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Pedestrian and transit accessibility on a micro-level: results & challenges

WSTLUR
Delft, the Netherlands

June 2014

(FCL) **FUTURE** 未来
CITIES 城市
LABORATORY 实验室

(SEC) **SINGAPORE-ETH** 新加坡－ETH
CENTRE 研究中心

IVT Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Accessibility

Four components

Land-use component

Transportation component

Temporal component

Individual component

Translated in five measures
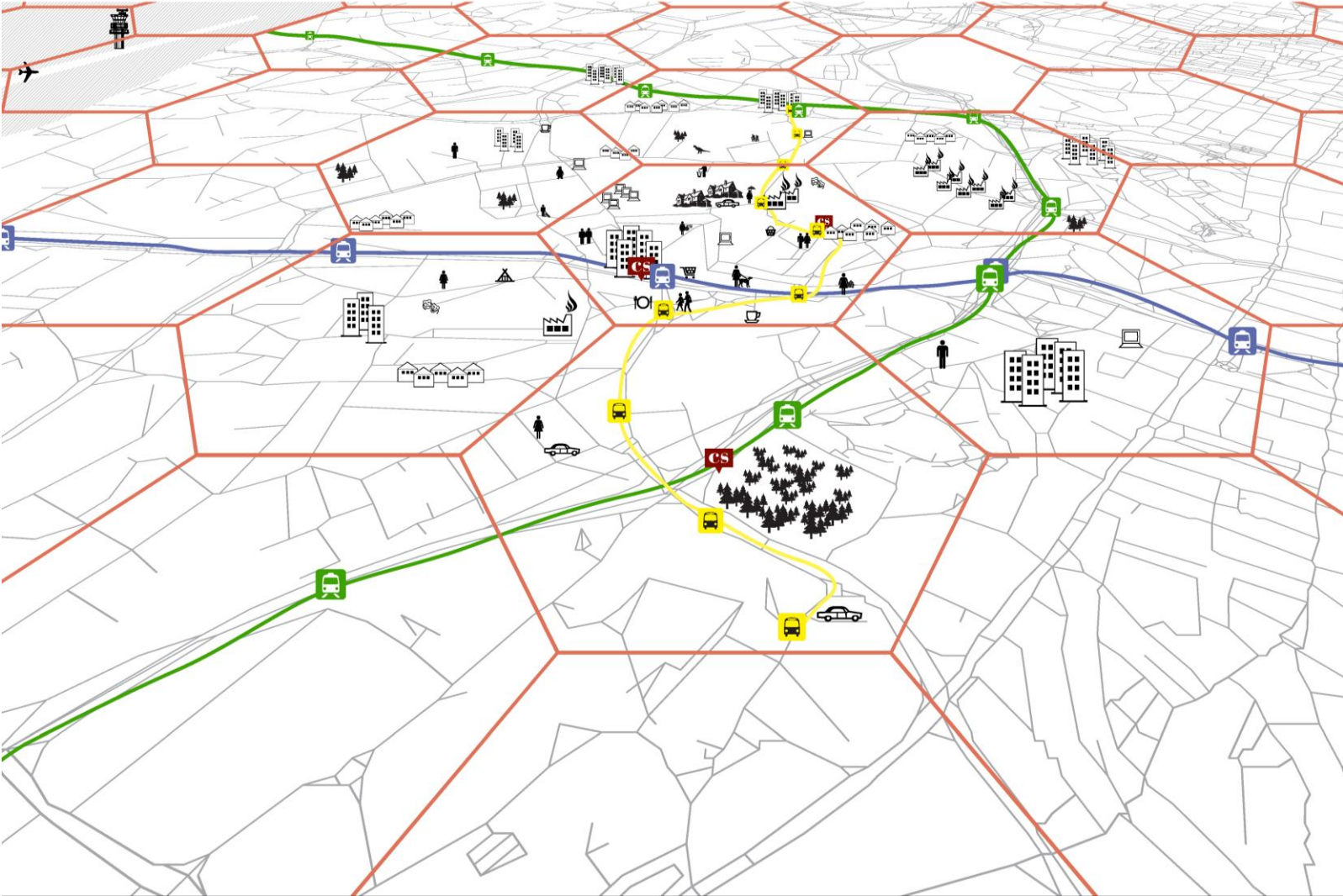
Spatial separation
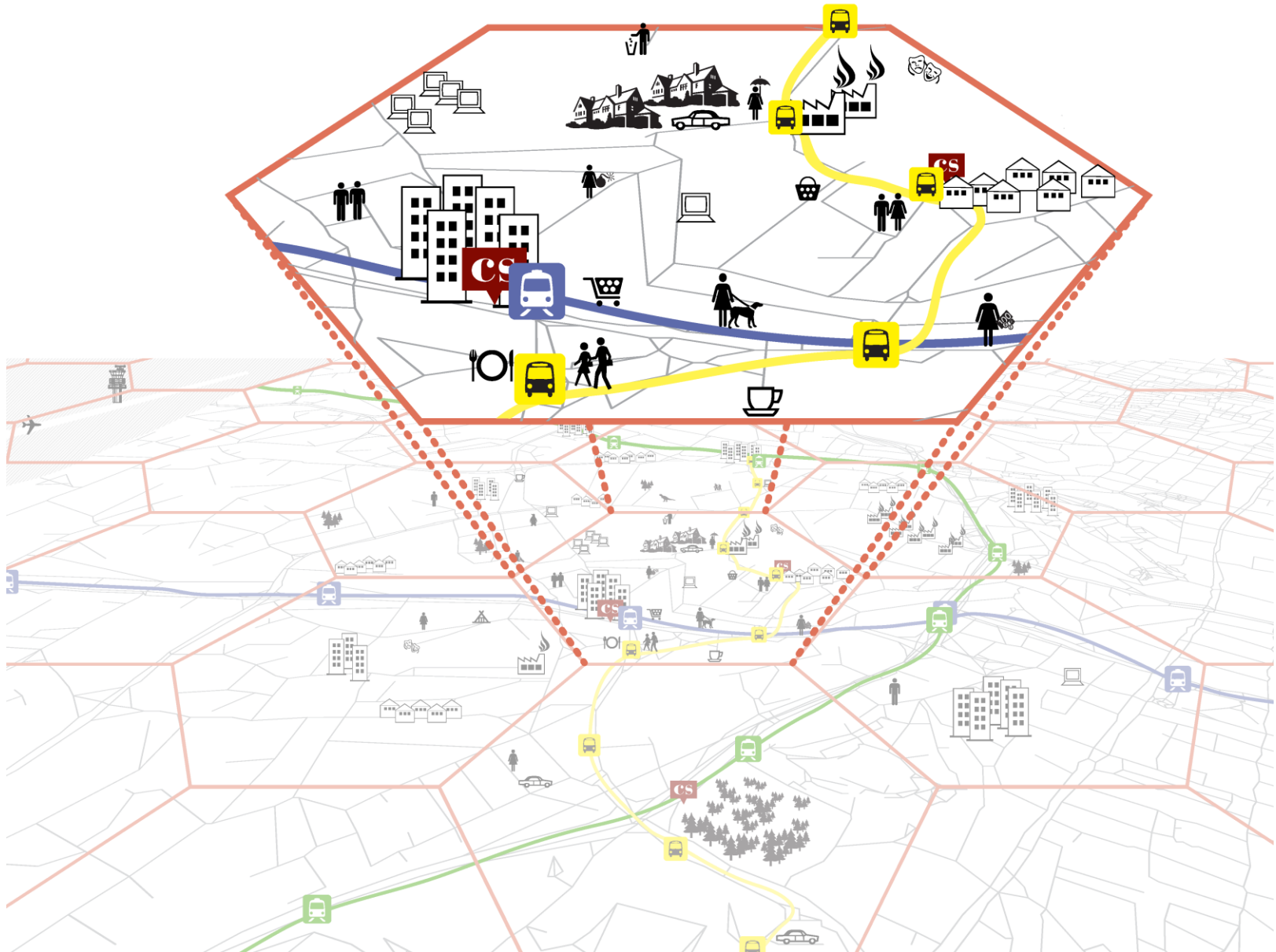
Cumulative opportunities
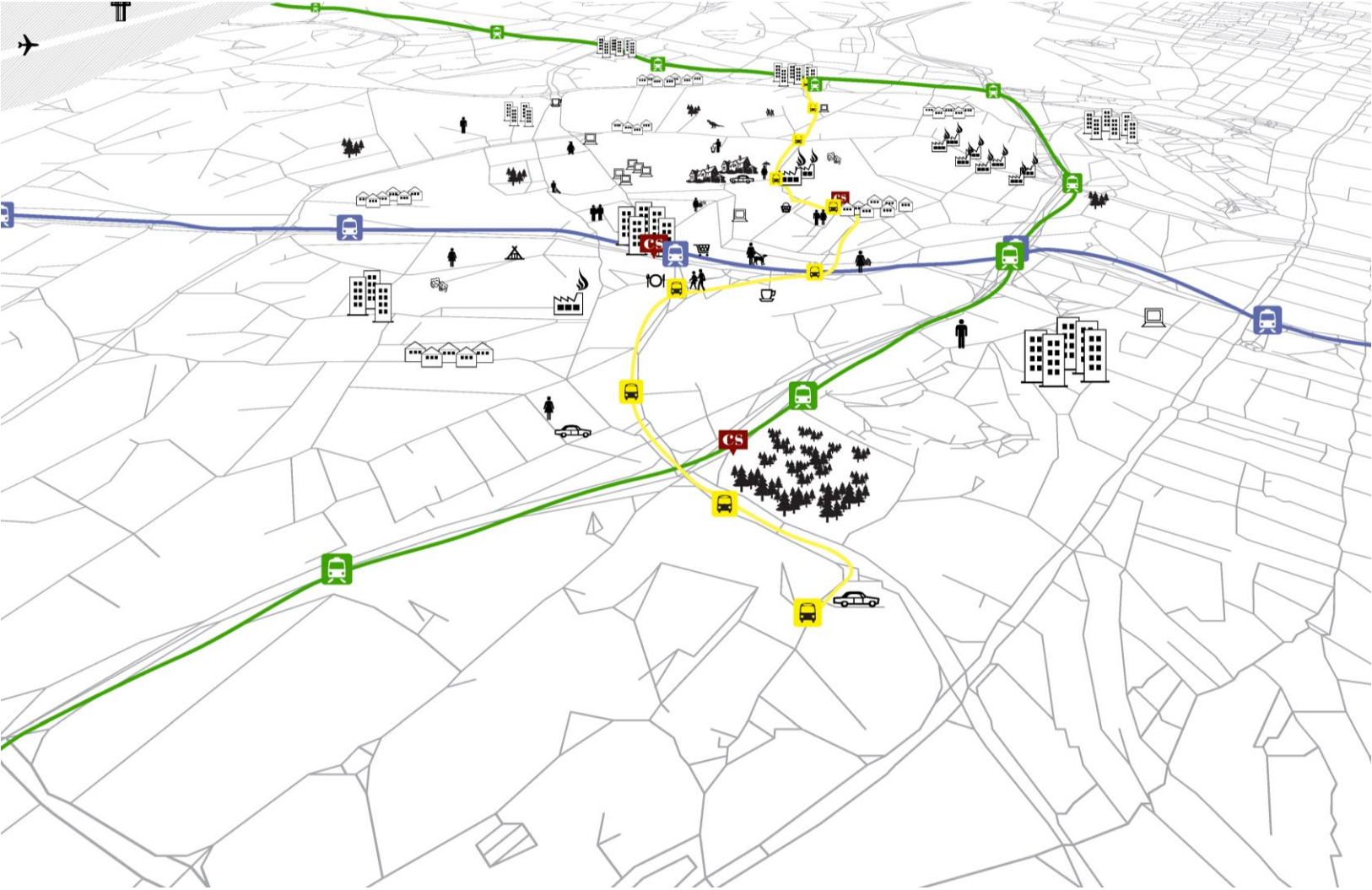
Gravity measures

Utility measures

Time / space measures

Accessibility on a zonal level
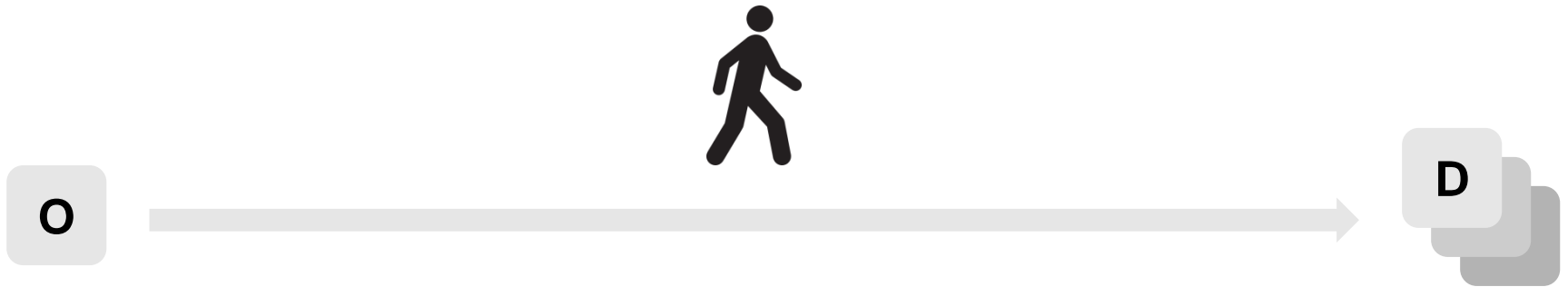
But….. A high diversity within a zone

Accessibility from anywhere to everywhere
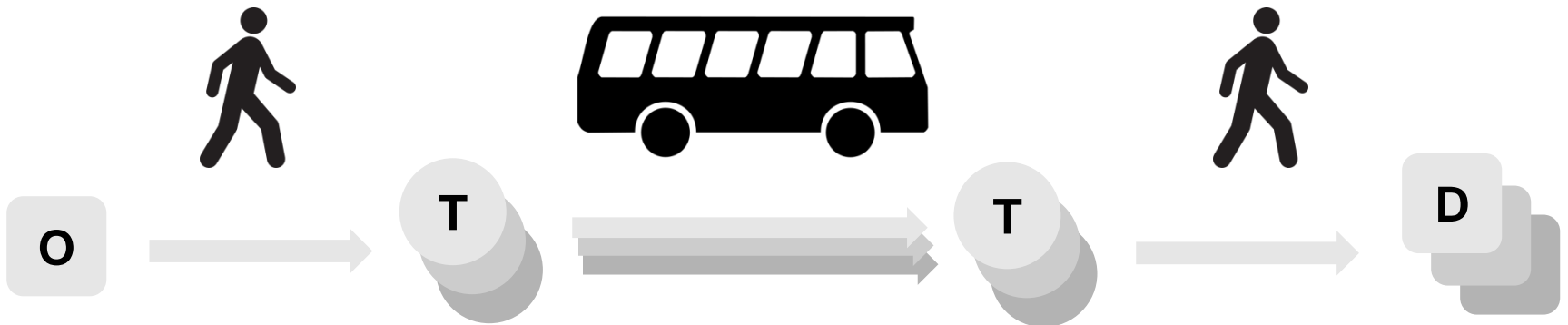
Calculating object-fine accessibility

Calculating object-fine accessibility

Pedestrian accessibility

O → D

+

Public transport accessibility

O → T → T → D

Pedestrian accessibility

Pedestrian accessibility
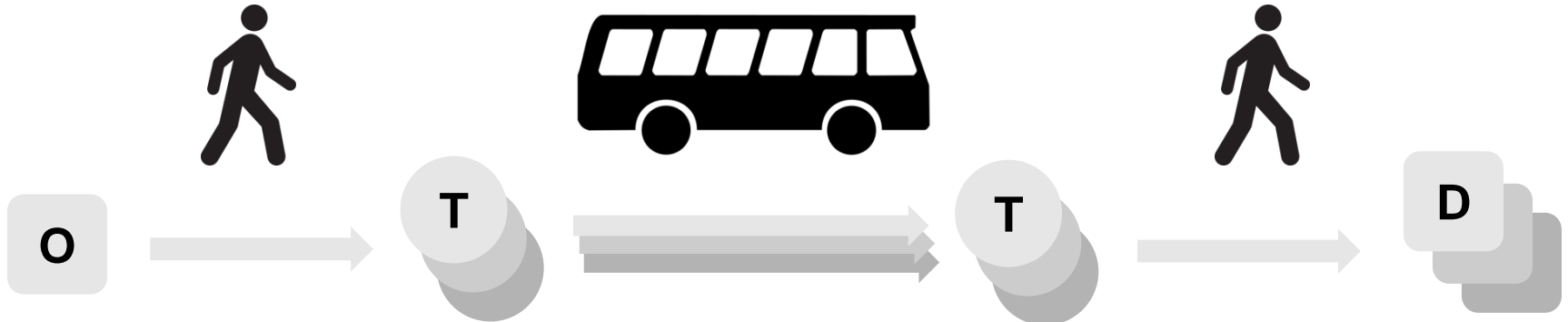
O → **D**

Calculation

origin building (location) **O** to all

destination buildings (location) **D**

within radius **R.**

Requirements

Activity locations

Opportunities available at building **D**

Costs of traveling from **O** to **D**

Distance or opportunity decay

Public transport accessibility

Public transport accessibility

Calculation

origin building (location) **O** to all

via public transport stop **T** within

distance **R** to destination buildings

(location) **D** in region of interest

Requirements

Activity locations

Opportunities available at building **D**

Costs of traveling from **O** to **T / D** to **T**

Costs of traveling from **T** to all **T**

Impedance

Study area & data
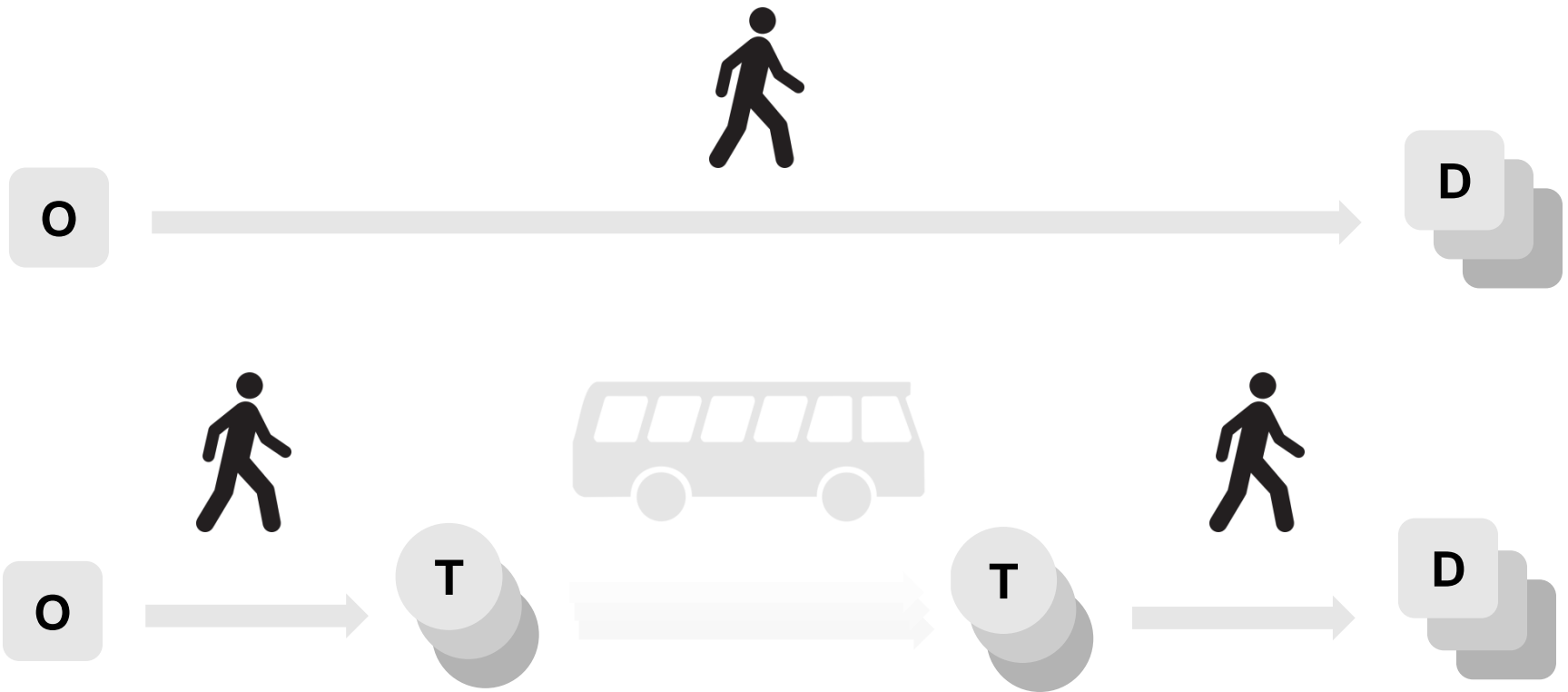
Singapore

Land area of 712 km2 (2010; 697 km2, 2000)

Total population 5.08 million (2010; 4.03 million, 2000)

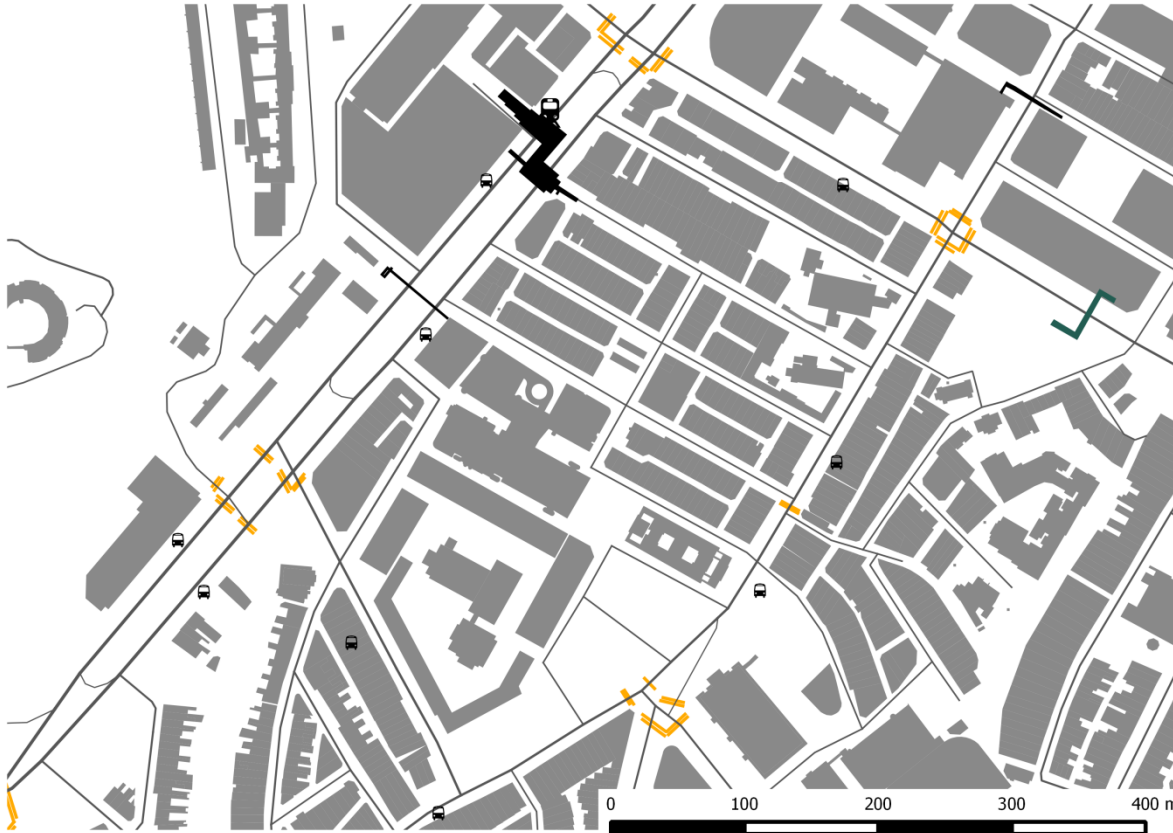GDP per capita amounts to S$ 59,813 (US$ 45,200, 2010),

Vehicle ownership 392,961 in 2000 to 597,746 in 2010 ,

Or 1 car per 10 households in 2004 to 1 car per 8.8 households in 2008 (Choi & Toh, 2010).

Pedestrian network

Pedestrian network

Data sources

Road centrelines

Lanemarkings

Overheadbridges

Underpasses

Building addresses

Building centroids

Bus stops

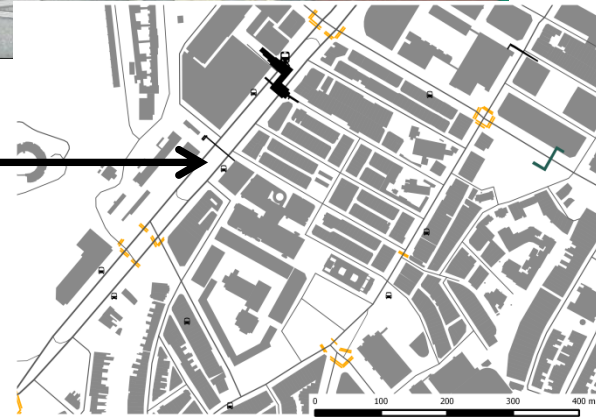Train station entrances and

platform location

Pedestrian network

Source data:

Centreline (Category B), overhead bridges

Network generation:

Sidewalks created on both sides of road,

length determined by offset width (5 meters).

Crossing at overhead bridge
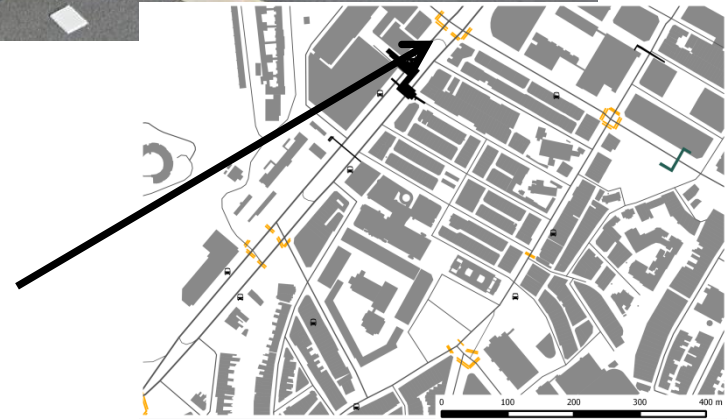
Pedestrian network

Source data

Lane marking

Network generation

Crossing, length determined by offset width
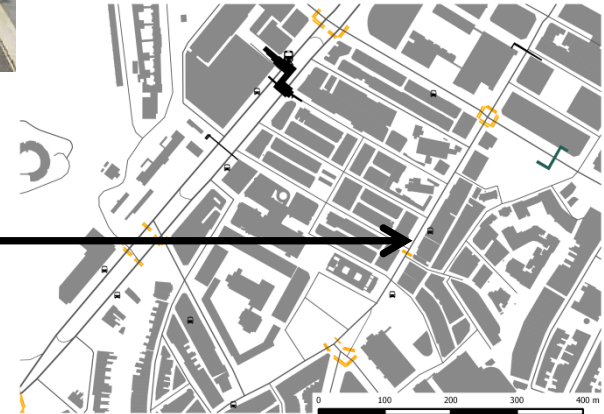
(5 meters)

Pedestrian network

Source data

Centreline Category C

Network generation

Sidewalks

Pedestrian network
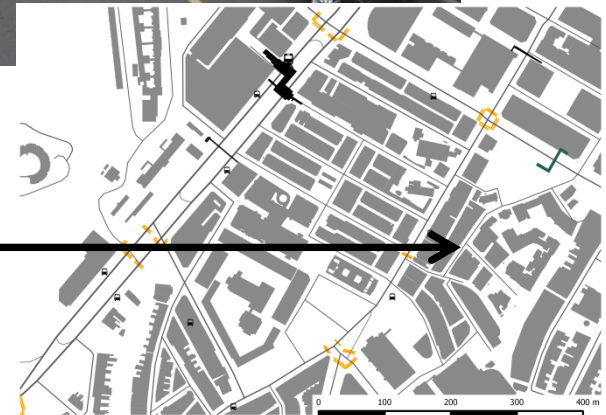

Source data

Centreline Category E

Network generation

No sidewalks

Pedestrian network

Source data

Legend

🚉 MRT stations
🚌 Bus stops
⬜ Building footprints
⬛ Overheadbridge / Underpass
--- Lanemarking
— Road centrelines

Pedestrian network

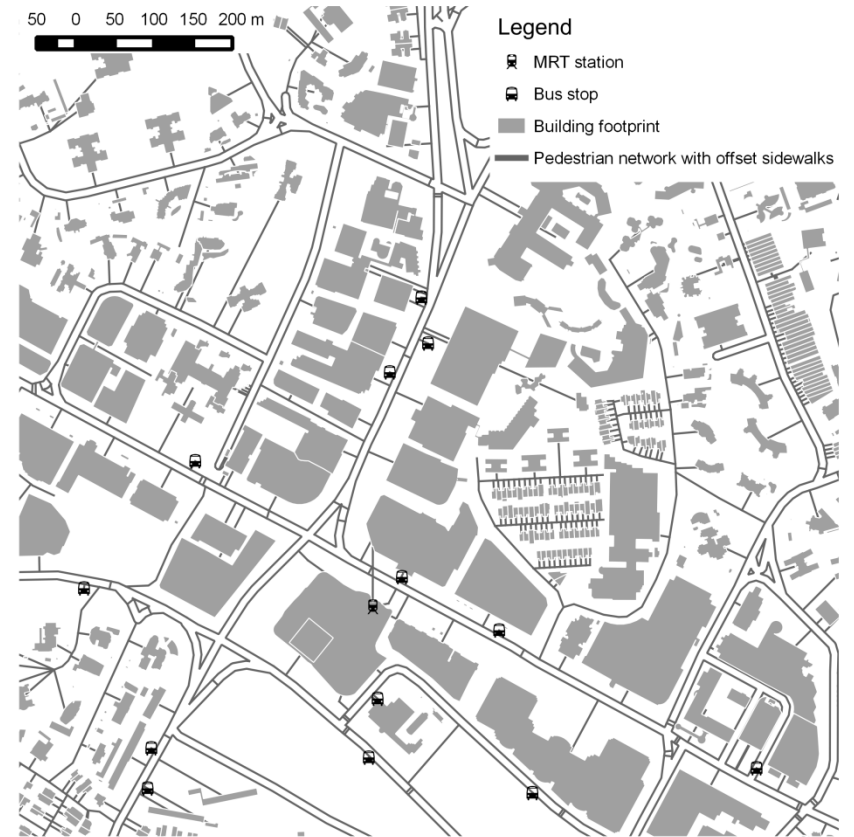**Legend**

🚉 MRT station
🚌 Bus stop
⬜ Building footprint
— Pedestrian network with offset sidewalks
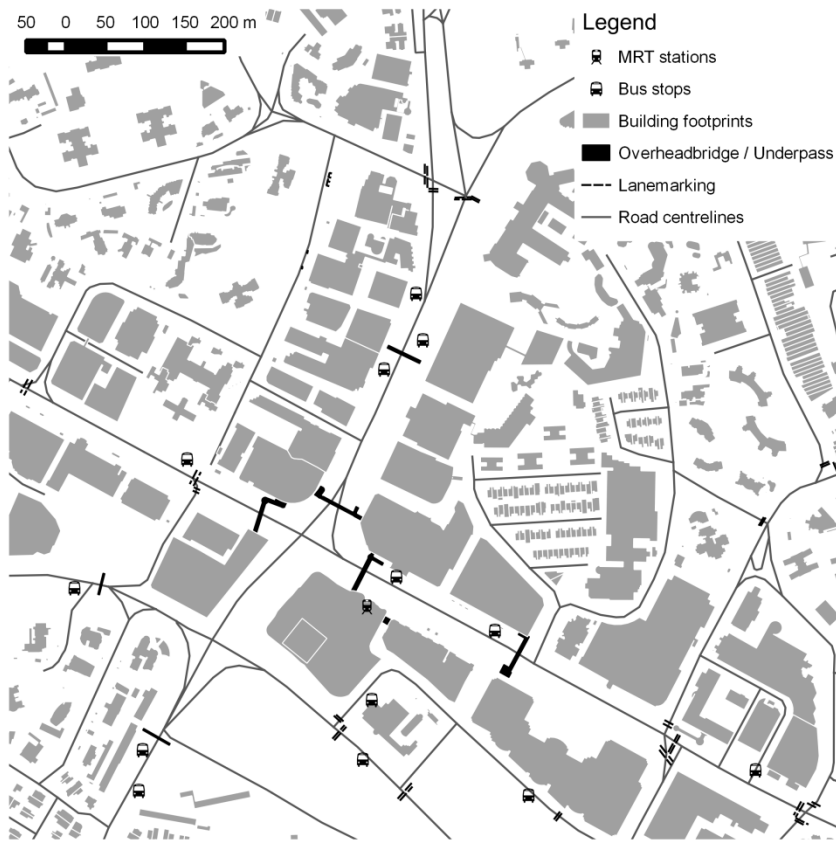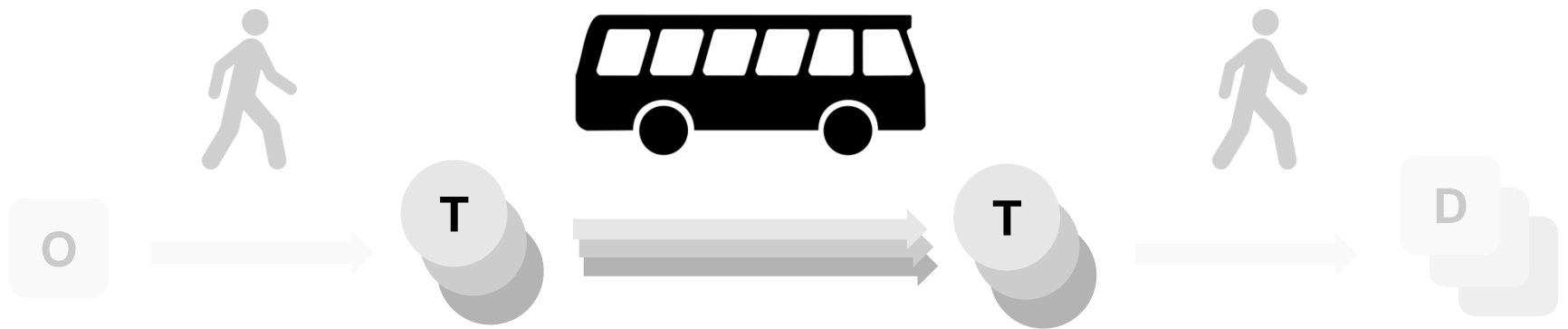
Travel times

Travel times

MATSim Singapore (agent-based transport demand simulation)

1 million agents, > 4000 transit stops, > 400 bus lines, 4 MRT lines

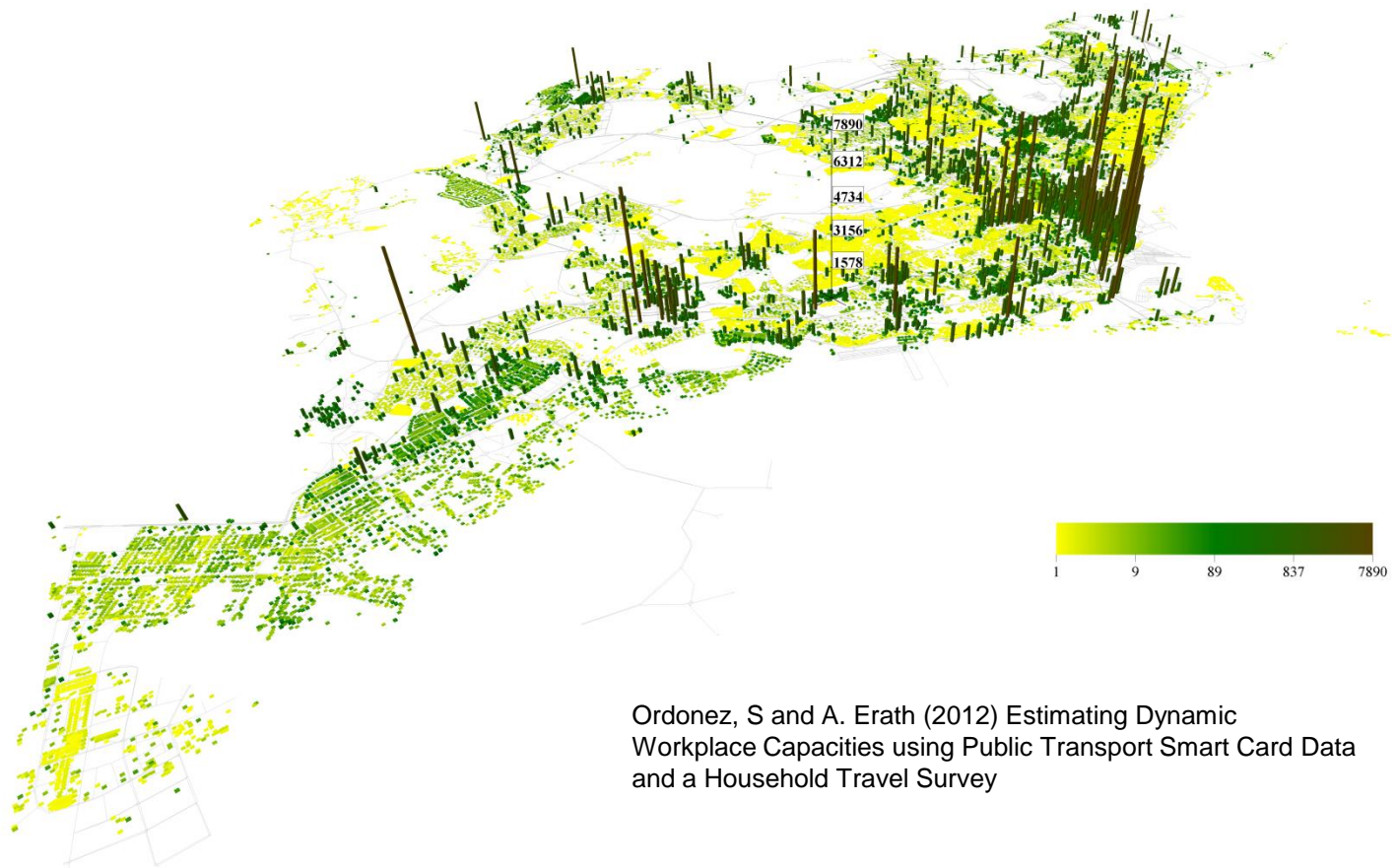Average link travel times per 15 minutes are calculated

Shortest transit route in each 15 minutes interval between each

transit stop

Median travel time between 7am and 9:30 am is used.

Activity locations

Work locations

Ordonez, S and A. Erath (2012) Estimating Dynamic Workplace Capacities using Public Transport Smart Card Data and a Household Travel Survey

Accessibility calculation

Pedestrian accessibility

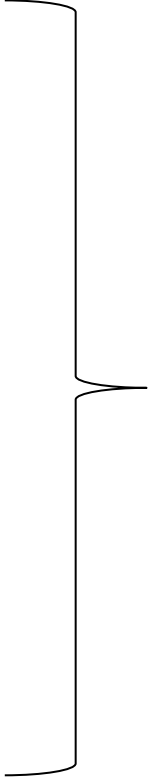Calculation of shortest route to all

buildings within **1000 meter radius**. .

Impedance factor of -0.2.
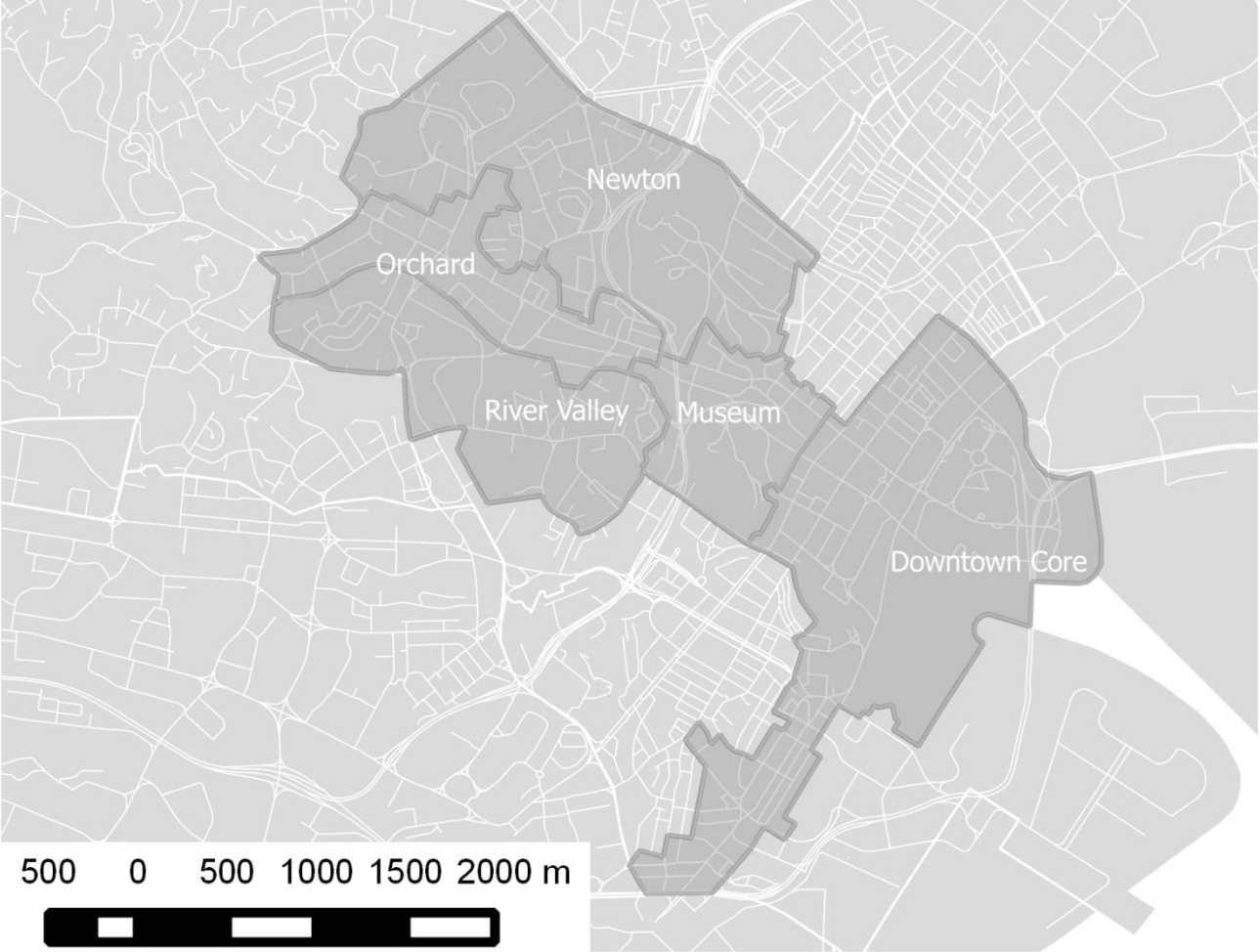
Public transit accessibility

Select transit stops within **700 meters** of

origin building & destination building

Determine shortest total travel time

combination of walking time and transit

time. Impedance factor of -0.2.

$$A_i = \sum_{j=1}^{n} d_j \exp(\alpha t_{ij})$$

Results

Study area

Results

Planning zone	Walk accessibility to jobs			Transit accessibility to jobs		
	Euclidean	*Centreline*	*Offset*	*Euclidean*	*Centreline*	*Offset*
Downtown Core	27,182	11,583	8,152	43,564	21,936	20,210
Museum	13,764	4,104	3,536	51,319	24,075	21,455
Newton	11,242	2,791	1,922	33,290	10,048	8,671
Orchard	15,566	6,484	4,741	51,120	24,137	21,503
River Valley	8,844	1,847	1,361	27,503	12,726	11,048

Downtown pedestrian accessibility - Euclidean

Legend

Walk accessibility with Euclidean distances

- 0 - 5000
- 5000 - 10000
- 10000 - 15000
- 15000 - 20000
- 20000 - 25000
- 25000 - 30000
- 30000 - 35000
- 35000 - 40000
- > 40000

0   1000   2000 m

Downtown pedestrian accessibility - network

Legend

Walk accessibility with offset distances

- 0 - 5000
- 5000 - 10000
- 10000 - 15000
- 15000 - 20000
- 20000 - 25000
- 25000 - 30000
- 30000 - 35000
- 35000 - 40000
- > 40000

0   1000   2000 m
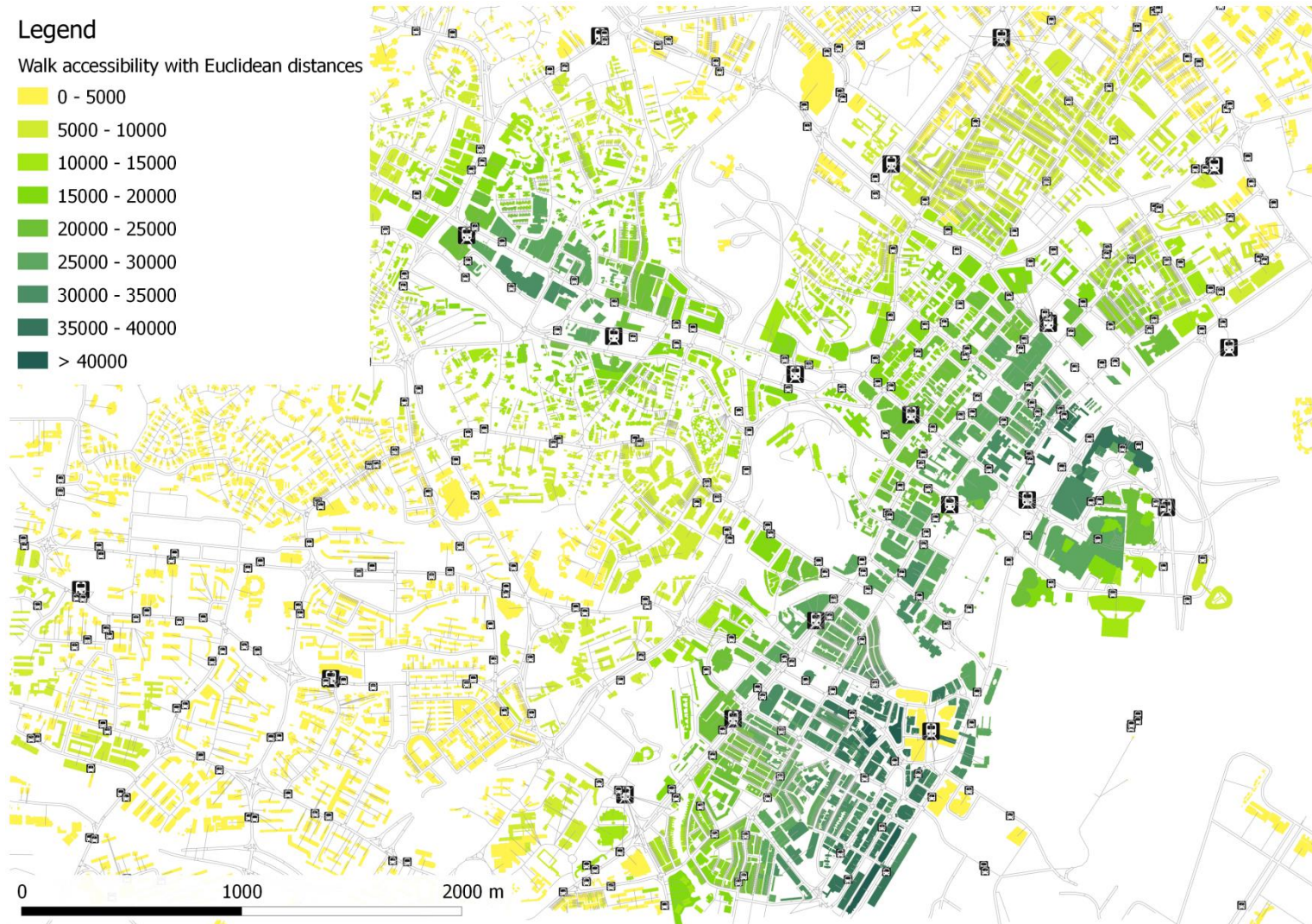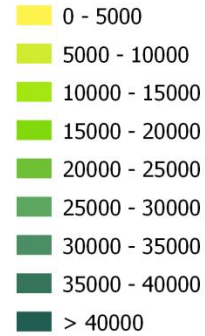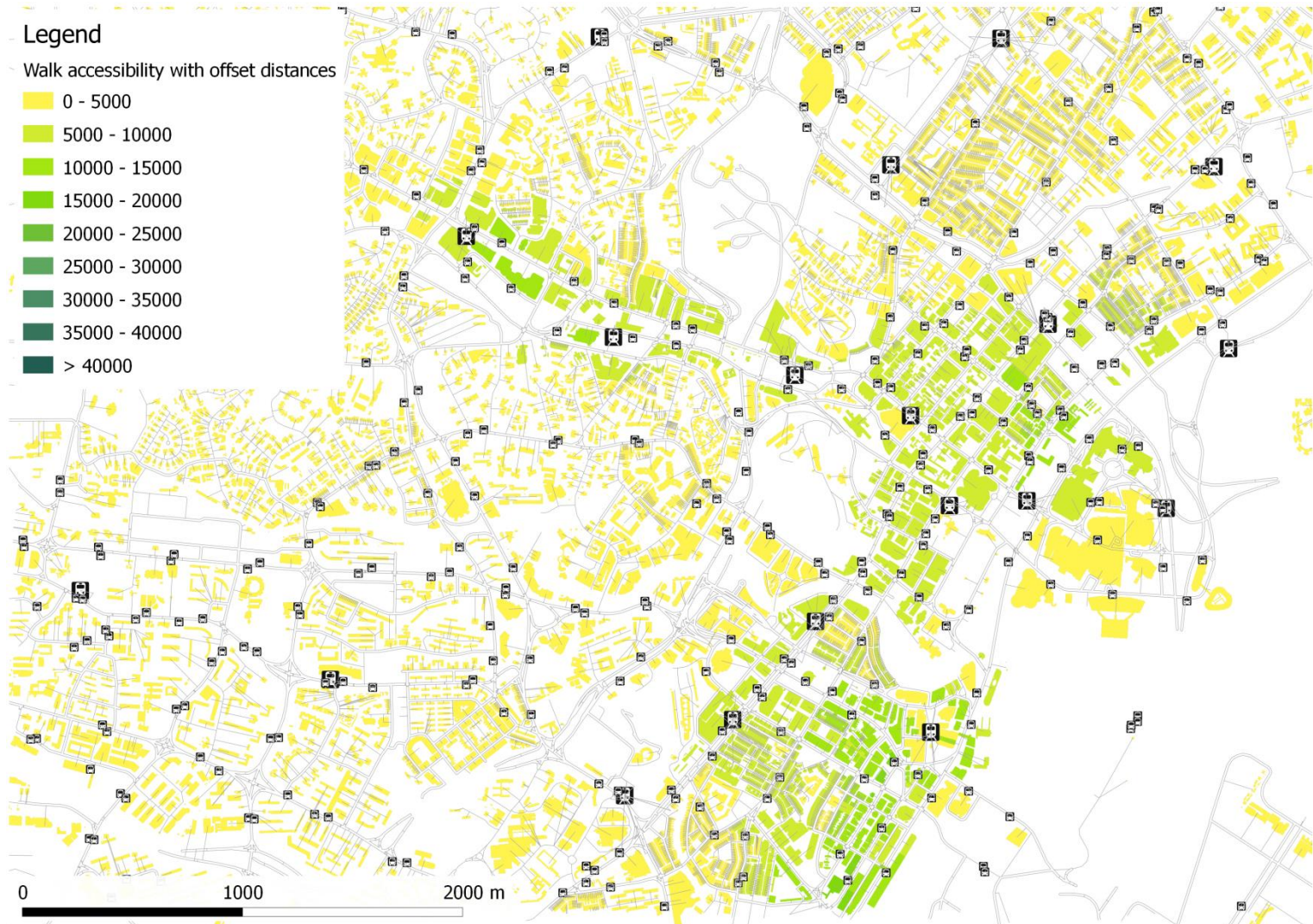
Distance to transit with different networks
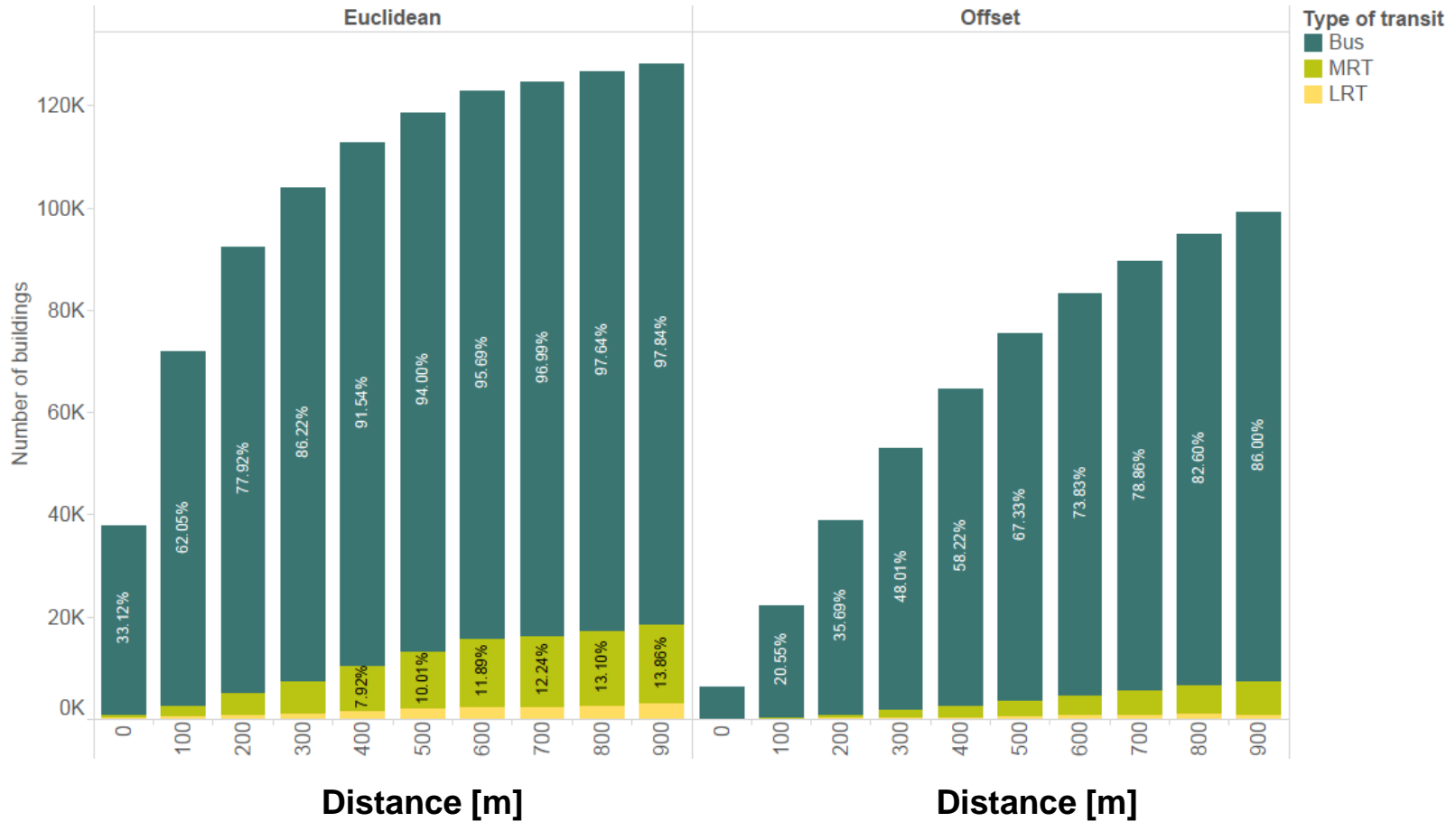
Downtown transit accessibility - Euclidean

Legend

Transit accessibility with Euclidean distances

- 0 - 10000
- 10000 - 20000
- 20000 - 30000
- 30000 - 40000
- 40000 - 50000
- 50000 - 60000
- 60000 - 70000
- 70000 - 80000
- > 80000

0   1000   2000 m

Downtown transit accessibility - network

Legend

Transit accessibility with offset distances

- 0 - 10000
- 10000 - 20000
- 20000 - 30000
- 30000 - 40000
- 40000 - 50000
- 50000 - 60000
- 60000 - 70000
- 70000 - 80000
- > 80000

0   1000   2000 m
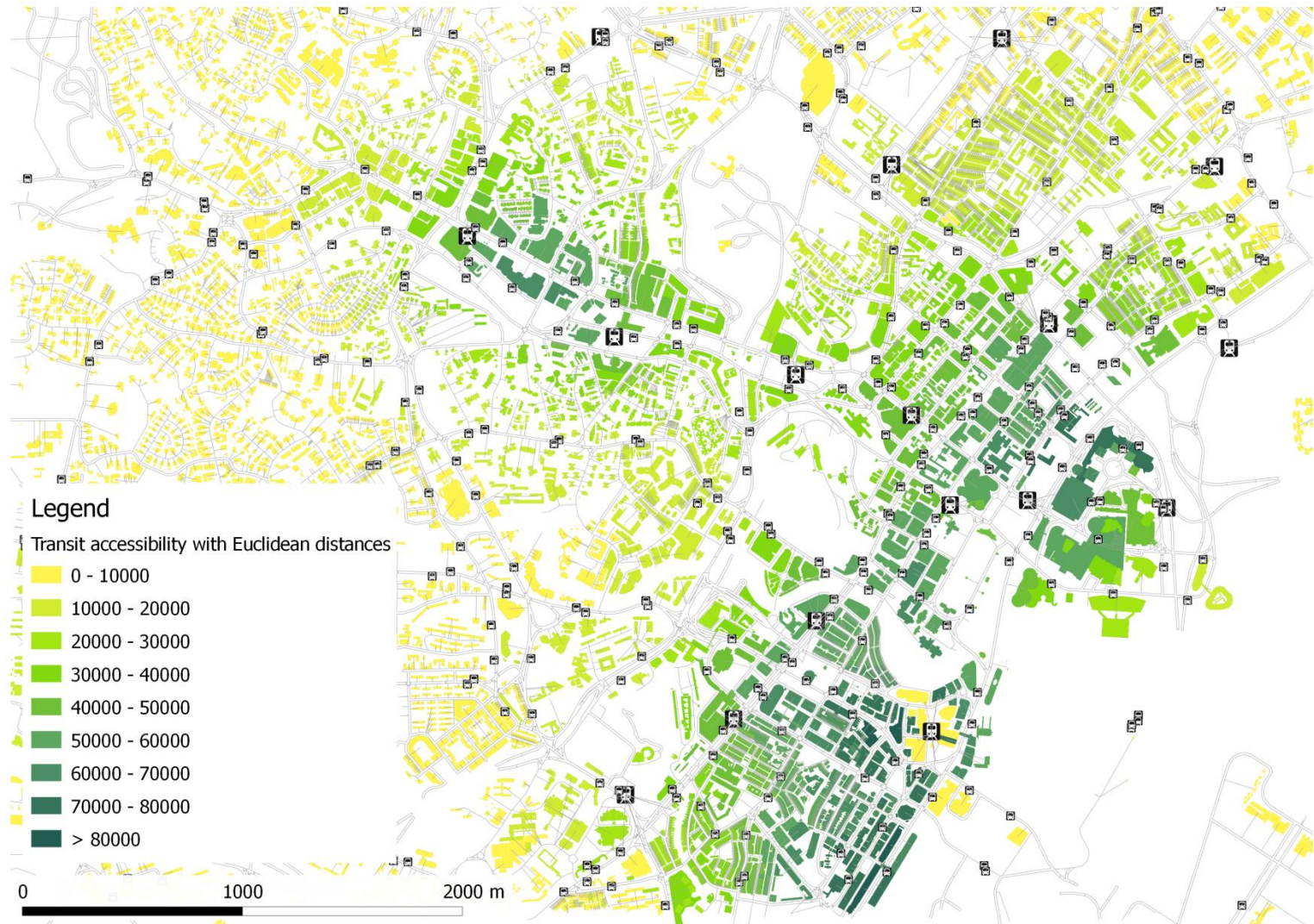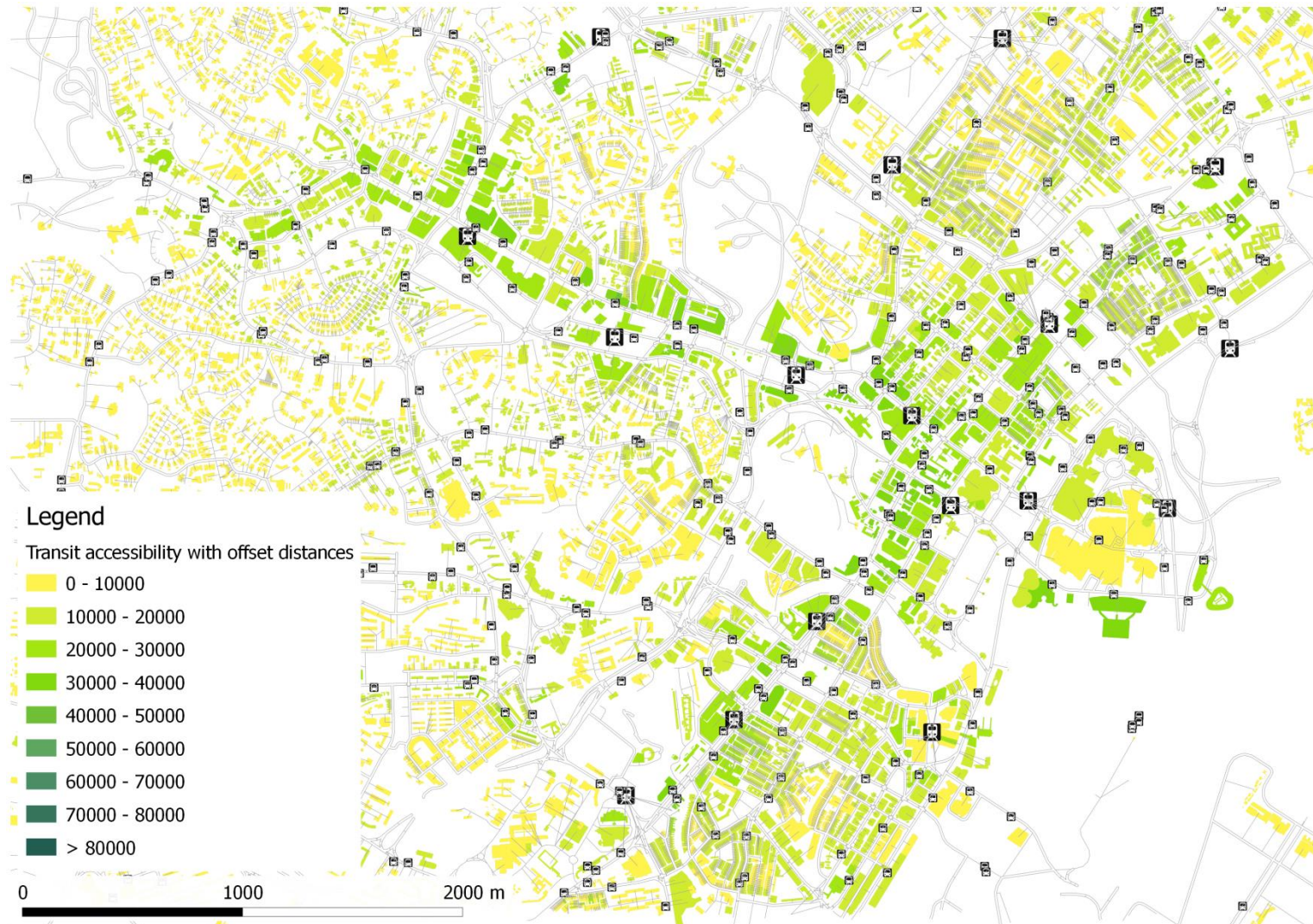
Data issues…..

Missing crossings

Matching buildings to the road network

Outlook

Outlook

OSM pedestrian network

Differentiated transit stop selection
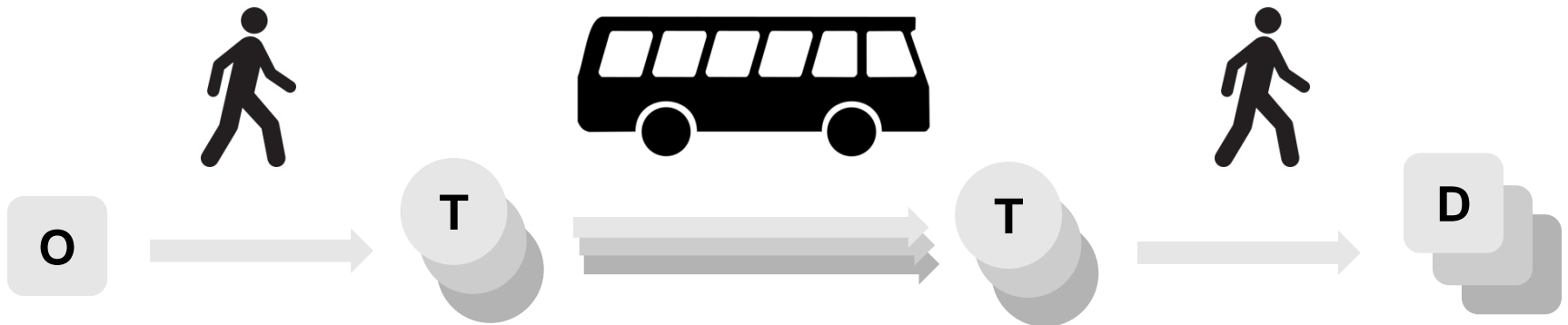
Generalized link costs for pedestrians

Realistic transit travel times in generalized format (GTFS)

Destination similarity

Destination competition

Directional similarity

Multiple types of opportunities

Outlook

Different types of measures

Compare network quality based on different measures

Visualization

Calculation

Incorporation in hedonic pricing and choice models

Questions

The research conducted at the Future Cities Laboratory is funded by the

Singaporean National Research Fund (NRF) and the ETH Zurich. We wish to

express our gratitude to the Land Transport Authority for providing us data sets

on land transport in Singapore. Also we are very thankful to the Singapore Land

Authority for providing us with a wide range of data sets.

Literature

Bhat, Chandra R., Susan L. Handy, Kara Kockelman, Hani Mahmassani, Issam Srour and Lisa Weston (2001). 'Assessment of Accessibility Measures'.

Choi, C. C., & Toh, R. (2010). Household interview surveys from 1997 to 2008: A decade of changing travel behaviours. Journeys, 5(May 2010), 52–61.

Geurs, Karst T. and Bert van Wee (2004). 'Accessibility Evaluation of Land-Use and Transport Strategies: Review and Research Directions', *Journal of Transport Geography* 12(2): 127–140.

Erath, A., Fourie, P. J., van Eggermond, M. A. B., Ordóñez Medina, S. A., Chakirov, A., & Axhausen,K. W. (2012). Large-scale agent-based transport travel demand model for Singapore. In IATBR (Ed.) 13th International Conference on Travel Behaviour Research (IATBR). Toronto.

Ordóñez Medina, S. A., & Erath, A. (2013). Estimating Dynamic Workplace Capacities by Means of Public Transport Smart Card Data and Household Travel Survey in Singapore. Transportation Research Record: Journal of the Transportation Research Board, 2344, 20–30.

Appendix

Routable road network – 500m max distance
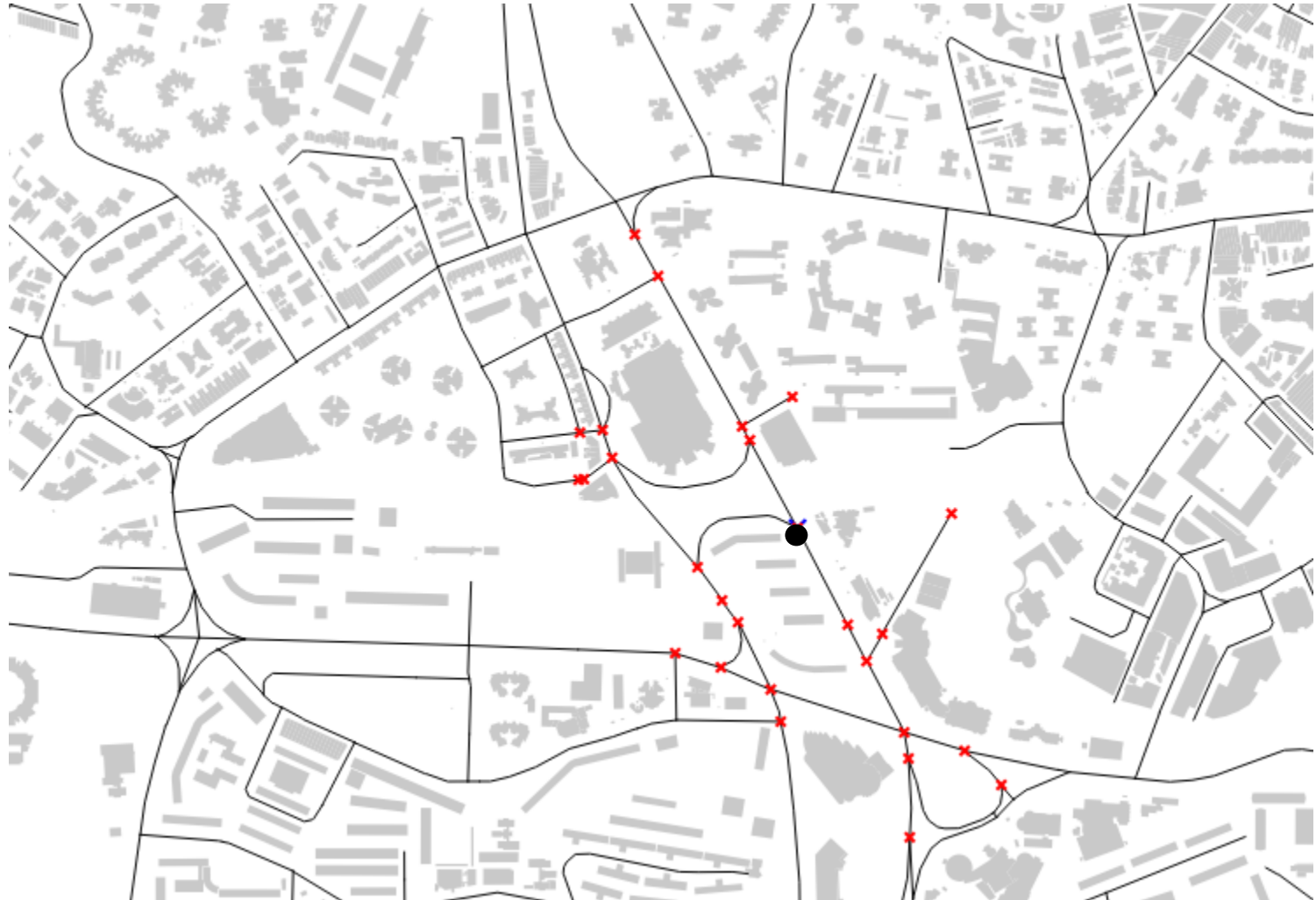
Simple pedestrian network – distance 500m

Offset network – distance 500m

Offset network with overhead bridges