Multi-site information exchange by mobile nodes without the communication infrastructure

Moemi Fukuda　Masahiro Shibata　Masato Tsuru

Computer Science and Systems Engineering, Kyushu Institute of Technology

1. Introduction

When a large-scale disaster happens, the communication infrastructure may not work properly in the disaster areas. Our study focuses on how to share a large amount of distributed information, e.g., safety confirmation among multiple evacuation centers, where vehicles equipped with Wi-Fi and large-sized storage are used to bring and exchange data as mobile node. We report a preliminary result on vehicles routes and their meeting points.

2. Multi-site data exchange by mobile nodes

Suppose each site has a vehicle to deliver/collect data to/from the own site and an access point (AP) as the source/destination of data forwarding. We consider the meeting-and-exchange (ME) approach where the vehicle from an AP meets other vehicles at some meeting points, exchanges the data there, and finally returns to the origin AP to bring the other sites' data exchanged on the way; vehicles work collaboratively. As shown in Fig.1, in the single-stage ME, all vehicles join at a single point to exchange the data with each other there. In the multi-stage ME, a group of vehicles can join at a point to exchange the data in a multi-stage manner.

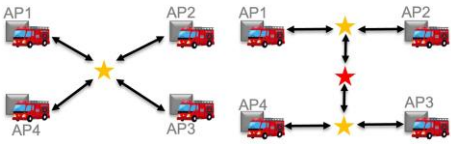

Fig. 1 Single-stage and multi-stage ME schemes

3. Meeting points for ME scheme

Where are the good meeting points in each scheme? If vehicles can freely run to any direction on a flat plane, the meeting points that minimize the total run distance can be derived by geometry; the diagonal intersection in the single-stage ME on convex rectangle and Steiner points in the multi-stage ME. But, in reality, vehicles can run only on the roads. We consider four simple methods (ME1/2 for the single-stage; ME3/4 for the multi-stage) with four APs. ME1's meeting point is on the actual road that is closest to the diagonal intersection of the rectangle. Let x1, x2 and x3 be the midpoints of the first, second and third shortest run routes between AP1/3, and also let y1, y2 and y3 be those between AP2/4; the best meeting point for ME2 is selected from the nine midpoints of all pairs (xi, yj).

In the multi-stage ME, let P and Q be the meeting points in the first stage and R in the second stage. We construct P and Q based on Melzak algorithm [1]. In ME3, let P' and Q' be the Steiner points of the rectangle of APs in the map; P (Q) is selected as the point on the actual road that is closest to P' (Q'); R is a point on the shortest route between P/Q. ME4 uses the shortest run distances between AP1/2, 2/3, 3/4, and 4/1. Let B and C be the Steiner points of the rectangle and A (D) be the midpoint of the line between AP1/4 (AP2/3); but the rectangle with the actual shortest run distance is used as shown in Fig.2. Let **rho** be the ratio of distances between A/B, B/C and C/D; let P' (Q') be the midpoint on the actual shortest route between AP1/4 (AP2/3). P and Q are selected as the points on the shortest route between P' and Q' that keep the same ratio **rho** of run distances between P'/P, P/Q and Q/Q'. Finally R is a point on the shortest route between P/Q.

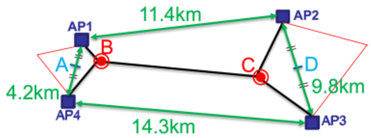

Fig. 2 Meeting point construction in ME4

4. Performance simulation

A simulation-based performance on an actual map with four sites is shown in Fig.3. Scenagie and its Bundle-router model with 802.11g are used. All vehicles start from their sites with 5[GB] data at a time. The data collection time (the time for a site to collect data from all other sites) and the total run distance (the total run length of all vehicles) are evaluated. In this example, ME2 performs best both in time and distance although the total run distance will be minimized by the two-stage ME in theory with no route constraint. Comparing ME2 (ME4) with ME1 (ME3), the gap between the average and maximum collection times among all sites is reduced in ME2 (ME4) by taking into more account the distance of actual run routes on the map.

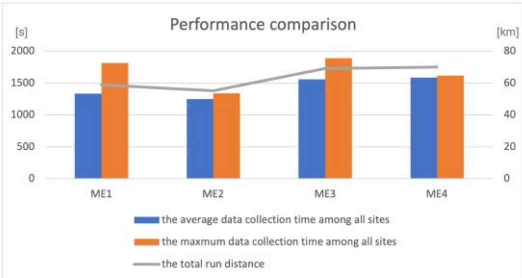

Fig. 3 Performance comparison (ME1, 2, 3, 4)

Reference

[1] Melzak, Z., "On the Problem of Steiner," Canadian Mathematical Bulletin, 4(2):143-148, 1961.