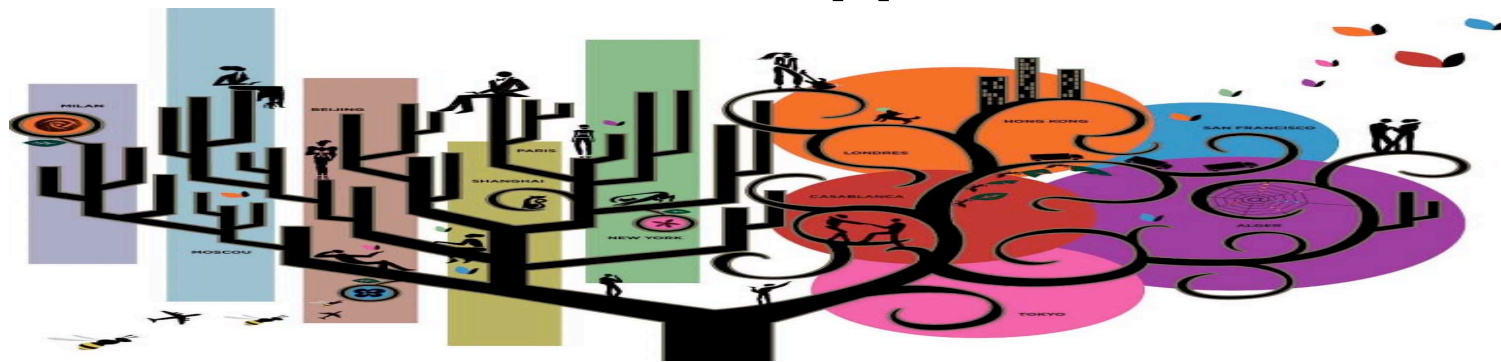


# Villes et Globalisation une approche par les réseaux

## Cities and Globalization a network approach

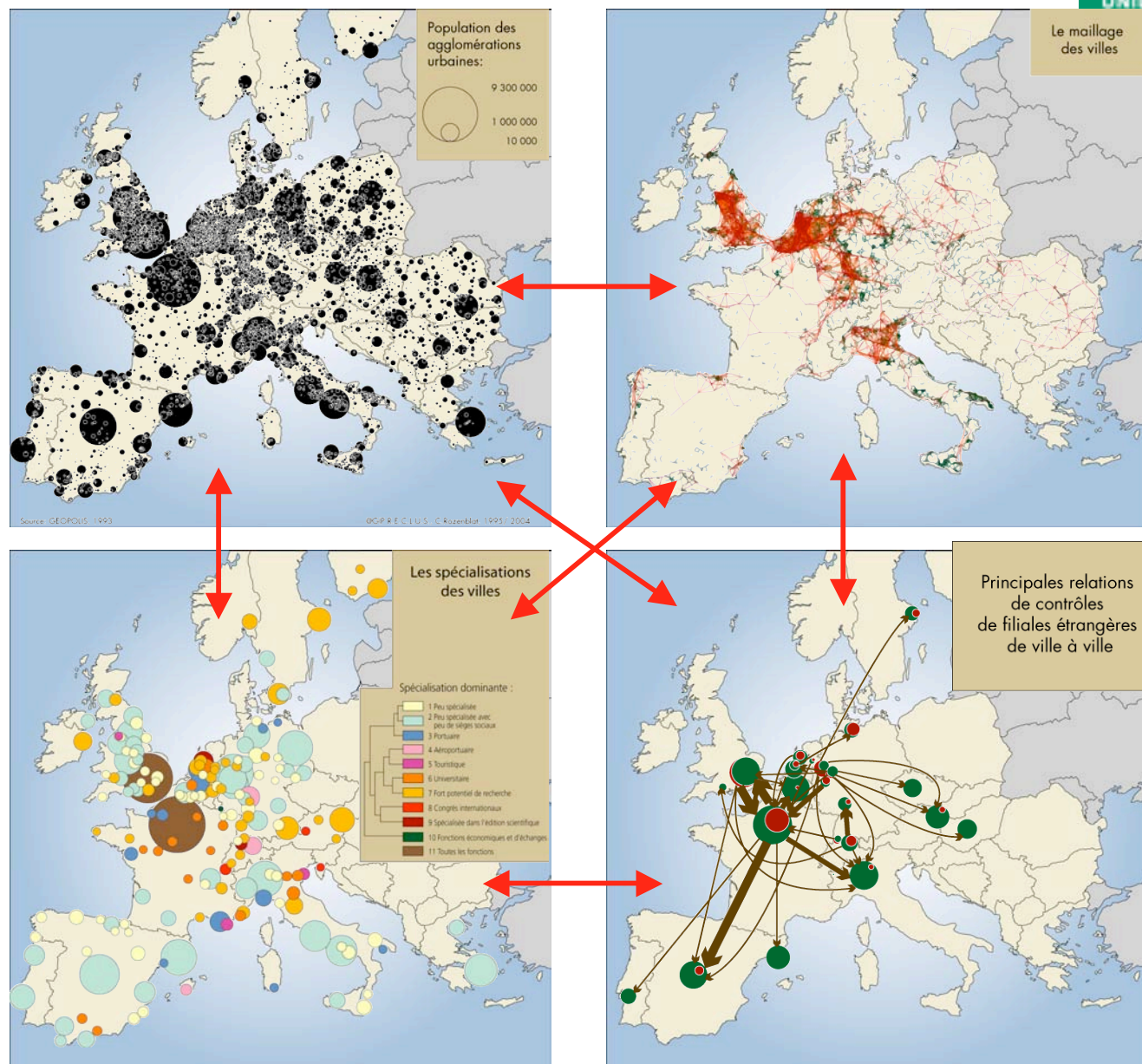


**Prof. Céline Rozenblat**

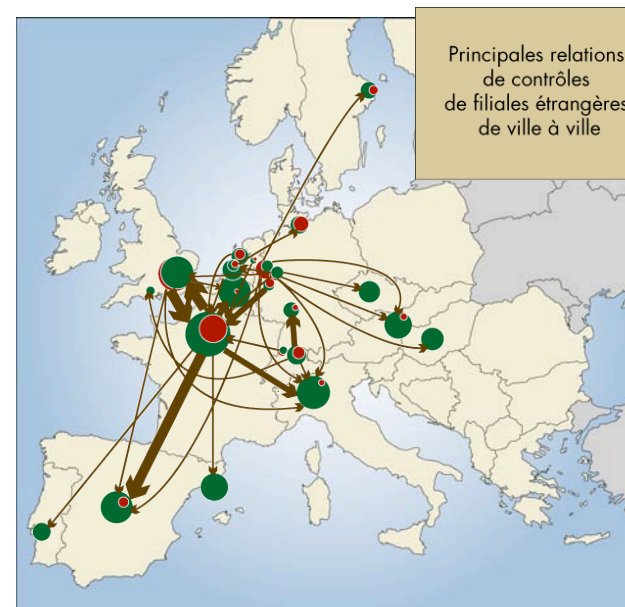
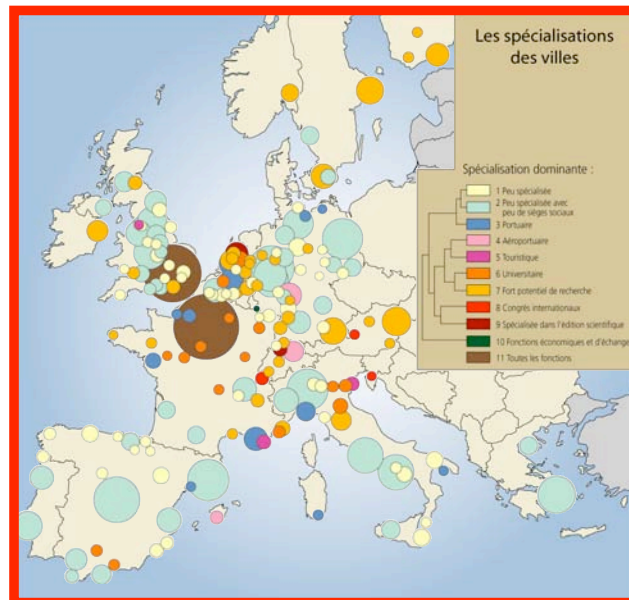
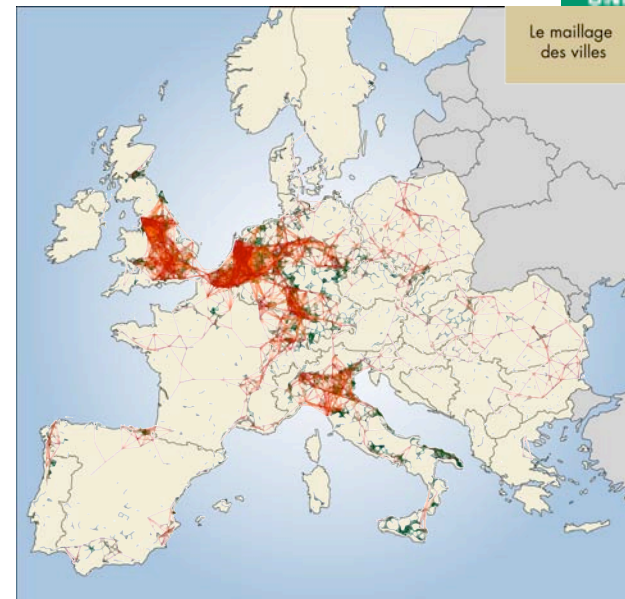
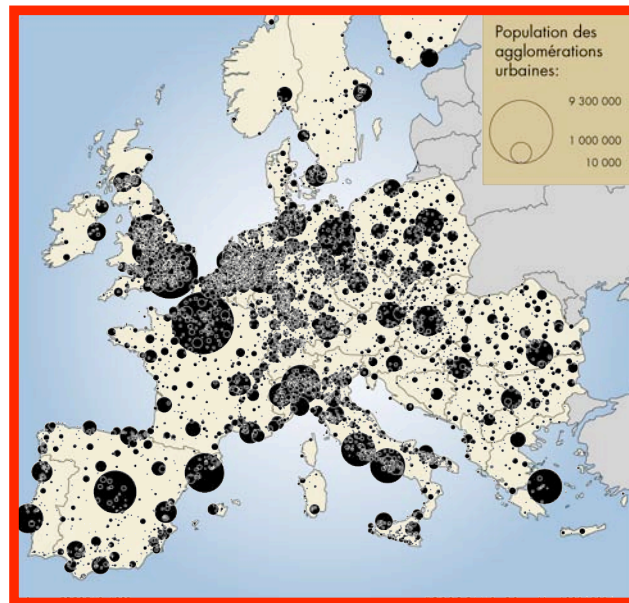


•**SPANGEO Project** (**SP**Atial **N**etworks in **GEO**graphy)  
Supported by the French National Agency of Research (2005-2008)  
Coordinated by **Celine Rozenblat** and **Guy Melancon**  
<http://s4.parisgeo.cnrs.fr/spangeo>

# Development of Urban Systems

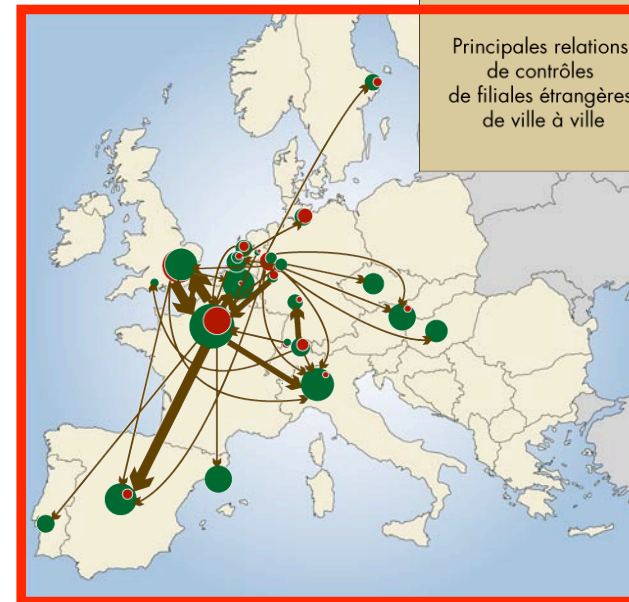
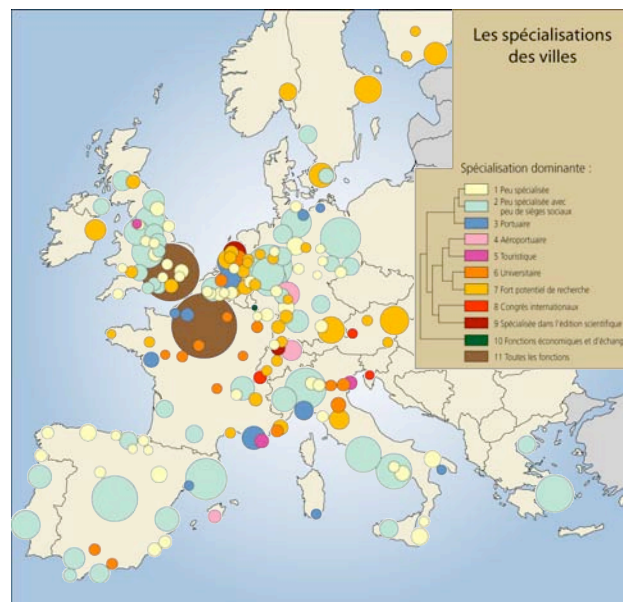
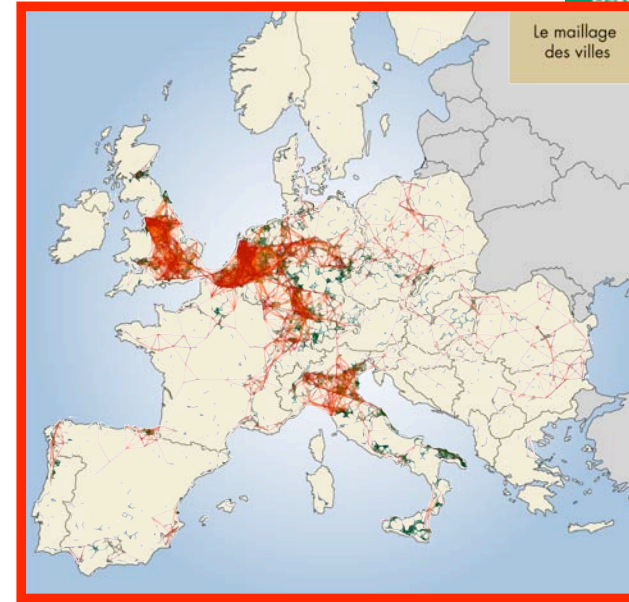
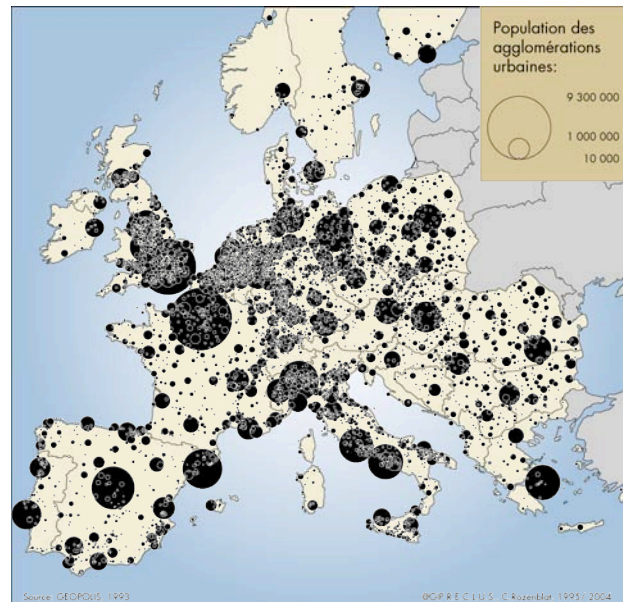


# Locations

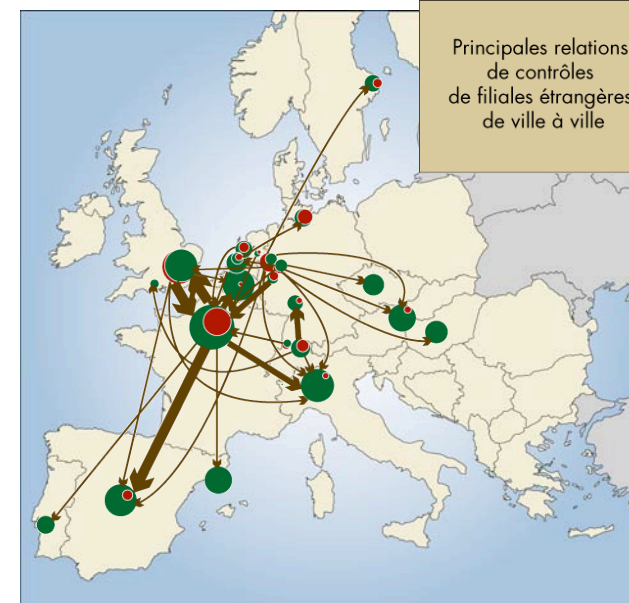
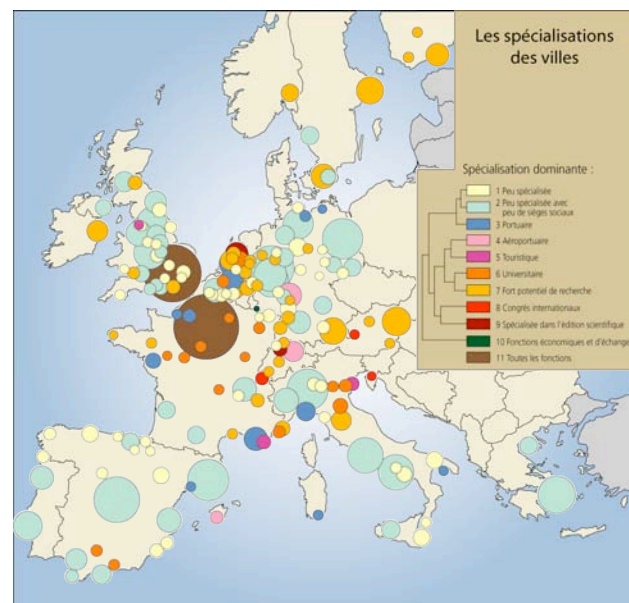
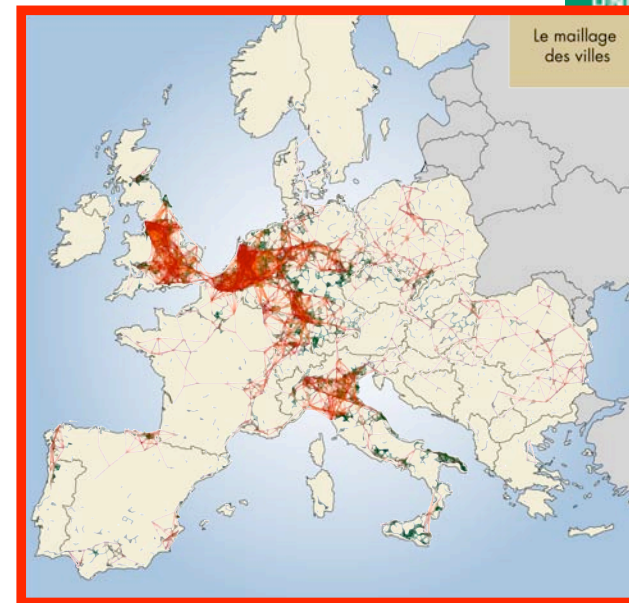
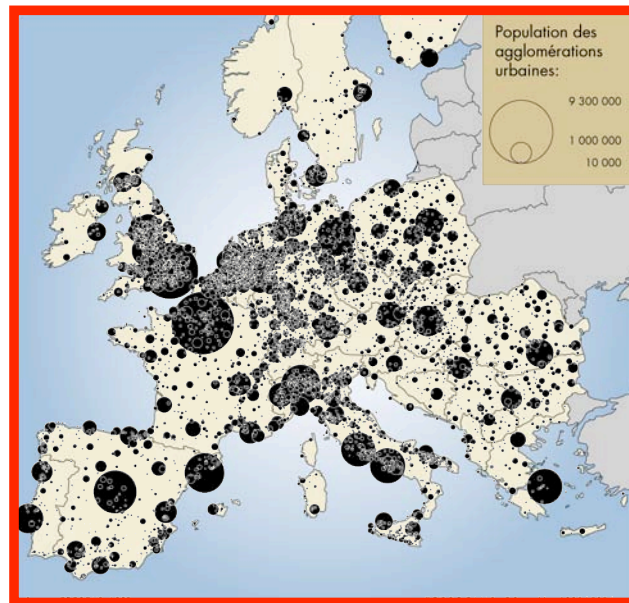




# Networks

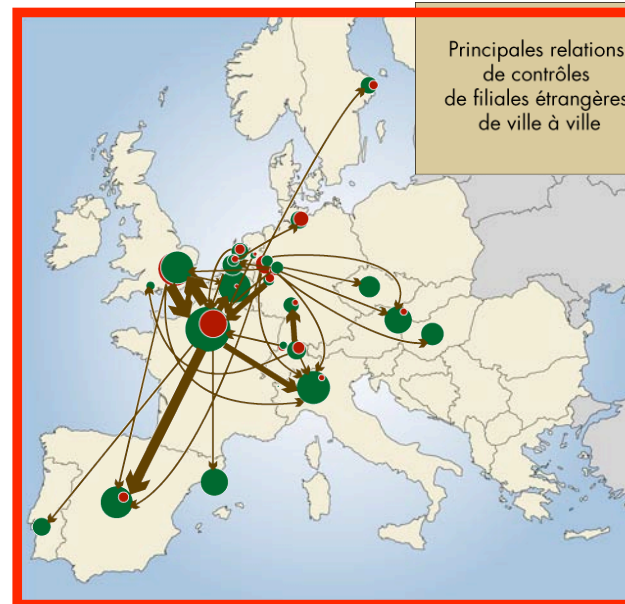
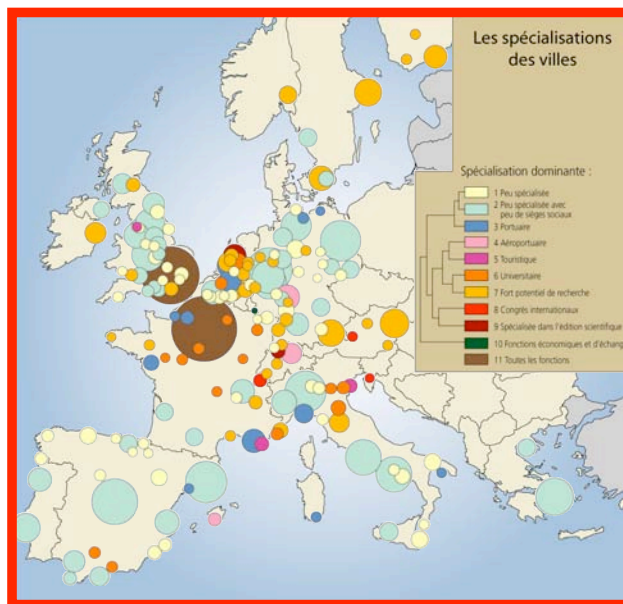
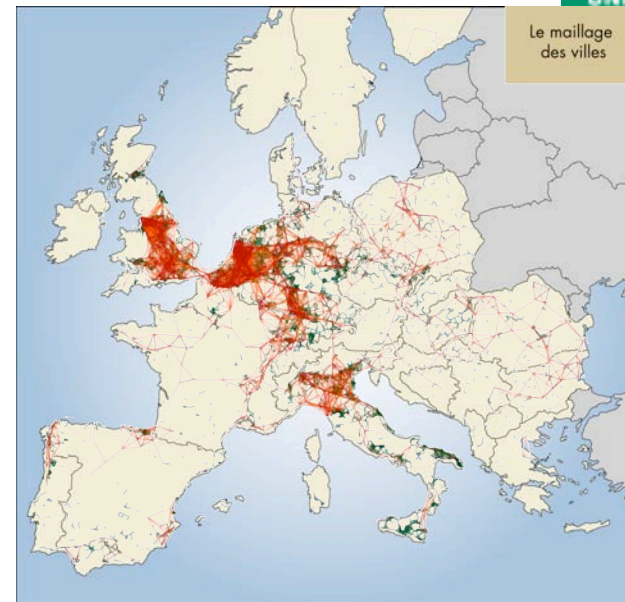
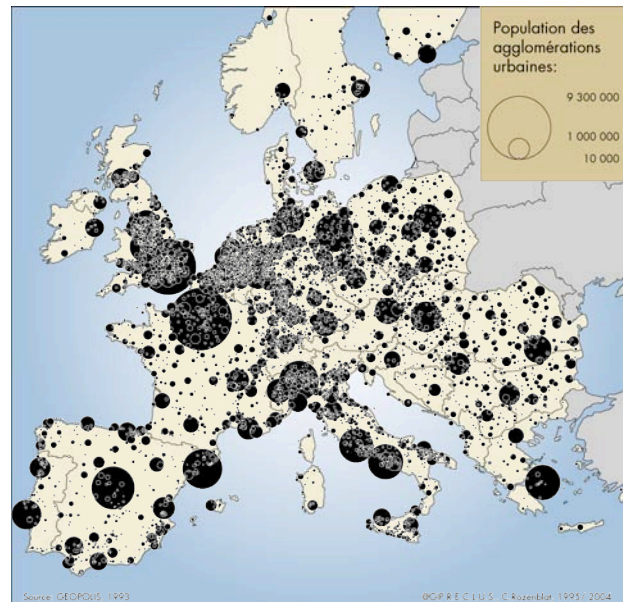


# Long-term dynamics of cities

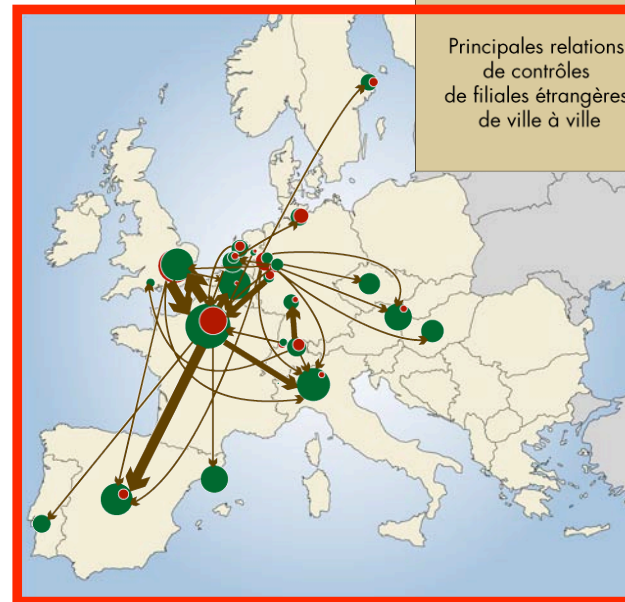
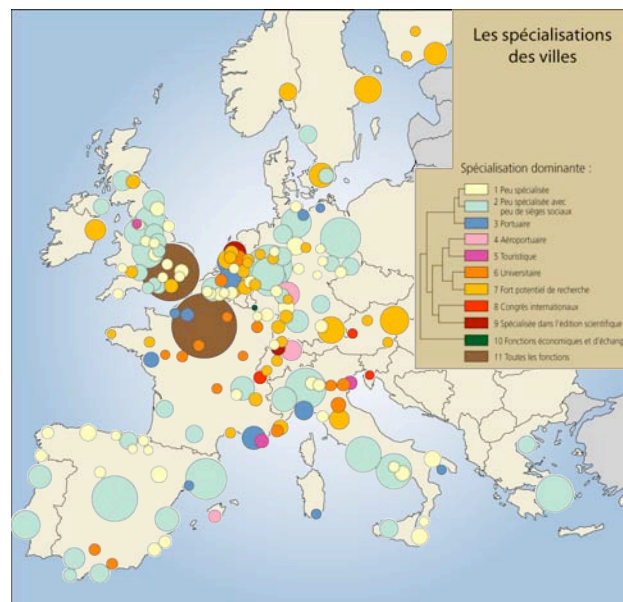
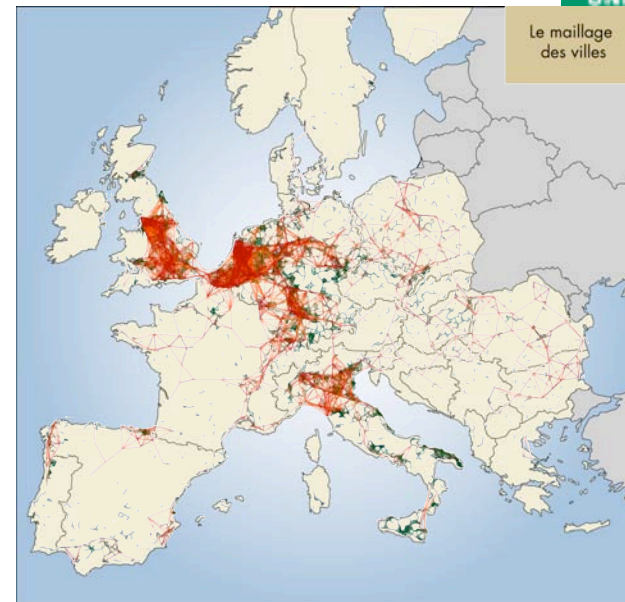
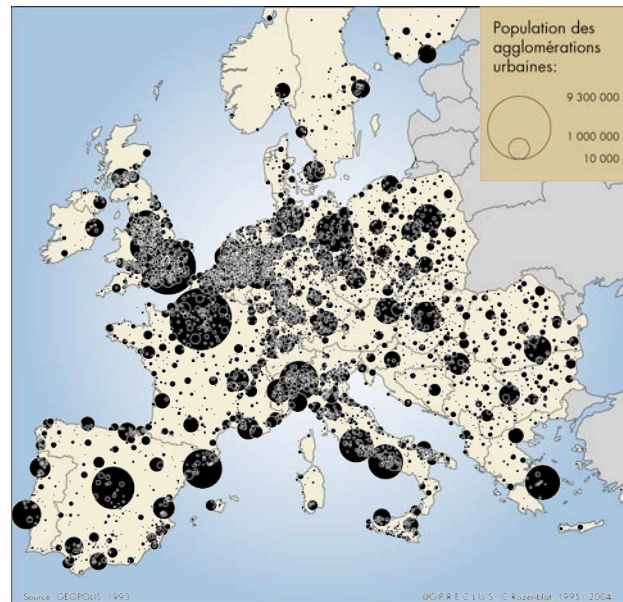




# Medium term dynamics of cities



# Inter-urban specialized networks

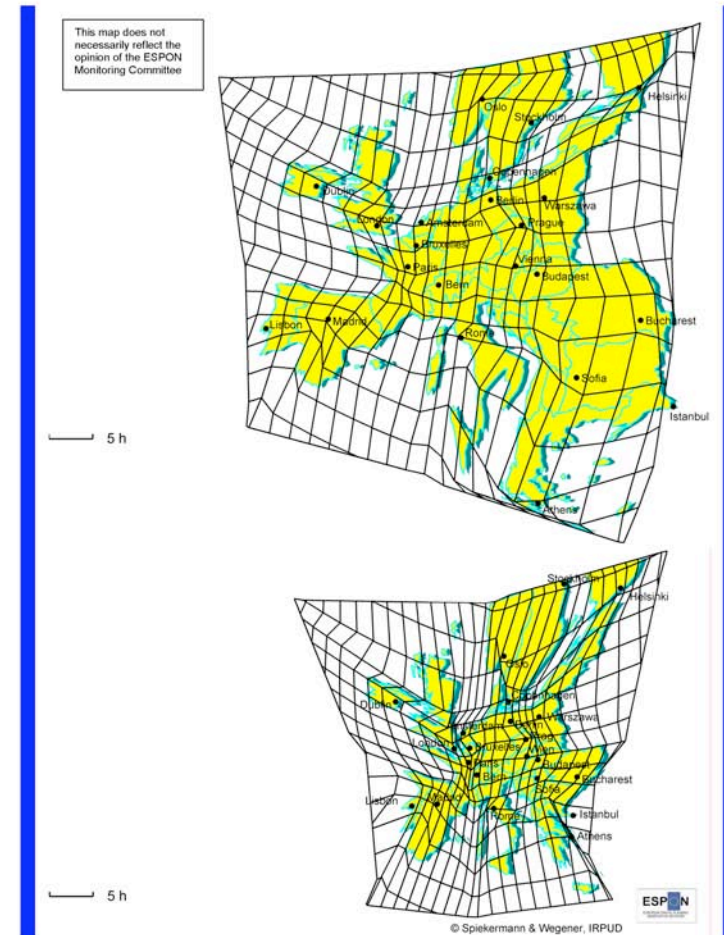


## **4 processus guidant les configurations territoriales**



# 4 processes leading territorial organizations

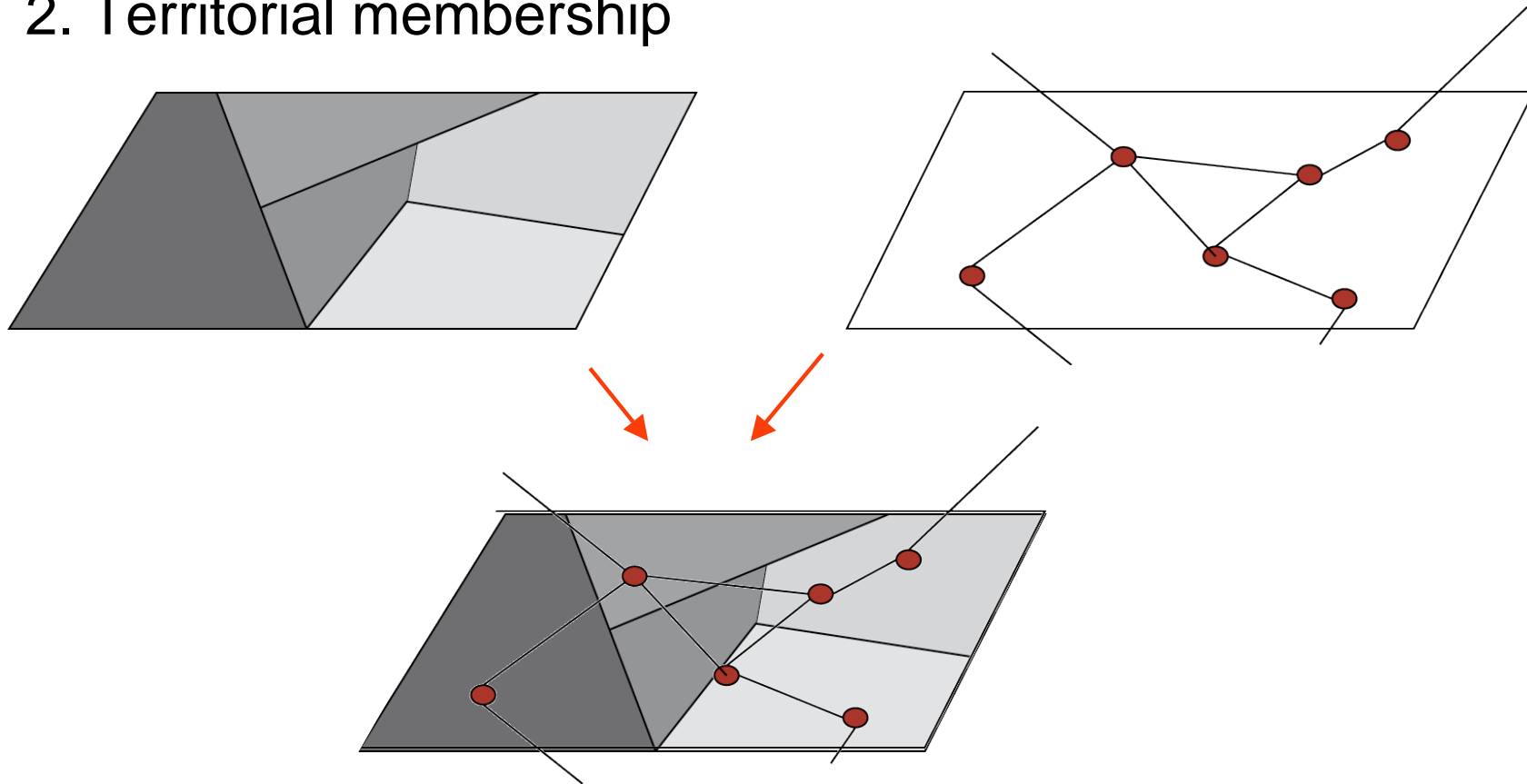
## 1. Spatial relational increasing



## 4 processes leading territorial organizations

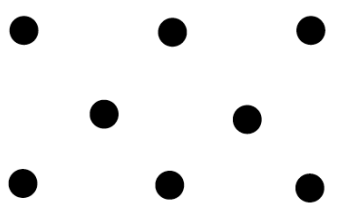
1. Spatial relational increasing

2. Territorial membership



## 4 processes leading territorial organizations

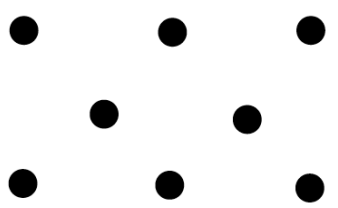
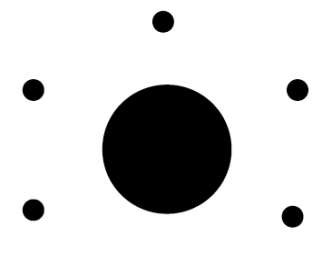
1. Spatial relational increasing
2. Territorial membership
3. Hierarchical reinforcement

		COUTS DE TRANSPORTS	
		ELEVES	FAIBLES
ECONOMIES D'ECHELLES	FAIBLES	<p>Structure spatiale dispersée</p> 	
	ELEVES		



## 4 processes leading territorial organizations

1. Spatial relational increasing
2. Territorial membership
3. Hierarchical reinforcement

		COUTS DE TRANSPORTS	
		ELEVES	FAIBLES
ECONOMIES D'ECHELLES	FAIBLES	Structure spatiale dispersée 	
	ELEVES		Structure spatiale polarisée 

## **4 processes leading territorial organizations**

1. Spatial relational increasing
2. Territorial membership
3. Hierarchical reinforcement
4. Diffusion through relays

## **4 processes leading territorial organizations**

1. Spatial relational increasing
2. Territorial membership
3. Hierarchical reinforcement
4. Diffusion through relays

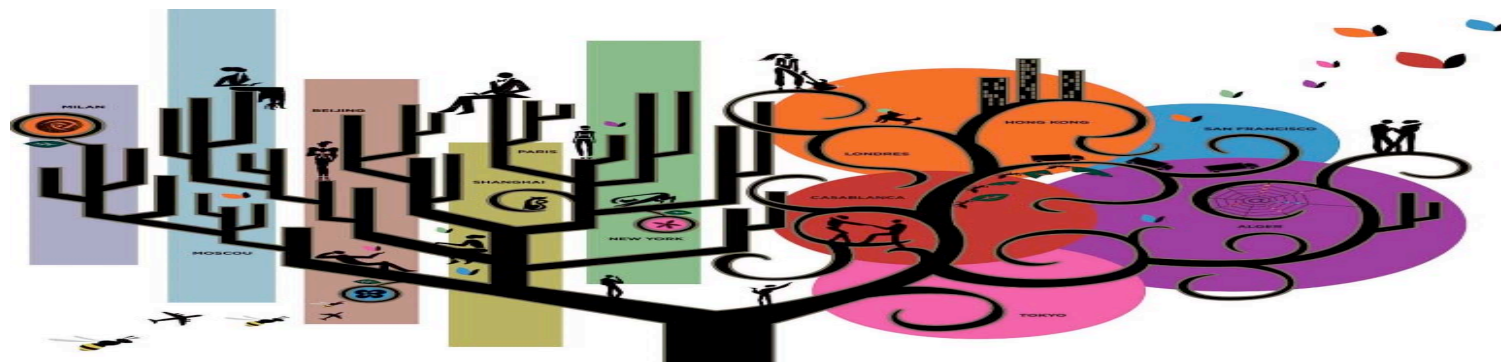
### **2 exemples:**

- Multinational Firms
- Air flows passengers



# Les réseaux d'entreprises multinationales et l'attractivité des villes d'Europe centrale

## Networks of Multinational Firms and Central European cities attractiveness



Pr. Céline Rozenblat  
University of Lausanne

Charles Bohan , CEFRES, Prague  
Bérengère Gautier , IAMM, Montpellier  
Gwenaëlle BENET, Univ. Dijon

•**SPANGEO Project** (**SP**Atial **N**etworks in **GEO**graphy)  
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<http://s4.parisgeo.cnrs.fr/spangeo>

# Two surveys on foreign subsidiaries of multinational firms



1990 :

300 first european firms

100 international networks of  
Multinational Firms

3 000 Foreign subsidiaries in  
occidental Europe

1996 :

300 first european firms

100 international networks of  
Multinational Firms

4 000 Foreign subsidiaries in  
occidental and central Europe



## Informations:

Financial links

Functions

Locations

Activities

# A New Survey

2006 - 2007 :

4 000 First World Enterprises  
(Turnover)

(=> 1 500 groupes)

Source: Bureau Van Dijk  
(Bruxelles)

500 000 subsidiaries



## Informations:

Financial links  
Functions  
Locations  
Activities

•SPANGEO Project

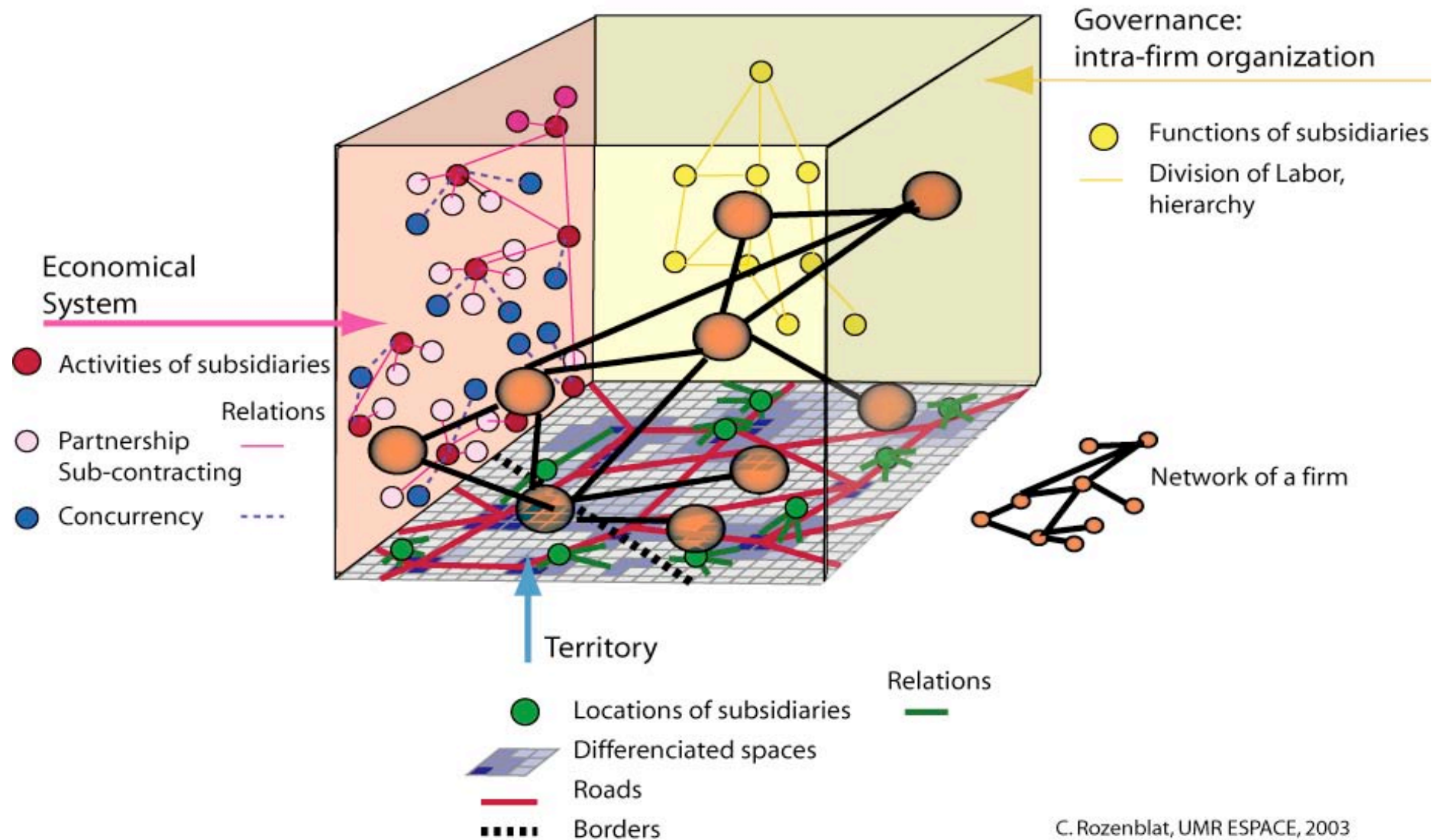
**TULIP Software**

[www.tulip-software.org](http://www.tulip-software.org)

David Auber (Bordeaux, FR)



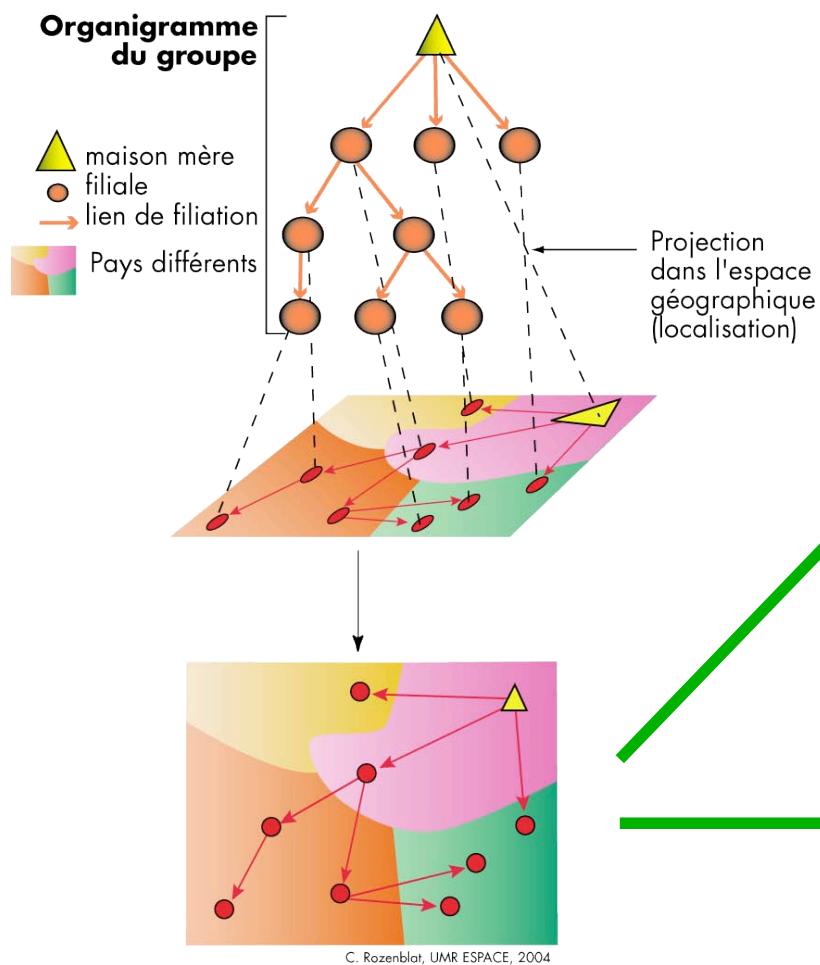
## Three Dimensions in Firms networks (Global value Chain)



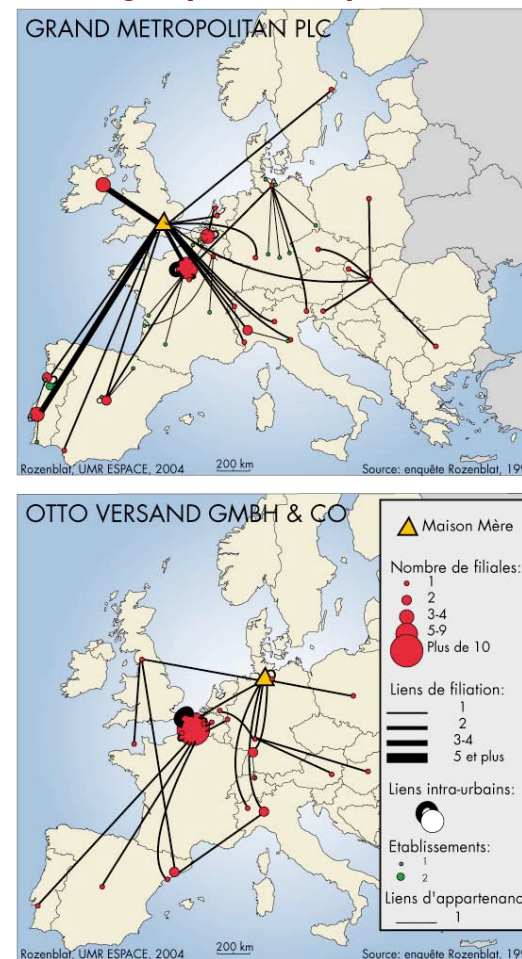
C. Rozenblat, UMR ESPACE, 2003

# Networks of foreign subsidiaries of multinational firms in Europe

## Projection spatiale des organigrammes des groupes d'entreprises



## Exemples des réseaux étrangers de deux groupes d'entreprises en 1996



# Hypothesis on foreign networks of multinational firms

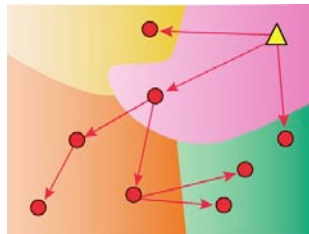
## Coopération degree between enterprises of a group

Integration in the cities



Intégration in the group

**Gawc  
Hypothesis**

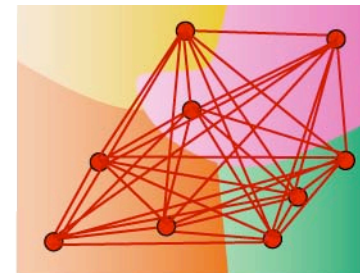


I. Locations



- ▲ Siège social du groupe
- Filiale étrangère

II. Hypothesis max. interactions



- Siège du groupe et des entreprises formant le groupe
- Appartenance au même groupe

## Centralization degree of décisions

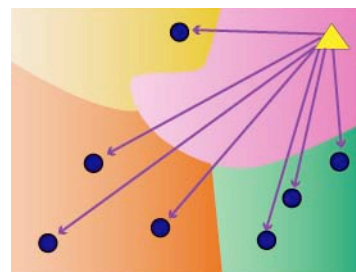
Centralized power



Decentralized power

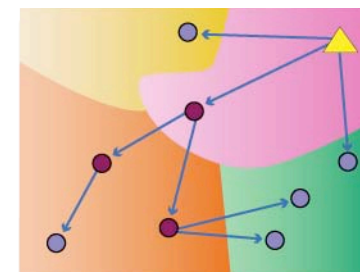


III. Centralized power



- ▲ Siège social du groupe
- Filiale étrangère
- Lien de filiation avec le siège du groupe

IV. Decentralized Power



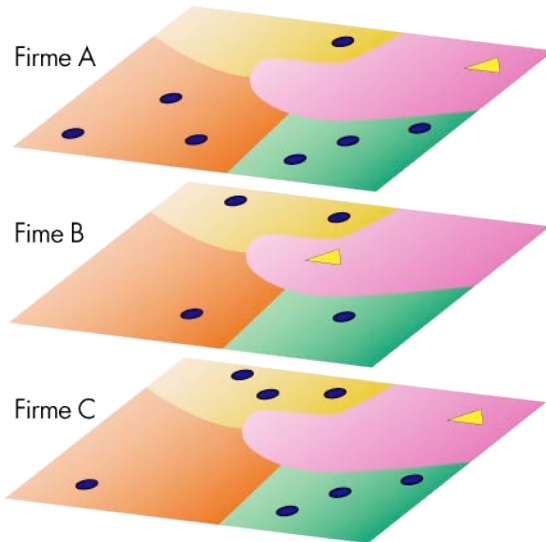
- ▲ Siège social du groupe
- Filiale étrangère ou liée avec l'étranger
- Filiale intermédiaire
- Lien de filiation hiérarchisé avec les sièges intermédiaires



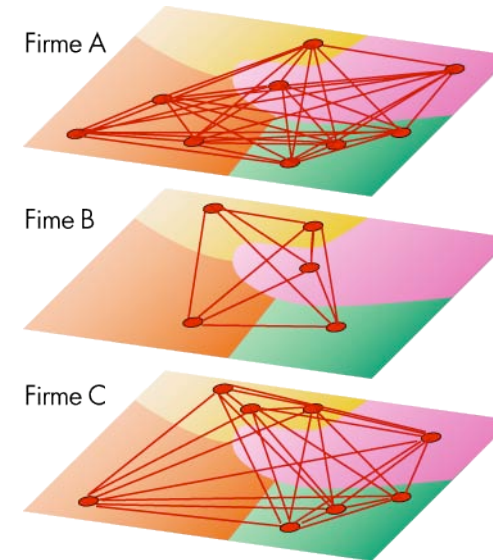


# Sum of plants and networks

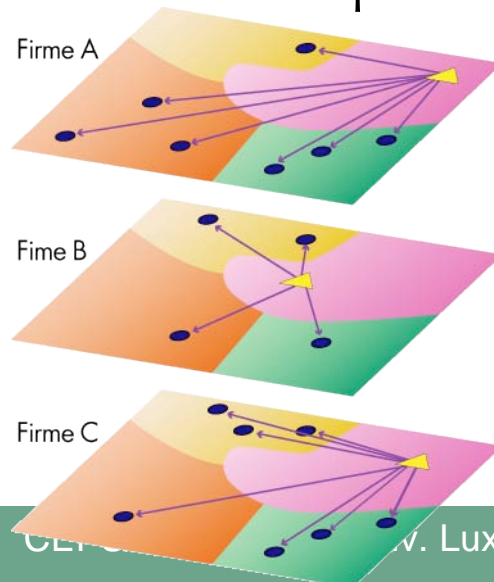
## I. Locations



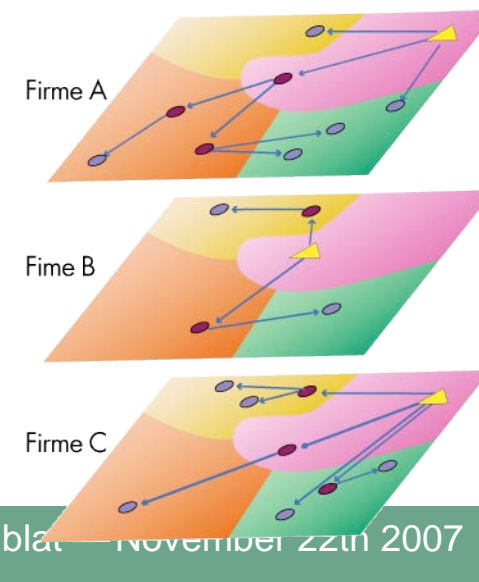
## II. Hypothesis max. interactions



## III. Centralized power

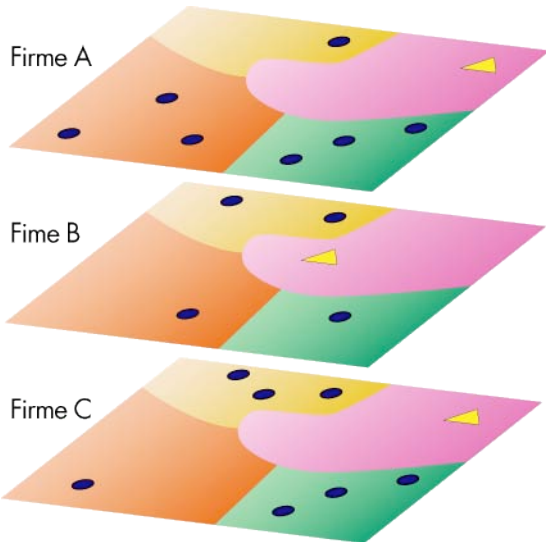


## IV. Decentralized Power

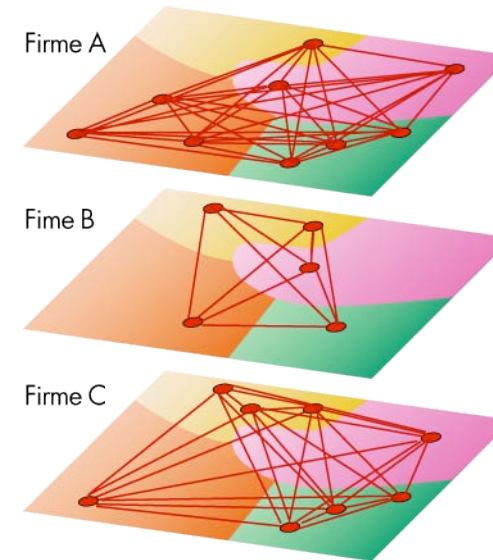


# Sum of plants and networks

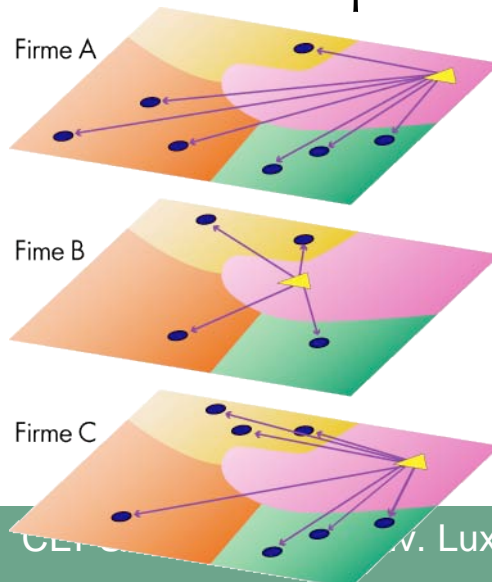
## I. Locations



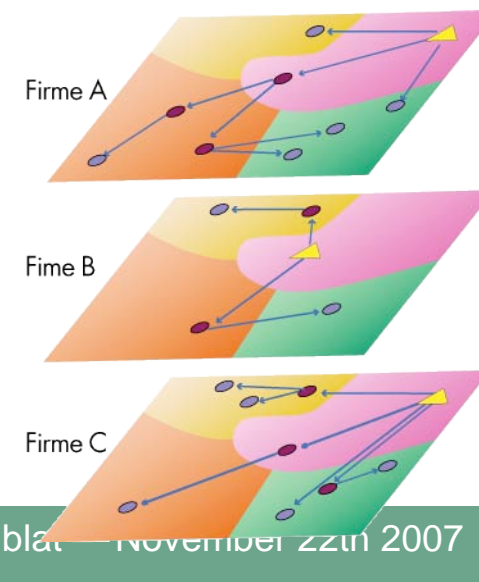
## II. Hypothesis max. interactions



## III. Centralized power



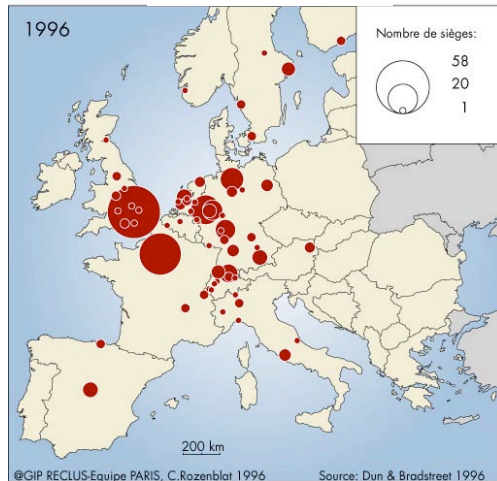
## IV. Decentralized Power



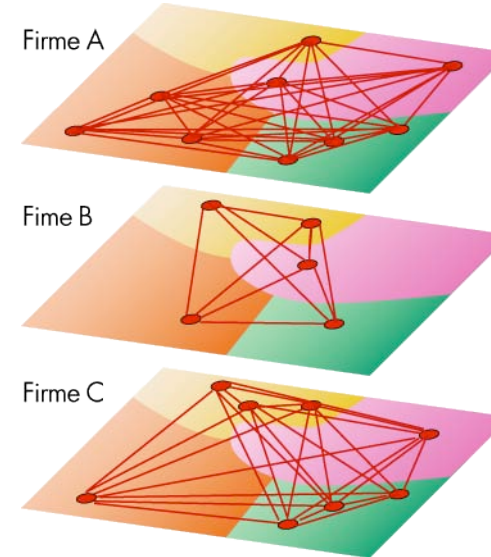
# Cities positions into firm networks

## I. Attractiveness

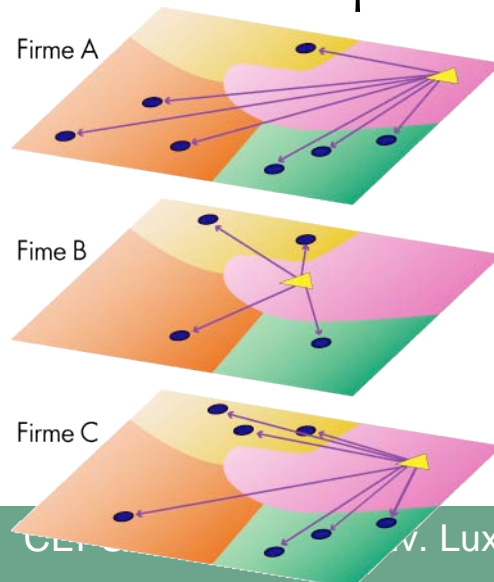
### Headquarters



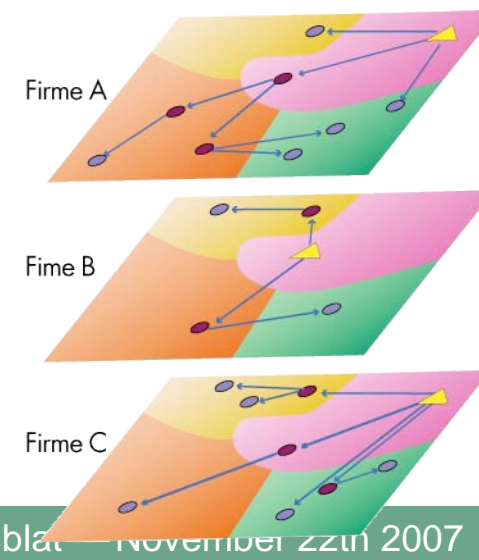
## II. Hypothesis max. interactions



## III. Centralized power



## IV. Decentralized Power

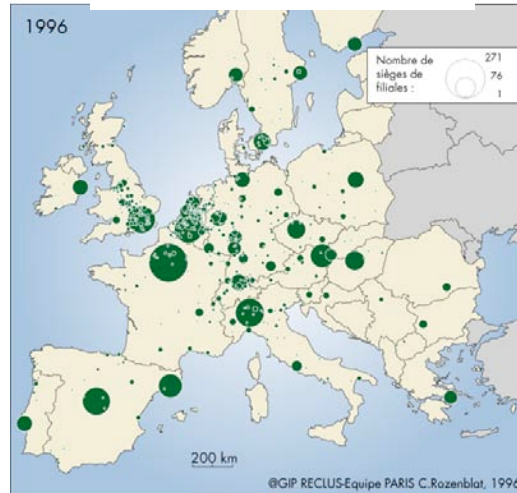




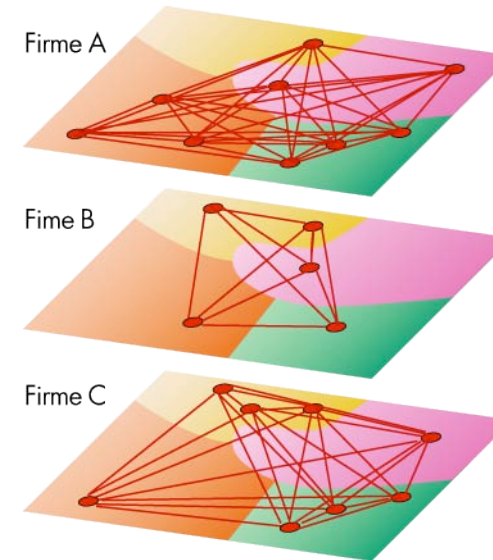
# Cities positions into firm networks

## I. Attractiveness

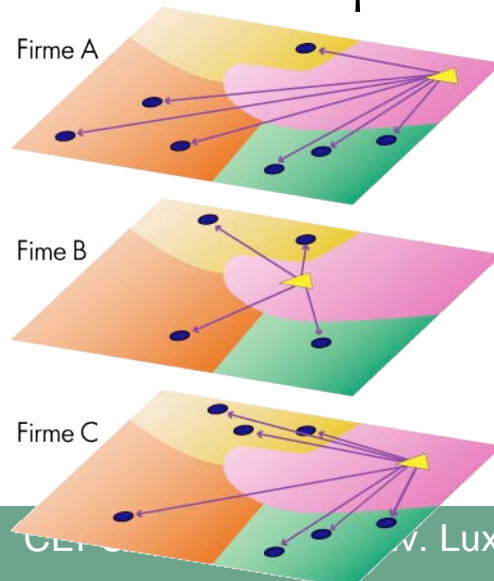
### Foreign Subsidiaries



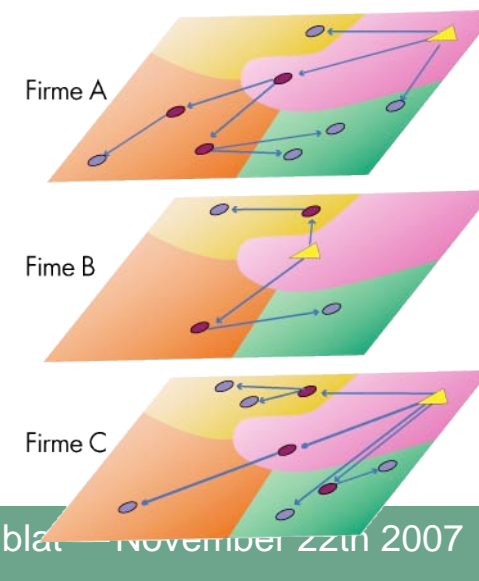
## II. Hypothesis max. interactions



## III. Centralized power



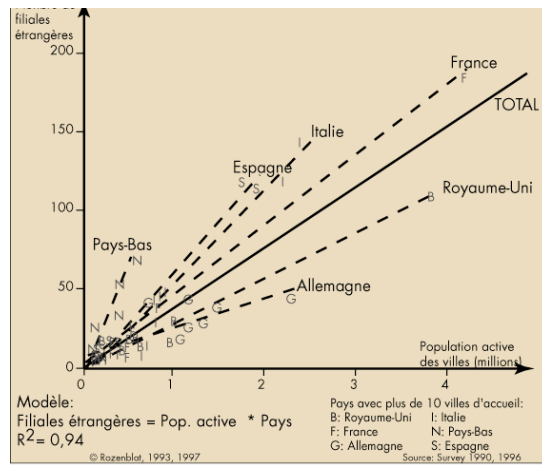
## IV. Decentralized Power



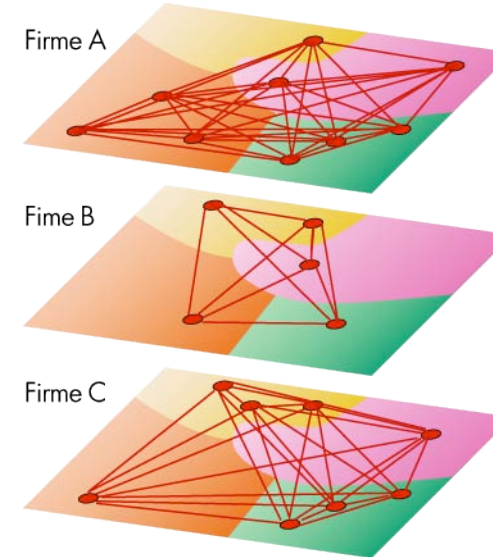
# Cities positions into firm networks

## I. Attractiveness

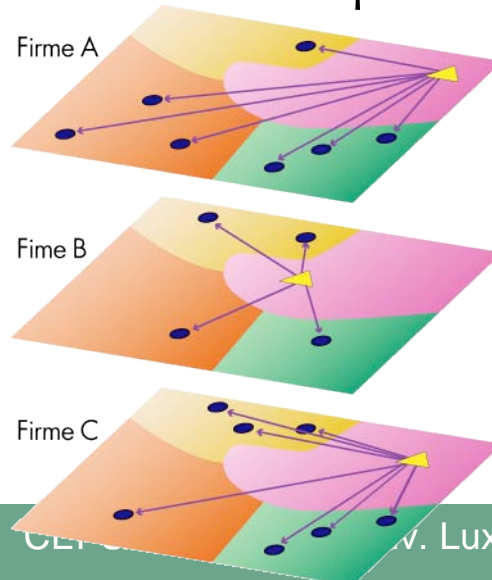
Foreign Subsidiaries according to cities population size by country



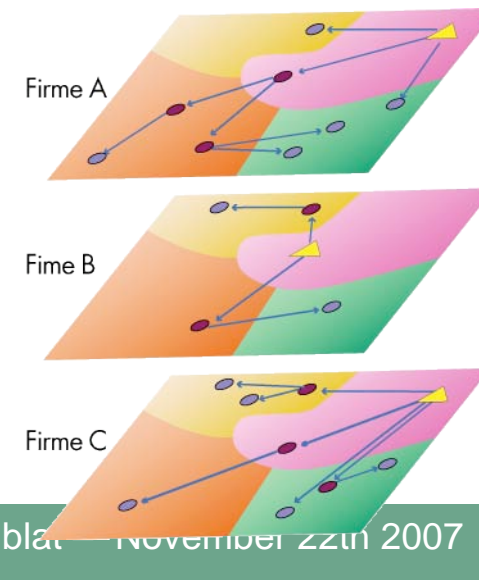
## II. Hypothesis max. interactions



## III. Centralized power



## IV. Decentralized Power

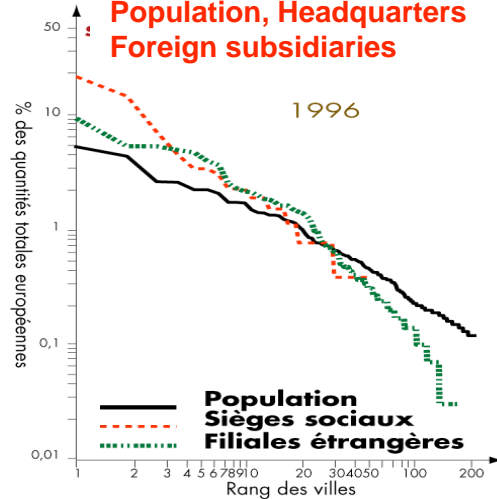




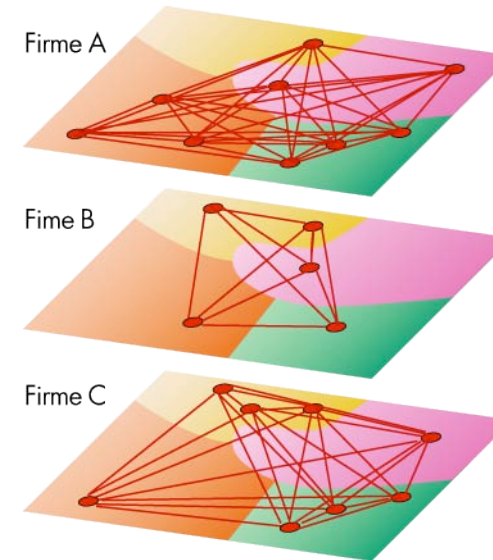
# Cities positions into firm networks

## I. Attractiveness

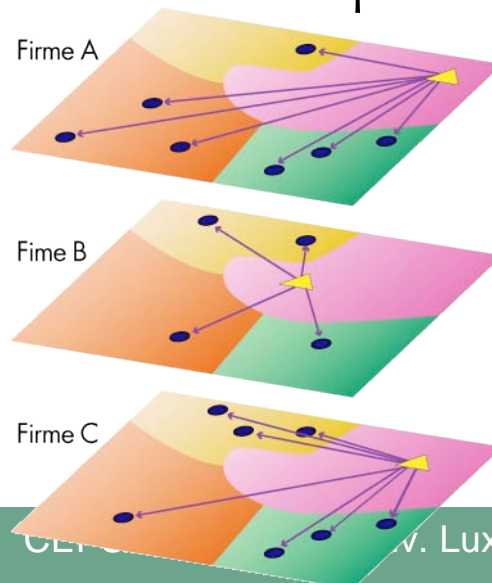
Cities Hierarchy:  
Population, Headquarters  
Foreign subsidiaries



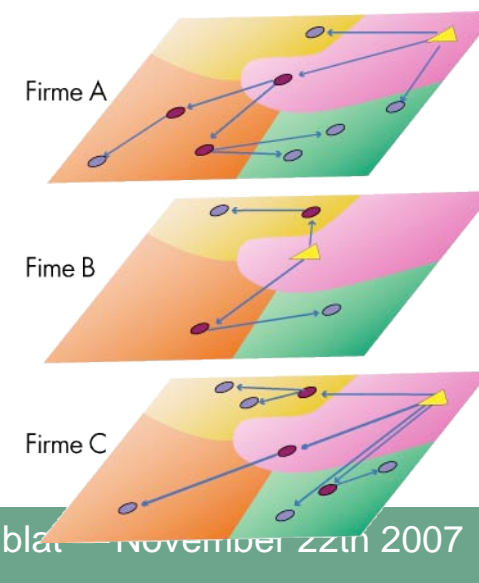
## II. Hypothesis max. interactions



## III. Centralized power

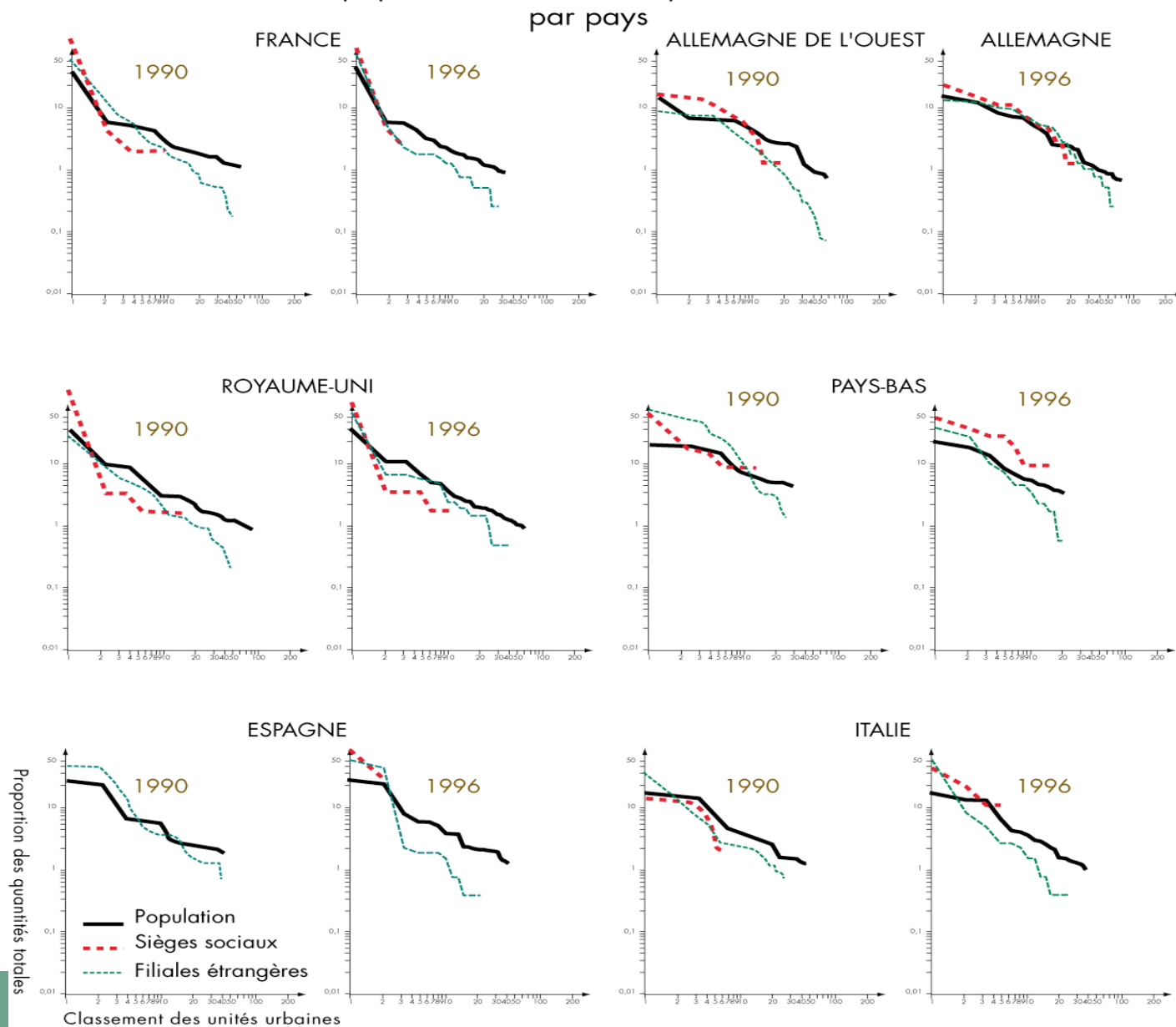


## IV. Decentralized Power



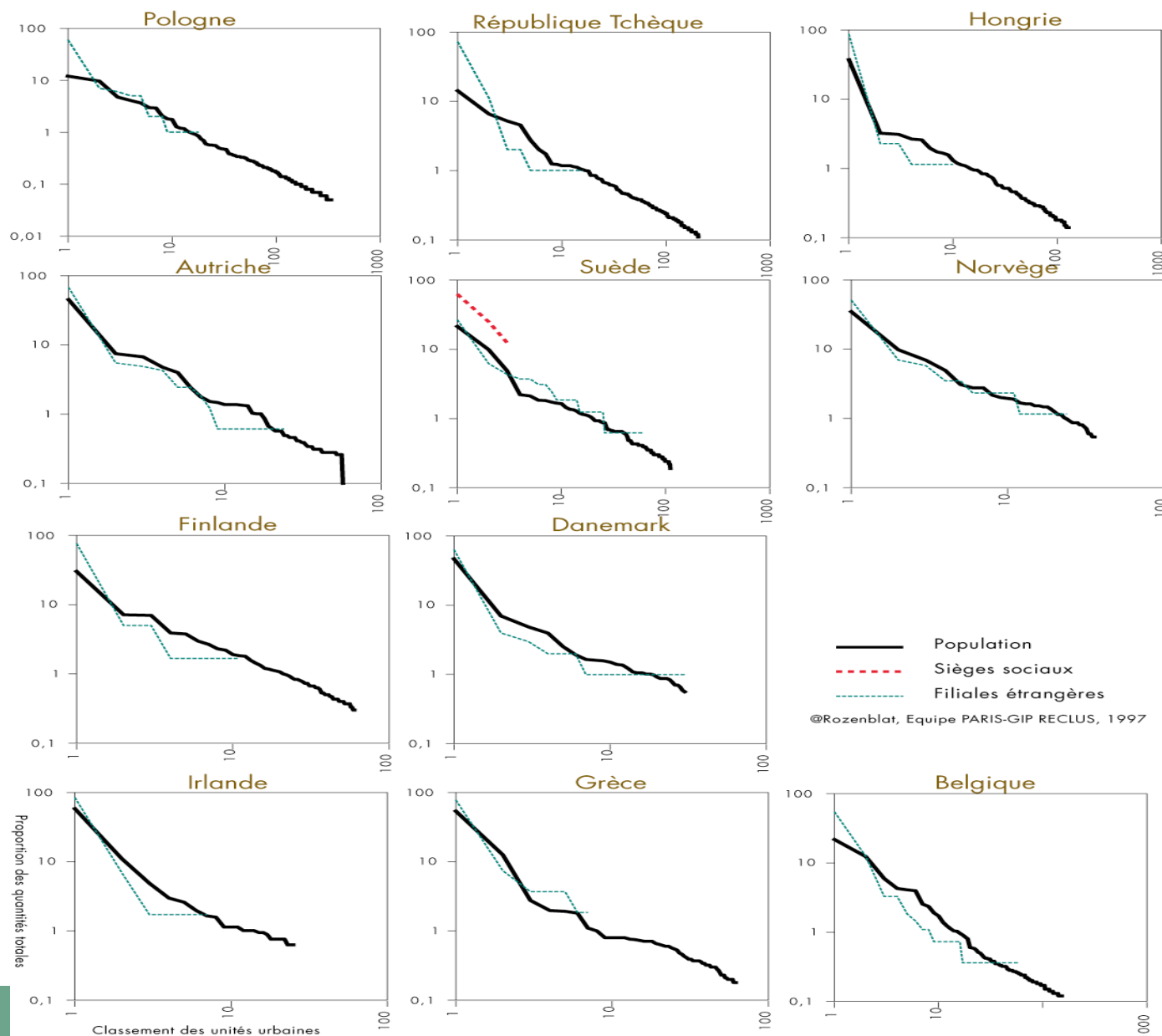
# Metropolization of firm networks

Cities Hierarchy by country:  
Population, Headquarters, Foreign subsidiaries



# Metropolization of firm networks

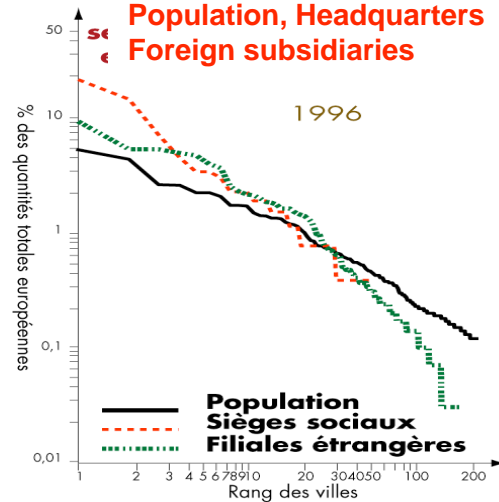
Cities Hierarchy by country:  
Population, Headquarters, Foreign subsidiaries



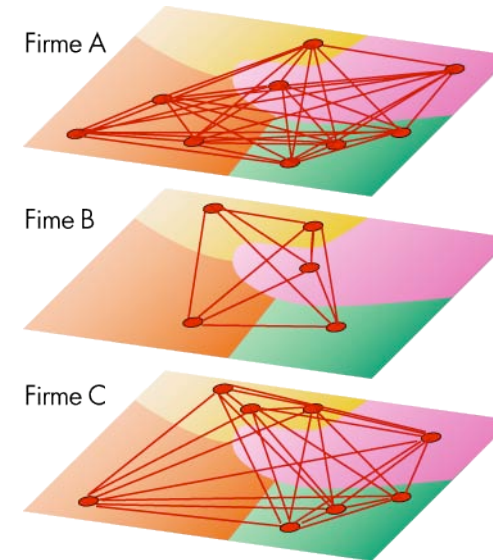
# Cities positions into firm networks

## I. Attractiveness

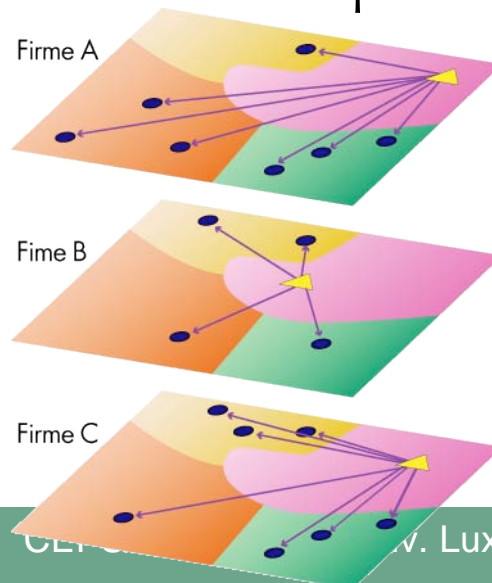
Cities Hierarchy:  
Population, Headquarters  
Foreign subsidiaries



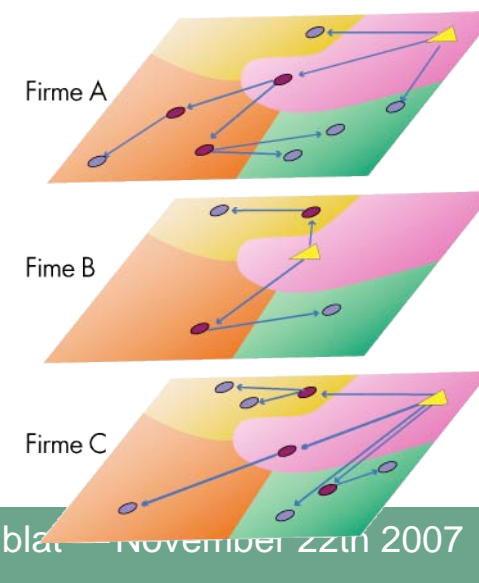
## II. Hypothesis max. interactions



## III. Centralized power



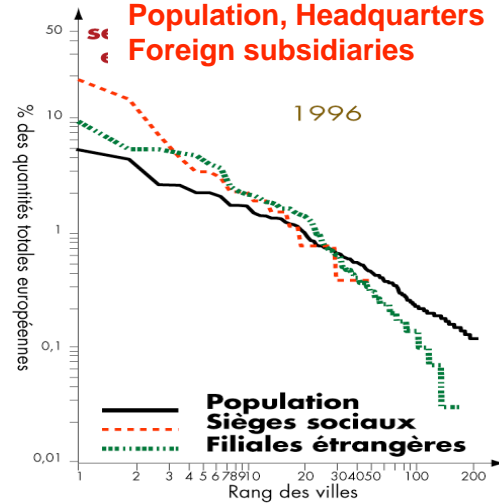
## IV. Decentralized Power



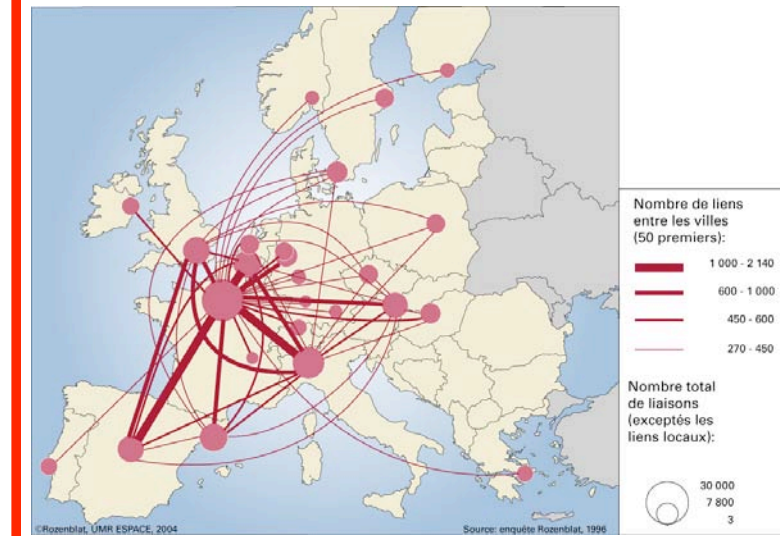
# Cities positions into firm networks

## I. Attractiveness

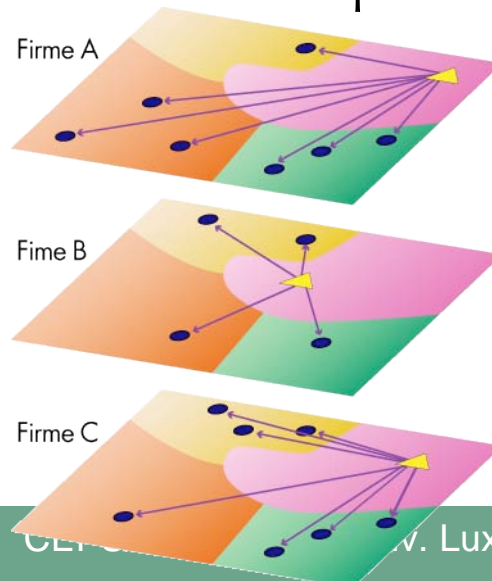
Cities Hierarchy:  
Population, Headquarters  
Foreign subsidiaries



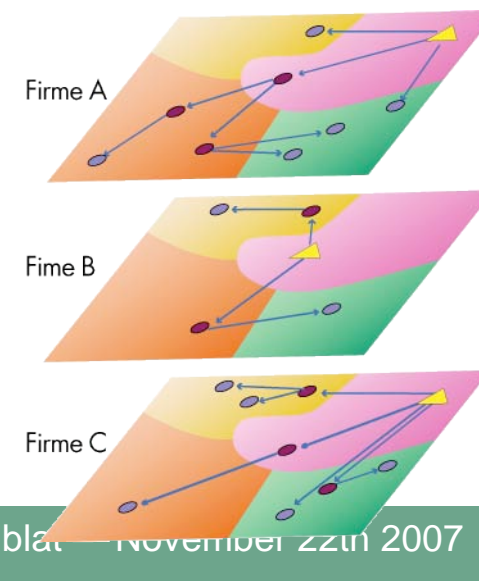
## II. Connexity



## III. Centralized power



## IV. Decentralized Power

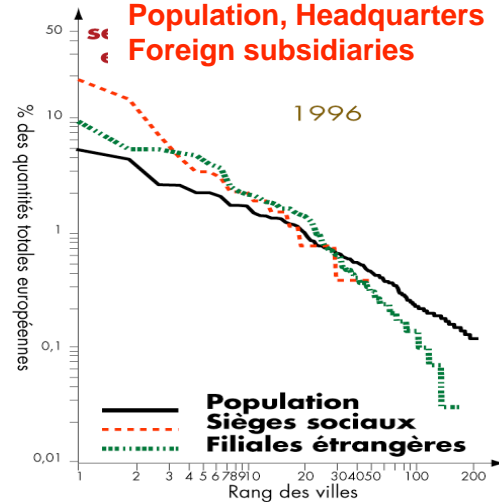




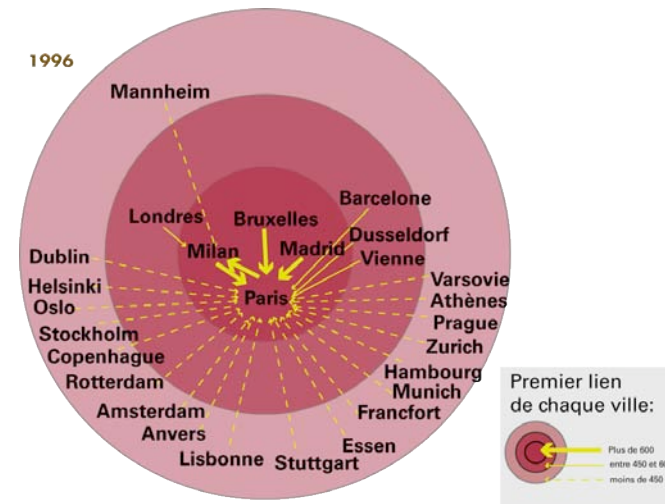
# Cities positions into firm networks

## I. Attractiveness

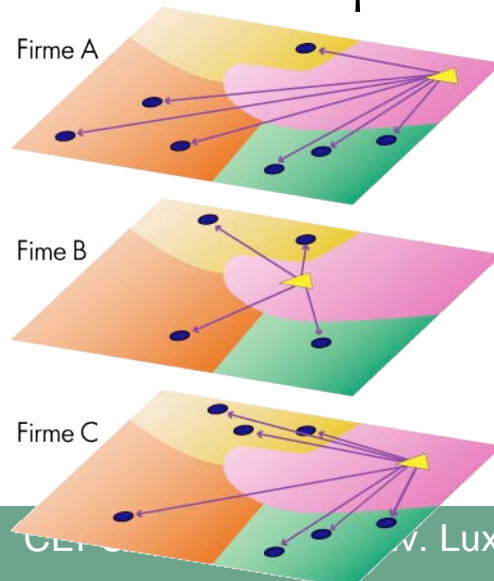
Cities Hierarchy:  
Population, Headquarters  
Foreign subsidiaries



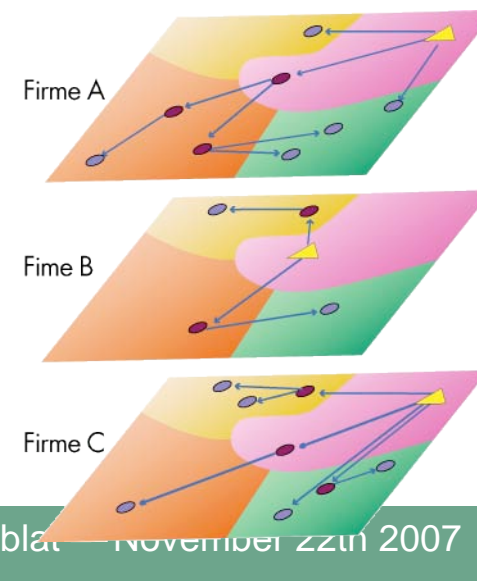
## II. Polarisation



## III. Centralized power



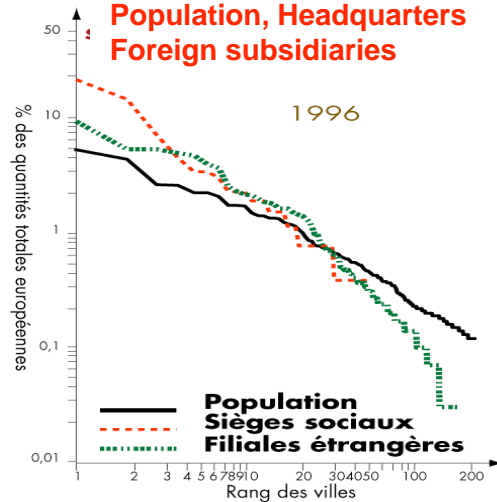
## IV. Decentralized Power



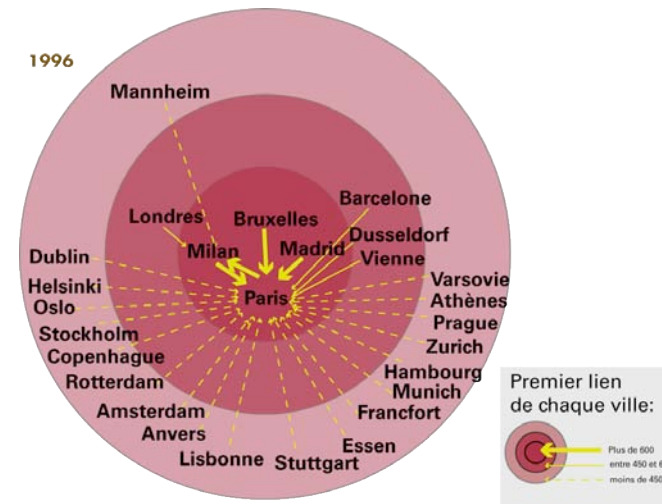
# Cities positions into firm networks

## I. Attractiveness

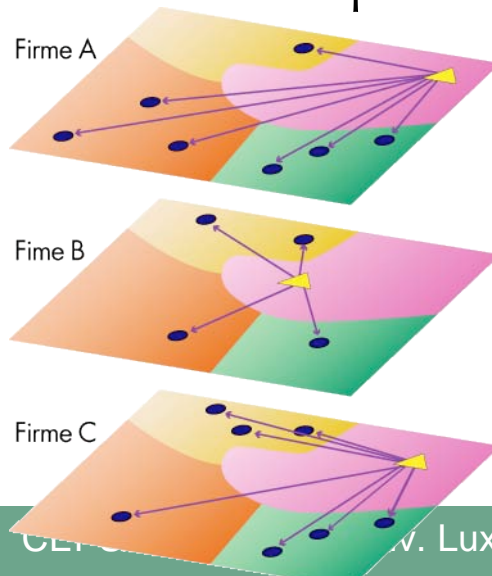
Cities Hierarchy:  
Population, Headquarters  
Foreign subsidiaries



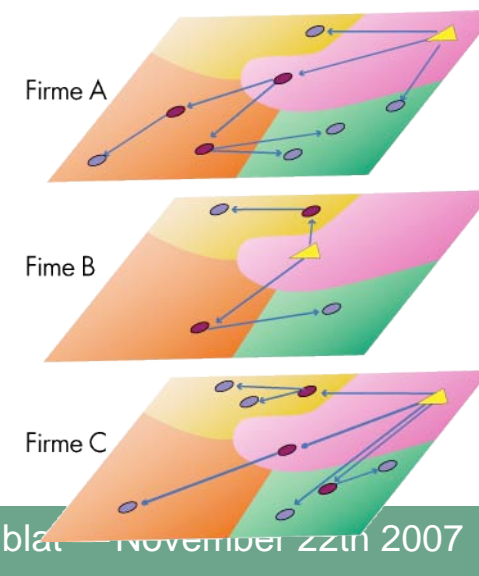
## II. Polarisation



## III. Centralized power



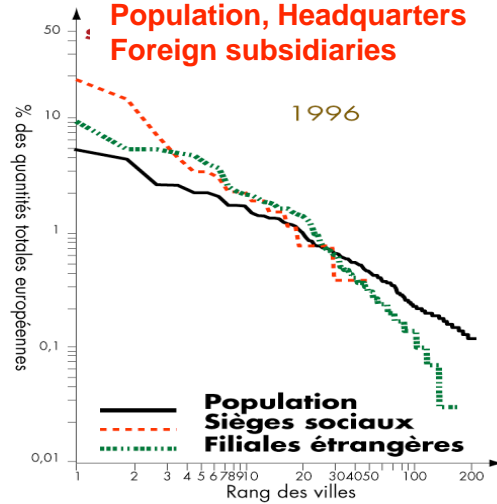
## IV. Decentralized Power



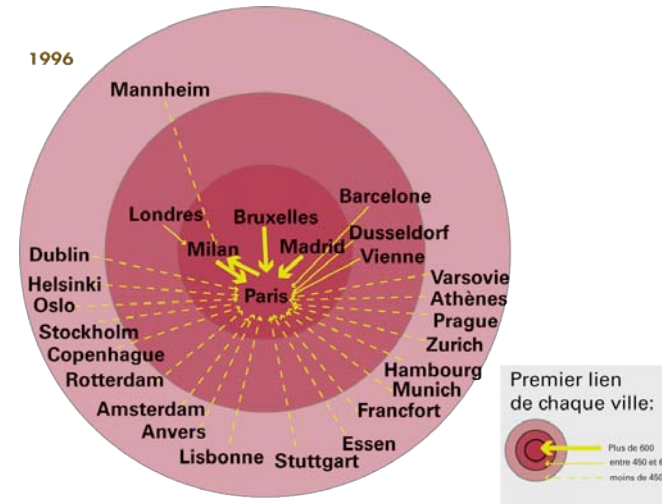
# Cities positions into firm networks

## I. Attractiveness

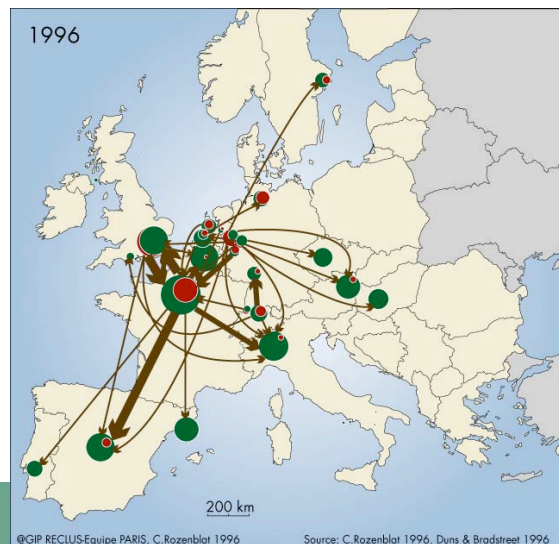
Cities Hierarchy:  
Population, Headquarters  
Foreign subsidiaries



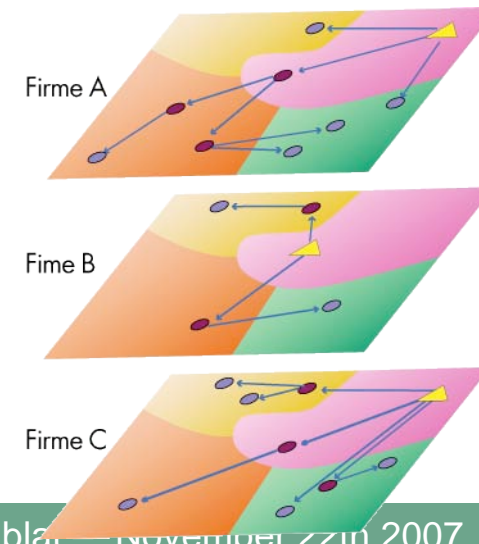
## II. Polarisation



## III. Centrality



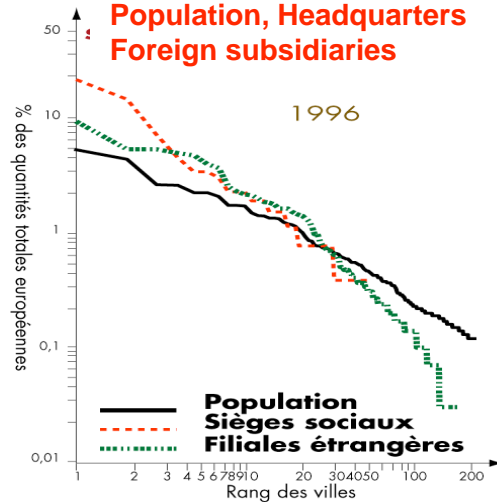
## IV. Decentralized Power



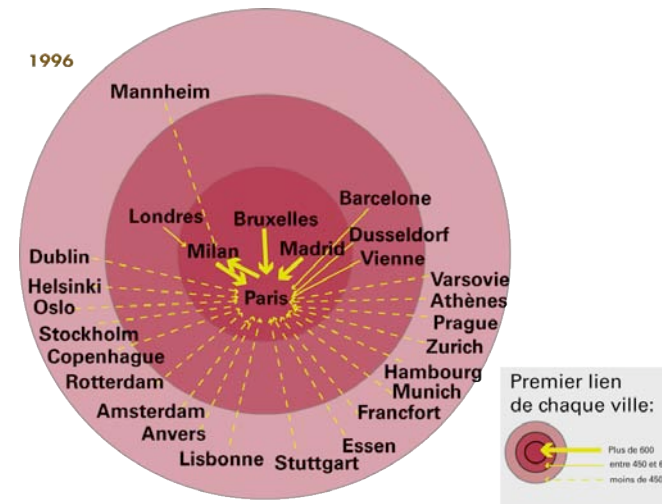
# Cities positions into firm networks

## I. Attractiveness

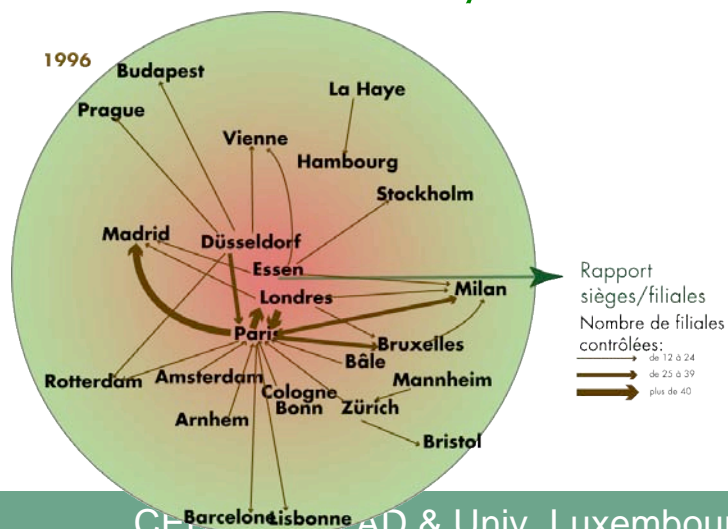
Cities Hierarchy:  
Population, Headquarters  
Foreign subsidiaries



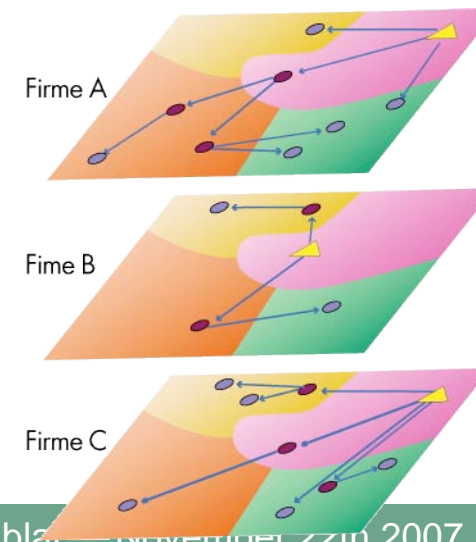
## II. Polarisation



## III. Centrality



## IV. Decentralized Power

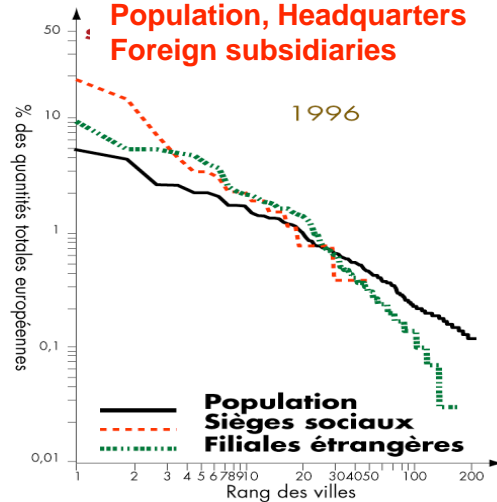




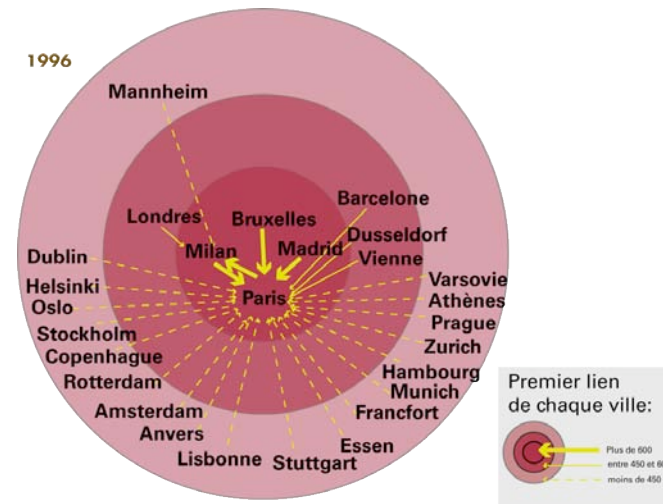
# Cities positions into firm networks

## I. Attractiveness

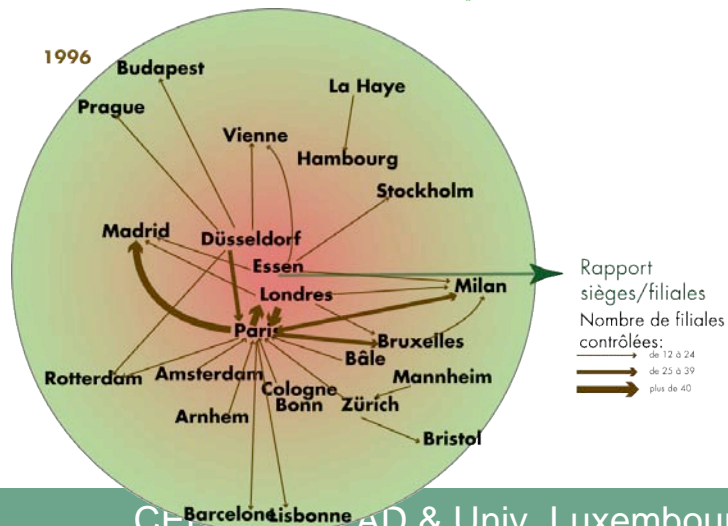
Cities Hierarchy:  
Population, Headquarters  
Foreign subsidiaries



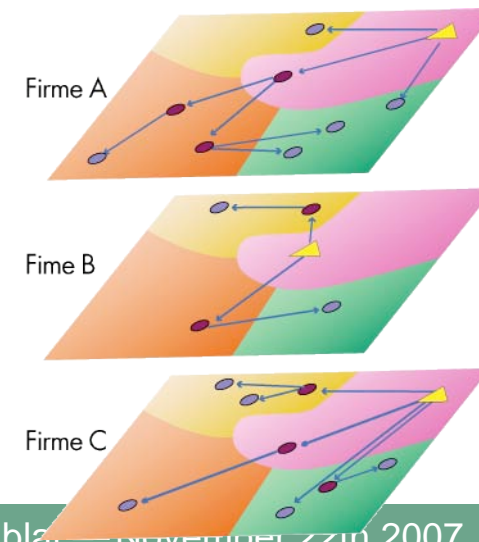
## II. Polarisation



## III. Centrality



## IV. Decentralized Power

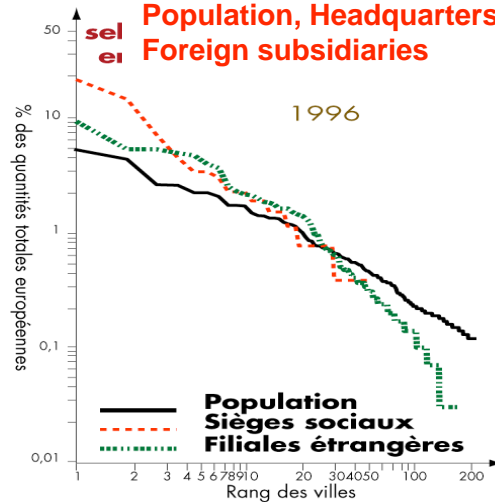




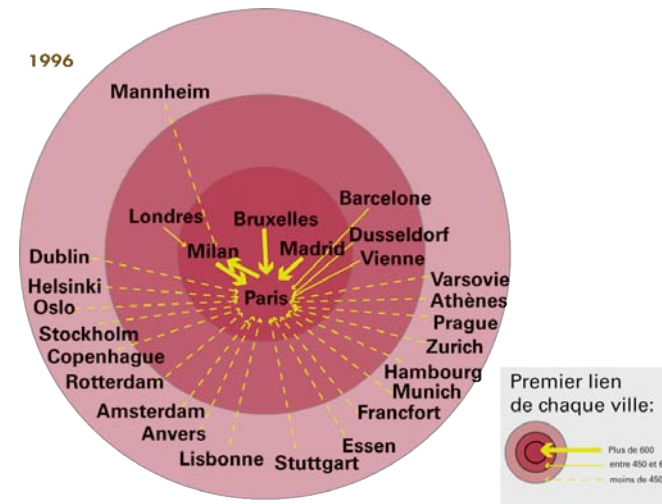
# Cities positions into firm networks

## I. Attractiveness

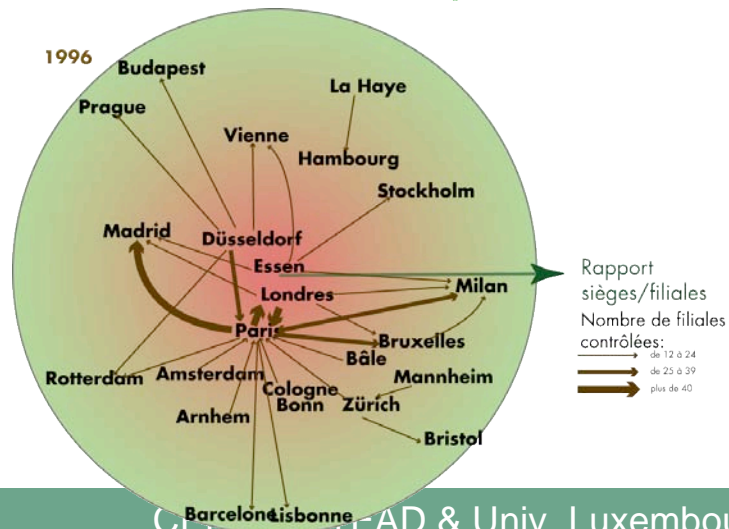
**Cities Hierarchy:**  
Population, Headquarters  
Foreign subsidiaries



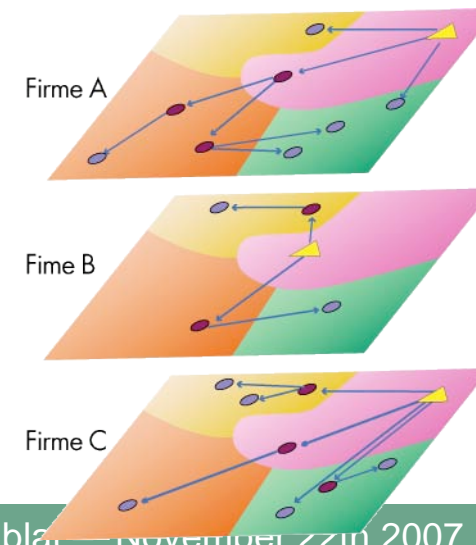
## II. Polarisation



## III. Centrality



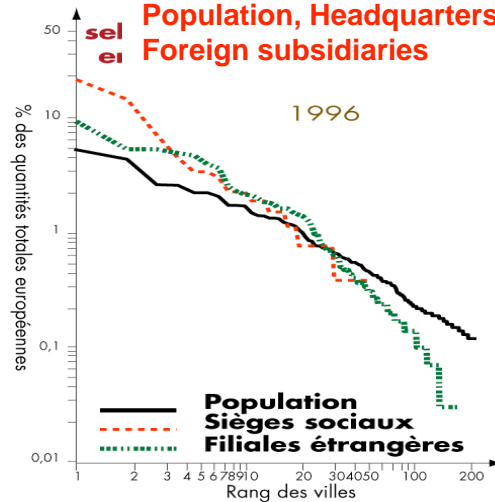
## IV. Decentralized Power



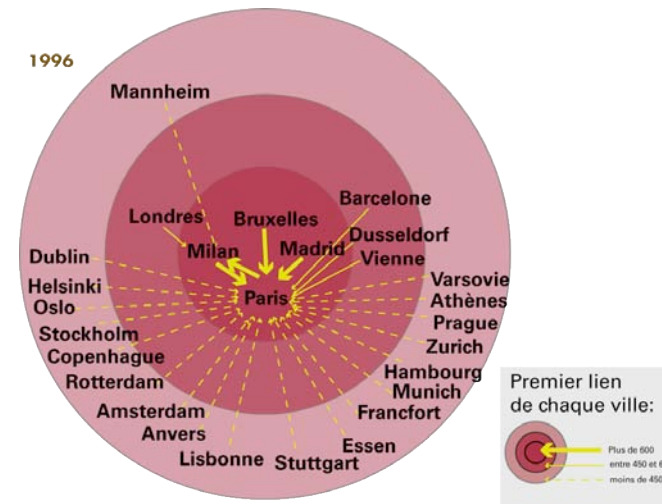
# Cities positions into firm networks

## I. Attractiveness

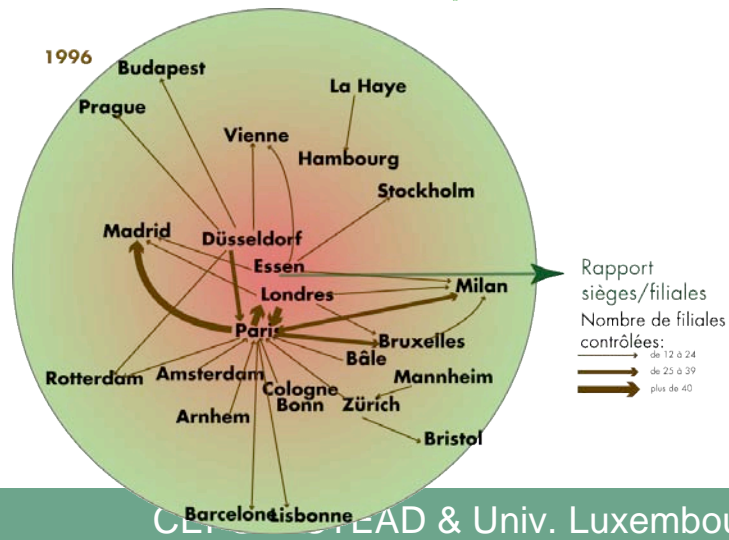
**Cities Hierarchy:**  
Population, Headquarters  
Foreign subsidiaries



## II. Polarisation

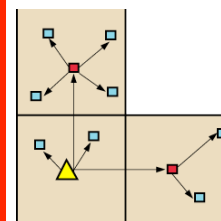


## III. Centrality

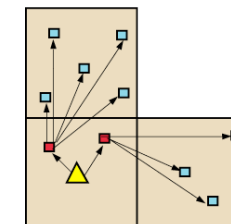


## IV. Cities - relays

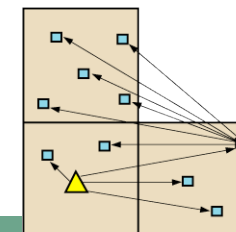
**A: Import**



**B: Export**

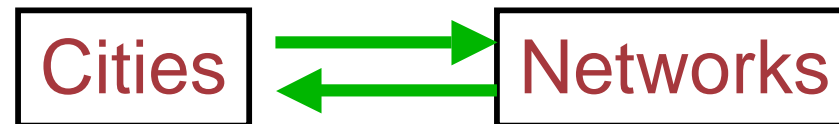


**C: International**

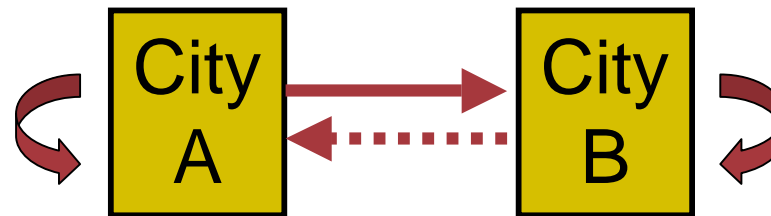


# Urban indicators

## Main Issues



Social interaction in space => spatial interaction

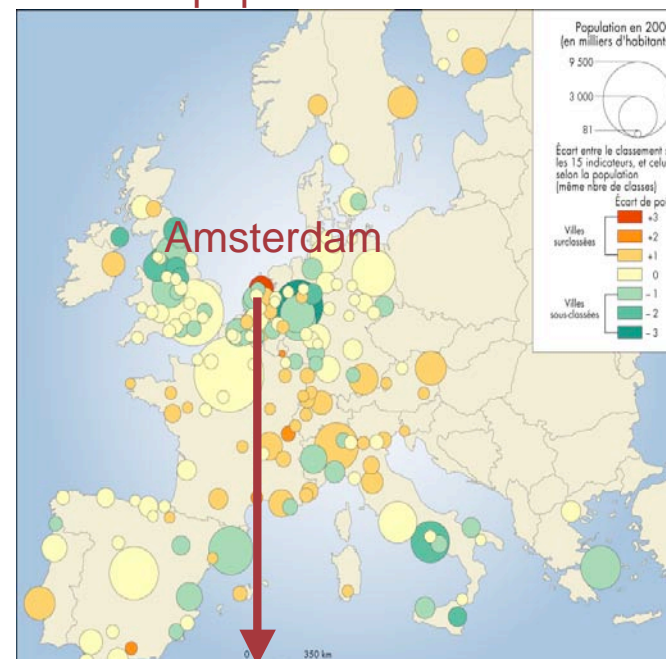
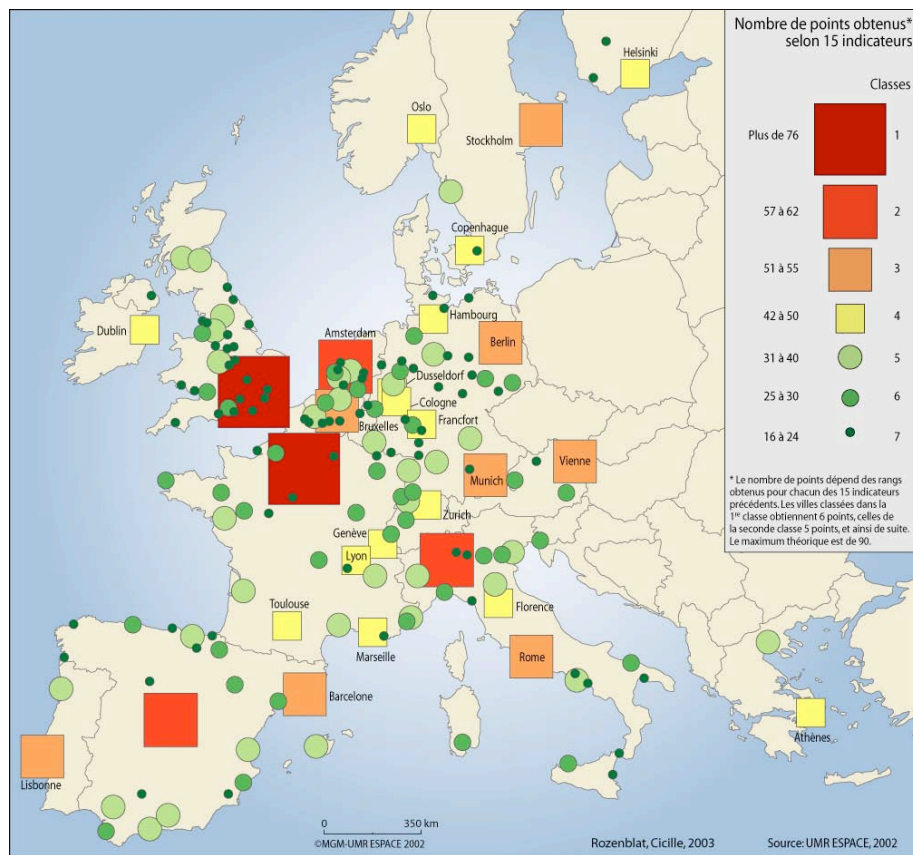


## Asymmetry

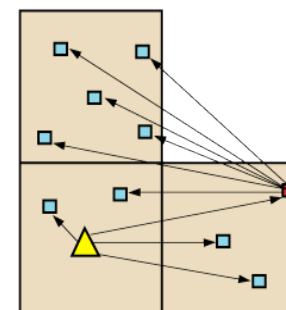
- Inequal ressources
- Different relative position

# International Functions of cities

Difference between International Functions Rank  
and population Size Rank



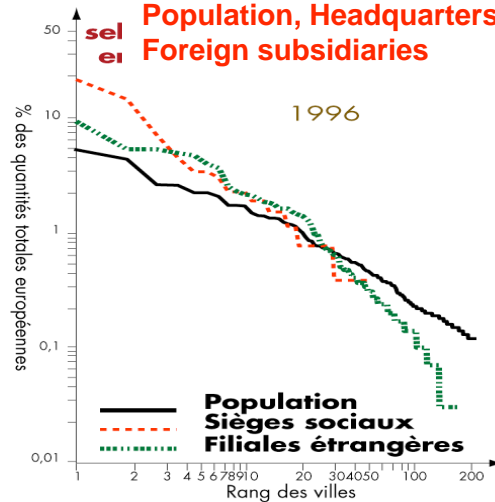
**Amsterdam:**  
European Platform for multinational Firms



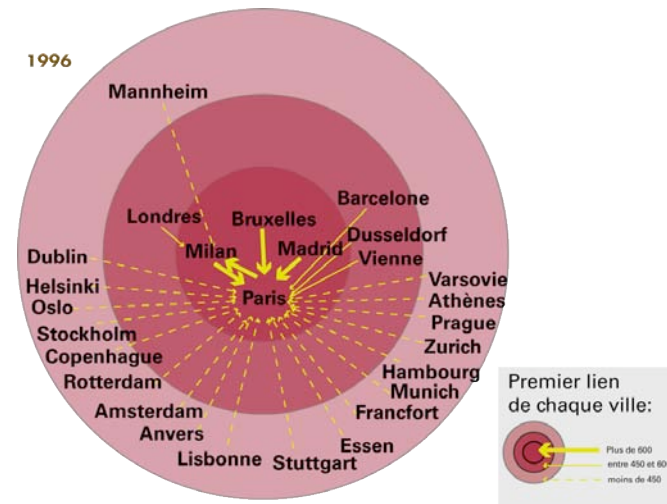
# Agglomeration Economies - Network Economies

## I. Attractiveness

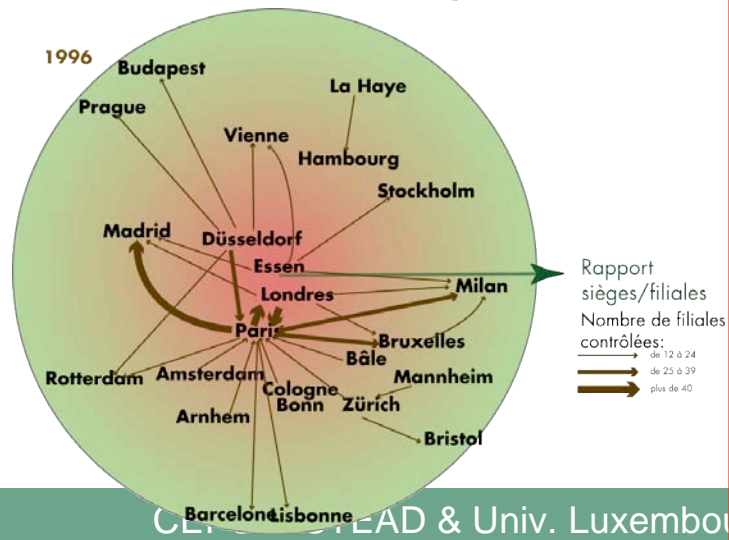
**Cities Hierarchy:**  
Population, Headquarters  
Foreign subsidiaries



## II. Polarisation

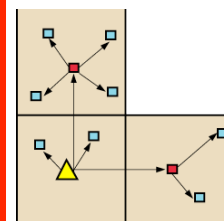


## III. Centrality

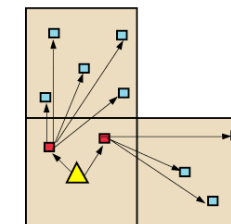


## IV. Cities - relays

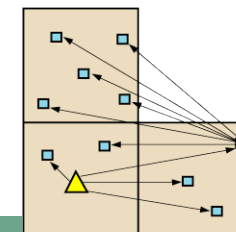
**A: Import**



**B: Export**

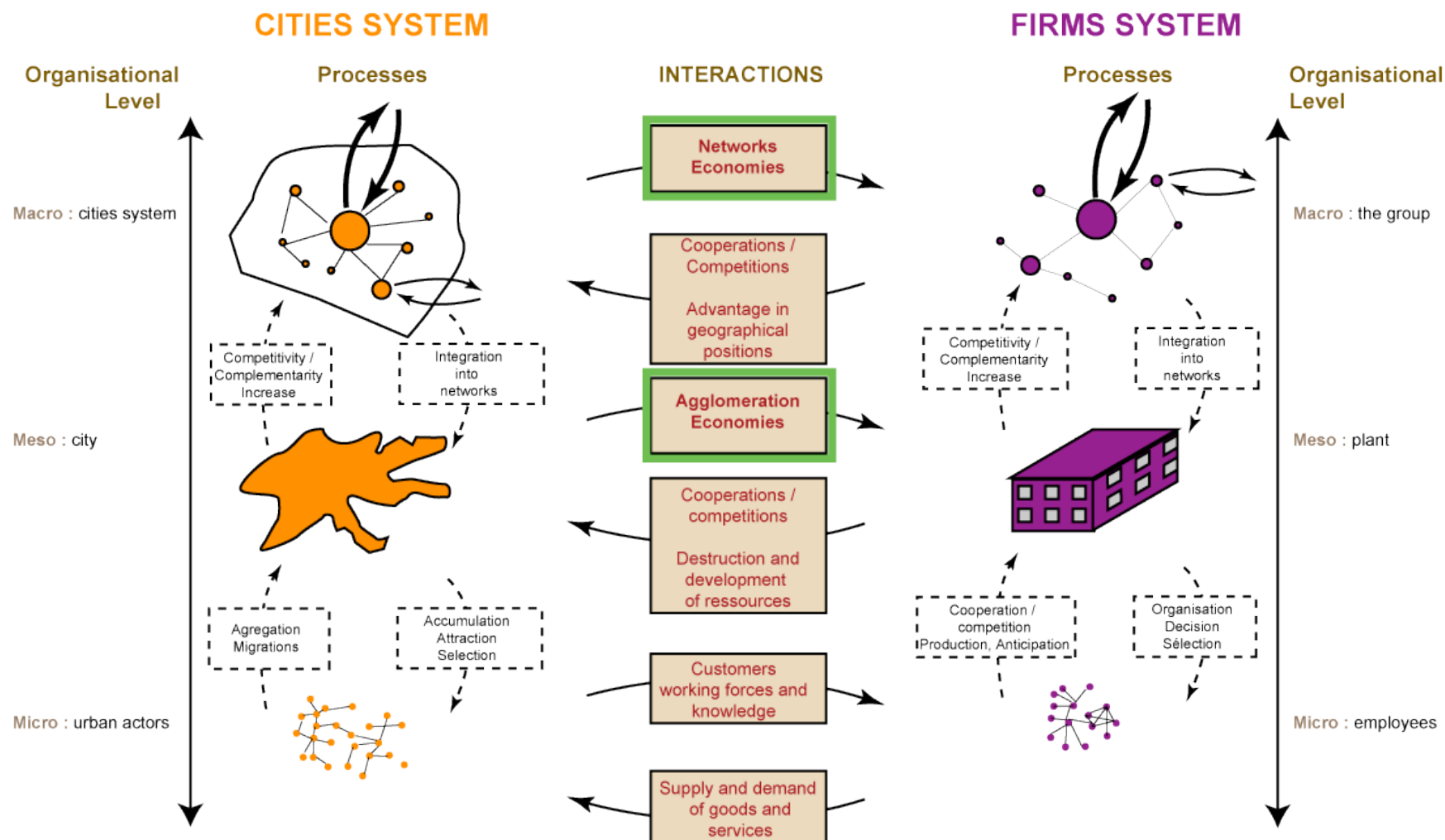


**C: International**





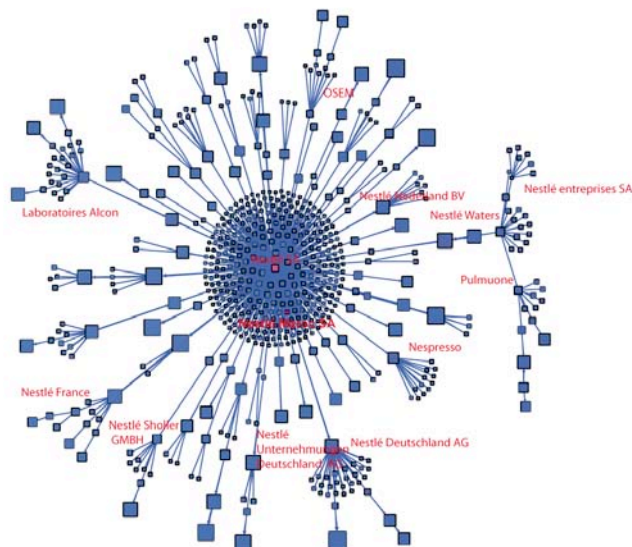
# Agglomerations Economies V/S Networks Economies



# Individual firms networks: financial relationships between units

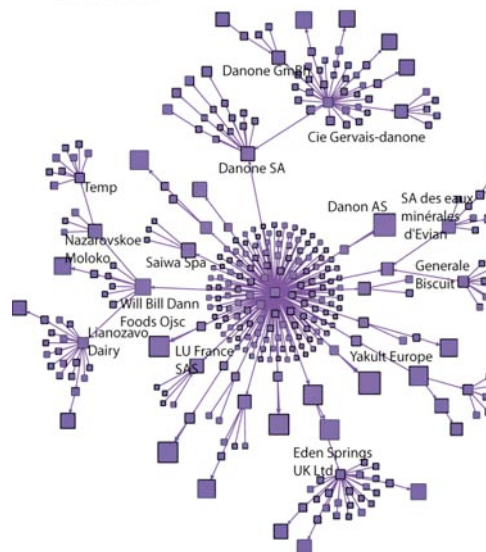
## Nestlé

Réseau de filiation Nestlé  
Sélection Kruskal, métrique Betweenness Centrality

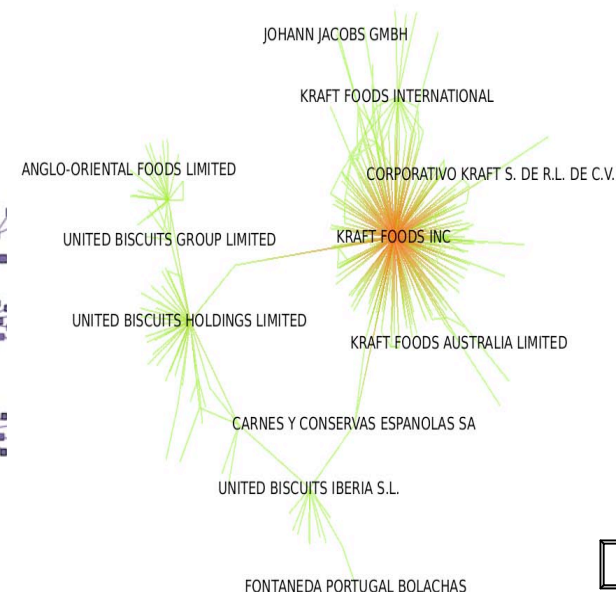


## Danone

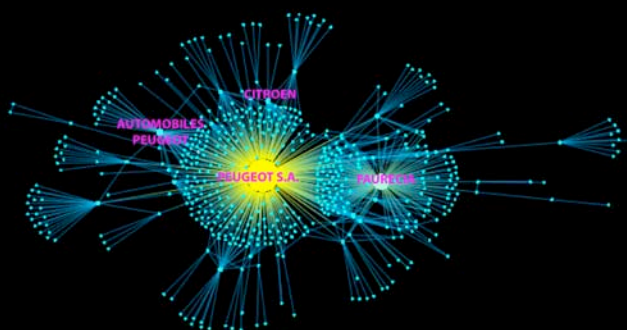
Réseau de filiation Danone  
Sélection Kruskal



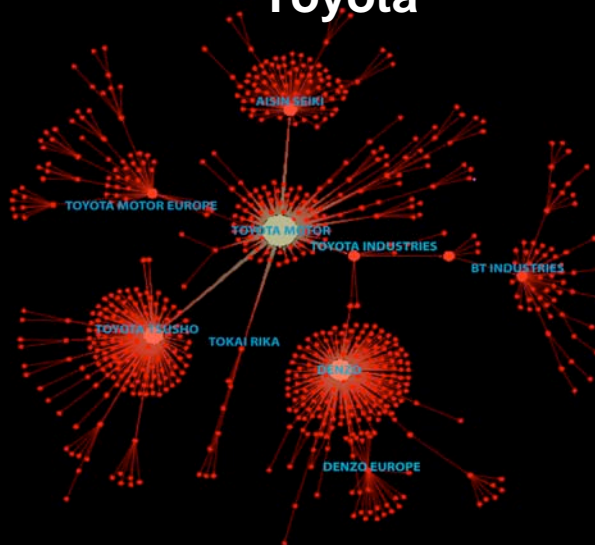
## Kraft food



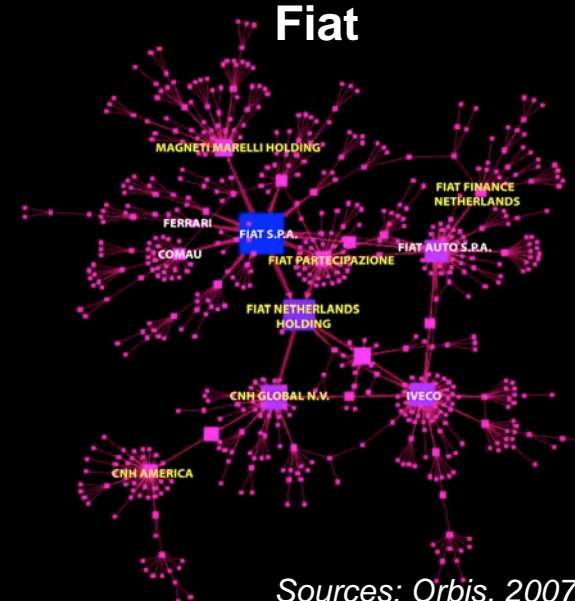
## Peugeot



## Toyota



## Fiat



Sources: Orbis, 2007

# Surrounding Networks

## Subcontracting networks of TPCA Kolin





# Cities Integration into worldwide air transport network (2000-2004)



Pr. Céline Rozenblat  
Dr. Jean-Christophe Loubier



SWITZERLAND

Pr. Mario Polese

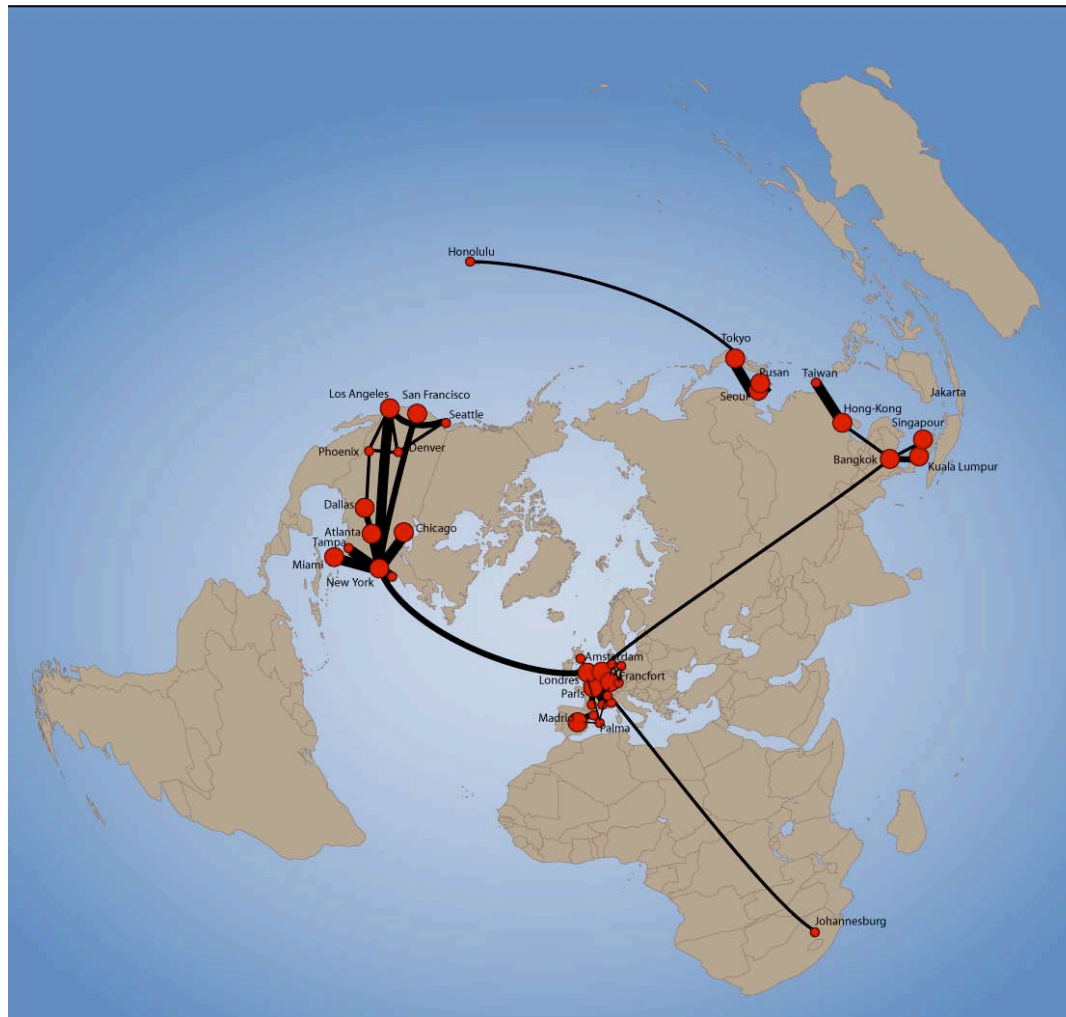


Montréal - CANADA

•**SPANGEO Project (SPAtial Networks in GEOgraphy)**  
Supported by the French National Agency of Research (2005-2008)  
**Coordinated by Celine Rozenblat and Guy Melancon**  
<http://s4.parisgeo.cnrs.fr/spangeo>

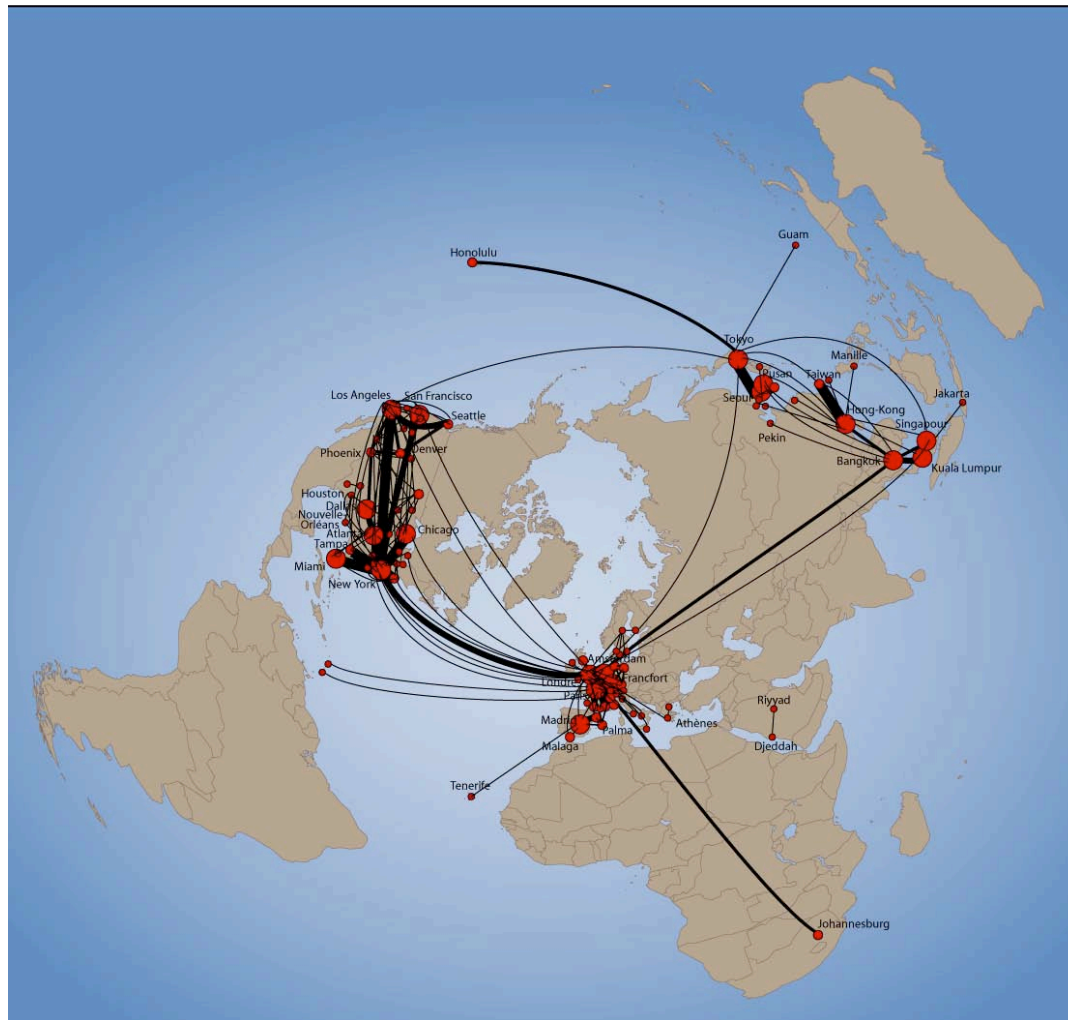


# Worldwide (passenger) air traffic



- More than 2 millions passengers

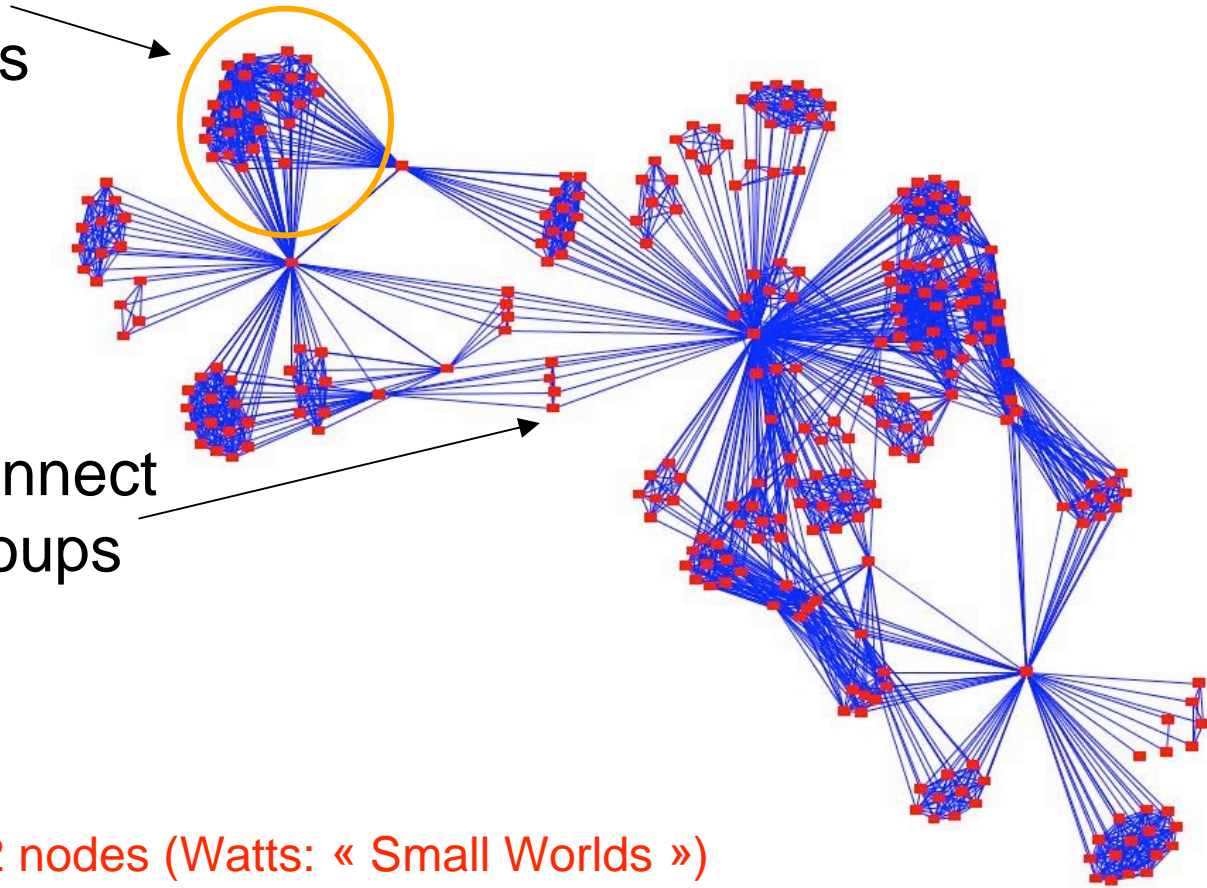
# Worldwide (passenger) air traffic



- More than 1 million passengers

## « Small worlds » of geographical networks

- Dense neighborhoods
- Weak links connect distinct subgroups



### 2 Main properties:

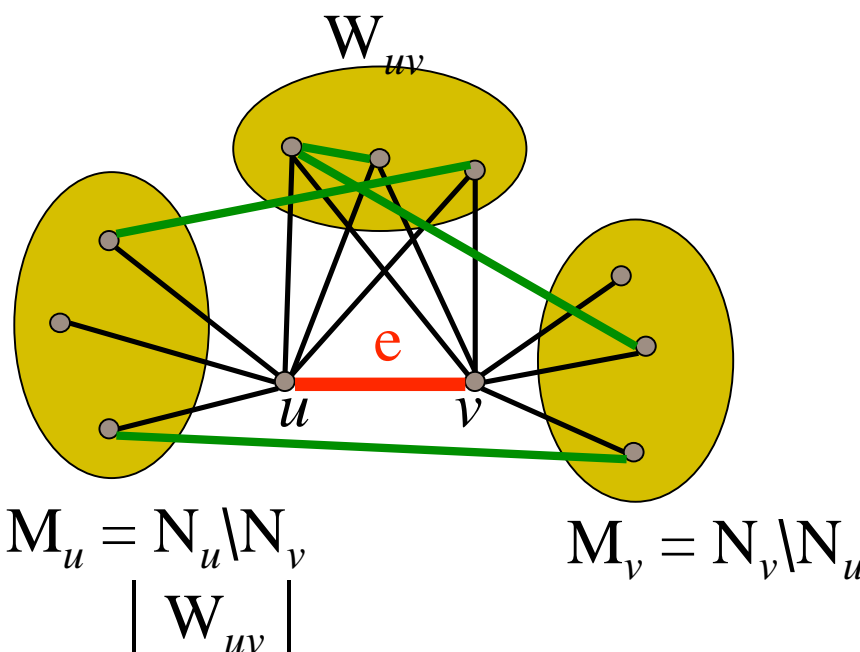
- shortest paths between 2 nodes (Watts: « Small Worlds »)
- High hierarchies: « Scale Free Networks » (Barabasi : preferential attachment)

# Methodology

- Organize the network into a *hierarchy of subgroups*
- Define an edge metric we call *edge strength*
  - Edge with **dense neighborhoods** have greater strength
  - Edge with a **low level of neighbors** are weak and act as a **path between distinct subgroups**



Strength : look at cycles of length 3 and 4



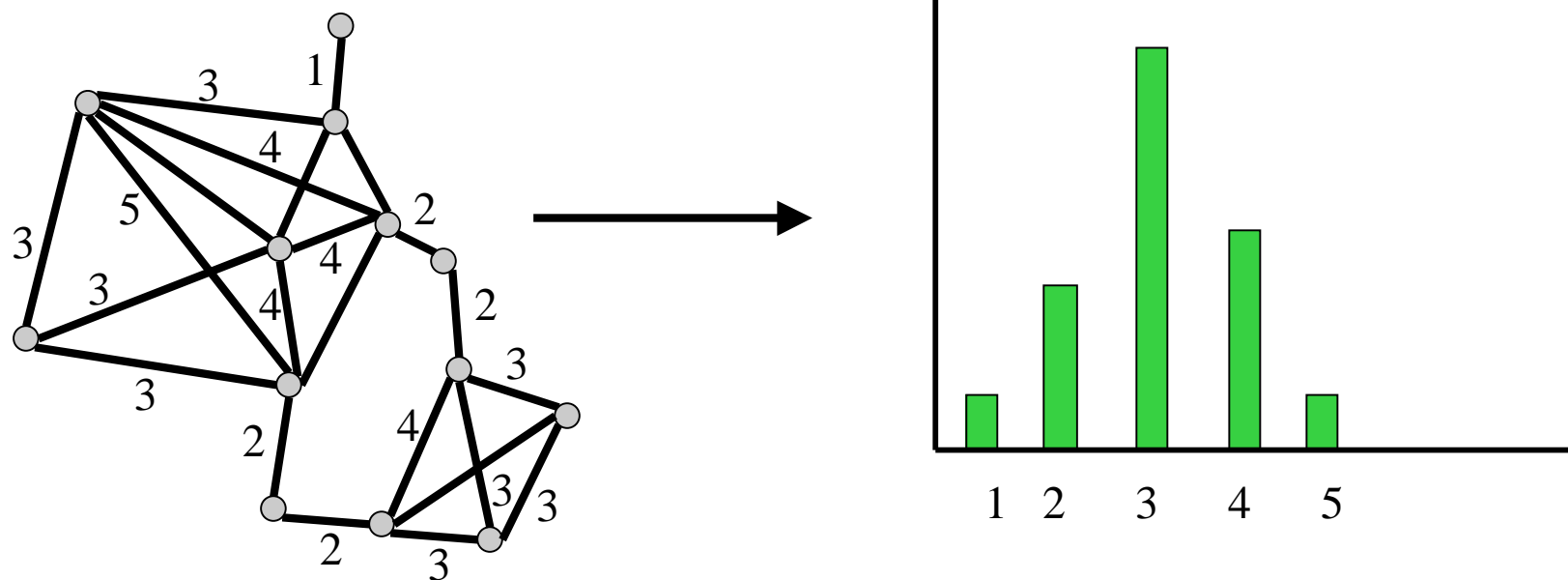
$$\gamma_3(e) = \frac{| M_u | + | M_v | + | W_{uv} |}{| M_u | + | M_v | + | W_{uv} |}$$

$$\gamma_4(e) = s(M_u, W_{uv}) + s(M_v, W_{uv}) + s(M_u, M_v) + s(W_{uv}, W_{uv})$$

→ **Strength index**

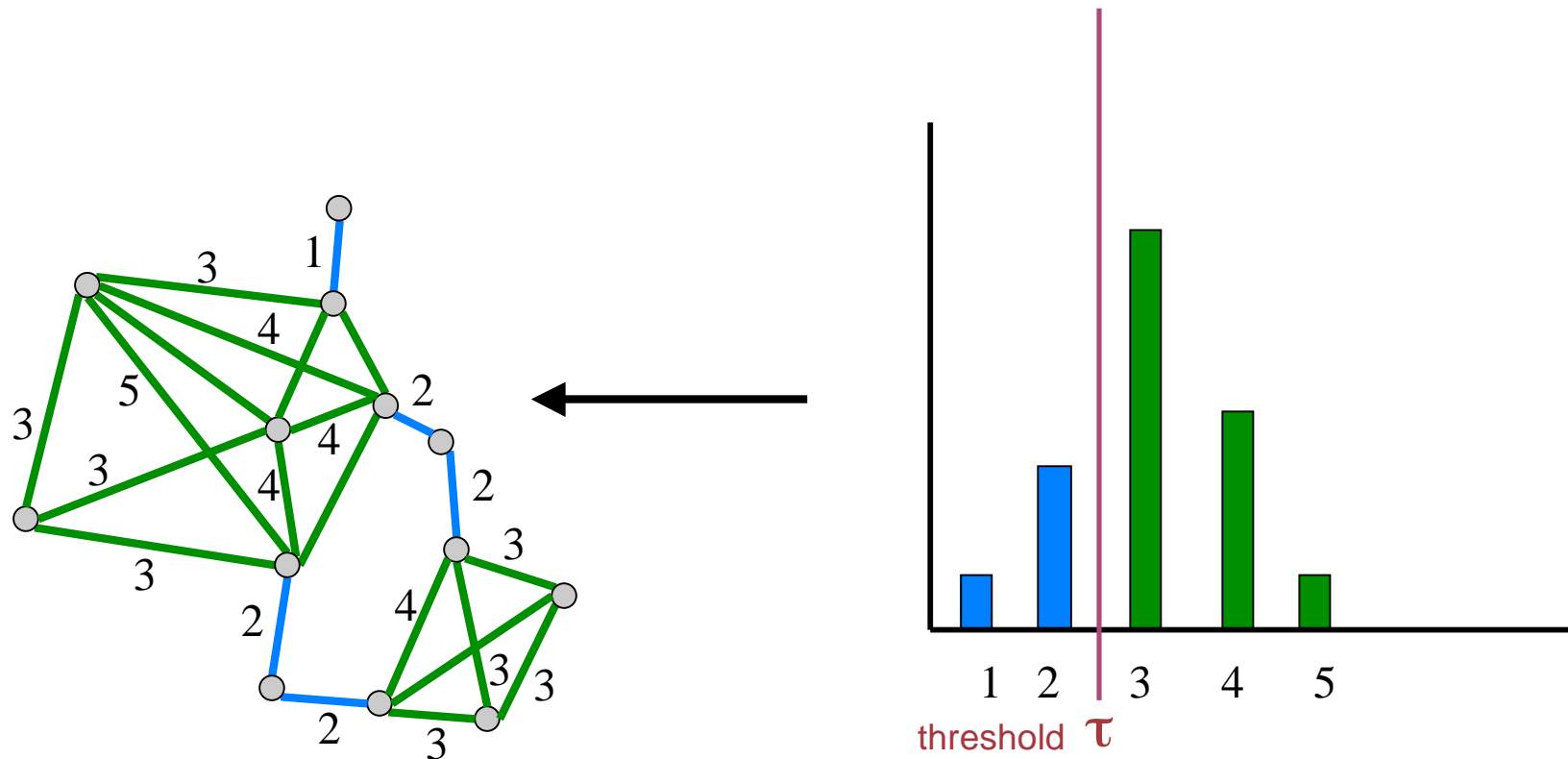
$$\Sigma(e) = \gamma_3(e) + \gamma_4(e)$$

# Use edge strength to infer a clustering of the graph



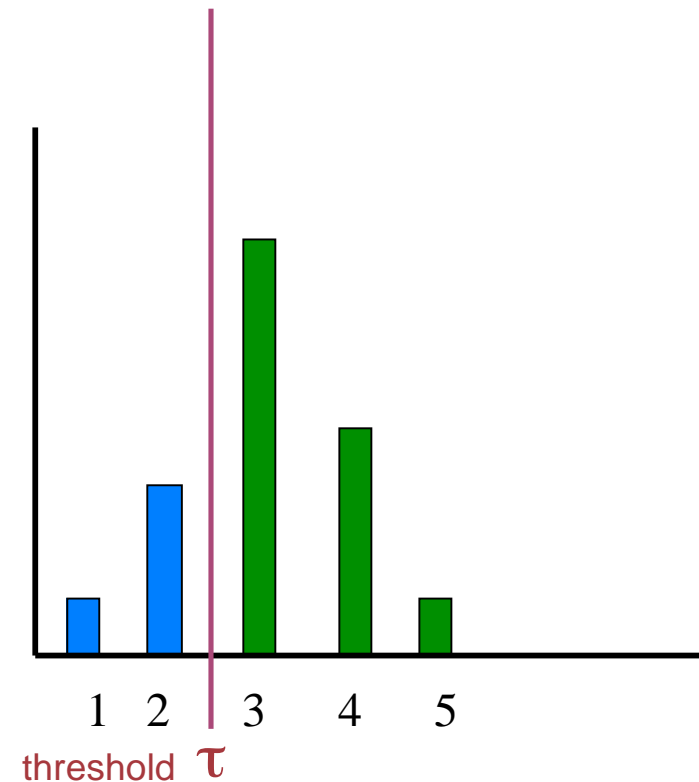
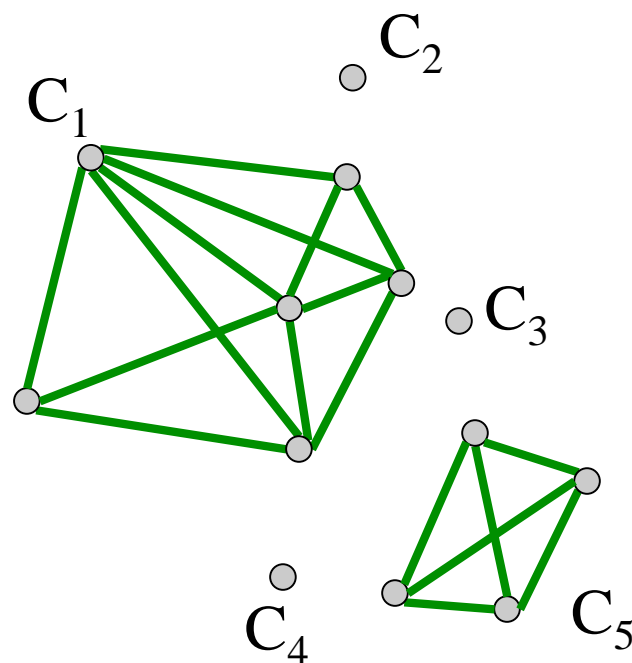
## Use edge strength to infer a clustering of the graph

- Temporarily ignore edges with weaker strength



# Use edge strength to infer a clustering of the graph

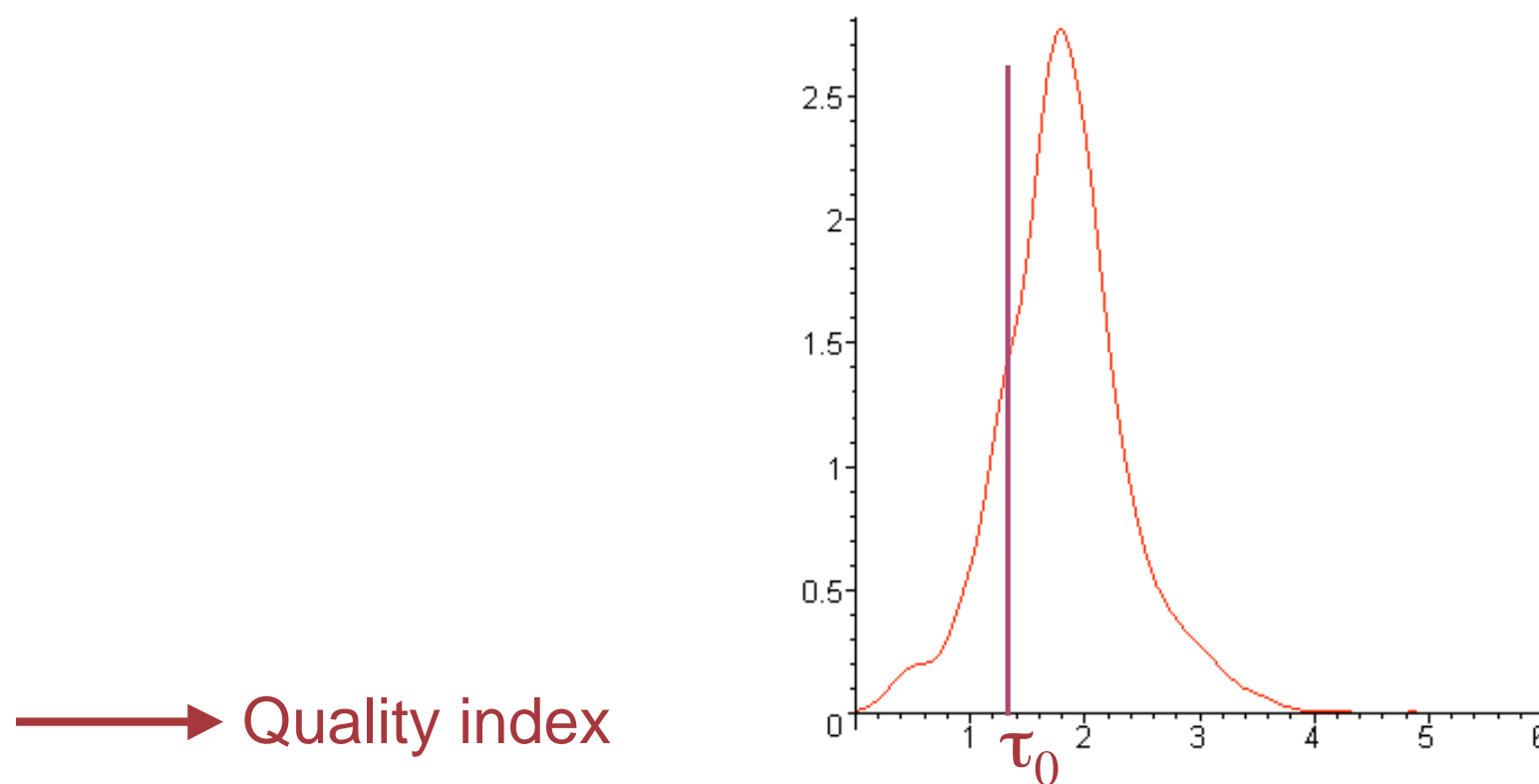
- Temporarily ignore edges with weaker strength





## Which threshold to choose ?

- The one leading to the “best” clustering
  - Optimization problem



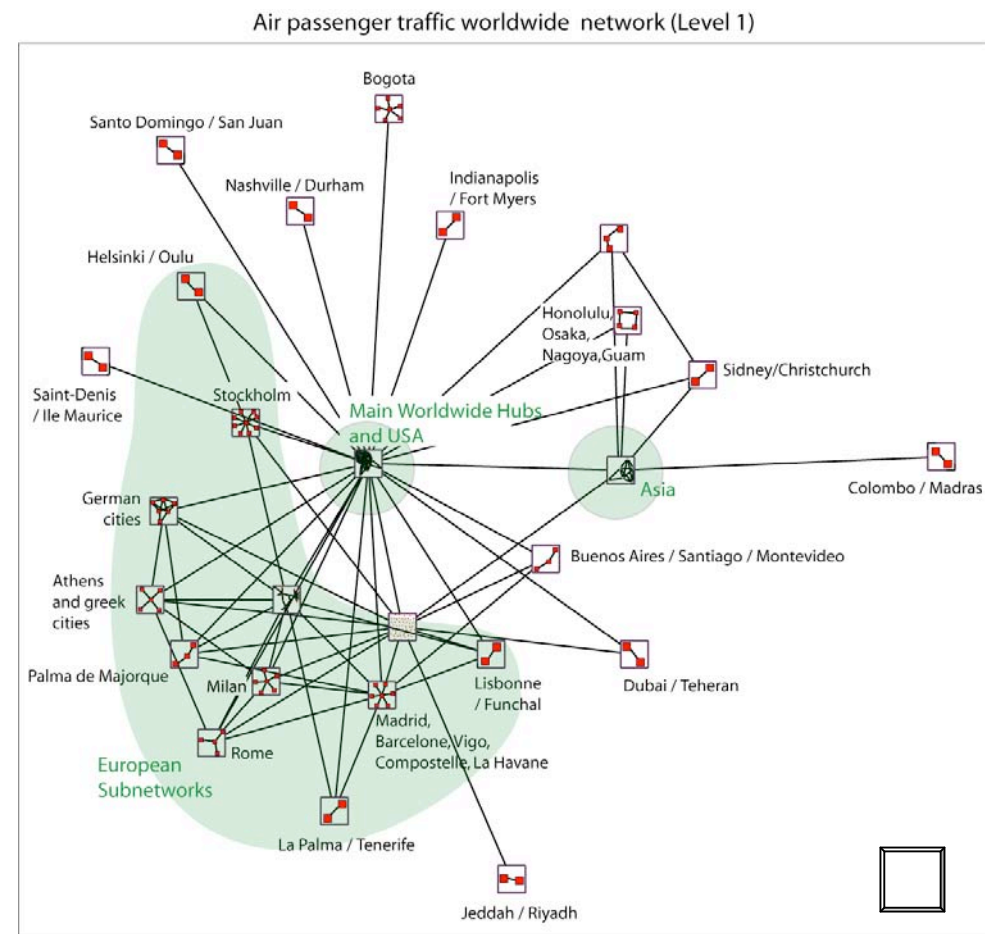
# Hierarchical organization of the network

- - Weighted measure
- - The procedure can be iterated to produce a hierarchy of clusters
  - Strength of edges is recomputed at each stage
  - Threshold is locally chosen for each component
  - More deep is a cluster more it is with high cohesion

## • TULIP Software

[www.tulip-software.org](http://www.tulip-software.org)

David Auber (Bordeaux, FR)

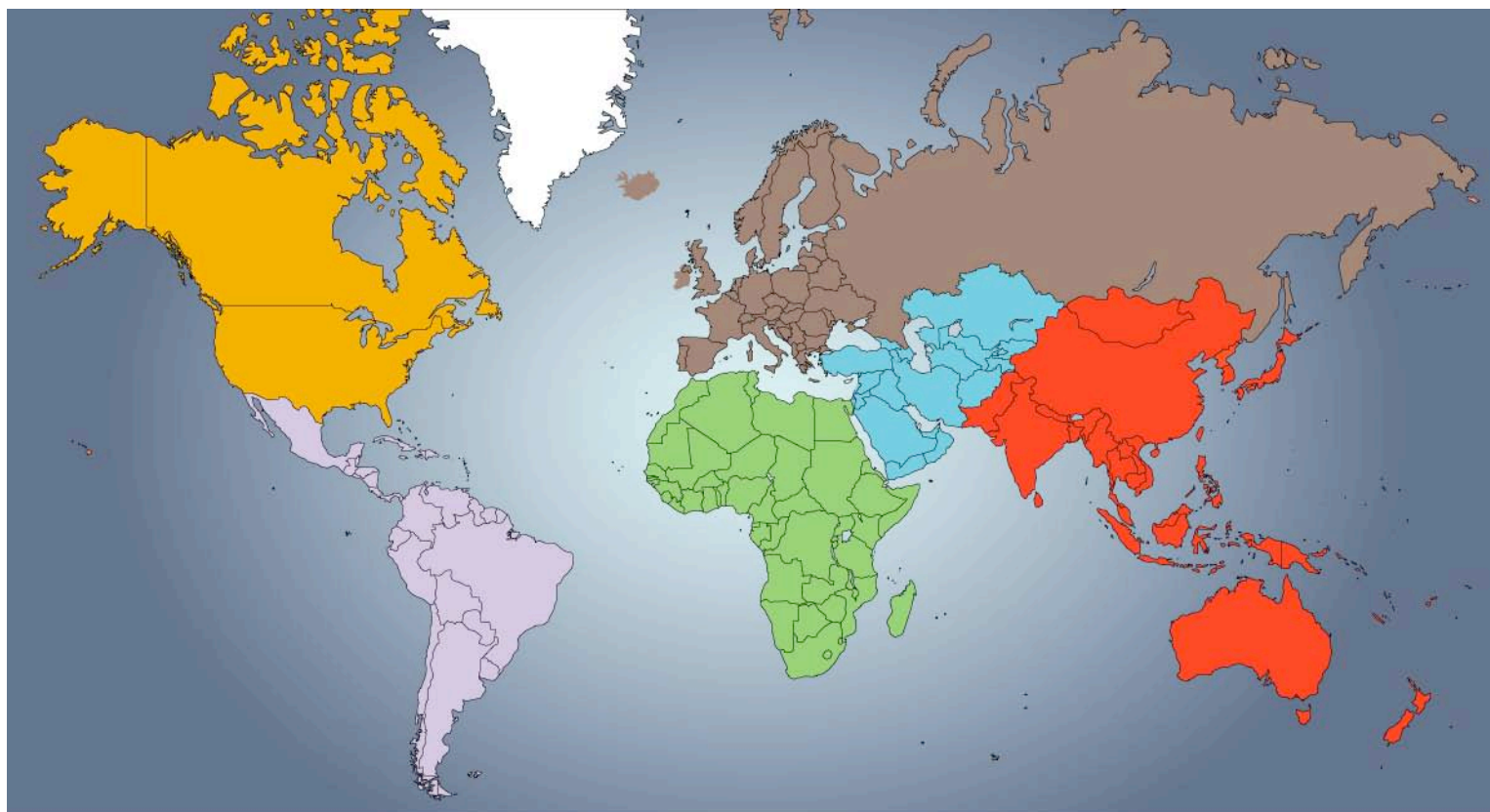


<http://mappemonde.mgm.fr> n°3 2005

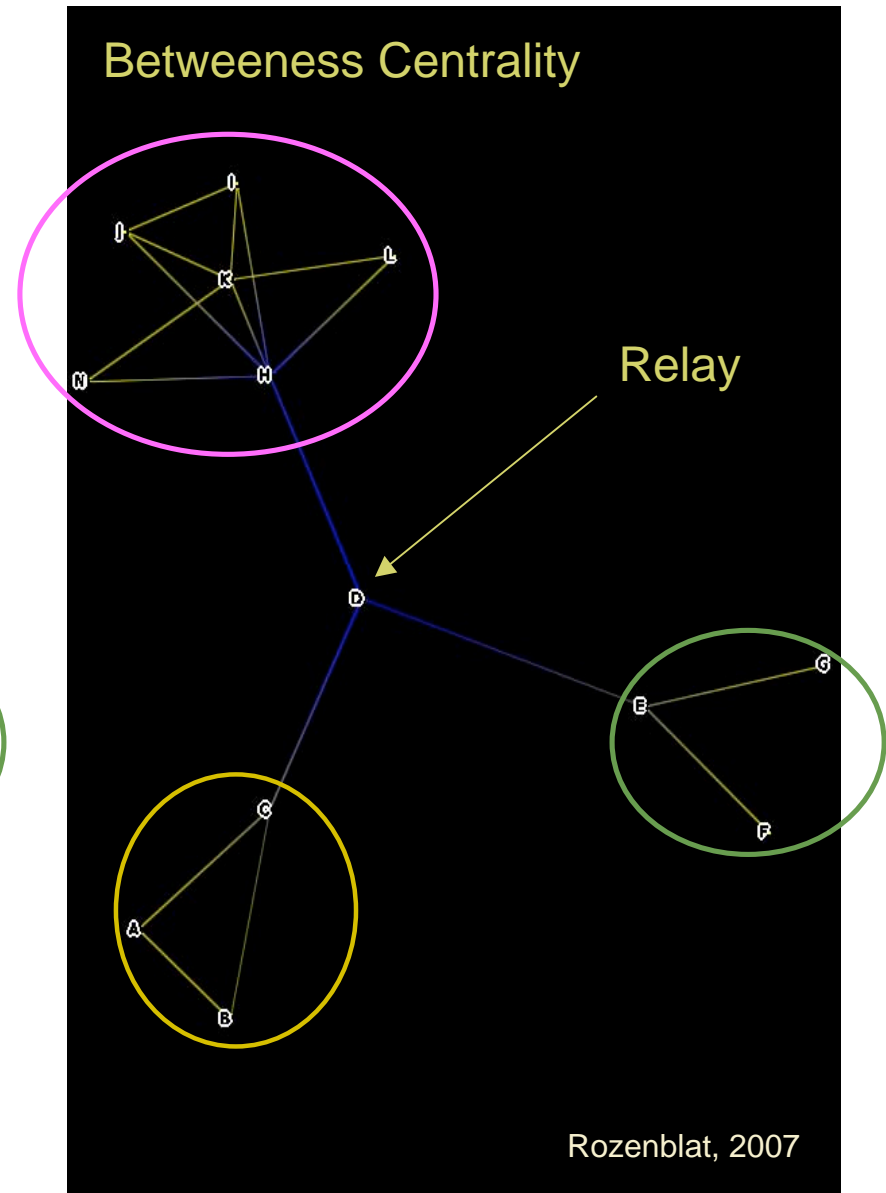
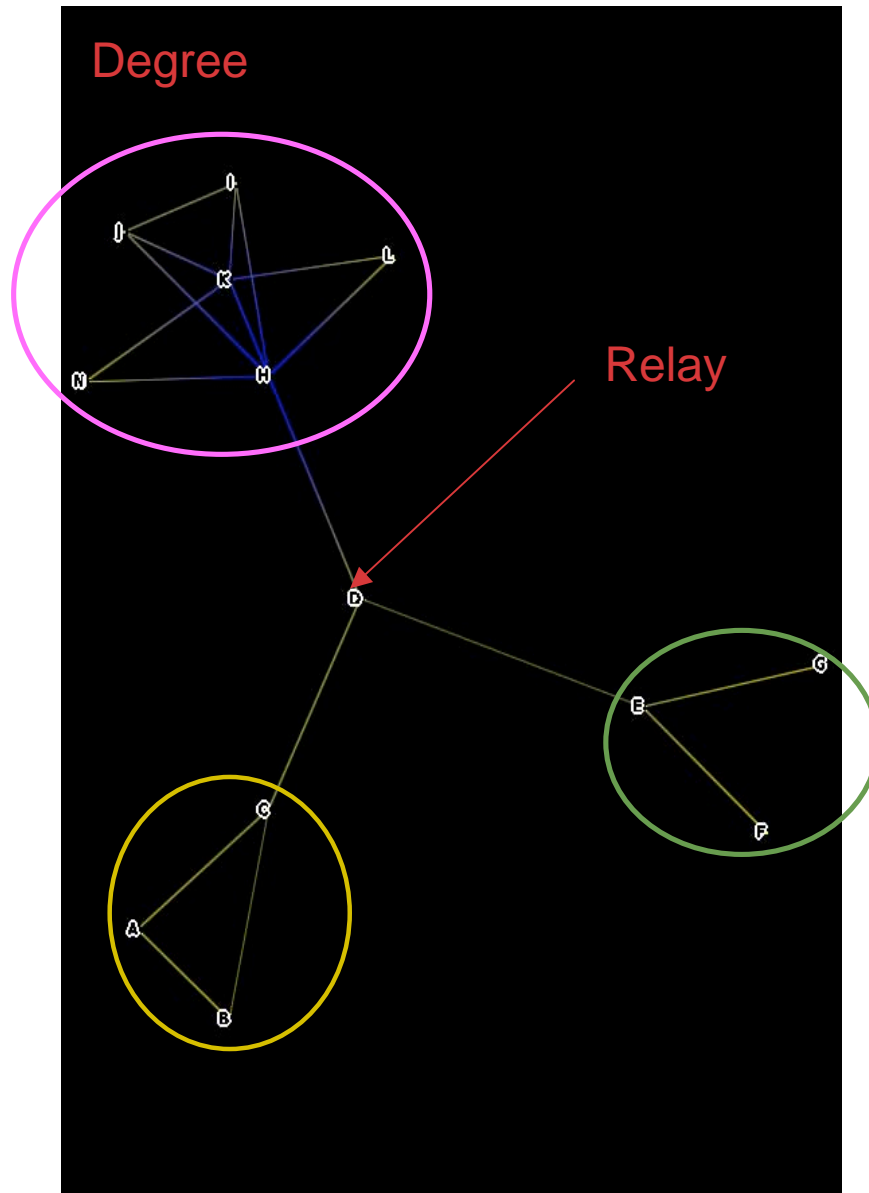
## 2- Continental effects

Intra-continental traffic :

- 2000 : 83%
- 2004 : 85%



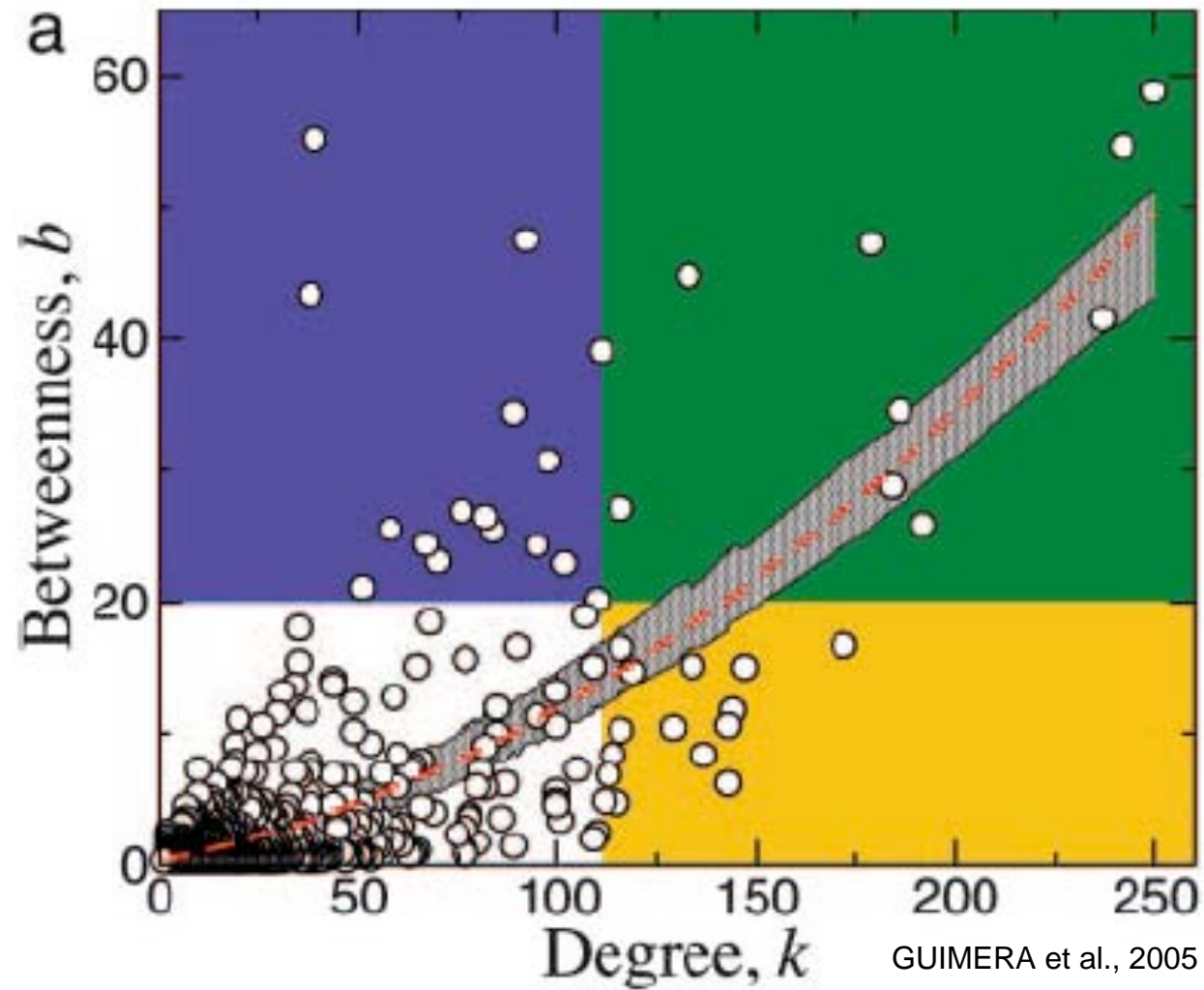
### 3- Closures and Structural Holes (Burt, 2005)





### 3- Bridges

Air Traffics



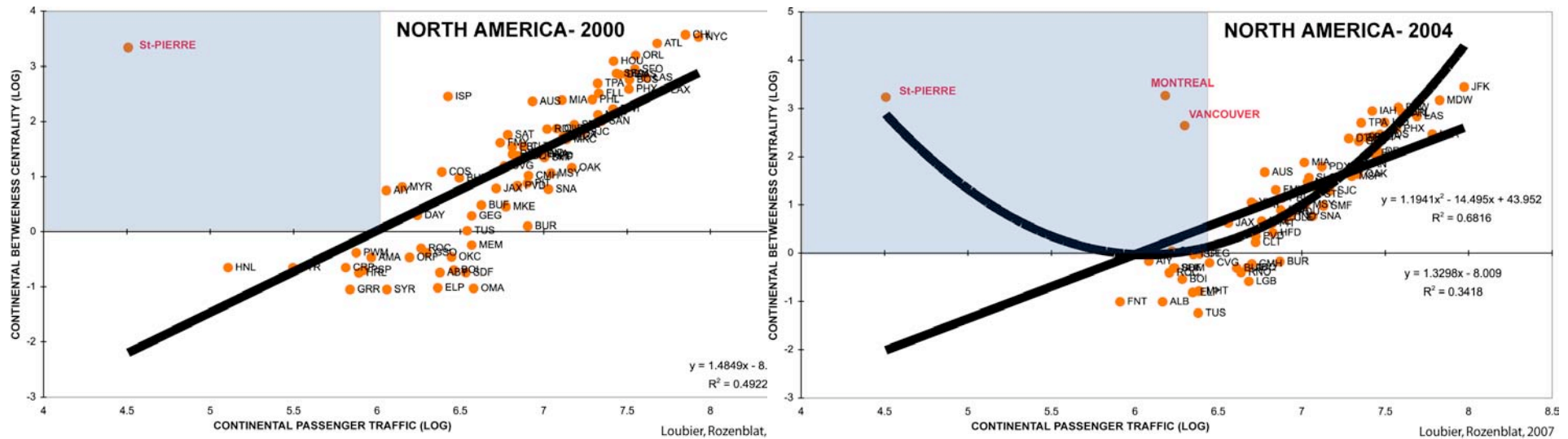
### 3- Bridges

#### The Transatlantic Bridge of GANDER

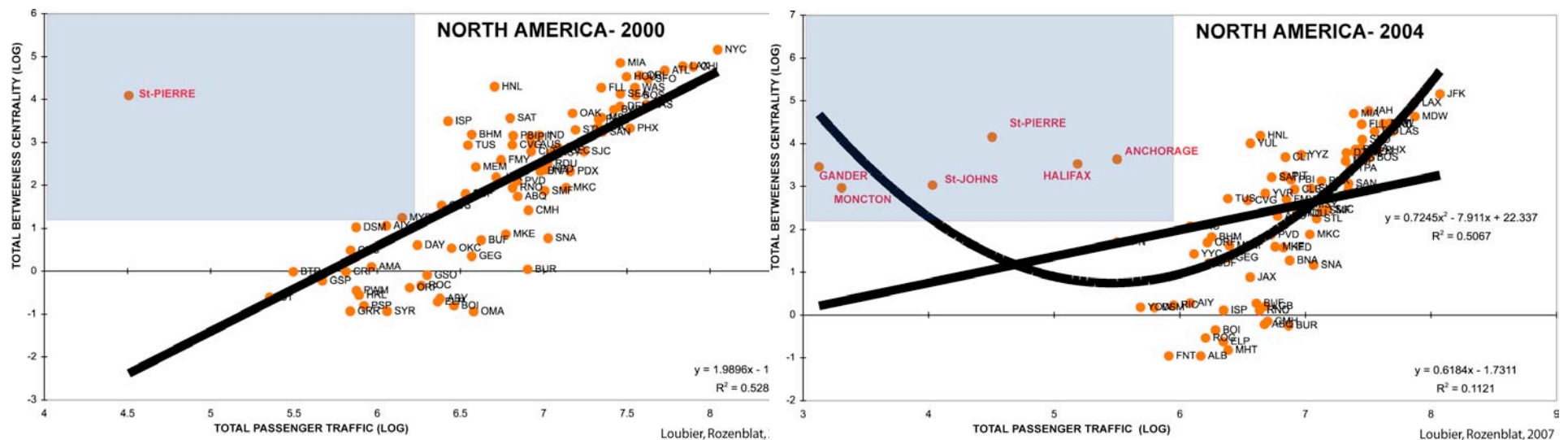


# 3- North American Bridges

## Continental Air Traffics

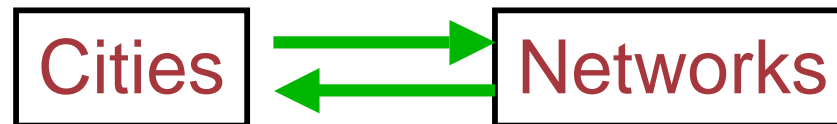


## Total Air Traffics

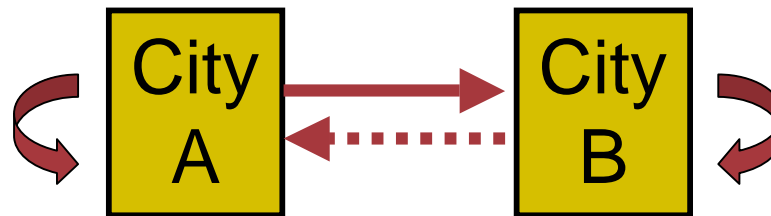


## 4 - Urban indicators

### Main Issues



Social interaction in space => spatial interaction



### Asymetry

- Inequal ressources
- Different relative position

## 4 - Urban indicators



Air Traffics 2000-2004 :

Source ITA

5 000 Airports

20 000 relations

World Urban Aggl.:

Source Moriconi, 2000

150 cities > 2 M. inhab.

European Urban Aggl.:

Source Rozenblat, Cicille, 2003

180 cities > 200.000 inhab.



- Traffics
- Centralities
- Edges
- Strength



- Pop. 80-90-00
- Evolutions Pop.
- GDP
- GDP/Inhab.



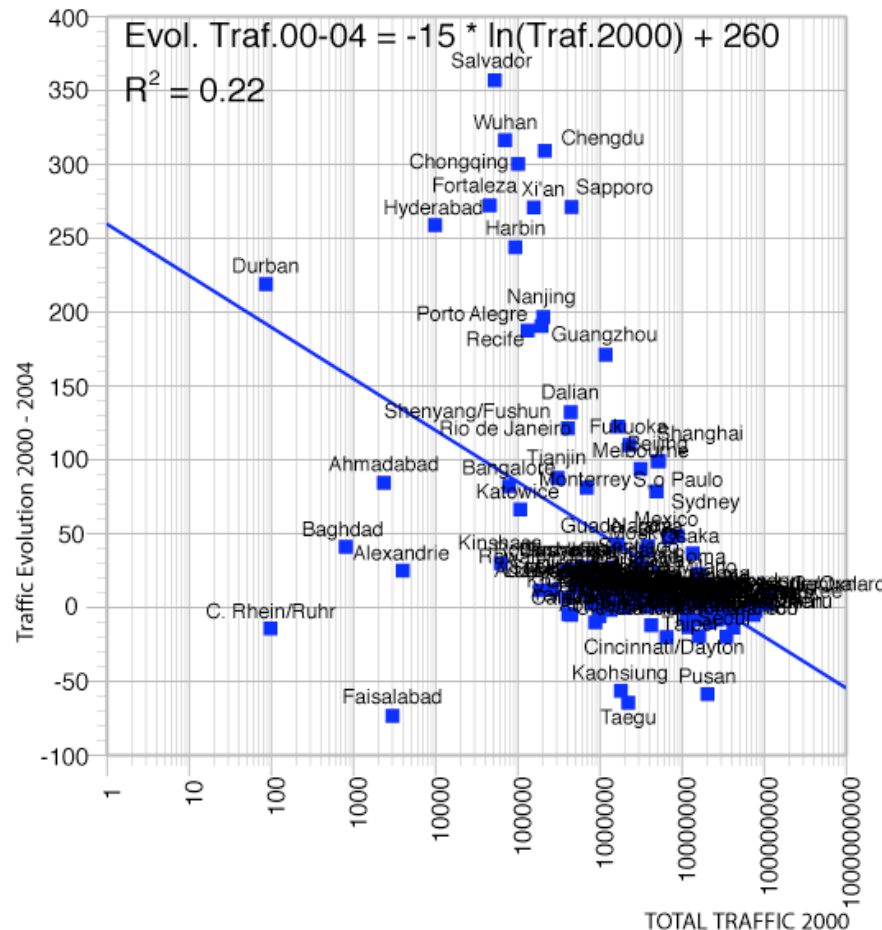
- Pop. 50-60-70-80-90-00
- Evolutions Pop.
- International functions



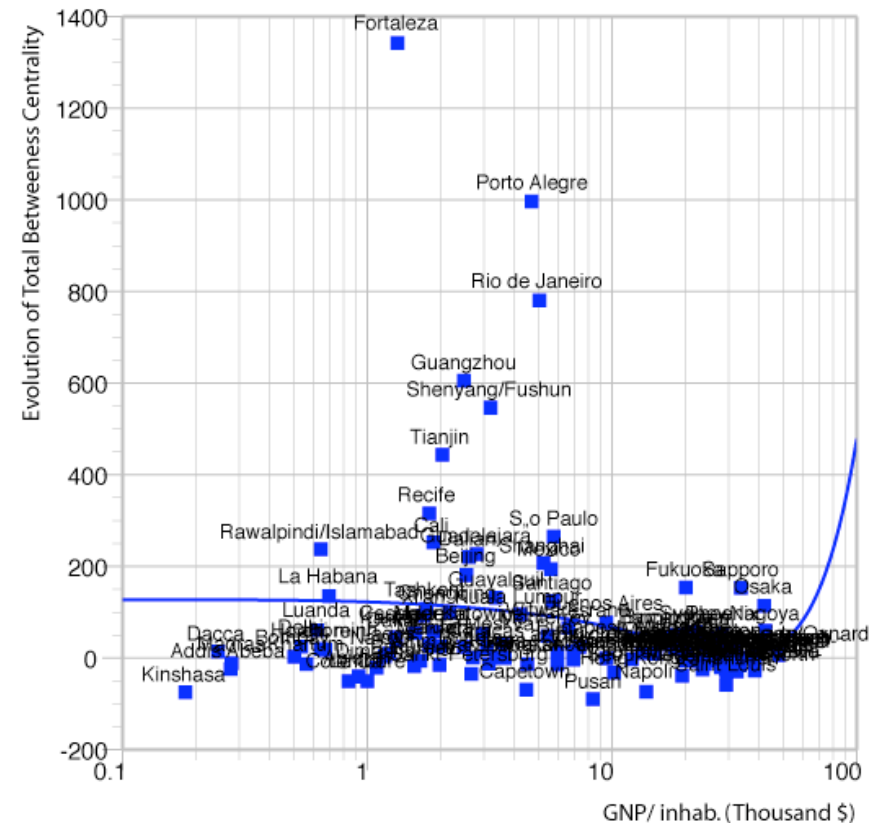
# 4 - World Urban indicators



Traffic Evolution acc. to Traffic



Centrality Evolution acc. to GDP/Inh.



Traffic increases in cities of developping countries  
 But centrality increases for intermediate cities

« Scale Free Networks »  
 (Barabasi : preferential attachment)

# SPANGEO project

## Spatial Networks in Geography (ANR 2005-2008)



### Thematic :

- Passengers air Traffics
- Multinational firms (1990, 1996, 2006) ;
- Research networking (FP1 to FP6);
- Transport timetables;
- Culture and art;
- Migrations (Saxenian);
- Commuters: inter and intra-urban approach of polycentrism

### Methodological :

- Adaptation to thematic questions
- Compute different variants of partitioning indexes
  - Fuzzy partitioning
  - Multi-level analyse (Guimera et al.)
- Diachronic data (graph evolutions)
- Comparing several graphs on the same space (hyper-graphs)

### Theoretical :

- Networks and systems of cities
- Geographical logics v/s Actors strategies
- Spatial interaction and networks economies

•**SPANGEO Project (SPAtial Networks in GEOgraphy)**

<http://s4.parisgeo.cnrs.fr/spangeo>

The projects are opened :  
Other dynamic partners are welcome

[Celine.rozenblat@unil.ch](mailto:Celine.rozenblat@unil.ch)

**Pr. Céline Rozenblat**



Viele Dank für ihre aufmerksamkeit....  
Thanks for your attention...  
Merci de votre attention...