C. Transportation specificities

The practice of transport demand analysis has required a number of adaptations, to which some attention must be given. Theses very interesting adaptations are all consistent with the detection of gross complements or substitutes, domains that themselves are attainable by all three decompositions. To define more formally these domains, one writes, since $\partial q_1 / \partial p_1 < 0$:

$$
\left.
\begin{array}{lll}
\text{(A) : goods are substitutes :} & \text{if} & \dfrac{\partial q_2}{\partial p_1} \cdot \dfrac{\partial q_1}{\partial p_1} < 0 \\
\text{(B) : goods are complements :} & \text{if} & \dfrac{\partial q_2}{\partial p_1} \cdot \dfrac{\partial q_1}{\partial p_1} > 0
\end{array}
\right\} \qquad (1)
$$

where (B) denotes changes in the same direction and (A) denotes changes (in quantities demanded) in opposite directions. Such domains are indicated again in Figure 4 with the transport decomposition.

i) Elasticity-related expressions of the transport decomposition

As all transportation models explain a shift from the original bundle 1 to the final bundle 2, the transport decomposition can be effected for any model, even those that do not formally distinguish between diversion and induction effects, because it is a conceptual decomposition. However, it need not be expressed as absolute variations in the quantities.

More practical expressions of the same decomposition are preferable, both generally to state results of any model, and to compare models pertaining to very different reference areas. We therefore outline two such metrics : the first one uses the classical notion of elasticity as invented by Marshall in 1882 ; the second, derived from the first, expresses results of interest in terms of rates. Given the definitions, both reexpressions are interesting tautologies.

Definitions. It is true that the total number of trips T is equal to the sum of modal trips T_m, and that the latter is equal to the product of the total number of trips T by p_m ,the market share of mode m:

$$T = T_1 + \ldots + T_m + \ldots + T_n , \qquad (2)$$

and

$$T_m = T \cdot p_m \equiv T \cdot \frac{T_m}{T} . \qquad (3)$$

Marshallian elasticities of induction and diversion. As (3) is a product, η, the elasticity of demand of mode T_m with respect to any variable X_k, can be decomposed between its impact on p_m, mode share, and its impact on T, total demand irrespective of mode :

$$[\ \eta\ of\ Mode\ ] = [\ \eta\ of\ Total\ ] + [\ \eta\ of\ Share\ ],$$

or (4)

$$\eta\ (T_m,\ X_k) = \eta\ (T,\ X_k) + \eta\ (p_m,\ X_k),$$

an interesting reexpression which does away with units and also matches the structure of many models (at least partially) : the components of the modal demand elasticity may naturally be called induction and diversion elasticities.

Diversion and induction rates

These elasticities can be used to obtain strict definitions of diversion and inductions rates that are also applicable to any model from which elasticities are computed (analytically or by simulation). Such computations are simple because all models compute ΔT, ΔT_m, Δp_m on the basis of references values of these variables and of prices (or other X_k that are changed). For any elasticity, the arc measure is

$$\eta\ (y,\ X_k) = \frac{\Delta y}{y} \Big/ \frac{\Delta X_k}{X_k} = \frac{\Delta y}{\Delta X_k} \cdot \frac{X_k}{y} \Bigg|_{y^r,\ X_k^r},$$

and the point mesure is (5)

$$\eta\ (y,\ X_k) = \frac{\partial y}{\partial X_k} \cdot \frac{X_k}{y} \Bigg|_{y^r,\ X_k^r,\ X_o^r},$$

where y^r, X_k^r and X_o^r denote reference levels of y, X_k or other variables X_o that may be involved in evaluating these expressions.

Assume therefore that the k^{th} characteristic of the m^{th} mode, X_k^m is modified. Then by (2)

$$\frac{\partial T}{\partial X_k^m} = \frac{\partial T_m}{\partial X_k^m} + \sum_{j \neq m} \frac{\partial T_j}{\partial X_k^m}, \qquad (6)$$

which is simply the decomposition of a change in total demand T into an effect on the demand for mode m, T_m, and a remaining effect on the other modes T_j (with $j \neq m$). Multiplying all terms of this tautology by (X_k^m / T) and the first term of the RHS by (T_m / T_m) and the second by (T_j / T_j) yields

$$\eta\ (T,\ X_k^m)\ =\ p_m\ \cdot\ \eta\ (T_m,\ X_k^m)\ +\ \sum_{j \neq m}\ p_j\ \cdot\ \eta\ (T_j,\ X_k^m) \tag{7}$$

or, obviously

$$\frac{\eta\ (T,\ X_k^m)}{p_m\ \cdot\ \eta\ (T_m,\ X_k^m)}\ =\ 1\ +\ \sum_{j \neq m}\ \frac{p_j\ \cdot\ \eta\ (T_j, X_k^m)}{p_m\ \cdot\ \eta (T_m, X_k^m)} \tag{8}$$

$$IR\ =\ 1\ +\ DR \tag{9}$$

which defines the transfer, substitution or **DIVERSION RATE** *DR* and its complement the generation or **INDUCTION RATE** *IR* :

$$DR\ (T_m,\ X_k^m)\ =\ \frac{\eta\ (T,\ X_k^m)}{\eta\ (T_m,\ X_k^m)\ \cdot\ p_m}\ -\ 1$$

$$\textit{DIVERSION RATE}\ =\ \textit{INDUCTION RATE}\ -\ 1 \tag{10}$$

where the modified demand for mode *m* is shown to be expressible as resulting from a diversion to or from modes and from a change in total demand.

It is useful to note three general properties of this expression of the transport decomposition :

a) DR is not restricted between -1 and 0 : it is obvious that the size of two elasticities and the market share of mode *m* matter in (10) ;

b) In the special case of a total demand that is insensitive,

$$DR\ =\ \frac{0}{\eta\ (T_m,\ X_k^m)\ \cdot\ p_m}\ -\ 1\ =\ -1, \tag{11}$$

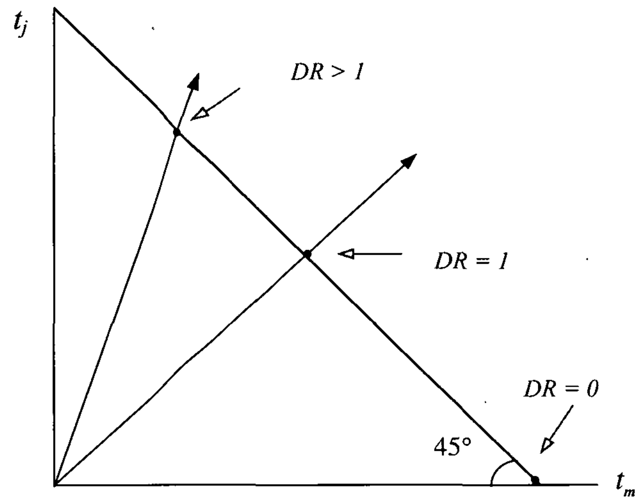
or, more generally, models with low « generation elasticities » will have diversion rates close to -1 ;

c) In the other special case of a share elasticity that is equal to zero, as $\eta\ (T,\ X_k^m)\ =\ \eta\ (T_m,\ X_k^m)$ by (4), we obtain

$$DR\ =\ \frac{1}{p_m}\ -\ 1\ , \tag{12}$$

or, more generally, we obtain that modes with low market shares will have higher diversion to or from other modes than modes with larger market shares. This means that, in Figure 5, the DR falls along the equal trip line as p_m increases from 0 to 1.

Figure 5. Diversion rate with Share Elasticity Equal to Zero



The computation of RATES therefore provides another common metric across models : as DR of -0,80 means that 80% of the effect of X_k^m comes from a diversion and the rest (20%) from a change in total demand ; a DR of -3 means high diversion relative to induction.

Elasticities of rates ? One would expect the elasticity expression (4) to remain as the most intuitive reexpression of the transport decomposition because it is totally independent from the value of market shares, which eases the understanding, and because its format matches that of many powerful and simple models. It also provides some guidance on the more difficult question of whether any change in input mix can be represented solely by a share model : one is tempted to say that it can if induction is non-existent. However, we shall not discuss here the implications for models that rely on Shepard's Lemma, but clearly not all movements may be analysable solely in terms of a share model.

ii) Other apparent ambiguities

Having shown that the common transport decomposition resembles but differs from standard economic decompositions sometimes referred to in similar terms, such as « modal substitution effect », it is appropriate to ask whether some other resemblances should be taken into account and discussed.

Generalisations of the notions of price and quantity. Naturally, elasticities can be obtained for different generalisations of the notion of price. A simple one is that of generalised cost, such as

$$g = p + \alpha \cdot tt, \qquad (13)$$

where an equivalence coefficient α transforms units of service, here travel time *tt*, into money units. A similar transformation is implied by any theoretical or empirical equivalence between a price and any characteristic of the good or service in question, recently referred to as a « hedonic » price, a misnomer less transparent that « generalised price or cost » (depending on whether a fare or a unit price is used in (13)).

Another slight variation on the notion of generalised price (or cost) is that of quality-adjusted price (or cost) p^*, associated to the quality-adjusted quantity q^*, namely

$$p^* = \frac{p}{K} \qquad \text{and} \qquad q^* = q \cdot K \qquad (15)$$

where K is an increasing function of the characteristics of transport services such as travel time *tt* or wait time *wt* , for instance

$$K = tt^{\alpha_1} \cdot wt^{\alpha_2} , \qquad \alpha_1 < 0, \ \alpha_2 < 0 \qquad (16)$$

or

$$p^* = \frac{p}{tt^{\alpha_1} \cdot wt^{\alpha_2}} \qquad \text{and} \qquad q^* = q \cdot [tt^{\alpha_1} \cdot wt^{\alpha_2}] . \qquad (17)$$

so that one distinguishes between the nominal price p and the real price p^*, as one does with standard price indices, and between the physical quantity q and the « utility » quantity q^*. Another way to refer to q^* is to state that it designates the true units of q, for instance seat-quality units.

Note that, although (17) looks different from usual demand functions written in terms of observable (nominal) prices and quantities, it is implicit in standard forms. For instance, if the demand function is multiplicative and estimated in terms of observed values in (18-C) :

$$\left.\begin{array}{ll} \text{(A)} & q^* = \beta_0 \cdot p^{*\beta_1} \cdot y^{\beta_2} \\ \text{(B)} & q = \beta_0 \cdot p^{\beta_1} \cdot tt^{-2\alpha_1\beta_1} \cdot wt^{-2\alpha_2\beta_1} \cdot y^{\beta_2} \\ \text{(C)} & q = \beta_0 \cdot p^{\beta_1} \cdot tt^{\gamma_1} \cdot wt^{\gamma_{21}} \cdot y^{\beta_2} \end{array}\right\} \qquad (18)$$

it is clear that $\alpha_1 = -\gamma_1/2\beta_1$ and $\alpha_2 = -\gamma_2/2\beta_1$, and that both are therefore recoverable from the estimated coefficients if desired. This means that the transport decomposition elasticities can be expressed in terms of quality-adjusted values (the β) or in terms of the elasticities associated with observed service characteristics (the γ) if the variable of interest in the decomposition is not the price but a service dimension such as frequency or travel time. The decomposition can therefore be effected for any dimension of generalised cost appropriate to a given model.

Modal transport services. Transport analysis requires the use of modal or PURE networks even if the specifics of various models combine them to define intermodal paths and alternatives, or even mode-abstract alternatives.

This means that, in computing the quantities T_m and T used to derive decompositions, or more simply in trying to decide whether two modes are gross complements or gross substitutes, it is necessary to sum changes occurring on links of PURE networks over the reference area, or group of origin-destination pairs of interest, and caused by changes in characteristics associated with these PURE links, the X_k^{ma} that define the links a. Gross substitution and gross complementarity are then defined on PURE modal totals following modifications of PURE link characteristics.

Activities : fixed, higher, new ? In the economic formulation above, the activity levels that define the isoquants (or the utility functions that define the isoutility or indifference curves), are well defined. In practice this is often a difficult question.

- In many transport demand models, the activity levels are in theory **fixed**. In this case transport demand is, in a strict sense, conditional upon the spatial distribution and level of activities. However, in practice, activity levels are not defined so precisely, so that demand is of the form

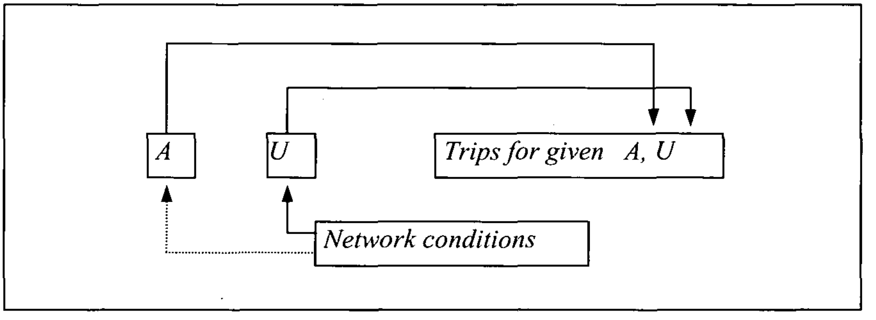
$$D = f(A, U) \tag{19}$$

  where U is the utility of transport. However, higher U levels imply higher demand levels, so that in practice the trip rates per unit of activity are influenced by transport utility U. This means that the difference between fixed activities - as the economic formulation requires - and **variable activities** is tenuous and that it is not always clear whether, following an improvement in U, one is on a higher isoquant or whether there are just more trips per unit of activity. For our purposes, we shall assume that higher trip levels arising from improved U levels imply higher isoquant levels. This means that we do not precisely distinguish here between more travel per unit of activity and more travel at higher activity levels.

In some transport models, there is a formal feedback of transport condition U upon the **level and distribution** of activities, indicated in Figure 6 by a dotted line, over and above the normal derived demand for given activity levels and distributions. This feedback would, in Figure 4, involve the addition of a third line somewhat to the right and parallel to that going through point 2, as in Figure 7. Now consider what may happen if one starts form point 1* in Figure 7. In the absence of this feedback, one is necessarily in the « Fixed Activity », or **normal**, induction domain. By contrast, if the improvement in mode 1 triggers an activity outburst, it is possible that this « Activity

Release Effect » will lead to a point such as 3 where the mode choice has not changed. Such a point, on the ray from the origin, can be said to exhibit « **homothetic** induction ». The new activity could even involve a move to point 4, that is to the left of the ray from the origin, which we call « **dominant** induction ». Homothetic or dominant induction could be caused by a trigger such as the development of the Docklands Light Railway in London : one could well imagine the land-use feedback implying a lower public transport mode choice than before at this location, but greatly increased volumes by both road and transit modes.

Figure 6. Feedback of Transport Utility upon Activity Level and Location



One could envisage being quite formal about such effects, associated with strong changes in the spatial distribution of activities. They are normally handled through « manual » scenario analyses and are outside of the transport demand models proper, as these assume a fixed level and distribution of existing activities. But analogous and fuzzier problems arise with new activities made possible by improved transport conditions..

- In all models, activities are indeed not defined strictly, there is consequently no obvious way to be precise concerning the role of **new activities** arising from modified transport conditions. To use again the transport and communications framework of Figures 1 and 2, assume that, at an original budget line, shown in Figure 8, the demand for transport and communications was nil for some activity □, the reason being that a minimum amount of communications C_{min} is required to perform the activity and that the original budget is insufficient to achieve even minimum output. Then consider that a drop in the price of C changes the situation and that the demand for transport and communications increases jointly from point 1 to point 2 as the activity becomes affordable. **New activities** such as □ are often not known or identifiable in models, so the existing set $\{A\}$ cannot contain them explicitly. Yet their presence is tantamount to both a shift and an heterogeneity of the activity structure description, and therefore difficult to account for. For instance, an interchange between an airport and a HSR line could create a new industry of « meetings at the airport ». For this new « activity release », more air trips and more HSR trips would occur, implying a gross complementarity for this new activity. But for remaining, pre-existing activities, these modes could be gross complements. The net effect would depend on the sizes of these effects.

Figure 7. Higher Activities at given Locations and Shifts in the Production Function at these Locations

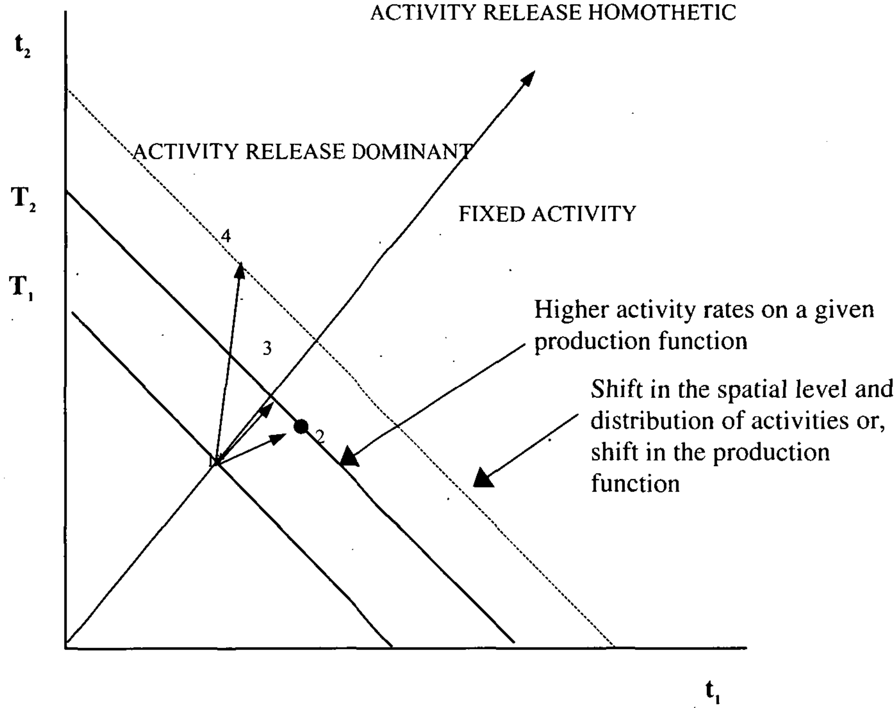
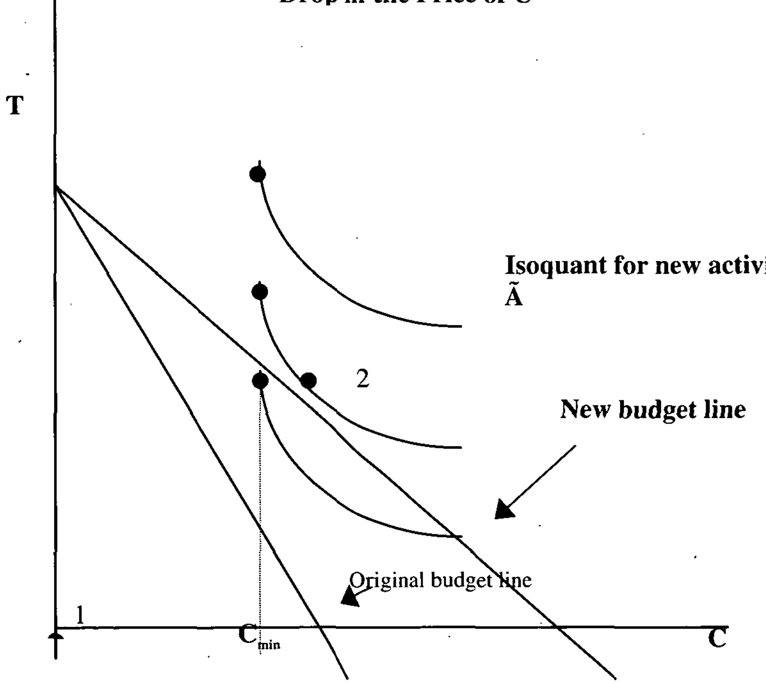


Figure 8. New Activity occurring due to a Drop in the Price of C



3. How could complementarity arise among PURE reference modes?

Although models vary greatly in nature, it is our task to ask how gross complementarity or, failing this, gross substitution, arises. To answer this question, we first recall the different dimensions of demand that are determined by sets of complex procedures called models ; we then analyse the two principal structural features that determine **whether** complementarity is possible. We do not discuss the determinants of **how much** complementarity or substitution is obtained until Chapter 4. Throughout both chapters, we will refer to a representative set of studies listed in Table 1 and selected from information supplied to the COST 318 Committee. The list is not meant to be exhaustive but to allow easy reference as we formulate **maintained hypotheses** as answers to a sequence of questions of interest. It is meant to shift the burden of classification from the present author to the set of authors of the studies, as they are expected to protest any incorrect maintained hypothesis concerning their work : naturally, any reader who has developed models can also answer for himself the same set of questions.

Our intention is not to assess the merits or shortcomings of practical models but to ask whether they include complementarity in any sense defined by the framework outlined above to make sense of the notion of « intermodality ». As any policy perspective with a view to optimisation of the multimodal transport system would use such models to derive responses, it is only natural to ask whether too much is being asked of them.

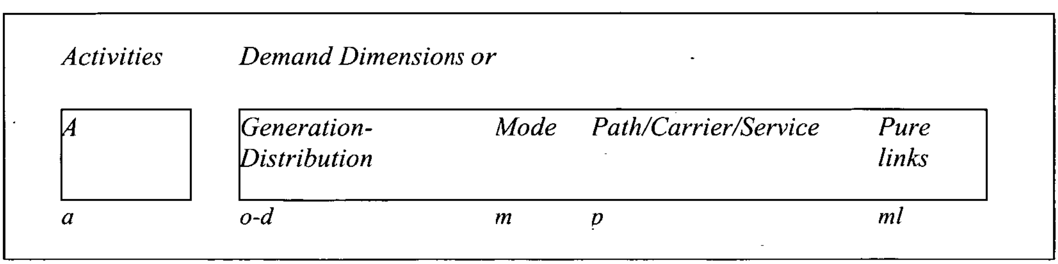
Table 1. Supplied Studies and their Representative Roots

Country	User	Name or Type	Main References	Code
Belgium	Westrail	Discrete Logit	Garda (1997)	B-1
Germany	BMV	QDF, 3rd generation (Spatial correlation ; captivity)	Gaudry *et al.* (1994) Mandel *et al.* (1997)	D-1
Spain	MOPTA'93	PERAM or SLAG QDF, 1st generation (Coupled Gravity and linear logit)	Rea *et al.* (1977) TEMA (1994)	E-1
	MOPTA'97	SOMPS QDF, 2nd generation (Box-Cox in Gravity and Logit)	Gaudry and Wills (1976) Transport Canada (1979) De Quiros (1997)	E-2
	RENFE	Share model	Pintidura (1997)	E-3
France	many	MATISSE (Fine segmentation ; price-time)	Marche (1980) Morellet et Marchal (1995)	F-1
	many	SNCF/SOFRERAIL (Gravity and Price-time)	Arduin (1989) Chopinet (1997)	F-2
Italy	many	n.a.	Cascetta (1995)	I-1
Netherlands	many	ILCM (Logit hierarchies)	Veldhuis *et al.* (1995) Kroes (1997)	NL-1
Sweden	n.a.	Mode choice (Segmented logit)	Algers (1993)	S-1
		(Segmented and Box-Cox logit)	Algers and Gaudry (1994)	

A. Dimensions of demand determined by demand procedures

Given the size and spatial distribution of activities, models explicitly and implicitly determine, for given sets of links associated to PURE modes, a demand by origin-destination pair, mode, path/carrier/service and link. This is schematically shown in Figure 9, where we do not mean that each stage corresponds to a particular sub-procedure but that complete models produce results that can be aggregated by origin-destination pair, mode, etc. We assume that, if models do consist of sub-models for different stages, these stages are somehow coupled.

Figure 9. Stages of Interest in Demand Procedures



For instance, if different services p are offered by a certain mode and the choice mechanism is a logit model, the utility index for this mode could be defined as

$$\left.\begin{array}{ll} \text{(A)} & U_m = \dfrac{(\sum_p e^{V_{p_m}})^{\lambda} - 1}{\lambda} \quad , \\ \\ \text{(B)} & V_{p_m} = \beta_{op} + \beta_1 \cdot tt_p^m + \beta_2 \cdot wt_p^m \, , \end{array}\right\} \qquad (20)$$

where say tt_p^m and wt_p^m denote the travel time and wait times associated with this path p by mode m. It is clear that, if the Box-Cox transformation used in (20) is such that $\lambda \rightarrow 0$, this form, used by Gaudry and Wills (1976), yields the Williams-McFadden (1977) log sum term as a special case :

$$U_m = ln\,(\sum_p e^{V_{p_m}}) \,. \qquad (21)$$

However, we do not require that the coupling be interesting, or have an interpretation in terms of utility, but only that it exist in order to guarantee the possibility of induction shifts when it is used to determine total trip making.

B. Structural features that make gross complementarity possible

We consider two structural properties that make complementarity possible if they are present for one or more stages: the first may hold for any stage considered by itself; the second has to do with the relative size of effects constrained by the induction-diversion border.

i) Inner structure : own and cross effects and their signs

For gross complementarity to be possible, the mathematical structure used to explain an outcome must allow for cross effects of the same sign as own effects, a condition that excludes all procedures consistent with the Independence from Irrelevant Alternatives (IIA) axiom of chice theory, namely all those procedures for which relative choice probabilities between alternatives depend only on the characteristics of these two alternatives. More formally, and using the language of representative utility to denote functions such as (20-B), the representative utility of potential outcome r must depend not only on r-indexed characteristics but also on s-indexed characteristics, as in

$$\left.\begin{array}{ll} & V_r = f\,(X_k^r, X_k^s) \\ \text{with} & \\ & (\partial V_r/\partial X_k^r)\cdot(\partial V_r/\partial X_k^s) > 0 \end{array}\right\} \quad (22)$$

where X_k is a variable such as travel time or speed and it is clear that one must have that $\partial V_r / \partial X_k^r$ and $\partial V_r / \partial X_k^s$ are of the same sign. A simple logit model with linear-in-variables form naturally contains only **own** terms and consequently permits only substitution. A practical form for (22) that could admit of complementarity is the Generalised Box-Cox form, or special cases of it such as Wills (1981) :

$$V_r = \beta_0 + \beta_1 \cdot X_k^{r(\lambda_r)} + \beta_2 \cdot X_k^{s(\lambda_s)}, \quad \lambda_r \neq \lambda_s, \qquad (23)$$

where λ_r is applied to all own terms and λ_s to other (cross) terms. But which stages of demand procedures could yield complementary outcomes ?

- « **Path** » **choice :** by structure, paths are constituted from links and they depend on the characteristics of many links. So a form of LINE COMPLEMENTARITY is associated with the constitution of paths if the links belong to different modes, as they do when mode-abstract networks, principal modes with access/egress modes or combined-mode alternatives are defined. Line complementarity means that the segments of paths or alternatives belonging to distinct pure modes are used together. As a working hypothesis, the first question used to detect complementarity could be

Does the model contain LINE COMPLEMENTARITY that arises by combining links belonging to pure modes in such a way as to define paths or alternatives ?	(Q-1)

And the maintained hypothesis would be:.

All models of Table 1 have LINE COMPLEMENTARITY.	(H-1)

In this type of complementarity, the combined elements are strong complements in the sense that the consumption of all components increases proportionately with the use of the path or alternative. Although LINE COMPLEMENTARITY is a relatively frequent occurrence in demand procedures, arising typically through the definition of access/egress modes for principal modes, it is naturally difficult to implement between air and rail services as it requires fine integration of service components, such as fare and ticketing, schedules, baggage handling and customs clearance.

- « **Alternative** » **choice :** if alternatives are made up of one or many paths, weak complementarity can arise if cross effects, although weaker than own effects, are of the same sign. In mode choice models, this possibility is usually excluded from the start as most models permit only own terms in (23). One could conceive of service choice models allowing for some measure of weak complementarity, for instance due to the lack of ubiquity of services : schedule complementarity could exist between, say morning flights and evening trains or buses. Naturally, the model has to allow for such complementarity at the individual level by defining these combined-mode alternatives (presumably as part of a time-of-day alternative choice). So a second question could be

Does the model define alternatives at any stage (service/carrier/schedule, or mode, or destination/mode) in such a way as to allow cross-effects of the same sign as own-effects to arise ?	(Q-2)

And the maintained hypothesis be :

Except for F-1 (which allows for some scheduling complementarity), all of the models allow only substitution among alternatives : cross-elasticities between mixed-mode alternatives and pure modes will produce gross substitutes.	(H-2)

Although some mode choice models—for instance those based on the Generalised Box-Cox Logit form—allow for the formal possibility of complementarity through the explicit use of cross-terms, they are expected to have **opposite** effects or signs and to exhibit **substitution** even if they are not IIA-consistent.

- **Frequency choice :** model stages that determine the frequency or LEVEL of demand by mode or groups may often violate IIA consistency but without allowing for complementarity. A frequent case would be that of doubly-constrained distribution models where the terms that satisfy the double constraints, the $\overline{A_i}$ and $\overline{B_j}$, are functions of all own *(ij)* and cross *(ik)* terms, although this is not readily apparent, as in

$$T_{ij} = \overline{A_i} \cdot \overline{B_j} \cdot O_i \cdot D_j \cdot f(U_{ij}) \qquad (24)$$

Despite the fact that ratios of demands for different destination pairs - say the ratio T_{ij}/T_{kl} - will depend on all U_{ij} present because they are explicitly used to define $\overline{A_i}$, $\overline{B_j}$, $\overline{A_k}$ and $\overline{B_l}$, the model excludes complementarity because, if a particular U_{ij} is modified, the flow from *i* to *j* will be modified (we exclude the special case of partial interactions through congestion on the network) in a certain direction and **all** other flows will be modified in the opposite direction - a rather strong property (some flows should be modified, not all) - due to the automaticity of the double constraints. So doubly-constrained distribution models violate IIA consistency but exclude complementarity.

But complementarity could arise in other ways. A case in point is that of trip frequency models where an accessibility index is used, for instance

$$T_i = f\ (\text{Activity at i ; ETC at i ; Accessibility from i to all j}), \qquad (25)$$

where it is clear that the modification of some pure link characteristic will, even in the absence of congestion, influence the trip emission rates at many locations ; if modal split is held constant, all modal demands could increase in the same direction from all zones for which accessibility increased. Again, the presence of cross terms, restricted to have the same sign by the restrictions built into the accessibility index, will produce some gross complementarity by effectively shifting the « equal trip » lines outwards.

Another way of producing this result arises in generation-distribution models where cross terms are implicitly or explicitly used, as in the very complex generalisation of Generation-Distribution models defined by Wills (1986), or through the exploitation of spatial correlation of the residuals in Gaudry *et al.* (1994), where the simplest structure is :

$$\left.\begin{aligned} T_{ij} &= f\,(A_i, A_j, U_{ij};\ A_k, A_l, U_{kl}) \\ &e.\,g. \\ T_{ij} &= A_i^{\beta 1} \cdot A_j^{\beta 2} \cdot U_{ij}^{\beta 3} - \rho \cdot A_k^{\beta 1} \cdot A_l^{\beta 2} \cdot U_{kl}^{\beta 3} + e_{ij} \end{aligned}\right\} \quad (26)$$

where the ρ term could arise from taking spatial correlation of residuals into account : a positive ρ would imply substitution and a negative ρ would imply complementarity between T_{ij} and T_{kl} flows. So the third question could be :

Does the model allow for cross-effects of the same sign as own effects in the determination of the frequency/destination levels or for given, or transport-condition sensitive, activities ?

(Q-3)

And the maintained hypothesis certainly is :. Except for D-1 (which does so among origin-destination pairs), none of the models do so, unless they use accessibility indices.

Unless models directly include ***multiple-index*** accessibility variables, making ***ij*** flows depend on ***ik*** or ***il*** conditions, or indirectly allow it as D-1, none of the models in Table 1 generally exclude spatial complementarity and do not allow for the possibility of such cross-effects.

(H-3)

As many models in current use consist of multi-stage coupled logit models of the linear-in-variables type (e.g. NL-1), they effectively constitute massive structures of substitute alternatives that generally preclude cross-effects through the exclusive use of own-effect specifications. This seems true even if trip chains are included to the extent that each chain option is treated as an alternative specified only with own-effect terms ; it could be false if the specification of chains allows for cross-effect terms in the very definition of alternatives, for instance if accessibility indices are used to define some alternatives (chains).

- Activity location feedback : for models that allow transport-condition sensitive land-use feedbacks, similar « inner structure » mathematical conditions (cross-effect terms ; same sign) are needed as for path or frequency choice.

ii) Basic induction/diversion component border structure

But such conditions differ from what we will now call «basic induction/diversion » structure. Indeed, all demand procedures must somehow determine totals by mode given by (2) on each link of the network : T_{ml}. To obtain this, one could imagine a procedure consisting of a single equation yielding directly the desired answer. However no such credible equation yet exists : in practice the problem has to be broken up. For given assignments to the network, the principal border between components is that between the component that determines LEVELS of trips and the component that splits or SHARES trips among alternatives (often with PROBABILITY MODELS). Although the border between these components may lie in many locations on the spectrum defined in Figure 9, there is always one. It is in effect the INDUCTION-DIVERSION border because the LEVEL part determines total trip making and the SHARE/PROBABILITY part splits it among alternatives. Some precisions are in order.

An alternative may be defined on many dimensions at the same time. For instance, a « short » LEVEL components may be split by a « long » alternative (joint choice of many dimensions), as in (1) of Figure 10. Or conversely, a long LEVEL component determining many dimensions may be split by a short SHARE alternative component, as in (2) of Figure 10.

Figure 10. The Induction-Diversion Border

1 :	*Population*	.	*Probability of trip to a destination by a mode using a service*
2 :	*Activities, Generation, Distribution by mode*	.	*Probability of a service*

The point of the border is that the LEVEL component determines the amount of travel, or INDUCTION LEVEL, and the SHARE component splits it among alternatives. The first component works like the total available budget in consumer choice and the second component like relative prices that determine the mix of goods purchased. As soon as it is declared that a single equation procedure is impossible to specify, it is not possible to avoid the border, which then restricts the relative size of induction and diversion effects. In that sense the border is structural, independently from LEVEL and SHARE procedure specifics.

Consider SHARE procedures first. They need not be probabilistic in the sense of a logit model. In France, for instance, a tradition of MICRO ASSIGNMENT using shortest path algorithms has existed for over 30 years, since Shreyer and Labbé developed for the R.A.T.P. in 1967 a procedure assigning individuals on a mode-abstract (or « multimodal ») network using all-or-nothing assignment. Similar ideas were used by Marche some 15 years later and extended in the MATISSE procedures recently. Combined with a « Population » generator, shortest path assignment of large numbers of individuals over multistage, multimode, multiservice networks effectively functions with a border of type 1 in Figure 10. This means that even population segments can be used to define alternatives—naturally some factors must in this case define segment SIZE or the LEVELS.

Many models spontaneously put the border after the Generation-Distribution stage. Models built around coupled hierarchies of logit models have gradually moved the border to the left as destination and frequency decisions began to be integrated as « alternatives », tasks much more difficult that the mode-service specification tasks.

In Figure 10, the levels and spatial distribution of activities may be affected by transport conditions within the model. No matter how sophisticated the feedback may be, it will generally modify the LEVEL component in such a way as to produce shifts over and above those of « normal » (i.e. for given activity levels or distributions) induction. As the final result - gross complementarity or substitution - depends crucially on the relative size of the two effects, as Figure 4 makes clear, a proper question that arises is

Does the model **globally** yield gross complements, defined as modal demands affected in the same direction by pure link service modifications, in the geographic area of the particular case study?	(Q-4)

It is our expectation, and maintained hypothesis that :

No current transport demand model yields gross substitutes over its reference area.,In particular, the induction effect is never sufficient to transform substitutes into complements as in Figure 3, even in models that allow for the possibility. Some exceptional Figure 7 type « trigger effect » land-use feedbacks may exist.	(H-4)

4. How much complementarity or substitution?

Given the structural features that make complementarity possible, namely the *inner structure* of stages and the *relative position of the induction-diversion border* that will determine their relative sizes, what major features of models will determine the strength of potential cross-effects or the sizes of induction and diversion decompositions ?

A. The location of variables : drifting socio-economic factors

It is of interest to note that, over the last 25 years, many variables of the socio-economic type previously used only to determine trip LEVELS have drifted into SHARE (or, equivalently in this context, PROBABILITY) mechanisms, notably into mode choice procedures.

Irrespective of one's opinion about this drift, and about the chances of a movement in the opposite direction as LEVEL and SHARE components are estimated jointly - thus allowing a determination of the best location for a variable - it is clear that this location has some relevant influence. We would venture to say that induction effects tend to be underestimated, at the expense of potential complementarity, as SHARE models include... everything ! This has the appearance of reasonableness because anything that differentially affects the level of demand for a mode will portended to have some effect in a share or probabilistic model as these models can be viewed as combinations of single-mode level-type demand equations. As the effects of this drift cannot easily be determined, no question can easily be asked concerning them.

B. The form of variables and market segmentation over agents

The effects of major changes in rail speeds, such as those associated with the introduction of HSR, depend decisively on the shape of the response curve, as curvature is central to impact analysis. The use of linear-in-variables logit models, for instance, assumes that gains in travel time have the same impact on HSR choice probability whether the trip is long or short and implies the existence of a symmetric response curve in the space of modal characteristics X_k and of utility V_r shown in Figures 11 or 12 below.

There are three ways to avoid this assumption, which is clearly not likely to hold. The first one is to use different models for different trip lengths, or more generally for different market segments. This produces piecemeal-linear approximations of the true form of the response, but requires much work. Alternatively, non-linear forms can be used, such as the Box-Cox transformation as in (23) which generally leads to rejection of the linear forms and yields to better fits and more reasonable solutions that linear-in-variables models ; or other asymmetric shapes can be used, such as log normal distributions of the value of time in assignment models - these imply asymmetric mode response curves that will capture the proper form of the nonlinearity in utility. A crucial general question is therefore :

Does the amount of substitution (or complementarity) obtained depend, in the SHARE or PROBABILITY component, upon asymmetric responses of the share or probability curve resulting from non constant marginal effects of changes in travel time, frequency or other modal characteristics ?

Our maintained hypothesis is :

All models that use log-normal distributions of values of time, Box-Cox transformations or significant segmentation have asymmetric response curves.	(H-5)

It is our suspicion that a principal role of segmentation is to obtain proper curvature of the response curves, and that the amount of DIVERSION decisively depends on such curvatures. Figures 11, 13 and 14 show the difference between symmetric and asymmetric responses (dotted lines). Note that, in the case of the logit model, the asymmetry can only be seen in the space of modal characteristics (as shown on the X-axis of Figure 11) : in the space of representative utility functions (used in Figures 12, 13 and 14), the logit model is always symmetric. The commonly held view that any model that is asymptotic to probabilities of zero or unity must have asymmetric responses to a given change in generalised travel cost component is false : the logit model will be symmetric, unless it is non-linear in the variable considered. In the Inverse-Power-Transformation families shown, asymmetry requires conditions on the inverse Box-Cox or Box-Tukey transforms used for all cases, included those in which the limits go to zero or unity.

Similar questions could be asked about the form of models that determine the LEVEL. However, they would be extremely hard to answer as the forms used tend to be non-linear and predetermined, as well as applied to a single (or a few) terms like population, without an explicit intent to capture the form of the INDUCTION effect.

Figure 11. Linear-Logit vs. Box-Cox-Logit

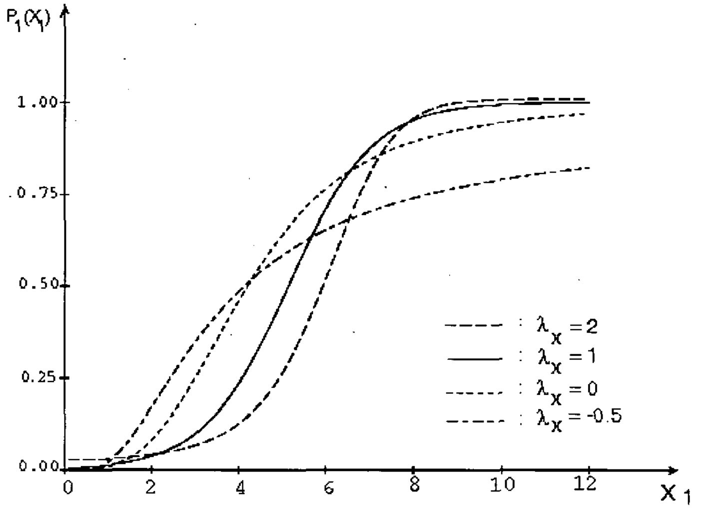


Figure 12. Linear-Logit vs. Standard-Dogit

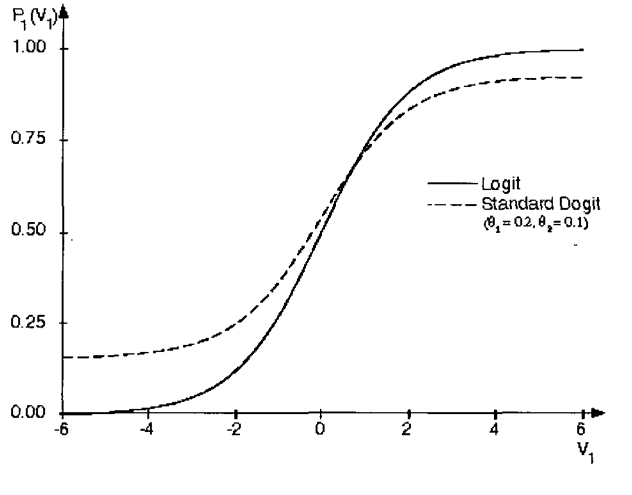


Figure 13. Linear-Logit vs. Linear-Inverse-Power-Transformation-Logit

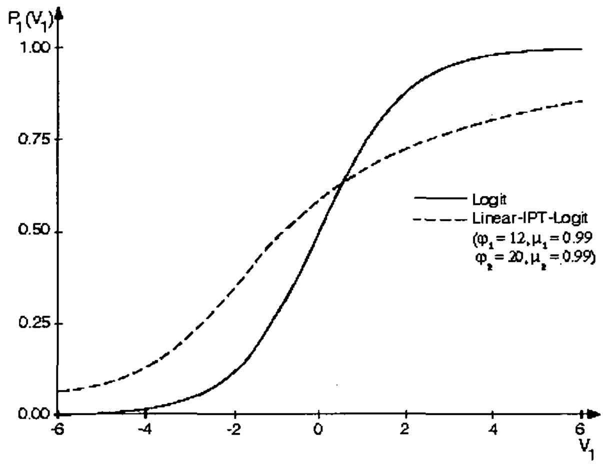
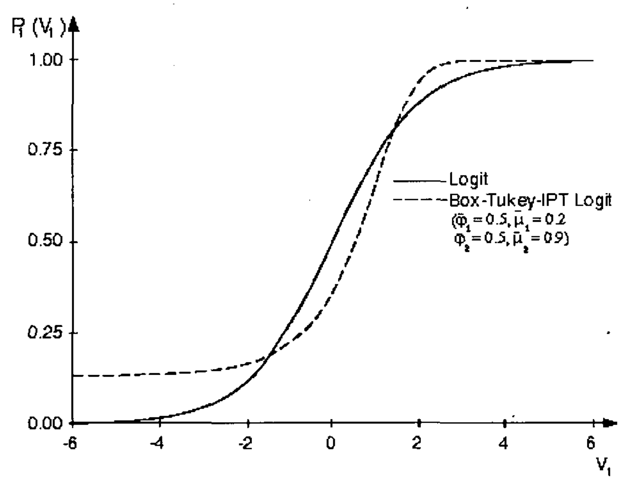


Figure 14. Linear-Logit vs. Box-Tukey-Inverse-Power-Transformation-Logit



C. Specific types of aggregation

Although numerous features affect all models, some are specific to transportation and are generally related to an aggregation problem :

- aggregation over *space*. In many models zone size plays a decisive role that can be assimilated to an « errors of observation » role as many variables associated with the networks will contain an error of measurement associated with the zonal system ;

- aggregation over *trip purposes*. Different trip purposes amount to different goods. The optimal number of trip purposes is not easily determined, in particular for multi-purpose trips that tend to produce trip chains and asymmetric origin-destination total flow matrices.

- aggregation over *dimensions or moments*. Clearly, travel depends not only on expected values of different service levels but also on their variability and on its asymmetry, or skewness. Formally, one could say that the first moment, the second and the third matter. Proper accounting of these features could influence the DIVERSION impact measurements. For instance, there are strong reasons to believe that the variance of freight trip times for multi-country train paths is much larger than it is for trucks connecting the same origin and destination (say Spain-Austria).

There are other features of models, such as the amount of apparent captivity to travel modes, that appear to be transportation specific. Figures 12, 13 and 14 show modal captivity as « thick » limits of response curves (asymptotic limits different from zero or unity). However, apparent captivity is a mixture of modeller ignorance concerning appropriate factors and brand fidelity behaviour, which are not specific to transport, even if they clearly influence DIVERSION estimates. A general question is therefore in order :

Which other features of models have the greatest impact on the INDUCTION and DIVERSION elasticities and on their relative importance ?	(Q-6)

Our maintained hypothesis H-6 is :

The location of centroïds is a most decisive transportation specific feature that generates errors of observation on the network variables. It will therefore influence greatly the model parameter estimates in practice, as will the misspecification errors consisting of incorrect trip purpose and service moment formulations.	(H-6)

D. The three elasticities or summary measures of interest

As all elasticities generally depend on where the functions (5) are evaluated, it is necessary to define reference values, for instance those of a particular scenario, used to evaluate them. A final summary question, applicable to and computable from any model, should therefore be :

What are the Modal, Total and Share elasticities (defined by Equation (4)) for HSR and AIR services in the study ?	(Q-7)

In view of the dearth of responses from authors concerning their model specifics, we conjecture the following:

No model current exhibits gross complementarity and all exhibit gross substitutability.	(H-7)

5. Conclusions

We have formulated a framework within which the existence of intermodality, or complementarity among modes, can be studied, and examined the structural features of models that make this complementarity possible, but without assessing the actual merits of individual models in current use. We can only conclude that substitution dominates most model forms and that, beyond the fact that gross complementarity situations are rather unusual, very few models allow even for the possibility of such a complementarity. We conclude that models introduce complementarity primarily through the definition of alternatives: this produces significant LINE complementarity by defining mixed-modes; more seldom, some induction features produce a modicum of complementarity, but not gross complementarity ; and it is not clear whether even adding land-use interactions might produce that. Unexplored avenues of research pertain to the role of new activities or of major shifts in activity location caused say by HSR-Air linkages, but those researches will not easily find gross complements. Of course, gross complementarity is a demanding requirement, and we have not been in a position to do justice to the full range of models that differ significantly in scope and refinement. Had we been provided with numerical answers to (Q-7), a common measure could have been supplied. This will have to await other opportunities that might build on this framework and make it useful for practical comparison of results from very different approaches and specifications.

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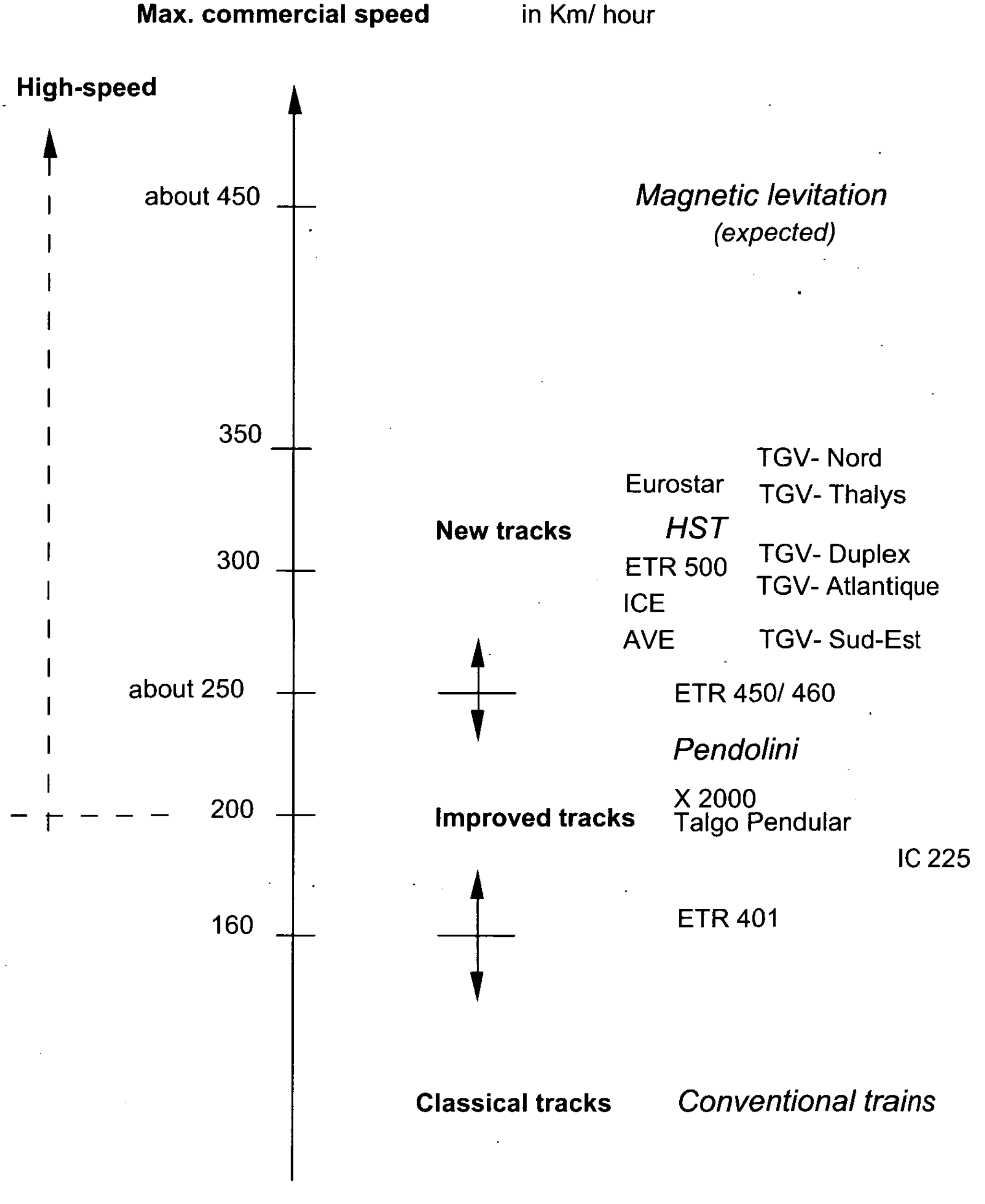
Annex 16: Max. Commercial Speed Selection on Rail



Annex 17: Typology of actual Air Passenger Transport Demand Distribution among Airports

within agglomeration:

A. free distribution: users choice.

A.1. A catchment area is centred on each airport within (or just outside) the agglomeration. As there are equal opportunities on each airport and as ground access is made on the urban road system, ground access time (traffic jam) is a main cause to choose the closest airport (especially for departure).

A.2. A better ground access provides enlarged catchment areas for (both) airports (by the same ground access time), so that catchment areas may overlap (where the are equal opportunities to reach the airport in the same time.

A.3. A much better ground access (on own site) provided by railways (with stations at airports) should be able to reduce ground access time significantly, so that from most parts of the agglomeration ground access times to the airports may no longer play a major role as other reasons, like flight departure time opportunities, may prevail for the choice of the one or the other airport. Consequently, catchment areas of the airports within the agglomeration overlap most of the area[111].

B. neither free nor imposed: airlines choice.

In this case, airlines wish to concentrate their operations on one airport[112] for cost-cutting purposes. Airport users have the choice to leave their favourite airline and go to the competitor at the more convenient airport. this will be (much) less the case as ground access is (very) good (see cases under A.).

C. imposed distribution: authorities choice.

Even by not improved ground access, catchment areas of the airports are large and quite identical, because of the selection of operations at airports. These constraints may be of different nature:

- technical: STOL-airports[113];
- regional air transport operations[114];
- charter-[115]/ scheduled operations;
- due to slot allocation[116];
- geography[117];

111 Bearing in mind a margin of appreciation error by the user; this margin may be narrower for the out-going than for the in-coming passenger.

112 We assume that competing airlines will not operate on the same airport, otherwise we have the same case as C within agglomeration.

113 London-City airport.

114 Berlin-Tempelhof; Stockholm-Bromma.

115 As Luton airport is the home base of two major british charter airlines.

116 At London-Heathrow, for instance.

117 Paris-Orly/-CDG; domestic hub at Orly, for instance.

between agglomerations:

A. free distribution: users choice.

A.1. The catchment area of one (major) airport involves the agglomeration and its (close) neighbourhood. There is also a (regional) airport represented; as ground access occurs on the classical road system, it lies outside both agglomeration catchment areas; its role makes sense.

A.2. A better ground access provides enlarged catchment areas for (both) agglomeration airports (by the same ground access time), so that catchment areas may overlap (where the are equal opportunities to reach the airport in the same time. This is also the case for the (regional) airport represented, which lies now within the catchment areas of (both) agglomeration airports; this means that its role may change dramatically as alternative for the users (from both agglomerations).

A.3. A much better ground access (on own site) provided by high-speed railways (with stations at airports) should be able to reduce ground access time significantly, so that ground access times to the airports may no longer play a major role as other reasons, like flight departure (day-) time opportunities, (ground access and air) fare differences[118], may prevail for the choice of the one or the other airport. Consequently, one airport catchment area includes the other agglomeration.

B. neither free nor imposed: airlines choice.

In this case, airlines wish to concentrate operations on one agglomeration for cost-cutting purposes. This may be in particular the case for long-haul services. Airport users have the choice to leave their favourite airline and go to the competitor, if any, at the more convenient airport. Will it be less the case as ground access is (very) good (see cases under A.)? It depend in particular (ground access and air) fare differences[119].

C. imposed distribution: authorities choice.

By improved ground access, catchment areas of the airports are larger. The (regional) airport represented comes within the catchment area of an agglomeration; this means that its role may change dramatically with regard to the original one: the scale reaches from becoming an agglomeration "relieve" airport to being closed down. Between both agglomerations, there is the (new) opportunity of a better balance of traffic volumes, imposing airport location in the region[120], which could be hard to fulfil, due to the air transport liberalisation in Europe[121].

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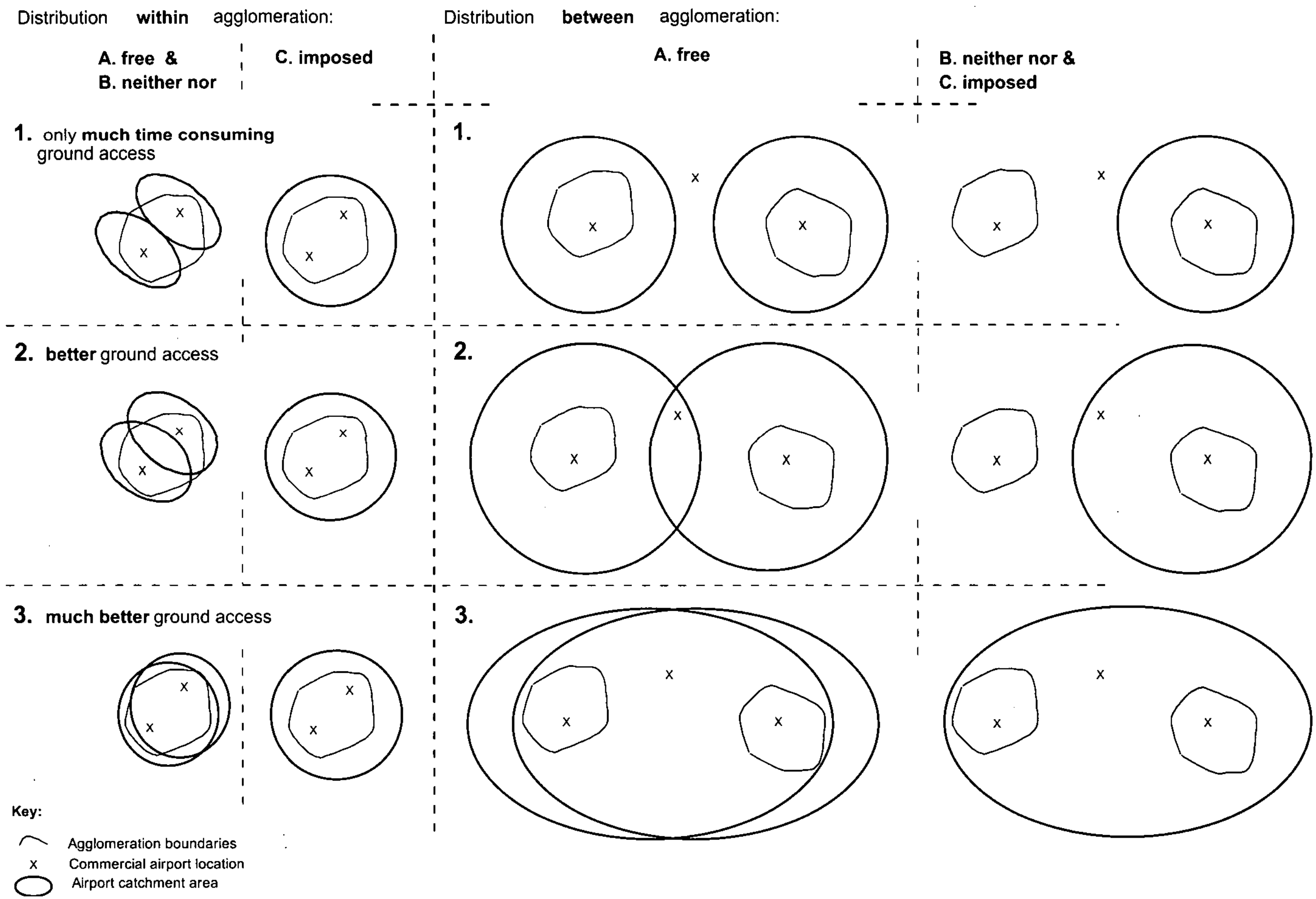
118 Bearing in mind a margin of appreciation error by the user; this margin may be narrower for the out-going than for the in-coming passenger.

119 This may be an important point, as, in particular on long-haul flights, transfers with feeder services generally apply at the same fare.

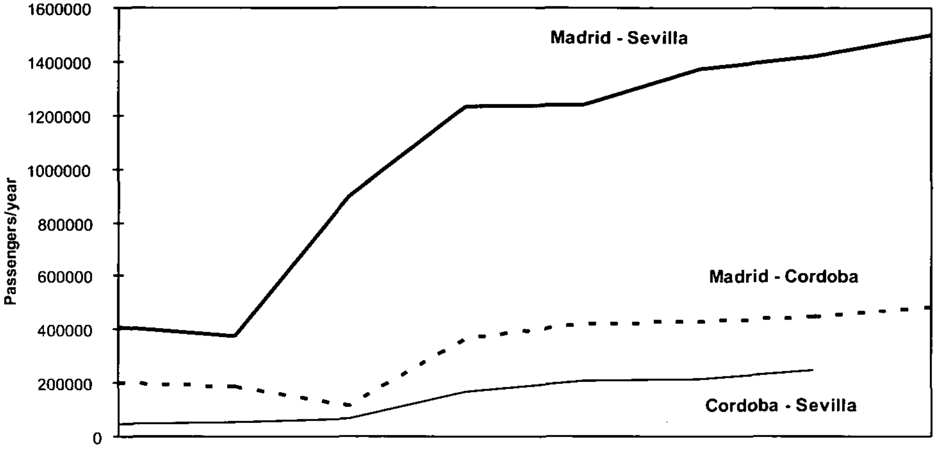
120 Between Cologne/Bonn - Dusseldorf, Basle - Zurich.

121 See the row at mid-year 1994 between British Airways and the French authorities for landing rights in Paris-Orly.



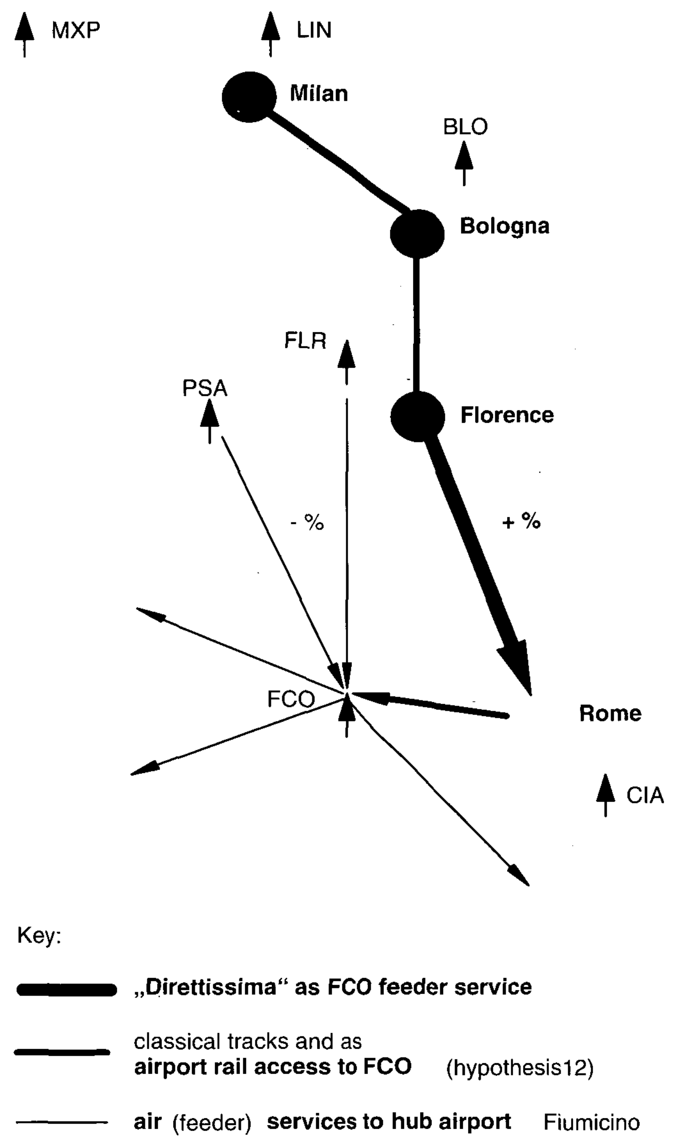
Distribution **within** agglomeration:
A. free & B. neither nor
C. imposed
Distribution **between** agglomeration:
A. free
B. neither nor & C. imposed
1. only **much time consuming** ground access
1.
2. **better** ground access
2.
3. **much better** ground access
3.
Key:
Agglomeration boundaries
x Commercial airport location
Airport catchment area

Annex 18: AVE + Talgo Traffic Volumes on Madrid-Cordoba-Sevilla

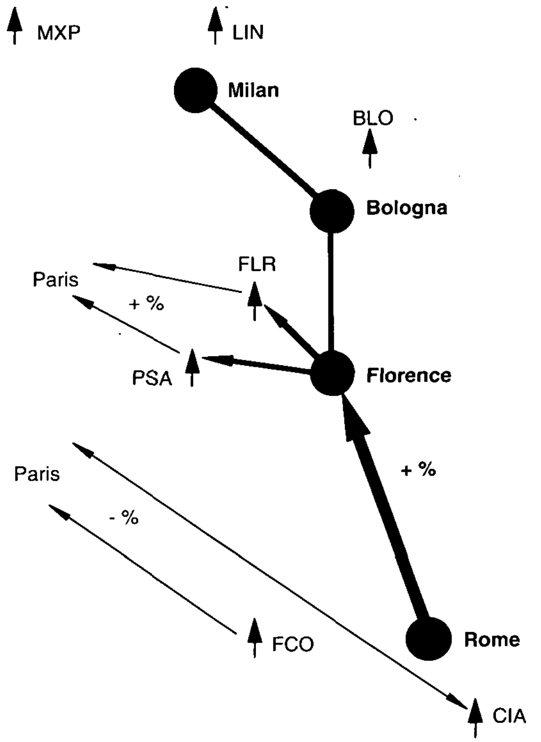


	1990	1991	1992	1993	1994	1995	1996	1997
Madrid-Sevilla	407'534	376'271	900'314	1'232'775	1'236'520	1'369'882	1'416'609	1'500'000
Madrid-Cordoba	204'027	187'048	115'039	368'343	420'482	425'813	449'212	480'000
Cordoba-Sevilla	49'286	51'235	64'699	166'271	206'182	216'882	246'627	255'000

Annex 19: „Direttissima“ and further Case Studies



Hub feeding by direttissima & FCO rail link



Key:

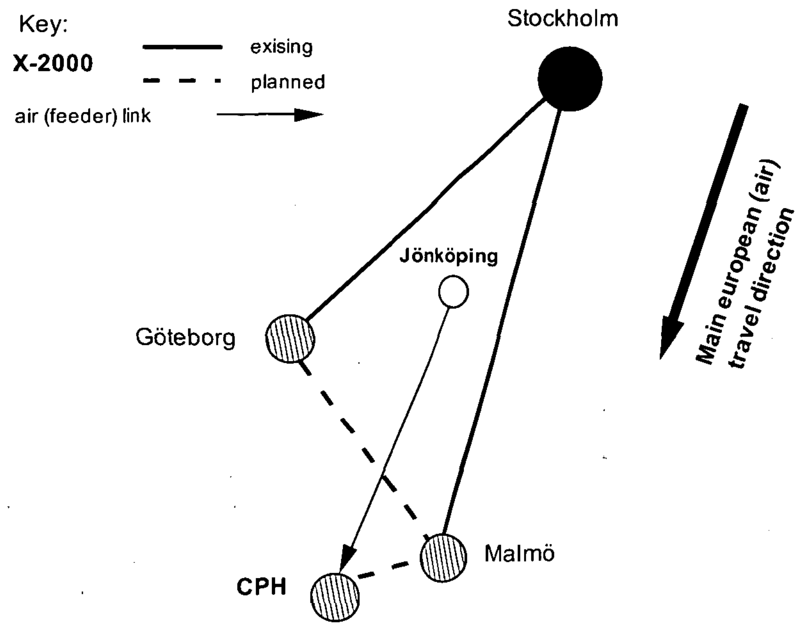
„Direttissima" as Florence airports feeder service

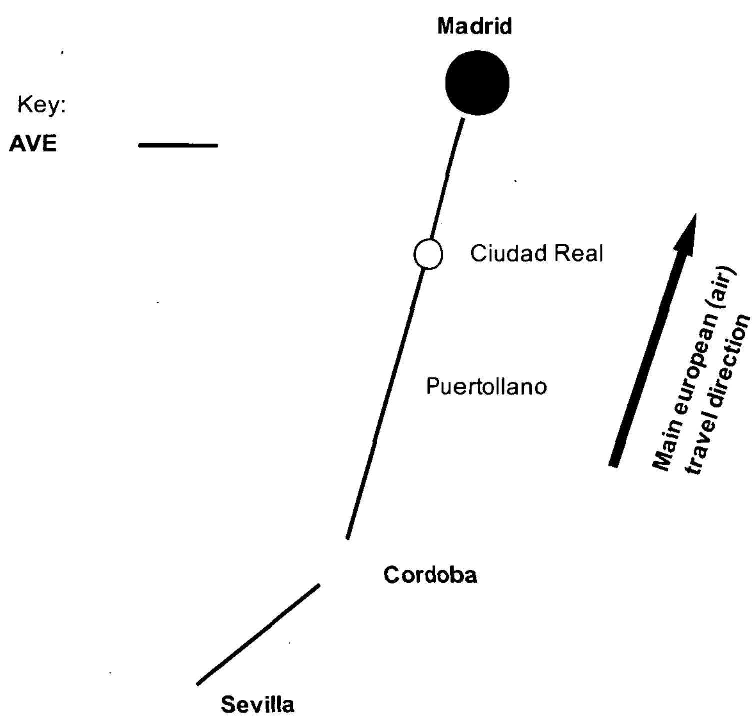
classical tracks and as
supposed **airport rail access in Florence only**
(hypothesis12)

air services (**as example**) to Paris **from Florence instead of Rome**

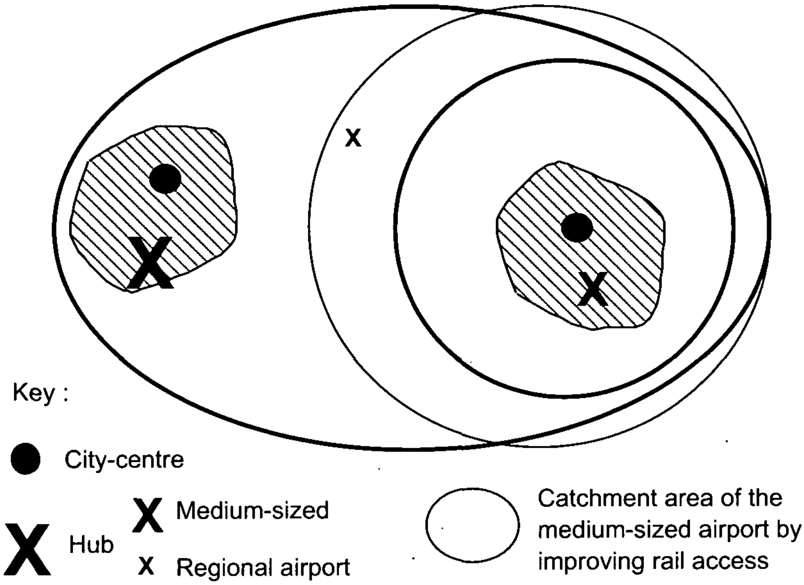
Regional airport (FLR & PSA) feeding by „direttissima" (from Rome) & airport rail access

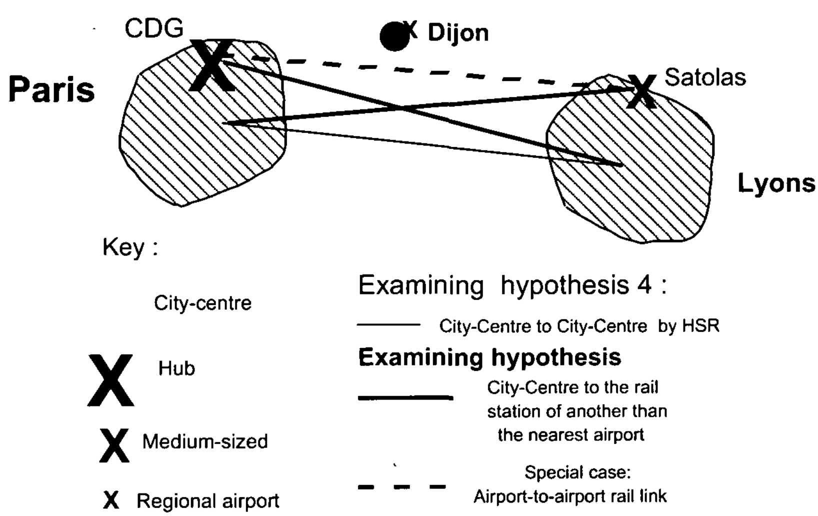
(as a (simulation) case where waiting times (delays) are extreme at the Rome (FCO) airport)


Key:
X-2000
exising
planned
air (feeder) link
Stockholm
Jönköping
Göteborg
Malmö
CPH
Main european (air) travel direction


Key:
AVE
Madrid
Ciudad Real
Puertollano
Cordoba
Sevilla
Main european (air) travel direction

Annex 20: Hypothesis 4 vs. Hypothesis 12





Annex 21: Answers to the Questionnaire on Hypothesis 12:

"**Rail stations at airports** allows a better distribution

of (air passenger) transport demand among airports"

and related to hypothesis 4:

"**High-speed rail transport** allows a better distribution

of (air passenger) transport demand among airports"

The following questions are related to hypothesis 4[122]:

- Assuming that rail stations at airports, that means airport ground access by rail, extend the catchment area of an airport, surely much more when high-speed rail stops at the airport, is there an extension of the airport catchment area to be expected, if there are high-speed rail services from an agglomeration without a rail station at its airport ?

  – overall answers:

HSR at the airport:	Yes: 17	No: 2
HSR in agglomeration		
without airport rail station:	Yes: 11	No: 6

- Is it important whether the airport is connected to high-speed rail ?

– overall answers:	Yes: 18	No: 2

- Does it make sense to have (non-stop) high-speed rail services between airport rail stations ?

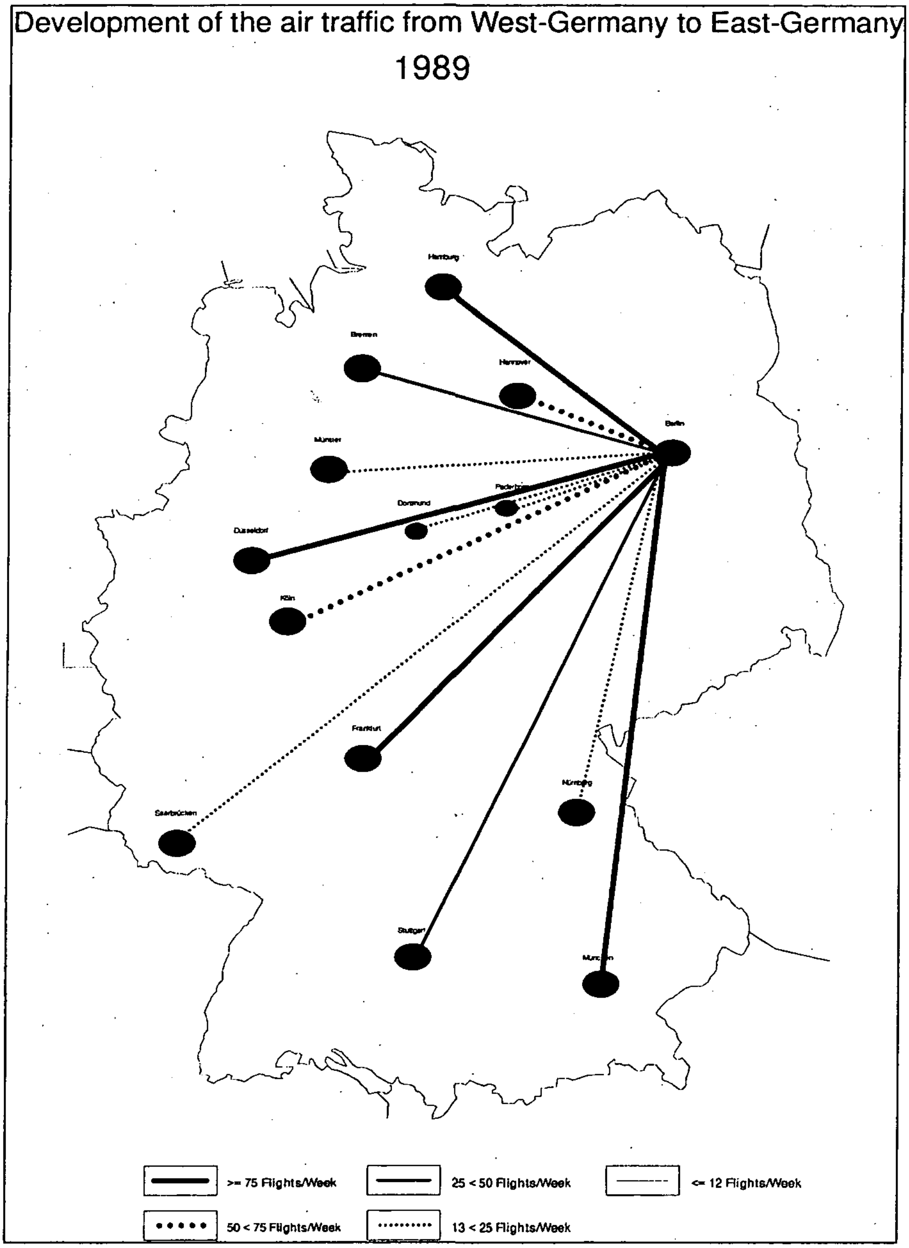
– overall answers:	Yes: 10	No: 10

- Characteristics for the choice of the transport system from/to the airport: "high"-speed.

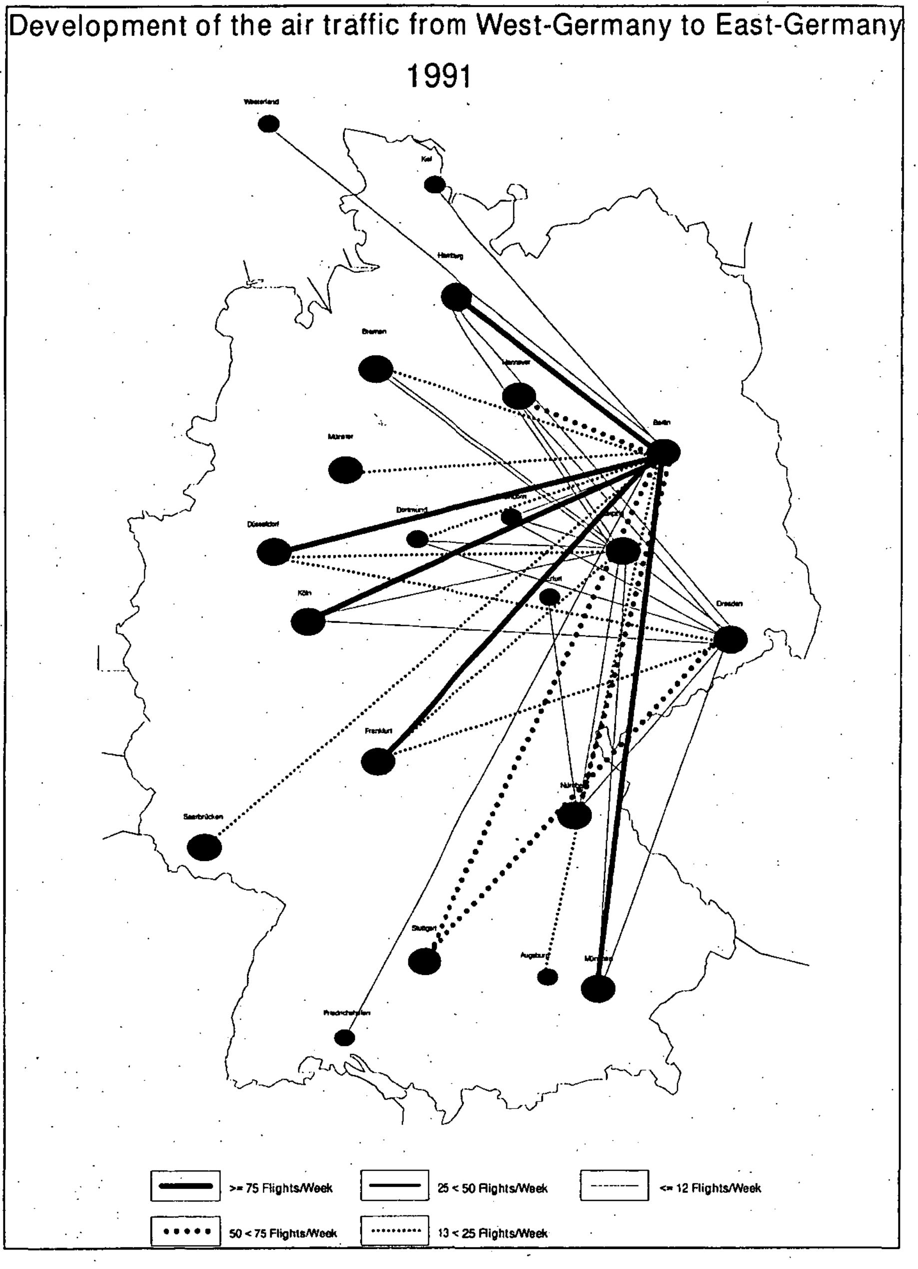
	for business &	for private purpose
– overall answer values:	3 to 6	2 to 6

122 High-speed Rail questions in the Questionnaire to Hypothesis 12, but not related to rail stations at airports.

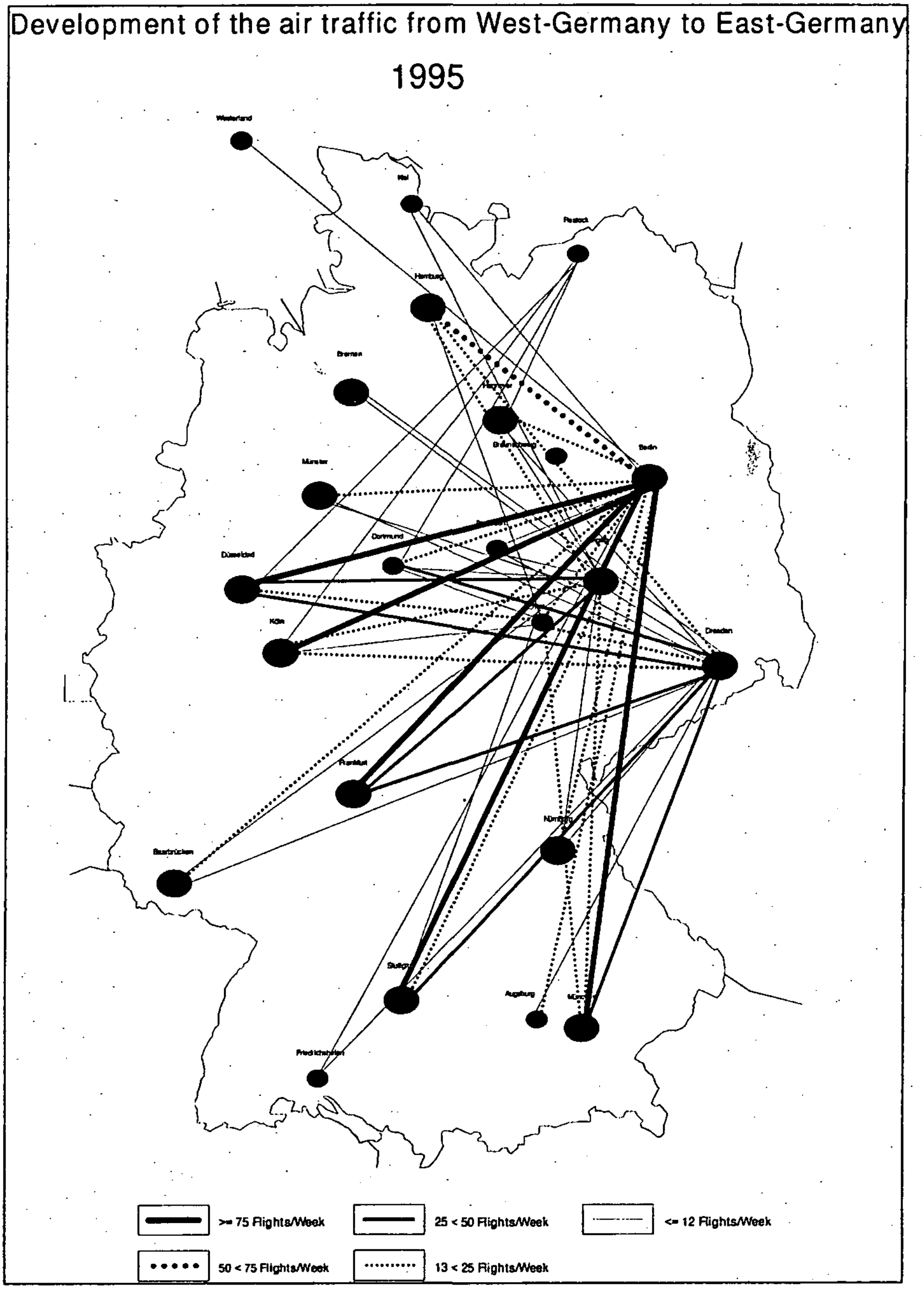
Annex 22: Air Traffic from West- to East-Germany 1989



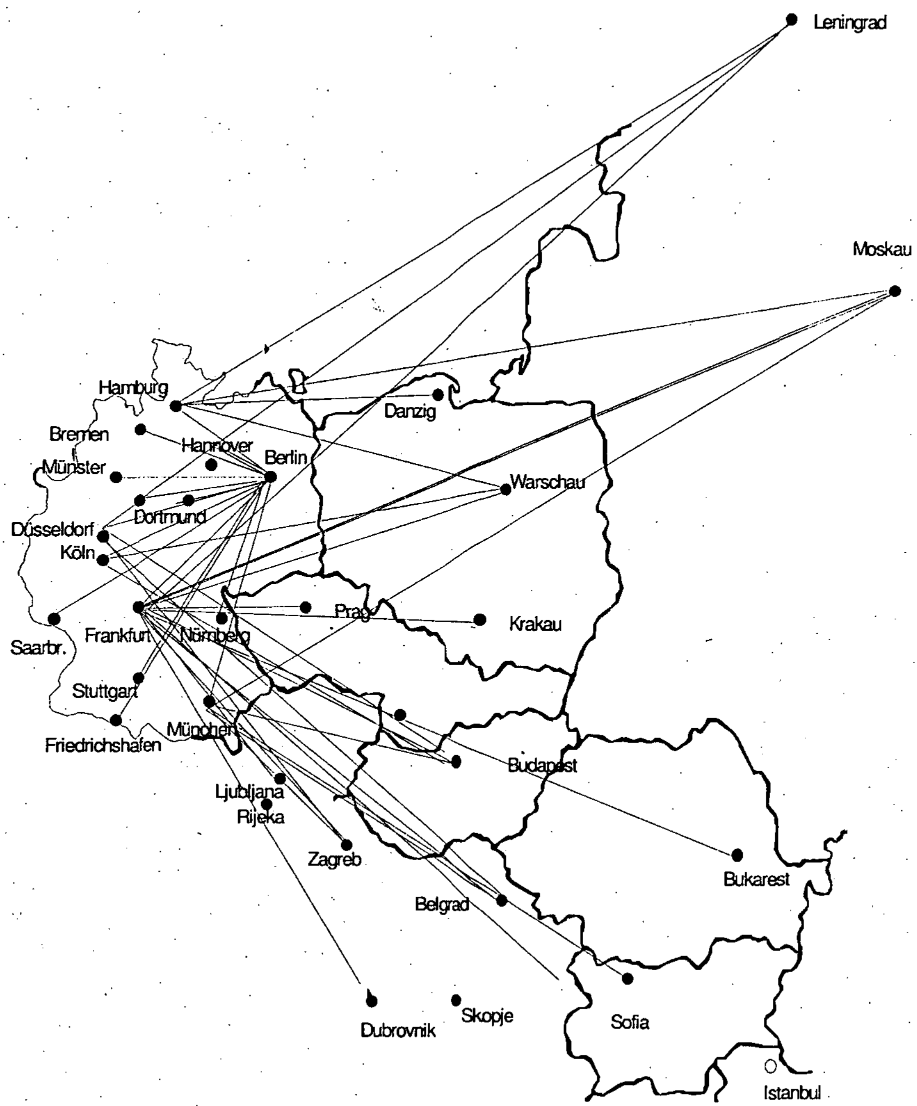
Annex 23: Air Traffic from West- to East-Germany 1991



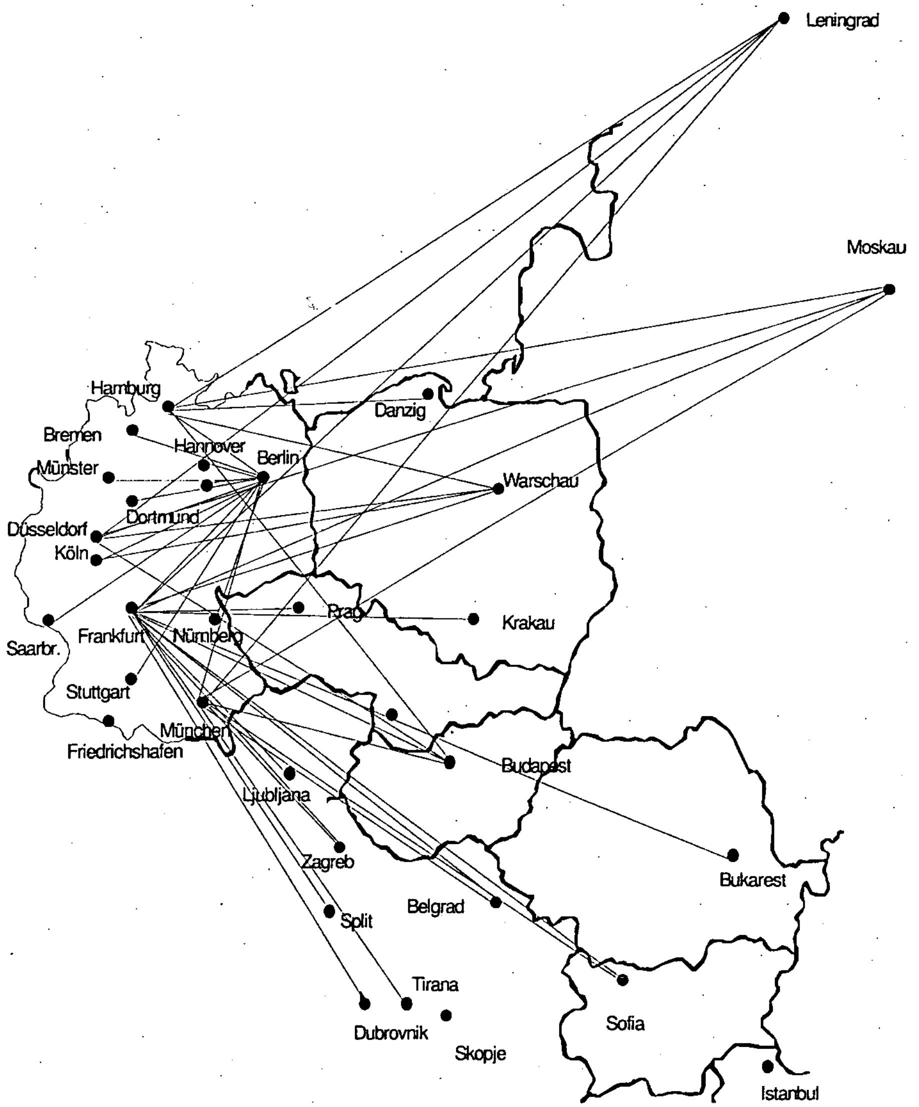
Annex 24: Air Traffic from West- to East-Germany 1995



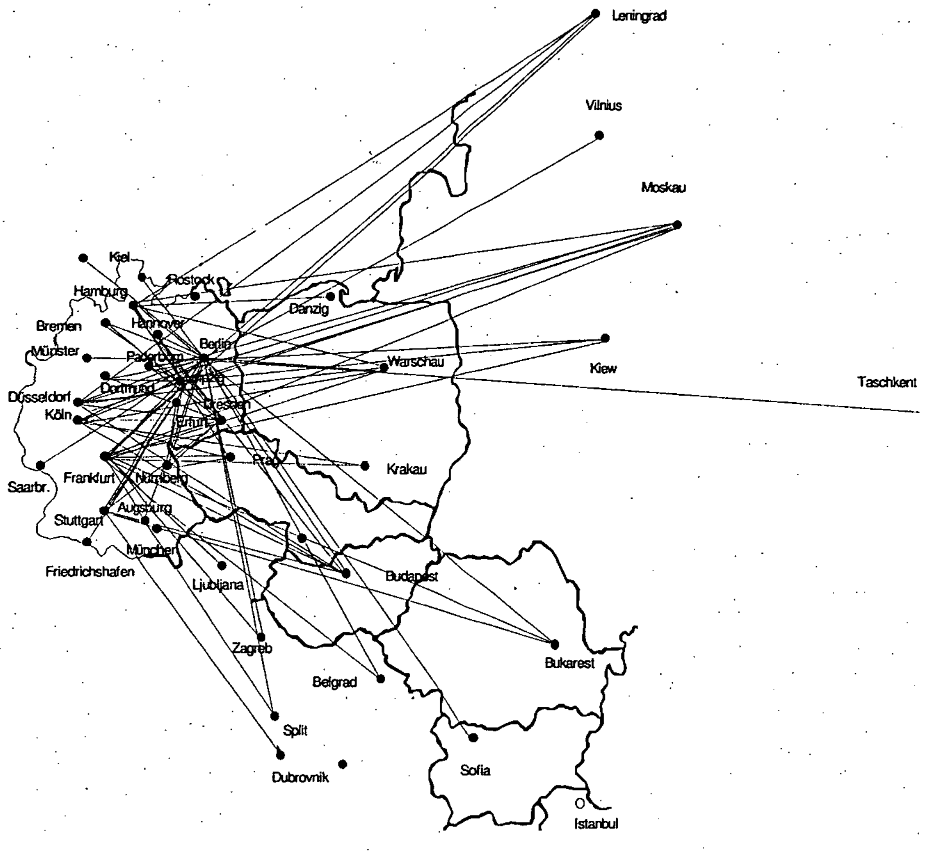
Annex 25: Air Transport West-Germany - East Europe 1987



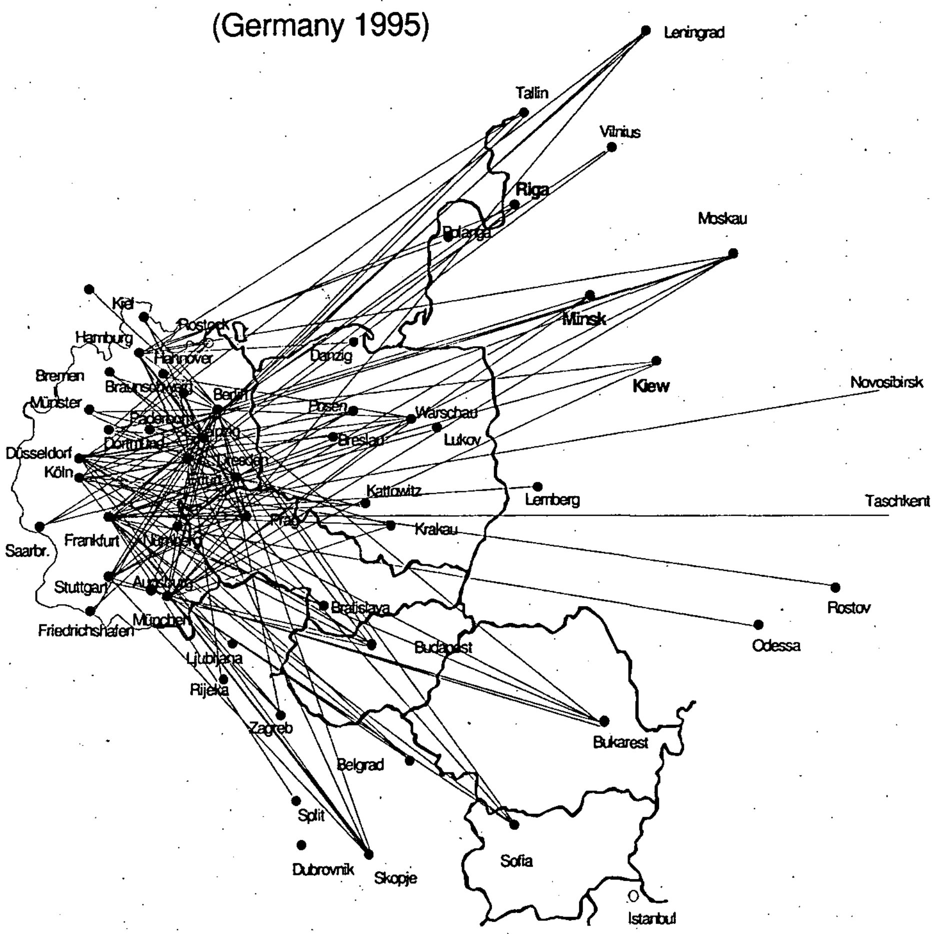
Annex 26: Air Transport West-Germany - East Europe 1989



Annex 27: Air Transport Germany - East Europe 1991



Annex 28: Air Transport Germany - East Europe 1995



Annex 29: Costs for High-Speed Infrastructure (million ECU 1992)

	Total	**up to now**	**1994**	**1995**	**1996**	**1997**	**1998**
Belgium	**4015**	154	319	450	616	594	575
Denmark	**8047**	1480	477	282	377	458	407
Germany	**53332**	9982	1839	2540	3234	3928	4283
Spain	**21220**	3061	562	1242	1369	1908	1462
Greece	**2452**	148	47	74	104	92	73
France	**36486**	7900	109	654	1204	1826	2071
Ireland	**310**	202	58	50	-	-	-
Italy	**18181**	9931	3304	3317	2913	2341	1041
Luxembourg	**160**	0	-	-	-	-	-
Netherlands	**4058**	101	32	60	135	272	387
Portugal	**49290**	0	-	-	-	-	-
England	**5168**	644	51	156	336	614	793
Total	**168349**	**33602**	**6798**	**8825**	**10288**	**12033**	**11092**
Austria	**20277**	1183	666	1049	1451	1786	1747
Switzerland	**12907**	374	142	1175	1175	1175	1278
Total	**33184**	**1557**	**808**	**2224**	**2626**	**2961**	**3025**
Sweden	**4839**	608	572	696	748	731	501
Norway	**1215**	0	-	87	175	264	264
Total	**6054**	608	572	783	923	995	765
Total	***207587***	***35767***	***8178***	***11832***	***13837***	***15989***	***14882***

Tab 1: Costs for High-Speed Infrastructure 1992 - 1998

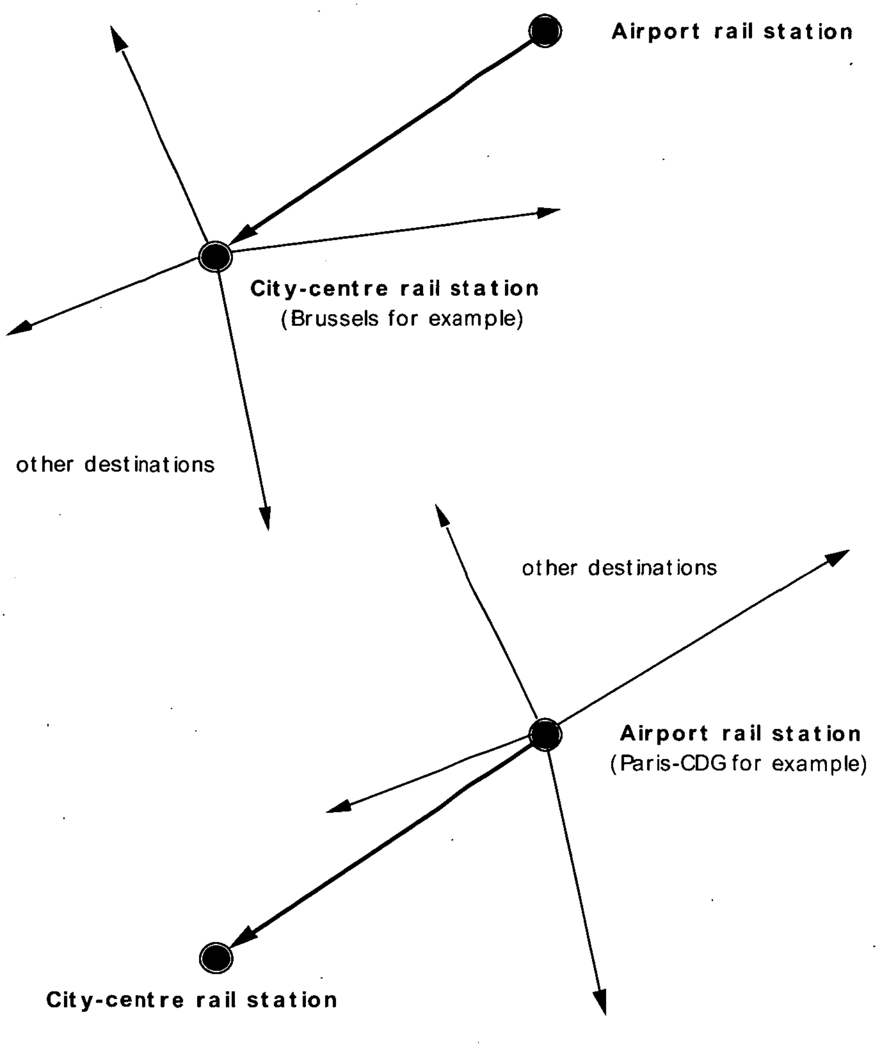
	1999	94-99	2000	2001	2002	2003	2004
Belgium	383	**2937**	291	206	188	120	96
Denmark	221	**2222**	-	-	-	217	348
Germany	3379	**19203**	2484	2125	2061	2390	2750
Spain	923	**7466**	654	788	721	731	954
Greece	93	**483**	116	138	166	222	252
France	2013	**7877**	2245	1686	1395	1724	1919
Ireland	-	**108**	-	-	-	-	-
Italy	81	**12997**	146	353	368	381	417
Luxembourg	-	**0**	-	16	32	48	48
Netherlands	470	**1356**	347	503	6590	468	468
Portugal	-	**0**	-	-	-	-	-
England	795	**2745**	542	542	542	-	-
Total	**8358**	**57394**	**6825**	**6357**	**6132**	**6301**	**7252**
Austria	1521	**8220**	1003	350	339	570	743
Switzerland	1252	**6197**	1252	1187	1058	1058	955
Total	**2773**	**14417**	**2255**	**1537**	**1397**	**1628**	**1698**
Sweden	258	**3506**	131	131	201	131	131
Norway	87	**877**	34	68	101	101	34
Total	345	**4383**	165	199	302	232	165
Total	***11476***	***76194***	***9245***	***8093***	***7831***	***8161***	***9115***

Tab. 2: Costs for High-Speed Infrastructure 1999 - 2004

	2005	2006	2007	2008	2009	2010	00-10
Belgium	24	-	-	-	-	-	**925**
Denmark	695	695	739	739	695	217	**4345**
Germany	2634	2023	1918	2124	2156	1482	**24147**
Spain	1031	1185	1408	1563	896	762	**10693**
Greece	273	224	158	115	102	55	**1821**
France	2024	2174	2115	2496	2221	710	**20709**
Ireland	-	-	-	-	-	-	**0**
Italy	364	539	762	852	787	284	**5253**
Luxembourg	16	-	-	-	-	-	**160**
Netherlands	156	-	-	-	-	-	**2601**
Portugal	-	492	984	1476	1476	492	**4920**
England	-	-	-	61	61	31	**1779**
Total	**7217**	**7332**	8084	9426	8394	4033	**77353**
Austria	1238	1325	**1594**	**1594**	**1515**	**603**	**10874**
Switzerland	826	-	-	-	-	-	**6336**
Total	**2064**	**1325**	1594	1594	1515	603	**17210**
Sweden	-	-	-	-	-	-	**725**
Norway	-	-	-	-	-	-	**338**
Total	0	0	0	0	0	0	**1063**
Total	***9281***	***8657***	***9678***	***11020***	***9909***	***4636***	***95626***

Tab. 3: Costs for High-Speed Infrastructure 2005 - 2010

Annex 30: Rail Links to Airports: Illustration of the Extremes



Annex 31: Saving Effects of High-Speed Rail & Air Transport related to each other

Guidelines to follow the diagrams

There are 4 diagrams on each page page divided into 2 columns: a left one, devoted to air passenger transport, and a right one, devoted to HSR:

- ***the first line of diagrams shows the evolution of the factor under scrutiny and related***, for instance, ***to the origin-destination distance***;
- ***the second line of diagrams shows, on the left the "saving saldo" of air transport related to HSR, and on the right, the "saving saldo" of HSR related to air transport.***

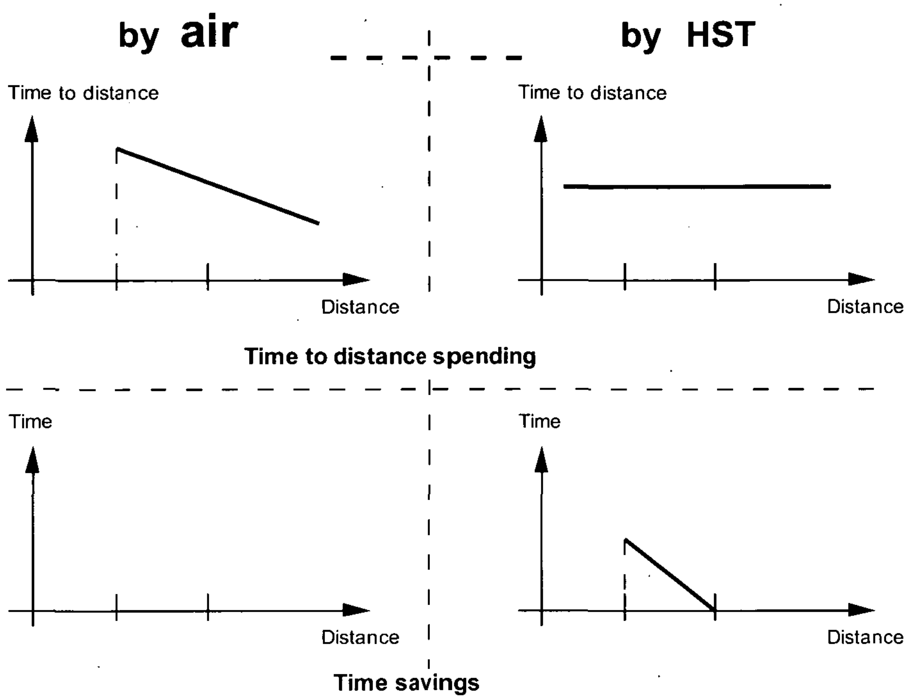
Note that, as air transport or HSR in specific situations is much "better" than the other mode, the result, ***considering a transport unit*** (seat x km & passenger x km), appears often quite obvious.

Comments to the diagrams

- **time-to-distance spending:**

Time-to-distance spent by air travel is decreasing with increasing flight distance, as a traveller is taking advantage of higher speed at cruise level compared to time wasting process at each start and arrival, whereas, this is almost irrelevant when travelling by high-speed train (assuming there are no stops between origin and destination, like Paris-Lyons or Paris-Bordeaux).

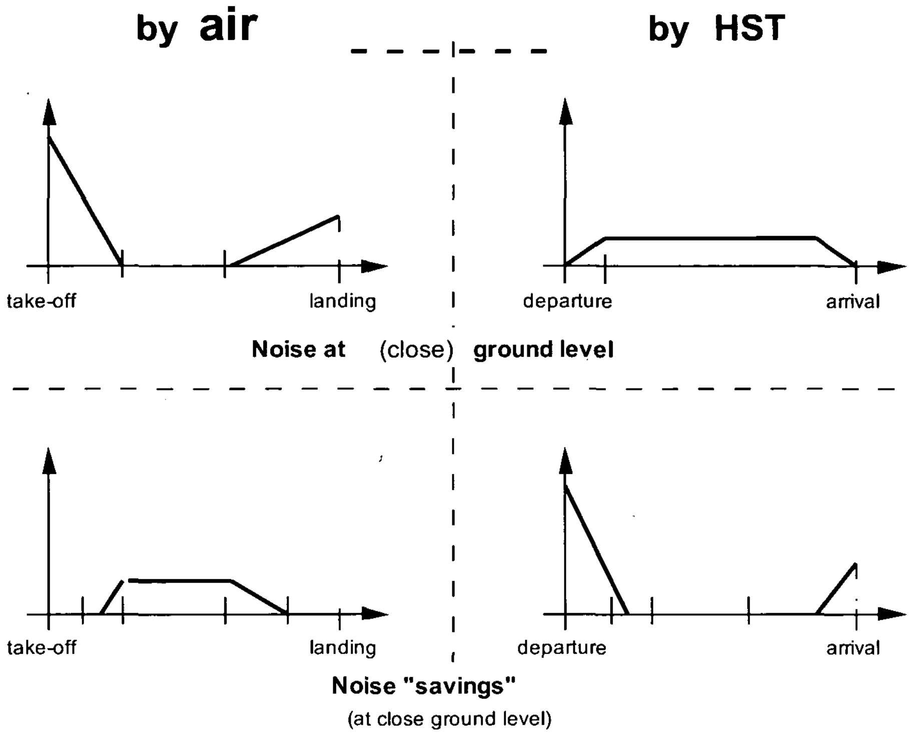
Saldi, ***savings of time-to-distance spending***, are favourable to HSR compared to air travel on the "shorter" travel distances, and favourable to air transport compared to HSR on the "longer" distances, as shown on the bottom diagram line.



- **noise level:**

Noise immission level is high at take-off, less on approach and landing, but at cruise level generally nobody at ground level hears somewhat. On the contrary, noise immission by rail increases with speed and this is to be heard all along the track vincinity.

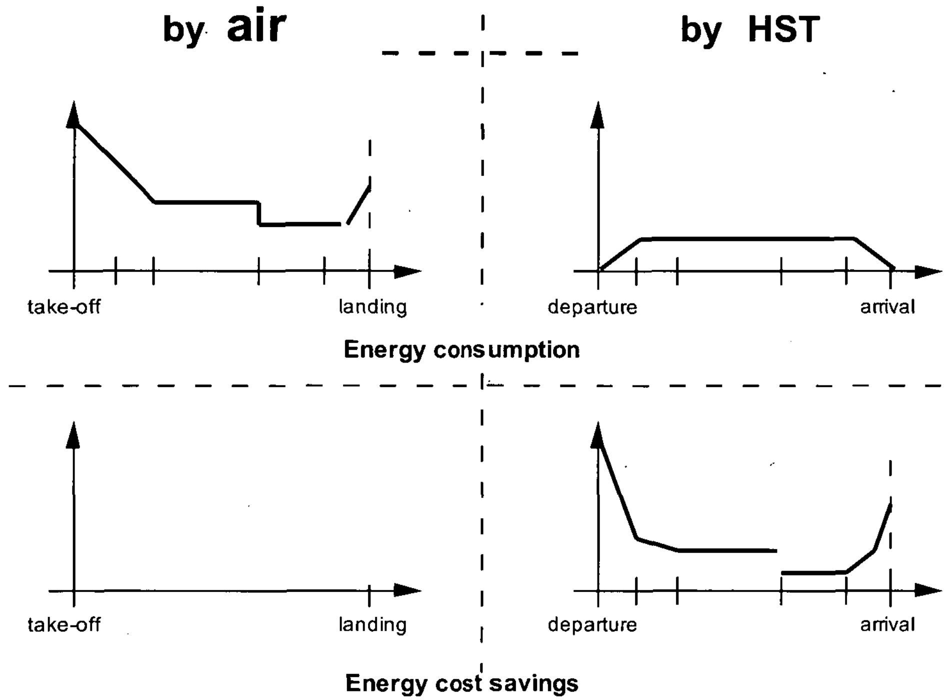
Saldi, ***savings of noise level on ground***, are favourable to HSR at the departure and arrival compared to aircraft; on the contrary, they are in favour of air transport at "cruise" levels, as shown on the bottom diagram line.



- **energy consumption:**

Energy consumption is higher at take-off and climb-out, less high on approach and landing and quite "economical" at adequate cruise levels. Energy consumption by HSR on the contrary is quite related to speed.

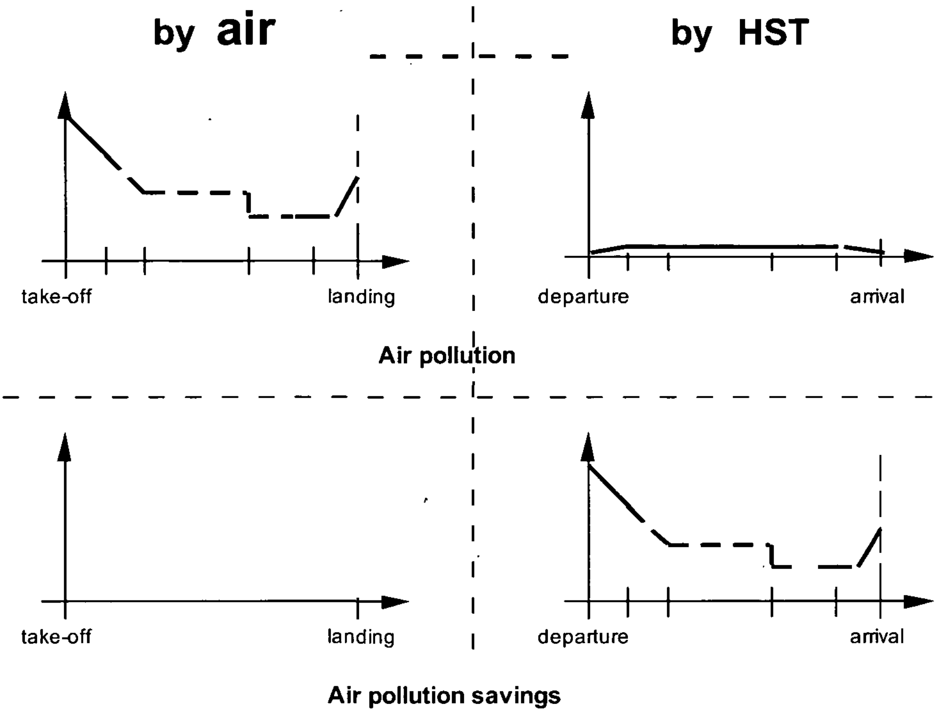
Saldi, ***savings of energy*** (once again, related to a transport unit, like seat x km **&** passenger x km), are favourable to HSR compared to aircraft on the whole travel distance, much more at the departure and arrival, than when "cruising", as shown on the bottom diagram line.



- **air pollution:**

Air pollution is higher at take-off and climb-out, less high on approach and landing. At cruise levels, where the emission occurs the effects may be however different, as one has to consider transformation of chemical elements differently according to levels in the atmosphere, but this is a rather complex matter, with still a lot of research work to do). Air pollution by HSR is nil, if assuming that hydro-electric and even nuclear powerplants are safe.

Saldi, ***savings of air pollution***, are (thoroughly) favourable to HSR compared to aircraft on the whole travel distance, and much more at the departure than at the arrival and expectedly when "cruising", as shown on the bottom diagram line.

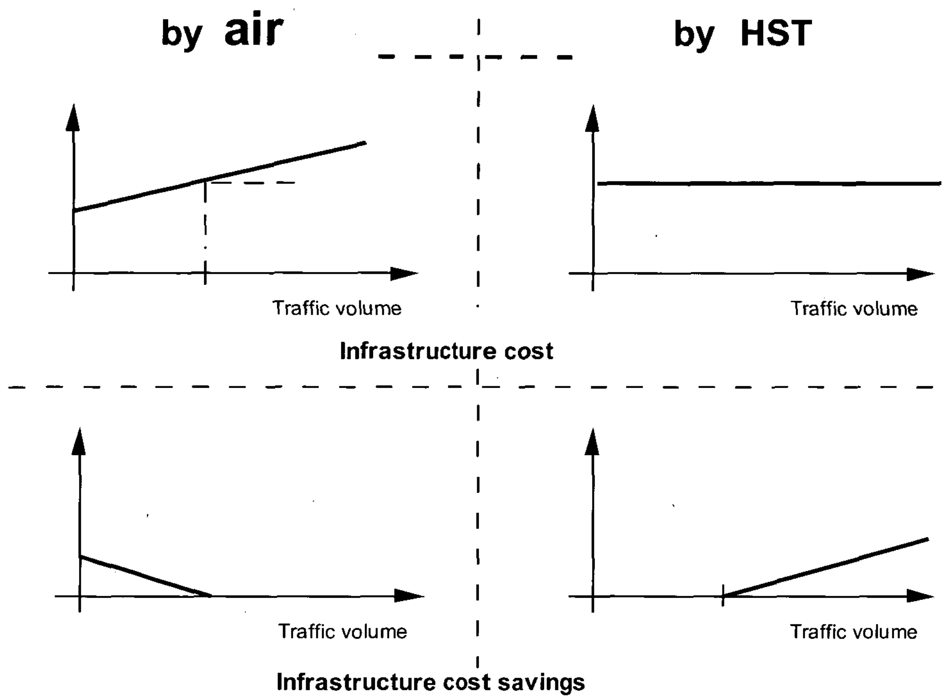


- **infrastructure costs:**

Infrastructure costs in air transport are on average raising with traffic volumes, in particular when considering congested airports, while they may be considered as past (once for all) as soon as a high-speed double track is in service (even on trunk lines, out of Paris for instance with "TGV- Sud-Est"; -Atlantique"; -Nord").

Saldi, ***savings of infrastructure costs***, are favourable to air transport when traffic volumes are low, in comparison to a high-speed track, which has to be built as a whole; as shown on the bottom diagram line.

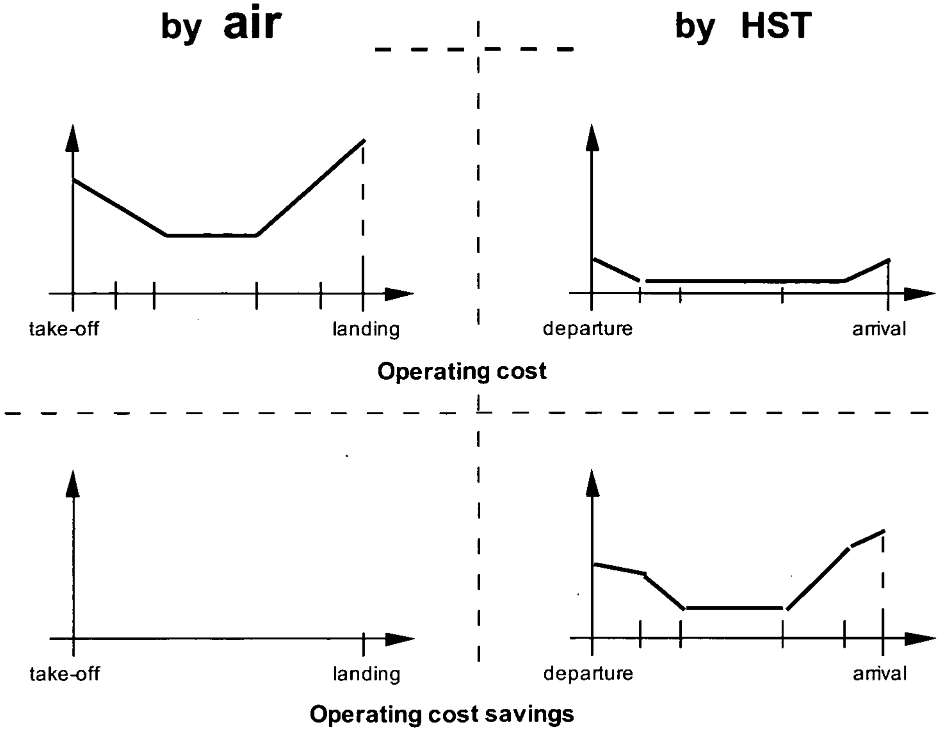
We consider that HSR is the "challenger". If a new airport & access has to be built, this is a (much) ***less clear issue*** however (***see hypothesis 10***).



- **operating costs:**

Operating costs in air transport (related to transport unit, like seat per km), are higher compared to HSR. This assumes however that traffic volumes are high enough to justify the running of a HST-system. Operating HST at low speed is quoted as more expensive than at high-speed, bearing in mind less rolling stock trips.

Saldi, ***savings of operating costs in this case***, are favourable to HSR, as shown on the bottom diagram line.


by air
by HST
take-off
landing
departure
arrival
Operating cost
take-off
landing
departure
arrival
Operating cost savings

Annex 32: Airports with more than 2 million Passengers in 1992 with existing or planned Rail Links

Airports in Europe in 1992:	Rank:	Air passengers:	Rail link at airport to City:	long-distance:
London- Heathrow	1	45'175'536;	yes;	missing;
Frankfurt	2	30'746'463;	yes;	yes;
Paris- Roissy	3	25'198'420; [123]	yes;	yes;
Paris- Orly	4	25'170'204;	yes;	missing;
London- Gatwick	5	19'969'440;	yes;	yes;
Amsterdam	6	19'145'064; [123]	yes;	yes;
Rome- Fiumicino	7	19'009'547;	yes;	missing;
Madrid	8	18'100'805; [123]	planned;	planned;
Zurich	9	13'048'938;	yes;	yes;
Stockholm- Arlanda	10	12'947'727;	planned;	planned;
Manchester	11	12'431'084;	yes;	planned;
Dusseldorf	12	12'274'348;	yes;	planned;
Copenhagen	13	12'166'823;	planned;	planned;
Munich	14	12'018'202;	yes;	planned;
Palma de Mallorca	15	11'941'861; [124]		
Barcelona	16	10'330'221; [125]	yes;	missing;
Brussels	17	9'398'636;	yes;	missing;
Milan- Linate	18	9'347'679;	missing;	missing;
Athens	19	9'066'756;	year 1997;	missing;
Istanbul	20	7'530'428;	missing;	missing;
Oslo- Fornebu	21	7'000'000; [126]	planned;	planned;
Gran Canaria	22	6'945'050; [124]		
Hamburg	23	6'925'273;	year 2000;	
Helsinki	24	6'862'529;	planned;	planned;
Vienna	25	6'808'612;	yes;	
Berlin- Tegel	26	6'664'045;	year 2000;	
Tenerife	27	6'431'927; [124]		
Nice	28	5'930'686;	missing;	
Dublin	29	5'808'024;	missing;	
Geneva	30	5'703'867;	yes;	yes;
Lisbon	31	5'594'811;	missing;	
Malaga	32	4'863'819; [124]	yes;	

123 TGV stations (Lyon and CDG have gone 1994 into operation).

124 Mainly charter traffic from northern Europe.

125 NB: Olympic Games in 1992.

126 Planned for the new Oslo airport at Gardermoen.

Airports in Europe in 1992:	Rank:	Air passengers:	Rail link at airport to City:	long-distance:
Glasgow	33	4'786'091;	missing;	
Stuttgart	34	4'770'186;	yes;	
Marseille	35	4'705'679;	missing;	
Lyon	36	3'904'262; [123]	missing;	yes;
Birmingham	37	3'829'722;	yes;	yes;
Cologne/ Bonn	38	3'552'708;	planned;	planned;
Larnaca	39	3'493'994; [124]		
Faro	40	3'366'542; [124]		
Milan- Malpensa	41	3'283'794;	year 1997;	planned;
Toulouse	42	3'126'192;	missing;	
Hanover	43	3'093'895;	planned;	planned;
Seville	44	2'892'437; [127]	missing;	
Lanzarote	45	2'842'404; [124]		
Alicante	46	2'833'501; [124]		
Heraklion	47	2'773'614; [124]		
Gothenburg	48	2'751'965;	missing;	
Antalya	49	2'734'731; [124]		
Edinburgh	50	2'679'633;	missing;	
Ibiza	51	2'606'519; [124]		
Bergen	52	2'526'428;	missing;	
Budapest	53	2'500'000;	missing;	
London- Stansted	54	2'355'400;	yes;	
Bordeaux	55	2'322'254;	missing;	
Belfast	56	2'261'645;	missing;	
Malta	57	2'230'789; [124]		
Aberdeen	58	2'201'800; [128]		
Ankara- Esenboga	59	2'187'061;	missing;	
Naples	60	2'092'543;	missing;	
Stavanger	61	2'073'754; [128]		
Newcastle	62	2'004'229;	yes;	
Izmir	63	2'003'490; [124]		
Basel/ Mulhouse	64	2'002'912;	missing;	
Valencia	65	1'748'700;	yes;	
Berlin- Schönefeld	66	1'523'726;	yes;	yes;
Pisa	67	1'060'286; [129]	yes;	
Leipzig	68	634'424;	year 2000;	planned;
Southampton	69	408'911;	yes;	yes;

source: AEA, Association of European Airlines;

127 NB: World exhibition in 1992.

128 Mainly helicopter traffic to/from oil rigs.

129 Connection with Florence

Annex 33: Short Mission Reports

The short missions carried out have quite a good completing factor:

- on the one side, the London area airports, with the major ***commercial airports within Europe's largest agglomeration area*** (and looking at the "Eurostar" HSR link with the other major agglomeration area of Paris);
- on the other side, ***a major European (HSR) transport axis between agglomerations*** from Amsterdam to Lyon, where regional (Antwerp-Deurne; Lille-Lesquin) to medium-sized (Lyon-Satolas) airports alternate with major (hub) airports (Amsterdam-Schipool; Brussels-Zaventem; Paris-CDG/Roissy & -Orly), which all have rail (and even HSR) stations in or close to the airports; a case study line for Action COST 318 which makes sense in this European context.

• London area airports

The London area analysis is ***a case within agglomeration*** (see rough drawing & description in Annex 34).

This short mission took place in November 1994[130]. The London area airports case study give the opportunity to examine the influence of rail access on the distribution of air transport demand between the airports within the largest agglomeration in Western Europe: that are major (Heathrow & Gatwick), medium-sized (Stansted, Luton), as well as small-sized (London City) airports.

According to British Airport Authority:

The two main determinants for passenger airport choice:

1. Frequency of flight departures;
2. Accessibility; journey time and cost each a factor.

There is a "very clear airport catchment area sectorisation" of the London area, due to cost and reliability.

130 Organizations met were BAA, British Airport Authority & London Underground. BR, British Rail, was reluctant.

However, two thirds are using Heathrow airport[131]. In fact the traffic distribution of the 10 busiest routes out of London is 80% for Heathrow and 20% for Gatwick airport.

Majority is still running by car: Heathrow airport is too close (to the city centre) to have a good rail attraction and as a 25-40 miles ride (to Gatwick and Stansted airports) is too expensive to use a taxi, rail links "are not powerful enough to have a more significant share".

Rail links are comparatively (much) more used at airports by people from abroad, much more dependent on (semi-) public transport than air passengers living spread in the agglomeration (and without direct rail access).

Without rail links the volume of passenger traffic at the Stansted and Gatwick airports would be (much) less. That's what can be said about catchment area extension due to rail links at the airport.

Direct links between airports should not be worth considering. The influence of the London Underground is, from the nature of service supplied, not relevant.

• Antwerp's Chamber of Commerce & Industry

This short mission took place in March 1996. The Antwerp case study give the opportunity to examine the influence of rail access on the distribution of air passenger transport demand with regard to a regional airport.

Antwerp lies between two European major airports (hubs) Amsterdam and Brussels. Antwerp has nevertheless a regional airport with a very close rail station, which should become, in a not too far future, the HSR Antwerp stop (TGV-Thalys) between Brussels and Amsterdam.

The choice of the Chamber of Commerce & Industry is due to its assumed representativity of the business community, for which specific conditions should be met in order that transport services are effectively used (and appreciated).

Considering air passenger transport demand distribution among airports, the present ground access time difference by rail of about one hour comparing the Brussels and Amsterdam airports should not be seen as exaggerated, depending on the destinations

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131 British Airways is willing to concentrate (as possible) on a (single, congested) airport (Heathrow) because of the (very) important (intra-airline) transfer traffic. Airlines want to go there, because of the opportunity of (inter-airline) transfer opportunities. If they could not do so, part of the traffic would go lost, i.e. go to other airports. This can't be in the commercial interest of a privatised BAA. BAA agree on the influence of ***free and imposed distribution***. As complementary factor to "free vs imposed distribution": frequent flyer programmes and reservation systems constitute a pole.

BA operates as airline a "free" distribution (to and from Italy) with leisure travel (Pisa, Florence) at Gatwick airport and business travel (Rome, Milan) at Heathrow airport (connections, aibility to take a cab to Gatwick would be too expensive). This means that this distribution is rather "imposed" for the BA-customers.

and choice of departure of air travellers. Even the with regard to timetable faster bus express service to the Brussels airport, further time margin is required, in order to take into account possible congestion (rush hours, accidents) on the motorway.

The airport ground access times by rail to airports should improve, as the Brussels airport is reported to be linked from Antwerp by IC trains directly at the new through-going airport rail station. It remains to be seen what impact HSR will have on distribution, as in this case rail access time to the Amsterdam airport will be reduced (significantly) according to present classical trains.

The Antwerp airport plays the role of a working regional airport, going to be much more involved in the overlap of the catchment areas of two major (hub) airports. Anyway, the Antwerp's Chamber of Commerce and Industry is confident that a HSR station in Berchem will be beneficial to the Antwerp area and to the Antwerp regional airport (with its regional airline). There is a need felt for a better distribution of air passenger demand among airports and that rail stations at airports are beneficial to this.

Based on the Experts' Questionnaire used for the "Delphi"-method approach of the issue, the following statements related to Antwerp are given by the Chamber's Speaker:

Airports will compete between them. Concentration in air passenger traffic will last or no, depending on the number of years necessary to implements the new airport aims (and with regard to the development of feeder services).

(For the very next time), there will be even more concentration in air passenger traffic. The Chamber's speaker does not think that the use of improved technology will (finally), with more concentration, avoid saturation (at hubs).

There will be in regional air transport more "hub-by-pass" flights and they will be relevant in term of air traffic volumes relief at major airports (hubs).

The future of regional airports lies in (more) intra-European air services, whereas major airports will have to cope first with overseas traffic.

Many regional airports are in grade to offer a 10' check-in deadline time; major airports are not.

The Chamber's speaker stresses that regional airports, such as Antwerp, have means to provide resources, even if they show with relatively poor traffic records. In Antwerp the runway extension could be considered.

Air service supply (destinations, frequencies, comfort) is considered as "very important", air transport fares "important", whereas ground access flexibility (rail versus road) seems to be "less important". Airport access in general is "not an important" issue and ground transport costs have "no influence".

The Chamber's speaker feels that rail stations at airports extend the catchment area of an airport, because it is a great opportunity. However, it depends on the frequencies supplied. The catchment area of the Antwerp regional airport will be surely much more extended when HSR stop at the Antwerp-Berchem station.

The Chamber's speaker sees the airport catchment area for businessmen within a 2 hours ground access limit.

A rail access to the airport causes a new distribution of air transport demand within an agglomeration with more than one commercial airport, as well as between a hub and a medium-sized airport, but not between major airports (hubs). Because of flexibility, (non-stop) high-speed rail between airport rail stations makes in any way sense.

Rail access share to airports has to be increased; important are however: comfort, frequencies (of public transport access to the airport).

Provided that connections and frequencies, as well as comfort and fares are adequate, an integrated multimode transport system suits very well as transport system to/from the airport. In this view is "high"-speed less important; an uni-modal transport system is "not important".

- **Brussels airport**

Short missions began in September 1994 and were introduced by the CEC (COST Scientific Secretariat). Organisations met were the BATC, Brussels Air Terminal Company, as well as SNCB, Société Nationale des Chemins de fer Belges.

When asking about distribution among airports, it seems that the BATC is keen to attract a bigger share of air traffic. Cities like Antwerp are clearly in the catchment area of both Amsterdam & Brussels airports, but it is difficult to estimate the shares: Amsterdam offers much more long-distance flights, whereas Brussels is nearer (in distance, if not in time and comfort, due to the motorway being saturated in the airport area at peak hours and the present poor level of service of the rail link to the airport).

High-speed trains could also lead to loosing traffic for the benefit of challenging airports. It seems that Paris-CDG (via Lille) is already on the way to attract a higher share of the Belgian air passenger traffic (see AdP address at the Eurailspeed 95 conference in Lille).

For BATC however, there is a clear distinction between "business" and "budget" travellers: the (full-fare) "business traveller" will not choose the airport because of its structure or his favourite airline, but because of the flight departure (and arrival) times; the "budget traveller" instead will follow the choice imposed by the tour operator, which will (try to) minimalize costs against comfort, time spent and accessibility.

Lille airport

This short mission took place in March 1996. The Lille case study give the opportunity to examine the influence of rail access on the distribution of air passenger transport demand with regard to a regional airport.

The much populated region of Lille lies at the crossroads of the major agglomerations of Western Europe, the Ruhr area, the Benelux States, London and Paris, and so quite now at the first HSR-crossroads in Europe (see rough drawing Annex 34), two major (hub) airports (Paris-CDG & Brussels-Zaventem) being within one-hour ride reach. Lille has nevertheless a regional airport working and getting quite much more involved in the overlap of the catchment areas of both close major (hub) airports, but (for the time being) no very close rail station.

The Lille-Lesquin regional airport is managed, as it is often the case in France, on behalf of the Chambre of Commerce & Industry. Met was the airport marketing director.

Considering air passenger demand distribution, flight frequencies supplied at Paris-CDG are of course overwhelming. That means for the business air traveller more opportunities and flexibility, according to his work. Furthermore, he is able to check-in at the TGV station in Lille (if he flies Air France).

Airport ground access (flexibility), air services supply (destinations, frequencies), air transport costs are considered as "very important", ground access costs as less.

Whether an airport has to be connected to high-speed rail is "indispensable", and "it makes sense" to have (non-stop) high-speed rail between airport rail stations. Only HSR stations at airports extend the catchment area of an airport like Lille.

Whatever the need at an airport, rail stations should offer extensive software opportunities (information, ticketing, luggage transfer, reservations of any kind).

Air passenger demand distribution is given by the context, but another distribution could occur according to a new one led by strong marketing. "The prospects are not bad".

A regional airport like Lille-Lesquin "has to use its strength: proximity" is seen as strength.

The marketing director is familiar with the idea of the Lille-Lesquin becoming a "reliever" airport (for both close hubs). "What the Lille airport needs is a strong airline". Should it be a home carrier? An airline should be "based" at the airport. It has been suggested to develop the airport as a CDG3, as the "3rd terminal" of Paris-Roissy airport. Air passengers would have to change their reflexes.

Much more related to the Experts' Questionnaire used for the "Delphi"-method approach, The Lille marketing director finally delivers its appreciation of the following situations:

Rail access does not cause a new distribution of air transport demand within an agglomeration with more than one commercial airport. More important are frequencies of public transport access to the airport.

More opportunities to choose its airport are a convenient access, but this does not lead to more air travels by someone living and/or working in an area where the catchment area of (several) airports overlap.

• Paris area airports

Short missions took place in January 1996, June & July 1997 and were kindly introduced by the French member to the Action COST-318. Organisations met were AdP, Aéroports de Paris, RATP, Régie Autonome des Transports Parisiens, RVS, RATPVAL Service, SNCF, Société Nationale des Chemins de Fer Français.

Orly airport is connected to the RER station of Antony by a fully-automated new technology guided light transit (see rough drawing & description Annex 34).

Paris-CDG plays a future role, taking into account the influence of the new HSR station at the CDG-airport. In this respect, the catchment area extension of the Paris-CDG airport by HSR ground access is worth considering[132] (see also rough drawing Annex 34).

Expected consequences are set as follows:

1. People living in towns without a significant regional airport will use CDG more frequently;

2. People living in towns with a regional to medium-sized airport (such as Lille) will continue to use it for the main destinations ("Lille airport" will not disappear);

3. People living in towns with major airports (such as Brussels) will choose among several opportunities (from their town or from CDG);

4. For people switching from CDG to Brussels for instance, very few opportunities are expected;

5. Induced (new) traffic: hard to see; no data available. What is known is the overall air passenger traffic volume with TGV at Paris-CDG.

However, as for Lyons-Satolas (third TGV station in the Lyons area), it seems for AdP that many of the TGV passengers getting off at Paris-CDG from Lyon are using

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132 Tours will be within the two hours and a half limit set for the (inner) CDG catchment area, as the cities of Le Mans, Poitiers, Nantes, Rennes, Lyon, Reims, Metz, Nancy, Strasbourg, Lille). When setting Paris-CDG airport access from Tours in the past as an example, TGV to Gare Montparnasse, then to Gare du Nord, RER station 1 at Paris-CDG and at last bus shuttle service, the journey took more than 3 hours with 3 breaks! Now: one hour and a half, and no break!

Paris-CDG as a second TGV station in Paris (and vice versa, using the special "TGV parking" at CDG). In this respect, one has to bear in mind, that the Parc des Expositions is close to the CDG airport (see rough drawing Annex 34).

This should not only be the case for people coming from the city centre rail stations of Lyon-Perrache and -Part-Dieu, but in particular for most of the rail passengers (about 10'000 a year) using the up-to-now single daily TGV non-stop connection between both airports of Lyon-Satolas and Paris CDG (as part of a TGV service Lille-Avignon). This means that Paris-CDG TGV-station is (mainly) not used as an interconnecting opportunity in air transport[133]. This fact is underlined by the newly growing traffic between Lyon and Paris-CDG, since Air France started the operation of a hub-and-spoke system in CDG in the Spring of 1996.

As the short mission in Lyon-Satolas states, an "Air Algérie effect" excepted, a new distribution of air passenger transport demand towards the still under-utilised airport of Lyon-Satolas is not going to happen, unless the Satolas airport is developing as a "hub". This implies the set-up by any airline (group) of at least a secondary hub.

For this, EU-liberalisation and fierce airline (group) competition may help in favour of Satolas.

In this case, AdP is familiar with the idea, that, first, feeder air services to CDG will be restricted to a strict (commercial) necessity, relieving slot congestion by more hub-by-pass flights. As air traffic supply "out of hubs" becomes more attractive, this fact constitutes, second, a growing alternative for air transport demand in the country, at least for the air transport demand lying south of the Paris region. And this air transport demand is already fairly well-connected by HSR to the airport of Satolas.

As AdP stress, Paris airports may not be saturated in terms of technical capacity (at CDG), but in terms of maximum movements authorised per year (already the case in Orly).

Discussions on a 3rd (major) airport (on grounds of environment protection around the existing ones) are not welcome by the AdP. It cannot be said whether it will be necessary. AdP encourages the regional airports rather than a 3rd airport for Paris.

Asking whether air passenger use the rail links (ORLYVAL + RER "B") between both Paris airports to transfer from flights in ORY to CDG and vv., the answer, RATP believes, is no, as, even having to take into account road traffic jams, people are expected to prefer the direct airport-to-airport coach comfort, being driven and having put their luggage in the appropriate place for the whole ride.

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133 Maybe not primilarly due to the ground access travel time (even by TGV), but because of the present air transport fare structure, which makes transfer at airports (according to tickets within the same airline group more attractive by air and) in some cases at no expense, depending on the final air transport destination. Things may change with integrated fare structures "rail + air" (the airline and/ or railway company having anyway to pay for the difference by HSR ground access usual fare, but being then relieved by experiencing more customers (railway company), by discontnuing some non-profitable air feeder services (airlines), the major (hub) airports saving slots at congested peak hours).

- **Lyon airport** & **"TGV-Sud-Est after** airport rail stations" (Paris-Lyons)

NB: a European case, where there is also an opportunity to compare the air transport distribution **before** the introduction of HSR rail stations at both airports (see Chapter 2.4)

The short mission took place in May 1997 at the Satolas airport, together with Action COST 318 management & working meetings, and were kindly introduced by the French member to the Action COST-318. Hosts were the Lyon-Satolas Airport authorities and the Conseil Régional Rhône-Alpes and talks involved in particular the Paris-Lyon links as a whole and the new airport HSR stations (see rough drawing and description attached in Annex 34).

Air passenger traffic between Lyon and Paris, "TGV is a very powerful competitor!".

However, air passenger traffic is now increasing again, due to the introduction of the Air France hub-and-spoke system in Paris-CDG last year. This fact speaks against HSR access to airport instead of feeder air services; but due to the air fare system, one has to consider overall ticket costs in many cases still cheaper by air than by rail access.

Rail passenger traffic volumes to/from Paris-CDG at the TGV-station in Satolas is stagnating, one having however to bear in mind that there is only one frequency per day (the TGV stops at Paris-CDG on the way to Lille) (see rough description values attached).

Considering rail passenger traffic volumes to/from Paris-Gare de Lyon at the TGV-station in Satolas, there is one event worth mentioning as illustration of HSR as air feeder service substitute: as flights to and from Algeria were suspended in Paris in the recent past, many passengers took the TGV to the Lyon-Satolas airport to catch their plane to destination. This shows that (when necessary) a new distribution of air passenger transport demand works quite efficiently thanks HSR (see rough description values attached).

Considering the distribution of air transport demand among airports, the airport marketing director thinks "one is hub or feeder"[134], meaning that this will be much more the case in the future (he takes the Geneva airport, having lost all but one long-haul flights, as a recent example). He is firmly convinced that Lyons-Satolas will develop as France's second hub; because it is well-located and well-connected at the cross-roads from the Mediterranean arc (Nice to Barcelona), from the western Alps and Italy, from the North-Western Europe regions (UK, Benelux states, Paris and Northern France) and from (Scandinavia and) Germany (the latter much more the case if the TGV Rhine-Rhone link is built), as well as within the Rhône-Alpes region, France's second economic region. EU-liberalisation of air transport would help in this respect. According to airport director, "a second big airport in France will not be a competitor to Paris."

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134 The marketing director sees the future in the airline industry with 3 groups of airlines, each led by one (powerful) american airline; this will lead to groups of airports (according to the network struc-ture of these airline groups). AEA, the Association of European Airlines, sees in Europe 5 "Mega-hubs" .... , whereas ACI, Airports Council International, many airports .....

Whether Lyon-Satolas (and its rail station) will be in grade to cause a new distribution of air transport demand by attracting air passenger demand from other sites[135], and doing so, a new pole in the French airport system, HSR is believed to take its part by better ground access to enhance air traffic development in Satolas and, doing so, to economic development in the region, being even an alternative to other airports, at least for travel origins and destinations lying between them and Satolas, and relieving air traffic congestion in the long-term at some close airports, where extension capability is lacking or does not make much sense.

This approach is taken for now cautiously step-by-step by the airport authorities; they focus for example on Dijon and 2 or 3 origin/destinations with Rail+air fares. Top on the agenda is a timetable on the existing "Guide for air/rail transfers".

Lyon-Geneva airport pair: Asked if the Lyons and Geneva airports are complementary, the answer is no ! Traffic is different: Geneva is "international and more political"; in Lyon "the market is stronger and more economical".

• ADV, Stuttgart

This short mission took place in March 1996. ADV, Arbeitsgemeinschaft Deutscher Verkehrsflughäfen, which as stated by the title, represents the community of German airports and is located at the Stuttgart airport. ADV deals also with airport access issues in Germany.

This short mission meeting gives COST 318 Action's 4th working group the opportunity to get an overview of the German airport (rail access) scene from the point of view of the same source. This point of view must not necessarily be in phase with the whole European scene, as the background elsewhere in Europe may be different.

It shows that the air travel destination (intercontinental, with an expected stay of many days vs. Europe, with an expected stay of may be only few hours), that is connecting at one of some few hubs or taking direct (non-stop) flights at one of several airports may lead to different airport access choices for air passengers.

It shows moreover that the air travel purpose distinction business/ private, that is mainly between "few time left" (as "time is money" and travel costs may be not so relevant) vs. "time is laying ahead" (private spending considered as an important issue) are also leading to different choices (flight arrival (& departure), access time).

Both aspects cited may coincide: "more time left" for a "stay of many days" at an "intercontinental destination" after a "feeder service to a hub" on the one side; "European destination" for a "short stay (of a few hours)" after a "direct (non-stop) flight (from the most convenient airport)".

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135 In fact, from the airline side, the former UTA expressed once (be-fore merging with Air France) the idea to be based in Lyons and to manage the ground access by TGV. The idea is now shared by the charter airline Corsair and the travel agency Nouvelles Frontières.

The catchment area extension of the Frankfurt airport by rail ground access is worth considering. Significant reductions in air feeder services, such as from Stuttgart, Cologne/ Bonn and Hannover, have been consequently reported. This could lead to further easing (slot) pressure of feeder flights at Frankfurt airport and freeing airport (slot) capacity for other (inter-continental) flights. Will it lead (in the second phase) to relieve the airport from some air passenger traffic in favour of other airports, as ground access by (high-speed) rail will also be provided in the other way towards under-utilised medium-sized up-to-date airports, such as Hannover or Cologne/Bonn?

Dealing with hypothesis 12, ADV sees, as background, 70% of the airport users within an airport access area of less than 1 hour airport access time, but wide-spread in the area, which is not what rail transport requires (demand concentration).

That is why access by car remains usually more convenient. However, when parking constraints come up, rail transport suits very well for ground access to airports: this may be the case at major airports; the convenience of car access prevails at medium- to small-sized airports if enough (parking) supply is available.

Air passenger demand among airports (in Germany) could be distributed in another way than the one in place, but small-scaled only.

Not for short-haul flights, but for long-haul flights, rail stations at airports enlarge the airport catchment area (and even much more when served by HSR). Note that, for ADV, this is not the case without rail stations at airports!

However, there are some doubts over the ability of (high-speed) rail to distribute (on its own) air passenger demand among airports.

A new distribution of air passenger demand among airports (in Germany) is seen by ADV only in the long-term, if forced to and railways are set to play then a role.

Air traffic concentration at hubs up to saturation will last in the meantime. Regional air transport will develop further, especially with "hub-by-pass" flights, but it will not be relevant in terms of air traffic volumes relief at major airports (hubs).

Prospects for medium- to small-sized airports are quoted by ADV as a "difficult issue" considering scheduled air transport, but "easier" when considering charter air traffic. In the medium term however, also supply of scheduled flights will be increased at these airports.

But ADV stresses that no development is 100%-foreseeable!

In line with the upper statements, ADV does not think that airport choice opportunities will increase just as those on airline choice; air passengers made their choice with airport in the vicinity.

When airport catchment areas overlap, the air transport demand is increasing; the direction of the journey may play a role for airport choice.

To sum-up, rail access to airport may cause a new distribution of air transport demand between airports within an agglomeration and even from an agglomeration with a major airport (hub) to a medium-sized airport, but not between major airports. According to this view, it does not make sense to have (non-stop) high-speed rail between airport rail stations: "we don't need it!".

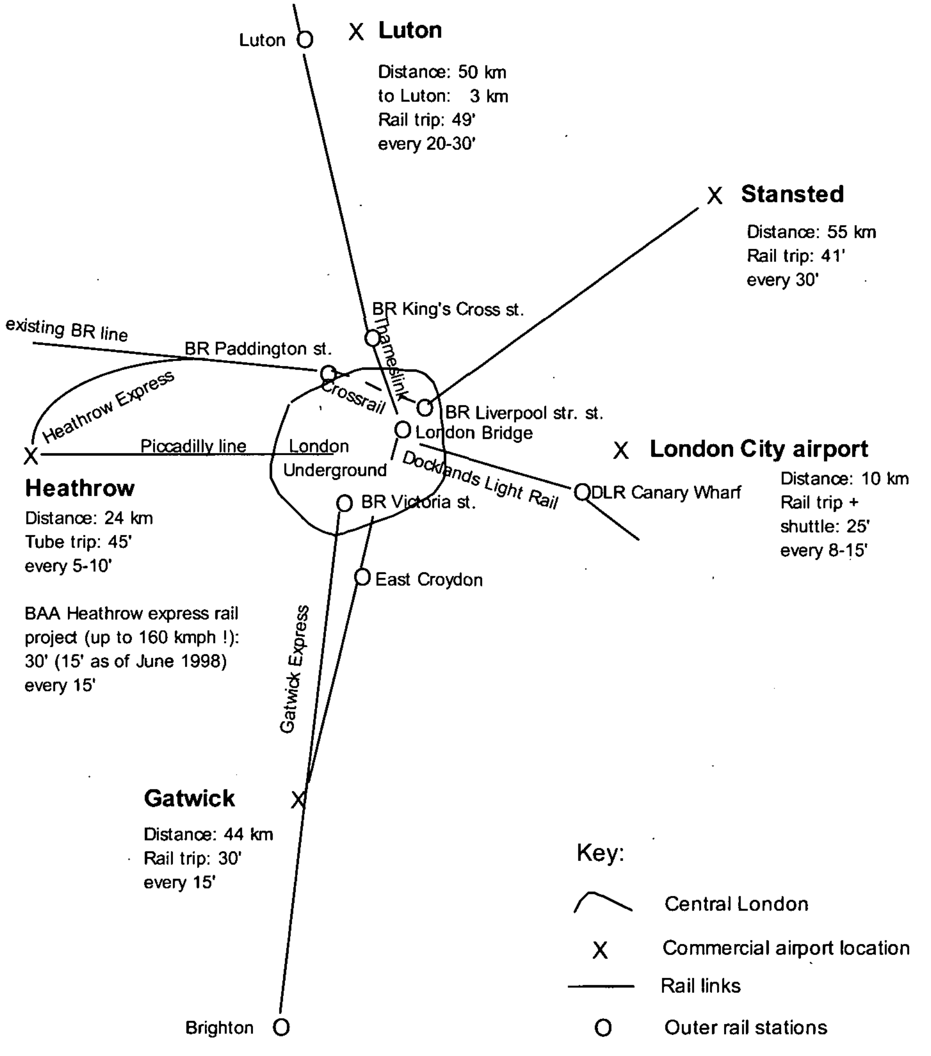
Nevertheless it is important to have an airport connected to high-speed rail, as (ground access) demand is to switch from car to HSR, leading to less intra-air passenger transfer traffic, that is less feeder flights. Only the region has to be linked by rail (to the airport).

Given a rail link to the airport exists or is feasible, its traffic volume share has to be increased. The most influent factors aiming at achieving this goal are "no change, adequate frequencies (every 15'); available seating". Even if changes (of habits) by users in favour of public transport may not happen immediately, it must be considered that infrastructure will be provided for the long-term ("for the next 100 years" !)

When considering a rail station at airport, traffic saturation and airport parking area issues may play a boosting effect.

Although ADV considers the passengers' airport choice for given, airport access in general and flexibility (rail vs. road) is regarded as very important for business travel, less for private travel. Whereas ground transport costs and air transport fares are important for the traveller on private purpose, this aspect is respectively less important for the business traveller. Air services supply (destinations, frequencies) is quoted as "important" for businessmen and as "not so important" for private purposes. An integrated (public) transport (with no change) and information system is regarded as very important for the choice of the airport access transport system, in addition to high-speed, comfort and fares.

Annex 34: Rail Links at Airports (rough drafts)



Rail links at airports in the London area

• London area airports

Transport infrastructure

Rail links to commercial airports concentrate to and from the city centre and are distributed as follows:

- to Heathrow (both airport stations on London Underground Piccadilly line 15 miles from the centre within three quarters of an hour); a Heathrow Express project run by BAA and BR, partly using existing tracks, should link the Heathrow airport and Paddington station (and further other stations thanks to Thameslink) in 30' (15' as of June 1998; max. commercial speed reaching 160 kmph !) "will challenge the Piccadilly line heavily". Crossrail, as a RER or S-Bahn-like connection run by BR rolling stocks, should furthermore link the Paddington and Liverpool street stations.

- to Gatwick airport since the beginning (BR rail line between London Victoria station and Brighton, Thameslink and now also 28 miles from Victoria station with Gatwick Express in half-an-hour every 15');

- to Stansted airport since the opening (BR rail line of 59 km from London Liverpool street station in 41' every half-an-hour);

- to Luton airport (BR rail line to London King's Cross station in 49' and connected by Thameslink through London), except a last-leg bus shuttle service from Luton rail station;

- to London City airport (Docklands Light Rail), except a last-leg bus shuttle service from the Canary Wharf light rail station;

Most of the Piccadilly line traffic volume came from the bus lines. The popularity of underground stations serving British Rail (quite a quarter of Heathrow air passengers choose underground) indicates that many journeys in fact continue beyond the underground network, as stated by London Underground.

Among the bus lines, only those connecting Central London are from London Transport, the others are private:

- there are two Air Bus (rapid bus) lines to Central London (lasting about half-an-hour to Russell Square and to Victoria station every 15-30' each) with a few stops.

Traffic development

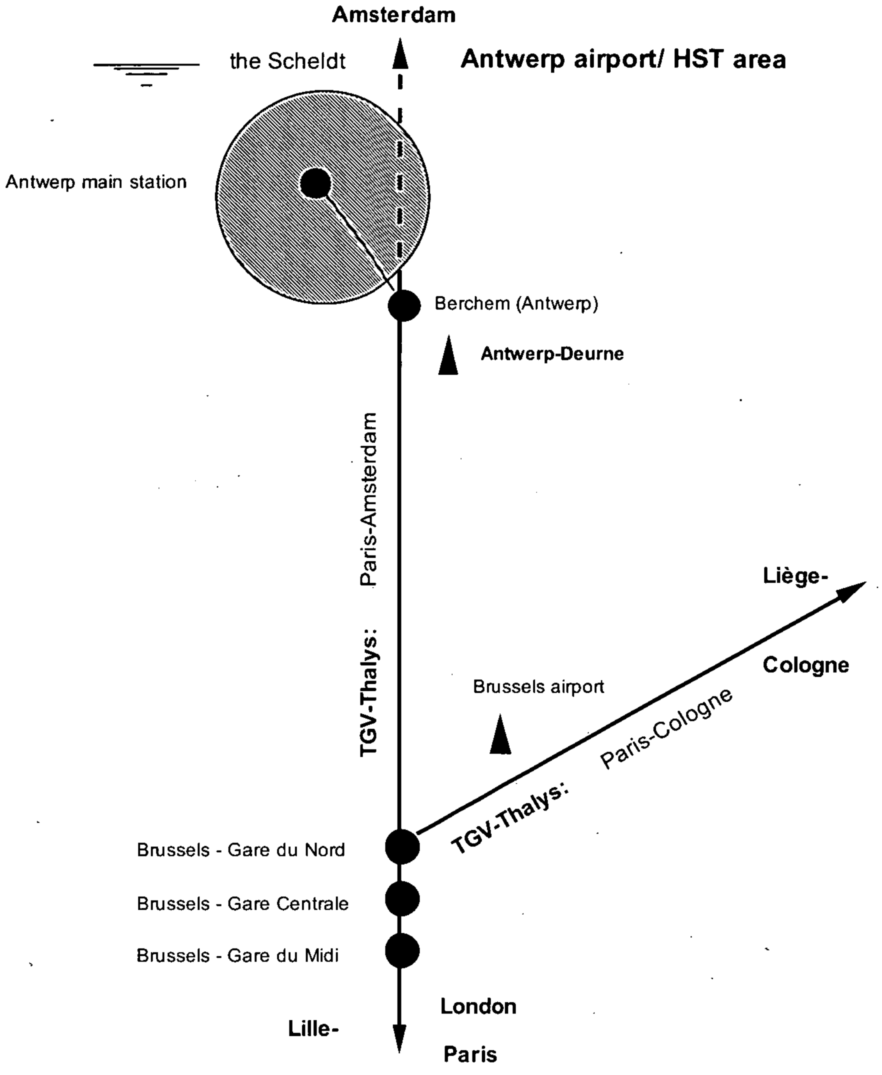
The planned terminal 5 at Heathrow airport should add 30 million air passengers more yearly and boost its capacity to 80 million Pax (having considered traffic volume at 50 million air passengers per year, today 55 million); Gatwick airport is dealing today with more than 20 million air passengers a year; the Stansted airport traffic volume does not exceed 5 million air passengers a year for the time being, (but) is increasing faster comparatively.

Of all air passengers arriving and departing Heathrow Airport at annual average, about half are on business.

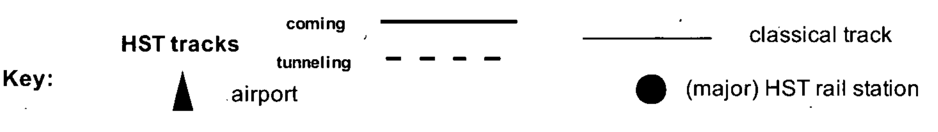
London's Underground market share (of the total number of passengers travelling to and from Heathrow) is approximately 24%, with forecasts by the year 2016 assuming a same market share; since 1980 it has varied between extremes of 14 and 28%, with a low of about 22% during the summer to a high of about 27% in January.

The two Heathrow stations count for 37% of all the traffic on their branch of the Piccadilly line. Most passengers travel all the way from Central London to Heathrow.

Over one third of journeys to and from Heathrow are not made by air passengers: for example "meeters and weepers" (15%), staff employed or at business meetings at the airport (10%) and sightseers (3%). "Tourists" make about 25% of the underground journeys to Heathrow.



NB: HSR-link Brussels-Amsterdam will go under the Scheldt; HSR-station will thereforebe Berchem (Antwerp) close to the Antwerp regional airport.



• Antwerp area airport

Introduction

The City of Antwerp, second city of Belgium, an important business centre, lies about 50 km North from Brussels very close to the heart of Europe. It has been since long a cultural centre (recall the famous painter Rubens) and an important commercial harbour at the Scheldt's mouth, as well as a world centre for the diamond-cutting industry.

Antwerp lies quite at the border of the Netherlands, between both European major airports (hubs) Amsterdam and Brussels. Whereas Brussels is the closer, Amsterdam has more to offer in terms of (overseas) destinations, frequencies, airline choice.

Antwerp has nevertheless a regional airport, very close to the city centre (about 3 km) and the rail station of Berchem (about one-and-a-half km on the way), which should become, in a not too far future, the HSR Antwerp stop (TGV-Thalys) between Brussels and Amsterdam.

Transport infrastructure

There are dense railway, road and motorway networks in the region, a dense car and an even more dense traffic of trucks as one can have experienced before elsewhere, but this is not particular to this region and neither in this part of Europe.

- **rail transport:** rail transport is classical as the infrastructure is still "classical". Presently, access to the Brussels airport by rail occurs with changes either at the Brussels -Gare du Nord or -Centrale, quite a displeasure for air travellers, whereas Antwerp is directly linked with Amsterdam-Schipool airport by rail on the way to Amsterdam, but the ride takes about two hours. For the future, a direct rail access to the Brussels airport is being prepared.

- **international HSR transport:** prospects to run TGV-Thalys high-speed on segments between Brussels and Amsterdam will see the existing rail station of "Berchem", at the very city boundaries, playing a major role, as it is not foreseen to use the present "dead-end" main station, whereas a tunnelling under the area is foreseen.

- **road infrastructure:** a (through-going) motorway access between Antwerp and the Brussels airport is used by a SABENA express bus service.

- **regional commercial airport:** the rail station of "Berchem" is on the way from the city-centre to the regional airport, south-east of the city centre. From the infrastructure point of view, the regional airport is small-sized. Nevertheless, it has a regional airline VLM based, operating Fokker F-50 aircraft, which started operations in May 1993. The regional airport is linked to the city-centre by a bus line.

Traffic development

Most of the air traffic demand from Antwerp go to Brussels; Amsterdam suits better for some (overseas) destination where the supply is estimated better. The "majority" of air travellers is away for business purpose.

- **rail transport:** rail transport to Brussels airport can be undertaken three times an hour and will last with an interchange slightly more than one hour. Rail transport to the Amsterdam airport is provided twice an hour on an ordinary day with a ride lasting two hours.

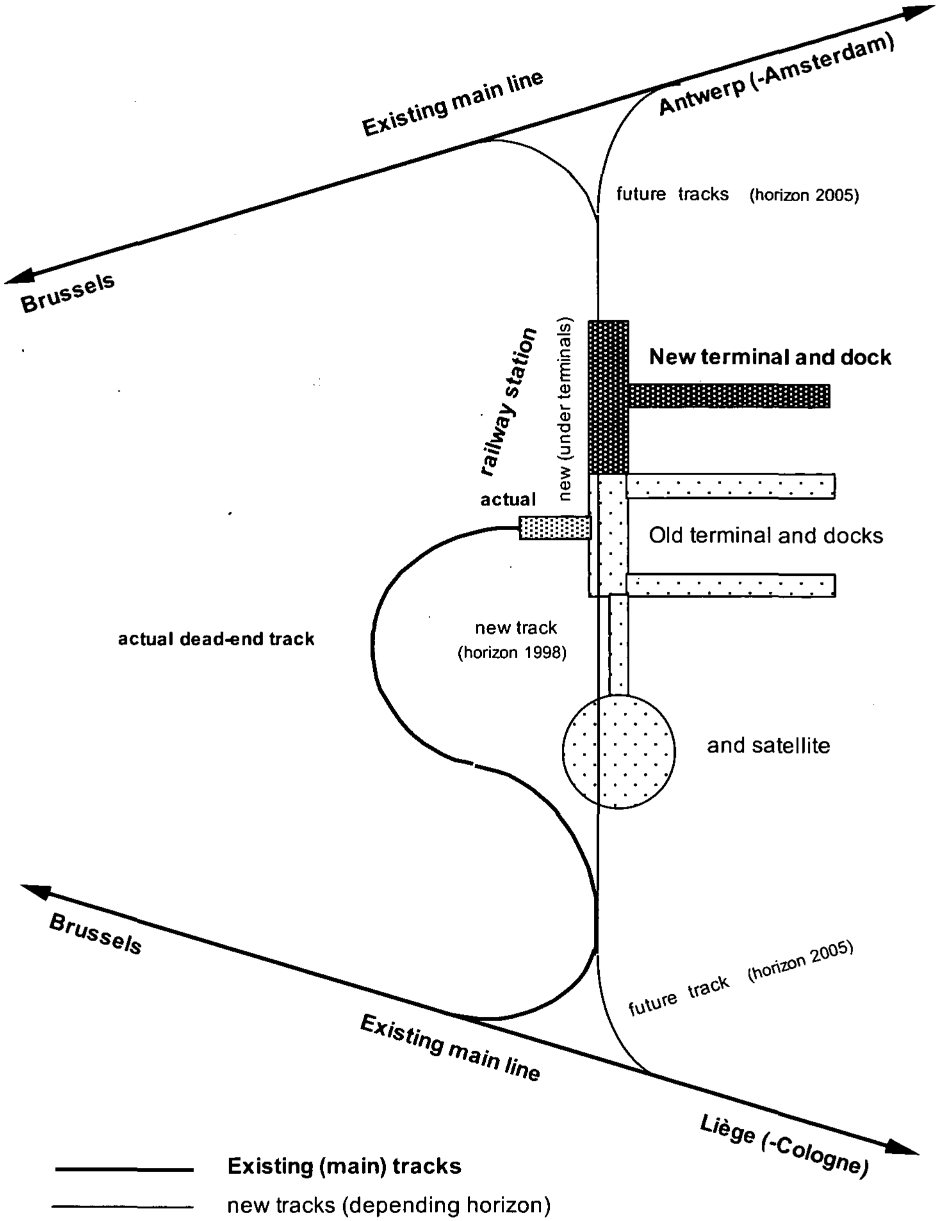
- **bus transport**: an hourly SABENA express bus service starts from the main Antwerp station to the Brussels airport; the ride lasts fifty minutes, provided the motorway is not congested, which happens, one is told, quite regularly (so at rush hours).

- **regional commercial airport:** from the point of view of commercial traffic volumes the Antwerp-Deurde airport is small-sized: there are only regional flights (mostly to London three to four times a weekday and a feeder service to

Amsterdam). The travel purpose on the main line to London City airport by VLM[136] is clearly business.

The bus line from the city-centre (railway stations) to the airport has very few hourly frequencies. This may not play a role as the airport is very close to the last city districts and as there are taxies on hire.

136 The contraction of Vlaamse Luchttransportmaatschappij.



Brussels airport (new) **rail links** (opportunities)

R. Cosyn, JPWi, 30/1/97

• Brussels airport

Introduction

The Brussels airport is (with SABENA as the home carrier) a hub of a small country of about 10 million people, with developed activities in many sectors, and, like Geneva, the agglomeration is the seat of important international administrations (EU-Institutions; Eurocontrol; NATO; ...), usually generating and attracting much (air) passenger traffic. Its real catchment area is to be set (for the time being) more or less a little bit outside the boundaries of Belgium (including also, for instance, the region of Lille, Roubaix, Tourcoing) and within an European area of dense population (Ruhr region, the Netherlands, Luxembourg, Northern France and Southern England).

Transport infrastructure

There are dense railway, road and motorway networks in the region, a dense car and an even more dense traffic of trucks as one can have experienced before elsewhere, but this is neither particular to this region nor part of Europe.

- ***Rail transport:*** Rail access (see rough drawing) is provided at Brussels-Zaventem airport by a local shuttle train to Brussels down-town (Gares du Nord & Centrale, where connections are provided with the Belgian railway network and the urban public transport system).

  BATC confirms that the first rail connection to the airport (in 1955, modified in 1958) was aimed at relieving local road traffic congestion. Road access situation now has worsened again.

  The existing rail shuttle service between Brussels Central station and the airport no longer fulfils the needs and expectations of such a service (demand exceeds capacity on the twin-coach trains; due to lack of space, no improvements at the present dead-end rail facilities at the airport, trains or means of ground transport change).

  An improved rail access is taking shape with a new location of the airport rail station under the New terminal. The first step for the new rail link will be a new dead-end railways station, perpendicular to the existing, but at a lower level, and ready as of 1998; the old rail station will then be closed.

  The closely following second step will, as a through-going railways station, allow operations of Inter-City trains to Antwerp and Liège (-Cologne) (see rough drawing). HSR now terminating at the Gare du Midi and taking a loop at the airport are in mind

- ***international HSR transport:*** Brussels is linked to HSR transport with the TGV-Thalys system as of June 1996 to Paris, high-speed track to the French-Belgian border expected to go into operations at the end of 1997. However, high-speed track extension, to Antwerp & Amsterdam on the one side, and Liège & Cologne on the other side, is not ready so far. It is not quite clear for the time being if and when TGV-Thalys will use the (through-going) rail station at the Brussels airport.

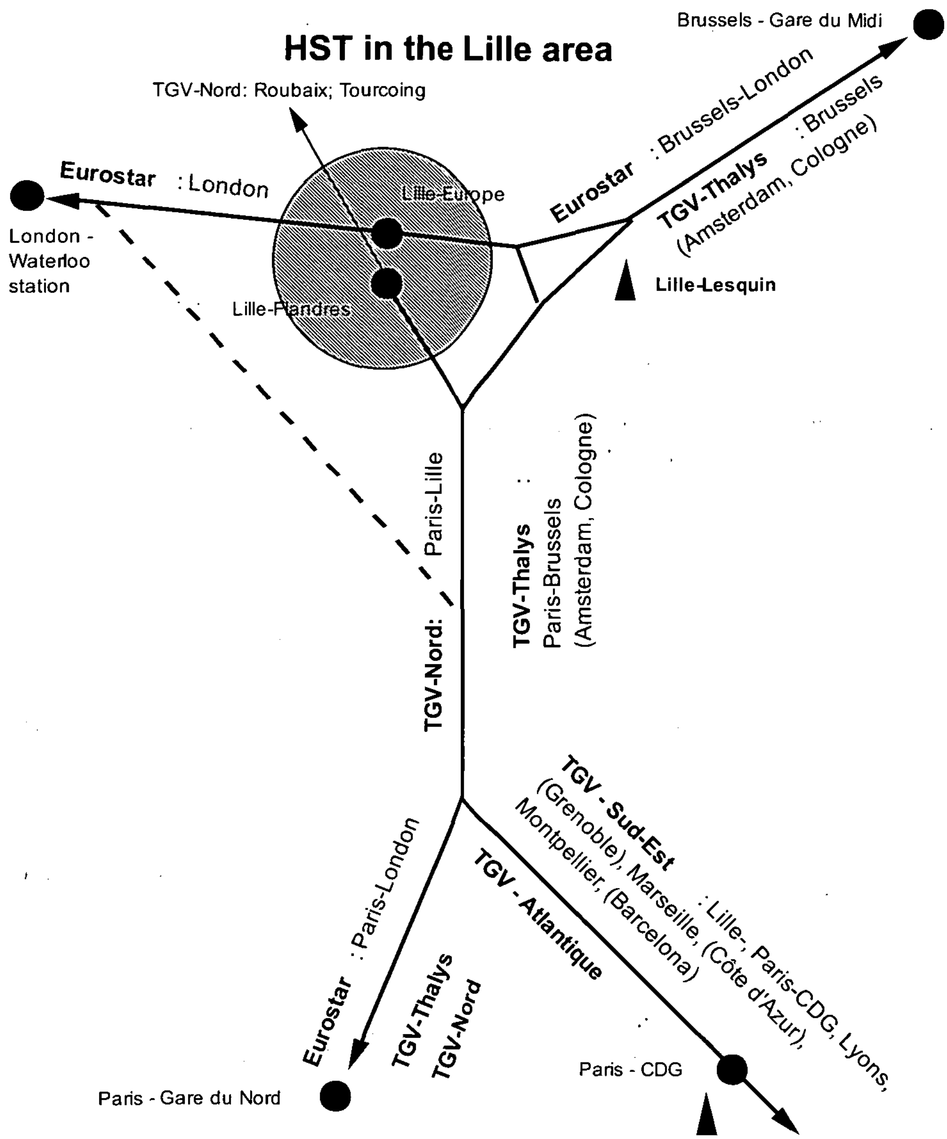
- ***Road infrastructure:*** The extended Belgian motorway system access is close to the airport.

- ***Regional aviation:*** Applies as hub feeder service, but international as the country is small (nevertheless, feeder flights operate from Antwerp).

Traffic development

The Brussels airport lies amid top-ranking major airports in London, Paris and Amsterdam. Amsterdam-Schiphol, a major European hub, lies only about 200 km far as the crow flies. Competition is stiff, as these airports are the home bases of major European airlines with extended, world-wide networks, whereas the overseas network operated by SABENA is strong in Africa only. European flights from these airports may arise from hub-and-spoke operations, mainly however from intra-European air transport demand.

For intra-European (connecting) air passenger transport demand, the Brussels airport may be (very) well situated. The airport ranking in air passenger traffic figures increased in the last years. Its terminal capacity is extending and its airside infrastructure capacities are far from being saturated. But the airport is lacking in long-distance (non-stop) links, especially since SABENA had to retire from many operations in this field (except Africa) for cost-cutting purposes.



NB: Although Lille-Lesquin is situated close to the HSR-link Brussels-Paris, it does not seem that any rail station is to be expected at the airport, or close to it, at least in the foreseeable future.

Key: HST tracks: now ——— ; coming – – – – ; classical track ——— ; ▲ airport ; ● (major) HST rail station

• Lille area airport

Introduction

The populous Lille region (with at its outskirts the cities of Roubaix and Tourcoing), lies very close to Belgium and was in the past most involved in heavy industry, leading to a (lasting) large-scale restructuring of the regional economy.

The Lille region is at the cross(rail)roads of two major directions within the European HSR network starting to work: London - Brussels/Paris & Paris - Brussels (- Antwerp - Amsterdam/ Liège - Cologne): an early decision banned the Lille airport (and the city) from having a TGV-Thalys stop.

On the contrary, the Lille region is already connected by the TGV (non-stop) to the Paris-CDG (hub) airport in less than one hour, equalling if not beating "door-to-door" access time; this will be the case in a foreseeable future with the Brussels airport.

Transport infrastructure

There is a dense road and motorway network, a dense car and an even more dense traffic of trucks as one can have experienced before elsewhere, but this is not particular to this region and neither in this part of Europe.

The "changement" in public transport as a whole, together with the level of implemented new technology in public transport, is in this region quite impressive, such as in:

- ***urban public transport:*** the fully-automated guided VAL- (underground) system (put into operation in 1983), with stations at short-distance (close to street levels) and a frequency departure every 3 minutes. Now there are two lines in service;

- ***inter-urban public transport:*** the new low-floor tramway (Stadtbahn) Lille-Roubaix-Tourcoing;

- ***intra-regional rail transport:*** with TER, Trains Express Régionaux (S-Bahn) on the classical rail network;

- ***French domestic HSR transport,*** with:
  - ***TGV- Nord:*** linking Northern France & Paris;
  - ***TGV- Sud-Est:*** linked by the ***HSR by-pass East of Paris***, which ***serves the Paris-CDG airport*** (connecting with the RER-network of Paris) & Euro-Disney (at Marne-la-Vallée);
  - ***TGV- Atlantique:*** linked as of June 1996 as TGV- Sud-Est;

- ***international HSR transport***, with:
  - ***Eurostar:*** linking London with Paris and Brussels (with stops in Lille);
  - ***TGV- Thalys:*** linking Paris with Brussels, later with Amsterdam and Cologne, (but without stops in Lille);

- ***regional commercial airport:*** The airport Lille-Lesquin is situated "eastwards" of the Lille agglomeration, in the vicinity of the new high-speed track Brussels-Paris (see rough drawing). From the point of view of the infrastructure, it can be considered as "medium-sized" (one of both runways with a length of 3'000 m; a brand-new terminal was put into service in May 1996).

  No direct rail access (see rough drawing) is provided at the airport; there is only a bus service to a location between both main downtown railway stations of Lille-Flandres (TGV-Nord) and Lille-Europe (Eurostar). The new high-speed track between Paris and Brussels (TGV-Thalys) is by-passing the city of Lille and although its alignment comes (very) close to the Lille airport, a halt (rail station) taken into consideration has not been decided (yet).

Traffic development

The Lille regional airport competes with a working "crossroads" of fast developing HSR lines:

– ***French domestic HSR transport,***	departures with:
– ***TGV- Nord:*** Lille-Paris Nord:	16 per weekday;
- ***TGV- by-pass East of Paris:*** Lille- Paris CDG:	9 per weekday; see summer timetable.

– ***international HSR transport,***		departures with:
– ***Eurostar:***	Paris- London:	up to 1 every hour;
	Brussels- London:	6 per weekday;
– ***TGV- Thalys:*** Paris- Brussels:		14 per weekday;

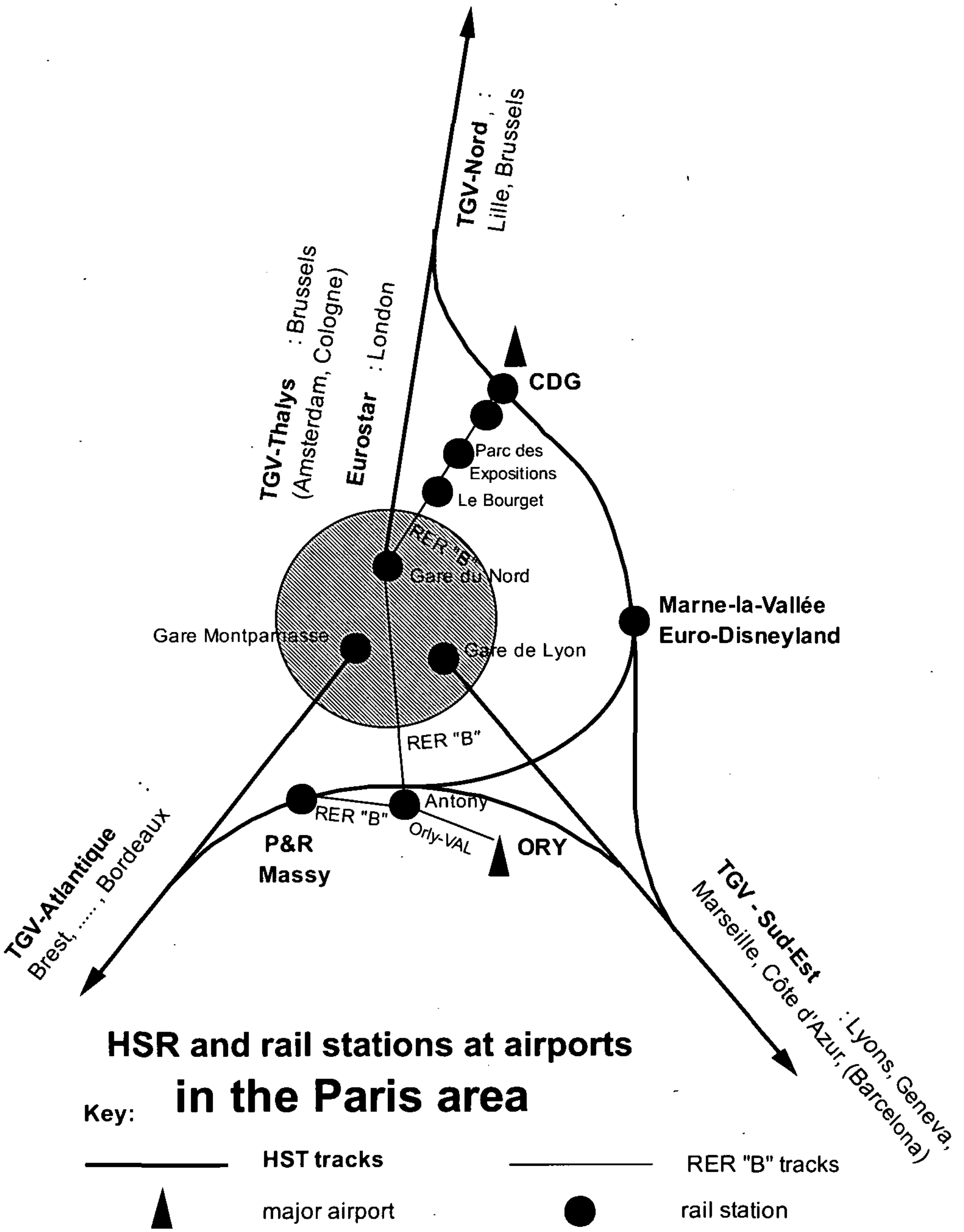
- ***regional commercial airport:*** see diagram attached. From the point of view of commercial traffic volumes the Lille-Lesquin airport is "small-sized". There is only a bus line from the city-centre (railways stations) to the airport.

  The repartition according to the travel purposes of 800'000 air passengers a year at Lille-Lesquin is estimated as follows:

  - business: 66%;
  - private: 33%;

of whom:	charter:	25%;
	workers (Algeria):	5%;
	others:	3%;

  The air traffic volume on the London-Stansted link suffered heavily from the introduction of the Eurostar service: from 8'000 down to 3'000 air passengers a year!



NB: Moreover, CDG is connected to Paris by the RER-suburban rail transit at the CDG 1 & CDG 2 terminal rail stations (CDG 2 rail station is common with the HST rail station), whereas at the second airport (Orly), an automated VAL-system at terminals "Sud" and "Ouest" operate a link to a remote RER "B" station ("Antony").

IVT, JPWi, 21/7/97.

• Paris area airports

Introduction

Both major commercial airports in the Paris area, managed by AdP, Aéroports de Paris, have a similar air passenger traffic volume size (at about 30 million a year each), but are geographically for at least two reasons apart:

- *location:* Paris-CDG airport is located at Roissy, north of Paris, and has land reserve for extension; Orly airport lies south of the City of Paris within a dense populated area.

- *operations:* whereas the Orly-Ouest remains the true Air Inter home base, CDG is increasing within the French domestic network as Air France started to operate a real hub-and-spoke system at the CDG airport as of summer timetable 1996; except Air France flights to North Africa and to some of the French overseas territories, which moved from Orly-Sud to the Orly-Ouest terminal; the Orly-Sud terminal remains the gateway of many foreign Mediterranean airlines[137]. The Orly airport operates under annual aircraft movement ceiling constraints.

This introduction illustrates, for reasons which may make sense, a rather "imposed" than "free" air passenger transport distribution among airports within an agglomeration.

Transport infrastructure

The CDG-TGV station, in service since November 1994, is situated eastwards of the Paris agglomeration on a high-speed rail by-pass, which linked first TGV-Nord and TGV-Sud-Est. A special double track for through-going non-stop TGV (at low high-speed) has also been built (see rough drawing attached).

Since June 1996, the eastern high-speed rail by-pass and the southern high-speed rail by-pass (the latter linking TGV-Sud-Est and TGV-Atlantique) are linked, so that the CDG-HSR station is connected to the TGV-Atlantique line.

AdP states as "out of question" that a TGV line will ever be built for the unique airport access reason; an existing HSR has to lie in the neighbourhood in order that an airport HSR station has a chance of being built.

- ***Investments*** at the "CDG terminal 2" common rail station (RER & TGV): it is a very longterm project (Government's role is to foresee 20 years ahead):

Total:	2.4 billion FF;	of which:
SNCF:		1.2 ;
AdP:		0.4 ;
Région Ile-de-France:		0.3 ;
AdP (exchange module):		0.5 ;

137 Air Algérie was obliged to move to the CDG airport for security reasons.

Note that there is no HSR-link from the CDG-TGV station to the City of Paris, but, for this and beyond within the Paris area, a connection by rail with the RER "B" is provided at the CDG-TGV station. The same RER "B" line connects at the station of Antony since in 1991 the VAL d'ORLY rail access link to the Orly airport, taking 5-6' to the West and 8' to the West air terminal.

VAL d'ORLY is a fully automatic rail guided system (very similar also in size to the VAL-systems operated in Lille and Toulouse) and as a high-frequency, and therefore narrow-gauge system, is reducing infrastructure investment costs, in particular tunnels;

Traffic development

When taking the decision of building the TGV-CDG station in 1986, it was considered that TGV and aircraft were competing and not complementary.

TGV operations started at CDG as of late 1994. For the time being every TGV from Lille to beyond stop at CDG (connections on the RER may occur).

CDG catchment area extension (see rough drawing attached) is set to play a role not only including (French) regional airports, such as Lille, but major ones, such as Brussels[138].

- ***HSR (TGV) traffic development impact:***

  Experienced ***air passenger traffic loose to HSR*** between 2 agglomerations shows the following figures:

70 - 80%	by 2 hours TGV travel time;
20 - 30%	by 3 hours TGV travel time;
10%	by 4 hours TGV travel time;

  Overall air passenger (PAX) traffic volume with TGV at CDG:

  now: 0.4 million PAX a year by TGV;
  Jan. 95: 25.000 PAX;
  Dec. 95: 50.000 PAX;
  2000:2.0 million PAX a year by TGV;

138 Brussels' link to the TGV-Sud-Est part-network and, doing so, to the Paris-CDG rail station by TGV, is now effective.

Passenger traffic volume figures (1996) at the Paris-CDG TGV station, distributed by month and by region:

Total in 1995:	495.000;
Total *in 1996:*	729.162;
– cabotage Ile-de-France (Paris region):	8.676;
– international:	1.688;
– North:	175.387;
– West (from June on):	89.780;
– South-West (from June on):	67.631;
– Burgundy & Franche-Comté:	14.529;
– Lyon/ Alps:	278.094;
– South:	93.377;

Out of the total, about 45% are air passengers (at the TGV-CDG station). NB: by region, much more if the regional airports are not well-connected, and consequently less in the case of Lyon.

More service improvements are starting or lie ahead:

- ticketing operations:
- Train + air fare structures;
- luggage check-in in Lille (AF-Group only);

- ***RER traffic development impact:*** French people prefer to drive their car to the airport. RER will be used if to be on time is imperative.

  NB: 4x more travellers by rail with RER than with TGV, but the ratio employees/PAX is not known (no surveys carried-out). Note that there are 40.000 employees at CDG.

- ***VAL d'ORLY*** demand was at the beginning far below expectations (about 4'000 passengers a day, instead of 12.000 forecast by well-known consulting firms). Now operating figures are at about 6.000 passengers a day.

  Now the VAL d'ORLY-system is running a little bit under the 2 million passengers level a year. Target as told by RATP is 2.3-2.4 million a year, but only getting the peak-off periods better used. This because the system is also limited in transport capacity ! The limitation of demand is expected to be achieved by price-elasticity (higher prices).

  - paying passenger carried:

1993:	1,244 million;
1996:	1,830 million;
within the 2 years to come;	2,000 million;

    of them 90-95% are air passengers, the rest visitors/ attendants, as for employees VAL d'ORLY is too expensive;
    Two thirds up to 70% of the total are on professional duty.

  - VAL d'ORLY market share: 1994: 5.9%;
    1996: 6.7%;

- ***VAL d'ORLY failed off expectations*** as a string of (system-inherent) hinting reasons appeared, such as:

  - ORLYVAL is a link with small-capacity trains to the high-capacity RER-system; it comes up that passengers have to wait further departures (just as they have to catch a plane);

  - there is not enough place for luggage;

  - many elderly people and foreigners don't like to have to change; foreigners have a clear idea where they want to go, but in a city they often don't know very well; they prefer a taxi or a coach ride because they are driven to destination;

  - furthermore, the "carte orange", the much appreciated season-ticket is not valid on the privatised ORLYVAL; the consequence is that very few airport employees use it.

- ***French airport development features:***

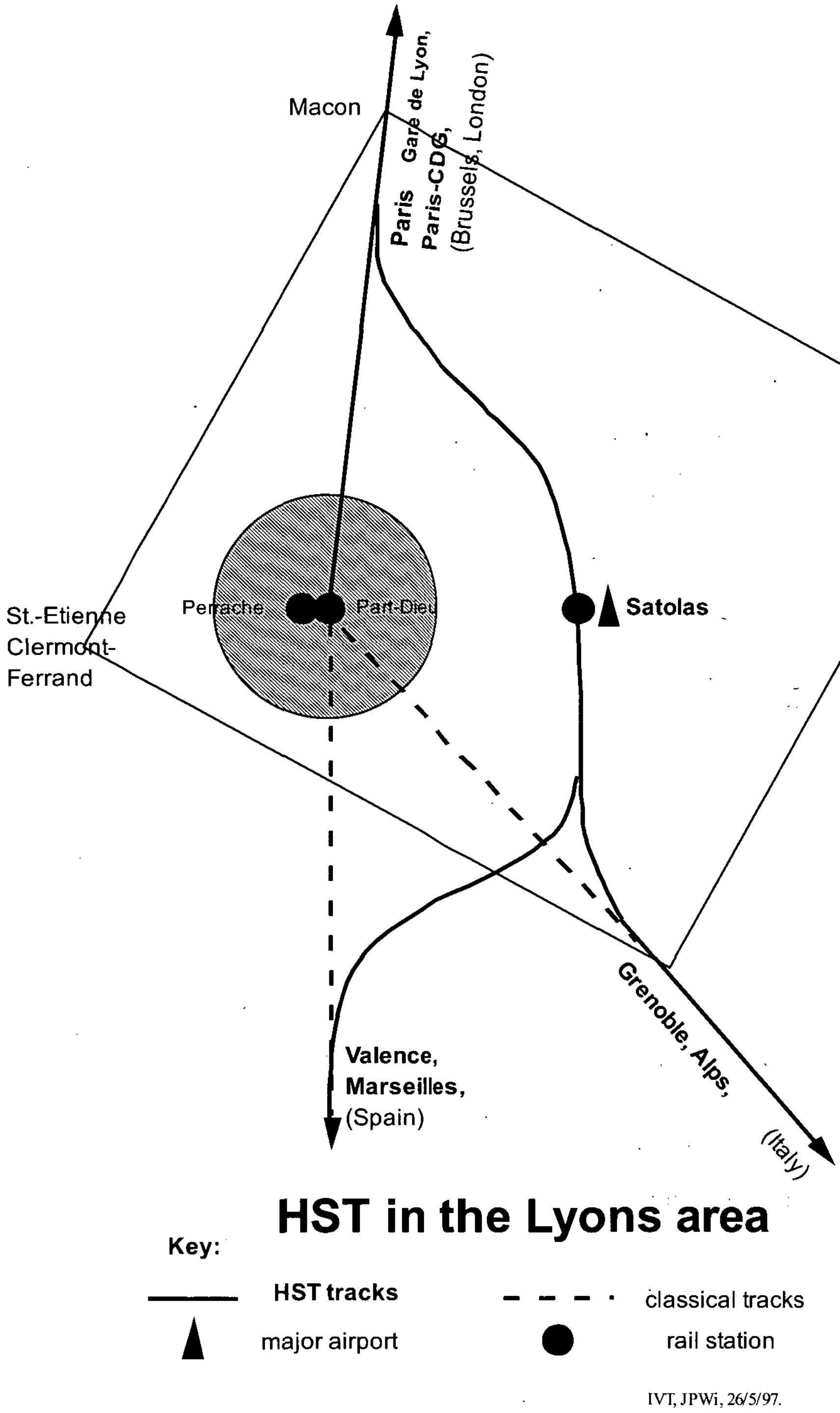
  AdP (55 million air passengers in 1995 for both airports) is "in the black", whereas all other French airports are "in the red". CDG is keen to develop as a hub (enhancing "correspondence" opportunities) as its home carrier (Air France) sees opportunities to improve its financial results.

  Air passenger transfer rates (connecting air passengers with change of flight number) accounted for 18% in Roissy (before AF introduced a hub-and-spoke scheme summer 1996), compared to 40% at the Amsterdam and 45% at the Frankfurt airports.

  Up to 5 airports are expected to continue to develop: Paris, Nice, Marseille, Lyons, Toulouse (Paris-Orly is blocked in terms of aircraft movements).

  Domestic air traffic is increasing (much) more than international traffic; in the past it was just the contrary. Air traffic on Paris-Toulouse increased within one year by 17%, only because of a fare battle between competing airlines.

  Air travel penetration rate (proportion of population using air transport more than once a year) reaches 17% at France's average (40% in the US) and 35% for the Paris area average.


Macon
Paris Gare de Lyon,
Paris-CDG,
(Brussels, London)
Annecy
St.-Etienne
Clermont-
Ferrand
Perrache
Part-Dieu
Satolas
Valence,
Marseilles,
(Spain)
Grenoble, Alps,
(Italy)
HST in the Lyons area
Key:
HST tracks
classical tracks
major airport
rail station
IVT, JPWi, 26/5/97.

• Lyon area airport

Introduction

The agglomeration of Lyon is described (see rough drawing attached) as related to:

- an inner zone of influence ("diamond") is square-like between the corners of St.-Etienne/ Clermont-Ferrand, Macon, Annecy and Grenoble;

- a Geneva-Annecy-Grenoble axis developing as an attractive research and new-technology axis;

- an extended zone of influence is considered reaching the Land of Baden-Württemberg, the cantons of Geneva, Vaud and Valais, the regions of Piemont & Lombardy and the regions South to Catalogne.

The HSR station at Lyon-Satolas is expected to have, beyond the airport access, an inter- & intra-connecting role, as the location is well-located within the HSR system between the London, Brussels and Paris areas on the one side, the Grenoble, Alps and (Northern) Italy areas on the second side, and the Mediterranean side ranging from the Côte d'Azur through the Provence to Catalonia (and the Spanish AVE system).

While defining Air/Rail intermodality, the airport authorities have 4 aims still to be achieved for the rail station at Satolas:

- integration into the regional rail network (by 2005/ 2007);

- to develop Satolas rail station as a main interconnecting HSR station of the European HSR network;

- to create a new co-operation with the air transport mode; an intermodality of services;

- to equip Satolas with an intermodal express freight terminal (access by rail by 2005/07);

Transport infrastructure

Lyon-Satolas is presented as a "young airport" with an area of 2'000 ha, of which 900 are on hold (by comparison, the Nice, Marseille and Geneva airports with more or less 500 ha can't be extended !). Two runways (of 4'000 m Cat III and 2670 m length) are in operation "round-the-clock". Two more parallel runways are expected to be built within a generation term. That means, the airport is not going to be saturated in the next future.

The airport HSR station in service since 1994 is situated eastwards of the Lyons agglomeration on a high-speed rail by-pass, which avoids going through the agglomeration of Lyons and its rail stations of Perrache and Part-Dieu.

The Satolas rail station yet is not linked by rail to the city-centre of Lyons. Space has however been reserved for a rail link project.

– ***Investments at the Satolas TGV station:***

Total:	Million FF 988 ;	of which :
SNCF:	260 ;	26% ;
Chambre de Com. & d'Industrie:	38 ;	4% ;
Région Rhône-Alpes:	455 ;	46% ;
Département du Rhône:	235 ;	24% ;
covered section:	67 ;	
building:	255 ;	
TGV station as such:	666 ;	of which :
SNCF:	260 ;	26% ;
Loan to the Lyons CCI:	58 ;	4% ;
Région Rhône-Alpes:	268 ;	46% ;
Département du Rhône:	100 ;	24% ;

Parking supply will be increased by 20% in 1997 from 6.540 to 7.759 places, as the airport is very well located within the dense motorway network in the region. Extension by 2.600 places is projected (260 million frs).

Traffic development

Lyons-Satolas ranks 4 after both Paris, the Nice and Marseilles airports in terms of air passenger traffic volume, which was in 1996 very close to 5 million, divided quite fifty-fifty into international (with Europe as one third of the total volume) and national traffic. The Paris air passenger traffic accounts for only 15%, due to TGV competition over the years by far lower compared to other French airports (3.5 million out of a total passenger traffic volume of 6.5 million in Nice, respectively 3.0 out of 5.5 million in Marseilles).

Contrary to Paris-CDG airport, not every TGV on the by-pass high-speed line stops at Lyons-Satolas: surprisingly only about 10 in 50 !

In 2015, Marseilles and Turin will be within a 1h30' reach by TGV. Moreover, as soon as the Rhine-Rhone connection is in operation, the Satolas interchange will be connected by TGV with Alsace and the German ICE-system.

Some data may be significant for identifying the airport within the air/rail transport system and the hypothesis issues:

– ***Air Passenger traffic*** evolution over the recent years:

1992:	3.89 million	+ 19.4%
1993:	4.01 million	+ 3.0%
1994:	4.26 million	+ 6.1%
1995:	4.43 million	+ 4.1%
1996:	***4.97 million***	***+ 12.1%***

The airport employed 3'100 persons in 1996, an increase of 600 over the 3 last years.

- ***Rail passenger traffic volumes at the TGV-station*** totals:

1994: (since July)	35'709
1995:	119'270
1996:	***214'493***
1997: expected	250'000

The airport Marketing Director reports that about 30% of the passengers at the rail station were air passengers and 1.5 % of the air passengers used the TGV. That would mean on a yearly base, about 74'500 air passengers used the TGV at the Lyons-Satolas airport station.

Compared to a 1995 survey on the TGV Lyons-Paris and -Lille, the Air/TGV connection at Lyons-Satolas was used by 1% of the air passengers at the airport and 13% of the TGV passengers at Lyons-Satolas were interconnecting TGV/ Air passengers: 63% for professional purpose; 23% for tourism, 14% for other private purpose.

Interesting details by rail destination and origin are given quite accurately in documents handed over[139].

- ***HSR (TGV) impact seen on air passenger traffic between Lyons and Paris:***

Especially air passenger volumes in 1982, the first TGV full year traffic on Lyons-Paris, and in 1984, as the entire high-speed tracks were in service:

1981:	968.401	- 0.4 %
1982:	807.477	- 16.6 %
1983:	757.493	- 6.2 %
1984:	524.759	- 30.7 %
1985:	494.995	-5.7 %

If there were no TGV competition, air passenger traffic on Lyons-Paris would be expected at 3 million a year by now: "TGV is a very powerful competitor !"

- ***Air Passenger traffic*** evolution over the recent years ***on Lyons-Paris:***

1992:	595.093	+ 8.4 %
1993:	598.367	+ 0.6 %
1994:	636.083	+ 6.3 %
1995:	604.995	- 4.9 %
1996:	***753.110***	***+ 24.5 %***

139 Aéroport Lyon-Satolas, Dossier de Presse, mai 1997; Rapport annuel 1995; Guide horaires & Correspondances TGV-Avion été 97; "L'intermodalité aéro-ferroviaire à Lyon-Satolas".

Paris air passenger traffic is now increasing again, due to the introduction of the Air France hub-and-spoke system in Paris-CDG last year.

- ***Rail passenger traffic volumes to/from Paris-CDG*** at the TGV-station in Satolas:

1994: (since July)	1.500
1995:	9.397
1996:	9.384

stagnating, one having however to bear in mind that there is only one frequency per day (the TGV stops at Paris-CDG on the way to Lille).

- ***Rail passenger traffic volumes to/from Paris-Gare de Lyon*** at the TGV-station in Satolas:

1994:(since July)	22.060
1995:	85.491
1996:	174.581

In 1996, as flights to and from Algeria were suspended in Paris in the recent past, many passengers took the TGV to the Lyons-Satolas airport to catch their plane to destination.

• ADV

Introduction

Germany is decentralised by the Länder structure and its population of about 80 millions (about a quarter of the EU population) is rather dense and wide-spread than concentrated in metropoles: there is no megalopole. The country has a powerful economy and (consequently) dense railway, road and motorway networks, but this is not particular to this part of Europe.

Transport infrastructure

- ***Rail transport:*** Rail transport is mainly classical as the infrastructure is still mostly "classical". Rail accesses to airports are based on the following sub-systems:
- ***underground*** (U-Bahn), like at the Berlin-Tempelhof (now regional air passenger) airport;
- ***suburb-trains*** (S-Bahn), such as at the Frankfurt (every 10-20'), Düsseldorf (every 20-30'), Munich (every 20'), Stuttgart (every 15') and Berlin-Schönefeld airports, providing direct links to the city-centres and the main rail stations;
- as well as on the so-called long-distance ***InterCity trains*** (IC-Ferbahnverkehr), like at the Frankfurt airport, with through-going rail station at the airport. The Frankfurt airport is linked by rail to most of the agglomerations of western Germany. Unfortunately it is yet the only German commercial airport to supply direct Intercity connections. Other IC-links direct to airports are at project level (Munich, Stuttgart, Cologne/Bonn, Dusseldorf).

–

- ***(international) HSR transport:*** ICE are to be seen at high-speed on (new-build) segments of the German railway network. There are no high-speed trains at airports yet, even if prospects to operate ICE trains through airports exist.
- ***Road infrastructure:*** Motorway access usually is not far from airport locations. So airport access by (private) car is regarded as the most convenient ground access mean within an airport catchment area, in particular when outgoing-traffic is considered.
- ***Regional aviation:*** At a first glance, regional air transport may not be as developed as in other (European) countries (of even smaller size), as the country offers very competitive alternatives by road and rail. Moreover, regional air transport as feeder services of major airports (hubs) are, let us say, barely welcomed as their flights use slots at already congested airports. However regional air transport exists and is emerging as hub-by-pass services to and from (non-hub) medium-sized airports.

Traffic development

In the largest country of western Europe in terms of population, the Frankfurt airport has developed as a hub.

Whereas the new Munich airport has been build to be a (second) hub, Frankfurt airport is still by far the main hub of Germany, as Lufthansa, the main airline in Ger-many, plays a major role in passenger air transport in Germany and it is (now) run-ning its airline business according to a main hub operating strategy, whatever the operative future may be.

This main aspect having been put forward, other commercial airports within the country, in particular those of big cities, provide within Europe plenty of direct (non-stop) air links, either by Lufthansa or other (regional) airlines. They have mostly developed infrastructures, even if ranking (far) from the (European) top in terms of traffic volumes, such as Cologne/ Bonn and Hannover.

Charter traffic (aiming at rock-bottom prices) is expected to continue to develop, even more strongly; whether with increasing operations from regional airports will continue remains to be seen, as larger aircraft may offer cost advantages.

Annex 35: „Delphi"-Survey Questionnaire

Name: ______________________ *Working with:* ______________________

Part 1: Hypothesis 12

- Do you have something to add to the information provided?

  ____
  ____
  ____

- Do you agree that the wording of hypothesis 12 suggests:
  a) air passenger demand could be distributed in another way than the one taking place nowadays? O Yes O No
  b) do you feel there is a need of a better distribution of air passenger demand among (more or less close) airports? O Yes O No
  c) rail stations at airports are beneficial to this need? O Yes O No

- What else does hypothesis 12 suggest to you?

  ____
  ____

Part 2: Considering airport authorities, airlines, air passengers and general public separately in the emerging European context (EU air transport liberalization):

- Do you think airport choice opportunities for users will increase just as present airline choice opportunities?
  O Yes O No

  If no, why?

  ____
  ____

- Due to EU-liberalization, airports will be keen to offer new services according to flexibility and market oppor-tunities just like airlines are doing it, competing between them?
  O Yes O No

  If no, why?

  ____
  ____

- Will concentration in air passenger traffic last? O Yes O No
  due to hub-and-spoke-systems? O Yes O No
  Why? ____
  Are there other reasons? ____
  ____

- Will there be even more concentration up to saturation at major airports (hubs)?
  O Yes O No
  Why? ____
  ____

- Will the use of improved technology, as well as airport and airline management, be able to cope with more concentration without a saturation to intolerable levels? O Yes O No

- How will people (airport neighbouring communities, etc.) react to more air traffic concentration with regard to noise and air pollution?
  - They will protest, but finally accept (as they did in the past)? O Yes O No
  - If no: they will protest and be in grade to stop the process? O Yes O No

- Is it correct that more traffic gives an airport the opportunity to be more cost-effective and more profitable? O Yes O No
  If yes, what prospects have medium- and small-sized airports?____________________
  ____
  ____

- Will there be a further development in regional air transport, especially with "hub-by-pass" flights? O Yes O No
  Will it be relevant in terms of air traffic volume relief at major airports (hubs)?
  O Yes O No

- How important are the following factors of airport choice for air passengers? (Please give a value among 6 (very important); 5 (important); 4 (less important); 3 (no idea); 2 (not important); 1 (no influence)):

	for business purpose	for private purpose
- airport access in general	value:_____	value:_____
- ground access flexibility (rail vs. road)	value:_____	value:_____
- air services supply (destinations, frequencies)	value:_____	value:_____
- ground transport costs	value:_____	value:_____
- air transport fares	value:_____	value:_____

- Catchment areas are related much more to ground access time than to ground access distance. Do you agree with this statement? O Yes O No
  If no, why ? ____________________________________
  ____

- Do rail stations at airports, that means airport ground access by rail, extend the catchment area of an airport:
  a) at every commercial airport? O Yes O No
  b) only at major airports? O Yes O No
  c) surely much more when high-speed rail stop at airports? O Yes O No
  d) if yes, is there an extension of the airport catchment area to be expected, if there are high-speed rail services from an agglomeration without a rail station at its airport?
  O Yes O No

- What about the area where the catchment areas of several airports overlap:
  a) will the area extend even more when airport access by rail is provided?
  O Yes O No
  If no, why?____________________________________
  ____

  b) is there an increasing demand in air transport in areas where the catchment areas of several airports overlap:
  1) between agglomerations? O Yes O No
  2) within agglomerations ? O Yes O No

- Are there additional effects of increasing catchment areas to be expected? O Yes O No
  If yes, which ones are important?________________________________
  ____

Part 3: Considering the advantages and constraints of rail transport

- Will railways lead to a new way of distribution of air passenger transport demand between airports? O Yes O No
  Due to: ____
  ____

  a) Do you think rail transport suits very well for ground access to airports? O Yes O No
  Due to:
  ____
  ____

  b) Do you think rail transport access to airport could provide the same opportunities to medium-sized airports as to major airports? O Yes O No
  Why ?____
  ____

  c) Is rail access to airport going to cause a new distribution of air transport demand between airports:
  1) within an agglomeration operating more than one commercial airport? O Yes O No
  2) from an agglomeration with a major airport (hub) to another major airport? O Yes O No
  3) from an agglomeration with a major airport (hub) to a medium-sized airport? O Yes O No

- In which ground access distance/time range to airports are the following types of rail links best suited:

	distance:		time:	
a) Underground ?	from km______	to km______	from h:min________	to h:min_______
b) Local train?	from km______	to km______	from h:min________	to h:min_______
c) Intercity train?	from km______	to km______	from h:min________	to h:min_______

  Any comments ?____

- Within which ground access distances/time to airport(s) has high-speed rail a complementary (feeder) func-tion to air travel ?

  from km_______ to km________ from h:min_______ to h:min________

- Within which city-centre to city-centre distance/time has high-speed rail a substitutional function to air travel?

  from km_______ to km________ from h:min________ to h:min_______

- Is it important, whether the airport is connected to high-speed rail? O Yes O No
  Why ?____
  ____
  ____

- Does it make sense to have (possibly non-stop) high-speed rails between airport rail stations? O Yes O No
  Why ?____
  ____

- Ground access to airports by rail has to be enhanced compared to airport road access.
  Given a rail link to the airport exists or is feasible, its traffic volume share to the other airport ground access modes has to be increased; by every possible means. Do you agree?
  O Yes O No
  If yes, which are the most influent factors aiming at achieving this goal?
  ____
  ____
  ____
  Anyway, which transport policy measures do you consider as appropriate to expect changes by users in favour of public transport ?______________________________
  ____
  ____

- Are there - besides transport aspects - further thematical areas and subordinate conditions to be found in the background and which may play an important role when considering an airport rail station?
  ____
  ____

- How important are the following characteristics for the choice of the transport system from/to the airport? (Please give a value among 6 (very important); 5 (important); 4 (less important); 3 (no idea); 2 (not important); 1 (no influence)):

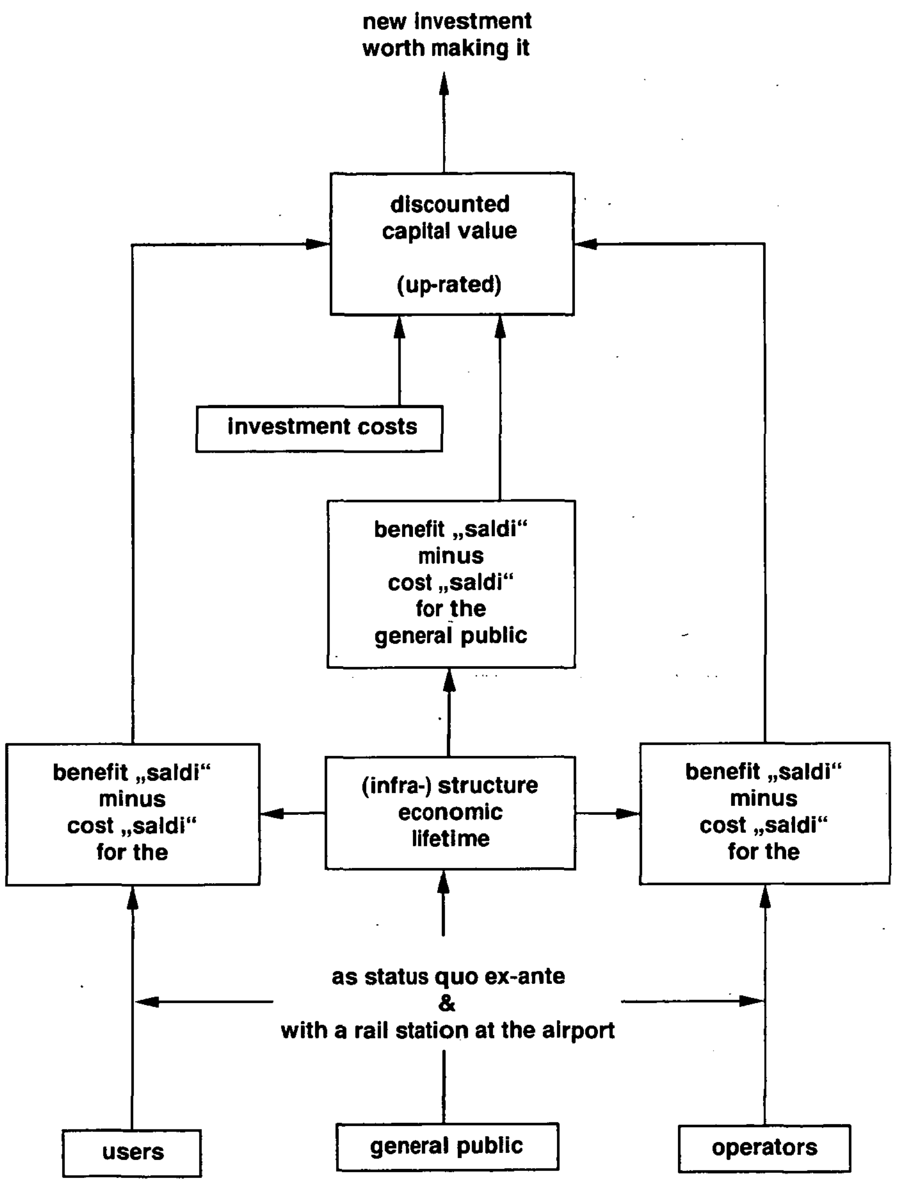
	for business purpose	for private purpose
- uni-modal transport system	value:_____	value:_____
- integrated multi-mode transport system	value:_____	value:_____
- "high"-speed	value:_____	value:_____
- frequencies	value:_____	value:_____
- comfort	value:_____	value:_____
- fares	value:_____	value:_____

  - what about other quantitative and qualitative opportunities within the transport supply?
  ____

- Special remarks: ______________________________
  ____

Thank you so much, indeed!

Annex 36: Flowchart of Cost-Benefit-Analysis



Data ***according to the calendar year as time unit***, and in time series as far as possible for operation data, ***before and after the opening of the new infrastructure.***

A. Airport rail-line and -station:

- ***Investments*** (related to the calendar years of construction):
  - overall costs;
  - land acquisition;
  - civil engineering works;
  - works on tracks;
  - superstructure works;
  - completion of works;
  - track equipment;
  - dispatch and safety equipment;
  - other equipments;

- ***Traffic volumes:*** Number of users getting on and off at each airport rail stations:
  - as air passengers,
    of them on professional duty;
  - as visitors / attendants;
    of them on professional duty;
  - as airport employees;
  - users not linked to air travel activities;
    of them as users of airport park-and-ride (by rail) facilities;

- ***Origin/ destination*** statistics ***of ground access*** to/from the airport: in revenues and travellers movements.

- ***Revenues*** (in addition) by comparision with the (former) situation without rail access at the airport:
  - from ticket-selling;
  - from other services;
  - from rents;

- ***Costs*** (in addition) by comparision with the (former) situation without rail access at the airport for:
  - staff costs;
  - operations and maintenance of rolling stock and equipments;
  - operations and maintenance of the airport rail tracks;
  - operations and maintenance of the airport rail station;
  - rents;

B. (sub-) urban public transport:each (sub-) urban line to/from the airport- before and after the opening of the airport rail line:

- ***Traffic volumes:*** Number of users getting on/off at the airport:
  - as air passengers,
    of them on professional duty;
  - as visitors / attendants;
    of them on professional duty;
  - as airport employees;
  - users not linked to air travel activities;

- ***Additional/ reduced revenues*** compared with the situation before the opening of the airport rail line and from:
  - ticket selling;
  - rents;

- ***Additional/ reduced costs*** compared with the situation before the opening of the airport rail line and from:
  - staff costs;
  - operations and maintenance of the rolling stock;
  - rents;

C. Taxis: before and after the opening of the airport rail line:

- number of users getting on /off at the airport;
  of them on professional duty;
- revenues and costs;

D. Private road traffic: before and after the opening of the airport rail line:

- for coaches: (number of units and) carried persons;
- "kiss-and-ride": number of (dis-) embarked persons;
- and car-parking users : revenues and costs;
  number of users:
  of them employees,
  visitors and attendants
  and PAX on professional duty.

E. Persons within the terminal(s) at the airport:

- air passengers except for those in transit or transfer;
  of them on professional duty;
- visitors / attendants;
  of them on professional duty;
- employees at the airport;

EUROPEAN CO-OPERATION
IN THE FIELD OF
SCIENTIFIC AND TECHNICAL RESEARCH

COST

Brussels, 20 September 1994

COST/286/94

NOTE

Subject: Memorandum of Understanding for the implementation of a European Research Project in the field of interactions between high-speed rail and air passenger transport (COST Action 318)

Delegations will find attached hereto the text of the abovementioned Memorandum, signed in Brussels on 3 March 1994.

MEMORANDUM OF UNDERSTANDING
FOR THE IMPLEMENTATION OF A EUROPEAN RESEARCH PROJECT
IN THE FIELD OF INTERACTIONS BETWEEN HIGH-SPEED RAIL
AND AIR PASSENGER TRANSPORT
(COST PROJECT 318)

The Signatories to this Memorandum of Understanding, declaring their common intention to participate in a European project in the field of interactions between high-speed rail and air passenger transport, have reached the following understanding:

SECTION 1

1. The Signatories intend to co-operate in a project to promote research in the field of interactions between high-speed rail and air passenger transport (hereinafter referred to as the "Project").
2. The main objective of the Project is to identify and analyse the interactions and complementarities between high-speed rail and air passenger transport and to stress the benefit which arises for the users and public welfare.
3. The Signatories hereby declare their intention of carrying out the Project jointly. in accordance with the general description given in Annex II, adhering as far as possible to a timetable to he decided by the Management Committee referred to in Annex I.
4. The Project will be carried out through concerted action in accordance with the provisions of Annex I.
5. The overall value of the activities of the Signatories under the Project is estimated at ECU 1 250 000 at 1992 prices.
6. The Signatories will make every effort to ensure that the necessary funds are made available under their internal financing procedures.

SECTION 2

The Signatories intend to take part in the Project in one or several of the following ways:

(a) by carrying out studies and research in their technical services or public research establishments (hereinafter referred to as "public research establishments");

(b) by concluding contracts for studies and research with other organisations (hereinafter referred to as "research contractors");

(c) by contributing to the provision of a Secretariat and/or other co-ordinatory services or activities necessary for the aims of the project to be achieved;

(d) by making information on existing relevant research including all necessary basic data available to other Signatories;

(e) by arranging for inter-laboratory visits and by co-operating in a small-scale exchange of staff in the later stages.

SECTION 3

1. This Memorandum of Understanding will take effect for three and a half years upon signature by at least five Signatories. This Memorandum of Understanding may expire on the entry into force of an agreement between the European Communities and the non-Community COST member countries having the same aim as that of the present Memorandum of Under-standing. This change in the rules governing the project is subject to the prior agreement of the Management Committee referred to in Annex 1.

2. This Memorandum of Understanding may be amended in writing at any time by arrangement between the Signatories.

3. A Signatory which intends, for any reason whatsoever, to terminate its participation in the Project will notify the secretary-general of the Council of the European Communities of its intention as soon as possible preferably not later than three months beforehand.

4. If at any time the number of Signatories falls below five, the 14,anagement Committee referred to in Annex 1 will examine the situation which has arisen and consider whether or not this Memorandum of Understanding terminated by decision of the Signatories.

SECTION 4

1. This Memorandum of Understanding will for a period of six months from the date of the first signing, remain open for signing, by the Governments of the countries which are members of the COST framework and also by the European Communities.

   The Governments referred to in the first subparagraph and the European Communities may take part in the Project on a provisional basis during the abovementioned period even though they may not have signed this Memorandum of Understanding.

2. After this period of six months has elapsed, application to sign this Memorandum of Understanding from the Governments referred to in paragraph 1 or from the European Communities will be decided upon by the Management Committee referred to in Annex I, which may attach special conditions thereto.

3. Any Signatory may designate one or more competent public authorities or bodies to act on its behalf, in respect of the implementation of the Project.

SECTION 5

This Memorandum of Understanding is of an exclusively recommendatory nature. It will not create any binding legal effect in public international law.

SECTION 6

1. The secretary-general of the Council of the European Communities will inform all Signatories of the signing dates and the date of entry into effect of this Memorandum of Understanding, and will forward to them all notices which he has received under this Memorandum of Understanding.

2. This Memorandum of Understanding will be deposited with the General Secretariat of the Council of the European Communities. The secretary-general will transmit a certified copy to each of the Signatories.

Done at Brussels on the third day of March in the vow m* thousand nine hundred and ninety-four.

Por el Gobiemo del Reino de España

Thar Ceann Rialtas na hÉireann
For the Government of Ireland

For the Government of the Kingdom of Sweden

Für die Regierung der Schweizerischen Eidgenossenschaft
Pour le gouvernement de la Confédération suisse
Per il Governo della Confederazione svizzera

Pour le gouvernement de la République de Slovénie

ANNEX 1

CO-ORDINATION OF THE PROJECT

CHAPTER I

1. A Management Committee (hereinafter referred to as "the Committee") will be set up, composed of not more than two representatives of each Signatory. Each representative may be accompanied by such experts or advisers as he or she may need.

   The Governments of the countries which are members of the COST framework and the European Communities may in accordance with the second subparagraph of Section 4(1) of the Memorandum of Understanding. participate in the work of the Committee before becoming Signatories to the Memorandum without however, having the right to vote.

   When the European Communities are not a Signatory to the Memorandum of Understanding, a representative of the Commission of the European Communities may attend Committee meetings as an observer.

2. The Committee will be responsible for co-ordinating the Project and, in particular, for making the necessary arrangements for:

   (a) the choice of research topics on the basis of those provided for in Annex II including any modifications submitted to Signatories by the competent public authorities or bodies; any proposed changes to the Project framework will be referred for an opinion to the COST Technical Committee on Transport;

   (b) advising on the direction which work should take;

   (c) drawing up detailed plans and defining methods for the different phases of execution of the Project;

   (d) co-ordinating the contributions referred to in sub-paragraph (c) of Section 2 of the Memorandum of Understanding;

   (e) keeping abreast of the research being done in the territory of the Signatories and in other countries;

   (f) liaising with appropriate international bodies;

   (g) exchanging research results amongst the Signatories to the extent compatible with adequate safeguards for the interests of Signatories, their competent public authorities or bodies and research contractors in respect of industrial property rights and commercially confidential material;

   (h) drawing up the annual interim reports and the final report to be submitted to the Signatories and circulated as appropriate;

(i) dealing with any problem which may arise out of the execution of the Project including those relating to possible special conditions to be attached to accession to the Memorandum of Understanding in the case of applications submitted wore than six months after the date of the first signing.

3. The Committee will establish its rules of procedure.

4. The Secretariat of the Committee will be provided at the invitation of the Signatories by either the Commission of the European Communities or one of the Signatory States.

CHAPTER II

1. Signatories will invite public research establishments or research contractors in their territories to submit proposals for research work to their respective competent public authorities or bodies. Proposals accepted under this procedure will be submitted to the Committee.

2. Signatories will request public research establishments or research contractors before the Committee takes any decision on a proposal, to submit to the public authorities or bodies referred to in paragraph 1 notification of previous commitments and industrial property rights which they consider might preclude or hinder the execution of the projects of the Signatories.

CHAPTER III

1. Signatories will request their public research establishments or research contractors to submit periodical progress reports and a final report.

2. The progress reports will be distributed to the Signatories only through their representatives on the Committee. The Signatories will treat these progress reports as confidential and will not use them for purposes other than research work. In order to assess better the final data on the project, the Signatory States are invited, for the preparation of the final report, to state the approximate level of spending at national level arising from their involvement in the said project. The final report on the results obtained will have much wider circulation, covering at least the Signatories' public research establishments or research contractors concerned.

CHAPTER IV

1. In order to facilitate the exchange of results referred to in Chapter I, paragraph 2(g), and subject to national law, Signatories intend to ensure, through the inclusion of appropriate terms in research contracts, that the owners of industrial property rights and technical information resulting from, work carried out in implementation of that part of the Project assigned to them under Annex II

(hereinafter referred to as "the research results") will be under an obligation, if so requested by another Signatory (hereinafter referred to as the "applicant Signatory"), to supply the research results and to grant to the applicant Signatory or to a third party nominated by the applicant Signatory a licence to use the research results and such technical know-how incorporated therein as is necessary for such use if the applicant Signatory requires the granting of a licence for the execution of work in respect of the Project.

Such licences will be granted on fair and reasonable terms having regard to commercial usage.

2. Signatories will by including appropriate clauses in contracts placed with research contractors, provide for the licence referred to in paragraph 1 to be extended on fair and reasonable terms, having regard to commercial usage to previous industrial property rights and to prior technical know-how acquired by the research contractor insofar as the research results could not otherwise be used for the purpose referred to in paragraph 1.

   Where a research contractor is unable or unwilling to agree to such extension, the Signatory will submit the case to the Committee, before the contract is concluded; thereafter the Committee will state its position on the case, if possible after having consulted the interested parties.

3. Signatories will take any steps necessary to ensure that the fulfilment of the condition laid down in this Chapter will not be affected by any subsequent transfer of rights to ownership of the research results. Any such transfer will be notified to the Committee.

4. If a Signatory terminates its participation in the Project any rights of use which it has granted, or is obliged to grant to, or has obtained from other Signatories in application of the Memorandum of Understanding and concerning work carried out up to the date on which the said Signatory terminates its participation will continue thereafter.

5. The provisions of paragraphs 1 to 4 will continue to apply after the period of operation of the Memorandum of Understanding has expired and will apply to industrial property rights as long as these remain valid, and to unprotected inventions and technical know-how until such time as they pass into the public domain other than through disclosure by the licensee.

ANNEX II

GENERAL DESCRIPTION OF THE PROJECT

1. Objectives and topics of the project

On the one hand railways in several countries are about to build up a Europe-wide high-speed railway system. By the year 2015, 30 000 km will have been built in Europe, of which 19 000 km are high-speed tracks and 11 000 km for speeds from 160 to 250 km per hour. On the other hand, rates of growth in air transport are expected to be even higher than in the past: according to up-to-date data for Europe, issued by IATA, passenger boardings are to decline by up to 7% in 1991, but forecasts show strong recovery in 1992, while average annual growth is expected to be 3.9% for the 1991 - 1995 period. In fact, air traffic slumps in the past 20 years recovered rapidly during the following years and did not affect the general upward trend. As a consequence, disturbing (and costly) capacity constraints are likely to increase. Even if there is some relief from Europe's airflow management, it still appears that by the year 2000 only a few major (West-) European airports will not have reached their "limits of capacity".

The topics of the project are to identify and analyse the interactions and complementarities between (high-speed) rail and air passenger transports, and to stress the benefit which arises from these combined actions for the users and public welfare.

Prerequisite: given the fact that the Commission of the European Communities (CEC) has started a study in the same field, and in order to manage a co-ordination of the works, the COST-project should take into account only those topics which are not or insufficiently included in the EC-study.

2. Information status

The prevailing information status has been summed up in 13 theses or hypotheses, whereby theses embody secured findings, whereas hypotheses are still unsecured, i.e. should be checked for approval or refusal.

According to case studies and preliminary works, remarkable findings are already available; they are however incomplete.

3. Motivation and results to be expected

To-date information status is often either too general in order to be applied, or too dependent on specific cases, so that a wide application is usually not possible. The statement of the problem is important, for transport and environment policy as well.
With Europe's airspace and (main) airport congestion expected to increase further, despite some improvements, such as the European air flow management about to be

implemented, but with some remaining constraints, such as the impossibility of extending airports (for environmental protection reasons), it makes sense to relieve air traffic from (heavy) demand between points where high-speed trains are able to provide the same (or even a better) level of service.

Accomplishing this. new slots will become available for air links which will not be challenged by any other mode of transport and where demand should be satisfied: for long-haul flights of course, but also on intra-European ones exceeding say a one-hour flight, i.e. the distance where high-speed trains are supposed to lose their advantages (at least for most of the one-day business travellers).

The surveys to be done, completing the existing information status, should provide quantitative results, so that an overview of opportunities for relief can be reached. Results depending on various factors of influence and feasible scenarios for 2000 and 2010 also seem to be meaningful.

The essential statements are those statements of the problem which are formulated as (unsecured) hypotheses.

4. Organisation of the project

The research project will first take an inventory of the existing documents, mainly standards, statistics, reports, settlements of accounts, specific projects, forecasts, and feasibility studies, as a basic information build-up relating to high-speed rail and air passenger transports, bearing in mind three groups of statements to be considered:

- the effects of high-speed rail transport on air transport;
- the effects of air transport on high-speed rail transport;
- the effects of rail stations at airports on rail and air transport.

The backbone of COST Project 318 is divided into theses and hypotheses assessing the interactions of high-speed rail and air passenger transports (within Europe).
The main part of the research work is embodied by the hypotheses, which are to be confirmed or refuted by research work.

A. Effect of high-speed rail transport on air transport

- Thesis 1:	High-speed rail transport is able to compete successfully with air transport demand
- Hypothesis 2:	"does high-speed rail transport enjoy its best time and is its development limited in the future?"
- Hypothesis 3:	"high-speed train: a booster of rail and air system co-ordination?"
- Hypothesis 4:	"high-speed train: a demand distributor among airports?"
- Hypothesis 5:	"what level of service on extended 'lair" services by train?"
- Hypothesis 6:	"does the high-speed train have meaningful saving effects on costs?"

B. Effects of air transport on high-speed rail transport

- Hypothesis 7:	"air transport: for high-speed train a forerunner and a model?"
- Thesis 8:	Air transport maintains all its chances for development on routes with weak transport demand
- Thesis 9:	Within the high-speed transport system as a whole, air transport is complementary to high-speed rail transport
- Hypothesis 10:	"does air transport have investment costs saving effects?"

C. Effects of rail station at airports on rail and air transport

- Thesis 11:	Rail stations at airports allow beneficial effects on rail and air transport systems within their respective field of influence
- Hypothesis 12:	"do rail stations at airports improve air transport distribution?"
- Hypothesis 13:	"do rail stations at airports save public money?"
- Thesis 14:	The reliability of rail connection at airports allows overall access costs at airports to be minimised, waiting time and (parking) space for passengers being reduced at air terminals, travel safety to be increased by the choice of rail transport.

The participating countries will have to help by providing more documents for the tasks of other delegations, in particular from their own country, assess the contributions made by third parties (consultants) and contribute to the tasks, co-ordination, discussion, final conclusions and recommendations regarding the COST Project 318 report.

The kind of issues dealt with by COST Project 318 will involve as summed up below from the terms of stated theses and hypotheses:

- competition aspects between modes of transport; user benefits;
- safety in traffic;
- environmental impacts;
- quality and capacity use of infrastructures;
- energy consumption savings;
- transport economics;
- effects on the national economies.

- From hypothesis 2, the statement of the problem is a realistic assessment (economically and from the point of view of the environmental protection and realist policies) of the high-speed railways network extension within Europe for 2000 and 2010. Question about hypothesis 2: what market potential is there for high-speed rail development and how much travelling is needed on a high-speed rail line to make it possible to operate?

- From hypothesis 3, there is the following question to be answered: what conditions have to be met, i.e. what measures have to be taken, in order that co-ordination between transport supplies improve? Interactions between competing modes of transport such as railways, with its strong dependence upon social economy, and airlines, mostly run in an entrepreneurial manner, bear a significant conflict potential. Furthermore, airlines within the European market are expected to compete much more between themselves, whereas railways do so less.

- Hypothesis 4 should be verified or refuted in the light of case study results. It should be shown to what extent a better distribution of the transport demand can be achieved and what the costs therefore would be. Also to be taken into account is the fact that even in the future too many people will probably go to the airport in their own cars.

- Hypothesis 5 should determine the improvement factors adding to that of reduced travel time. What effect does each of these factors have on the modal choice? What service level is required to make travel times of more than about three hours accepted on high-speed trains? Would a higher frequency (more than one departure per hour) have much impact on the modal choice? A combination of revealed preference and stated preference by means of inquiries/interviews should be performed.

- About (hypo)thesis 6: in the light of a parametric study it should be shown how significant the benefit of high-speed railways could be with regard to the savings of time, transport costs, energy costs and dependency on energy supply, air pollution and noise. Available relevant studies in these fields would have to be explored.

- Topics according to hypothesis 7: relating to examples from the practice and to studies in the fields of transport planning and economics, it should be shown whether air transport is a forerunner for a developing high-speed railways system or not.

- About hypothesis 10: given its flexibility, how far is air transport able to save a large amount of investment and operation costs compared to the construction and operation of high-speed railways? Where are contrary circumstances to be found?

- Question about hypothesis 12: to what extent and range of operation are high-speed trains able to contribute to a better distribution of transport demand between (close and congested) airports?

- Main point of analysis from hypothesis 15: as a matter of fact, existing railway stations at airports account for a high volume of passenger traffic. The question is whether the balance of a cost-benefit analysis, including environmental aspects, is positive or not. The results of existing studies in this field should be compiled. Subsequently, an overall analysis related to significant parameters is to be carried out.

5. Duration of the project

The timetable of the project will be spread out over a 3 112 year period, the work being done mostly in parallel among the various working hypotheses to be treated. Co-ordination meetings are to take place every quarter.

NB.: all the hypotheses being examined in parallel, plus a half- to one year period to complete the report, meaning a total duration of about 3 112 years starting from signature of mandate documents:

examining hypothesis 2:	2 1/2 years;
examining hypothesis 3:	1 112 - 2 years;
examining hypothesis 4	(+ 12): 2 - 3 years;
examining hypothesis 5:	1 112 - 2 years;
examining hypothesis 6:	1 112 years:
examining hypothesis 7:	2 1/2 years;
examining hypothesis 10:	2 112 years;
examining hypothesis 11	2 112 years;
completing the report:	112 - 1 year;

Total:	3 112 years;

6. Estimation of the costs:

About ECU 1 200 000 including 13 man-years.

COST TRANSPORT OVERVIEW

COST Transport is one of 17 domains existing in COST at the present time.

It was to be one of the seven areas seen as best suited for this new form of collaboration, which was officially set up by a Ministerial Conference in November 1971.

The Transport area lends itself particularly well to the COST framework, both because it combines aspects from a number of disciplines, and because of the need for harmonisation at European level. Liaison with the Transport Ministries and Administrations in the various countries is a key element of these COST Actions.

The COST Transport Secretariat is located within the Directorate General for Transport of the European Commission. The location with the staff managing the Fourth Framework Transport RTD Programme, as well as the proximity with the Common Transport Policy Directorates, enables close collaboration between Transport Research activities and serves as a basis for further political action.

COST Transport Actions are authorised and supervised by the COST Technical Committee on Transport which, in turn, reports to the COST Committee of Senior Officials. Both of these decision-making bodies comprise representatives of the national governments of the COST countries.

By the end of September 1998, the COST Transport domain comprised 14 ongoing Actions, with a total estimated cost of ECU 30 Million. 26 Actions have been completed, and a further 8 Actions have been selected by the COST Technical Committee on Transport and are under preparation.

Actions Underway

COST 319:	Estimation of pollutant emissions from transport
COST 323:	Weigh in motion of road vehicles
COST 326:	Electronic marine chart display
COST 327:	Motorcycle safety helmets
COST 329:	Models for traffic and safety development and interventions
COST 331:	Requirements for pavement markings
COST 332:	Transport and Land-Use policies
COST 333:	Development of new bituminous pavement design method
COST 334:	Effects of wide single tyres and dual tyres
COST 335:	Passengers accessibility of heavy rail systems
COST 336:	Falling weight deflectometer
COST 337:	Unbound granular materials for road pavements
COST 339:	Small containers

Actions in preparation

COST 338:	Information overload in the field of traffic signs
COST 340:	Towards an intermodal transport network: Lessons from history
COST 341:	Habitat fragmentation due to transportation infrastructure
COST 342:	Parking policy : Effects on Mobility and the Local Economy
COST 343:	Reduction in Road Closures by Improved Maintenance Procedures
COST 344:	Improvements to Snow and Ice Control on European Roads
COST 345:	Procedures Required for Assessing Highway Structures
COST 346:	Instantaneous Energy Consumption and Emissions of Road Vehicles, especially of Heavy Duty Vehicles

Completed Actions

COST 30:	Electronic aids to traffic on major roads
COST 30 bis:	Same aim as COST 30 but with demonstration action
COST 33:	Forward study of passenger transport requirements between major European conurbations
COST 301:	Shore based marine navigation aid systems
COST 302:	Technical & economic conditions of the utilization of electric road vehicles in Europe
COST 303:	Technical and economic evaluation of dual-mode trolleybus national programmes
COST 304:	Alternative fuels for road vehicles
COST 305:	Data system for the study of demand for interregional passenger transport
COST 306:	Automatic transmission of data relating to transport
COST 307:	Rational use of energy in interregional transport
COST 308:	Maintenance of ships
COST 309:	Road weather conditions
COST 310:	Freight transport logistics
COST 311:	Simulation of maritime traffic
COST 312:	Effects of the Channel Tunnel on traffic flows
COST 313:	Socio-economic cost of road accidents
COST 314:	Express delivery services
COST 315:	Large containers
COST 317	Socio-economic effects of the Channel Tunnel
COST 318:	Interactions between high speed rail and air passenger transport
COST 320:	Effects of E.D.I. on transport
COST 321:	Urban goods transport
COST 322:	Low Floor Buses
COST 324:	Long term performance of road pavements
COST 325:	New pavement monitoring equipment and methods
COST 328:	Integrated Strategic Infrastructure Networks in Europe
COST 330:	Teleinformatics links between ports and their partners

Up to date information on COST Transport can be found on the World Wide Web, at the following address: http//www.cordis.lu/COST-Transport/home.htm

European Commission

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Having as a main objective to identify and analyse the interactions and complementary effects between high-speed rail and air passenger transport, and to stress the benefit which arises from these combined actions for the users and public welfare; 11 COST countries: Belgium, France, Germany, Ireland, Italy, The Netherlands, Portugal, Slovenia, Spain, Sweden and Switzerland joint in COST 318.

During 4 years the Action has analysed the interactions between high-speed rail and air passenger transport by assessing the effects of high-speed rail on air transport, the effects of air transport on high-speed rail transport, and the effects of railway stations at airports on rail and air transport; the main conclusions are presented in this report.