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A Study of Multi-Hop Wireless Networks Model for Smart Vehicle Adaptive Traffic

Jinhong Kim[1] and Seungcheon Kim[2*]

[1]*Department of Computer Engineering, Hansung University*
[2]*Department of Information and Communication Engineering, Hansung University*

{jinhkm, kimsc}@hansung.ac.kr

Abstract

The expanding ring search is a useful technique for reducing the overhead of the broadcast storm problem when it is applied to route-searching in multi-hop wireless network for adaptive trajectory service. Usually the centered source in this algorithm searches successively larger areas to find out the vehicle location information for trajectory service and wireless network traffic condition. In this paper we propose an expanding ring search with multi-hop cooperative transmission and routing strategies that can be applied to the second part of Cognitive-Adaptive-A-Software (CAAS) Project. We suggest that the proposed scheme should be applied to Multi-hop Wireless Network Model for Smart Vehicle Adaptive Traffic.

Keywords: *Multi-Hop, Wireless Network, ERS, Network-wide Broadcast, RREQ*

1. Introduction

Broadcasting is one of public methods to resolve many issues in networks. Especially the broadcasting method in wireless networks can be used to forward data to the destination. Since RREQ packets are flooded throughout the network, this algorithm does not scale well to large networks. If the destination node is located relatively near the source, issuing a RREQ packet that potentially pass through every node in the network is wasteful. The optimization AODV uses is the expanding ring search algorithm. Usually the intermediate nodes cooperatively forward data streams toward the final destination when they receive different set of data stream in multi-hop networks [1]. In addition, they execute jobs such as finding a route to a particular host, and sending an alarm signal while they are forwarding the data streams [2]. As the demands for mobile communication network increase, the importance of careful use of radio resources increases. The deficiency of the radio resources is expected to be extreme in next generation wireless networks including vehicle inner space.

However, broadcasting data in vehicular traffic environment incurs considerable data overhead in terms of wireless bandwidth, node processing, and energy consumption [3]. The major reason of smart vehicle and smart transportation system basically lies in alleviating traffic jams and drivers burden. In other words, techniques to reduce the extent of such

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[*] Seungcheon Kim is Corresponding Author.

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broadcasting are a key requirement in resource-constraint multi-hop wireless networks. Expanding Ring Search, so called ERS, is a widely used technique that aims to avoid network-wide broadcasting by searching successively larger areas in the network centered on the source broadcast [4]. ERS can be used not only in multi-hop wireless networks, but also in other multi-hop networks, *e.g.*, in mesh networks and peer-to-peer networks [5]. Network-wide broadcasting is initiated only if the information cannot be located in the local area, and one key parameter of the ERS is the threshold of local search before initiating a possible network-wide broadcast. Although there is a large volume of work that uses ERS to reduce broadcasting, this parameter must be selected to achieve the best possible performance.

Accordingly, in this paper, we propose that there exists an optimal search threshold that would minimize the broadcast cost of ERS for the advanced Smart Vehicle Traffic Service. The major contribution of this paper is a theoretical modeling to gain an insight of the performance dynamics of ERS as a function of the search threshold, and then we're probably able to show that there exists an optimal threshold for any random network topology.

This paper is organized as follows. Section II provides a brief Network Model, Section III present analytical model, Section IV have experiment in detail. Finally Section V show conclusion in this paper.

2. Network Model

In this section, we show our network of Smart Vehicle (SV) model and notations. Then we have some preliminary research on hop-counts [6].We make the following assumptions in our network of SV that we describe: i) we assume that the source node locates at the center of circular network distributed region randomly. ii) The query packet carries a TTL value and a sequence number. iii) We define the 'Search Cost (SC)' as the number of expected inter-broadcasts before the source node receives a SC-free acknowledgement from the intended destination of the inquiry packet iv) Eventually, we assume the broadcast are collision-free, that is all broadcasts are conscientiously scheduled so that all neighbors of the sender will be able to overhead the message successfully [7]. We generalize a RS schema with a search set of $\underline{R} = \{r_1, r_2, \ldots r_n\}$.In this schema, if the search does not locate the destination, a broadcast with TTL = r_1 is sent first. Otherwise, a new broadcast with TTL = r_2 is sent. A broadcast with TTL = r_n fails to locate the destination, a process is a continuous. Besides, we also consider the following notations: ***M*** is number of network nodes; ***H*** is the maximum hop that M nodes may spread from the source node at the center of the network; ***r*** is radio transmission range; ***n(i)*** is number of nodes that are exactly ***i*** hops away from the source node; ***k*** is the size of the search set, where $1 \le r_1 < r_2 \ldots < r_n \le H$. We use the random distribute of nodes to estimate ***N(i)*** and ***n(i)***, the number of nodes within ***i*** hops from the source node and the number of node on the ***i-th*** hop *'ring'*, respectively, $\boldsymbol{0 \le i \le H}$.

3. Performance Analytical Model (PAM)

As we known, the searching threshold is a key parameter that affects the performance of the ERS. There is some work related to finding an optimal value of the search threshold to obtain the best performance for the ERS. The network model has the following properties. There are ***N*** randomly placed wireless nodes that form a multi-hop wireless network based on the SV. Each node is equipped with an omni-directional wireless broadcast antenna and they communicate with other nodes in their radio coverage range [8]. The node that initiates the search is called the source node. All nodes that are on hop away from the source node form ring 1, nodes that are two hops away from ring 2, and so on means that the starting radius is 1 and the incremental value is. Ring i has $0 \leq n_i \leq N$ nodes and the distribution of n_i depends on the network topology. In the end, when a limited radius search is initiated with a radius of k (TTL), then the broadcast cost for the search is basically the number of nodes contained in all the ring up to (s-1), which is given by $B_s = 1 + \sum_{i=1}^{s-1} ni$ as shown Figure 1.

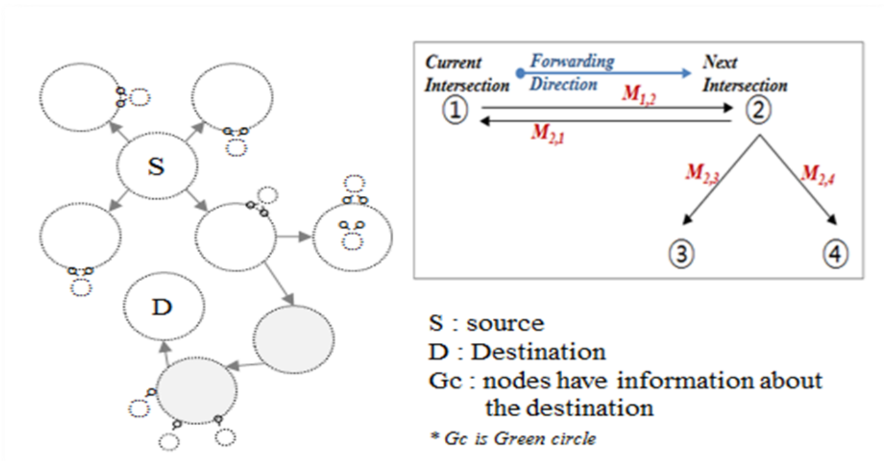

Figure 1. The Figure 1 is shown Ring Search (RS) with PAM of Smart Vehicle Adaptive Traffic Service. The motivation for this idea is that if there are some nodes that have the needed information or if the information is located near the source, then the network-wide broadcast can be avoided. So to speak, control the radius of the search, the source node sets the TTL parameter in the message to a specific value (Left). The other side is presented Smart Vehicle Adaptive Service (Right) [9].

4. SV Traffic Service based Experiments

In this section, we evaluate the performance of restrict ERS according to the calculated ideal value of searching threshold with traffic service. The effect of the searching threshold on the overhead of the ERS is analyzed for many networks with different sizes and node placement by the narrow environment. We investigate the RS({R}) schemes with R in a more general form. The cost of the RS({r1}) scheme is C({r1}) = C(Φ) + [N(r1-1) – N(r1)] ≤ C(Φ). Therefore, when n(r1) = N(r1) – N(r1 – 1) > 0, the RS({r1,}) scheme our-performances the RS(Φ) scheme. This being so, we is equivalent to premise scheme in a place as following; (1) The cost of the RS(Φ) scheme is given by C(Φ) = M. (2) The cost of the RS({r1,< r2 …. <rn}) scheme decreases with the increase of rn≤H, i.e.,C({r1,< r2 …. <rn}) > C({r1,< r2 …. <r'n}), when rn<r'n≤ H. (3) For a large position integer H and a real-valued variable z, 0 < z ≤ H-2/H, the function f(z), that is f(z) = -1/1-z2 + H2z2 – [(zH+1)(H-1) / H]2, achieves minimum when z takes a value close to z* = (H-1)2 / (2H-1)H. Accordingly, we have the RS({1, [(H-1)2 / 2H-1], H}) scheme is the optimum scheme that achieves lowest cost among all RS schemes as following in Figure 2.

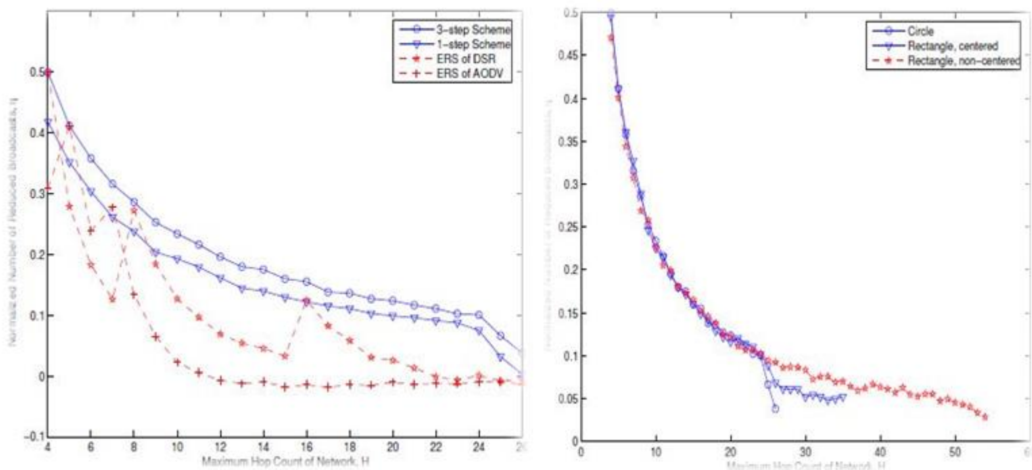

Figure 2. We show the performance of a class ERS schemes, the *RS(R)* scheme with $R = \{1,2,3, \ldots\ldots L\}$ and a limit of $L \leq H$ is presented for different maximum hop-count of the network, *H*. From left figure, we could observe that the benefit of using these ERS scheme is extremely limited. In most of the scenarios of ITS system/SV traffic service that we have shown, the ERS schemes have higher search cost than pure flooding $(n< 0)$. We also show the performance of the $RS(\{r_1, r_2, r_3 = H\})$ schemes with H = 60 by right figure. As observed from Figure 2, the $RS(\{r_1, r_2, r_3 = H\})$scheme is more efficient.

5. Conclusion

This research paper had published in first research with the Knowledge-oriented Smart Vehicle Adaptive Traffic Service by generic algorithm. About that time, we merely proposed simple prototype by using KTD and SVAS in our CAAS Project. In this research, we focus on the problem of locating a randomly chosen destination in a large multi-hop wireless network with ERS into RS schemes, in which a search set *(R)*is used to set the TTL field of the inquiry packet sequentially before network-wide flooding in initiated. Our research is getting to more advantage, supporting the self-adaptive vehicle service of the aspect mechanism and Motor Company in Korea is going to sponsoring. Although, we have on-going project, we really a wishful thinking, smart vehicle and wireless network infrastructure (V2X) will hope to provide in next generation smart vehicle useful service, as well as improve many researcher to help.

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