Targeting air travel markets in a fluctuating context : a methodology for non-hub airports

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Abstract

Recent events show strong interactions between air traffic, political events and the global economy. In a context of economic development, air transportation experiences strong growth, characterised by saturated airports, competing airlines, environmental constraints and often severe delays. However, the industry can abruptly be affected by international or economic crisis and the loss of consumer trust.

Attempting to take these air travel market fluctuations into account, a methodology has been developed. This work aims to help non-hub airports in their air network planning and forecasting. It also intends to target strong and weak markets. It has been tested through a four steps process:

- a European air transport model has been established
- an airport and links typology has been structured with six identified airport types, 21 European and six intercontinental linkages
- a so-called "transfer equation" has been developed, based on airport link typologies and on a plausible hierarchy of transfer rates, in order to estimate the number of passengers transferring at hubs
- passenger benchmarks are used to assess whether a specific by-pass hub market is viable or not.

Keywords

Non-hub – hub – airlines – airports – transfer - 2nd Swiss Transport Research Conference – STRC 2002 – Monte Verità

1. Introduction

Recent events show strong interactions between air traffic, political events and the global economy. In a context of economic development, air transportation experiences strong growth, characterised by saturated airports, competing airlines, environmental constraints and often severe delays.

Unlike the *hub* airport, the *non-hub* airport is not dominated by a home-carrier, but it is served by a greater diversity of airlines than the *hub*. Its network is mainly continental, dominated by *hub* links and sometimes complemented by one or several intercontinental links. *Non-hub* operations do not depend on transfer traffic as it is the case for *hubs*, where the home-carrier is feeding and de-feeding its intercontinental network with short- and medium-haul links (spokes). This strategy allows more destinations to be linked with less spokes, but in return, travelling through the *hub* is unavoidable.

Air transport's impressive evolution required the setting-up of an effective analysis of air activity that could be used as a working base, even in a situation of falling demand. 1998 is the chosen reference year for this determination of air activity. In this year, 1.5 billion passengers travelled by plane, of which about one third, to, from and within Europe (without Russia). Worldwide, 6% of the routes (9'700 city-pairs) link 33 airports and represent 50% of total traffic. Moreover half of the world aircraft fleet is owned by 17 airlines, so it is easy to realise why everything is saturated.

Attempting to take these air travel market fluctuations into account, a methodology has been developed to help *non-hub* airports in their air network planning and forecasting. This work also intends to target strong and weak markets. It has been tested through a four steps process:

- a European air transport model has been established
- an airport and links typology has been structured with six identified airport types, 21 European and six intercontinental linkages
- a so-called "transfer equation" has been developed, based on airport link typologies and on a plausible hierarchy of transfer rates, in order to estimate the number of passengers transferring at *hubs*
- passenger benchmarks are used to assess whether a specific by-pass *hub* market is viable or not.

2. European air transport model

2.1 Main aspects

The first step of the methodology has been the development of a European air transport model. Based on 1998 supply and demand data, the modelling considers ~10’000 inner-European and ~4’000 intercontinental links with at least 5’000 annual passengers one way, 565 European airports and 265 extra-European airports (on five continents). This is the reference base dealing with passenger traffic flows and not an OD matrix.

Other 1998 characteristics include:

- Estimated demand totals 542 million passengers (of which 139 millions are intercontinental) and total supply amounts to 802 million seats. Demand is underestimated by 3.2%, which reflects the method that has been used, with lower limits in passenger flows.

- Average load factor on the whole network is 68%.

- All 565 European airports managed 946 million passengers. Estimated 390 airports’ traffic totals 924 million passengers and real traffic of the same airports accounts for 934 million passengers. The difference ratio is 1.1% .

- Total number of airlines is 314 and is being split into : 212 European, 3 unknown European (coming from the modelling process), 23 African, 12 Latin-American, 12 North-American, 39 Asian et 12 Middle-Eastern and one unknown intercontinental (coming from the modelling process).

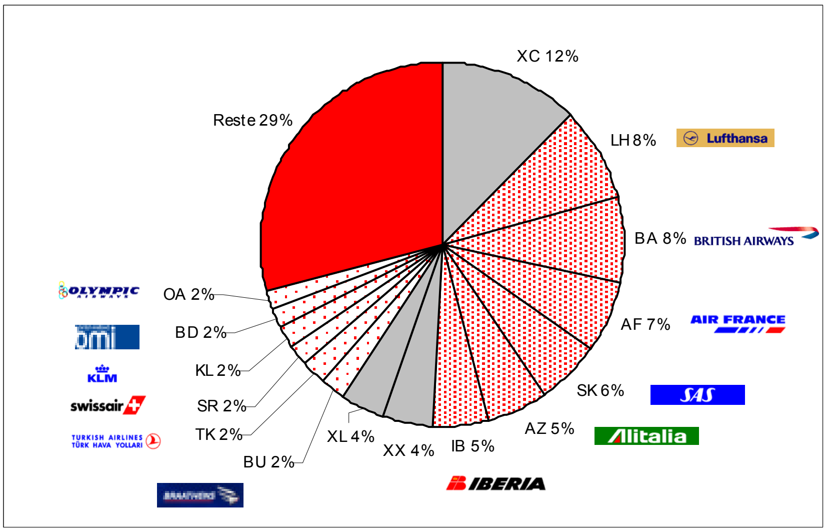
2.2 One specific aspect: airline traffic

One of the several aspects that emerges from the European air transport model is the share of European airlines traffic. Total European demand is 403 million passengers in 1998[1]. As it is shown below, inner-European traffic is dominated by six major airlines (Lufthansa LH to Iberia IB : 39%), but also by charter flows (XC - Charters, 12%), whose precise carriers could not be identified, because supply data do not cover irregular activity.

Although a small part of this demand had probably been transported through regular carriers, most of these passengers used links provided by airlines such as *Air 2000*, *Air Berlin*, *Air Europa*, *Britannia*, *Condor*, *LTU*, *Germania*, *Hapag Lloyd*, *Monarch*, *Onur Air*, etc.

XL and XX are two other unknown airlines that appeared from the modelling process. Their share is 4% each within Europe, quite less than the unknown charter airline XC. A second group of six smaller airlines share around 12% of inner-European traffic. Less than 30% of the estimation is being split into 189 known airlines.

Figure 1 Inner-European airline split



[1] The difference between total demand and intercontinental demand.

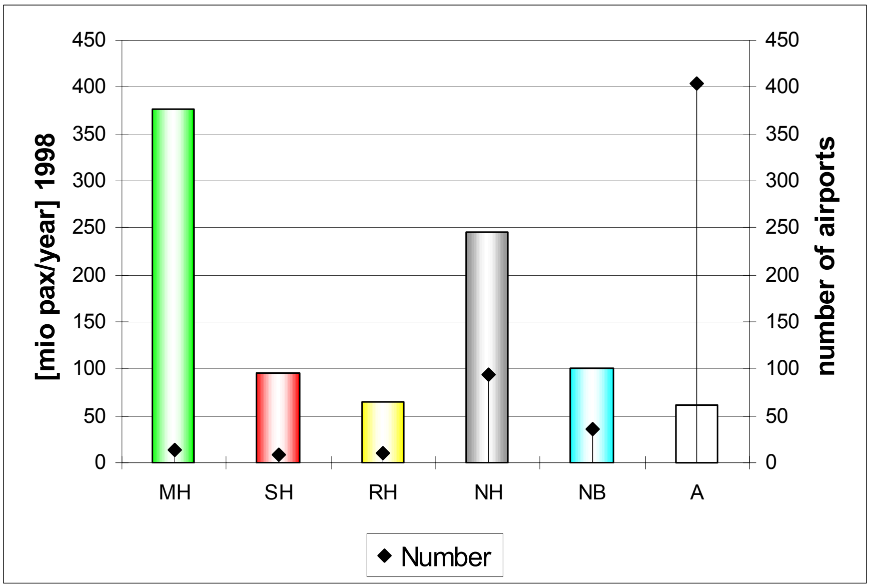
3. Airport and link typology

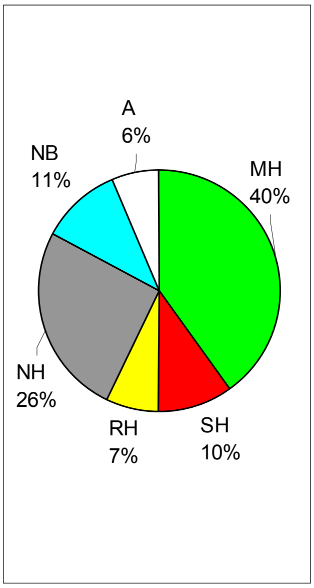
In a second step, an airport typology has been structured with six identified airport types. All 565 European airports are classified as 14 *main hubs* (mh), 8 *secondary hubs* (sh), 10 *regional hubs* (rh), 94 *non-hubs* (nh), 35 *non-business destinations* (nb) and 404 *aerodromes* (a). This is a **personal categorisation**[2], mainly based on passenger traffic and on estimated airline traffic split at each airport. This typology allows furthermore:

a) To categorise links and to test the replacement of links with a stop at a European *hub* by direct links, avoiding *hub* platforms

b) To distinguish airports with a high transfer rate from those with little or without transfer.

Figure 2 Airport typology with estimated 1998 traffic





[2] The US *Federal Aviation Administration* established its own classification. Within *commercial service airports* (with regular traffic of at least 2'500 passengers per year), *FAA* distinguishes in 1994 in the US : 27 *large hubs*, 38 *medium hubs*, 83 *small hubs*, 269 *non-hubs*, 149 *other commercial service*; that means 566 airports. These airports are classified regarding their percentage of total national (US) passenger enplanements.

Main *hubs* represent 40% of total traffic cumulated at 565 European airports. Generally speaking, all 32 *hubs* generate more than half of total traffic, but they represent only 6% of total number of airports. Average traffic at these 14 *main hubs* is 27 million passengers per year, about 5 millions more than *Zurich*, which has also been included in the group of *main hubs*, although its home-carrier *Swissair* went into bankruptcy in October 2001.

On the opposite side, *aerodromes* make up 70% of total number of airports, and together they account for only 6% of traffic! *Secondary hubs* and *regional hubs* share 17% of European traffic.

Non-hub airports total together 246.0 millions passengers a year, which stands for an average of 2.6 million per airport. *Geneva* gets a high rank (8th among 94 *non-hubs*, 6.3 million estimated passengers), far above the average. This position is due to the existence of almost 50 *non-hubs* with a traffic between 1 and 2 million passengers a year. *Manchester* and *Dusseldorf* are the biggest European *non-hubs* in terms of traffic (17.8 et 15.7 millions).

Non-business destinations show similar trends to *non-hubs* in terms of average traffic with 2.9 million passengers per year. However, unlike *non-hubs*, whose monthly profile is less uneven, *non-business destinations* count on European summer migrations to boost their traffic. *Non-business destinations* have been chosen because they have specific transfer rate. *Non-hubs* and *non-business destinations* account together for one third of the traffic.

In total 27 link types can be derived from this airport typology: 21 European and 6 intercontinental linkages. This process permits to highlight the fact that feeding traffic between *non-hubs* and *hubs* is very important in Europe, as well as frequencies offered by major airlines serving their own *hub* airport. As expected, intercontinental traffic is almost entirely monopolized by *hub* airports, especially at *main hubs*.

4. Transfer

The airport typology with 32 *hubs* (14 *main hubs*, 8 *secondary hubs* and 10 *regional hubs*) is one of the central elements of the study of *hub* by-pass links, whether on a intercontinental or inner-European point of view. One transfer is permitted at a European *hub*. The following reflection deals with these *hubs*. It is performed in four phases:

– Traffic split regarding the type of node (six airports and one continent)

– Transfer rate at all 32 European *hubs*

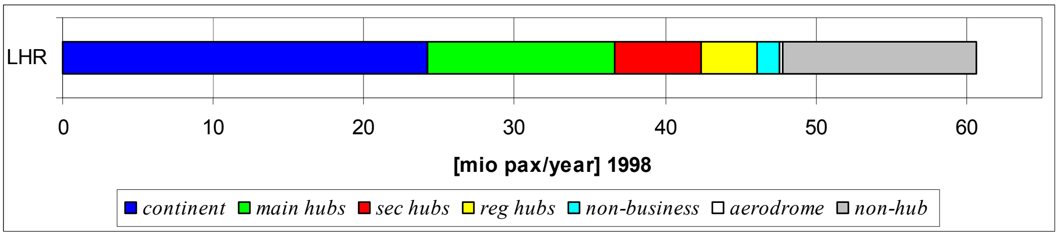
– Transfer split on each *hub* regarding the type of node

– Indicator of the *hub*s' inner-European and intercontinental attractiveness.

4.1 Phase 1: traffic split

For all 32 *hubs*, data can be grouped in a way to show the contribution of each node to its total traffic. For example, *London Heathrow*'s 1998 traffic was estimated at 60.3 million passengers, and can be displayed as follows:

Table 1 *London Heathrow*'s traffic split in 1998



4.2 Phase 2: Transfer traffic

Airport traffic is divided into **local** passengers, who begin or finish their trip at this specific airport, **transfer** passengers who change plane, without leaving the airport perimeter and **transit** passengers, who continue their trip with a same flight number, without changing plane.

Transfer passengers have various characteristics. First they are counted twice in the statistics. Secondly, these persons do not need parking facilities, as well as surface transport. Most of the time they do not meet any relatives or friends. However these persons are an interesting market for shops and restaurants.

In this work, airport traffic is split into two categories : local passengers (access and egress of the airport) and transfer passengers (landing and departing). If no information is available, departing passengers are equal to those who arrive. Transit passengers are distributed among transfer passengers, because their share in total airport traffic is quite low. This assumption contributes to an artificial rise on the supply side.

Transfer rate can be used for airlines, links, airports. The one used here is the ***hub* transfer rate**. Such data may sometimes be obtained, but some airport authorities do not provide such information, due to confidentiality. The rate can be expressed by this equation, defined for a specific period of time, in this case one year:

Equation 1 $$tt_{hub} = Tft_{hub} / Dem_{hub}$$

tt_{hub} : transfer rate of a *hub*, [%]
Tft_{hub} : total transfer traffic at a *hub*, [passengers]
Dem_{hub} : total traffic at a *hub*, [passengers]

To carry on using the same example, *London Heathrow*'s transfer rate was 34% in 1998.

4.3 Phase 3: Transfer split

4.3.1 Transfer equation

The *hub* transfer rate is a general information about connecting passengers. True origin and destination of passengers are still missing. The study of *non-hub* potentials should allow to know how many people started their trip at one of the 94 identified *non-hubs*, then changed plane at one of the 32 European *hubs* to reach their final destination or vice versa.

Nodes and link typology will be helpful to initiate a transfer hierarchy, thanks to various hypotheses. Such a hierarchy consists of an increase/decrease of the *hub* transfer rate (tt_{hub}), according to the type of node which is linked to this *hub*. The transfer equation formulates this reflection in mathematical terms. Each node's contribution is expressed below, using the concept of increase and decrease rates.

Equation 2 $Tft_{hub} = Tft_{hub}^{\Sigma co} + Tft_{hub}^{\Sigma mh} + Tft_{hub}^{\Sigma sh} + Tft_{hub}^{\Sigma rh} + Tft_{hub}^{\Sigma nh} + Tft_{hub}^{\Sigma nb} + Tft_{hub}^{\Sigma a}$

Equation 3 $Tft_{hub}^{\Sigma nodes.type} = [(tt_{hub}+m_{hub}^{\Sigma nodes.type})Dem_{hub}^{\Sigma nodes.type}]$

Tft_{hub} :	total transfer traffic at a *hub*, [passengers]
$Tft_{hub}^{\Sigma nodes.type}$:	transfer at a *hub*, between this *hub* and all same types of nodes, [passengers]
tt_{hub} :	transfer rate of a *hub*, [%]
$m_{hub}^{\Sigma nodes.type}$:	increase/decrease of tt_{hub} according to nodes with a same type,[%]
$m_{hub}^{\Sigma nh}$:	increase/decrease for *non-hub* airports, [%]
$Dem_{hub}^{\Sigma nodes.type}$:	traffic at a *hub*, between this *hub* and all same types of nodes, [passengers]

The transfer equation has been established to find out the increase/decrease rate of *non-hub* airports $\boldsymbol{m_{hub}^{\Sigma nh}}$. For other nodes categories, there are six increase/decrease rates to be defined, that have to satisfy following criteria:

- Transfer flows must be balanced between three categories of *hubs*. The amount of transfer is the same in one direction than in the opposite direction. In this case, admitted rates are fixed values, and not increase or decrease rates of the *hub* transfer rate.

- The highest decrease must not exceed the smallest transfer rate. Similarly, the increase cannot lead to more than 100% of transfer.

4.3.2 Admitted transfer hierarchy

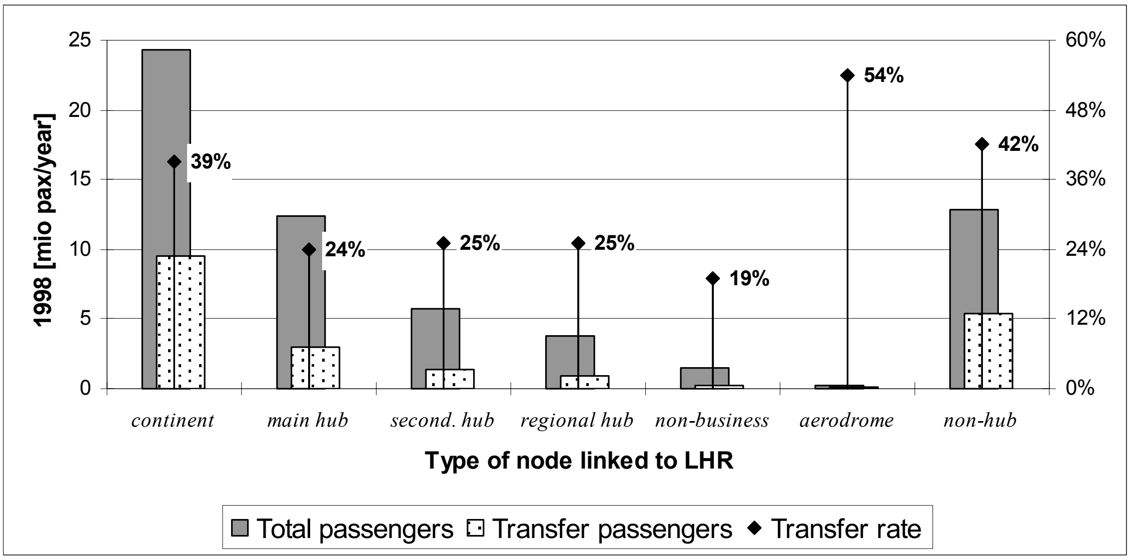
The admitted transfer split hierarchy is as follows. This is used as a guideline to define further increase and decrease rates. Mathematical constraints and common sense are priority principles. One more parameter to include is the *hub* transfer rate; this rate is generally higher at *main hubs*, followed by *regional* and *secondary hubs*.

Table 2 Transfer hierarchy

		Inc/Dec	**Comment**
1.	***MH***-*A*	++++	Strong dependence of the *aerodrome* on the *main hub*.
2.	***SH***-*A*	+	Average dependence of the *aerodrome* on the *secondary hub*.
3.	***MH***-*CO*	+	Intercontinental flows are concentrated at *main hubs*.
4.	***RH***-*A*	0	Average dependence of the *aerodrome* on the *regional hub*.
5.	***SH***-*CO*	0	Intercontinental links out of *secondary hubs* have a similar connecting traffic than the transfer rate of such an airport.
6.	***MH-SH***	Permanent	A *main hub* at one link end indicates a connecting activity, but the rate needs to be a fixed value, because of transfer flows' balancing.
7.	***MH-RH***	Permanent	
8.	***SH-RH***	Permanent	A *secondary hub* at one link end leads to a smaller fixed value than the first one.
9.	***RH***-*CO*	-	A decrease takes into account higher transfer rates at *regional hubs* than at *secondary hubs*, in order to have a similar connecting traffic than on links between *continents* and *secondary hubs*.
10.	***SH***-*SH*	-	A complementary supply between those airport types leads inevitably to some transfer.
11.	***MH***-*MH*	- -	*Main hubs* lead to transfer, but their plentiful supply allows them to be considered as "autonomous".
12.	***RH***-*RH*	- -	A complementary supply and quite high transfer rates lead to some transfer between *regional hubs*.
13.	***Hub***-*NB*	- - -	Links with *non-business destinations* have few transfer, because they imply point to point passenger flows, what ever the *hub* at the other link's end.

At *London Heathrow*, with a total traffic of 60 million passengers, of which 21 millions are connecting passengers (tt_{hub}=34%), the hypotheses bring the following results. The British airport is directly linked to 45 non-hubs[3], and the transfer rate on these links is supposed to be 42% ($m_{hub}^{\Sigma nh}$=8%), that means 5.5 million passengers.

Figure 3 1998 transfer situation at London Heathrow



This information about connecting traffic needs to be brought back to the study of *hub*-bypass links. The transfer equation allows to assess total number of passengers to and from *non-hub* airports and connecting at one of the identified *hubs*.

But a parameter is missing, which should distinguish whether this transfer at a *hub* is inner-European or intercontinental. 100% of connecting passengers on *non-hubs – hubs* links did effectively choose one of these two options! Looking for this parameter will be the fourth phase of the reflection conducted on *hub* airports.

3 Other airports to be linked include: 5 *continents*, 12 *main hubs*, 8 *secondary hubs*, 6 *regional hubs*, 11 *non-business destinations* and 7 *aerodromes*.

4.4 Phase 4: Intercontinental or inner-European transfer

If you consider a transfer passenger, how can you know whether he is going to stay in Europe or connect for an intercontinental destination ? In order to answer this question, the idea was to formulate an indicator based on supply measured at each of the 32 European *hubs*. This indicator will help to define the share of *non-hub* passengers transferring at a *hub* staying in Europe or leaving Europe.

The parameter used is the total number of air links available at each *hub* in 1998, which can be obtained through the European air transport model.

London Heathrow has been indexed at 75 %, because this airport has the highest share of intercontinental air links with 49 %. Other gateways follow *London Heathrow* proportionally.

The indexation of the 32 *hubs* makes possible to consider a new step in the reflection of *hub* by-pass links. After splitting the demand among all European *non-hub* airports and *extra-European airports*, passengers connecting at a European *hub* between these two categories of airports are now available.

This process permits to test the replacement of links with a stop at a European *hub* by direct links, avoiding *hub* platforms. The intercontinental domain has been chosen as the primary test ground for this study sequence.

This is the most disaggregated phase of the reflection. The last step consist in coming one level back (see next page).

5. Targeting markets

For all origin-final destination matrixes (European *non-hub – extra-European airport*), subtotals need to be performed in order to cumulate all passenger connecting at European *hubs*. Remember that a transfer has two segments, but people are the same ones !

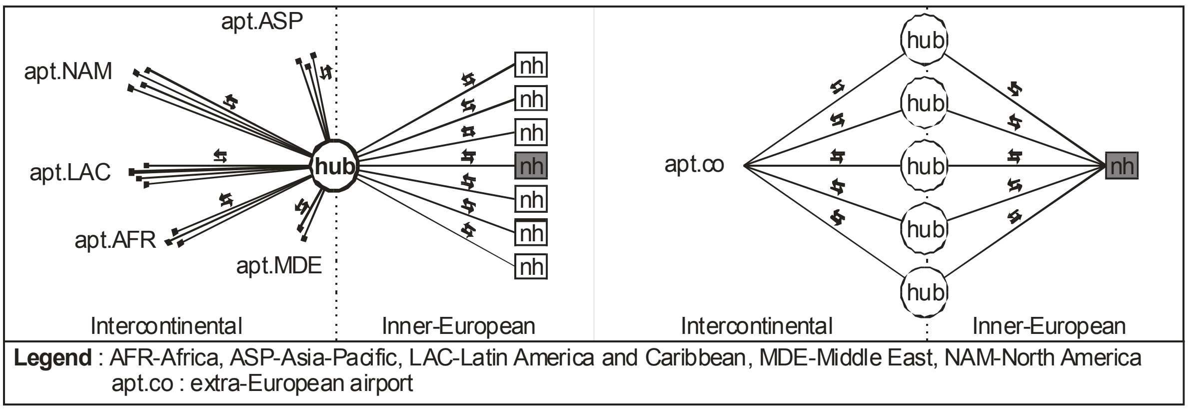
Equation 4 $Tft_{\Sigma hub}{}^{\leftrightarrows nh}apt.co = \Sigma_{hub}(Tft_{hub}{}^{\leftrightarrows nh}apt.co)$

$Tft_{\Sigma hub}{}^{\leftrightarrows nh}apt.co$: Transfer go and return, cumulated on the inner-European segment, and calculated on all *hubs* linked to a specific *non-hub* and to a specific *extra-European airport*, [passengers]

$\Sigma_{hub}(Tft_{hub}{}^{\leftrightarrows nh}apt.co)$: Sum, performed on all *hubs*, of the estimated transfer at a *hub* and cumulated on the inner-European segment, from an *extra-European airport* to a *non-hub* linked to this *hub* an vice versa, [passengers].

Doing so, passenger flows with same origins and destinations are gathered through a group of *hubs*, which symbolises transfer points.

Figure 4 Cumulating transfer at European *hubs*



6. Outlook

Values situated in these origin-destination matrixes allow a direct comparison with intercontinental passenger benchmarks. It is admitted that a **potential for a new intercontinental link** between a European *non-hub* and an *extra-European airport* exists if one of these values is equal or above an identified benchmark.

Finally, the introduction of growing or falling air traffic rates in the model allow to establish future air travel patterns. Passenger benchmarks are then used to assess whether a specific market is viable or not, and the performance of the method can be judged by comparing predicted official results with those of the estimation.

The first results (still confidential at this time) tested for Geneva Airport show a highly acceptable level of prediction according to Geneva Airport officials. Passenger breakeven points may also be used to react in case of traffic loss, resulting in the withdrawal of direct links to destinations out of the *non-hub* airport.

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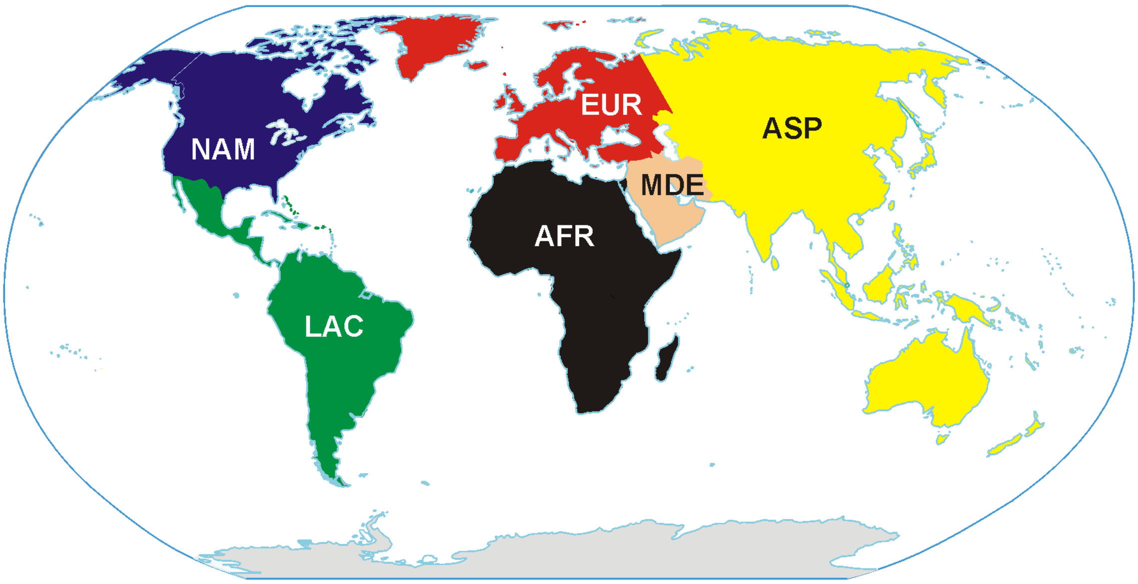
Appendix A: World airport traffic 1998

Découpage géographique de l'*Airports Council International* et population 1998



Légende et population en 1998 :

- Amérique du Nord (pop : 305 mio)
- Amérique Latine-Caraïbes (pop : 504 mio)
- Europe (pop : 778 mio)
- Moyen-Orient (pop : 164 mio)
- Afrique (pop : 749 mio)
- Asie-Pacifique (pop : 3'403 mio)

Note : population mondiale : 5'903 mio