How to prospect along multiple timescales, through complex switches

by

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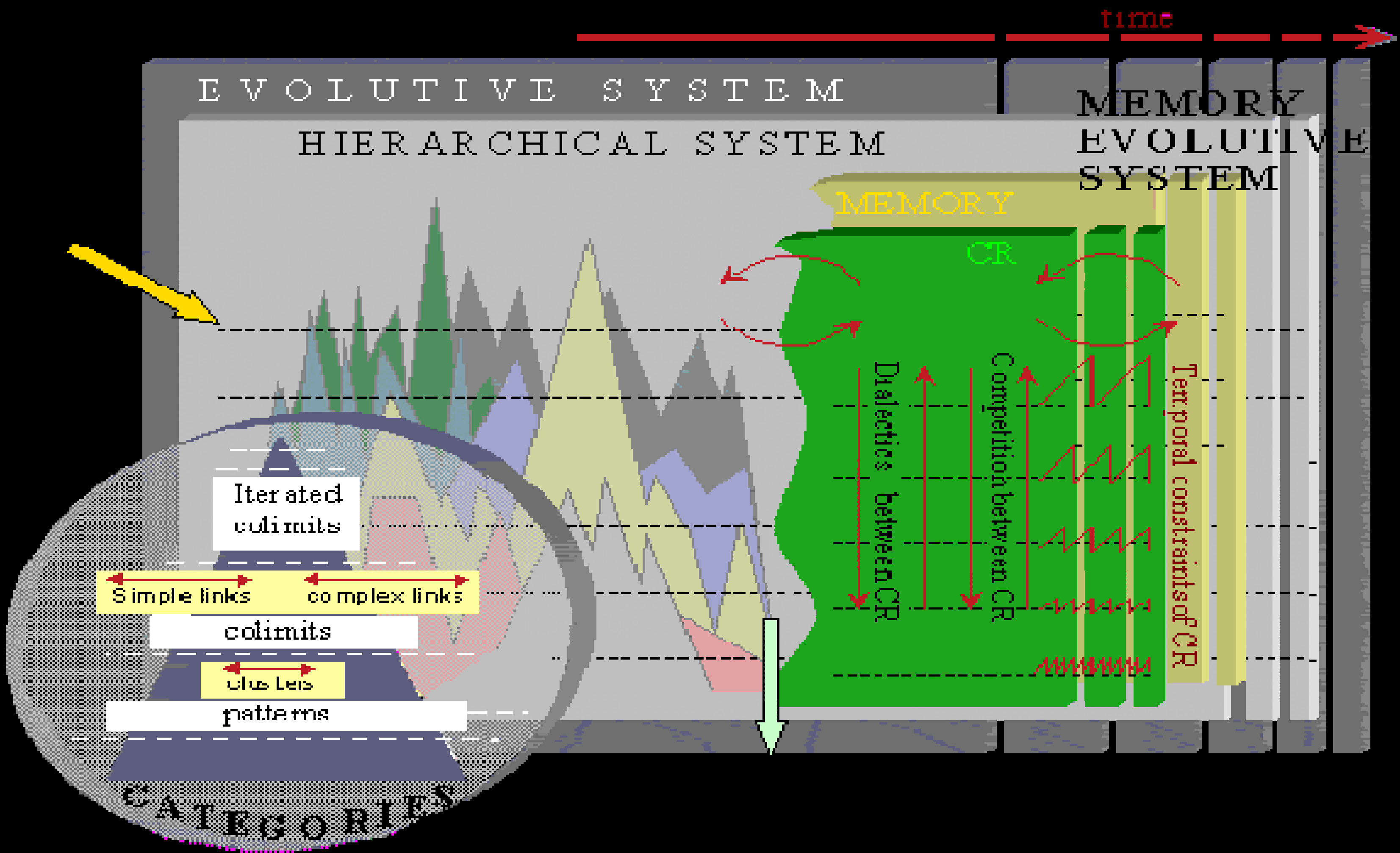
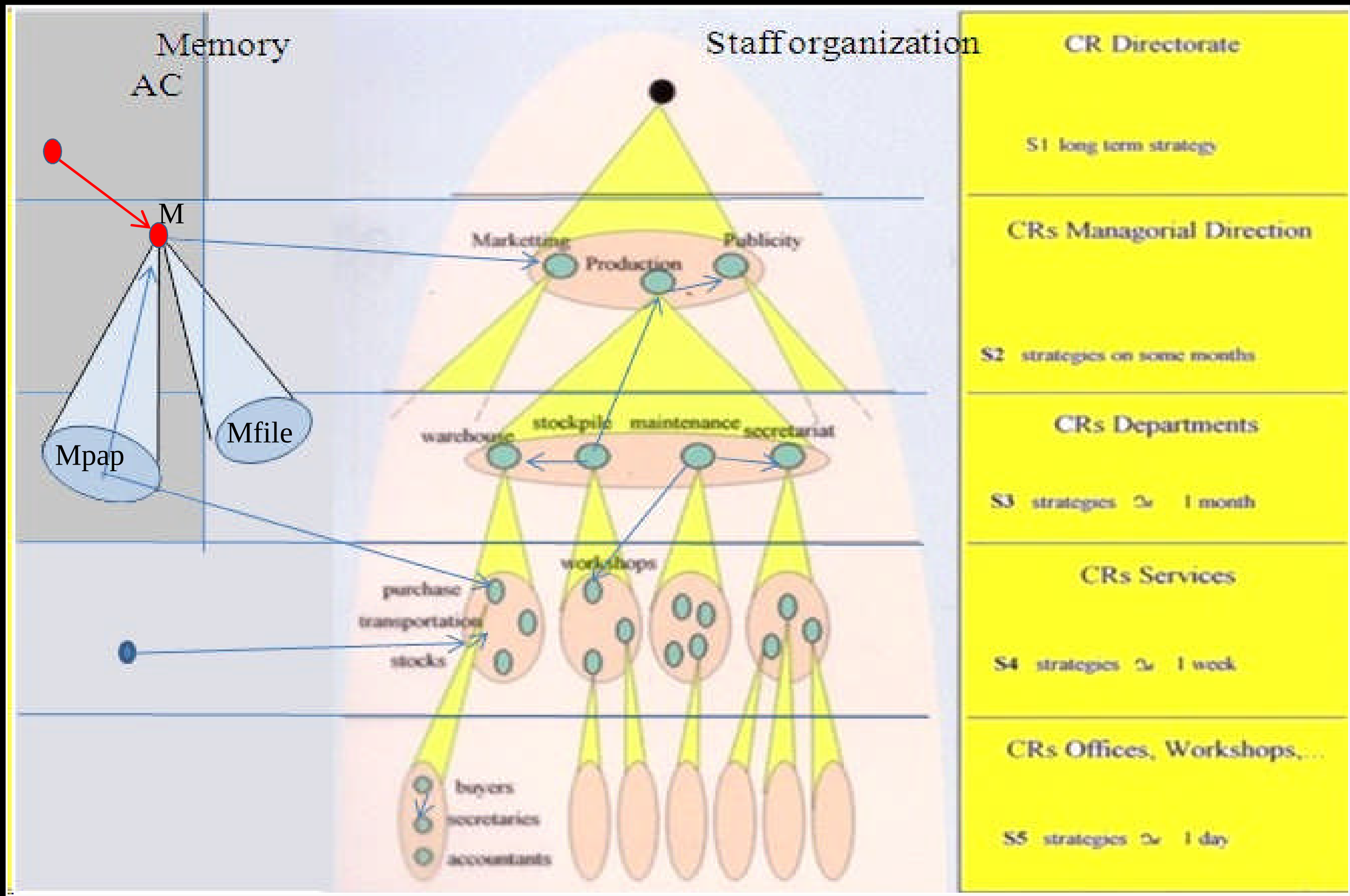
A FRAME FOR ANTICIPATION

The anticipation process will be studied in an evolutionary system of higher complexity with a tangled hierarchy, self-organized thanks to a multiplicity of mutually entailed functional subsystems, the CoRegulators CR, each operating at its own rythm. Such a system is modeled by a Memory Evolutive System (EV 1987-2009).



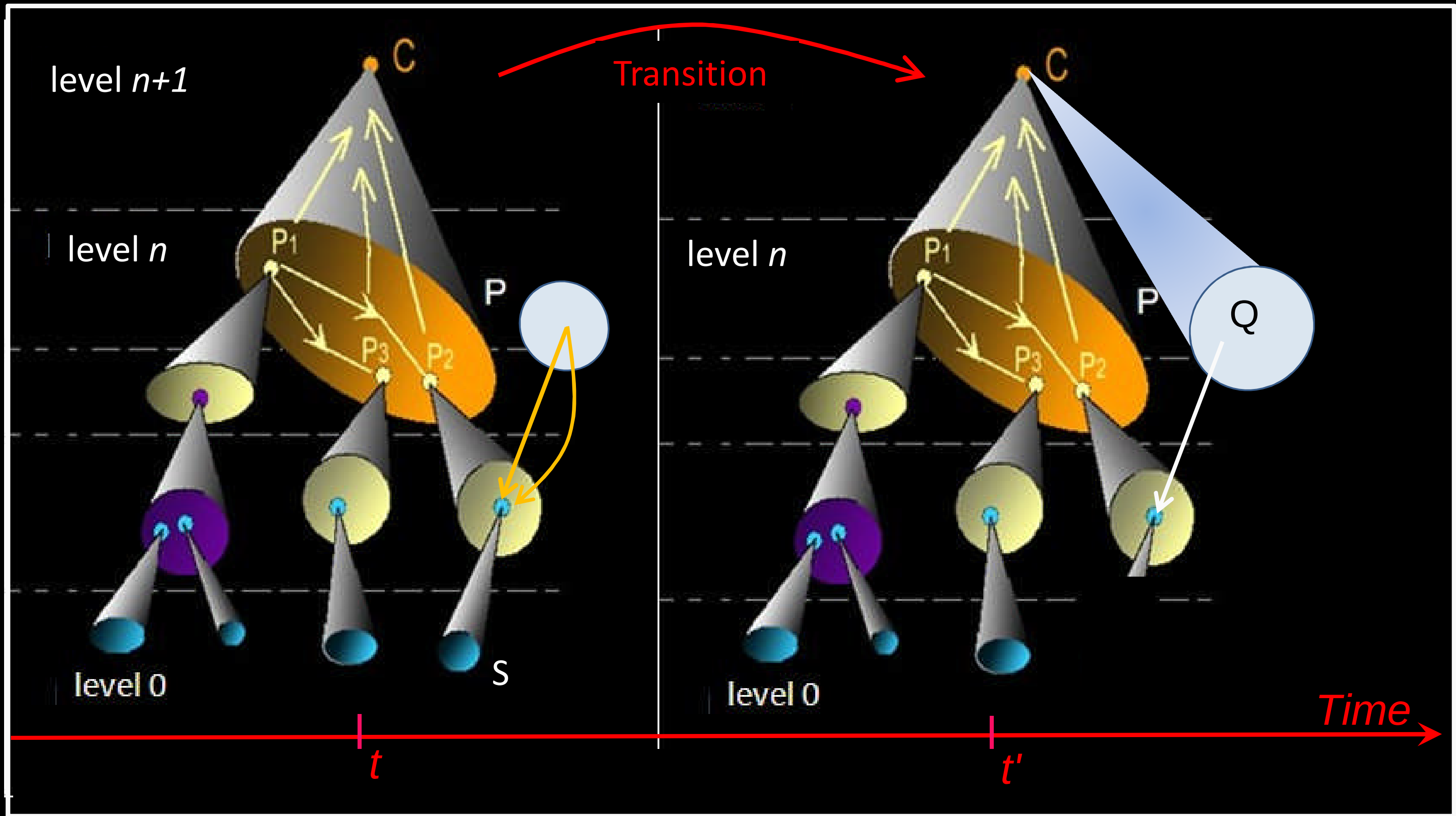
THE MEMORY EVOLUTIVE SYSTEM OF AN ENTERPRISE

The components are the personnel with its hierarchical organisation, and the various resources, the links their interactions. The dynamics is directed by a net of coregulators operating with different temporalities (on the right). The constantly revised "Memory" stores the knowledge necessary for functioning, past events and various archives; part of it, the Archetypal Core AC, acts as a flexible internal model.



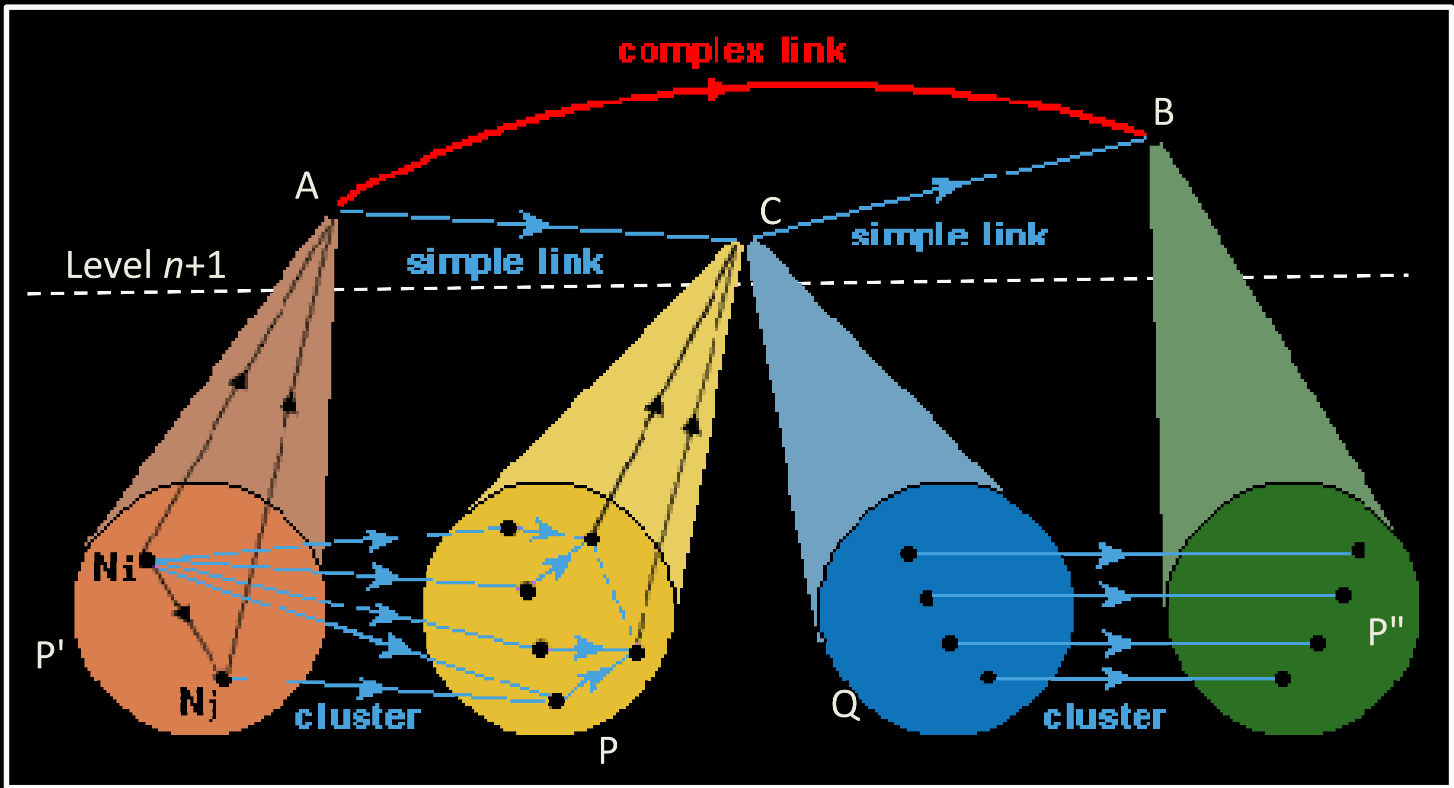
A HIERARCHICAL EVOLUTIVE SYSTEM

The system is modeled by a family of categories (= graphs with composition of paths) indexed by Time, and (partial) transition functors between them. The components are distributed in a tangled hierarchy. Each component C of level *n*+1 admits at least one decomposition into a pattern P of linked lower level components with the same functional role (C is the colimit of P); it may have several, actual or latent ones, as P and Q for C.



COMPLEX SWITCHES AT THE ROOT OF COMPLEXITY

If A and C are two components of level *n*+1, a link from A to C is (P', P)-*simple* if it is generated by a cluster of links between their lower components in P' and P.. There is *a complex switch* when 2 patterns P and Q are decompositionse of a same C (so that they have the same functional role) though not connected by a cluster. The existence of such switches entails the existence of *complex links* composites of simple links but not generated by links between lower level components. We have proved that this *multiplicity principle* characterizes the emergence of higher complexity.

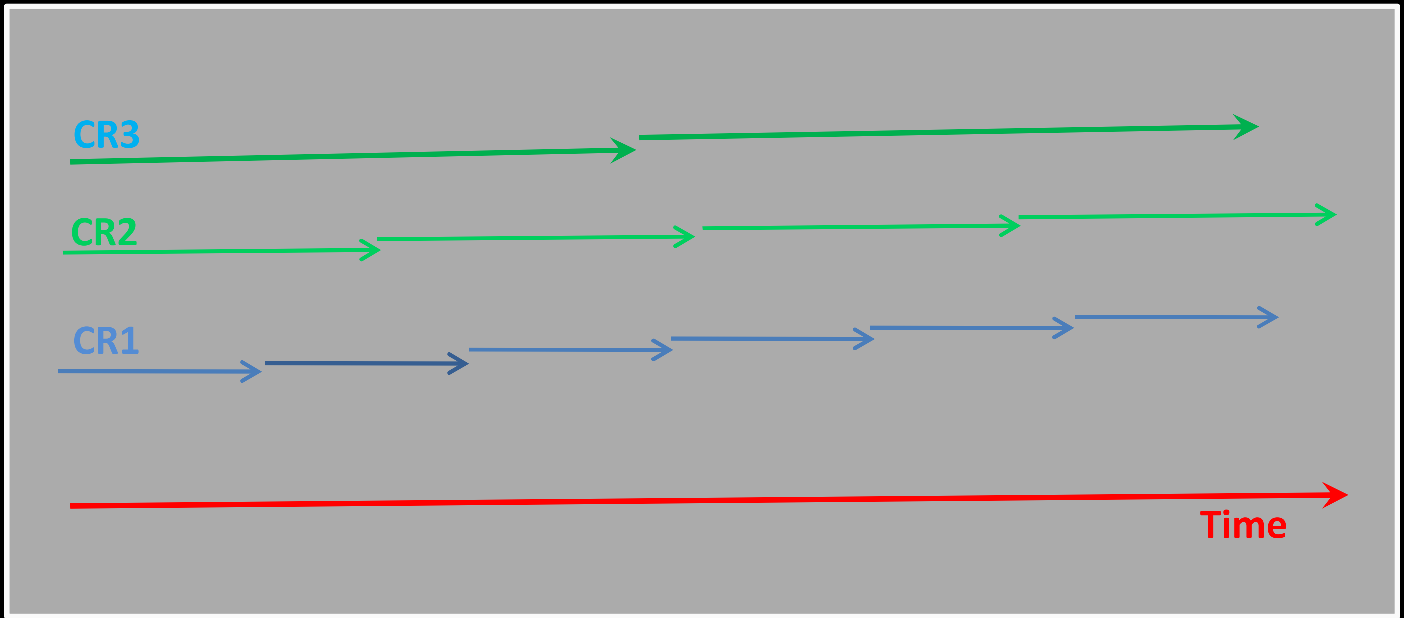


THE VARIOUS TIMES OF THE COREGULATORS

A Memory Evolutive System is a hierarchical evolutive system wihose dynamics is directed by a net of functional evolutive susbsystems, the CoRegulators, which act as controllers of different types, each at its own rythm (determined by its discrete timescale). Thus we have to deal with several times:

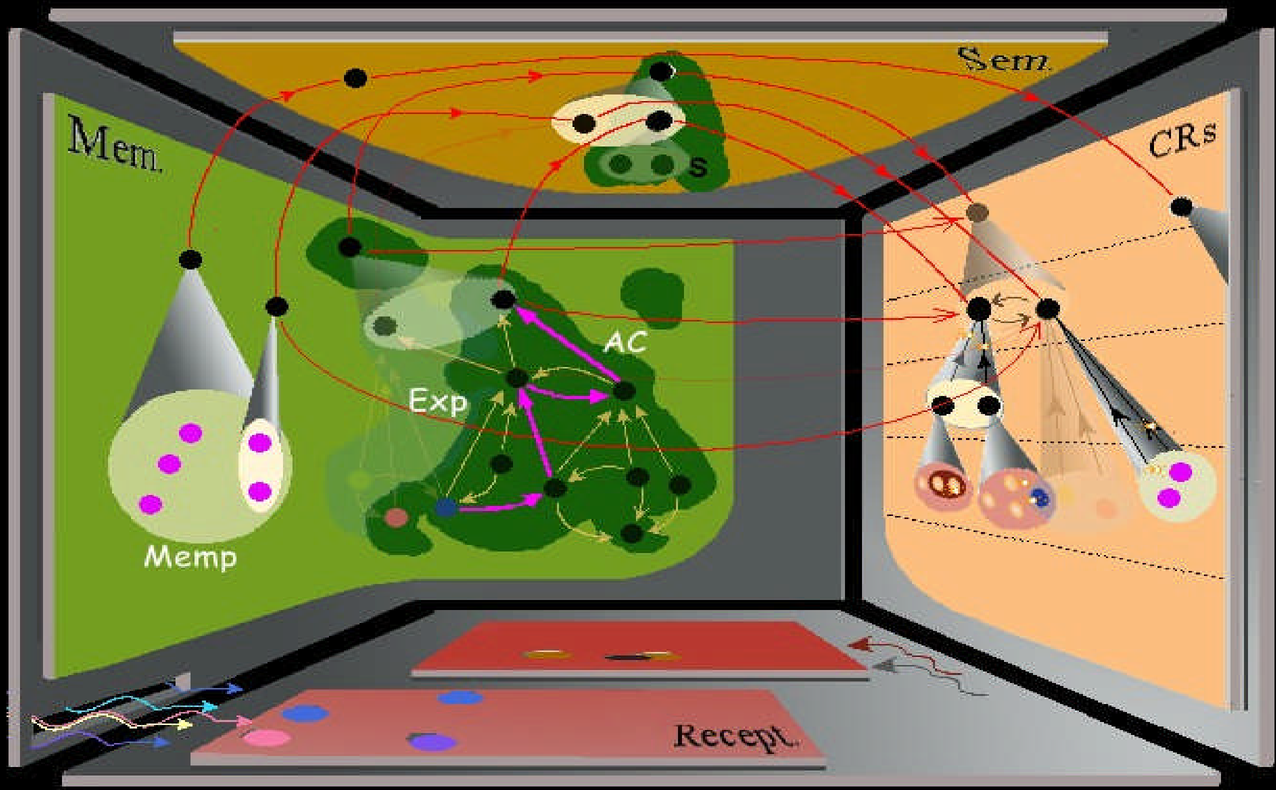
= the "objective" continuous clock-time Time which allows coordinating the whole system;

= the "thick relational" times of the CRs, each determined by a discrete timescale (included in Time), a "thick present" extending between 2 instants of this timescale. The period of each CR_i , which is the mean duration of its preceding thick presents, may change over time.



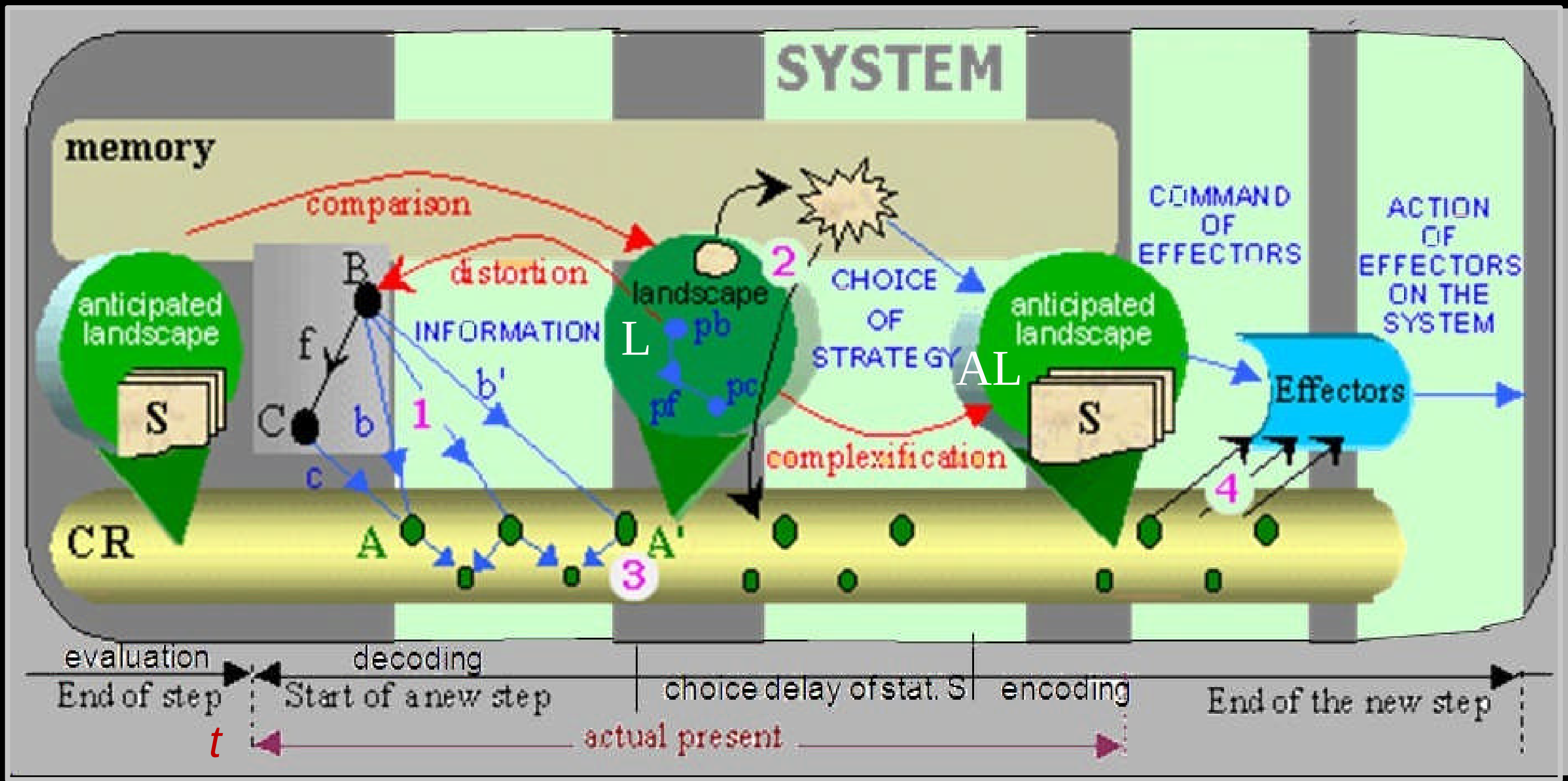
THE MEMORY AND THE ARCHETYPAL CORE

In a Memory Evolutive System, the CRs act with the help of a flexible central memory, represented by the evolutive subsystem Mem, which models the knowledge of any kind (procedural, episodic, semantic…) of the system and is contstantly revised to account for the new situations. Mem has a subsystem, the Archetypal Core AC, which develops over time and consists of well connected integrated key components, whose constant recall make their links stronger and faster. AC acts as a flexible internal model of the main characteristics of the system, maintaining its identity.



ONE "THICK PRESENT" OF A CR

It is divided in 3 phases: 1. Analysis: Formation of the CR landscape L at *t* with incoming and remembered information; 2. Decision: choice of a strategy S on L, the "anticipated future" being modeled by AL (deduced from L by a 'complexification' process); 3. Command and Evaluation: the objectives of S are sent to effectors and the result (positive or negative) is evaluated at the beginning of the next step by comparing AL with the new "active future". There is a *fractu*re for CR is the objectives of S are not met.



INTERPLAY AMONG THE STRATEGIES

The strategies selected by the various CRs at a given time may not fit together for they are selected on their own landscapes, start processes unfolding at their own rhythm. and compete for the common resources of the system. The operative strategy actually carried out on the system in the present comes from an equilibration process between them, the *interplay among the CRs*, possibly by-passing the strategies of some CRs (thus causing dysfunction to them).

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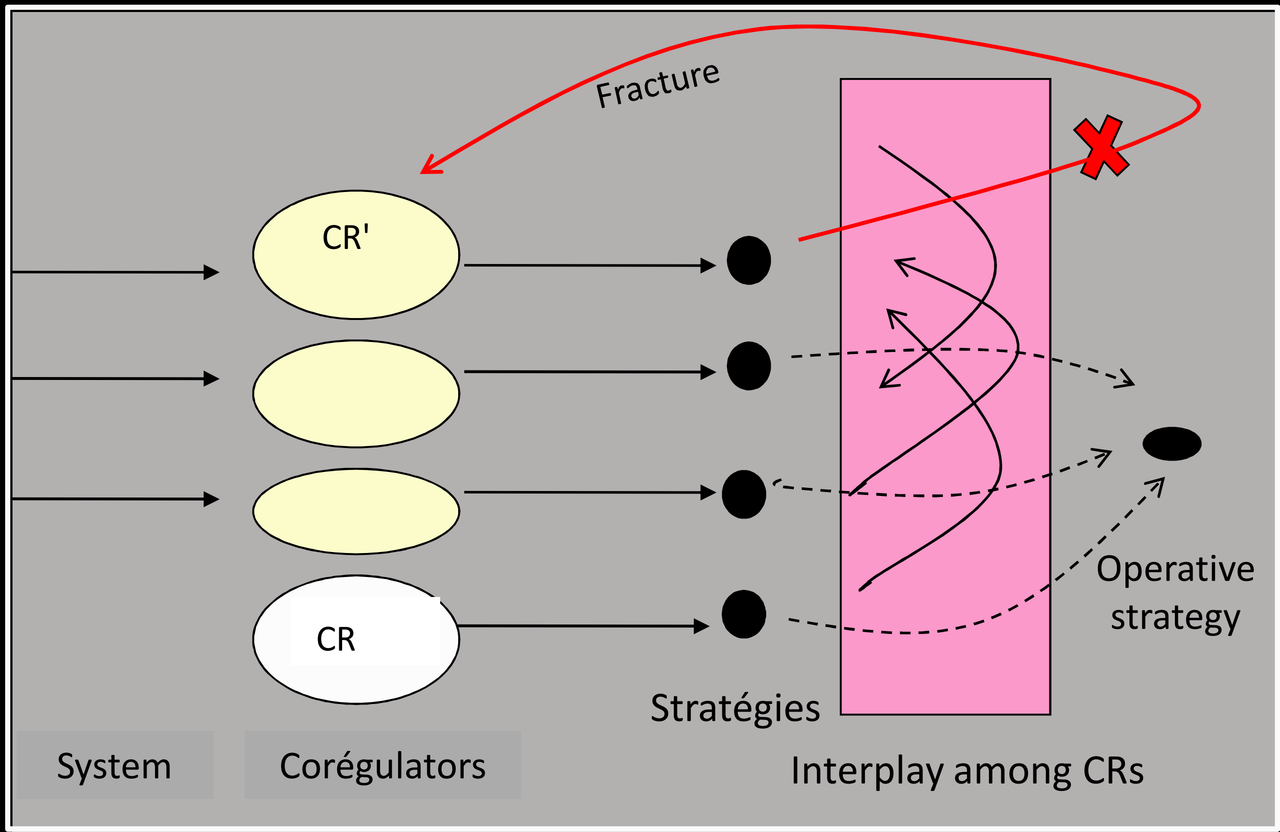


TEMPORAL CONSTRAINTS

The functioning of a MES is subject to the following material conditions:

each link has a *propagation delay* for transmitting iinformation between the components it joins,

each component N has a *stability span* which is the longest period during which N exists and admits a lower order decomposition which maintains its working conditions.

These conditions imply that a CR has "*structural temporal constraints*' to be respected so that its step beginning at *t* be achieved in time. Theiir non-respect is one of the causes of fractures or dysfunction. They are expressed by the inequalities (*laws of synch"*);

$$p(t) << d(t) << z(t)$$

where:

p(t) is he *time lag* of the CR which is the mean propagation delay of the links between its agents and with the memory, during the CR actual present at *t,*

d(t) is the *period* of the CR (which is the mean length of its preceding steps),

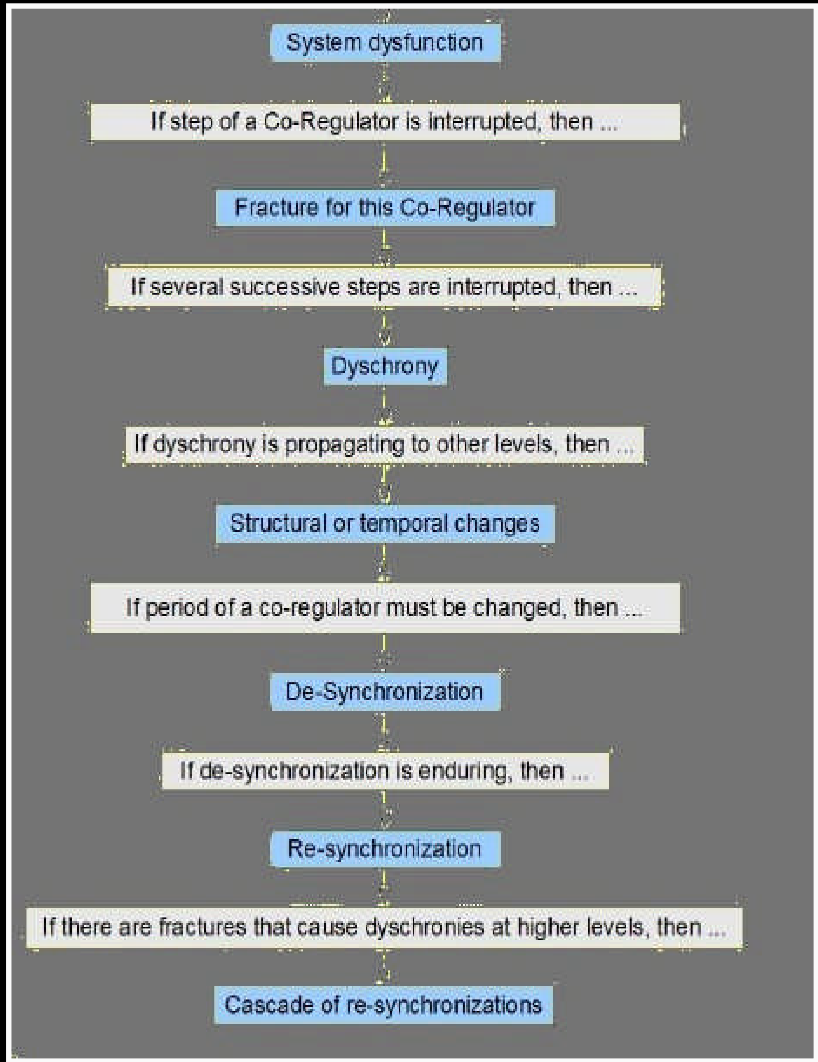
z(t) is the smallest *stability span* of the components intervening in the landscape at *t* and the selected strategy.

DIFFERENT KINDS OF DYSFUNTION FOR A CR

Some causes of fractures:

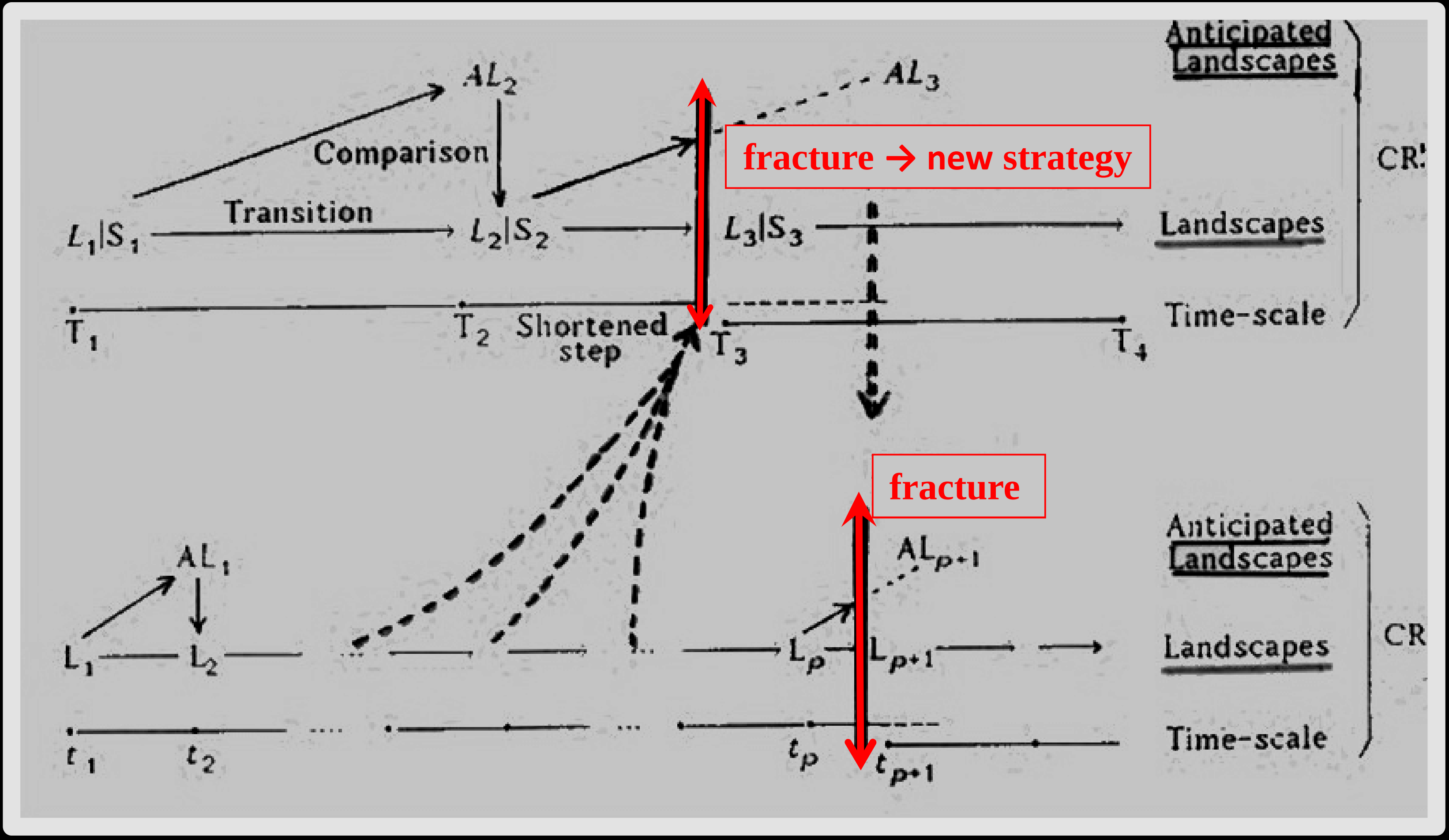
1. an increase of the time lags, so that information and commands are not sent in time: the landscape is not well constructed or the strategy is not realized in time;
2. no admissible strategy is found, or the commands of the strategy cannot be effected;
3. a decrease of the stability spans: the information is no more valid or the strategy cannot be realized

A fracture not repaired at the next step causes a dyschrony on the CR, and may later lead to a re-synchronization (i.e. change of period) of the CR. It may backfire to CRs of increasing levels, leading to a "dynamic disease" possibly repaired by a cascade of re-synchronizations. as in our Theory of Aging (EV 1993)



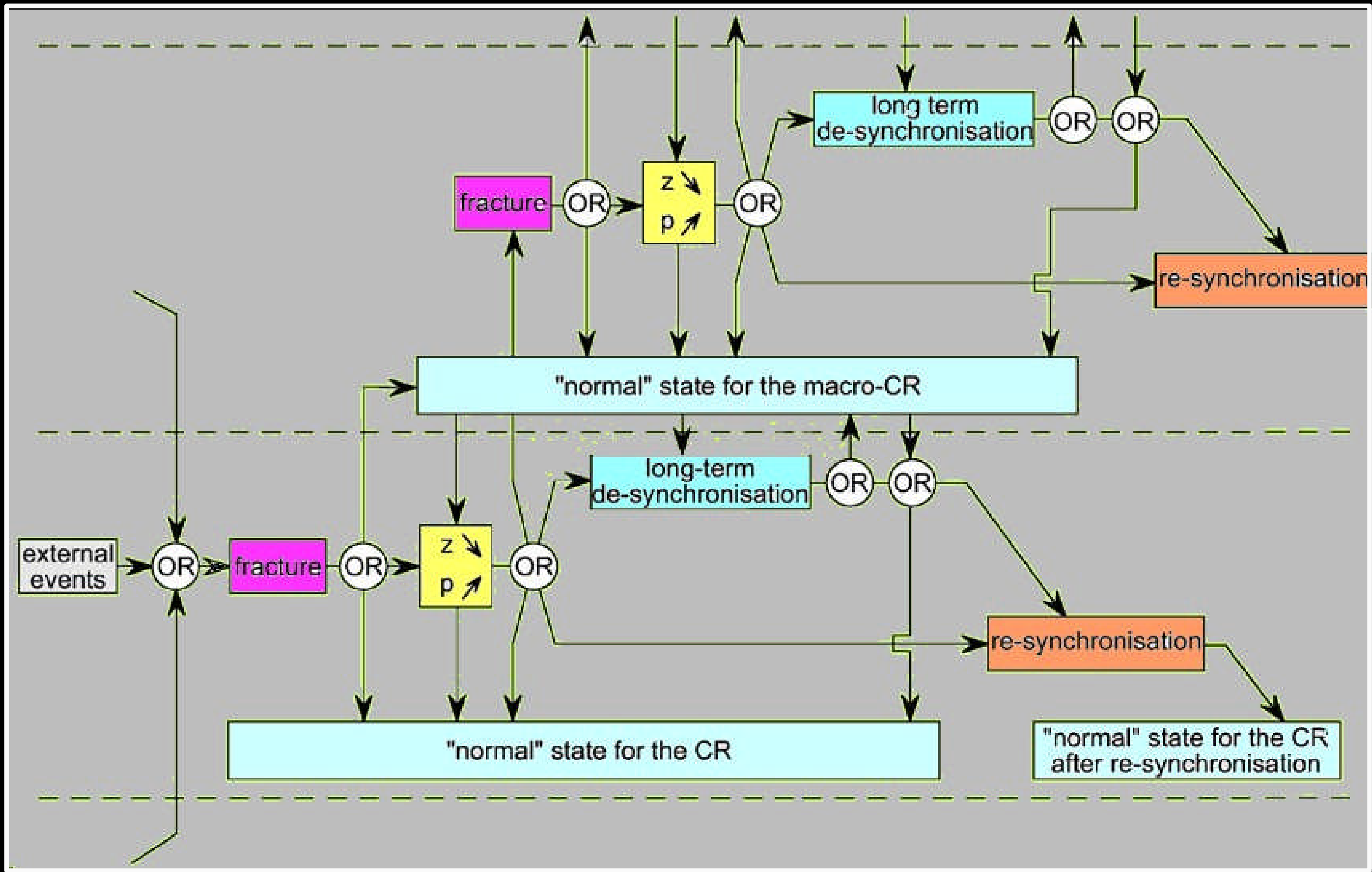
DIALECTICS BETWEEN HETEROGENEOUS CRS

An accumulation of changes caused by a lower coregulator CR is only seen later at the higher one CR' then causing it a fracture. It is repaired by a change of strategy of CR' which can later backfire on CR by causing a fracture at this level.



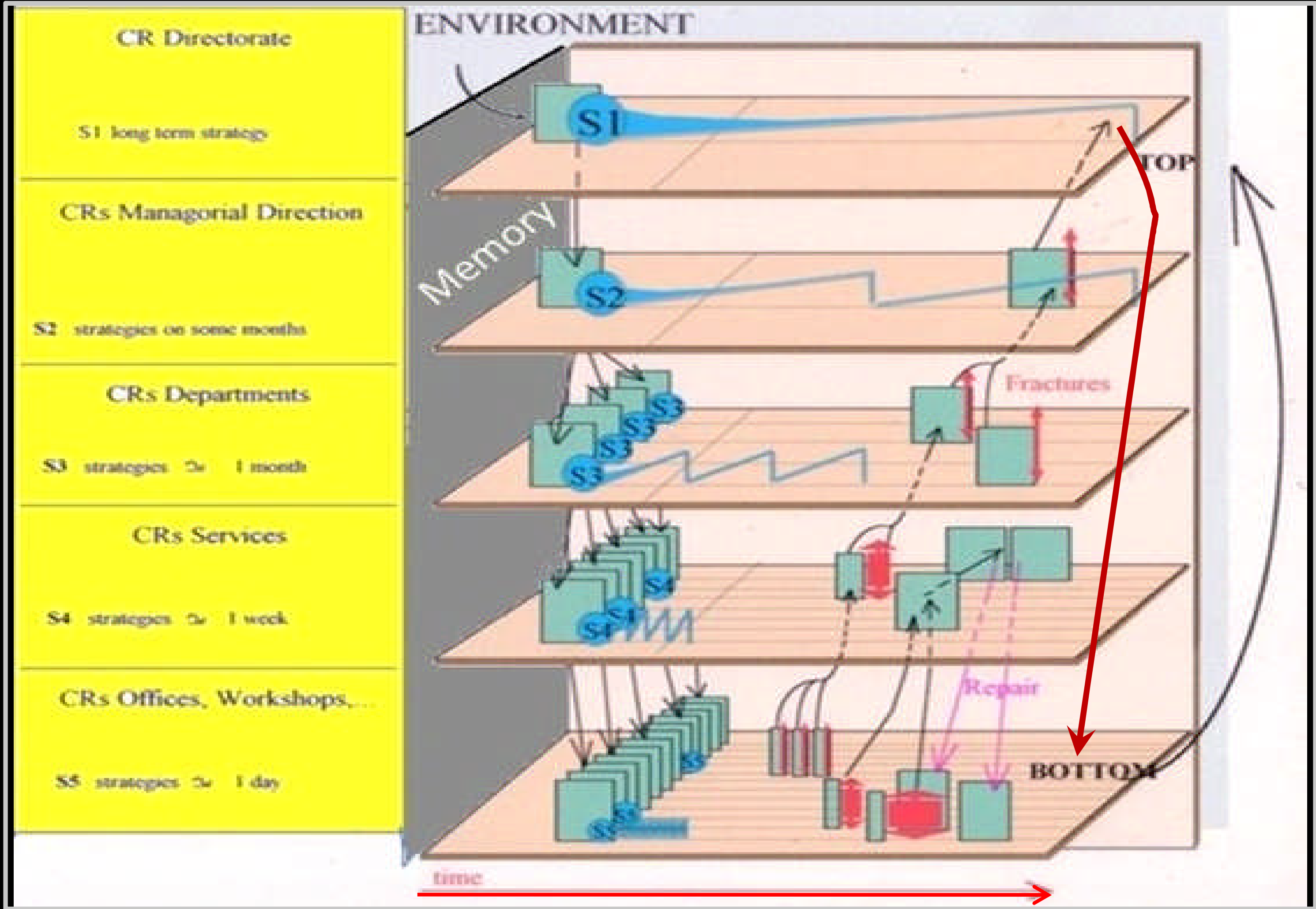
NORMAL OPERATION / DYNAMIC DISEASE

The repair of fractures backfiring between levels may necessitate a re-synchronisation of the CRs by change of period of one of them, possibly leading to a cascade of re-synchronisations to avoid a "dynamic disease".



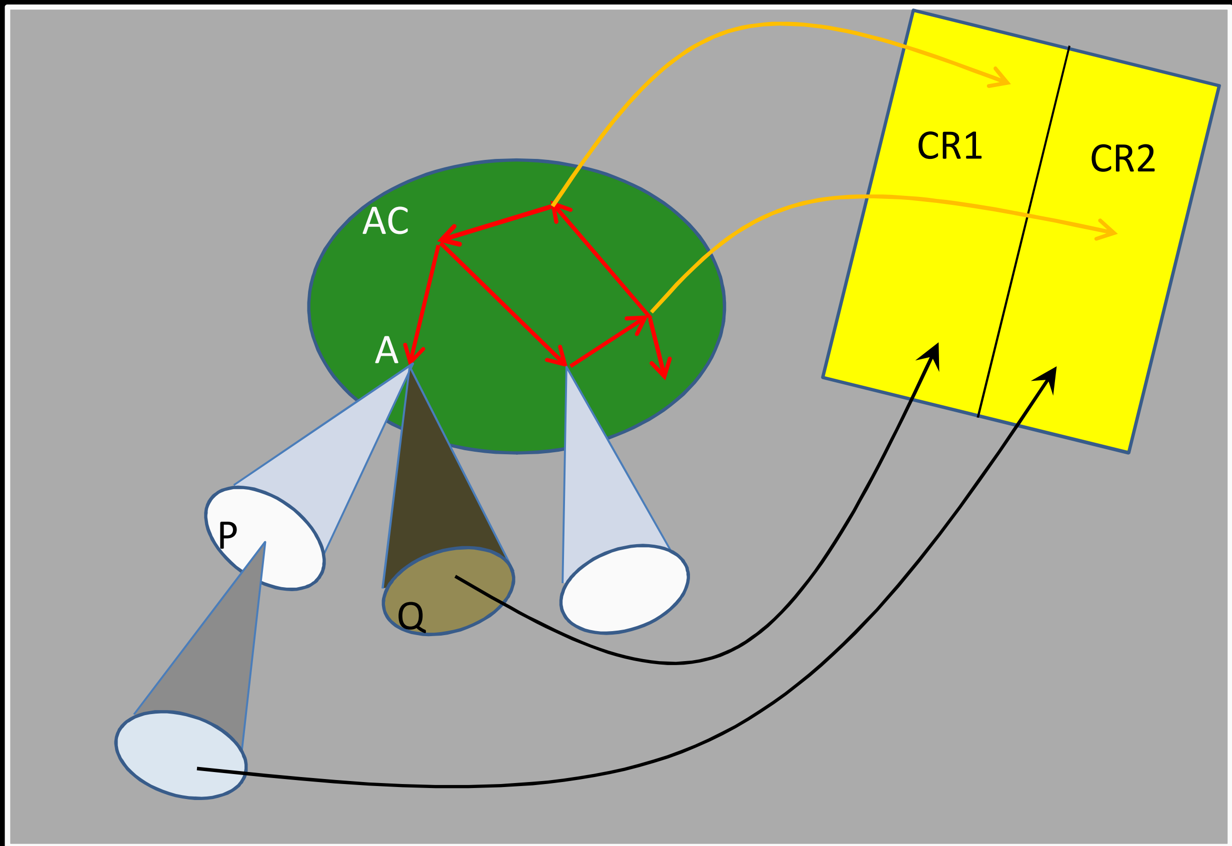
INTERPLAY AMONG THE SERVICES OF AN ENTERPRISE

The dynamics showing the different time-lags and how fractures can propagate among the services from bottom to top. Then higher CRs can initiate different types of repair for avoiding dynamic disease, and possibly leading to a deep re-organisation of services.



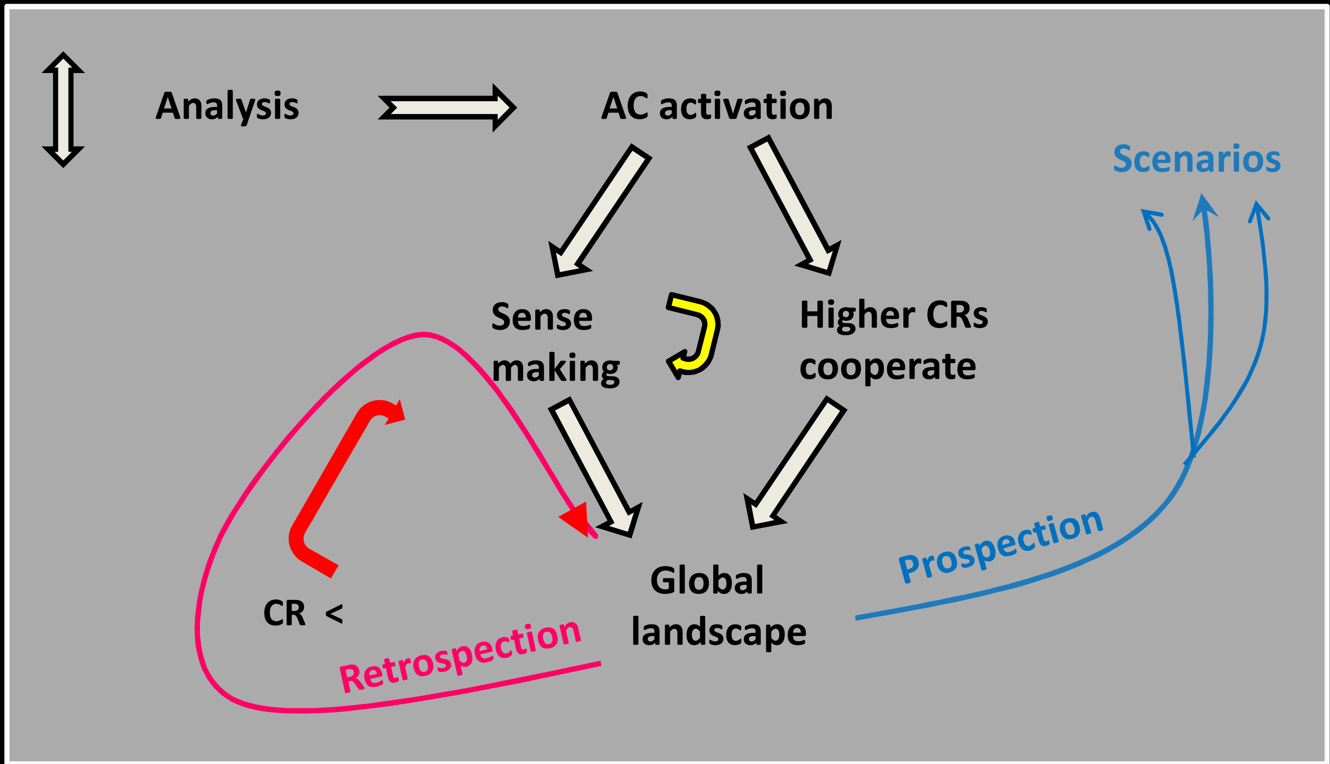
SENSEMAKING AND CONSTRUCTION OF SCENARIOS

To anticipate, higher CR_i reflecting about the present and the past, recall some archetypal objects. Through archetypal loops, it triggers a self-maintained recollection of a large domain of the AC, which propagates first to a decomposition P of an object A, then, via a complex switch, to another nion-connected decomposition Q of A and to a decomposition of components of P. The information so collected is transmitted to the CR_iiforming a a *global landscape w*hich coordinates and extends their landscapes and has a longer tiemporal span.



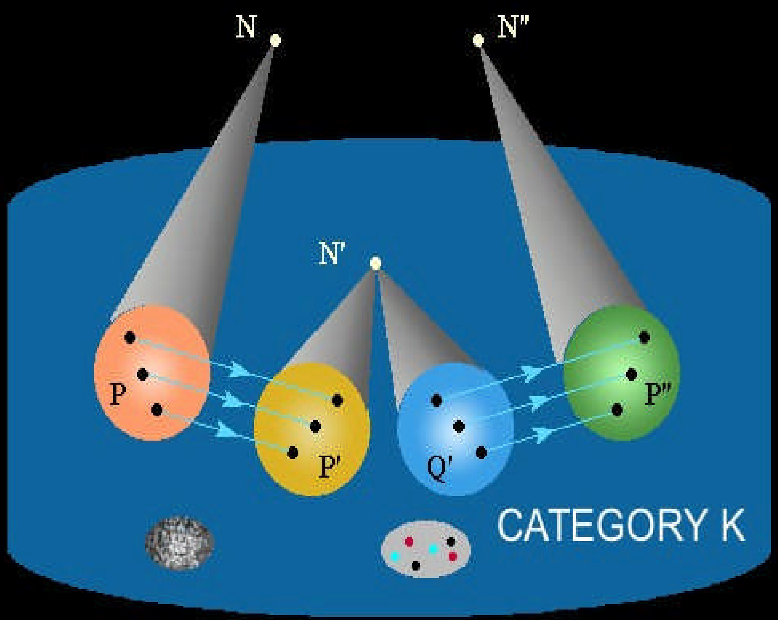
SENSEMAKING AND CONSTRUCTION OF SCENARIOS

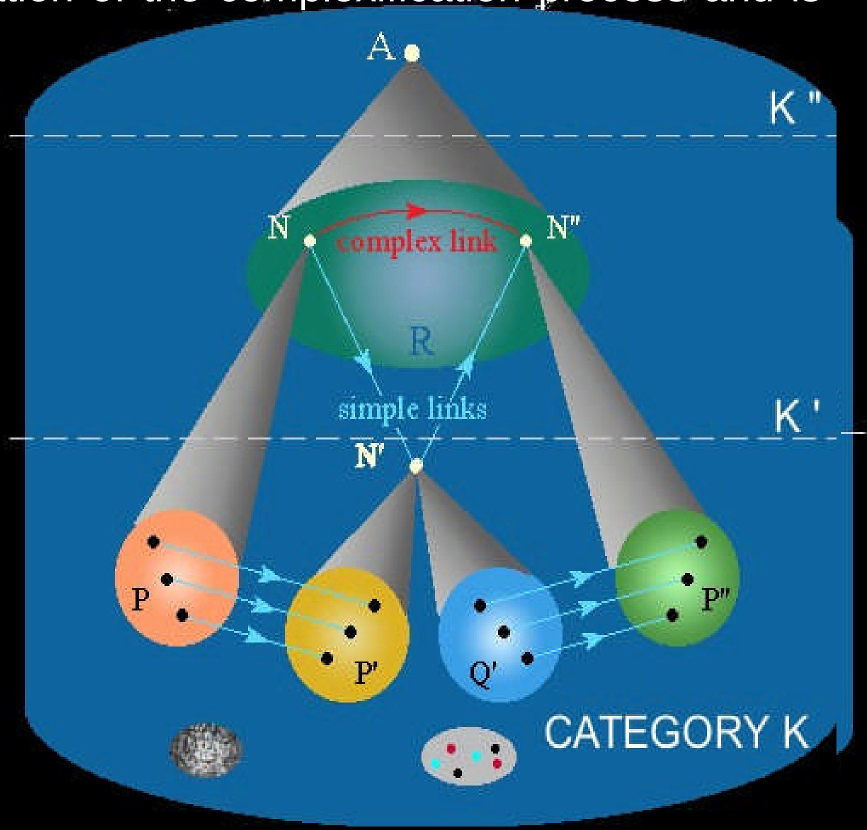
A *retrospection process* in thie global landscape *GL* (possibly starting new searches) allows recollecting the recent past, "sensemaking" of the present, and diagnosing new trends. Then a *prospection* process can be developed in the longer term *GL*, still using the motor role of AC, to iteratively construct virtual landscapes in which sequences of strategies are tried with evaluation of their risk of dysfunction (by use of the temporal constraints and results of former similar situations). Thus various scenarios are built. Once a scenario is selected, the retrospection process allows backcasting to find sequences of strategies able to realize it.



HOW COMPLEX SWITCHES ALLOW CREATIVE ANTICIPATION

Besides scenarios directly inspired by the present and the contextual environment and trends, more creative or desired ones can be realized, adding new on-connected decompositions to a component, leading to the re-organization, or even the suppression, of some CRs and the formation of others. We show how the use of complex switches in the prospection process allows constructing such scenarios by increasing the freedom degrees and may lead to the emergence of components of increasing complexitywhose causal links cannot be teaed apart. (It relies on the fact that the realization of a sequence of strategies necessitates an iteration of the complexification process and is not reducible to a unique one.





CONCLUSION

The Memory Evolutive System model shows how the creation of imaginative scenarios and their realization in several steps are possible in an evolutionary system of higher complexity, provided the following characteristics are taken into account:

= specific "thick time" of each Coregulator and the *structural temporal constraiints* they must respect,

= interplay among the different temporalities of the Coregulators,

= development of a flexible and constantly revised internal model of the system, the Archetypal Core;

= existence of *complex switches* which allows the emergence of new properties at higher levels.

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