Brussels Studies
La revue scientifique pour les recherches sur Bruxelles / Het wetenschappelijk tijdschrift voor onderzoek over Brussel / The Journal of Research on Brussels
Collection générale | 2008

The (in)efficiency of trams and buses in Brussels: a fine geographical analysis

L'(in)efficacité des trams et bus à Bruxelles : une analyse désagrégée

(In)Efficiëntie van de trams en bussen in Brussel: een geografisch uitgesplitste analyse

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Electronic version
URL: http://journals.openedition.org/brussels/608
DOI: 10.4000/brussels.608
ISSN: 2031-0293

Publisher
Université Saint-Louis Bruxelles

Electronic reference
Xavier Courtois and Frédéric Dobruszkes, « The (in)efficiency of trams and buses in Brussels: a fine geographical analysis », *Brussels Studies* [Online], General collection, no 20, Online since 27 June 2008, connection on 03 July 2020. URL : http://journals.openedition.org/brussels/608 ; DOI : https://doi.org/10.4000/brussels.608

BRUSSELS STUDIES the e-journal for academic research on Brussels

www.brusselsstudies.be Issue 20, 27 June 2008

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The (in)efficiency of trams and buses in Brussels: a fine geographical analysis

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Summary

At a time when mobility in Brussels is becoming increasingly critical from the standpoints of the environment and efficiency, this article gives a detailed and exhaustive analysis of the geography of traffic conditions affecting the trams and buses of Brussels' main mass transit network. The finely disaggregated data that we were able to obtain from the Brussels Interborough Transport Company (STIB/MIVB) enabled us to calculate and map three indicators (commercial speed, irregularity, and lost time) that make it possible to identify the network's problem spots. The figures show that, in the current state of affairs, fewer than a third of the city's tram line segments meet the commercial speed performance levels that they are expected to achieve under STIB/MIVB's new management contract. The problem spots, which are found primarily but not solely in the first urban ring (from Saint-Gilles to Schaerbeek, via Ixelles), stem basically from a mixture of roads and public areas that are narrow and/or heavily used by cars, inappropriate traffic light management, and political stalemates that make it impossible to get around the first three factors. In this framework, the regional mobility and sustainable development plans can scarcely be achieved.

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They published "De l'intérêt des SAE pour l'analyse géographique des performances du transport collectif : aspects méthodologiques et application à Bruxelles", Recherche, Transports et Sécurité *98, pp. 39-51.*

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Brussels Studies is published thanks to the support of the ISRIB (Institute for the encouragement of Scientific Research and Innovation of Brussels - Brussels-Capital Region)

Introduction

The Brussels-Capital Region's announced urban transport and environment objective is to reduce automobile pressure by means of a modal shift to mass transit and, more marginally, the bicycle and walking. The Region's latest estimates show that if the current trend continues, the situation in 2015 will be catastrophic: a huge increase in automobile traffic and congestion, the consequences of which will include a 33% increase in vehicle fuel consumption and thus exacerbated environmental problems (MRBC-AED, 2006).

The first regional mobility plan (Iris Plan), which was adopted in 1998, set out to reduce the automobile's market share from 65% in 1991 to 58% in 2005 for the area corresponding to Brussels and its outskirts (Brussels-Capital Region, 1999)[1]. This objective was not achieved. However, meanwhile the Regional Development Plan (PRD in French) set the objective of a 20% reduction in automobile traffic in Brussels[2] from the 1999 level by 2010 in order to comply with its Kyoto Protocol obligations (Brussels-Capital Region, 2002). This gave rise to a second Regional Mobility Plan, which is in the process of being finalised and has more determined modal shift objectives to the detriment of the car's share in the transport market.

To achieve such a goal, it is known today that improving mass transit alone, however necessary this may be, is not enough (Kaufmann, 2000). It is effectively necessary to adopt a set of measures aimed at improving mass transit's efficiency and dissuading automobile traffic. The latter is achieved by acting upon the amenities that are offered (road capacity and parking possibilities at the destinations) and incentives that dissuade individuals from using mass transit (company cars being the primary culprit). It is also necessary to take measures to limit urban sprawl and not overlook the impact of the chains of trips, in which a single "subtrip" can suffice to make the use of the car preferable or practically unavoidable.

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[1] The market share of mass transport was supposed to rise from 34 to 38% and that of the bicycle from 1 to 4%. These market shares were computed from the number of trips taken.

[2] Measured in vehicle-km.

Be that as it may, improving mass transit's efficiency, even if it is not sufficient, must remain a priority, for it affects both the attractiveness of mass transport and the productivity of its operation. Slower commercial speeds will effectively force the operators to inject more vehicles into the network solely to guarantee the same level of supply. This increases their costs considerably and is a waste of money at a time when regional finances are limited. The regional plans have systematically put forward improving the efficiency and regularity of mass transport as one of their priorities, and this was effectively recently reconfirmed by the new 2007-2011 management contract between STIB/MIVB [3]and the regional authorities (STIB/MIVB, 2007a). Yet the average commercial speed of mass transport in Brussels is low. To mention only the trams, their average commercial speed is 17 km/hr during the week (15.9 km/hr during peak hours and 19.4 km/hr in the evening). In comparison, Strasbourg's trams post an average of 21.4 km/hr in a city where the trams run in part in semi-pedestrian areas at slower speeds [4].

Given this state of affairs, it is worthwhile analysing the city's mass transport networks in order to determine exhaustively and rigorously the places that pose problems and require priority intervention. Dobruszkes and Fourneau (2007) have already presented such an analysis, but from a geographic standpoint it concerned the tram network only, whilst the data were from 1999. Yet traffic conditions in Brussels have continued to deteriorate, whilst 55% of the trips made by the STIB/MIVB network correspond to the surface network (STIB/MIVB, 2007b). That being so, the aim of this article is to propose a quantitatively and geographically exhaustive analysis of the efficiency of STIB/MIVB's tram and bus network, given that this company is the main mass transport operator in Brussels, using recent data. The originality of our research has to do in particular with the detailed scale of analysis, since we shall work on the segments between stops.

The rest of this article is organised as follows: We shall first present the methodological aspects of our research (data used and efficiency measurements). Then we shall examine the tram and bus networks in the light of three indicators to document the main causes of their poor performances. We shall wrap up the article with our conclusions.

[3] Brussels interborough transport company.

[4] Source: The transport companies' annual reports.

Methodological aspects

Data used and pre-processing

Our analyses were based fundamentally on the data that STIB/MIVB collects through its operating aid system (OAS). This system was implemented for its bus lines in the 1980s and then extended to the trams more recently in order to be able to follow the vehicles' progress in real time and take action if problems arose[5]. To the extent that the OAS keeps a constant log of a certain number of types of information, including segment travel times, it "suffices" to recover these data and process them to be able to perform detailed analyses of the trams and buses performances. The approach that we took involved two inputs, as follows: The raw data were extracted from the OAS[6] and pre-processed to be regrouped by 15, 30, or 60 minute periods, and then they were regrouped in a single database. This then made it possible to generate requests providing the indicators defined below for all the segments in the network. In addition, digitising the STIB/MIVB network completely and assigning the STIB/MIVB's standard code to each segment[7] (geocoding) enabled us to connect the data with their segments for mapping and analysis. For a more extensive discussion of this, see Dobruszkes and Courtois, 2008.

The data that we used refer to all the segments between stops that were covered by the operator's trams and buses during the week from 6 a.m. to 11 p.m. from 15 September to 13 October 2006, inclusive. This period was sufficiently extensive to avoid atypical situations. In addition, we excluded the 5% of extreme travel times (minima and maxima) that often corresponded to unusual situations (vehicle breakdowns, driver absent or late when s/he theoretically should have clocked in, one-off work done at the start or end of the day, and so on).

Three measures of (in)efficiency

The literature, operators, and authorities that organise transport usually define a certain number of indicators that enable one to analyse a network's efficiency (for a large range of them, see UITP, 2006). We defined three such indicators for our purposes. They relate to both the operator's and the passengers' interests. So, we added to the classical measurement of commercial speed that of irregularity of service and time lost by the vehicles. Together, these three indicators give complementary information about the network's performances on the segment level.

Commercial speed

Commercial speed simply gives one an idea of the network's performance through the speed at which a trip may be made. For the passenger, it contributes to the total time of her/his trip. For the operator – and municipality that finances the service – the commercial speed has a direct impact on the number of vehicles to put on line

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[5] STIB/MIVB's regulators can, for example, inject an additional vehicle into the flow to offset a "gap" in service. If two trams or buses follow on each other's heels, they can force one of them to turn around before reaching the end of the line in order to limit the consequences of such bunching on the other direction.

[6] Segment by segment, line by line, in first one and then the other direction.

[7] An eight-digit code composed of the upstream and downstream stops' codes.

to the extent that this figure is directly linked to the route travel time and frequency of service.

Irregularity over a given period

The segment travel times vary greatly over time. Beyond the peak and off-peak performance differences, one must also consider the variations over a given period, for example, the morning rush hour.

For the operator, the variability of travel time for a given period makes it more difficult to draw up the timetables. This variability strains relations between management and the drivers as well as between the drivers and their passengers[8]. The timetables are based on mean travel times, with the risk that vehicles will go by early or late. What is more, the known risk of delays requires scheduling more buffer time at the end of the line, which means putting more vehicles on the road, with the attendant increase in operating costs. For the passengers, the uncertainty of travel times means that they have to allow greater safety margins for all trips that require that they reach their destination at a specific time.

The irregularity of travel times is easy to detect through their standard deviations for a given period. However, the standard deviation is linked to the travel time itself, as segments that are characterised by high travel times more often have high standard deviations. To avoid such skewing, we looked each time at the ratio of the standard deviation of each segment's travel time over the segment's mean travel time.

Time lost by the vehicles in a day

As soon as the commercial speed fluctuates, one can assume that the deterioration in the travel time compared with the periods of maximum fluidity[9] (early in the morning or late at night) entails a time loss for the vehicles. This time loss can be calculated from the difference between the travel time at each period of the day and a fluid reference period (in our case, from 9 to 10 p.m.[10]), multiplied by the number of passes on the line.

From an economic and political standpoint, calculating the time lost at peak hours lets you deduce immediately the addition number of vehicles that must be sent out onto the road solely to make up for the slower commercial speed. This surplus can then be turned into a monetary value through the investment and operating costs to which it gives rise (Dobruszkes and Fourneau, 2007).

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[8] The drivers complain that the delays limit their rest times at the ends of the lines and make their passengers, who are upset by the delays, aggressive. Some of the latter effectively take out their irritation on the drivers as the ones who are supposedly responsible for the delays or as the company's sole visible representatives.

[9] It should be pointed out that the maximum fluidity is not necessarily the optimal fluidity, for even during the corresponding period mass transport can be slowed down by inappropriately timed traffic lights, rubbish collection, passengers who are not regulars and thus get on without tickets or passes, etc.

[10] One could consider a later reference period, say, from 10 to 11 p.m., but one must ensure that all the lines are still running. In the case of Brussels, the hour from 9 to 10 p.m. seems to be a good compromise between a fluid situation and the number of lines still operated. In the case of lines that do not run at night, 6 to 7 a.m. can be taken as a reference.

From an analytical and operational standpoint, fine mapping of the time losses, for example the time lost on an average day, lets one identify the segments that require more urgent action to improve the network's efficiency and operator's productivity and thus the efficient spending of public monies. Seen in this light, the indication of the time lost by all of the vehicles that run along a given segment each day complements the measurement of commercial speed most usefully, for it enables one to allow better for the volume of the supply that is concerned.

A fine analysis of the STIB/MIVB network's efficiency

General overview on the network and 24-hour scale

Figure 1 shows how great the variations in commercial speed (Y axis on the left) and irregularity of service (Y axis on the right) are in the course of a day. It is easy to pick out the morning and evening peak hours on this graph. We can see a parallel between the drop in commercial speed and increase in irregularity, which complicates

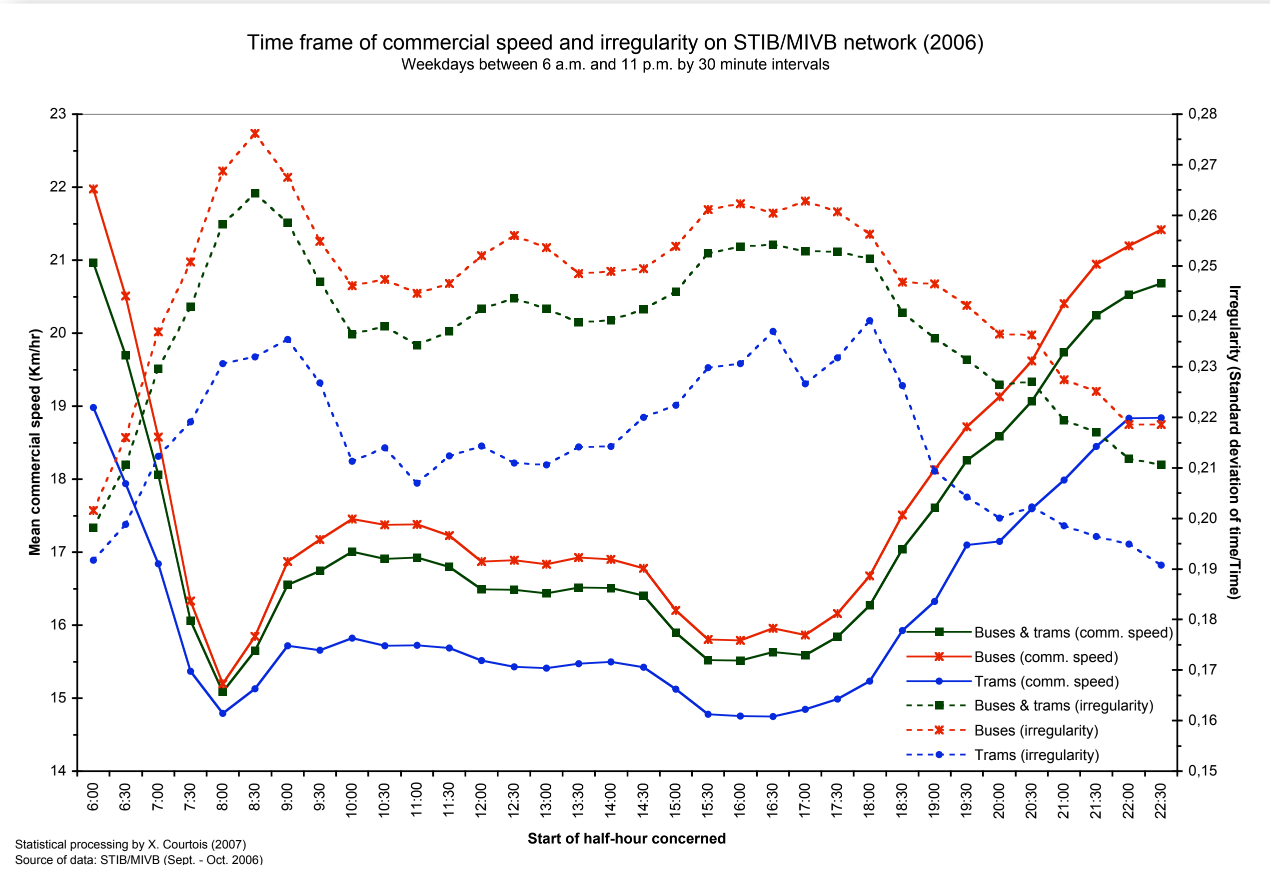


Figure 1

the operator's job even more. We also see that the trams' commercial speeds are consistently lower, on average, than those of the buses, and this is the case despite the many segregated tracks and sections that go through tunnels. The trams' irregularity, on the other hand, is of less importance than that of the buses, according to the figures posted by the bus network[11]. As we might expect, the best performances are posted early in the morning and late in the evening, that is, when the road traffic is more fluid due to a markedly smaller number of automobiles on the road.

So as not to swamp the reader with facts and figures, we shall limit the presentation of our findings to those for the morning rush hour, which appears to be even more problematic than the evening rush hour, and the whole-day cumulative analysis.

Analysis of commercial speed

Figure 2 shows the tram and bus line segments' rankings by commercial speed. We see first of all the large number of segments that are covered at very low commercial

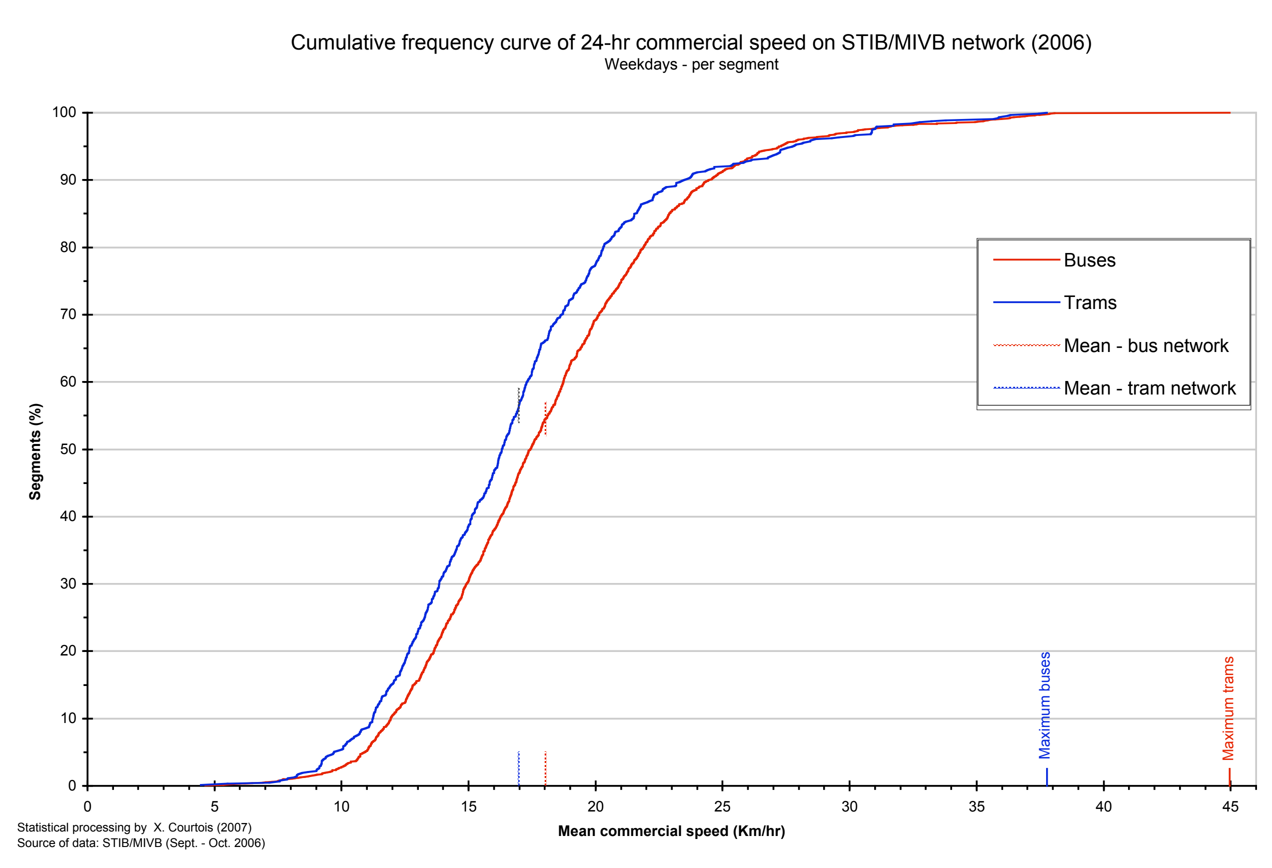


Figure 2

[11] Which is not necessarily reassuring, for this may simply mean that the commercial speeds for a number of segments are constantly poor.

speeds: More than 10% of them are covered at speeds that are slower than can be achieved on a bicycle (10-15 km/hr). Second we see the difference between the two modes, i.e., trams and buses: For the same percentage of segments considered, the trams run at lower commercial speeds. Finally, we see a difference between the mean and median speeds for each of the networks: The means of both networks are raised by a minority of segments with much better performances.

The objectives set out in the new management contract for 2007-2011 include placing large proportions of the tram and bus networks on segregated tracks or in dedicated lanes, respectively: 90% and 40%, respectively, versus 60% and 10% at the end of 2005 (STIB/MIVB, 2007a). The aim of this measure is obviously to increase the vehicles' commercial speeds significantly, to at least 20 km/hr for the lines with priority ranking[12] and 18 km/hr for the other lines. When it comes to the priority lines, the aim is "to achieve performance levels comparable with those of Europe's most efficient networks". Figure 2 shows how much catching up there is to do, for less than a third of the tramline segments post such performance levels.

Figure 3 presents the geography of these commercial speeds for the entire STIB/MIVB network. Please note that for each of these maps we opted for symbols that would show up the problem segments.

In the centre of Brussels both the trams and buses generally run at the network's mean commercial speed. This is due to the impacts of a few separate rights of way or lanes reserved for buses that have been created in recent years and the premetro tunnel. However, the network's mean is hardly a satisfying reference, for it itself is too low. Moreover, it is sometimes difficult to cross the boulevards of the inner beltway. The trouble spots are, however, over-represented in Brussels's first ring, where narrow streets and dense road traffic form a combination that is detrimental to the commercial speed of mass transport when the latter is mixed with the general traffic almost everywhere it runs. The entire area from the south to the north-east of the central pentagon, from Saint-Gilles/Sint-Gillis to the borough of Schaerbeek/Schaarbeek, with Ixelles/Elsene and the European quarter in between, is thus characterised by poor commercial speeds. The other neighbourhoods surrounding the central pentagon are hardly better off, even though the commercial speeds there are not as systematically bad.

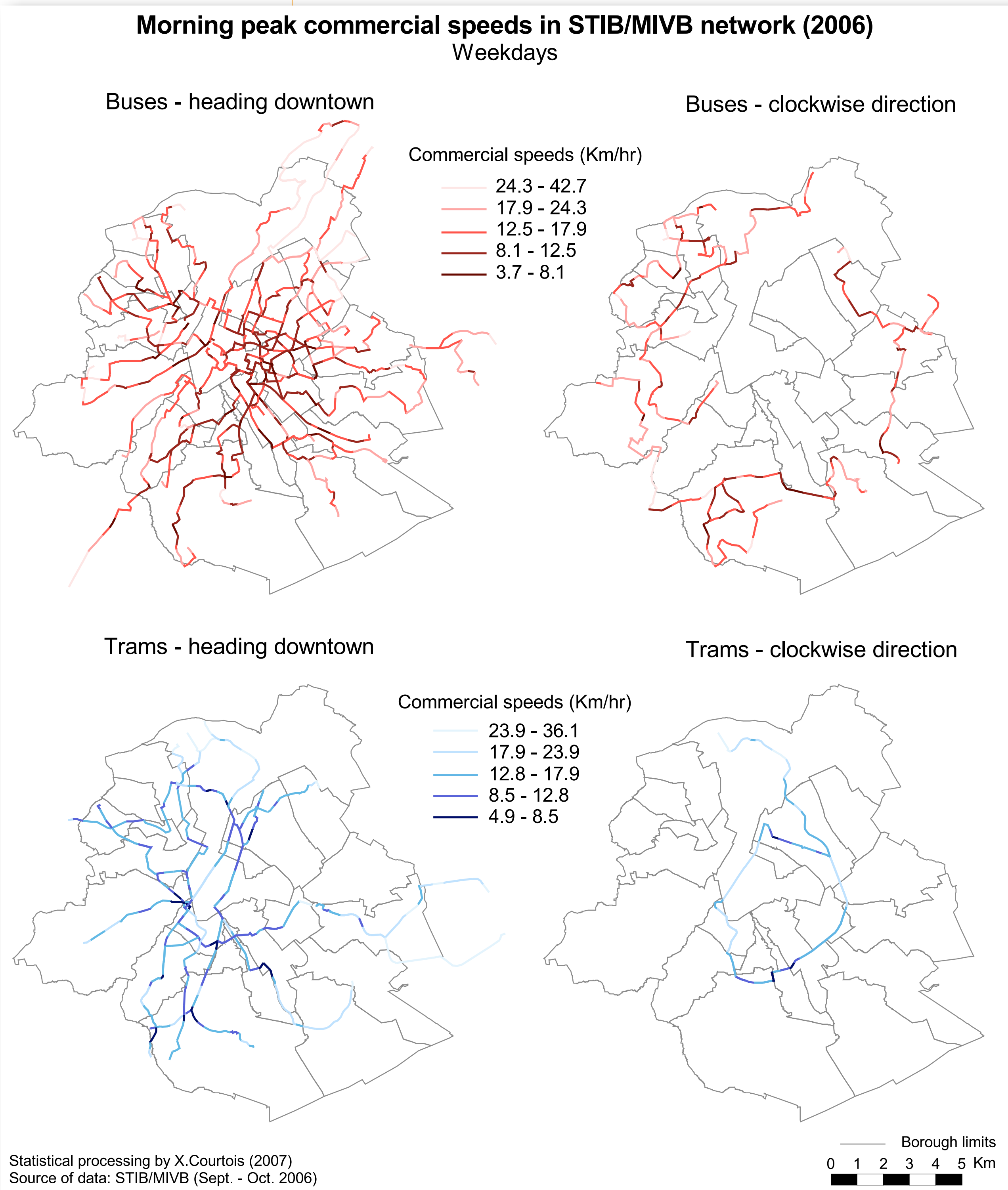
We find a certain number of trouble spots with longstanding reputations in the second ring of Brussels and the city's outskirts, i.e., the edges of the wooded park (Bois de la Cambre/Ter Kameren Bos)[13] and Solbosch Campus, chaussée d'Alsemberg/Alsembergse Steenweg, avenue Charles-Quint/Keizer Karellaan, and so on, especially when it comes to the lines that encircle the city. However, overall, the situation is less disastrous than in the first ring.

Finally, we see that the majority of higher commercial speeds in the tram network are posted on the segments that run on tracks that are truly separated from the automobile traffic, whether by tunnels (premetro segments) or on segregated tracks that are truly independent from the lanes for cars (boulevards of the greater beltway,

[12] Trams of the outer circle, Louise-Souverain trams, North-South premetro lines, and eight bus lines.

[13] Situation recently improved by a new route in the southern part of the wood.

Figure 3


Morning peak commercial speeds in STIB/MIVB network (2006)
Weekdays
Buses - heading downtown
Buses - clockwise direction
Commercial speeds (Km/hr)
24.3 - 42.7
17.9 - 24.3
12.5 - 17.9
8.1 - 12.5
3.7 - 8.1
Trams - heading downtown
Trams - clockwise direction
Commercial speeds (Km/hr)
23.9 - 36.1
17.9 - 23.9
12.8 - 17.9
8.5 - 12.8
4.9 - 8.5
Borough limits
0 1 2 3 4 5 Km
Statistical processing by X.Courtois (2007)
Source of data: STIB/MIVB (Sept. - Oct. 2006)

Quai des Usines/Werkhuizenkaai, Avenue de Tervuren/Tervurenlaan, boulevard du Souverain/Vorstlaan, etc.).

Analysis of irregularity

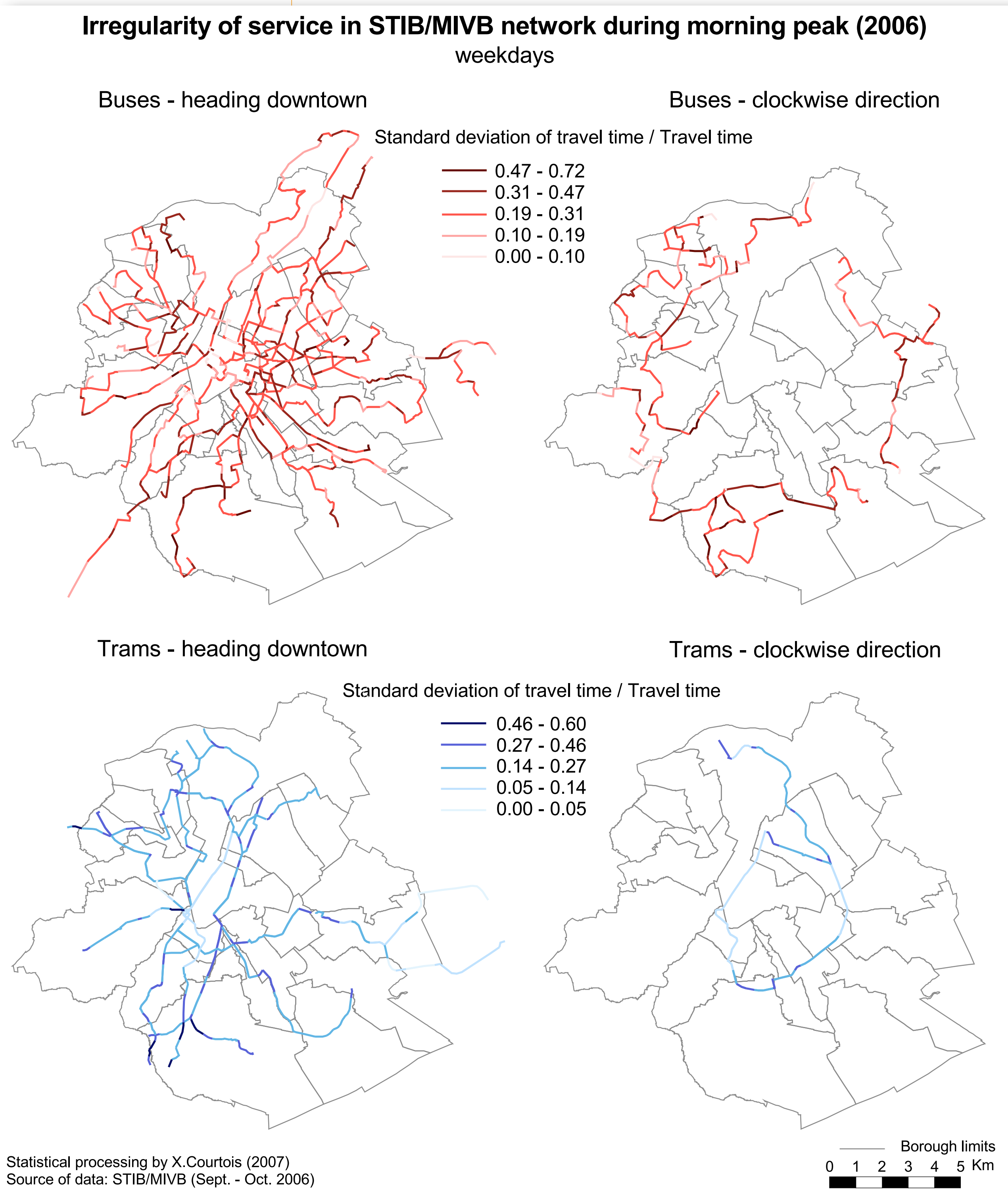
As Figure 4 shows, the geography of irregularity during the morning peak hours is not identical to that of commercial speed. This time, the area inside the central pentagon exhibits the best values of the mapped indicator. Whilst the automobile traffic in downtown Brussels does not necessarily enable the buses and trams to escape low commercial speeds, the traffic is sufficiently constant to limit the irregularity of service. It would seem that the traffic lights on the inner beltway's boulevards let a steady stream of cars into the central area, a stream which is in turn fed by the long queues that form on the major thoroughfares that converge on the centre. The tram network's situation is somewhat special in that half of the segments in downtown Brussels are in tunnels (the North-South axis), where internal signalling regulates the high traffic that goes through them.

The first ring is characterised by significant irregularities. Given the context of very dense automobile traffic, the absence of expressways between the inner and outer beltways leads to the dissemination of a large number of vehicles in many streets that are narrow to boot. The alternate or "overflow" transit routes taken by drivers trying to avoid the major thoroughfares (and thereby causing local interference) are variable itineraries that consequently have unpredictable effects on the traffic conditions in which STIB/MIVB's buses and trams must navigate.

However, the regularity of service has deteriorated most in the city's second ring. The most worrisome spots concern narrow roads similar to those of the dense first ring and/or major arteries for incoming traffic (Avenue De Fré/De Fré Laan, Boulevard Industriel/Industrielaan, Chaussée d'Alsemberg/Alsembergse Steenweg, Chaussée de Wavre/Waverse Steenweg, etc.). We must also draw attention to the large amount of overflow transit traffic that wends its way around more local streets, although these streets are still used by mass transport, especially in Uccle.

Finally, we must mention the unsatisfactory regularity of service of the trams that run on their own rights of way (Avenue Louise/Louizalaan, Boulevards of the outer beltway, and Boulevard du Souverain/Vorstlaan), which is markedly poorer than that of the underground tram lines, thereby attesting to the current scheme's perfectibility. We shall come back to this later.

Figure 4


Irregularity of service in STIB/MIVB network during morning peak (2006)
weekdays
Buses - heading downtown
Buses - clockwise direction
Standard deviation of travel time / Travel time
0.47 - 0.72
0.31 - 0.47
0.19 - 0.31
0.10 - 0.19
0.00 - 0.10
Trams - heading downtown
Trams - clockwise direction
Standard deviation of travel time / Travel time
0.46 - 0.60
0.27 - 0.46
0.14 - 0.27
0.05 - 0.14
0.00 - 0.05
Borough limits
0 1 2 3 4 5 Km
Statistical processing by X.Courtois (2007)
Source of data: STIB/MIVB (Sept. - Oct. 2006)

Analysis of time losses

Figure 5 shows the amounts of time lost on the bus and tram networks at the end of a day calculated from the differences in travel times compared with the fluid situation observed between 9 and 10 p.m. This map pinpoints the worst trouble spots directly, i.e., spots that are marked by a serious deterioration in travel time and/or a very high number of passes.

Seen from this point of view, Ixelles/Elsene exhibits the points of greatest concern, namely, Chaussée d'Ixelles/Elsense Steenweg, the Buyl-Bois de la Cambre/Ter Kamarenbos segment, Couronne/Kroon-Trône/Troon-Idalie-Luxembourg segment, Bailli-Lesbroussart segment, Chaussée de Vleurgat/Vleurgatse Steenweg, etc.). The situation in Uccle/Ukkel also raises questions, especially Chaussée de Waterloo/Waterloose Steenweg, Chaussée d'Alsemberg/Alsembergse Steenweg, and Avenue De Fré/De Frélaan. The side streets around Montgomery traffic circle are a catastrophe for the buses, as are the narrow streets of the borough of Saint-Josse/Sint-Jos. In Saint-Gilles/Sint-Gillis, the trams that run aboveground are penalised everywhere, especially Chaussée de Charleroi/Charleroise Steenweg and Avenue Fonsny/Fonsnylaan, despite the fact that they were recently redone. In the central pentagon, the positive effect of the separate bus lanes between Boulevard de l'Impératrice/Keizerinlaan and De Brouckère Square is highly visible, especially compared with the situation of the parallel route of penetration via Lombard Street (Rue du Lombard/Lombardstraat). Finally, we must point out the deteriorated traffic conditions of the trams, even though they run underground, approaching the South Station (Gare du Midi/Zuidstation) and between the North Station (Gare du Nord/Noordstation) and De Brouckère Square. The infrastructural overload (number of passes per track) and excessive number of vehicles (at least until the recent advent of the new, high-capacity trams), as well as operating constraints (criss-crossing of lines) contribute greatly to this state of affairs.

We draw the reader's attention to a large difference between the tram and bus networks' observed time losses. For an identical number of vehicle passes, the bus network posts a 28% greater time than the tram network. Exclusive rights of way, which concern the tram network above all, thus truly do have a positive influence on the performance posted by mass transport, even if it is insufficient.

Given the differences that we observed between the boroughs making up Brussels and the great powers that the boroughs have when it comes to traffic engineering and management, thanks to their local police powers, we aggregated the time losses in each borough (Table 1). There is no correlation between the total time lost and time loss per vehicle on the borough's scale. That means that in some boroughs, i.e., Brussels and Schaerbeek/Schaarbeek, the magnitude of the time loss is linked more to the borough's size and its corollary, the lengths of the lines that service it. In other boroughs, time losses are smaller because the borough is small and/or the network is shorter, but they are proportionally more worrisome as reflected in the time loss per vehicle. This is the case of Etterbeek, Saint-Josse/Sint-Jos, Saint-Gilles/Sint-Gillis, Auderghem/Oudergem, and other boroughs. Finally, a few boroughs combine worrisome time losses both on the whole and per vehicle – Ixelles/Elsene and Uccle/Ukkel are typical examples of this. Last remark: The differences in time lost per vehicle from one borough to the next are particularly high (Factor 2).

Figure 5

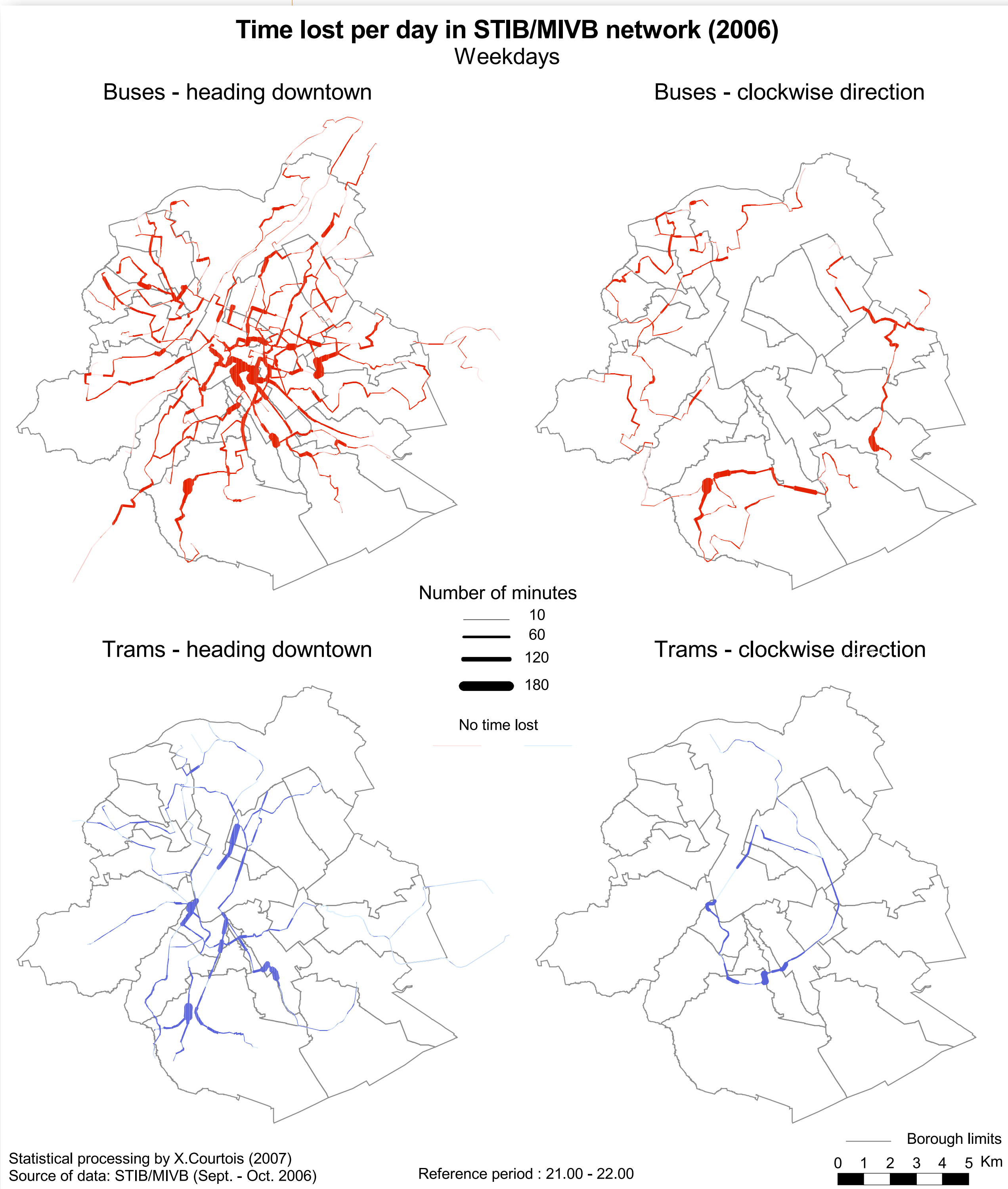

Time lost per day in STIB/MIVB network (2006)
Weekdays
Buses - heading downtown
Buses - clockwise direction
Number of minutes
10
60
120
180
No time lost
Trams - heading downtown
Trams - clockwise direction
Borough limits
0 1 2 3 4 5 Km
Statistical processing by X.Courtois (2007)
Source of data: STIB/MIVB (Sept. - Oct. 2006)
Reference period : 21.00 - 22.00

Table 1 : Time losses by borough
* BCR : Brussels Capital Region
** The tram network does not go through the borough of Ganshoren

Processed by X. Courtois (2007)
Source of data: STIB (Sept.-Oct. 2006)

Borough	Bus network			Tram network			Bus and tram					
	Minutes lost/day	Passes/day	**Seconds lost/vehicle**	Minutes lost/day	Passes/day	**Seconds lost/vehicle**	Minutes lost/day	Passes/day	**Seconds lost/vehicle**	Ranking buses (/20)	Ranking tram (/19)	Ranking bus and tram (/20)
Etterbeek	1495	3306	**27.1**	419	1803	**13.9**	1913	5109	**22.5**	20	14	20
Auderghem	1193	3184	**22.5**	12	141	**5.2**	1205	3325	**21.7**	18	3	19
Ixelles	3835	10918	**21.1**	1313	3729	**21.1**	5148	14647	**21.1**	15	19	18
Uccle	3213	8085	**23.8**	1940	6802	**17.1**	5153	14887	**20.8**	19	17	17
Saint-Josse-Ten Noode	1070	3031	**21.2**	253	1053	**14.4**	1322	4084	**19.4**	16	15	16
Saint-Gilles	491	1745	**16.9**	1739	5429	**19.2**	2230	7173	**18.7**	13	18	15
Koekelberg	626	1772	**21.2**	99	671	**8.9**	725	2443	**17.8**	17	6	14
Woluwe-Saint-Lambert	2266	7954	**17.1**	88	391	**13.6**	2355	8346	**16.9**	14	13	13
Anderlecht	1968	7093	**16.6**	324	1347	**14.4**	2292	8441	**16.3**	11	16	12
Woluwe-Saint-Pierre	851	3186	**16.0**	40	265	**9.0**	891	3451	**15.5**	9	7	11
Schaerbeek	2659	9474	**16.8**	1156	5652	**12.3**	3816	15126	**15.1**	12	12	10
Brussels	7334	26823	**16.4**	2224	11948	**11.2**	9559	38772	**14.8**	10	11	9
Molenbeek-Saint-Jean	1577	5999	**15.8**	221	1318	**10.0**	1798	7318	**14.7**	7	9	8
Ganshoren **	851	3596	**14.2**	-	-	**-**	851	3596	**14.2**	4	-	7
Berchem-Sainte-Agathe	692	2656	**15.6**	263	1433	**11.0**	955	4089	**14.0**	6	10	6
Watermael-Boitsfort	851	3304	**15.5**	124	970	**7.7**	976	4274	**13.7**	5	5	5
Forest	1193	4467	**16.0**	653	3994	**9.8**	1845	8461	**13.1**	8	8	4
Outside BCR *	1145	5458	**12.6**	43	509	**5.0**	1187	5967	**11.9**	3	2	3
Evere	1512	7398	**12.3**	43	538	**4.7**	1555	7936	**11.8**	2	1	2
Jette	1379	6813	**12.1**	309	2439	**7.6**	1689	9252	**11.0**	1	4	1
Total/Mean	36201	126262	**17.2**	11262	50433	**13.4**	47463	176694	**16.1**			

Synthesis

To wrap up these analyses, we generated a mapped synthesis of our findings crossing the three different indicators used (Figure 6). The thresholds chosen for commercial speed and irregularity were the network's mean values. Bear in mind that this means are themselves unsatisfactory. What is more, in so doing we get a threshold that is markedly lower than the targets set in the regional mobility plan (a minimum of 18 km/hr for peak service intervals on all the tram lines and a large proportion of the bus lines) and even lower than those set in STIB/MIVB's new management contract. However, opting for a harsher threshold would have led to the inclusion of a very large portion of the network on the synthesis maps.

The synthesis for the tram network clearly documents the existing contrast between the better performances of the segments that benefit from tracks that are truly separated from automobile traffic (premetro, large beltway, and Avenue de Tervuren/Tervurenlaan) and the poor performances posted by the rest of the network. The mapping of the bus network confirms what we saw previously: The first ring posts the worst results, that is, low commercial speeds and highly irregular service; the central pentagon, for its part, is dominated by segments with low commercial speeds; and the number of segments in the second ring that are marked by highly irregular service cannot be discounted.

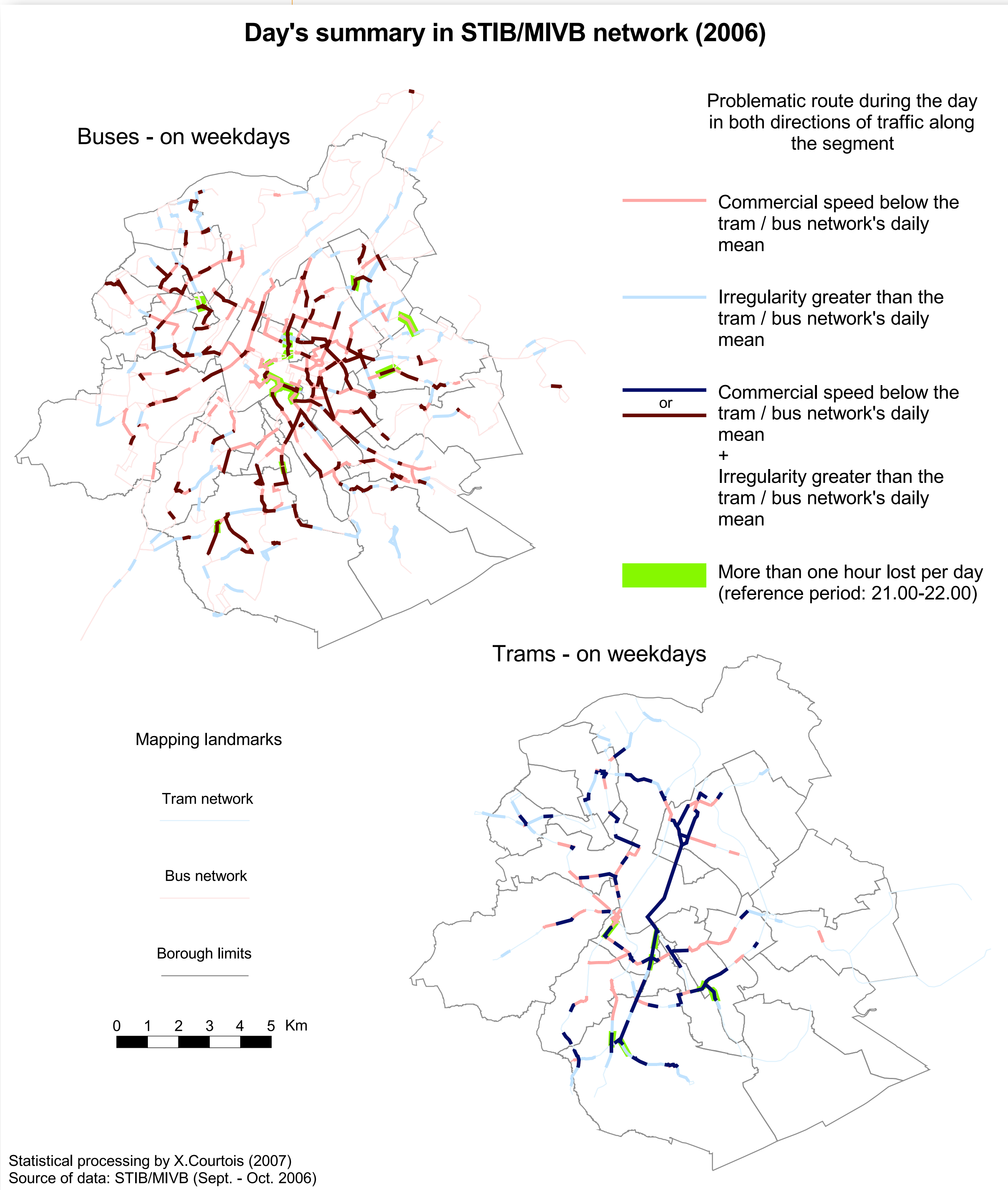
Main factors of poor performances[14]

The car's dominance and the topology of Brussels's roadways and public areas

All the available figures and simple observation converge to show that automobile traffic in Brussels has been rising steadily. The result is increasing congestion that "contaminates" mass transport's running conditions, since most of the time the city's mass transport runs mixed with its automobile traffic. This fact is related to Brussels's urban development and resulting topology: Unlike the broad avenues typical of the town planning that presided over Paris or Barcelona's development or cities that were rebuilt after World War II, Brussels has a fabric of relatively narrow thoroughfares, and this applies to the regional arteries as well as to local (neighbourhood) streets. The mesh of tram and bus lines required to serve the entire city being what it is, the mass transport routes are forced to take streets of limited capacity (Figure 7). In such a context it is physically impossible to have sufficiently wide sidewalks, parking, automobile traffic, and exclusive rights of way for mass transport. Political arbitration aimed at reducing the predominance of automobile traffic by eliminating parking spaces, detouring traffic, or reducing the number of traffic lanes) is the only way to be able to set up enough segregated tracks and bus lanes or reserve streets for trams and buses (if necessary via a scheme of pedestrian areas through which mass transport vehicles pass, as exists in various other European cities). We shall come back to this in Section 4.3.

[14] This section is based largely on Courtois, 2007. The reader should also consult STIB/MIVB, 2007b, for more information.

Figure 6


Day's summary in STIB/MIVB network (2006)
Buses - on weekdays
Problematic route during the day in both directions of traffic along the segment
Commercial speed below the tram / bus network's daily mean
Irregularity greater than the tram / bus network's daily mean
or
Commercial speed below the tram / bus network's daily mean + Irregularity greater than the tram / bus network's daily mean
More than one hour lost per day (reference period: 21.00-22.00)
Trams - on weekdays
Mapping landmarks
Tram network
Bus network
Borough limits
0 1 2 3 4 5 Km
Statistical processing by X.Courtois (2007)
Source of data: STIB/MIVB (Sept. - Oct. 2006)

That being so, the buses and trams' efficient progress is not guaranteed in the high-capacity major arteries, either. This is where the matter of traffic light management, which we shall discuss farther on, comes up. Second, once again, the bulk of their capacity tends to be reserved for general traffic. So, this brings us once again to the problem of arbitration when it comes to the distribution of public space amongst the various transport modes.

Figure 7: Tram in a narrow street shared with automobile traffic (Moris Street, Saint Giles Borough)

Traffic light management

Whereas in most European towns the trams and, to a certain extent, buses are given high, even unconditional, priority at the traffic lights, Brussels lags behind this trend. Technically, what needs to be done is simple: You need only detect approaching trams or buses far enough upstream to be able to adapt the lights' phases to allow the vehicle in question to get through the crossroads. As in the case of distributing public space, this calls for clear arbitration in favour of one mode of transport over another. Now, the compromise reached in Brussels is as follows: Trams are often detected and buses are rarely detected, but the effect on the traffic lights, however, is usually marginal – the lights' phases are influenced just a few seconds to help the tram or bus, but not to guarantee that it will get through. Here, too, the idea that is foremost in the minds of not only political but also technical decision-makers is not to penalise automobile traffic. Giving unconditional priority to mass transport – in any event where that is possible, given the places' configurations – would effectively conflict with the green light times that are allocated to cars. Moreover, the task is not made easier by the number of players involved (Region, boroughs, and subcontractors). Still, in all cases, the current situation stems first and foremost from the political stalemates described below.

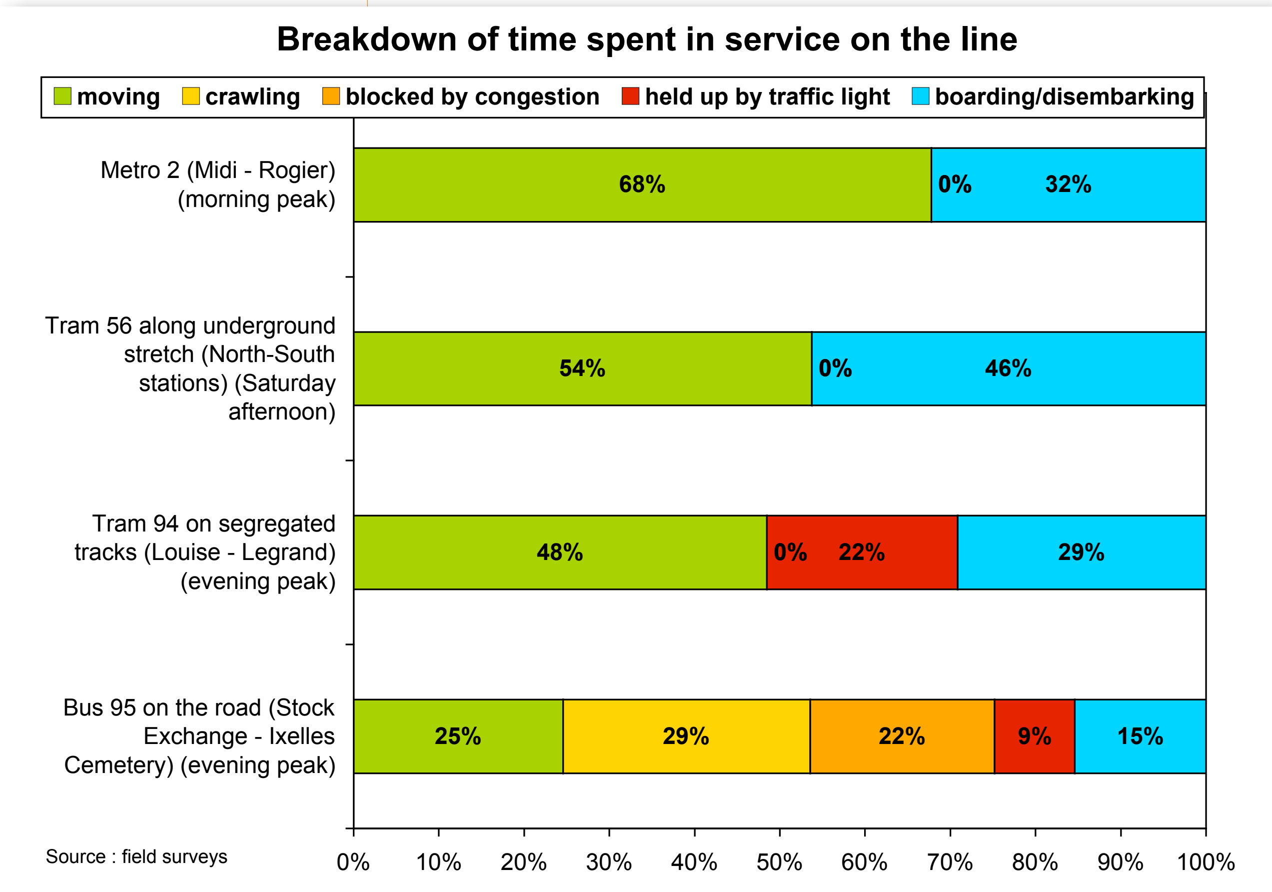


Figure 8: The impacts of red lights and traffic

This brings us to a double paradox. First, considerable funds have been invested to equip traffic lights with mass transport detection equipment, without much effect. Second, the trams and buses that run on exclusive rights of way can spend as much time stuck at lights as moving, which thus cancels out part of the exclusive right of way's positive effect. This is the case, for example, on Avenue Fonsny/Fonsnylaan, where the trams turning left into Theodore Verhaegen Street have very little time to get through the crossroads and, even worse, block those that continue straight through. Even in the thoroughfares where they run more freely, such as Louise Avenue and the boulevards of the outer beltway, the trams spend a significant amount of time stuck at traffic lights (Figures 8 and 9).

Figure 9: Red light for the new T4000 tram on its separate right of way but green light for the cars (General Jacques Boulevard, a regional artery).

The political stalemates

Of course, there are many other cities in Europe with relatively narrow streets that do not, for all that, prevent them organising efficient mass transport with regular service. One need only visit a few cities elsewhere in Europe to realise how far behind the Brussels authorities are in this respect. In this context, the distribution of public space amongst the various modes of transport and traffic light management are much more clearly policy problems than technical problems.

We are forced to acknowledge that both the municipal (i.e., borough) and regional authorities are usually highly reluctant to chip away at automobile traffic's dominance. The borough councilpeople are of course in almost direct touch with their constituents and local shopkeepers. To the extent that motorists are often more mobilised, unlike the silent majority that uses other means of transport, the borough councils are often little inclined to take presumably unpopular measures in favour of mass transport. The over-riding de facto weight that motorists have on urban spatial planning and mobility management raises questions. Without falling into simplistic Manichaeism, we can say that it most likely is connected to the social differentiation of the public concerned, to the extent that the mass transport system carries many captive users, i.e., poor people without much political clout, immigrants, and young people, who do not vote. In contrast, the people who drive cars belong to a broader and on average more elevated socio-economic spectrum, which doubtless means that they are guaranteed better "access" to their local elected officials.

The regional authorities are not necessarily more motivated to overcome these contradictions to the extent that most of the regional representatives have very strong constituencies in their boroughs. Some of them have such authority that nothing can be done in “their boroughs” without their consent, including on thoroughfares that are under the region’s jurisdiction. Such “angry murmurs” from the boroughs are bolstered by the recurrent permeability that exists in the politicians’ careers, as they go from the local to the regional level and back again with the changing electoral tides and majorities that are formed (Misonne and Hubert, 2003). Without passing judgment on the grounds of the case, we can add that the boroughs’ abilities to “make nuisances of themselves” or thwart regional action have been proven a number of times by legal actions filed against town planning permits that the Region had granted for regional projects (let us mention in particular the extension of Tram 56 to Anderlecht and the refurbishment of Flagey Square (place Flagey/Flageyplein)). The success of this method creates a constant sword of Damocles over regional projects’ heads.

In this context, the culture of compromise holds sway. Usually, either things are left as they are or half-measures only are taken. We have already mentioned the case of traffic lights that are only marginally influenced by mass transport. We can also add many examples of partially segregated tram tracks or bus lanes that disappear where they bother automobile traffic too much or are set up in places where they are not required[15]. For example, the formerly separate bus lane on Avenue de la Couronne/Kroonlaan, which was already scaled back to a simple bus lane at the borough’s request, breaks off a few hundred metres before the crossroads with General Jacques Boulevard in order to increase the road’s capacity at this spot (Figure 10). The separate bus lane on Boulevard du Souverain/Vorstlaan, near Val Duchesse mansion, for its part, covers a section of the road where traffic is fluid and then breaks off where cars start to build up because of the red light located farther down. Ironically, the buses are kept waiting by an additional light at the end of the exclusive right of way that allows them to re-enter the stream of traffic.

In other cases, the options chosen by the public authorities in their own plans are not implemented. If we look at the thorny problem of Chaussée de Charleroi/Charleroise Steenweg, for example, the plan was to detour automobile traffic heading for downtown Brussels via Defacqz Street, which made it possible to rethink the road’s entire layout. As this option was refused, a number of partial solutions that were totally unsatisfactory, judging by our maps, had to be cobbled together.

The list of such examples is long. Let us simply bear in mind that a sizeable group of Brussels’ political elite does not seem ready to challenge the car’s domination over the city, its neighbourhoods, and its mass transport.

[15] Most likely for the sole benefit of the annual activity reports.

Figure 10: Bus lane that disappears as it approaches a crossroads (Avenue de la Couronne/Kroonlaan, a regional thoroughfare)

The causes within the mass transport system

Finally, we must point out some malfunctioning within the mass transport system itself. First of all, the rule that passengers must board at the front that was gradually re-instated in 2003-2004 very likely had a negative influence on the buses efficiencies at this time, explaining their very poor performances when schools let out, just before the evening peak in road traffic. Next, some switching complexes that are highly solicited in various directions, given the many lines that pass over them (especially near the South Station), inevitably slow down tram traffic. In other places, the large number of vehicles and lines that pass through linked to high demand and/or the physical impossibility to diversify the routes often leads to a build-up a trams or buses that are forced to “queue”. However, we must not fool ourselves as to the true causes of these build-ups, for they are often due to downstream crossroads that are managed to benefit the streams of cars or great irregularity upstream that results in trams or buses arriving in waves rather than being spaced out better in time.

Conclusions

The findings presented here confirm the worrisome lack of efficiency that characterises a large part of the STIB/MIVB tram and bus network in Brussels. Slow commercial speeds and highly irregular service, sometimes the two together, mark many of its segments. This often contributes to mass transport's poor performance, further dissuading potential users from getting on board. Need we point out that by making a route between two points problematic, a single problematic segment can suffice to cancel out all the efforts made elsewhere?

Of course, the topology of Brussels' public thoroughfares does not make running buses and trams easier, nor does it facilitate the taking of measures that would not interfere with automobile traffic or parking. However, we must remember that a trip to a number of cities elsewhere in Europe is enough to show that many public authorities have made their mass transport systems more efficient than they used to be despite narrow streets that are barely any better than in Brussels. You do not have to have broad boulevards to separate automobile traffic from mass transport and manage traffic lights in the latter's favour. The recent inauguration of the Marseilles tramway shows that a first effort could be made along the routes of the city's two new lines, even in a Mediterranean city where cars are everywhere and occupy practically every inch of available land, including many sidewalks and squares. If Brussels's public authorities truly want sustainable mobility, that is, mobility that reduces the volume of automobile traffic and guarantees the possibility of moving about in the long term, the regional and – perhaps even more so – borough authorities will indeed have to change their ways and explain to their constituents that the current situation will be untenable in the medium term.

Acknowledgements

This research would not have been possible without STIB/MIVB's authorisation and the invaluable help of its staff, especially Mssrs L.-H. Sermeus (STIB/MIVB Director), Y. Fourneau, and C. Van Kaudenberg, whom we thank most sincerely.

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Annex: The worst problem spots (Figure 6 list)

BUSES	From	To	Borough	Line(s)
Commercial speed	Porte de Hal	Fontainas	St-Gilles	48
	Héros	Marlow	Uccle	41
	Brabanconne	Dailly	Schaerbeek	61
	de Stassart	Porte de Namur	Bruxelles	54
	De Brouckère	De Brouckère-Halles	Bruxelles	63
	Bockstael	Gare Bockstael	Bruxelles	53
	Patton	Bascule	Uccle	38
	Brabanconne	Dailly	Schaerbeek	54
	Roodebeek	Roodebeek	Woluwe-St-Lambert	45
	Braemt	Gutenberg	St-Josse	59
	Dailly	Brabanconne	Schaerbeek	54
	Bourse	De Brouckère P58	Bruxelles	63
	Presse	Madou	St-Josse	65-66
	Rogier	St-Lazare	St-Josse	58
	Borne	Comte de Flandre	Molenbeek	89
	La Chasse	Buedts	Etterbeek	34
Irregularity	Viaduc E40	Thumas	Outside BCR	42
	De Trooz	Outre-Ponts	Bruxelles	57
	Thumas	St-Antoine	Outside BCR	42
	Rue Traversière	Quetelet	St-Josse	61-65-66
	Linkebeek (B)	Homborchveld	Uccle	38-43
	Roi Baudouin-Amandiers	Roi Baudouin-Citronniers	Bruxelles	84-89
	Engeland	Groelstveld	Uccle	41
	Uccle Sport	Neerstalle	Forest	50
	Roi Baudouin-Citronniers	Roi Baudouin-Amandiers	Bruxelles	84-89
	Crocq	Brugmann (H)	Jette	53
	Gare Bockstael	Karel Bogaerd	Bruxelles	53
	Gare de l'Ouest	Beekkant	Molenbeek	20
	St-Guidon	Meir	Anderlecht	46
	Wielemans	Charroi	Forest	50
	Roodebeek	Vellemolen	Woluwe-St-Lambert	42
	Herrmann-Debroux	Herrmann-Debroux	Auderghem	96
Time lost	Luxembourg (B)	Parnasse	Ixelles	34-38-60-80-95-96
	Trône	Porte de Namur	Bruxelles	34-54-80
	Rittweger	Danco	Uccle	38-43
	Parnasse	Luxembourg (B)	Ixelles	34-38-60-80-95-96
	St-Boniface	de Stassart	Ixelles	54-71
	Georges Henri	Montgomery	Woluwe-St-Lambert	27-80
	Trône	De Meeus	Bruxelles	21-27-34-38-54-60-80-95-96
	ULB	Jeanne	Ixelles	71
	Merode	Montgomery	Etterbeek	22-27-61-80
	de Jamblinne de Meux	Gueux	Bruxelles	21-28-63
	Luxembourg (B)	De Meeus	Ixelles	34-38-60-80-95-96
	Auderghem-Shopping	Herrmann-Debroux	Auderghem	42
	De Meeus	Trône	Bruxelles	21-27-34-38-54-60-80-95-96
	Museum	Parnasse	Ixelles	34-80
	Groeselenberg	Héros	Uccle	38-41
	Degrooff	Georges Henri	Woluwe-St-Lambert	27-28-80
	Ducale	Royale	Bruxelles	27-95-96
	Gutenberg	St-Josse	St-Josse	29-63
	Trinite	Lesbroussart	Ixelles	54
Commercial speed + irregularity	Diamant	Diamant	Schaerbeek	21
	Quetelet	Rue Traversière	St-Josse	65-66
	Dailly	Brabanconne	Schaerbeek	61
Commercial speed + Irregularity + time lost	Presse	Madou	Bruxelles	29-63

TRAMS	From	To	Borough	Line(s)
Commercial speed	Héros	Marlow	Uccle	92
	Janson	Trinite	St-Gilles	81-82
	Robiano	Lefrancq	Schaerbeek	90
	Lefrancq	Robiano	Schaerbeek	90
	Marlow	Héros	Uccle	92
	Barrière	Barrière	St-Gilles	18
	Ernest Salu	Stuyvenbergh	Bruxelles	19-81
	Trinite	Janson	St-Gilles	81-82
Irregularity	Merode	Montgomery	Etterbeek	81-82
	Marlow	Wolvendael	Uccle	18-92
	Hunderenveld	Azur	Berchem-Ste-Agathe	19
	Verboekhoven	Pr. Elisabeth	Schaerbeek	56-92-93
	Rodts	Grand'Route	Outside BCR	52
	Kufferath	Stienon	Bruxelles	18
	Rittweger	Globe	Uccle	55
	van Beethoven	Frans Hals	Anderlecht	56
	Stuyvenbergh	Centenaire	Bruxelles	19-81
	ULB	Solbosch	Ixelles	24-93-94
	Cimetière de Jette	Cimetière de Jette	Jette	94
	Demolder	Pr. Elisabeth	Schaerbeek	23-24
	Van Ophem	Stalle	Uccle	91
	Keyenbempt	Rodts	Uccle	52
Time lost	ULB	Jeanne	Ixelles	24-93-94
	Thomas	Gare du Nord	Schaerbeek	52-55-56-81-90
	Bascule	Longchamp	Bruxelles	23-90
	Gare du Midi	Lemonnier	St-Gilles	18-52-81-82
	Gare du Midi	Suède	St-Gilles	18-52-81-82
	Janson	Ma Campagne	St-Gilles	91-92
	Suède	Gare du Midi	St-Gilles	18-52-81-82
	Verhaegen	Suède	St-Gilles	18-52-81-82
	Rogier	De Brouckère	Bruxelles	3-52-55-56-81
	Faider	Stephanie	St-Gilles	91-92
	Suède	Verhaegen	St-Gilles	18-52-81-82
	Gare du Nord	Rogier	St-Josse	3-52-55-56-81
Commercial speed + irregularity	Frans Hals	Parc Vivès	Anderlecht	56
	De Wand	Meysse	Bruxelles	52
	Berchem (B)	Berchem-Shopping	Berchem-Ste-Agathe	82-83
	Miroir	Place Reine Astrid	Jette	19
	Bayens	Hunderenveld	Outside BCR	19
Commercial speed + time lost	Trinite	Lesbroussart	Ixelles	81-82
	Ma Campagne	Janson	St-Gilles	91-92
	Étoile	Buyl	Ixelles	23-90-93-94
	Buyl	Étoile	Ixelles	93-94
	Xavier de Bue	Globe	Uccle	55
	Globe	Xavier de Bue	Uccle	55
	Moris	Janson	St-Gilles	81-82
Irregularity + time lost	Faider	Janson	St-Gilles	91-92