ITS solutions supported by multilevel modelling of transport systems- the case of the City of Gdynia

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Assumptions for the concept of developing a system for forecasting and traffic analysis in Gdynia

Multi-level model of transportation systems (MST-Gdynia):

- cover an area of Gdynia, but to be fed with data from regional and national models
- have a hierarchical structure consisting of layers of different management levels
- enable the efficient exchange of information and data between management layers as well as the Transport Planning System and software to traffic control, which is implemented within TRISTAR system
- enable the provision of data to the various tasks arising from the process of functioning of the transport systems and facilities, which will facilitate optimal decision-making
- provide data for planning work, feasibility studies of transport facilities, projects of changes in the traffic arrangement plans, taking into account geometric solutions at intersections and interchanges and advanced traffic control

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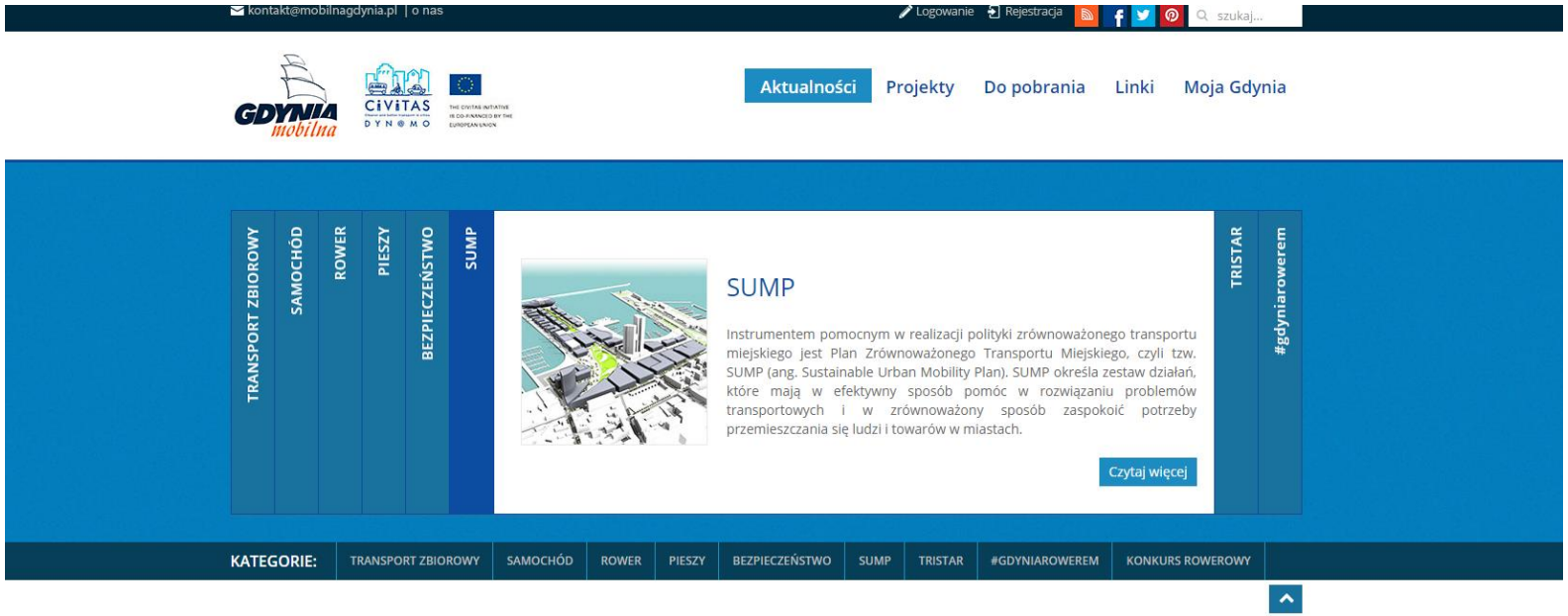
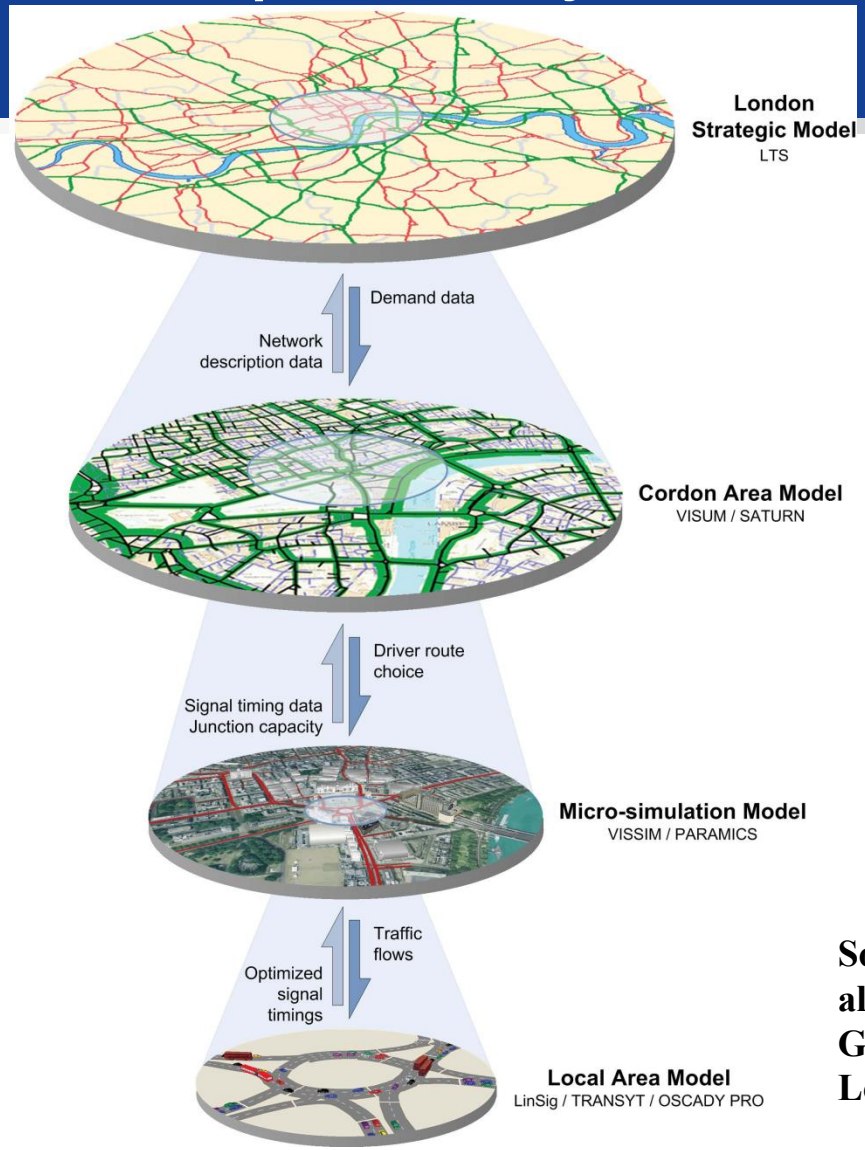
Assumptions for the concept of developing a system for forecasting and traffic analysis in Gdynia

Multi-level model of transportation systems (MST-Gdynia) should:

- set up data and information for updating Gdynia's SUMP and provide detailed analyses and verification of effects on mobility management initiated by SUMP proposals and measures
- provide simulation tools to convince residents of Gdynia to proposed SUMP and other solutions



Multi-level Model of Transportation Systems



Source: Smith, J., Blewitt, R. at al: Traffic Modelling Guidelines. Transport for London (2010)

Development of tool for transport analysis - MST

Statistical data (baseline and forecasts)
- Demographics
- Economical (economic development, unemployment)
- Land use

Street network parameters
- Public Transport
- Private Transport

Stated Preference Survey
Traffic counts
PT passengers counts
Travel times measures
(to calibrate and verify models)

Four stage model
- Trip Generation
- Trip Distribution
- Modal split/shift models
- Assignment/simulation

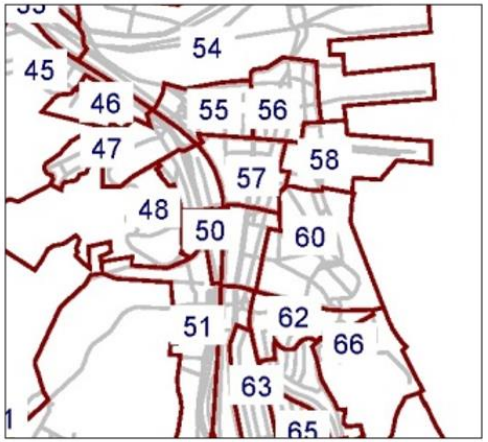
- Trip matrices
- Traffic forecasts
- Indicators

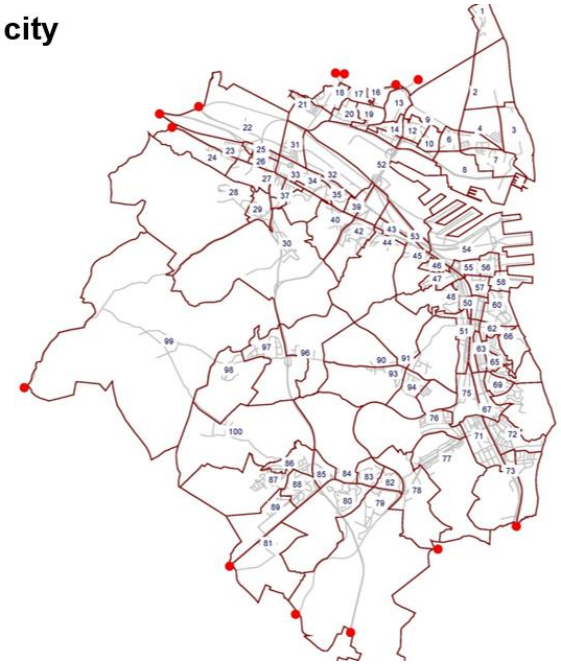
Multi-level Model of Transportation Systems

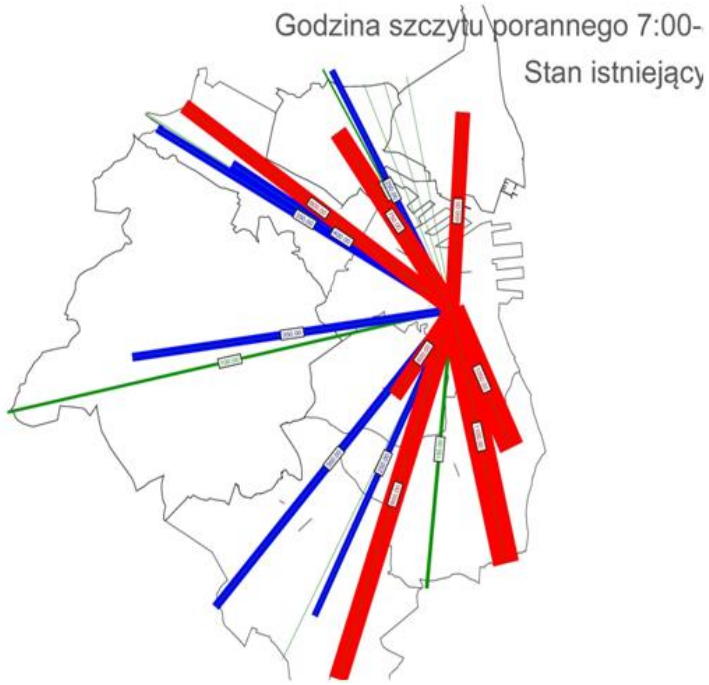
Strategic level includes the provision of data to develop a transport policy, the implementation of planning studies and network studies. The model is also used to collect the data for the mesoscopic model, including the existing and planned routes located in the vicinity of the city.

Transportation zones (TAZ) in the city

Transportation zones:
- 100 – internal
- 17 - external







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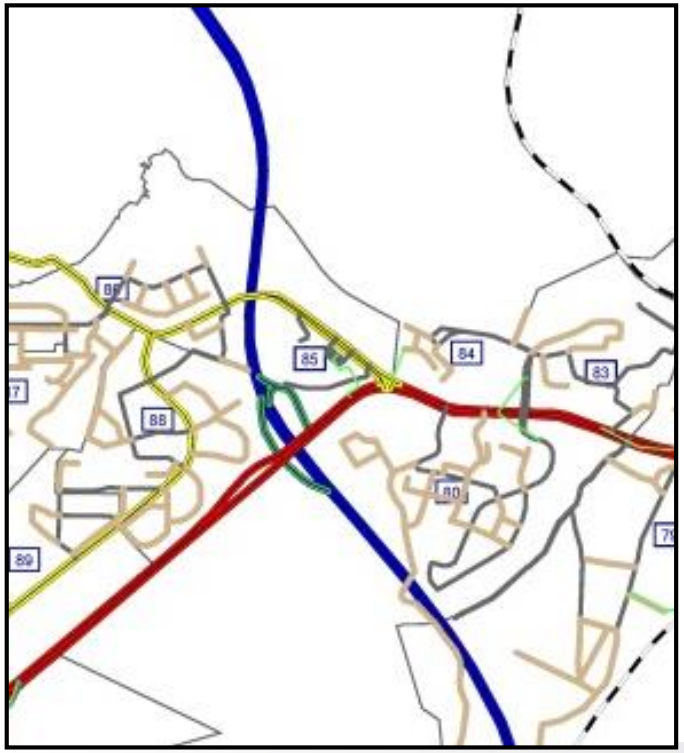
MST-Gdynia

Transportation network – baseline scenario

- Expressway
- Main roads
- Collective roads
- Local roads



MST-Gdynia

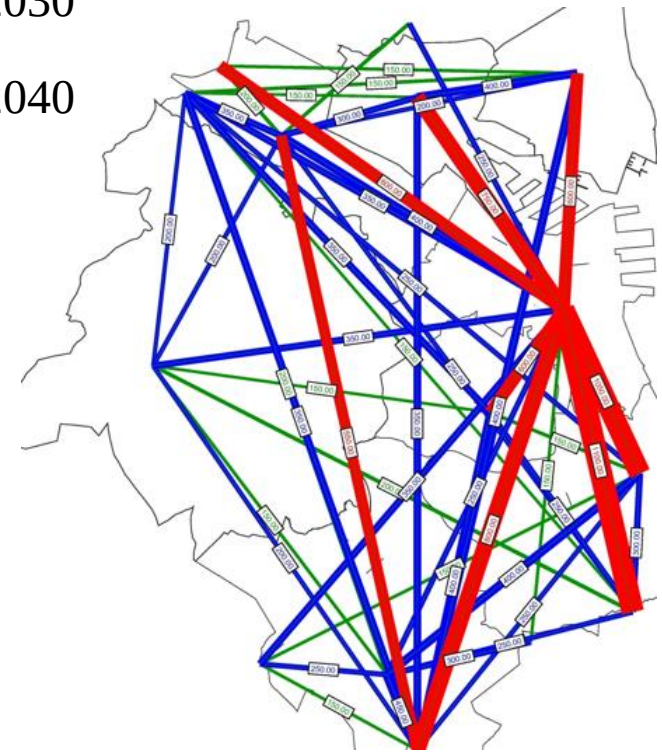
Staging of the expansion of the road network

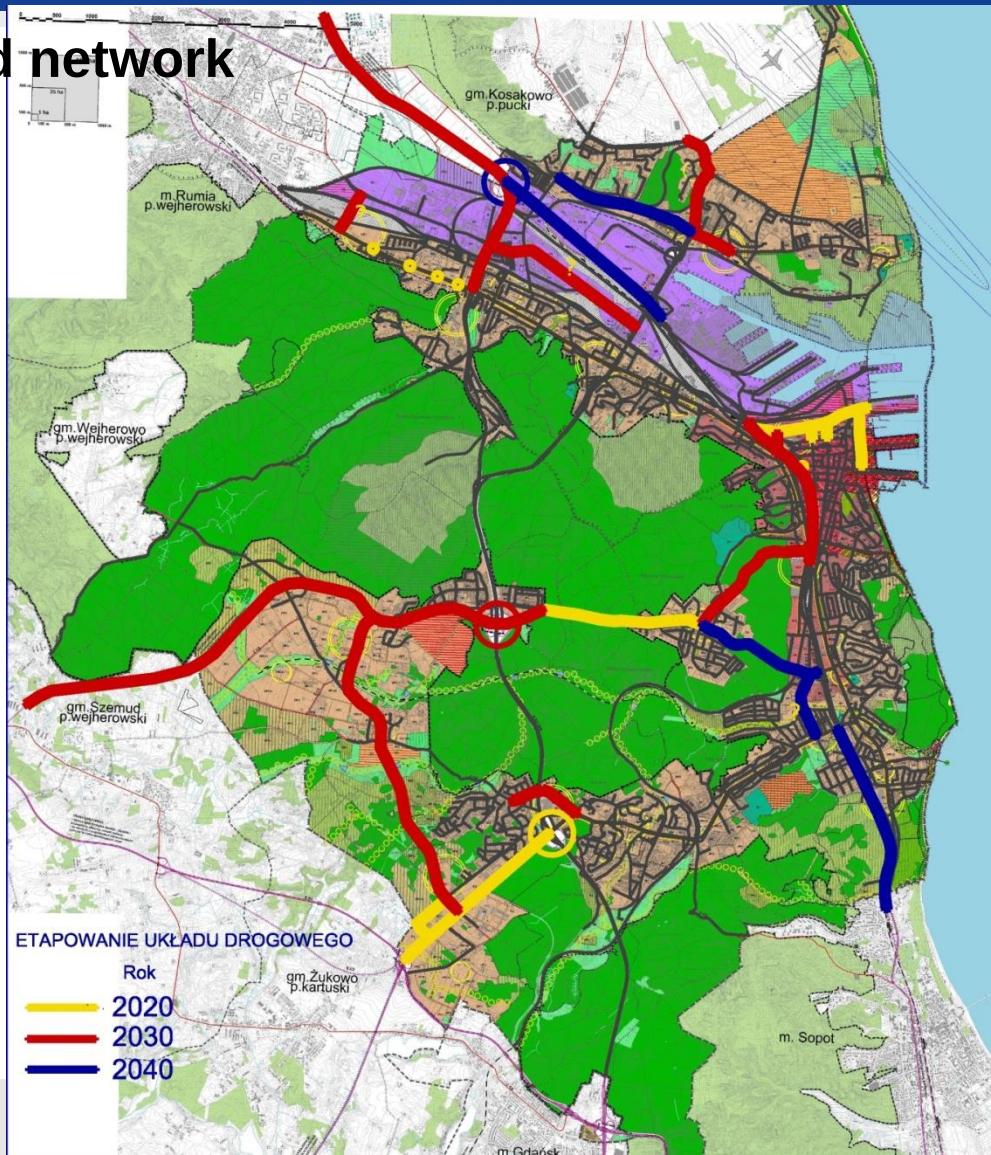
Year

2020

2030

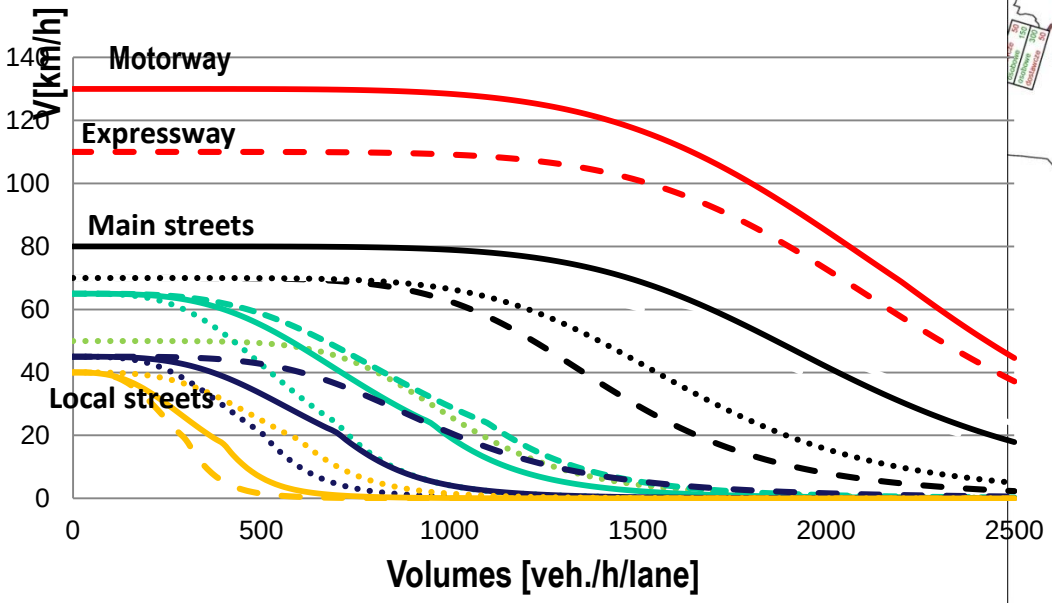
2040

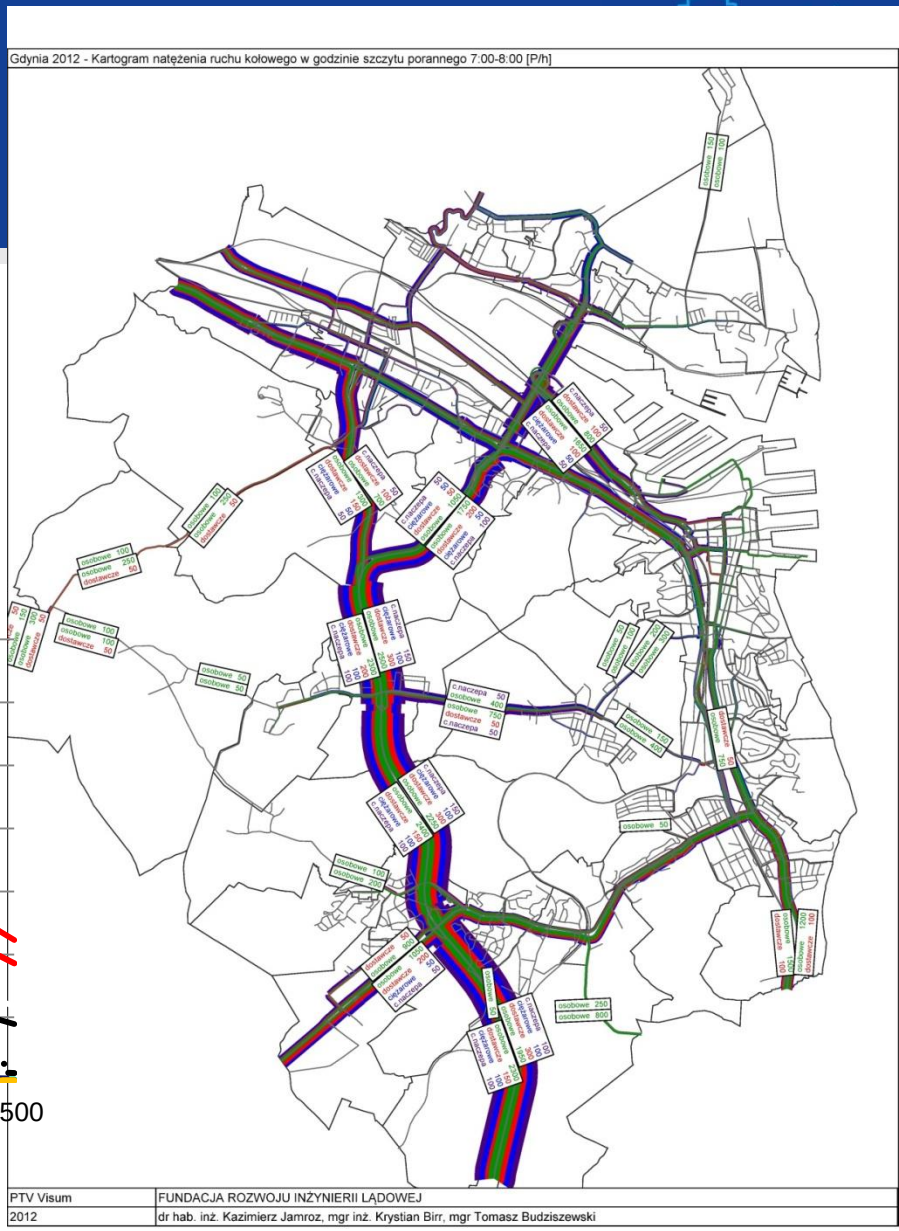




Strategic level (VISUM)

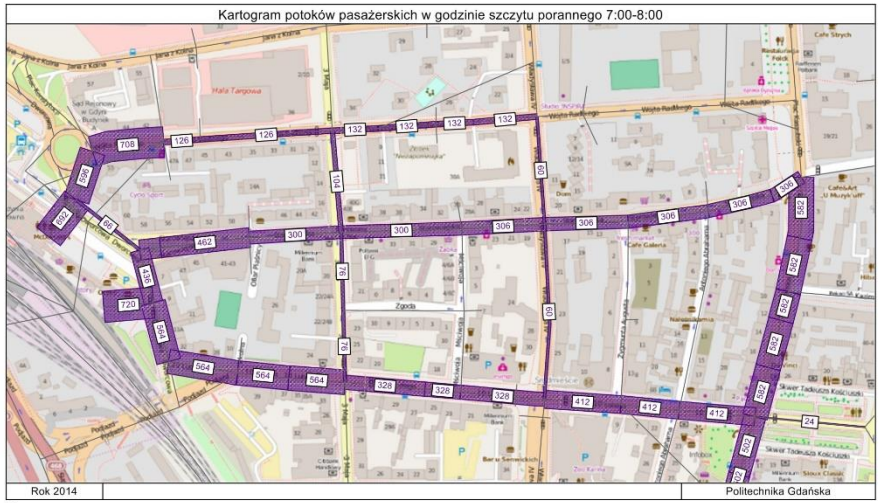
Example of traffic flow chart (morning peak) Assignment

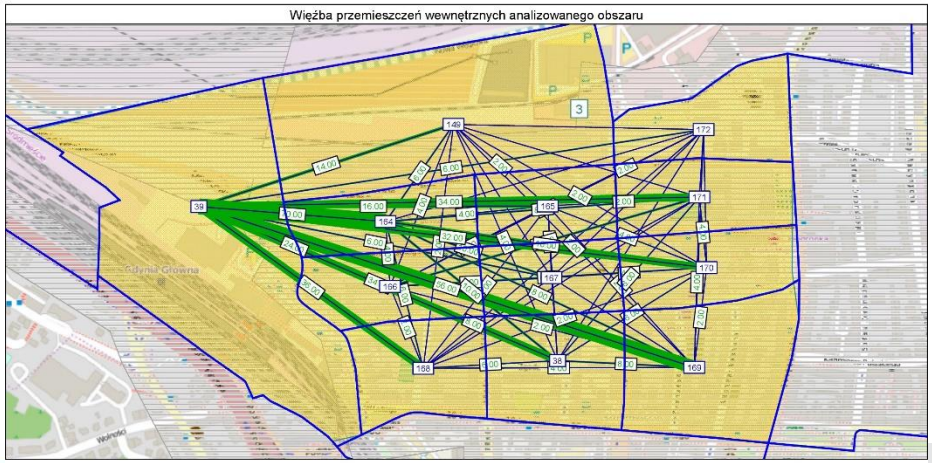




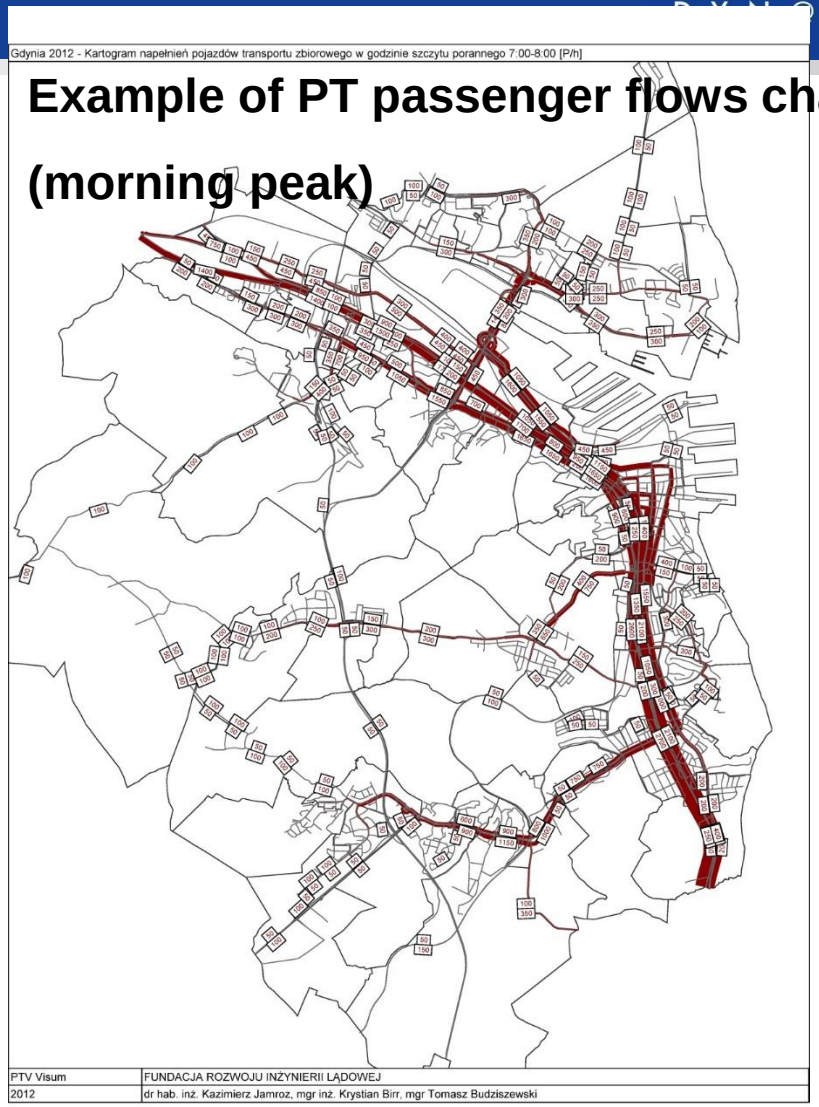
Strategic level (VISUM)

Pedestrian flows





Example of PT passenger flows chart (morning peak)



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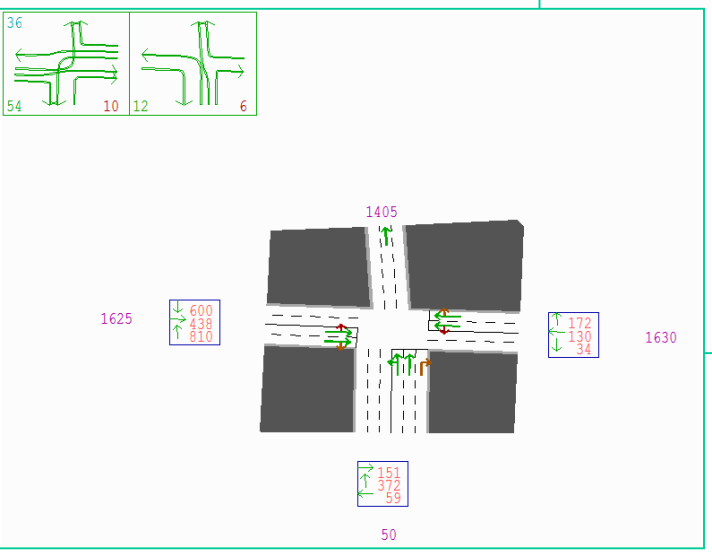
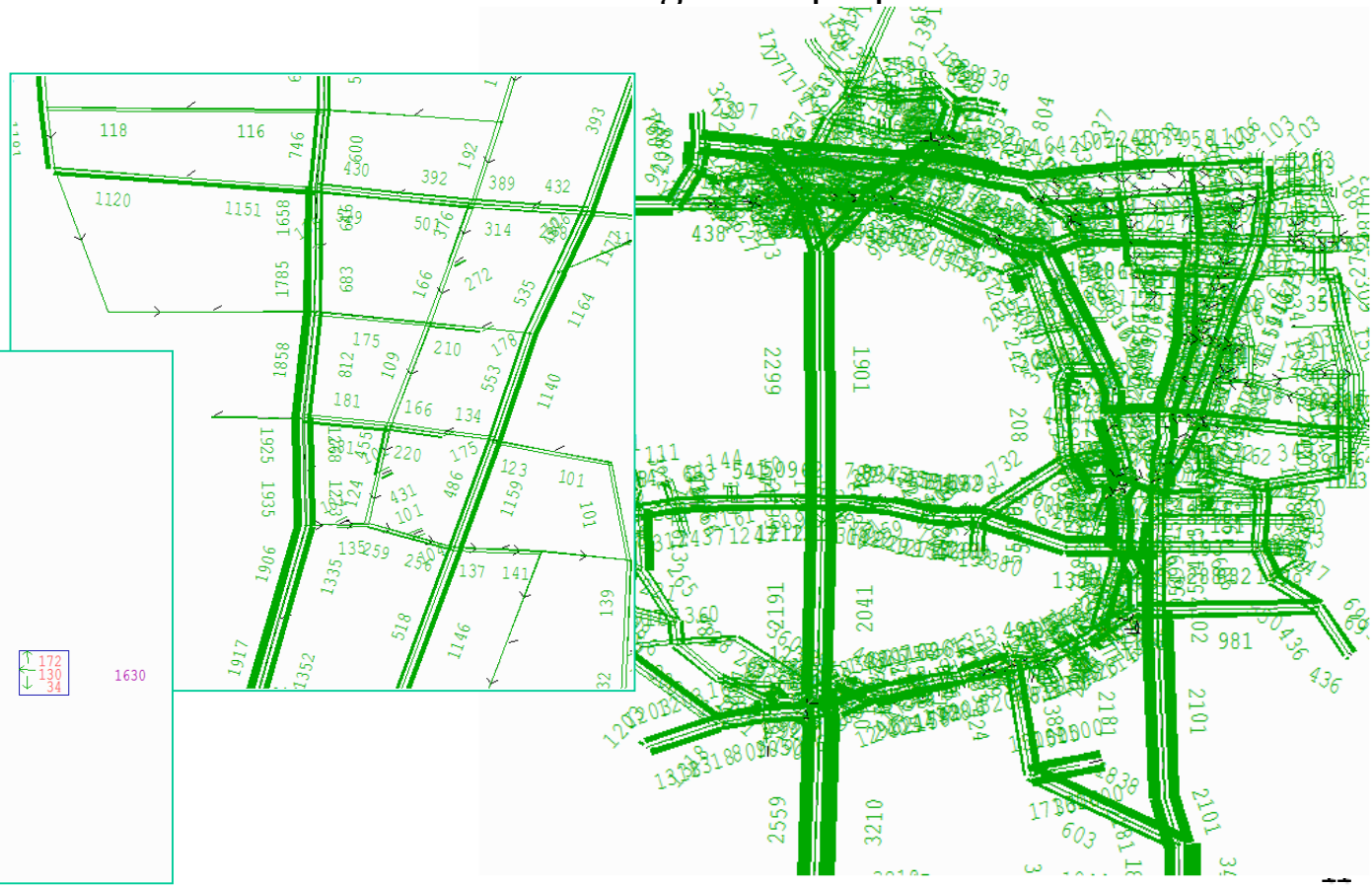
Multi-level Model of Transportation Systems
Tactical level (SATURN)

Tactical level includes the provision of data to develop a decision-making papers (network and corridor studies, feasibility studies), projects of traffic arrangement, traffic control and evaluation of planning solutions effectiveness as well as for traffic management purpose.

Assignment

and simulation





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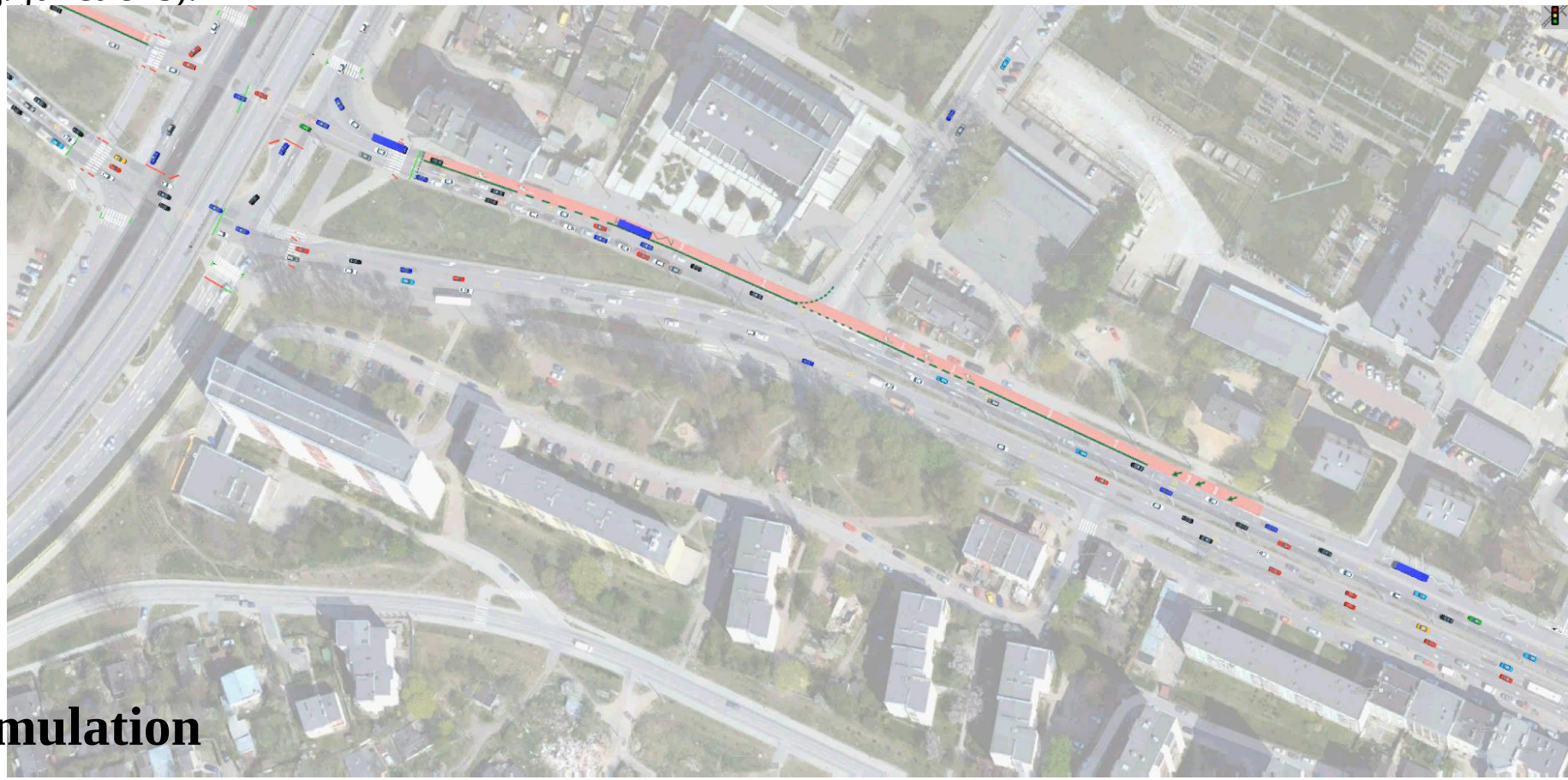
Operational level (VISSIM + SATURN)

Operational level includes the provision of data to develop specific projects of traffic arrangement, traffic control programs and visualization of traffic in street network components (e.g. junctions).



Simulation

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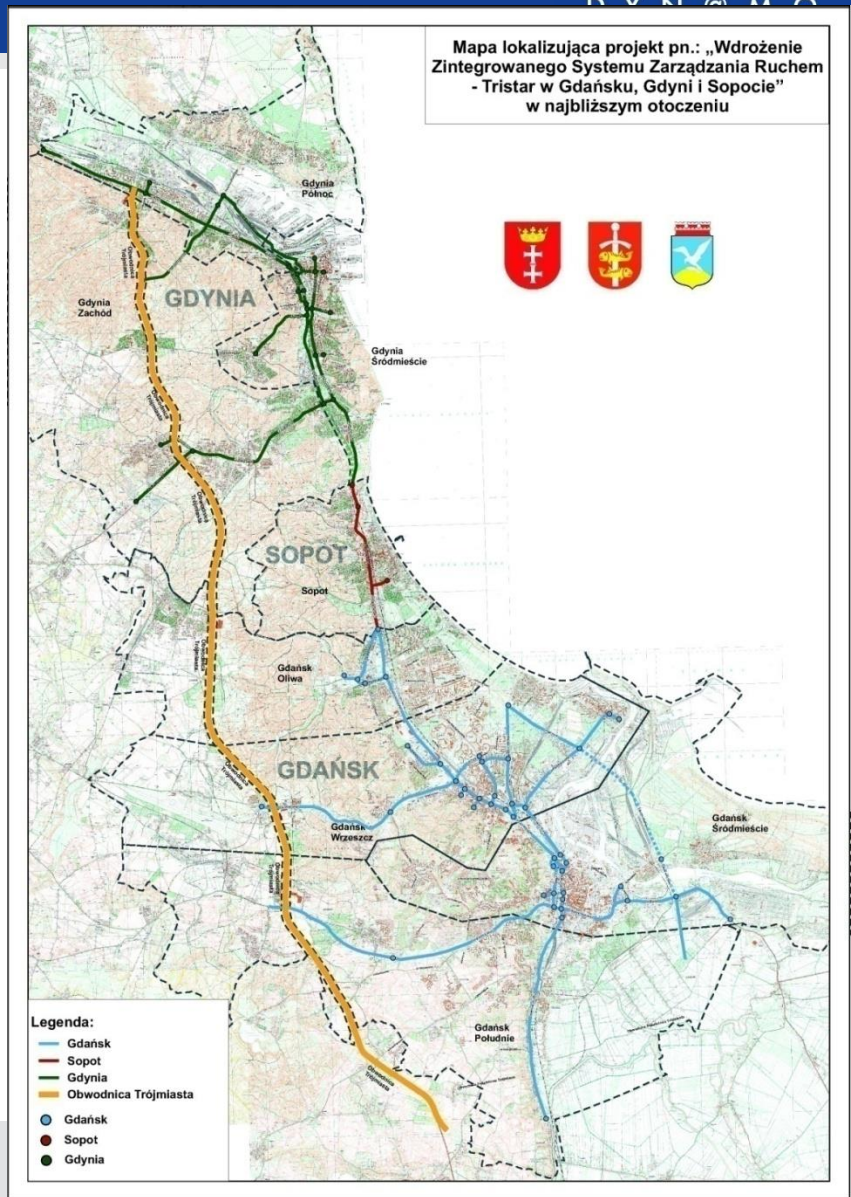
Multi-level Model of Transportation Systems

Area	Level of management	Strategic	Tactical	Operational
	Object	Transport network	Transport network/ streets and PT lines	Street, PT line, set of junctions, junction
	Model type	Macroscopic	Mezoscopic	Microscopic
Region	Tool	VISUM		
City		VISUM	SATURN/DRACULA	
Cordon		VISUM	SATURN/DRACULA	
Local			SATURN/DRACULA	VISSIM, DRACULA

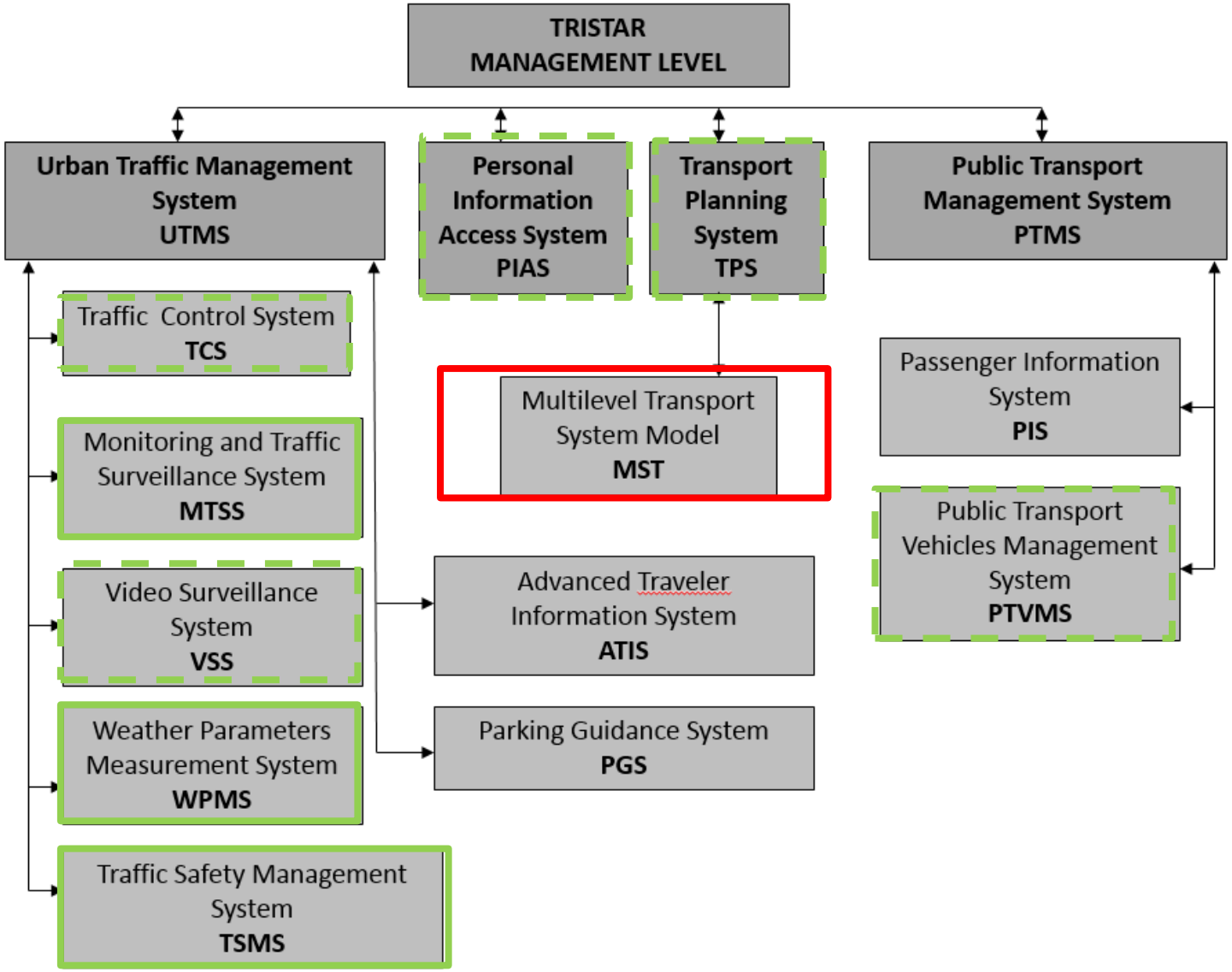
After implementation of TRISTAR system in Gdynia the models are supplied with the information on traffic parameters in real-time.

TRISTAR System

- 148 km of fiber optic connections
- 161 intersections with traffic lights (BALANCE/EPICS system)
- 73 video surveillance cameras
- 61 points with ANPR cameras
- 36 guidance parking information signs
- 34 Passenger Information boards
- 22 Bluetooth/WiFi scanners
- 19 Variable Message Boards
- 16 Tripplanners
- 14 Weather stations
- 7 Variable Message Signs



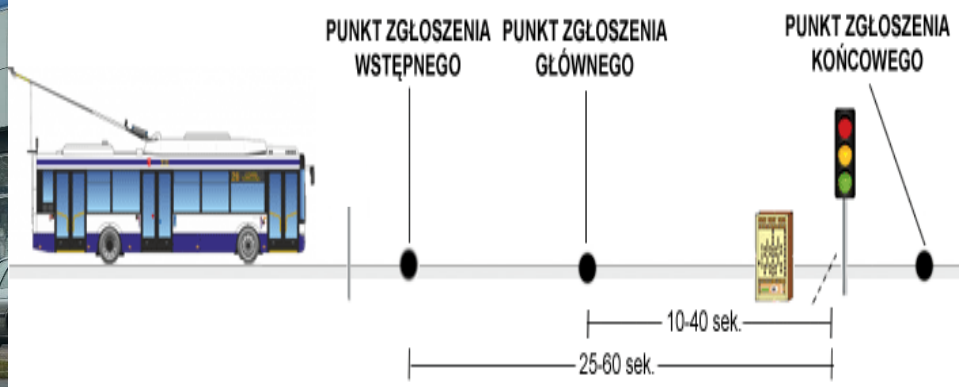
TRISTAR System Architecture



Monitoring and Traffic Surveillance System - MTSS

Examples of detection systems in TRISTAR:

- traffic measurement stations – 161 intersections – inductive loops
- Traffic Control System - inductive loops or video detection
- bluetooth and Wi-Fi sensors - incident detection algorithms
- ANPR cameras – Driver Information System / Traffic Safety Management System
- Public Transport Vehicles – PT Vehicles Management System / priorities for PT vehicles in TCS



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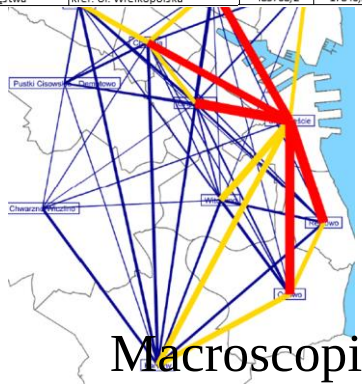
Dedicated bus lanes

Strategic level (VISUM)

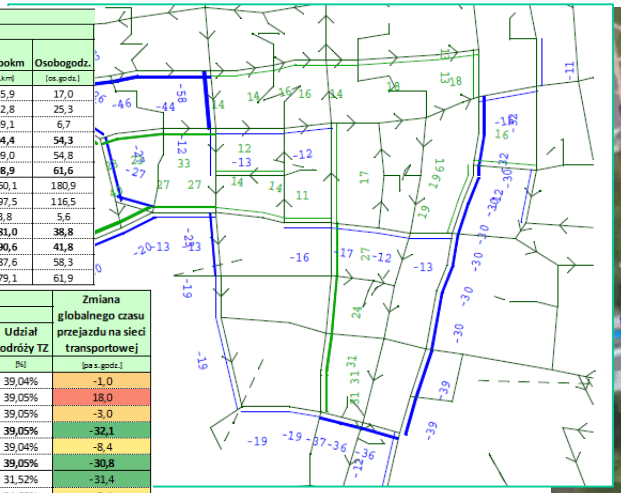
Nazwa ciągu	Kierunek	Szczyt (okres obarzonych największych strat czasu)	ODCINEK			
			Paskm [pas.km]	Pasgodz [pas.godz.]	Osobokm [os.km]	Osobogodz. [os.godz.]
10 Lutego	kier. Dworzec Główny	popołudniowy	129,6	7,2	335,9	17,0
10 Lutego	kier. Skwer Kościuszki	popołudniowy	277,6	22,3	322,8	25,3
3 Maja	kier. ul. Armii Krajowej	popołudniowy	134,7	3,6	159,1	6,7
Kielecka	**kier. Witomino**	**popołudniowy**	**1016,4**	**28,8**	**904,4**	**54,3**
Kielecka	kier. Wzgórze Św, Maksymiliana	popołudniowy	847,1	52,9	909,0	54,8
Morska 1	**kier. Chylonia**	**popołudniowy**	**678,4**	**33,1**	**998,9**	**61,6**
Morska 2	kier. Śródmieście	poranny	2170,5	113,7	3460,1	180,9
Morska 3	kier. Śródmieście	poranny	2657,4	93,6	2997,5	116,5
Wójta Radtkego	kier. Plac Kaszubski	popołudniowy	224,7	16,9	83,8	5,6
Władysława IV	**kier. Wzgórze Św, Maksymiliana**	**popołudniowy**	**1328,1**	**51,8**	**1181,0**	**38,8**
Władysława IV	**kier. Śródmieście**	**popołudniowy**	**1168,7**	**44,6**	**1290,6**	**41,8**
al. Zwycięstwa	kier. Wzgórze Św, Maksymiliana	popołudniowy	2395,7	77,6	2087,6	58,3
al. Zwycięstwa	kier. Ul. Wielkopolska	popołudniowy	2408,8	94,3	2179,1	61,9

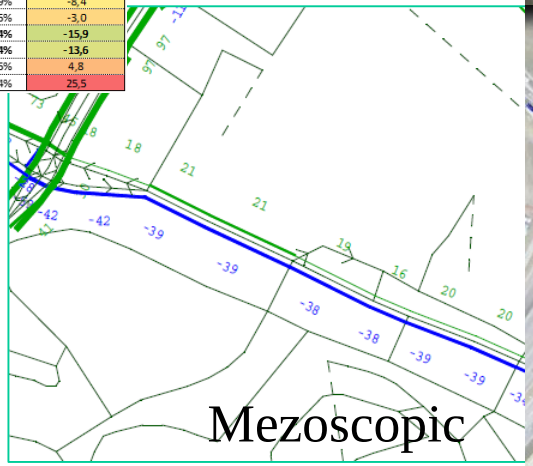
Nazwa ciągu	Kierunek	SIEĆ				Zmiana globalnego czasu przejazdu na sieci transportowej
		Praca przewozowa [pas.km]	Globalny czas [pas.godz.]	Średnia prędkość [km/h]	Udział podróży TZ [%]	[pas.godz.]
10 Lutego	kier. Dworzec Główny	485228,6	17820,4	27,23	39,04%	-1,0
10 Lutego	kier. Skwer Kościuszki	485273,2	17839,4	27,20	39,05%	18,0
3 Maja	kier. ul. Armii Krajowej	485185,6	17818,4	27,23	39,05%	-3,0
Kielecka	**kier. Witomino**	**485277,0**	**17789,3**	**27,28**	**39,05%**	**-32,1**
Kielecka	kier. Wzgórze Św, Maksymiliana	485173,7	17813,0	27,24	39,04%	-8,4
Morska 1	**kier. Chylonia**	**485055,2**	**17790,6**	**27,26**	**39,05%**	**-30,8**
Morska 2	kier. Śródmieście	414300,9	13685,1	30,27	31,52%	-31,4
Morska 3	kier. Śródmieście	414327,4	13708,2	30,22	34,69%	-8,4
Wójta Radtkego	kier. Plac Kaszubski	485196,4	17818,4	27,23	39,05%	-3,0
Władysława IV	**kier. Wzgórze Św, Maksymiliana**	**485245,0**	**17805,5**	**27,25**	**39,04%**	**-15,9**
Władysława IV	**kier. Śródmieście**	**485268,4**	**17807,8**	**27,25**	**39,04%**	**-13,6**
al. Zwycięstwa	kier. Wzgórze Św, Maksymiliana	485615,3	17826,2	27,24	39,05%	4,8
al. Zwycięstwa	kier. Ul. Wielkopolska	485708,2	17846,9	27,22	39,04%	25,5



Macroscopic

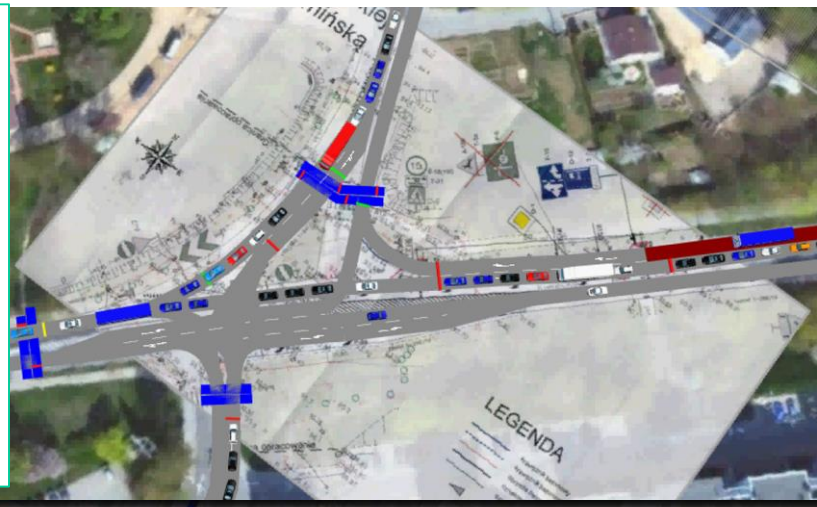
Tactical level (SATURN)

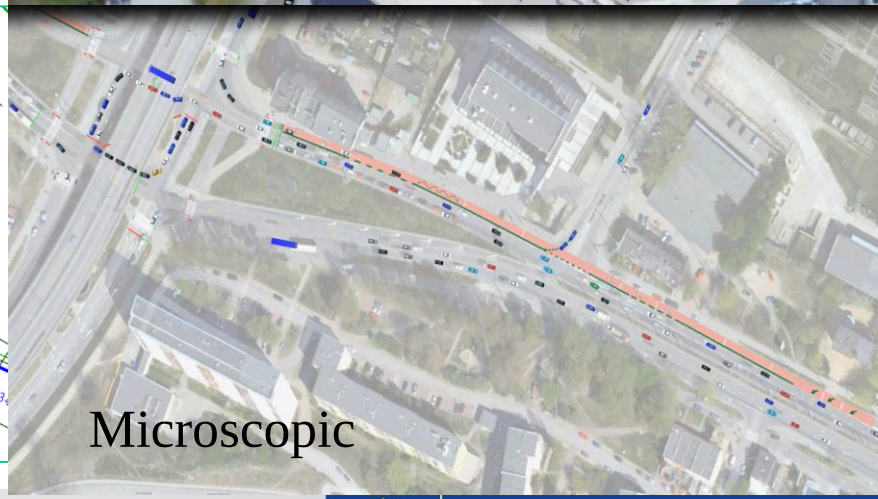




Mezoscopic

Operational level (VISSIM)





Microscopic

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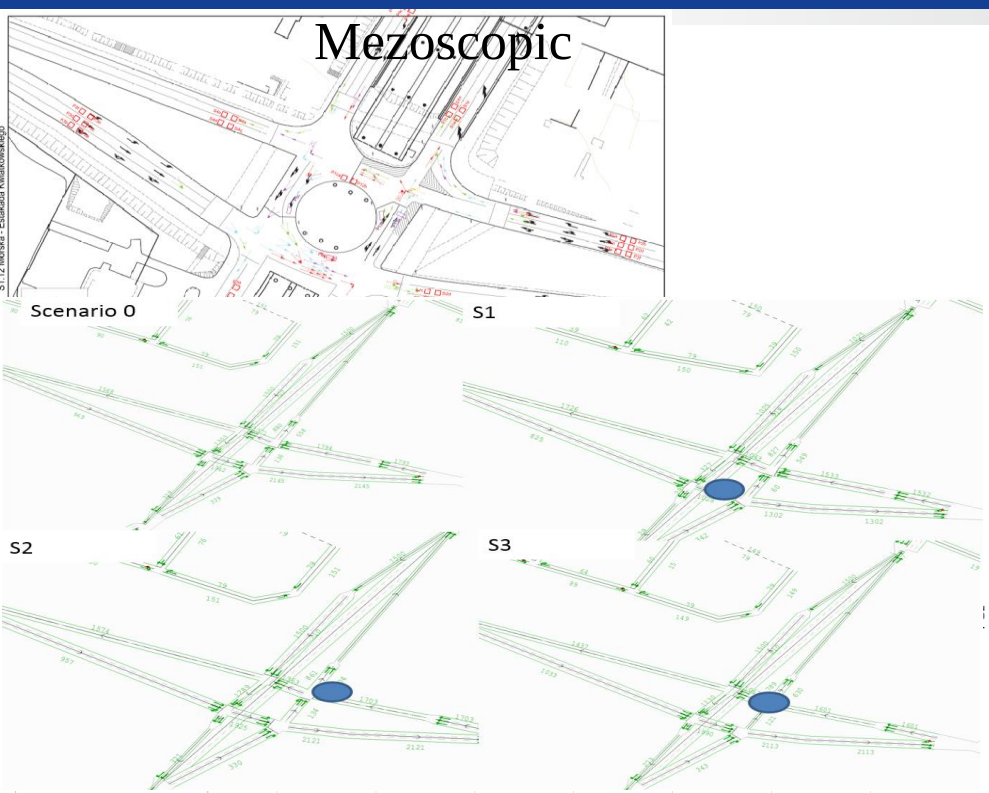
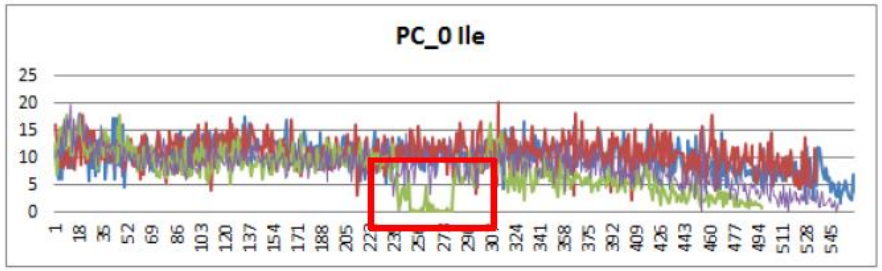
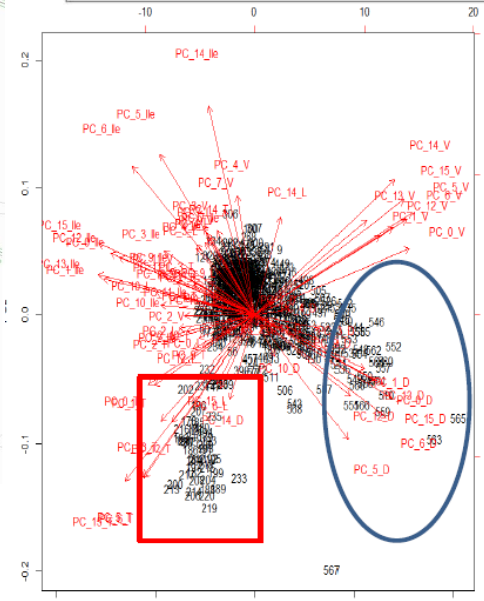
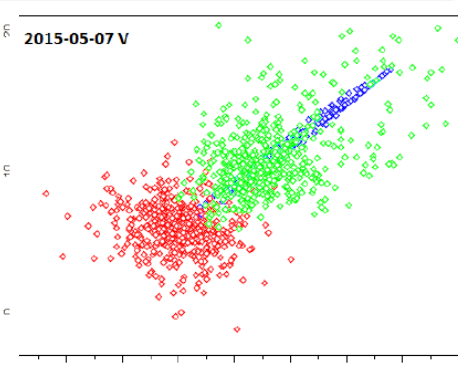
Automatic Incident Detection

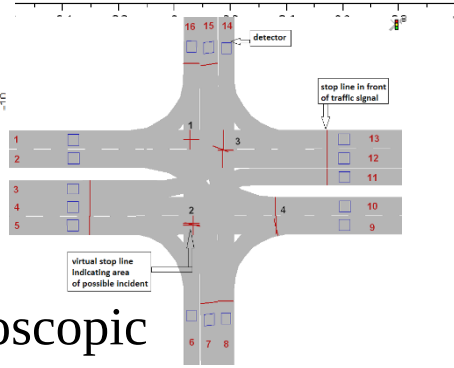
Mezoscopic











Microscopic

Popołudniowy - Kwiatkowskiego-Morska							
	WARIANT 0	WARIANT 1s1	WARIANT 1s2	WARIANT 1s3	WARIANT 2s1	WARIANT 2s2	WARIANT 2s3
Sumaryczny czas podróży w siec	6267,6	6664,5	6723,6	6117	6051,8	5975,1	6282,1
Praca przewozowa	240353,2	237671,2	236521,4	241010	241132	241967,3	239395,9
Średnia prędkość	38,3	35,7	35,2	39,4	39,8	40,5	38,1
Liczba zatrzymań	226373,9	202603,9	233580,4	222081,9	223235,2	221407,5	223935,7
Zużycie paliwa	22163,5	22425,5	22649,7	22059,6	21981,7	21915	22225,6
Emisja tlenku węgla (CO)	2093,87	2154,59	2186,39	2070,83	2051,93	2034,64	2099,79
Emisja dwutlenku węgla (CO2)	22172,8	22439,11	22662,21	22064,32	21989,26	21921,28	22234,6
Emisja tlenków azotu (Nox)	532,71	527,47	530,36	532,9	529,94	529,5	529,6
Emisja węglowodorów (HC)	379,96	389,72	395,13	376,13	372,82	369,93	380,73
Wariant 0 – brak zdarzenia drogowego							
Wariant 1 – wystąpienie zdarzenia (wg. scenariusza), brak modułu zarządzania incydentami							
Wariant 2 – wystąpienie zdarzenia (wg. scenariusza), istnieje moduł wykrywania zdarzeń i informacji							

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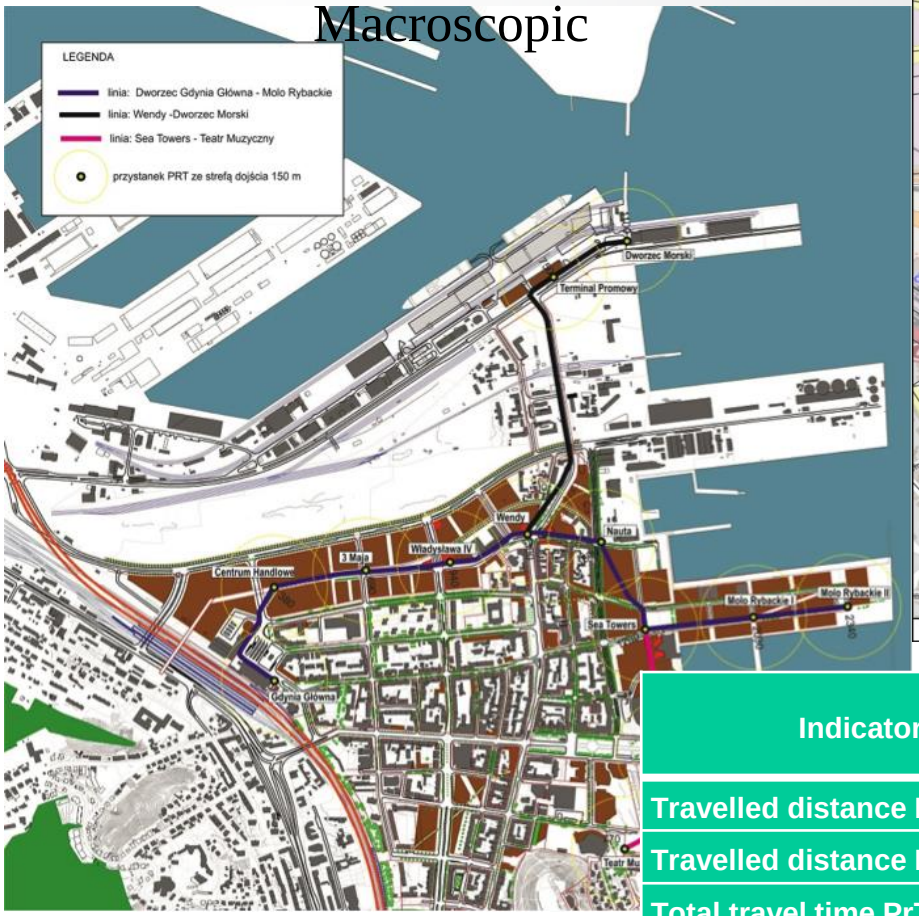
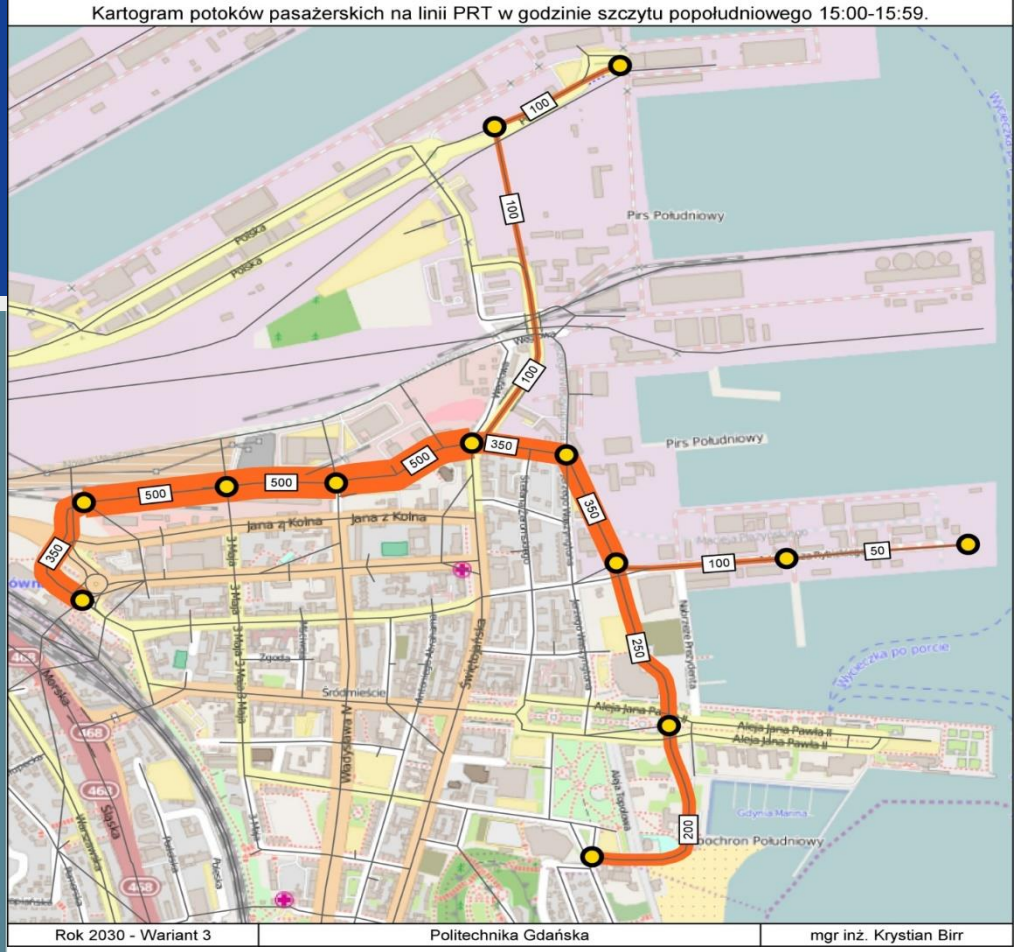
Personal Rapid Transit

Macroscopic

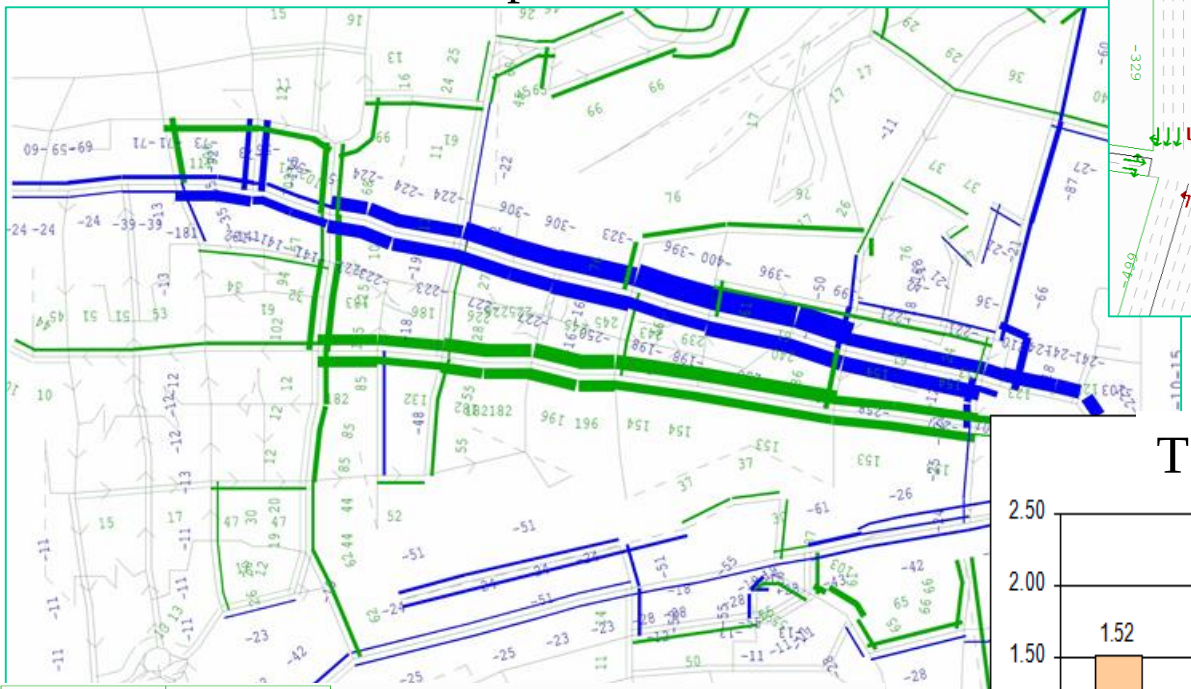


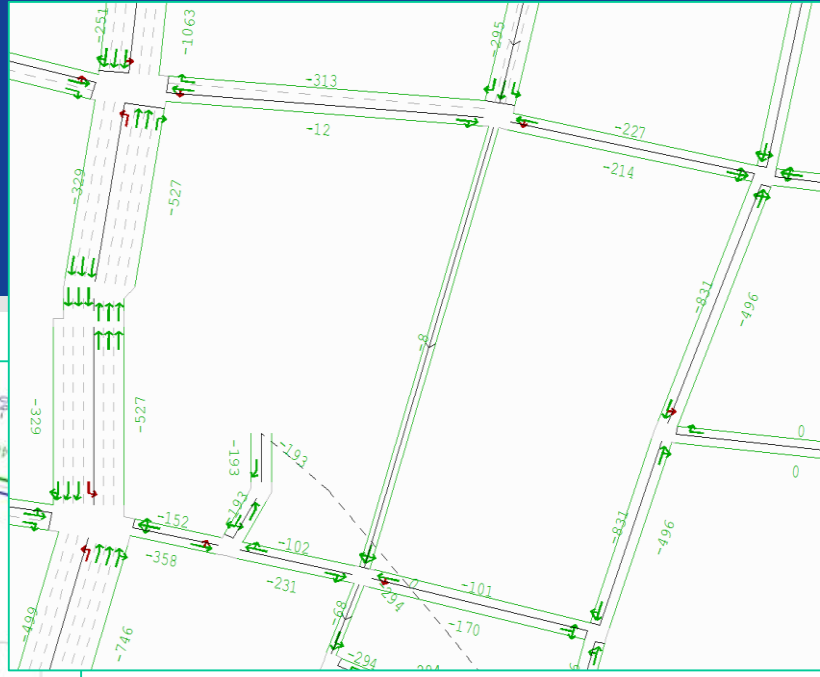


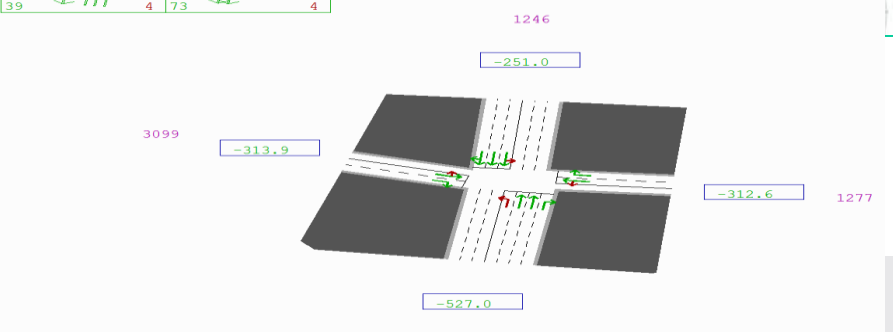
Indicator		Scenario			
		W0	W1	W2	W3
Travelled distance PrT	[poj.km]	6671,4	6673,4	6667,1	6661,8
Travelled distance PT	[pas.km]	8091	8807	8820	9395
Total travel time PrT	[h]	180,87	180,91	180,73	180,56
Total Travel Time PT	[h]	1030,13	1043,45	1028,08	1045,80
Average speed PrT	[km/h]	36,884	36,887	36,890	36,896
Average speed PT	[km/h]	7,85	8,44	8,58	8,98

Change of traffic organization

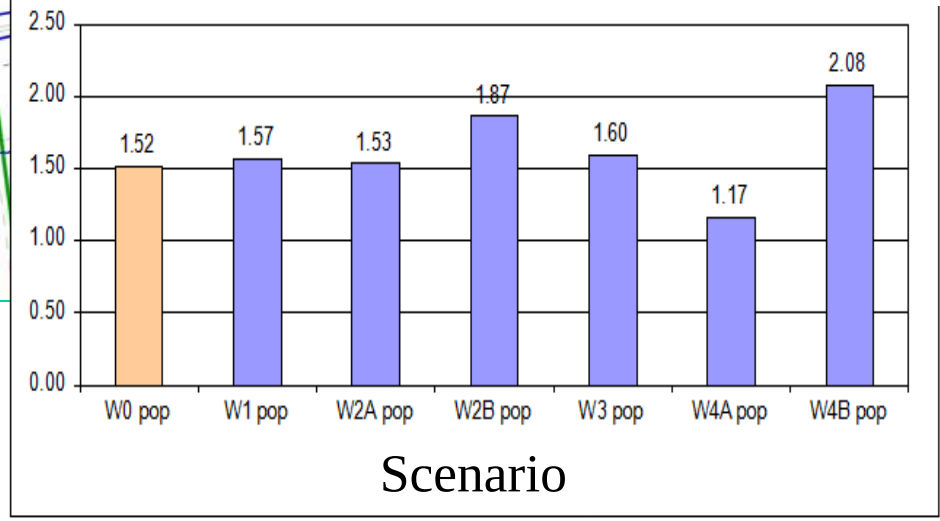
Mezoscopic







Total travel time [mln. hours/year]



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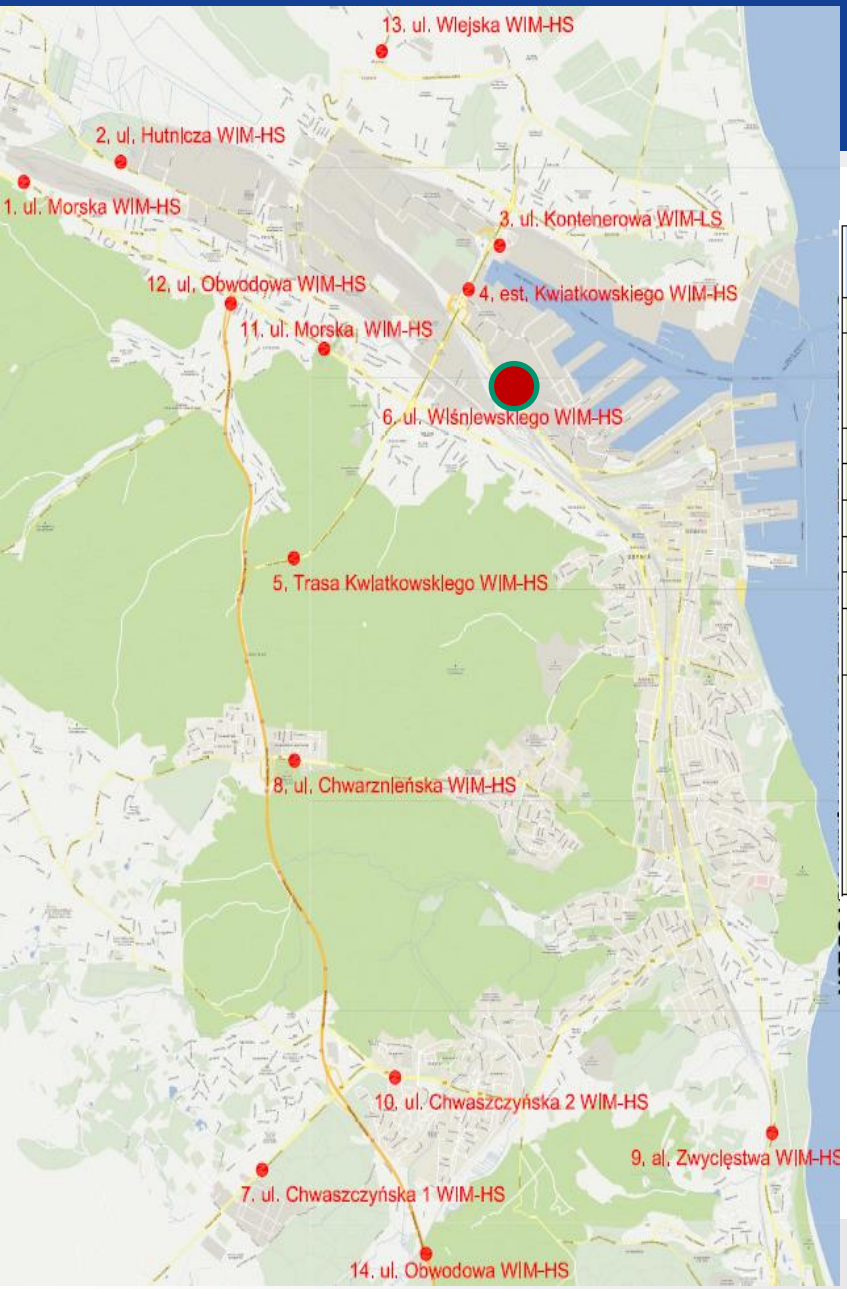
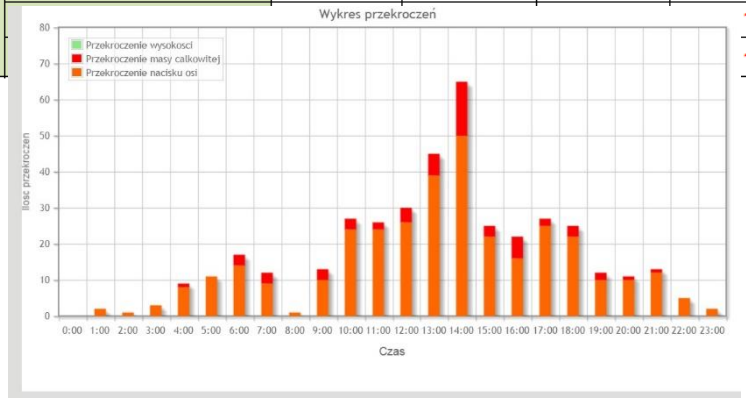
Weigh in motion (WIM)



Mezoscopic

Parametr		Scenariusz				
		S0	S1	S2	S3	S4
Kolejki na wlotach		799,5	797,1	996,2	796,0	1237,4
Kolejki pozostające na wlotach, wynikające z przekroczenia przepustowości		605,6	446,4	2243,9	521,7	3814,2
Całkowity czas podróży		5511,7	5349,5	7994,4	5409,5	10322,1
Średnia prędkość		40,8	41,6	32,5	41,4	27,6
Praca przewozowa		225007,6	222305,2	259856,9	224124,3	285367,5
Liczba odbytych podróży		31951,9	31553,3	37396,1	31784,7	42332,7
Wskaźnik zużycia paliwa		19790,6	19574,6	25560,2	19796,7	26009,4
Liczba zatrzymań pojazdów w przeciągu jednej godziny		141087,9	176569,0	254733,2	176482,7	293254,3
zanieczyszczenia	CO	1834,43	1819,05	2504,30	1828,96	2643,60
	CO2	19797,35	19580,00	25575,53	19801,52	26039,87
	NOX	486,09	488,40	582,50	487,26	584,03
	HC	334,16	331,72	451,09	333,29	598,71
					1,96	3,34
					1,96	3,34



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Thank you!

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