize transmission of V2V and V2I messages according to its type (e.g. whether road safety related message or not).

Raouf Abozariba et al. (2019) proposed a framework to enhance resource allocation and to manage the mobility of IoT devices using NOMA technique to enabling autonomous vehicles. the offered optimization solution of this algorithm are: maximizing throughput calculation, contributing to QoS enhancement and minimizing complexity of re-arranging NOMA clusters by using k-means clustering to respond to the dynamics of the cells. The clustering of IoT devices based on distance, taking into account the maximum number of devices in a cluster. In addition, based on the number of devices and required QoS, they computed the required number of sub-carrier for each cluster. However, IoT devices are grouped independently of their type of traffic such as real time traffic/Non real time or safety traffic/Non safety.

Liang Jinho Choi (2018), proposed a power and rate allocation algorithm for uplink NOMA based on a multicarrier system, which aims to maximize the system throughput under the constraints of code word error probability, with practical transmission: modulation and coding scheme employed at each user to simulate the system. However, the limitations of the proposed approach that does not consider the heterogeneous QoS requirements, the channel condition and traffic classifications for each user.

Hong Xing et al. (2018), studied average sum-rate maximization for two-user with delay-tolerant transmission over fading channels in both scenarios of full and partial channel state information at the transmitter (CSIT) for downlink NOMA. This method takes into account the minimum average rate constraint and certain level of fairness. In the full CSIT case, the dynamic resource allocation approach was optimally obtained using Lagrangian dual decomposition, while in the partial CSIT case, the power allocation strategy was developed based on analytical results. However, this approach does not consider the QoS requirements demanded by users, the services classifications and it is simulated with limited simulation parameters.

Therefore, the problem of calculating the bandwidth requirements to support safety V2X communication in NOMA, has not been addressed. The most of related works mentioned above focus on the problem of joint PA and UP by training a lot of compromises to find a solution without considering services classification. However, the advantage of safety traffic at the road cannot be made use of adequately by these schemes.

## 3. SYSTEM MODEL

We consider a V2X communication scenario based on a simplified NOMA system that consists of a single cell containing one eNodeB and N active vehicular users in the cell, which are denoted by $N = \{1, 2, \cdots, N\}$. We assume the number of the available physical resources blocks in the coverage area is M where the PRBs set $M = \{1, 2, \cdots, M\}$. To satisfy the high link capacity requirements of the N VUEs, we consider power-domain NOMA scheme connecting with the eNodeB. Hence, we suppose that $N \geq 2M$ and each VUE occupies one single PRB in the same TTI while all the other VUE are not served. We also consider that the distribution and the position of the VUEs are variable in the cell. To meet the requirements of V2X communications, the eNodeB is applied to manage the radio resource allocation and Transmitter (Tx) – Receiver (Rx) selection in each time slot (TS).

In NOMA, the eNodeB superimposes the information waveforms for its serviced users. Each VUE employs Successive Interference Cancellation (SIC) technique to cancel multi-user interference and detect own signal. The Rx user decodes signals in a decreasing order of channel gains. Then, those signals are subtracted from the combined signal until the related user's decodes own desired signal.

The transmitted signal at the base station can be written as follows:

The transmitted signal at the time slot i on the channel K can be modeled by the following equation:

$$Y^{i}_{m,k} = \sum_{j\in N_m} \gamma^{(i)}_{j} \cdot \mu^{(i)}_{j,k} \sqrt{P^{(i)}_{j,k}}\, H^{(i)}_{j,m,k} S^{(i)}_{j} + n^{(i)}_{m} \quad (1)$$

Where:

$N_m=\{1 \leq j \leq N \mid \max (SINR^{(i)}_{j,m})\}$: indicates the index set of users within Rx user m's communication range of interest.

$\gamma^{(i)}_{j}$ : Binary variable denotes that time slot (TS) i is assigned by the BS to Tx VUE j.

$\mu^{(i)}_{j,k}$: Binary variable implies that subchannel k is allocated by the BS to Tx VUE j.

$P^{(i)}_{j,k}$: The transmit power of the transmitter Tx VUE j.

$H^{(i)}_{j,m,k}$: represents the channel coefficient of subchannel k between Tx VUE j and Rx VUE m in TS i.

$S^{(i)}_{j}$ : Defined the transmitted symbol of Tx VUE j in TS i.

$n^{(i)}_{m}$ : $CN\sim(0,\sigma^2)$ is the additive white Gaussian noise (AWGN) for Rx VUE m, and $\sigma^2$ is the noise variance.

Furthermore, the channel gain can be expressed as:

$$H^{(i)}_{j,m} = G \cdot h^{(i)}_{j,m,k} \cdot \beta \cdot \left(d^{(i)}_{j,m}\right)^{-\alpha} \quad (2)$$

Where:

G: Constant power gain factor introduced by amplifier and Antenna.

$h^{(i)}_{j,m,k}$: Complex Gaussian variable CN (0,1) representing Rayleigh fading.

β: Representing shadowing fading.

$d^{(i)}_{j,m}$: The distance between VUE user j and m in RB.

α: Representing the path loss exponent.

## 4. PROPOSED ALGORITHM

The main goal of our proposed strategy is to find a compromise between the performance factors of the system, which can guarantee a higher average throughput, taking into account the equity index, the heterogeneity of channel conditions of VUE and further improvement of the system spectral efficiency. This approach aims to decrease the average blocking rate value (ABR). Note that in our problem, the average blocking rate value is measured in terms of the number of VUE of ST that not served due to unavailability of BRs while reaching a certain defined threshold $P_0$ whose :

$$ABR \leq P_0 \quad (3)$$

Where $P_0$ is the maximum tolerable ABR.

Our proposed algorithm is based on four major steps.The first step named traffic classification which aims to classify the incoming connections of the vehicular users according to their types of traffic namely: ST and N-ST. The last one is referred to as managements traffic (MT) and infotainment traffic (IT).

The second step is designed to allocate radio resources to the pairs VUEs which can be shared the same RB by considering the channel quality of each Tx VUE on each RB. The proposed algorithm improves the fairness in resource allocation among different classes of traffics. Indeed, if the scheduler has already allocated an RB during the current TTI to the pair vehicular users, this one will no longer have another RB in the same TTI while all the other VUE are not served. This simultaneously, increases the capacity and spectral efficiency of the system within the cell and makes a good compromise between throughput and fairness. The purpose of the third step is to calculate the outage probability of each type of services in order to decide to proceed to step four which aims to satisfy the ST class by increasing the percentage of served ST VUEs. The non-served V-UEs with ST traffic in the current TTI will be considered with the highest priority to be allocated for the next TTI.

## 5. DESCRIPTION OF THE PROPOSED ALGORITHM

In this section, we give a detailed explanation for each step of our proposed algorithm.

The input and variable parameters used for the proposed algorithm are given below.

**Table 1. Notations**

| Symbol | Description |
|---|---|
| N | Number of VUEs |
| I | Set of VUEs |
| M | Number of RBs |
| U | Set of RBs |
| $N_{ST}$, $N_{MT}$, $N_{IT}$ | Number of ST, MT and IT VUEs |
| A, C, E | Set of ST, MT and IT V-UEs |
| $R_{ST}$, $R_{MT}$, $R_{IT}$ | Number of available RBs for ST, MT and IT traffics |
| Á, Ć, É | Set of ST, MT and IT RBs |
| $NS_{ST}$, $NS_{MT}$, $NS_{IT}$ | Number of served VUEs for ST, MT and IT class |
| Ú, Ó | Set of MT and IT served VUEs |
| NS_No_Served_ST | Number of not served ST VUEs |
| Í | Set of not served ST VUEs |
| $ABR_{ST}$, $ABR_{MT}$, $ABR_{IT}$ | Average blocking rate for ST, MT and IT respectively, calculated in step 3 |
| $P_0$ | The target ABR for ST traffic |
| M1_No_Served_ST | Matrix contains the not served ST VUEs |
| M3_ Served_ IT | Matrix contains the served IT VUEs |

### *5.1 Step 1: Services classification*

V2X communications have to be real time and come with stringent requirement on reliability. Thus, two types of service classes are defined. The first one is ST (Safety traffic) that imposes strict reliability, timeliness requirements and network scalability and refer to the case that the messages transmitted require high QoS and needs to be served almost immediately in order to reduce road accidents, like forward collision warning, queue warning and co-operative adaptive cruise control / platooning, Cristiano M.Silva et al. (2018).

The second one is N-ST (Non- Safety Traffic) which can be divided into two categories: MT (Management Traffic) and IT (Infotainment Traffic). The MT needed to be treated with most urgency thanks to their importance which aims to improve traffic fluidity by reducing the travel time and the congestion, examples vehicle to vehicle merging assistance and green light optimal speed advisory, Cristiano M.Silva et al. (2018).

IT traffics are the connections that can tolerate delay and provides comfort and convenience applications for users to enhance their driving experience such as remote diagnostics and point of interest notification, Cristiano M.Silva et al. (2018).

The purpose of step 1 is to classify the incoming connections of the vehicular users according to their types of traffics namely: ST, MT and IT that priority 1 is given to ST VUEs, priority 2 is given to MT VUEs and priority 3 is given to IT VUEs. It is important to pass through this step to decide the scheduling priority. Indeed, the objective is to prioritize the VUEs with good channel condition without sacrificing the VUEs with bad one.

### *5.2 Step 2: RBs allocation*

The objective is to prioritize VUEs with good channel conditions at the same time not to starve VUEs with bad ones. So, this step aims to allocated available RB to pair of VUEs belongs to the same class of traffic with higher channel conditions expressed by the SINR value and at the same time without compromising fairness criteria. Furthermore, the M RBs are divided using a partial sharing system where some resources are partitioned for ST connections, some others for MT connections and the rest for IT one.

Indeed, the proposed allocation process aims to assign $R_{ST}$, $R_{MT}$ and $R_{IT}$ RBs to $N_{ST}$, $N_{MT}$ and $N_{IT}$ active VUEs respectively to the ST, MT and IT classes. The idea is to search for the combination ((VUE1j, VUE2j), RBk) with $1 \leq j \leq Nn$ and $1 \leq k \leq Rn$ where $n \in \{ST, MT, IT\}$, with the highest metric value $m_{j,k}$ on this RB. This metric defines the quality of the channel. The element $m_{j,k}$ is expressed by the following "(4),".

$$m_{j,k}=\max\{SINR_{j,k}\} \quad (4)$$

Specifically, the SINR at the receiver Rx is computed as:

$$SINR_{j,k} = \frac{P_j^{(i)} \rho_{j,m,k}^{(i)}}{1 + \sum_{l \in L_n, l \neq j} P_j^{(i)} \rho_{l,m,k}^{(i)}} \quad (5)$$

Where Ln is the subset of active VUEs causing interference when the Rx VUE m using a RB for the transmission.

$$\rho_{j,m,k}^{(i)} = \left|H_{j,m,k}^{(i)}\right|^2 / \left(n_m^{(i)}\right)^2 \quad (6)$$

$\rho_{j,m,k}^{(i)}$ denotes the SINR of subchannel k between the Tx VUE j and Rx VUE m link.

Based on this metric, if the scheduler has already allocated an RB during the current TTI to one user, this served VUE will not have another one in the same TTI, in order to maximize the equity index. The RB allocation process for the ST class is summarized by algorithm 1.

| Algorithm 1 |
|---|
| **{Inputs}**<br>$N_{S\_ST}=0$; $N_{S\_MT}=0$; $N_{S\_IT}=0$ % Number of served VUEs<br>**{Main}**<br>**% Allocation of RBs for ST VUEs**<br>**For** k=1 **to** $R_{ST}$ **do**<br>// selecting the (VUE1, VUE2, RB) pair VUE with the highest metric at the same RB in Mat.<br>Find (j1, k) = max Mat (j1, k), with (j1, k) ∈E X È;<br>selecting the fist $VUE1_j$;<br>Remove the $j1^{th}$ row from Mat;<br>// At the same RB<br>Find (j2, k) = max Mat (j2, k), with (j2, k) ∈E X È;<br>selecting the second $VUE2_j$;<br>Remove the $j2^{th}$ row from Mat;<br>Assign $RB_j$ to ($VUE1_j$, $VUE2_k$);<br>Update È: È = È \ {k};<br>$N_{S\_ST} = N_{S\_ST} + 1$;<br>Calculate the flow rate of $VUE1_j$ and $VUE2_j$ on $RB_k$<br>**End for**<br>Save the ST VUE to be allocated at the step 2;<br>//Calculate the average blocking rate of ST traffic of served VUEs.<br>$ABR_{RT} = 1 - (N_{S\_ST} / N_{ST})$; |

### *5.3 Step 3: Performance evaluation*

In this step we calculate the average blocking rate value (ABR) which is computed as the ratio between the number of blocked transmitters due to unavailability of RBs and the total number of VUE of each type of traffic in order to decide the reallocation process in step 4.

The $ABR_n$, where $n \in \{ST, MT, IT\}$, is expressed by the following "(7),".

$$ABRn=1-(N_{S\_n} / N_n) \quad (7)$$

Since the proposed algorithm gives more priority to the ST services than others ones because they not tolerate the delay and must be served immediately. This allowed us to provide a threshold $P_0$.

### *5.4 Step 4: Reallocation process*

This step aims to decrease the ABR of not served ST packets without exceeding a certain predefined threshold in order to guarantee higher fairness index between the different classes. In order to reallocate an RB to safety traffic which is not served in step 2, it is necessary to check whether his SINR value is greater than or equal to SINR_Threshold which is calculate from the average throughput achieved in the second step. Algorithm 2 briefly describes the process of reallocation.

| Algorithm 2 |
|---|
| **{Inputs}**<br>%Calculate the value of SINR_Threshold from the value of the average throughput achieved after step 2<br>**{Main}**<br>*% **Reallocation in $R_{IT}$***<br>**While** $ABR_{ST} < P_0$ **do**<br>//Selecting the (VUE, RB) pair with the highest SINR value:<br>Find ( x, n) = max M1_No_Served_ST (x, n), with x ∈ Ì<br>% Find the minimum of the $n^{th}$ column (on the same $RB_n$) of the matrix M3_IT_Served<br>Min1= min M3_Served_IT (z, n), with z ∈ Ò<br>**if** ( (max_M1_No_Served_ST >= Min1) \|<br>(max_M3_ No_Served_ST > SINR_Threshold)) **then**<br>Cancel IT connection<br>Assign $RB_n$ to $VUE_x$ % Allocate $RB_n$ for the ST connection<br>Remove the $x^{th}$ row of the matrix Mat_No_Served_ST_VUE<br>Remove the $z^{th}$ row of the matrix M3_Served_IT<br>Update $N_{S\_ST}$ and $N_{S\_IT}$<br>Update $ABR_{ST}$ and $ABR_{IT}$<br>Update Ì: Ì = Ì \ {x}<br>Update Ò: Ò = Ò \ {z}<br>**end if**<br>**end while**<br>*% **Reallocation in RMT***<br>restart the same work as that carried out for the reallocation in RIT |

Following the above calculation of SINR in "(5)," the achievable data rate obtained from Tx VUE j over sub-channel k in the RB can then be mathematically formulated as:

$$R^{(i)}_{j,m,k} = BW \log_2\left(1 + \frac{P^{(i)}_j \rho^{(i)}_{j,m,k}}{1 + \sum_{l \in L_n, l \neq j} P^{(i)}_j \rho^{(i)}_{l,m,k}}\right) \quad (8)$$

## 6. SIMULATION RESULTS

We assume that the simulation model used to evaluate the performance of the proposed algorithm consists of a single cell containing a single eNodeB which is the element responsible for allocate radio resources in time and frequency. We vary the total number of VUEs with random connection types and CQIs in the cell in order to evaluate the system performance. we assume that one user has only one V2X service. In addition, we consider that the distribution and the position of the VUEs are variable in the cell. Thus, we compared the performance evaluation of the proposed scheme with the reaying scheme assisted by conventional OMA. The parameters used for simulations are listed in the following table 2.

**Table 2. Parameter setting**

| Parameter | Value |
|---|---|
| System bandwidth | 10 MHz |
| Number of RBs | 50 |
| Number of users | [100, 150] |
| Number of eNodeB | 1 |
| Number of users sharing the same RB | 2 |
| Duration of TTI | 1 ms |
| Percentage of STs services | 70% |
| Percentage of MTs services | 20% |
| Percentage of ITs services | 10% |

### *6.1 Average Blocking Rate (ABR)*

ABR considered as one of important key performance indicators (KPIs) Giammarco Cecchini et al. (2017). The proposed algorithm divides the resources according to the type of connections. Moreover it maximizes the use of available RB by allocating a single RB for optimal vehicular user pairing during the current TTI.

Fig.1 shows the variation of the ABR of ST class as a function of the number of active VUE in the cell for NOMA compared to OMA.

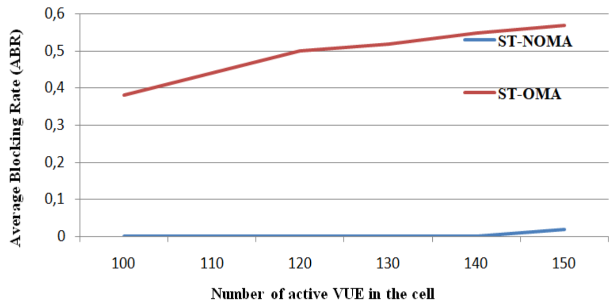



Fig.1. ABR analyses for safety traffic class

With raising the number of VUEs in the cell, the ABR grows slightly due to unavailability of BRs. We find that the increase of ABR is less important for ST traffic in NOMA than in OMA. This is because the proposed algorithm based on NOMA aims to maximize the number of served VUE by allocating one RB for two vehicular users and gives more priority to the ST connections. In DSA-PA-OMA, the user with a good channel condition has a higher priority to be served while the user with a bad channel condition has to wait for access, which leads to a fairness problem and high latency. This approach cannot support massive connectivity. However, DSA-PA-NOMA can serve multiple users with different channel conditions simultaneously. Therefore, it can provide an improvement in term of higher massive connectivity as showing in Fig. 1.

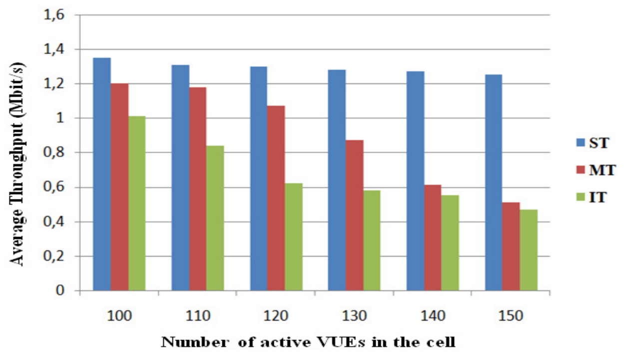
### *6.2 Cell throughput*

NOMA is adopted in the network to increase spectral efficiency. Indeed maximizing system throughput is one of the principal objectives of our study. In order to highlight the impact of the priority for the traffics classes, Fig. 4 shows the comparison of the cell throughput for VUEs with ST, MT and IT traffics.

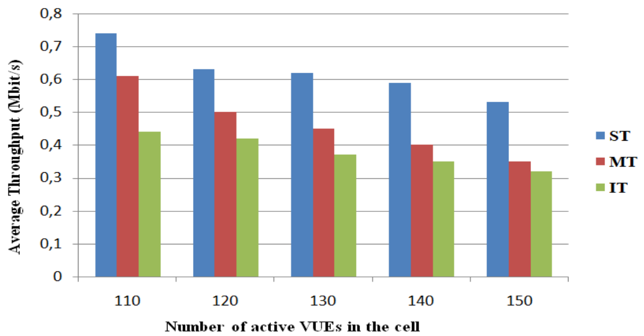
Safety traffic has the highest priority while infotainment has the lowest one. We find that the increase in average throughput is more important for ST than for MT and IT.

Fig. 2(a) and (b) shows the performance of DSA-PA scheduler in terms of average throughput as a function of the number of active VUEs in the cell respectively based on NOMA and OMA.

From the Fig. 2, the proposed algorithm achieve 1,3 Mbitps, at the targeted active VUEs in the cell of 110, while DSA-PA-OMA achieve 0,74 Mbitps. So, our proposed scheme performs better than the OMA-based scheme due to a smart utilization of the time and frequency resources.




(a) Average throughput analysis for NOMA.




(b) Average throughput analysis for OMA.

Fig. 2. NOMA VS OMA

Indeed, DSA-PA-NOMA always achieves the highest throughput and it outperforms DSA-PA-OMA scheduler which has a gap to the maximum achievable sum rate.

According to, 3GPP (2017), for V2X communications, ST often require high reliability, low latency and short message size compared to N-ST one. For some ST traffic like forward collision warning, control loss warning and queue warning the transmitted messages have a size of 50-300 Bytes. Fig. 2 indicates that the obtained throughput for safety traffic can support variable message sizes. In fact the proposed algorithm allows an exchange of messages with 160 Bytes when the throughput is equal to 1.3 Mbps. The results satisfy the 3GPP recommendation when the minimum message size is 50 Bytes.

## 7. CONCLUSION

In this paper, we present a new scheduling scheme called DSA-PA based on NOMA access for V2X communications which aims to maximize the cell throughput by taking into account the channels condition of each VUE, to allow a fair distribution of available RBs, to decrease the average blocking rate value for ST traffic and to handle ST, MT and IT communications. The simulations results show that the proposed method could prove better performances than obtained with OMA in terms of throughput and ABR. A better trade-off between fairness and throughput has been obtained. In future work, we can apply the same algorithm in a real environment, where several eNodeBs can be considered. We plan to introduce many improvements to the proposed algorithm such as planning to integrate the power control mechanism to ensure alright interference management.

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