

# A WORKFLOW-BASED APPROACH FOR THE KERNEL 0 OF EUSC REFERENCE FACILITY

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## ABSTRACT

The 3-year EUSC Programme named Reference Facility aims at creating an integrated, service-oriented IT infrastructure that, by enabling an efficient and effective processing of the *tasks* performed within the Centre, should fully support the production of the requested dossiers of information.

Project Cervantes, born within a collaboration between Spectrum Graphics, the Canadian company Galdos Systems and the Spanish company Ilog, has a twofold objective:

1. set up a baseline configuration (termed Kernel 0) for the future development of Reference Facility Kernel 1 (i.e. the first phase of EUSC Programme);
2. act as a function demonstrator to EUSC users, by means of an implemented prototype of the application.

In particular, the scope of our work has been the rigorous analysis of the business processes and cooperation environment that underlay the primary mission of EUSC, and the design and implementation of a preliminary, workflow-based platform supporting the activities needed to manage and carry out the “life-cycle” of (concurrent) *tasks*.

The main outcome of the work has been a better process integration within the Centre and an improved management and retrieval of satellite products to be used in the task fulfilment.

The present paper is organised as follows.

Section 1 describes the context and the main motivations. Section 2 illustrates our general approach and method of analysis and design. Section 3 describes the architecture of our solution. Section 4 highlights possible extensions. Section 5 contains the conclusions.

## 1. Context and Motivation

As is known, the primary mission of EUSC (European Union Satellite Centre) is the utilisation of Earth observation space imagery in order to produce derived information in support of decision-making of the

European Union in the field of Common Foreign and Security Policy. In this setting, a EUSC user can be:

- ✍ the EU Council;
- ✍ a EU Country;
- ✍ NATO;
- ✍ other organisations, e.g.: JRC.

Any of them may ask for a specific information dossier, focused on a particular geographical location to be observed during a certain period of time.

The characterisation of the location of interest, the interval of time of the observation, and the type of derived information that is requested by the user settle the complexity and cost (in terms of engaged resources, including external suppliers) of the dossier (actually termed *task portfolio*) to be produced as outcome of the task activated within EUSC as a follow-up of the user request.

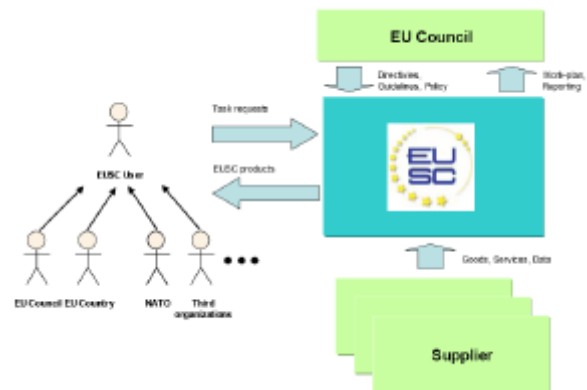


Fig. 1. EUSC Context

After the preliminary analysis of the task and agreement with the user, the identified task is generated, its fulfilment is planned, and the necessary resources are allocated.

The final EUSC product is compiled by EUSC staff members (analysts, image experts, etc.) in the course of fulfilling the user task. It can contain various digital and multimedia data items, along with intelligence information and results aimed at satisfying the user demand and specifications.

Since each task involves, in general, many experts, each of whom possesses specific knowledge and skills

to perform a part of the whole job, and many tasks may be simultaneously on-going within the Centre, there naturally arises the problem of coordinating and optimising the whole process. Moreover, the envisaged solution should also enable future evolutions in the Centre role and in the kind of services provided to users.

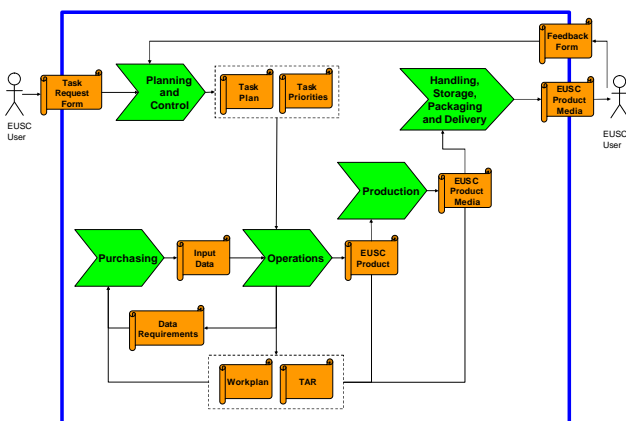
In order to devise an enterprise-wide solution to the above problem, we have carried out a full analysis of the overall process that implements a task fulfilment, with the following objectives:

1. Identifying actual needs of all EUSC actors (i.e. participants to the main process).
2. Integrating different data views through a Common Information Model.
3. Automating routine steps of activities via application software.
4. Providing practical support to concurrent, human-driven activities, through an easy-to-use, custom-developed, cooperative environment.
5. Providing preliminary reporting capabilities to measure the productivity of the overall application infrastructure.

To cope with those objectives, we have adopted an integrated approach for the process analysis and workflow design, which is described in the next section.

## 2. Analysis and Design Method

The high-level schema of the task fulfilment process carried out within EUSC can be depicted as follows (Fig. 2).



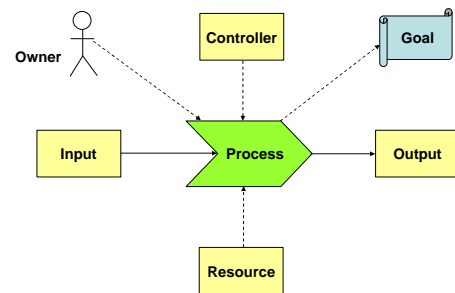
**Fig. 2. High-level process of task fulfilment**

(TAR stands for Task Analysis Report).

This picture reflects the “as-is” situation of the Centre.

In order to take into account the new requirements implied by the Reference Facility Programme of the Centre, a further detailed process analysis has been done, which has been based on the Eriksson-Penker formalism (with some adaptation) for business process analysis (see [1]). This formalism is based on a business-oriented extension of the well-known UML (Unified Modeling Language) notation, and uses the notion of process pattern in order to “factorise” the business requirements towards recurrent user scenarios and process environments.

The main building block of this method of process analysis is the following:



**Fig. 3. Basic process pattern**

This means that each process is characterised by a number of elements:

- ✍ an actor playing the role of Owner;
- ✍ a class acting as Controller;
- ✍ a class used as Resource
- ✍ a class received as Input;
- ✍ a class given out as Output;
- ✍ a class pursued as an assigned Goal.

At instance level, then, each process instance is governed by a specific owner, and is related to a number of specific class instances.

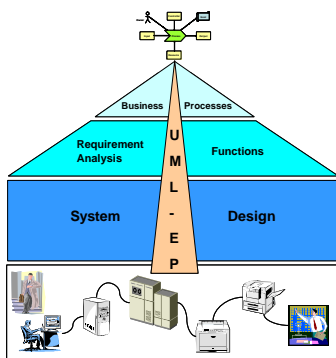
Let us suppose now, very generally, that a given organisation (e.g. EUSC) has a number of actors and goals, manages resources, and has to produce some outputs by processing suitable inputs under the supervision of appropriate controllers. Then, by combining and chaining several basic process patterns, one can model complex, enterprise-wide business processes in an integrated and consistent way.

More importantly, if those business processes span “transversally” the whole enterprise organisation, each role/function within the enterprise is involved in the model at the correct responsibility level. In other words, if there are strategic goals and resources that have to be mapped from the top management and high-

level enterprise assets down to operational procedures, people, and objects, our method allows one to precisely track the process dependencies and allocate the process elements throughout the whole organisation.

In the case of EUSC mission, in particular, since one of the major objectives of the RF Programme is to achieve a better process effectiveness by means of the adoption of open standards (e.g. OGC, Web Services, SOA), this method appears very promising as long as it has already proved successful during the Kernel 0 implementation.

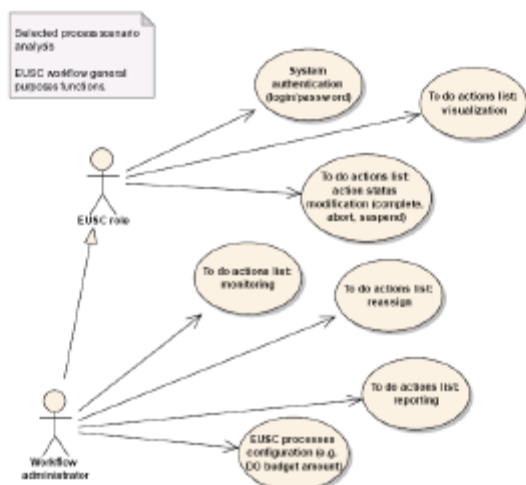
It is worth noticing that, since the Eriksson-Penker notation is an extension of UML (let us denote it by UML-EP), it allows for a seamless development cycle, from the processes and user requirements to the application systems, as depicted below (see Fig. 4).



**Fig. 4. Seamless development cycle**

In the particular case of Kernel 0 of EUSC Reference Facility, the process analysis has identified some improvements in the user scenarios, which have been expressed through a collection of UML-EP diagrams, validated by the users themselves.

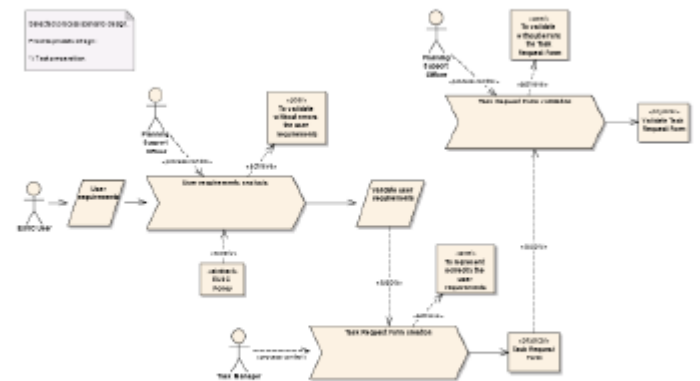
As an example of user scenario, we show in the next figure a Use Case Diagram, depicting the general-purpose functions.



**Fig. 5. Use Case Diagram showing general-purpose functions**

From those scenarios, a detailed process analysis has been carried out, expressed in the UML-EP notation.

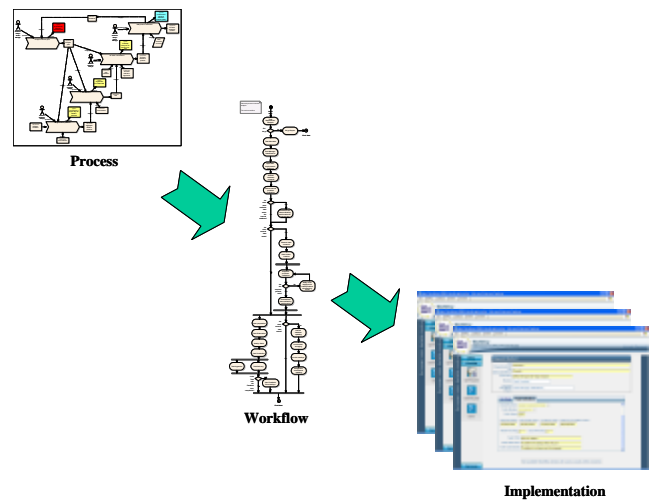
As an example, we give in the figure below the process diagram representing the "Task Preparation" process.



**Fig. 6. Process Diagram of the "Task Preparation" Process**

After having collected all relevant aspects of EUSC business processes and having represented them in an integrated way through the UML-EP formalism, technical specifications and constraints for the software application have then been derived.

These technical requirements have been taken as input for the design of the workflow-based architecture of the solution (see Fig. 7).



**Fig. 7. From analysis to design and implementation**

The need of a workflow-based architecture in the solution relies on the fact that the notion of the EUSC task can be easily related to the notions of case and task in the workflow technology.

In fact, a workflow case has:

- ✍ a unique identity;
- ✍ a limited lifetime;
- ✍ a particular state, consisting, in turn, of three elements:

- the values of the relevant case attributes;
- the conditions that have been fulfilled;
- the content of the case.

On the other hand, a workflow task is a logic unit of work that manipulates a workflow case. As such, a task is then committed to a well-defined fulfilment, either successful (normal completion) or unsuccessful (with possible rollback). A task may be either manual, or automatic or semi-automatic, and involves people and resources, possibly supported by computer applications and information systems.

Whenever the primary mission of an enterprise is going to significantly evolve (and EUSC is just in this situation), then the question arises on how to “extract” the (new) business logic from the current processes and applications, model the new scenarios, and mapping them back onto an open, renewed application infrastructure. The workflow approach is exactly the enabling technology to manage this type of mission evolution within an organisation. Workflows represent the automatable portion of the new business processes, equipped with built-in, service-oriented features ensuring integrity and consistency of the processes, the most effective usage of the enterprise assets, and the “levers” of operational governance made available to process owners.

Based on the above considerations, the architecture of the solution that has been designed for EUSC, in the framework of Kernel 0 of the Reference Facility, uses a workflow management system (WFMS), which acts as the “engine” of the cooperative environment.

The architecture of the solution is described in the next section.

### 3. ARCHITECTURE OF THE SOLUTION

#### 3.1. The Data Model

The data model design has been based on the following main activities:

- ✍ A deep analysis of EUSC business processes with the aim of deriving the Common Information Model used within the Centre.
- ✍ A clear identification and separation of the data model devoted to the business support with respect to the geospatial data model.
- ✍ A design of the data model schema oriented to profiling users, which is mandatory to support the collaboration mechanism within the workflow.

The following figure represents the data model derivation from the business process analysis and

underlines the reverse engineering activity based on the EUSC legacy system (e.g. the General Information Browser, GIB).

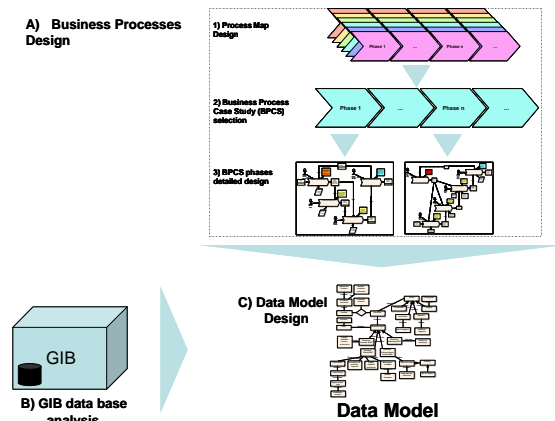


Fig. 8. Design of the Common Information Model

The decoupling of the conceptual levels of the geospatial and business models is important to define the scope and identify the functional responsibility between the OGC catalogue and the database supporting the workflow.

Within the workflow implementation, a crucial aspect is the collaboration among the several user roles. The collaborative functionalities are based on a dedicated data model, containing the following concepts:

- ✍ *User*: a workflow user;
- ✍ *Division*: the organisation unit;
- ✍ *Role*: the role played by the user;
- ✍ *Business process action*: an action within the workflow available to a user while he is playing a certain role.

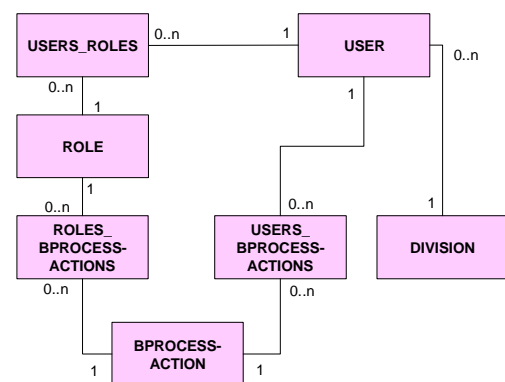


Fig. 9. Data Model subschema for user profiling

It is evident that the above subschema allows the application administrator to suitably configure any user according to the role(s) played in the workflow logic.

### 3.2. The Prototype Architecture

The main architectural components of the deployed system are the following:

- ✦ the *Presentation Layer* for the human-machine interactions;
- ✦ the *Workflow Engine* for the process implementation;
- ✦ the *Integration Services* for decoupling the workflow and the used packages;
- ✦ the *Persistent Data Object Layer* for the data access from the other components;
- ✦ the Database for application data;
- ✦ the *Rule Engine* for the definition and implementation of process rules;
- ✦ the *OGC Catalogue* as geospatial data repository, in accordance with the Open Geospatial Consortium specifications.

The following figure depicts the whole architecture. The components implemented by Spectrum Graphics appear in green colour, while the other ones have been implemented by Galdos Systems and Ilog.

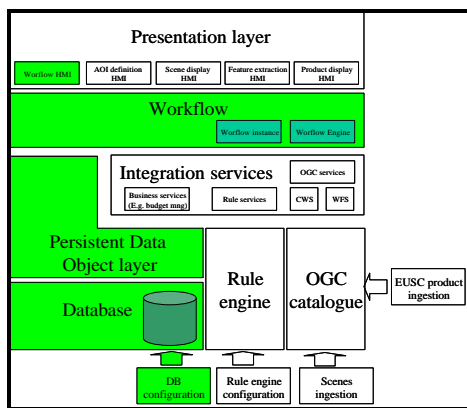


Fig. 10. Architecture of RF Kernel 0 Prototype

The physical implementation of the workflow application has been based on the following open-source packages, which have been successfully used and integrated:

- ✦ *WebWork*, as a MVC (Model-View-Controller) framework for the internal portal implementation.
- ✦ *OSWorkflow*, for the workflow engine implementation.
- ✦ *Hibernate*, as a framework aimed at implementing the object-relational mapping to manage persistent data.

In addition, *Oracle* has been adopted as the underlying DBMS for the database.

The following figure shows an example of the workflow solution front-end.

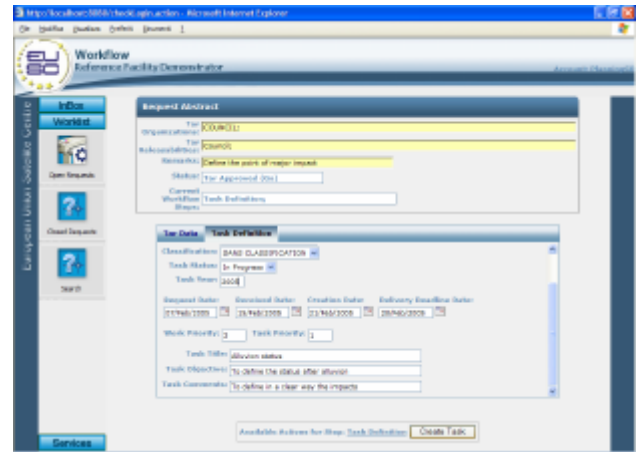


Fig. 11. A sample screen shot of the prototype

As may be noted, within the workflow front-end the following user-oriented features have been implemented:

- ✦ a left bar for the general-purpose functions (messages; collaboration; get, fulfil and supervise *task*, etc.);
- ✦ a header with main information of the selected *task*;
- ✦ a tab with several panels, where a tab represents, in general, a workflow step within the *task* elaboration;
- ✦ a set of dedicated buttons, at the bottom of the window, for moving steps within the workflow.

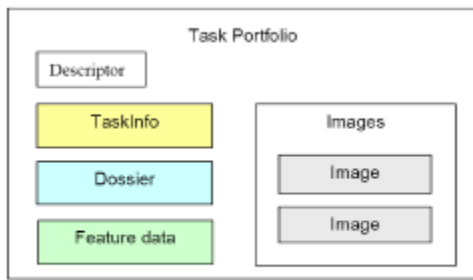
Therefore the user is provided with a global view of the progress status of the various tasks he has in charge, along with the necessary access to the selection and elaboration functions he has to invoke to perform his portion of the whole job.

As matter of fact, as we said at the beginning, a response to a task request involves the creation, verification, packaging, and distribution of a complex set of digital information items pertaining to some situation or location of interest.

These items may include, but are not limited to:

- ✦ *satellite and aerial imagery*;
- ✦ *extracted feature data and other vector data sets*;
- ✦ *collateral data*;
- ✦ *maps*;
- ✦ *documents such as analytical reports, dossiers, and briefing notes*;
- ✦ *animation graphics*;
- ✦ *audio and video clips*.

The end product is a task portfolio, which is a compound, multimedia digital information object that may be distributed electronically or on physical media.



**Fig. 12. The structure of a task portfolio**

It is worth mentioning that one of the major objectives of EUSC RF Programme is the standardisation of the management of digital media elements, so as to achieve a full portability (i.e. workspace and platform independency) of the final products of the Centre, with the obvious benefit to greatly broaden the community of possible final users.

The RF Kernel 0 prototype is fully in line with this perspective, as long as it is based on open standards (including web services) and on a Common Information Model supporting both workflow operations and indexing/retrieval capabilities of task portfolios.

These aspects, suitably combined, are expected to provide major enhancements in the overall activities of the Centre, in terms of optimisation of resource usage and leverage of value-added knowledge, along with capabilities to efficiently deploy new services in the next future.

#### 4. POSSIBLE EXTENSIONS

The lessons learnt from the implementation of the prototype suggest the following possible extensions, in line with what is being envisaged with the overall EUSC RF Programme:

- ⌘ Enrichment of the data model devoted to the business support as new RF-derived services are made available by the Centre.
- ⌘ Better support to the internal knowledge management and training of the Centre staff, through the new infrastructure.
- ⌘ Better support to the internal/external interfaces of EUSC. In particular:
  - the procurement process of satellite products, managed by the Data Manager;
  - monitoring and reporting on performed activities (including control of costs);
- ⌘ a more detailed categorisation of the basic workflow into sub-workflows to gain flexibility

and efficiency, thereby enhancing global productivity;

- ⌘ the definition and implementation of new services to be offered to EUSC customers;
- ⌘ implementation of a full-fledged portal to provide EUSC services to external customers, including service level agreement (SLA) support;
- ⌘ start of a business intelligence policy, oriented to measure customer satisfaction and service effectiveness.

#### 5. CONCLUSIONS

This paper has described the prototype implementation of a workflow-based system, oriented to the management of an enterprise-wide cooperative environment for the production of advanced dossier of intelligence based on satellite imagery.

Our solution can only benefit of advances in the imagery treatment and retrieval, as long as the added value that can be extracted from satellite products, once suitably organised and interpreted through human expertise, can lay the foundation to totally new generations of information services offered to growing and severally-profiled communities of final users.

#### 6. ACKNOWLEDGEMENTS

The authors are pleased to acknowledge the strong and fruitful cooperation achieved with EUSC staff and with the other project partners during the course of Cervantes Project.

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