The GRAI method Part 2: detailed modelling and methodological issues

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- 2. The GRAI nets
- 3. The structured approach
- 4. The rules of inconsistencies
- 5. The GRAI methodology

First part

INTRO-DUCTION

Definition of the GRAI method

- The GRAI method owns to the enterprise modelling domain. The purpose is to design or reengineer production systems (manufacturing or service).
- The GRAI method focuses on the decisional aspect (control system).
- From a general point of view, the GRAI method applies to performance improvement.

Composition of the GRAI method

The GRAI Method:

- is built up starting from a **reference model**, the GRAI model, which is a consistent set of concepts that model any production system in a generic way and *a priori*,
- is based on **graphical modelling languages** which instantiate the concepts of the GRAI model to build the specific model of the studied case,
- follows a structured and participative **approach** within which actors and steps are defined, allowing effectiveness and time saving.

Composition of the GRAI method

Note:

The GRAI reference model and the GRAI grid are not presented in this course and can be found in:

The GRAI Method
Part 1: global modelling

Application domains of the GRAI method

- Production systems **engineering**,
- Choice and implementation of **software packages** for management: ERP (Enterprise Resources Planning), SCM (Supply Chain Management), CRM (Customer Relationship Management) or other computerized solutions (decisional...);
- Choice and implementation of **performance indicators** systems;
- Development and implementation of **industrial strategies**;
- Support to **quality** approaches;
- **Knowledge** Management.

Application domains of the GRAI method

Remark:

The GRAI method takes part in these applications without being sufficient enough in general ⇒ necessity to increase the modelling domain (see GRAI methodology, 5th part)

Second part

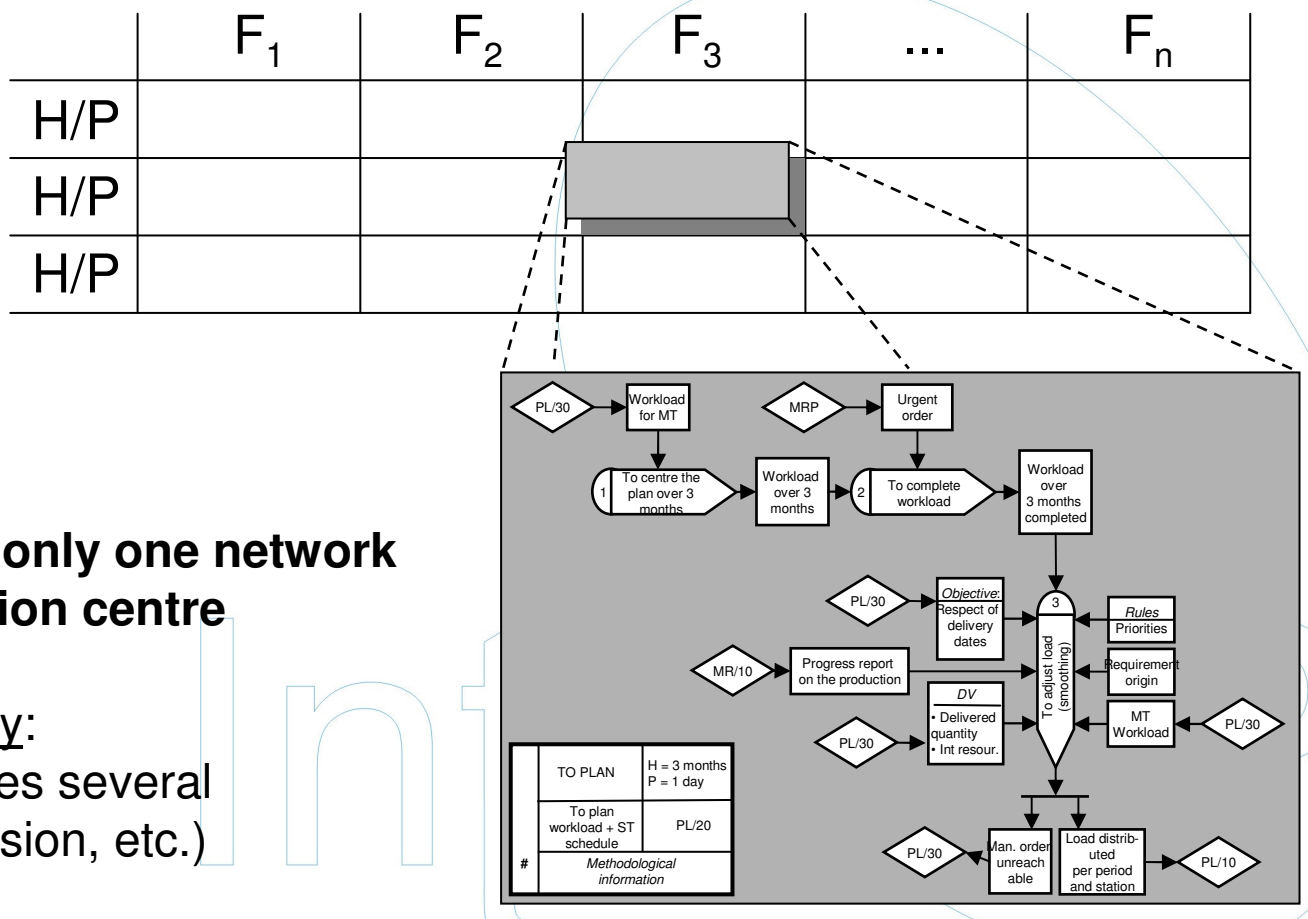
THE GRAI NETS

INTRODUCTION

Definition

The GRAI Nets represent the running of the whole or a part of a decision centre according to the GRAI modelling concepts (model of a decision centre activities).

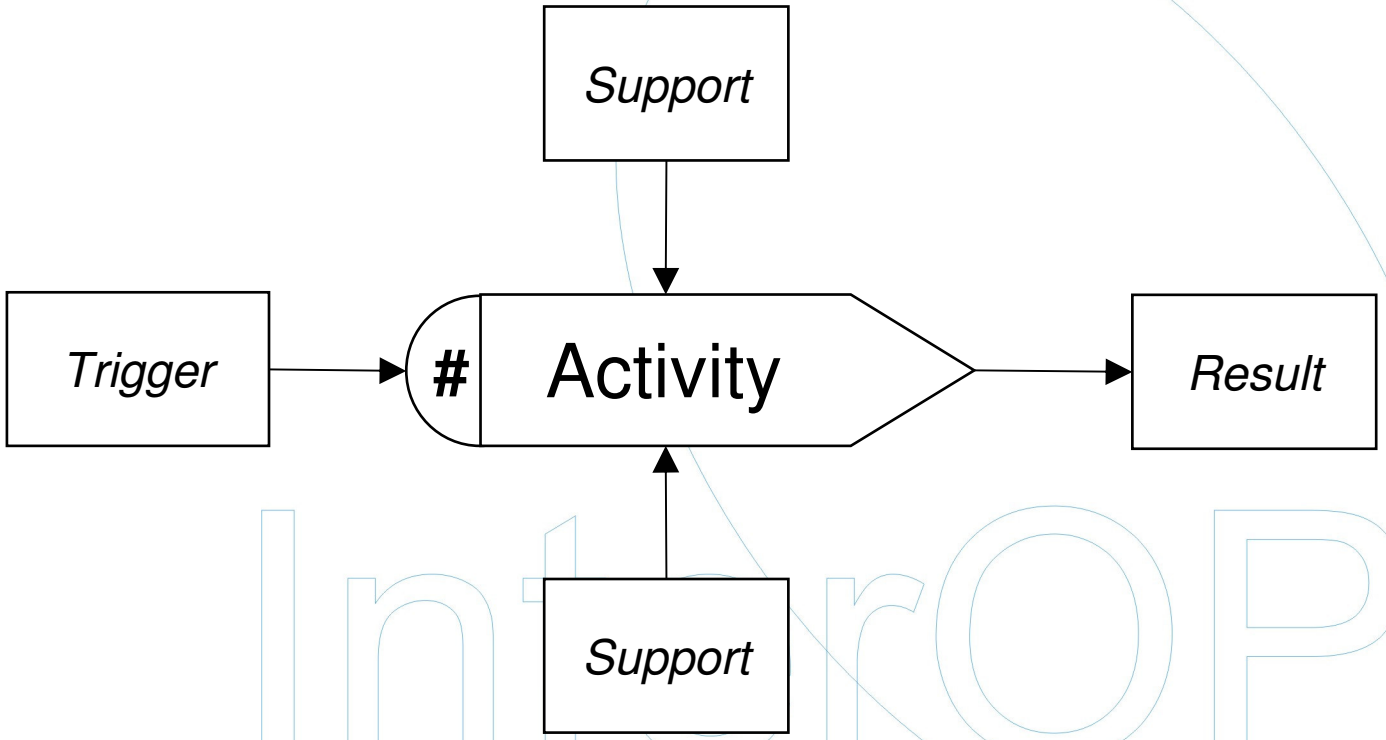
Situation of GRAI nets in modelling



Principle:
There is only one network by decision centre

Practically:
Sometimes several (size, version, etc.)

Graphical representation of an activity



MODELLING COMPONENTS

Activity and entity

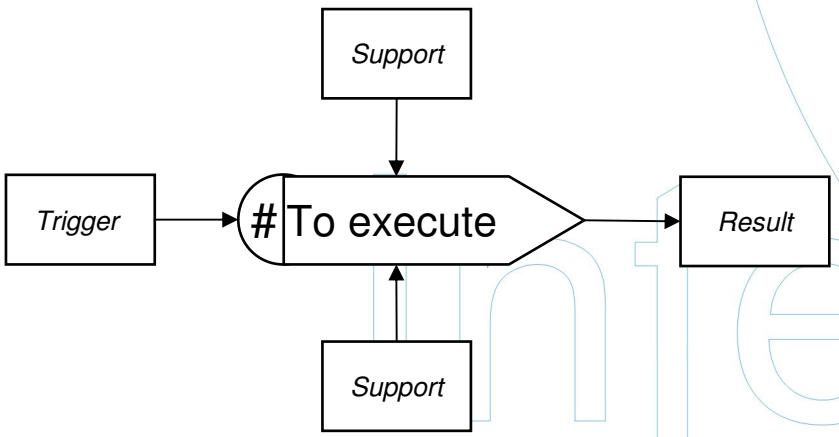
Activity. Part of the behaviour of a decision-making centre. An activity is dynamic and provides one or more entities. The activities are named and numbered.

Entity. Physical or abstract object that belongs to the control system. The entities are necessary to the course of the activities or are produced by those ones. The entities are named.

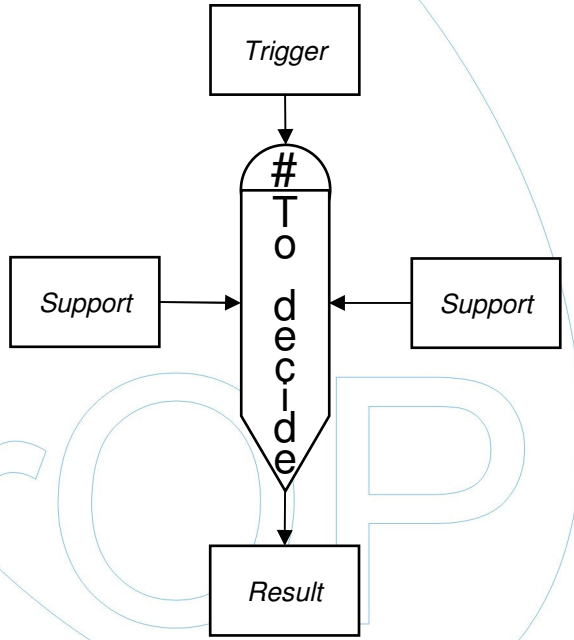
Activities type

Two types of activities exist

Execution activity



Decision activity



Activities type

Execution. Deterministic activity. Activity giving the same value to the result for the same values of the convergent entities (trigger and supports).

Example: activity managed completely by a rule, procedure, programme, etc.

Decision. Activity being able to give several values to the result for the same values of the convergent entities.

Example: choice of a solution in uncertain context

Nature of entity

There are seven natures of entities:

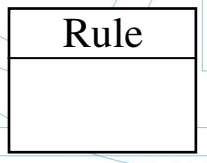
- **Objective**. Level of performance attended after the realization of the activity.
- **Decision variables**. Element on which one can play during the activity implementation.
- **Criterion**. Help to the choice of the actions on the decisions variables.
- **Rules**. Specification of the behaviour of an activity or a part of this one.

Nature of entity

There are seven natures of entities (cont'):

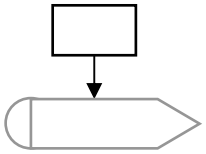
- **Performance indicator**. Report on a performance.
- **Information**. Entity of informational nature unspecified.
- **Resource**. Concrete means, technical or human, necessary to the implementation of the activity.

The nature of the entity is mentioned (or be an information by default)



Role of entity

Three roles are possible for an entity



Support. Entity required for the progress of an activity

Result. Entity produced by an activity

Trigger. Entity required for the progress of an activity and of which the disposal triggers the activity.

Additional information

Trigger

- The trigger of an activity can also consist of an exogenous logical condition. In this case, this one is indicated as an entity trigger.
- The trigger can also consist in the period of the level where the decision centre is located. In this case, no trigger is mentioned.

Support

- Objectives, decision variables and criteria are only and mandatory represented for decisional activities.

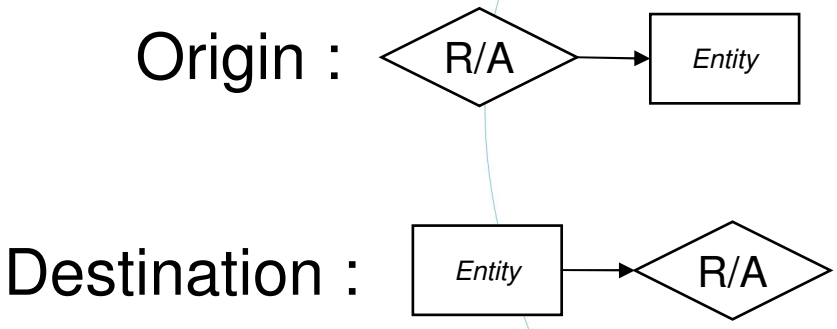
Reference operators

Reference operators are used when it is necessary to indicate the origin or the destination of an entity when this origin or this destination is external with the diagram.

Situations for which these operators are necessary:

- when an entity circulates between the studied system and its environment,
- when an entity circulates from one decision centre to another one,
- when the net is too large to enter on a page!

Reference operators



- R: number of the net,
- A: number of the origin or destination activity
- R/A: name of the system or service out of the study domain

LOGICAL OPERATORS

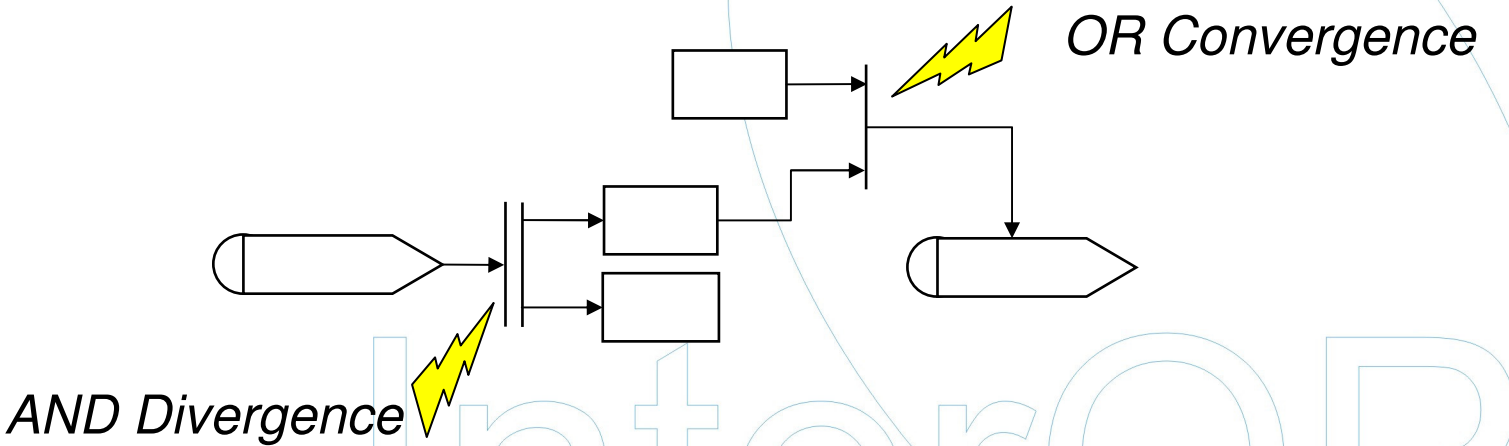
Generalities

- It appears combinations or decompositions in the GRAI nets which result in divergences and convergences into AND and OR, from entities to activities and reciprocally.

  These situations are represented by logical operators.
- The representation of these operators follows the general rule:
  - AND are represented by double features (| |)
  - OR are represented by simple features (|)

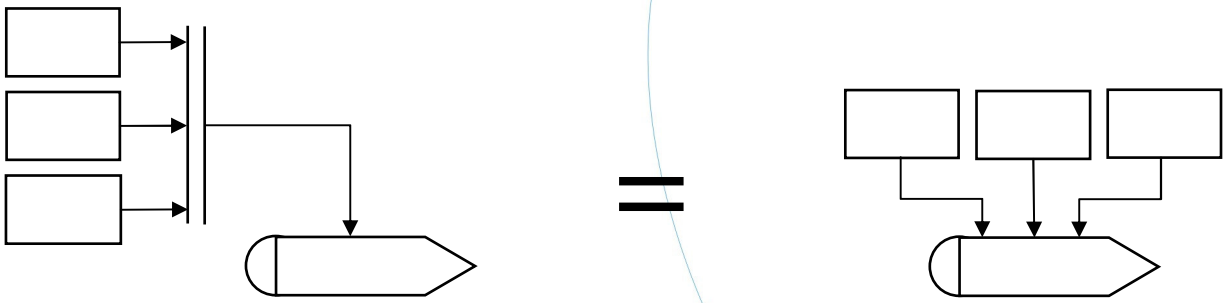
Generalities

Example



Particular case

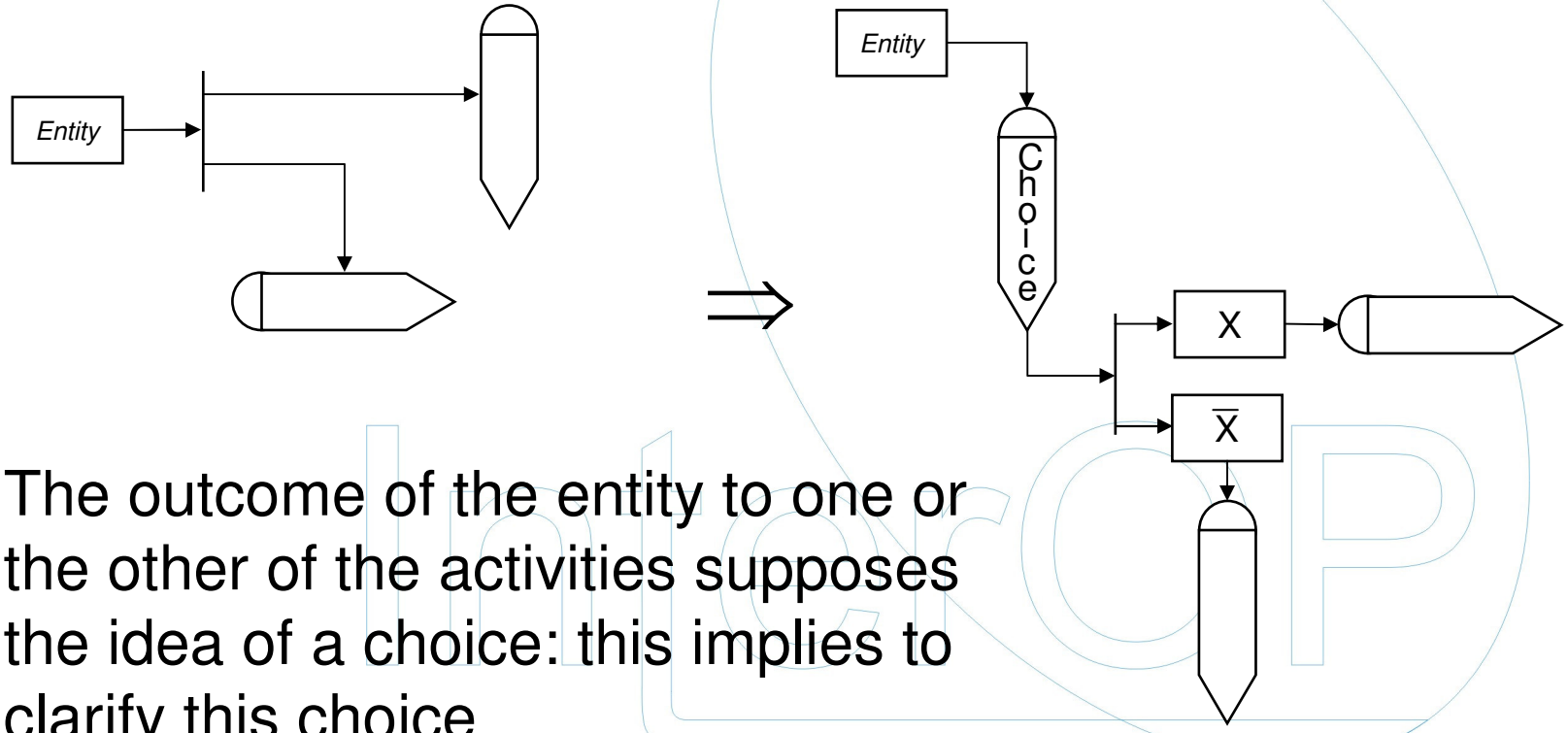
Link: Entity → Activity / AND / convergent



Because supports are not optional

Prohibited structure

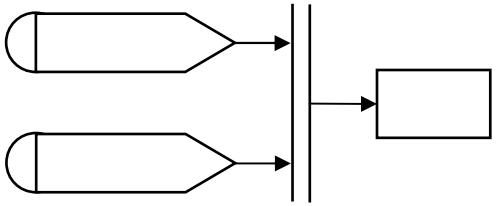
Link: Entity → Activity / OR / divergent



The outcome of the entity to one or the other of the activities supposes the idea of a choice: this implies to clarify this choice

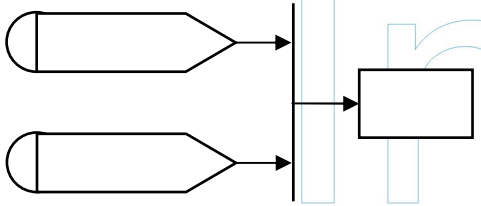
Prohibited structure

Link: Activity → Entity / AND / convergent



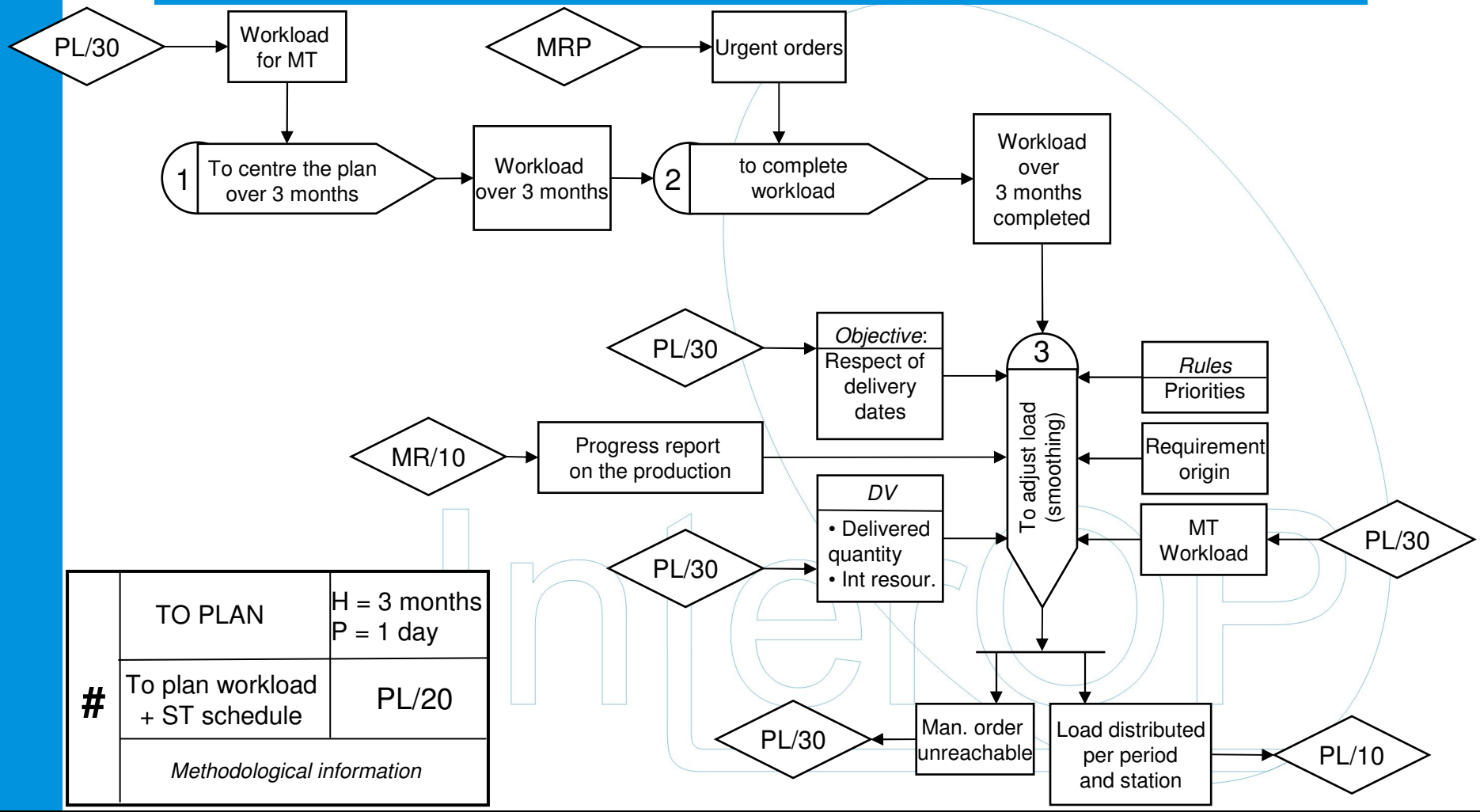
An activity must have its own result

Link: Activity → Entity / OR / convergent

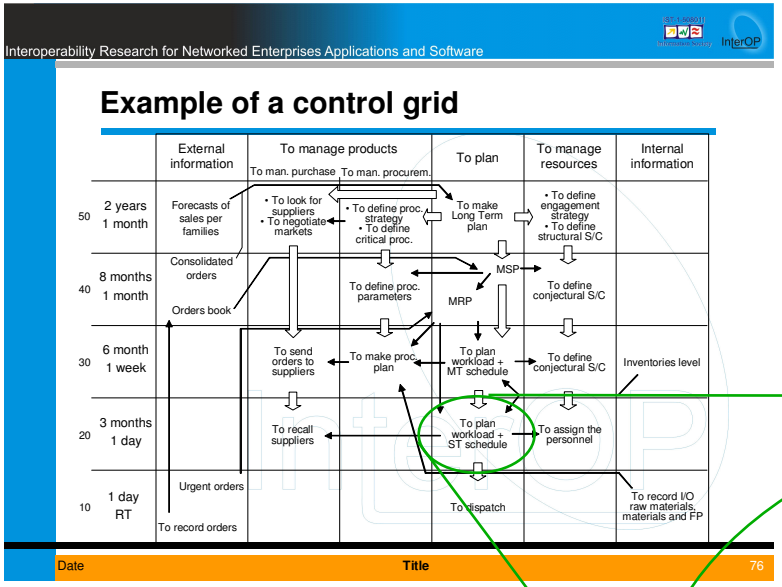


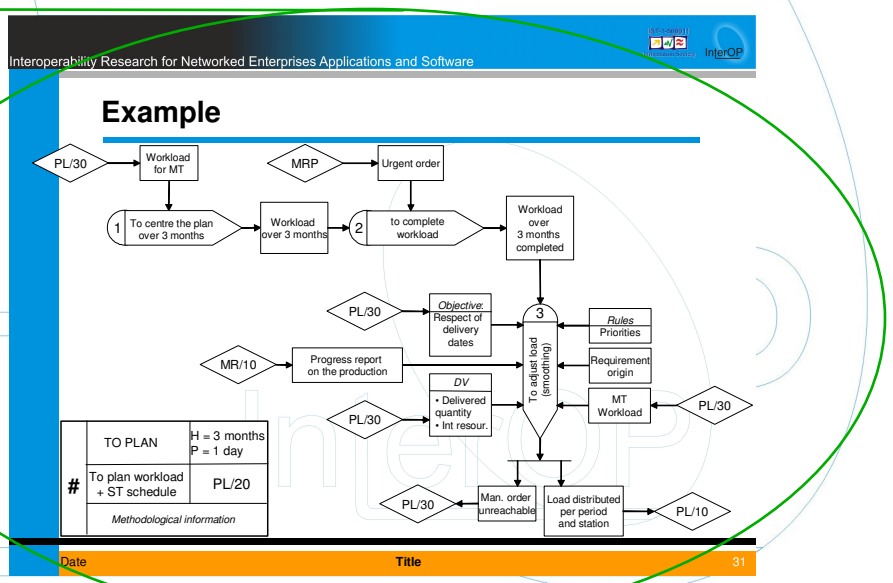
EXAMPLE OF NETS

Example


PL/30
Workload for MT
MRP
Urgent orders
1
To centre the plan over 3 months
Workload over 3 months
2
to complete workload
Workload over 3 months completed
PL/30
Objective: Respect of delivery dates
3
Rules Priorities
MR/10
Progress report on the production
Requirement origin
DV
• Delivered quantity
• Int resour.
To adjust load (smoothing)
MT Workload
PL/30
PL/30
PL/30
Man. order unreachable
Load distributed per period and station
PL/10
#
TO PLAN
H = 3 months
P = 1 day
To plan workload + ST schedule
PL/20
Methodological information

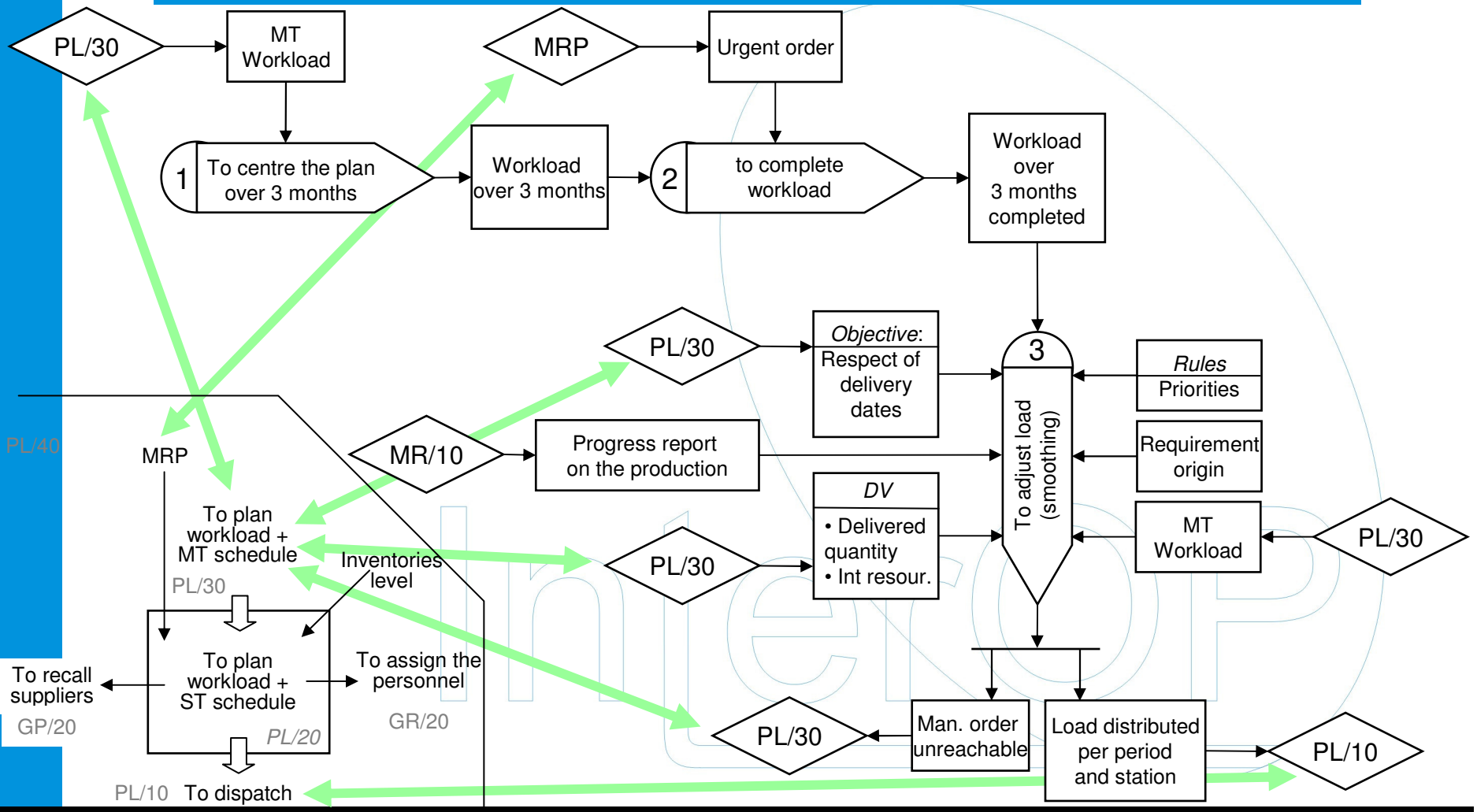
Link with the corresponding grid



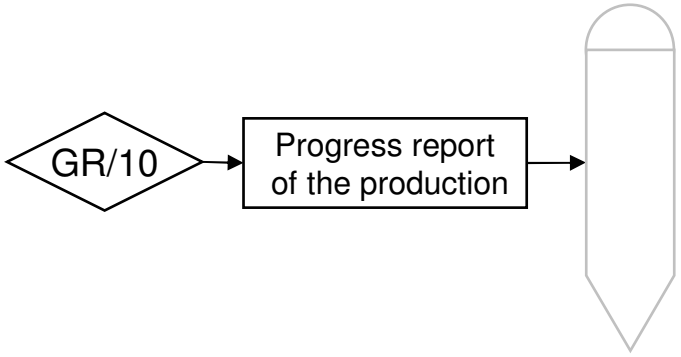


#		
	TO PLAN	H = 3 months P = 1 day
	To plan workload + ST schedule	PL/20
	Methodological information	

Example: links with the corresponding grid

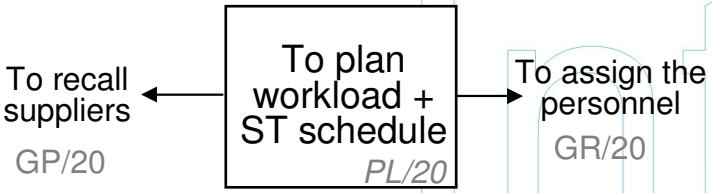


Example: links with the corresponding grid



Consistence

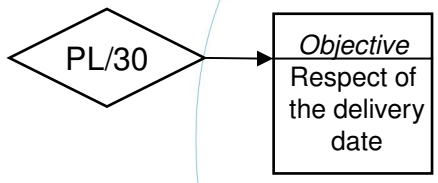
Absent of the grid: normal (additional detail at the level of the nets)



Absent relations in the net: abnormal

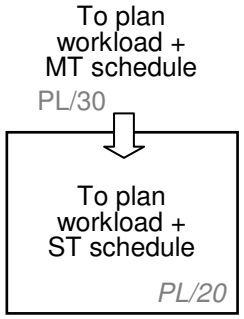
Example: links with the corresponding grid

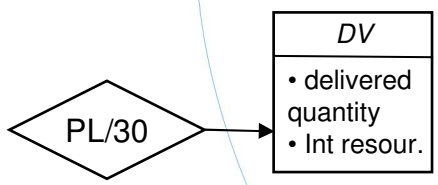
Analysis of the content of the decision framework
PL/30 → PL/20



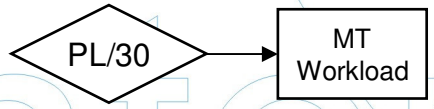
Transmission of the value of the objective

In the grid:

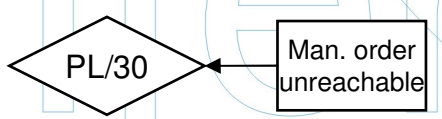




Transmission of the value of the constraints



Order transmission

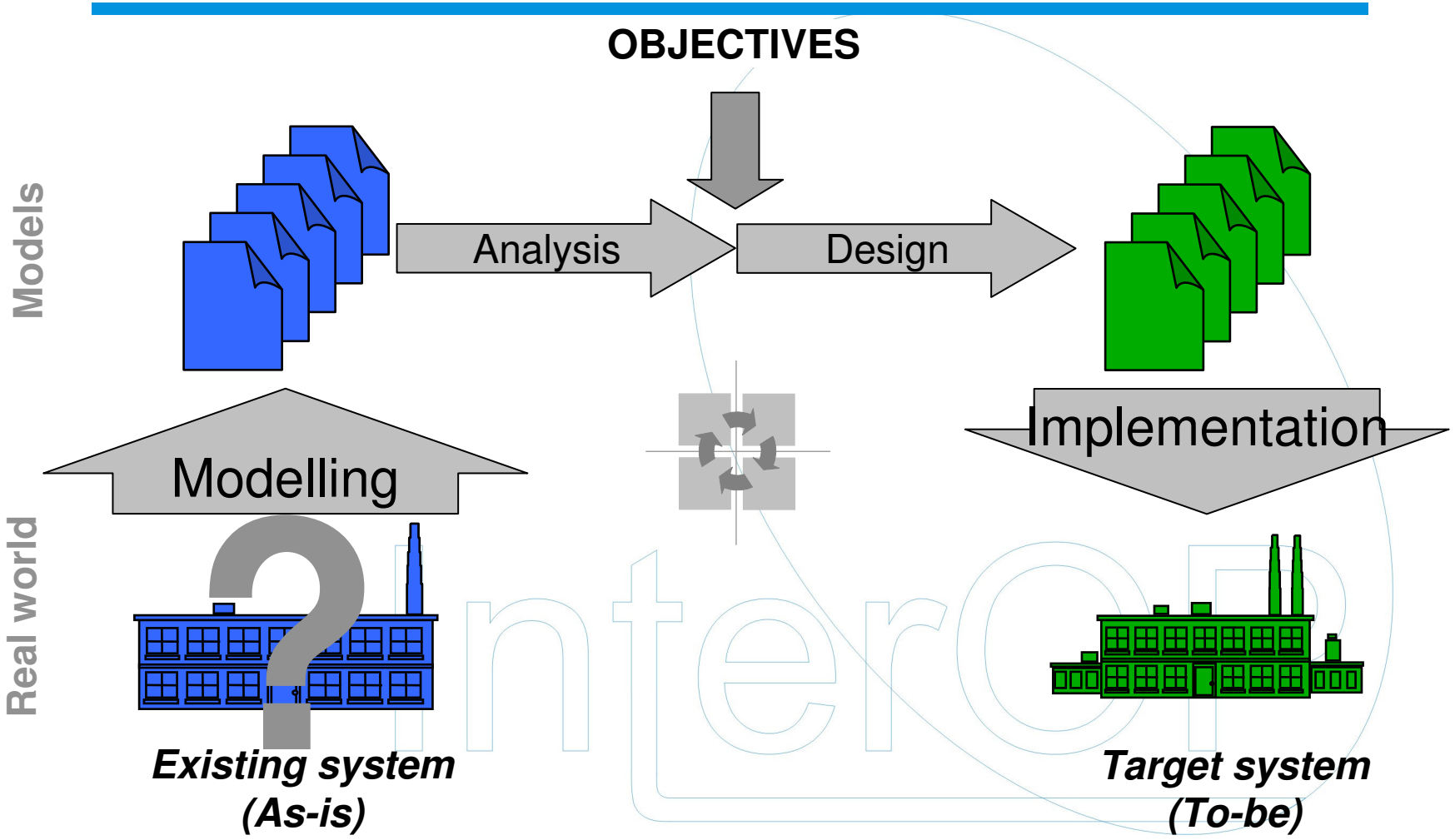


Information follow up

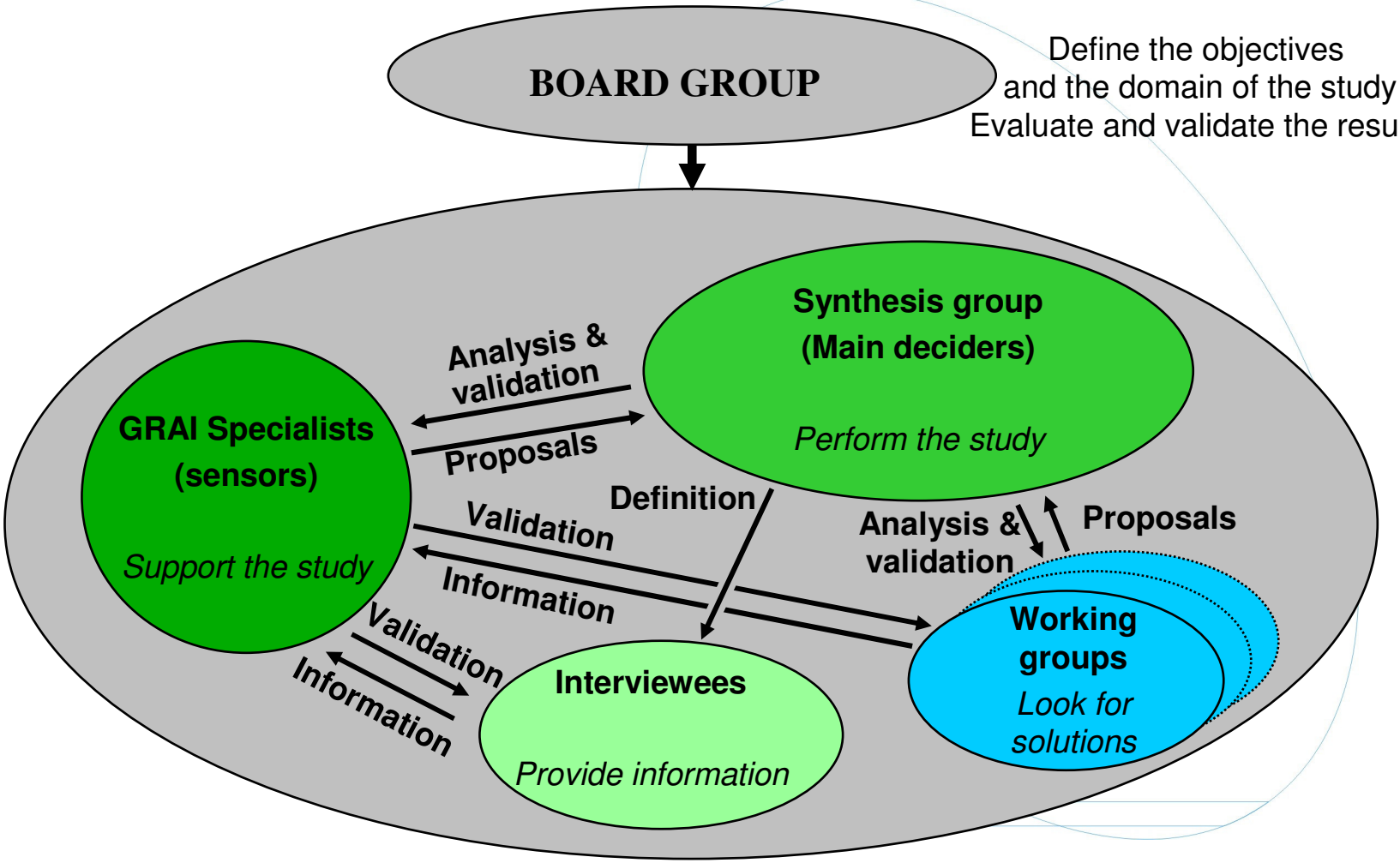
Third part

THE STRUCTURED APPROACH

General principles



The actors


BOARD GROUP
Define the objectives
and the domain of the study
Evaluate and validate the results
Synthesis group
(Main deciders)
Perform the study
GRAI Specialists
(sensors)
Support the study
Analysis &
validation
Proposals
Definition
Validation
Information
Analysis &
validation
Proposals
Validation
Information
Interviewees
Provide information
Working
groups
Look for
solutions

The actors

Example of a group composition (study of a SME)

Board group

- person in charge of the SME
- responsible for the division of the group to which the SME is attached
- **Synthesis group**
- person in charge of the SME
- responsible for procurement / subcontracting
- responsible for manufacturing

…/…

The actors

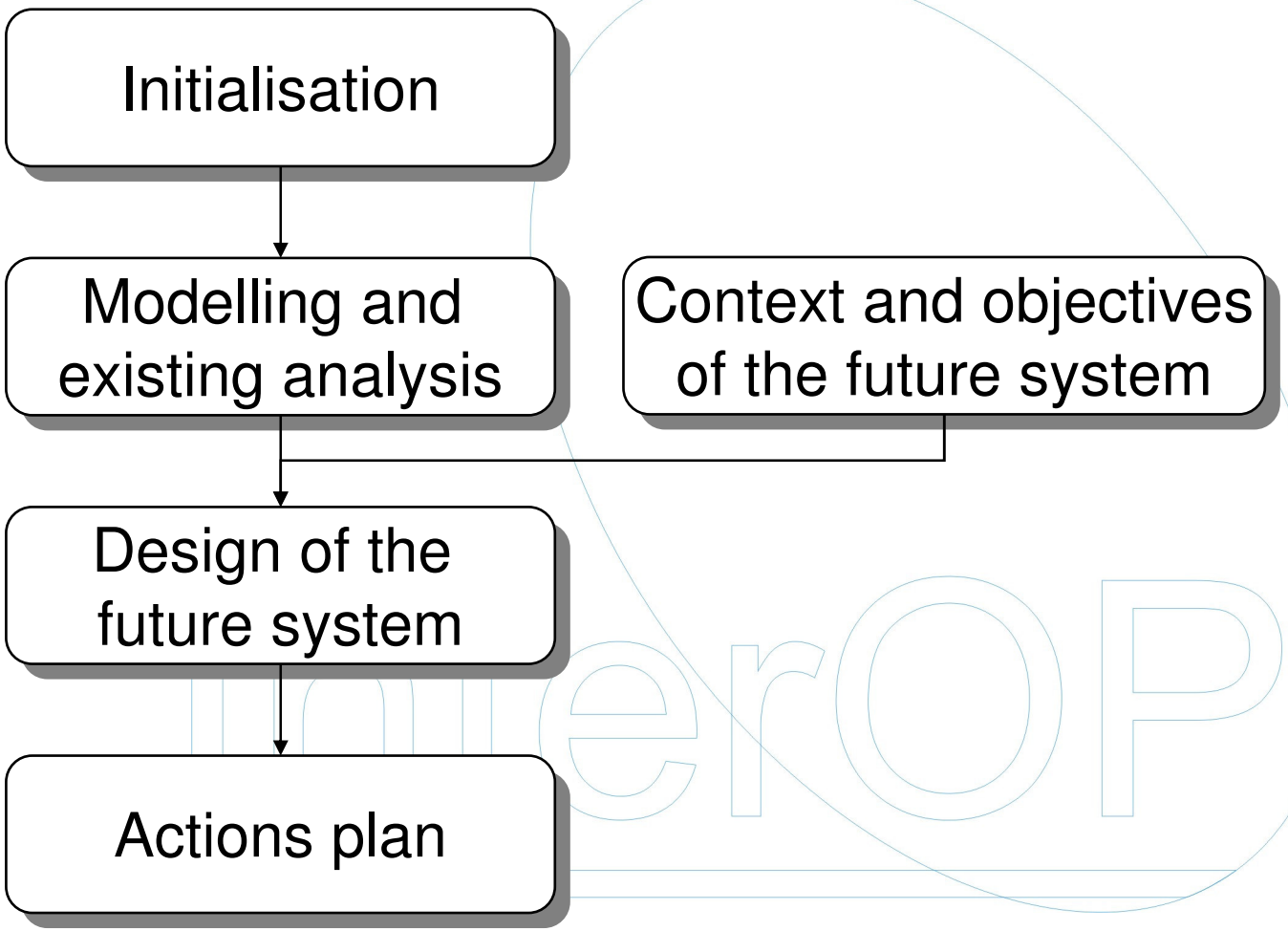
Example of a group composition

- responsible for quality
- responsible for estimation / preparation
- responsible for scheduling
- responsible for commercial

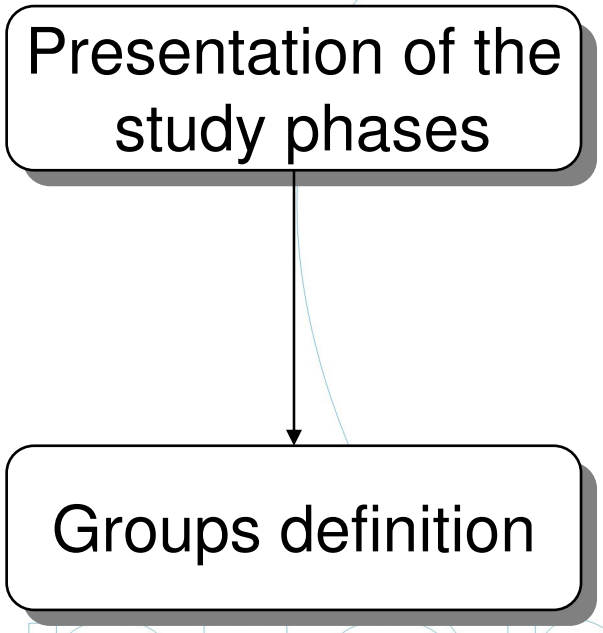
Specialists

- a specialist from a service company
- a specialist assistance provided by the group

General progress



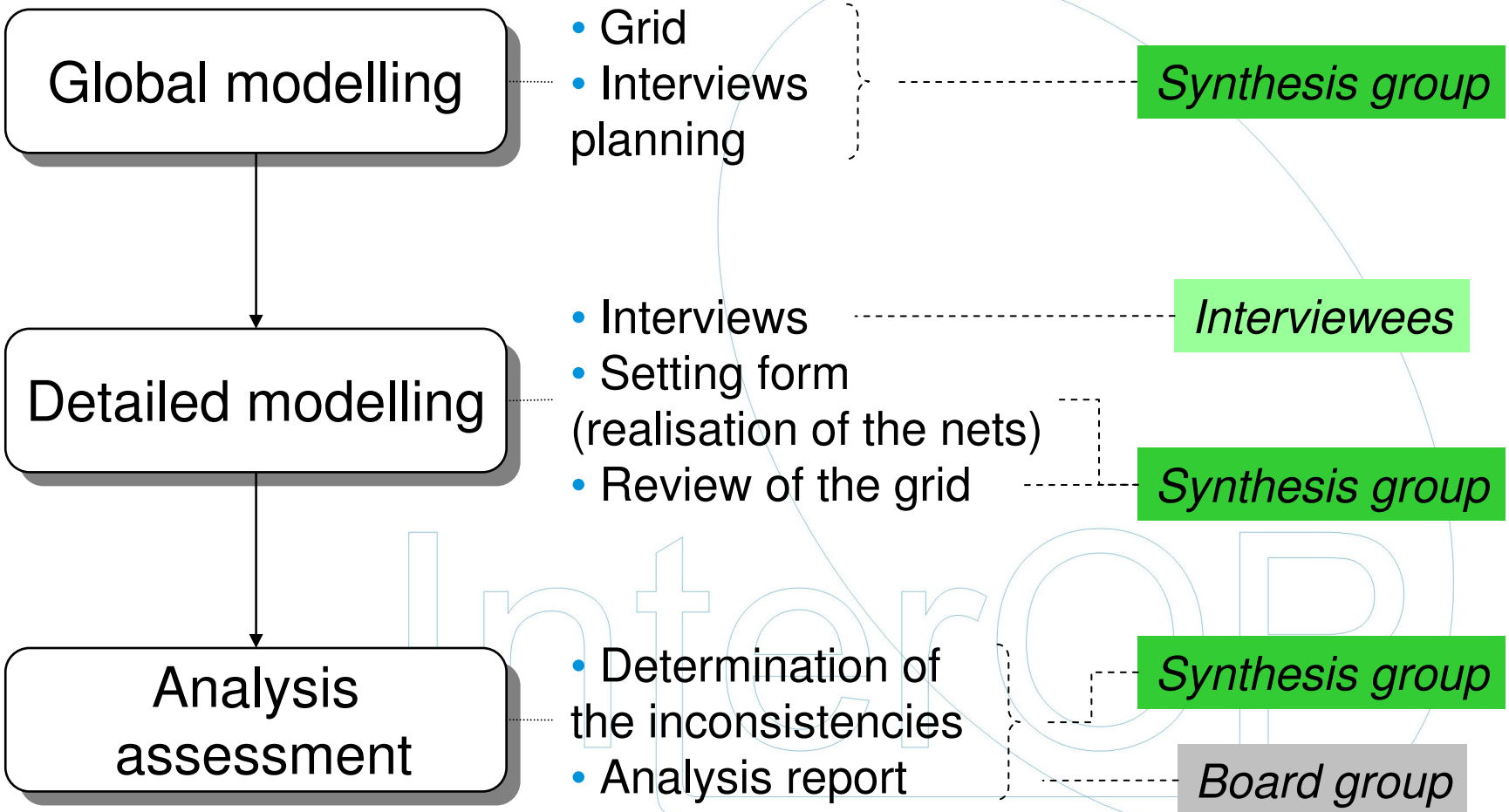
Course of the phase « initialisation »



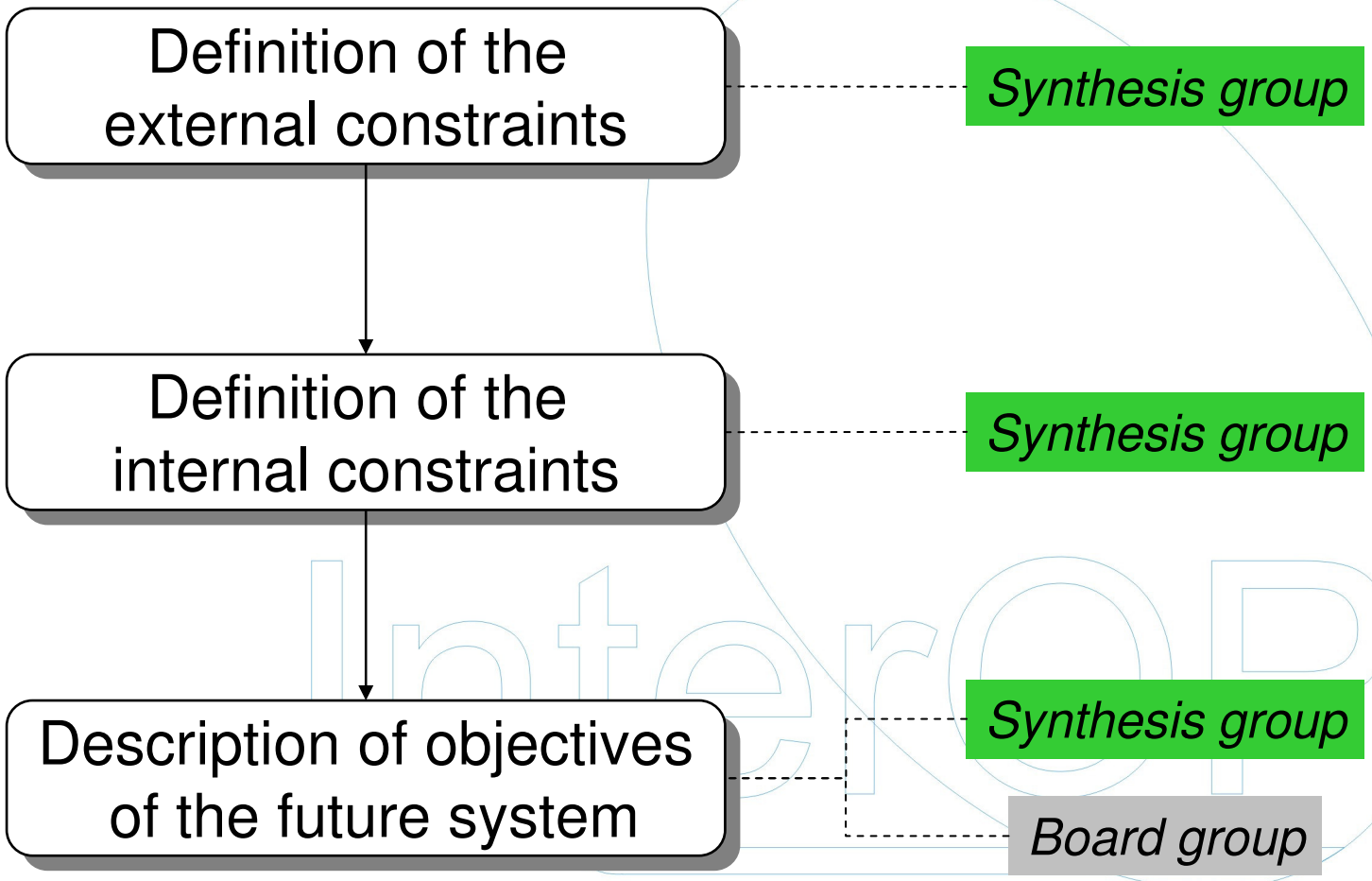
Synthesis group

Board Group

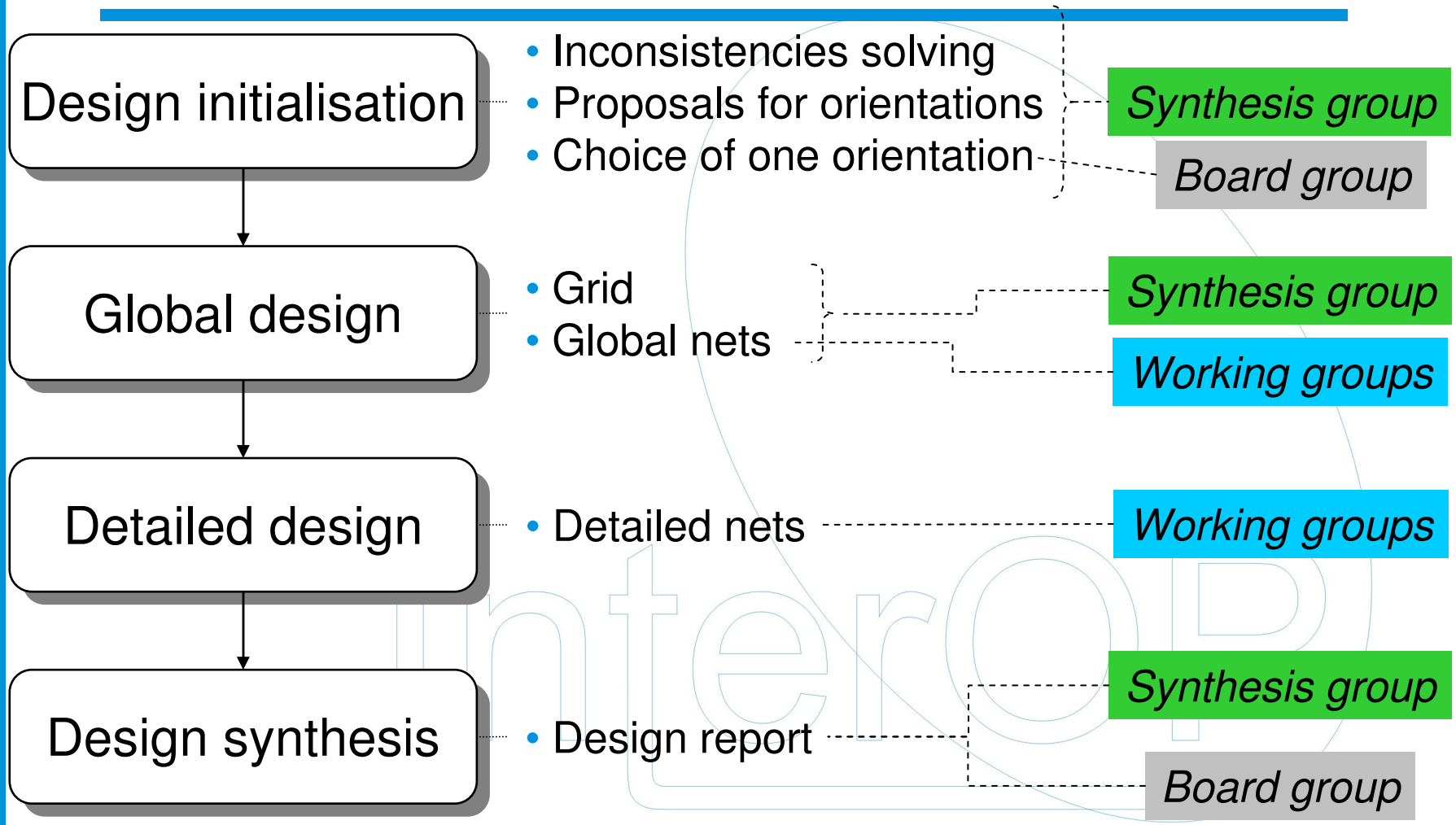
Course of the phase «modelling and existing analysis»



Course of the phase « context and future system objectives »



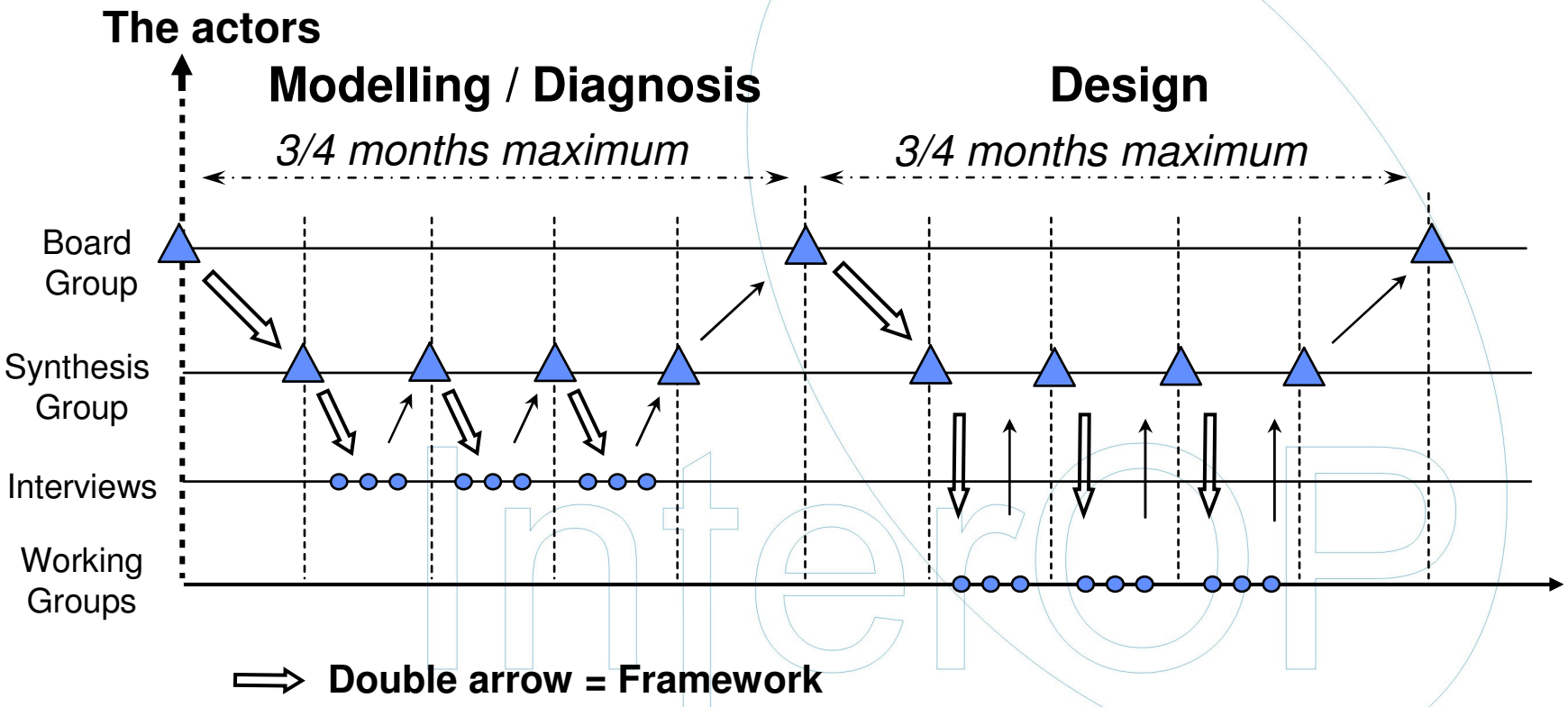
Course of the phase « future system design »



Some precisions

- The phases do not proceed a such sequential way (overlapping, looping);
- It is necessary to regularly gather the group of synthesis (to remain "in catch" with the study) without overloading its members (1/2 day every 2 or 3 weeks): that involves intermediate versions of the results.

Example of planning



Fourth part

THE INCONSIS-TENCIES RULES

Generalities about inconsistencies rules

- The most important rules come from the GRAI model (in this way, they are a part of the model);

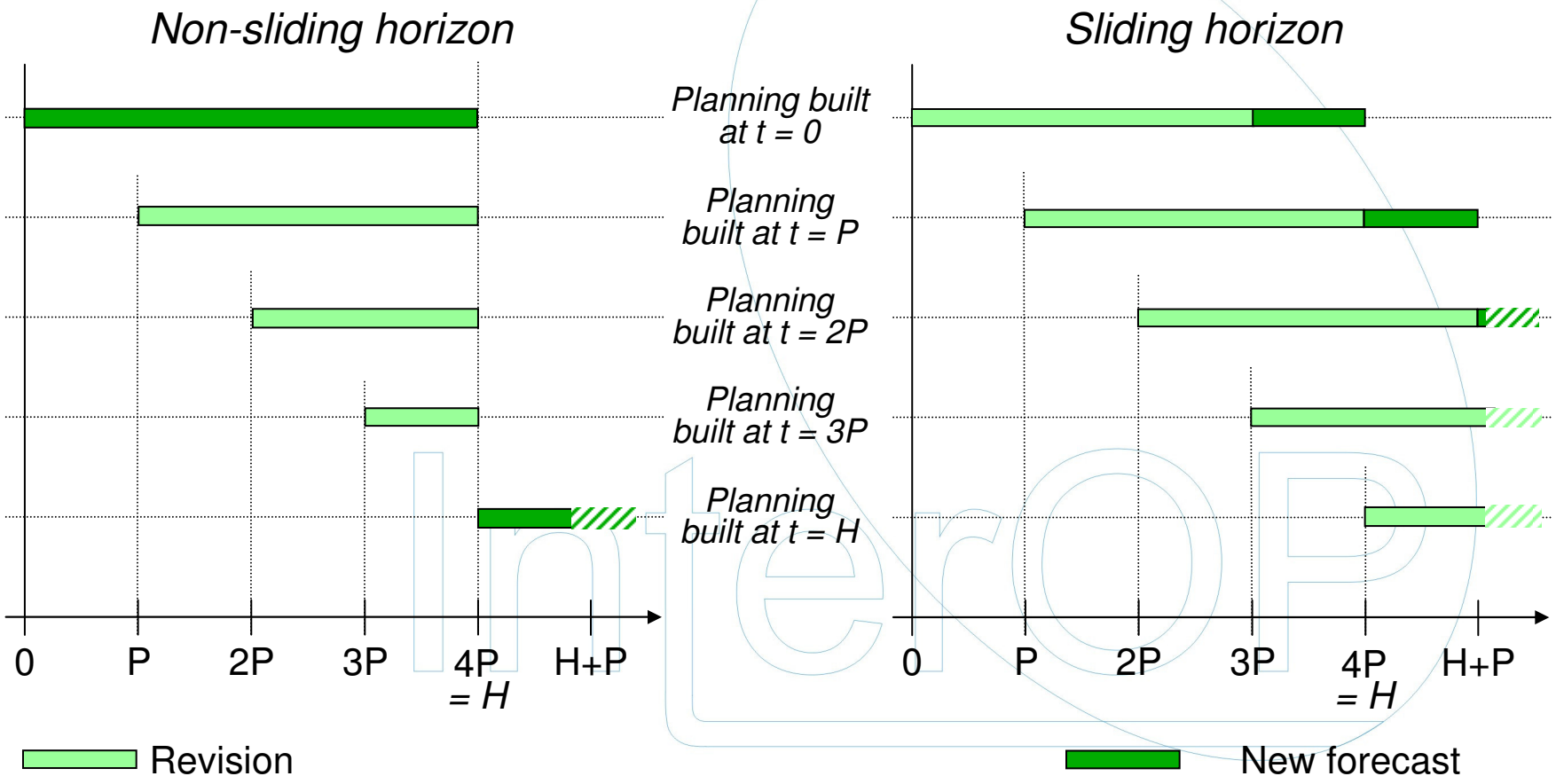
- The inconsistencies rules correspond to the ideal vision of a control system;

- The goal is not to obtain such an ideal system, the studied system will not be requested to match all the rules:

⇒ ***Set of inconsistencies rules = Guide to think about the consistence of the studied system.***

«A» rule

Horizons must be sliding.

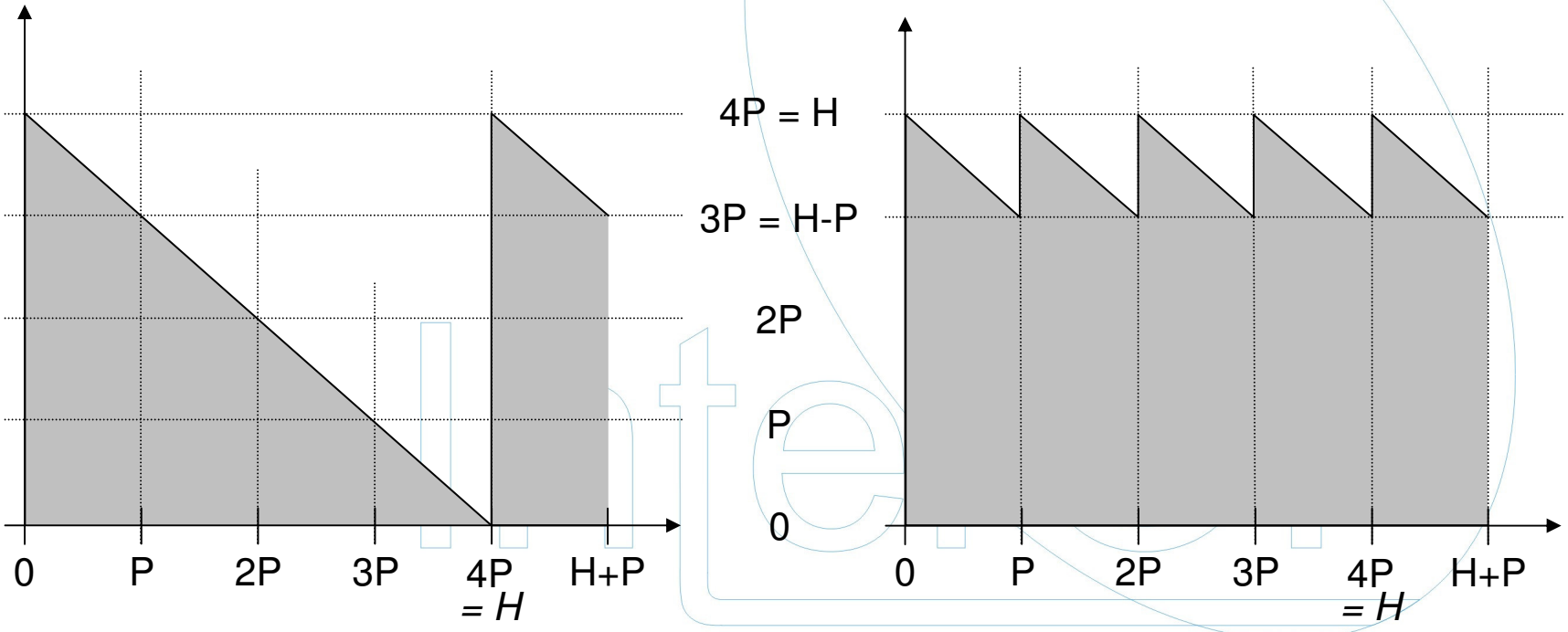


«A» rule

Vision of the future

Non-sliding horizon

Sliding horizon



«A» rule

The control systems we take into account are based on forecasts (that is why the notion of horizon exists);

The only way to permanently keep a **minimal vision of the future** is to have a sliding horizon;

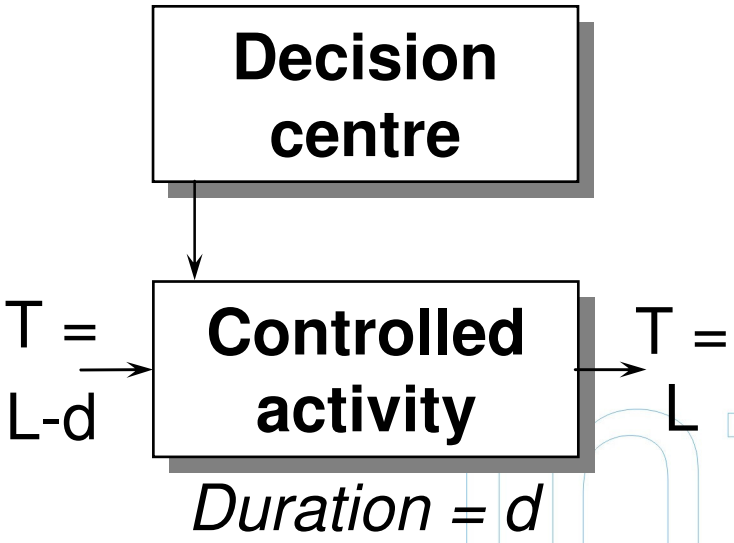
With a sliding horizon: **Vision at decision period** = H,

Minimal vision = H - P;

Note: when H = P, the notion of sliding horizon has no sense anymore and we consider then that the situation corresponds to a non-sliding horizon.

«B» rule

The horizon must be longer than the time to achieve physical activities of production controlled by the decision centres of the level.



L = delivery date

The planning realized at L-d must take the result expected at L into account, then a vision in the future over d is necessary:

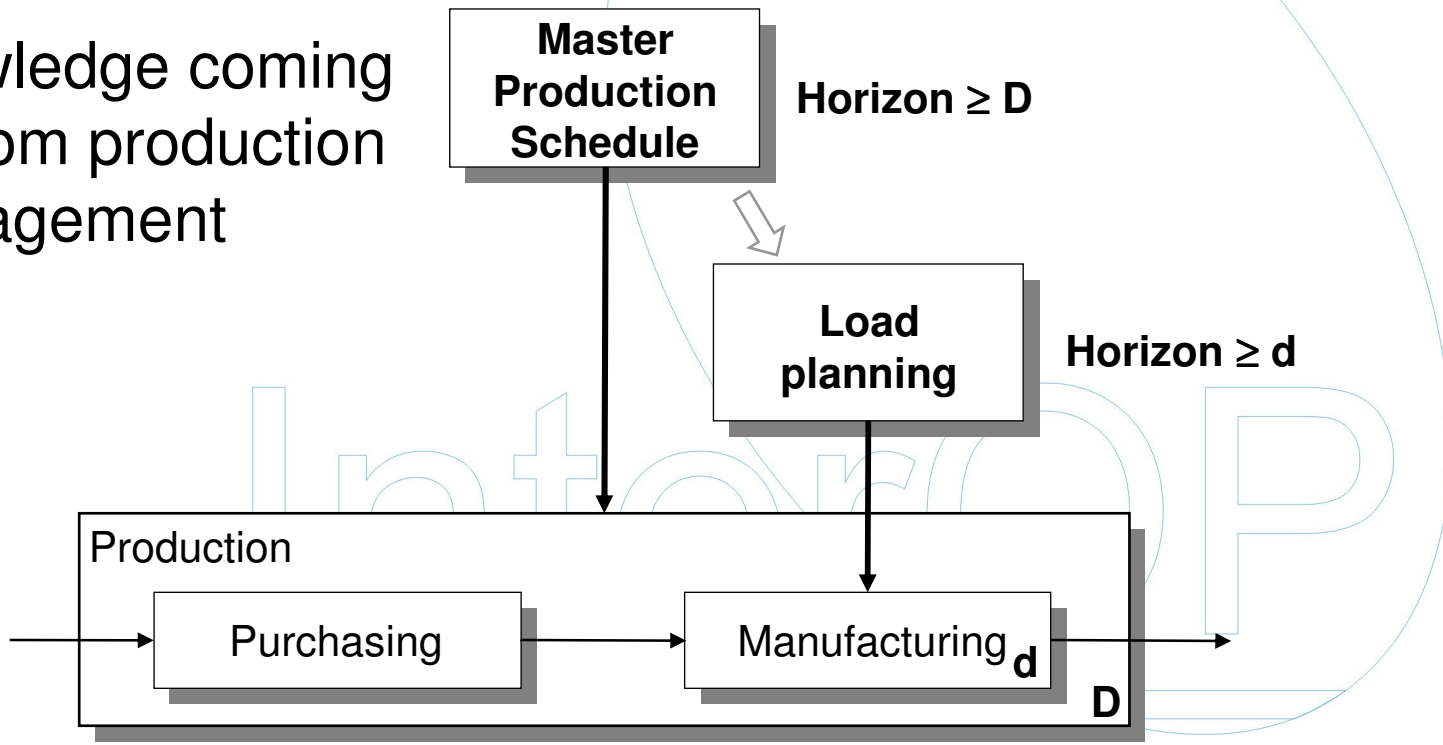
$$\Rightarrow \mathbf{H} \geq \mathbf{d}$$

Note : This is true when there is a commitment about the delivery date (generally the case in production management).

« B » rule

Definition of the relationships between physical activities of production and decision centres

Knowledge coming up from production management



« B » rule

Precision

The former general rule is true for the nominal running since the vision in the future is equal to H at the period of decision making.

In the case where many adjustments are needed, the minimal vision in the future must be considered: H - P.

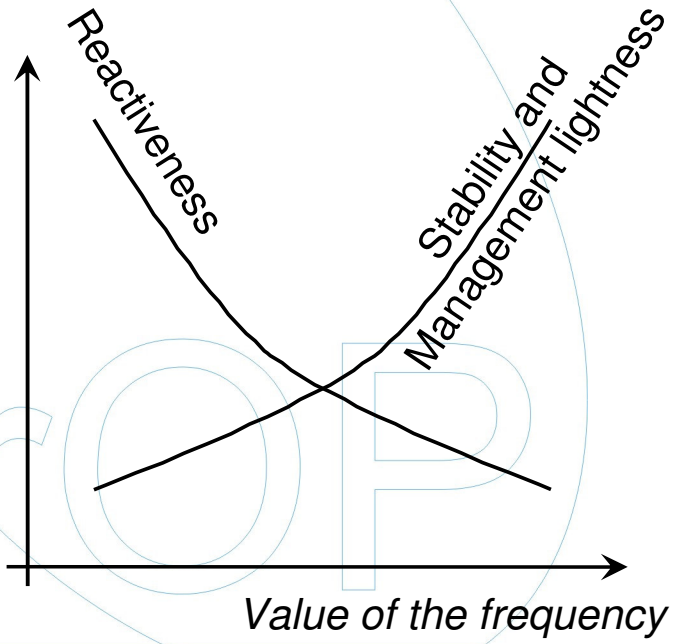
Then, if the environment of the system is very disturbed, it is necessary that:

$$\mathbf{H - P \geq d}$$

«C» rule

The value of the period is linked to the frequency of fluctuations impacting the decision centre considered.

- Shorter the period is, more the system is reactive,
- Longer the period is, more the system is stable and light to manage.



Stability: by implementing « enough » a plan before revising it.

Management lightness: less effort with a batch-process of events.

«D» rule

The ideal number of decisional levels is between three and five.

Too much levels make the system too complex and is often the symptom of a synchronization issue between decision centres.

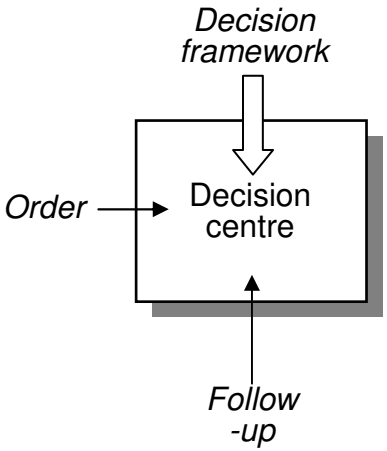
Not enough levels does not allow a « progressive co-ordination » of the system.

Empirical rule defined by experience.

«E» rule

The horizon of a level must have a value equal or greater than the value of the period of the upper level.

Sources of variations:



Orders and follow-up are continuously received, the decision framework is emitted only at each period of the upper level. Then, the environment of the decision centre is stable from this point of view during P_{n+1} (period of the upper level).

This stability is taken into account by having:

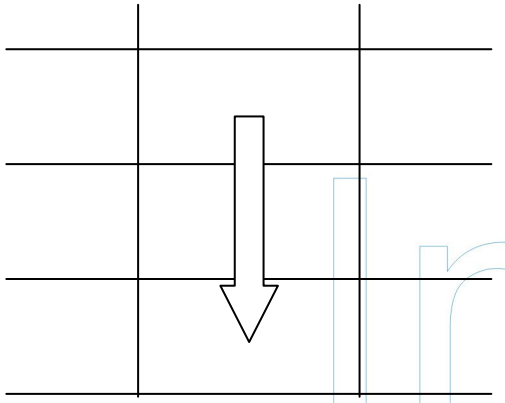
$$\mathbf{H_n \geq P_{n+1}}$$

Empirical rule : $H_n = 2.P_{n+1}$

«F» rule

A decision framework must not jump a level.

Configuration that does not match the rule:



- This configuration denies the raison d'être of the jumped decision centre and the interest for having a progressive co-ordination.
- The decision centre receptor receives a frame not often enough and too global related to the detail it processes itself.

«G» rule

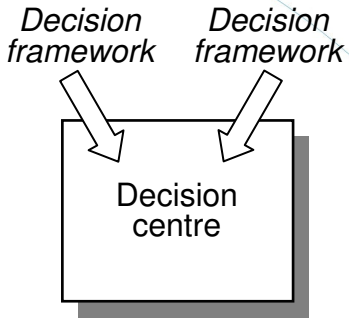
A decision centre must receive only one decision framework.

- The objectives sent risk to be **contradictory**;

- The decision space of the decision centre receptor corresponds to the intersection of decision spaces defined by each decision framework (decision variables and constraints). This space risks to be **empty**.

« G » rule

Configuration that does not match the rule:

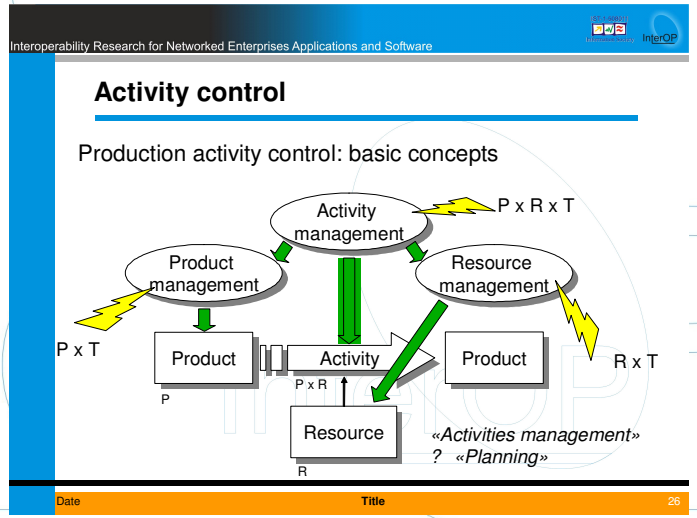


Configuration theoretically possible (mainly if it exists a unique decision centre upstream the decision frameworks) but not practically recommended.

«H» rule

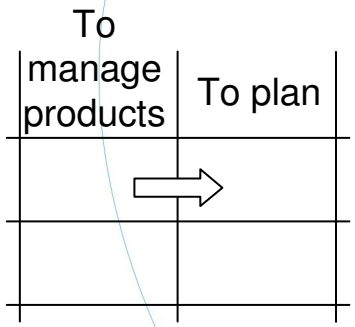
A decision framework inter-functions is possible only if the decision centre emitter belongs to a function whose the basic elements contain the basic elements of the function that the decision centre receptor belongs to.

Reminder:



« H » rule

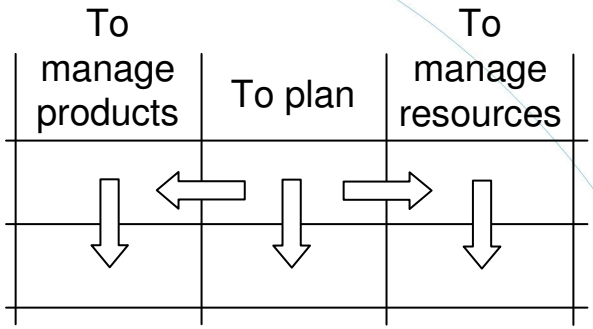
Example of forbidden configuration:



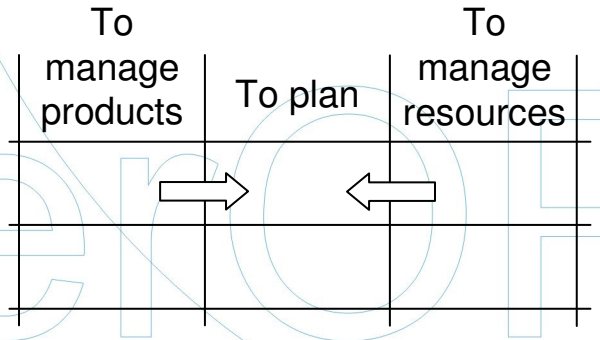
The decision centre emitter does not master the notion of Resource: it cannot completely frame a decision centre belonging to the “Plan” function

« H » rule

Possible configurations (for the three elementary control functions):



Theoretically possible configuration but forbidden by the G rule:



«I» rule

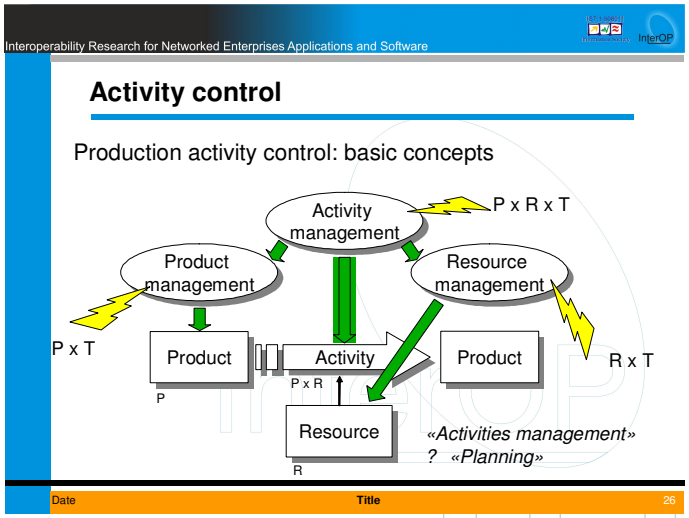
A function is an exclusive set of activities having a role participating to a common and identified finality.

- Common understanding of the function and its finality,
- Each decision centre of the function participates effectively to the finality of the function,
- Consistent set of objectives deployed all along the hierarchy.

«J» rule

Each elementary control function must have a decision centre at each hierarchical level.

Reminder:



The «Activity management (planning) / Products management / Resources management» triplet cannot be dissociated ⇒ If one element of the triplet is present at one level, then the two other ones must be present as well.

«K» rule

The production management system must be informed enough about its environment (external information) and about the physical system (internal information).

The system is:

- open: information coming from its environment,
- looped : information coming from the physical system.

Knowledge about production management is necessary to know what information is required and where.

Conclusions about inconsistencies rules

- Some rules are general and express control principles (GRAI model): they are applied to the grid

(rules presented here);

- Other more accurate rules come from production management principles and are applicable to the grid and to the nets

(rules not presented here);

- It is possible to enrich this set of rules (with rules dedicated to a class of systems, etc.).

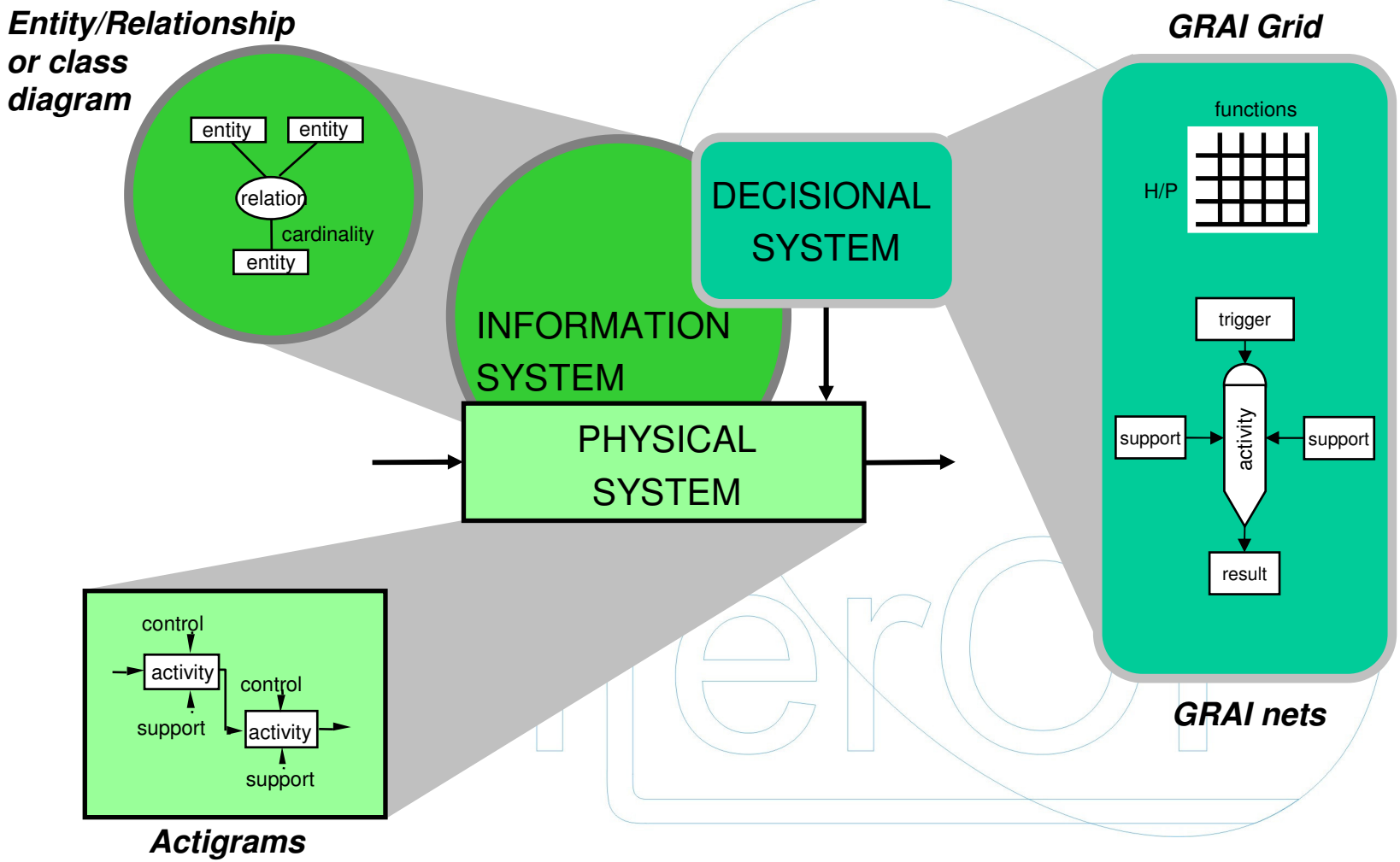
Fifth part

THE GRAI METHODOLOGY

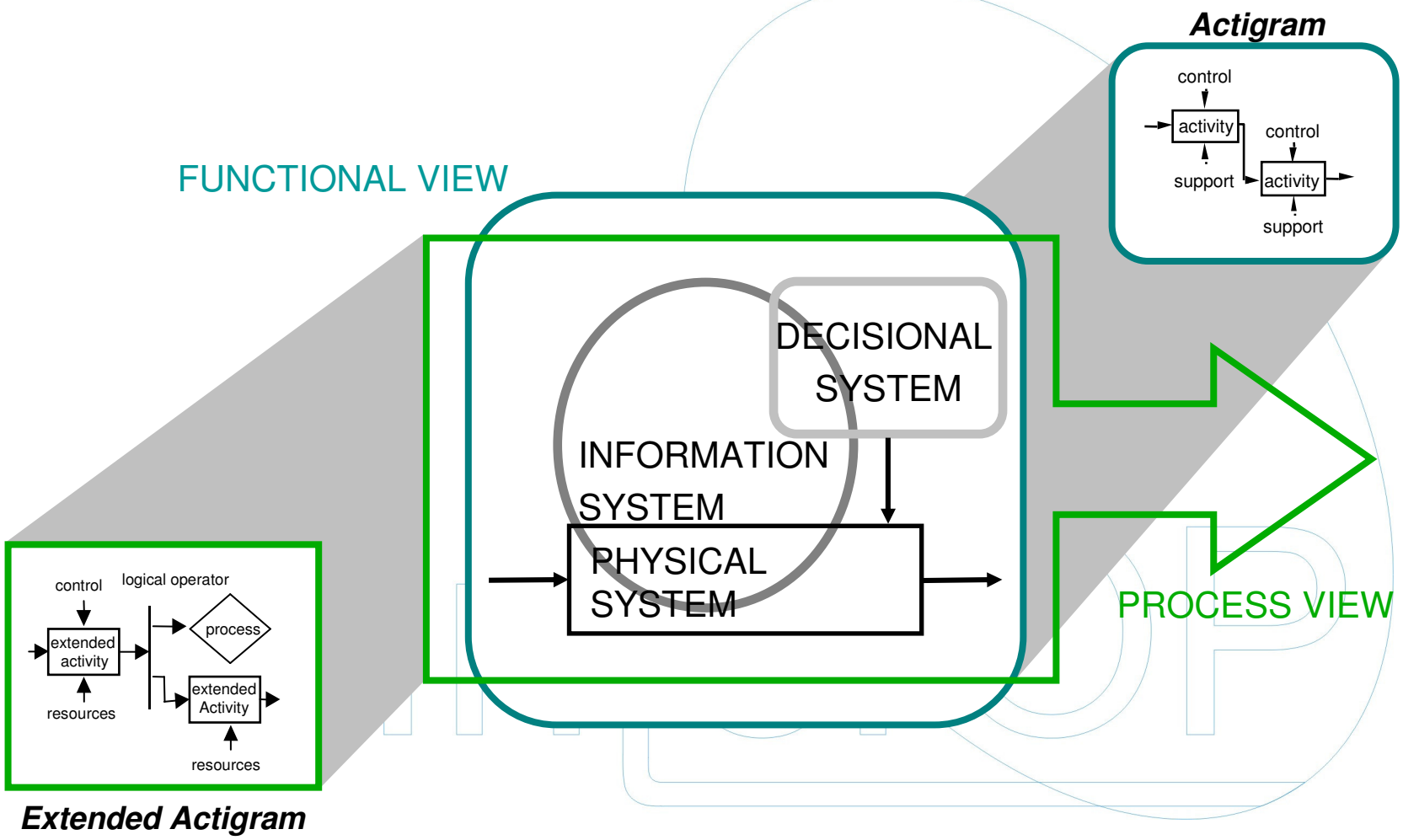
The GRAI methodology: definition

- The GRAI Methodology applies in the same general optics as the GRAI method (improvement of performances).
- The GRAI Methodology is also based on a reference model, graphic languages and a structured approach.
- The difference concerns:
  - the modelling domain,
  - the offer of specific approaches according to the aims of the study.

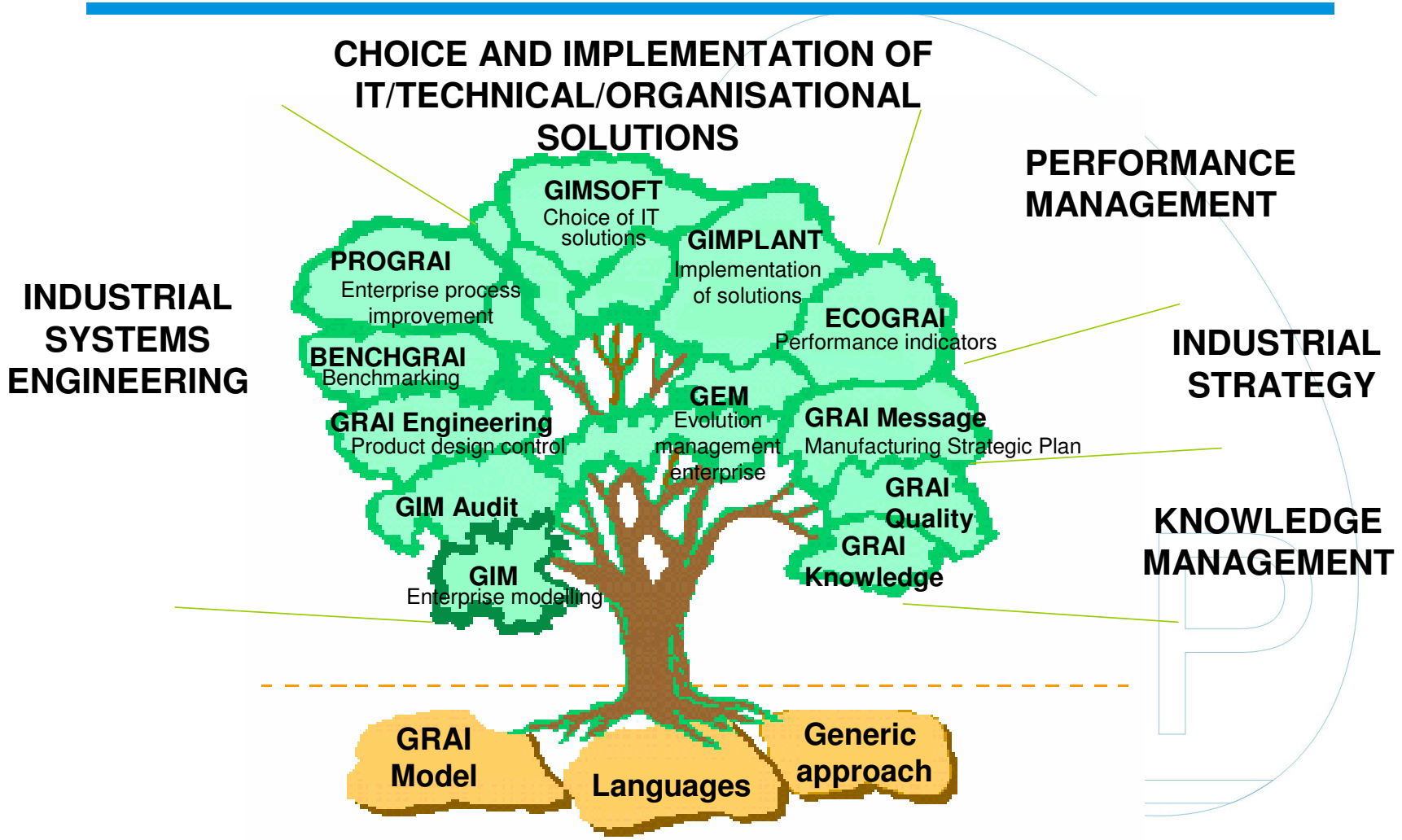
Modelling domain (by sub-systems)



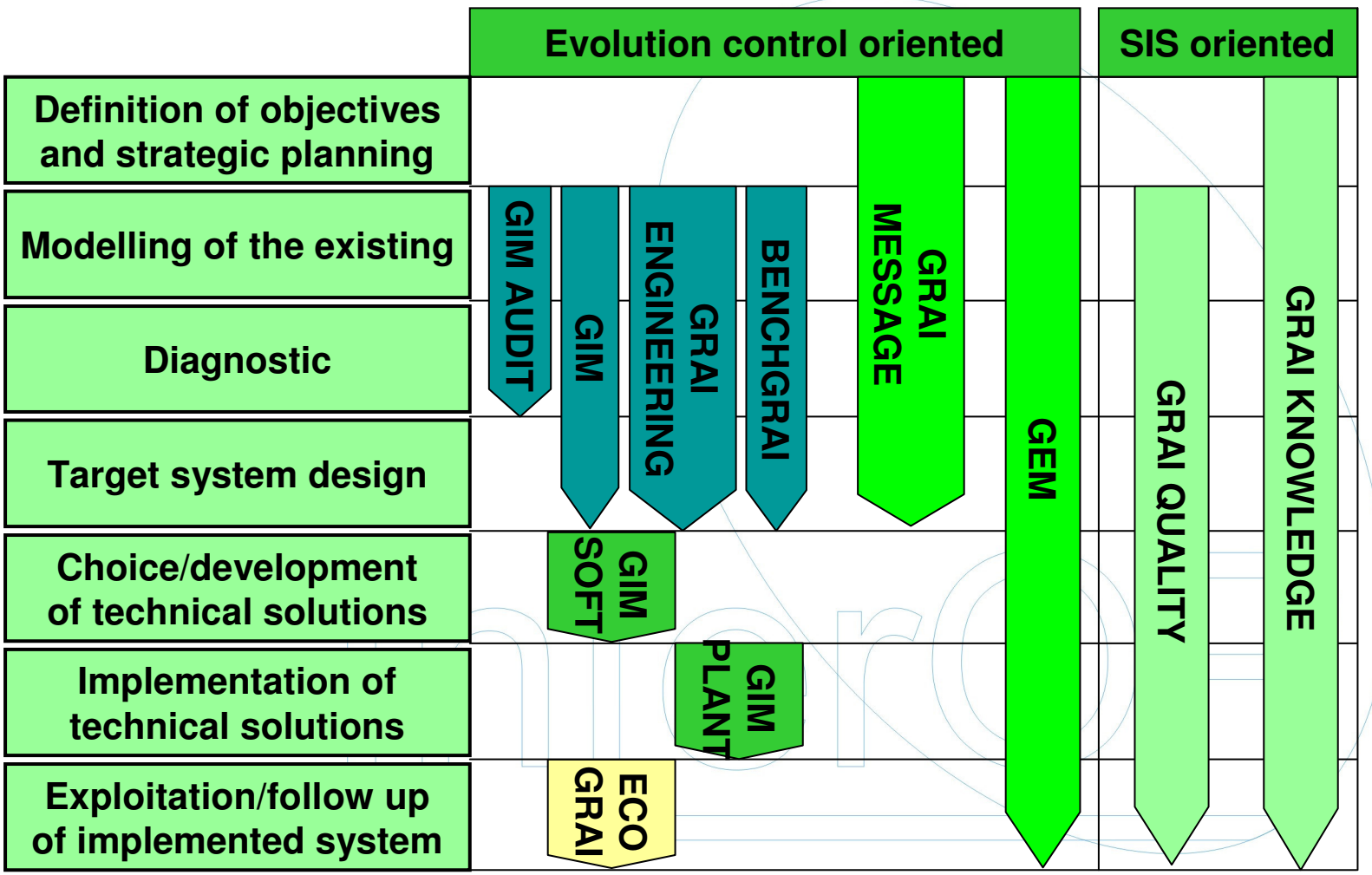
Modelling domain: global representation



The offer of specific approaches



Specific approaches and life cycle



Thank you for your attention