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Reliable Communications for Vehicular Networks

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Vehicular communications, referring to information exchange among vehicles, and infrastructures. It has attracted a lot of attentions recently due to its great potential to support intelligent transportation, various safety applications, and on-road infotainment. The aim of technologies such as Vehicle-to-Vehicl (V2V) and Vehicle to-Every-thibg (V2X) Vehicle-to very-thing is to include models of connectivity that can be used in various application contexts by vehicles. However, the routing reliability of these ever-changing networks needs to be paid special attention. The link reliability is defined as the probability that a direct communication link between two vehicles will stay continuously available over a specified period. Furthermore, the link reliability value is accurately calculated using the location, direction and velocity information of vehicles along the road.

Keywords: Vehicular networks; routing reliability; link reliability.

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1. INTRODUCTION

Vehicular communication is a growing field of the vehicle-to-vehicle communication that include infrastructure of roadside communication [1]. Advances continuous in wireless communications make it potential to interchange information by communicating among vehicles and networks in the real time, and this has been resulted in technologies aimed at the increasing of vehicle safety and contact between passengers and Internet [2]. Vehicle connectivity standardization initiatives are also under way to made vehicular transport safer, and simpler [3].

Vehicles are expected not to be only safer, but also greener and more enjoyable and comfortable, with the present of automotive technologies though self-driving is defining necessity for possible vehicles [4]. in addition, (VANETs) Vehicular communication networks allow cars to communicate with each other's through vehicle to vehicle [5,6].

(V2V), communication and the network through vehicle-to-infrastructure (V2I) communication, and to exchange information efficiently and effectively through (V2V) and (V2I) communications, or generally, vehicle-to-everything (V2X) communication, as a promising technology to serves these standards [7, 8]. (VANETs) also can be make a range of useful applications simpler such as improving safety road, management of traffic, self-driving assistance and mobile data services for vehicles [9-11]. While efficient and effective vehicle communications to meet different criteria in specific higher reliability and lower latency also are very difficult to provide [12,13]. The dynamic nature of (VANET) topologies makes trust assessment between the involved vehicles is technically challenging and crucial for the applications. In large (VANET) environment, and vehicles are assumed to have unknown confidence relationship with each other [14,15].

Computer network fields are changing day after day and, owing to increased features across traditional networks, new approaches such as the named data networks (NDNs), SDNs and ad-hoc vehicle networks (VANETs) become more attractive [16,17]. NDN is a new paradigm that mitigates the IPv4's technique of addressing the constraints [18]. In NDN there is communication with content names instead of IP addresses between various nodes [19]. On the other side, by separating data and control planes, SDN gives greater control and managed the network effectively [20,21]. VANET Communication comprises two components I V2V (vehicle to vehicle) (ii) V2I communications (vehicle-to-infrastructure) [22,23]. In V2V, communication among various cars is carried out through the vehicles and in V2I via roadside devices (RSU) [24,25]. When each vehicle has flooded the identical packets, a broadcast storm problem arises. The diffusion storm problem can be handled with the use of both NDN and SDN in VANETs [26,27]. In this article we presented a novel approach to mitigating storm diffusion, called the Broadcast Storm Avoidance Mechanism (BSAM) [28,29].

Traditional vehicles networks rely on end-to-end communication that results in inefficiencies in vehicle data transmission [30,31]. In this letter, we present Named Data (NDN) to the vehicle network in order to utilize the benefits of NDN in order to increase the efficiency of vehicle data delivery [32,33]. In the vehicle network, however, many mobile cars participate in a backbone routing process, leading to rapid changes in the backbone topology and making it impossible to preserve transmission data and to accomplish the major benefit to NDN's data delivery aggregation [34,35]. As a result, cars often use broadcast to provide data, resulting in substantial data transmission and delay [36,37].

As intelligent transport systems developed quickly, large quantities of delay-sensitive vehicle services emerged and both vehicle network architectures and protocols were challenged [38,39]. However, present cloud-based embedded vehicle networks cannot ensure prompt data or service access due to lengthy delays in propagation and cloud traffic congestion [40]. Meanwhile, the existing dispersed network design does not allow the administration of scalable networks and makes smart data computers unusable [41-43].

The development of transport systems has attracted a great deal of attention from cars to cars and vehicles to infrastructure connectivity. Efficient routing mechanisms are a significant problem for delay intolerant networks like VANET [44,45]. In this respect, geo-routing methods give the finest services due to their simplicity and lack of road finding [46]. While the coordinators are best for transferring a packet in most of the existing geo-routing protocols, study into the technique of selection of coordinators is lacking [47,48]. A coordinator is a car that has the highest number of neighbors surrounding it and therefore makes it easier to send the package [49].

Vehicle ad-hoc networks (VANETs) are meant to ensure traffic safety by enabling vehicles to proactively prevent collisions using information such as speeds, position and cross-vehicle direction [50,51]. However, if not safeguarded, assaults targeting these networks might outweigh their benefits. Vehicle botnets are a major threat to VANETs [52]. In our previous work, we have numerous assaults by vehicles botnet that may damage the security and privacy of VANETs [53,54].

Vehicle networks provide new potential for developing novel and sophisticated solutions for dependable vehicle communication [55,56]. A large density of cars on the road is required for efficient information distribution in vehicle networks [57,58]. Information transmission is a particularly essential issue as vehicle networks typically do not have continuous connectivity from end to end, characterized by substantial node density fluctuations [59]. Connectivity between vehicles and vehicles (V2V) and infrastructure becomes harder to maintain when the vehicle density is low [60,61].

The design and use of series and various types of network deployments is feasible in many contexts via advances to hardware, software and computer technologies [62,63]. The vehicle ad hoc networks are one example of these networks that are deeply concerned with research and industry (VANETs) [64,65]. Information distribution is now accomplished by routing in real communication networks. Nevertheless, network coding may be seen as the optimistic generalization of routing that has the ability to change network conditions [66,67]. Although several investigations of the application of network coding to broadcast communications in mobile ad-hoc networks have been carried out, there are few radio broadcast protocols for network coding applicable to VANETs [68,69].

The main aim of the analysis conducted in this study is to display that implementation of this clever transport engineering systems lead to genuine road safety advantages. The development of technical solutions aimed at improving safety road is most important area of focus in vehicle industry today.

The remainder of the paper as follows is organized; in Section 2, the vehicle network, protocols, architectures, applications and characteristics are explained. In section 3 focus on reliable vehicular communication that presenting the REMD and Reliability cross-layer approach between network layer and transport layer.

2. VEHICULAR NETWORK

In order to avoid accidents and improve road safety, the production of (VANETs) is needs to spread road safety information between vehicles [70]. All data have been collected from sensors on vehicle can being, according on certain requirements, that displayed to driver and transmitted to a roadside unit RSU or were transmitted to neighboring vehicle [9,10,71]. In addition, to road safety several many applications are propose for vehicle networks such as car to-home communications, Distribution of tourism and travel information, Multi-media game applications and Internet connectivity [72]. Fig 1 represents an illustrative example of Vehicular Networking.

2.1 Vehicular Networking Architectures

Vehicles communicate with (VANET) by wireless connections that are installed on each vehicle node [73]. The nodes communication to the other intermediate nodes which put in its own transmission extent, each node within (VANET) function as both router and network's participant [74]. According to their self-organizing nature, (VANETs) have not set architecture [75]. (VANETs') architecture divided into three types:

a- Pure wireless local area cellular networks.
b- Pure ad- hoc networks.
c- Network hybrids.

2.1.1 Pure wireless local area cellular networks

vehicular nodes access to the Internet by the cellular gateways and wireless local area networks access points. Also, by providing data on traffic management and traffic congestion it supports vehicular nodes. Infotainment services as data uploading, the latest news parking information or advertisement are also offered [76]. Owing to large cost of cells tower, the wireless access points and geographical constraints, the implementation of some forms of architecture are very difficult [77]. The cellular wireless local area network is shown in Fig 2.

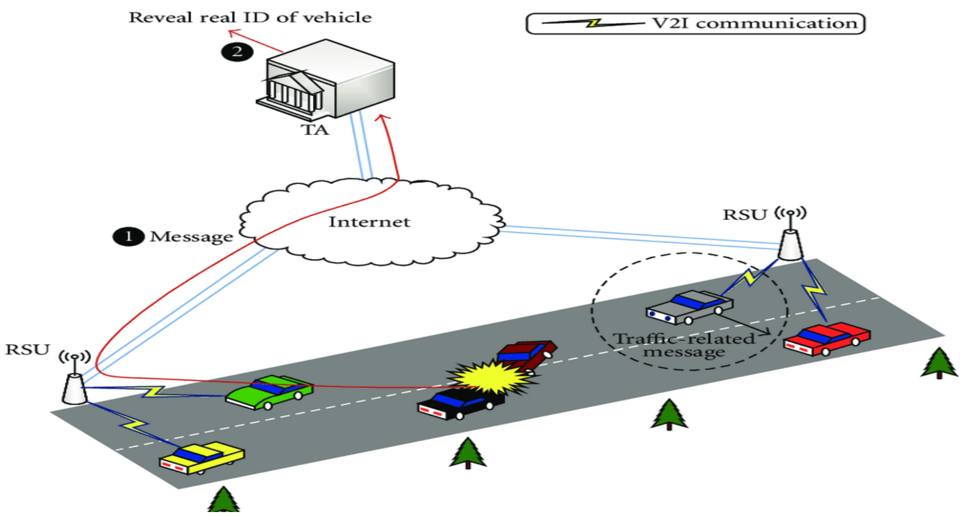

Fig. 1. Vehicular networking [72]

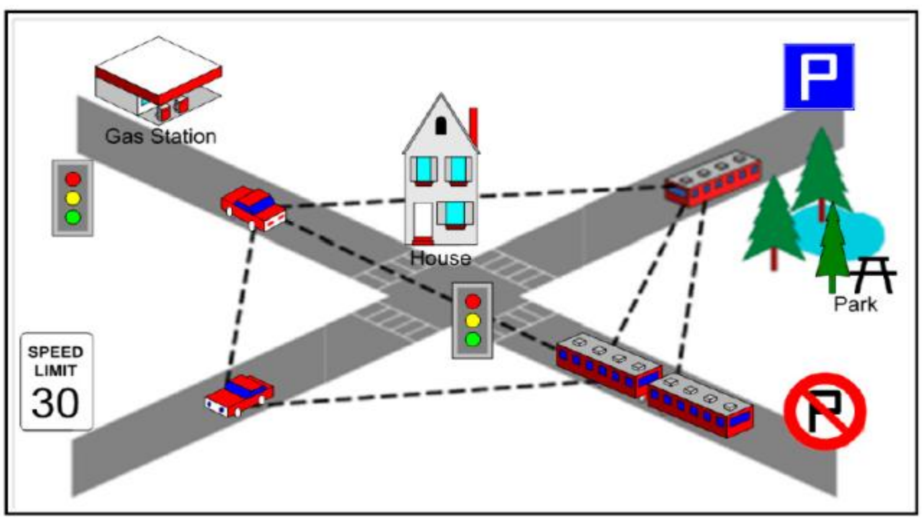

Fig. 2. Pure wireless local area cellular networks [77]

2.1.2 Pure ad-hoc networks

Communication between nearby vehicles and vehicles is given. It's also called an (ad-hoc inter-vehicle network). Without considering any fixed infrastructure this type of disseminates road-related information and architecture collects. Vehicle is free to travel on route, and the high mobility of vehicles creates rapid changes in topology of the networks. The rapid modifications in the topology generate fragment in the networks. Because the high mobility of vehicular nodes the frequent partitions of the network render routing the data more difficult in pure ad-hoc mode. The value of pure ad-hoc is mode that overcomes the expense of the base station deployment. The pure ad- hoc networks architecture is show in Fig (3).

2.1.3 Network hybrids

It consists of domain and an ad-hoc domain for infrastructure. Connection between (V2V) vehicles and vehicles also between (V2I) vehicles and infrastructures is given. This type of architecture is useful in enhanced versatility and provides richer content in sharing content [75,79,80], the hybrid architecture is show in Fig. 4.

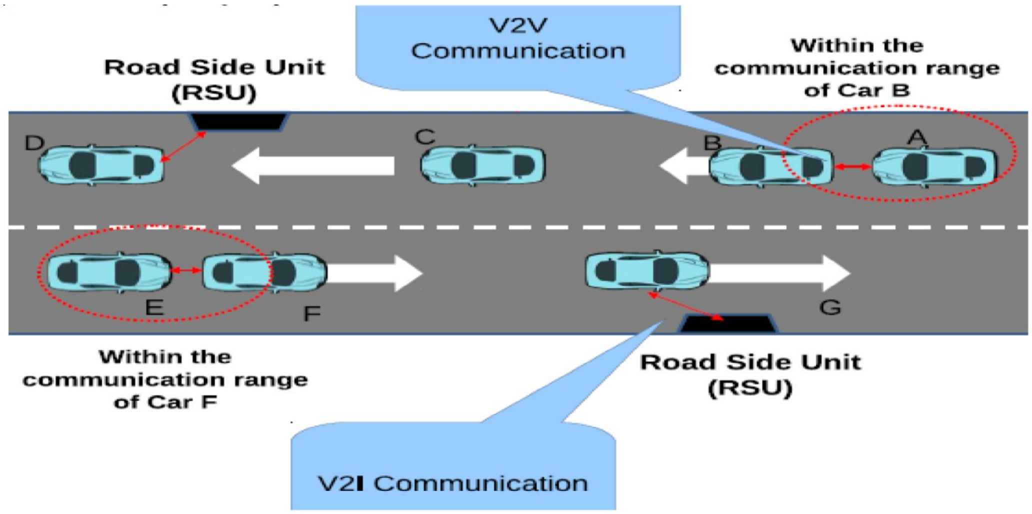

Fig. 3. Pure ad-hoc networks [78].

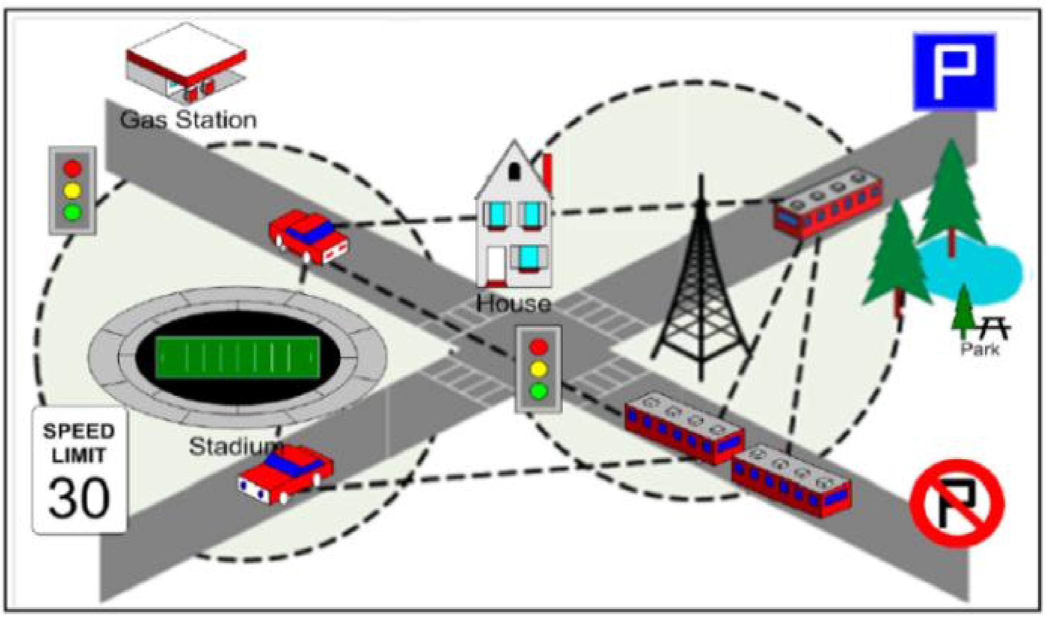

Fig. 4. Hybrid architecture [75]

The biometric information is stored in a database after extracting the important features in return, when the identity of the person is verified, the same methods are used to extract the features and compare the result with those stored in the database in the event that the extracted characteristics match a certain percentage, and the system makes an authorized or unauthorized decision. [81]. The necessary steps of any typical authentication biometric system comprise four steps Fig 1.

Acquisition: Biometric sensor hardware is the core component of this device, collecting biometric data from individuals. There are camera sensors to take pictures of a person's face and iris image, scanner to extract fingerprint samples [82,83].

Feature extraction: The extracted biometric information is then stripped of all obsolete or corresponding data and isolated useful characteristics [84-86].

Matching component: In this stage, the unknown features are evaluated against the stored database results. The result represents the degree of similarity between a pair of biometric data using the same features [87,88].

Decision module: Here function vectors from an unknown topic are matched against data in a database. The matches are then placed into a matrix as scores representing the degree of relation between the unknown data and the stored reference data. For the same subjects with both positive and negative data, you need high and low scores and different issues and have other final scores [87, 89].

2.3 Characteristics of Vehicular Networks

(V2V) communications are essentially carried out in vehicle networks by applying principles of the mobile ad-hoc networks MANETs, for example, wireless communication is spontaneously developed for data exchange. In addition, to some related characteristics to MANETs [90,91]. The vehicular network has been their own specific characters because their mobile nodes, as management and self- organization, short to the moderate transmission range. Omni-directional transmission and low band width. These characteristics can be divided into detrimental and beneficial ones, depending on whether they are useful for the exchange of knowledge or not.

- Characteristics of detrimental: These characteristics affect obstacles and threats to vehicular network including the high mobility, dynamic communication environments and strict delay constraints.
- High Mobility: Speed of high vehicle movement also leads to often interrupted wireless contact the link and then decreases amount of effective time between vehicles for communication. In addition, is also causes topology of networks to changes dynamically and furthermore adds challenges to exchange of information between vehicular.
- Stringent Delay Constraints: Some vehicle networks systems, as some infotainment applications and security applications enable the sharing of information to be performed successfully within a specific time period in order to prevent accidents of traffic and to ensure quality of infotainment services, so the delay referred to the maximum retard from the source to destination, and not the typical vehicle network delay [91,92].

2.4 Vehicular Networks Applications

Networks of communication are traditionally originated for information exchange and support for wide range of cooperative application for moving vehicles that can be divided into non-safety application and safety application.

2.4.1 Safety application

A safety resources can be provided by exchanging safety-related information, traffic incidents can be dramatically reduced, and the lives, health, and properties of passengers can protect effectively. Once safety related information has been obtained from others vehicles, and drivers could be taking measures in the advanced to develop driving safety and to be aware of unexpected hazardous circumstances in order to avoid traffic accidents [93]. Vehicle travel state information like real-time location, direction and speed is one type of the safety related information, and this type of information is critical not only for assisting automated driving systems or drivers in passing and avoiding collisions and changing lanes but is also for maintenance of the string stability of platoons/convoys by cooperative driving between AVs [94]. Another type of safety information such as traffic situation warning, emergency vehicle alert and rear-end collision caution is case driven safety data. In order to help others vehicles, gain real-time knowledge of situations and identify potential hazards, event driven safety information created by some vehicles participating in detection a dangerous status as emergency brake and sudden lane changes, must be exchanged. Sharing collaborative collision and rear-end clashing caution information between vehicles as shown in Fig 5, can be help prevent accidents in several scenarios [91,95].

2.4.2 Non-safety applications

Value-added services, such as traffic management and infotainment assistance, can be offered to improve commuters' comfort by exchanging information between moving vehicles. Many traffic management applications are designed to reduce traffic congestion, similar to some safety applications, in order to develop traffic flow and to save for commuters travel time. Traffic management applications may, for example, be implemented by exchanging information on traffic monitoring and road situations between moving vehicles to assist drivers in redirecting to their destinations and to improve the efficiency of traffic light schedules, thereby reducing traffic jams[80, 96]. Infotainment-support applications, unlike traffic control, focus primarily on offering location-based services and amusement means for travelers. Infotainment-support applications, for example, may provide location information for moving cars, such as fuel stations, parking, restaurants and hotels, when related services are needed by drivers or passengers [96,97]. In addition, infotainment-support applications can also provide moving vehicles with Internet connectivity for downloading multimedia entertainment information [96]. The implementation of non-safety and safety applications has their own problems, considering the advantages of the above applications. All usable spectrum resources could be used for each of safety or non-safety purposes in a vehicle network with any communication technologies. Relevant information is of high importance for safety applications in terms of transmission delay and reliability, so that drivers can receive it and take effective action on time [96, 97]. Moreover, meeting these criteria is often very challenging because changeable network density, high mobility, and unsettled topology in the vehicular networks [79,92,96,98,99]. Safety applications have given higher primacy than non-safety applications for these reasons. Many Non-safety applications have not strict real time specifications, unlike safety applications. However, it’s necessary to develop the service quality of non-safety applications and especially for some infotainment applications [96] [26], in order to decrease the delay and packet absence for Non-safety information without affecting safety application.

2.5 Vehicular Networking Protocols

(DSRC) Dedicated short range communications based on the IEEE 802.12p standard and cellular communications with 3Gpp LTE are the most common emerging wireless access protocol candidates for vehicular communications.

(DSRC) it depends on the wireless two-way device operating within licensed spectrum band of (5.9GHz). In the USA, the spectrum (75MHz) was reserved by the Federal Communication Commission, while in Europe, (ETSI) allocated 30MHz in the same category. The major physical and (MAC) layers are depends on the (IEEE 802.11p) standard in both USA and Europe. In Europe, ITS G5 has been introduced within the (ETSI, and ITS-G5A) specified to security related applications andthe ITS-G5B dedicated to Non-safety application [100,101]. The implementation in the USA. On the other hand, meets (IEEE WAVE) standard [102]. The major comparison between 2 implementation which are the upper layer and networks in particular as show in Fig 6. The dual stack architecture is confirmed by both implementations separating traffic into generic IPbased applications and ITS-specific applications. A latter is supported over an IPv6 network via TCP/UDP or another transport protocol. These are non-security applications and are taken into the European stack by (ITS G5 B) or (UMTS. IPv6) can be converted to GeoNetworking layer and GeoAddress can be used. The (ETSI) has suggested (BTP) (BTP) basic transport protocol and (UDP) such as transport protocol that runs on the top of Geo-Networking layer for ITS-specific applications. The different packet forwarding methods (geocast, unicast and broadcast) based on the regional routing is supported by GeoNetworking. On the other hand, the Wave Short Messages Protocol (WSMP) was proposed as the major networks layer for ITS-specific traffic by IEEE WAVE architecture. The (WSMP) based solely on the single-hop broadcasting unlike ETSI GeoNetworking, so no routing protocol used as no forwarding application has built in the WAVE architecture [100].

2.5.1 Dedicated short range communication in vehicular environment

For benchmarking and for the comparison with optimized protocol proposals have been carried out several performance tests of DSRC networks. The network in expressway and civilian scenarios with respects to the delay and ratio of packet delivery. Both vehicles broadcasting single hop packet of the same form such as CAMs and with size (300) byte on daily basis with frequency of 10Hz. For the assessments the following Poisson entry, they supposed density of vehicle is (1400) and (1800 veh/h/lane) by 3 lanes- direction and vehicles traveling in highway scenarios with speeds ranging from 60-120km/h9. In urban scenarios, following a Poisson entry, the density of vehicle is (900 veh/h/lane) again with 2 lanes-directions. Vehicles drive at speeds of 50-60 km/h in (Manhattan Grid Road Topology). In both scenarios the path loss model takes into account the shadowing effects and large scale, with the urban scenarios building block line of the sight communications. The state evaluation of the art work such as Mir [103] and Wu et al. [96, 100] are consistent with finding of the baseline in (figure 3). In general, in most situations (DSRC) can meets the rigorous latency constraints for effective protection, but the percentage of packet received through delay limits increase as vehicle speed and vehicle density increase. For DSRC networks, as the transport frequency and the number of vehicles increases, the delay increases. However, with the load rise of network, denser networks as the higher transportation rates results in the higher end-end delay. If the speed of vehicle increases the end-end delay increased. As a consequence of greater neighborhood densities and since they need to use channel more oftentimes for the higher transmission rates, and vehicles spends more times contending for general channel.

Only the (single-hop broadcasting scenarios) promote safety and the traffic efficiency application have been protected by the previous review. Unicast multi-hop communications are necessary for cloud-based applications and infotainment. (DSRC) cannot be fulfill data rate requirement high through putting the infotainment applications as (4K TV). by default, (IEEE 802.11p's) high data rate of 27Mbps configuration can only be accomplished with good channel efficiency. Only this situation is accomplished with static node and line of sight communications, whereas for highly mobile situations, lower rates (6-12Mbs)

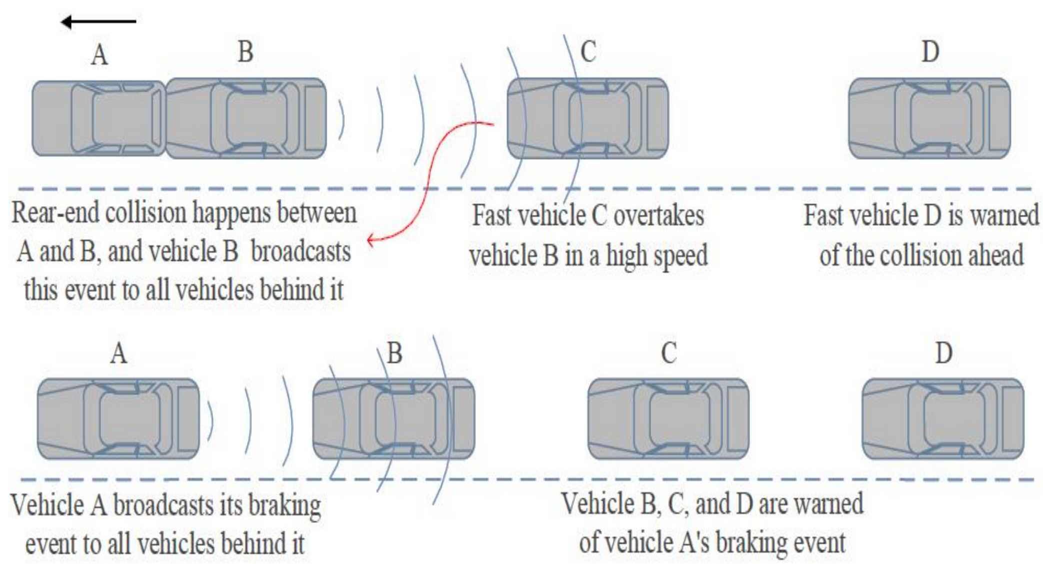

Fig. 5. Example on sharing event driven safety information [91,95]

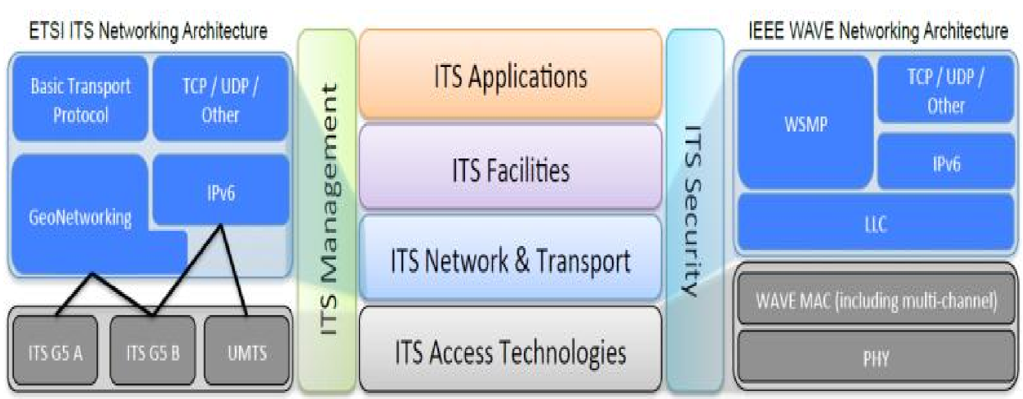

Fig. 6. Protocol stack of DSRC in USA (right) and Europe (left) [102]

that are more stable are chosen. Furthermore, connectivity to RSUs and from there to the internet is sporadic, depending on vehicle speed, with average time of a few seconds. Handing-off between RSUs in the new access point [100,104] causes major delays in address re-configuration and authentication. The Ultra-low future latency visibly cloud based real-time control system in the current DSRC system cannot be reached.

3. RELIABLE VEHICULAR COMMUNICATION

A reliable protocol is a communication protocol that notifies the sender whether it has been effective in transmitting data to intended recipients or not. Reliability is a synonym for assurance. Usually, reliable protocols are more overhead than unreliable protocols, and thus perform slower and less scalable. To guarantee high transmission reliability and minimum latency requirements of critical road safety messages in vehicular networks. There are many ways to achieve the reliability that we will describe in this chapter.

3.1 Link Reliability

Because the high relative velocity of vehicle, the discovery of stable path in VANETs is a complex activity. Most parameters such as mobility patterns and vehicle traffic distributions, influence routing performance. Comprehension of the mobility model and traffic characteristics is important for an effective vehicle reliability model. Two wide techniques have been used in transport to describe dissemination of the traffic flows of vehicles, as macroscopic and microscopic [105]. The technique of macroscopic defines with regard to macroscopic quantities, the physical flow of the traffic in given road section, as relative velocity, traffic flow and density. The cluster of vehicles are described as shown in Eq. (1).

N= _Vi, Vj , Vk, ...Vn (1)

In the highly complex environment with better QoS-based efficient routes in term of the reliability, latency, energy usage and throughput. CRLLR aims to find optimal route, while satisfying the latency constraints. We used the relative velocity coordinates of the vehicles in order to calculate the relation reliability. Suppose velocity of vehicles follows the usual distribution N (μ, σ2) and Tzis the continuous availability of a specific connection l (Vi, Vj) for each two vehicles with time, the value of link reliability (rt (l)) for link is determine [106] as shown in Eq. (2).

$$r_t(l) = \int_{t}^{t+T_z} f(T)dt \text{ if } T_z > 0 \quad (2)$$

The f (T) show (Pdf) probability density function of the communications time period (T) calculates as shown in Eq. (3).

$$f(T) = \frac{L_{V_iV_j}}{\sigma_{\Delta v_{ij}}.\sqrt{2\pi}}\frac{1}{T^2}e^{-\frac{(\frac{L_{V_iV_j}}{T}-\mu_{\Delta v_{ij}})^2}{2\sigma^2_{\Delta v_{ij}}}} \quad (3)$$

Where the μ_vij= |μvij1−μvij2| and σ2_vij= σ2vi+σ2vj represent the means and variance of the relative velocity _vij among communicating vehicles correspondingly, Lvivj shows Tz and wireless communication range it calculated as shown in Eq. (4).

$$T_z = \frac{L_{V_iV_j} - \theta\sqrt{(y_i - y_j)^2 + (x_i - x_j)^2}}{|v_i - \vartheta v_j|} \quad (4)$$

Where the ϑ =1 and θ = −1 when vehicle Vj Cross- vehicle Vi, ϑ =1, and θ =1when vehicle Vi runs forward against vehicle Vj, θ = -1 and ϑ = -1 when vehicle (Vi & Vj) is moving toward each other. For the all specific route K(sr, ds) among destinations ds and source sr, shows the number of link as n :I1= (sr, V1), I2= (V1, V2).......... In = (Vn, ds). For each link In (n =1, 2, 3, ...n), denote by rt (li) value of their link reliability as calculated using [9].

3.2 Route Reliability

Reliability of the multi-path route for any route (K) is represented with R (K (sr, ds)) is defined as shown in Eq. (5).

$$R(K(s_r, d_s)) = \prod_{i=1}^{n} r_t(l_i) \text{ where } 0 \le R(K(s_r, d_s)) \le 1 \quad (5)$$

The value of route reliability is products of values of relate reliability of links that make up this route[106].

3.3 Reliable Emergency Messages Dissemination, (REMD)

Reliable emergency message dissemination is prepared to publish highly accurate emergency communications throughout the urban vehicle network. REMD's key concept to ensure broadcasting reliability (for example, rth =99 percent) [98, 99], each hop with conducting optimum number of repetitions of the broadcast. Essentially, with the high precision, REMD calculates the receptions efficiency of the wireless link in the transmission range. Then, to determine an optimum number of the messages repetition and to pick multiple forwarders and its locations on any hop, this information is used. To improve the achievement of high reliability, the forwarders of any hop conduct cooperative contact.

The solution to existing reliability problems is given by REMD. More precisely, REMD enables the link reception quality to be estimated or predicted with high accuracy, and then uses this knowledge to guarantee:

802.11p- based broadcast one hop reliability: by conducting optimal number of repetitions emergency messages, to combat secret terminal problems, repetition pattern is counted according to (UPOC) Uni-polar orthogonal codes.

Reliability of multi-hop: by the selecting carefully multiple forwarders and its position each single-hop, and by the using cooperating communications mechanism which enable forwarders to retransmit optimum number of times, the emergency message with goal of ensuring the high retransmission reliability [98].

3.4 Components of Reliable Emergency Message Dissemination

The aim of REMD is to determine the optimum numbers of repetitions of messages and forwarder along its position, and it consist of initialization steps known as (IN) and five main stages:

a- (DC) Data Collection.
b- (LSP) Local State Processes.
c- (BR) Broadcast Reliability guarantee.
d- (FS) Forwarders Selection.
e- (C- Reliability) Cooperative one-hop reliability guarantee.

The (IN) is carried out once to given each zone zero-correlated uni-polar orthogonal code. The (LSP) & (DC) are continuously runs, while (FS), (BR), and (C-reliability) only running when there is incident that needs messages to transmitted to the vehicles in the target place. It is an important to remember that of safety application that relies at one- hop message transmission, REMD is also applicable. The (FS) and (C-reliability) phases are neglected in that context.

a- (DC) Data Collection; is carried out by the uniform vehicles and its more precisely, the uniform vehicle record the state details of that vehicle, e.g. (average signal power attenuation and packet collision rate), and then it includes in their periodic beacons this detail. The purpose of this process is to providing information to the coordinator about condition of the wireless channel in their successfully zone.

b- (LSP) Local State Processing; is performed by the coordinator with process beacons obtain from adjacent vehicle to predict or estimate the receptions quality of (802.11p) wireless communication of vehicles in any area, and this information then used in the next (CP).

c- (BR) Broadcast Reliability; is done at the forwarders and source. The source or forwarder calculates optimum numbers of broadcast repetition using recent obtained CPs that meet reliability criteria in thier transmission range.

d- (FS) Forwarder selection; is performed at the particular forwarders and source. The forwarders or source select several forwarder nodes and its locations in their transmission range using recently obtained CPs.

e- Cooperative one-hop reliability guarantee (C-reliability); the same hop forwarders perform distributed C-reliability and organize the collection of the next- hop relays. Precisely, the forwarder carries out cooperative cooperation to send or repeat the appropriate number of times emergency message, with a goal of ensuring high reliability in the next Hop [98].

3.5 Reliability and Cross-layer Approach between network Layer and Transport

Due to the wireless nature of the VANET environment, vehicle-to- vehicle or (inter-vehicle) communication networks are connected to the problems of the incessant networks route breakup led to the erroneous messages' transmission. The challenges of the reliability in vehicular communication networks emerges from this issue. In order to achieve efficient transmission of the packet in wireless communication with regarding to vehicular communications network, and many errors recovery strategies were implemented and

Table 1. The advantages and drawbacks

Feature	Advantages	Downsides
Maintenance of road surface and signs	- Improvement of ITS systems performance	- Economic costs
Technological infrastructure	- Full operation of V2V, V2I, and V2X communications	- Complexity of large-scale implementation - Standardization
Big Data management	- Economic returns for possible private investors - More information thanks to analysis	- Ensure data privacy
Integration between ITS systems and technological infrastructure	- Improved performance in system operation - Development of possible new future applications	- Complexity of large-scale implementation - Standardization - Economic costs

suggested over years. In vehicular communication, standard strategies such as (ARQ) Automatic repeat re-Quest [107], and (FEC) Forward error correct ion [108], have not yet been able to achieve the desired result in the vehicular communication yet. In point-to-point uni-cast communications, ARQ can only be used to guarantee reliability. Each vehicle produces pack et regularly and automatically in face of emergencies and broadcasts to others vehicles unlike (FEC) that deal with the readily awaiting packet stream. Therefore, in the design and implementation of VANET, the problem of broadcasting communication reliability remains open research challenges. Accordingly, successful and competent loss packet recovery schemes are need for the secure and efficient vehicle communication network to be achieved on the top of inherently unreliable wireless network. In vehicular communication networks, the design of cross layer (MAC) medium access control which extends across the networks routing layer and transmission layer to help real time services and multi-media application of the immense advantage.

4. ASSESSMENT AND RECOMMENDATIONS

There are some points in (VANET) that still and needs to attention, so the most important recommendations are:

1) A new standalone algorithm must be proposed to provide modest and stable (VANET) models that can resist any vehicular scenarios.
2) Another important aspect is security which must be consider, also authentication services and privacy should be provide to overcome malicious attack from outsider.
3) Making of effect decision mechanisms without participation of driver must be develop to rule of other functional impediment in real–time system.

From the review of this paper, the advantages and drawbacks can be assessed through summarized in Table 1.

5. CONCLUSION

In conclusion, these sense public or private partnerships will have to be provided by all national governments which will allows them to find necessary fund to modernize the entire-road networks. The proper management and design of communication networks is to essential steps in delivery of the most important critical number of applications. This purpose would be a critical step in making this system robust and reliable. The time-line can be still more practically for algorithms, computational formulations, optimization models, and probabilistic approaches, and it is important to establish appropriate (its) models.

There is an increasing trend towards cooperation between vehicles and all forms of equipment in transport sector, in the main areas of interest in vehicle today industry. The requirements are necessary for realization of the effective technology cooperation at service of road safety, beginning with technologies applied to today's vehicles and that can theoretically function independently. (v2v), (v2i), and (v2x) communications are certainly play an important role among the models helpful for this purpose.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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