# accessibility instruments in planning practice

## Spatial Network Analysis for Multi-Modal Transport Systems (SNAMUTS): Helsinki

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# POLICY CONTEXT

Cities worldwide - interest in a more coordinated approach to growth management → sustainable urban form → sustainable transport outcomes.

A popular planning strategy → public transport oriented development (PTOD), more commonly referred to as transit oriented development (TOD)

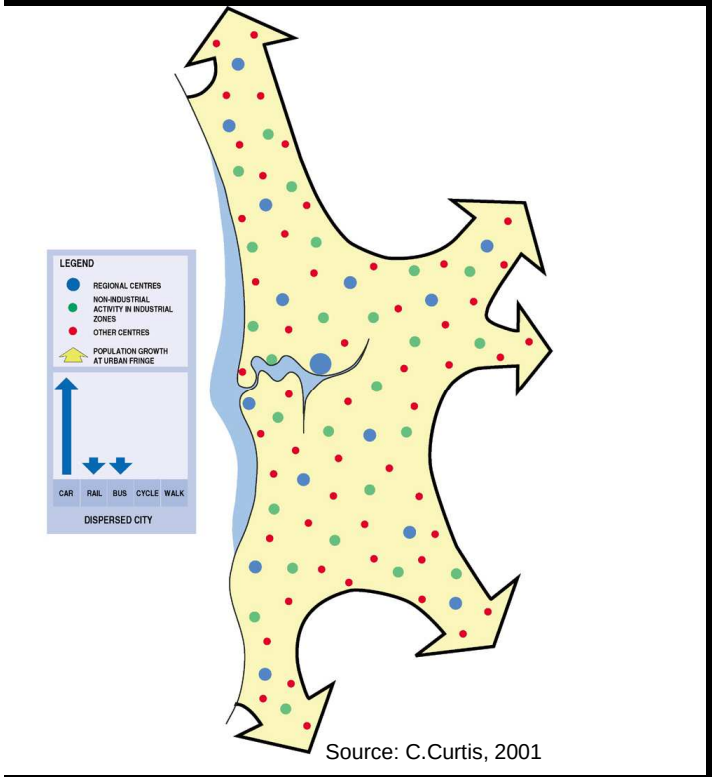
→ need to consider both land use planning and transport planning in an integrated way,

→ city planning framed around public transport
- → address both the form and structure of the city, and
- → quality of the public transport network

to ensure each are mutually supportive and provide for improved accessibility.

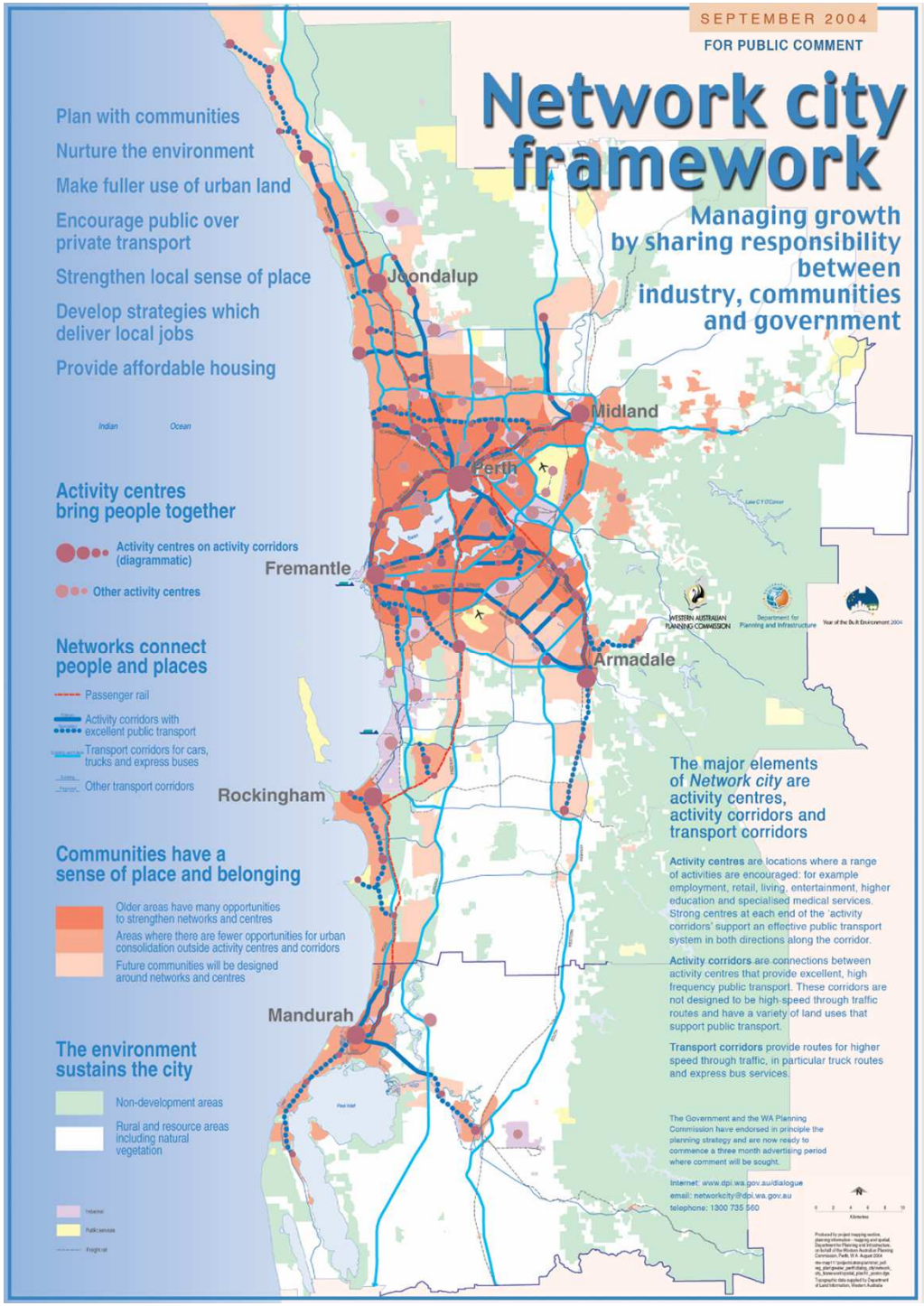
Curtis C (2015) Public Transport Orientated Development and Network Effects, in *An International Handbook on Transport and Development,* Edward Elgar, Co-Editors: Hickman, R., Bonilla, D., Givoni M., Banister D.

# Context - Land use transport integration in Australian cities



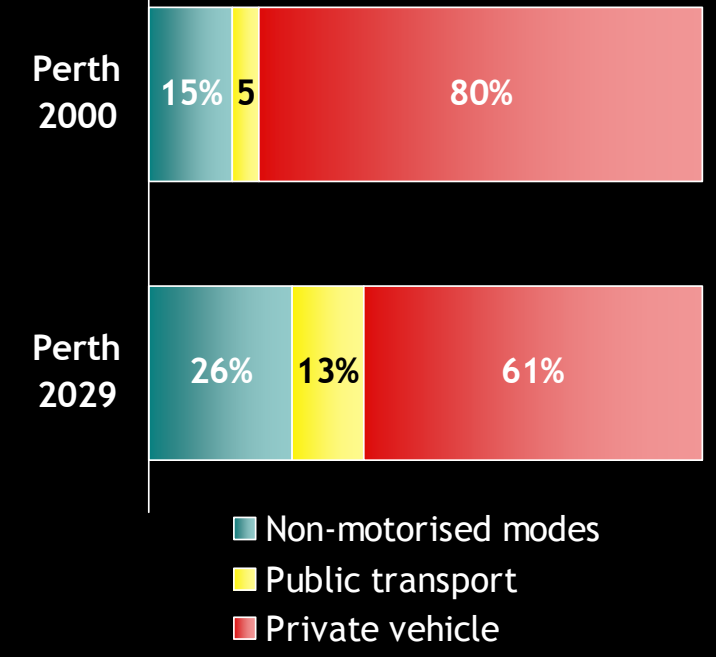

Source: C.Curtis, 2001

- clear policy intentions in Metropolitan Plans for LUTI
- but selective implementation resulted in low density and dispersed form
- not only are cities spread out but land use activity is scattered.. a myriad of centres
- possibility of supplying a high frequency public transport system to serve these centres a challenge.



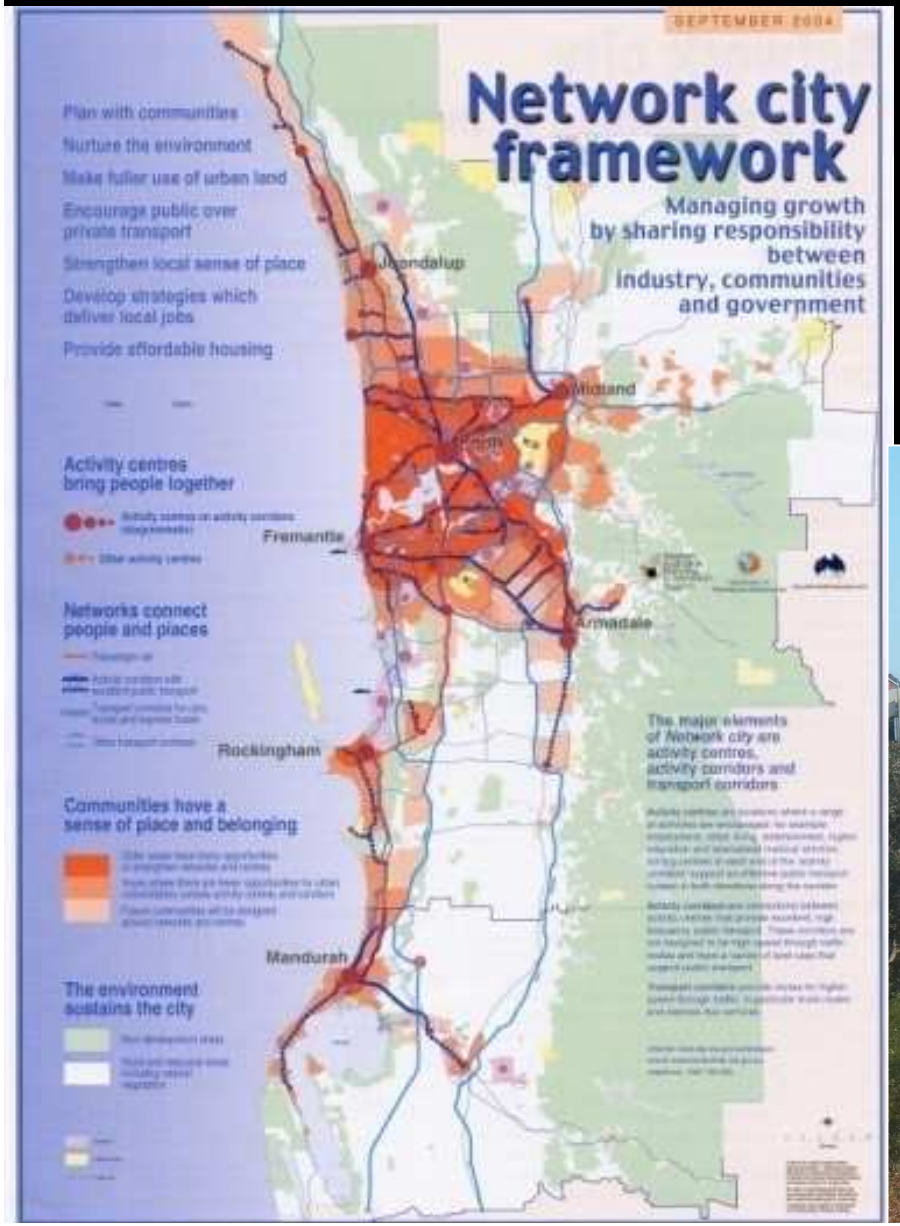

## mid 1990's new approach emerging

Mode Share Target by trips (1995):




...targets imply that public transport patronage needed to grow four-fold between 2000 and 2030...

# Network City spatial framework




did not determine which centres should perform which role within the goal of sustainable accessibility

# These new policy goals demanded a multi-dimensional perspective…

- Which Activity Centres and Corridors can best be intensified?
- Which Centres should perform a regional role and which a local roles?
- Where should public transport investment (infrastructure, service improvement) go?
- What effect would changes to transport accessibility by car have (through fuel price increases, parking strategies etc)?
- Centres must not be considered in isolation from each other… the way in which they are networked forms an important component shifting from a case by case perspective to a strategic perspective

Answers to these questions provide a robust basis for decisions about the future metropolitan structure.

# Evolution of our accessibility work…

1. ARC Project on TOD examined how accessibility changed following opening of a new 72km railway

2. Research Consultancy – Australian State Governments:
   a) Metropolitan growth choices
   b) Public transport investment

3. ARC 3 year project - Continue the development of the interactive accessibility tool by examining 25 Cities in Australia, Europe, N. America & Asia:
   - SNAMUTS as a benchmarking tool
   - SNAMUTS methodology and robustness in a range of city types

1. EU COST Action TU1002: Accessibility Tools in Planning Practice:
   - 22 European Countries & Australia
   - Local (National) Workshops – USE & USEABILITY

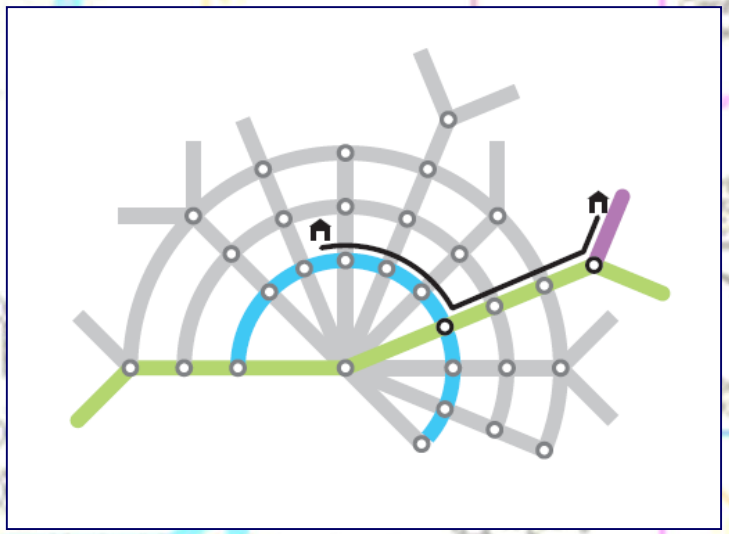
# spatial network analysis for multimodal urban transport systems (SNAMUTS)

**Purpose:** To assess and quantify how transport networks, in terms of geographical configuration and service levels, perform in their urban context (distribution of land use activities).

SNAMUTS is a **supply-side tool:** it does not provide predictions about usage or capacity levels. Rather it asks: **What is the role of the public transport system in facilitating movement and activity across a city region?**

# network connectivity





**Create a 'network effect' by local optimisation to routes, good interchange facilities, high and standardised service frequencies, timetable coordination and the presence of orbital/cross-suburban routes to maximise market penetration for public transport.**

**Map Sources:** www.railpage.com.au, www.hitrans.org

# public transport from a user perspective

**How can we measure distance** (or travel impediment) **in ways that come close to user perceptions and motivations?**

Public transport users are only marginally interested in geographical distance: the main factors of travel disutility are travel time, and the ubiquity of travel opportunities (service frequency)

# compiling a base network

**Spatial separation or impediment measure:** Travel time divided by service frequency ($d=4t/\sqrt{f}$)

**Minimum service standard (SNAMUTS *23*):** 20 min frequency during the weekday interpeak, 30 min on Sat/Sun (buses, trams), 30 min weekdays and 7 day service (rail)

**Identifying activity nodes:** SNAMUTS matrix of activity nodes derived from activity centre hierarchy in strategic planning documents and from field observation. Helsinki has 102 activity nodes with an average catchment of approximately 14,000 residents and jobs.

# 8 key snamuts indicators

**Service Intensity**
*Operational input*

**Closeness Centrality**
*Ease of movement*

**Degree Centrality**
*Transfer intensity*

**Network Coverage**
*Who gets access?*

**30-minute Contour Catchments**

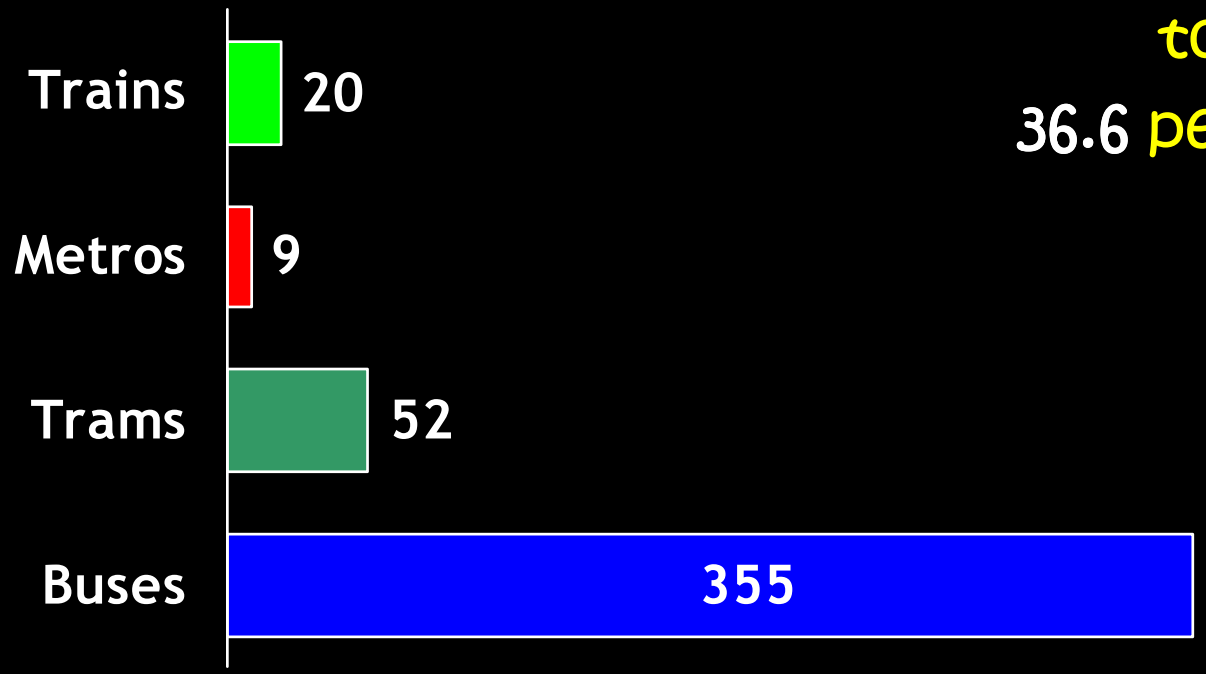
**Betweenness Centrality**
*Presence and distribution of PT travel opportunities*

**Network Resilience**
*How future-proof is the public transport system?*

**Nodal Connectivity**
*Flexibility of movement in urban space*

# helsinki: service intensity

Number of vehicles/train sets required in simultaneous operation for the minimum standard network (20 min weekdays, 30 min weekends for trams and buses, 30 minutes weekdays for trains)




total: 436

36.6 per 100,000 pop (2014)

# service intensity: what does and what doesn't this index tell us?

**Operational efficiency:** Networks dominated by slow modes (especially buses) tend to require greater operational input (in number of vehicles/drivers) than networks dominated by fast modes (especially light or heavy rail).

**Performance expectation:** Does a higher outlay of operational resources consistently result in better public transport accessibility and network performance?

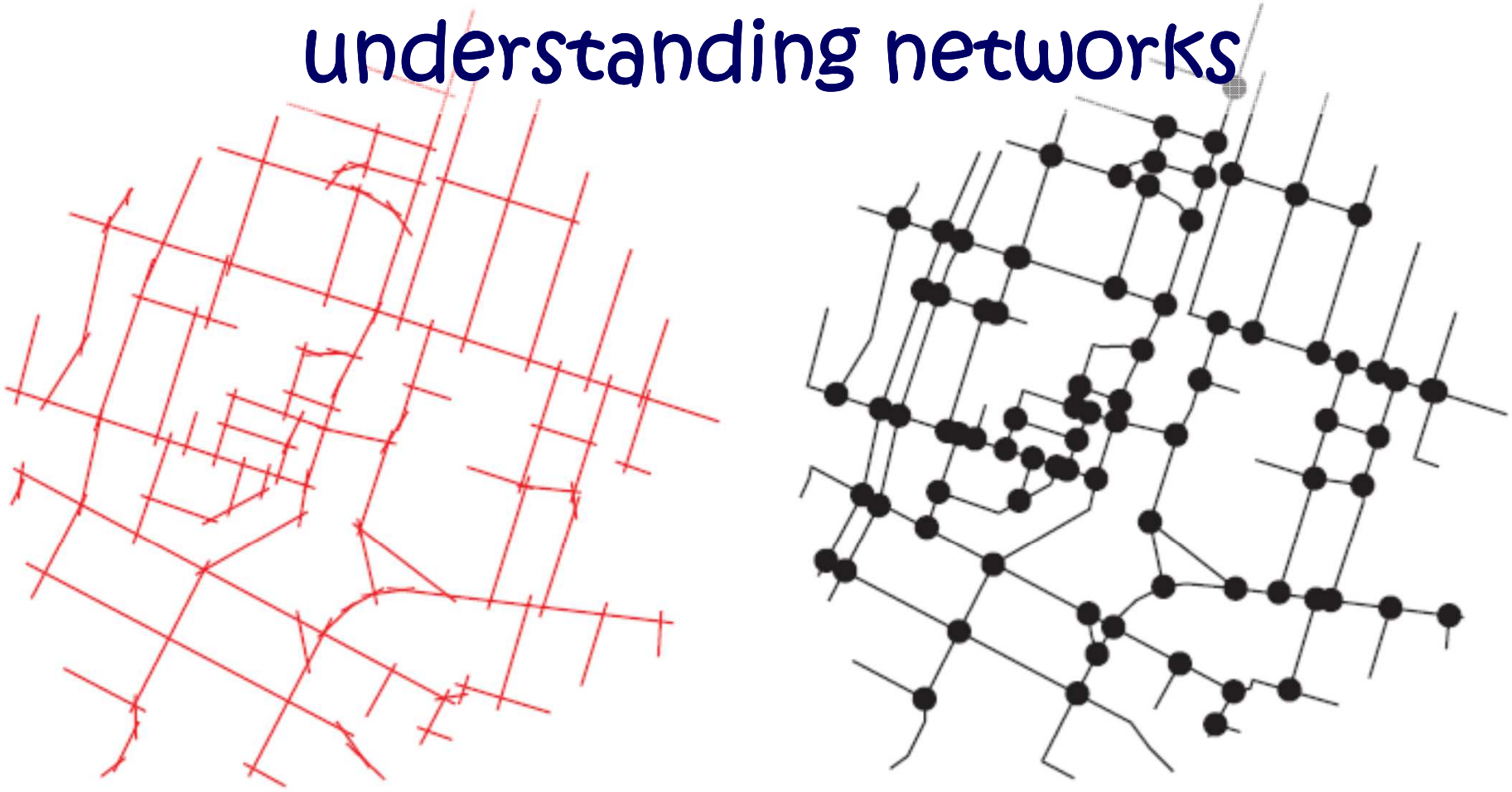
# Comparison of service intensity

## vehicles per 100,000 population



| | |
|---|---|
| Singapore | 48.9 |
| Hong Kong | 41.9 |
| Edinburgh | 38.2 |
| **Helsinki** | **36.6** |
| Göteborg | 32.3 |
| Amsterdam | 28.7 |
| Zürich | 25.9 |
| Wien | 25.5 |
| Oporto | 24.9 |
| København | 24.8 |
| Oslo | 23.5 |
| Barcelona | 21.9 |
| Vancouver | 19.3 |
| Adelaide | 18.1 |
| Hamburg | 17.2 |
| Zuid Holland | 16.8 |
| Utrecht | 16.2 |
| Sydney | 14.9 |
| München | 13.9 |
| Melbourne | 13.4 |
| Perth | 12.6 |
| Brisbane | 11.6 |
| Montreal | 10.4 |
| Portland Seattle | 10.2 |
| Auckland | 9.2 |

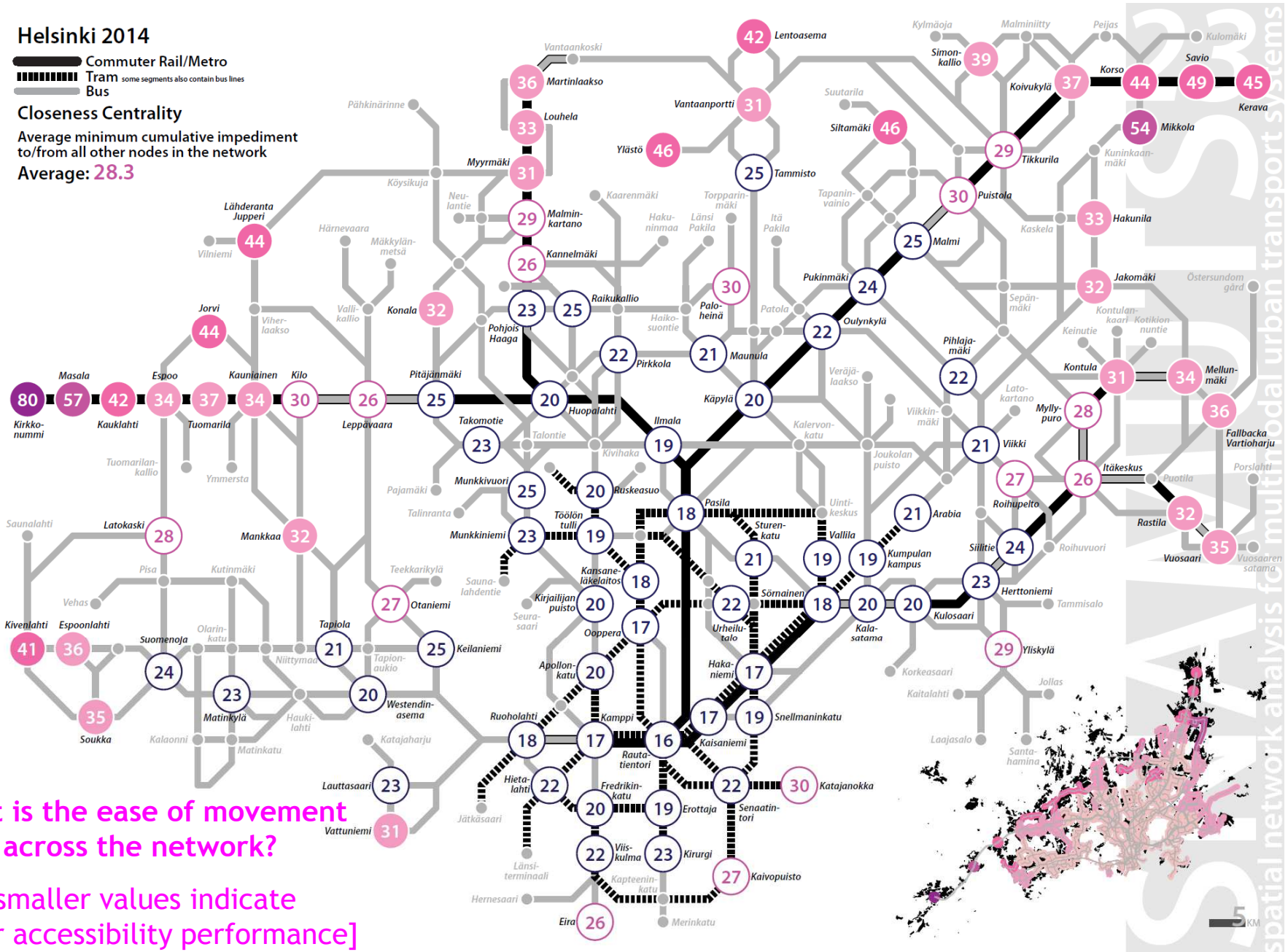
# understanding networks



Networks have topological properties (how many degrees of separation from A to B) and metric properties (how many units of distance/impediment from A to B)

**Source:** Porta, Crucitti and Latora 2006

# Closeness Centrality



# Closeness centrality: what does and what doesn't this index tell us?

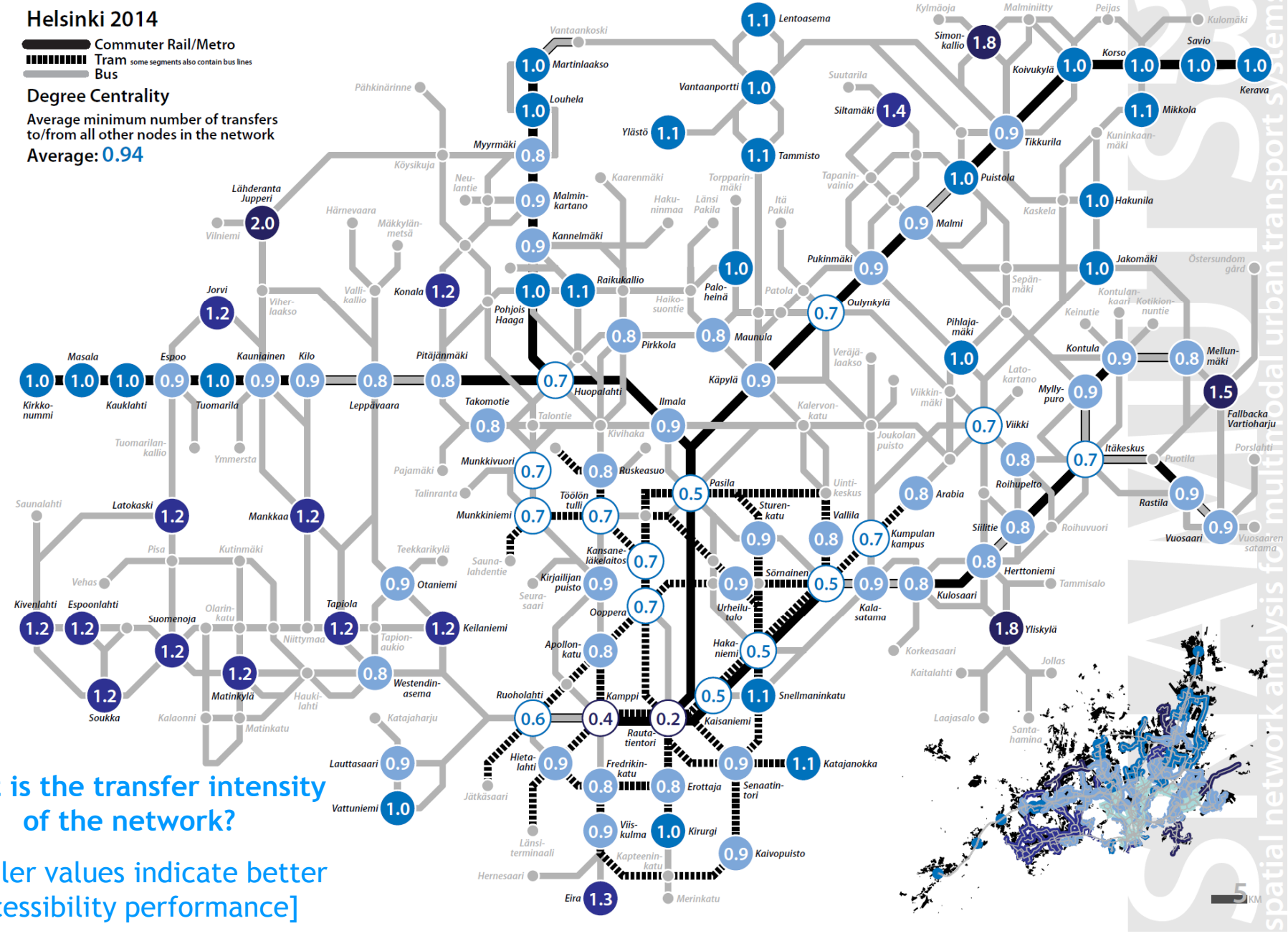
**Ease of movement:** Closeness scores are a spatial separation measure for the activity centre network. They are inflated by
(1) dispersed settlement patterns,
(2) detours forced by geographical barriers or missing links,
(3) slow travel speeds,
(4) low service frequencies,
or a combination of several of the above.

**Network size:** Larger networks with a greater number of activity centres will generally produce higher (poorer) average closeness centrality scores than smaller ones.

# Comparison of Closeness Centrality
## average per network

| | |
|---|---|
| Helsinki | 28.3 |
| Wien | 38.8 |
| Göteborg | 39.6 |
| Vancouver | 42.1 |
| Oslo | 43.1 |
| Barcelona | 44.8 |
| Oporto | 46.4 |
| Montreal | 47.1 |
| Zürich | 47.4 |
| København | 47.9 |
| München | 48.4 |
| Amsterdam | 48.8 |
| Utrecht | 49.2 |
| Hamburg | 51.4 |
| Singapore | 51.6 |
| Hong Kong | 53.7 |
| Portland | 57.4 |
| Auckland | 59.0 |
| Perth | 59.3 |
| Adelaide | 61.1 |
| Melbourne | 62.3 |
| Zuid Holland | 62.9 |
| Brisbane | 64.1 |
| Seattle | 64.3 |
| Edinburgh | 72.1 |
| Sydney | 81.5 |

# degree centrality



# degree centrality: what does and what doesn't this index tell us?

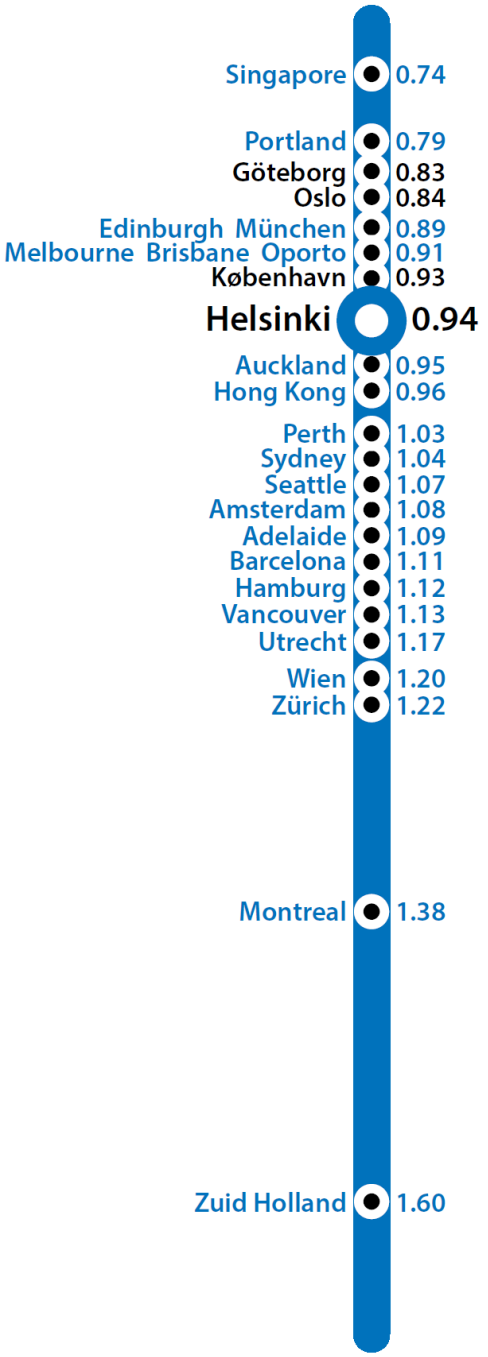
**Network organisation:**

Is the public transport network organised around a modal hierarchy with lower-capacity modes acting as feeders and distributors to higher-capacity nodes (greater transfer intensity)?

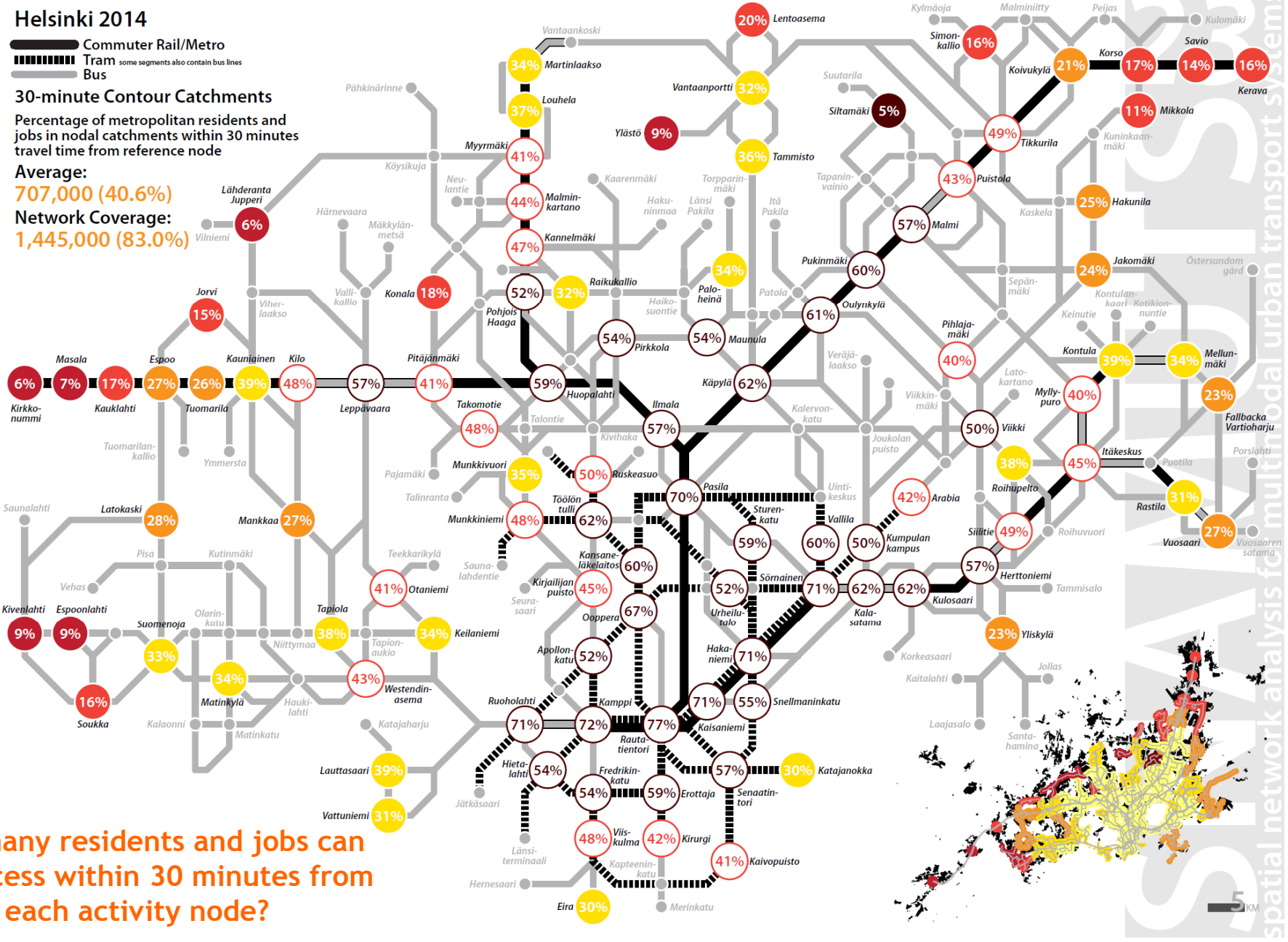
Or do the networks of modes with different performance coexist (compete?) in spatial terms (lower transfer intensity)?

# comparison of degree centrality
## average per network





# Contour Catchments



# network coverage and contour catchments: what do and what don't these indexes tell us?

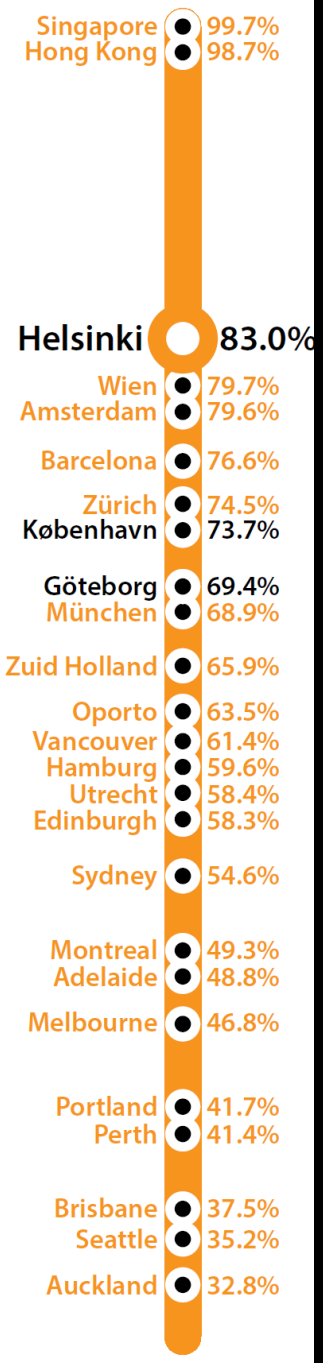
**Network coverage** describes the quantity of people with access to public transport, while the **contour catchment measure** expands this with a qualitative message (how many people can you access within 30 minutes?)

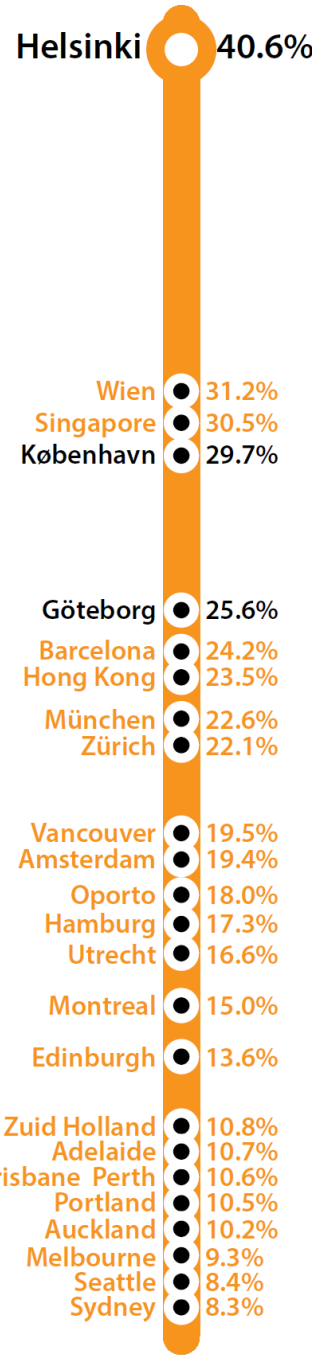
The **contour catchment** assesses how successfully public transport endowment translates into the practical penetration of the settlement area with useful public transport journey paths.

Ideally, a city should achieve 100% network coverage and an average contour catchment of 50%.

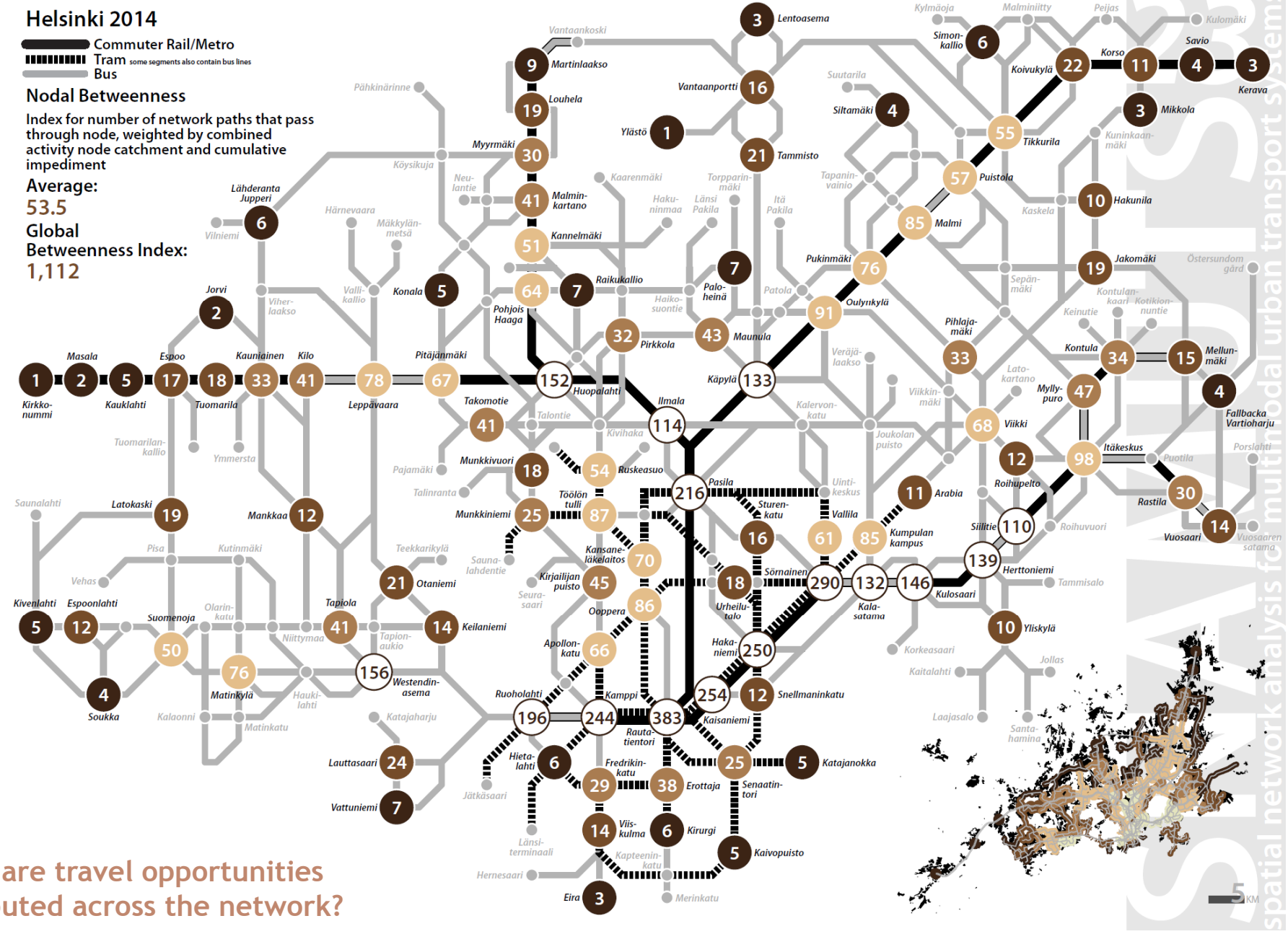
# Comparison of network coverage (left) and average contour catchments (right)

## percentage of metropolitan residents and jobs

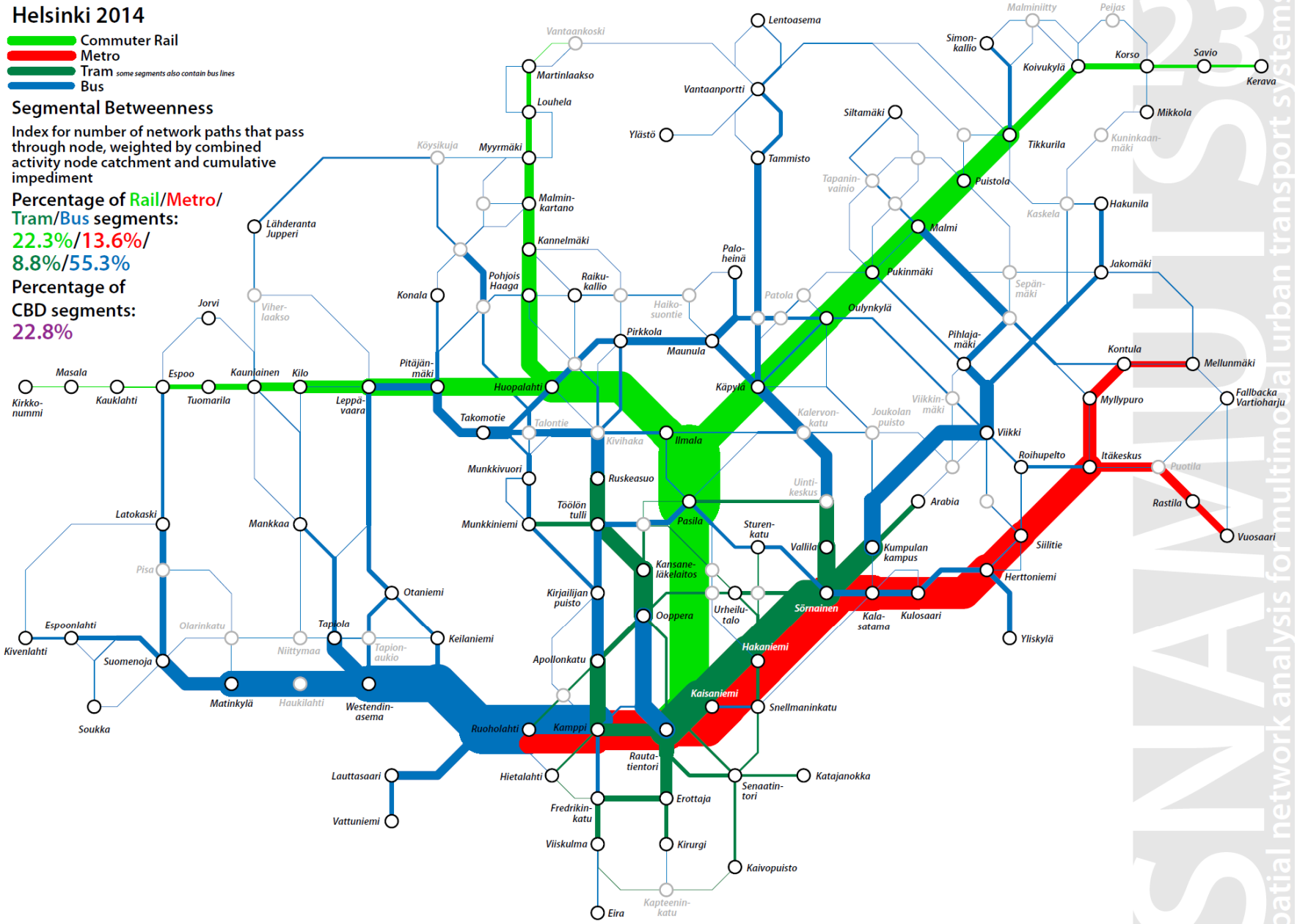


# betweenness centrality



# nodal and segmental betweenness



# betweenness centrality: what does and what doesn't this index tell us?

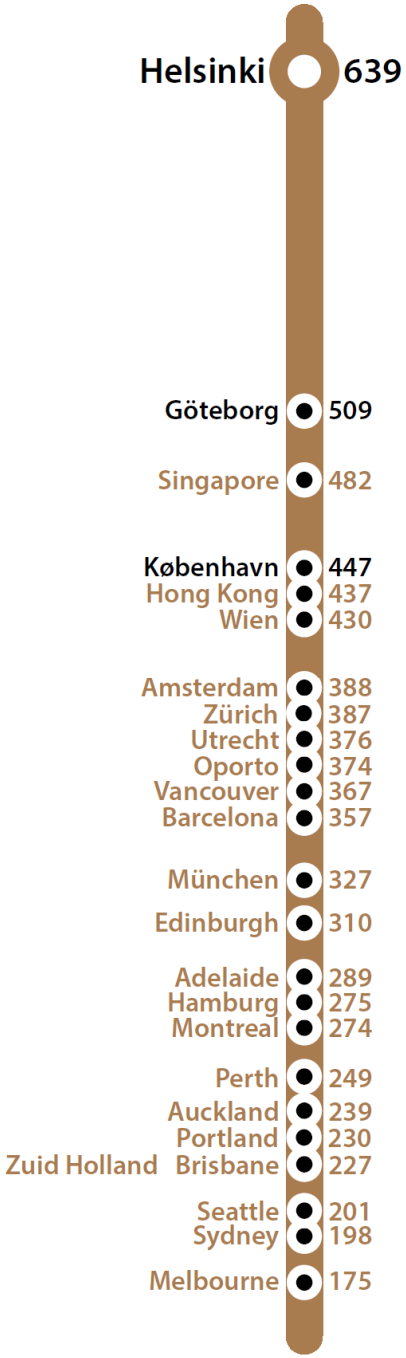
**Public transport 'movement energy':** Betweenness centrality attempts to quantify the presence of public transport opportunities in each centre, and across the metropolitan area, as well as visualise how this presence flows across the network.

**Balanced and unbalanced nodes/places, stressed locations and routes:** Betweenness can help identify pressures on network elements originating from either their land use or their transport function (or both in conjunction).

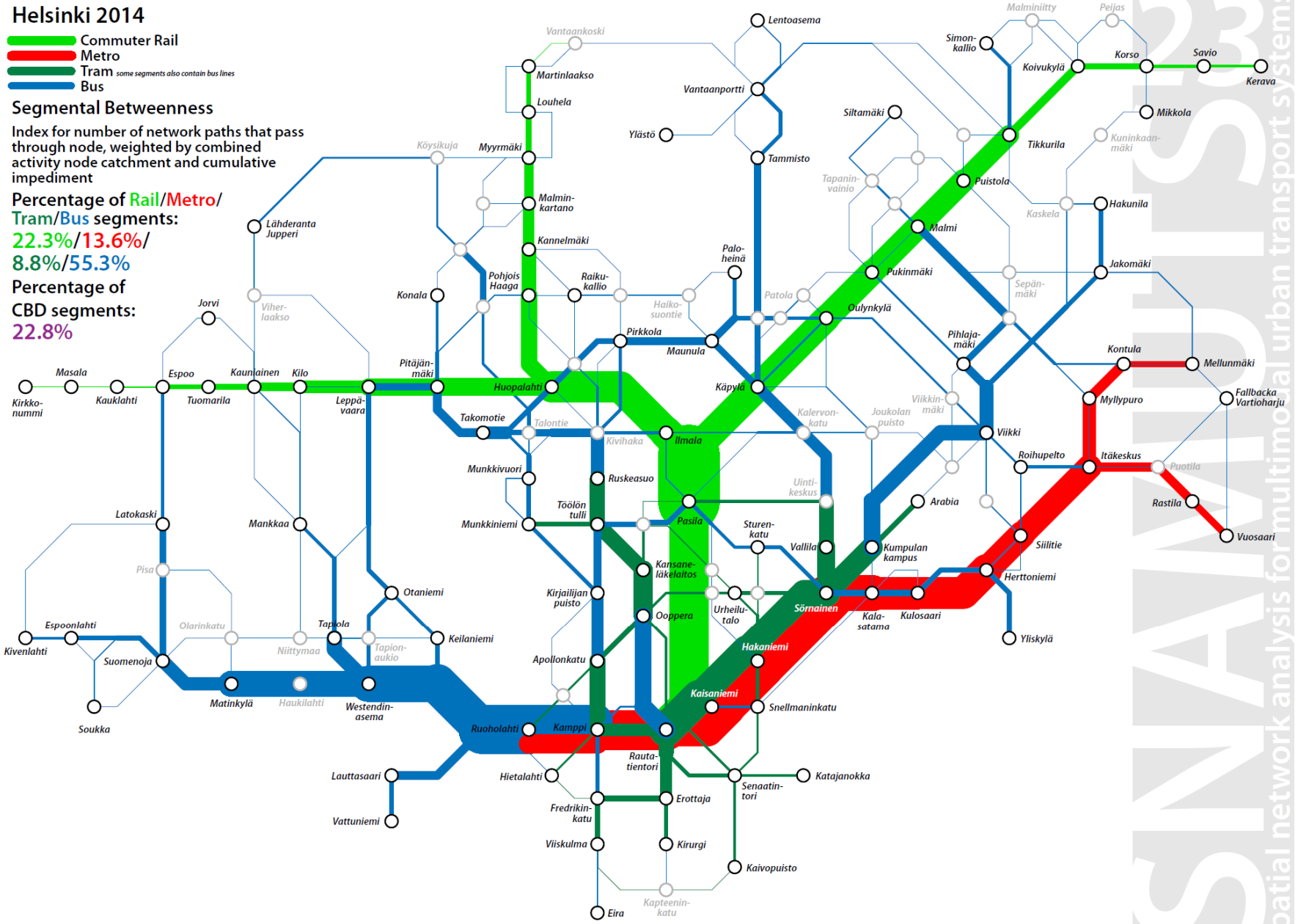
Betweenness scores are not necessarily proportional to usage levels, but **correlations with usage can point to under- or over-utilised potential** for public transport movement.

# Comparison of global betweenness

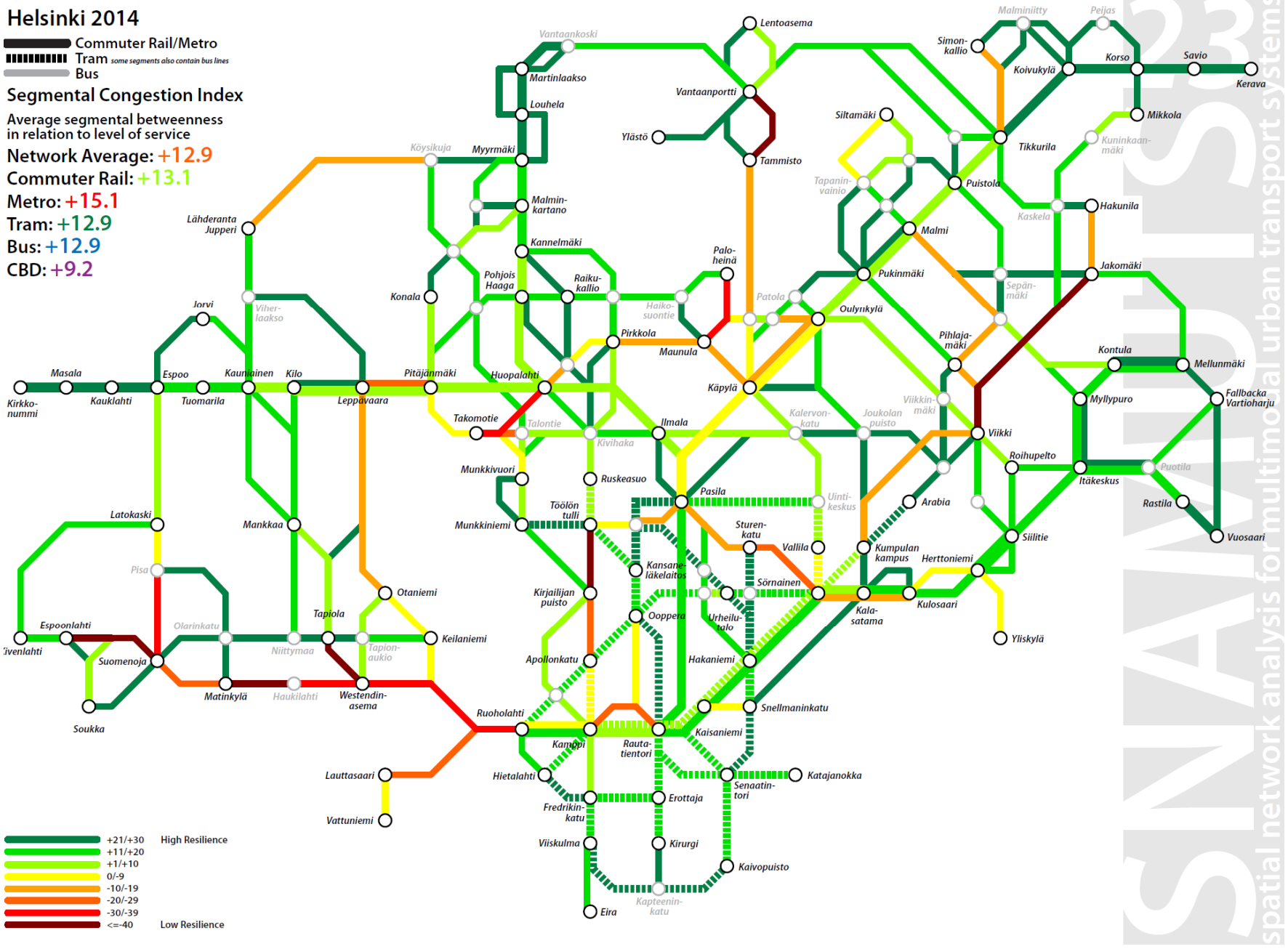
## total per network per million residents and jobs

# segmental betweenness and resilience



# segmental betweenness and resilience



# network resilience: what does and what doesn't this index tell us?

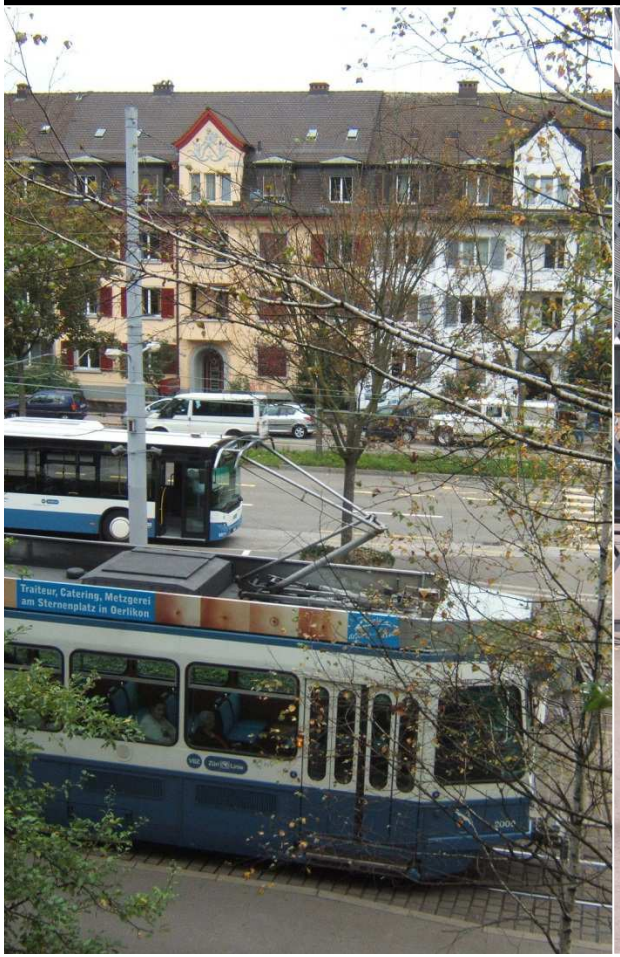
**A 'troubleshooting' tool to pinpoint mismatches in public transport supply and (potential) demand** (ie. demand as derived from urban form and network configuration)

**Includes a feedback loop**, as isolated measures to improve service levels to relieve stress (ie. frequency upgrades) will also add to network stress through greater ease of movement.

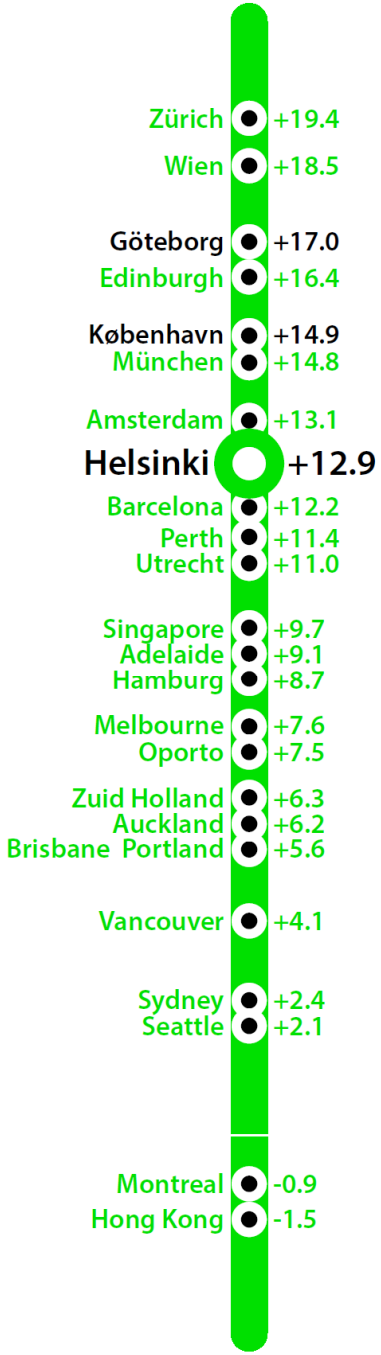
Responds most vigorously to **more comprehensive solutions**, such as network reconfigurations and mode upgrades.

# Comparison of network resilience

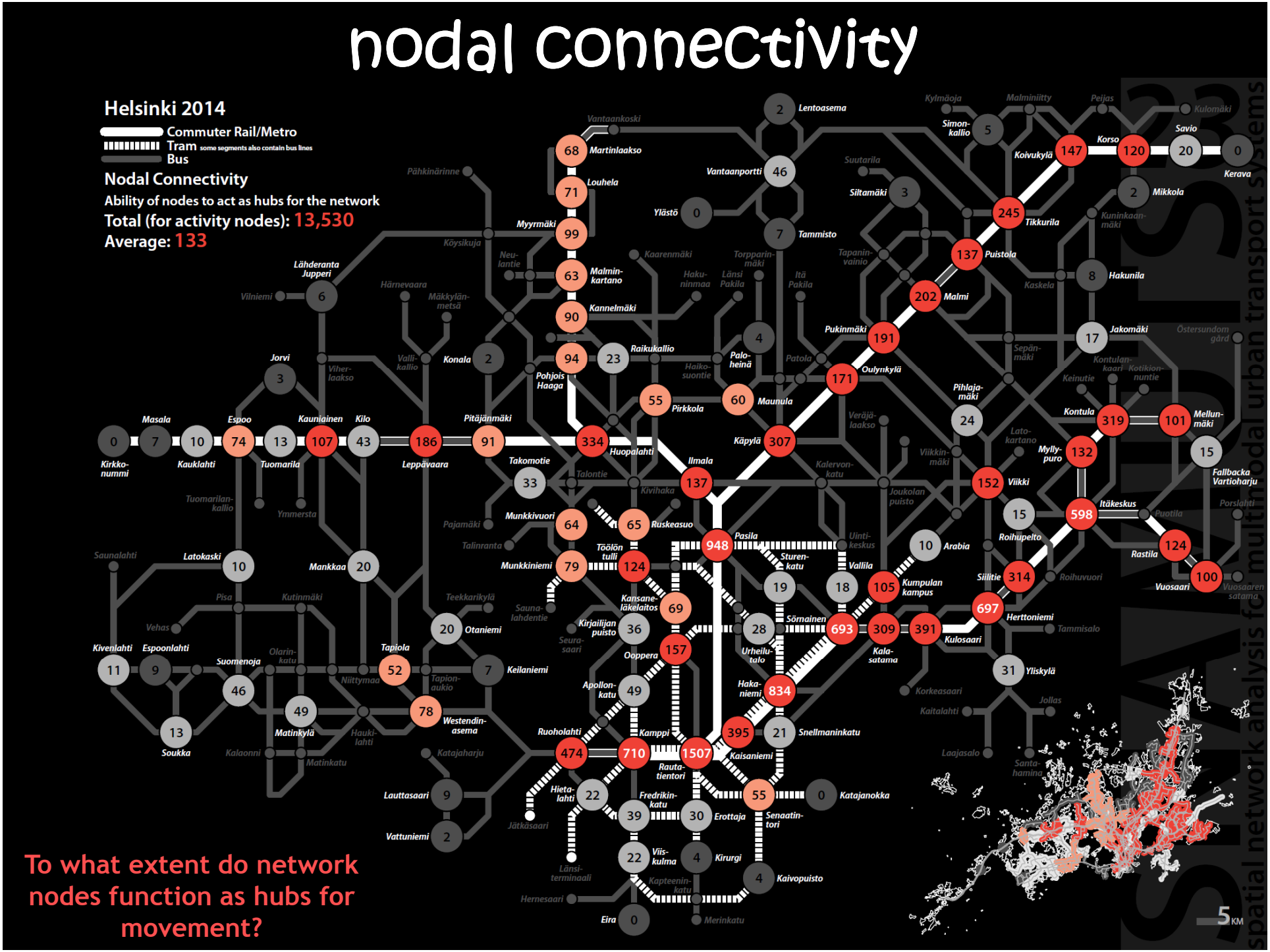
## average per network







# nodal connectivity

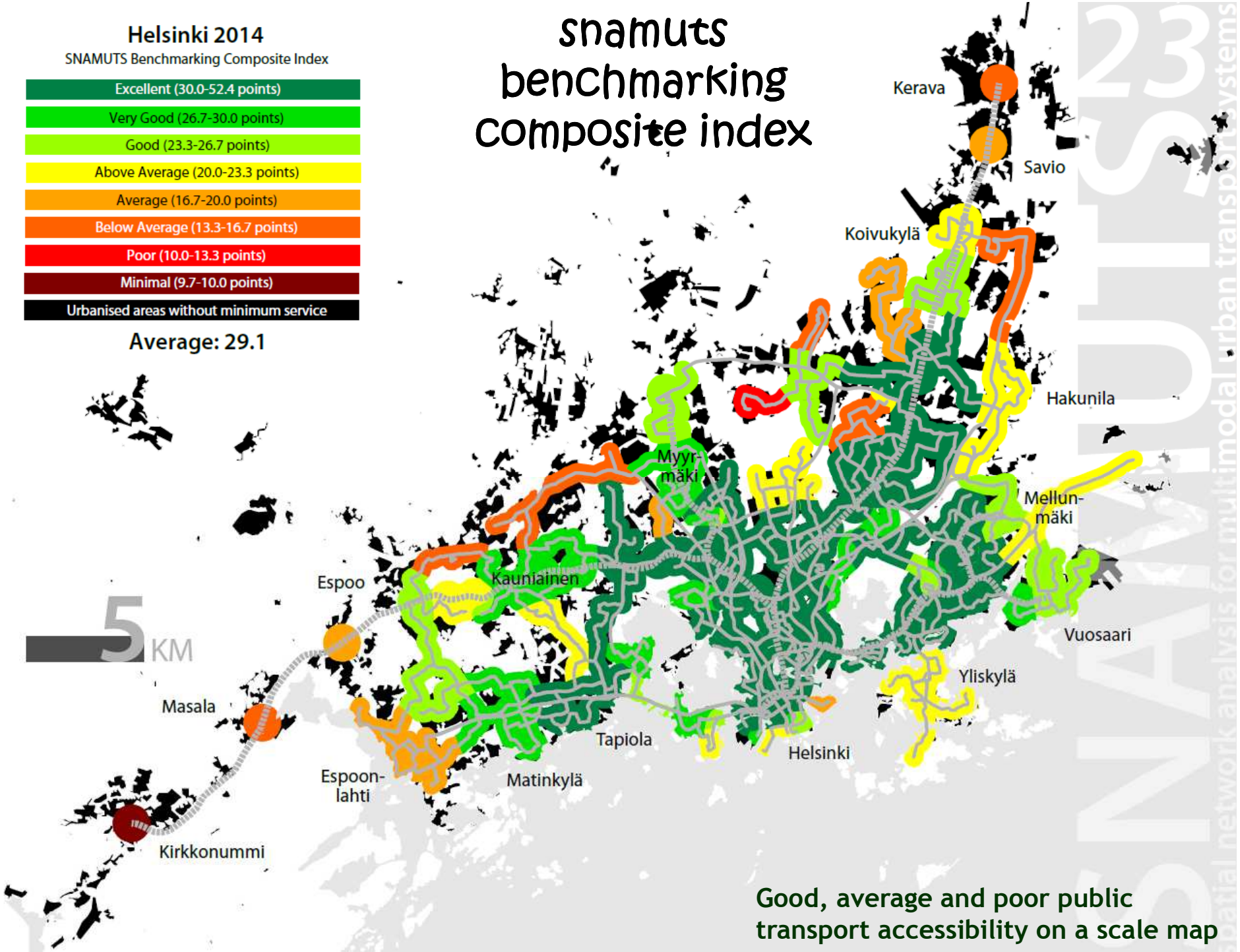


# Comparison of nodal connectivity
## average per network



| | |
|---|---|
| Hong Kong | 868 |
| Singapore | 751 |
| Barcelona | 305 |
| Wien | 193 |
| München | 176 |
| Hamburg | 166 |
| **Helsinki** | **133** |
| Amsterdam | 123 |
| København | 88 |
| Vancouver | 87 |
| Zuid Holland | 86 |
| Zürich | 83 |
| Melbourne | 82 |
| Sydney | 77 |
| Göteborg | 71 |
| Utrecht | 60 |
| Montreal | 52 |
| Oporto | 47 |
| Brisbane | 42 |
| Edinburgh | 31 |
| Seattle Portland | 26 |
| Perth | 19 |
| Auckland | 13 |
| Adelaide | 12 |

# snamuts benchmarking composite index




**Good, average and poor public transport accessibility on a scale map**

# snamuts helsinki: preliminary findings (i)

Helsinki has the **second highest level of operational input** relative to population among the non-Asian SNAMUTS cities. This largesse translates into the **highest concentration of public transport travel opportunities** in the SNAMUTS sample, and the **highest level of network coverage** outside Asia.

The **average ease of movement** in Helsinki's public transport network is by far the best of all cities in the sample. [Comparatively small city size supports this outcome.]

Helsinki's network **has mixed modal hierarchies:** developed task-sharing between metro and bus and to some extent between tram and bus, but less so between train and bus.

# SNAMUTS Helsinki: preliminary findings (ii)

Small size, compact city shape, good travel speeds and a multidirectional network that effectively bridges geographical barriers (water bodies) combine to deliver the **largest average 30-minute contour catchment** relative to population of all 26 SNAMUTS cities.

Helsinki's network **remains relatively bus-reliant** (though this is set to decrease with the opening of Länsimetro) and shows **some weaknesses in resilience** on critical bus links, suggesting unexhausted potential for ridership – perhaps this is due to a generous and highly competitive road system particularly in the middle and outer suburbs?


so what happens once ring rail and länsimetro have been added to the network?

# the effects of ring rail and länsimetro (stage 1)

**Service intensity:** slight decline from 36.6 to 35.4 vehicles/trains per 100,000 inh

**Closeness centrality:** average decline from 28.3 to 30.3

Degree centrality: average constant at 0.94

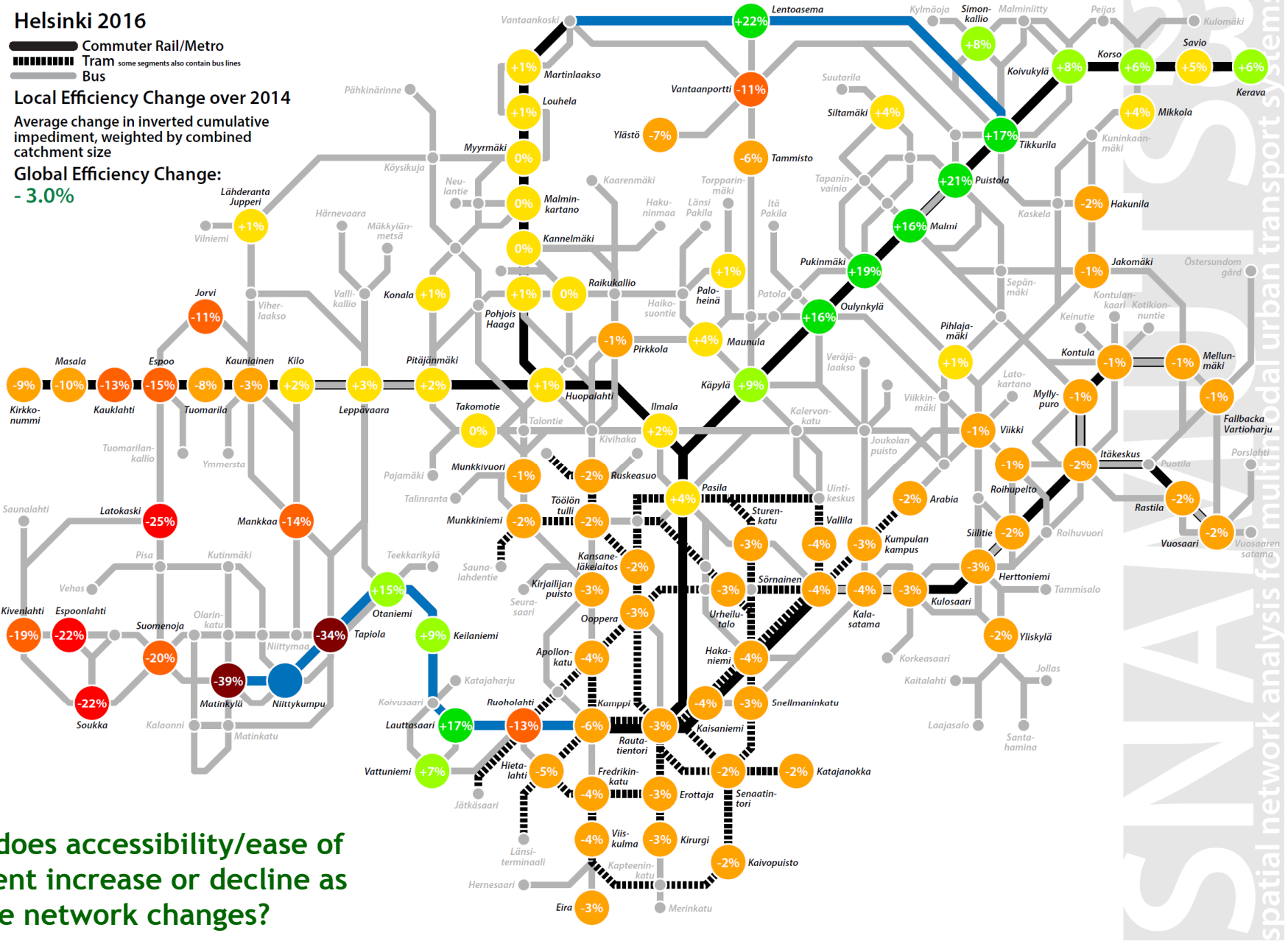
**Network coverage** and **average contour catchments** increase slightly (83.0 to 83.3%/40.6% to 41.1%)

**Betweenness centrality:** global betweenness declines slightly from 639 to 630. Heavy rail share (segmental betweenness) increases from 35.9% to 50.2%. CBD significance declines slightly from 22.8% to 21.5%

**Network resilience:** average increase from +12.9 to +16.2

**Nodal connectivity:** average increase from 133 to 139

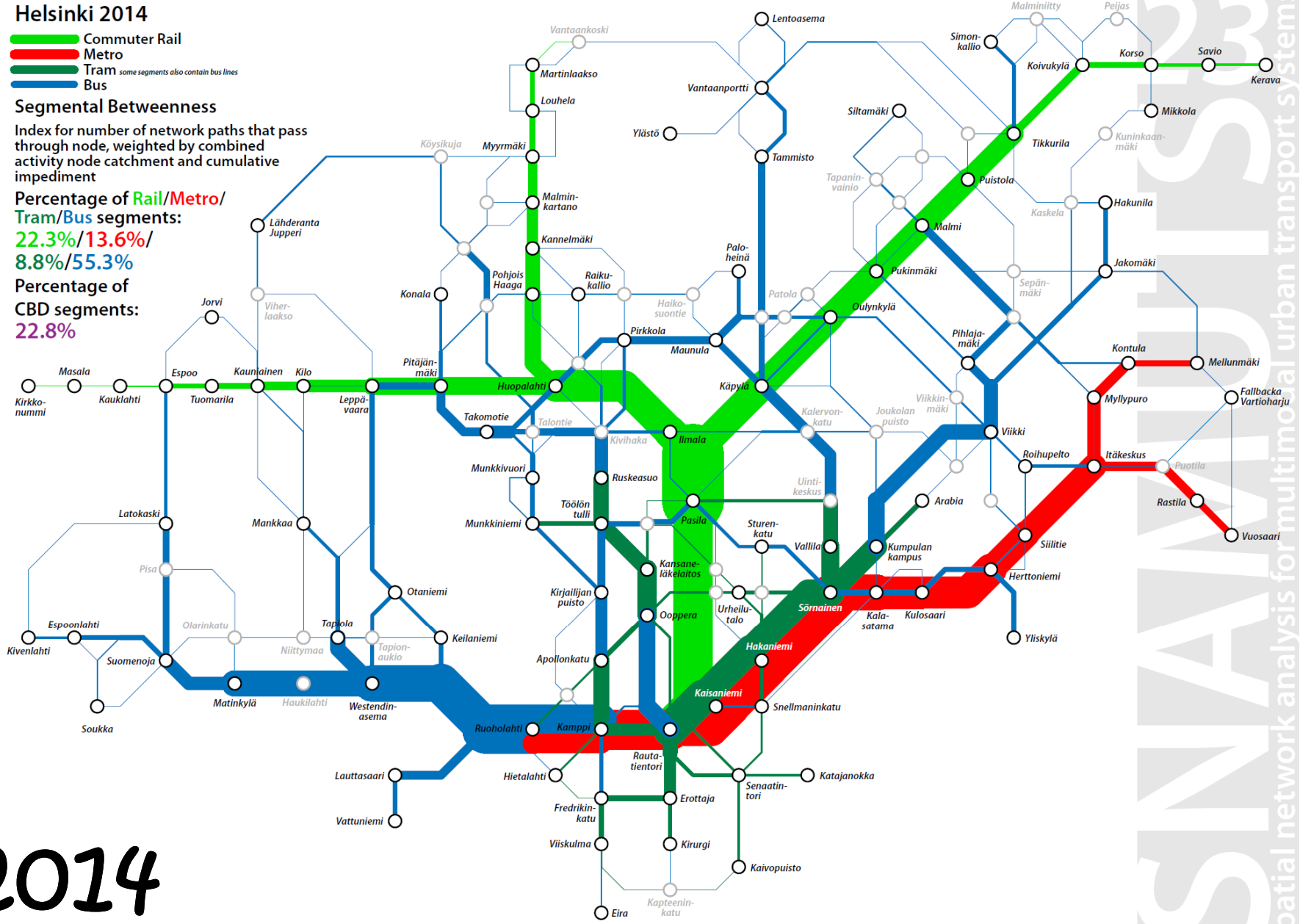
# efficiency change




**Where does accessibility/ease of movement increase or decline as the network changes?**

SNAMUTS spatial network analysis for multimodal urban transport systems

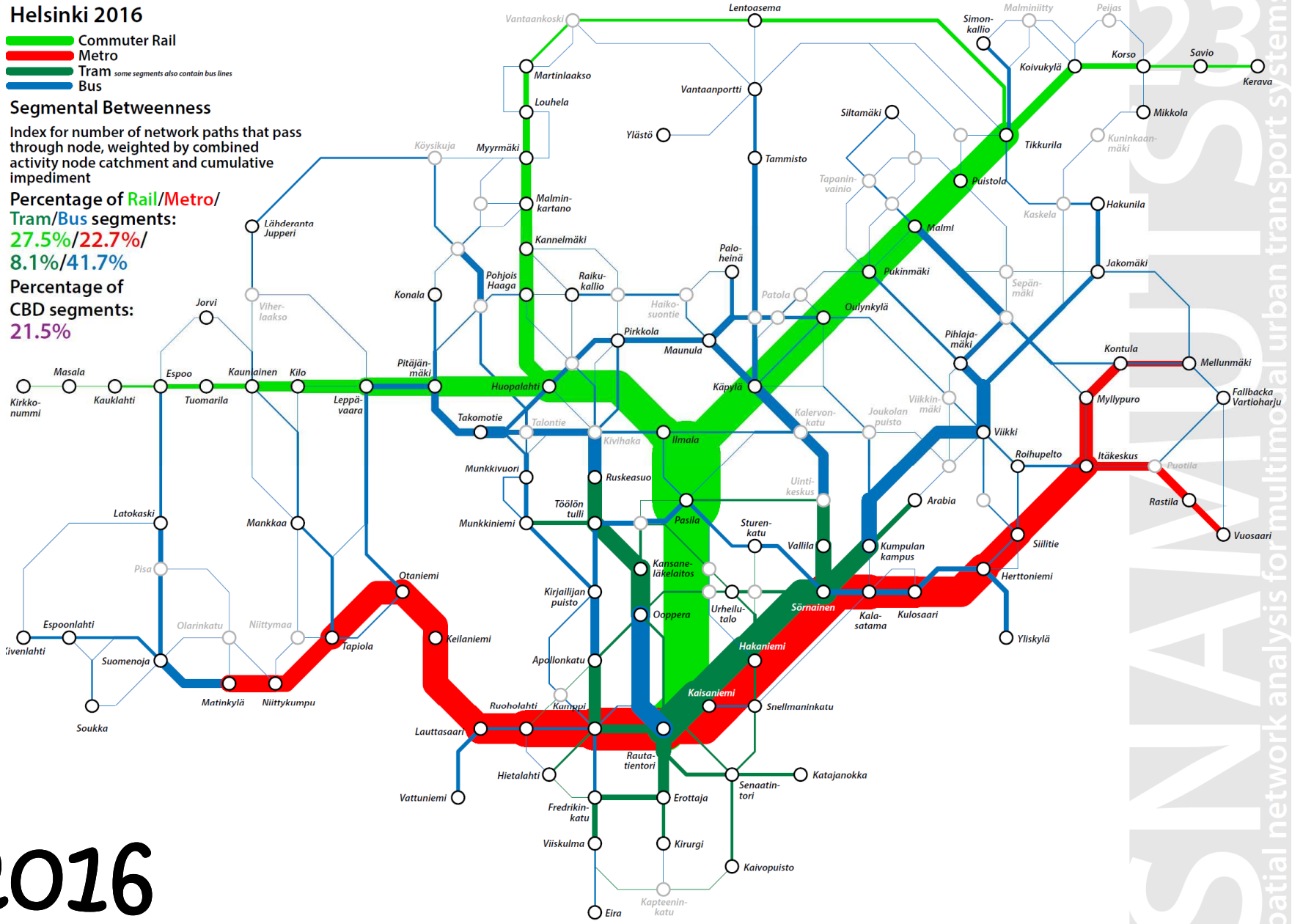
# segmental betweenness




2014

SNAMUTS2 spatial network analysis for multimodal urban transport systems

# segmental betweenness

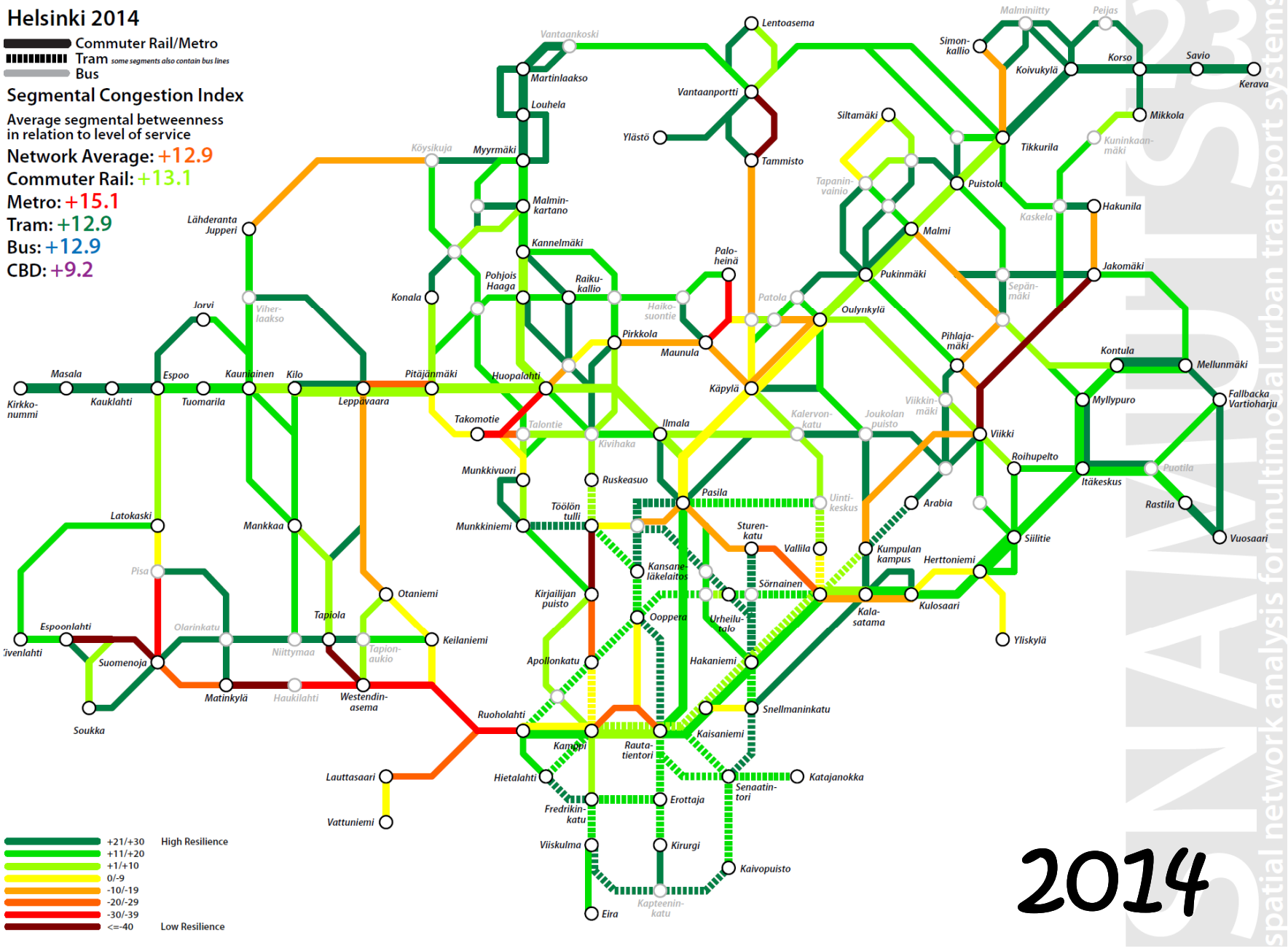



2016

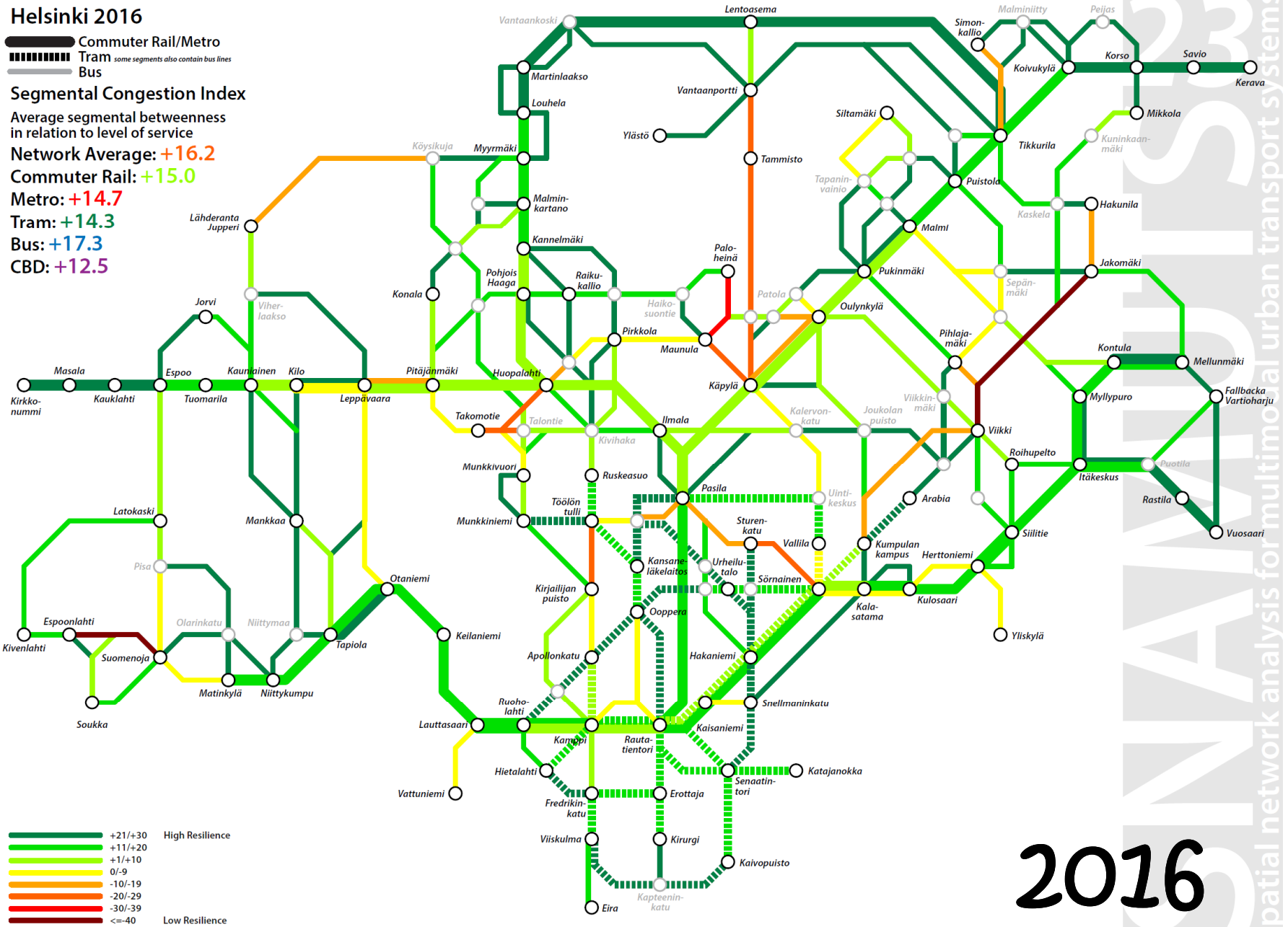
SNAMUTS3

spatial network analysis for multimodal urban transport systems

# network resilience



# network resilience



# accessibility instruments in planning practice

## Spatial Network Analysis for Multi-Modal Transport Systems (SNAMUTS): Helsinki

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