비콘메세지 릴레이를 이용한 라우팅 프로토콜

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Beacon Relay Notifying Routing Protocol

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요 약

Vehicular Ad-Hoc Networks (VANET) 에서 가장 풀기 어려운 문제점은 802.11 AP들의 불규칙적인 배치로 인한 intermittent connectivity가 발생하는 것이다. 위의 문제로 인해 AP로의 접근에 대한 성능이 상당히 줄어들 수 있다. 이러한 connectivity가 없는 지역에서 안정적인 connectivity를 제공하기 위해 이 논문에서 멀티홉을 이용한 beacon relay notifying routing protocol (BRP)를 제안한다.

Abstraction

One of the most challenging problems in Vehicular Ad-Hoc Networks (VANET) is unplanned deployment of 802.11 access points (APs) throughout an area so that intermittent connectivity problem arises. Mobile users in the vehicle drive the roadway so fast that chance on connecting APs deployed along the roadside in stable is too short. This makes frequent disconnection so that results in dropping overall throughput when nodes access the Internet through these APs. To provide the connectivity in stable for the vehicles where are out of communications range of APs, we propose beacon relay notifying routing protocol (BRP) where the vehicles out of AP's range can notice where APs are nearest and can be reachable by multi-hop.

1. Introduction

The demands of providing the Internet access in the vehicles (i.e., high mobility) have increased dramatically. To meet the customers' demands, many service vendors introduce new technology, such as IEEE 802.11, IEEE 802.16, cellular technologies such as 3G HSDPA/HSUPA or 4G, under high mobility. Although cellular technologies provide the wide range connectivity, they involve low data rate and high cost, which is obviously not cost-efficient. On the other hand, IEEE 802.11 PCF mode has shorter coverage range even though it provides high data rate and low cost. In order to some reasons, it is hard to provide seamless connectivity if vehicles move fast and are outside the AP's range. The situation, where connecting and disconnecting is altered as a user moves, is called intermittent connectivity. Intermittent connectivity leads to frequent and unpredictable disconnection from APs, i.e., discontinuous connectivity. Fig.1 shows scenario of intermittent connectivity.

In this paper, we focus on providing seamless connectivity under such a tough environment, i.e., intermittent connectivity situation, which result in significant degradation of throughput and increase of delay. To deal with these problems, we introduce multi-hop.

Our basic idea is expanding AP's coverage range by using multi-hop. To do that, vehicles receiving beacon message within AP's coverage range, relay back to vehicles outside the range of AP. Vehicles receiving beacon message and outside the AP's coverage range, use this information to determine nearest AP via multi-hop. Furthermore, to utilize channel and reduce scanning delay [3], we divide a link into two channels, i.e., control channel, and data channel. Control channel which is beacon messages are exchanged and fixed. To do so, we use multi-channels/multi-radios.

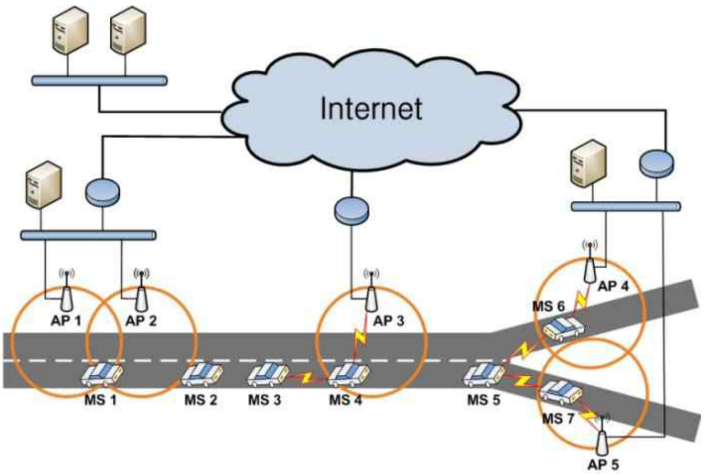

Figure.1 Intermittent Connectivity Scenario

First, we present some related work in Section 2. Next, in Section 3, we introduce our proposed protocol. In section 4, we show evaluation methodology and the results. Finally, we conclude our work in section 5.

2. RELATED WORKS

"Drive-thru Internet" highly depends on density of APs deployment at certain area. In other words, many APs cover many areas. For instance, if there are many APs deployment along roadside, vehicles have more chance to access the Internet via APs; if there is spare density of APs deployment, however, intermittent islands which are not provided for reliable connection are distributed randomly throughout an area. Furthermore, unplanned and clustered APs deployment would become much more challenge to solve above problem. Therefore, providing seamless connectivity is much important to realize the VANET.

Many researchers have conducted developing new routing protocols using carry-forward scheme, i.e., only multi-hop fashion, not infrastructure fashion. [4] describes that if a moving vehicle carrying the packet, meets a new vehicle moving near the destination, then it forwards the packet, i.e, opportunistic fashion. However, if there is no route to go further no longer, a packet goes around rather than shortest path. [5] also uses stored-carry-forward scheme, but it uses static assisted nodes deployed over traffic light to minimize packets' end-to-end delay in order to travel shortest path. However, what if density between cars is sparse at certain area, disconnection frequently happens then end-to-end delay is increased dramatically [6]. Furthermore, due to this frequent disconnection, traditional routing protocols such as DSDV, AODV and DSR are not suitable for the VANET. In DSDV, one of the table-driven routing protocols, it may take a long time to converge routing information so that it is not suitable to vehicle-to-vehicle (V2V) communication. The communication of V2V is unstable so that it is prone to fragile. Therefore, AODV is also not suitable because the time required by a routing protocol to detect a path is longer than the average period of path.

2.1. Internet Access for Vehicular Networks

[1] introduces a session protocol, named "Drive-thru", to offer persistent end-to-end communication in the presence of intermittent disconnection. The architecture adopts intermediate nodes "Drive-thru Proxy" to maintain the TCP connection between a client and servers throughout several periods of the AP-Client disconnections. By concealing the mobile client's temporary unavailability from corresponding servers, this protocol allows mobile clients to enjoy uninterrupted Internet application services.

[2] introduces the idea of Drive-thru Internet. It uses the WLAN technology to provide network access for users traveling by car, particularly on highways or the Autobahn. Authors have measured transmission characteristics for sending and receiving high data volumes in vehicles moving in different speed that pass one or more IEEE 802.11 access points at the roadside. From these measurements, authors analyze the performance that can be expected for the communication in several scenarios, and show that TCP performs reasonably well. Finally, implications for higher-layer protocols and

applications are discussed.

Despite the possibility of "Drive-thru Internet" explored by above works, they cannot still provide seamless connectivity.

3. BEACON RELAY NOTIFYING ROUTING ALGORITHM

3.1. Overall Procedure

In legacy IEEE 802.11 PCF mode, AP node broadcasts its beacon message periodically within its communication range (i.e., BSS). By using this message, MS nodes can connect the Internet through AP as one-hop. However, nodes which are outside the AP's coverage range has no way to connect the Internet because there is no connectivity. To address this problem supporting outside AP's coverage range, we propose multi-hop based routing protocol. The major difference between our idea and legacy IEEE 802.11 PCF mode is that MS nodes which receive beacon message within AP's communication area relay beacon message back to outside the communication range by multi-hop and through a specific channel. Using this information contained in beacon message, MS can decide which AP is closest and has route to it. By doing so, we can extend communication range significantly. The main idea of us is extending communication range by relaying beacon message and communication by multi-hop.

3.2. Main Operation of a Mobile Station

1) A MS Relaying AP's Beacon Message inside BSS

AP broadcasts its beacon messages to a specific channel periodically. When MS receives beacon message from a specific channel and it wants to communicate AP, it just follows legacy IEEE 802.11 procedure. Otherwise, MS relays beacon message through a specific channel to nodes one hop away. Nodes also do same ways. The procedure of broadcasting an AP's beacon message to a specific channel is shown in Algorithm 1.

Algorithm 1: Relaying AP notifying message on specific Channel

```
if (data to send) then
   Legacy IEEE 802.11 operation
else
if (channel is idle) then
   Broadcast AP's beacon message on specific channel
else
back off
```

Algorithm 1 consists of two parts. If a MS have data to send it just follows legacy IEEE 802.11 operation, i.e., ordinary IEEE 802.11 PCF mode procedure. Otherwise, a MS will attempt to broadcast the beacon message on a specific channel. In the meanwhile, if the medium is not idle a MS should back off a certain time as legacy technology to avoid collision.

2) A MS Receiving AP's Beacon Message outside communication range

When MS nodes outside the BSS receive AP's beacon message, it first updates routing table on whether MS nodes use or not. Furthermore, a MS may receive multiple beacon messages from so many APs. In this case, a MS uses the most nearest AP's beacon message which contains hop count information. After updating, it again relays back to MS nodes through a specific channel.

The procedure of deciding on whether to use a beacon message is shown in Algorithm 2.

Algorithm 2: Deciding whether to use an AP message

```
if a MS receives an AP's beacon message then
   if no other AP message exists then
      update routing table
      relay
   end if
   if other AP message exists then
   compare with other received AP message
      if same AP message exists (x = x) then
         discard
      else if there is no same AP message (x ≠ x) then
         update routing table
         relay
      end if
   end if
end if
```

Since many BS nodes broadcast beacon message and intermediated MS nodes also broadcast, actually relay, beacon message, following MS nodes can receive multiple beacon messages. In case of this, a MS should choose the most appropriate one. By using hop count information, MS nodes can know which AP is the most nearest and how to connect AP via multi-hop. This will allow the MS to extend communication range.

4. SIMULATION

4.1. Simulation Setup

In this paper we use high way traffic model to generate mobility. Furthermore, to implement our idea we modify AODV routing protocol. Suppose that there are some APs along the highway. A vehicle which is in AP's communication range can obtain the Internet access for some periods. In figure 1, 1) MS1 is moving left to right. At first, it can access the Internet via AP1 or AP2. However, when MS1 moves out of the AP2's communication range, there is no AP until it enters AP3's area. To obtain the Internet access persistently, a MS1 communicates with other vehicles (MS2 and MS3) and communicate with AP3 in a multi-hop fashion. If there is a vehicle which is in the AP3's area (MS4), it can forward a message to MS1 through other vehicles on the road. 2) MS5 can associate both AP4 and AP5 via MS6 and MS7 respectively. In this case it must choose one AP. MS5 can choose the AP from which receives message first. But this approach is not an optimal solution. For example, if MS5 is going to move right in the intersection, it will better to choose AP5 than AP4. This problem must be considered.

4.2. Results and Analysis

The result has shown improvements in out of the AP's coverage range than original protocol. The Figure 2 shows significant improvement in out of the AP's coverage range than legacy protocol. We succeed in providing connectivity in between 1 and 41 sec, and 105 and 201 sec which cannot be done in legacy scheme at all.

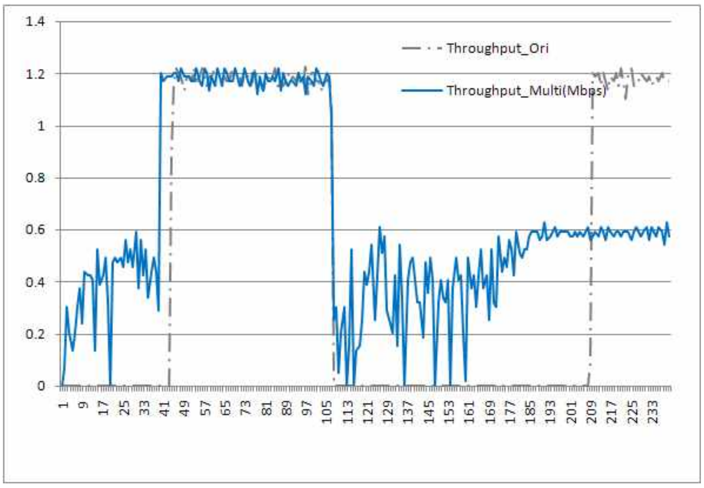

Figure 2. Thoughput_Ori is throuput of legacy scheme, Throughput_Multi is throughput of our proposal.

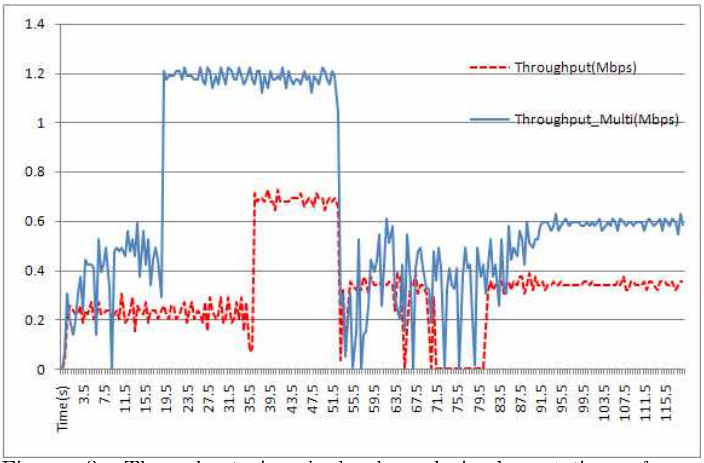

Figure 3. Throughput is single-channel implementation of our scheme, Throuput_Multi is multi-channel implementation of our scheme

Figure 3 shows comparison between using single-channel and multi-channel. When using multi-channel, the throughput is almost doubled compared to single-channel.

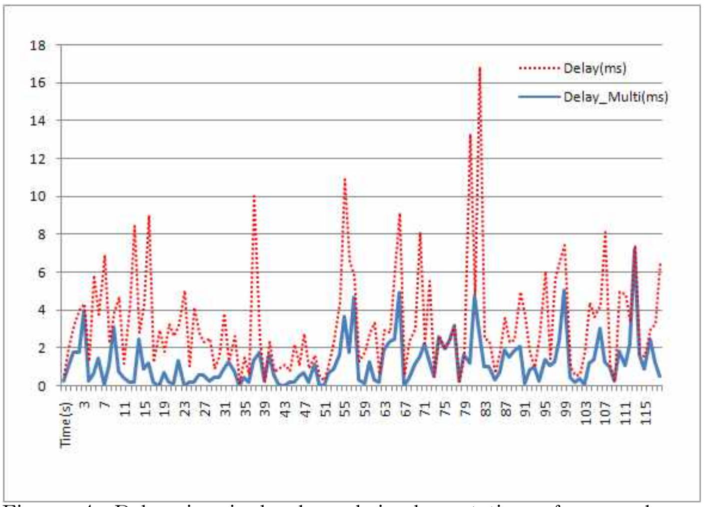

Figure 4. Delay is single-channel implementation of our scheme, Delay_Multi is multi-channel implementation of our scheme

Figure 4 shows the result of delay. It also shows double improvement in delay than using single-channel.

5. CONCLUSION

Providing seamless Internet connectivity is one of the biggest technological challenges that we face in this ubiquitous era. However, thanks to high mobility and unplanned APs' deployment, continuous network access can be hardly obtained by nomadic users. And this leads to overall performance degradation. Although our proposal provides connectivity in out of AP's range, the throughput is still unstable. This is because we use traditional AODV routing protocol to find route. We need to do research on more efficient routing protocol.

6. REFERENCES

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