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Current Trends in Vehicular Ad Hoc Networks

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ABSTRACT

Vehicular Networks are receiving a lot of attention due to the wide variety of services they can provide. Their applications range from safety and crash avoidance to Internet access and multimedia. A lot of work and research around the globe is being conducted to define the standards for vehicular

Communications. These include frequency allocation, standards for physical and link layers, routing algorithms, as well as security issues and new applications. In this paper we review the standardization work and researches related to vehicular networks and discuss the challenges facing future vehicular networks.

millions of people around the world die every year in car accidents and many more are injured. Implementations of safety information such as speed limits and road conditions are used in many parts of the world but still more work is required. Vehicular Ad Hoc Networks (VANET) should upon implementation, collect and distribute safety information to massively reduce the number of accidents by warning drivers about the danger before they actually face it. Such networks comprise of sensors and On Board Units (OBU) installed in the car as well as Road Side Units (RSU). The data collected from the sensors on the vehicles can be displayed to the driver, sent to the RSU or even broadcasted to other vehicles depending on its nature and importance. The RSU distributes this data, along with data from road sensors, weather centers, traffic control centers, etc to the vehicles.

I. INTRODUCTION

Vehicular Ad Hoc Network (VANET) is the most important component of Intelligent Transportation System (ITS) in which vehicles are equipped with some short-range and medium-range wireless communication. In VANET two kinds of communication are supposed: Vehicle-to-Vehicle and Vehicle-to-road side units, where the road side units might be cellular base station for example. From the definition of VANET, a salient challenge is obvious. Suppose at the mid-night in some rural area, a vehicle has a very important data packet (i.e. detection of an accident) which should be forwarded to the following vehicles immediately. The probability of low density of vehicles in the rural areas at mid-night is very high. Consequently, in this situation the packet will be lost due to lack of presence of other vehicles to receive and broadcast it, and arrival of the following vehicles in the accident area is unavoidable. If the above discussed accident occurs in a tunnel and fire takes place, a tragedy may turned out by presence of the other vehicles; do remember tragedy of tunnel of the Mont-Blanc between France and Italy [5]. To overcome this serious issue, we suppose to utilize wireless sensor nodes on both sides of the highway too. We call our proposed system as Vehicular Ad Hoc and Sensor Networks or in short VASNET. The motive behind VASNET is safety on highway roads, since many lives were lost and many more injuries have been occurred because of the car accidents. There are two types of sensor nodes in suggested VASNET, some are embedded in the vehicles – known as vehicular Nodes (VN)- and others are deployed in predetermined distances besides the highway road, known as Road Side Sensor nodes (RSS). We can have some Base Stations (BS) such as Police Traffic Station, Firefighting Group and Rescue Team. The base stations may be either stationary or mobile. The VNs are supposed to collect the real data such as vehicle' velocity, and forward towards BSs via RSS nodes. On the other hand, for sending a query from BSs, RSS are supposed nodes receive it and rebroadcast the packet to the vehicles in its coverage area.

II. VEHICULAR AD HOC NETWORK (VANET)

Vehicular Ad Hoc Networks (VANET) upon implementation should collect and distribute safety information to massively reduce the number of accidents by warning drivers about the danger before they actually face it. VANET consist of some sensors embedded on the vehicles. The onboard sensors' readings can be displayed to the drivers via monitors to be aware of the vehicle condition or emergency alarms, and also can be broadcasted to the other adjacent vehicles. VANET can also be helped by some of Roadside Units like Cellular Base Stations, to distribute the data to the other vehicles. VANET makes extensive utilization of wireless communication to achieve its aims.VANET is a kind of Mobile Ad Hoc Networks (MANET) with some differences, like (1) Limitation in Power: in MANET, power constraint is one of the most important challenges which has shadowed all other aspects namely routing, fusion, on the other hand in VANET, huge battery is carried by the vehicle (i.e. car's battery),so energy consumption is not a salient issue, (2) Moving pattern: which is random in the MANET while vehicles tend to move in an organized fashion in VANET, and (3) Mobility: there is high mobility in the VANET in comparison to MANET. However, self-organization and lack of infrastructure are similarities between MANET and VANET. There are some salient challenges in VANET such as; (1) as mobile nodes (vehicles) moving with high mobility, therefore quick changes in the VANETs topology are difficult to control. (2) The communication between the vehicles is prone to frequent fragmentation. (3) Rapid International Journal of Ad hoc, Sensor & Ubiquitous Computing change in link's connectivity cause many paths to be disconnected before they can be utilized. (4) There is no constant density in VANET, as in highways high density and in the rural low there is density. (5) A message can change the topology, for instance, when a driver receives an alarm message, s/he may changes his/her direction, which may cause the change the topology.

III. VASNET TOPOLOGY

VASNET inherits its characteristics from both Wireless Sensor Networks (WSN) and Vehicular Ad Hoc Networks (VANET). There is no infrastructure for VANET, therefore the vehicular nodes do perform data collection as well as data routing. Therefore, the necessity of designing a new architecture to overcome the mentioned challenges is transpicuous. In this paper, we propose a novel topology, which can be a suitable solution to overcome VANET issues. VASNET is a fusion of WSNs and MANET, which can be divided in to three layers. The upper layer consisting of traffic monitor stations, e.g. traffic police located at the cities. These are connected by either fiber optic cables to form the backbone of traffic information network. The middle layer is region layer, consisting of traffic check post located through highways. These stations can be connected via the Internet or local networks, and finally the lower layer is the field layer, consisting of WSN nodes deployed on beside the highway and onboard sensors which are carried by the vehicles. These nodes are connected by short-range or medium-range wireless communication. The components are as follows:

(1) Vehicular Sensor Nodes; which are carried by the vehicles. These nodes are supposed to sense the real phenomena e.g. the velocity of the vehicle. The sensor readings are to be sent to the base stations via RSS nodes. These nodes can communicate with each other or the roadside sensor via short-range communication.

(2) Road Side Sensors (RSS); are deployed in a fixed distance beside the road. RSSs act as cluster heads for vehicular nodes. RSS nodes receive the data from mobile nodes and retransmit towards the BSs. These nodes are equipped with two kinds of antenna, unidirectional and bidirectional. Unidirectional antenna is for broadcasting and directional antenna are intended for geo-casting. We need to satisfy the following requirements for deploying the sensor nodes on a road side, such as; (a) high reliability, (b) long time service and (c) high real time.

(3) Base Station (BS); are Police Traffic Control Check-Post, Rescue Team Buildings or Fire Fighting Stations in some fixed point trough the roads. We can have mobile BS like, Traffic Police patrolling team, Firefighting Truck, or ambulance.

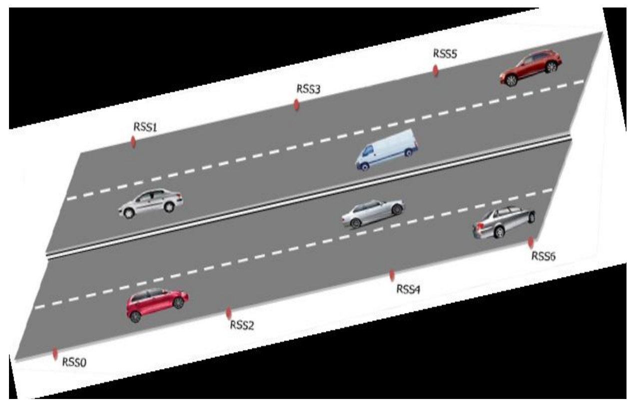

Figure 1: VASNET Topology

IV. VASNET COMMUNICATION ARCHITECTURE

The sensor nodes are deployed in vehicles as well as both sides of highway roads. Vehicular nodes have the ability to collect imperative data and route data to the base stations. Sensor readings are routed to the end users by multi-hop infrastructure architecture via intermediate nodes i.e. RSS nodes. The protocols stack which may be used by CR-VASNET nodes is given in figure 2.

The protocol stack consists of five layers and three planes. The planes are to help sensor node o coordinate the sensing tasks and lower overall power consumption. More specifically, the power management plane, manages power consumption for example defining sleep and wake status for the nodes. The mobility management plane monitors the movement of sensor nodes, so a route back to the user is always maintained. And finally, the task manager plane balance and coordinates the sensing tasks given to a particular given region. In the following subsections we investigate and briefly explain the specific design consideration of each communication layer of nodes with respect to dynamic spectrum management.

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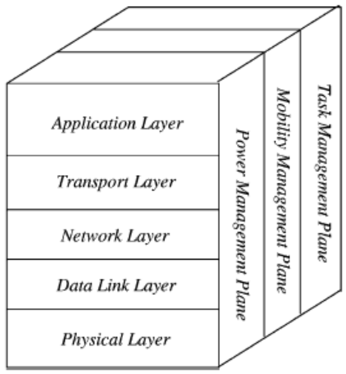

Figure 2 : The protocol stack

V. CONCLUSION

This paper presented a state-of-the-art survey in Vehicular Ad hoc and Sensor Network (VASNET), a fusion of Wireless Sensor Networks (WSN) and Mobile Ad Hoc Networks (MANETs), as a promising approach for future intelligent transportation system (ITS). However, we introduced some aspect and involved challenges. We explained feasible topology and communication architecture applicable to VASNET. And also conceivable applications were introduced. VASNET as a novel scenario for vehicular networks need a lot of research works. Hence, we state some of its requirements e.g. data fusion, localization and spectrum access.

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