1- INTRODUCTION

Intermodality in transport is to consider modal integration. Its aim is to result in a global consistent system, which is able to manage the interactions between the various transport modes. On the contrary, multimodality in a system implies the presence of several modes without any previous assessment of their compatibility. If the actions on the infrastructure are significant, the contribution of the management systems making it possible to coordinate the operation of transport modes should not be neglected.

This paper tries to draw a synthesis on the consideration of intermodality in the existing management systems, which take into account the private vehicle (PV) and the public transport (PT) in urban areas. It proposes an analysis according to a time scale: from the strategic level (delay time) of the planning systems to the operational level (real time), through the tactical level.

2- THE STRATEGIC LEVEL

At the strategic level, the decision makers need tools to forecast the demand and the trip behaviours, which will help them to make their decisions on transport policies. The goal is to match demand with offer either for the long, mean or short term.

2.1 The existing planning models and softwares

There are softwares on the market, which are computer tools with a toolbox design providing several methods of mathematical modelling. The main multimodal softwares existing on the market are the following:

EMME/2 (Canada), POLYDROM (Switzerland), START (Great-Britain), TP+VIPER (the successor of MINUTP, United States), TRANPLAN (United States), TRIPS (Great Britain), VISEM/DAVISUM (France-Germany).

Models could be designed using or not one of the mentioned softwares. For our study, we have analysed some French models such MODUS, GLOBAL, ANTONIN, IMPACT, etc.
Critical analysis

If the above-mentioned models and softwares process multimodality, it is difficult to qualify them as intermodal. We can formulate two types of observations on these models. The first ones are constructive as far as they enable to point out the deficiencies of the models which could be corrected. The other ones on the contrary, put in question the capacity of these methods to represent an intermodal demand. In the first category the following deficiencies can be mentioned:

- The majority of the softwares don't allow any integrated representation of the individual vehicles and public transport networks. It sets problems, on the one hand to achieve a simultaneous assignment on consecutive networks and on the other hand to represent parking areas as interchanges between both modes.
- Models are interested by the design of networks rather than by management aspects. Thus the models cannot assess all of the qualitative measurements aiming at enhancing modal shift, such as improving PT safety or comfort or interchanges quality, etc.

The second series of observations are made of the following points:

- Whatever the robustness of the used mathematical theories, a sequential processing of the four steps doesn't allow any intermodal forecasting. Indeed an essential step among the four consists in determining the origin destination matrixes for each transport mode. The various modes rather are processed as modes in competition and not as complementary modes. It implies that even in the case of the models which process the PV + PT modes, either it is a sub-mode of another one (most often public transport) or it is a different mode but it is in competition with the others.
- Normally, the models are calibrated according to the survey results which reproduce the current situation; they then have a conservative characteristic. However the present intermodal demand is marginal and what is seeked is to create a new intermodal demand which probably would provide new behaviours.

3- THE TACTICAL LEVEL

At the tactical level, the concern is more the short term, because the problem is to forecast the implementation of efficient operation measures so as to manage offer and demand. The used tools at that level should enable to reach the following objectives:

- To know the traffic and assess the operation measures before they are applied in real time. This knowledge should be acquired either to solve a recurrent congestion problem or to implement a strategy making it possible to cope with the foreseeable anomalies in transport offer (strikes, works, poor meteorological conditions) or in transport demand (sport or cultural events, markets, etc). This is possible thanks to the simulation models.
• To plan the offer. Here it is a matter of defining the strategies to apply before the trip and which enable to optimise the offer (individual network capacity, public transport capacity, parkings, etc) either to cope with recurrent problems or with special events. This is possible through the implementation of signals, traffic light plans, vehicle schedules for public transport, static information strategies etc.

3.1 Simulation models

Traffic simulation models aim at reproducing in the most accurate way situations which cannot be tested in real time, either because their application in real time is too expensive or too risky or simply because it is not feasible. Because of their aggregated structure, the macroscopic models rarely process intermodal simulation. The rare models which take into account the bus traffic, but they do it in order to represent its influence on road traffic.

The microscopic models, which model private vehicle and public transport traffic are the following: CORSIM (USA), DRACULA (UK), DYNASIM (France), FLEXYT II (Netherlands), HUTSIM (Finland), INTEGRATION (Canada), MICSTRAN-II (Japan), NEMIS (Italy), PLANSIM-T (Germany), SIGSIM (UK), SITRA B+ (France), TRANSIMS (USA), VISSIM (Germany).

The majority of these models consider a PV and PT integrated network, which enables a combined modelling of both modes. The size of the network ranges from ten nodes in SIGSIM to ten thousand nodes and five million vehicles in TRANSIMS.

Critical analysis

The existing microscopic and mesoscopic simulation models are the best to solve the simulation problems of intermodal traffic. Those models generally are able to represent an integrated network of PV and PT. They can test control strategies of PV or PT, bus priority strategies, etc. However several deficiencies still are to be improved, especially on the following points:

• Services are briefly taken into account, because the models are centred on the physical networks, which doesn't allow to study the impact of service quality improvements on intermodal transport;
• Parking places are not considered as interchanges. Indeed, though some models represent parking places or the search for a parking place, none of them considers these parking places as a traffic source for public transport, which is in contradiction with an intermodal policy;
• Pedestrians, bicycles and two wheels are little or not taken into account in the models whereas they are more and more significant in traffic.
3.2 Offer planning

It is a matter of network use planning in order to satisfy the demand, while respecting the comfort and safety aspects.

One can suppose that the offer is intermodal when it has the following characteristics:

- The connectivity of networks in order to provide consistent intermodal trips;
- The quality of public transport offer so as to promote modal shift;
- The quality of intermodal services, especially with travellers information, unified pricing, parking safety, etc.

If a significant work still remains to be provided to each of these three domains in order to represent an actual intermodal offer, it certainly is the first point which has been most neglected until now.

4- OPERATIONAL LEVEL

At the operational level, the intermodality between PV and PT should be achieved through the development of trip integrated management systems. Those systems will have to act both on the transport demand (pricing and information systems) and on the offer through operation aid integrated systems.

4.1 The systems of demand management through pricing

The aim is to act on the modal split of trips through the management of pricing structures. **Integrated electronic payment**: the single transport ticket is a mean which could enhance public transport use, especially if that ticket makes it possible to have access to relay parks. The experiences led in Europe (GAUDI project, STRADIVARIUS) have shown the success of these operations among travellers.

**Urban electronic toll**: urban road toll enables to regulate the access to some areas according to air quality or congestion. Some rare experiments have been achieved in Singapore, Oslo and Trondheim, and more recently in London, Bologna, etc. This type of measures requires preliminary studies so as to ensure social and space equity.

**Critical analysis**

One of the levers of intermodality between PV and PT implies to implement common integrated payment systems for PV and PT. However, the achievement of such systems is not at the agenda. They probably will be extended to urban road toll once the first generation of intermodal ticketing systems for public transport will have been deployed.
4.2 Interchanges management systems

These systems must make it possible to ensure the connection between transport modes through the management of the access points. They control the sequence of operations of the connections and inform the passengers on the potential delays and disturbances.

Critical analysis

The works on interchanges rather deal with the infrastructure design than with the development of management systems. Such systems still are little developed, especially when they require the cooperation of several operators.

4.3 Intermodal systems of travellers information

The multimodal information concerns the various modes and their interconnections. It gives the traveller the opportunity to optimise his trip and to improve his comfort through reducing uncertainty. The pre-trip information which is significant for the choice of the trip mode, route and schedule is distinguished from the information during the trip which can give information on the disturbances about the various transport modes (road congestion, operation incident on a public transport line, parking filling) and give recommendations for the transfer towards more relevant modes.

The information dissemination is based on various communication medias such as board displays, information boards, interactive terminals, minitel or Internet servers, mobile phones (SMS messages, WAP), etc.

Critical analysis

The state of the art of those systems rather shows a superposition of monomodal information systems than the existence of actual intermodal information systems. Their implementation comes across institutional and organizational barriers concerning the sharing and operation of common data. However, some of these systems have been carried out with the support of European programs as in Munchen (EUROSCOUT), Hannover (MOVE), Marseilles (INFOPOLIS, LE-PILOTE), Southampton (ROMANSE) or Torino (5T, TITOS).

4.4 The priority management of PT and the intermodal traffic control

The principle of the priority management of public transport is part of an intermodal management of the road. It consists in giving the priority to surface transport (bus, tramways) at traffic lights. The strategies of bus priority and their generalization have been recently considered in the frame of PRISCILLA the European project.
Critical analysis

Too often, one forgets that the bus priority can prove inefficient, or even detrimental, in case of congestion. Only the integrated management of the modes offers another solution to develop an intermodal control of the bus priority. From the knowledge of the traffic conditions of buses and individual cars, it would be possible to apply more sophisticated dynamic strategies, taking into account both the congestions and disturbances which affect public transport.

4.5 Networks integrated management systems

The integrated management systems use the concentration and the merging of multiple data sources. However, this integrated management must go beyond the simple interconnection of the existing systems, and result in the setting of a higher-level system, which is still called mobility management system. These systems will have to dispose of a real generic model of the reference transport network, the support of a common database which must be compatible. It includes the various functional and technical networks of public transport and individual vehicles.

The works around the global management of mobility will concentrate the current research on sites such as Toulouse (CLAIRESGGD project), Torino (5T, TITOS), Munchen (MOBINET project), Koln (ENTERPRICE project).

Critical analysis

Now, integration rather is placed at the level of information, through concentrating and merging data sources than at the level of decision. The systems already propose strategies for the cooperative management of congestion (CLAIRES system for instance) or intermodal strategies for information dissemination in order to enhance modal shift (5T, MOBINET).

However, significant progress still remains to be achieved to constitute an actual intermodal diagnosis and implement coordinated and multimodal actions. It is in that context that INRETS develops a multimodal research platform on the combined management of individual vehicle and public transport modes.

5- CONCLUSION

In this paper we have demonstrated that whatever their intervention level, most of the existing information systems rather are multimodal than intermodal. This poor modal integration partly is due to the fact that one rather attempted to complete the monomodal systems than to propose systems to model modes interaction. This latter approach will involve the formalization of an explicit modelling of an intermodal transport system and of its functions. A significant research and development field thus remains open for the next decade if one desires to obtain an actual intermodal transport system.