



**Seminar on
African Electrical Interconnection**

Module 1

**The feasibility
of **R**egional **E**lectricity
Cooperation and **I**ntegration**



Module 1 - RECI Feasibility



Focuses on:

- Winning conditions for cooperation and integration
- Approaches for establishing optimum and sustainable cooperation and integration
- The RECI organization and its role

and highlights the following features:



Winning Conditions of a RECI enterprise



- True will for cooperation between all regional partners involved in power system operation
- Integration of power systems into a single one
- Free circulation of energy and uniform transmission costs for all
- Mutual help
- Respect of “commercial” contracts and agreements



Benefits of a RECI strategy



- Increased availability of electricity to meet local needs
- Minimized cost of electricity
- Increased regional growth due to lower electricity rates

Obtained thanks to a thorough knowledge of the region's economic, commercial, social and environmental issues

- also a vehicle for political integration



Summary of contents

1. The integration of national power systems
2. The electric power sector in developing countries
3. Organizing and implementing RECI



1: The integration of national power systems

a) Interconnecting the electric networks

- the technical and economic case
- the political, institutional and financial case

b) The various steps of RECI

c) The experience of the E7 Network utilities

d) Possible leverage for pooling electricity resources



1.a : Interconnecting the electric networks



A twofold rationale for interconnection

to reduce the operation cost

to increase the generation capacity margin

A basic fact

political barriers

power system naturally develops through an iterative and continuous interconnection

optimised by planning

national security objectives

improper institutional structure



1.a : Interconnecting the electric networks



A main criterion to be accepted as determining



to minimize **the cost of supply** of electricity for a given region and for a given reliability level

A number of other objectives not to be forgotten

sustainable development

national energy security

electrification

A crucial condition to fully exploit the potential surplus



to set up an **adequate structure** of the regional electricity industry integrating interconnection investments and operations



1.a : Interconnecting the electric networks



1

Developing **hydroelectric** resources is a major incentive for interconnecting power systems

2

Other incentive is the possibility of **reducing the generation capacity**

3

The electricity industry is subject to **economies of scale**
but maximum unit size # 10-15 % of the peak load

4

Flattening of the load curve



1.a : Interconnecting the electric networks



Complementarity between

distributed generation

integration

to achieve overall efficiency

In the present context of a liberalized integrated electricity market, that may be reassuring !



1.a : Interconnecting the electric networks



Some ways to overcome the financial obstacles

- ❖ to agree on institutional structures to build and operate an interconnection that minimize the financial risk
- ❖ to obtain the support of institutional development funds
- ❖ to obtain loan guarantees by the local governments



1.b : the various steps of RECI



full integration of electricity markets

sharing emergency reserves

asynchronous interconnections

joint-ventures, especially for hydroelectric power plants

exchange of information on the operation and development of electric power systems

pooling of expertise in regional entities

A long term process



1.c : experience of the E7 utilities



Interconnection in E7 countries has been developed for at least half a century and most of the possible benefits have already been got

In developing countries

economies of scale still to be captured

- hydroelectric potential not yet harnessed
- high growth rate of demand

⇒ Need to plan a significant expansion of the system

HIGHLY FAVORABLE TO RECI



1.c : experience of the E7 utilities



Development of a **transnational electricity network allowing electricity exchanges**

- a key in the **least-cost process** for developing the electricity sector
- **BUT** not «naturally» fostered by state-owned and controlled electricity utilities

Achieving a high level of RECI may need a **strong** political support from :

Mercosur

SADC

Regional
organizations

International
institutions

Marshall plan

Asean

CEDEAO/ECOWAS

World Bank



1.d : Possible leverage for pooling electricity resources



Sustainable development objectives can provide an opportune catalyst to overcome political and social barriers to RECI

- Clean Development Mechanisms of the Kyoto Protocol
- persuade political actors to meet and agree on common rules for integration of power systems
- higher profile given to the economic, social and environmental benefits

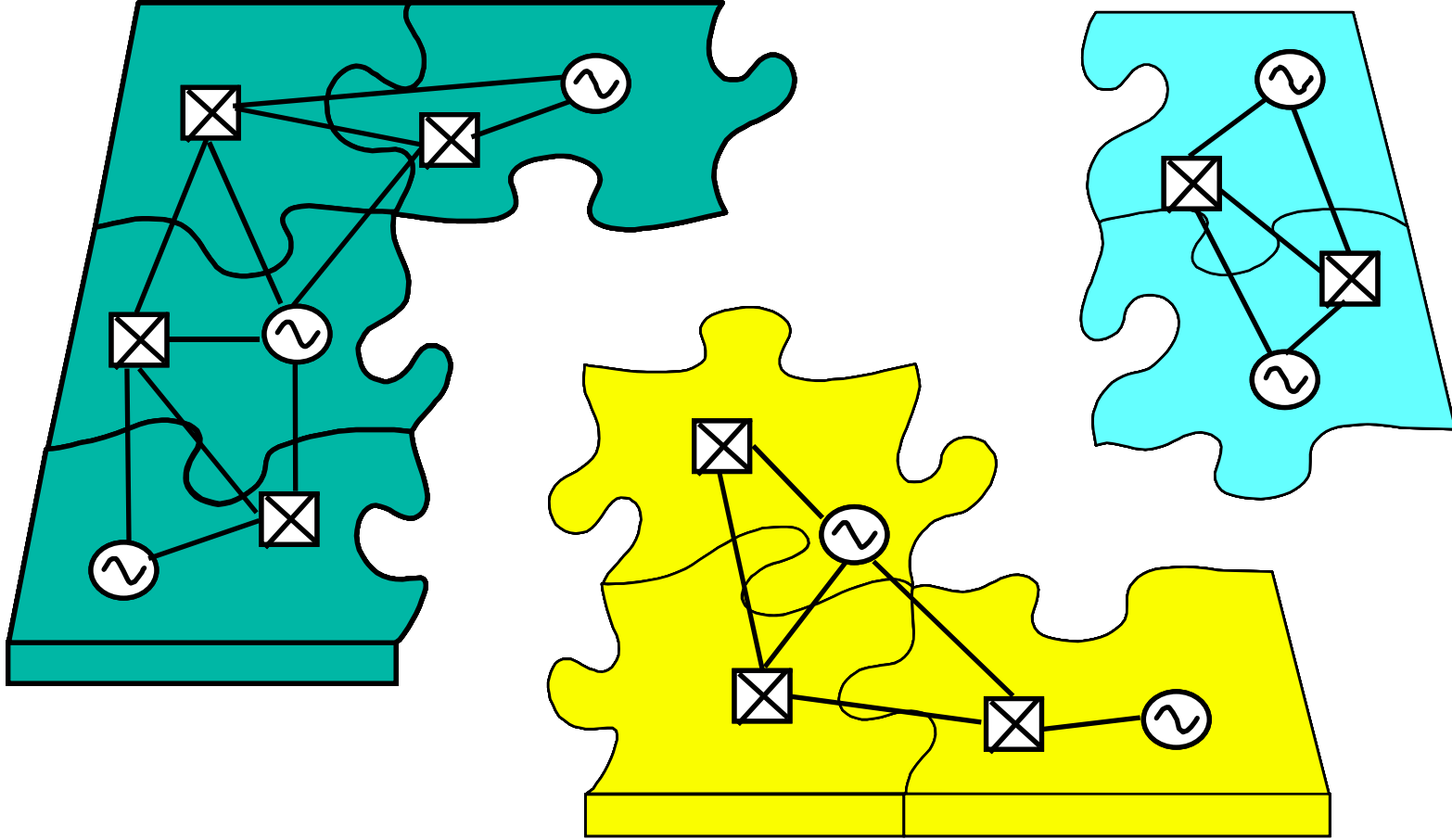


DEVELOPING INTERCONNECTION IS A TRUE
« COMPLEXIFICATION – GROWTH PROCESS »

« IRRESISTIBLE TREND » TOWARDS BIGGER
AND BIGGER SYSTEMS

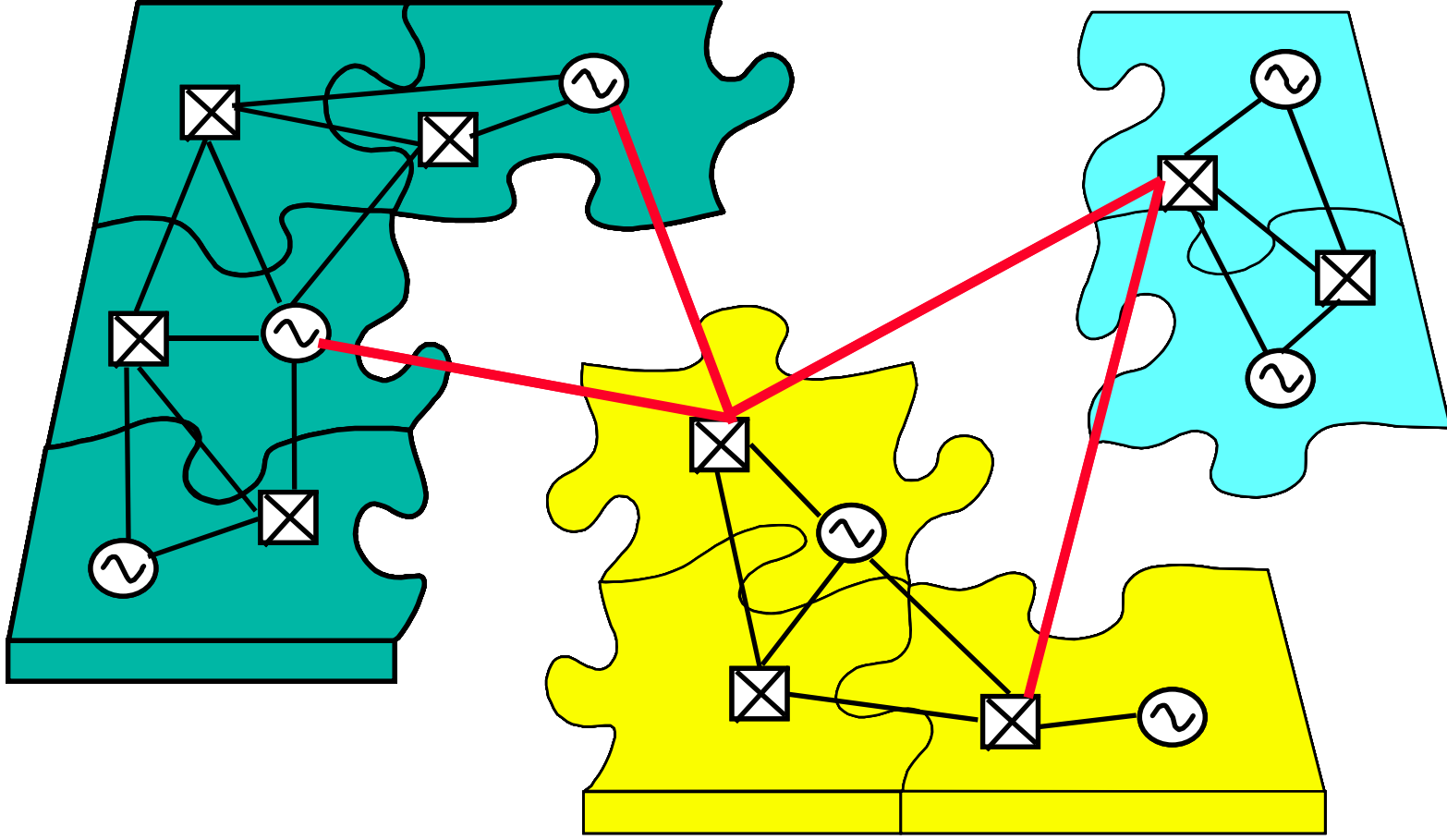


Different systems...



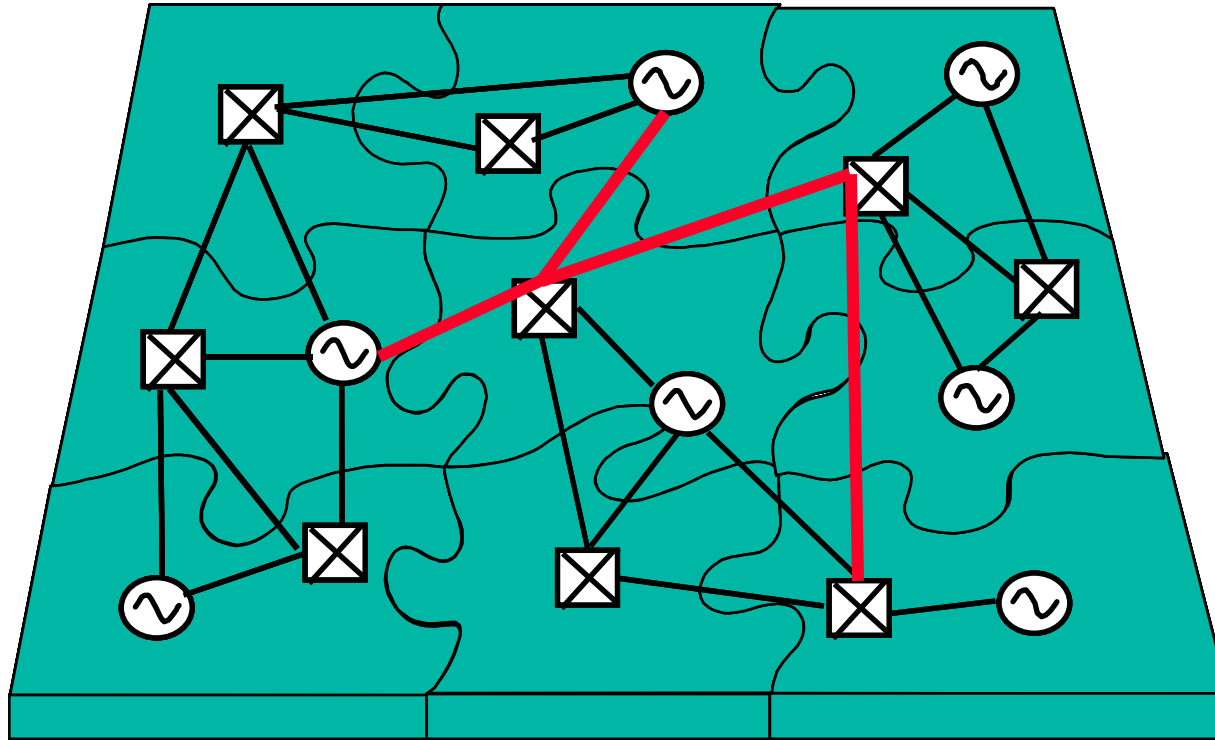


... join together...



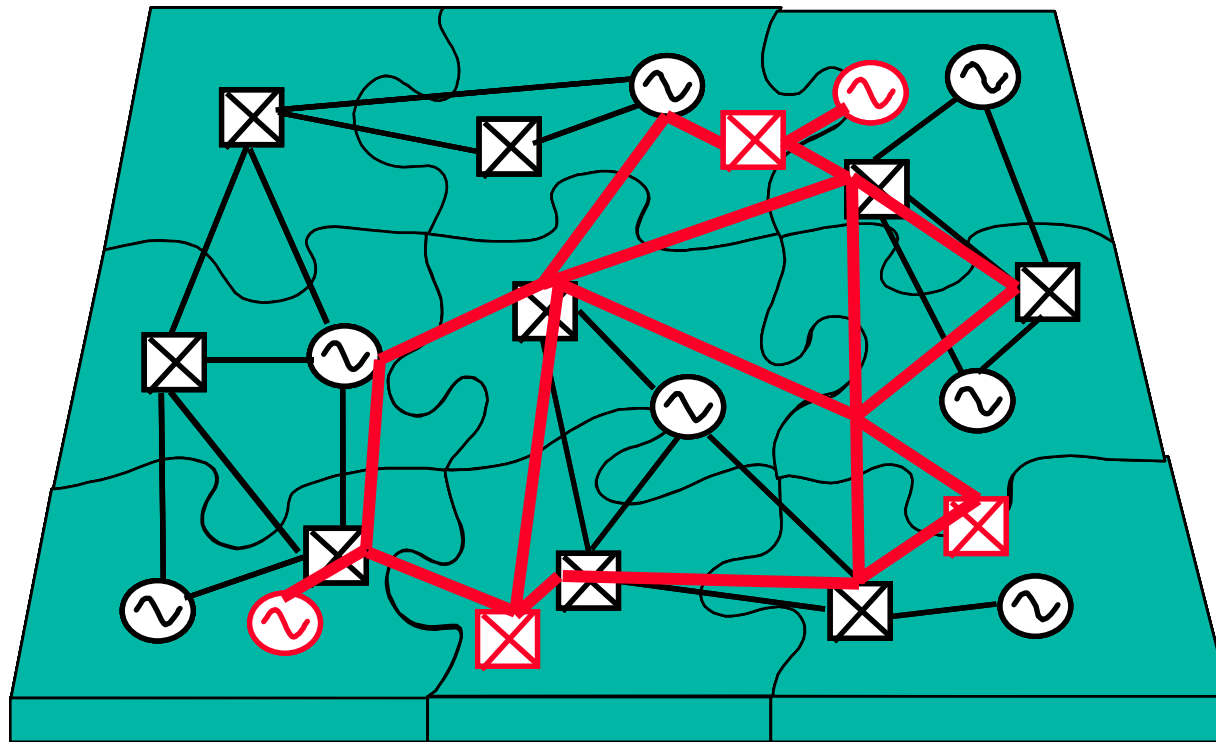


... building a single synchronous zone



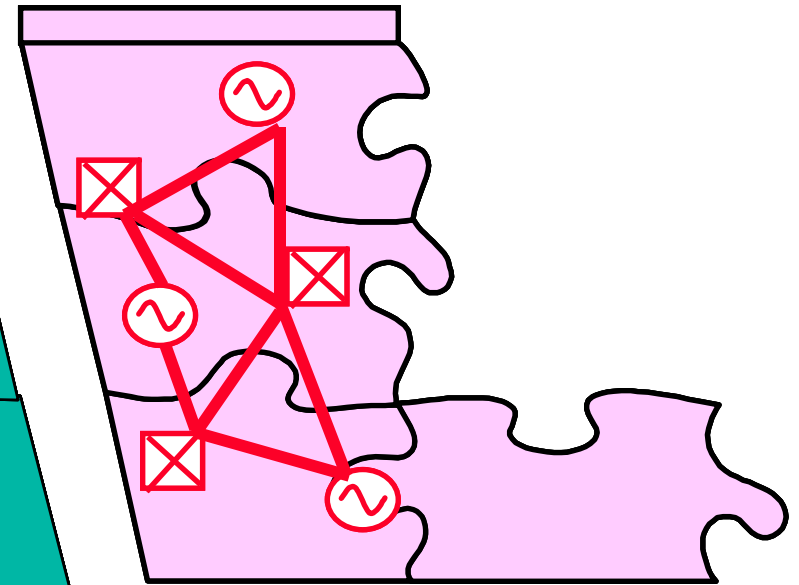
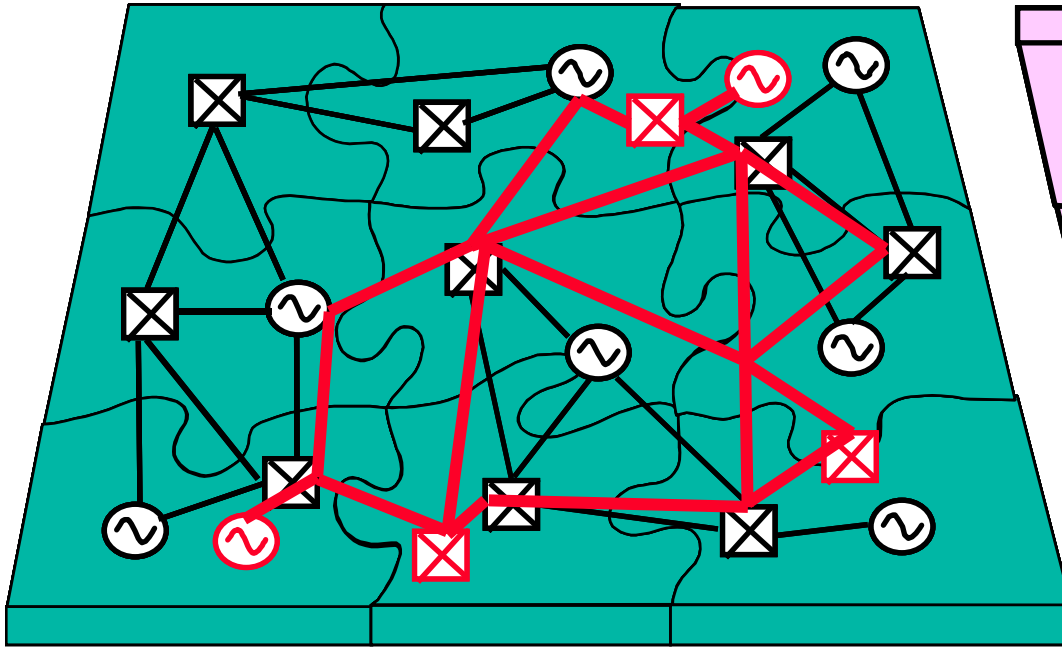


The grid becomes more meshed and reinforced...



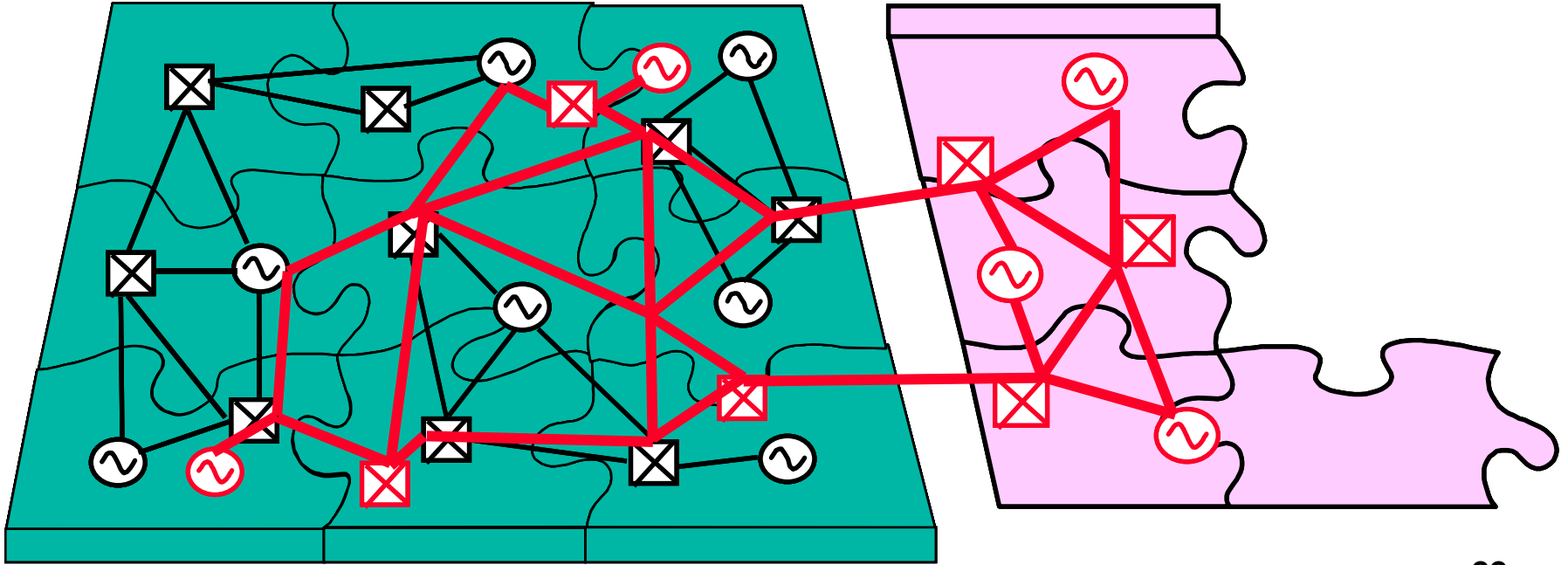


... independently within two neighbouring zones...



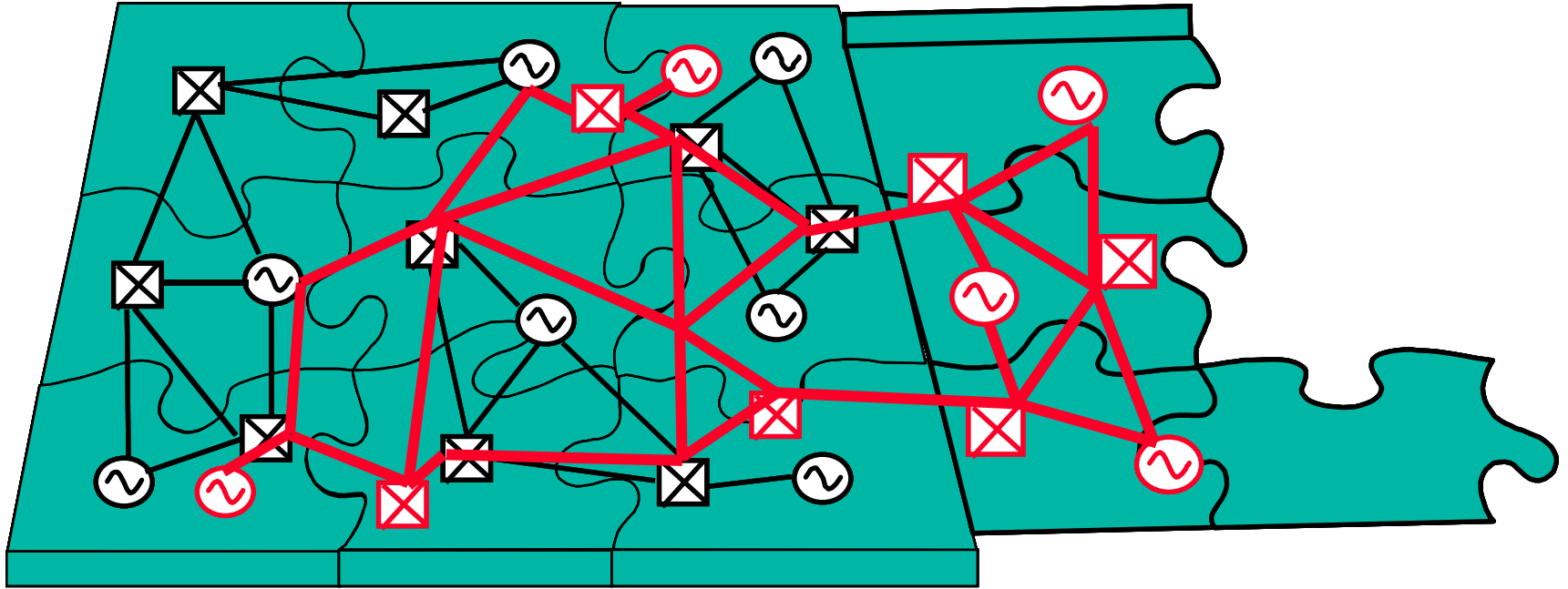


... which will eventually join...



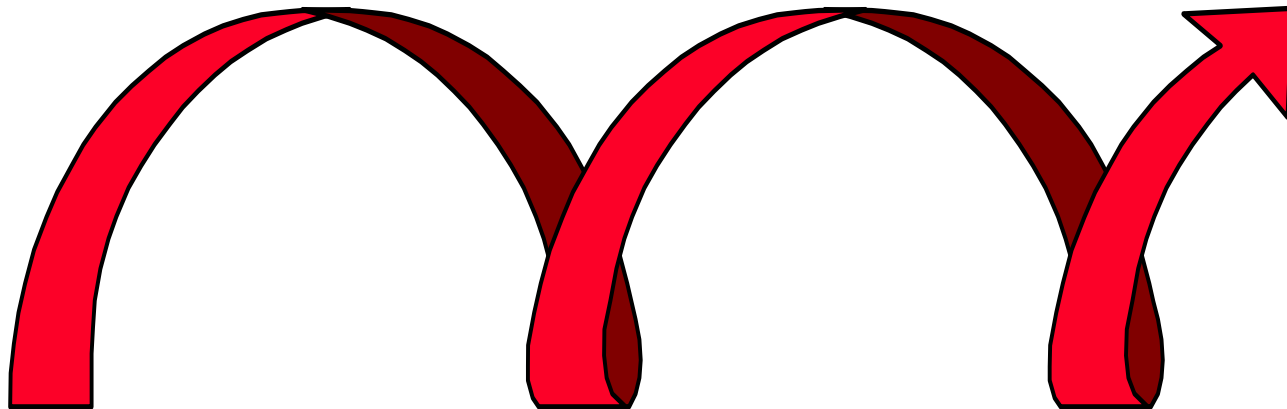


... and the synchronous zone expands



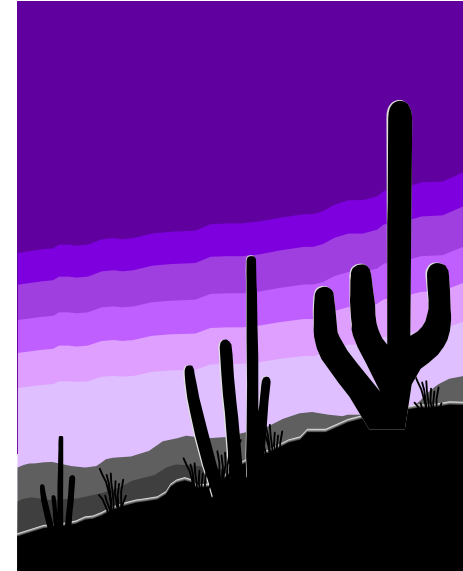
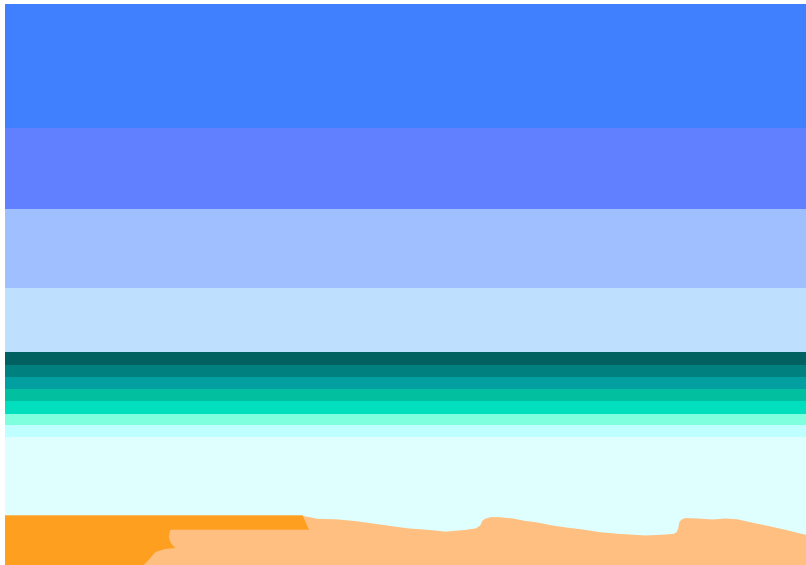


The process tends to continue...





...as long as there are no major obstacles

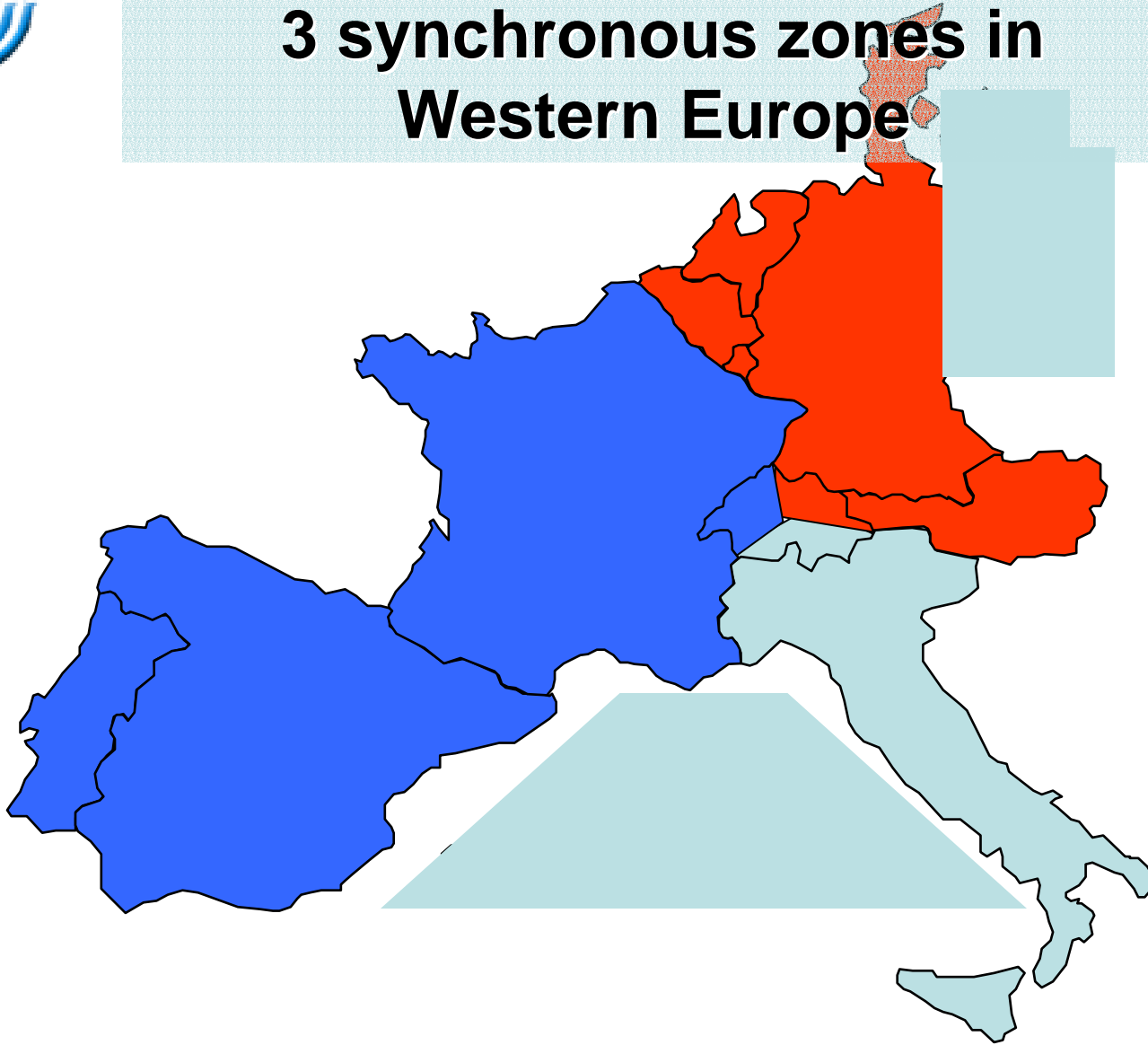




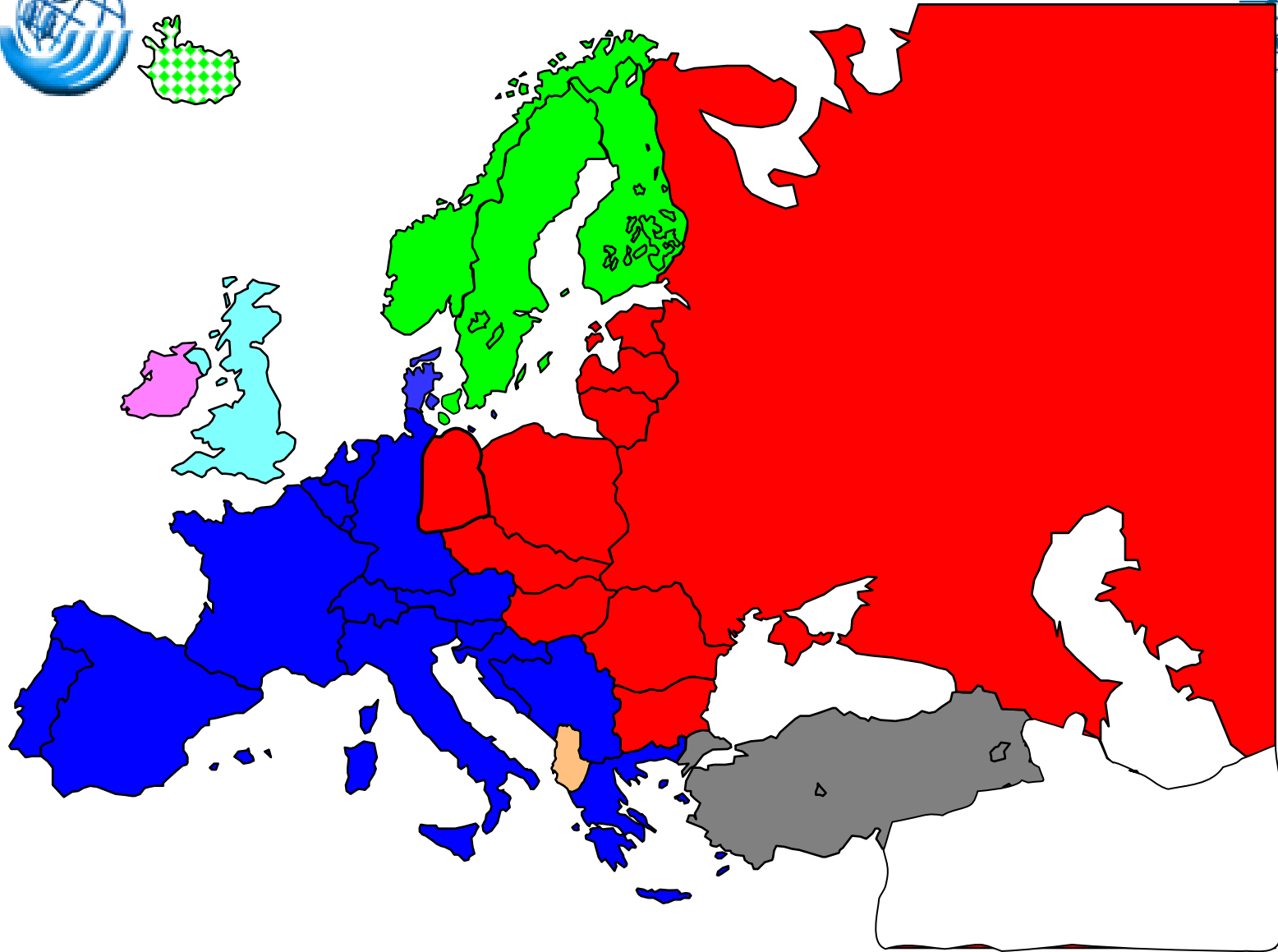
THE STORY OF THE INTERCONNECTION IN EUROPE



Before 1958, 3 synchronous zones in Western Europe



The various synchronous zones about 1980

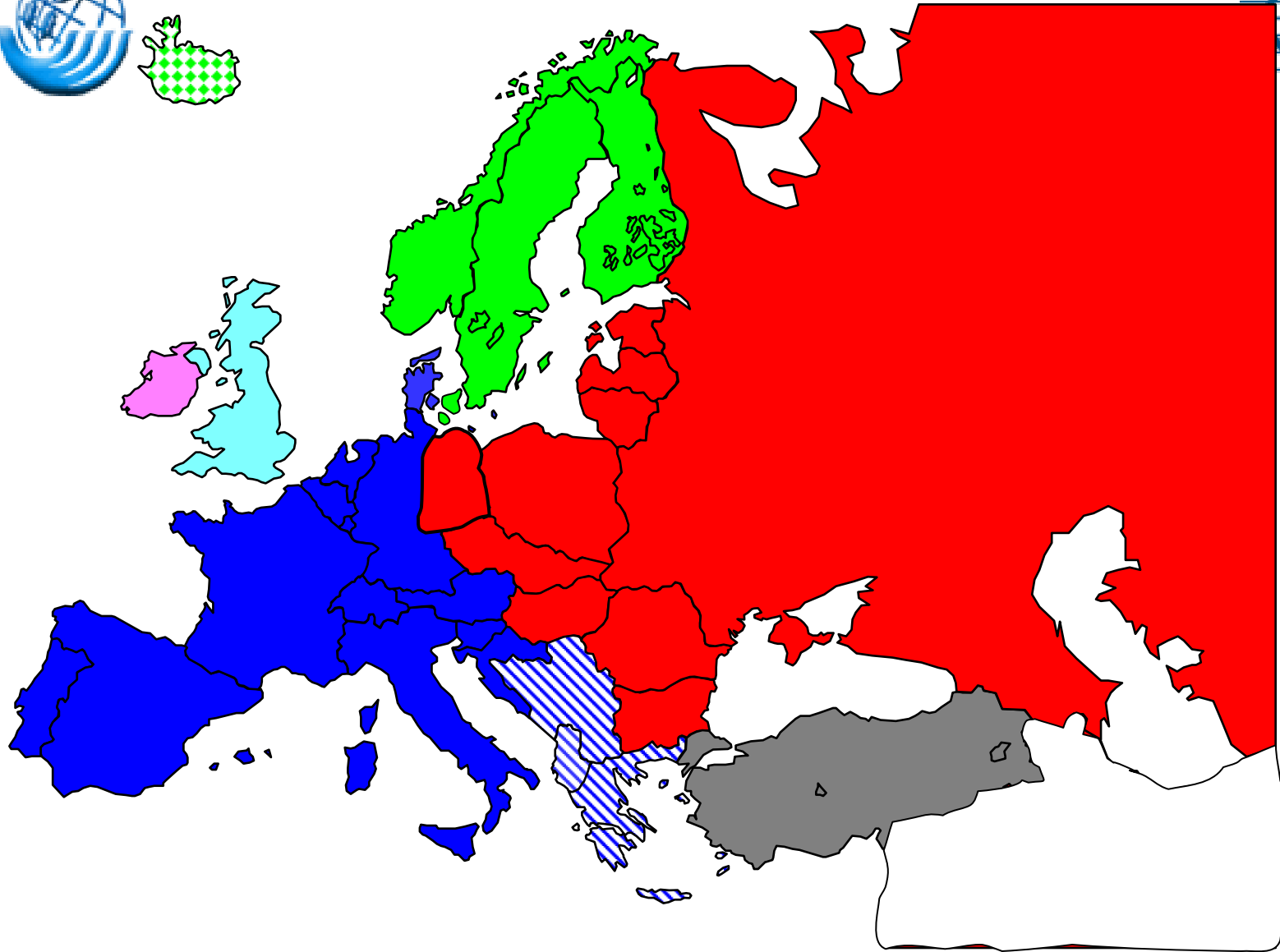


■ WEST

■ NORTH

■ EAST

The synchronous zones in 1993



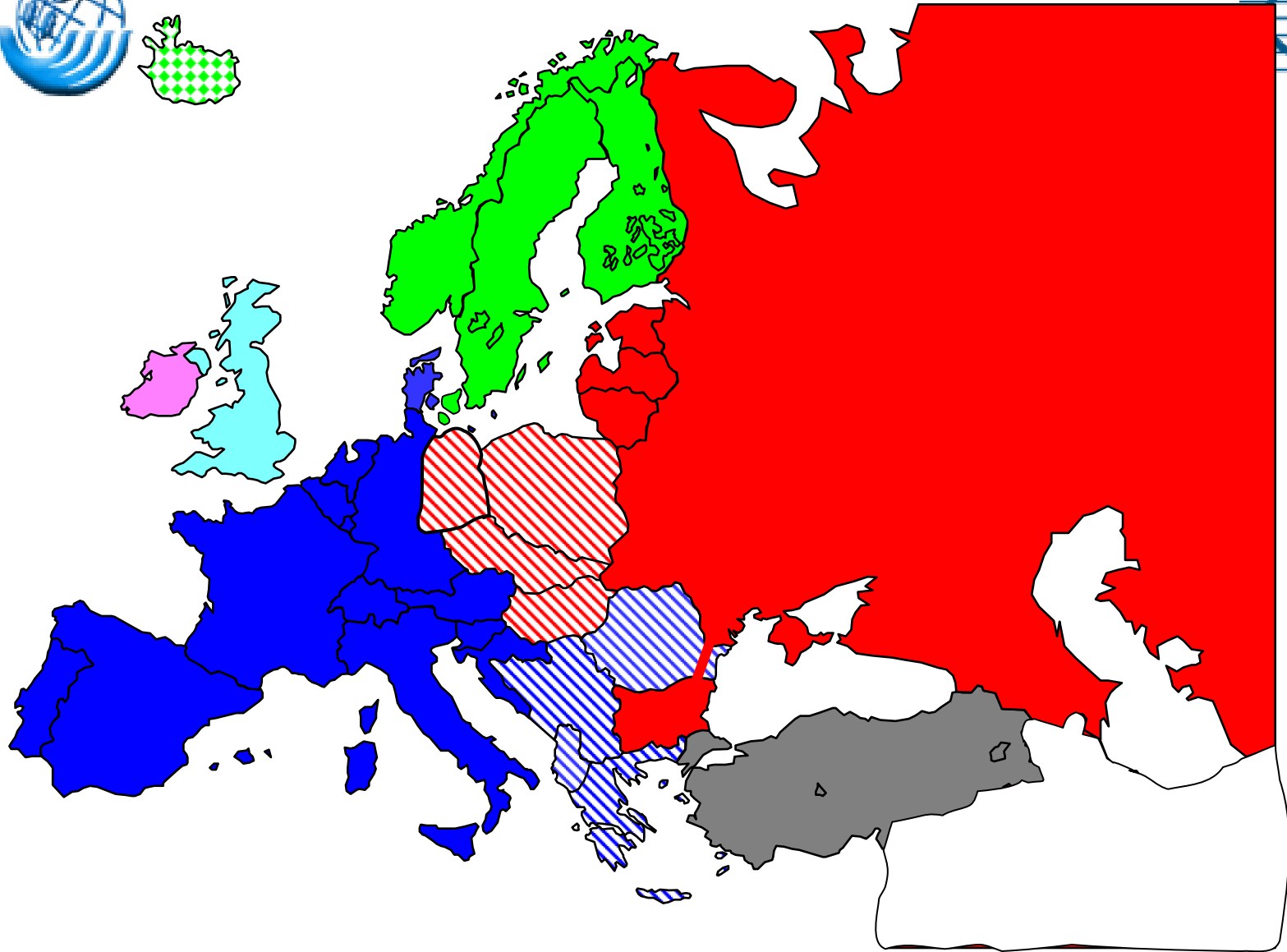
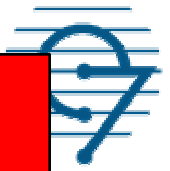
■ WEST 1

▨ WEST 2

■ NORTH

■ EAST

The synchronous zones in May 1995



■ WEST 1

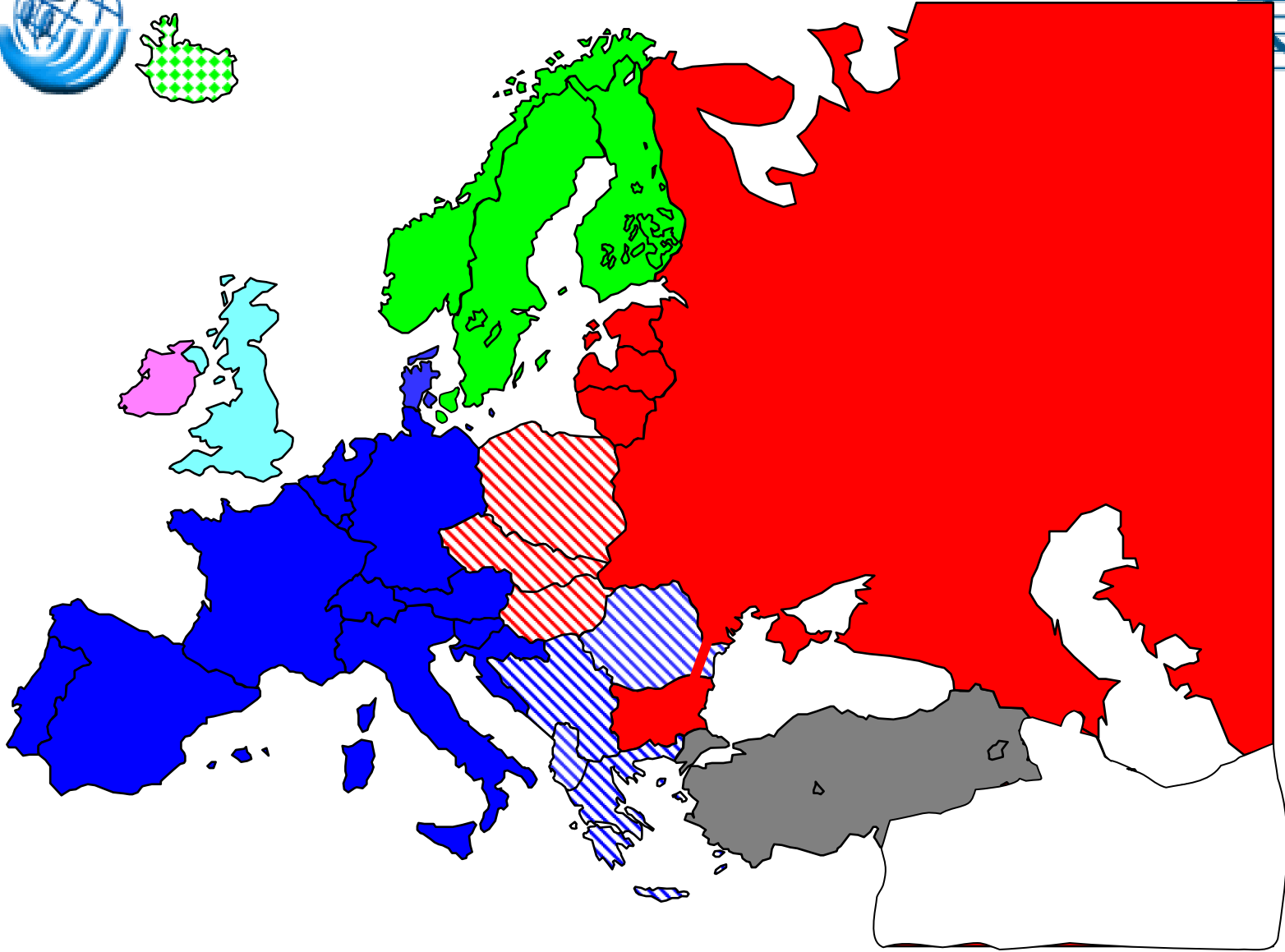
▨ WEST 2

■ NORTH

■ EAST

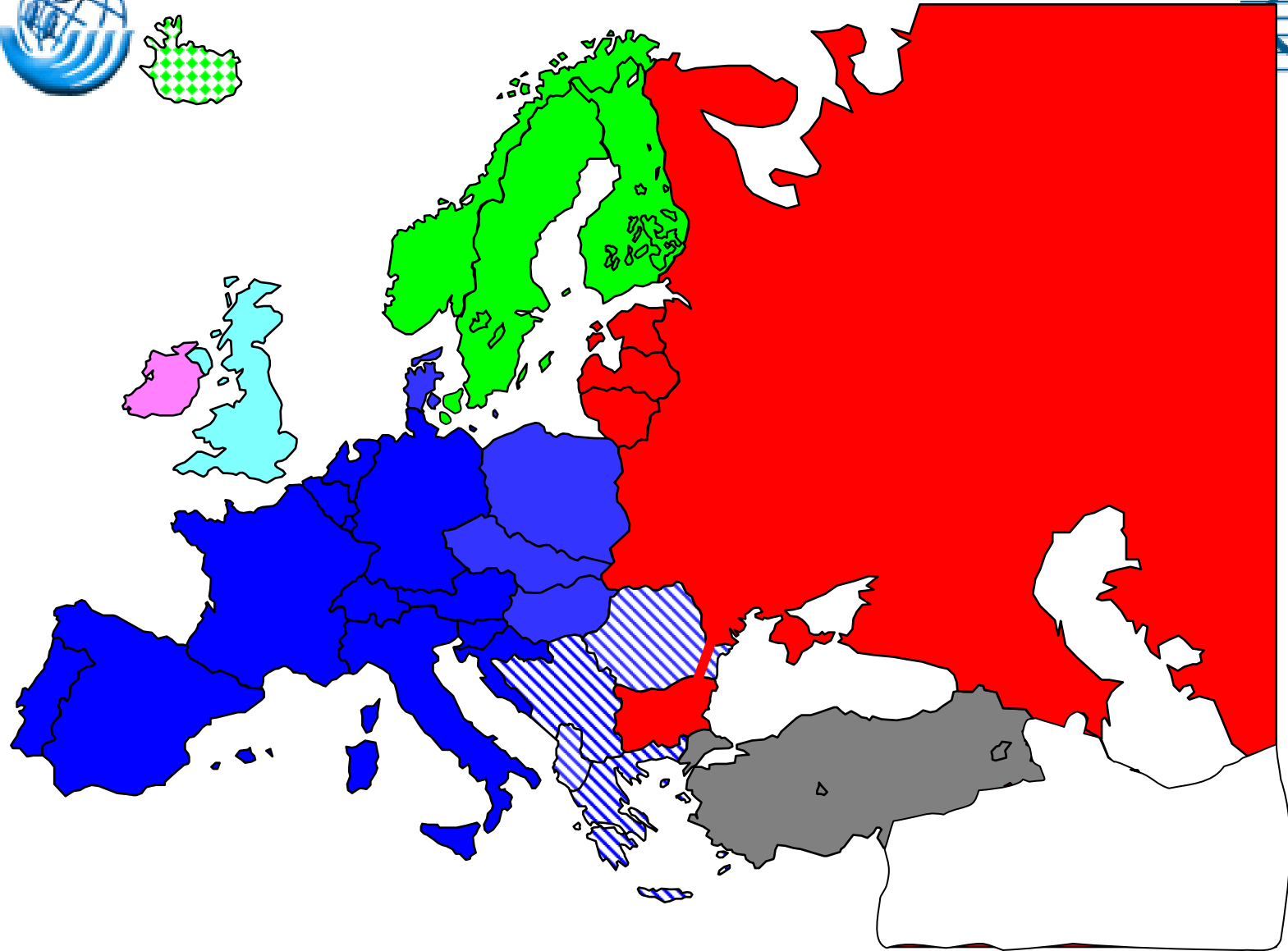
▨ EAST 2

The synchronous zones in September 1995



- WEST 1
- ▨ WEST 2
- NORTH
- EAST
- ▨ EAST 2

The synchronous zones in October 1995



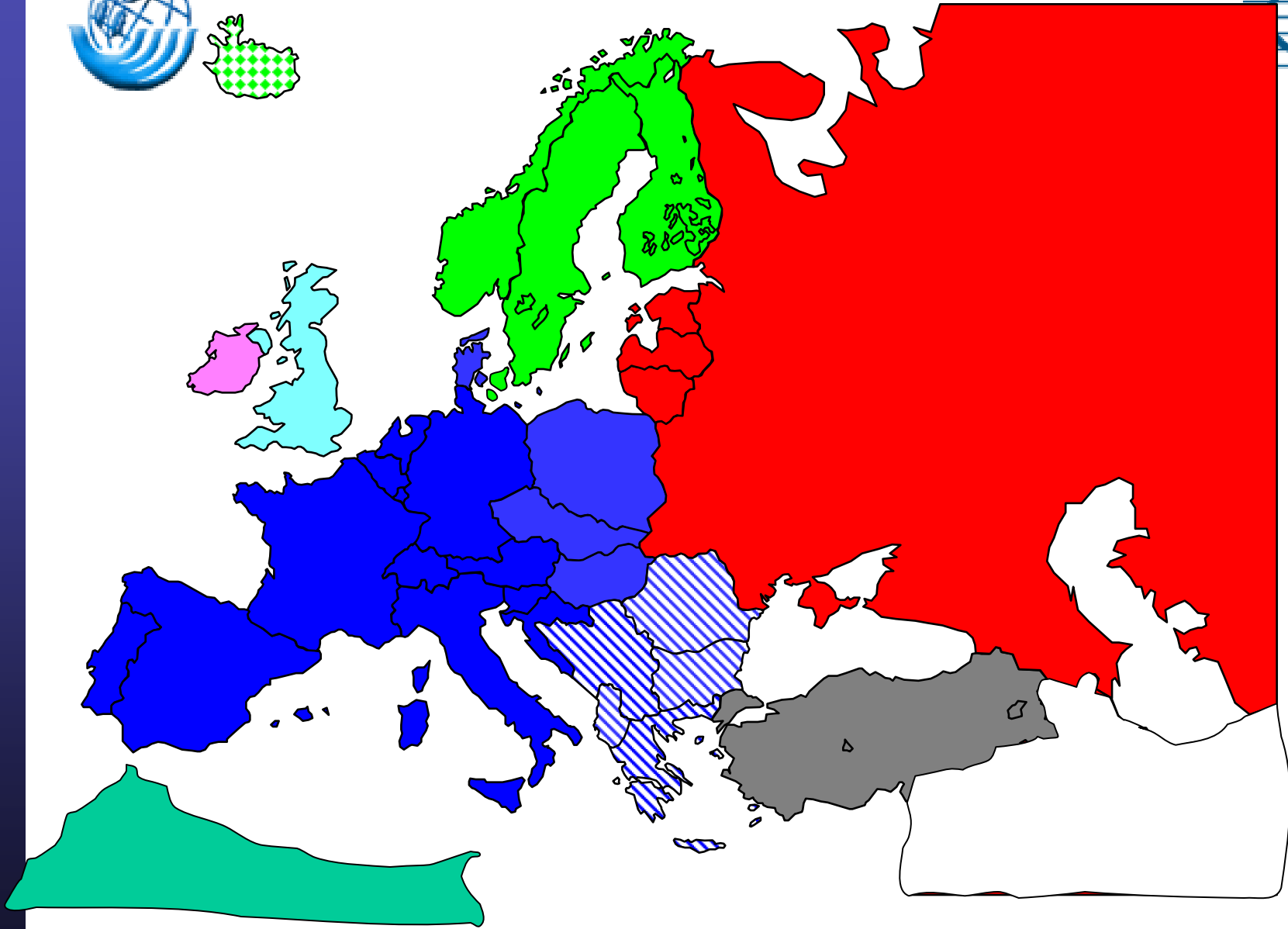
■ WEST 1

▨ WEST 2

■ NORTH

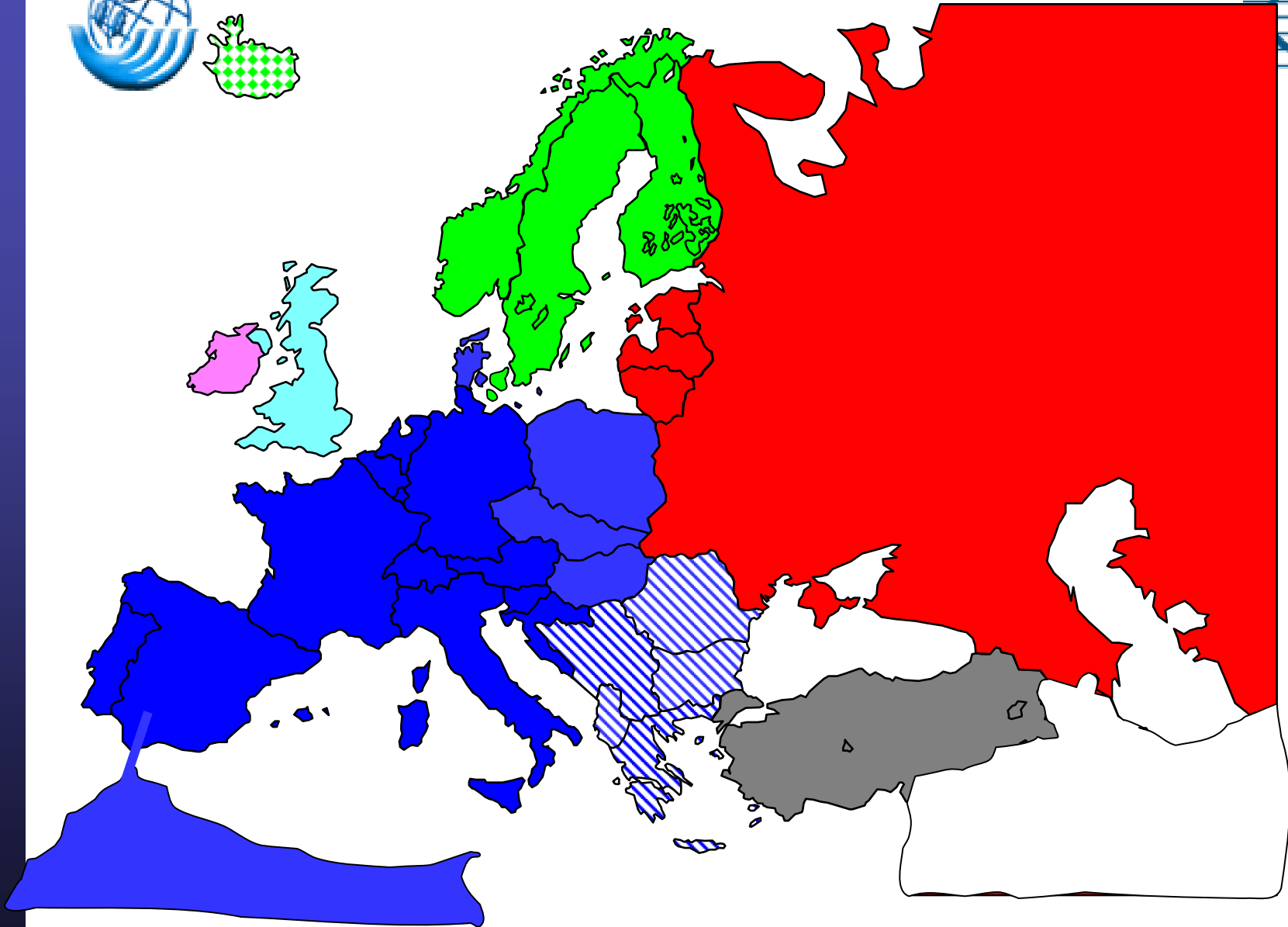
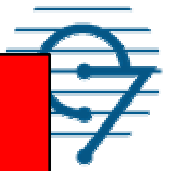
■ EAST

The synchronous zones mid-1996



■ MAGHREB ■ WEST 1 ■ WEST 2 ■ NORTH ■ EAST

The synchronous zones mid-1997



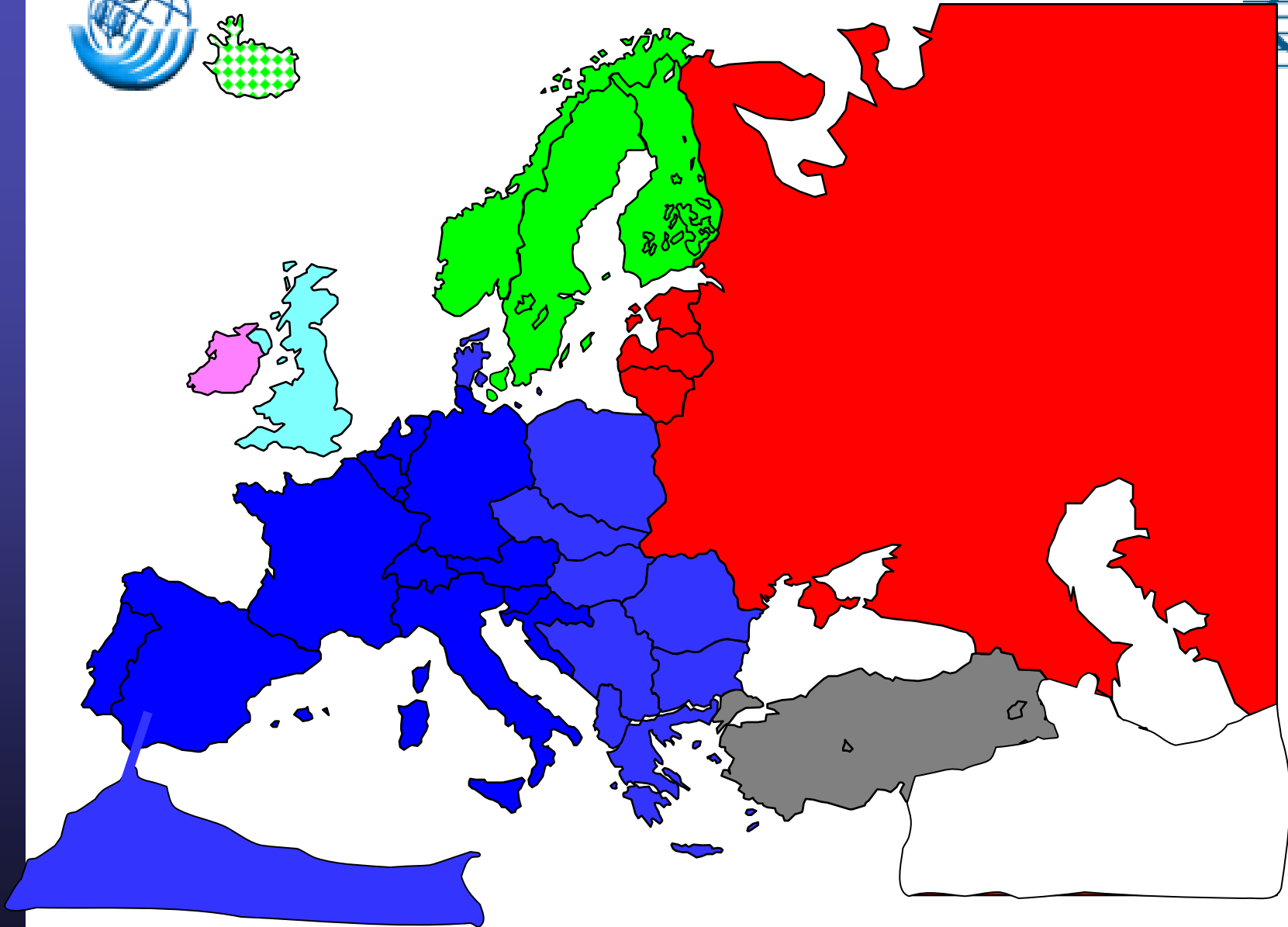
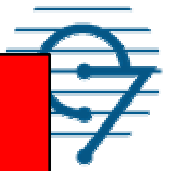
■ WEST 1

▨ WEST 2

■ NORTH

■ EAST

The synchronous zones end-2004

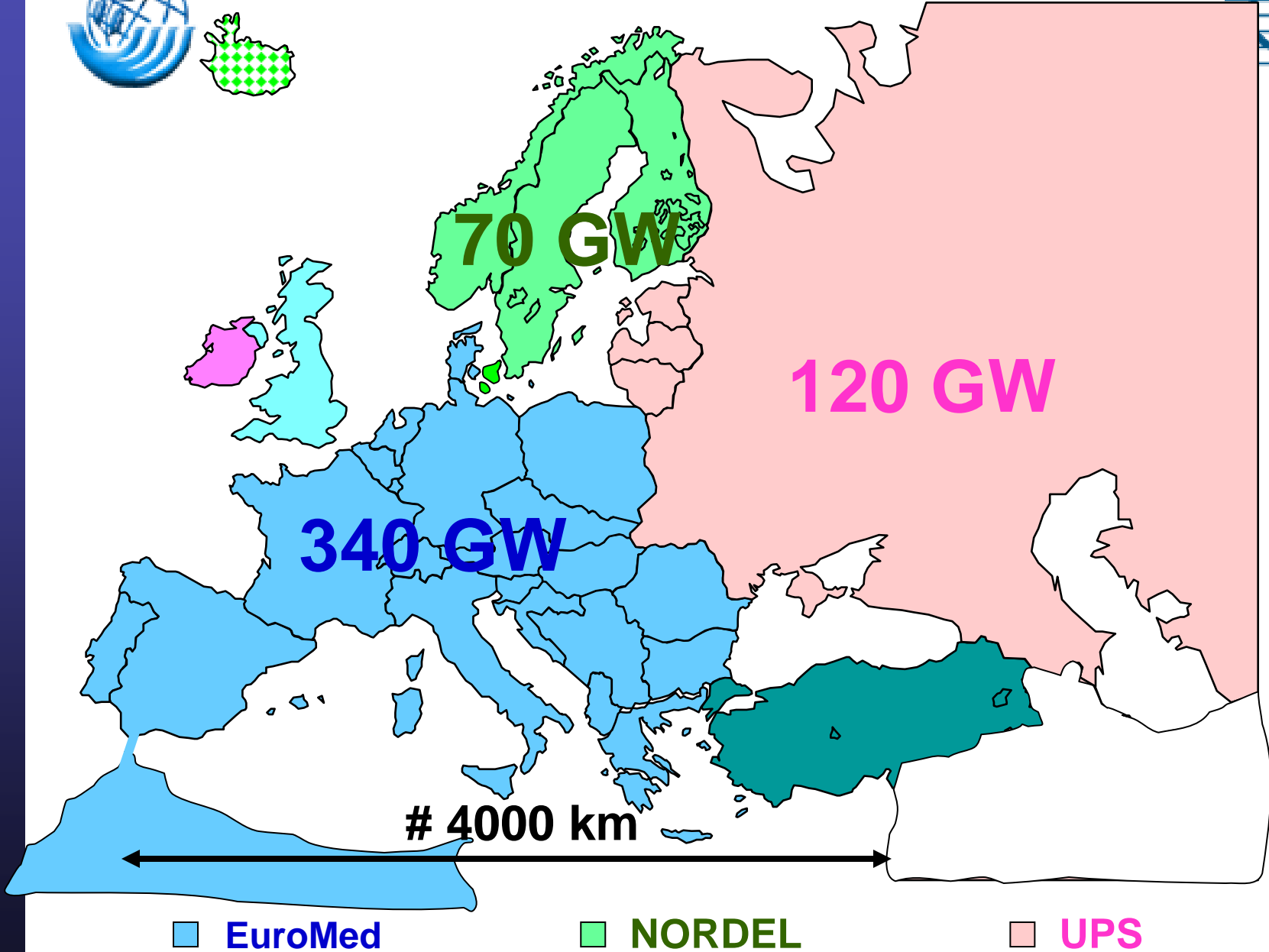
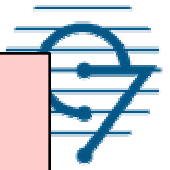


■ EuroMed

■ NORTH

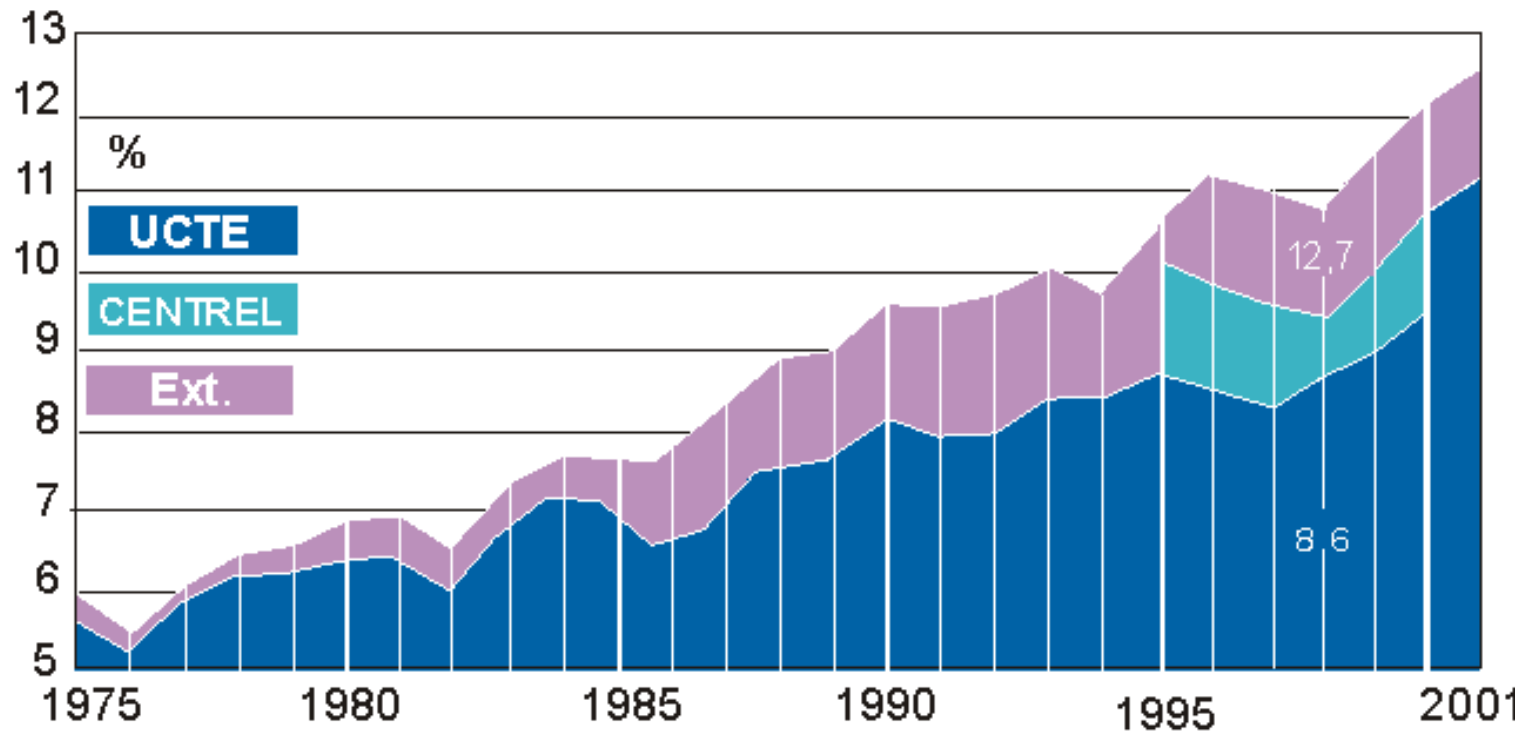
■ EAST

POWER SYSTEMS IN 2004





Part of exchanges in the consumption 1975 - 2001



UCTE: Sum of exchanges between the UCTE countries
 CENTREL: Sum of exchanges between the UCTE countries and CENTREL
 Ext.: Exchanges with third countries



2: The electric power sector in developing countries



- a) Technical and economic characteristics of the power systems
- b) Political, institutional and financial characteristics of the electricity supply industry
- c) Classification of power systems relevant to RECI issues



2.a : Technical and economic characteristics of the power systems



Important features as catalysts towards regional integration

High actual or potential growth rate of consumption of electric power (4,0% / year for 2000-2030 *source IEA 2002*);

Significant unexploited hydroelectric resources

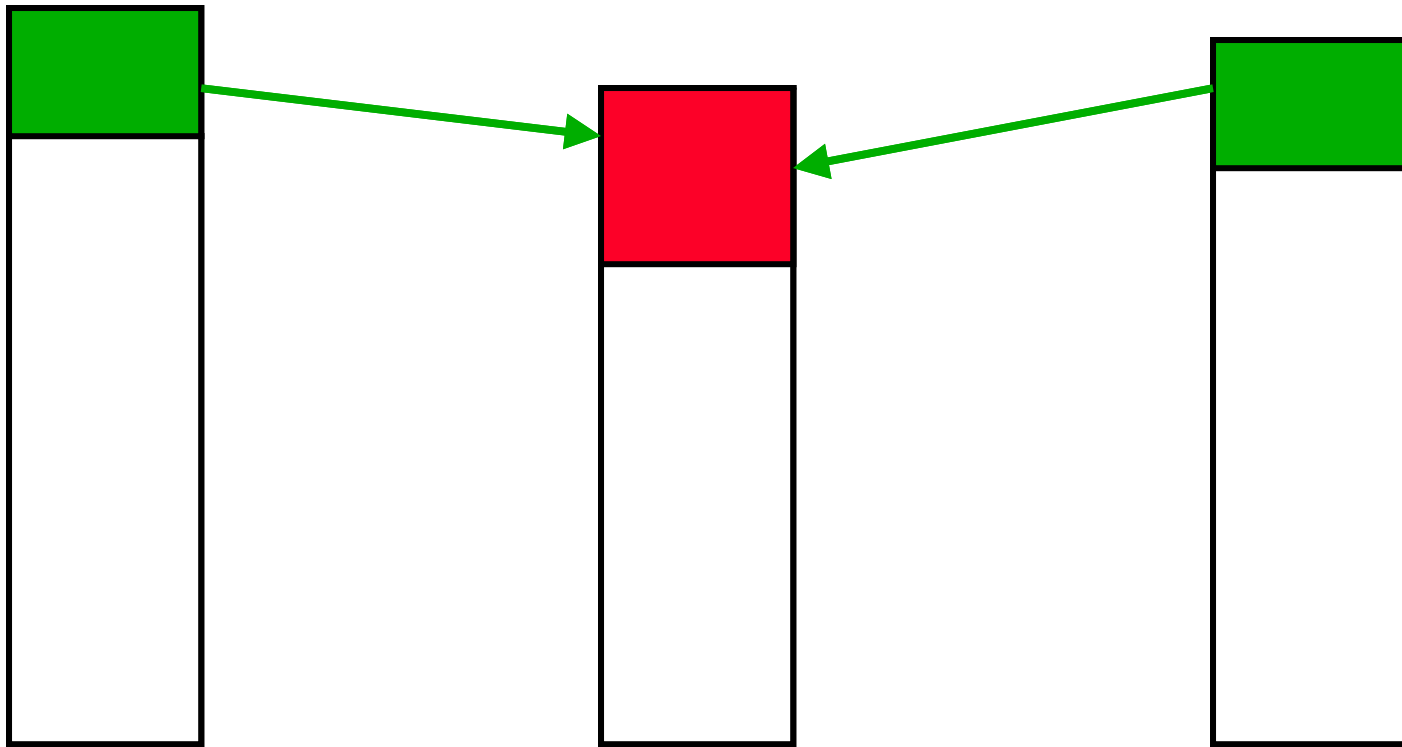
Lack of national financial resources to develop the electric power system

Lack of an efficient infrastructure for fuel procurement

Importance of rural electrification



INTERNATIONAL INTERCONNECTIONS ALLOW FOR MUTUAL COMPENSATION OF DEFICITS IN THE VARIOUS NATIONAL POWER BALANCES





2.b : Political, institutional and financial characteristics of the electricity supply industry

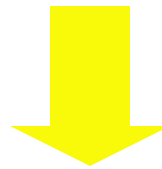


State-owned monopolies

Highly subsidized domestic sector

High level of non-technical losses

Operation costs not recovered



Liberalization considered by the financial and funding institutions as an urgent need

Corporatisation

Removal of subsidies

A regional political organization would be helpful for building a RECI



2.c : Benefits of RECI initiatives particular to developing countries



Generation

Harnessing the hydroelectric potential in a regional framework

Investment attraction (risk perception by potential investors)

Regional political organisation

Similar political and institutional electricity structure



3: Organizing and implementing RECI



- a) Regional integration: how to proceed ?
- b) Planning the development of resources for the electric power system in a regional perspective
- c) Setting the framework for the technical operation of a regional electric power system
- d) Transition towards a regional electric power market
- e) Evaluation and development of regional projects
- f) A RECI Organization
- g) The role of international institutions in fostering regional integration



3.a Regional integration: how to proceed ?



In regions where electricity is not yet a « mature » product and where national markets are too small to justify large-scale facilities, RECI normally implies:

- The study of the development of the regional electric power system in a concerted way, preferably through some regional organization
- The development and implementation of projects
- The management of power generation and transmission, preferably by regional entities created for that purpose



3.a Regional integration: how to proceed ?



1. **Planning the national power systems in a sustainable development and regional perspective**
2. **Setting up legal frameworks, rules, protocols, coordination regional mechanisms and bodies responsible for:**
 - *the operation of the interconnected network*
 - *the management of the market if any*
3. **Implementing mechanisms and structure for the development and the operation of regional projects**

Setting up a regional organization responsible for the implementation of these actions and/or the operation of the interconnected system



3.b Planning the development of the electric power system



Objective :

setting a reference framework for all future projects of regional interest with enough flexibility

Step 1 :

establishing a simplified master plan to get a schematic idea of the optimal **energy** and **electric power** flows

Step 2 :

studying more thoroughly the **regional generation and transmission expansion plan** based on common assumptions for price of fuels, balances of trade, realistic demand forecast



3.c Setting the framework for the technical operation of a regional electric power system



Objectives:

- 1) Set up operation and management rules to be complied with by the national power systems
- 2) Coordinate and monitor the operation of the regional power system

Among various agreements, this may include the following:

bilateral agreements

rules and guidelines

a regional grid code

the establishment of a Regional Coordination Center

criteria and rules for generation, transmission and system operation



SINCE THE EARLY FIFTIES, UCTE HAS DRAFTED RULES FOR OPERATION



To ensure

- security of the operation of the system as a whole
- free trade of electricity between countries

Through

- a minimal « hard core » of common technical rules
- operational procedures at the interface between national power systems



3.d Transition towards a regional electric power market



In the medium term, most national electric power systems of developing countries do not allow for full liberalisation

A 10-15 year long transition period is needed

A single buyer model is a short term option

- *purchases by a single entity from producers on a contractual basis*
- *the nearest to the current vertically integrated structure*

evolving in the long term towards

Third Party Access model (open access)

This applies both at the national and regional level



3.d Some features of the transitional structure towards a regional electric power market



A medium term transitional structure (10-15 years), allowing for different national market structures MAY INVOLVE (among others)

- a few national private suppliers, sometimes a main state-owned supplier
- the possibility for IPP in every country
- one transmission entity for each national system
- the possibility for private transmission entities in the case of large interconnections
- the possibility for large customers to choose their supplier at national or regional level
- local control centres operating national systems under the supervision of a regional coordination centre



3.e Evaluation and development of regional projects



Make sure that required optimal investments are actually developed and are not locked out by non-optimal investments

Step 1: assessment of the technical feasibility, risks and economic viability

Step 2: development of the institutional framework for the project in order to:

- maximise the effective use of the project
- minimizing future disputes
- providing a service at a «sustainable» price

Step 3: set up the organization to develop the project

Step 4: establish the financial simulations of the project

Step 5: raise the financing



3.f A RECI Organization



*Setting up a RECI Organization is the real starting point of **true regional integration***

- 1. creation of a regional forum for the exchange of information**
- 2. drafting and signing of a protocol /intergovernmental agreement between the governments of the region**
- 3. setting up of a process for designing and implementing regional integration**
- 4. formation of management and operational bodies to coordinate and execute actions**
- 5. evolution towards a Regional Transmission Operator controlled by an independent Regulator**



3.f A RECI Organization, *primary objectives*



- 1. Looks for the least-cost operation of the regional system**
- 2. ensures secure and reliable operation**
- 3. promotes optimal development on a regional basis with a special emphasis on interconnections**
- 4. develops regional energy trade**
- 5. runs the market in an efficient, non-discriminatory manner**



3.f A RECI Organization



Harmonizes technical rules

Organizes the wholesale power market

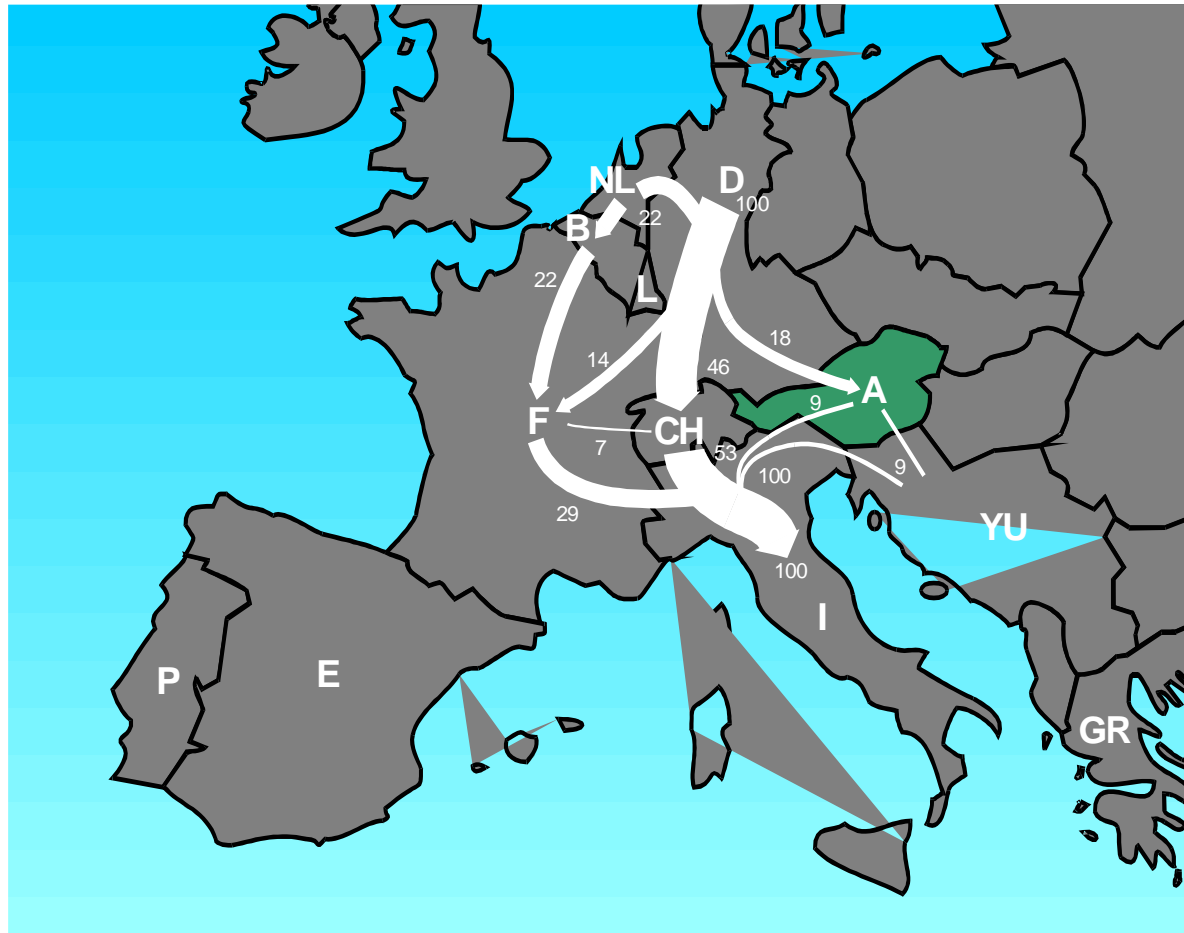
Develops master plans for generation and transmission development on regional basis

Coordinates the development of projects having influence on the interconnected network

May eventually evolve towards a responsible for the operation the regional power system (RTO)



« LOOP » flows would call for an unique regional control centre but...





in case of large and highly meshed power systems

- **almost impossible to implement, even with the most modern IT technology,**
- **impossible for a single operator to control the system**

⇒ « hierarchical » approach of system operation as a solution

Also some « political » reluctance (ex. UCPTE vs. CDO)