Ground Transportation Technology Symposium: Big Data and Innovative Solutions for Safe, Efficient and Sustainable Mobility
Nov. 19th, 2014

A study of Feedback-based Traffic Flow Control Using Estimated Traffic Congestion

Hideyuki Kobayashi†, Shweta Jain‡, Theodore Brown††

†National Institute of Technology, Sendai
‡York College and Graduate Center, CUNY
††Queens College and Graduate Center, CUNY

Kobayashi LAB.

Background

Loss from traffic congestion (Japan,2003[1])

- $ 116 billion / year

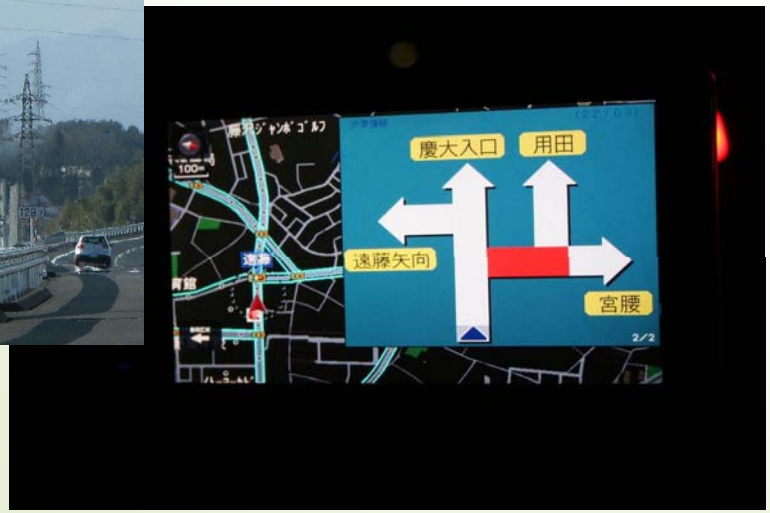
[1] K.Makimura et.al., “Traffic Congestion Indicator Measurement Using Probe Vehicle Data”, Proc. Committee of Infrastructure Planning and Management, Vol.27, Jul. 2003.

Background

Loss from traffic congestion (Japan,2003[1])

- $ 116 billion / year

VICS (Vehicle Information and Communication System)



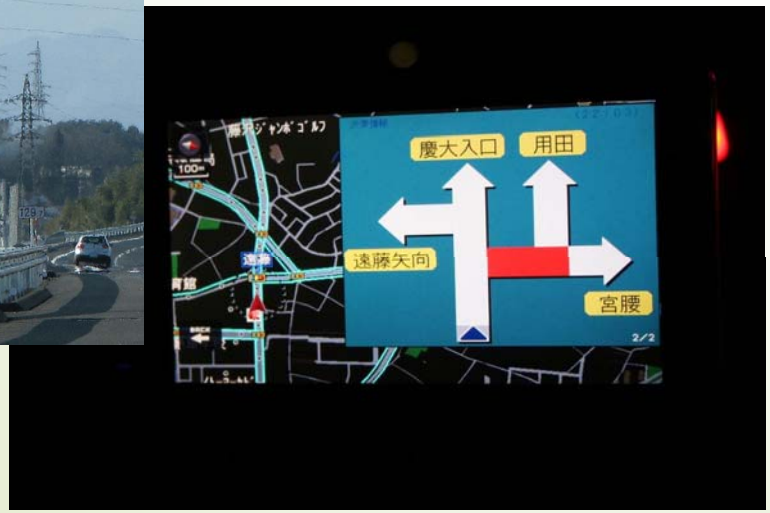
[1] K.Makimura et.al., "Traffic Congestion Indicator Measurement Using Probe Vehicle Data", Proc. Committee of Infrastructure Planning and Management, Vol.27, Jul. 2003.

Background

Loss from traffic congestion (Japan,2003[1])

- $ 116 billion / year

VICS (Vehicle Information and Communication System)

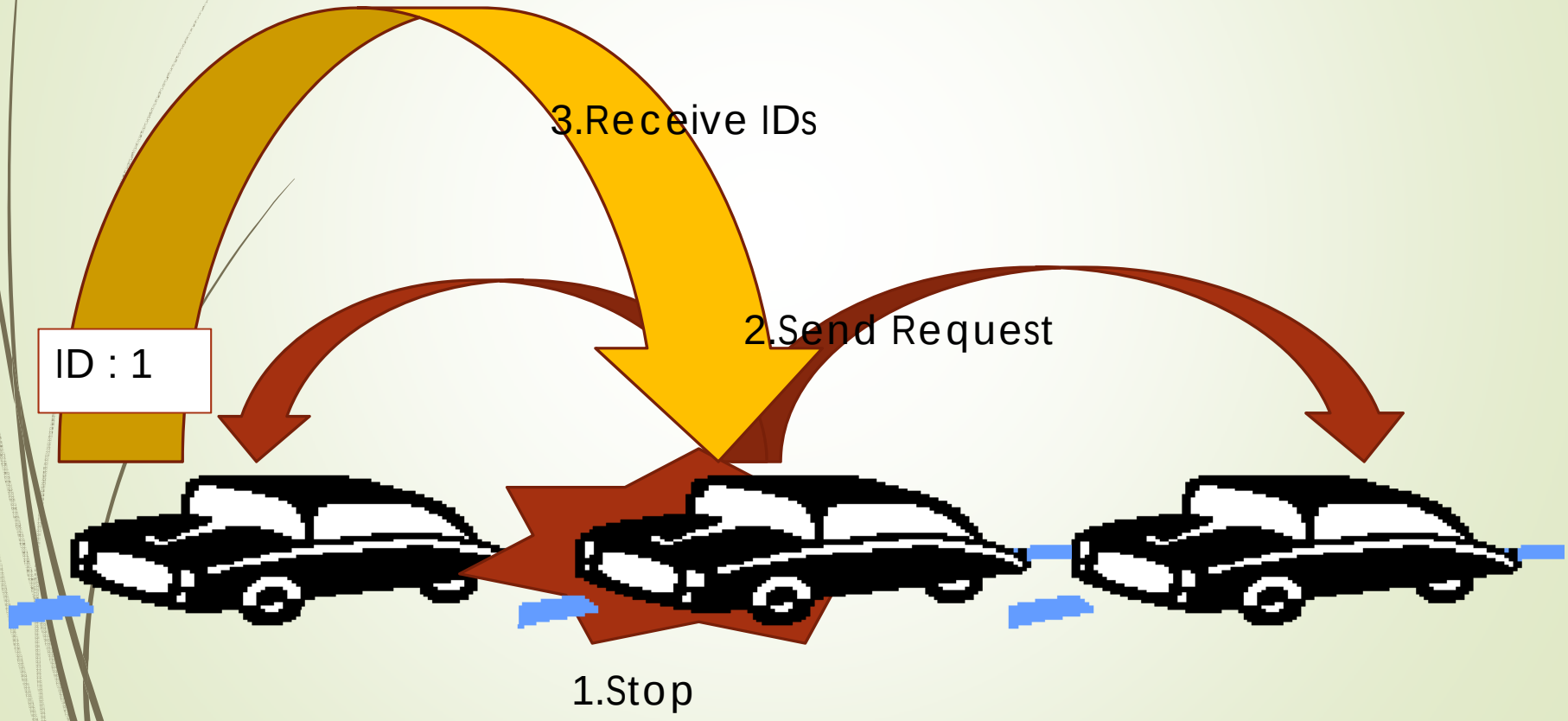


Central Terminal

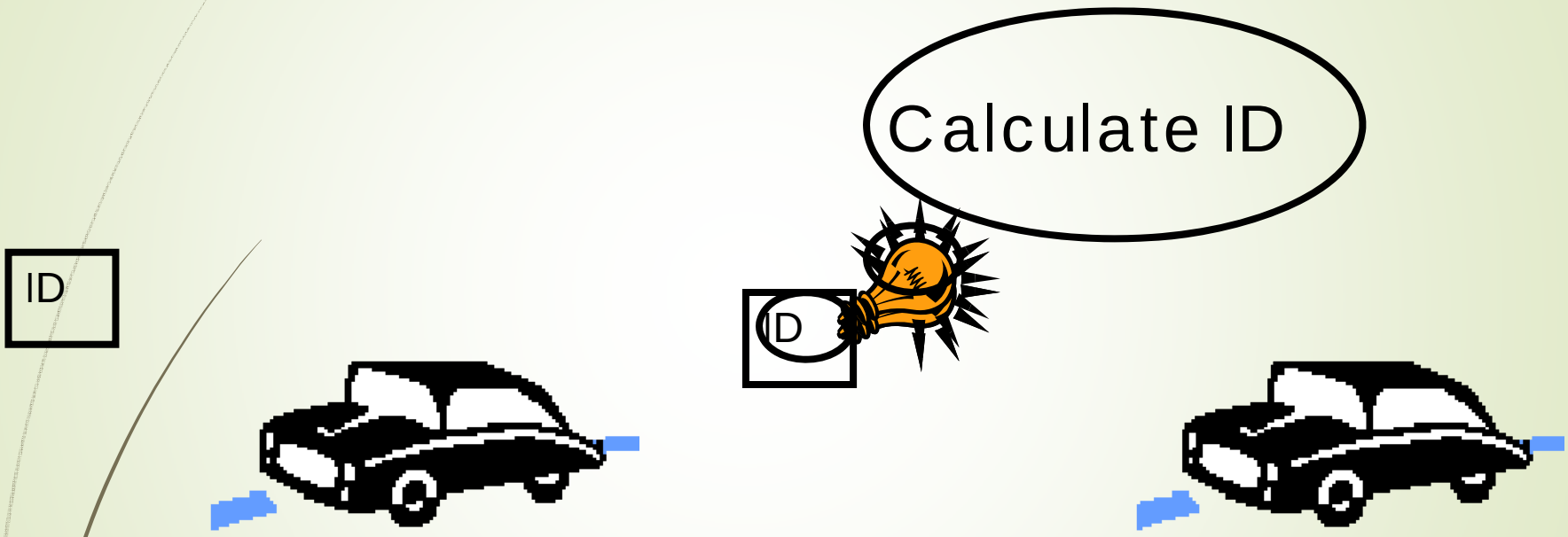
High Cost

[1] K.Makimura et.al., "Traffic Congestion Indicator Measurement Using Probe Vehicle Data", Proc. Committee of Infrastructure Planning and Management, Vol.27, Jul. 2003.

Existing method



Existing method



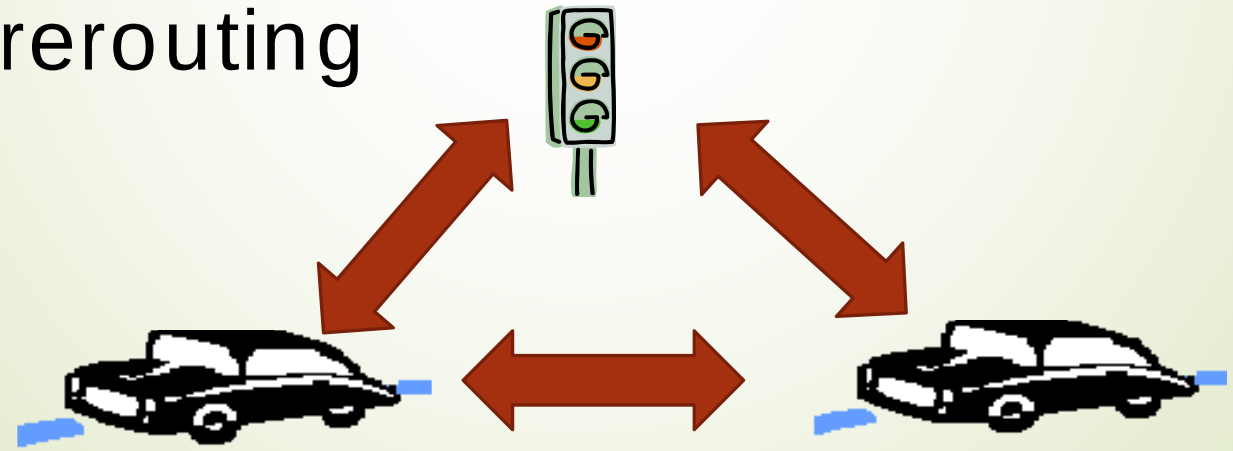
Problems

- Driver decide to re-route
  - ➢ Independently and manually

- Partitioned communication graph

Purpose

- Self organized
  - V2V, V2I, I2I
- Traffic congestion control without driver intervention i.e., rerouting



Proposed Method

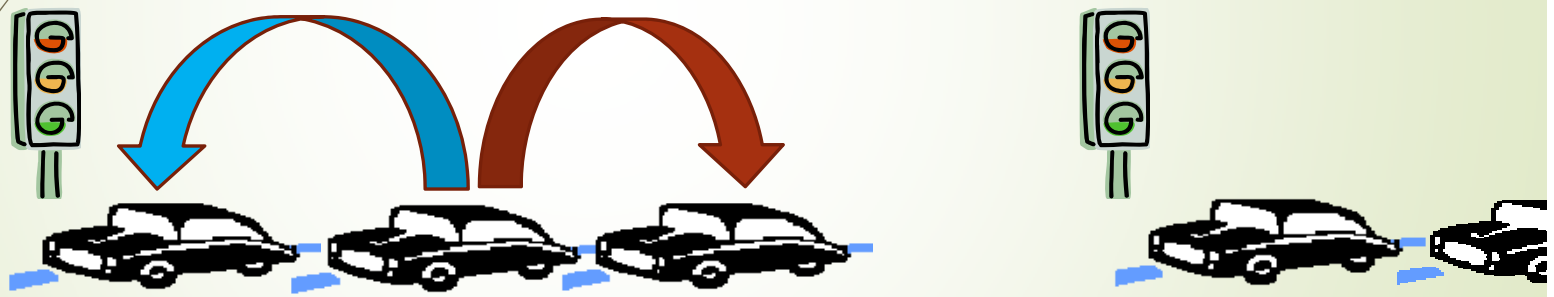
TSP (Traffic Signal Priority) for improved traffic movement

Proposed Method

TSP (Traffic Signal Priority) for improved traffic movement

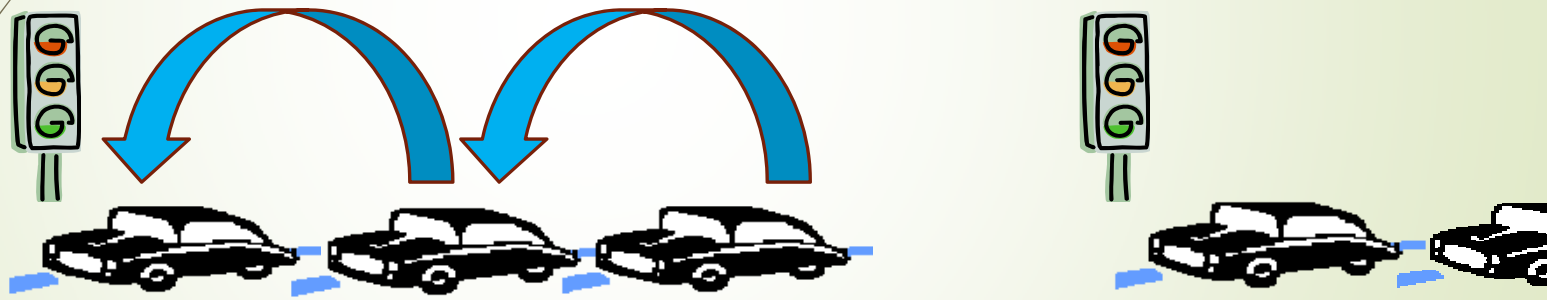
Proposed Method

TSP (Traffic Signal Priority)for improved traffic movement



Proposed Method

TSP (Traffic Signal Priority) for improved traffic movement

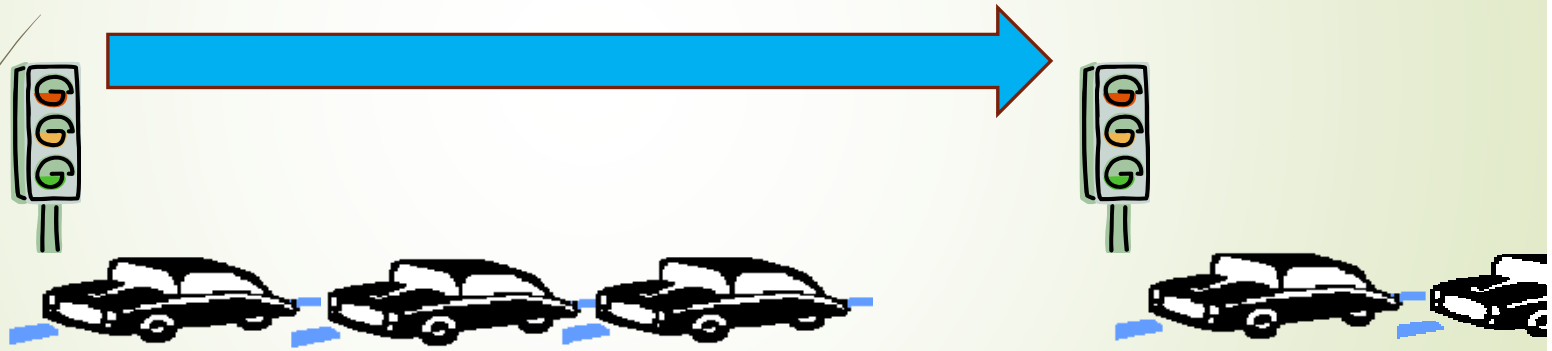


Proposed Method

TSP (Traffic Signal Priority) for improved traffic movement

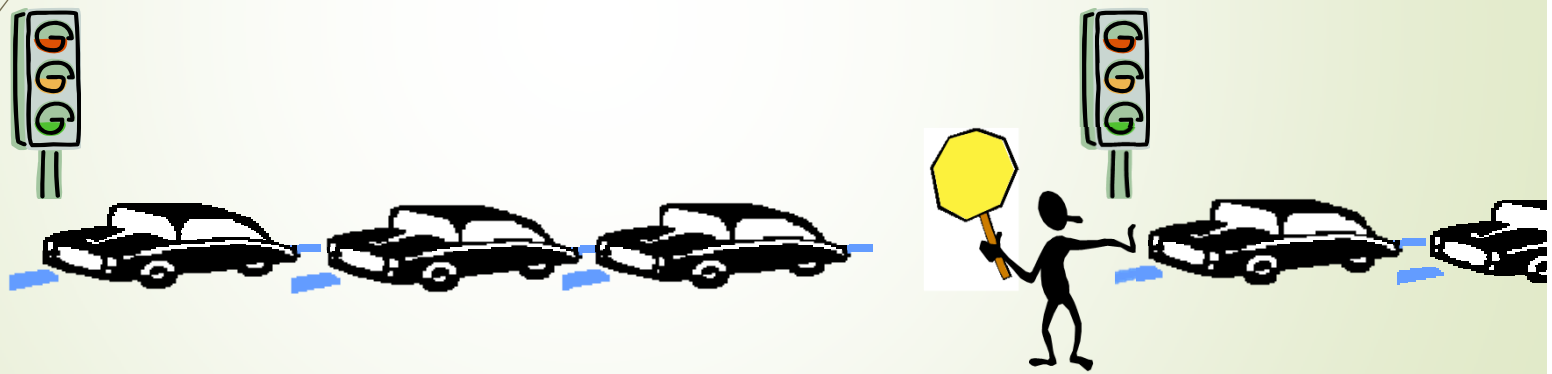
Proposed Method

TSP (Traffic Signal Priority) for improved traffic movement



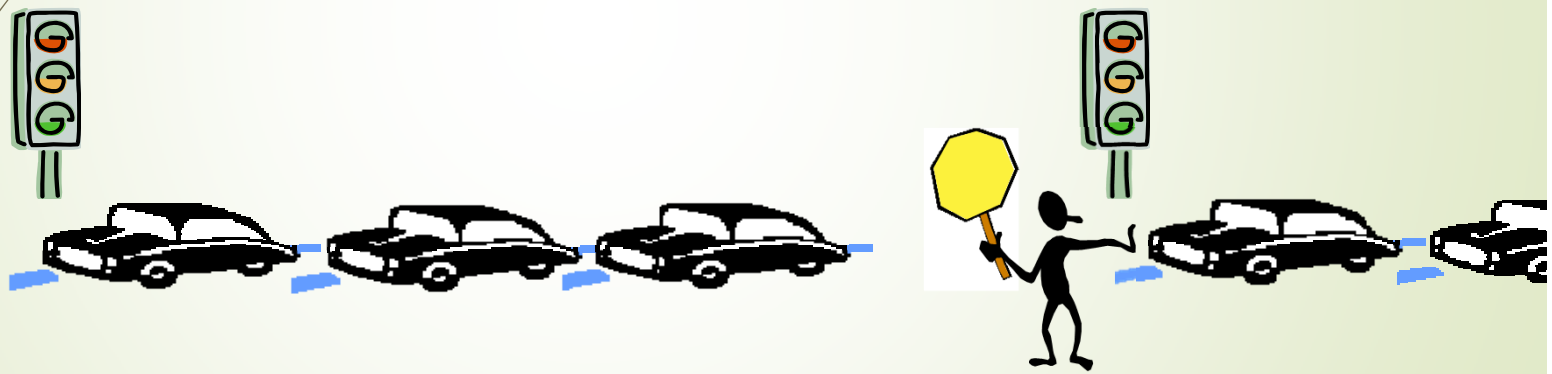
Proposed Method

TSP (Traffic Signal Priority) for improved traffic movement



Proposed Method

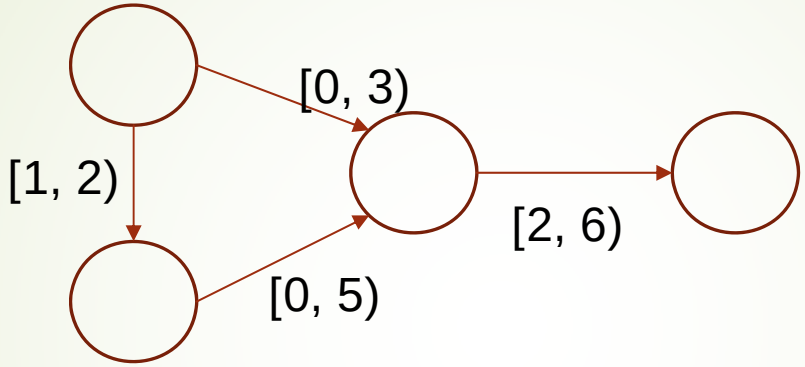
TSP (Traffic Signal Priority) for improved traffic movement



Avoid traffic congestion
(User insensible)

Time-Varying Graphs

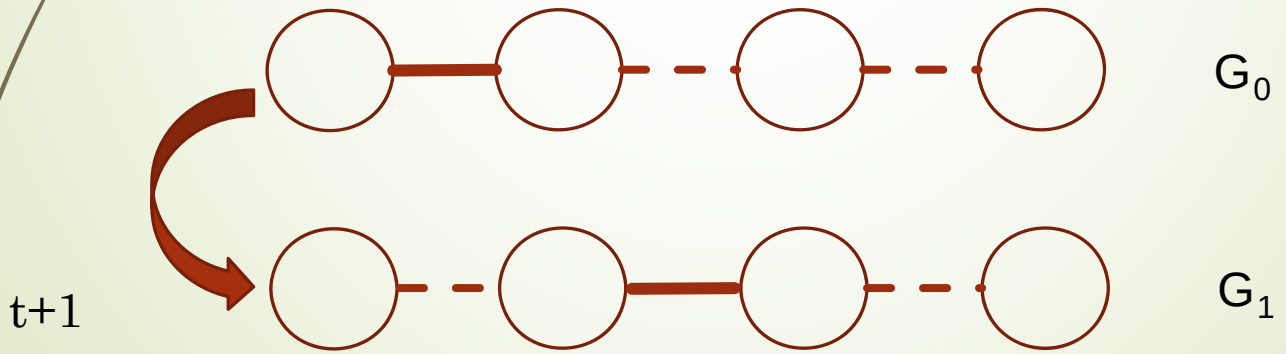
Castegits' [2]



Each edge represents available time

Birand's [3]

changed relation by Time



[2] A. Casteigts, et. al., "Time-Varying Graphs and Dynamic Networks," ADHOC-NOW, pp.346-359. Jul. 2011.
[3] B. Briand, et. al., "Dynamic Graph Properties of Mobile Networks under Levy Walk Mobility," Proc. 2011 Eight IEEE International Conf. Mobile Ad-hoc and Sensor Systems, pp.292- 301, 2011

Applied Proposed Method

$$t_0 \begin{bmatrix} - & 1 & 0 & \cdots & 0 \\ 1 & - & 0 & \cdots & 0 \\ 0 & 0 & - & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & - \end{bmatrix} \qquad t_0 \begin{bmatrix} - & 1 & 1 & \cdots & 0 \\ 1 & - & 1 & \cdots & 0 \\ 1 & 1 & - & \cdots & 1 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 1 & \cdots & - \end{bmatrix}$$

$$t_1 \begin{bmatrix} - & 1 & 1 & \cdots & 0 \\ 1 & - & 1 & \cdots & 0 \\ 1 & 1 & - & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & - \end{bmatrix} \qquad t_1 \begin{bmatrix} - & 0 & 1 & \cdots & 0 \\ 0 & - & 1 & \cdots & 0 \\ 1 & 1 & - & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & - \end{bmatrix}$$

Summary

- Communication between Traffic lights and cars (T2T, C2C and C2T)
- TSP (Traffic Signal Priority), Congestion control and Surface Mass Transit
- Time-Varying Graphs

Future work

- Simulation
  - (Mobility model<-> Communication feedback loop)
- Verification