Second T-LOG/EASTS Logistics IRG Seminar
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An assessment on the influence of network characteristics on the route choice of freight vehicles

Sideney Schreiner, Dr. Eng.
Post-Doctoral Researcher
Global COE Program at the Kyoto University

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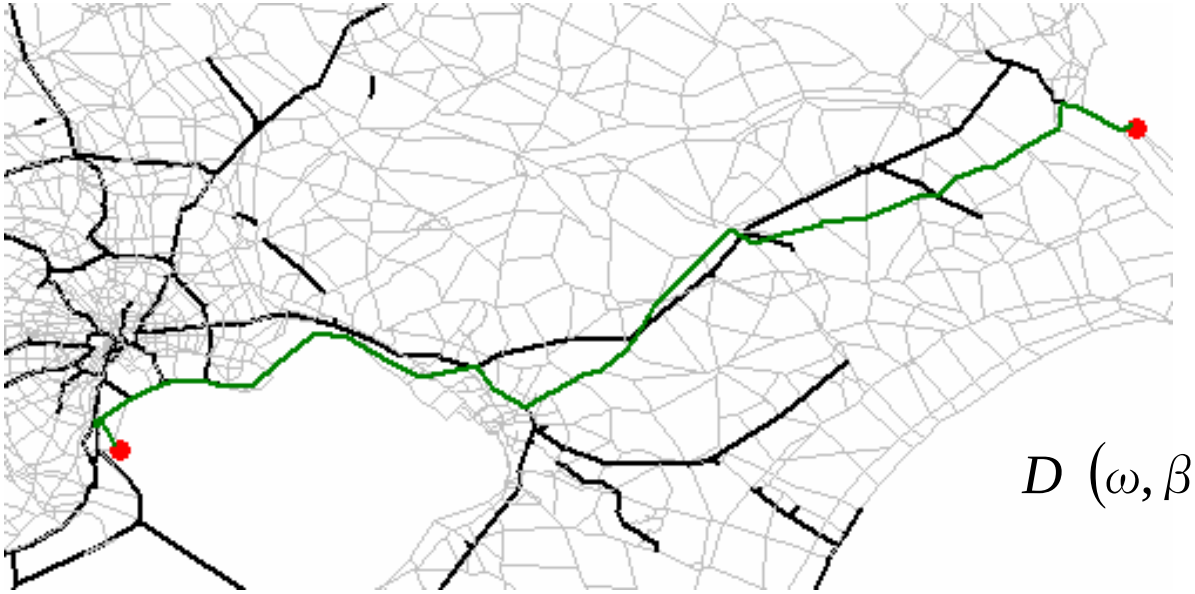
While the definition of the routes of freight vehicles are commonly addressed by the private companies using optimization procedures, the assessment and forecast of those routes from the **transportation planning point of view** – usually a role of the government – depends on adequate route choice models.

This study focuses on the influence of the network characteristics on the route choice of those freight vehicles and the potentiality of implementation on assignment procedures.

MAXIMUM ROUTE OVERLAPPING

An assessment on the influence of network characteristics on the route choice of freight vehicles



$$D\ (\omega,\beta) = \frac{\sum^{n}\sum^{a}\delta_{na}\cdot\ \delta^{*}_{na}(\omega,\beta)\cdot\ l_{a}}{\sum^{n} X_{n}}$$

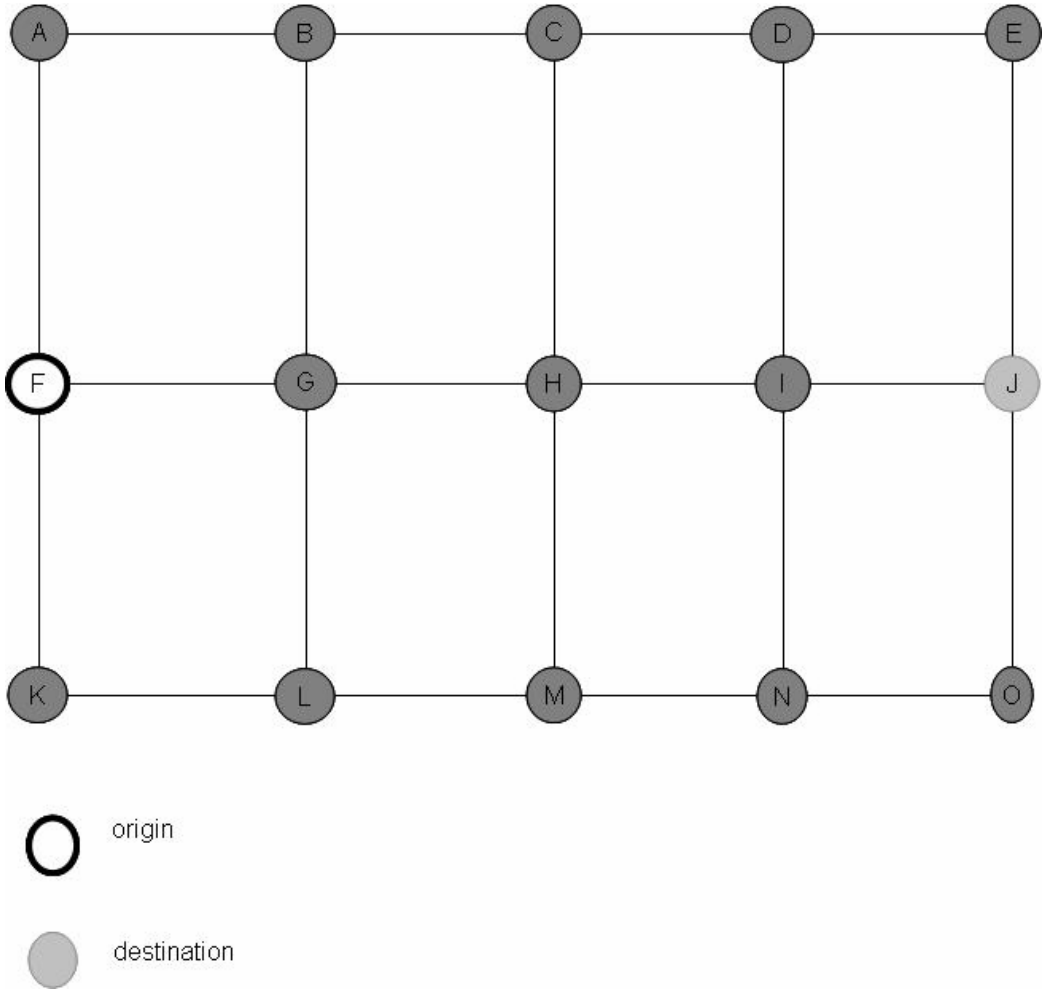
Reveled preference data

Maximum Route Overlapping

Perception parameters to link attributes

Consider the example network:

All links have length = 1

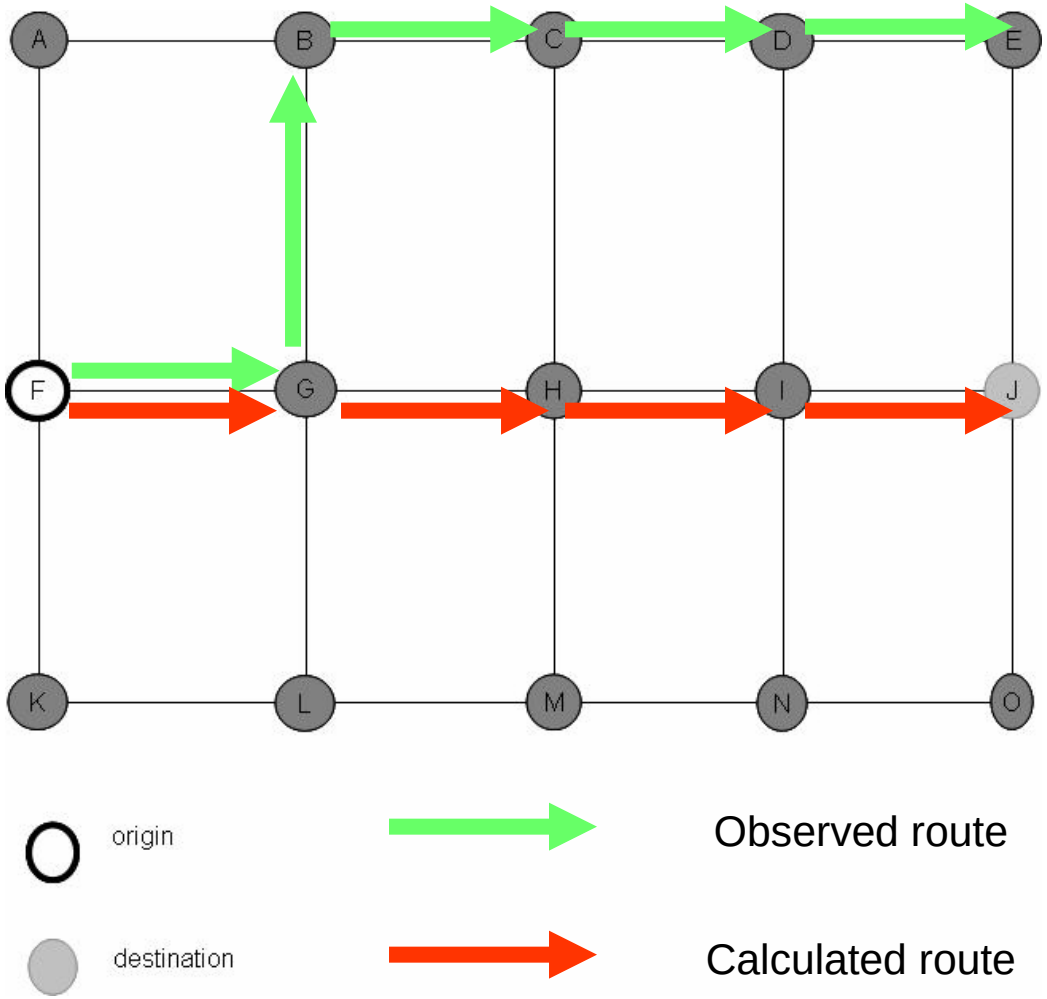


An assessment on the influence of network characteristics on the route choice of freight vehicles

The fitness of the shortest path is given by

$$D\ (\omega,\beta) = \frac{\sum^{n}\ \sum^{a} \delta_{na} \cdot\ \delta^{*}_{na}(\omega,\beta) \cdot\ l_a}{\sum^{n} X_n}$$

$$D = \frac{1}{5} = 0.2$$



An assessment on the influence of network characteristics on the route choice of freight vehicles

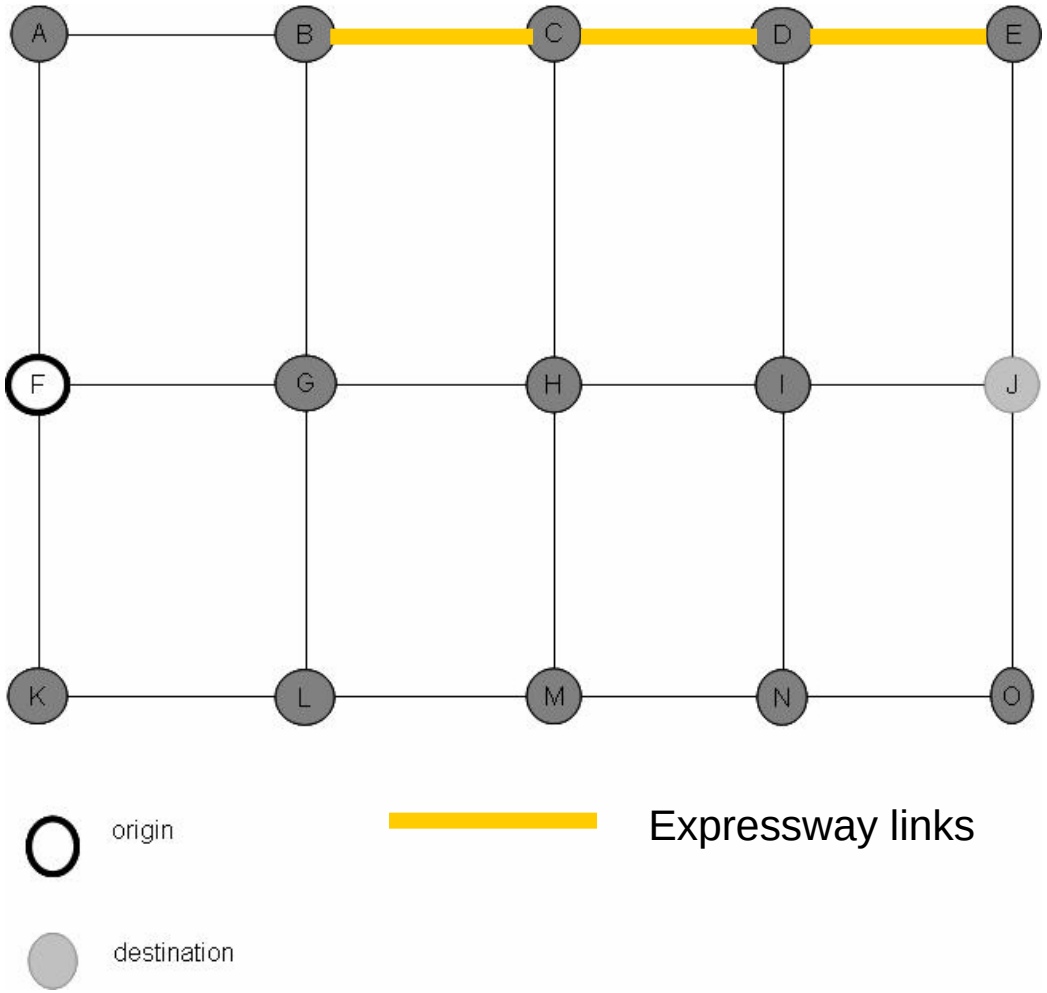
The hypothesis is

$$L^{*}_{an}(\beta) = L_a \prod_k \beta_k^{z_{ak}}$$

In this example, let's consider the characteristic "Expressway"

Z = 1 if the link is expressway

Z = 0 otherwise



An assessment on the influence of network characteristics on the route choice of freight vehicles

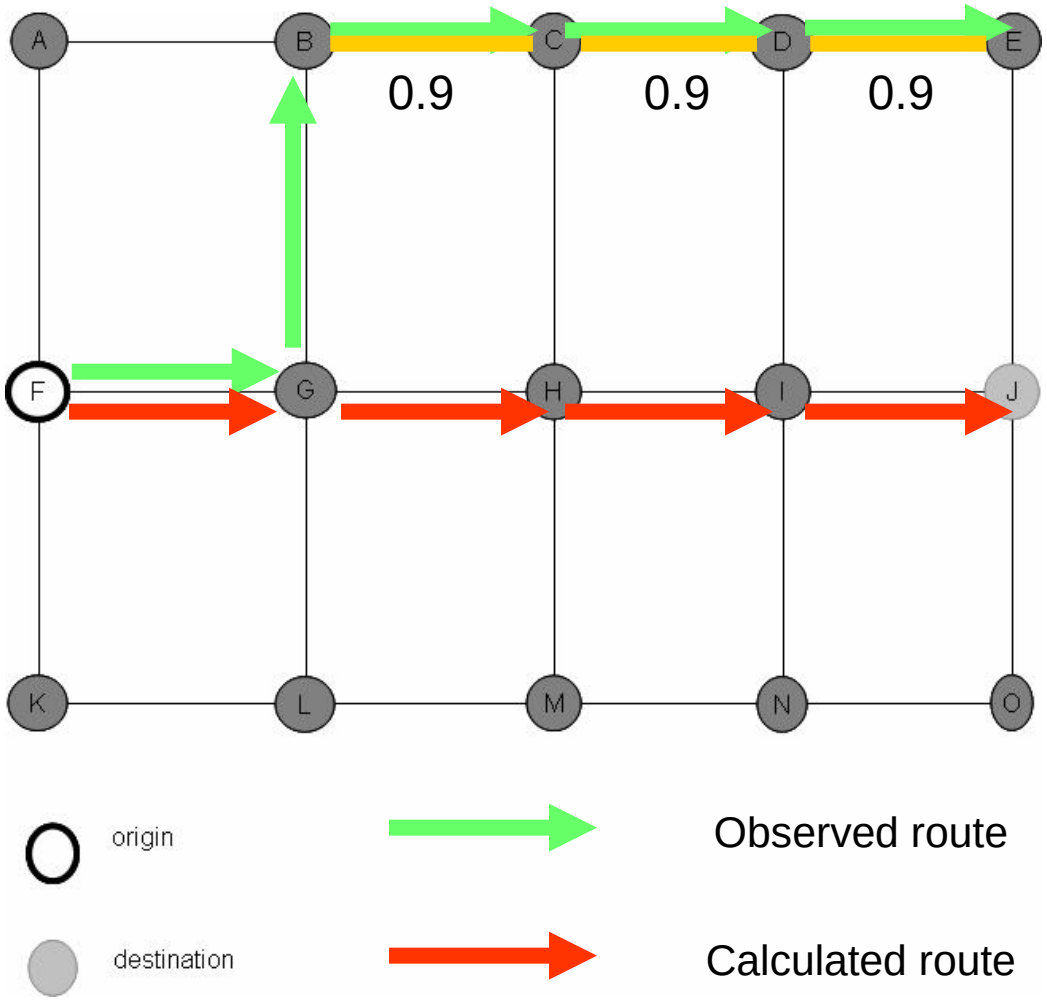
Let's assume $\beta = 0.9$

Path length along the observed route is:

1+1+0.9+0.9+0.9=4.7

Shortest path length is still 4

$$D = \frac{1}{5} = 0.2$$



An assessment on the influence of network characteristics on the route choice of freight vehicles

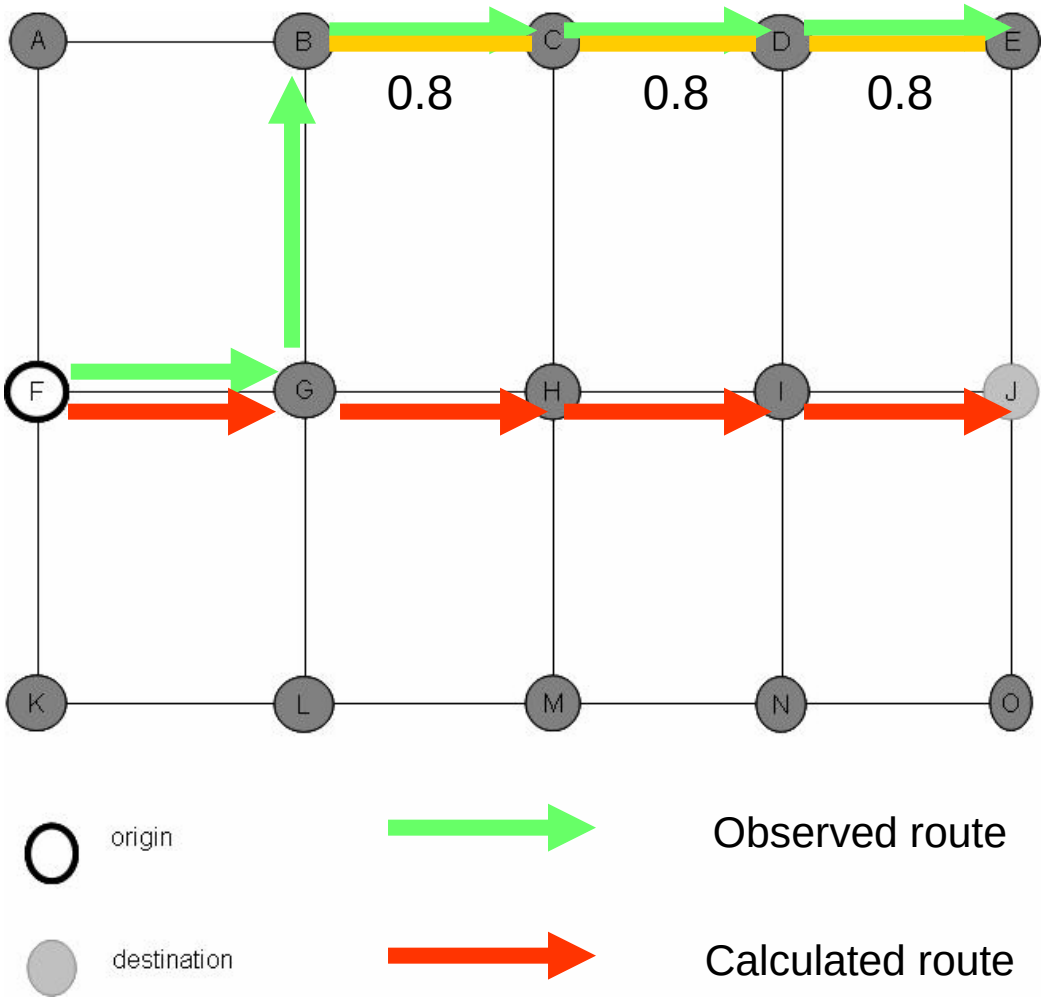
Let's assume $\beta = 0.8$

Path length along the observed route is:

1+1+0.8+0.8+0.8=4.4

Shortest path length is still 4

$$D = \frac{1}{5} = 0.2$$



An assessment on the influence of network characteristics on the route choice of freight vehicles

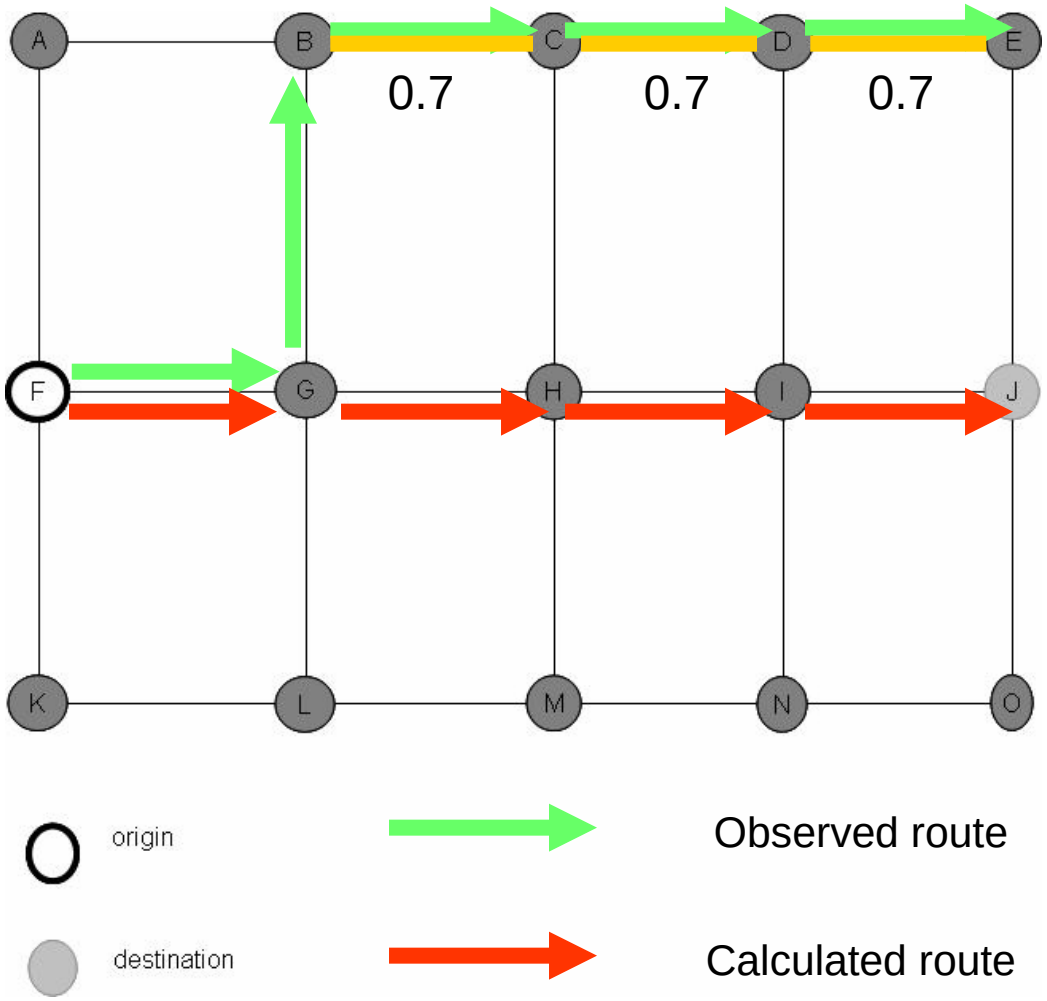
Let's assume $\beta = 0.7$

Path length along the observed route is:

1+1+0.7+0.7+0.7=4.1

Shortest path length is still 4

$$D = \frac{1}{5} = 0.2$$



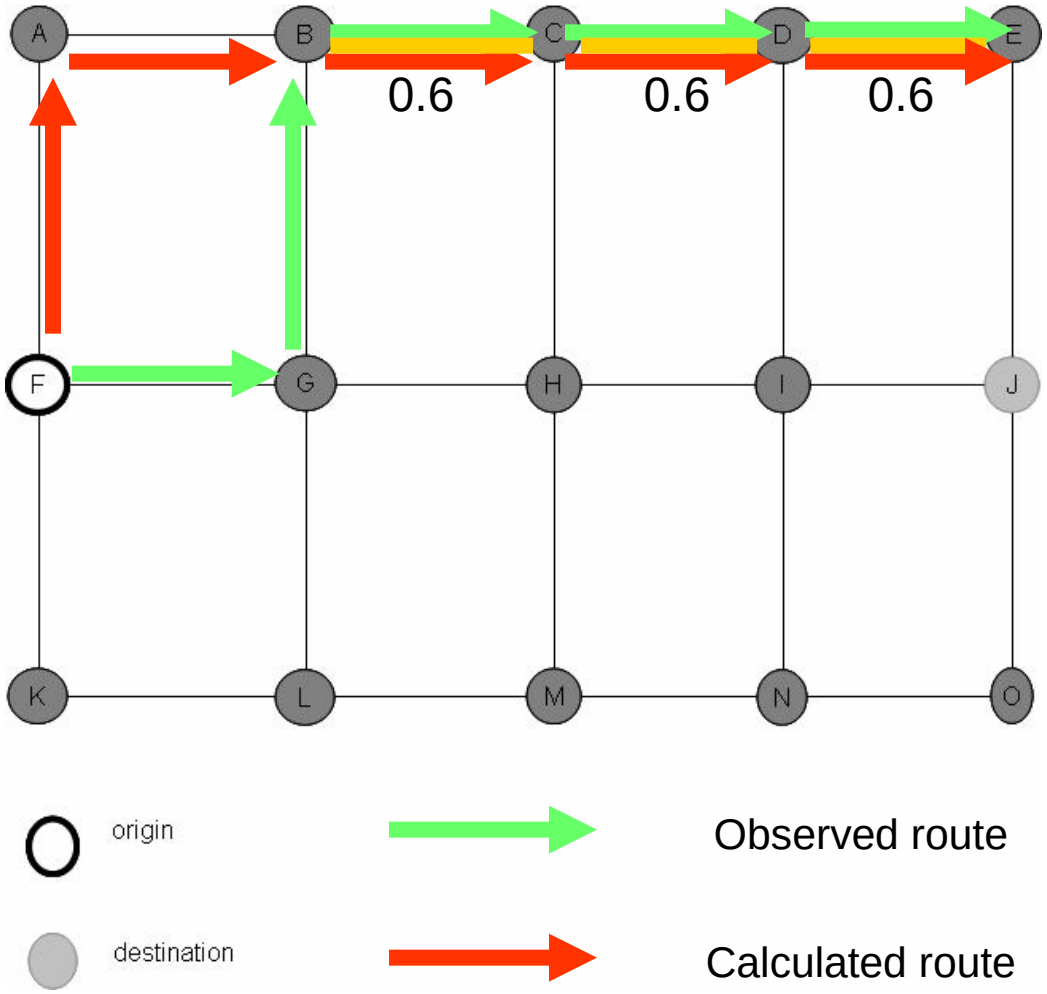
Let's assume $\beta = 0.6$

Path length along the observed route is:

1+1+0.6+0.6+0.6=3.8

Shortest path length is now 3.8

$$D = \frac{3.8}{5} = 8.8$$



Route Choice

- Based on shortest path. Instead of link length, it uses Generalized Cost:

$$GC_a = \left(Cons_a + VOT \times Time_a\right) \times \prod \beta_k^{z_{ak}}$$

Advantages of this method over others:

- Does not require enumeration of paths;
- Considers the perception parameters;
- Considers the user's value of time;
- Considers the travel time in each link.

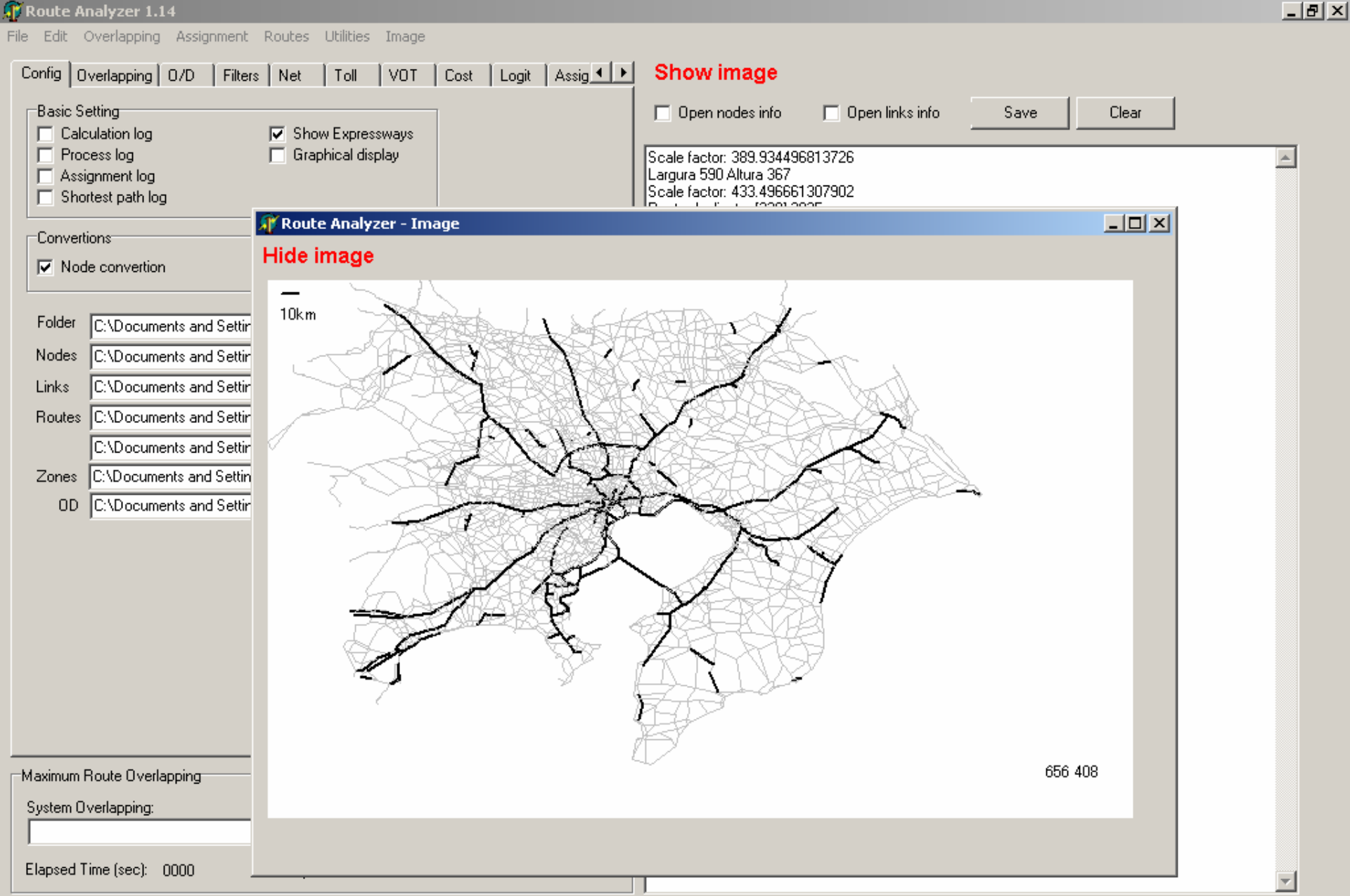
Estimation of value of time

Estimation of Value of Time

- Side product of the Maximum Route Overlapping model

$$GC_a = \left(Cons_a + VOT \times Time_a\right) \times \prod \beta_k^{Z_{ak}}$$

The variation range of the Value of Time was from 0 to 100 ￥/min.



Over 45,000 lines of programming

Route Analyzer 1.14

File Edit Overlapping Assignment Routes Utilities Image

Config | Overlapping | O/D | Filters | Net | Toll | VOT | Cost | Logit | Assig

Route: [7] 764 Nodes: 112 From: 4635 To: 4073

Route-by-route pause Describe route

Dummy searching setting

	From	To	Increment
VOT ($/min)	0	100	1
Expressway	0.6	1	0.1
CBD	1	1	0.1
Ring Road 7	0.9	1	0.1
Numer of lanes (4)	0.6	0.7	0.1
Weight	0.8	0.9	0.1
Height	0.9	1	0.1

Consider truck type

Show details Show route nodes' number

Shortest Path Search

From 4635 To 4073

Ignore tolled links Calculate

Route Ove

Routes

Reset

Maximum Route Overlapping

System Overlapping:

Elapsed Time (sec): 0000 Loops: 000

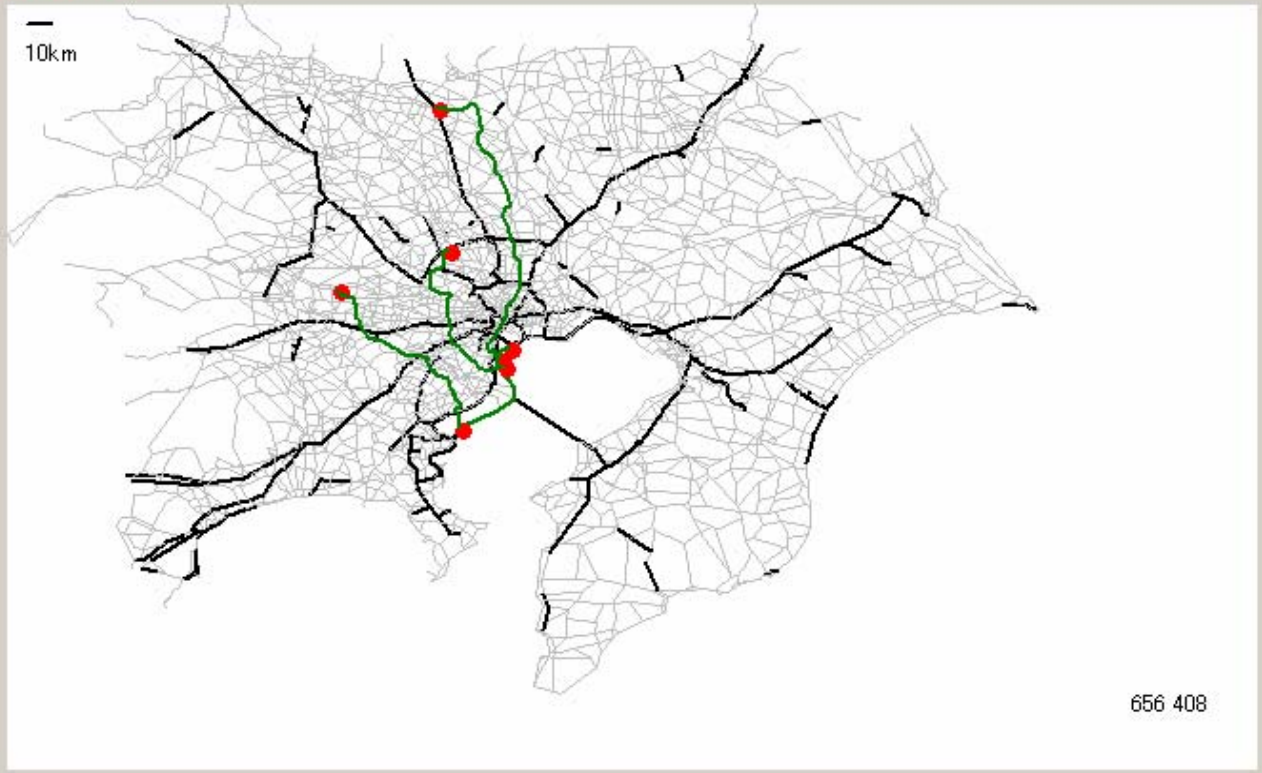
Show image

Open nodes info Open links info Save Clear

Scale factor: 389.934496813726
Largura 590 Altura 367
Scale factor: 433.496661307902

Route Analyzer - Image

Hide image



Route Analyzer 1.14

File Edit Overlapping Assignment Routes Utilities Image

Overlapping | O/D | Filters | Net | Toll | VOT | Cost | Logit | Assignment

Show image

Open nodes info Open links info Save Clear

Scale factor: 389.934496813726
Largura 590 Altura 367
Scale factor: 433.496661307902
Route duplicate: [229] 3035
Route ID modified to: 90229
Route duplicate: [236] 3115
Route ID modified to: 90236
Route duplicate: [287] 3535
Route ID modified to: 90287
Route duplicate: [289] 3535
Route ID modified to: 90289

General Graphics

	Width	Color
All	1	
Expressways	2	

Volume Scaling

Update limits

Traffic volume
Link cost

Volume >=	Width
75	2
34501	2
36801	2
43701	2
45541	6

Min 84
Max 46002

Only tolled roads Show Node Code

Link filter

Info 0 Criteria 0 Ap

Button16 App

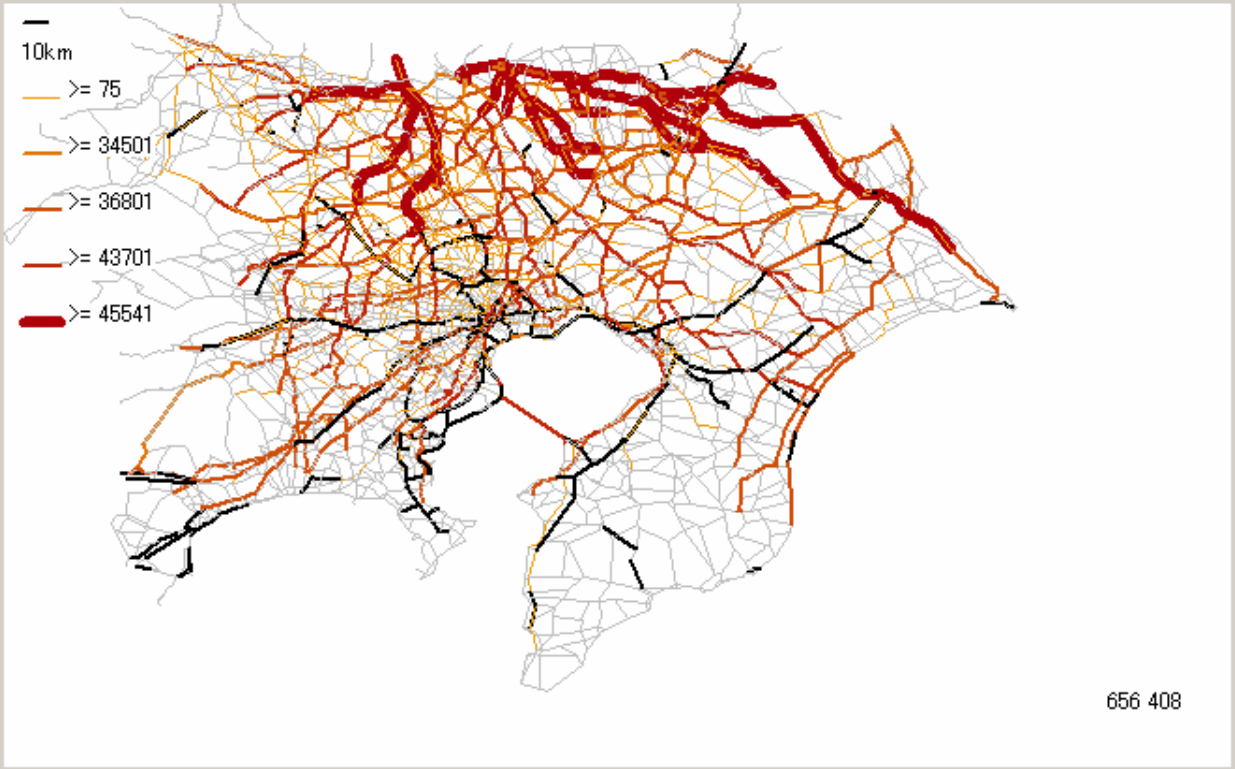
Maximum Route Overlapping

System Overlapping:

Elapsed Time (sec): 0000 Loops: 000

Route Analyzer - Image

Hide image



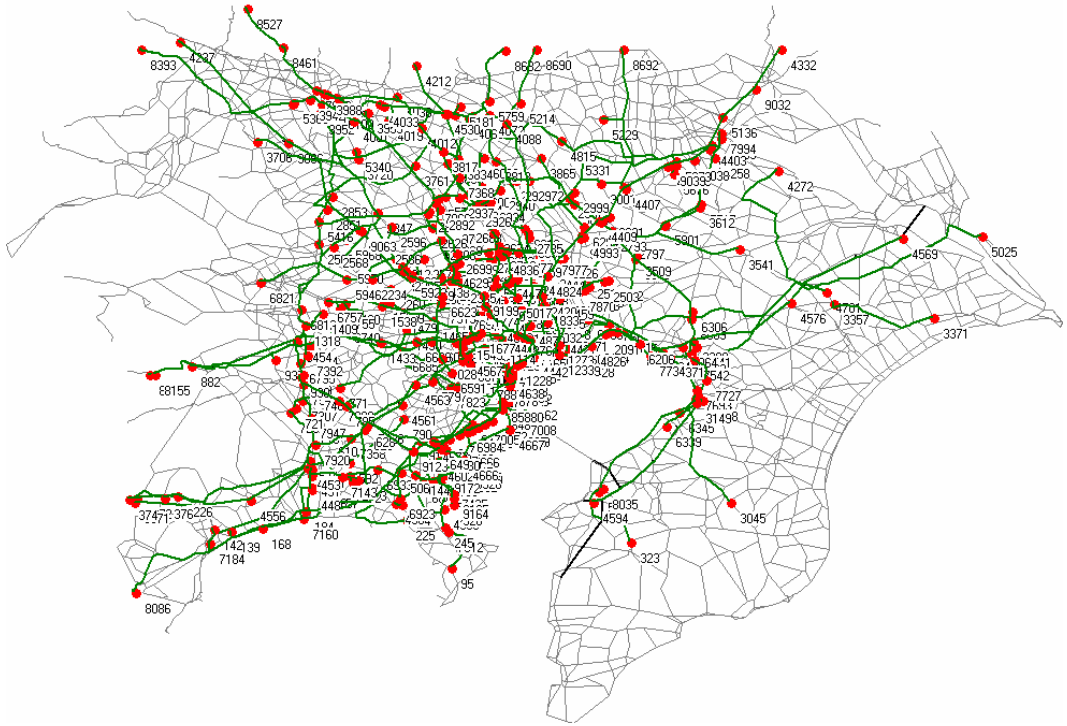
Case Study
Tokyo, Japan

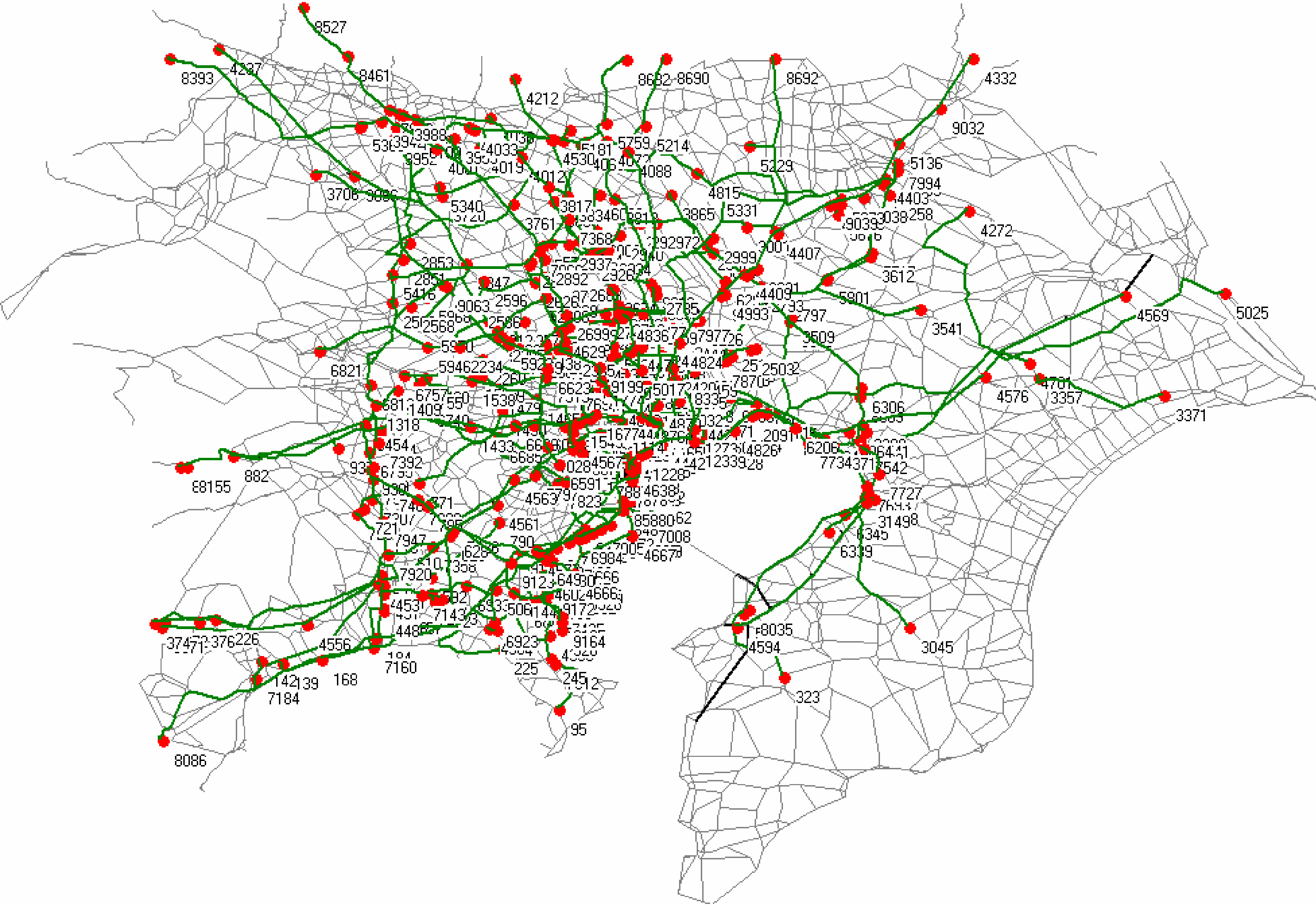
An assessment on the influence of network characteristics on the route choice of freight vehicles

The sample:
597 truck routes

The network:
- ❑ 9,231 nodes
- ❑ 25,062 links

Link attributes:
- ❑ 26 possible
- ❑ 6 selected




8527
8393
4237
8461
4212
8690
8692
4332
9032
5136
7994
5214
5229
4088
4815
5331
3706
5340
3761
3817
3865
4272
4407
3612
2999
2853
5416
9063
2596
3541
4569
5025
6821
3509
4576
3357
3371
6306
1318
882
7392
4563
4561
790
7008
6345
6339
3045
8035
4594
323
4556
168
7160
7184
139
225
9164
95
8086
6923
7920

Attributes selected to the evaluation of perception parameters

	Attribute	Condition for $z_{na}= 1$	Condition for $z_{na}= 0$
1	Tolled road	tolled link	otherwise
2	CBD area	inside CBD area	otherwise
3	Ring Road 7	inside ring road7	otherwise
4	Number of lanes	>= 4 lanes	otherwise
5	Heavy truck permission	yes (over 20ton)	otherwise
6	Tall truck permission	yes (over 3.8m)	otherwise

Results for individual parameter estimation – all sample

Variable	Parameter	Duplicate Rate (Weighted)
Value of Time [Yen／Min.]	74	**0.64962**
Dummy of “Heavy”*	0.550	
Value of Time [Yen／Min.]	88	0.63677
Dummy of “Height”**	0.775	
Value of Time [Yen／Min.]	102	0.63754
Number of lanes >= 4	0.725	
Value of Time [Yen／Min.]	58	0.64372
Expressway Dummy	0.625	
Value of Time [Yen／Min.]	80	0.59173
C.B.D. Dummy	1.100	
Value of Time [Yen／Min.]	86	0.58515
Inside “Ring Road 7” Dummy	0.900	

Results for collective parameter estimation – Non-container trailers

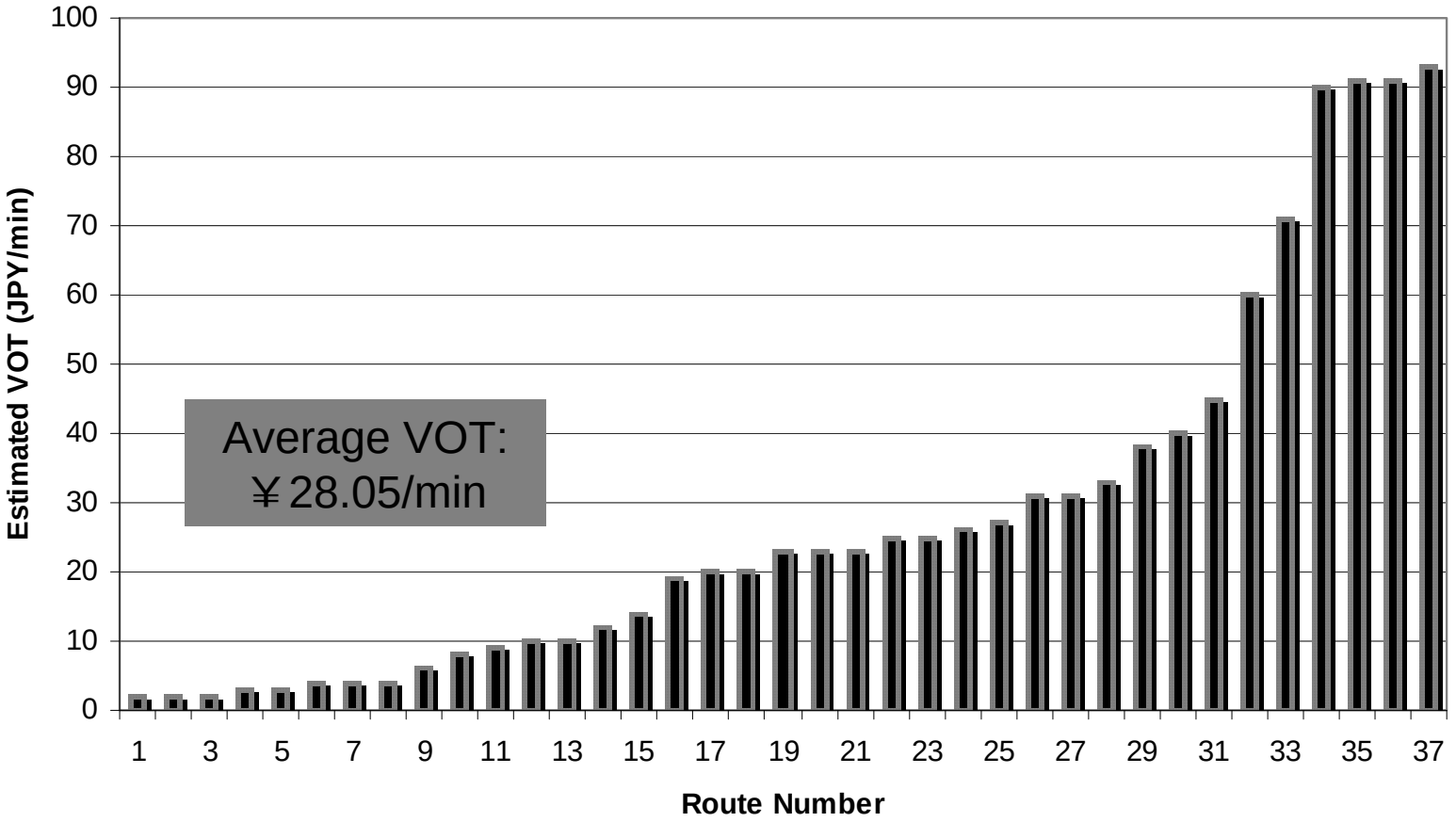
Attribute	Parameter	Duplicate rate
VOT	90	
Tolled	0.6	
CBD	1.0	
RingRoad7	0.9	0.803336
4 Lanes	0.6	
Weight	0.8	
Height	0.7	

Results for collective parameter estimation – **Container trailers**

Attribute	Parameter	Duplicate rate
VOT	14	
Tolled	1.0	
CBD	1.0	
RingRoad7	1.0	0.669285
4 Lanes	1.0	
Weight	0.8	
Height	0.9	

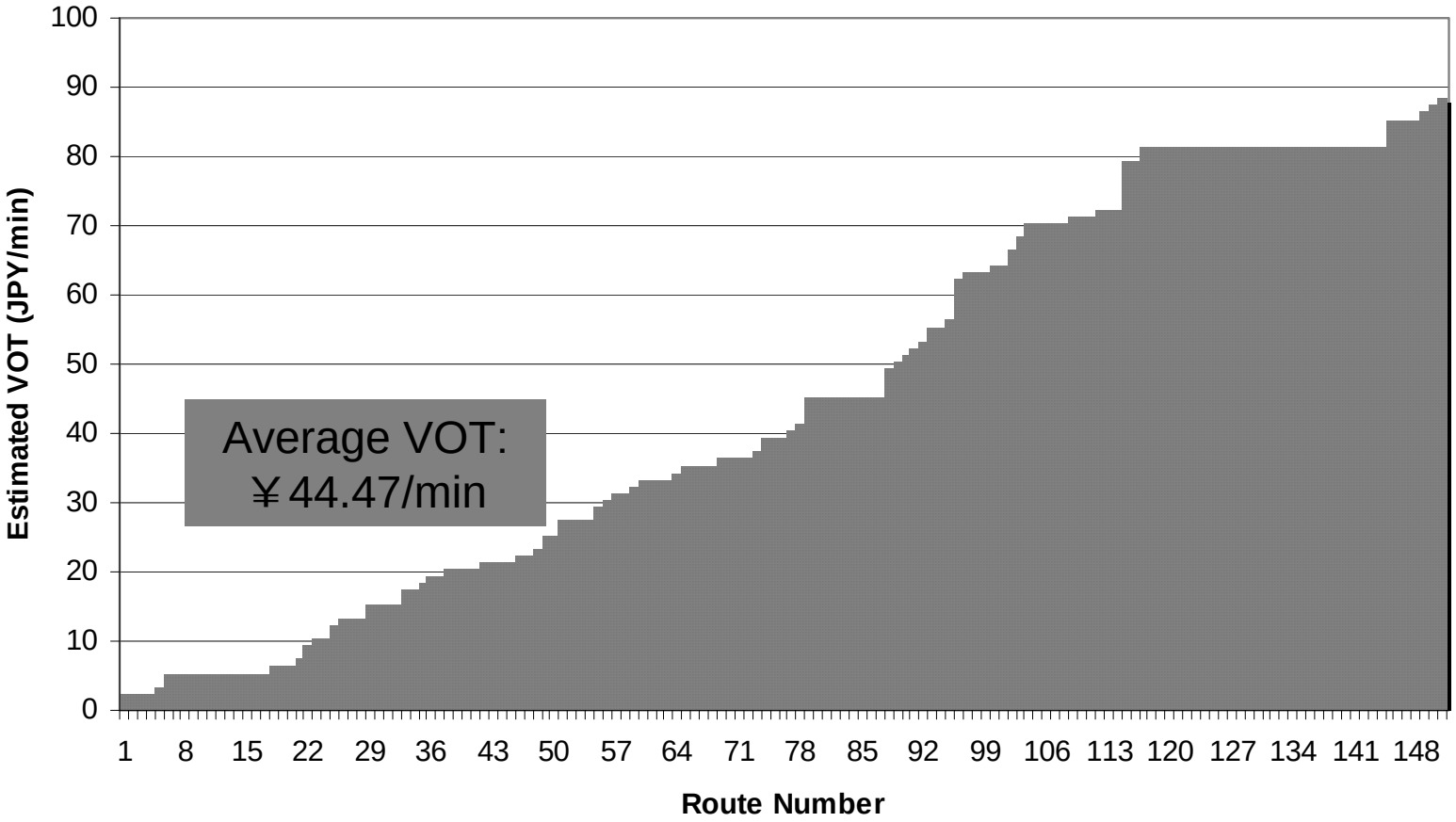
Estimation of Value of Time and its implication in assignment procedures

(Container Trailer)

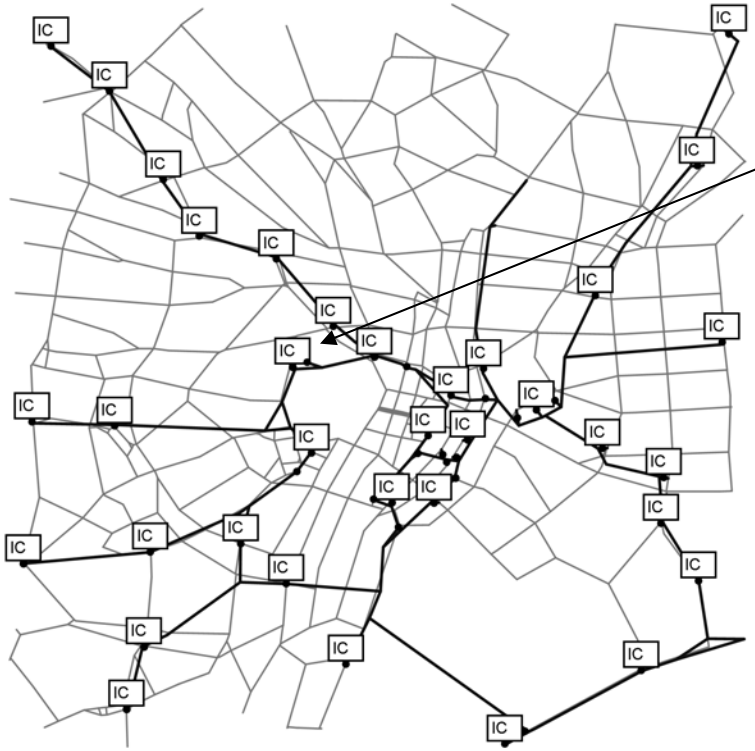


Estimation of Value of Time and its implication in assignment procedures

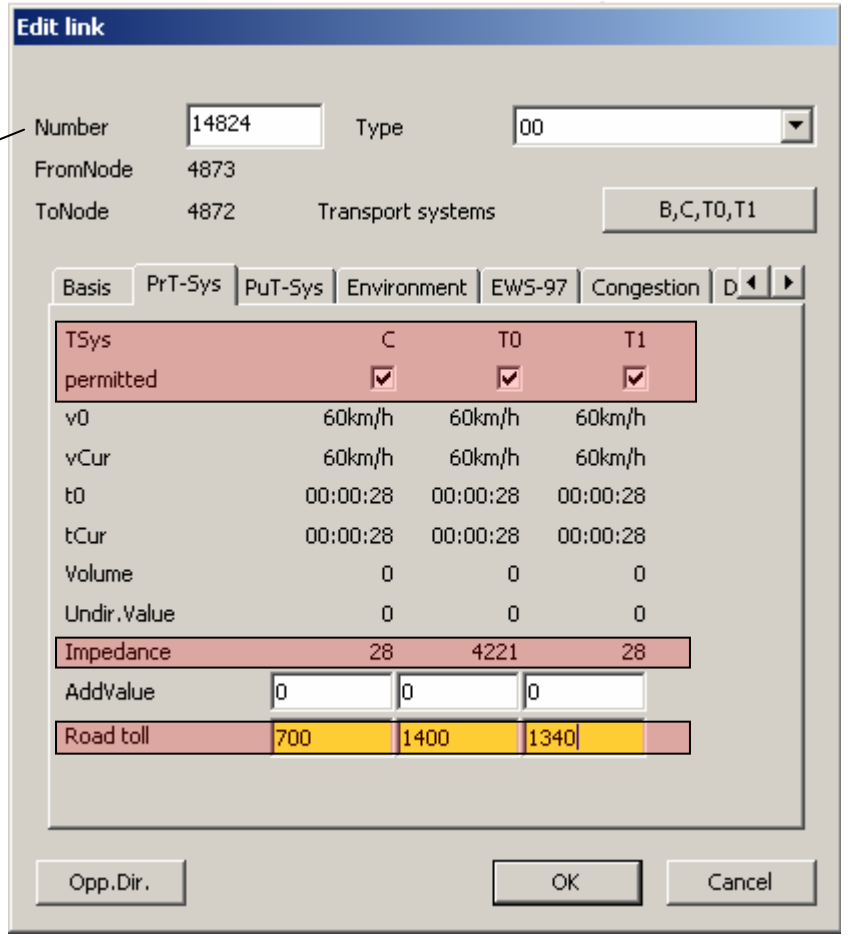
(Non Container Trailer)

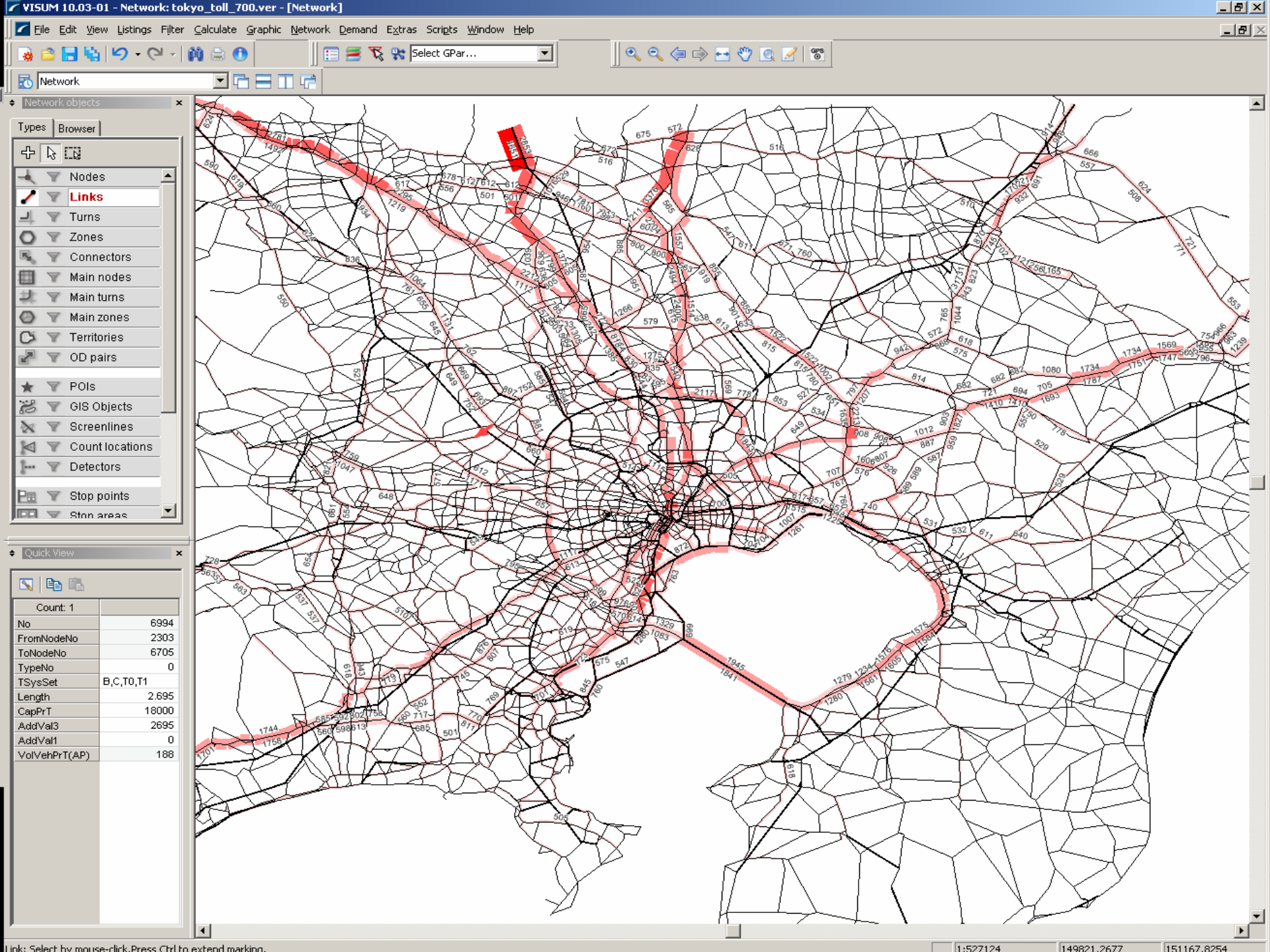


An assessment on the influence of network characteristics on the route choice of freight vehicles

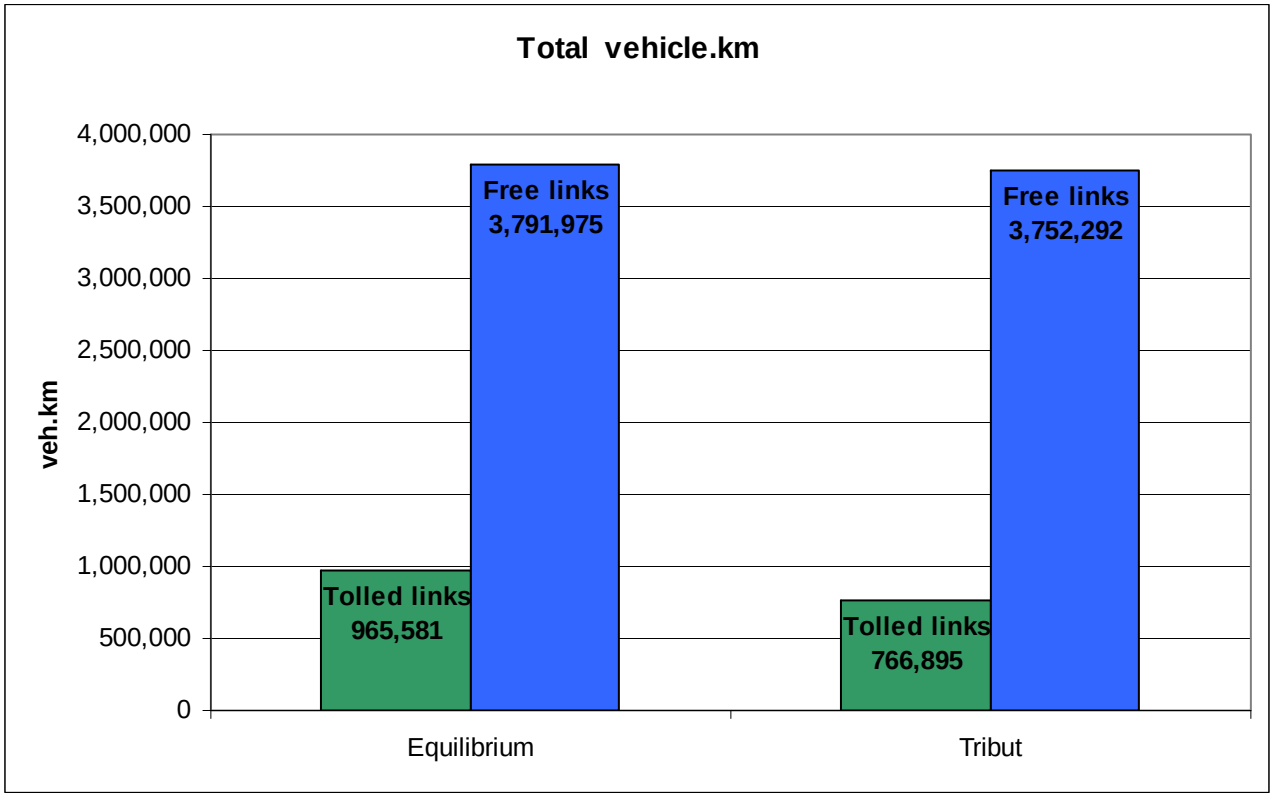


Vehicle class dependent toll price and impedance for each IC link




VISUM 10.03-01 - Network: tokyo_toll_700.ver - [Network]
File Edit View Listings Filter Calculate Graphic Network Demand Extras Scripts Window Help
Select GPar...
Network
Network objects
Types Browser
Nodes
Links
Turns
Zones
Connectors
Main nodes
Main turns
Main zones
Territories
OD pairs
POIs
GIS Objects
Screenlines
Count locations
Detectors
Stop points
Stop areas
Quick View
Count: 1
No 6994
FromNodeNo 2303
ToNodeNo 6705
TypeNo 0
TSysSet B,C,T0,T1
Length 2.695
CapPrT 18000
AddVal3 2695
AddVal1 0
VolVehPrT(AP) 188
Link: Select by mouse-click.Press Ctrl to extend marking.
1:527124
149821.2677
151167.8254

Estimation of Value of Time and its implication in assignment procedures



Difference for the tolled links reaches 198,686 vehicle.km/day

How much is a vehicle.km?

￥24.6 !

Difference: 488万円/day

An assessment on the influence of network characteristics on the route choice of freight vehicles

CONCLUSIONS

About the results

- ✓ Increased quality of route forecasting
- ✓ Large difference in the value of times of each route sample
- ✓ Identification of the most significantly influential network parameters for non container trailers
- ✓ Additional factor influencing route choice of container trailers could not be identified

Policy implications

- ✓ Development of transportation infrastructure focusing on logistics improvements:
  - ✓ Development of guidelines for the construction of connection links among terminals, distribution center, and other important locations.
  - ✓ Identification/coordination of use of the most appropriated type of vehicle to a certain area.

Thank you for your attention!