Collaborations in European research programmes

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Introduction

- Framework Programmes are the main funding tools of European Union to support research
- (4-year funding schemes, currently FP7)
- Inter-national collaborations encouraged (practically forced)

“Instruments”

- Different schemes with varying targets
  - STREP: Collaboration for research of ~8-10 partners
  - IP: Integrated Projects, Large collaborations of ~20 partners
  - MCA: Marie-Curie Actions, Exchange of students, postdocs, usually 2 partners
  - SSA, CP, CPR …

FP5 data (1998-2002)

- **84267** partners in **16558** contracts
- **27219** unique partners
- **147** countries

FP6 data (2002-2006)

- **69237** partners in **8861** contracts
- **19984** unique partners
- **154** countries

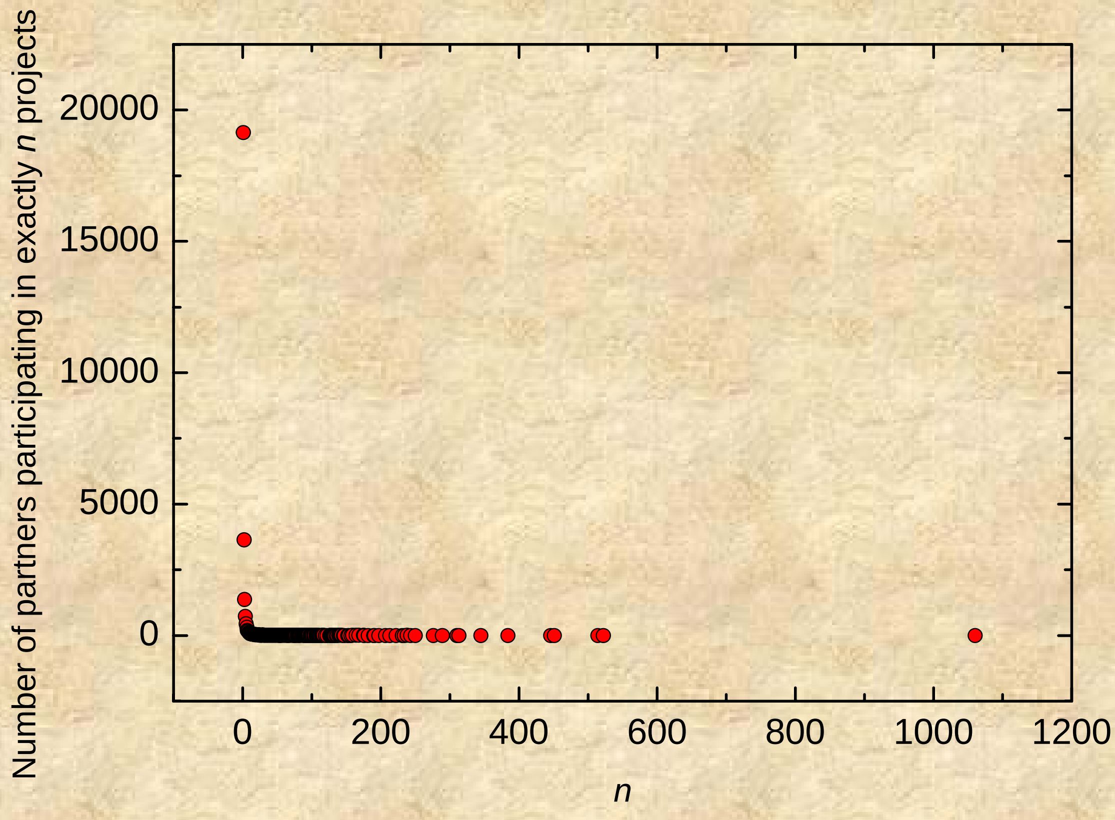
FP6 data

Instrument	Number of Projects	Number of partners (not unique)	Partners/Project
STREP	2139	20023	9.36
IP	696	17046	24.4
NOE	170	5078	29.8
MCA	3627	7169	1.97
SSA	1271	7560	5.9
CA	462	6666	14.4
II	85	945	11.1
I3	11	293	26
CRAFT	348	3290	9.45
CLR	52	1069	20.5
Total	8861	69139	7.8

Why use these data?

- Reliable data: all collaborations are listed
- PRACTICAL PURPOSES:
  - Using network theory can take us beyond usual statistical analysis
- THEORETICAL PURPOSES:
  - Easy to observe under different scales
    - Relate directly networks and fractality

In how many projects did a University participate during FP5?



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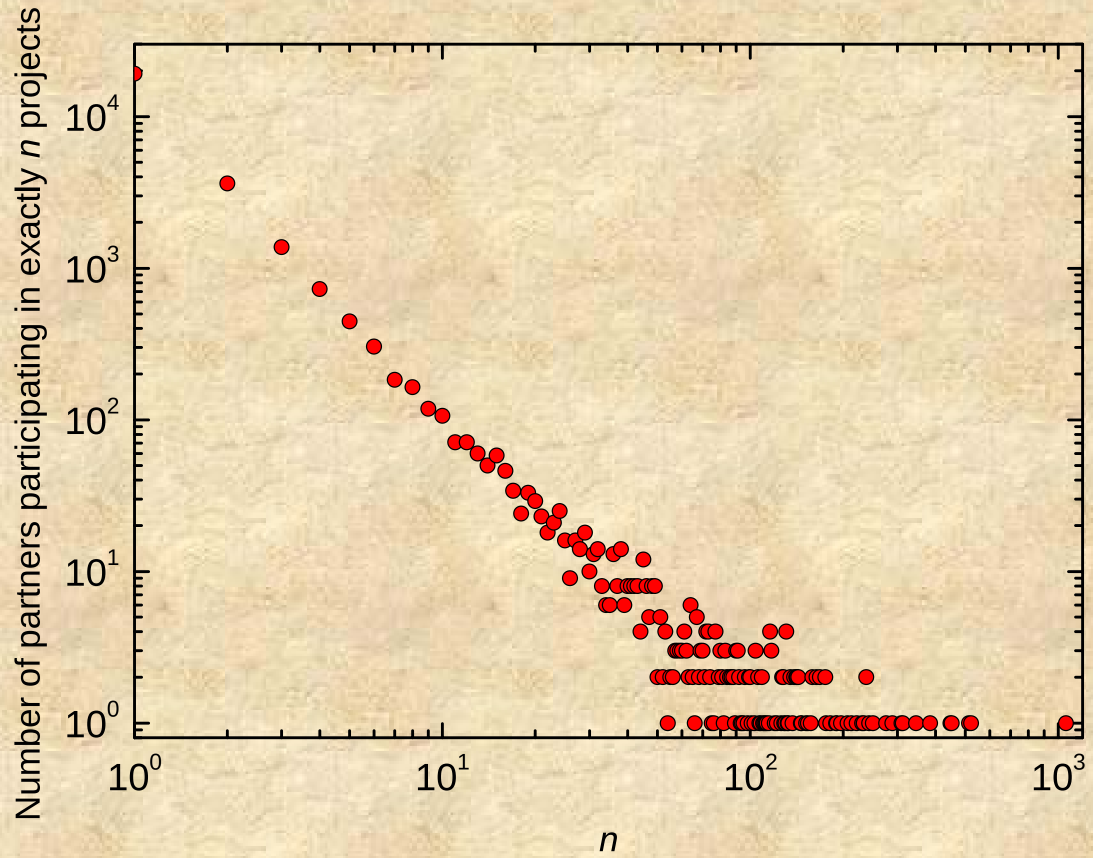

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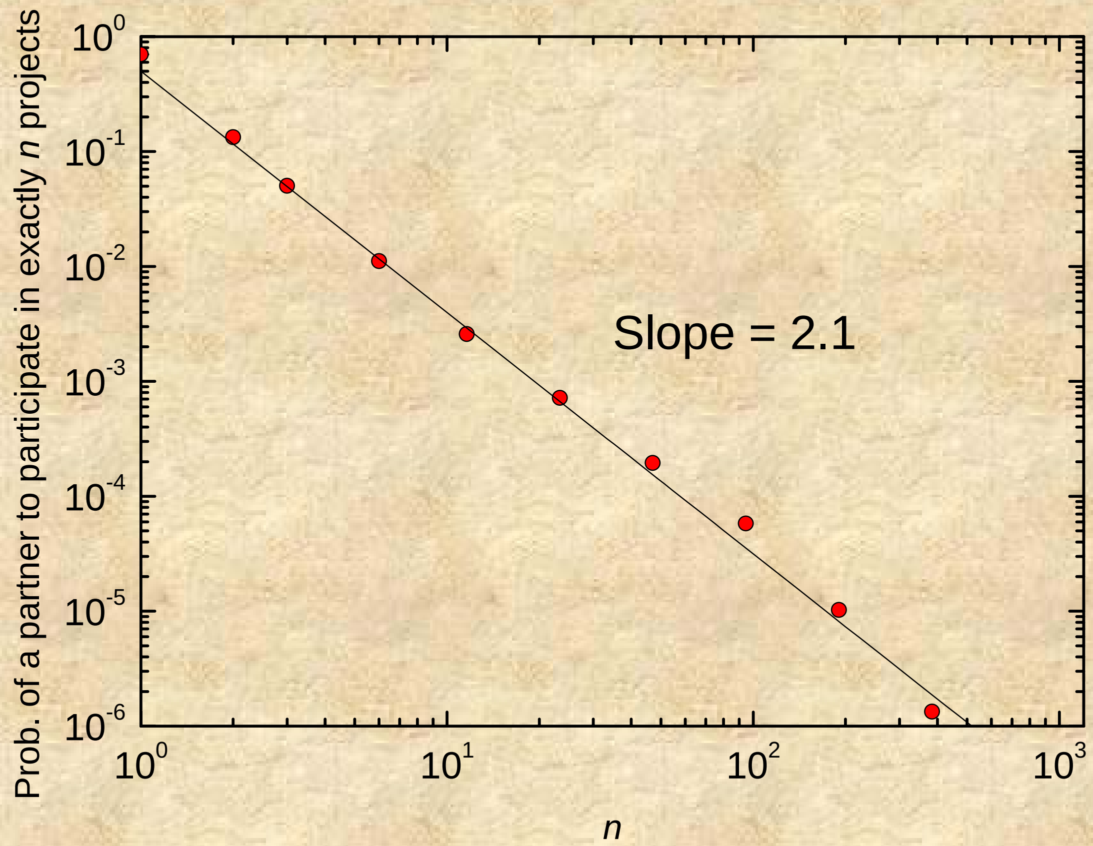
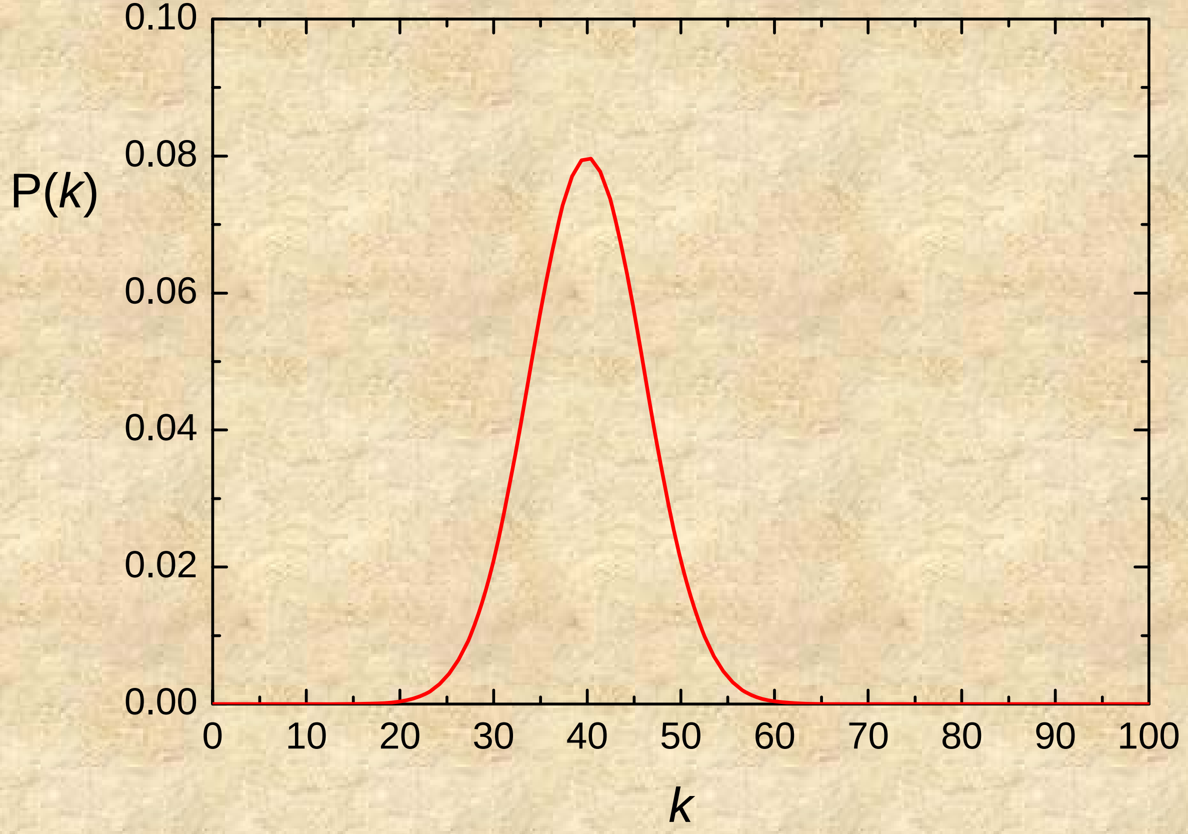
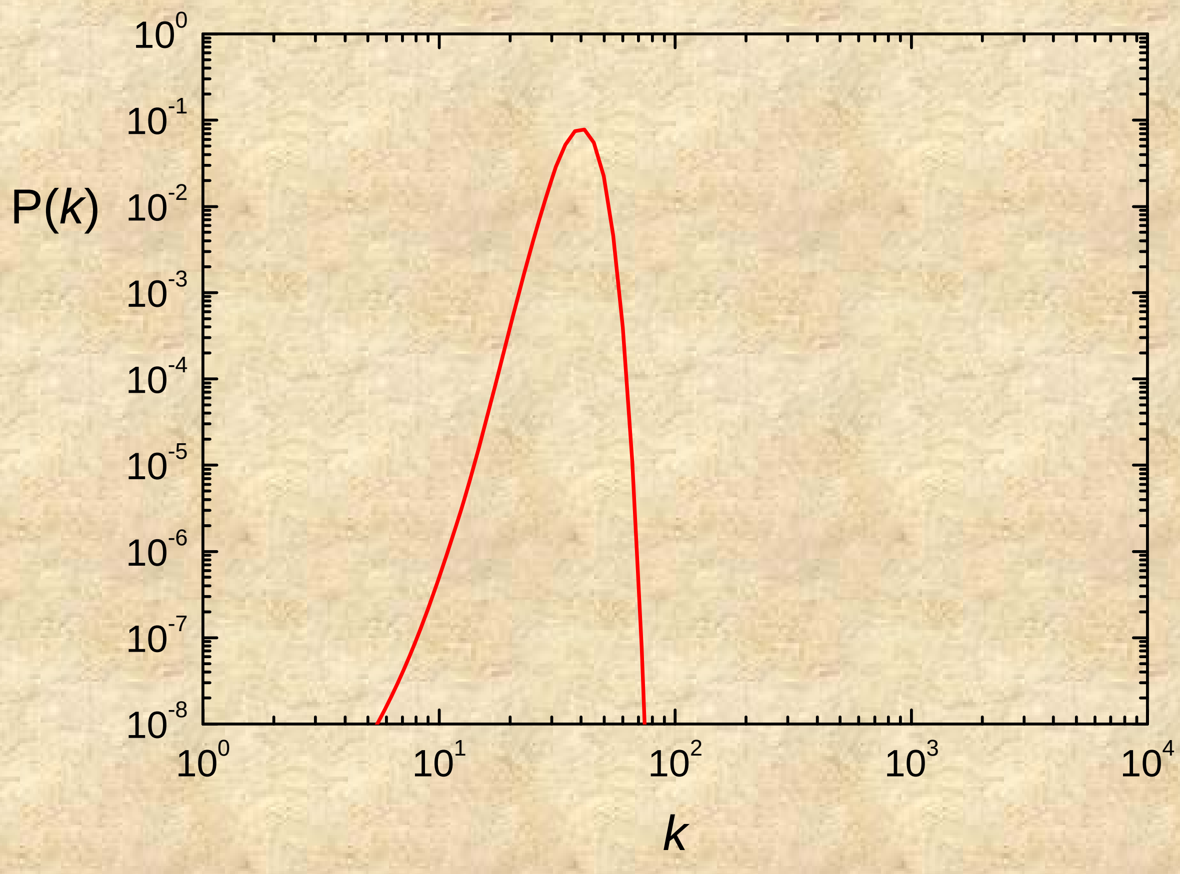


Assuming random connections

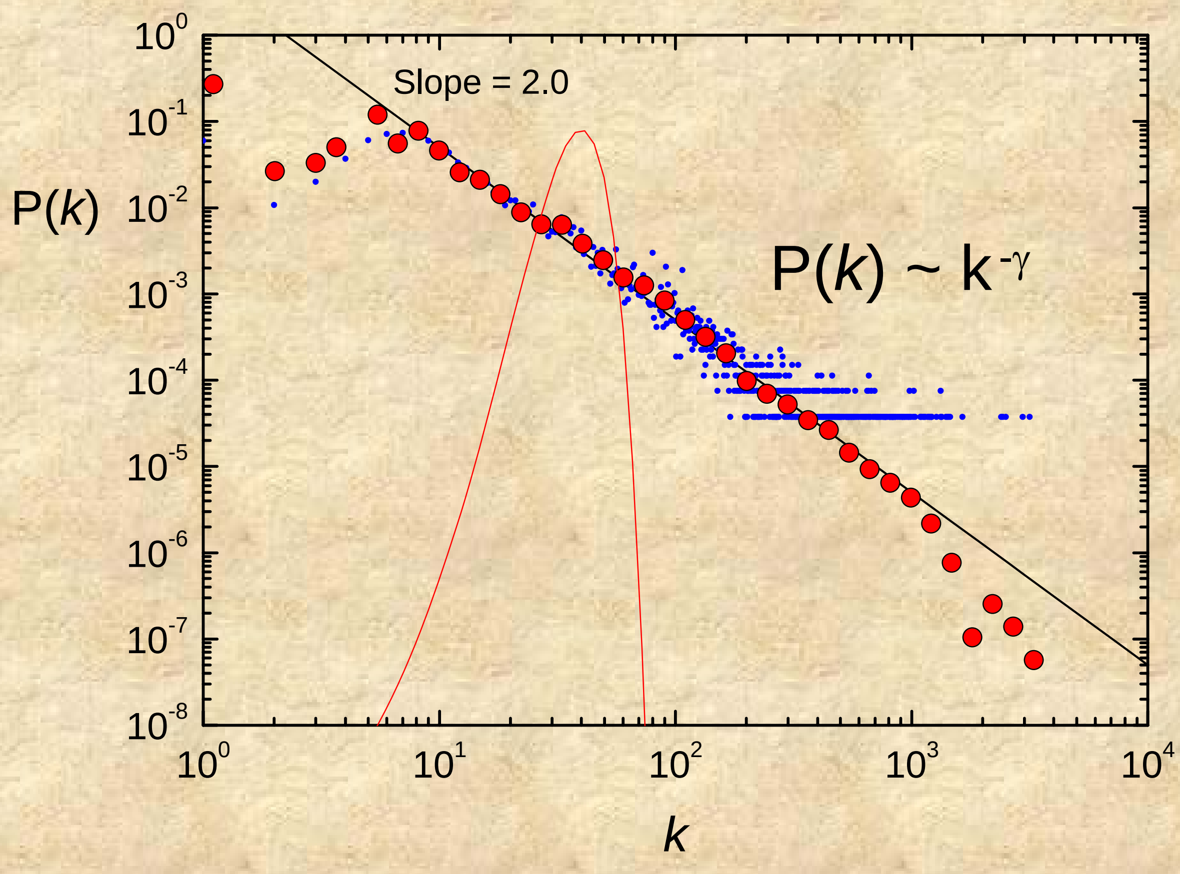


Degree distribution, P(*k*):
Probability that a node (partner) has *k* links (partnerships) with other nodes

Assuming random connections



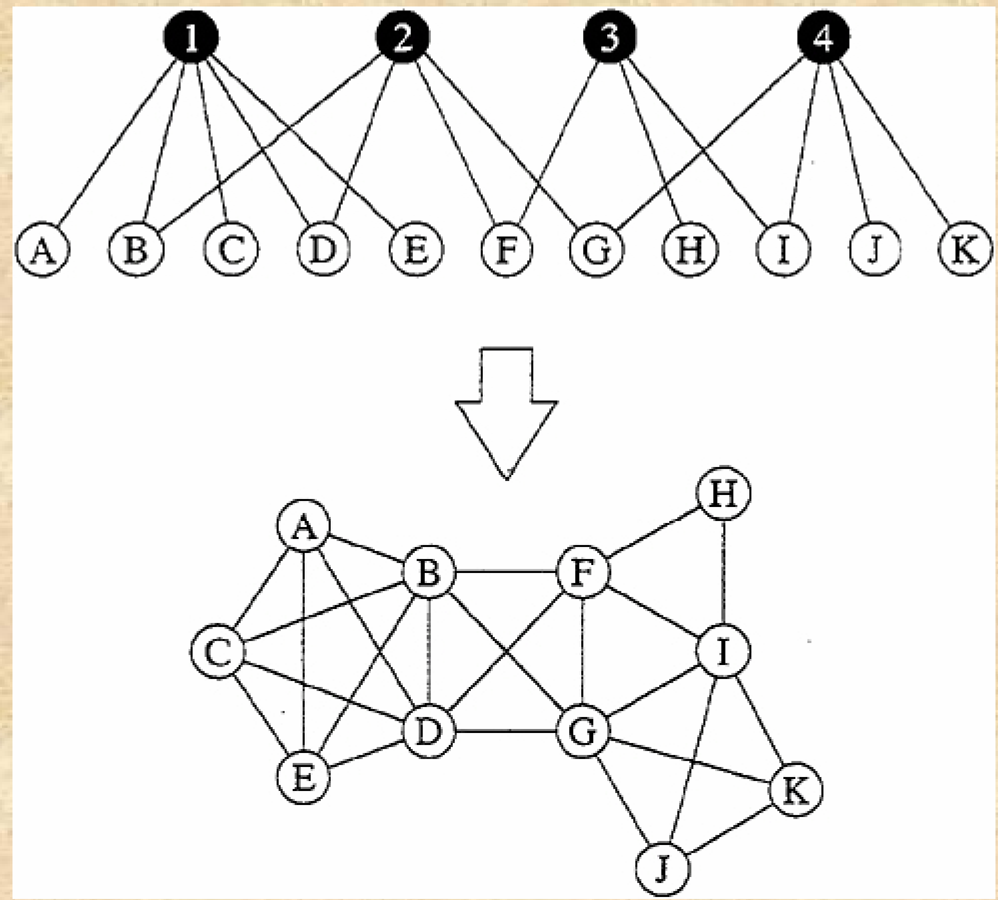
Degree distribution of the projected network (FP5)



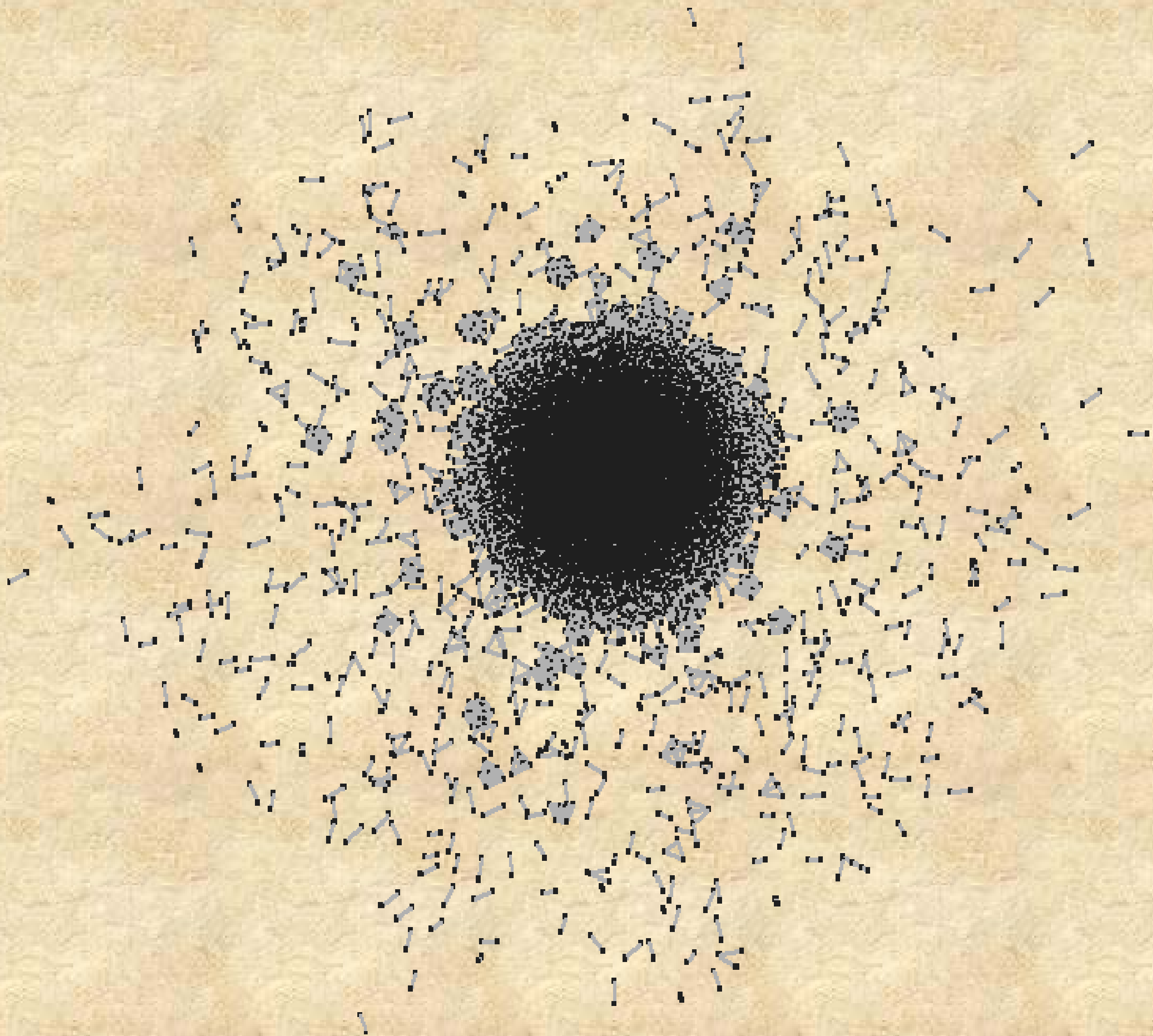
Bipartite network

Projects

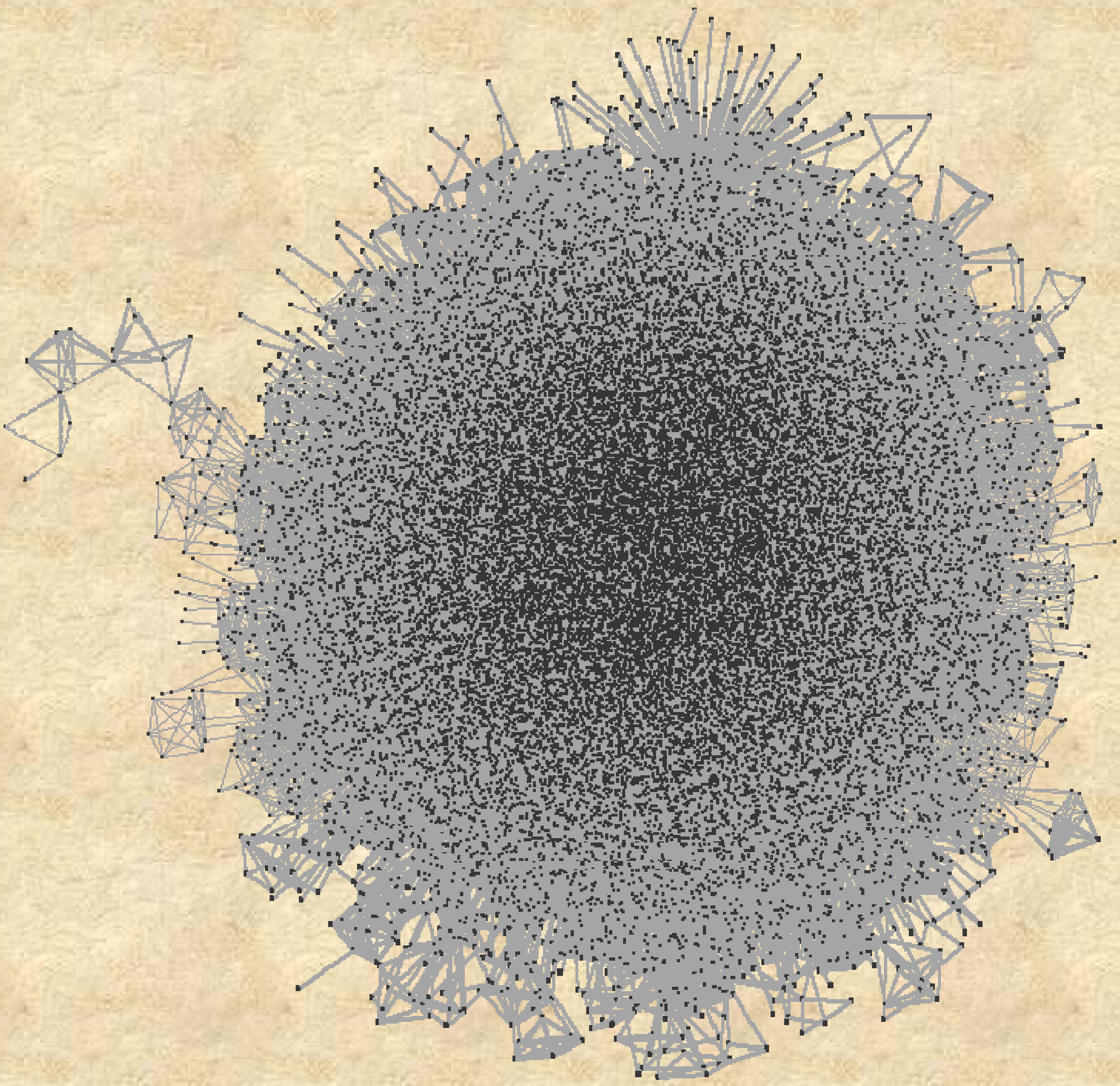
Partners



Network of partners

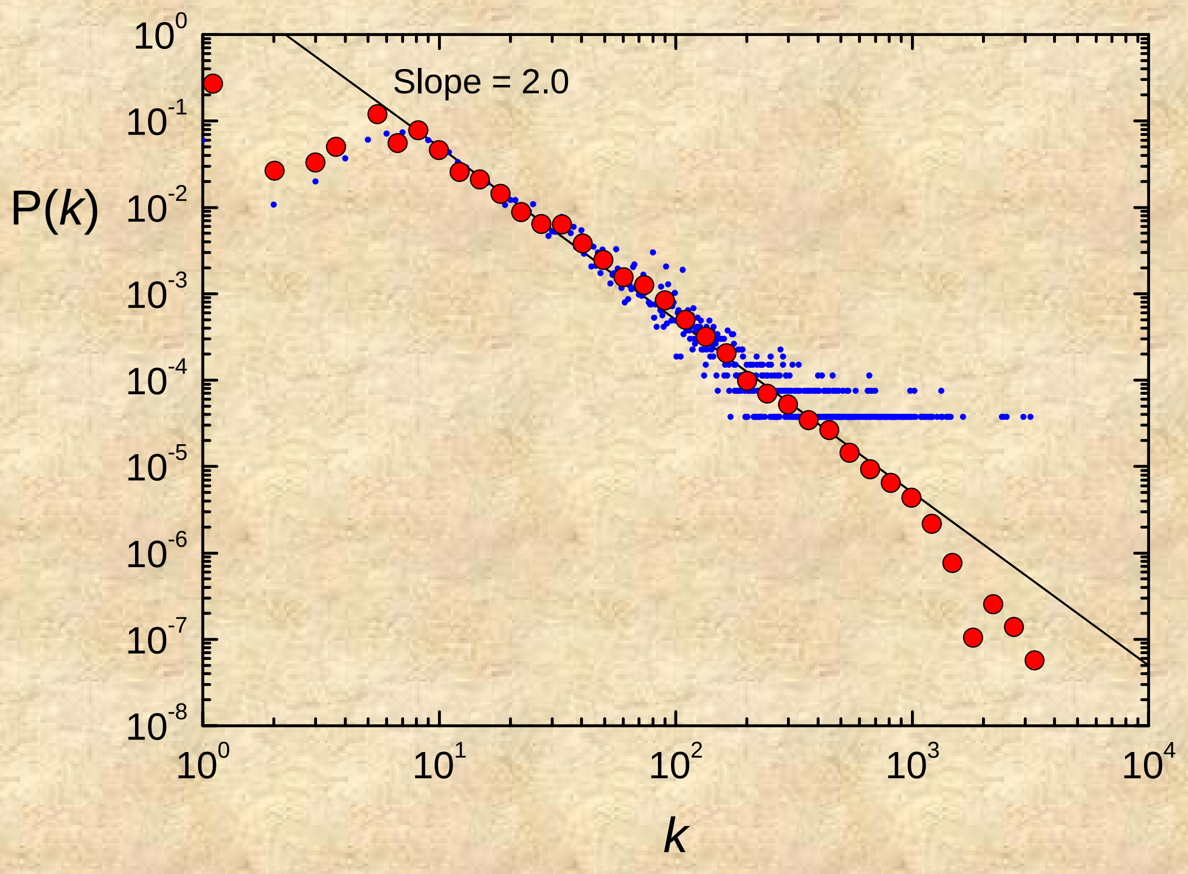


24982 partners in the largest cluster (**27219** total)

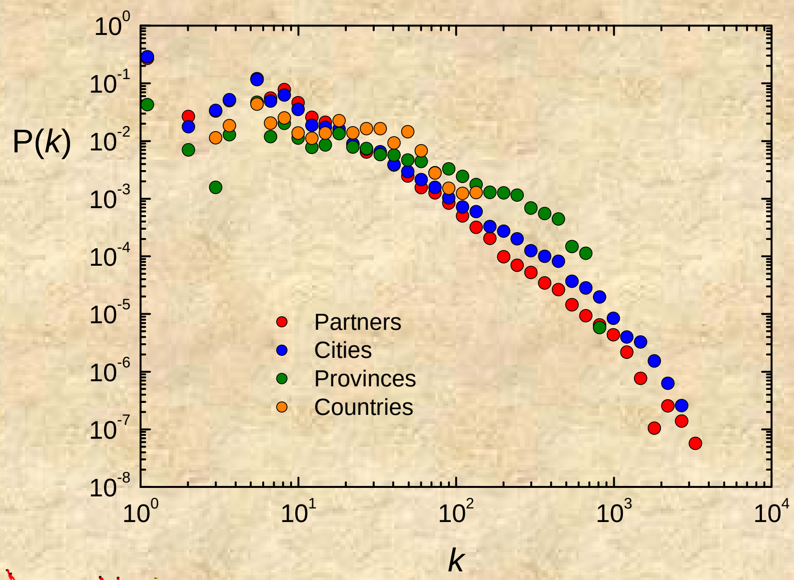


FP5

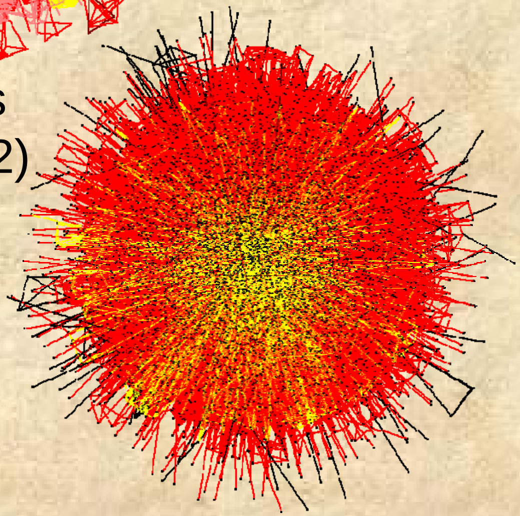
Degree distribution of the projected network (FP5)



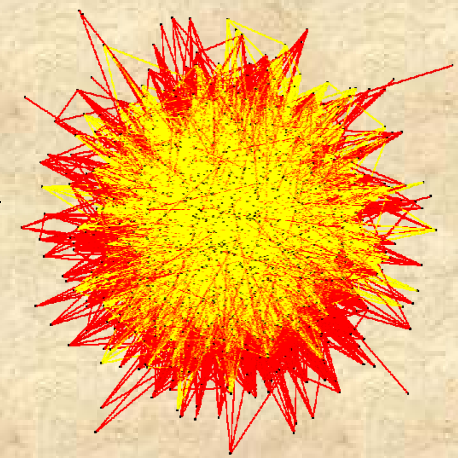
Coarse-grained networks (FP5) [Partners, cities, provinces, countries]



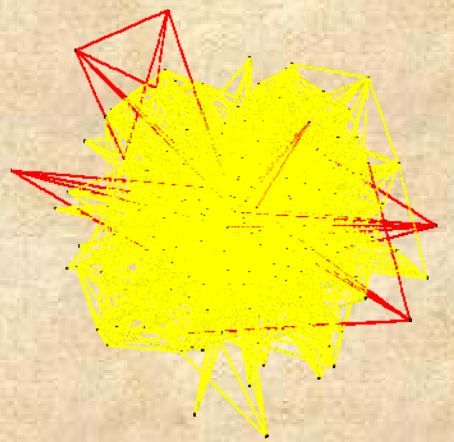
Partners
(N=24982)



Cities
(N=7091)

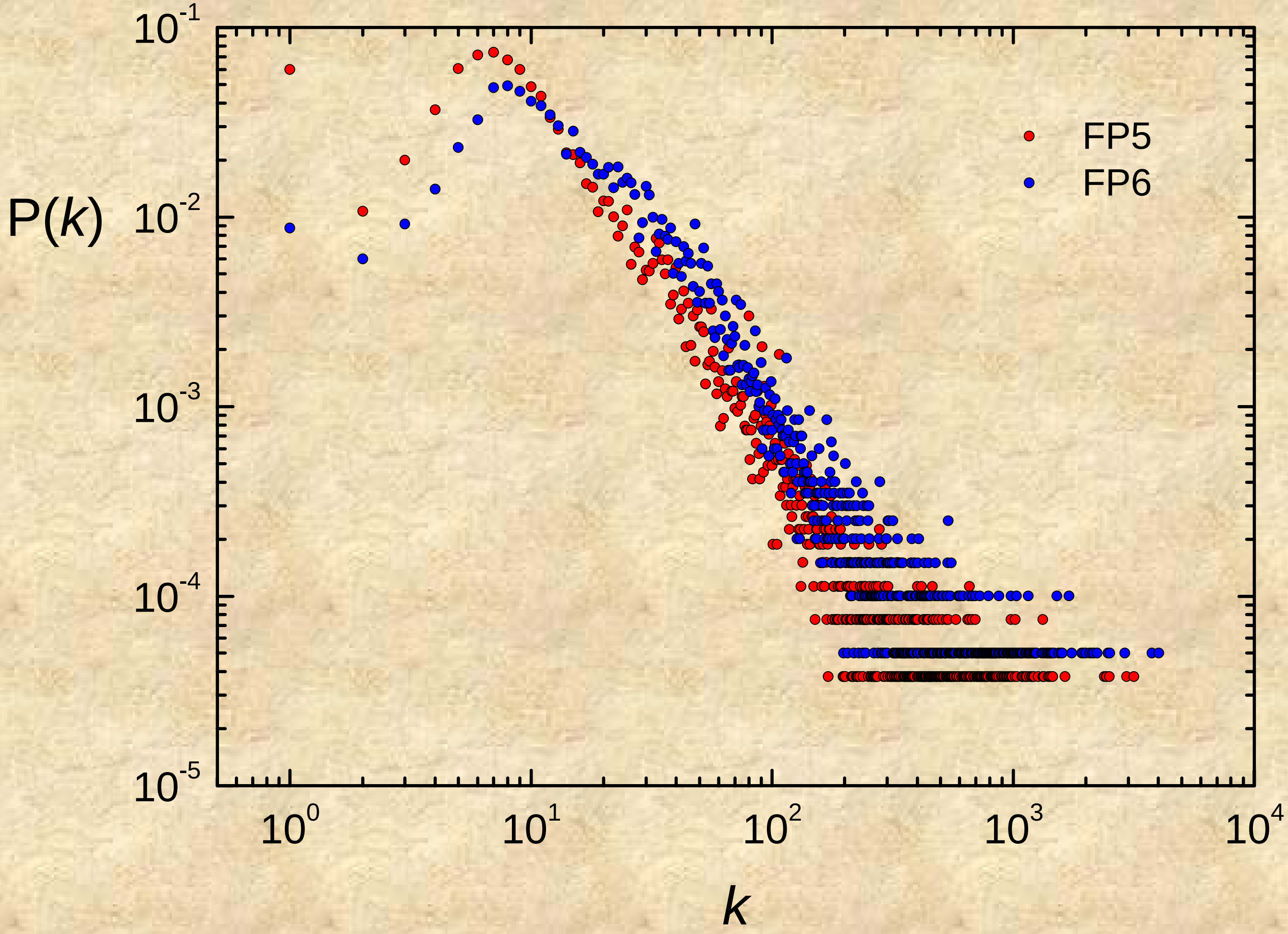


Provinces
(N=1066)



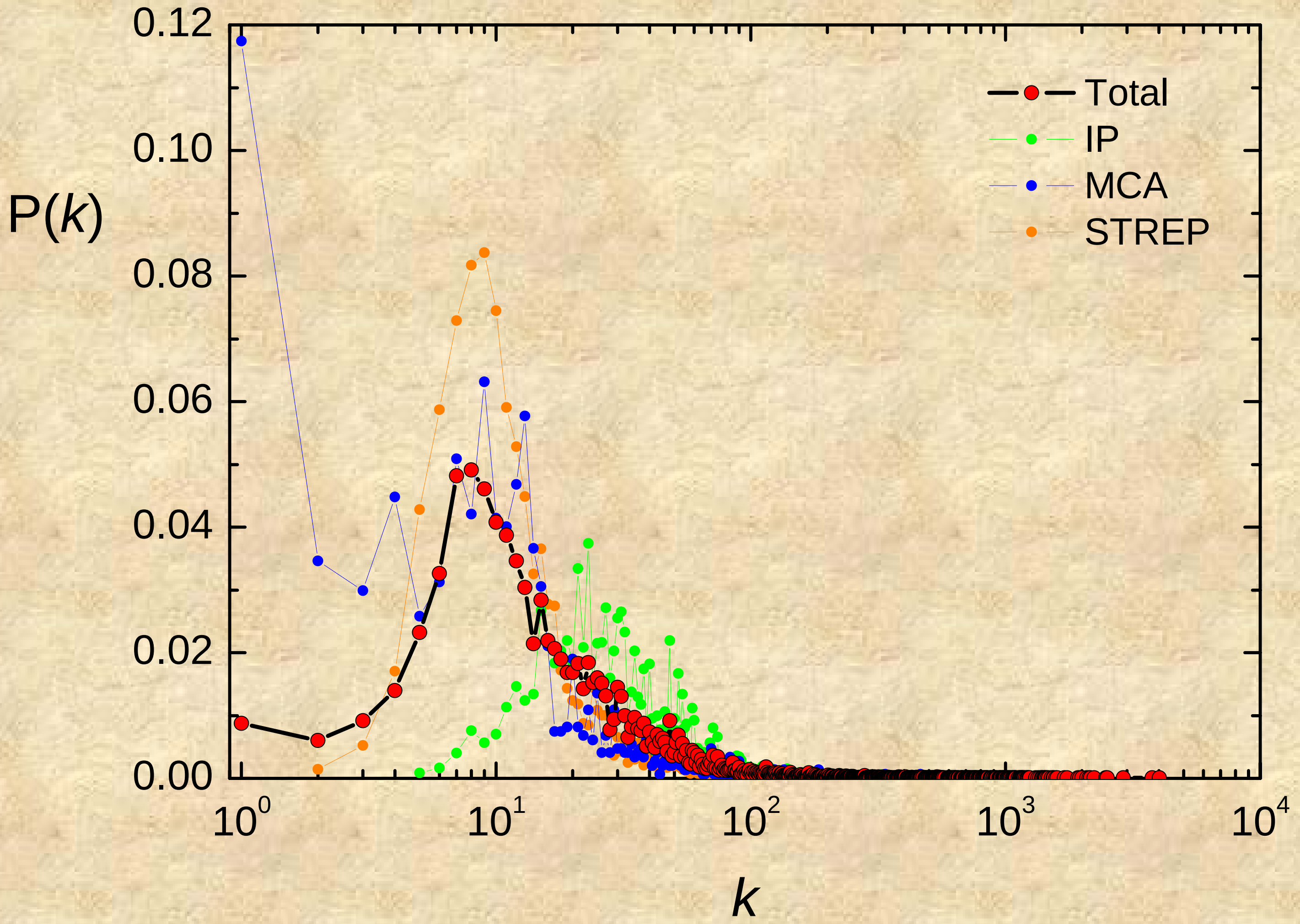
Countries
(N=147)

Degree distribution of the projected network



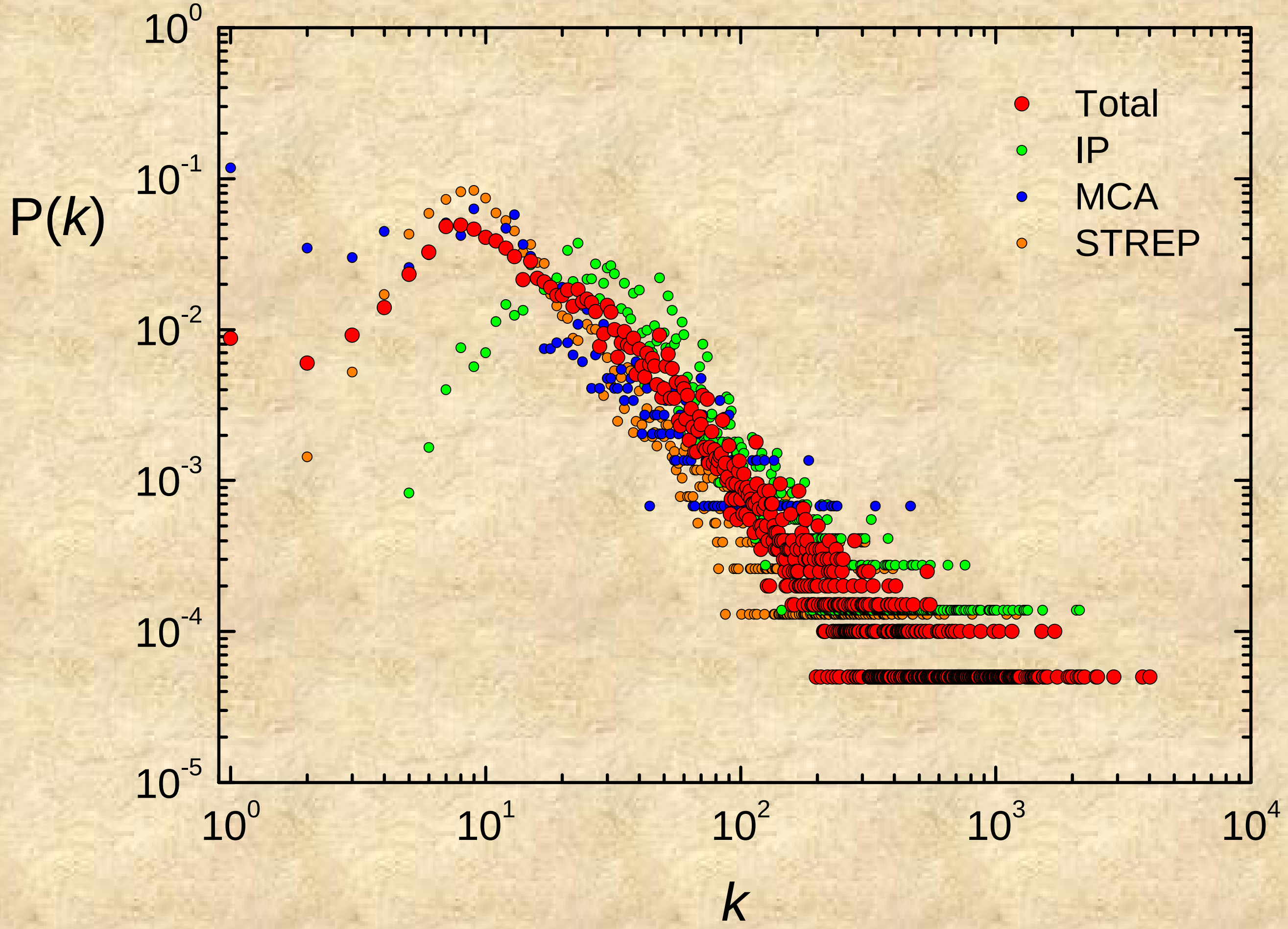
Conclusion: Enhanced collaboration with time

Degree distributions for collaborations in different instruments



FP6

Degree distributions for collaborations in different instruments

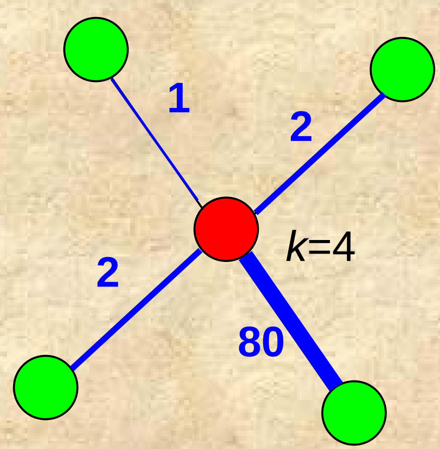


FP6

Similar large-degree behavior
starting from different 'building blocks' !

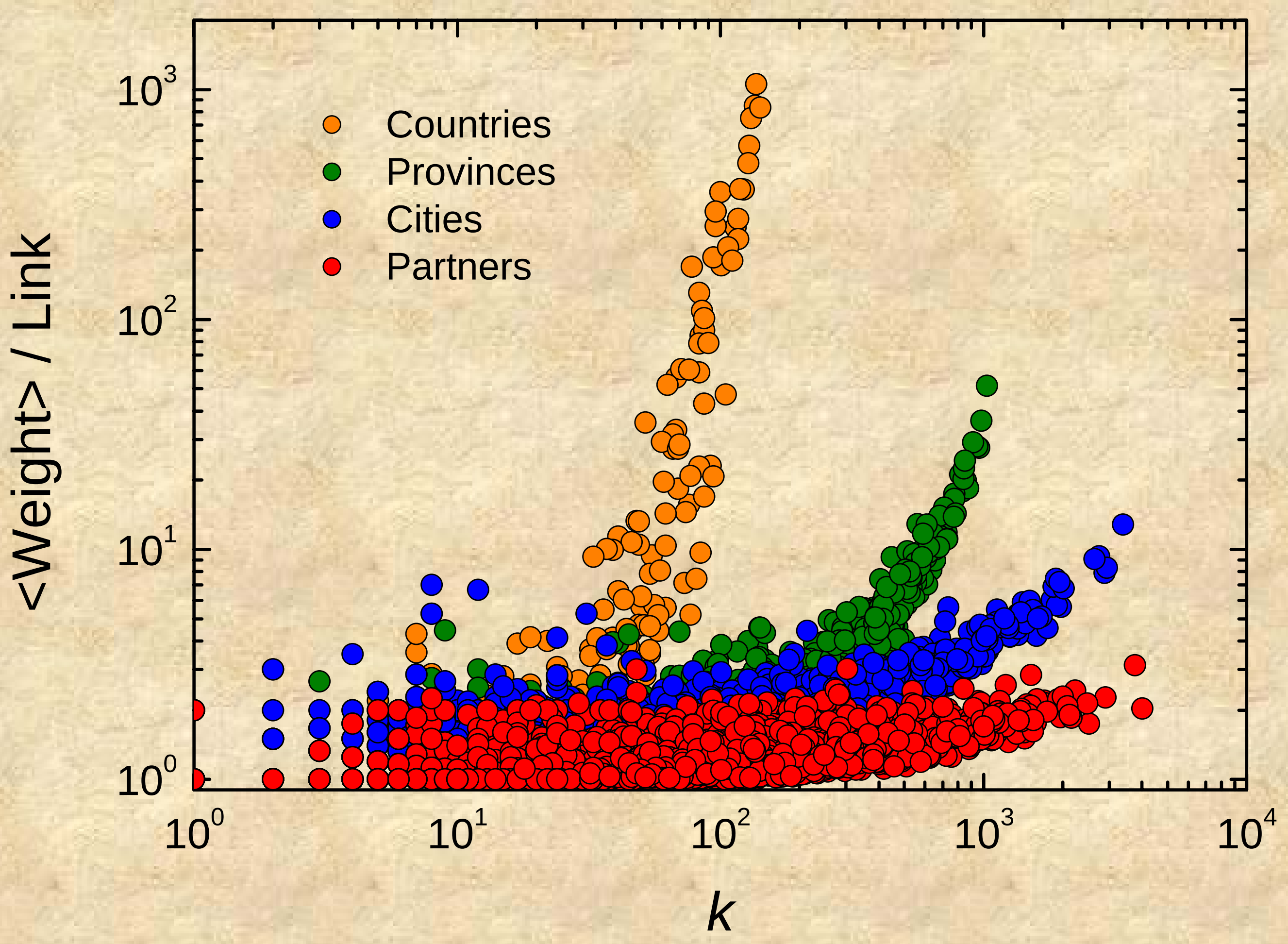
Conclusion: Instruments lead to different collaboration behavior

Weights (number of collaborations with a partner)



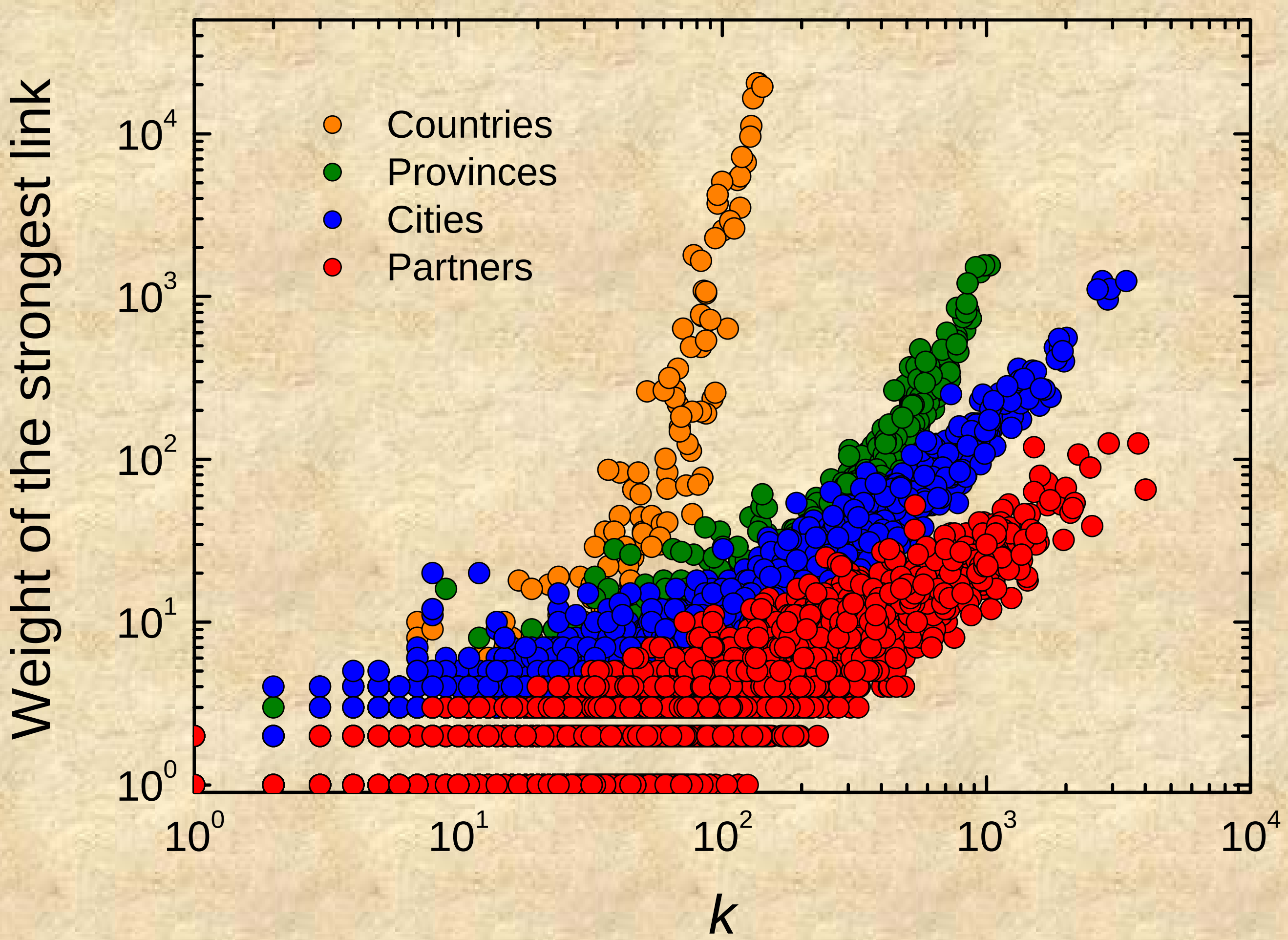
We consider as *link weight*
the number of collaborations between two partners

Weights (average number of collaborations with a partner)



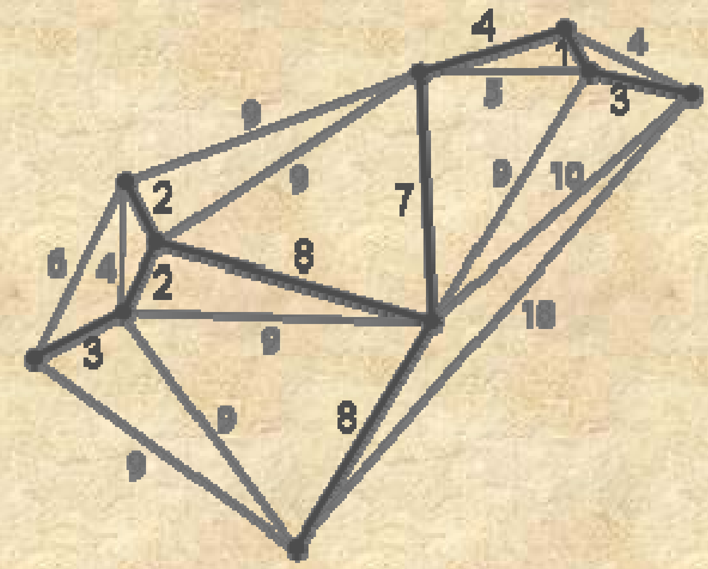
FP6

Strongest links



FP6

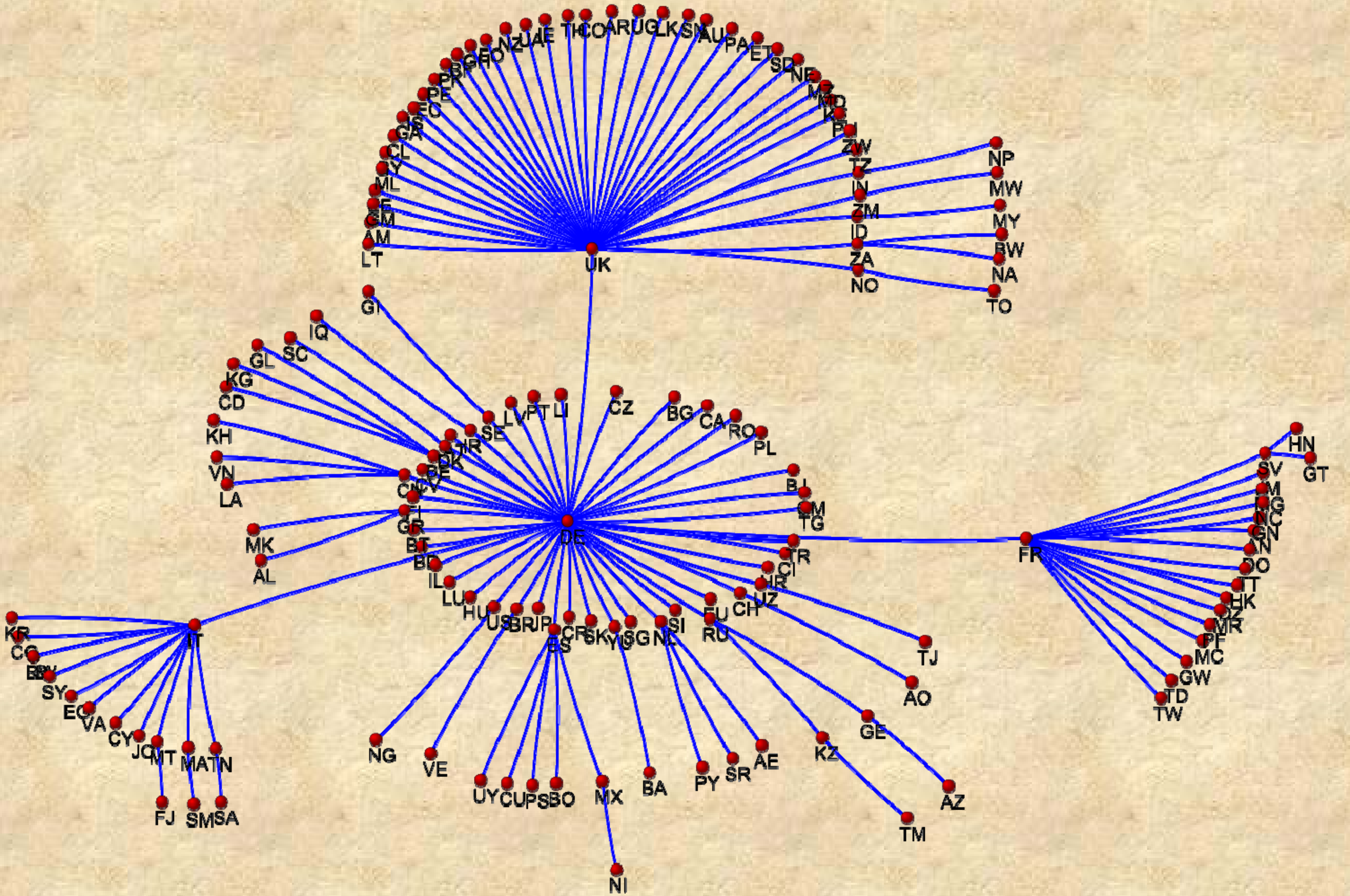
What is a minimum spanning tree ?



• Add links in increasing weight order, as long as they do not form loops. Continue until all nodes are included.

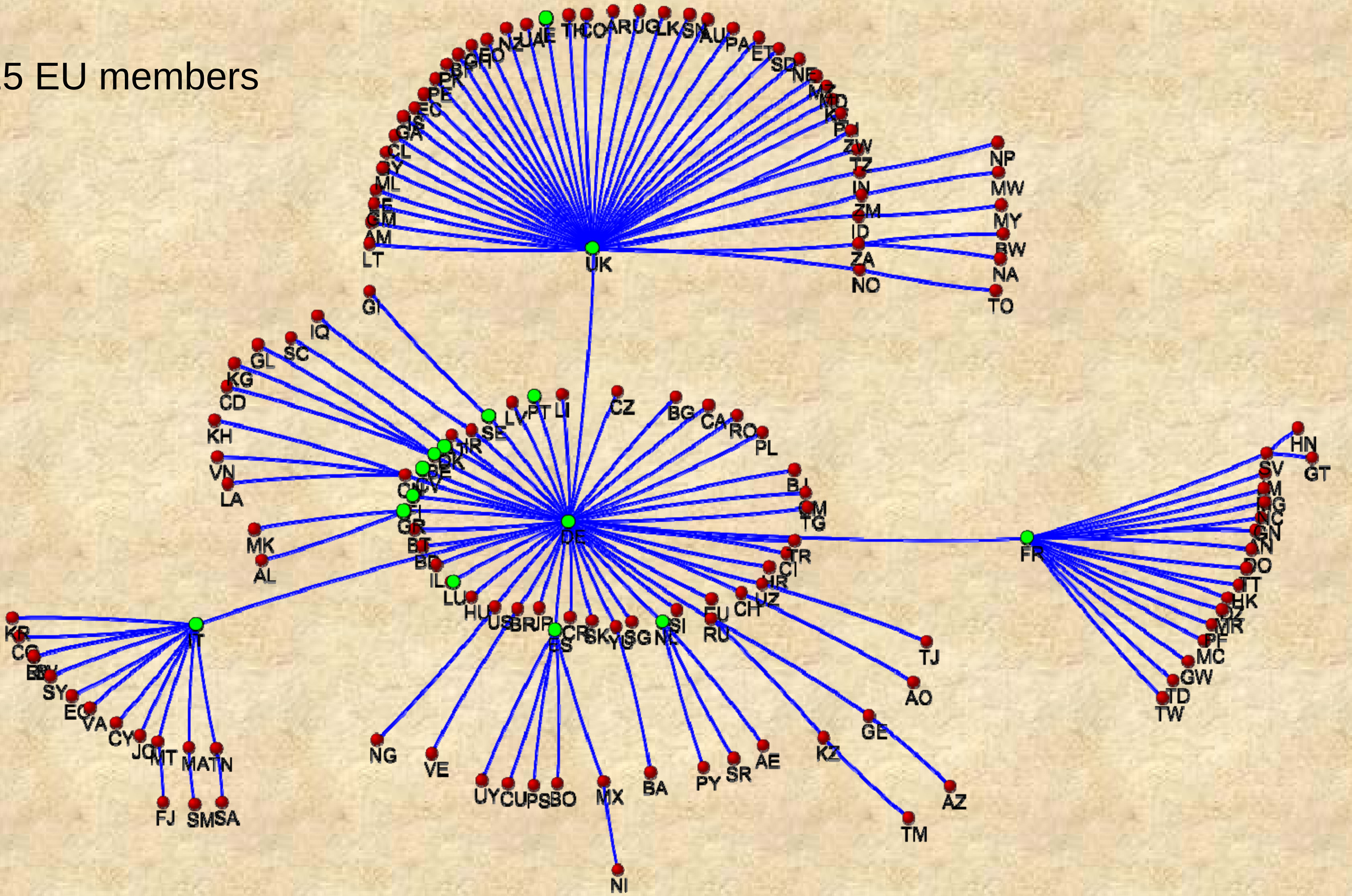
• Here, weights are the number of collaborations between two countries

FP6 Minimum Spanning Tree (countries)



FP6 Minimum Spanning Tree (countries)

● 15 EU members



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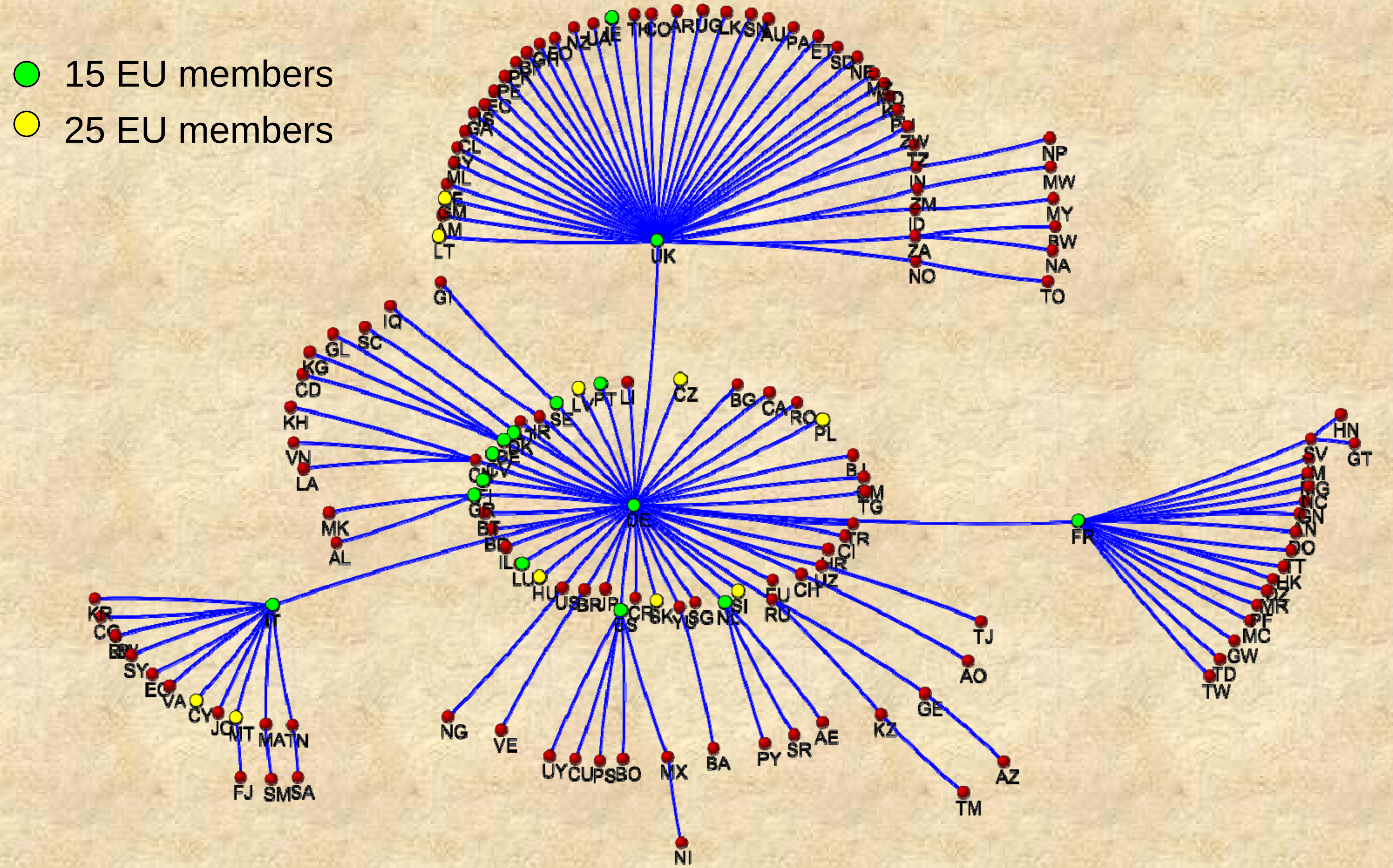


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500 km
Reykjavik
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Açores (P)
Madeira (P)
Canarias (E)
Guadeloupe (F)
Martinique (F)
Paramaribo
Suriname
Guyane (F)
Brasil
Réunion (F)
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Candidate countries

FP6


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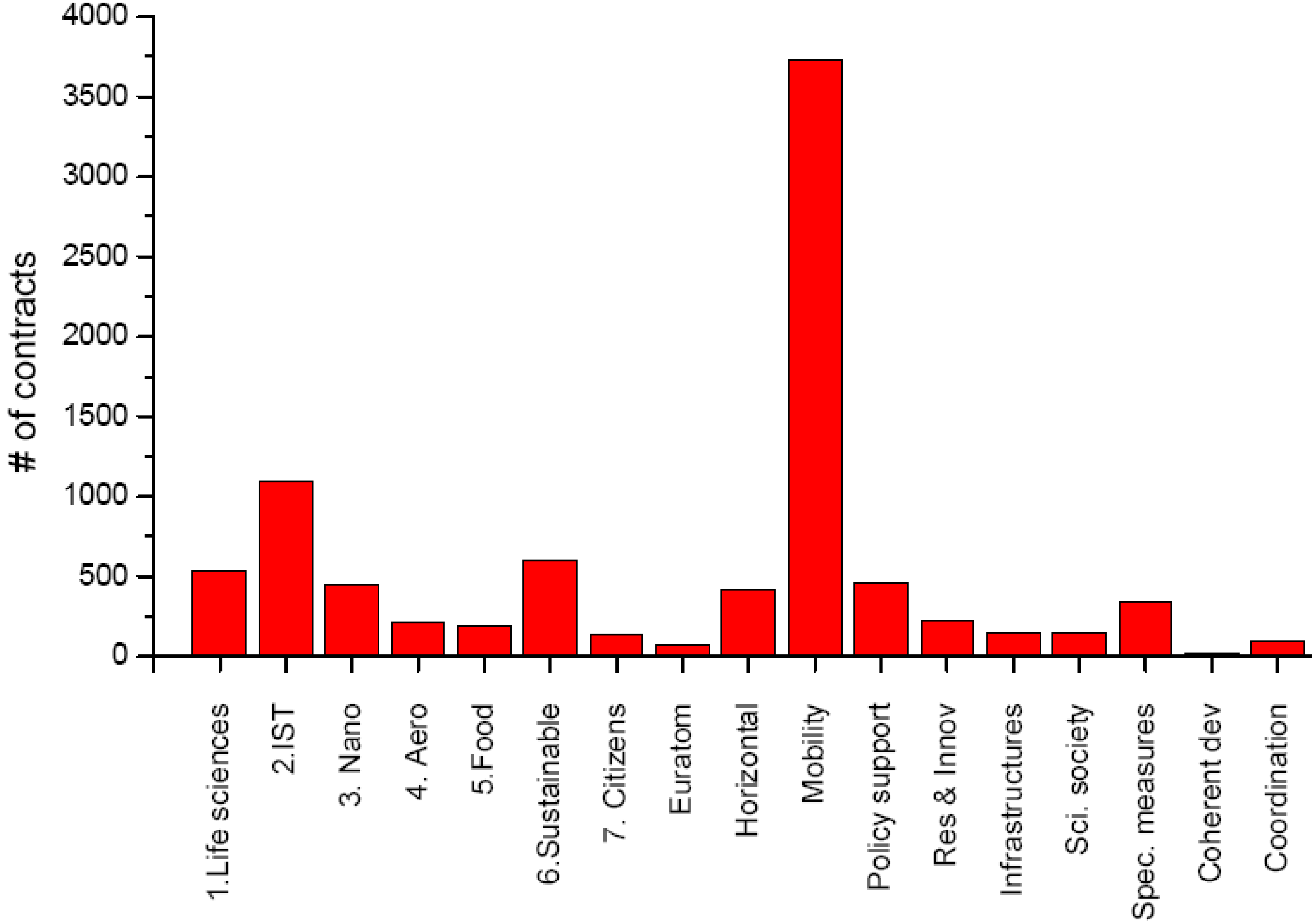
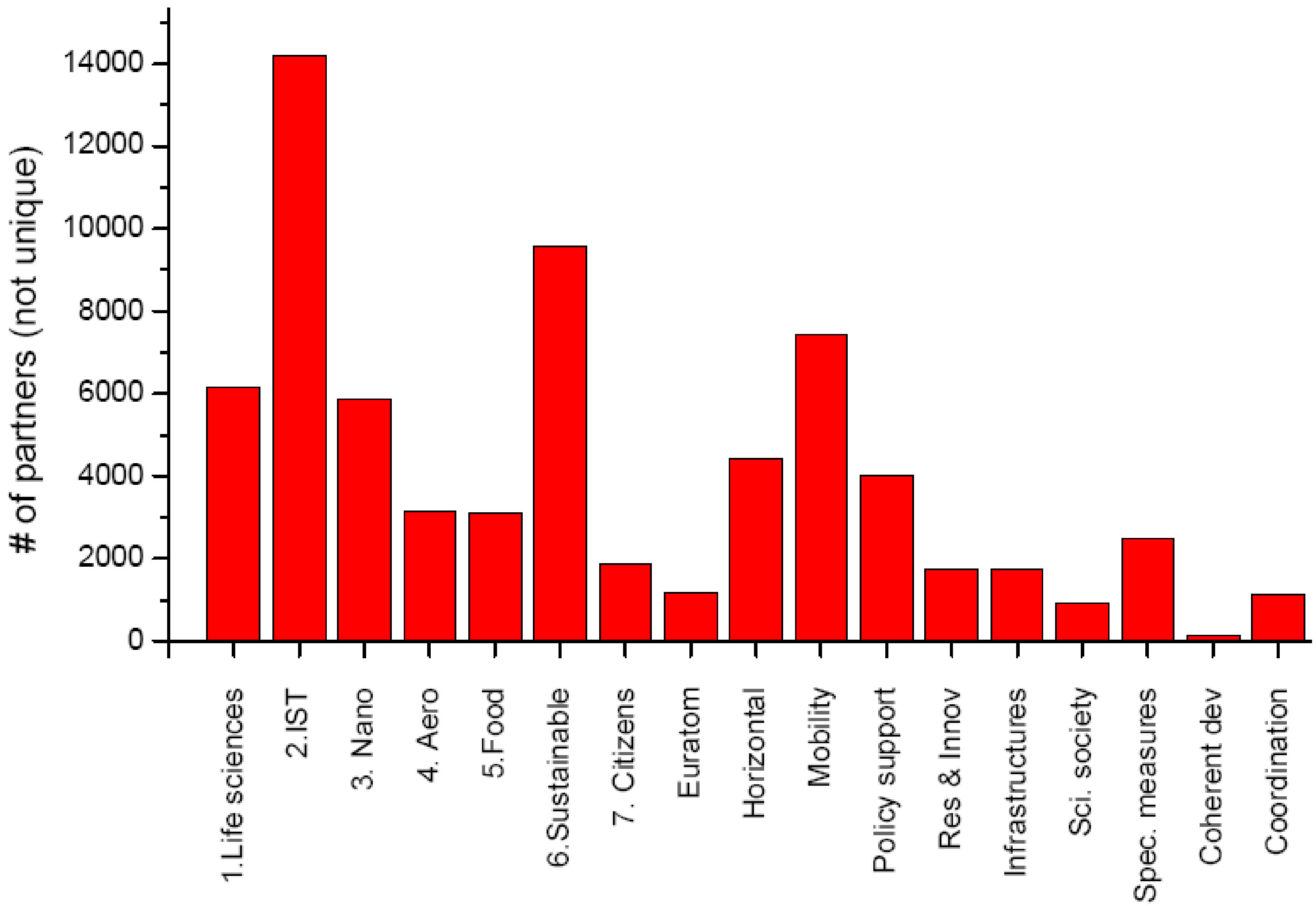
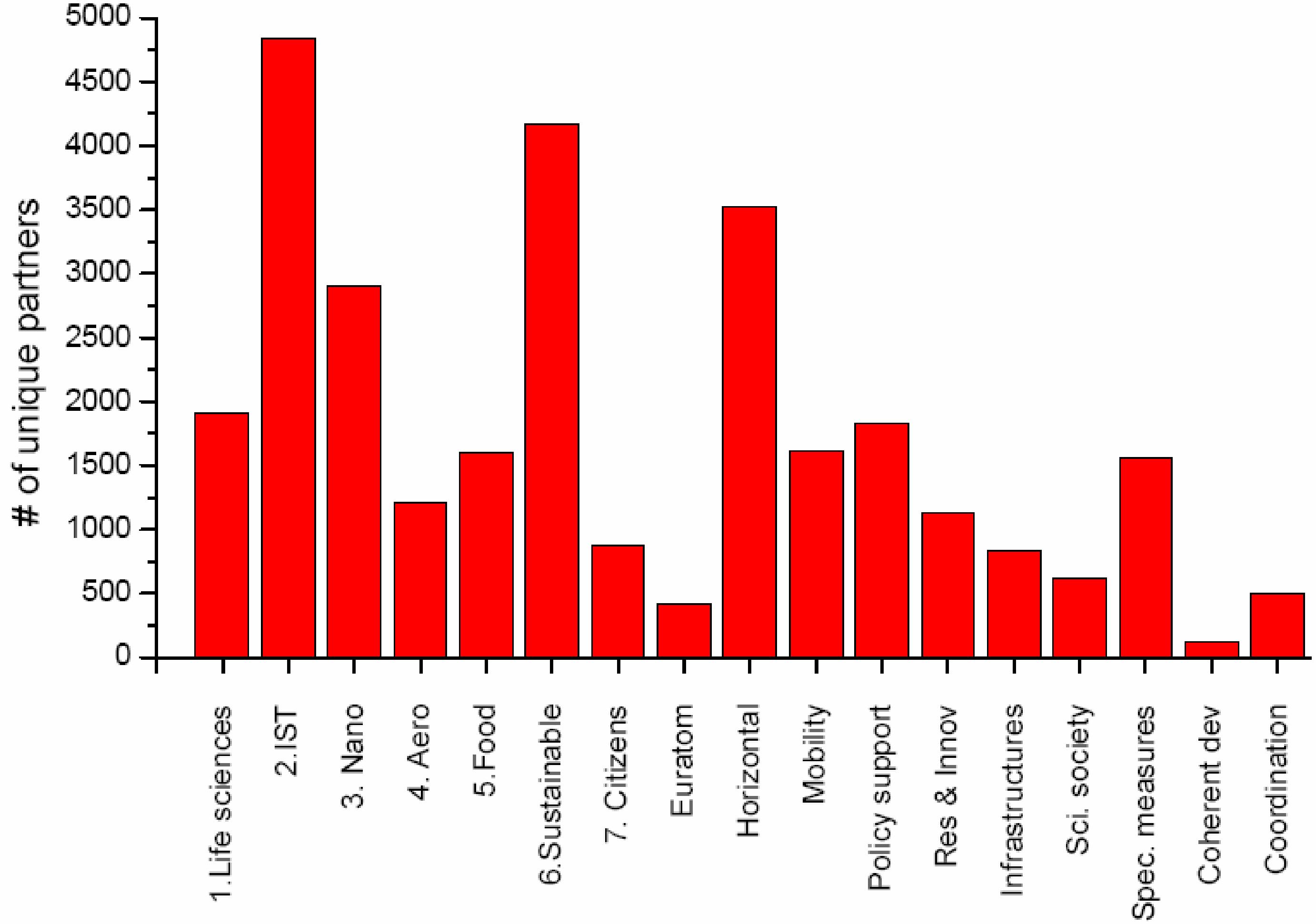


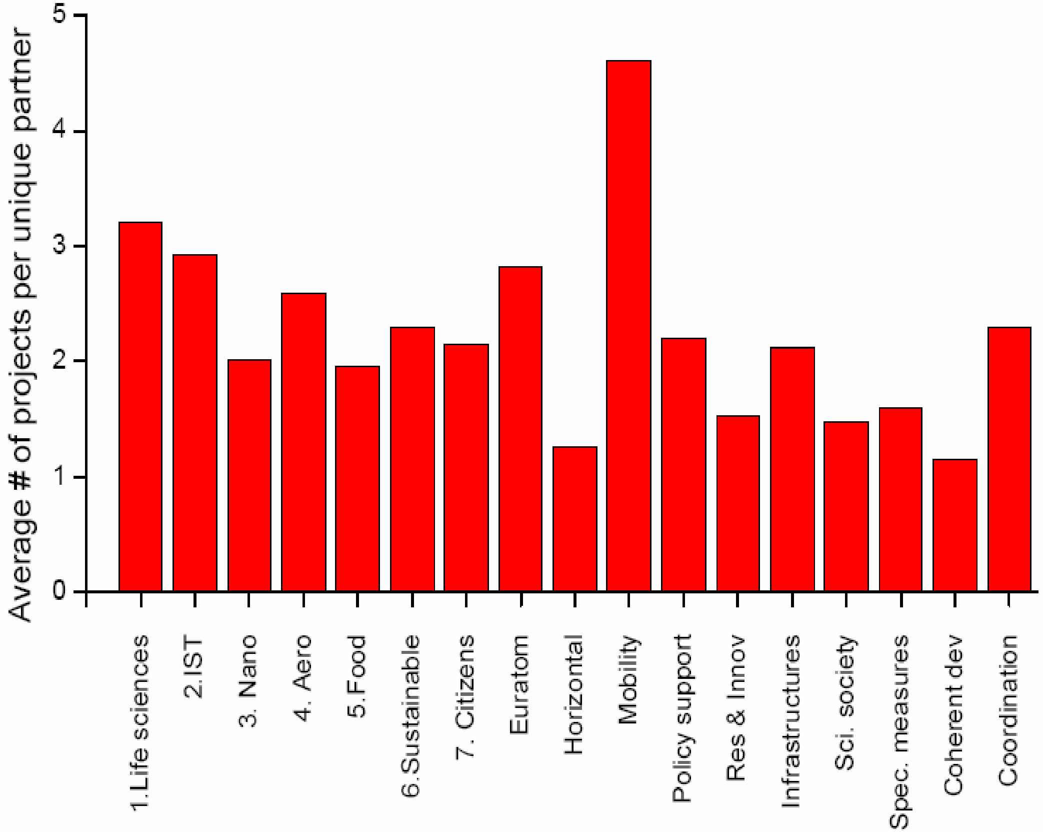
Number of contracts per thematic area for the entire FP6 duration.



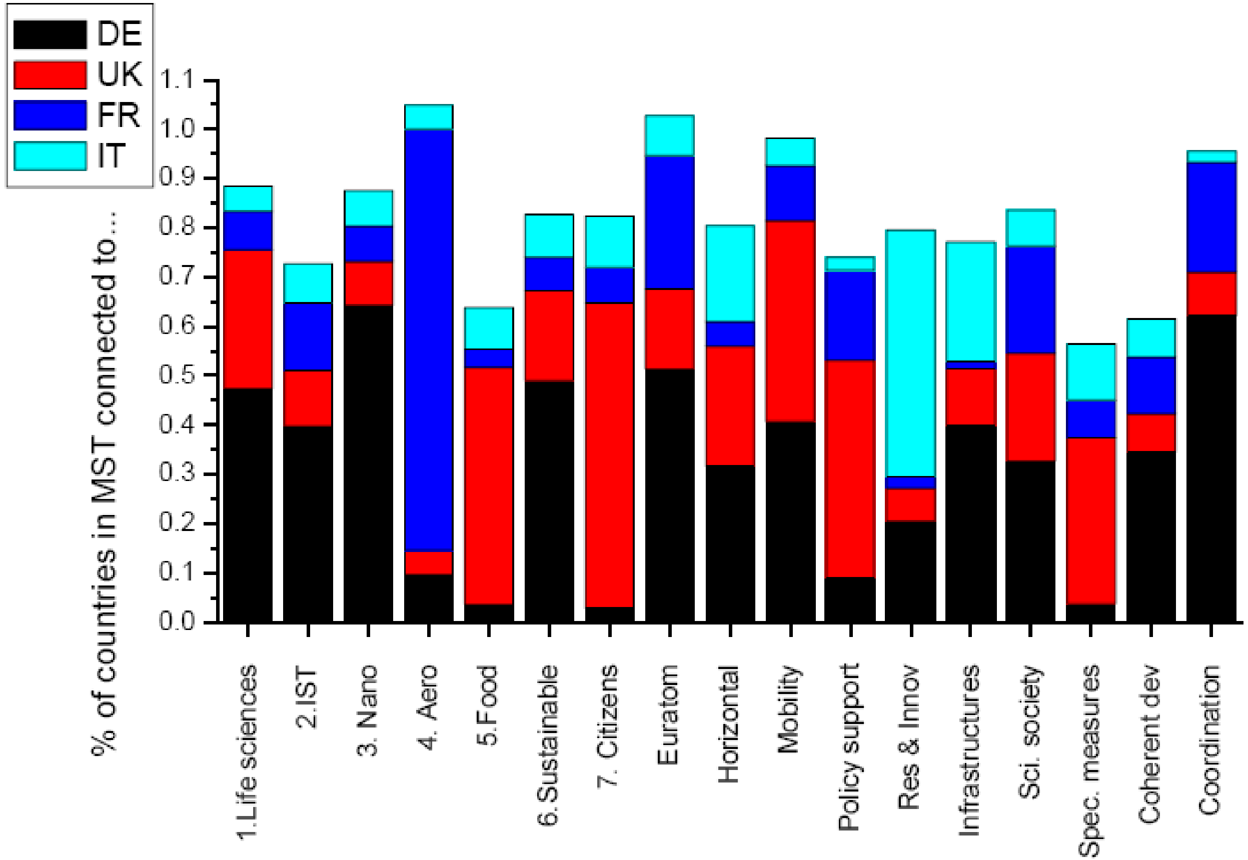
Number of contractors per thematic area for the entire FP6 duration.



Number of unique partners per thematic area for the entire FP6 duration.



Average number projects for an institution per thematic area for the entire FP6 duration.



We construct the MST for collaboration between countries in a given thematic area. Then we focus on a given country, say Germany, and measure what percentage of the MST nodes are connected to Germany. This shows how 'central' Germany is in a given thematic area. We repeat the same for UK, France and Italy. For example, in 3. Nanoscience 65% of the nodes are directly connected to Germany, while in 4. Aero-Space more than 80% are connected to France.

TOTAL

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500 km
Ísland
Reykjavik
Açores (P)
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Candidate countries

TOTAL

Member states of the European Union (2007)

Candidate countries

1. LIFE


0
500 km
Reykjavík
Ísland
Norge
Oslo
Sverige
Stockholm
Suomi
Finland
Helsinki
Helsingfors
Eesti
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Latvija
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1. LIFE

Member states of the European Union (2007)

Candidate countries

2. IST

Member states of the European Union (2007)

Candidate countries

2. IST

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3. Nano

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500 km
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Madeira (P)
Canarias (E)
Guadeloupe (F)
Martinique (F)
Paramaribo
Suriname
Guyane (F)
Brasil
Réunion (F)
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Kibris
Lefkosia
Lefkosa
Libnan
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Souriya
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3. Nano

Member states of the European Union (2007)

Candidate countries

4. Space

Member states of the European Union (2007)

Candidate countries

4. Space

Member states of the European Union (2007)

Candidate countries

5. Food

Member states of the European Union (2007)

Candidate countries

5. Food

0
500 km
Ísland
Reykjavík
Norge
Sverige
Stockholm
Suomi
Finland
Helsinki
Helsingfors
Eesti
Latvija
Lietuva
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Baile Atha Cliath
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Souriya
Dimashq
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Beyrouth
Κύπρος
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Slovensko
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Tunis
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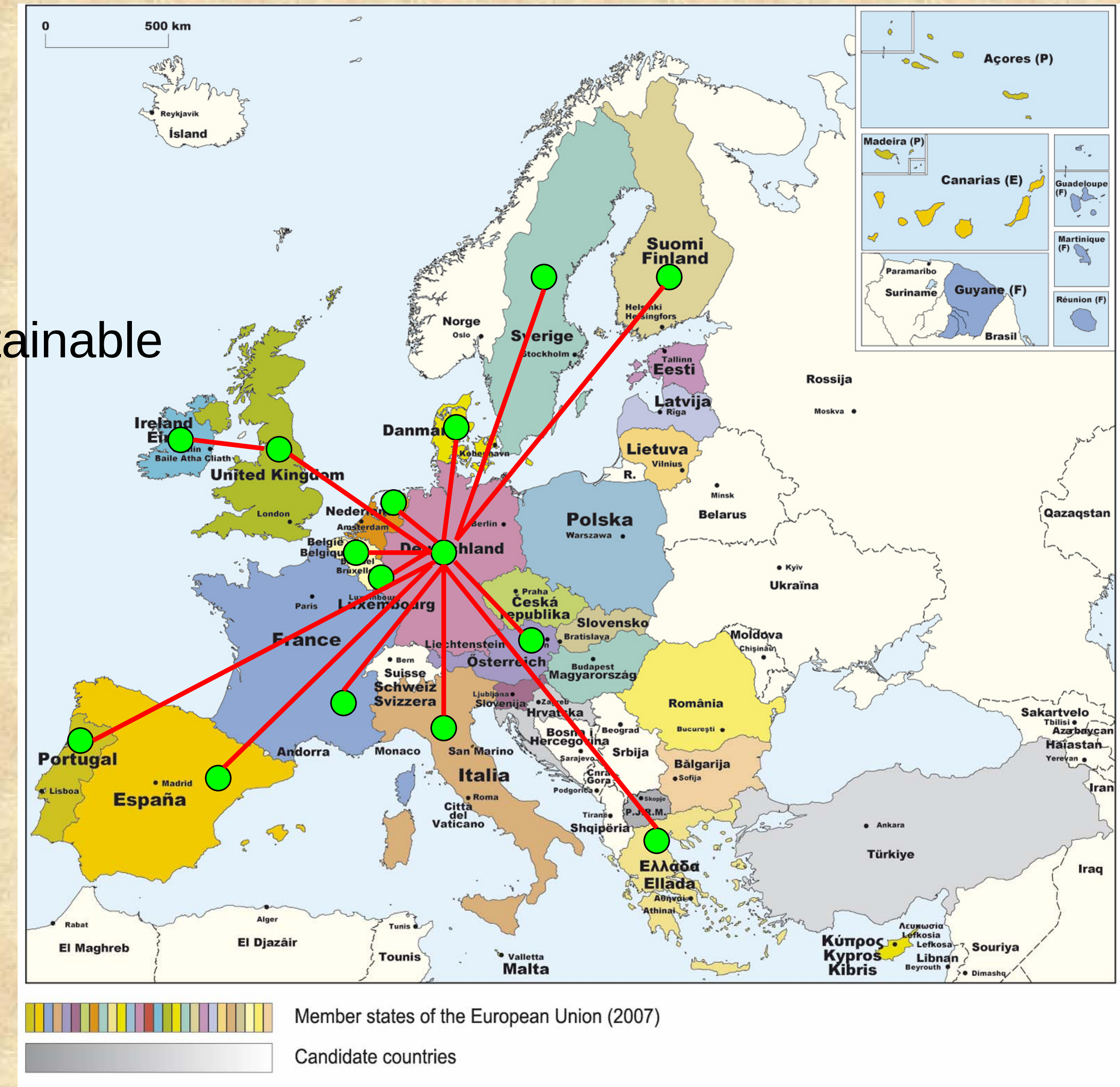
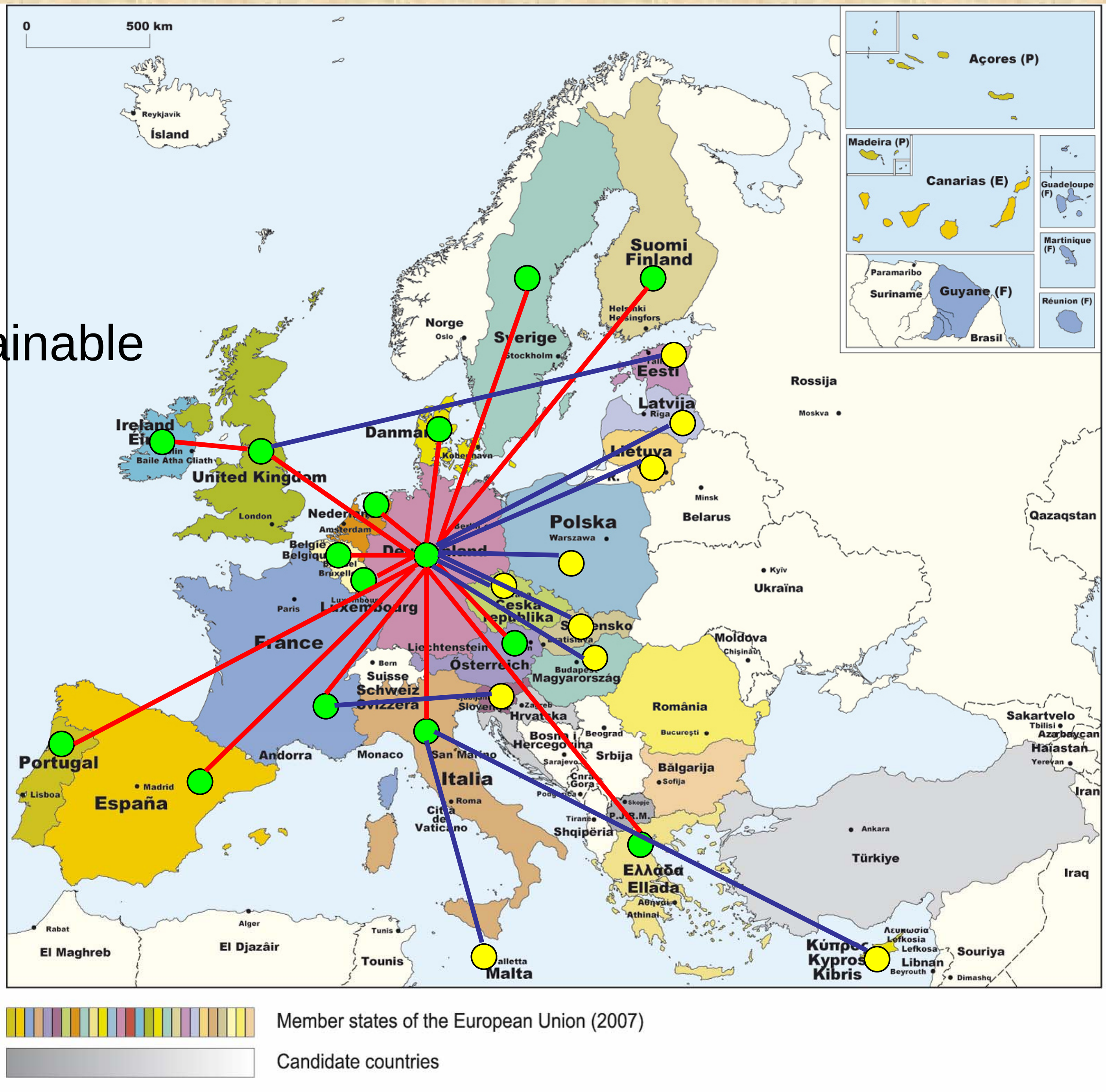
Madeira (P)
Canarias (E)
Guadeloupe (F)
Martinique (F)
Paramaribo
Suriname
Guyane (F)
Brasil
Réunion (F)
Member states of the European Union (2007)
Candidate countries

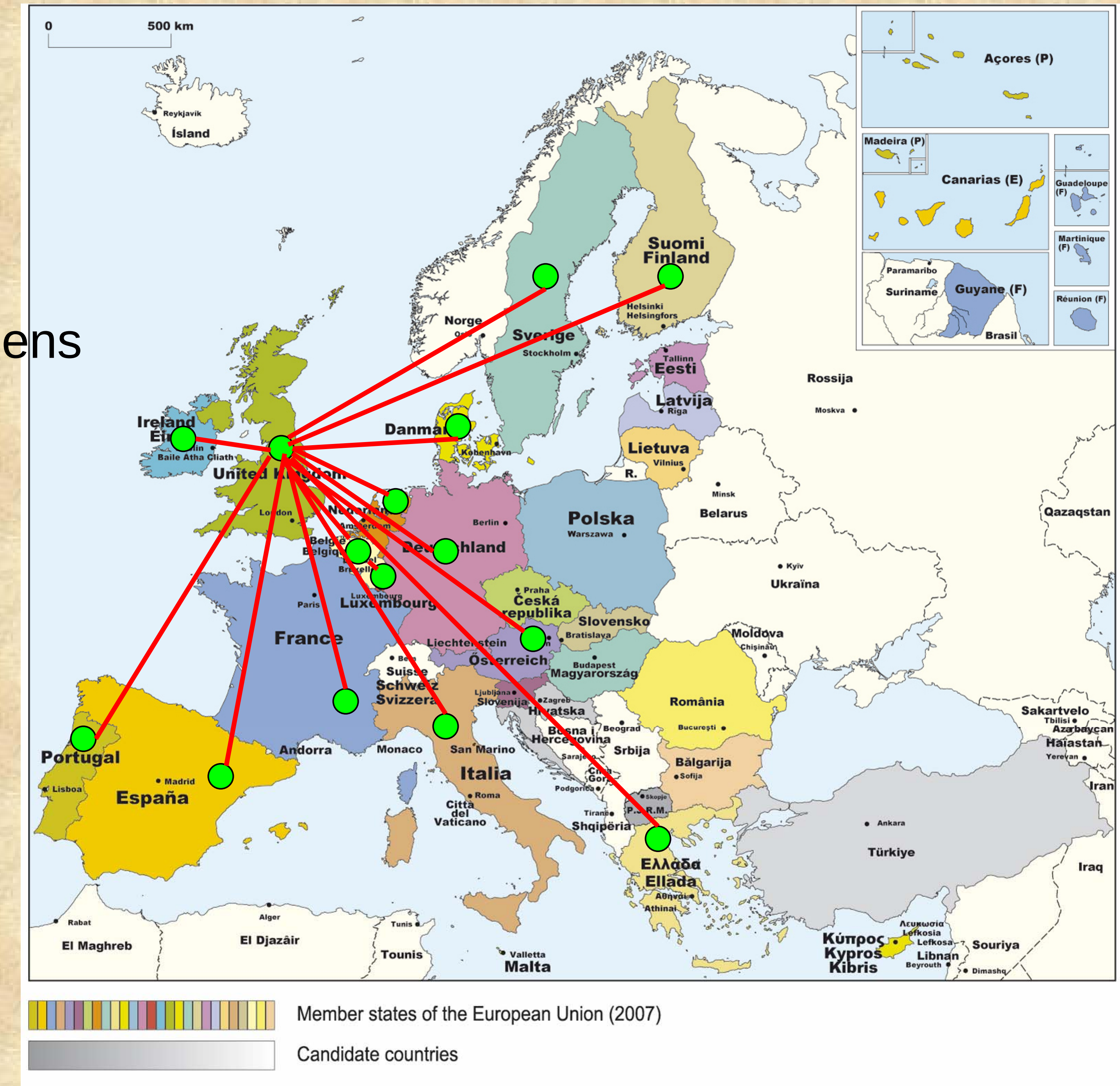
6. Sustainable



6. Sustainable



7. Citizens



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Reykjavik
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Madeira (P)
Canarias (E)
Guadeloupe (F)
Martinique (F)
Paramaribo
Suriname
Guyane (F)
Brasil
Réunion (F)
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Finland
Helsinki
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Norge
Sverige
Stockholm
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Riga
Rossija
Moskva
Ireland
Baile Atha Cliath
United Kingdom
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Portugal
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Beograd
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Podgorica
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Shqipëria
Skopje
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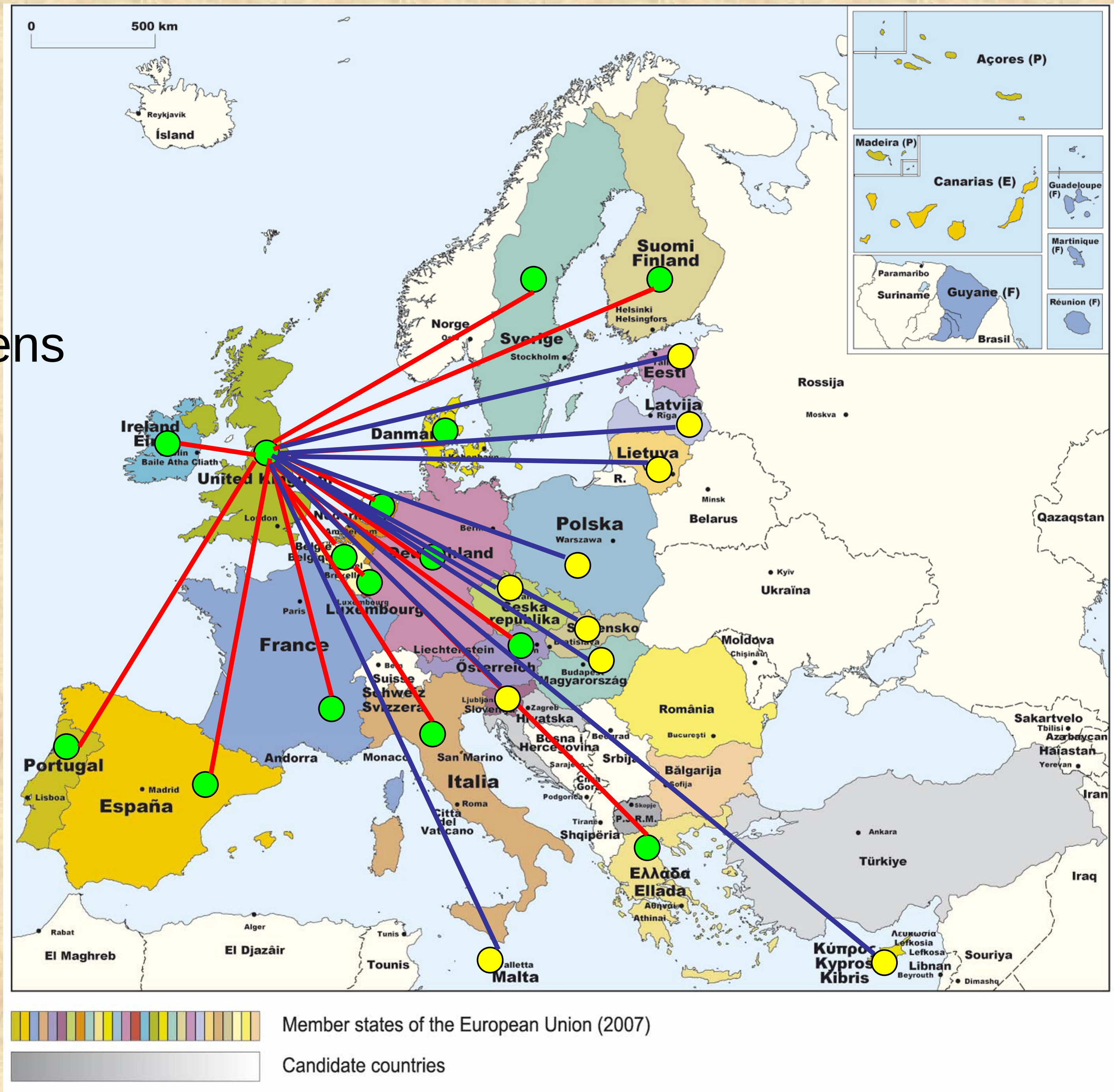
Member states of the European Union (2007)
Candidate countries

7. Citizens



Member states of the European Union (2007)
Candidate countries

Euratom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Reykjavik
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Madeira (P)
Canarias (E)
Guadeloupe (F)
Martinique (F)
Paramaribo
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Euratom

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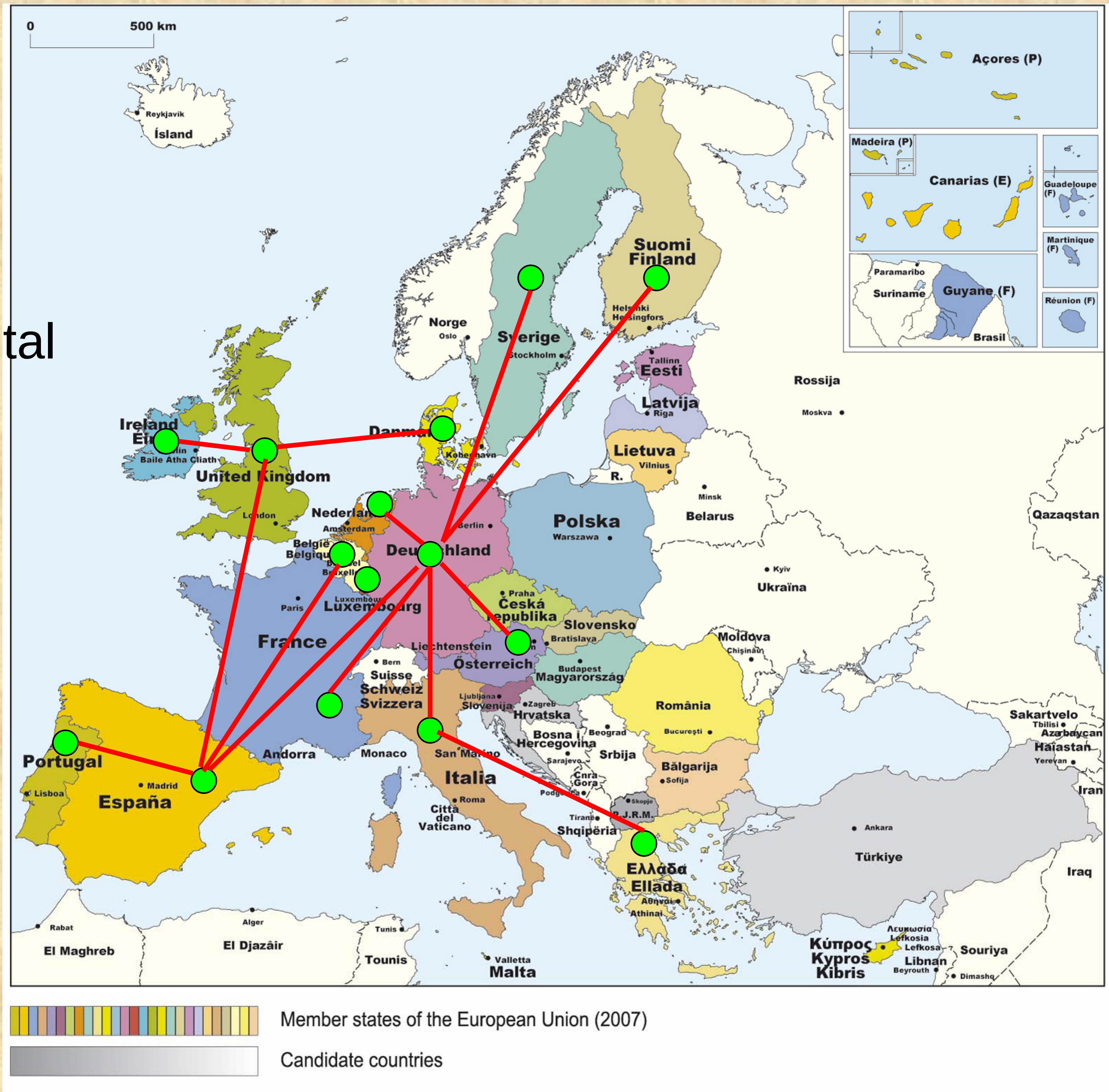
Candidate countries

Horizontal



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Madeira (P)
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Horizontal

Member states of the European Union (2007)

Candidate countries

Mobility

Member states of the European Union (2007)

Candidate countries

Mobility

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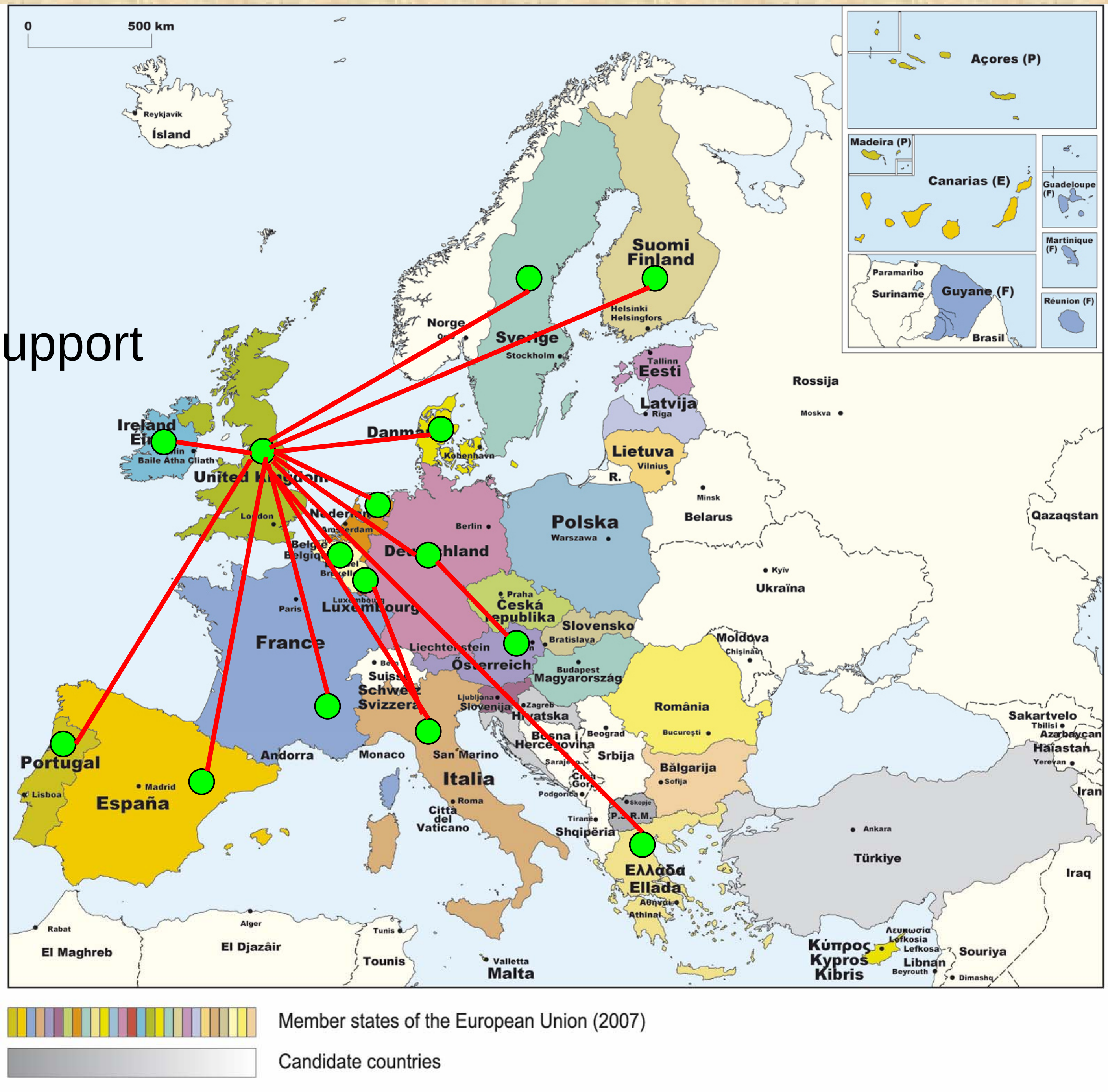
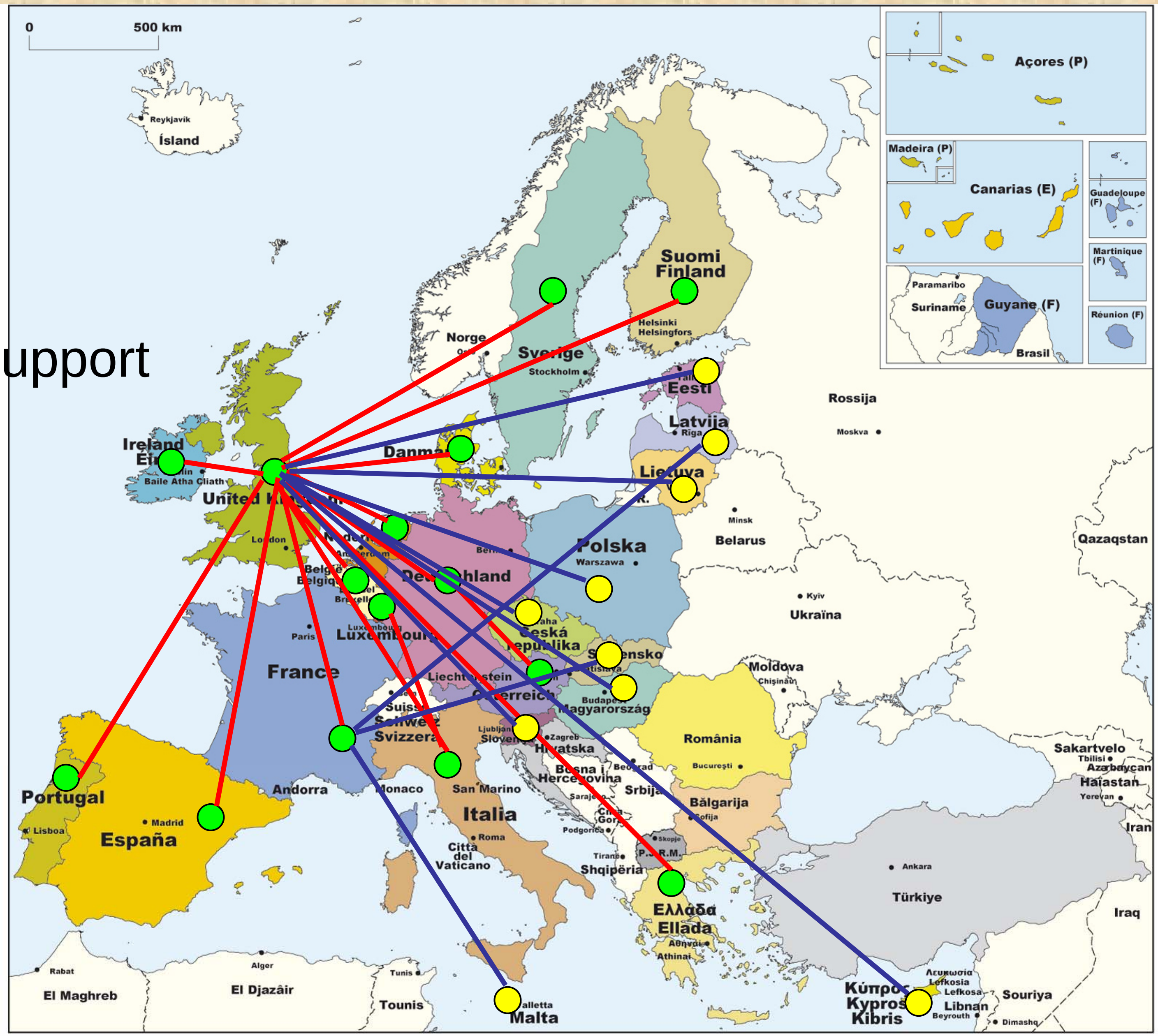
Policy support



Policy support



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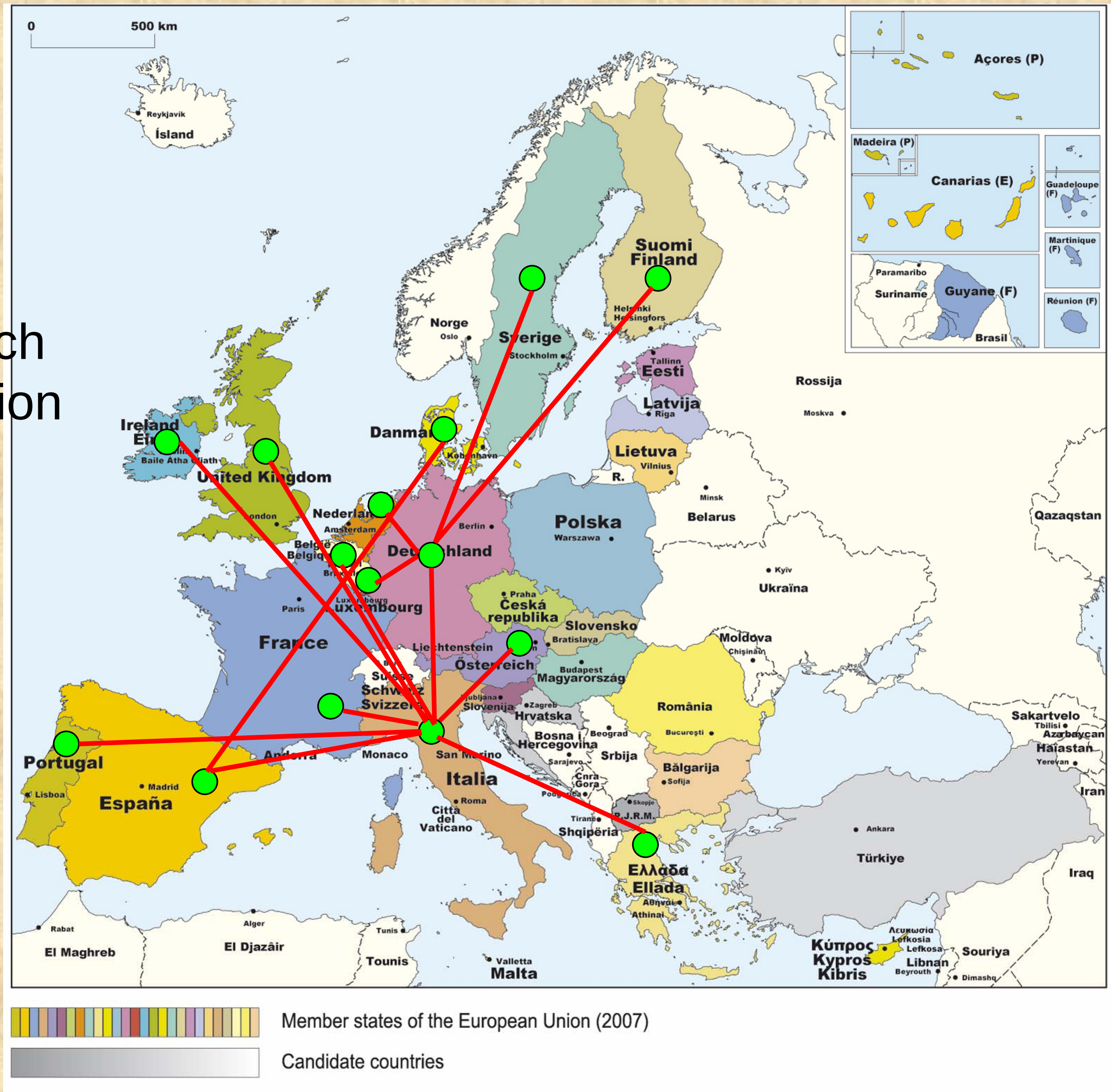
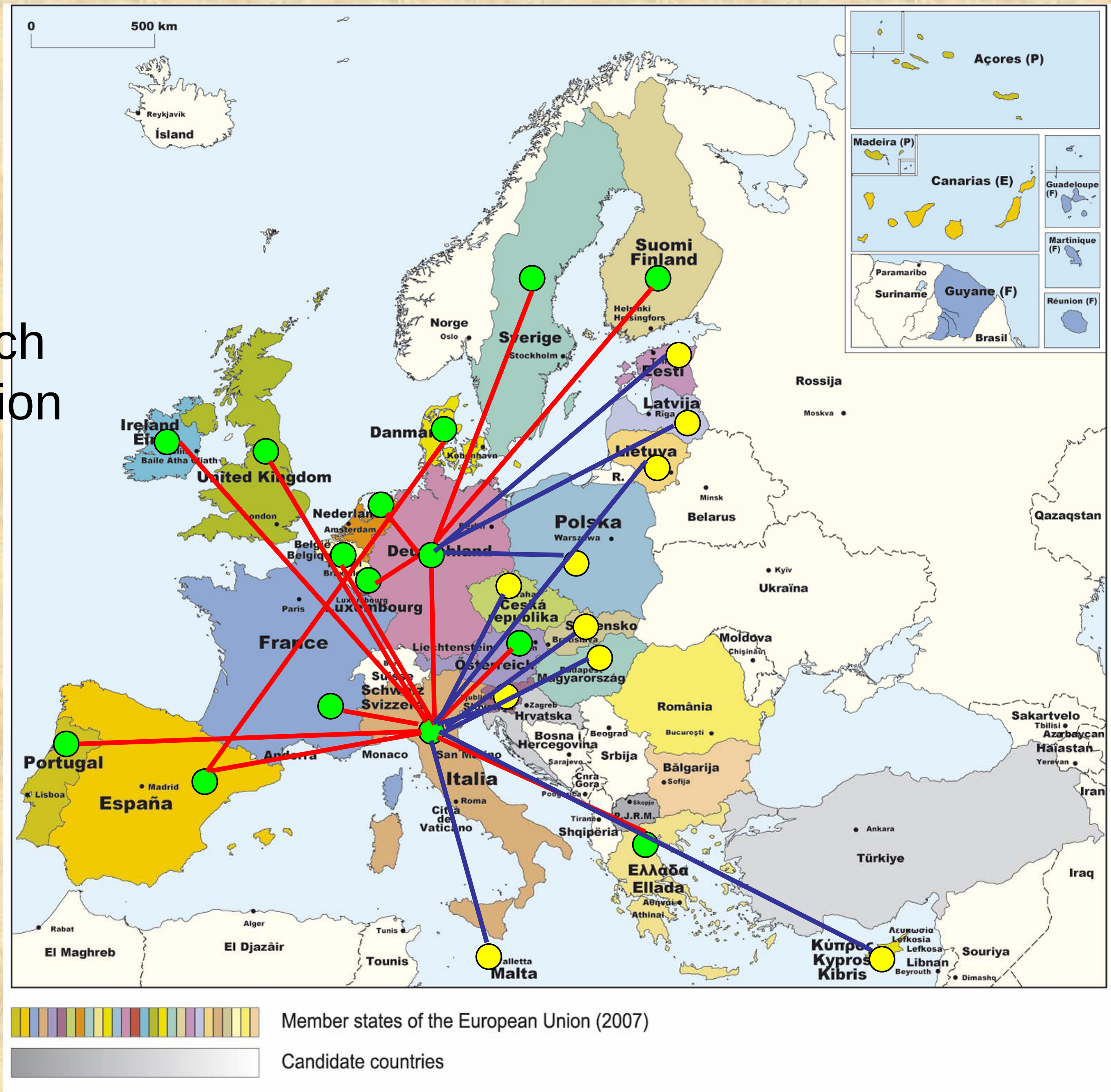
Research
Innovation



Research
Innovation



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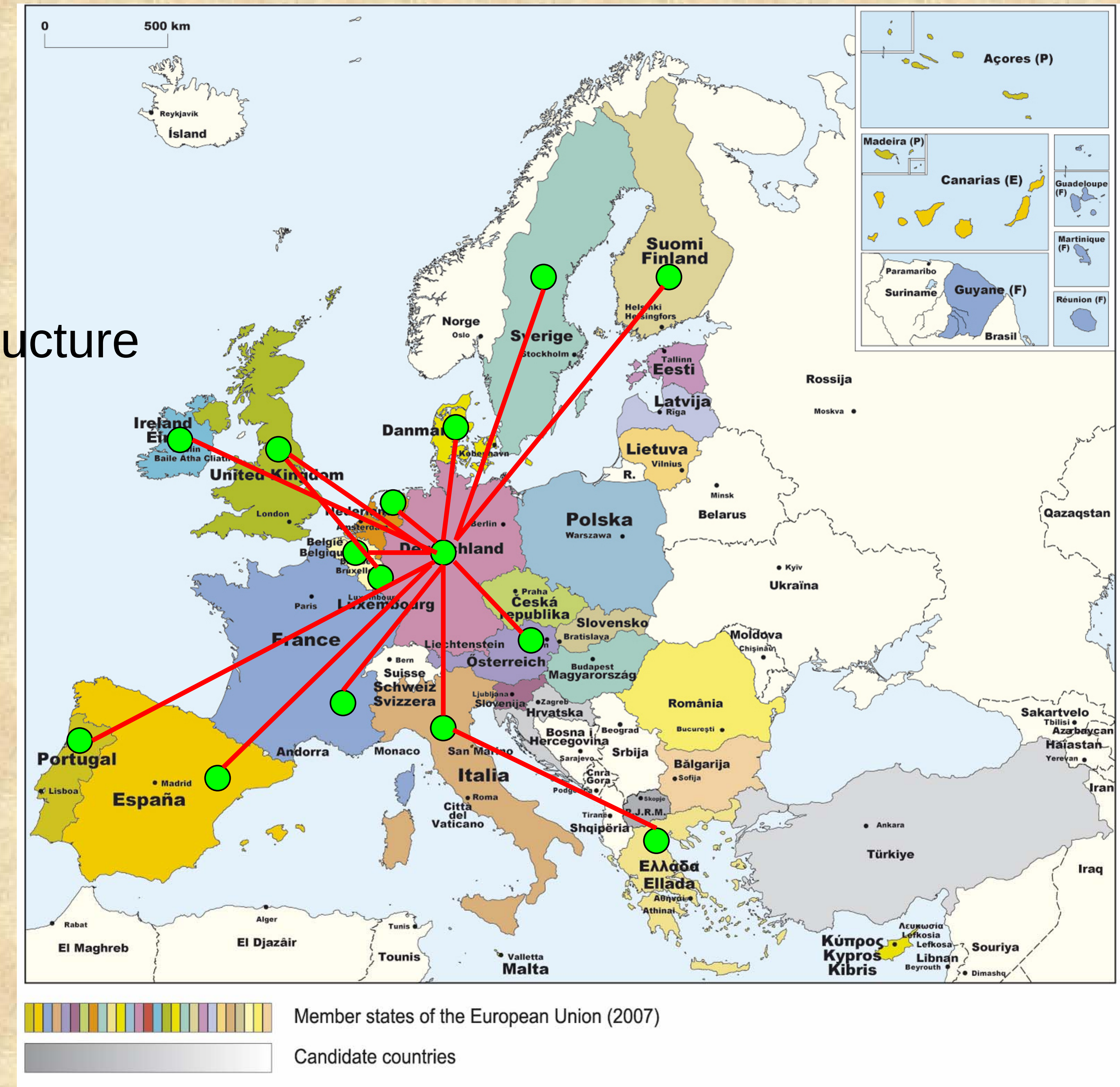
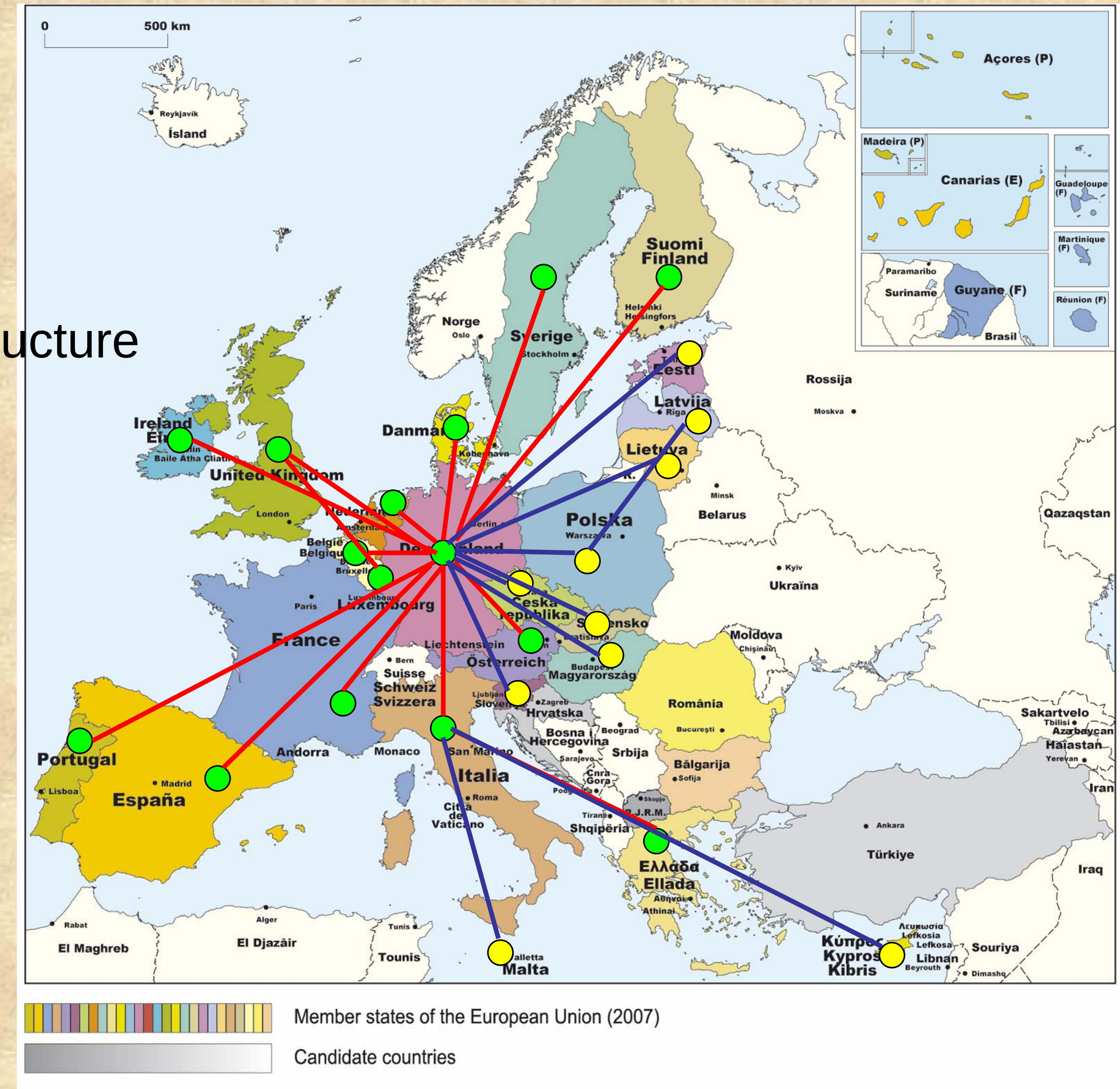


Infrastructure



Science & Society

Science & Society

INCO

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INCO

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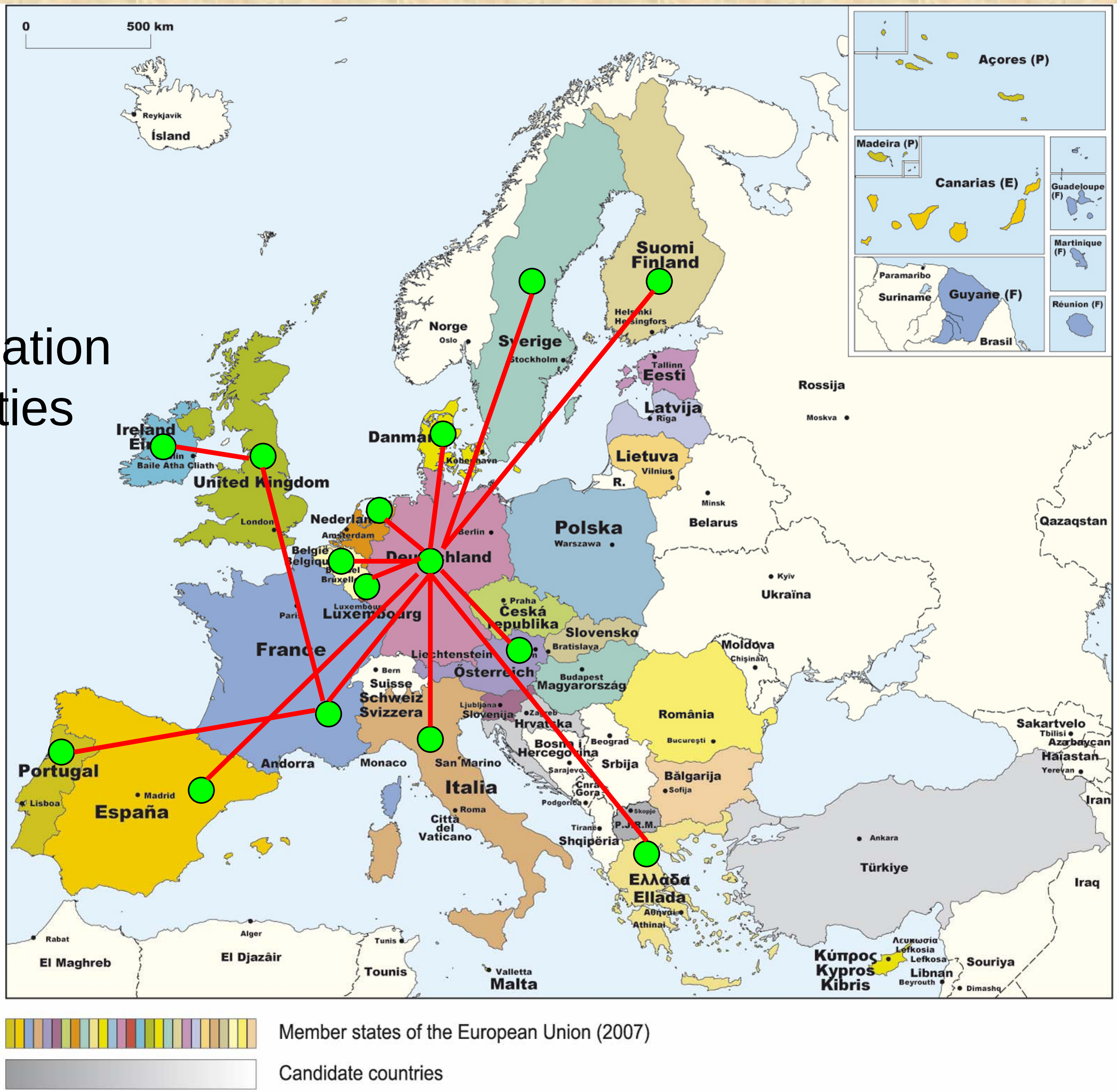
Coordination of activities



Coordination of activities

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The network of scientific collaborations within the European framework programme

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Abstract

We use the emergent field of complex networks to analyze the network of scientific collaborations between entities (universities, research organizations, industry related companies,...) which collaborate in the context of the so-called framework programme. We demonstrate here that it is a scale-free network with an accelerated growth, which implies that the creation of new collaborations is encouraged. Moreover, these collaborations possess hierarchical modularity. Likewise, we find that the information flow depends on the size of the participants but not on geographical constraints.

PACS: 05.10.−a; 89.65.−s; 89.75.−k

Keywords: Complex networks; Accelerated growth; Hierarchical modularity

CONCLUSIONS

- Network theory can help us address questions of importance to research policy-makers
- The same collaboration databases reveal significant self-organization principles

Boxing a network

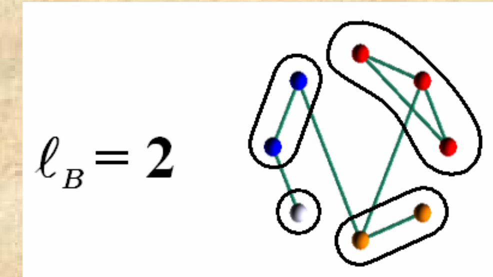
How to "zoom out" of a complex network?

- Generate boxes where all nodes are within a distance l_B
- Calculate number of boxes, N_B, of size l_B needed to cover the network

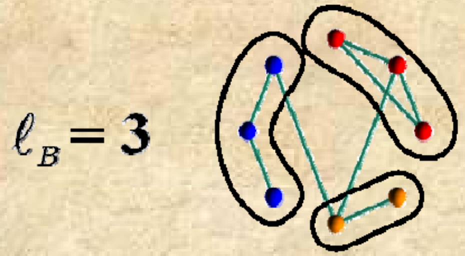
$$N_B(l_B) \sim l_B^{-d_B}$$

(Song, Havlin, and Makse, *Nature 2005, Nature Physics 2006)*

Larger distances need fewer boxes

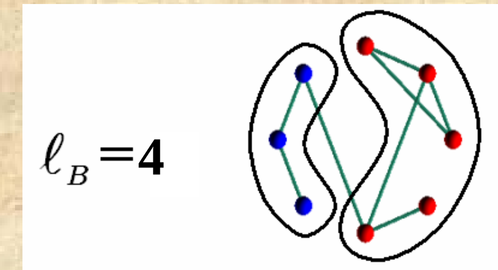


$$N_B = 4$$

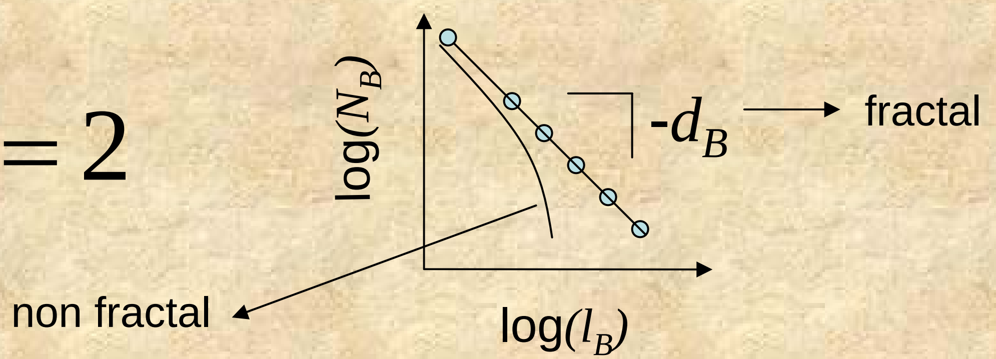


$$N_B = 3$$

$$N_B(l_B) \sim l_B^{-d_B}$$

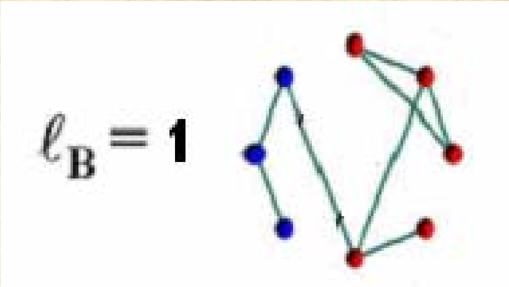


$$N_B = 2$$

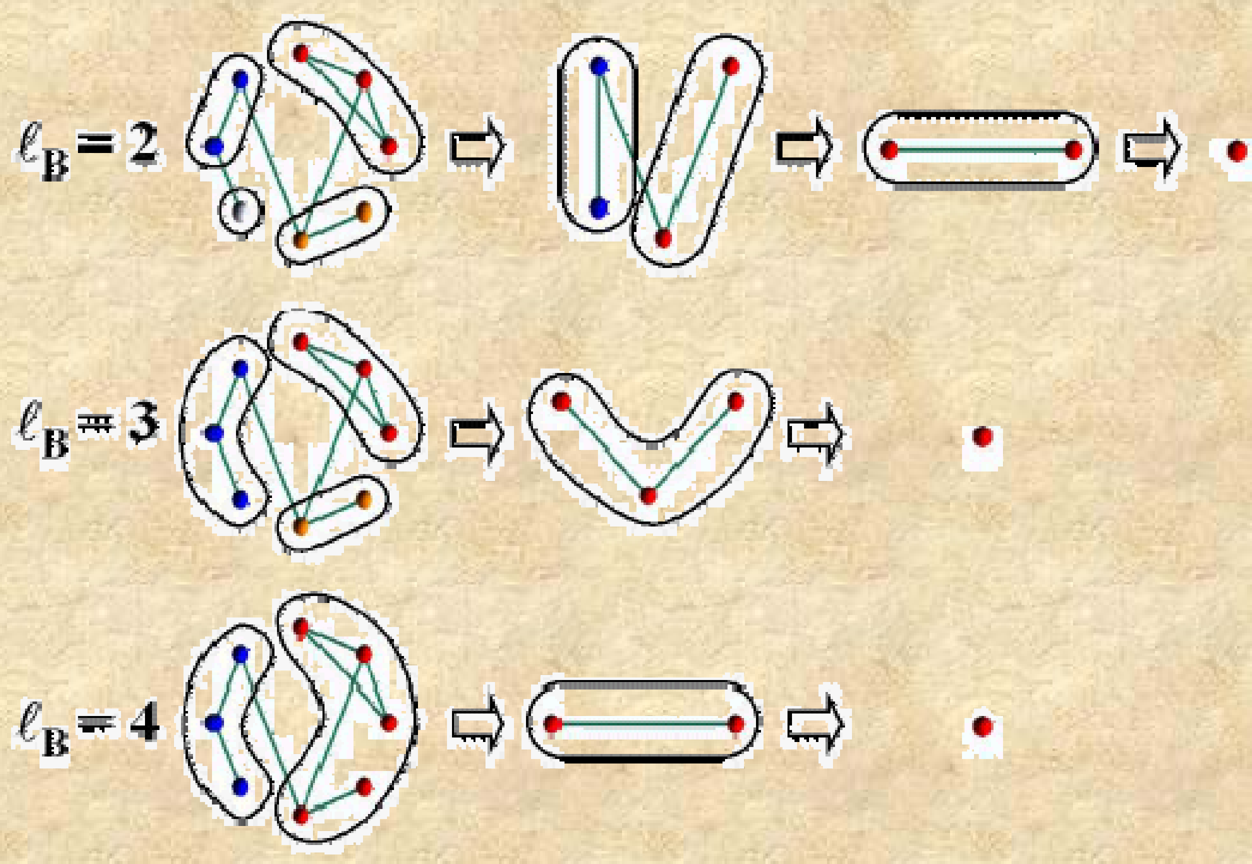


$$d_B \rightarrow \infty$$

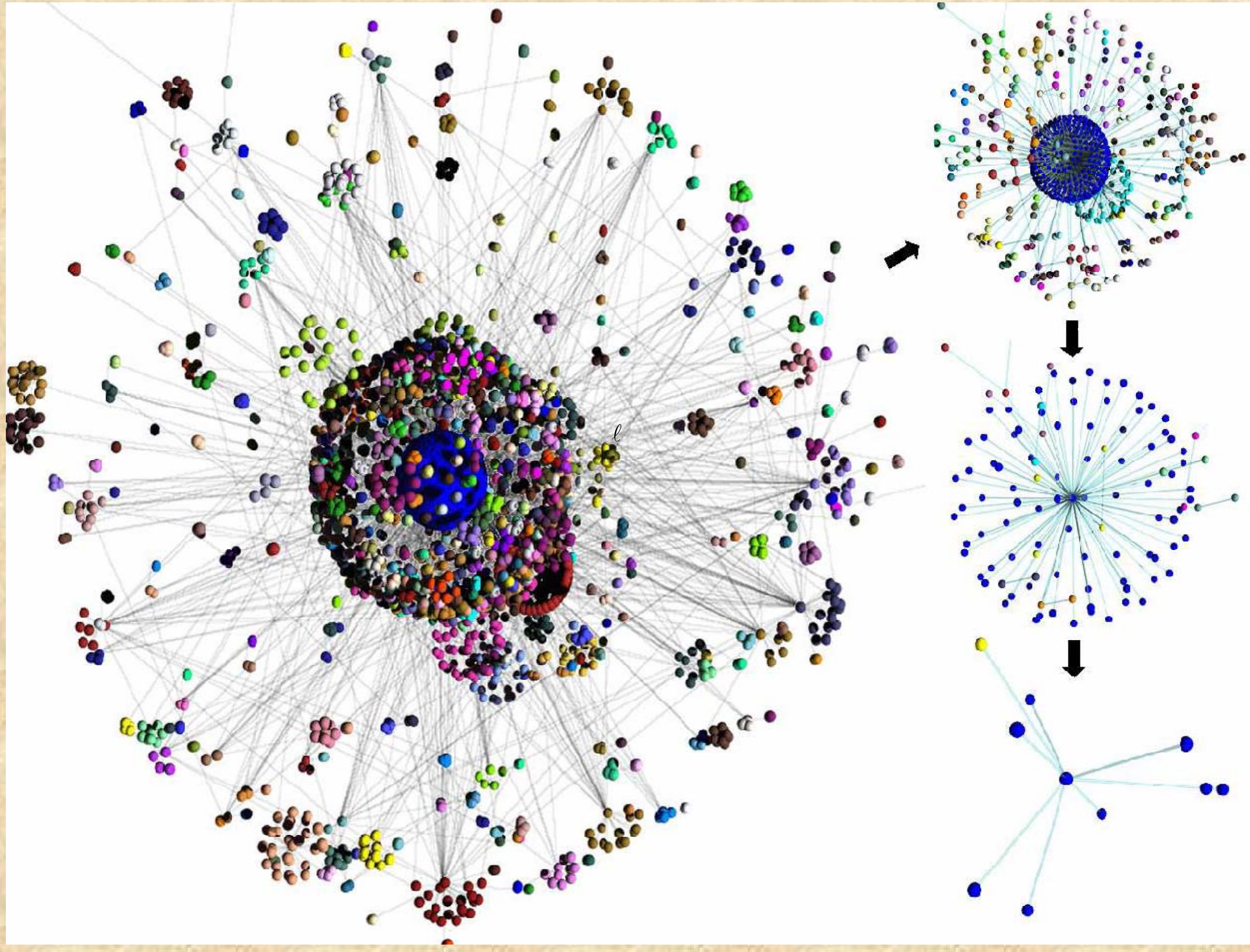
Renormalization in Complex Networks



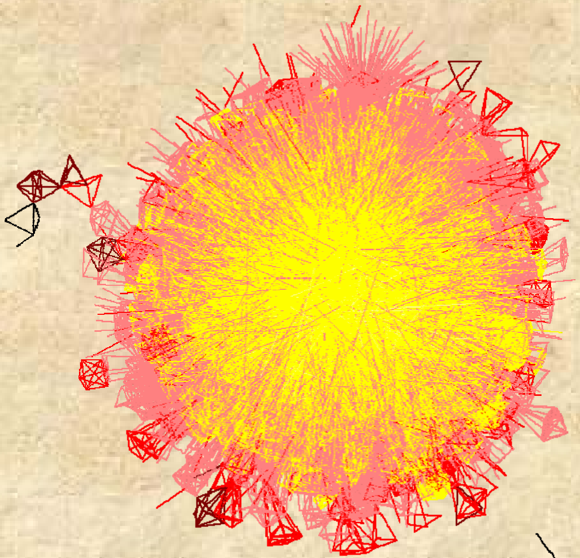
Now, regard each box as a single node and ask what is the degree distribution of the network of boxes at different scales

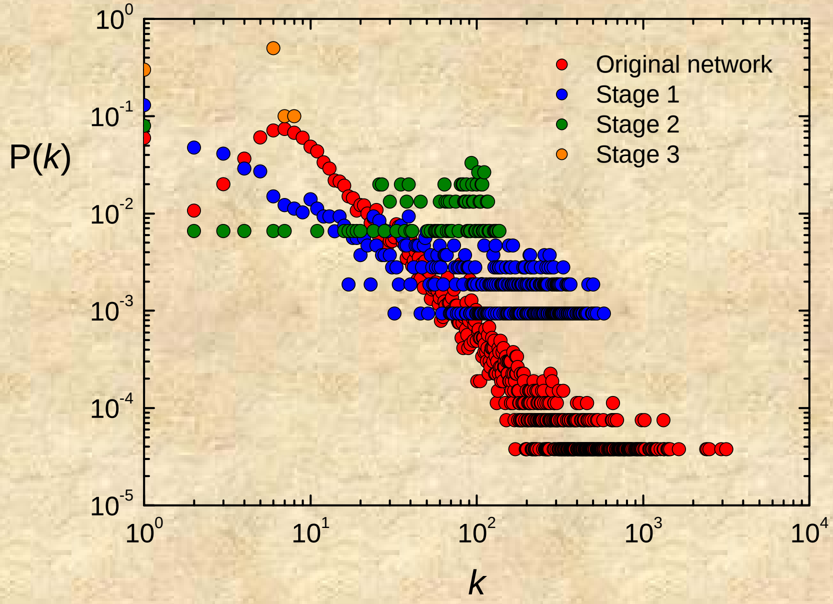


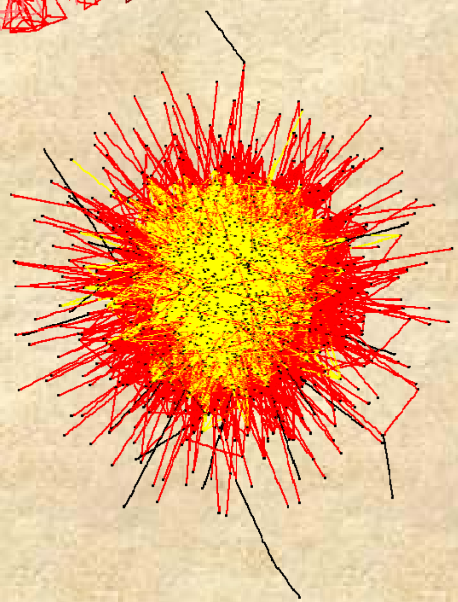
Renormalization of WWW network with $\ell_B = 3$

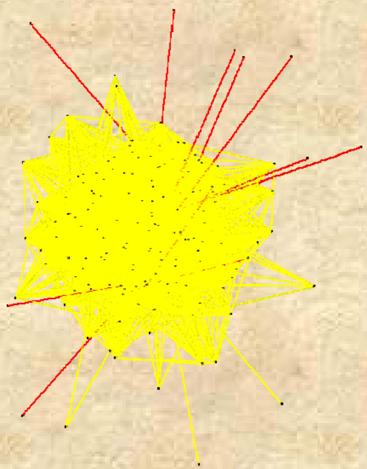


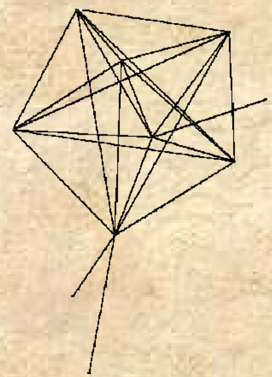
Renormalization of the FP5 collaboration network



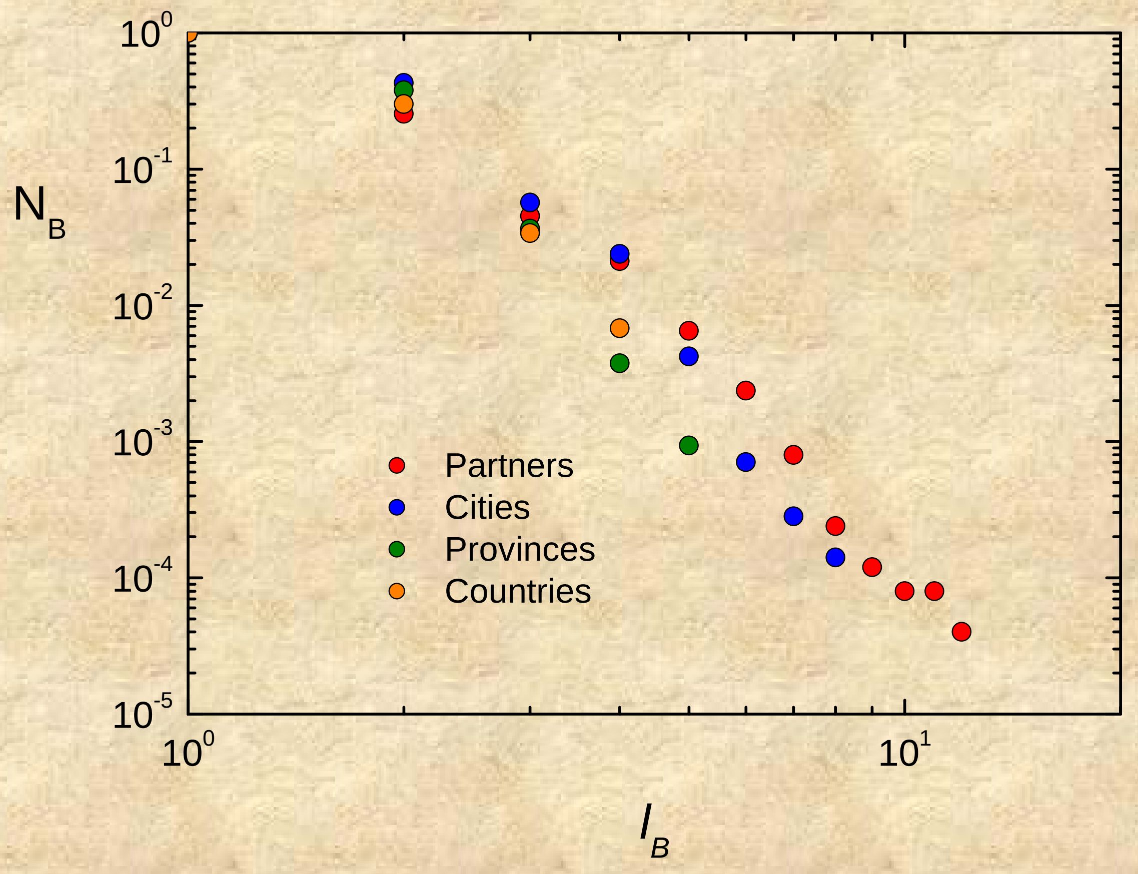








Are they fractal?



FP5