Poster Abstract: Graph Coloring for Smartphone-Based V2X System

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***Abstract*—To support safety critical application at low cost, we have proposed the smartphone-based V2X system as an alternative of DSRC. To assess the feasibility of our system on the road, we should address channel interference. We briefly describe (1) our smartphone-based system, (2) a typical graph coloring algorithm TABUCOL, and (3) our idea to avoid interference.**

I. SMARTPHONE-BASED V2X

A smartphone which is widely distributed personal mobile devices supports various network technologies such as Wi-Fi Direct (WFD), and cellular network. In proposed smartphone-based system, WFD is mainly used as an alternative to support Vehicle-to-Everything (V2X) without Dedicated Short Range Communication (DSRC) because it provides data rates up to 250Mbps, cost-free, and fit perfectly into forming an ad-hoc network. However, there are several challenges to be addressed in WFD for V2X communication, such as long connection establishment time, short transmission range, human intervention, and inter-group communication. Therefore, we consider a cooperative system that uses a flexible mix of cellular network and WFD. Our system consists of server and smartphones. Each smartphone periodically updates its position information to server while vehicles with the smartphone travel. By monitoring the position information collected from moving smartphones, the server can immediately detect a chance encounter among smartphones, and rapidly notify their information to the adjacent smartphones. Before smartphones exchange safety messages, they immediately form a group using WFD. Consequently, the original process to manually search for neighbor can be eliminated from smartphones using WFD. Note that the cellular network is only used in the update and the notification between smartphones and server, and the exchange of the safety messages among smartphones is performed through WFD. However, the formed group from either WFD communication or smartphone-based V2X is generally limited up to max 8 nodes because of performance degradation of WFD. In this regard, multiple small groups are concurrently formed on the congested road, and some of them might operate on the same channel. They likely suffer from interference among groups and may fail to exchange safety message in time. Therefore, we plan to develop an interference-free channel assignment to groups based on complete improper k-coloring algorithm in the cooperative system.

II. PROBLEMS IN TABUCOL ALGORITHM

TABUCOL (TABU search for graph COLoring) is k-coloring algorithm which finds minimal *k* value in a given graph with *tabu* search. it is a heuristic searching algorithm for choosing the best solution after finding multiple local optima. Every vertex in the graph is colored with a random color in initialization step where a set of vertices is defined as initial solution S_0 as shown in Fig. 1. Two vertices are conflicted if two vertices have the same color and are adjacent. After TABUCOL finds the conflicted vertices, it randomly changes a color of one of them, and makes a new solution S_1 from initial solution S_0. In this way, it continues the search for making the list of new solutions S_i ($0 \leq i \leq n$, n is the maximum number of iteration for the list of new solutions). This iteration is finally at the end when it exceeds the given iteration counter n or detects no conflict. TABUCOL performed by a server takes 48 seconds on allocating only 12 different colors with 500 vertices [1], where it does not consider the mobility of vertices. It is not proper for network topology being prone to short-term changes such as a road environment.

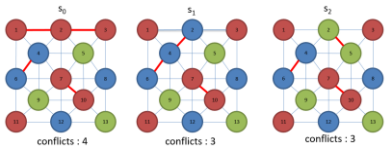

Figure. 1. List of possible solutions in TABUCOL.

III. FUTURE WORK

To reduce computation time of centralized calculation and consider the mobility of vertices, we plan to develop distributed TABUCOL driven by each group owner (GO). Each GO can draw its own local graph without help of centralized server. It is possible because each GO knows which channel is used by neighboring GO via scanning. However, the new channel assignment of one GO triggers a series of channel switching at adjacent GOs, since distributed TABU is independently and locally carried out at each GO in order to avoid interference. To address this problem, in our distributed TABUCOL, we will adopt channel switching coordination by utilizing server managing smartphones' request for new channel assignment. After server gathers several requests received from smartphones, it picks some of them, and assigns a permission to them in order to reach global optimum of whole network performance.

ACKNOWLEDGMENT

This research was supported in part by Global Research Laboratory Program (2013K1A1A2A02078326) through NRF, and the DGIST Research and Development Program (CPS Global Center) funded by the Ministry of Science, ICT & Future Planning (MSIP).

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