THE VARIOUS AGENT'S ROLES IN INTERCONNECTION PROCESSES : THE STUDY OF SEVERAL PUBLIC TRANSPORT NETWORKS

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Among all factors favourizing interconnectivity, the willingness of the whole actors concerned cannot be considered as the less important one. If technical constraints are in general surmountable, commercial, strategic and economic issues seem to be more determinant (Gille, 1992). First of all, there must be either a convergence of interests, or a strong political willingness imposed to network operators. In all cases, processes are quite complex.

Moreover, the interconnected "product" can have various forms, from the minimal option (only connection) to the autonomous operator of interconnected services, who maximizes interconnection effects (size effects, economic optimization). It can become more and more complex, as fast as changes of use occur in the new interconnected network[1]. The operation rules can be modified, either by operators themselves, or by external actants (more regulation, deregulation, dismemberment, etc.)

This paper aims to propose a typology of interconnected networks ways of management, in comparison with the system of actors that made the interconnection feasible, and with their possible evolution.

I - Systems of actors

Interconnectivity is a process bringing into contact at least two different network operators, and political authorities managing the corresponding institutional territories. Operating scale of networks and territorial management scales can be different : we may obtain a great number of actants, with divergent interests.

Even inside the process, the relationship between actors can be modified, on the occasion of changes of purpose. For instance, the achievement of the long maturing process of the "Passante" project in Milan takes place after a *volte-face* done by the city of Milan council, and provoked by a changeover of political power in 1975.

We made a distinction between three categories of systems of actors, according to the origin of interconnectivity projects initiative : in two cases, one single actor (political authority, operator) gives the impetus with a strong willingness, and in the third case, the whole actants grasp collectively an opportunity, and they work in a real partnership.

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[1] cf. the example of the *dispatching* in the French interconnected electricity network in the 1930's : there is a change from a simple search for adequacy between supply and demand to the regulation of network effects and to arbitrations between different energy sources whose production costs are not the same.

In the two first cases, one of the actors try to lay down his own solution, putting forward town or country planning necessities (creation of new solidarity links between different parts, territorial equity, etc.), or purely technical reasons (interconnection has positive effects on service quality, and there is no other possibility). In the third case, there is a consensus between actors for the choice of one solution.

A - The imposed interconnection, as a space planning tool

In this category, the territorial manager is the initiator of the process. In most cases, the willingness to interconnect comes from a newly-created actor heading up the others. This new entity has a territorial competence permitting a comprehensive understanding of the problems for the whole urban area. The RER interconnection in Paris urban area would not has been possible without the creation of the Parisian Region (future "Île-de-France") in 1956. The same kind of explanation can be given for the milanese project of rail "Passante" : the creation of the Lombardy Region in 1970 favours its maturation. In both cases, interconnection is decided within the context of a new regional organization of the railways network.

So interconnection projects appear first in town or regional planning documents, and they are more or less imposed to the companies which manage networks. For instance, the "Passante" project frustrates the aims of the urban public transport company (*ATM*), particularly the creation or continuation of subway lines, and the takeover of the private regional railway network operating in the northern part of the urban area (*Ferrovie Nord Milano*[2]). In other cases, the principle of a collaboration between different companies in an interconnection process is hard to be admitted. For the interconnection of RER lines in Paris, the urban transport company (*RATP*) agrees to the creation of a regional interconnected network, but solely if it becomes the only operator, as it occurred when line A has been created (Two parts of this line took into account by *RATP* were previously operated by the French national railways, *SNCF*).

Networks operators, not being prepared to work together, have inevitably to reorganize themselves, and to reduce as far as possible technical and organizational disparities. The national railway company creates in general a specific regional department on that occasion : for instance, SNCF creates in 1988 a department in charge of parisian regional transit. Furthermore, the difference in size between interconnected networks can add another problem : *FNM* or *RATP* appear as "Tom Thumbs" compared to national rail

[2] This company has been finally taken over by the Lombardy Region in 1975.

companies like *FS* or *SNCF*. Decision-making processes, mentalities, even objectives are quite different. If interconnection is a major event for little networks, its importance is relative for national-operating companies.

On the other hand, some operators can gain by the event : they obtain the financing of infrastructure works very useful for not interconnected services. For instance, the capacity of the urban section operated by *Ferrovie Nord Milano* has been improved (from two to four tracks). That was a *sine qua non* requirement for the approval of the *Passante* project. SNCF also benefits by the creation of RER line B with a complete retructuring of Paris-Nord station, grouping together, on several levels of the same "box", interconnected services (lines B and D) and classical suburban services.

When authorities stop commending interconnection, the collaboration dynamic does not go on for new projects. In Paris, the competition between *SNCF* and *RATP* for a new line doubling RER line A illustrates this point : each company produced its own project (*Eole* for *SNCF* and *Météor* for *RATP*), radically different one from the other. This opposition repeats the old antagonism between the city of Paris and the association State / major railways companies at the time of the subway network conception (ca. 1895) : *SNCF* promotes a new RER line (with the characteristics of national railways), linking together eastern and western parts of the urban area. On the contrary, *RATP* wants a new subway line, operating at a smaller scale. The final choice made in 1991 by the State and the Île-de-France Region is the most costly one : the two lines will be built. It will take more time (the instantaneous loan costs must stay to an affordable level), and other projects in peripheral areas (where demand is now the most important) will be delayed.

The impulsing function of Authorities cannot be limited to the technical interconnection : an optimal use of the future network requires also tariff integration at the same time. As it occurs for technical choices, each network stands up for its own tariff rules, and is not necessarily interested by tariff intégration. This debate emerges now in projects of interconnection between regional rail and urban transport networks in some main French cities. The formers link tariff and distance, and offer weekly tickets ; the latters use inclusive tariff and rather monthly tickets, etc., so finding a common ground is a very hard task (Zembri, 1993).

Interconnection as a tool used within the framework of a planning policy is more imposed than desired. The impulse must be continuous if political authorities want the operators to go on in their collaboration for future

projects. Even if they need, as it occurred in Milan, to impose a single operator for interconnected lines.

B - Interconnection as a technical necessity

An interconnection phase, within a technical process of network morphogenesis (Offner, 1993), can be necessary, in order to ensure a better quality of service to the user, and to limit the dependance on local resources (especially available for electricity, water or gas networks). In this case, the impulse is delivered by the operators, anxious to optimize their production and aware of the weakness factors of their tools. Some remarkable personalities for their perceptiveness emerge in networks history, like Samuel Insull (who created the first large electricity network in Chicago), Ernest Mercier in France (who interconnected for the first time regional electricity networks), or Th. Vail (who founded AT&T).

The example of electricity illustrates very well this voluntarily innovative processes (Lacoste, 1986 ; Bouttes, 1990), with the objective of developing the network, or more simply, of making it survive in the competitive context of the 1920's.

Two major technical innovations make possible a large scale development of electricity networks : the victory of alternating currant on direct one circa 1900, and then the development of long range electricity transport at low costs, without any power losses on line. At the same time, the increase of power plants unitary size permits energy supply to larger areas. Exhaustive massif equipment programs for production of hydro-electricity becomes feasible, the transport of surplus power to less favourized territories being possible.
Interconnection allows the regulation of production, and gives an opportunity to arbitrate between several energy sources, according to their availability and to their cost. Even between hydro-electric producing regions, interconnection is a way of limiting the effects of seasonal irregularity, generation peaks taking place in different periods from one massif to the other. It also permits optimization of the demand profile, by juxtaposing purely urban needs and industry needs. There is no need to maintain power plants sized for a peak of demand which is not necessarly long : demand is rarely exacerbated in all points of the interconnected network at the same time. In fact, the larger is the network, the more diversified is the clientele, and the overconsumption risks stay at a low level.

In the French case, there have been successive connection waves between networks. In 1920, networks are organized around a single plant. With

hydro-electric plants more complex combinations of networks including thermic ones begin to appear : that is the first regional interconnection. The next phase is the interconnection of regional networks, which creates a "super-network", in order to unite by a common linking the thermic and industrial northern part and the hydro-electric and rural southern part of the country. This inter-dependance, gloryfied by operators and authorities, becomes a symbol of national unity. As from 1934, six main companies divide the French territory among them, and get some comfortable profits despite the 1930's economic depression. The last phase is the nationalization of production, transport and distribution of energy. The process begins in 1938, during the "Front Populaire" government - creation of the "Groupement de l'électricité"- and continues in 1941 with the creation of public energy transport companies. The final result is a complete nationalization in 1946, with the creation of *Electricité de France* (EDF).

Interconnection appears as a result of the exploitation of technological innovations effects by operators with a commercial purpose. The process constitutes the basis of the emergence of large companies like *AT&T*, and of the enacting of standards at a large scale (especially for telecommunications). In the same time, transport companies lived cut off from this integration-interconnection movement impulsed by technical necessities. The motives of mergers, absorptions and other nationalizations which happened have been very different.

C - Interconnection as taking advantage of an opportunity

In this way of linking very dissimilar networks, the process is facilitated by favourable circumstances : actors for which interconnection had never been a priority, suddenly convert to this idea, without neither any significant technological overhang, nor basic changes in networks environment. The two following examples illustrates very well this kind of situation :

- **Interconnection of a urban light rail network and a regional rail system in Karlsruhe (Germany)** (Zembri, 1993 ; Troin, 1995) : Karlsruhe is a middle-size urban area (300.000 inhabitants in the central city, 800 000 inhabitants in the whole built-up area), served by a hundred kilometers-long light rail network, which is operated by the *Verkehrsbetriebe Karlsruhe* (*VBK*) for the six urban lines, and by the *Albtal Verkehrs GmbH* (*AVG*) for a suburban line. The outskirts are served by suburban trains ("*S-Bahn*") operated by the federal railways company, *DBAG*. But the central station suffers from its localization, 1,5 kilometer far from the city centre.

The necessity to transfer being a handicap for the use of public transport[3], the Karlsruhe public transport companies thought about new opportunities of direct links between peripheral areas served by *DBAG* and the city centre. After several long months of studies and dialogue, it has been decided to interconnect the two networks at two points (on both sides of the centre), in order to create a mini-RER with technical characteristics of the tram. The two very short connections have been built for a short time and for a low price. The first interconnected line has been put into service in september 1992.

At all stages of the decision-making process, the consensus between all parties, operators and authorities, has been exemplary. The national railways operator didn't put forward technical-based objections (lack of safety, urban rolling stock too light, etc.), as the French railways did when, once the success of the German experience was known, several French urban authorities wanted to launch feasibility studies for her own networks. *DBAG* even agreed that the "hybrid tram" would be driven from one end to the other, whatever infrastructure owner may be, by *AVG* drivers.

Local and regional authorities put up all the money for this project : 50 % by the City of Karlsruhe (which considers interconnection as a mean to reduce car traffic and parking in the city centre), 25 % by peripheral cities, and 25 % by the *Landkreis*.

The Karlsruhe case is not very different from other medium-size European cities. This fact explains that, once the experience was known, lots of cities applied for interconnection : Lausanne and Geneva in Switzerland, Orléans and Tours in France, Sarrebrück and Cassel in Germany, etc. Nevertheless, the technical solutions used in the Karlsruhe case weren't previously unrealizable. There has probably been an "unblocking" in some minds, the end of a generally accepted idea rejecting any compatibility between the two types of networks. Goodwill of all the actors has to be considered too : the idea has been launched in a favourable context, and it has filled everybody with enthusiasm. Maybe each actor's logic has encountered an unexpected case, which finally didn't harm individual interests.

- **Interconnection by exchange nodes of high-speed rail emerging network and air transport in France** : This is an original case if we consider that railways operators and air transport companies relationship are generally characterized at best by a polite indifference, and at worst by an exacerbated competition (in the case of domestic airlines). If connections between airlines and urban or suburban transport services were previously

[3] If urban networks have a market share of 30 to 40 % in their operation zone, the *S-Bahn* attracts only 10 % of centre-péripheral areas transit flows.

possible (and desirable), they were much less conceivable with long distance lines. Moreover, domestic air transport is well-developed in France (because notably of a very attractive fare policy), and the recently-built high-speed train lines are formidable competitors, permitting in some cases (Paris - Lyons, Paris - Nantes, etc.) equivalent center to center travel time length.

In other European countries, connection precedents between air lines and long distance trains are themselves rare and recent : Zürich-Kloten, Francfort, Geneva-Cointrin. In Germany, some attempts to put in complementarity train and plane for short domestic lines took place in the 1980's : *Lufthansa* has chartered during a few years trains between Frankfurt-on-Main and Cologne in order to replace too short and too expensive flights. These "*Airport Express*" services were referenced as flights (with a *Lufthansa* flight number), and on-board services were looking like air transport ones (luggage registration and check-in in airports[4], board-staff, etc.). The dedicated trains were wearing *Lufthansa* colours. But this experience had no following.

The new type of rail-air interconnection has not been initially desired neither by air operators (air lines, airport managers), nor by *SNCF*. But il appeared that, in two new high-speed lines projects, designed according to a purely rail logic, and passing respectively in the eastern part of Lyons and Paris urban areas, the airport was in the chosen "corridor". So was it possible, with limited additional costs[5], to bring the TGV under air terminals. The occasion has not been missed.

In a second phase, the different actors have agreed on the use of the new intermodal nodes, but in a very timorous way : trains and planes are not really connecting, even if *SNCF* asserts that TGV serves Roissy Airport in periods of time corresponding to the daily maximal air traffic peaks. The travellers flows from one mode to the other will be relatively restricted, at least at the beginning. On the other hand, the choice made by *SNCF* of a reservation system ("*Socrate*"), directly derived from *Global Distribution Systems* (GDS) used by airlines, prepares the way to a common ticketing accessible from any travel agency in the world. Agreements in this way have been concluded in 1994 with various GDS operators. Interconnection of distribution systems is apparently more achieved than services connecting process...

Unlike the earlier example, the partnership between operators is not complete at the beginning ; there is a kind of "habituation" phase during

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[4] Both of them are served by train stations.

[5] If we except a sometimes exorbitant cost of the stations themselves, designed according to a "high-tech" monumental style.

which the different actors discover gradually the potentials of gain that could follow the achievement of the interconnection process.

The main reason of this long evolution is that the interests of the operators are fondamentally divergent, and the dividing lines do not strictly separate different modes : if *Air France* wants to move closer to high-speed rail transport, which is supposed to tout for new customers[6], its subsidiary *Air Inter*, specialized in domestic airlines, and for which TGV is a serious threat, wants the opposite. *SNCF* for its part relies nearly more on local customers, living in urban zones surrounding TGV stations, than on connecting travellers[7]. Airport managers have a relatively neutral attitude : high-speed train is an additional mode in the large existing display. So it is treated exactly like the others : *Aéroports de Paris* partly finances the costs linked to the Roissy Airport interconnection[8]. Public authorities intervene in a very marginal way : only Lyon-Satolas TGV station was financed by the Rhône-Alpes Regional Council.

Interconnection between high-speed trains and airlines is first of all an affair of operators. It may evolve as fast as the different actors' interests will converge.

II - Interconnected networks ways of management : a typology

Once the interconnection is decided, it remains the question of the management of interconnected services : the choice is made in a last resort by the responsible authority (or authorities if several ones are concerned). According to the quality of relationship between networks and to the degree of technical compatibility, all configurations are possible, from separate operations to inter-opérability, and even to the setting up of a specific operator for the interconnected network.

A - "Not in my Backyard !" : the minimal interconnection

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[6] *Air France* proposed *SNCF* to sell itself a quota of reserved seats in each TGV serving Roissy for connecting air passengers. This kind of occupation guaranty hasn't been accepted by the railways company.

[7] By the year 1996, *SNCF* counts on a local potential passengers traffic growing to 1,070 millions and on a connecting passengers traffic attaining 1,310 millions. The air passengers are not the only ones taken in account in order to make the new station profitable.

[8] The total cost, evaluated at 1 325 millions FF in 1989, has been divided up among *Aéroports de Paris* (401 millions FF) and *SNCF* (924 millions FF).

In this case, operators protect their own interests at the maximum (considering their proper logic) : they don't authorize other operators to have access to their infrastructure. All interconnected services, even though there is no need to transfer (perfect technical compatibility), are successively under the responsability of each concerned operator.

The best example of this way of managing is the parisian RER, and especially lines A (north-western branch, to Cergy-Pontoise and Poissy) and B (all services), overlapping *SNCF* and *RATP* networks. If trains pass from one network to the other, there is a compulsory changing of driver, and of regulation in the two border-stations of Paris-Nord and Nanterre-Préfecture. There are two categories of reasons for this choice :

- technical-based reasons : a single regulation from one end to the other of the interconnected lines isn't possible insofar as *SNCF* tracks used by RER, not dedicated to this particular traffic, are also used by suburban, long distance passenger trains and freight ones ;

- organizational-based reasons : *SNCF* and *RATP* employees have very different status and working conditions (work duration rules, rotations organization, etc.), that may make problems arize in the perspective of a drivers interpenetration. To make the rules of the two companies converge without any additional cost, is a nearly-impossible task, considering the social context in the French public sector.

The adopted system is very delicate, and is susceptible to be disrupted by the slightest failure in one of the two networks. For instance, if *RATP* (or *SNCF*) drivers are on strike, interconnection is suspended, and each company operates according to its possibilities, on either sides of the border-station, which becomes a terminal station with a compulsory transfer. This situation can also disrupt the service on other lines using the same tracks, as it regularly happens at Paris-Nord to the new line D (put in service in october 1995), only operated by *SNCF*. Line D trains use line B tracks, between Châtelet-Les Halles and Paris-Nord. In case of interconnection rupture, the underground part of Paris-Nord station, becoming then a platform-to-platform transfer station, cannot receive line D trains.

Once this acknowledgement of fragility is done, it's not so easy to propose another different solution, if we take into account the technical conditions and lack of quality of social relationships (a French exception !). We must also admit that the RER interconnection works quite well, and that in normal conditions (without any strike or technical incident), the interconnected lines user doesn't notice the changing of network, otherwise greatly facilitated by

the "francilian" tariff complete integration. On the other hand, interconnection territorial effects are a recognized fact, and no one can prove that a more integrated way of management would accentuate them.

At last, we have however to notice that the two operators have merged together at several levels : schedules, works periods, and even vocabulary harmonization, rolling stock grouped purchases, maintenance done only by *RATP*, *SNCF* means of signalling adopted by *RATP*, closer contacts between the two parts of line regulators, etc.

The case of the parisian RER differs from other foreign examples because of the management of several former suburban *SNCF* lines (before the interconnection) by the urban transport system operator. *RATP* is also at the origin of the RER concept (connection between two suburban lines passing through city centre)(Dupuy, Gely & Offner, 1990). In most of the other cases (*S-Bahn* in German cities, *Crossrail* in London), the national rail system operator logically manages the interconnection between its own lines, and the operator of the urban transport system confines himself to pure urban services on specific infrastructures.

B - Towards inter-operability

In more elaborate ways of interconnection, only one or both operators serve all infrastructures linked together, without any technical or organizational border. This is a quite old solution : Tokyo and Seoul urban rail transport companies have welcomed on their tracks for several years suburban trains operated by other public or private companies. Trains and operating modes are perfectly compatible ; all users gain by a generalized tariff intégration.

But inter-operability is also possible between more dissimilar networks, as it recently happened in Karlsruhe (see *supra*). In this case, urban network drivers work on the whole route, including *DBAG* tracks. The rolling stock specificity, more tram than train, seems to be at the origin of this fact : the "cultural integration" of *DBAG* drivers to this type of vehicle would had been too long, even though it is directly derived from urban trams that already run on the municipal network. Pragmatism prevailed over the temptation of compartmentalization .

However, the interconnected system could suffer from inter-operability in the current deregulation context, concerning the rail infrastructure use. The urban transport operator actually pays a toll proportionally to the number of kilometers covered on *DBAG* network. This toll, until now modest because of an amicable negociation which took place before the deregulation process,

would be seriously increased if there was a strict implementation of the recently-published *DBAG* tariffs for the use of the whole network by other operators[9]. The future of the Karlsuhe interconnection could be compromised, that shows another time, if it's felt to be necessary, the unstable character of an interconnected system.

C - The emergence of operators specialized in interconnected services

In this last case, there is a total integration of the interconnected services, coupled together with the building-up of a new specific operator, put in charge of organizing and managing only these services. Two cases can be envisaged :

- The new operator results from the merging of the whole former operating companies. Former distinct networks are incorporated in a new "super-network". This is exactly what generally happened as electricity networks were growing within a national framework. The main reason of such an evolution is that, once the interconnection carried out, all the production units become interdependant, and the management of the whole system takes inevitably place at a larger scale ;

- one (or several) specific operator(s), only managing interconnected links, appear in addition to pre-existing companies. In this case, the network of interconnected lines (eventually characterized by specific organization, tariffs, conditions of management, etc.) can be distinguished from the non-interconnected lines, which are only affected by limited changes. That's the well-known situation of telecommunication networks, interconnected by high-debit links which are operated by specialized organizations, like *Intelsat* (only satellite links), or companies like *AT&T* or *Sprint* (Griset, 1992). This kind of organization also exists in the domain of transport, in at least two cases : the milanese "Passante" (see *supra*), and the recently-built Channel Tunnel, linking together France and United Kingdom .

These two last examples however differ one from the other. If all interconnected lines running through the "Passante" will be operated by a subsidiary of the *Ferrovie Nord-Milano* created for the occasion[10], the Cross-Channel link will be passed through by several specialized operators' services : *Eurotunnel* of course, the infrastructure manager also operating shuttle services between Coquelles and Cheriton terminals, but in the same time a few specially-created common subsidiaries of bordering railway networks, for

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[9] according to the European directive 91/440.

[10] including *FS* part of the interconnected network.

high-speed services (*Eurostar*), freight trains, and night trains (*European Night Services*).

The Chunnel experience has repercussions on the approach of existing (and sometimes very old) connections between railway networks in Europe : some other specialized common subsidiaries operating international services have been created since a few years. They own a dedicated rolling stock, and their tariff policies are very different from these generally put into practice (fixed prices disconnected from the distance, and evolving according to the market). They even exist for night trains between Germany, Austria and Switzerland (*DACH*), for TGV services between France and Switzerland, and other ones are in creation for services between France and Italie, France and Spain, etc.

On the other hand, a "super-network" of railways like *British Railways*, born of the merging and the nationalization of lots of little companies, is now broken up into 26 entities, according to a geographical cutting out for 10 of them. If the process is achieved with the privatization of these companies, we would logically wonder about means of interconnection management between the different sub-networks.

Deregulation can perturb in several ways the balance which stems from previous interconnection phases. Howether, as we have seen in the case of international railways services in Europe, changes in conceptions of operation, which occur quite late if we refer to the date of connection, can modify this balance in the right direction : it seems clear that the user will gain by these changes (with more attractive tariffs, comfortable and homogeneous rolling stock, shorter travel durations, etc.).

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In fact, interconnection processes and ways of "life" of the interconnected networks are very diverse, even in cases apparently similar. Differences are very weakly linked to the technical options chosen. The different plays of actors according to interests susceptible to evolve, the existence of "guaranteed incomes" previously gained, or on the contrary of penalizing factors, more or less easy to question, produce finally an organization rather than another one.

References :

BOUTTES (Jean-Pierre), 1990, "Régulation technique et économique des réseaux électriques", Flux, n°2, Autumn, pp. 43-55.

DUPUY (Gabriel), GELY (Corinne), OFFNER (Jean-Marc), 1990, "RER et interconnexions : les vertus d'un réseau hybride", Flux, n° 2, Autumn, pp. 81-94.

GILLE (Laurent), 1992, "Interconnexion des réseaux", in Économie et management des entreprises de réseau, ENSPTT-Economica, Paris, november, pp. 31-51.

GRISET (Pascal), "The development of intercontinental telecommunications in the twentieth century", Flux, n° 9 (july-september), pp. 19-32.

HUBERT (Jean-Paul), MARGAIL (Fabienne), OFFNER (Jean-Marc), ZEMBRI (Pierre), 1995, Les enjeux organisationnels et territoriaux des interconnexions de réseaux de transports collectifs, Rapport au Ministère de l'Équipement, des Transports et du Tourisme (D.T.T.), G.D.R. "Réseaux", may, 112 p.

LACOSTE (Jacques), 1986, "Raisons et enjeux de l'interconnexion en France, 1919-1941", Cahiers du Groupe Réseaux, n° 4, Paris, ENPC, pp. 105-141

OFFNER (Jean-Marc), 1993, "Le développement des réseaux techniques : un modèle générique", Flux, n° 13/14, july-december, pp. 11-18.

TROIN (Jean-François), 1995, Rail et aménagement du territoire, Aix-en-Provence, Édisud, 264 p.

VARLET (Jean), 1992, L'interconnexion des réseaux de transport en Europe, Paris, Institut du Transport Aérien, Coll. Études et documents, vol. 24.

ZEMBRI (Pierre), 1993, "Services régionaux de voyageurs et transports urbains en province : des rapports perfectibles", Transports Urbains, n° 79, april-june, pp. 21-27.