INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY HYDERABAD

R&D SHOWCASE 2021
Technology, Social Impact

A Global Edge Bandwidth Cost Gradient Based Heuristic for Fast Data/Service Delivery Under Vehicle Overlap

Introduction

Motivation

- Edge resource allocation problem is non trivial.
- Many challenges like moving vehicles, multiple edges and vehicles, vehicle overlaps and varying densities at edges.

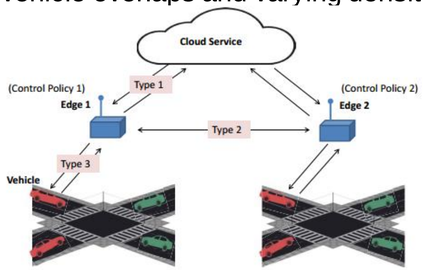

Fig. 1: Illustration of the three layers and constituent entities in vehicle connectivity architecture.

Contributions

- Optimization framework is presented.
- Using concept of overlapping vehicles.
- A cost gradient-based heuristic was developed.

Problem Statement

- There are N vehicles and M edges in the system.
- Considered overlapping of vehicles by making clusters of vehicles.
- Improvement in edge resource constraints was achieved.
- Considered edge resource constraints, timing constraints, bandwidth schedulability constraints, etc.

- The objective function is given by

$$\min \sum_{j=1}^{M} \delta\left(1 + b\omega_j^{util}\right)^2$$

δ is the bandwidth cost factor

Solution Approach

- Proposed an algorithm to find overlapping sets.
- Derive the earliest arrival and latest departure times of each vehicle.
- Above times are compared for pairs of vehicles to determine vehicle overlapping.

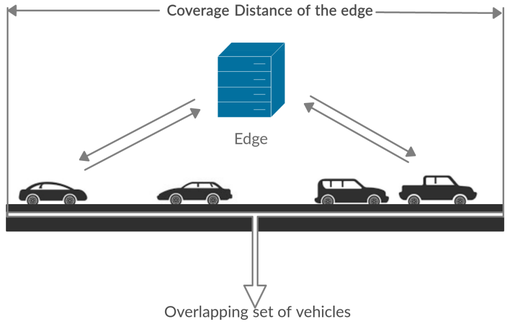

Fig. 2: Illustration of an overlapping set of vehicles.

- Proposed a cost gradient based heuristic.
- At each iteration minimum increased cost is calculated.
- It is calculated by allocating a data chunk m* to each edge.

- The cost gradient function is given by

$$\Delta = \frac{\delta \times m^*}{k_j} \times \left(2 + \frac{2 \times a_j + m^*}{k_j}\right)$$

where a_j is the memory used and k_j is the constant for edge E_j

Results

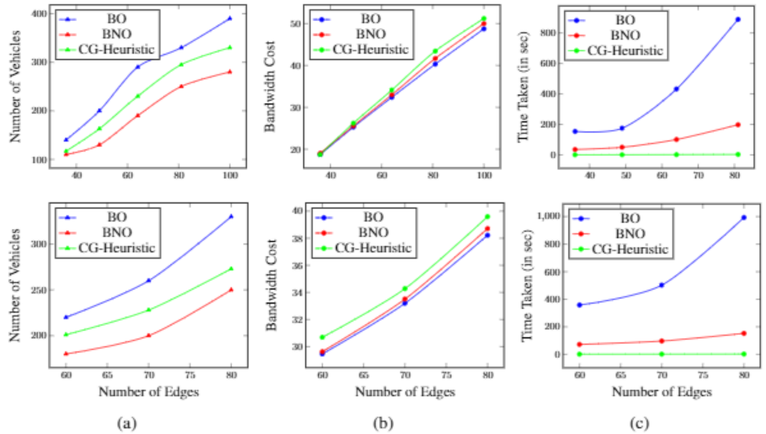

Fig. 3: Synthetic and Real Data set results

- Maximum number of vehicles serviced is greatest for BO being more than CG-Heuristic and BNO by 15.38% and 28.57% respectively
- Edge bandwidth cost of CG-Heuristic is slightly more than both BO (by 1.37 units) and BNO (by 1.06 units).
- While BNO is significantly faster than BO, CG-Heuristic is even faster than it by nearly 65 times

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