

# THE ARCHITECTURE OF PARADIGMA, A SYSTEM FOR COOPERATIVE WORK IN THE MEDICAL DOMAIN

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## ABSTRACT

PARADIGMA (PARTicipative Approach to DIsease Global Management) is a pilot project which aims to define and to disseminate a common methodology and optimized protocols (Clinical Pathways) to support service functions directed to different stakeholders. PARADIGMA will provide a platform of information services - user oriented and optimized against social, cultural and technological constraints - supporting the Health Care Global System of the Euro-Mediterranean Community in a continuous improvement process.

## KEY WORDS:

Health information systems, Clinical pathways, Cooperative disease management, Decision Support Systems, Ontology, Health Care.

## 1 INTRODUCTION

PARADIGMA (PARTicipative Approach to DIsease Global Management) is a pilot project which defines and disseminates a common methodology and optimized protocols (Clinical Pathways) to support service functions directed to patients and individuals on matters like prevention, post-hospitalization support and awareness [1]. Moreover, it aims to develop and demonstrate an Internet based reference framework to share scientific resources and findings in the treatment of major diseases. Started on June 2003, June 2005 will be the effective end of the project. PARADIGMA chooses to concentrate on expertise for a set of relevant diseases in the Euro-Mediterranean community:

- Prevention focused, infant death reduction from pregnancy to the first year of life.

- Colorectal cancer prevention and treatment.
- Prophylaxis of thrombo-embolism and monitoring of anticoagulant treatment.
- Evaluation and improvement of performance in intensive care.

These domains cover a set of main medical aspects (from prevention to follow-up) that will be addressed to define optimal practices, according to specific social, cultural, technological and organizational conditions.

The PARADIGMA Consortium comprehends 26 partners of 10 different Countries (5 of EU: Italy, Germany, Austria, The Netherlands, Portugal, and 5 of the Mediterranean, non-EU area: Lebanon, Syria, Turkey, Egypt, Tunisia), structured in 4 Competence Groups (one for each basic disease) and 9 Pilot Sites.

Each Competence Group will formalize, for its specific disease, an integrated multi-disciplinary assistance plan (clinical pathway), created to solve specific clinical problems, minimize incorrectness in medical practice and reduce related cost. They define the best sequence of actions to treat patients with specific clinical conditions, enlarging the attention from the clinical case to the patient and his complex needs of assistance.

The Pilot Sites will be asked to describe their context and working conditions and to define their requirements in terms of information services and decision support tools.

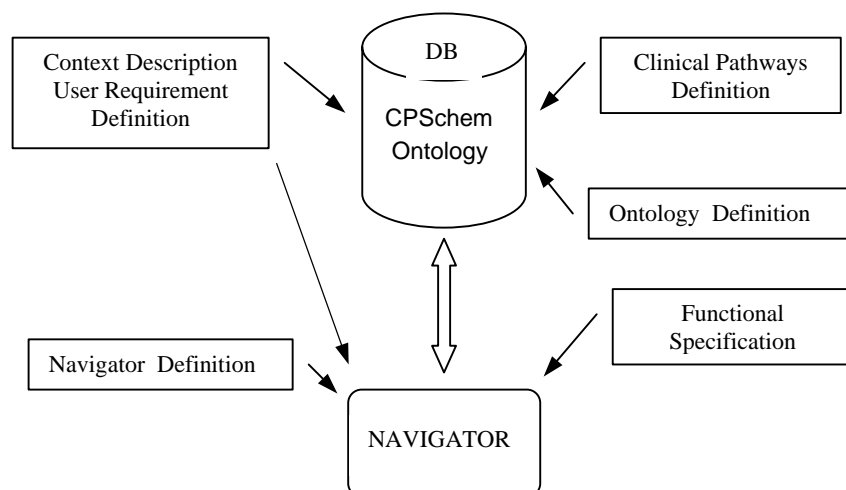
The outline of the paper is as follows. Section 2 deals with the PARADIGMA's project Framework. In this section the core architecture of the Care System under development is introduced. Section 3 illustrates the architecture of a tool, the Navigator, which supports service functions directed to the different types of system users. Section 4 discusses the Intensive Care unit supporting tool. Lastly, section 5 contains some conclusions and suggestions for future research.

## 2 THE PROJECT FRAMEWORK

PARADIGMA's objective is to support Disease Management improvement, focusing on needs and characteristics of patients, workforce and structures. Two basic knowledge repositories (Fig. 1) have been implemented, starting from context descriptions (which provide a formalisation of the "as is" reality of pilot sites) and user requirements (which provide a set of possible use scenarios) [2]:

- a structured dictionary of concepts, the Ontology for Disease Management Systems description,
- a set of the Clinical Pathway Schemata (CPSchem) which specify the scientific, technological, organizational and human aspects of medical practice related to the different Diseases.

Then, functional and system specifications have been used for the implementation of the PARADIGMA Navigator, which provides a set of disease oriented and context adaptive services, based on a user friendly "navigation" of the ontology, the clinical pathway schemata and the information stored on several local data bases.



**Figure 1 PARADIGMA Framework**

The PARADIGMA framework will make provision for suitable user interfaces both to input data (electronic forms, questionnaires, guided interviews, etc.) and to navigate (user and context oriented interfaces, customized functionalities, aimed training, etc.) the framework itself. Moreover, IT and Health Care expertise are needed to benchmark, customize and use existing commercial tools, both for formalizing the Ontology and for implementing Navigator functionalities.

## 3 NAVIGATOR DEFINITION AND IMPLEMENTATION

The PARADIGMA Navigator can be seen as a knowledge-based computing environment for [3]:

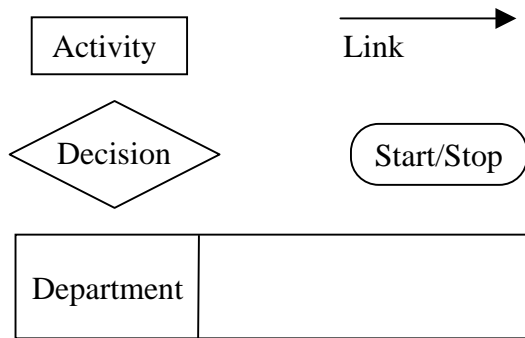
- modeling: eliciting of clinical informal process descriptions, and their conversion into formal process models;
- analysis: evaluating static and dynamic properties of a pathway model (consistency, completeness, internal correctness, traceability);
- simulation: enacting pathway models in order to validate the flow of intermediate tasks and to evaluate process statistics;
- visualization: providing users with graphic views of pathway models that can be viewed, traversed, and animated;
- context specification: describing any single Pilot Site (PS) context (activities, resources and organizing elements related to a clinical pathway);
- localization: a clinical pathway is imported in a local PS context evaluating all the possible

execution patterns that are compatible with local resources;

- execution: at run time, the "best" execution pattern (which is compatible with the state of resources at that time) is selected (resolving step); then a workflow engine reads patient data and implements actions specified in the pathway

In PARADIGMA these activities are supported by a tool for business process modeling and simulation, iGrafx Process [4]. Practical experience has demonstrated that little training is necessary for people to create and evaluate a clinical pathway. Moreover, iGrafx generates many useful statistical reports that allow to evaluate times, costs, resource utilizations, and queues.

The model used to describe a pathway is based on a set of basic modeling elements which are displayed in Fig. 2.



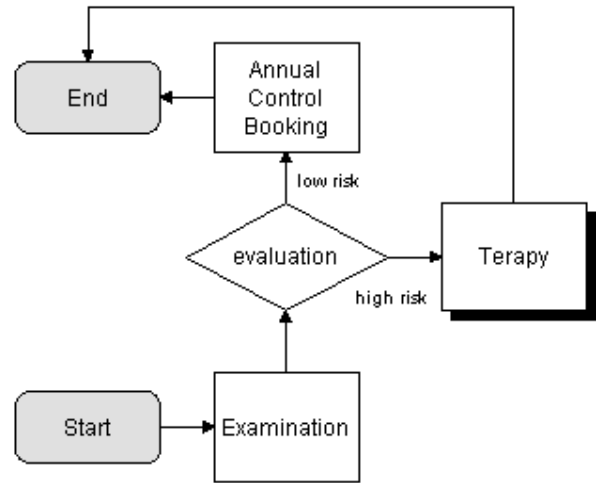
**Figure 2 Basic Modeling Elements**

An activity is a step in the flowchart which represents the clinical pathway. Each activity is specified by a set of parameters:

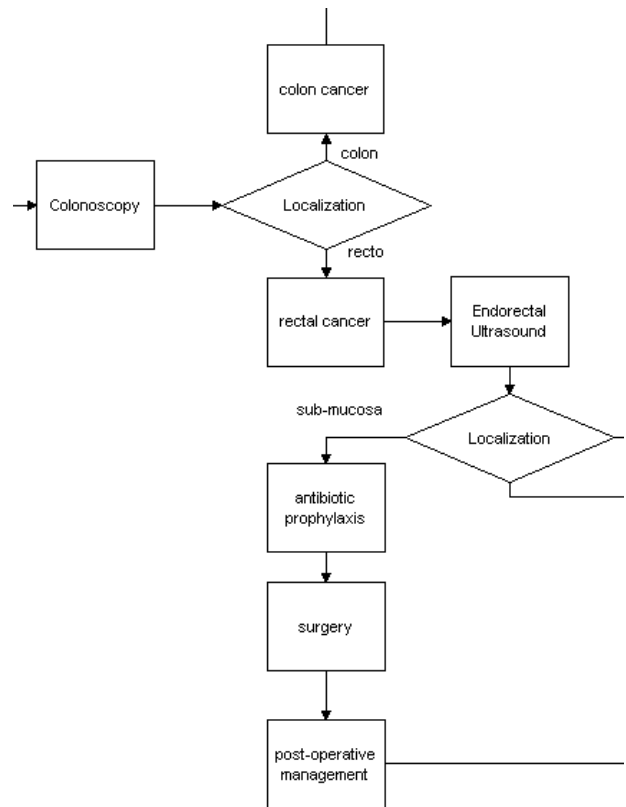
- **Inputs:** inputs to activities are “tokens” that flow from activity to activity over the connection lines (links). A token represent, in our case, a patient which enters the activity.
- **Resources:** a resource is a person, machine or other organizational asset which has to be used to execute a given activity (i.e., to process a token). When several token are processed, they can contend for resources. A resource is managed by a Department of the organization under analysis (e.g. a Pilot Site).
- **Task information:** refers to how an activity processes a token, including activity’s duration, its related costs, its capacity and scheduling of resources.
- **Outputs:** outputs are tokens which leave the activity through the output links and become inputs to other activities (if no link leaves an activity, the token stops).

Modeling elements are connected with links which describe the control flow. An activity is placed into a Department (represented as a “swimming lane”) which performs the activity.

To illustrate the model, let us consider the Colorectal cancer treatment. The related clinical pathway can be described at several level of detail. In Fig. 3 the top level is shown. Therapy, in this case, is a complex activity (a sub-process), which has been decomposed at a lower level. Fig. 4 illustrates a fragment of the Therapy pathway (obviously, the real pathway is much more complex).



**Figure 3 Colorectal cancer top level pathway**

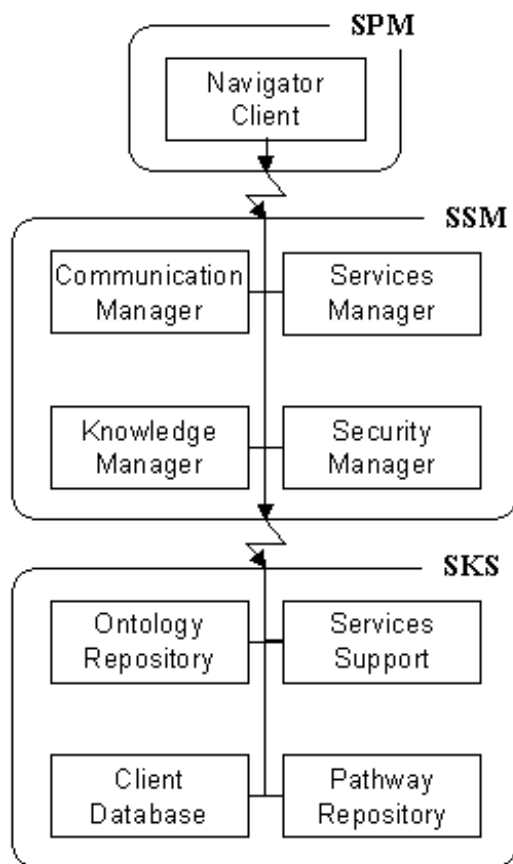


**Figure 4 Fragment of the Therapy pathway**

The Navigator IT infrastructure is the result of the integration of three systems (see Fig. 5):

SPM - System for Presentation Management	[level 1]
SSM - System for Services Management	[level 2]
SKS - System for Knowledge Storing	[level 3]

Each system works as a stand alone system and is separated from the other two by a communication channel (Internet or intranet). The integration of the three systems is made only by means of predefined input/output interfaces.



**Figure 5 The Navigator Infrastructure**

The System for Presentation Management contains the Navigator Client, a graphical user interface (GUI) which makes available functionalities for the acquisition of the user inputs and for the presentation of specific outputs about activated procedures and services.

The System for Services Management provides an environment to control and to manage the information. It provides many services to define concepts, to exchange

information between different systems and to maintain the security of the information.

The System for Knowledge Storing provides an environment to store the knowledge in a structured way. It contains databases which store all the data describing the ontology, the clinical pathways, the clients (users and Pilot Sites features), and the supports for the services at higher level.

The NAVIGATOR infrastructure proceeds through a cyclical flow of request/response that take advantage of predefined and standard system interfaces. The communication protocol among the systems is standard XML.

#### 4 THE INTENSIVE CARE UNIT

Aim of the Care Unit clinical pathway is to create a web-hosted database to assess performance in intensive care unit (ICU). To assess performance, the best indicator of which is outcome, it is crucial to characterize the case mix one is dealing with, the procedures performed from admission of each patient to dimission/exitus, and to balance all this against environment (number of medical doctors-nurses to patients ratio, facilities present in the hospital..).

Crucial to the process is to collect homogeneous data that will allow comparisons. The project will start with environment description, than move towards case mix characterization (patients\_admitted/day0). We will peculiarly focus on patients with acute lung injury (ALI) and follow over time (day by day) the procedure (one of the many performed!) of mechanical ventilation. PARADIGMA will produce documents on:

- Environment description
- Case mix on day 0 characterization and outcome measures
- Definition of acute lung injury and variables to be collected, day by day, related to mechanical ventilation.

As an example, Fig.6 shows the main menu acquisition environment for the Intensive Care Unit case.

The acquisition forms for Case Mix (data related to a Patient) are illustrated in Fig.7 and Fig.8.

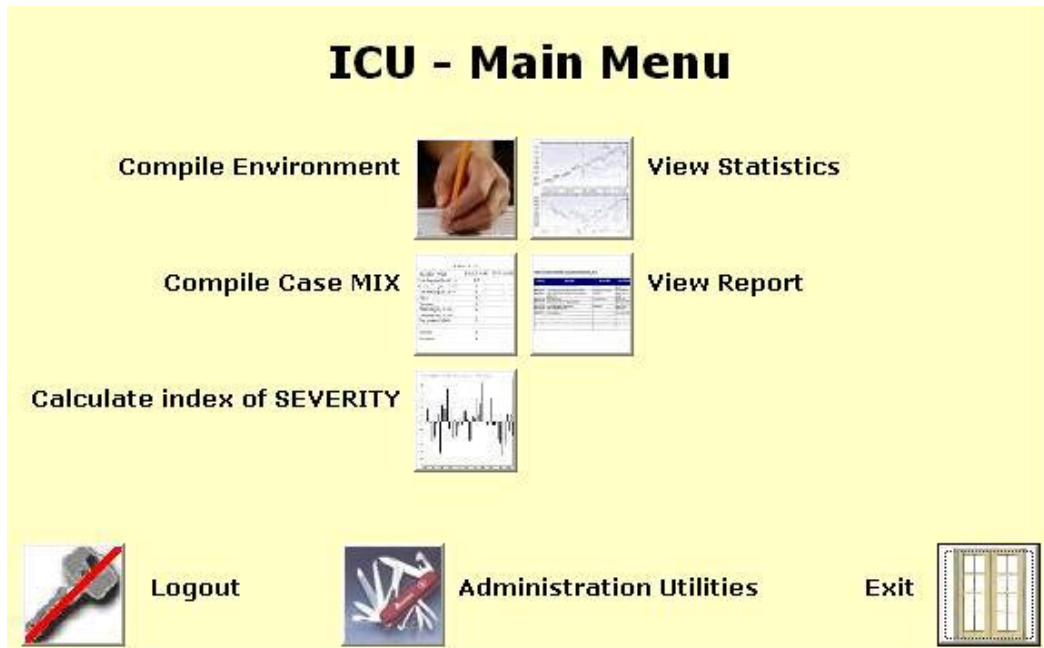


Figure 6 Intensive Care Unit Main Menu

## ICU - Compiling Case Mix

Anagraphic Data | Hospitalization | Main causes of admission | Organ Failures | Presence Co-morbidity/ies

Patient ID codice paziente

Name

Surname

Address

Birthday

Age

Sex  M  F

Weight

Height

BMI






Figure 7 Private Data Acquisition Form

Figure 8 Causes of Admission Form: Presence of Co-morbidity

## 4 CONCLUSIONS

The development of the PARADIGMA Project offers an insight into steps that can be needed to develop a network based information environment which aim is to connect the actors at all levels in the Health Care System and to promote a “participative” approach to diseases management.

The Navigator represents the most relevant software tool developed in the PARADIGMA project, making use of the opportunities that modern ICT offers. It would be a clever interface between the Health Care structure, its processes, its users (doctor, nurse,...), and its supporting tools, making data and knowledge exchange possible.

Besides this, the Navigator will provide the PARADIGMA users an easy to use and attractive interface to go through the procedural steps of Clinical Pathways and use the available tools in the process of solving problems. The following impacts are to be expected from the research and development in the project:

- the improvement of performances (diagnosis and therapy pathways, hospitalisation, etc.) and the reduction of costs in the health care environment;
- the creation of a network of care structures, aimed to compare schemes and experiences in medical practice, for continuous information exchange and improvement;

- the increase of patient satisfaction by providing, in less time, the best practice and more complete assistance to take care for the whole needs related to a patient’s disease.

## 5 REFERENCE

- [1] A. Di Leva and C. Reyneri, *The PARADIGMA Approach for Cooperative Work in the Medical Domain*, Proc. of "e-HDC 2004 - e-Health for Developing Countries", May 31- June 1, 2004, Rome.
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- [4] iGrafx Process, Corel Corporation, 1600 Carling Avenue, Ottawa, Ontario Canada.

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Project documents can be obtained from the PARADIGMA site: [www.paradigmamed.org](http://www.paradigmamed.org)