

# Estimating Missing Path on Trajectories Trip by Using Bluetooth Technology

Prof. Atsushi Fukuda

Assoc. Prof. Sorawit Narupiti

Assoc. Prof. Tetsuhiro Ishizaka

Miss. Pitchaya Panwan

Mr. Thana Potanon

With Prof. Masao Kuwahara

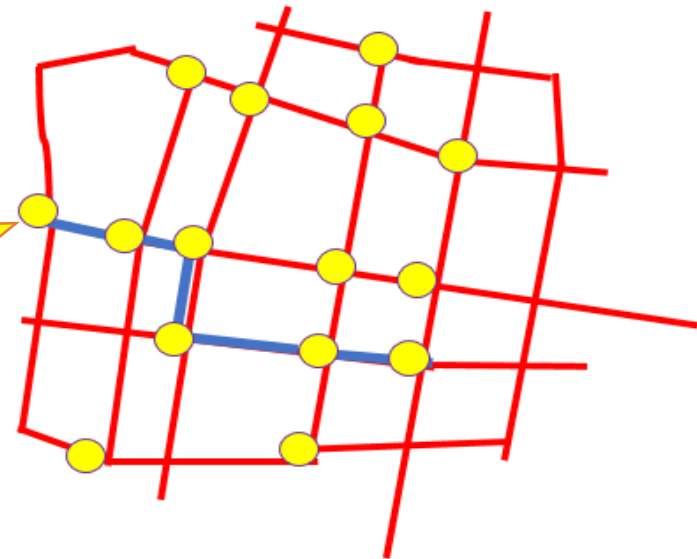


# Bluetooth technology for Transportation

- ◆ Receiving Bluetooth (BT) signal by scanner at difference location has a possibility of a new method to estimate traffic state such as travel time
- ◆ Bluetooth scanner, which is installed at the location along the road networks, can detect Bluetooth-enabled devices (i.e. Mobile Phone, Navigators, headset etc.) from vehicle.



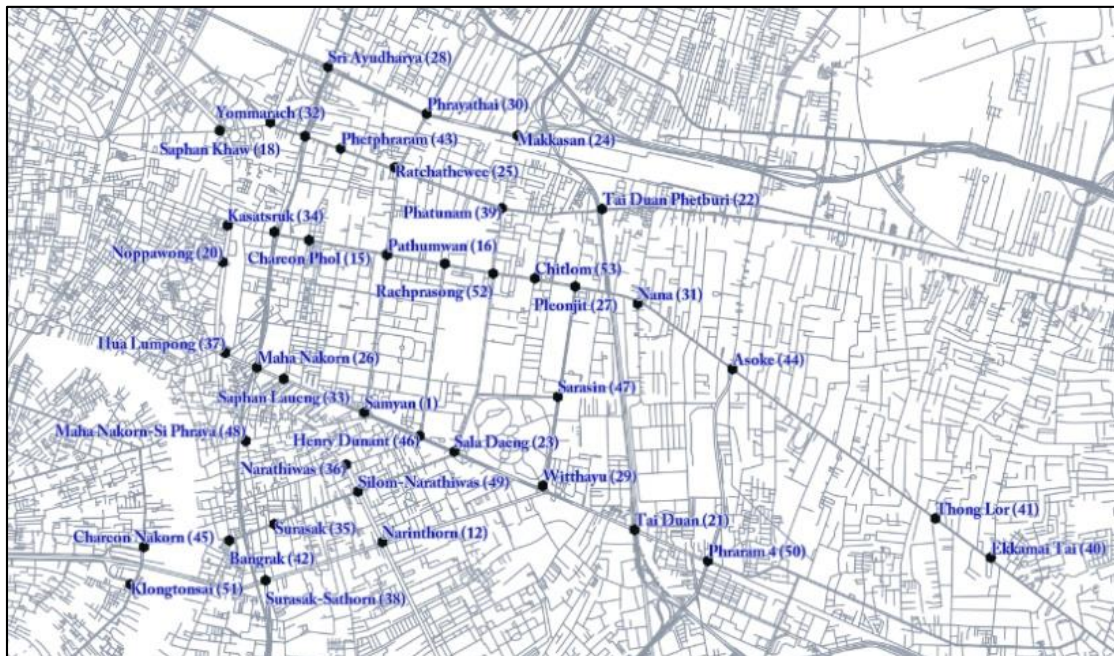
scanner



Travel time, route choice, OD matrix

# Study area and location of Bluetooth detectors

- ❑ BT detectors were set at 48 stations where are police box controlling traffic signal at intersection.
- ❑ Data was collected 24 hours from 5/Feb. to 4/March, 2016.



11km



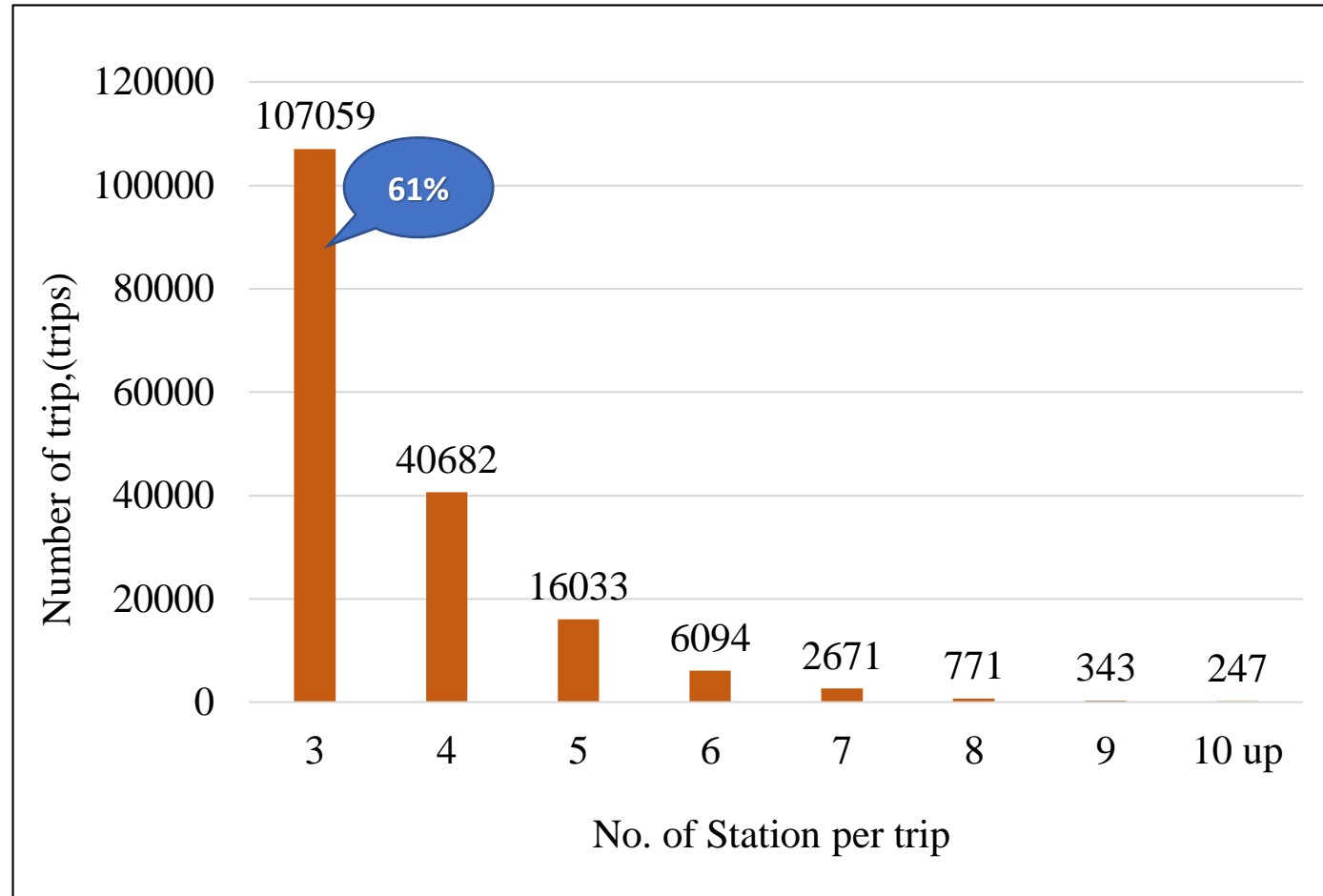
Police box



BT detector

# The Reliability of Bluetooth technology

- ◆ The highest proportion of continuous station per trip is 3 stations (61%).
- ◆ The maximum of continuous station per trip is 14 stations with 2 trips.
- ◆ Therefore, there are many missing stations per trip.



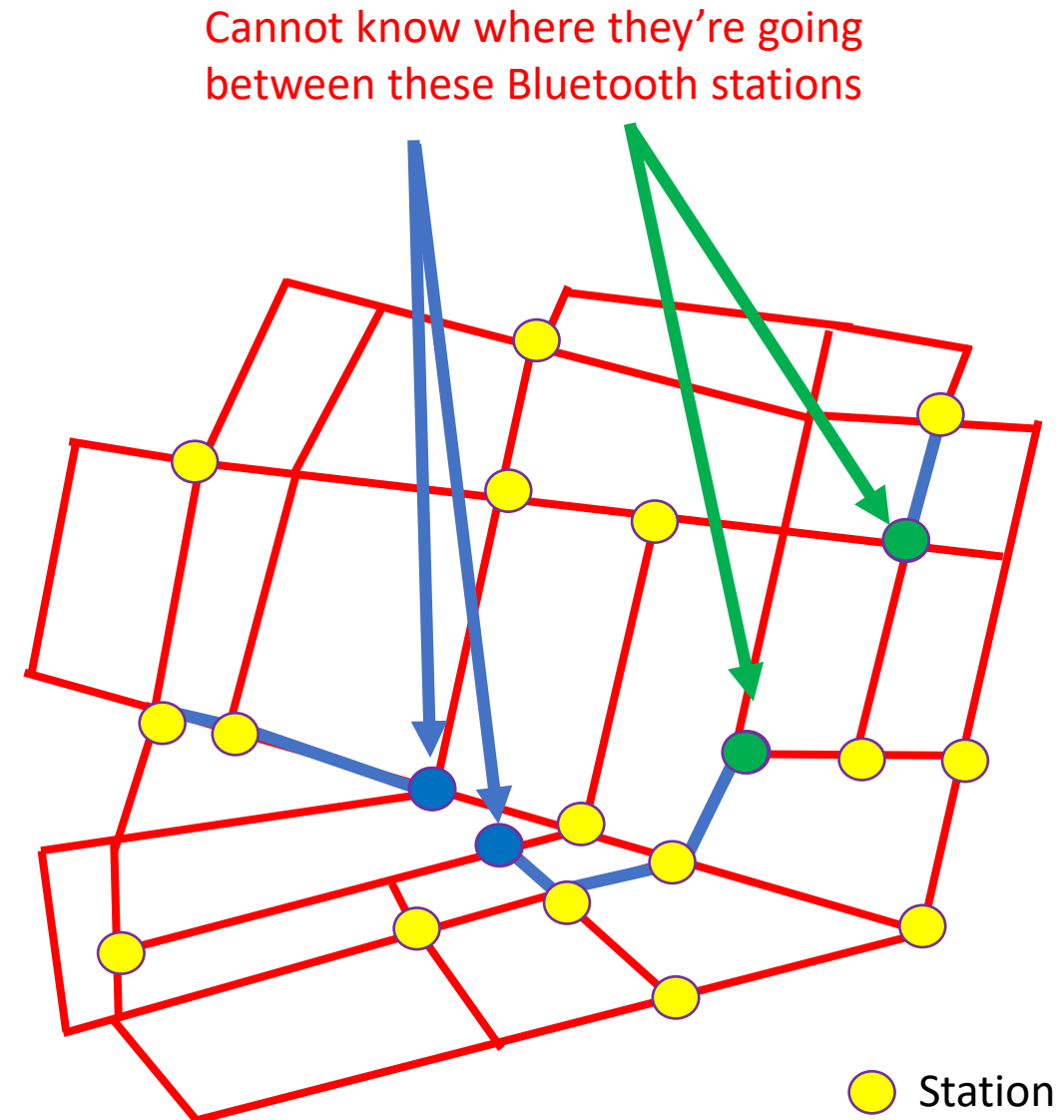
# Challenging of Bluetooth technology for transportation

## Problem

In case of Bluetooth detector cannot track MAC address from vehicle, we could not know a route of vehicle.

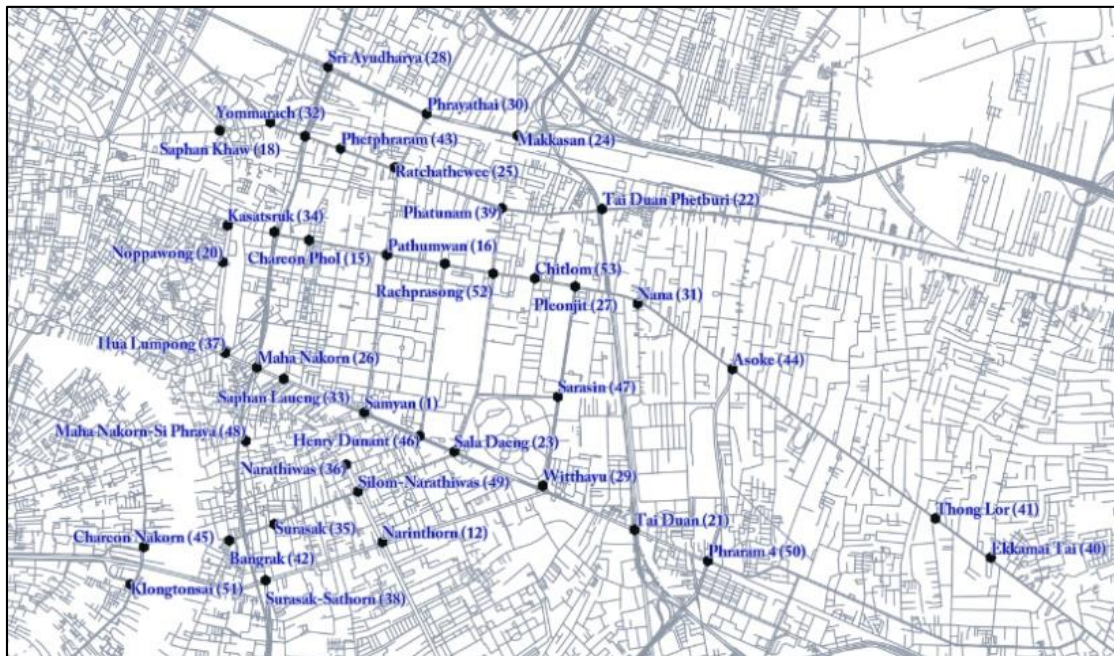
## Objective

Recovering missing path of missing trip.



# Study area and location of Bluetooth detectors

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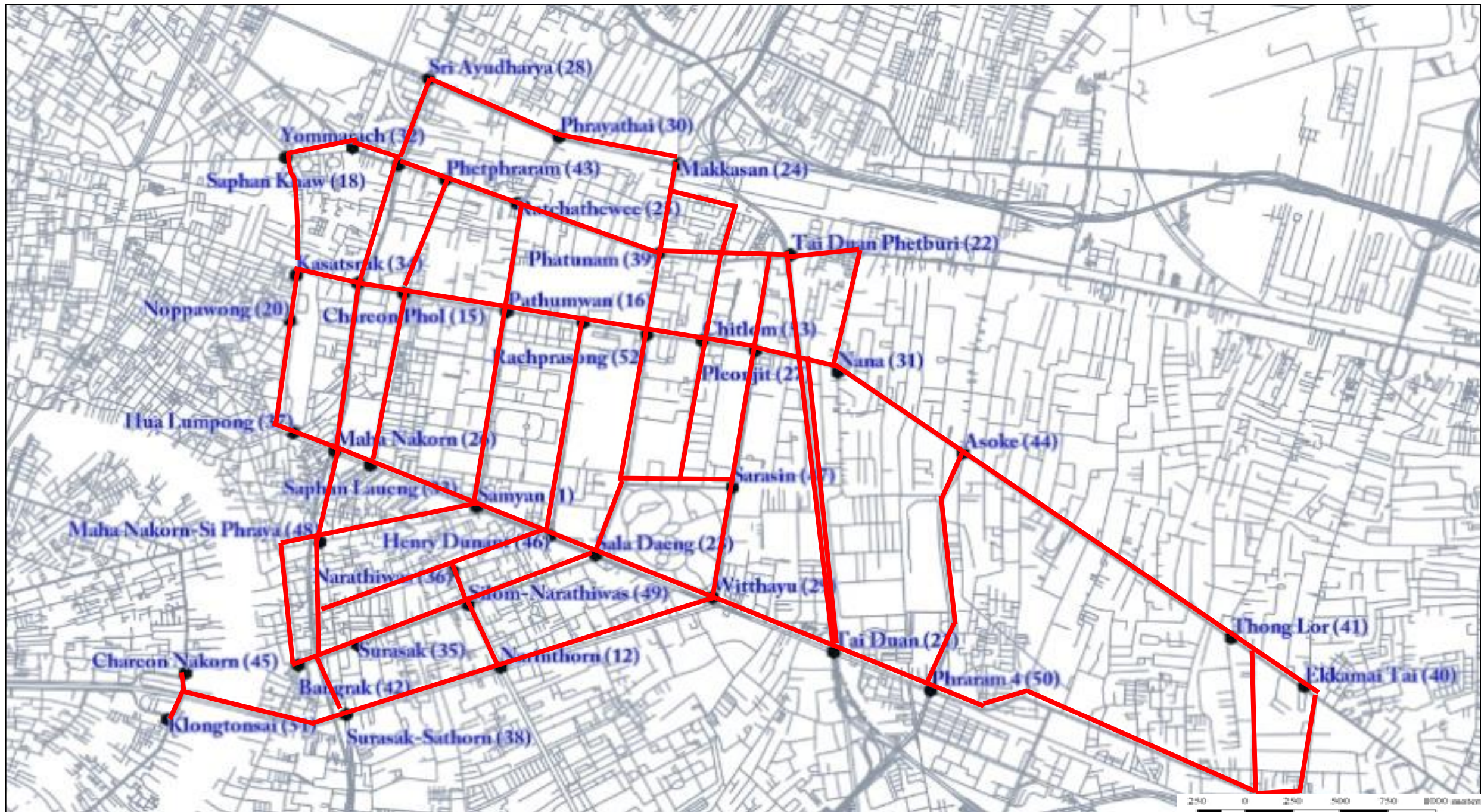
11km



Police box



BT detector



# Data set on this experiment

All Trip

1,398,329 trip



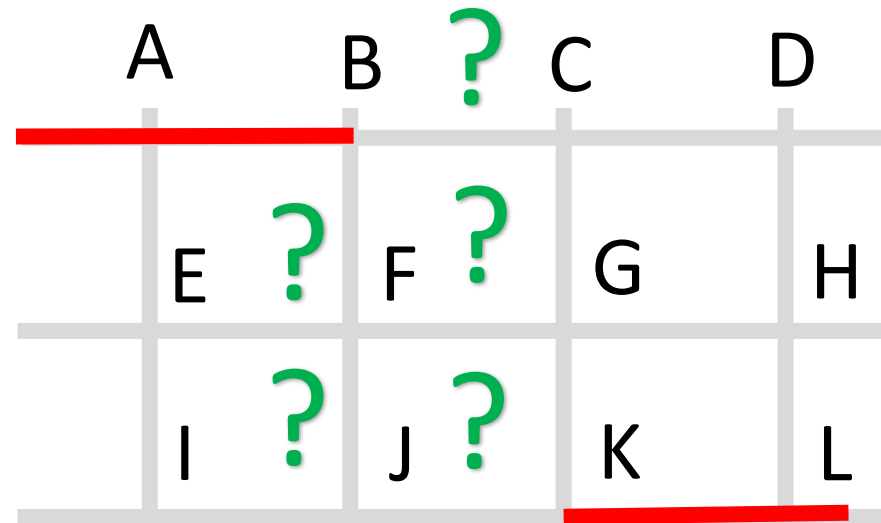
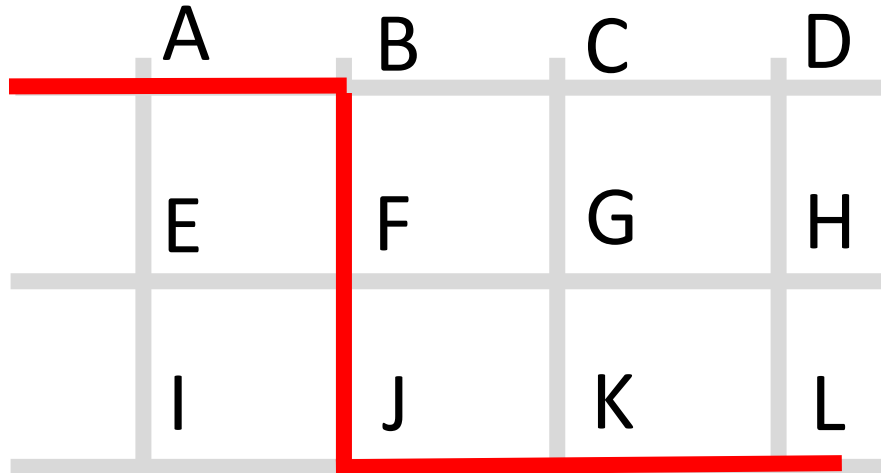
Complete Trip

612,056 trip



Missing Trip

786,273 trip



We cannot know, where a route of traveler is.



# How to track missing link

## Conventional methodology

Select a route of shortest travel time from missing links(routes)



Identify the selected shortest route as actual route

## Our methodology (Historical Travel time)

Calculate **historical Travel time** on missing links(routes)

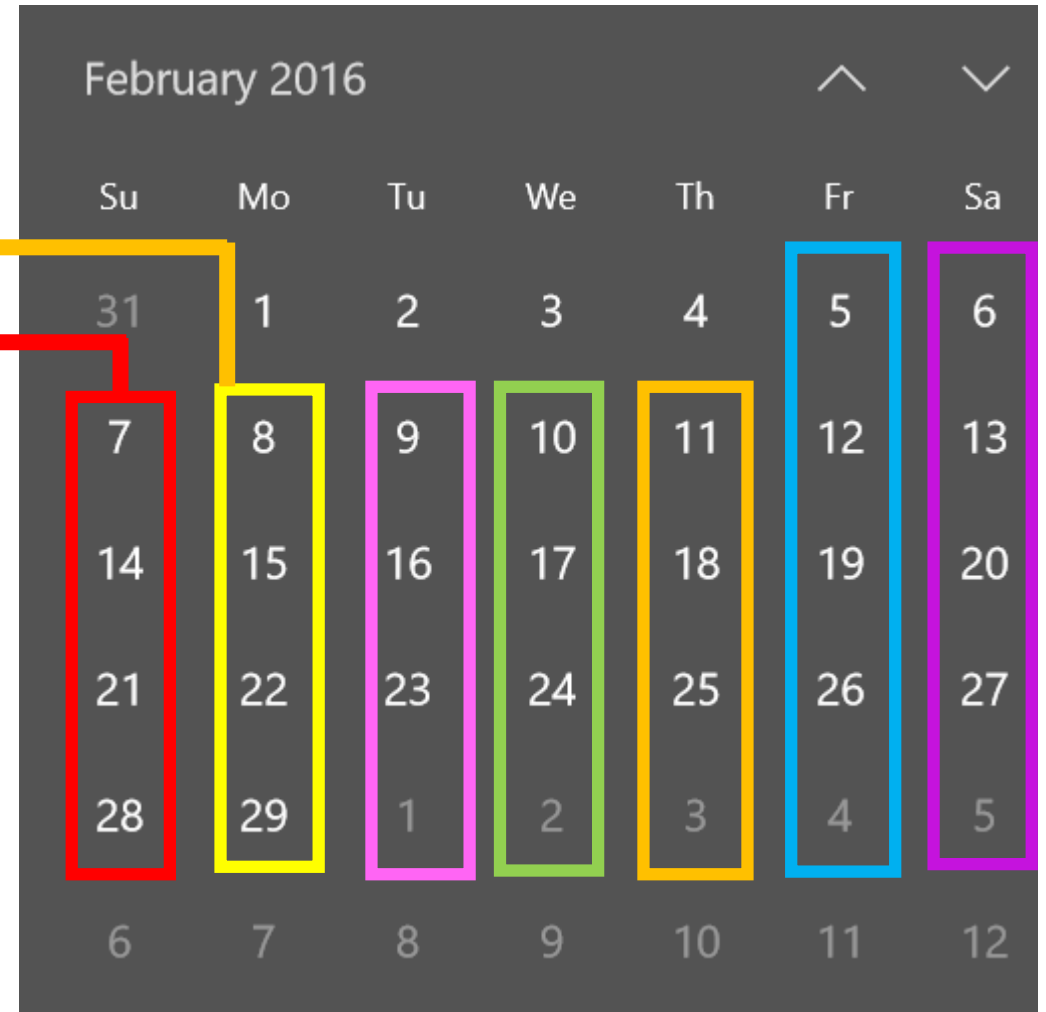
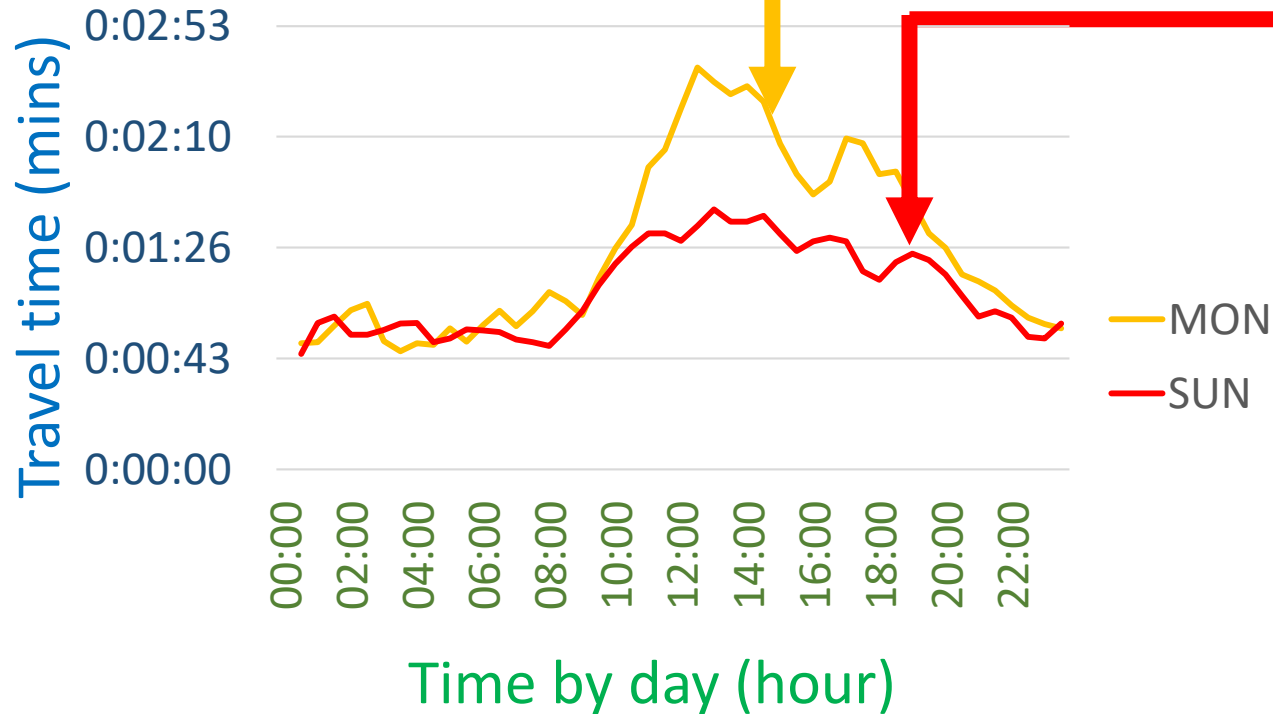
Calculate the **actual travel time** from BT data



Identify the route of minimum difference of travel time as actual route

# How to track missing link

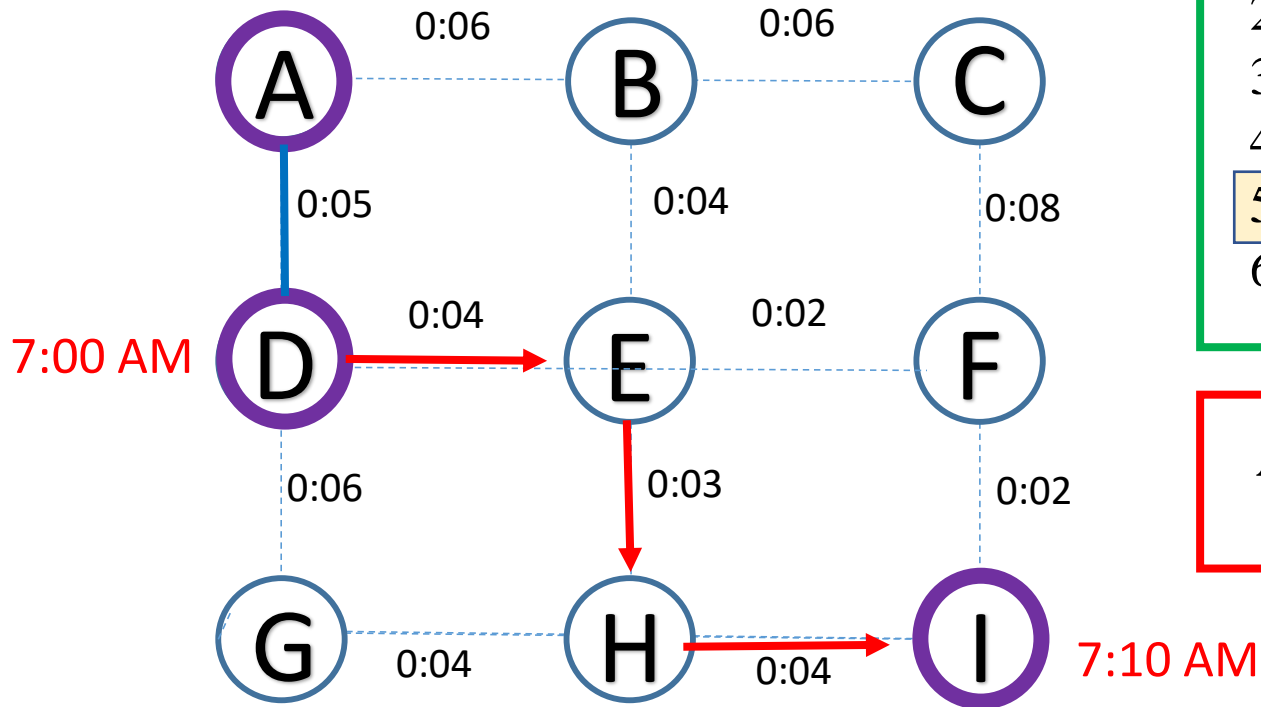
Sample Travel time data set for estimation of link 26-37



# How to track missing link

## Our methodology

Historical Travel time



There are 6 possible links to travel from D to I

- 1) D - E - B - C - F - I (Route 1, 24 mins)
- 2) D - G - H - E - F - I (Route 2, 17 mins)
- 3) D - E - F - I (Route 3, 8 mins)
- 4) D - G - H - I (Route 4, 14 mins)
- 5) D - E - H - I (Route 5, 11 mins)
- 6) D - G - H - E - B - C - F - I (Route 6, 33 mins)

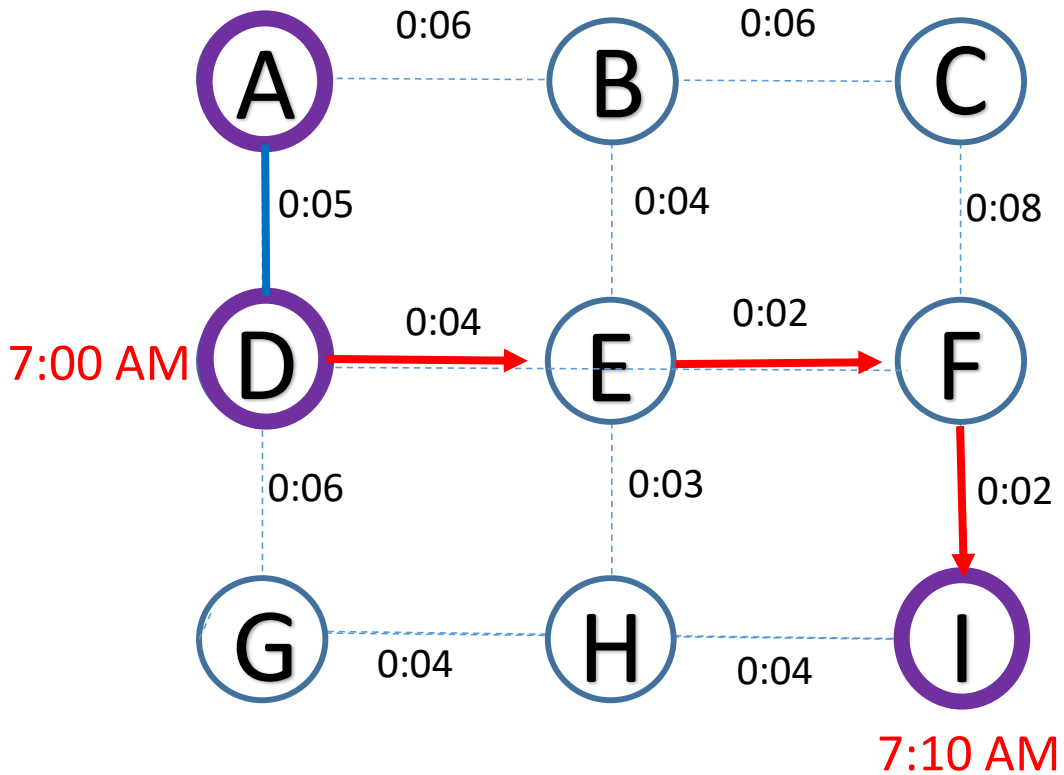
Actual travel time from D to I

- 1) D - I (10 mins)

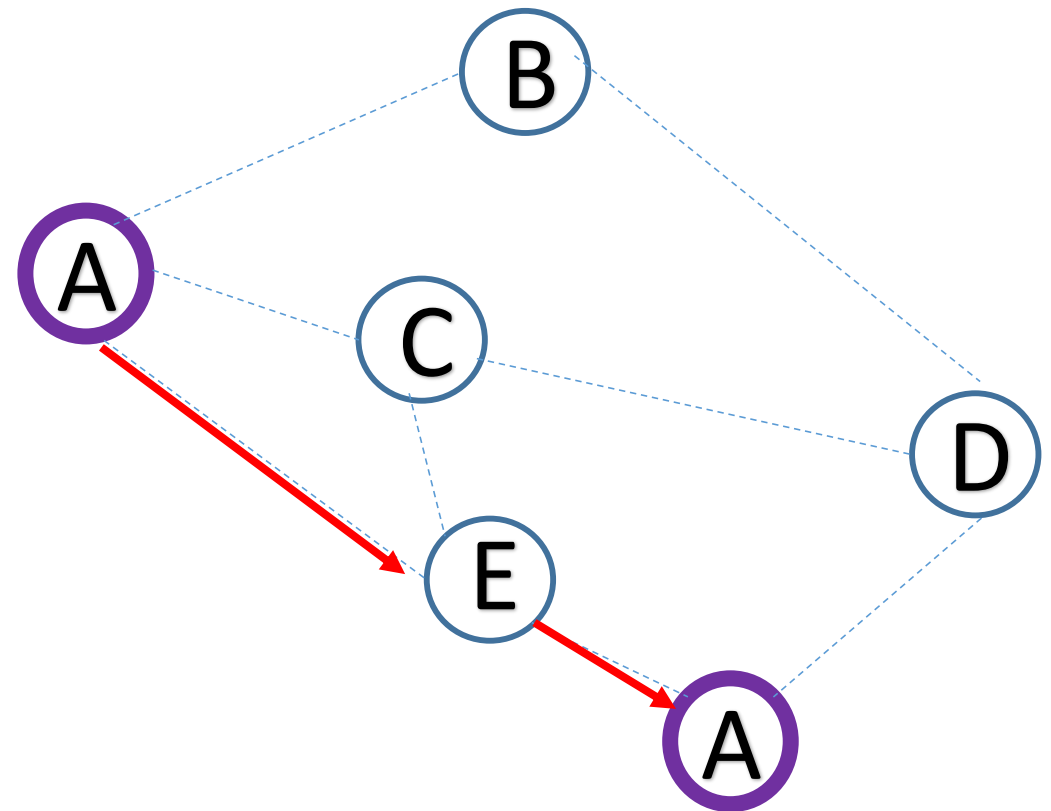
# How to track missing link

## Conventional methodology

shortest Travel time

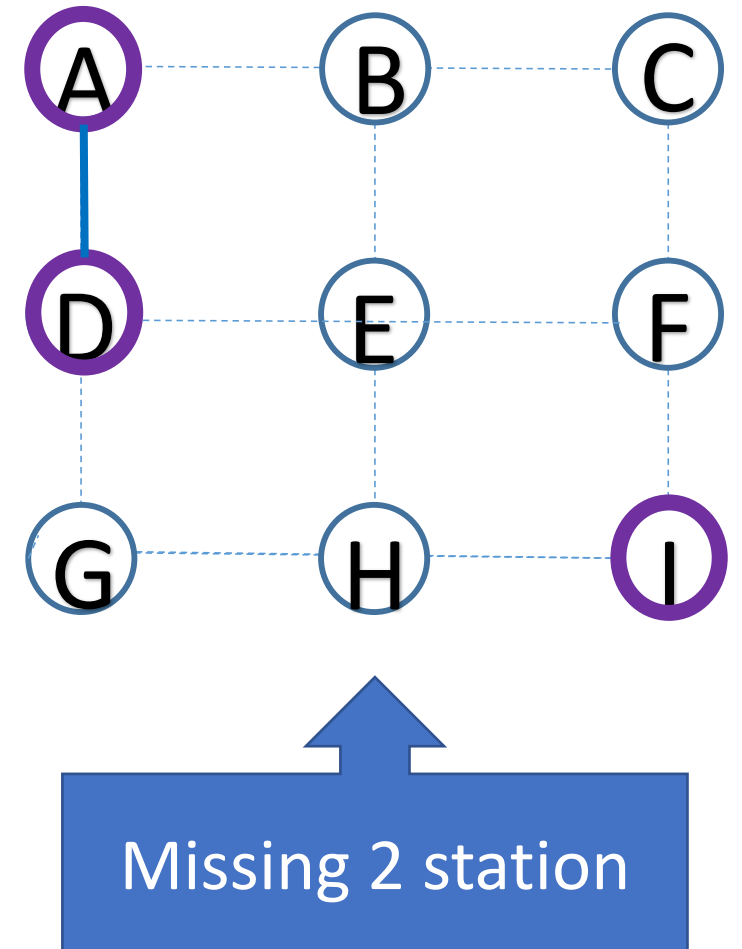
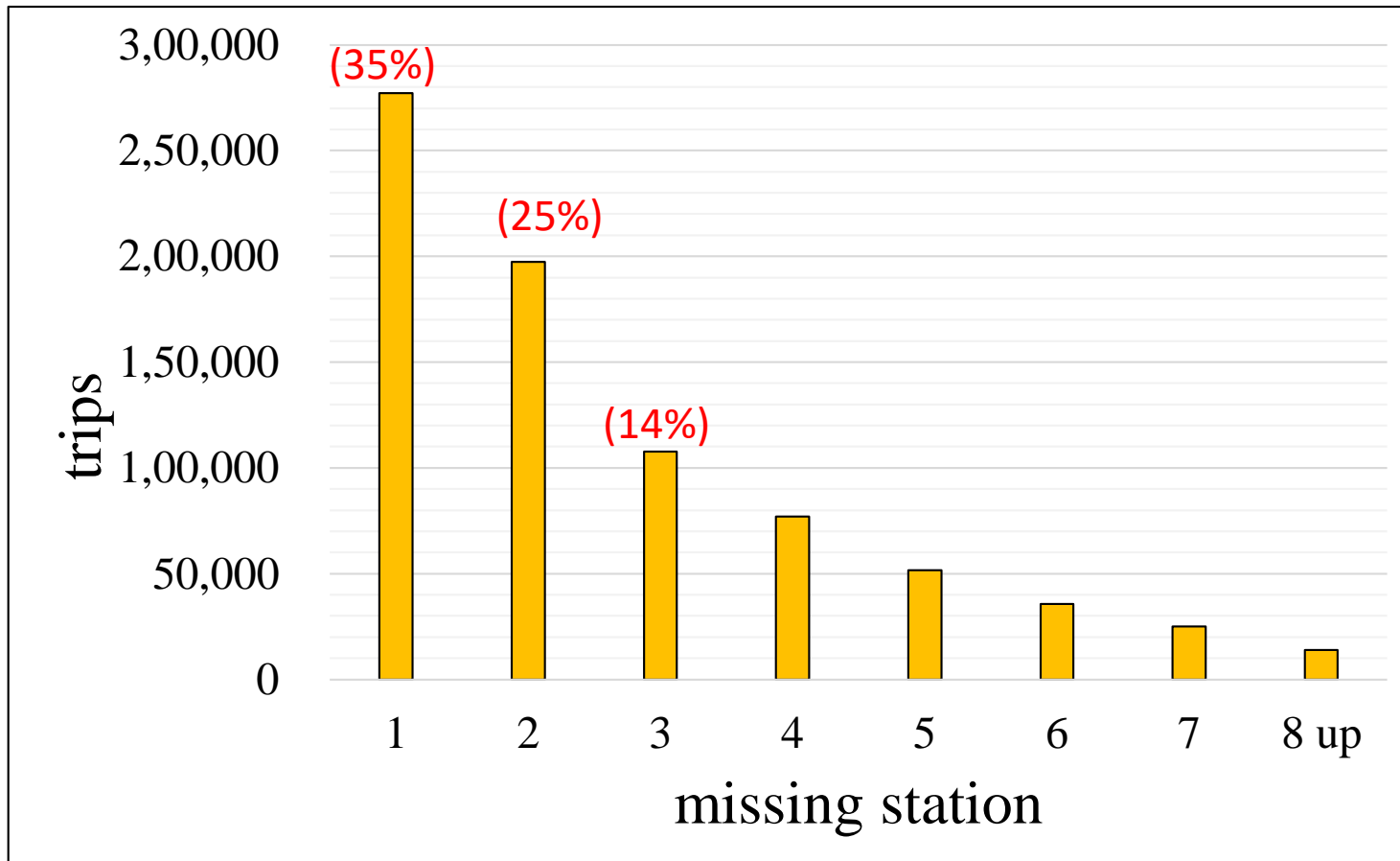


shortest distance



# Data set on this experiment

- Proportion of missing station from Missing trip data



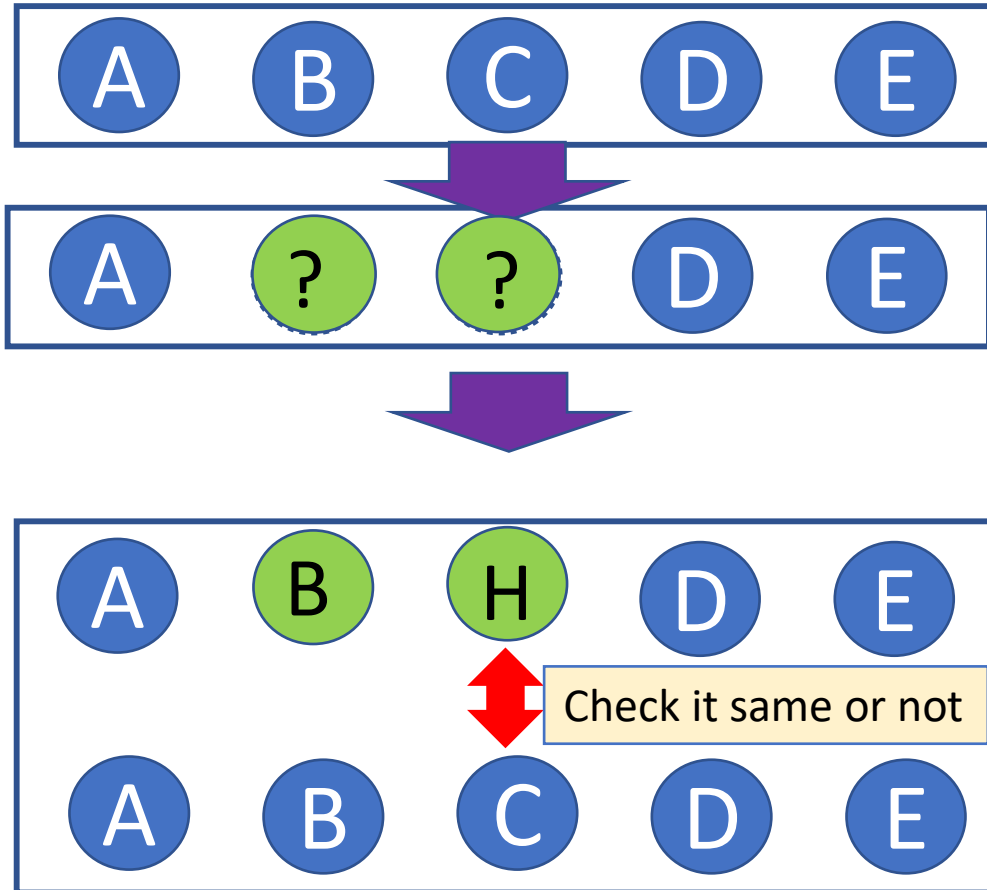
# How to verify

Original Complete Trip

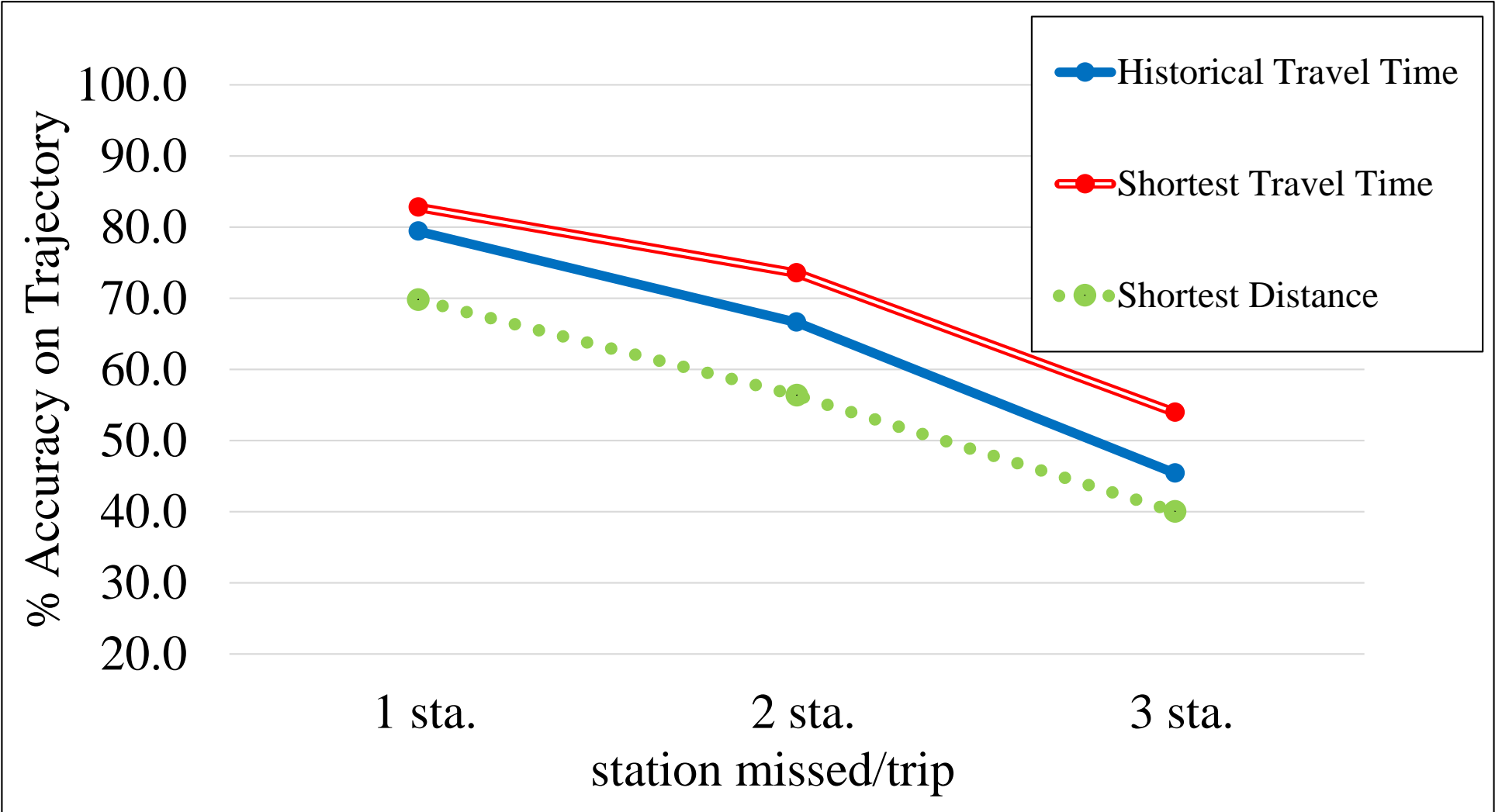
Delete some stations of Bluetooth detector

Investigate Missing station by each method

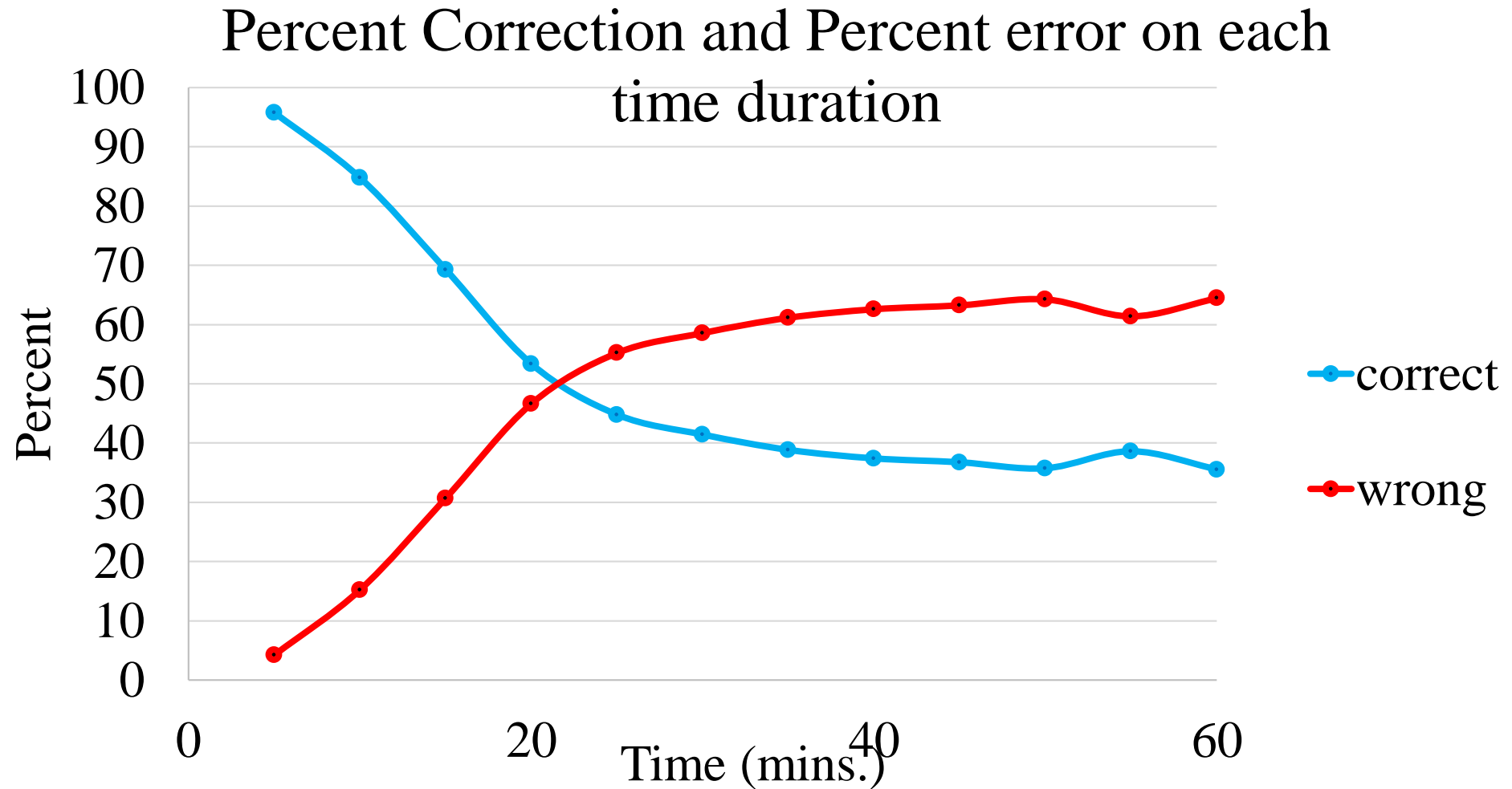
Compare Original Complete trip with New complete trip



# The accuracy of each methodology to estimate missing station on each trip



# Characteristic of missing link estimation





# CONCLUSIONS

❑ The most applicable method in terms of accuracy:

1. The shortest travel time method
2. The historical travel time method and
3. the last one is shortest distance method.

❑ In the rough estimation to multiply the percentage of missing link by each missing station and percentage of recover,

- 52 % was recovered from all of missing links