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# **Scheduled accessibility in the multimodal transport network of the Nord-Pas-de-Calais region: measures of the transport service for the assessment of the spatial planning policy**

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## ***Abstract***

The aim of the paper is, in the context of the transfer from the state level to the 'Régions' of the management of the passenger rail transport system (TER that stands for 'Train Express Régional'), to provide an analysis of the links between regional planning and transport, and to build a decision help framework. Amongst the regional planning missions that may be assigned to the passenger rail transport system, the focus is put –in this contribution– on the objective to reach the region capital from the major urban centres in less than one hour.

The improvement of accessibility may be classically measured by many ways, especially using GIS techniques. Nevertheless the classical accessibility indicators do not provide a correct measure of the travel times through a scheduled transport system. The railway service architecture –the way omnibuses and expresses are associated in the transport supply– and the intramodal transfers introduces strong threshold effects in the measure of the travel times.

Because the travel demand at a regional scale is strongly constrained by the daily urban rhythms and the location of the major traffic attractors, the transport supply firstly has to address the demand in peak hours.

To deal with these constraints accessibility measures using scheduled graph modelling are proposed. All the timetable information concerning the regional rail transport system is considered in order to model the transport supply of a usual week day. The accessibility measures produced by this model provide an assessment of the way the transport system can address the spatial planning policy objective of putting the major regional urban centres at less than one hour of Lille.

## ***Introduction***

In the French context of the transfer from the state level to the 'Régions' of the competency on the rail passenger transport system, this contribution focuses on the relations between collective transport networks and regional planning in the Nord-Pas-de-Calais region. Beyond the analysis, we want to build a prospective approach, in order to propose some modifications of the transport system as responses to identified regional planning stakes. Through a modelling of the transport system it is possible to simulate the modifications of the supply and to measure the potential consequences.

Located at the intersection between supply and demand, the notion of transport service allow us to question and to go beyond the classical accessibility indicators based on averaged travel times and frequencies.

Many modelling works, mostly stemming from operations research, tackle the fields of mobility and transport, but mainly in an economic perspective. The general purpose of these models is to optimise the adequacy between the supply and the demand. The regional planning criteria being not reducible to an economic optimisation problem, we propose –in complement to these approaches– to build a specific tool for measure and simulation. If our aim is different, many methodological advancements developed in the flow models may be mobilised to enrich our approach.

It has been a long time since the design of flow models is oriented towards a more and more precise description of the demand (Trépanier and Chapleau 1996) (McFadden 1997). However, this movement in direction of a disaggregate approach has not touched the field of the supply description with the same intensity. Nevertheless, in the study of a regional collective transport system one can not ignore the constraints induced by the schedules: the missing of a transfer –inside a mode or between two modes– can provoke a substantial increase of the total duration of the trip. *De facto*, the complete integration of the timetables in the flow models is very recent (Nuzzolo, Crisalli et al. 2000).

In addition, the interest shown to the question of intermodality –reinforced in France by the law on the sustainable development of the territories (Loi d’Orientation sur le Développement Durable des Territoires)– implies an important effort on the transfers, and therefore on the coordination of the timetables of the different transport modes.

In order to build this assessment of the transport system in its contribution to regional planning objectives, the work is divided in three steps:

- The first step concerns the identification of the major regional planning stakes through the creation of spatial organisation scenarios;
- The second step aims at confronting the scenarios to the spatial planning orientations wished at the state and the regional levels, concerning the Nord-Pas-de-Calais territory.
- The analysis of the transport service, through a measure of the gap between the existing and the desired situation, allows to indicate the modalities of intervention.

## ***The scenarios***

In order to build the scenarios of possible futures of the Nord-Pas-de-Calais région we exploit a set of works from geographers and spatial planners including P. Bruyelle, F. Damette, D. Pumain and Th. St-Julien, or B. Giblin-Delvallée.

The scenario “0” refers to an the existing conditions which is in fact largely the heritage of the introduction of the high speed rail in the region and the accompanying measures.

### **0 : Paris attraction : high speed rail and accompanying measures**

The organisation of the Nord-Pas-de-Calais rail network is based on the principle of an articulation on the high speed rail system. In this perspective, the focus is set on the relations to Paris.

Such a scenario is developed by Bruyelle (Bruyelle 1994) and named « the great north in the Parisian orbit ». The modifications of the rail infrastructures related to the high speed rail (Menerault 1997) (Menerault 1998) come in support of the scenario with:

- ▶ The organisation of the crossing of the TGV inside Lille that creates the main regional node for the access to the high speed rail;

- ▶ A set of investments realised in the regional territory, on the initiative of the national railways company (SNCF), including:
  - The Arras junction that creates the second regional entry point on the high speed rail,
  - The electrification of the Calais-Hazebrouck line in order to improve the security level on the high speed line to the tunnel,
  - The electrification of the Lille-Tournai line that allows a direct of Eurostars to Belgium in the period preceding the opening of the new line.
  - L'électrification de Lille-Tournai qui permet un raccordement d'Eurostar à la Belgique dans la période qui précède l'ouverture de la voie nouvelle ;

A set of complementary investments financed by the Regional Council to create direct TGV links to Paris with:

- The Cassel junction for the links to Dunkerque;
- The electrification of Boulogne-Calais ;
- The electrification of Douai-Cambrai.

Except the electrification of Lille-Tournai, all these investments have for function to facilitate the relations between the major cities of the Nord-Pas-de-Calais and Paris.

Nevertheless, the system offers some potentialities for the development of intra-regional relations centred on Lille –or going through Lille–, potentialities that have started to be exploited only very recently with the introduction of regional high speed relations since the year 2000.

The main stakes of this phase of the regional planning process corresponds on one hand to the opening of Lille to the European network, and on the other hand to an improvement of the extra-regional accessibility to Paris. In these choices made on the system of relations, one can identify a planning model in which the reinforcement of the Parisian attraction is put first.

A scenario directly these trends would lead to a strengthening of the centrality of Lille with an "hegemonic metropolis".

### **1 : hegemonic metropolis**

The "hegemonic metropolis" scenario is developed by Damette (Damette 1994) from the statement of the predominance of Lille:

*"The Nord-Pas-de-Calais is the model of the rudimentary network: between the Lille conurbation and the second agglomeration of the region, Valenciennes, there is a true abyss" (Damette 1994)*

The results of the last census in 1999 confirm the demographic dynamism of Lille. The relations analysis –through the study of the phone flows– and the functional analysis –from the rail passenger flows– conducted by Damette shows the importance of the relations with Lille for the entire regional territory. Within this framework, the regional planning strategy –in the spirit of the 'equilibrium metropolis' policy– considers of first importance the reinforcement of the relations with Lille.

This scenario consists in an accompaniment of an unavoidable metropolisation, with the objective to redistribute the fruits of the economic dynamism. The spatial model associated

with this scenario is based on center-periphery connections between Lille and all the cities of the region. To consolidate this scenario based on an extension of the metropolitan space to the totality of the 'Région' territory, the action on the regional transport system consists in giving the priority to:

- ▶ Direct rail relations between Lille and the cities of the former mine basin ;
- ▶ Direct and fast rail relations from pole to pole towards Lille with:
  - The regional high speed rail (called TER-GV that stands for 'Train Express Régional à Grande Vitesse') for the littoral area and Arras, and
  - Relations to the East of the region through the modernised lines to Valenciennes, Maubeuge and Cambrai.

In addition, the extension of the metropolis integrates the reinforcement of the links with its Belgian side (Tournai and Courtrai). In this principle of spatial organization there exists no assertion of the sub-regional identities around Valenciennes or the littoral area.

## **2 : Reinforcement of the regional solidarities**

Departing from the statement of the Parisian prevalence, a future different than the one developed in the first scenario can be considered: by beginning to bear on Arras which constitutes the second entry gate on high speed rail (Barré 2000) one can develop the relations not centred on Lille and imagine a scenario of 'reinforcement of the regional solidarity'.

The main idea of this scenario is that of a bipolarisation of the regional space around Lille and Arras, bearing on relay cities –Valenciennes and Calais. But the objective is also to bring closer the peripheries of the region, particularly by developing the railway bypass of Lille.

To ensure this 'reinforcement of the regional solidarity', the main relations to be developed follows an East-West axis with:

- ▶ A major axis Dunkerque-Lille-Valenciennes with tangential relations Dunkerque-Valenciennes that avoid the central station of Lille-Flandres, which is today close to the saturation point;
- ▶ Reinforcement of the Arras-Etaples-Boulogne line in order to open the Boulogne area to Paris via Arras and to develop the proximity relations in all the areas touched by the line.

## **3 : Reinforcement of sub-regional areas**

The spatial planning principle operating through the first two scenarios is that of an accompaniment of the metropolisation process of the entire regional territory, polarised around Lille for the first scenario, bipolarised for the second. A different principle –which consists in first establishing or consolidating a set of coherent areas is attested in several analyses and orientations (Direction Régionale de l'Équipement Nord-Pas-de-Calais 1999). From this point of view three major urban systems take shape: the central urban area around Lille, the littoral area and a network of cities around Valenciennes. imply

- ▶ The metropolis is enlarged to the former mine basin integrating Valenciennes, according to the concept of the *metropolis area* (Direction Régionale de l'Équipement Nord-Pas-de-Calais 1993) implying:
  - Relations of good quality between Lille and the cities of the former mine basin and

- relations of good quality between cities of the former mine basin.
- ▶ The East of the region around Valenciennes as a relay pole, which implies:
  - Relations of good quality from Valenciennes to Maubeuge and Cambrai
- ▶ The littoral area with Boulogne, Calais, Dunkerque and Saint-Omer which means:
  - In priority establish good quality relations alongside the littoral axis Boulogne-Calais-Dunkerque.
  - In a second time, reinforced relations to Saint-Omer

This scenario raises the question of the location of Arras in the regional urban system between the insulation, the Parisian influence or a connection to an enlarged metropolitan area. In a regional scenario which privileges territorial coherence, one will choose the last option which corresponds to an inclusion of Arras to the metropolitan area in a secondary layer.

#### **4 : Euroregional scenario of an integrated and hierarchised network**

In an the Eurorégional perspective the preceding scenario of reinforcement of the regional subspaces can be extended by developing cross-border relations towards Belgium and the South of England. The objective is then to balance the Parisian pressure by open relations on the close countries of Northern Europe with:

- ▶ The extension of the urban systems to cross-border Belgian poles:
  - From Lille to Kortrijk, Tournai and Ieper
  - From Valenciennes to Mons
  - From Maubeuge to Mons and Charleroi
  - From Dunkerque to the Belgian littoral
- ▶ Develop the international station of Calais-Fréthun activated as a gate towards Great-Britain with:
  - An articulation of the regional rail system onto Calais-Fréthun, and
  - a reinforcement of the Fréthun-Ashford relations.

The Belgian cross-border area can be envisaged through a polarization on Lille and/or a reinforcement of the Franco-Belgian relations (Belgian littoral-Dunkerque-, reopening of the Valenciennes-Mons line, development of the Sambre-Charleroi and Sambre-Mons lines, inside the metropolis the Comines line towards Ypres and relations Lille-Courtrai and Lille-Tournai, and the prolongation of the urban lines)

### ***Confrontation of the scenarios to the Regional Council and State orientations***

The analyse of the orientation documents of the Regional Council and the l'Etat involves :

- ▶ on the side of the Regional Council:
  - ▶ « Document d'Orientations Régionales », juin 1999 (Document of Regional Orientations)

- ▶ « Rapport d'orientation sur le schéma régional ferroviaire des transports de voyageurs », 1995 (Orientation Report on the Passenger Rail Transport Regional Scheme)
- ▶ on the side of the state:
  - ▶ « Schémas multimodaux de services de transport de voyageurs et de transport de marchandises », automne 2000 (Multimodal Fret and Passenger Transport Service Schemes)
  - ▶ « Stratégie de l'Etat dans la Région Nord-Pas-de-Calais 2000-2006 », 1999 (Strategy of the State in the Nord-Pas-de-Calais Region 2000-2006)

Table 1 : Confrontation of the State and Regional Council orientations to the regional planning scenarios

	State	Regional Council
1		<ul style="list-style-type: none"> <li>▶ Programme of mobilisation of the high speed rail network at the regional level</li> <li>▶ Opening up the Sambre and Cambrai areas through fast and rhythmmed relations towards Lille (Speed of 200 km/h, Maubeuge in 50 min)</li> <li>▶ Objective that no major agglomeration of the Region</li> <li>▶ That no great agglomeration of the area be at more than one hour of the Metropolis</li> </ul>
2	<ul style="list-style-type: none"> <li>▶ Find solutions to the saturation of the rail traffic node of Lille for the crossing of the metropolis</li> </ul>	<ul style="list-style-type: none"> <li>▶ The metropolis as a “head of network of a regional network of cities” with an “equilibrated repartition of the urban functions”</li> <li>▶ The Boulogne-Etaples-Arras line</li> <li>▶ Modernisation of the Lille-Maubeuge line</li> <li>▶ According to the principle of an intra-regional cooperation “Cambrai must cooperate with Valenciennes, but also with Arras and Douai”</li> <li>▶ The Arras area –“Southern gate of the Nord-Pas-de-Calais”– as a relay pole of the metropolis organising a network of cities in the South of the region (St-Pol, Bapaume, Cambrai)</li> </ul>
3	<ul style="list-style-type: none"> <li>▶ Develop or create an integrated collective transport network at the scale of the urban area of Lille from:               <ul style="list-style-type: none"> <li>▶ The existing railways network and,</li> <li>▶ A set of inter-connexions with the urban networks</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>▶ The Region wishes to encourage the development dynamic of the littoral area around the University and a strengthened association of the local authorities (the cross-Channel is seen here as an economic activity but not as a spatial relation)</li> <li>▶ The East of the Region must open itself to the Valenciennes area</li> <li>▶ Avesnes must cooperate with Valenciennes and Cambrai</li> <li>▶ Doubling of the track on the Don-Sainghin-Béthune line</li> <li>▶ Electrification of the Calais-Dunkerque line</li> <li>▶ <i>Good connexion of the rail network on Calais-Fréthun (Orientations TER 2010)</i></li> </ul>
4	<ul style="list-style-type: none"> <li>▶ A hierarchised spatial organisation at the regional scale that:               <ul style="list-style-type: none"> <li>▶ Facilitates the access to the high speed networks</li> <li>▶ Facilitates the access to the functions and services available only in the regional metropolis</li> <li>▶ Reinforce the links around the sub-regional poles</li> </ul> </li> <li>▶ <i>Cross-border relations referring to the RAPHAEL network : Valenciennes Mons, Lille, Courtrai et Tournai (Stratégie de l'Etat 2000-2006)</i></li> </ul>	<ul style="list-style-type: none"> <li>▶ A development of the metropolis according to the model of the Central Urban Area developed by the planners in the early 1970's (OREAM Nord)</li> <li>▶ The cross-border development of Lille</li> <li>▶ Cooperation of the East of the Region with the Belgian side</li> <li>▶ Strengthen the interregional links with “our Belgian and British neighbours”</li> <li>▶ Make of Calais-Fréthun a real international station (<i>Orientations TER 2010</i>)</li> </ul>

From a general point of view, in the planning orientations, the regional rail transport system has to ensure in priority the inter-city relations; the model of the Parisian railway network (called RER that stands for ‘Réseau Express Régional’) with almost no hierarchy of the services is not defended at all.

The State orientations express a clear preference for the scenario number 4 of an 'Euroregional hierarchised and integrated network'.

On the other hand, the orientations of the Regional Council are much more ambiguous. It is not a unique scenario which emerges, but rather a superposition of the principles and actions which define the scenarios number 2 of a 'reinforcement of the regional solidarity' and 4 'Euroregional hierarchised and integrated network'.

The priority measurement put on view by the Regional Council consists in connecting the major agglomerations to the metropolis in less than one hour through the high speed regional network for the cities of the littoral, and the modernization of the axis Lille-Jeumont for the Eastern areas. This measure is associated clearly with the scenario of the 'hegemonic metropolis'; nevertheless, concerning the relations with the littoral and Maubeuge areas, the measure also corresponds to the scenario 2 of 'reinforcement of regional solidarity'.

We propose now to evaluate this objective through an analysis of the quality of the service of transport.

## ***Method***

The method developed here aims at the assessment of the transport systems in their contribution to spatial planning objectives. The approach of the transport system is based on the notion of transport service, which means that the focus is put not on the internal performance of the system but on the service rendered by the system as answers to mobility needs. The transport service is defined through three principles:

- the principle of segmentation of the demand
- the identification of the major attracting locations
- the urban rythms

The evaluation method is based on an accessibility indicator that refers to the definition of the transport service. Such an accessibility indicator allows to go beyond the notion of transport supply by including explicitly some elements of the demand spatially and temporally disaggregated (Rietveld and Bruinsma 1998). At a regional scale the focus is set on the daily mobility which constitutes from far the most important part of the overall regional mobility (CERTU and SNCF 1998).

The assessment method exploits the railways time-tables at the origin or at destination of stations located in the Nord-Pas-de-Calais. When necessary the travel times and time-tables of the urban transport system are considered. All these data are inserted in a graph representing the passenger rail network and counts approximately 30 000 arcs and nearly 300 nodes. The measures of accessibility are built from the calculation of time minimum paths which integrate possible transfers.

Concerning the level of disaggregation, the method consists in applying at a regional scale principles that are more usually employed at the urban scale (Trépanier and Chapleau 1996).

## ***Is the 'hegemonic metropolis' a reality?***

The 'hegemonic metropolis' scenario considers that the spatial relations to develop in priority are the bilateral links between Lille and each regional urban pole. This scenario clearly is pushed on by the objective of putting the cities at less than one hour of Lille. An assessment of this transport policy objective corresponds to an assessment of the collective transport system in its contribution to the spatial planning scenario of the 'hegemonic metropolis'.

### **Classical accessibility: potential relations**

In a first step we apply a classical accessibility indicator with no reference to the notion of transport service. We consider the relations in less than one hour over all the day, to determine the agglomerations which can not verify the objective. These first measures of travel time concerns the duration of the rail trip –from station to station– including the possible transfer waiting times. Map 5 indicates the best travel times on the railway network on the whole day at destination to Lille-Flandres or Lille-Europe, the two central stations of Lille. The map 6 which indicates the best travel times starting from Lille corresponds to the returns. It comes out from these two indicators that for all the great agglomerations of the Nord-Pas-de-Calais –except Maubeuge– there is at least one railway service that make it possible to connect Lille in less than one hour

The shortest travel time all over the day starting from Maubeuge lasts 1h18: there is thus here a significant qualitative gap to implement in order to achieve the stated goal. It has been shown (L'Hostis and Menerault 2000) that the relation in one hour to Lille is possible, but only at the price of a major reorganization of the architecture of the railway service.

### **Peak period accessibility: useful relations**

The problem raised by this first result for the interpretation in terms of transport service is the lack of references to the rhythms of the daily mobility. Indeed, at the regional scale, 61 % of the residence-to-work trips done during the week arrive between 7h00 and 9h00 in the morning (CERTU and SNCF 1998). While 67 % of the work-to-residence trips reach the destination between 17h00 and 19h30, the evening peak period being more spread out.

Consequently the preceding measure has to be limited to the peak hours in order to integrate the urban rhythms. The second indicator proposed here –a peak period accessibility– stands one step further in the description of the transport service including the urban rhythms and a first segmentation of the demand.

In the perspective of the polarisation onto Lille we focus on the trips from the major urban centres at destination of the metropolis. The map 7 shows the shortest travel times in direction of Lille arriving between 7h00 and 9h00, whilst the map 8 shows the best travel times starting from Lille reaching back the central stations of the agglomerations between 17h00 and 19h30. Considering the morning arrival, only the departure from Maubeuge does not satisfy the objective, while Cambrai with 1h01 of Lille can be considered as verifying the constraint. In the evening, if we put Maubeuge apart, the situation is more difficult: the returns to Calais (1h23), Boulogne (1h53) are not ensured under satisfying conditions. The reason is that if the regional service of high speed trains plays its role in the morning, it is not the same for the returns with arrivals around 20h00, beyond the peak period.

Moreover, one observes a good adequacy between the best travel times all over the day and the shortest travel times at the peak periods for the whole Nord-Pas-de-Calais, except for the return to the littoral between 17h00 and 19h30. Indeed, travel times are practically doubled compared to the shortest travel times all over the day for Dunkerque, Calais and Boulogne.

We have here highlighted a heterogeneity of the transport service between the metropolis and the littoral in terms of the stated objective. Considered through the assessment of the objective of the cities at less than one hour, the 'hegemonic metropolis' scenario is almost a reality yet for a large majority of the agglomerations of the Nord-Pas-de-Calais. Two areas only remain beyond the limit of one hour: the East with Maubeuge for which a deep modification of the rail service would be needed, and the littoral touched by a more limited difficulty with the evening return for which an adaptation of the high speed services would offer an efficient answer.

### **Scheduled accessibility: real relations**

In order to fully integrate the three principles of the notion of transport service, the peak period indicator has to be extended in two directions: on one hand the rhythms of the urban activities impose time constraints that are often more precise than the indication of a two hour period and, on the other hand, the trip does not end at the station of the destination.

We focus first on the trip-to-work segment at destination of Lille: within a walkable radius of ten minutes (Bertolini and Spit 1998) around the central stations –Lille-Flandres and Lille-Europe– one can find a set of traffic attracting locations with a very developed commercial centre, and a significant tertiary centre. To build an analysis of the service of transport it is necessary to integrate the final part of displacement, from the station to the final destination. In addition, the mobility for work purpose is strongly constrained by hours of beginning of activity. It is thus necessary to introduce measures more precise than those corresponding to the shortest travel time over a peak period. In this perspective, the transport service can be defined as the conditions of access to the centre town of Lille for a trip to work constrained by the time of starting of activities.

From this point of view, the maps 9 to 12 show the times of departure from the major urban centres corresponding to a constraint of arrival in Lille integrating 10 minutes to reach the final destination.

The service of transport thus defined puts forward a measure corresponding to the point of view of the user. The transport system has to make it possible for the user to reach its workplace before the time of beginning of his activity. Under these conditions, the objective of the relations in less than one hour for four time constraints of the peak period of the morning is achieved by no agglomeration. In the best of the cases the objective is achieved for two time constraints out of four: namely, Douai, Béthune, and Valenciennes as well as Courtrai and Tournai.

The time constraint the most favourable is that of the arrivals before 8h00 where 6 agglomerations out of 13 are located at less than one hour of the metropolis, and where the regional high speed rail places the littoral at less 1h10. On the other hand, for an arrival before 7h30 no agglomeration is at less than one hour, and from Boulogne it is not possible to reach the metropolis.

The regional valorisation of the high speed line produces a manifest effect for the access to Lille from the littoral. However the railway supply could be improved so as to better answer the constraints in term of service of transport. In particular Calais could be better connected if the connection with the Fréthun station was optimised: for the constraints of arrival before 8h00 and 8h30 the relation between Calais and Calais-Fréthun takes 26 minutes, which means that it takes hardly less time than the high speed trip between Fréthun and Lille-Europe.

### **'Hegemonic metropolis' scenario assessment**

The objective to put the major agglomerations of the Region at less than one hour of Lille, which corresponds to the first scenario of the 'hegemonic metropolis', can now be tested using measures of the service of transport. It comes out from this confrontation between the scenarios and the maps of scheduled accessibility two levels of analysis.

First, the measure of best rail travel times all over the day shows than the direct relations Maubeuge-Lille must be deeply modified to be able to answer the objective. Concerning all the other agglomerations, the railway supply is able allow –at least potentially– to establish relations in less than one hour. In this first approach, the accessibility indicator indicates a regional situation not very far away from the scenario of the 'hegemonic metropolis'.

In a second level of analysis, the approach by the service of transport proposes more contrasted vision which highlights the problem of the evening return to the littoral and the question of connection between Calais and -Fréthun. The improvement of this connection – presented as an objective by the Regional Council and coming in support to the scenario 4 of an ‘integrated and hierarchised network’– could be implemented to answer the objective of the cities at one hour of Lille, while also contributing to the scenarios of reinforcement of the internal relations of the littoral.

The objective to put the major cities of the Region at less than one hour of the metropolis appears more like a transport supply criterion than a transport service criterion. The transport supply analysis, as described through the classical and peak period accessibility indicators, shows a situation not very far from the Regional Council objective except for some peripheries of the territory. On the other hand the transport service analysis –expressing the user’s point of view– raises the question of the internal coherence of the metropolitan area, namely Lille and the former mine basin.

### ***A valorisation of intermodality to reinforce the internal coherence of the metropolis***

We have established a measure of the quality of service corresponding to the residence-to-work segment which constitutes a part only of the demand. It is necessary to extend the demarche for the studies related demand segment in order to reach a more comprehensive approach.

We focus now on the studies related mobility, that constitutes one half of the usual users of the rail network in the Nord-Pas-de-Calais. To build our analysis of the transport service we need to identify the major traffic attractors corresponding to this demand segment. On map 13 are figured the five major campuses of Lille and the urban transport system that can be used for the access from the regional rail transport network.

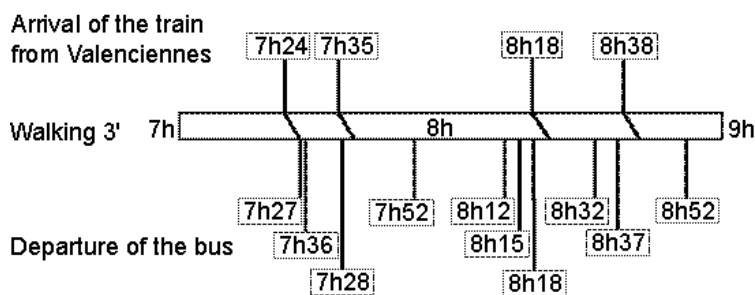
At the origin, the urban transport system was designed to link the major campuses to the central station of Lille-Flandres through an automatic metro called VAL (Véhicule Automatique Léger). From the regional users point of view the access to the campuses of Lille have to be done through the metro line number 1 with an interconnection in the central station. Nevertheless, the regional rail network includes a set of stations located inside the metropolis and for some of them located at proximity of the campuses. In order to *better exploit the existing network* –according to a principle defended in the French law on the sustainable development of the territories– our approach is based on the principle of the virtual network developed by Dupuy (Dupuy 1991). By exploring all the possible ways to reach the destinations –the virtual network– one can build a ‘real network’ that considers credible alternatives exploiting the connectivity of the network. The virtual network appears on map 13 with interconnections between rail and metro –at the hospital station ‘Halte CHR’, at the ‘Porte-de-Douai’ station, and at the Human Sciences University campus Pont-de-Bois station– and between rail and buses –at Ronchin, Porte-de-Douai, Baisieux, Tressin, and Lesquin stations.

The normal way of acceding to the Sciences University by Lille-Flandres and the metro produces the base accessibility measure shown on map 15. The transport service needed by the students of the Sciences University consists in reaching the campus before 8h00 in the morning, classical time of beginning of the lectures. The map shows the best departure times from each railway station to get to the campus according to the 8h00 constraint. The ‘Ecole Centrale’ is chosen as a place representative of this quite large campus. This first measure is not very favourable whilst except Douai no major urban centre of the region is located at less than one hour of the campus. The accessibility to the Sciences Campus even less favourable than the accessibility to the centre town of Lille as shown on maps 10 and 11.

The following map show the access conditions to the Medicine University campus. In the access to the Medicine campus located in the East of the metropolis, it is impossible to consider the central stations only, and to ignore the Hospital railway station ('Halte CHR'). As a result of the introduction of this second entry to the metropolis, the map 16 shows a better level of accessibility at the origin of the stations located on the line serving the hospital. Béthune enters the set of the stations at less than one hour even if the accessibility from Douai with a departure at 6h58 is slightly degraded.

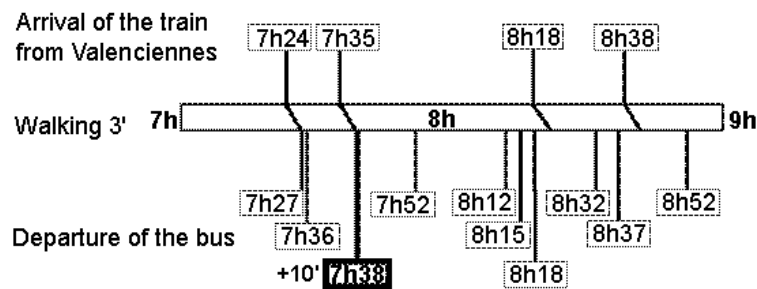
Can the accessibility improvement due to the exploitation of the new entry constituted by the Hospital station be useful for some other campuses of the metropolis? If we refer to map 13, the Law University campus can be reached through the Hospital station using the two metro lines. Due to the very high frequency of the metro system during the peak period –1'30" between two metros– and to the quality of the pedestrian link –one minute only is necessary to join the two platforms–, the interconnexion added in this access alternative can be considered as credible. Moreover, the railway timetables are likely to be more reliable in the 'Halte CHR' than in Lille-Flandres due to railways congestion at the central station. The effect on accessibility is visible on map 17 through a difference of the departure times with and without the valorisation of intermodality and the access alternatives. A strong threshold effect occurs due to the fact that the few minutes saved by going through the Hospital station allows to take the next train at the origin of Béthune and the surrounding stations. This is why a gain of 45 minutes can be observed on a set of stations of the Western part of the former mine basin, that puts Béthune at less than one hour of the Law University campus.

The virtual network principle applied on the Eastern campuses access exploits a set of bus lines. Amongst them one only is able to constitute a credible alternative: the connection at the Lesquin station can be use by the students coming from the Valenciennes to Lille line and beyond. A close examination of the connection conditions is developed on Figure 1.



**Figure 1: existing train-bus connections at Lesquin in direction of the Sciences University**

On top of Figure 1 one can see the time of arrival of the trains from Valenciennes and on the bottom the times of departure of the bus to the Sciences University campus. Amongst the four trains of the morning peak period one only is connected to the bus if we consider a three minutes walking from the railway station to the bus station. Clearly the interconnexion is not today a criterion in the design of the bus timetables. Nevertheless, marginal modification of the bus timetables could allow to improve the quality of the rail-bus connections as shown on Figure 2.



**Figure 2: proposed train-bus connections at Lesquin in direction of the Sciences University**

The Figure 2 shows a modification of 10 minutes of the arrival of one bus at Lesquin allowing to connect the two trains arriving between 7h00 and 8h00 that are supposed to be predominantly used by the students. The introduction of a new bus service could also be considered.

It must be noticed that this proposal has no effect on fares, whilst since Lesquin belongs to the Urban Transports Perimeter, going to the Sciences University by bus from Lesquin costs the same price as taking the metro from the Lille-Flandres central station.

The improvement of accessibility brought by this modification is measured on map 18 through the difference of the departure times with and without the activation of alternates entries to the metropolis –Lesquin station and the Hospital station– including urban transport supply modifications at destination of the Sciences University. The effect is patent with fifteen minutes gained at the departure from Valenciennes that brings the city into the one hour relations class. The same travel time saving can be observed at St-Amand, Orchies and Templeuve the three major stations in terms of traffic on the Lille-Valenciennes section. Beyond Valenciennes, the savings are very important with half an hour from Le Quesnoy and 45 minute from Maubeuge. This last improvement can be seen as a contribution to the development of the Maubeuge-Lille relations as displayed in the strategic orientation of the Regional Council.

Concerning the Hospital station, the improvements revealed through the valorisation of intermodality in the access to the Law University (map 17) are also effective in the access to the Sciences University. Indeed, the metro line between Lille-Flandres central station and the Eastern campuses begins in the hospitals area: for this reason the students coming from the Lille-Béthune section and beyond may use the Hospital station instead of the Lille-Flandres station to take the metro. By doing so they avoid the congestion of the central station and they save a few minutes that allow them to take the next train, and benefit of a significant accessibility improvement at the departure from Béthune and the surrounding stations.

In addition, the accessibility measures are the same for the Human Sciences University than for the Sciences University, and the effect of a development of intermodality produces the same effects on this second campus. These modifications could thus provide important improvements of the access conditions towards the two major campuses, where is located one third of the total regional student population.

In terms of regional planning strategy the accessibility to the campuses puts forward the relations inside the metropolis extended to the former mine basin and to the close cross border areas. We will consider the one hour relations in terms of transport service as the maximum travel time acceptable inside the metropolis for the campus and centre towns destinations. By summarising the information presented on maps 9 to 12 and 15 to 18 we are able to assess the spatial organisation scenarios of the metropolis developed before with Lille in relation with Béthune, Lens, Douai, Valenciennes, Tournai, and Kortrijk. Concerning the relations to Lille's centre town considered on four time constraints inside the morning

peak hour, all the cities appears two time under the one hour limit (the relations from Lens with 1h01 to arrive before 8h00 can be considered as following the same rule).

The analysis of the maps 15 to 18 give indications on the studies related accessibility concerning the campuses of Lille. Firstly Kortrijk is never at less than one hour of any of the campuses of Lille, while Tournai always verifies this level of accessibility. A closer examination of the railway services would then be needed in order to determine the improvement opportunities if one wish to support the Euroregional scenario. The links with leper depends on the reopening of a crossborder line at Comines: this relations would need heavy investment.

Amongst the former mine basin the relations from Douai –with an access in less than one hour to each campus of Lille except the Medicine University one in 1h02– is credited of the best situation, confirming the result observed on the transport supply and the access to the centre town analysis. The development of intermodality allows to enlarge the one hour relations group to Béthune, and also to Valenciennes in a lesser extent.

## **Conclusion**

This paper presents a first step of the assessment of the contribution of the transport systems to four regional planning scenarios. After the focus put on Lille, the region's metropolis, the work has to be extended to the analysis of other traffic attractors located in the urban centres of the Region, using the same methodological approach, in order to fully assess the four scenarios. Further investigations are needed to complete the evaluation, in particular concerning the two peripheral urban networks of the littoral and of the East.

This contribution belongs to the field of the strategic orientations. However, to build a correct analysis of the service of transport it is necessary to drive the modelling work to an extremely precise level of description of the supply in which the full time-tables are detailed. It is an apparent paradox of our work which associates an analysis of the planning orientations at the strategic level, with a very precise study of the transport system.

The objective to put the cities of the Region at one hour of Lille –emblematic measure of the 'hegemonic metropolis' spatial organisation scenario– corresponds to a transport supply objective. Traditional accessibility indicators can be used in the assessment, even if the introduction of time constraints allows to introduce a better adequacy to transport needs. The analysis conducted invites to put the effort on the relations to and from Maubeuge, and to improve the evening return in direction of the littoral area if one wishes to establish the first scenario of the 'hegemonic Metropolis'.

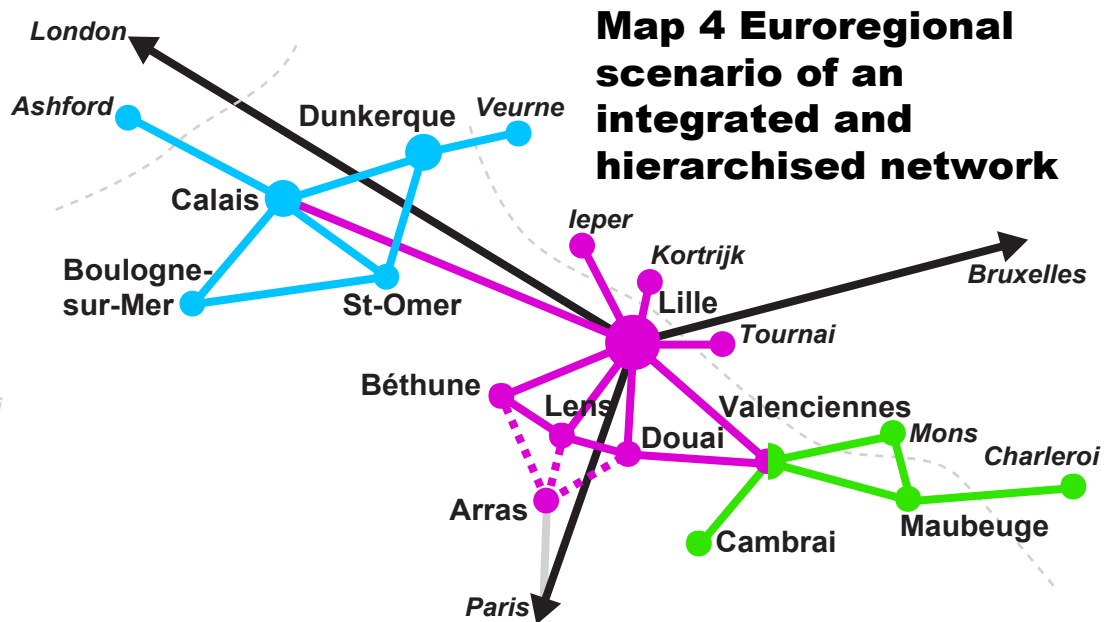
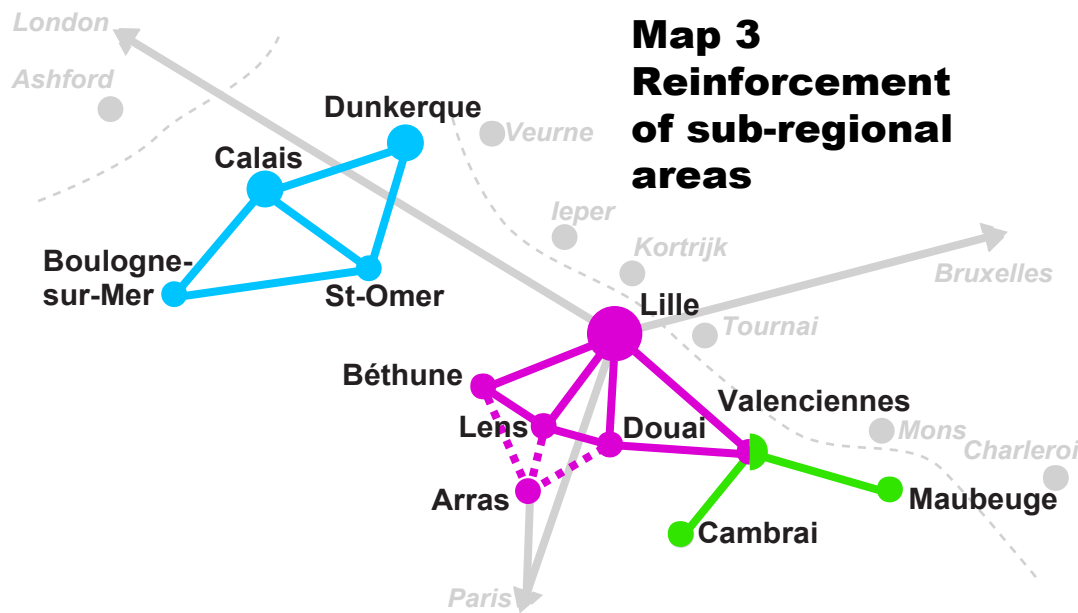
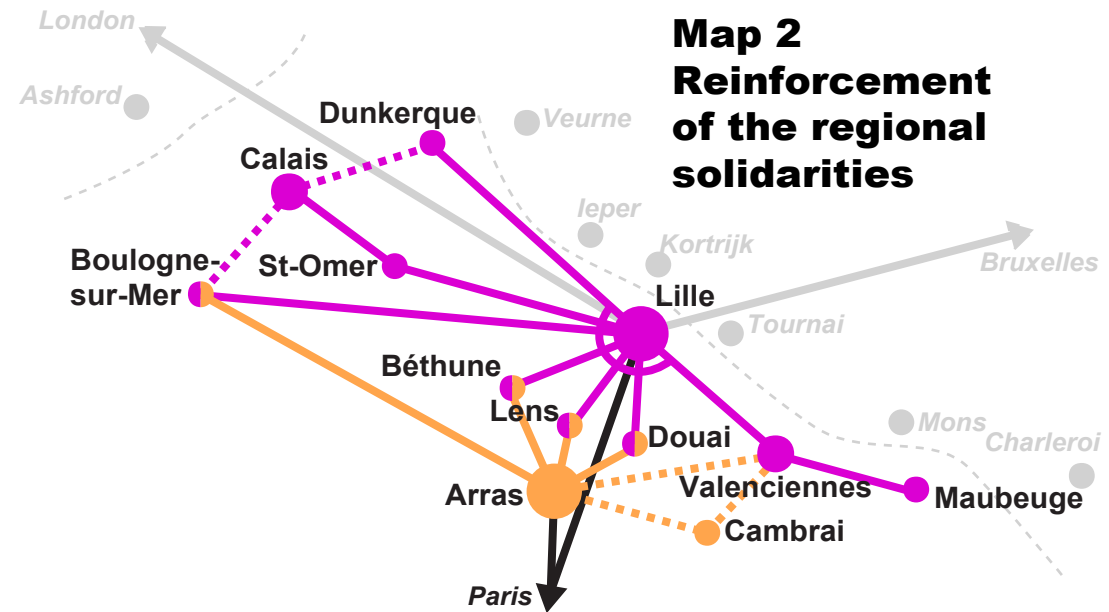
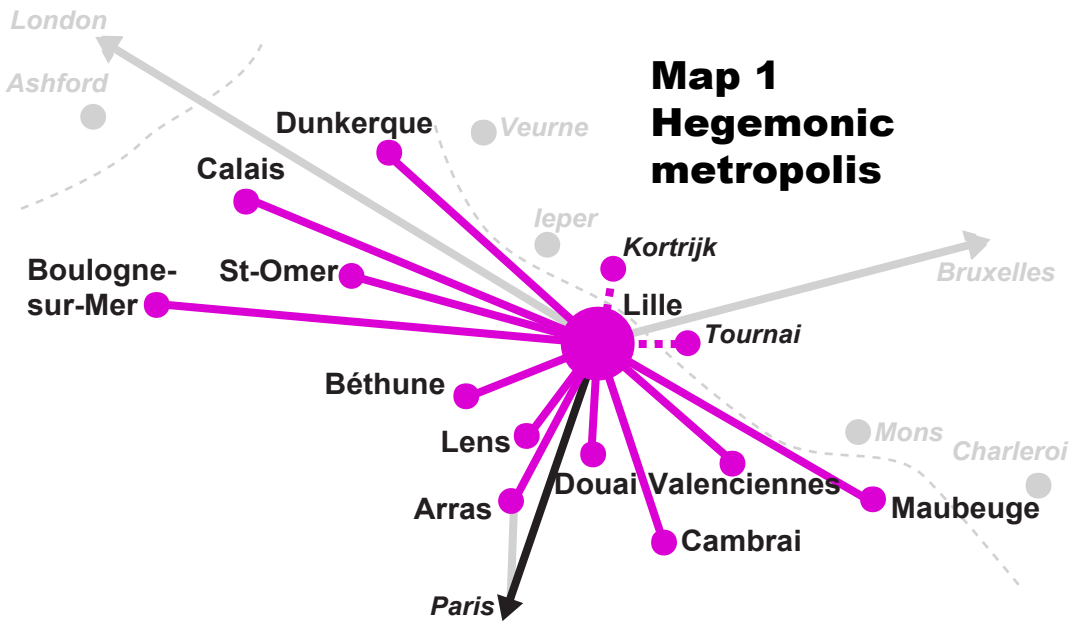
The analysis in terms of transport service can be used to assess the regional planning scenarios with criteria not only based on transport supply principles but including also some elements of the demand –segmentation of the demand, identification of major traffic attractors and urban rhythms.

The modelling framework allows to identify unsatisfying states of the system, and to simulate some correcting modifications of the transport supply, and their potential consequences on the transport service at the regional level. The scheduled accessibility measures produced can then be interpreted in terms of regional planning strategy. In particular, the results demonstrate the potential positive effects of a valorisation of intermodality to improve the transport service but also to better answer to regional planning objectives.

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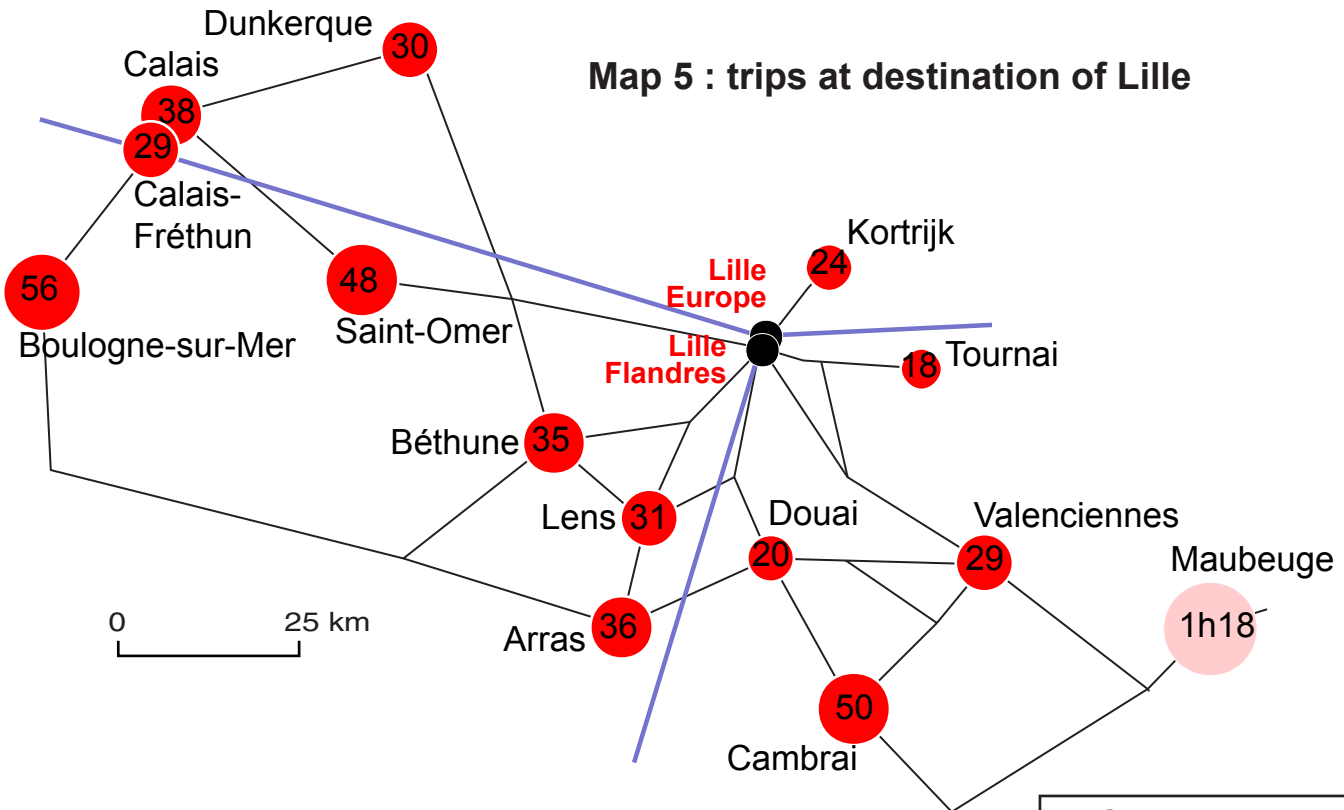
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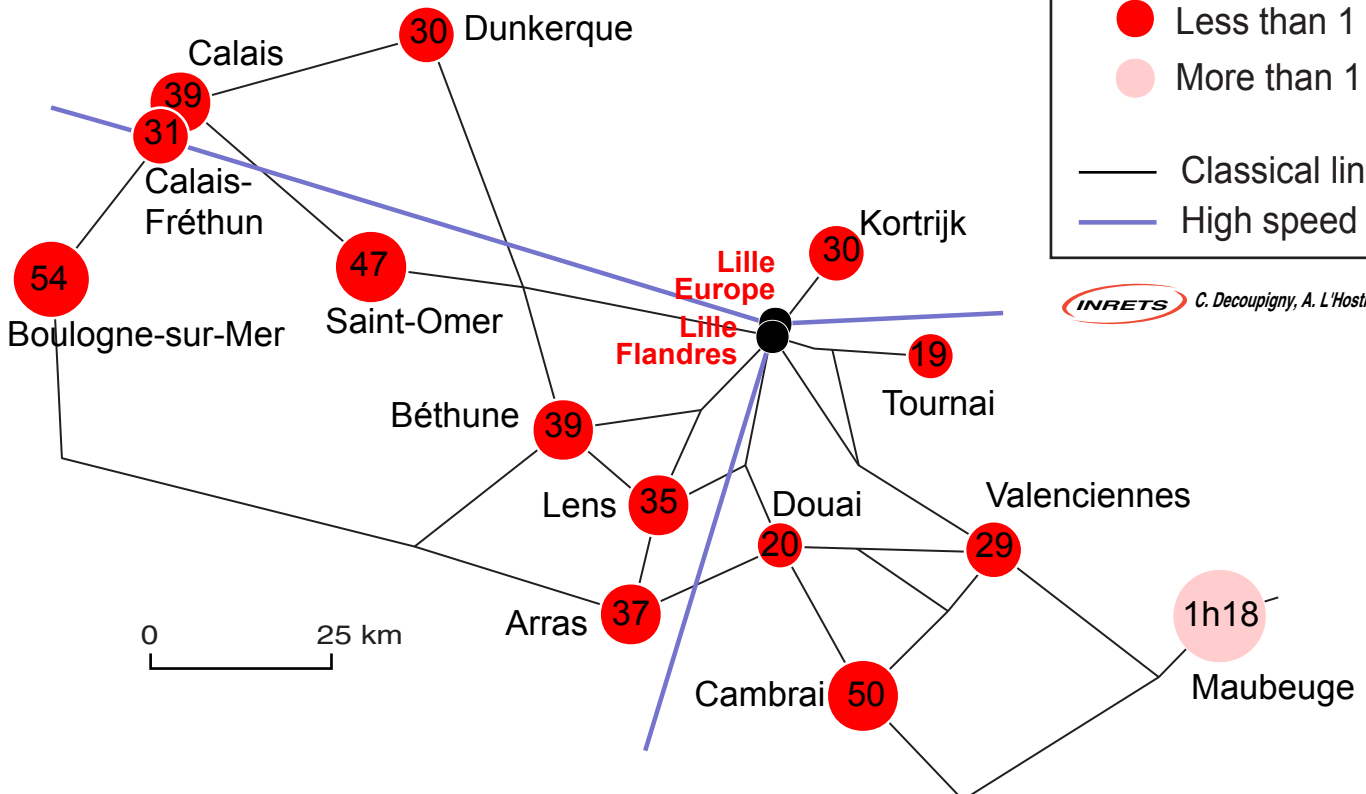
# CLASSICAL ACCESSIBILITY

Minimum travel times all over the day from station to station considering a normal week-day of the winter 2000-2001

Map 5 : trips at destination of Lille



Map 6 : trips starting from Lille



**Station-to-station travel times**

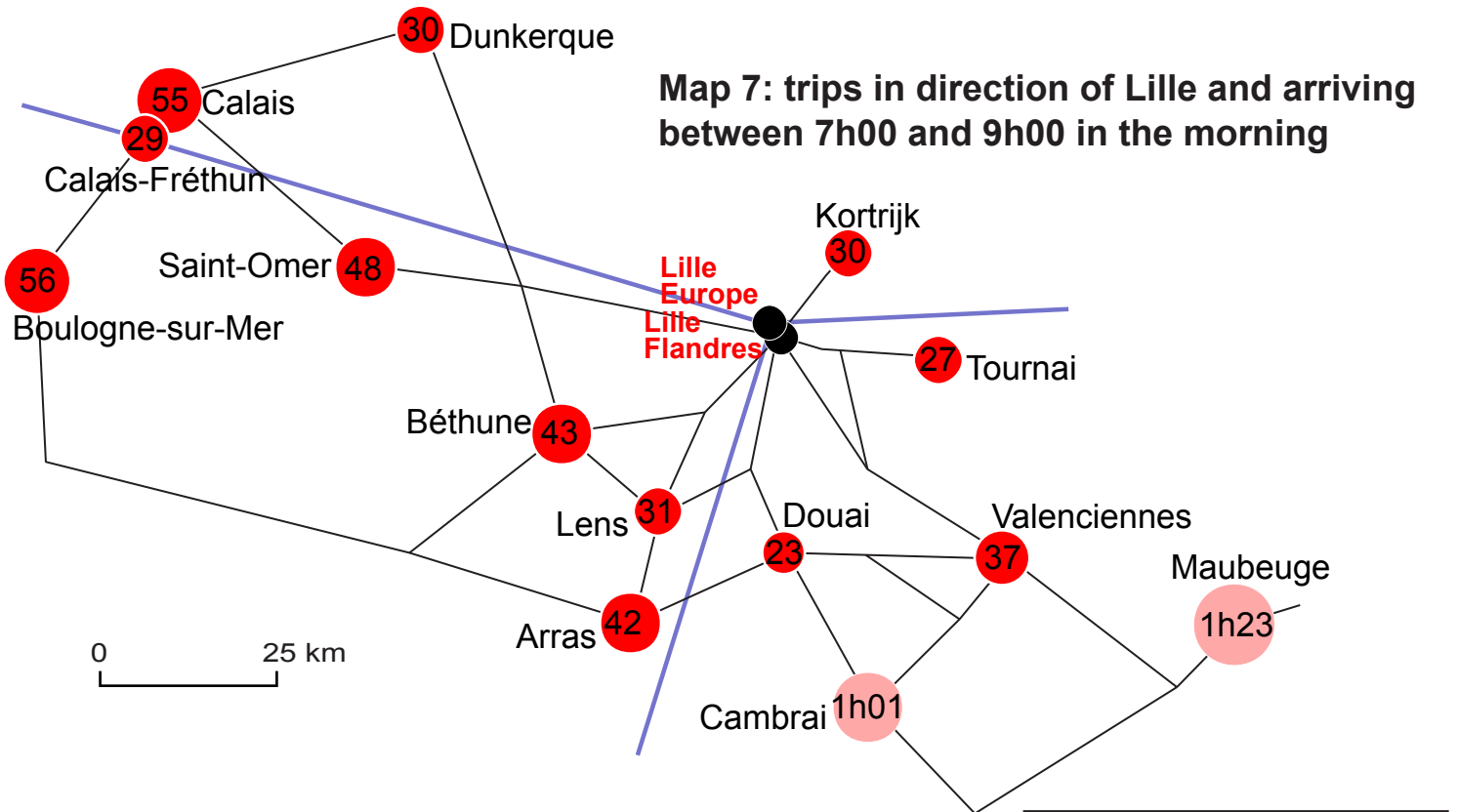
0 30 min 1 hour

- Less than 1 hour
- More than 1 hour
- Classical line
- High speed line

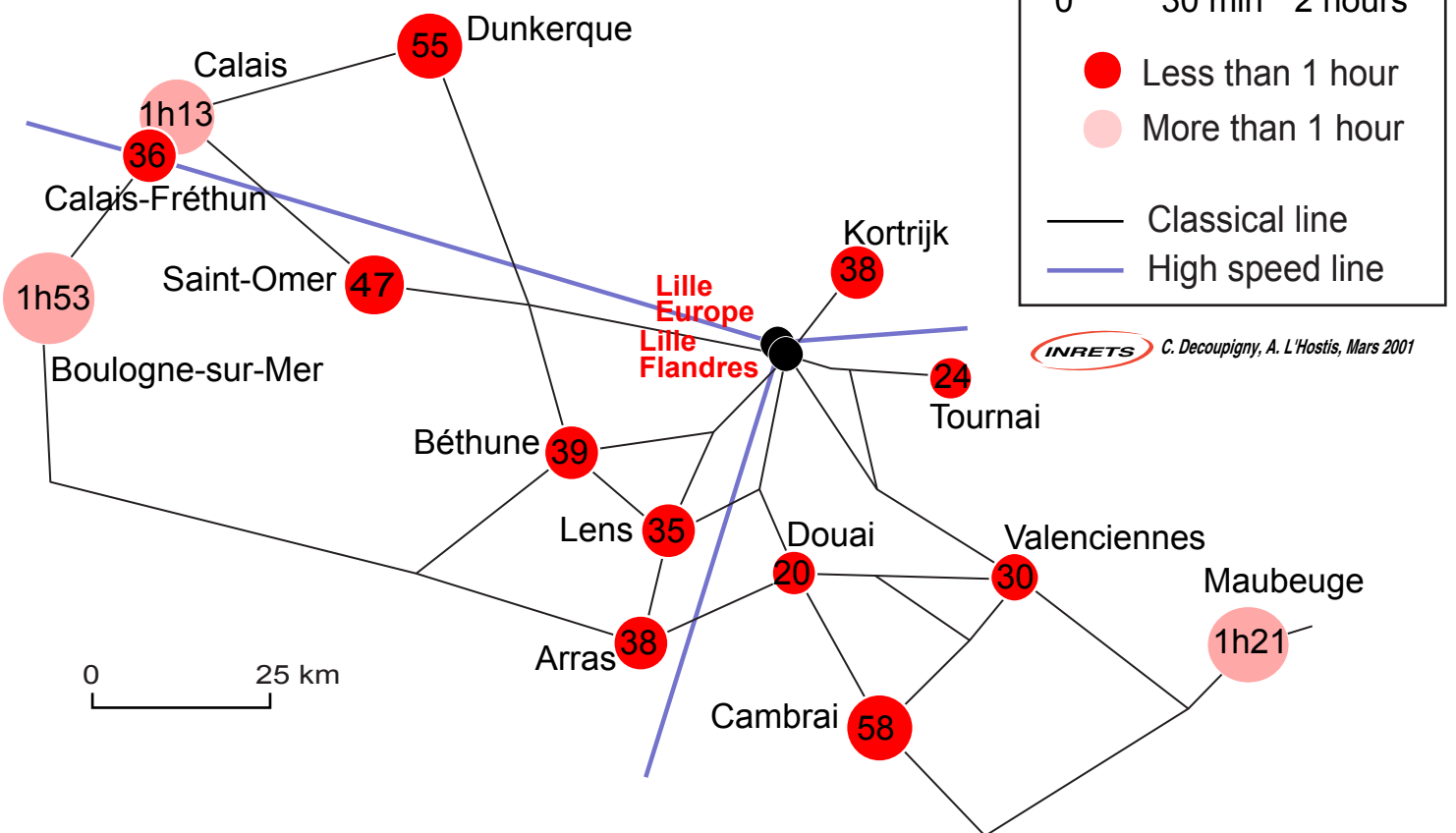
# PEAK PERIOD ACCESSIBILITY

Minimum travel times during peak periods from station to station considering a normal week-day of the winter 2000-2001

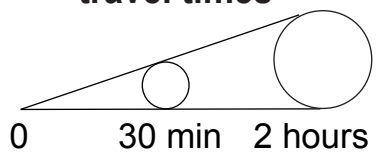
**Map 7: trips in direction of Lille and arriving between 7h00 and 9h00 in the morning**



**Map 8: trips starting from Lille and arriving between 17h00 and 19h30**



**Station-to-station travel times**

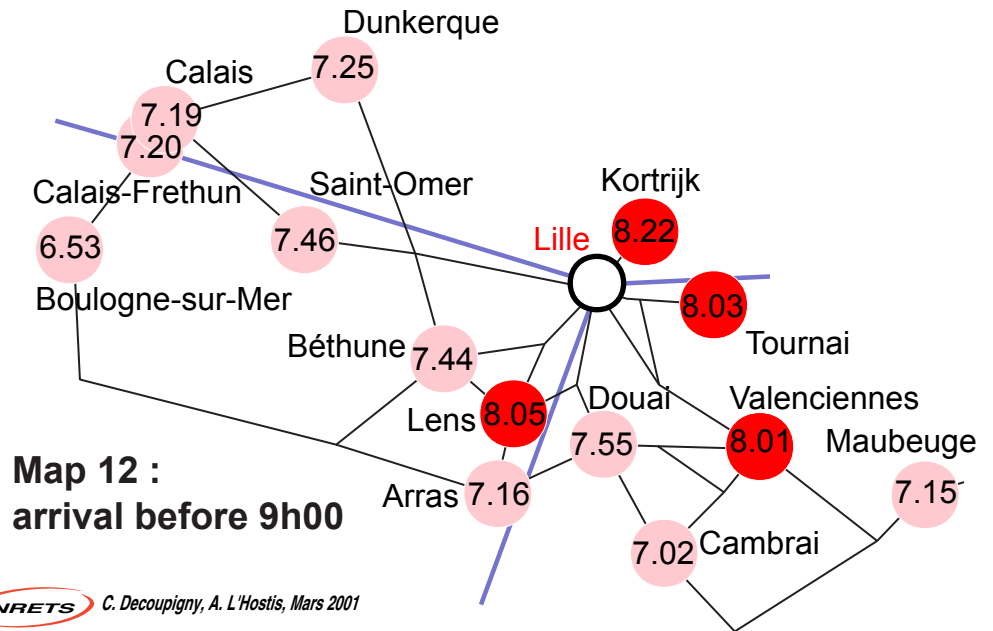
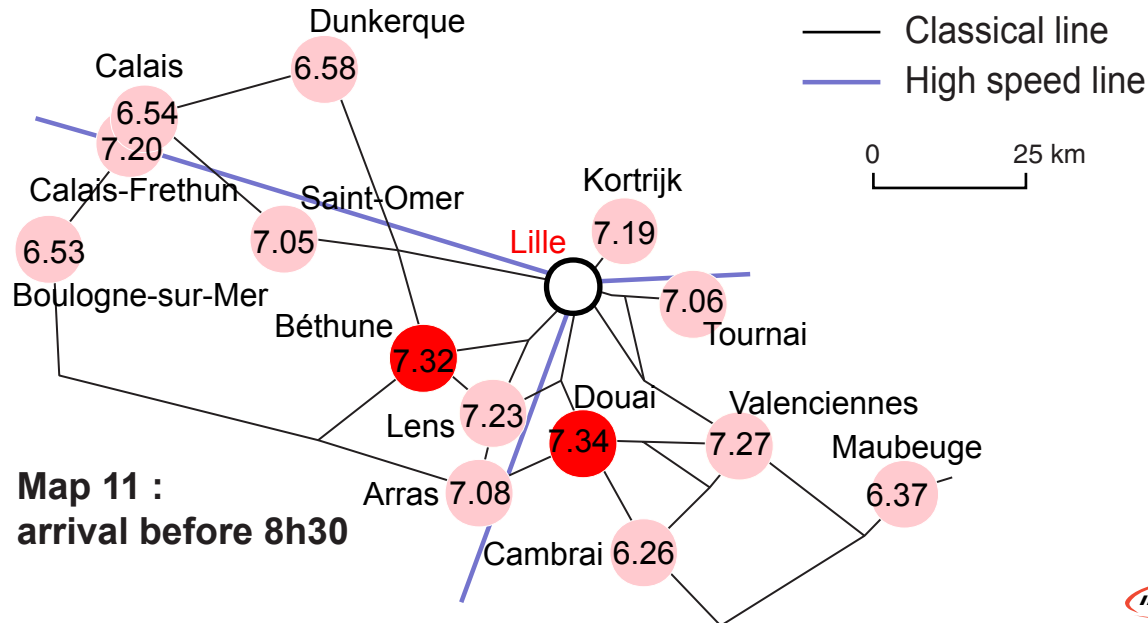
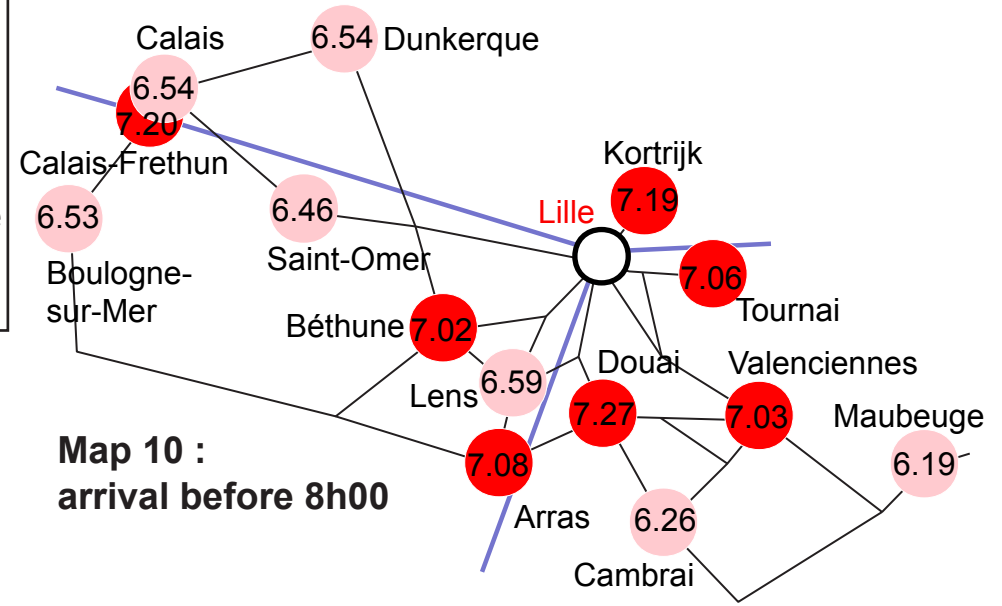
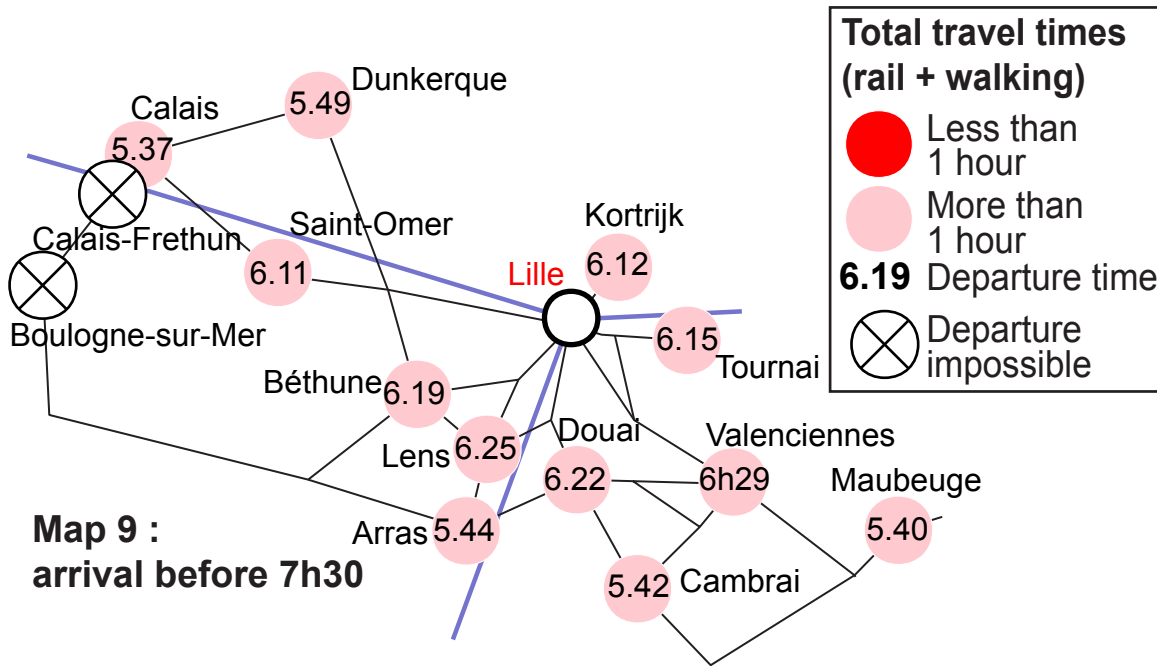


- Less than 1 hour
- More than 1 hour

- Classical line
- High speed line

# SCHEDULED ACCESSIBILITY TOWARDS LILLE

Minimum travel times by rail + ten minutes walking from Lille's central station

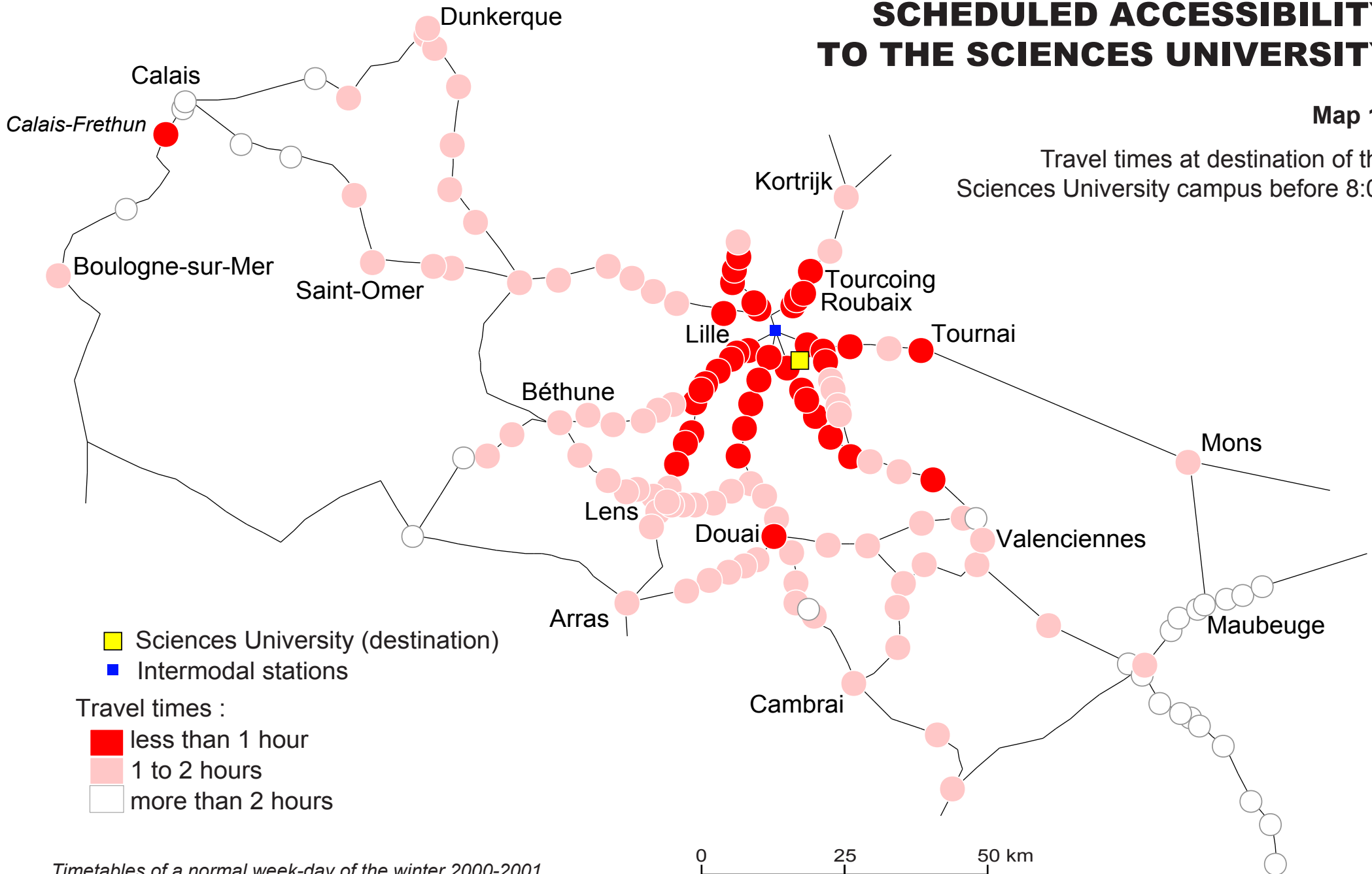




# SCHEDULED ACCESSIBILITY TO THE SCIENCES UNIVERSITY

Map 15

Travel times at destination of the Sciences University campus before 8:00



- Sciences University (destination)
- Intermodal stations

Travel times :

- less than 1 hour
- 1 to 2 hours
- more than 2 hours

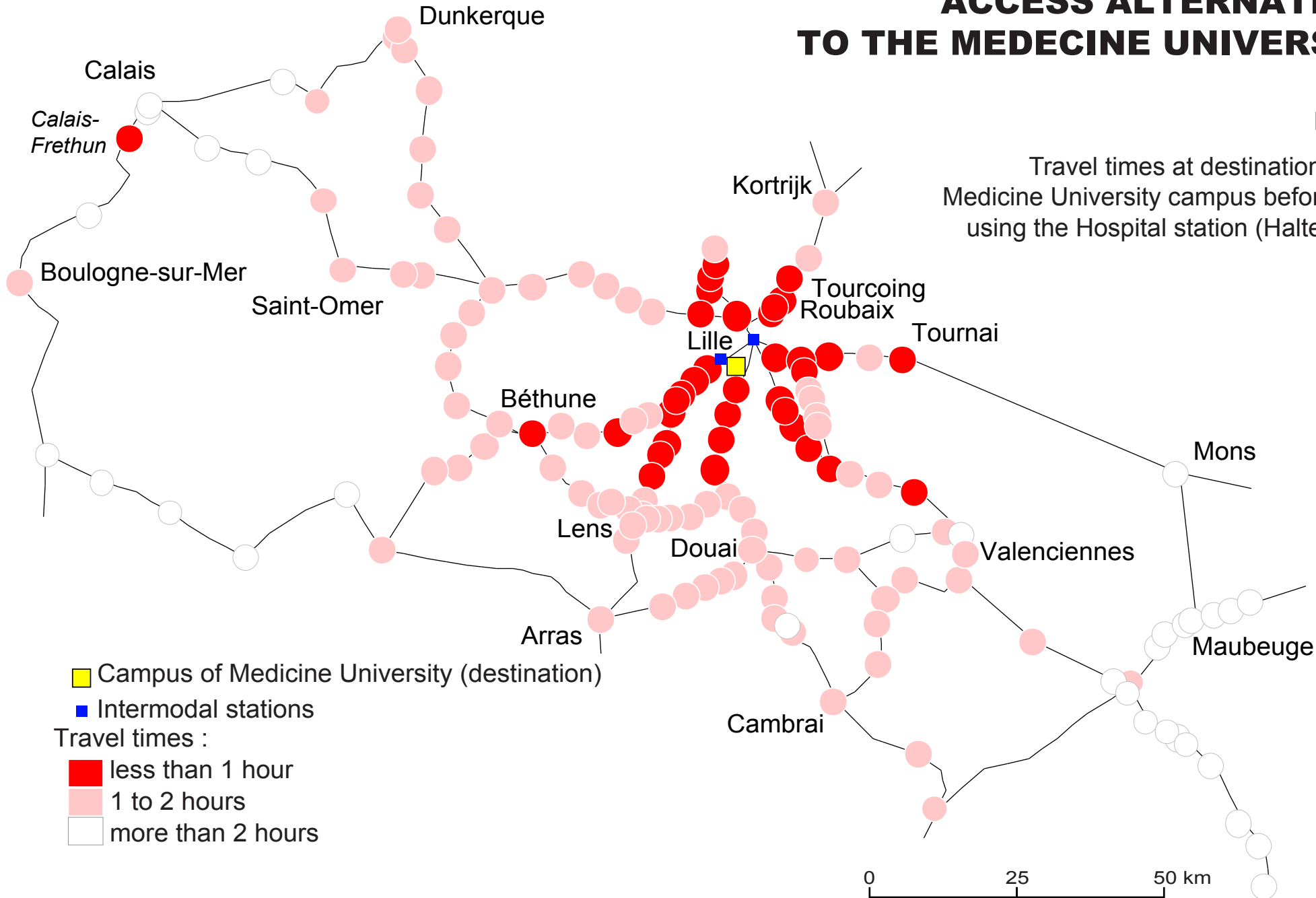
Timetables of a normal week-day of the winter 2000-2001

0 25 50 km

# ACCESS ALTERNATIVES TO THE MEDECINE UNIVERSITY

Map 16

Travel times at destination of the Medicine University campus before 8:00 using the Hospital station (Halte CHR)



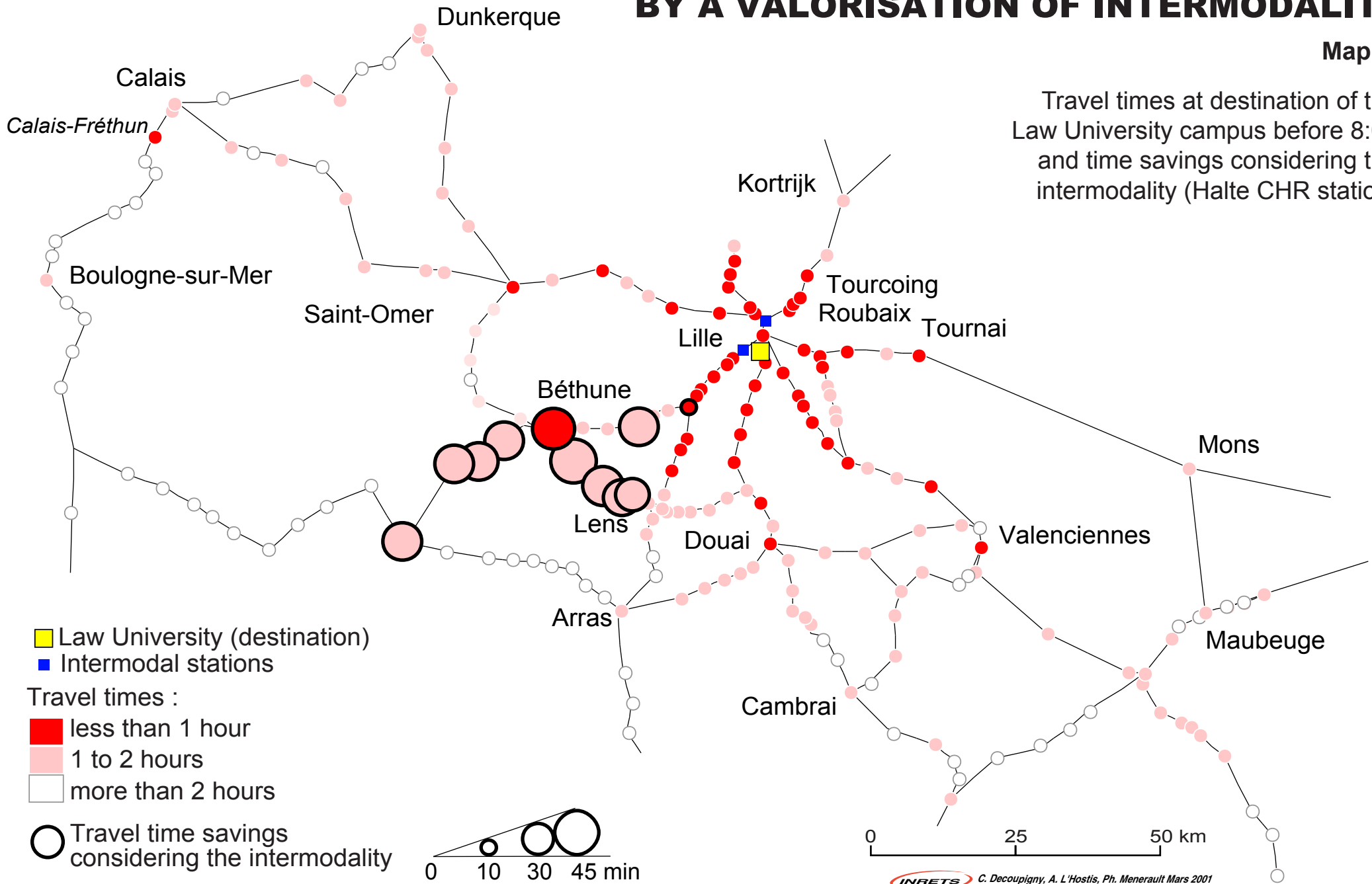
- Campus of Medicine University (destination)
  - Intermodal stations
- Travel times :
- less than 1 hour
  - 1 to 2 hours
  - more than 2 hours

Timetables of a normal week-day of the winter 2000-2001

# ACCESSIBILITY IMPROVEMENT BY A VALORISATION OF INTERMODALITY

Map 17

Travel times at destination of the Law University campus before 8:00 and time savings considering the intermodality (Halte CHR station)



■ Law University (destination)

■ Intermodal stations

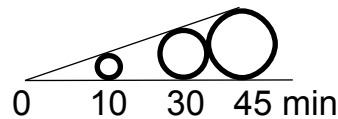
Travel times :

■ less than 1 hour

■ 1 to 2 hours

□ more than 2 hours

○ Travel time savings considering the intermodality



0 25 50 km

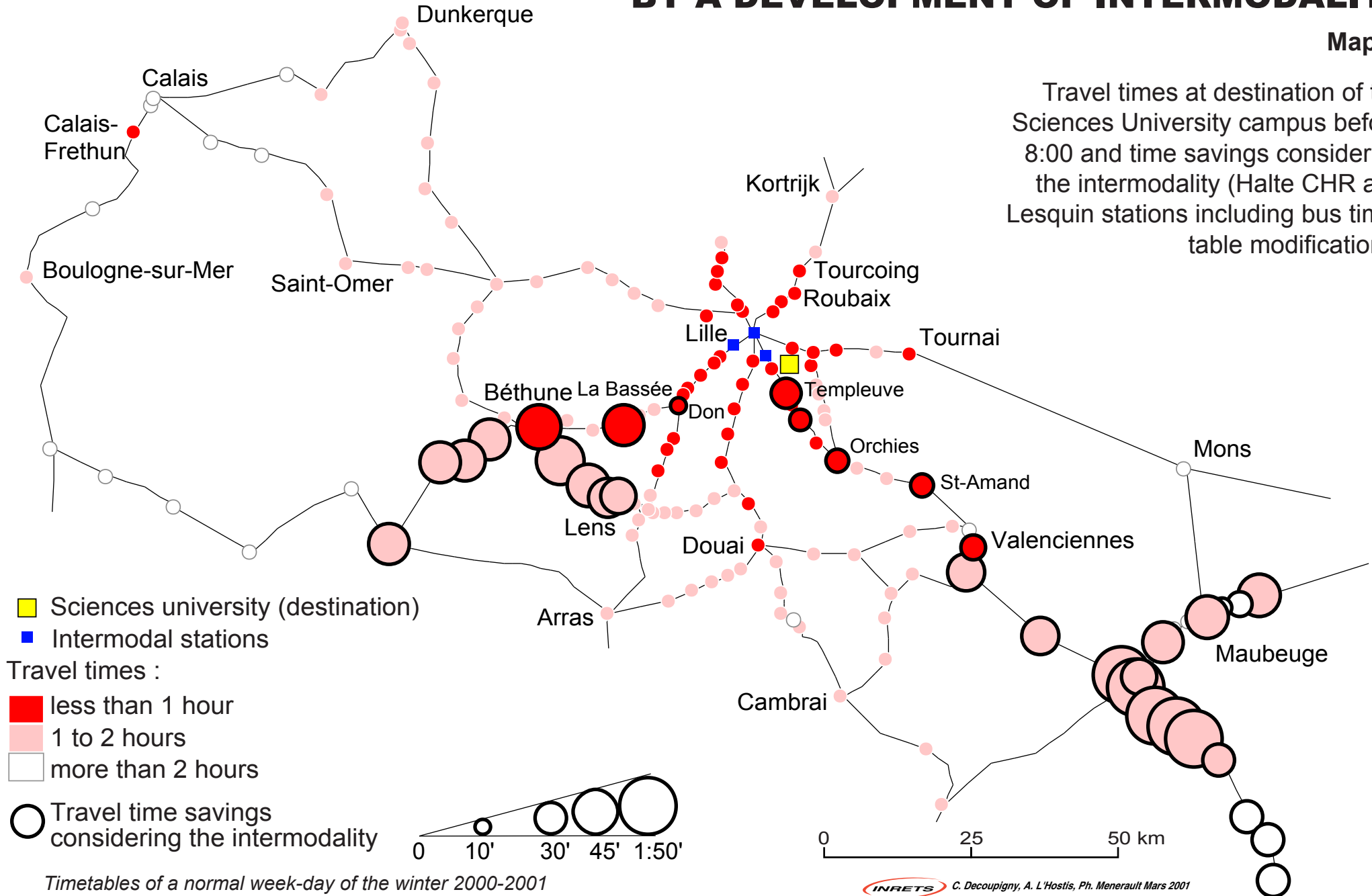
INRETS C. Decoupigny, A. L'Hostis, Ph. Menerault Mars 2001

Timetables of a normal week-day of the winter 2000-2001

# ACCESSIBILITY IMPROVEMENT BY A DEVELOPMENT OF INTERMODALITY

Map 18

Travel times at destination of the Sciences University campus before 8:00 and time savings considering the intermodality (Halte CHR and Lesquin stations including bus timetable modifications)



Timetables of a normal week-day of the winter 2000-2001