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AWC: Alternating Wireless Channel for VANET Information Dissemination

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Abstract
This paper proposes the concept of the information dissemination model for VANETs communication system. The purpose of this article is to solve the problem of collision avoidance and message unreachable. An alternating wireless channel(AWC) model was developed by different wireless channels for dissemination messages to target stations. The AWC model studies the performance of disseminate information base on a fixed grid network; investigate the broadcasted message using AWC in m × n and n × n grid and then assigned to realize vehicular transport system by broadcast message agent (BMA). A BMA algorithm used the lane level position to design the odd-even lanes. This articles the wireless channel's policy is the odd lane broadcast channel x and even lane broadcast channel y.

Keywords: VANETs, collision avoidance, message unreachable, fixed grid network, lane level location information

1. Introduction

The wireless network uses radio frequency to communicate information or resource between wireless devices. RF caused by electromagnetic spectrum and generate a wireless signal channel for supportive wireless devices such as access point, mobile, Tablet, etc. Wireless manipulate a channel by media access control (MAC) protocol [1] which control and manage mobile device access to the wireless channel. Two categories of wireless form are infrastructure-based and mobile ad hoc network (MANET). The infrastructure-based network, with preconstruction or fixed, wired network node and gateways such as WLAN. On the other hand, an ad hoc network is a group dynamically and self-organize of mobile nodes. Each node moves randomly and connects to nearby nodes directly without a centralized administrator. In addition, the connection of the mobile ad hoc network (MANET) can communicate both types wirelesses, properties differ from an infrastructure-based network such as ad-hoc-base, autonomous, and mobility.

The MANET is a multi-hop network that is highly node mobility using IEEE 802.11 standard and CSMA/CA[2] for media controllers and disseminates data many platforms such as broadcast, multicast, unicast, and geo-cast [2]. In an Ad Hoc network, routing protocols are the mechanism to search or find between the pair nodes. Proactive routing and reactive on-demand routing protocols are two basic routing mechanisms. A proactive routing maintains up-to-date routing information between every pair of nodes in the table, such as DSDV, CGSR, WRP, GSR, OLSR, FSR, LAN-MAR, and HRS [3]. The reactive on-demand creates a route to destination nodes only, such as DSR, AODV, TORA, ABR, and SSR [3]. However, these routing protocols perform based on information dissemination by used broadcast protocol [4].

The wireless network was applied to many applications, where one of the applications is Vehicular Ad Hoc Network (VANET). VANET is an application of MANET that can communicate in the style of ad hoc and infrastructure-based. Accordingly, there are two types of VANET called stationary, and movement. An access point is a stationary device or node is placed on the road or roadside. The movement node is in a vehicle. The VANET characteristics are movement rapidly, no limitations of the power consumption and vehicle movement under constraints of the street lane and traffic rule. Each node communicates based on short-range wireless communication. The federal communication commission (FCC) proposed dedicated short-range communication (DSRC) [5] protocol applied for modern intelligent transportation. The DSRC is resulting in various vehicle communication platforms as vehicle-to-vehicle communication (V2V), vehicle-to-roadside infrastructure (V2I), and road-to-vehicle communication (RVC) [6]. Information dissemination in VANET broadcast various types of the message such as safety traffic, infotainment services, and data content. These reliable messages depend on information dissemination, which sends messages or data from transmitter to receiver. Many factors affect information dissemination in VANET, such as street layout, the speed of the vehicle, density of vehicle, or size of the network. These factors are challenging for many researchers. The e-road project [7] proposed the traffic view for disseminating and gather information about the vehicle on the road. A beacon message dissemination [8] is the safety message in which the vehicle attempts to inhibit events that may occur, such as wrong left/right turning, forward collisions or error lane changing. The resources information dissemination applied the information dissemination report to represent spatial-temporal events (parking-slot) by a simple flooding algorithm.

Currently, the VANET is combining with other technology for information dissemination adaptation. The global positioning system (GPS) is the technology to determine their current location, time, and velocity. The VANE GPS is applied for location [9] or position services. The direction antenna [10] is used to control the angle by cooperating with GPS. The software mobile agents [11], widely used in VANET to exhibit intelligent behavior involving discovery, routing, and broadcast message. The main characteristics of agents are; mobility, autonomy, adaptability, interaction, and interoperability.

This paper is addressed the performance of information dissemination in VANET by studying the message passing from a fixed grid network. Next, adapt to ad hoc network by simulation in cellular automata [12] and finally, simulates in the fashion of 2D automatic movement by used mobile agents in city section mobility model [13]. The rest of this paper is structure as follows. Section 2 revises the problem to disseminate in the fixed grid network. Section 3 proposed the AWC for these problems and applied it in VANET. Section 4 is the future work. In section 5 is the summary of this work.

2. Fixed Grid Network Information Dissemination

Fixed grid networks are the graph, which shares between nodes and edges. The node denotes a network station, and the edge represents the communication channels between nodes. Information dissemination or broadcast in a fixed grid network, which is the passing of messages completely between nodes via edges. Tree type grid to verify in this study are; m × n, n × n: n = 2k + 1, and n × n: n ≠ 2k + 1, when m = row, n = column, and k is a non-negative integer.

2.1 The broadcast message Definition

Two mechanisms for message passing are shouting and whispering, show in figure 1. The shouting is sending the message to all of one's neighbors in a single time step. On the other hand, the whispering is sending to only a neighbor node at a time. In the transmission mode, the nodes are allowed to transmit to all neighbors at once. It is unable to receive more than one transmission by using the same communication channel at a time.

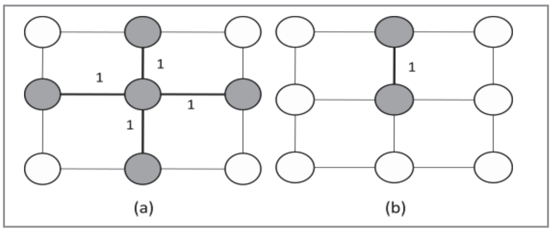

Figure 1. Shouting (a) and whispering (b) message.

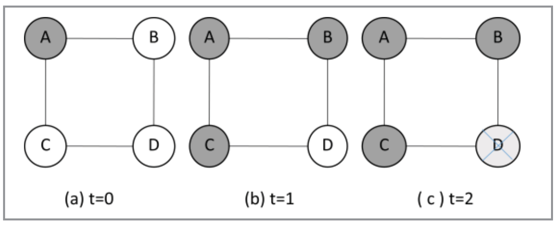

Figure 2. A collision of message.

A collision occurs if the node attempts to receive a message from more neighbor's nodes. Picture 2 illustrates shouting from a corner node. Node A sent the data to nodes B and C when t is 1. In the second step, t is 1, nodes B and C receive the message and attempts to send the message to node D. In the third step, t is 2, the data collides, and node D cannot receive the data.

2.2 Broadcast Message Theorems in Fixed Grid

The efficiency of message passing in a fixed grid is the time step to pass the data from the original node to the last node. In the worst case of the fixed grids, m × n and n × n nodes are the one corner node. Usually, each node attempts to pass a message by shouting, but it may be impossible due to collision or data reached. The meaning of reach, the data touched all nodes and collision. For the performance of broadcast in fixed grid proposed tree theorems as follow:

1. *Broadcasting cannot be completed by shouting in an m x n grid where m and n are both greater than 1.*
2. *All nodes in an n x n grid, where $n = 2^k + 1$, for a non-negative integer k, will be touched by shouting starting from a corner and continuing until doing so no longer advances the message.*
3. *If a message has been shouted throughout an n x n grid, where $n = 2^k + 1$, for a non-negative integer k, by starting in a corner and continuing until the message is no longer being advanced, then broadcasting can be completed in one additional time step if all of the informed node whisper once in the same direction away from the source corner.*

Figure 3, illustrate broadcast message in the fixed grid 3 × 4, in which a message has been shouted from the upper left corner.

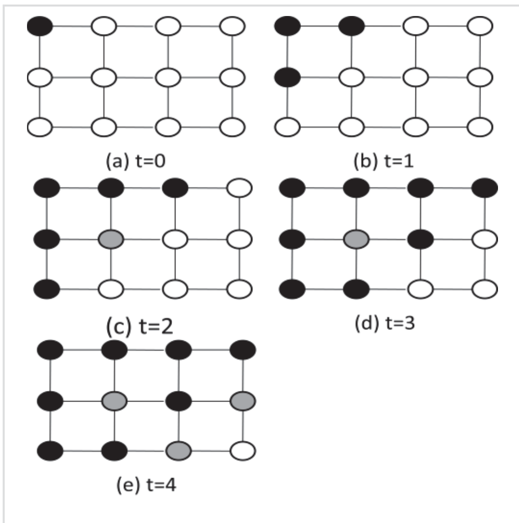

Figure 3. Time step for broadcast in fixed grid 3 × 4.

Reference to theorem 1, the message cannot be touched all nodes after broadcast completely in figure(3), where the black node denotes received. The grey node is denoted the reach, and the white node is denoted the message never reach. In $n \times n$ grid or a square grid, if n = 2k + 1 such as; n = 5, 7, 9, the message can touch all nodes as follow theorem 2, but cannot reaches because the data collide in some nodes. Broadcast message in n × n, where n = 5, shown in figure 4 (a). After the broadcasting, the data touched all nodes. In this case, the broadcast cannot complete. From theorem 3, broadcasting can be completed by using whisper in the same direction away from the source corner, shown in figure 4 (b). In the case of $n \times n$ grid, and $n \neq$ 2k + 1, such as 4 × 4, shown in figure 5. The message cannot touch all nodes due to a collision of messages. After the messages occur collisions, their node cannot advance the message to the neighbor's node. In the next section, we will be proposing the idea for this problem.

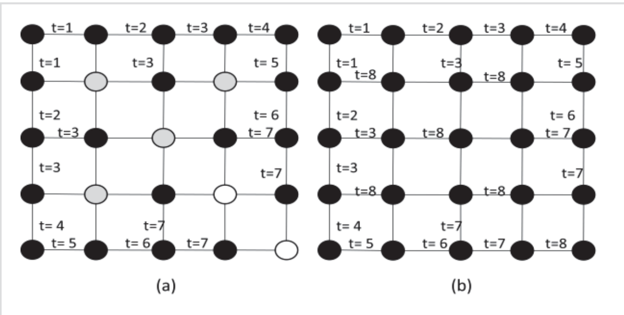

Figure 4. Broadcast in grid 5 × 5, message touched all nodes and not complete in (a), message received completely in (b) by whispering.

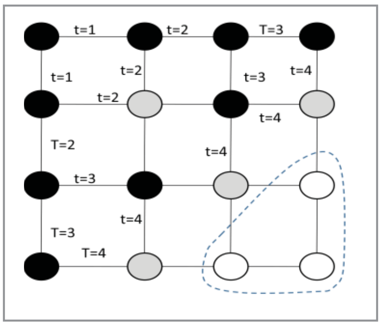

Figure 5. Broadcast in 4 × 4 grid.

3. AWC Dissemination Model

In the previous section, the message collision has affected the performance of broadcasts in the network. This case was the result of message reaches and message touch. We propose the AWC model to solve these problems. The main AWC structure composes agents and algorithms, which broadcast different communication channels together with lane information. Before broadcast messages, each node received data from the neighbour node and lane location information from GPS [14]. An agent BMA will be used this information and algorithm for the broadcast message to the next node. A broadcast for AWC illustrates in figure 6.

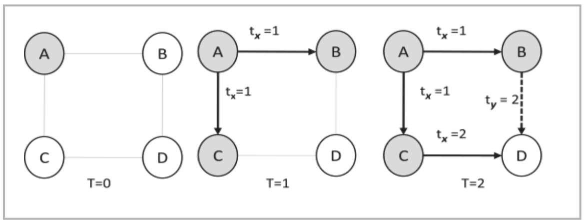

Figure 6. The broadcast model of AWC.

In figure 6, the message starts from node A at *T=0*, where the BMA copies the message and is sent by two different routes. At time *T=1*, the first route is ***tx***, and the second route is *ty*, while *x*, *y* is the route or channel for the broadcast message. At the time *T=2*, BMA in node *D* message will be reached from two routes. In this time step, the collisions do not occur due to the message from different channels (C and B).

3.1 AWC in Fixed Grid Network

In section 2, the main problem of the broadcast message is the collision. When a collision occurs, a message will be reaching and cannot touch all nodes. The AWC in which is described in the previous section can solve these problems. Figures 7(a) and 7(b) are applied AWC in fixed by *3 × 4* and *4 × 4*, respectively. A message starts from the first node and broadcasts to row y and column x alternatively. In figure 7, a BMA in the node at the second column monitors the previous channel and change the difference channel to the next column.

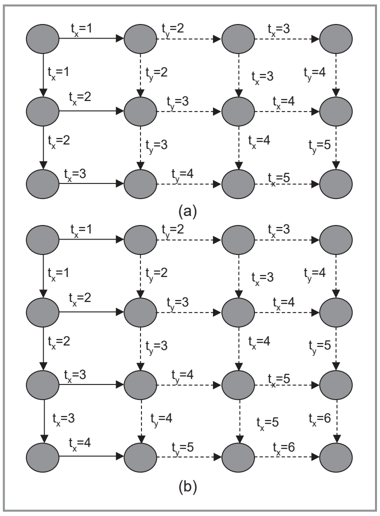

Figure 7. Applied AWC in Fixed Grid 4 × 4.

A message broadcasts by AWC in the fixed grid of *3 × 4*, shown in figure 7 (a), the collision occurs at time step t=2, t= 4, and the message can touch advances the data of all nodes at t =5. Similarly, the fixed grid *(4 × 4)* can be touch to advance the data of all nodes at t=6.

3.2 Applied AWC for VANET Disseminations

Many styles for vehicles broadcast messages as mentioned. The first time, demonstrate AWC comparable to lane on the road or V2V communication. However, uncertainly several lanes can be two, four, or six lanes. In this case, apply four lanes, and the number of vehicles is ten that the fixed grid is *4×10*. Figure 8 represents concept AWC. Each node supposes a fixed vehicle at the first time (t =1) a corner node on the left of (A) broadcast message by channel *x* (tx=1) to node B and D. Second time t =2, these nodes monitor a lane location and change to channel y if difference. Thus, node B has no change broadcast channel and node D alternate to channel y. Third-time t=3, in the same nodes C and E broadcast same as the incoming signal and Only node H alternate from x to y.

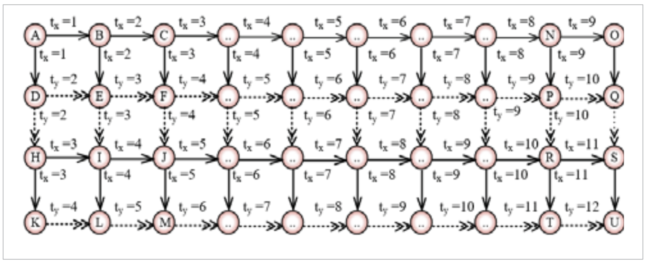

Figure 8. A message broadcast in lane *4 × 10* with AWC.

4. Future Work

The objective of this work is the improvement of the message broadcast on VANET. We approach the new mechanism by a study from the fixed grid network. Currently, exhibit the broadcast message in $m \times n$, $n \times n$ grids, and applied with the straight road VANET.

In the future, we will study this broadcasts mechanism in the intersection and crossroad. After that, we will create a framework for simulation by using a moving agent. The moving agents are the node; represent the vehicles on the road. The function of the moving is the broadcast message when nodes are a movement. For the simulation, first, we will design the BMA agent to manage and control the message. Secondly, the algorithm to provide the AWC will be designed. Finally, it was simulated using the city section mobility framework, which is referred to as the cellular automata neighborhood.

5. Conclusion

AWC model is a concept for broadcast messages in VANET to solve the problem of messages collision. The main idea of AWC broadcast a message with a different broadcast channel automatically. The BMA is agent technology for support the basics function in AWC, which manage and control messages for send or receive indifference channel. As a result of proof in this paper, AWC can prevent the message collision and touch in grids $m \times n$ and in $n \times n$; wile $n \neq 2^k + 1$, for grid $n \times n$; wile $n = 2^k + 1$, ***and*** message can touch advances the message all nodes in network.

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