



# Train and bus commuting in Polish metropolitan areas: complementary or separate services?

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Pictures taken by Karol Kowalczyk

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# Background aspects (1) – administrative divisions of Poland

Country level (NUTS 0)	Provinces / Voivodships (NUTS 2)	Counties / Poviats (LAU 1)	Municipalities / Gminas (LAU 2)
<p>Area: <b>312 679 km<sup>2</sup></b>                      Population: <b>38 437 000</b>                      Pop. density: <b>123/km<sup>2</sup></b>                      Capital city: <b>Warsaw</b></p>	<p><b>16 units</b>                      18 regional capital cities</p>	<p><b>380 units in general</b>                      314 land units                      66 city units</p>	<p><b>2478 units in general</b>                      1559 rural units                      616 town-rural units                      303 city units</p>
			
<p><b>Central government:</b></p> <ul style="list-style-type: none"> <li>• President of Poland</li> <li>• Prime minister and the Council of ministers</li> </ul> <p><b>Legislature:</b></p> <ul style="list-style-type: none"> <li>• National Assembly (Sejm and Senate)</li> </ul> <p>Source: Self elaboration and data of Central Statistical Office of Poland</p>	<p><b>Provincial agency of the central government:</b></p> <ul style="list-style-type: none"> <li>• Governor (Wojewoda)</li> </ul> <p><b>Self-government:</b></p> <ul style="list-style-type: none"> <li>• Marshal (Marszałek) and the Voivodship's board</li> </ul> <p><b>Self-government legislature:</b></p> <ul style="list-style-type: none"> <li>• Voivodship Parliament</li> </ul>	<p><b>Self-government:</b></p> <ul style="list-style-type: none"> <li>• Starosta of land unit</li> <li>• President of city unit</li> </ul> <p><b>Self-government legislature:</b></p> <ul style="list-style-type: none"> <li>• Powiat's Council</li> </ul>	<p><b>Self-government:</b></p> <ul style="list-style-type: none"> <li>• President or Mayor (Burmistrz) of city unit</li> <li>• Mayor (Burmistrz) of town-rural unit</li> <li>• Village mayor (Wójt) of rural unit</li> </ul> <p><b>Self-government legislature:</b></p> <ul style="list-style-type: none"> <li>• City Council</li> <li>• Gmina's Council</li> </ul>

# Background aspects (2) – Polish railway network



## CONTEMPORARY RAILWAY NETWORK

Total length of the network: **19 995 km**

- **approx. 19 500 km** (1435 mm)
- **approx. 500 km** (broad 1520 mm)

Network density: **6,39 km/100km<sup>2</sup>**

Infrastructure management companies:

- **PKP Polskie Linie Kolejowe S.A.**  
(national company)
- Infra SILESIA
- Kopalnia Piasku Kotlarnia
- Jastrzębska Spółka Kolejowa
- CTL Maczki-Bór
- UBB Polska
- PMT Linie Kolejowe

Infrastructure management and carrier companies:

- PKP Szybka Kolej Miejska w Trójmieście
- Warszawska Kolej Dojazdowa
- PKP LHS

Source: *Railway Sector in Poland*



# Background aspects (2) – Polish railway network

## DEVELOPMENT OF RAILWAY NETWORK DURING THE PERIOD OF POLAND'S PARTITION

Opening dates of the first railways:

- **1842** (German zone)
- **1845** (Russian zone)
- **1850** (Austro-Hungarian zone)



# Background aspects (3) – train and bus domestic carriers in Poland

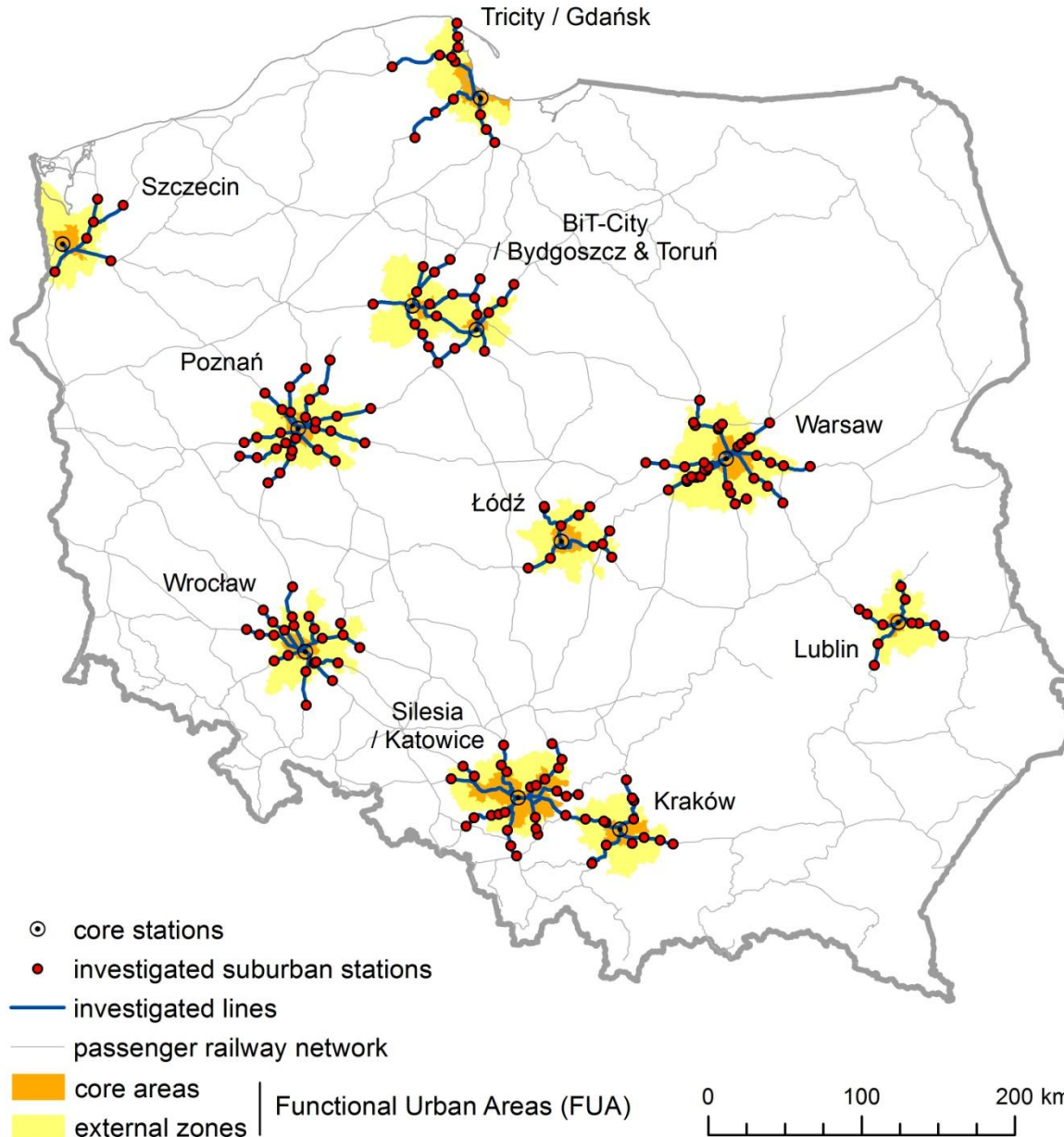
Railway sector			Bus sector		
Inter-regional	Regional	Local (urban)	Inter-regional	Regional	Local
<p><b>Property of Polish State Treasury:</b></p> <ul style="list-style-type: none"> <li>• <i>PKP Intercity</i> (before 2001 a part of one big national company <i>Polish State Railways</i>)</li> </ul>	<p><b>Properties of voivodship's self governments:</b></p> <ul style="list-style-type: none"> <li>• <i>Przewozy Regionalne</i></li> <li>• <i>Koleje Wielkopolskie</i></li> <li>• <i>K. Mazowieckie</i></li> <li>• <i>K. Śląskie</i></li> <li>• <i>K. Dolnośląskie</i></li> <li>• <i>K. Małopolskie</i></li> <li>• <i>Łódzka Kolej Aglomeracyjna</i></li> </ul> <p><b>Private company subsidised by voivodship's self governments:</b></p> <ul style="list-style-type: none"> <li>• <i>Arriva RP (DB company)</i></li> </ul>	<p><b>Property of the city of Warsaw self government:</b></p> <ul style="list-style-type: none"> <li>• <i>SKM (Fast City Railway) in Warsaw</i></li> </ul> <p><b>Property of Mazowieckie Voivodship's self government:</b></p> <ul style="list-style-type: none"> <li>• <i>WKD (Warsaw Commuter)</i></li> </ul> <p><b>Property of Pomorskie Voivodship's self government:</b></p> <ul style="list-style-type: none"> <li>• <i>SKM Tricity</i></li> <li>• <i>Pomorska Kolej Metropolitalna</i></li> </ul>	<p><b>Private independent companies:</b></p> <ul style="list-style-type: none"> <li>• <i>Polski Bus</i></li> <li>• <i>LUX Express</i></li> <li>• several carriers from the group of former <b>PKS</b> (<i>Poland's State Road Transport</i>)</li> <li>• <i>Arriva</i></li> <li>• and many other</li> </ul> <p><b>Properties of voivodship's self governments:</b></p> <ul style="list-style-type: none"> <li>• several carriers from the group of former <b>PKS</b> (<i>Poland's State Road Transport</i>)</li> </ul>	<p><b>Private independent companies</b></p> <p><b>Private companies subsidised by gminas' self governments</b></p> <p><b>Properties of the cities' self governments</b></p> <p><b>Properties of the rural gminas' self governments</b></p>	

Pictures taken by Karol Kowalczyk





# Research area (1)



## INITIAL SET OF SUBURBAN RAILWAY STATIONS

190 selected potential interchange points investigated during a field work and located in ten Polish metropolitan areas.

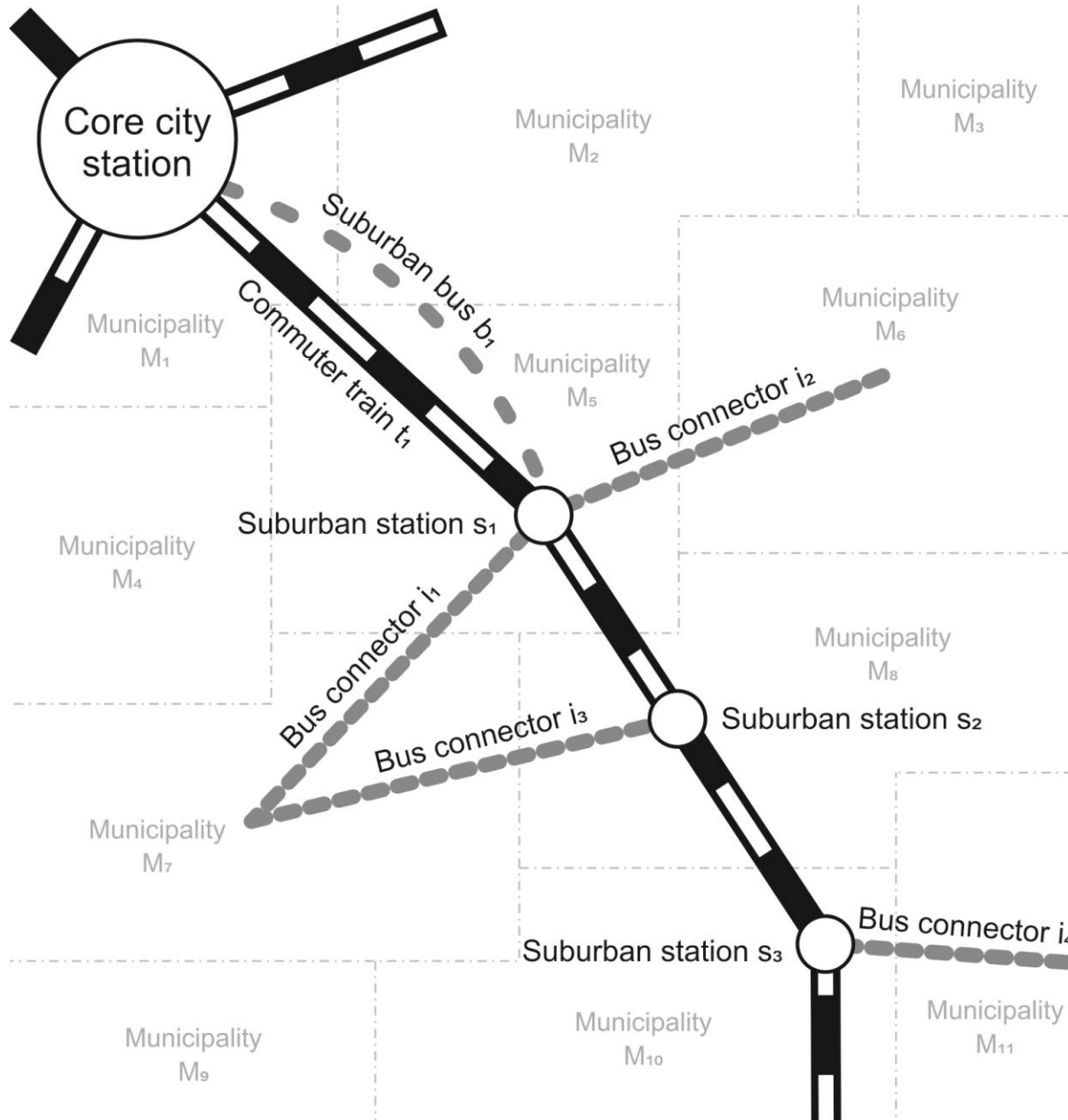
Metro-politan area	Inhabitants		
	Total	Core area	External zone
<b>Warsaw</b>	2 788 339	1 700 612	1 087 727
<b>Silesia / Katowice</b>	2 485 542	1 933 590	551 952
<b>Kraków</b>	1 169 351	757 611	411 740
<b>Tricity / Gdańsk</b>	1 065 053	748 104	316 949
<b>Łódź</b>	1 042 389	728 892	313 497
<b>Poznań</b>	907 507	554 696	352 811
<b>Wrocław</b>	879 649	630 131	249 518
<b>BiT-City</b>	784 318	568 880	215 438
<b>Szczecin</b>	556 908	410 131	146 777
<b>Lublin</b>	538 050	349 103	188 947

## Research area (2)

Name of the set of suburban interchange points	Number of investigated points	Criteria
<b>INITIAL</b>	<b>190</b>	Selected railway stations visited during field studies, located in the suburbs of ten metropolitan areas, supposed as potential interchange points
<b>INFRASTRUCTURAL INTEGRATION</b>	<b>138</b>	The stations from the initial set having an access to a bus stop within a distance of <b>300 m</b>
<b>REASONABLE INTERCHANGE</b>	<b>103</b>	Selected stations from the previous set denoting conditions for reasonable train-bus interchanges



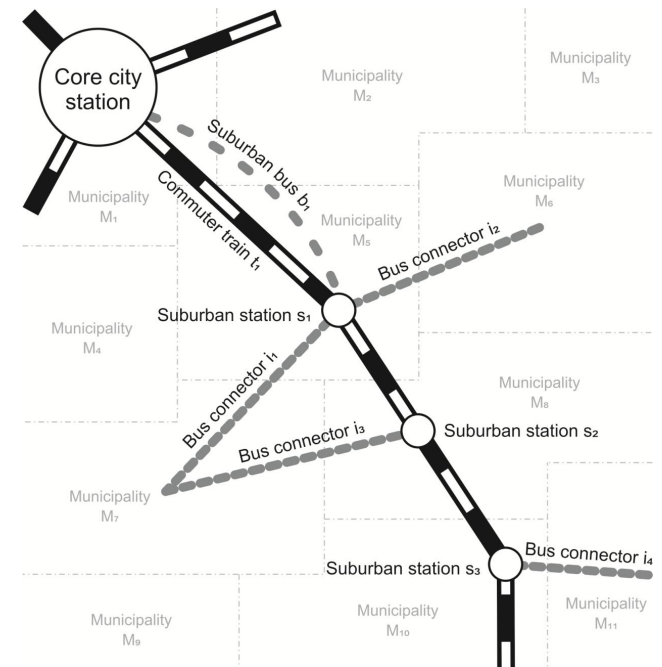
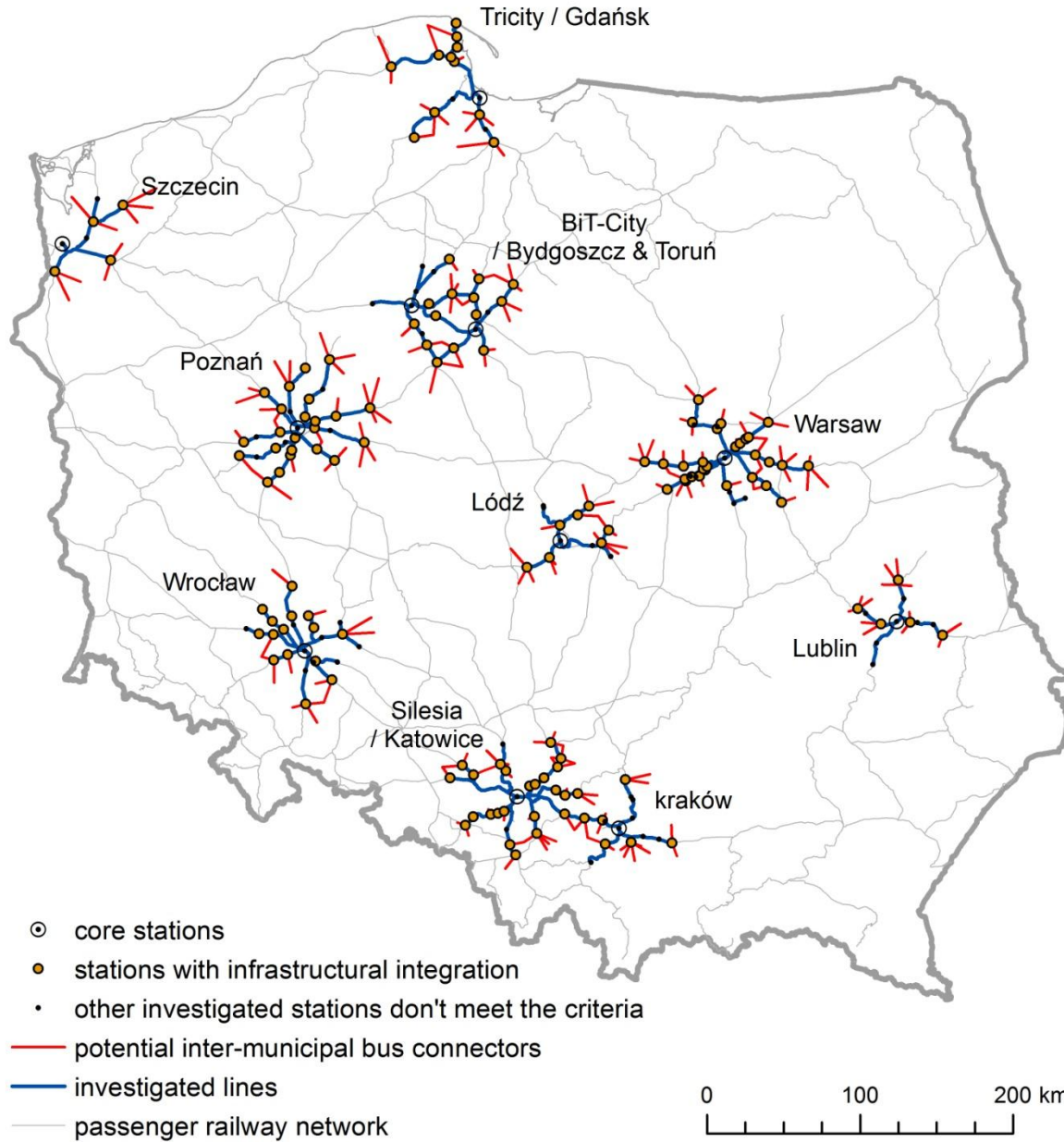
# Potential inter-municipal bus connectors (1)



## THEORETICAL SCHEME OF SUBURBAN BUS-TRAIN MULTIMODAL SYSTEM IN METROPOLITAN AREA

# Potential inter-municipal bus connectors (2)

195 POTENTIAL INTER-MUNICIPAL BUS CONNECTORS

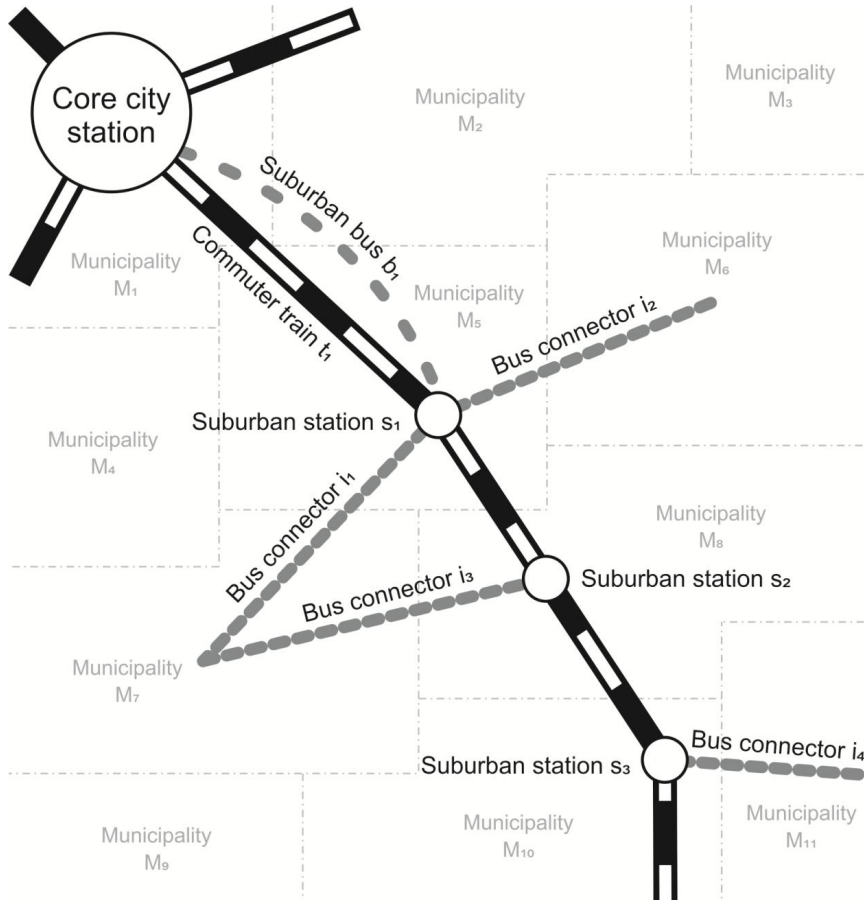




# The index of timetable synchronization (*Index #1*)

$$Index\#1 = \bar{x}_s = \frac{\sum_{i=1}^n w_i \bar{x}_i}{\sum_{i=1}^n w_i},$$

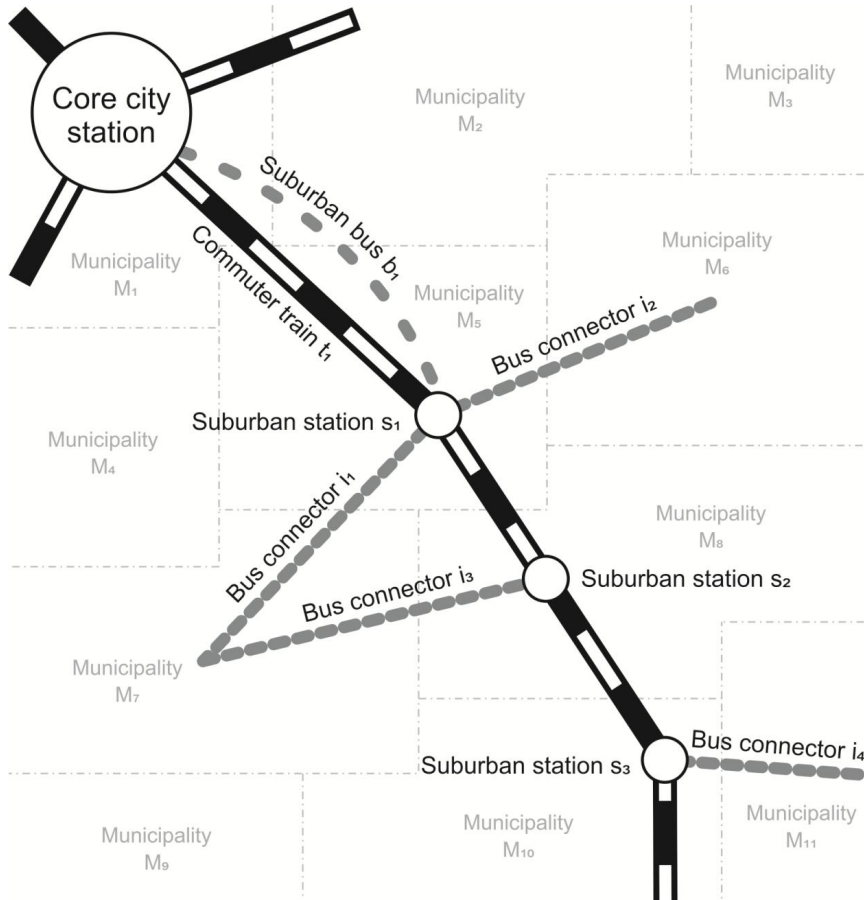
$$w_i = \frac{b_i}{t_s}, i \cap s = \{1, 2, 3, \dots, n\}$$



Source: Self elaboration

- $x_s$  – a weighted arithmetic mean of train-bus interchange time [min] at a suburban station “s”;
- $w_i$  – a weight of an inter-municipal bus connector “i”;
- $x_i$  – an arithmetic mean of train-bus interchange time [min] for an individual inter-municipal bus connector “i”;
- $b_i$  – a number of buses for an inter-municipal connector “i” available to change at suburban station “s” after commuter train arrivals during the peak hours;
- $t_s$  – a number of commuter train arrivals at a suburban station “s” allowing to change for buses running on an inter-municipal connector “i”.

# The index of time competitiveness of trains (*Index #2*)



Source: Self elaboration

$$Index\#2 = \frac{bd_s}{td_s},$$

$$s = \{1, 2, 3, \dots, n\}$$

**$bd_s$**  – a travel duration [min] of the fastest suburban bus from surroundings of a core city central station to a neighbourhood of a suburban station “s”, available during the peak hours 3-6 p.m.;

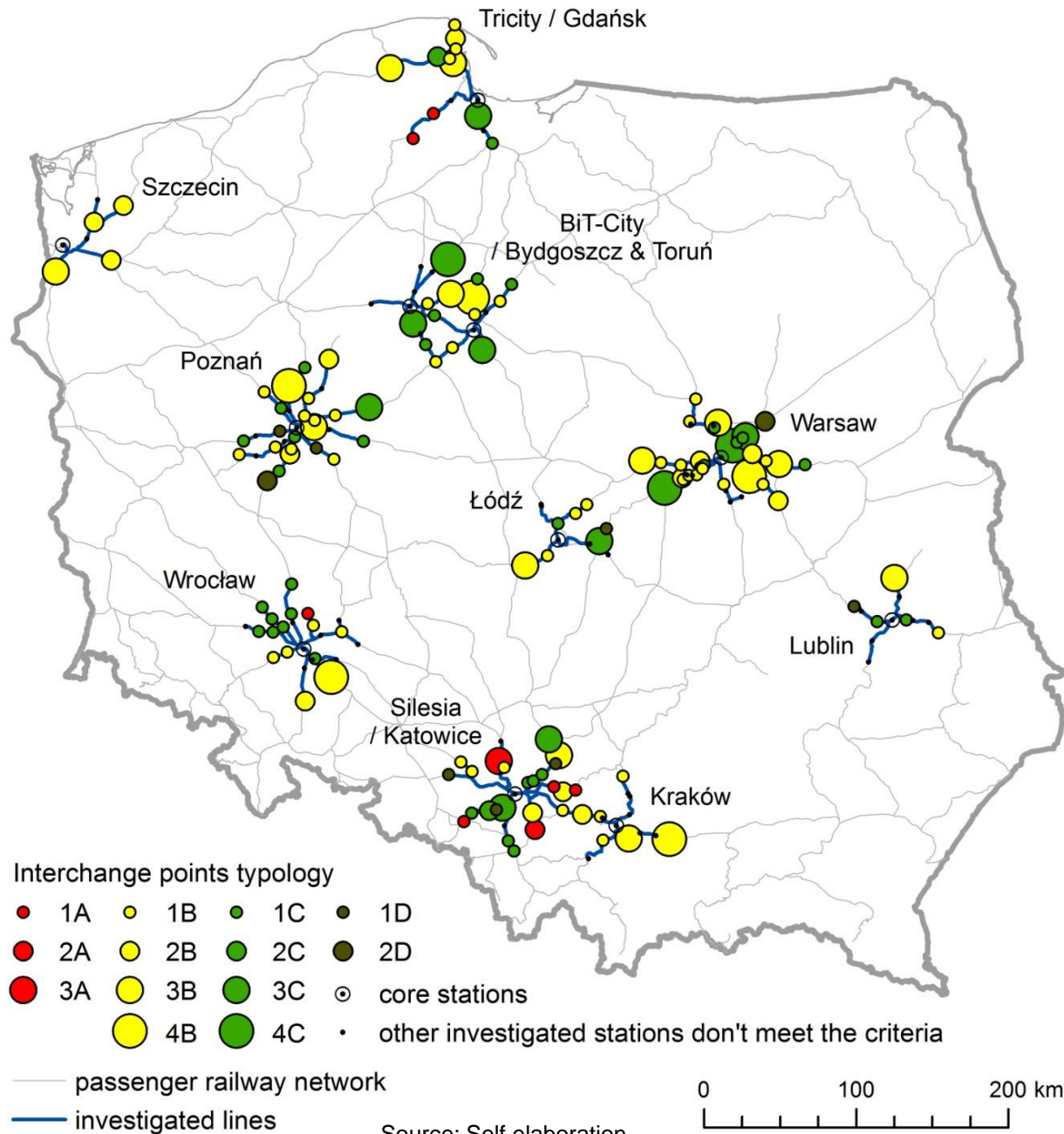
**$td_s$**  – a travel duration [min] of the fastest commuter train from a core city central station to a suburban station “s”, available during the peak hours 3-6 p.m..



# Dual-index typology of suburban interchange points

Train and inter-municipal bus timetable integration ( <i>Index #1</i> ) at the suburban interchange points	Time competitiveness of trains ( <i>Index #2</i> ) in travel between the cores and the suburban interchange points			
	A. Bus competitive advantage ( <i>Index #2 &lt; 1</i> )	Train competitive advantage		
		B. Slight ( $1 < \textit{Index #2} < 2$ )	C. Strong ( <i>Index #2 &gt; 2</i> )	D. Full (no bus connections)
1. Non-integrated (interchange impossible / services for local residents only)	1A (totally separate services / bus travel recommended)	1B (totally separate services / train travel to consider)	1C (totally separate services / train travel recommended)	1D (totally separate services / compulsory train travel)
2. Unacceptable ( <i>Index #1 &gt; 30 min</i> / bus-train interchange unadvisable)	2A (almost separate services / bus travel recommended)	2B (almost separate services / train travel to consider)	2C (almost separate services / train travel recommended)	2D (almost separate services / compulsory train travel)
3. Acceptable ( $15 \text{ min} < \textit{Index #1} < 30 \text{ min}$ / bus-train interchange to consider)	3A (slightly integrated services / bus travel recommended)	3B (slightly integrated services / train travel to consider)	3C (slightly integrated services / train travel recommended)	3D (non-found type)
4. Good ( <i>Index #1 &lt; 15 min</i> / bus-train interchange recommended)	4A (non-found type)	4B (complementary services / train travel to consider)	4C (complementary services / train travel recommended)	4D (non-found type)

# Spatial diversity of suburban interchange points (1)





# Spatial diversity of suburban interchange points (2)

Metro-politan area	Index #1				Index #2			
	Structure		Sta-tions	%	Structure		Sta-tions	%
Warsaw		1	17	58,6		A	0	0
		2	5	17,3		B	19	65,5
		3	4	13,8		C	9	31
		4	3	10,3		D	1	3,5
Silesia / Katowice		1	15	65,2		A	5	21,8
		2	4	17,4		B	6	26,1
		3	4	17,4		C	9	39,1
		4	0	0		D	3	13
Kraków		1	4	57,1		A	0	0
		2	1	14,3		B	7	100
		3	1	14,3		C	0	0
		4	1	14,3		D	0	0
Tricity / Gdańsk		1	6	54,5		A	2	18,2
		2	2	18,2		B	6	54,5
		3	3	27,3		C	3	27,3
		4	0	0		D	0	0
Łódź		1	5	71,4		A	0	0
		2	0	0		B	4	57,1
		3	2	28,6		C	2	28,6
		4	0	0		D	1	14,3

Metro-politan area	Index #1				Index #2			
	Structure		Sta-tions	%	Structure		Sta-tions	%
Poznań		1	17	73,9		A	0	0
		2	3	13		B	13	56,5
		3	2	8,7		C	7	30,4
		4	1	4,4		D	3	13,1
Wrocław		1	13	86,6		A	1	6,7
		2	1	6,7		B	6	40
		3	0	0		C	8	53,3
		4	1	6,7		D	0	0
BiT-City		1	9	64,3		A	0	0
		2	0	0		B	7	50
		3	3	21,4		C	7	50
		4	2	14,3		D	0	0
Szczecin		1	0	0		A	0	0
		2	3	75		B	4	100
		3	1	25		C	0	0
		4	0	0		D	0	0
Lublin		1	4	80		A	0	0
		2	0	0		B	2	40
		3	1	20		C	2	40
		4	0	0		D	1	20

## Spatial diversity of suburban interchange points (3)

Type		Warsaw	Silesia / Katowice	Kraków	Tri-City / Gdańsk	Łódź	Poznań	Wrocław	BiT-City / Bydgoszcz & Toruń	Szczecin	Lublin
1	A	-	3	-	2	-	-	1	-	-	-
2	A	-	1	-	-	-	-	-	-	-	-
3	A	-	1	-	-	-	-	-	-	-	-
1	B	11	3	4	3	3	9	4	5	-	1
2	B	4	2	1	1	-	2	1	-	3	-
3	B	3	1	1	2	1	1	-	1	1	1
4	B	1	-	1	-	-	1	1	1	-	-
1	C	6	6	-	1	1	6	8	4	-	2
2	C	-	1	-	1	-	-	-	-	-	-
3	C	1	2	-	1	1	1	-	2	-	-
4	C	2	-	-	-	-	-	-	1	-	-
1	D	-	3	-	-	1	2	-	-	-	1
2	D	1	-	-	-	-	1	-	-	-	-



## Conclusions

- Train and bus services in Polish metropolitan areas work more often separate than complementary, and an existence of multimodal chains is a rareness.
- In spite of relatively high level of infrastructural integration of the investigated railway stations and bus stops, there are usually insufficient conditions for reasonable multimodal commuting.
- Multimodal commuting could be more common in case of the interchange points situated in more distant suburban towns of *poviat* level.
- The stations located in smaller suburban towns and villages are usually served by intra-municipal bus carriers (without any inter-municipal connections).
- Higher values of the timetable synchronization index (*Index #1*) can be sometimes an effect of random coexistence than a result of any official agreements between bus and train carriers (during the research two such agreements were identified only).
- Identification of poor schedule integration at many investigated points are an evidence of single-mode pattern popularity in Poland.
- Train service seems to be used mostly by local residents who live within a neighbourhood of a railway station. Their access travel is short (intra-municipal) and they can likely walk, cycle or use a private car.
- The single-mode pattern can be also popular in case of the residents of non-railway municipalities who choose private car or direct bus connections in commuting.



**THANK YOU! GRACIAS! DZIĘKUJĘ!**

