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A Taxonomy on Vehicle to Vehicle Communication using 5G

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Abstract: *With the fast development of technology, the fifth generation mobile communication (5G) had wide range of attention due to higher frequency, greater network capacity, and lower latency. It has many technologies, among which beam management for vehicle to vehicle communications in millimeter wave 5G plays important part in vehicular communications .It is always required to design and develop wireless technologies to reach raising demands of high speed wireless data to get advanced transport system As 5G wireless communication adoption is increasing and it's vehicle to everything communications had implemented V2V communications and main motto of vehicle to vehicle communication is to improve efficiency of traffic and to avoid accidents as intake of 5G is increasing beam formed vehicular communications at millimeter - wave bands await to allow the most demanding connected driving applications. Beam management is a fast changing scenario and we come across practical limitations of 5G to enhance successful beam forming procedures This paper came up with two beam management techniques . Both the techniques are examined in terms of power performance , beam recovery time and channel usage and the outcome is there is significant differences came when beam is more frequently updated and there is brief enhancement is noticed by increasing size of beam set so selection of proper strategy also plays a key role.*

Keywords: 5G , V2V, Beam forming, Beam management

I. INTRODUCTION

Advancement in technology helped us a lot in wireless network technology For the past 2 decades mobile technologies like 1G , 2G , 3G and 4G worked on enhancing the speed and efficiency of wireless communications although there are few hurdles with these technologies. It is predicted that 5G will be more efficient than the rest mobile technologies a survey anticipates that during 2020 to 2030 there will be drastic increase in traffic and such huge volume of traffic data leads to the development of 5G and also to use efficiently in a new high frequency band And a factor like ultra low latency reduce the power consumption and increase life of battery smartphones, laptops etc.

Table 1: Features of 5G Communication

S.NO	FEATURES	CHARACTERISTICS
1.	Capacity	10000 times more traffic
2.	Cost	Ultra-low cost for M2M communications
3.	latency	1 millisecond latency
4.	User data rate	10 Gbits/s peak data rate
5.	Coverage	100 Mbits/s

Automotive industry emerged as one the vital vertical industries to get full potential of modern wireless communications. The expected transformation is improvement towards safer, more efficient and automated driving systems have developed standards of communications mainly vehicular communications.

II. MAIN FEATURES OF 5G ARE

1. Coverage
2. Capacity
3. Cost
4. Latency
5. User data rates

Radiation in this case is doesn't radiate in all directions, but based on sharp beams where power is concentrated in particular angular region in space. Therefore, communicating pairs need to maintain their beams constantly aligned to prevent outage and additional signaling between them is required for this purpose. Beam management, consists a set of procedures to acquire and update the less beams for communications, is gaining importance in V2X studies. the requirements for beam management procedures for proposed, the use of new radio mechanisms as the baseline. In each procedure there is one or more than one beam measures to improve robustness against failure of beam, and also fast recovery on blockage, misalignment or outage.

III. LITERATURE SURVEY

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According to a report published by the U.S. Department of Transportation and National Highway Traffic Safety Administration in [12], 37,461 people were killed in motor vehicle crashes in 2016, an increase of 5.6% and 14.4% when compared to 2015 and 2014 respectively. Similarly, according to the UK Department for Transport [13], a total of 27,130 people were severely injured in road accidents out of which 1,710 lost their lives. V2X communication mainly refers to the set of standards and technologies that will enable the vehicles to interact with the current infrastructure including roads and road users. Vehicle to Vehicle (V2V) communication plays a significant role in the Intelligent Transportation System (ITS) in Vehicular Ad hoc Networks (VANET) for which the usage of IOT in vehicles is increasing rapidly. Vehicles communicate with each other through wireless networks. However, the deployment of new generation of mobile networks 5G needs a major upgradation of its existing systems such as 4G, LTE and other infrastructure. Therefore, it is proposed to introduce advanced technology of 5G networks upgradation in Vehicle to Vehicle communication. Massive MIMO have the important role for the DSRC (Dedicated Short Range Communication) wireless technology. This mechanism works on the vehicle-to vehicle communication such as the vehicle relative speed, range transmission etc., base station (tower) and RSU control and monitor of the vehicle to vehicle communication. In this research, the road styles such as square, straight, triangle and any other are designed and tested through simulation program using MATLAB 2017. The upcoming 5G technology for driverless V2V communication makes the journey easier and safer with full control.

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In Europe alone, around 40 000 people die and 1.7 million are injured annually in traffic accidents. At the same time, traffic increases on our roads leading to traffic jams, increased travel time, fuel consumption and increased pollution .Cooperative intelligent traffic systems (C-ITS) can address these problems by warning drivers of dangerous situations and intervene through automatic braking or steering if the driver is unable to avoid an accident. In order to provide a wireless network to enable the information exchange process, the new generation of wireless network should be designed to offer a solution with a high degree of reliability and availability, in terms of data rate, latency etc.

[3] 978-1-7281-0447-8/19/$31.00 ©2019 IEEE

These days, road accident and traffic jams have increases significantly on the route due to higher number of vehicles. The study presented in [8] defines the 5G mobile communication in Next Generation (NextGen) study and 3rd Generation Partnership project (3GPP) mentioned 5G communication will be the main component of smart homes, smart cities and connected cars. For improving the mobility and safety, different countries are functioning on improving the DSRC technology applications for different connected vehicle. For the linked vehicles' functionalities, the wireless transmission coverage is one of the significant feature.

[4] S. A. A. Shah, E. Ahmed, M. Imran, and S. Zeadally, ''5G for vehicular communications,'' IEEE Communication, Jan. 2018.

5G is ongoing, and it is an emerging platform that not only aims to augment existing but also introduce a plethora of novel applications that require ultra-reliable low-latency communication. It is a new radio access technology that provides building blocks to retrofit existing platforms (e.g., 2G, 3G, 4G, and WiFi) for greater coverage, accessibility, and higher network density with respect to cells and devices. It implies that 5G aims to satisfy a diverse set of communication requirements of the various stakeholders. Among the stakeholders, vehicles, in particular, will benefit from 5G at both the system and application levels. The authors present a tutorial perspective on vehicular communications using the building blocks provided by 5G. First, we identify and describe key requirements of emerging vehicular communications and assess existing standards to determine their limitations. Then we provide a glimpse of the adopted 5G architecture and identify some of its promising salient features for vehicular communications. Finally, key 5G building blocks (i.e., proximity services, mobile edge computing and network slicing) are explored in the context of vehicular communications, and associated design challenges are highlighted.

[5] D. Medina, L. Hu, H. Rosier, S. Ayaz, Interference-aware dynamic resource allocation for D2D proximity services with beam forming support, in: 2015 IEEE Global Communications

A low-overhead interference-aware approach to spectrally efficient, fully distributed dynamic resource allocation with beam forming support for unassisted broadcast and unicast device-to-device communications. A resource may only be allocated for transmission over a link if a) the transmitter is guaranteed to not cause excessive interference at any scheduled receivers, and b) the total interference caused by all scheduled transmitters can be handled by the receiver. In order to determine whether a resource satisfies these interference constraints, information derived from physical layer measurements (rather than geometry or network topology) is periodically exchanged among neighbours. Support of beam forming antennas is achieved in a straightforward manner by taking into account the optimal array configuration when performing such measurements.

[6] D. Jiang, L. Delgrossi, IEEE 802.11p: towards an international standard for wireless access in vehicular environments, in: IEEE Vehicular Technology Conference, 2008.

Vehicular environments impose a set of new requirements on today's wireless communication systems. Vehicular safety communications applications cannot tolerate long connection establishment delays before being enabled to communicate with other vehicles encountered on the road. Similarly, non-safety applications also demand efficient connection setup with roadside stations providing services (e.g. digital map update) because of the limited time it takes for a car to drive through the coverage area. Additionally, the rapidly moving vehicles and complex roadway environment present challenges at the PHY level. The standard body is currently working on a new amendment, to address these concerns. This document is named wireless access in vehicular environment, also known as WAVE. As of writing, the draft document for is making progress and moving closer towards acceptance by the general working group. It is projected to pass letter ballot in the first half of 2008. This paper provides an overview of the latest draft proposed for. It is intended to provide an insight into the reasoning and approaches behind the document.

IV. METHODOLOGY

Driverless and autonomous cars have increased in popularity because of their increased in applications of commercial and emergency services. In order to fulfill such services, connected and autonomous vehicles require continuous access to sensory data from which the cars can perform advanced trajectory planning and complex high speed maneuver.short-term trajectory decisions, the car can use on-board sensor information, but for long-term decisions, the car needs data and information from vehicles in near proximity. Wireless connectivity-enabled vehicles that can communicate with each other and with the infrastructure, establishing interactions between vehicle-to-sensor on-board, vehicle-to-vehicle, vehicle-to-road infrastructure, and vehicle-to-internet.

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each other and with the infrastructure, establishing interactions between vehicle-to-sensor on-board, vehicle-to-vehicle, vehicle-to-road infrastructure, and vehicle-to-internet.

In the below Fig1 let us assume a particular intersection that is the a junction of four roads let us assume a car is C1 and another car C2 ,C3,C4 coming on each different roads in the case of vehicle to vehicle communication it works like a mobile hotspot i.e hotspot like connection is present around each particular car ,and when car C1 and C2 come under the region they transfer information similarly when C2 and C3 come under the region they transfer information for V2V communication we use DSRC(Dedicated short range communication)

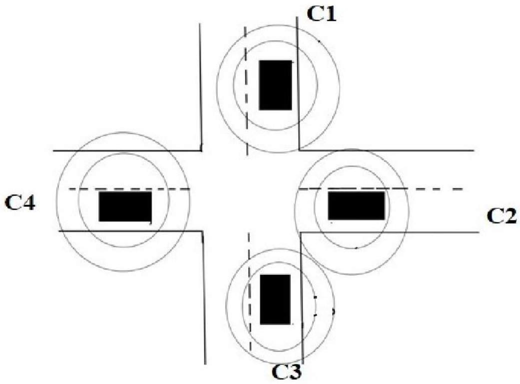

Figure 1: Scenario Of Four Vehicles Approching From Intersecting Roads

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Based on these interactions, the vehicles can take safe dynamic decisions, can enhance their awareness, and can provide an information-rich and safer environment to other motorists and or pedestrians. millimeter wave (mm Wave) V2V communication is used in order to better utilize the channel and to prioritize sharing the sensory data for emergency connected and autonomous vehicles (e-CAVs). By using the same method, the authors also address the issue of obstacle avoidance maneuvers and advance trajectory planning in terms of e-CAVs as compared to regular CAVs (r-CAVs).Rough set theory is formulate the lane-changing rules to enhance the decision making process of autonomous vehicles in a complex urban environment .

In the below Fig 1.1 , If car 1 wants to change lane while car 2 and car 3 are interfacing .So the decision of driver of car1 depends on the distance between car1 and car 3 and also the velocity between car 1 and car 2.Key applications of V2V communications are :

V2V communication enhances driving safety and traffic efficiency along with information or entertainment provision to drivers in a number of use cases such as traffic safety, traffic efficiency, infotainment and payments etc. In terms of traffic safety, V2V communication disseminates warning messages on several occasions.

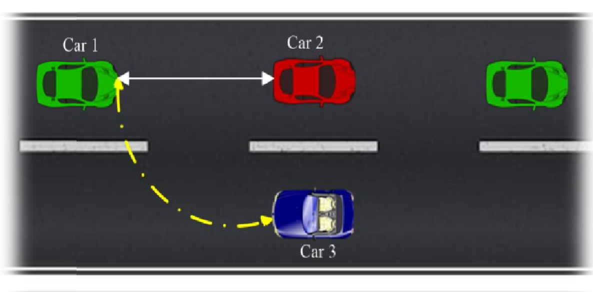

Figure 1.1: Line Changing Process

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5G NR introduced in analog beam forming at both the base station and the user equipment (UE) so-called beam management procedures, beam management has set of features to align the beams at both ends ,to ensure link stability. These include

1. Beam determination
2. Beam measurement
3. Beam reporting
4. Beam sweeping

Beam determination: selection of a suitable beam ends.

Beam measurement: allowing both ends to measure the characteristics of the received signals.

Beam reporting: beam measurement information is given back to the transmitter

Beam sweeping: covering an angular sector by switching to different analog beams over the area.

The 3rd generation partnership project mentioned one process Is not sufficient different transmission requires different processes So this gave different procedures for support they are:

P1: used to find initial beam pairs, a beam sweep at the transmitter is performed to select one or more transmitting and (if possible) receiving beams.

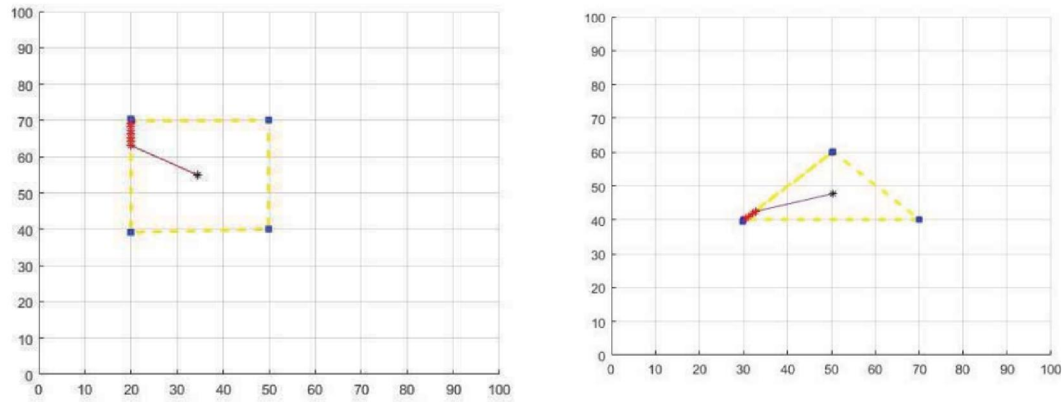
P-2: once beam pair is determined, a smaller set of beams from the transmitter can be swept over a reduced angular region to maintain the link. If needed, this smaller set can consist of narrower beams – a process also known as beam refinement.

P-3: focused on beam determination at the receiver side, a previously-determined transmitting beam is fixed during a receiver beam sweep

in each procedure there are one or more than one beam measures can be noticed to increase strength against beam failure so fast recovery is possible when ever there is blockage, misalignment or outage.

Since the direct V2V communication corresponds to a point-to-multipoint transmission, the successful transmission ratio has a different impact on retransmission compared with the unicast transmission. The reason is that successful transmission ratio of X in multicast does not mean that packets do not need to be retransmitted with a probability of X. For instance, one transmitter multicasts two packets to the nearby 10 vehicles where the two different vehicles fail in receiving the first and second packet transmission, respectively. Thus, a successful transmission ratio of 90% is encountered here but both the two packets have to be retransmitted. Therefore, we can see that a larger number of packets need to be retransmitted in multicast mode compared with unicast mode, when the same successful transmission ratio is experienced.

The various road styles such as straight, triangle, circle, overpass, underpass, four ways, square and etc. automatically connects the nearby vehicles with each other when it comes to the coverage of the base station. Some of the base stations placement and the road styles are illustrated



(a) (b)

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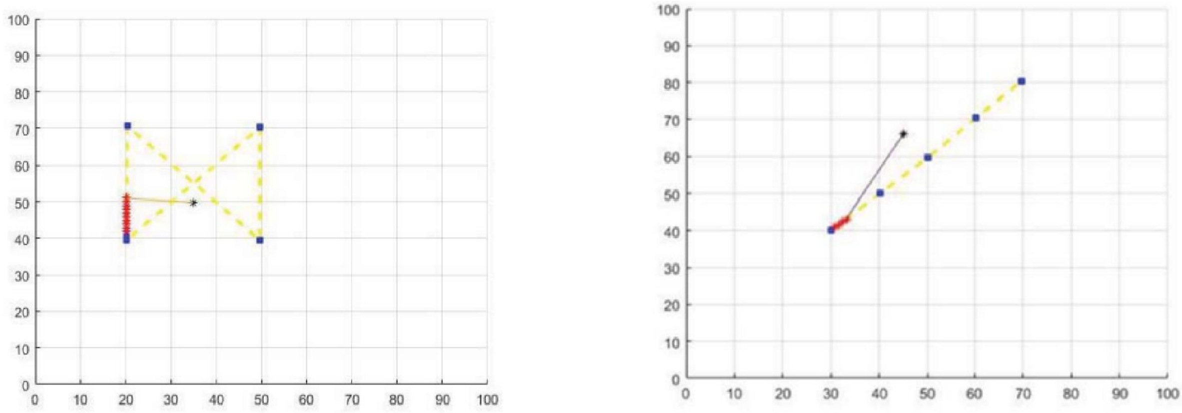

(c) (d)

Figure 1.2: Various Road Structures and Placement of Tower (A) Square Style Road (B) Triangle Style Road (C) Zigzag Style Road (D) Straight Style Road

The below figures shows the stepwise coverage of vehicle monitoring and communication with the tower. When the vehicle comes under the coverage the tower monitors and Communicates information until the vehicle is under coverage. From top left to right bottom ,the figure shows the connection process of various scenariao when any vehicles comes under coverage then the tower starts sending and receiving messages for the controlling, information and other processes.

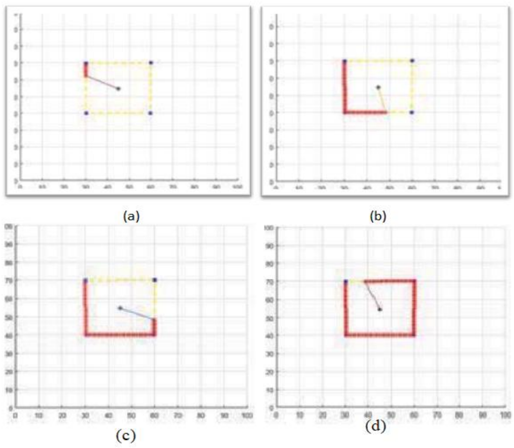

Figure 1.3: Vehicle Under the Tower Control for Sending and Receiving Information in Square Scenario

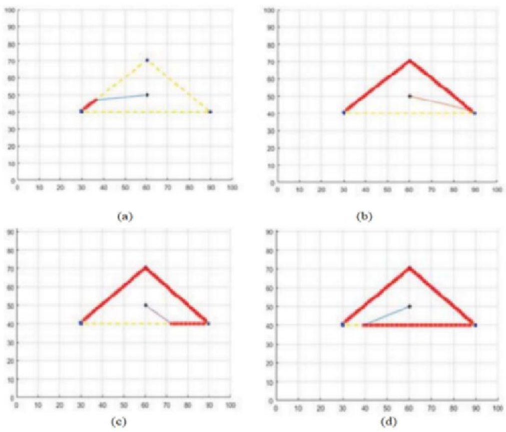

Figure 1.4: Vehicle Under The Tower Control For Sending And Reciving Information In Triangle Scenario

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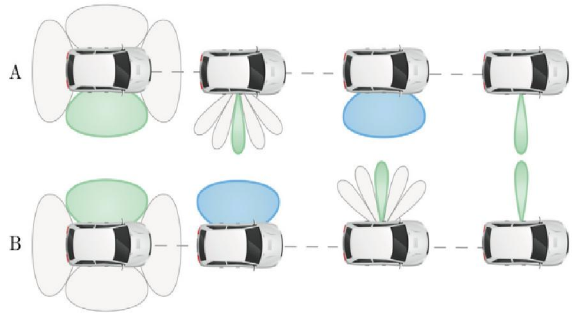
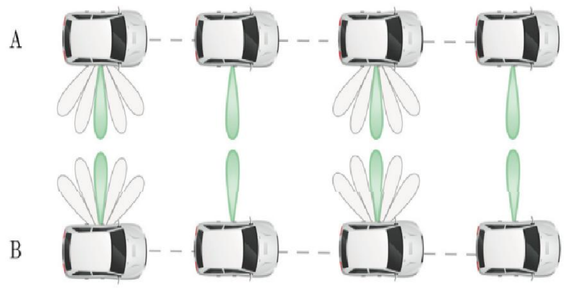


(a) Strategy 1.



(b) Strategy 2.

Figure 6: Vehicle under the Tower Control for Sending and Receiving Information in Straight Scenario

Now let's have a view on beam management strategies there are two beam management strategies

STRATEGY 1: Coarse Anchoring and Refinement: Every TSS a SS burst measures all coarse beam combinations for both vehicles and defines a coarse anchor. Then, KCSI CSI bursts are performed between SS bursts for each node, where a subset of 1 + Nngh fine beams from the transmitter are measured using the coarse anchor from the receiver end, as shown in Fig. 3a. The transmitting fine beam that provides the maximum RSRP is chosen. The same process is also performed inversely KCSI times to choose the most suitable receiving fine beam.

STRATEGY 2: Fine Tracking: Both S-SSB and CSI are used to measure fine beams. Every TSS and KCSI times in between both nodes measure all combinations of a subset of 1 + Nngh fine beams, as shown in Fig. 3b. The beam pair that provides the maximum RSRP is chosen until the next measurement. The initial beam is determined by a full sweep.

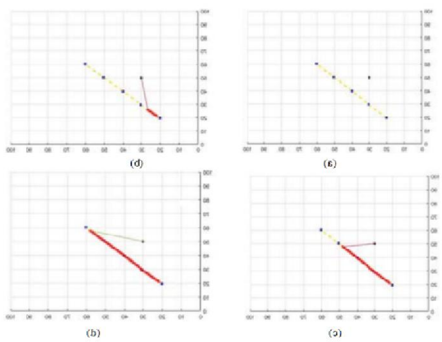


Figure 7: Beam Management Strategies

V. RESULTS

This report is all about V2V Communication along with it's applications and also addressed the limitations and how to overcome them. V2V aims to road safety and traffic efficiency by sending advanced warning messages to drivers to support their decisions, through the cooperative exchange of messages between connected vehicles. Both strategies have been evaluated in terms power performance and channel usage.

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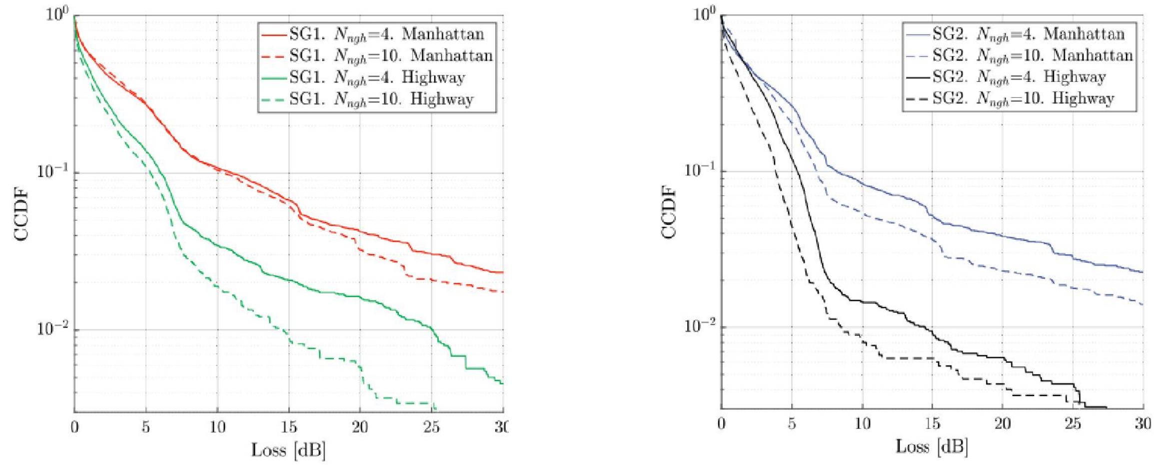
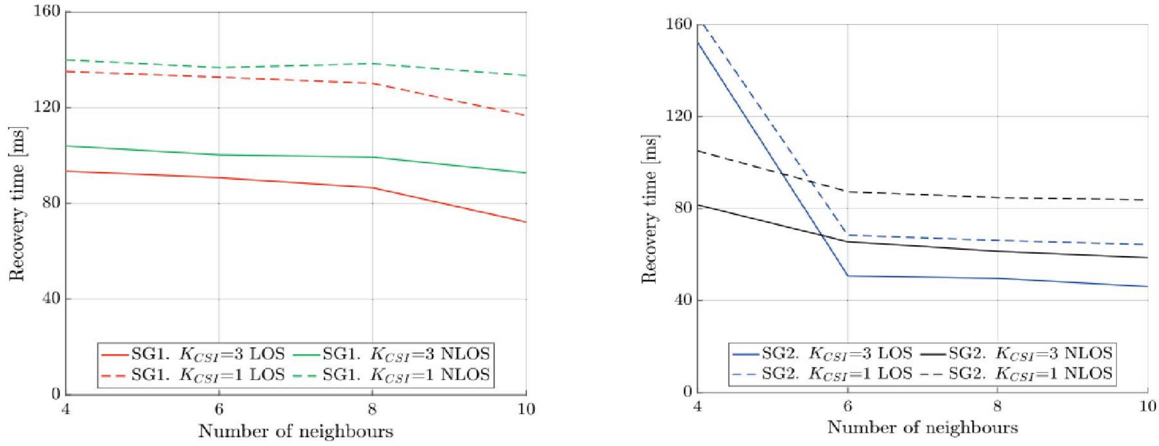
Power Performance: The power profile for each pair of nodes is compared with the reference beam alignment strategy in order to evaluate the overall performance of the proposed strategies. A two-level hierarchical beam set is built using Nant = 4 antenna elements per panel, using 1 port for the fine beams and 3 ports for the coarse beams. The resulting beams have a directivity of 12 dB and 7.9 dB for the fine and coarse configurations. The coarse beam has a half power beamwidth of 94◦, covering the whole sector, whereas the half-power beamwidth for the fine beams ranges from 24◦ to 35◦, being sharper in the broadside. beam management strategies are evaluated using different number of neighbors (Nngh = {4, 6, 8, 10}).

In the above figures, the dashed lines correspond to a slower update and thus an increase in the mean recovery rate is shown in every situation Strategy 2, exhibits higher resilience to misalignment, as an increase in update rate only delivers a mean of 15.9 ms less recovery time in LOS conditions and 23.4 ms in NLOS conditions. Where as in Strategy 1 sees its recovery time improved from 38 ms to 42.9 ms.SG1 shows little improvement when changing from 4 to 10 neighborsSG2 presents nonetheless a noticeable improvement when more than 6 neighbors are used, and it presents in this situation the best performance in terms of beam recovery.



(a) Strategy 1. (b) Strategy 2.



(a) Strategy 1. (b) Strategy 2.

To properly evaluate the damage exerted over the link quality due to the misalignment, the loss in power with respect to the reference profile is calculated for both strategies To know loss, the complementary cumulative distribution function (CCDF) of the experienced to evaluate which potential losses in each strategy Noteworthy difference between scenarios can be seen, which can be due to the variability of the required pointing angles. In Manhattan scenario there is a wider range of potential angles of arrival in the same data session, whereas in highway scenario require less frequent beam switch This increased beam update requirement in the Manhattan scenario, when handled by practical beam update rates and manageable beam sets.

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70% of the time the loss stays below 3 dB, the chosen beam is generally the optimum one or one consecutive neighbour. Although this loss can be considered in general operation, it is also important to consider the loss experienced at a low probability conditions. When CCDF = 10^{-1}, the loss observed in the above picture exceeded 10% of the time. SG1 presents then a 10% probability of exceeding a 10.9 dB power loss with N_{ngh} = 4 and 10.5 dB with N_{ngh}= 10 in the Manhattan scenario, and this margin when using different N_{ngh} slightly increases for the highway scenario – which ranges from 6.0 dB to 5.3 dB. Again increase in neighbor makes a noticeable impact on SG2 performance.

VI. CONCLUSION

The use of multi-element antenna systems in vehicles stands as a promising enabler for the most demanding driving applications foreseen in the connected and automated future of transportation. The millimeter wave band and its large available bandwidths will be the next step to support the most data-hungry services beam forming is essential to overcome the propagation hurdles at these bands. Beam formed vehicular communications with the currently specified mechanisms are described. With these considerations, two beam management strategies have been proposed, inspired by conventional procedures used today for links with the base station. The strategies are analyzed in terms of power performance – addressing time and power loss related issues.

The proposed strategies differ fundamentally in the approach to maintain the optimum beam pair from a subset of beams, either by establishing a wide-beam anchor and refining (Strategy 1) or by constantly measuring a subset of sharp beams (Strategy 2) The proposed strategies differ fundamentally in the approach to maintain the optimum beam pair from a subset of beams, either by establishing a wide-beam anchor and refining (Strategy 1) or by constantly measuring a subset of sharp beams (Strategy 2). both approaches see these metrics improved when beams are more frequently updated. operating just with fine beams (Strategy 2) presents the best performing power metrics, Strategy 1 remains stable regardless of the beamset size, so having a coarse anchor beam appears to give predictable results unless this one deviates from the optimum.

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