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THE DIFFERENT LEVELS IN COMPLEX SYSTEM ARCHITECTURES : THE USE OF DESIGN TOOL FOR CHECKING THEIR COSISTENCY

The ACTIF tool applied to sea/water-way interfaces and to modelling water-way information systems.

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INTRODUCTION:

In the transportation area, a lot of public authorities, operators, users act with their own logic and strategies. Sometimes their interests can converge and they can decide to exchange information, to collaborate, or to share common tools. Implementing an interoperable transport system means a very clear definition of the service they want offer, of the scope of the project (geographic perimeter, stakeholders involved), of the functionalities, of the organisation which will carry the project (distribution of functionalities between stakeholders and/or subsystems), of the information system (data collected, stored, information elaborated, disseminated... data form and ways of dissemination or sharing)...

Those different levels must be defined as a background before conceptualizing technological solutions. They are the different levels of **the** architecture of the system they want implement. Each level of this architecture (political, services, functional, organisational...) must be coherent with the other one, if not the system will come to nothing... in reality, there won't be system: each part won't hold (-tem) with(sys-) the other ones.

Therefore building interoperability of systems is very difficult and need tools for checking the consistency of each level of architecture. With ACTIF (for "Aide à la conception de systèmes de transports interopérables en France"), the French Ministry for Ecology, and Sustainable Development and Urban and Rural Planning wants offer an Assistance for the design of inter-operable transport systems in France.

This paper describes the various uses of ACTIF, which can be described as a "tool-kit" for the design of interoperable transport systems in France, and the different elements that constitute it:

-*the method* describes the essential stages of system architecture design,

-*the model*, provides a simplified illustration of the data acquisition, processing, storing and dissemination logics and processes involved in various transport professions, enables standards to be specified according to the geographical area concerned and the eventual interfaces with other professions and bodies to be identified. It can act as a reference manual (for vocabulary or specific logics), for those who are already familiar with it but equally for those who are not, and may be used as a check-list to verify the functions to be carried out (in terms of data exchange) and the interfaces to be developed,

- *the simplified tool for system architecture design, OSCAR,* enables different functional and/or physical architecture scenarios to be developed through the identification of sub-systems, the definition of their functional limits (the selection of functions to be ensured, as described in the model), and the identification of data exchange requirements between each of them (data flows between the different functions extracted from the model).

The application on the sea/water-ways interfaces study in Rouen harbour is the Ariadne's thread of this paper. It will show the different uses of ACTIF and its impact at different levels: technological (which standards must be used) and decisional level for designing the information systems masterplan of Voies Navigables de France. This application has also shown the needs for standardization works in aim of coherence with the European projects RIS (River Information Services) which they are strongly linked with.

1 – The need for coherent infrastructures :

1-1 Voies Navigables de France issues

Voies Navigables de France manage the whole French public waterways: i.e. an infrastructure network of 6 700 kms, with more than 2000 specific points like locks or sluices, briges and tunels. Allowing the best use of this network in the main elements and functionalities is its essential assignmment and this implies:

- to maintain this important capital;
- to ensure the infrastructure availability and capacity;
- to ensure the technical functioning;
- to survey the users safety
- to enforce the regulation;
- to monitor the traffic and, often, it means to assist each boat.

Along the time, numerous applications have been carried out in aim to assist each activity. The problem is now the lack of interoperability between each one.

In 2006, VNF asked the ACTIF-team to work on the project concerning the interfaces between the maritim and river information systems, in aim to allow a continuous service in Rouen harbour. In fact, the two transport authorities Port Autonome de Rouen et VNF did not use compliant navigation systems (location systems): it inducted some misunderstanding in the place allocation, or in the boat and ship movements.

This first work on interfaces between maritim and river information system, was the first step before a more important work of the VNF information systems urbanization. This work was led in parallel of the RIS directive implementation. It show the need for **coherent architectures.**

1-2 Project or System Architecture

The word “architecture” is too much used with different meanings. Sometimes, for one session called “architecture”, one speaks about “technical architecture”, the other one about “logical architecture”, and the third one about “framework architecture”… and after the session, nobody can say what are the links between such exposés. Therefore it is essential to explain what “architecture” means.

Etymologically, “architecture” – *arch-* foundation/underpining/principle/first and *tektos* roof/overpinning/building – means building principle. For one project, several principles can be used: technical (wood or concrete…), organisational (2 or more bedrooms), functional (sleeping, living, washing… and perhaps working). It concerns different points of view about the same things: every one must be coherent with each others… otherwise the building won’t make system or – it is the same thing - hold (tem) together (sys).

So, for each transportation system project, we can define at least, seven levels of architecture.

- Political level: in which are defined the needs, the aim, in a masterplan;
- Conceptual level: where we define the services we want offer, with their quality, their objectives;
- Logical level: in which are described the functionalities, and the different functional chains of information treatment;

- Organisational level: where we hand out the different functions between each structures and stakeholders;
- Information system level, where we explain the way we use to describe and exchange information, even so automatically (with electronic and telematic system) or without technical system;
- Technical and electronic level: in which we define the means, as well as human than technical, the languages (data forms) and the hardware.
- Software architecture: algorithms and data handling.

For one ITS project, it is essential to have defined the first level of architecture before to define the other ones… eventually, we can follow an iterativ way, so that every level of architecture be coherent with the other ones. As the VNF case shows, thinking about interoperability at the technical level of architecture is often too late: we must be very lucky if the data form compliance is enough to allow the exchange of information between different structures. Most of time, we observe that the different working processes don't allow these exchanges at the right moment or with the reliability wished. We must think about interoperability of systems since the first steps of ITS building, with the clear will of each partner in collaboration and co-operation.

When the partners have defined, together, the services they want offer at political and conceptual levels, they can describe the different functionalities they need through the prism of information system. For one process, whose aim is the production and dissemination of an output information, we describe the data which must be collected, stored, handled. At this level, they can show the interfaces which could exist between each process: the output of the first one can interest the second one, and reciprocally. That is at this level that we can need a model which describe the different professions with their main logical processes for handling information.

1-3 Framework architecture, generical architecture or design assistance

ACTIF, like all other "Intelligent Transport System Framework architecture" around the world, is an assistance for conceptualizing interoperable transport systems. This "tool-kit" is allocated to all ITS project managers and designers, in aim to design the functional and organisational architectures of their systems. Some links with the technical architecture can be proposed, when standards are bound with the functions, data stores or data flows of the model.

The aim of ACTIF, like other "Framework Architecture" for ITS around the World, is to help the project managers during the conception of their transport systems so that they can interoperate: id est, exchange information during coordinated processes, collaborate, use common technical tools. It means that we speak about two or more technical systems, two or more project owners, two or more structures.

But, the Framework architecture we speak about, are essentially concentrated on a functional (or logical) model, which can help ITS project designers, managers, stakeholders, in the understanding of their partners: vocabulary, logic, profession. Some tools can be carried out in aim to concept the principles of an organisation. They must be used as a tool-kit for helping decision.

2 – The ACTIF components

ACTIF proposes:

- a model, as a professional repository;
- a tool (OSCAR), used to describe from the model objects, the logical and organisational architectures of ITS project;
- a methodological guideline suits, which explain how to lead ITS projects in complex situations, and how the ACTIF model and tool can be used in such situations.
- Some applications.

2.1 ACTIF's model: the new version V5

The applications of ACTIF on real life projects have shown that the choices made by ACTIF-team during the model V4 elaboration was certainly well-adapted for local project designers. A model is a simple and understandable representation of the real world, limited at the necessary and enough objects which have to be used in a clear context. Making clearly, a model which is not simple, is not read and not used. The ACTIF-team chose to apply consistently modelling rules (like patterns) very simple and understandable. The different functions and actions of each service or "profession" are now logically described in clear diagrams from the collection of information (on the left) to the dissemination of concise messages (on the right).

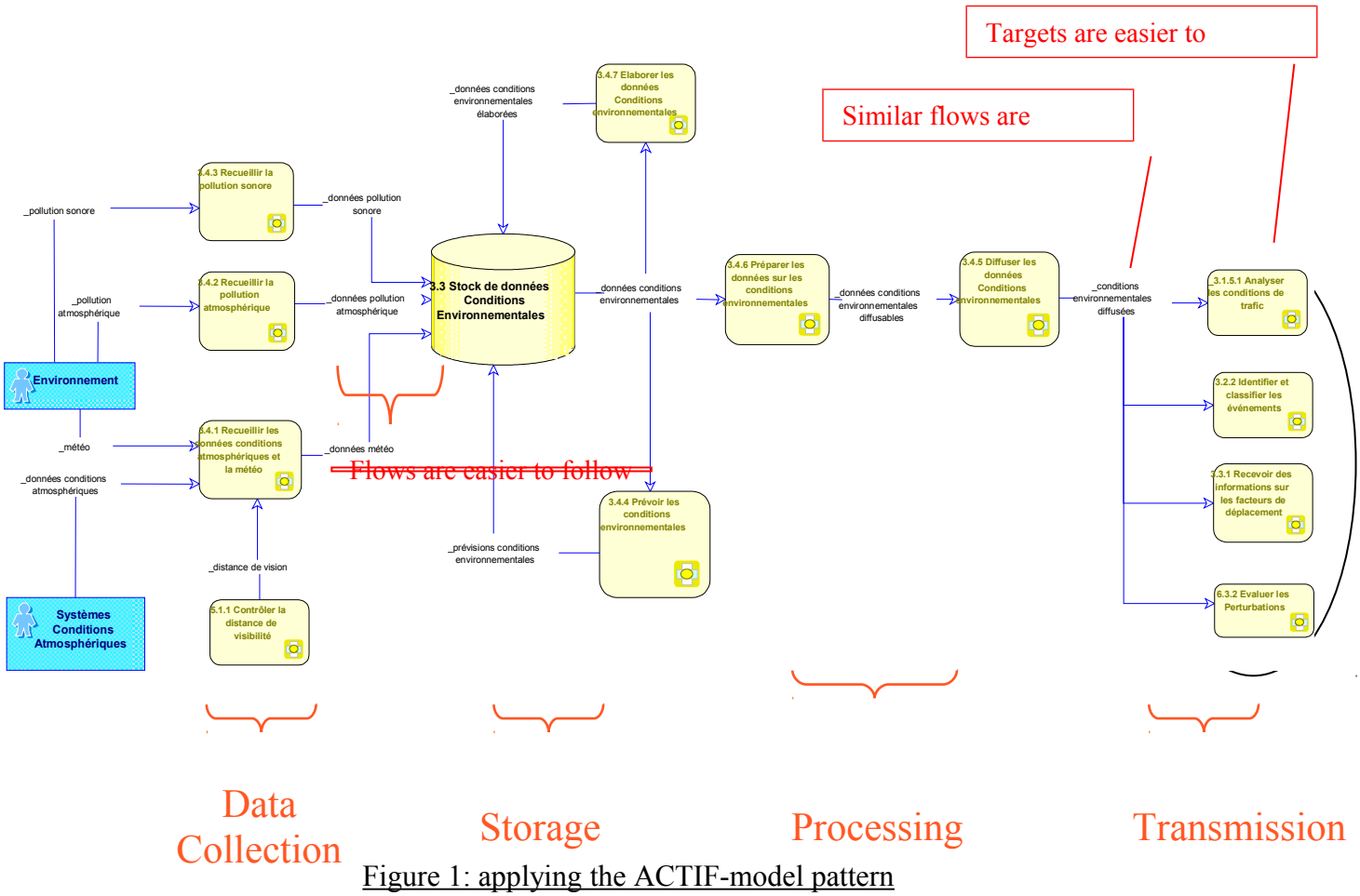

Figure 1: applying the ACTIF-model pattern

The use of this organised knowledge for the design of real project architectures has led to more clearly defined rules for the data flows between elementary (ex low-level) functions and the need for greater consistency in the naming of elements, in order to know what kind of information is requested from other "terminators" or associated systems.

During the different applications of ACTIF, different lakes or mistakes have been corrected. A strategy pattern has been added for different profession and the object descriptions have been enriched in aim of taking into account the different transport modes.

2.2 ACTIF's tool: the OSCAR new version V3

A new version of the OSCAR tool (tool for facilitating ITS architecture design) was developed during the last months in aim to answer the project designers requests. The OSCAR using principles have been maintained. OSCAR allows the functional definition of different or quasi-similar systems and highlights the interfaces that must be maintained. The ability to create diagrams and generate files (WORD, EXCEL, ACCESS) allows the tool to be used as a basis for specification.

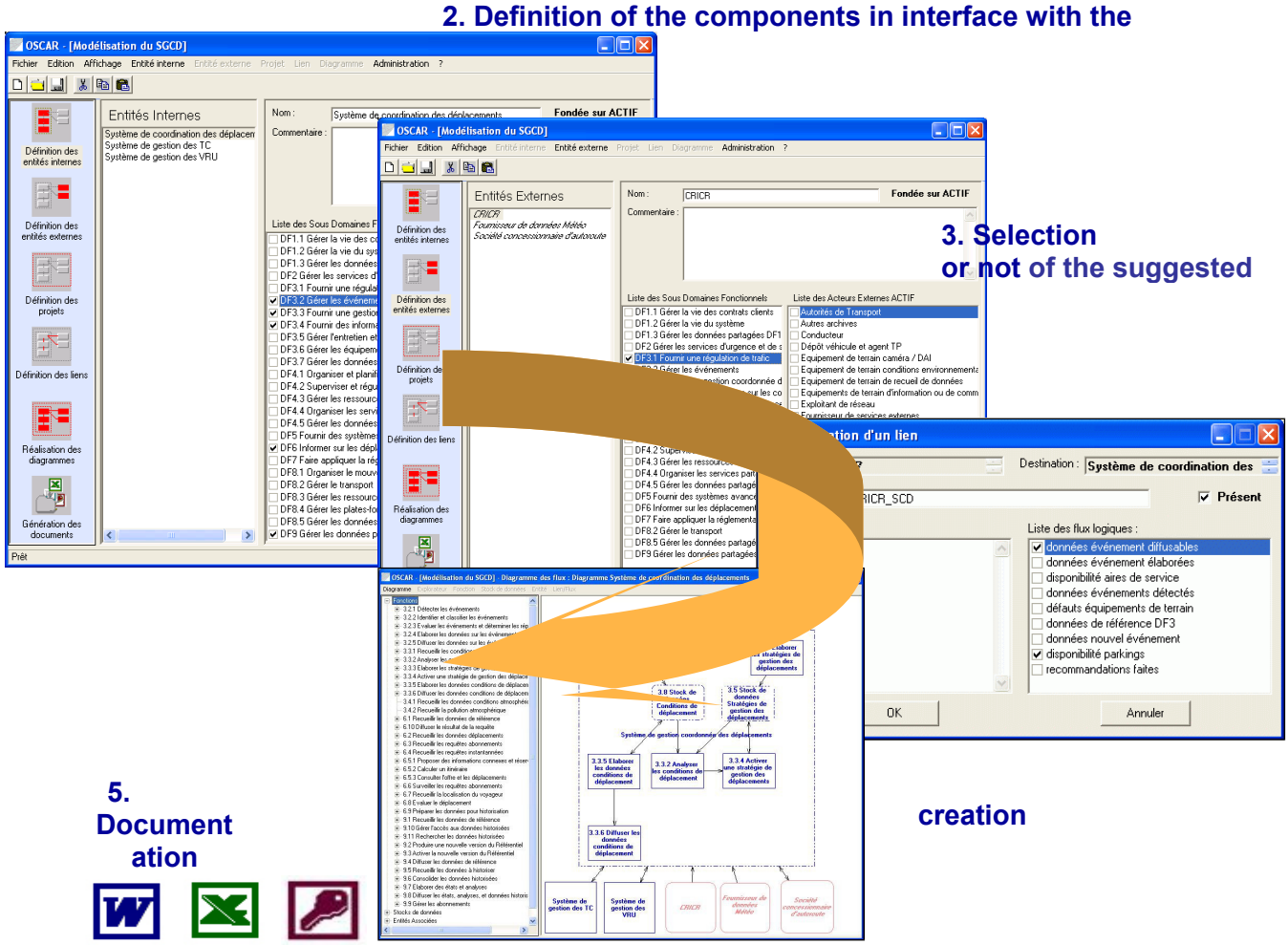

Fig 2: OSCAR principles

But, new functionalities have been added allowing to product more readable and useable diagrams. The functions of each subsystems and the links between each partners can be detailed, as below.

The OSCAR tool can be downloaded free of charge from the project website:
http://www.its-actif.org/spip.php?rubrique6

2-3 ACTIF method and application

A design-assistance « kit » naturally requires a set of documents describing the method used, the different elements of the kit and their use. In ACTIF, the basic element made available to designers, independent of the model and the tool, is a handbook outlining a method for designing transport systems in an interoperable manner.

Developed in 2003, this methodology is based on project management practices that specifically take into account several actors, systems and projects. The six phases listed are in fact similar to those used within the scope of any typical project management:

- The kick-off phase, where requirements are identified.
- Present situation analyse
- Definition of functional and physical architectures scenarios
- Definition of an implementation plan (based on several scenarios)
- Application of tfe implemetnation plan
- Architecture management. The sixth and final phase is essential: as in urban planning,

But in real case, this ideal method is never correctly applied. The VNF example is very meaningful.

3 – The VNF case study

3.1 Interfaces between maritim and waterways information systems in Rouen harbour

Voies navigables de France (The French Waterways Service) and the port autonome de Rouen (Rouen Harbour) needed to modelize the interfaces between their different existing information systems. Actually, the tools for maritim and waterways navigation are different, and especially for the geographicall positioning. The instructions given to boats needed to be homogeneous, in aim to help their navigation on the Seine River around the harbour (waterways before Rouen, maritim and waterways after Rouen).

ACTIF has been used in two ways: first to modelize the functioning of intermodal platforms, and second, to describe the information exchanges during the approach, reception and arrival operations. The interfaces between maritim and waterways services was deducted from these two approaches.

Fig.3: Functional diagram of river information system in Rouen harbour – scenario 2 made with OSCAR

This study showed the necessity to analyze the activity sharing between each stakeholder, and to determine through different scenario, which could be the more appropriated technical choice in link with the best organisation for the future: in fact it can depend on political decisions, which concern the role of each organisation. The technical choice must be, as far as possible, independent of this organisational level, but takes it into account.

3-2 Information system masterplan

This analyze has been linked with a precedent study on VNF information systems masterplan, which proposes a mapping of each ITS applications in aim to deduct interfaces. It has shown the necessity to identify the links between functionnalities and applications

ACTIF-model's functions have been used in aim to produce this mapping. In fact, it is very difficult to make, afterward, clear links between applications (and their local functionalities) and ACTIF: it needs a lot of interviews with the different users. The diagram made with the modeling tool MEGA from this functional analyze show all the interfaces which should exist between each one. That is the prefiguration of the Information system masterplan.

But the best result of ACTIF application was the use of the method: actually the first step has been the opportunity to meet together the different users. They have exchanged about their needs, their constraints and their requests.

This work has been made in the frame of the European services project "River information services" and its functional applications like ECDIS (for dynamic cartography) or COMPRIS (for Comprehensive Information Systems)...

Fig.4 : interfaces between existing and future ITS applications – made with MEGA

3. Conclusion: the need for design tools for interoperability

The interoperability of systems must be built when two or more stakeholders have discovered the interest to exchange information, to collaborate or to use common tools. The VNF case show that this interoperability of ITS should begin first at political or decisional level.

When a project starts from nothing, it is more easy to obtain that all the different levels of an system architectures must be designed from the higher level (political) to the lower (technical). But in real world, nowhere we start from "tabula rasa" and the experience shows that building interoperability from technical level is quite impossible. It is why the ITS project owners and designers must follow a clear and rigourous method to build this interoperability.

ACTIF like other Framework Architecture for ITS around the world can help this work. But ACTIF is not only a methodological guideline. It is also a way to organize the background knowledge necessary to allow a better understanding between stakeholders.

This knowledge is first logical: that is the professional repository proposed by the model. It is enough central to permit the definition of the service the stakeholders want offer, and enough independent on technology and organisation to imagine different open scenario including the application which soon exists.

The OSCAR software tool permits to apply the method and to use the model's knowledge. This use allow the stakeholders to check the consistency between each levels of the project architecture.

But better than "architecture", we could speak about "system urbanization". In fact, like a urban project, it is necessary that the stakeholders manage the global project during the system life. Each local project must be compliant with the deployment plan (scope, schedule, budgect…) and this urbanization plan can evolve with new environment (rules, services, technology…). Therefore, it is essential that stakeholders implement a permanent organization (like a steering committee) to manage their common project. Using ACTIF can also form the basis for a co-operation agreement between stakeholders.

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