SUMO: Operation and Maintenance Management web tool for astronomical observatories

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ABSTRACT

SUMO is an Operation and Maintenance Management web tool, which allows managing the operation and maintenance activities and resources required for the exploitation of a complex facility. SUMO main capabilities are: information repository, assets and stock control, tasks scheduler, executed tasks archive, configuration and anomalies control and notification and users management.

The information needed to operate and maintain the system must be initially stored at the tool database. SUMO shall automatically schedule the periodical tasks and facilitates the searching and programming of the non-periodical tasks. Tasks planning can be visualized in different formats and dynamically edited to be adjusted to the available resources, anomalies, dates and other constrains that can arise during daily operation. SUMO shall provide warnings to the users notifying potential conflicts related to the required personal availability or the spare stock for the scheduled tasks.

To conclude, SUMO has been designed as a tool to help during the operation management of a scientific facility, and in particular an astronomical observatory. This is done by controlling all operating parameters: personal, assets, spare and supply stocks, tasks and time constrains.

Keywords: Operation and maintenance management, software tool, scheduler, tasks, resources, equipment, facilities, spares, supplies, anomalies, configuration control.

1. INTRODUCTION

SUMO (System Use Management Tool) is an Operation and Maintenance Management web tool developed by FRACTAL. SUMO allows managing the operation and maintenance activities and resources required for the exploitation of a complex facility during the Operation phase.

SUMO main capabilities are to provide a) an operation and maintenance information repository, b) assets and stock control, c) tasks scheduler, d) executed tasks archive, e) configuration and anomalies control and f) notification and users' management.

The information collected at the Operation and Maintenance Plan must be initially stored at the tool database.

SUMO shall automatically schedule periodical tasks and facilitate the search and the programming of non-periodical tasks. Tasks planning can be visualized in different formats and dynamically edited to be adjusted to the available resources, anomalies, dates and other constrains that can arise during daily operation.

SUMO shall provide warnings to the users notifying potential conflicts such as the required personal is not available or the stock has run out of the spares needed for carrying out the scheduled tasks.

SUMO is part of the FRACTAL System and Project Suite, which includes also the tools GECO (System Engineering and Configuration Tool), DOCMA (Documentation Management Tool) and MANATEE (Project Management Tool). All these tools are being successfully applied to carry out international, complex and geographical distributed projects. An example is the project MEGARA; the future fiber fed optical spectrograph for the GTC 10-m telescope, for which FRACTAL is responsible of both Management and System Engineering Work Packages.

In the following sections, we first introduce FRACTAL System and Project Suite, to provide an overview of the set of applications that are used in combination with SUMO to track and manage projects during their whole life-cycle (i.e., from the design phases to the operational and disposal phases). Then, we describe in detail SUMO functionality.

2. FRACTAL SYSTEM AND PROJECT SUITE

Having computer-aided tools is particularly important when generated data increases (which occurs as the projects or organizations evolve). In such cases, the information can become unmanageable very fast and the need for a specific software tools to control it becomes essential.

This assessment is particularly important for companies or organizations where most of the involved people are geographically distributed (which is also the FRACTAL situation). In such a case, people located in different work centers (often in different cities or even different countries) need to access the project data in a controlled way.

FRACTAL is a company founded in 2005 and dedicated to carry out engineering and scientific projects mainly related with telescope and professional astronomical instrumentation. Our main customers are universities and research centers involved in large Consortia responsible for delivering cutting-edge developments for the ground-based professional observatories and/or Space missions. It is also important to mention that most of the people working or collaborating in our company and/or our customer's organizations, is geographically distributed, which makes the effective communication becomes a key tool for project success.

For this reason, we have developed several customized tools fully focused on solving the main problems found when participating in instrument projects. GECO, DOCMA and MANATEE, which are more focused in the development projects phase, share a common database. SUMO, to be used during the operation phase, has its own database. All these tools are focused to support the team by accessing and exchanging information, and to perform and coordinate the Management and/or System Engineering activities during the entire project life cycle.

- **GECO - System engineering and configuration control.**

  System Engineering is defined as the interdisciplinary effort that governs the global technical effort done in a project framework to transform the initial requirements into the final system. Therefore, Systems Engineering provides the basis to establish a good organization during the technical development of a project, and will be essential to provide the needed help to Project Management to fulfill both the system requirements and the project schedule and budget. This discipline is always essential for the success of any project, especially the more complex ones, which include different professional skills and whose partners and working groups are often geographically distributed.

  The System Engineering group must produce the System Engineering plan for the development of a system. During the implementation of such plan, the system configuration data are generated: Product Tree (PT) elements, requirements, interfaces, specification documents, verification matrix, configuration control records, non-conformities records, etc.

  GECO is a Configuration Management Tool that provides the means to manage the configuration data generated in all phases of a project, i.e., not only during the design phases of a system but also during its integration, verification and, even later, when the system enters into operation.

  The application has been developed with two objectives: firstly, to assist the System Engineering Group and Configuration Control Group to control and maintain the configuration items of a system and, secondly, to make this information available to other groups within the organization or the consortium in charge of developing and operating the system.

  GECO helps to keep updated the configuration data, to establish the links among data (e.g. requirements traceability) and to manage configuration changes, non-conformities and anomalies. The final goal is to facilitate the configuration control process by tracking correctly the system development in order to ensure the successful system development and integration.

  Finally, this tool can automatically generate the requirement section of the documents from the updated requirements stored in GECO database, which helps to keep a coherent set of requirements and to avoid maintaining duplicated information, reducing considerably at the same time the work needed to have the documents updated. Requirement Documents are an important view of the system and these documents have to be distributed to third parties, such as contractors and/or customers, and have to keep updated to comply with the intended project milestones and reviews.

  Fig. 1 provides several view of the GECO graphical user interface.

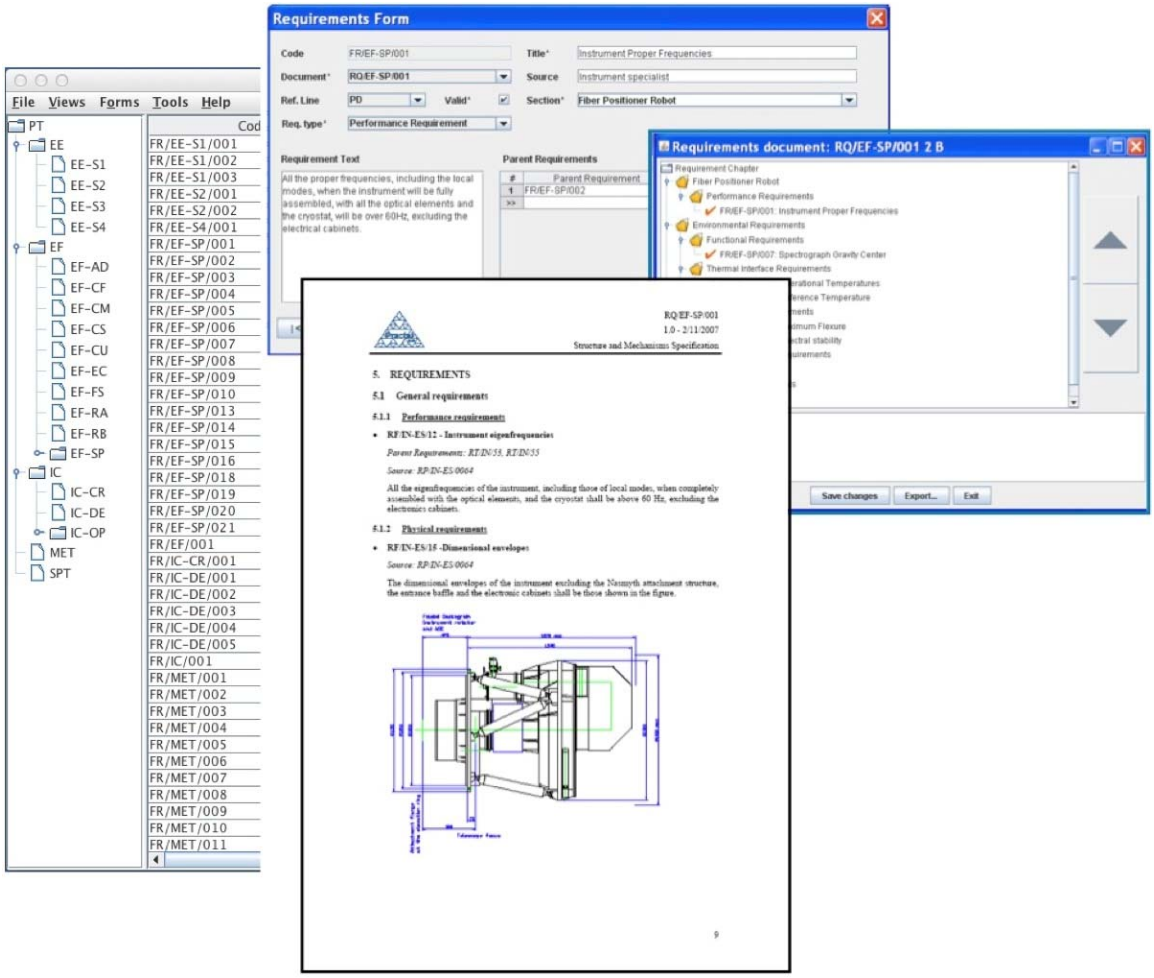

Fig. 1. GECO snapshots. Some views on documentation, requirements and configuration-change views are shown.

- **DOCMA - Project documentation.**

  All organizations produce and store a good amount of documents. The number of documents is usually high enough to make a documentation management tool always a need. When several companies and/or institutions collaborate in a multi-discipline, complex project in a geographically distributed environment, a documentation tool starts to be even more important. In such a case, the number of documents generated and stored in the diverse work centers, with different versions, written and reviewed by several individuals can become a communication problem in the project, being unmanageable very fast. Then, a specific computer-aided tool becomes essential.

  DOCMA is a Documentation Management Tool that provides the means to manage the documents generated in a company or organization during the whole document life-cycle and according to the permission granted to the users. This allows us to keep and organize documents and to improve the internal communication among the different members involved in a project.

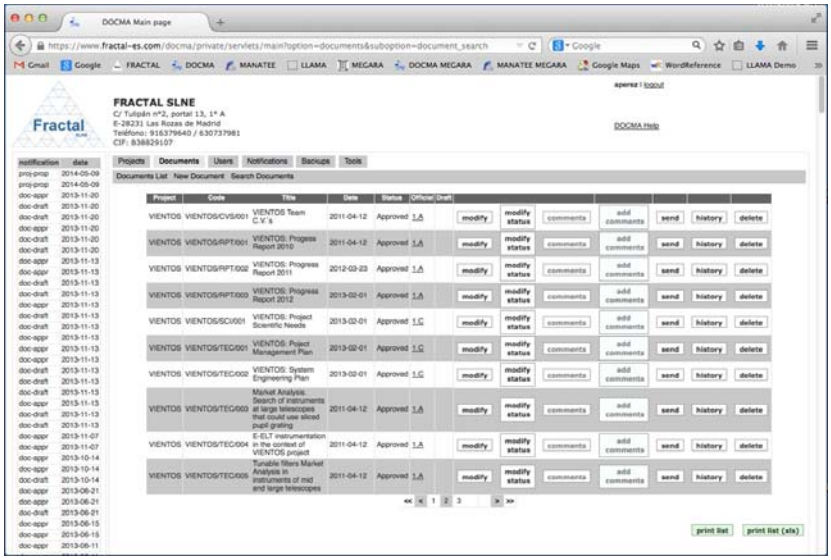

Fig. 2. DOCMA web interface view (document list).

- **MANATEE – Project Management.**

  All projects must be defined in terms of their managerial parameters: Scope (Performance), Schedule (calendar and time relationships among tasks) and Price (overall budget and cash-flow along the project). These three parameters must be planned from the beginning of a project, but the real difficulty appears when trying to control them and their inter-relationships as far as the project progresses. The core management activities are usually a huge amount of day-to-day tasks related to making decisions, managing and coordinating the team that could lead to a provisional abandon of the crucial project control task. MANATEE has been designed to help in the optimization of the project achievement, acting as an electronic project controller able to be fed by the team members and to inform them and the managers of the project progress, generating also warning when important deviation from the planned goal are detected.

  The set of tasks managed by the same overall responsible, oriented to produce a single deliverable or to offer certain kind of services to the project are called Work Packages. The WPs are usually divided by the nature of the tasks to do (usually due to the skills of the people that have to carry out the work) or by organizational needs. Each Work Package has an associated deliverable (or set of deliverables) in such a way that the sum of the Work Packages is the system to be delivered. Each WP is divided in sub-work packages and these into smaller pieces of work, tasks, and all together constitutes the Work Breakdown Structure, WBS. The Project Manager has to propose the Work Breakdown Structure at the time of designing a project plan. The WBS is a deliverable-oriented grouping of project elements, which organizes and defines the total scope of the project via the needed tasks to complete all the deliverables. The WBS technique uses a hierarchical tree structure. Each task is an activity and it is an element of work with clear assigned project parameters.

  In order to control the project parameters (scope, schedule and budget), it is essential to follow in detail the tasks execution and project milestones or, in other words, to have close access to the relevant tasks data that allow understanding the status of the project. This includes the possibility of making lists and/or figures such as the level of task complexion, the hours assigned and spent in each task, milestones lists, critical path and milestone dependence, etc. Project managers need to receive (or to access) these data (fully updated) in order to make decisions and to anticipate any risk or problem. At the same time, the people participating in the project need to have the means to record the information relative to the tasks under their responsibility.

  In addition to the above items, when the project office is geographically distributed and/or when the project is too complex, in terms of number of disciplines, number of resources, funding sources, etc. a web-based software tool allows people being more active in the project and keep them fully informed on the project status. A tool such MANATEE also makes the relevant information available to everybody.

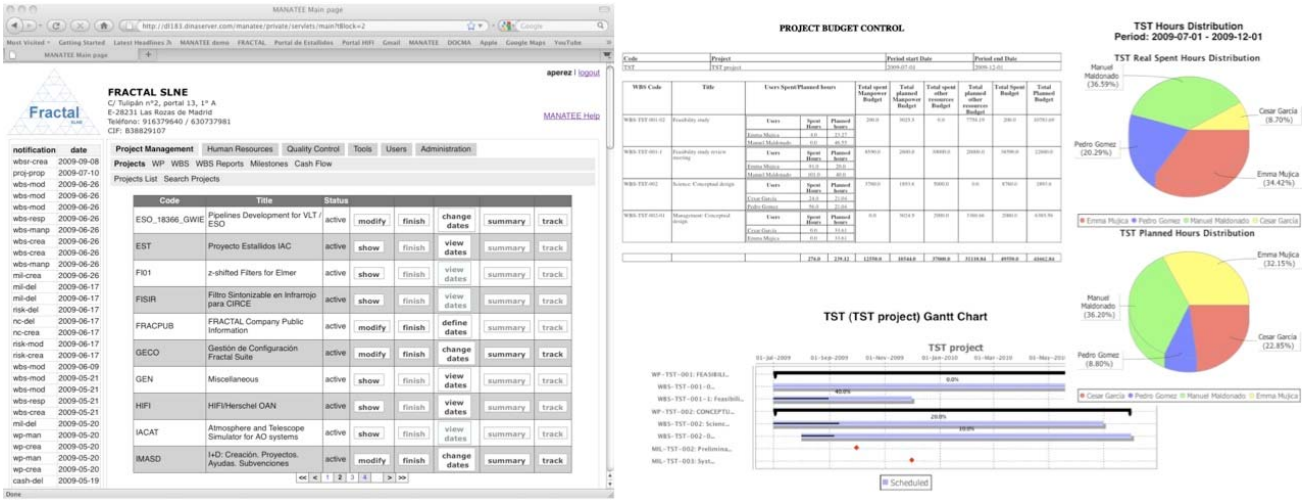

Fig. 3. MANATEE web interface view (project list and some results charts).

An additional feature, common to all the applications of the suite, is that they have been developed to run on different environments and at different locations. This is important taking into account the geographical distribution of the personnel in the organizations involved in these kinds of projects. Besides, in order to minimize the maintenance costs and complexity, we have chosen a platform-independent technology; providing simple ways to install the software in a distributed environment and implement a user access policy and encryption features to protect the project's data.

GECO is developed in Java, while DOCMA, MANATEE and SUMO provide a graphical user interface based on WEB forms. The four tools allow accessing the full functionality and the project data remotely from any place. More information about the suite can be found in FRACTAL webpage http://www.fractal-es.com/en/Suite.html.

3. SUMO

3.1 Overview

SUMO allows managing the operation and maintenance tasks and all type of resources required for the exploitation of a complex facility during the Operation phase.

The Operation and Maintenance Plan of a scientific facility must be developed to optimize the use of the observing time while keeping a cost effective maintenance program. This is worth mentioning that the total budget for the operational phase can be eventually larger than the development one. Therefore, it is important to take into account the operation and maintenance constrains at the system design to ensure that the facility shall provide the expected performance while optimizing the Operation and Maintenance Plan costs during its execution.

To design a system for being easily and economically supportable, the reliability, availability, maintainability and safety requirements must be defined and considered from the beginning of the project. Reliability, Availability, Maintainability and Safety (RAMS) analyses must be performed since the early design phases and draft versions of the Operation and Maintenance plan must be produced. The RAMS analyses will provide the input for identifying preventive, predictive and corrective activities. The maintenance tasks must include accessibility issues, safety measures, task duration and frequency, manpower, support test equipment and facilities required, manpower skills and training needed, and the spares and supplies availability to carry out the tasks.

The level of definition of the Operation and Maintenance Plan shall evolve during the system development. The detailed definition of the tasks and the support elements (test and support equipment, staff, facilities, technical manuals, training, external services, spares and supplies) must be ready before the system enters into operation. For complex facilities, the volume of this data would make advisable to have a software tool that facilitates the management.

A software tool like SUMO shall allow organizing and accessing in a controlled manner the operation and maintenance data and facilitate the planning of the tasks. SUMO is a user-friendly tool that will record not only the activity description but also the information related with the support elements.

SUMO capabilities can be summarized as follows:

- Operation and maintenance information repository
- Assets and stock control
- Tasks scheduler
- Executed tasks archive
- Anomalies control
- Notification and users management

3.2 Operation and maintenance tasks

The operation and maintenance information includes the detailed definition of the operation and maintenance tasks and the resources that are required to carry them out.

The definition of the operation and maintenance tasks shall include:

- The detailed description of the task (step by step) or the link to an operation or maintenance procedure, where the task is defined.
- The tasks periodicity (whenever applicable).
- The links among tasks (if any). It means, for those tasks that must be scheduled when a condition is met instead of each certain period.
- The task estimated duration.
- The task estimated priority.
- The resources that are needed to carry out the task, which must be selected from the ones stored in the tool.

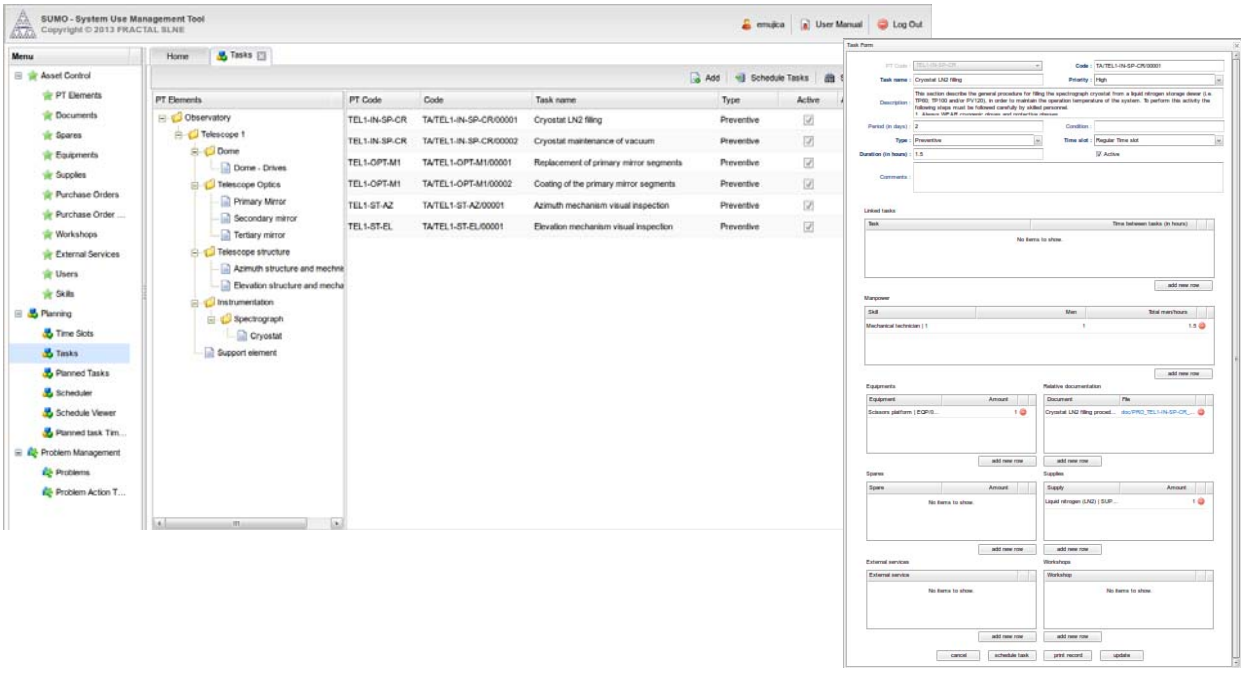

Fig. 4. SUMO web interface view and task form.

3.3 Operation and maintenance resources

SUMO keeps the following operation and maintenance resources:

- Product tree elements.

  The product tree (PT, Product Tree) describes the hierarchical break-down structure of a complex system in the necessary levels to completely define the system.

  All subsystems, components and parts that constitute the system to be operated and maintained must be introduced with a unique identifier, which will be used to link part of the archived information.

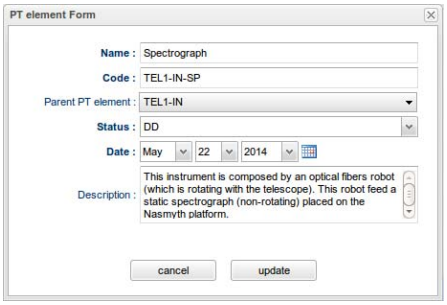

Fig. 5. PT element form view

- Documents.

  All operation and maintenance documents (procedures, user manuals, technical data sheets, reports, etc.) must be accessible at the tool. SUMO provides documentation version control capabilities.

- Spares

  The spares that are needed for fulfilling the system availability budget must be kept at the tool. SUMO also facilitates the control of the stock (consumed and purchased spares must be also registered).

- Supplies

  The supplies that are needed for fulfilling the system availability budget must be kept at the tool. SUMO also facilitates the control of the stock (consumed and purchased supplies must be also registered).

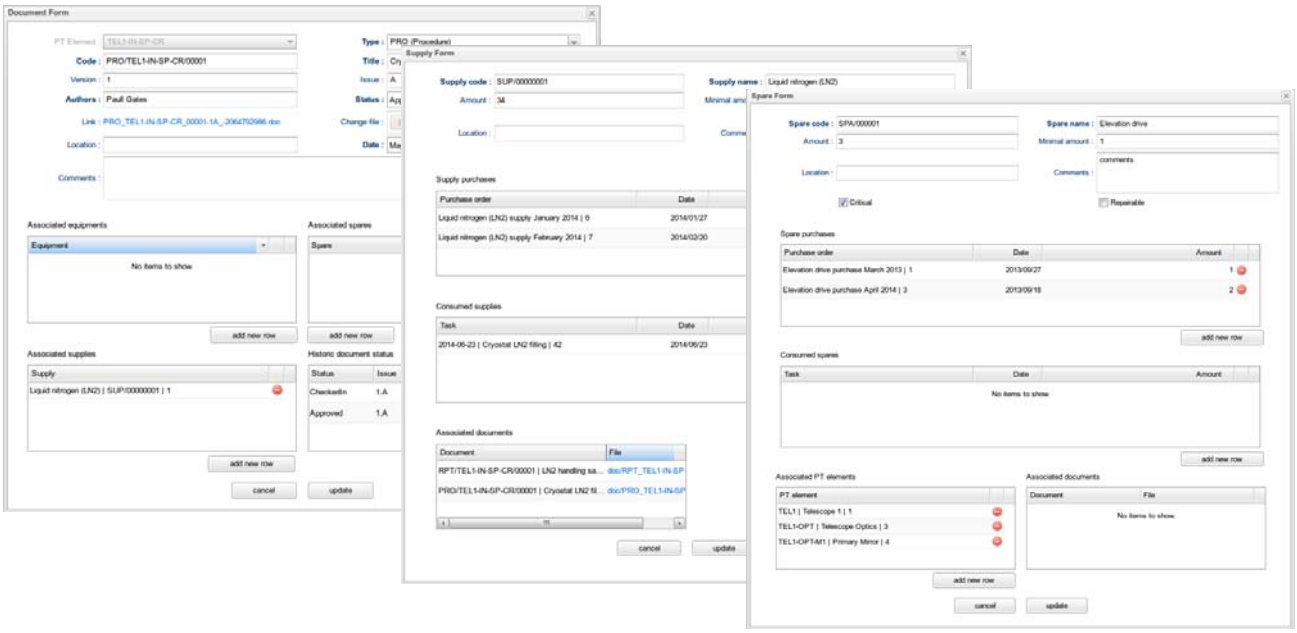

Fig. 6. Document form, supply form and spare form view

- Equipment

  The equipments needed to accomplish the operation and maintenance tasks must be also stored at the tool. As for the spares and supplies, SUMO facilitates assets control keeping all the information related with the acquisition of the components.

- Workshops

  The workshops that are available at each maintenance level and are required to carry out a certain task must be identified in order to allow SUMO checking work shop availability conflicts when generating schedules.

- External services

  Some tasks could be carried out by external services. SUMO allows tracking these contracts in order to ensure that they are available whenever required.

- Skills (operation and maintenance manpower profiles)

  Operation and maintenance profiles presents at the organization must be introduced at the tool. This allows defining at each task the profiles required to carry it out and, afterwards, to identify manpower conflicts at the schedule generation.

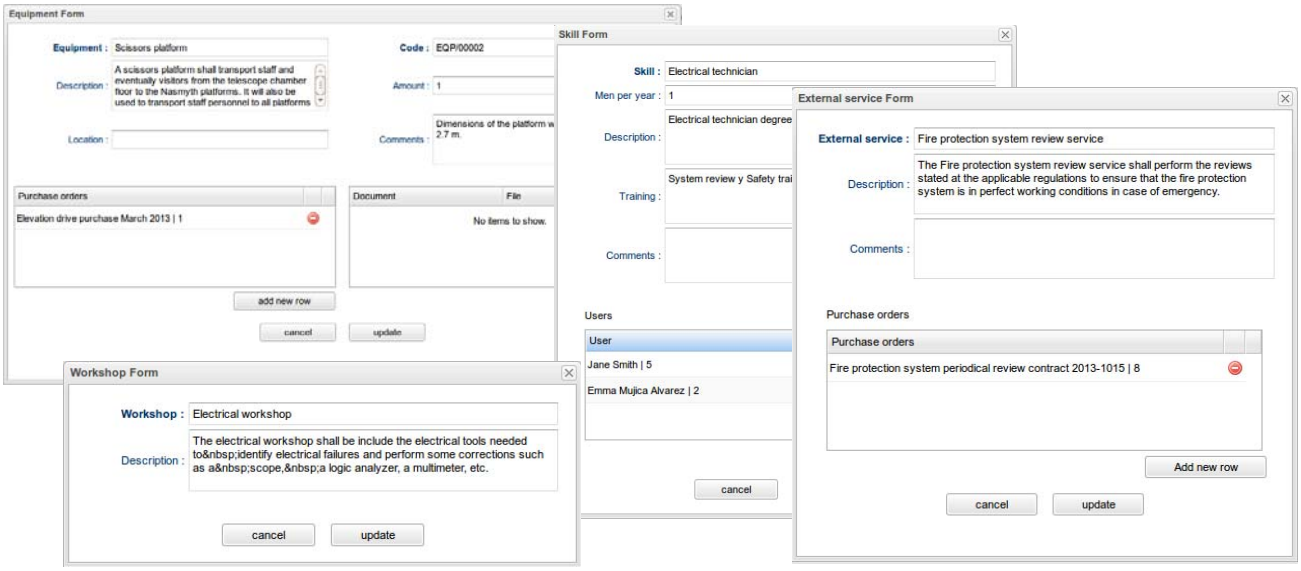

Fig. 7. Equipment form, external service form, skill and workshop form view

In addition, the purchase orders that are generated to acquire new assets shall be also registered. A purchase order must be generated each time that an item (spares, supplies, equipments or external services) is acquired or contracted in order to keep the purchase information for budget control.

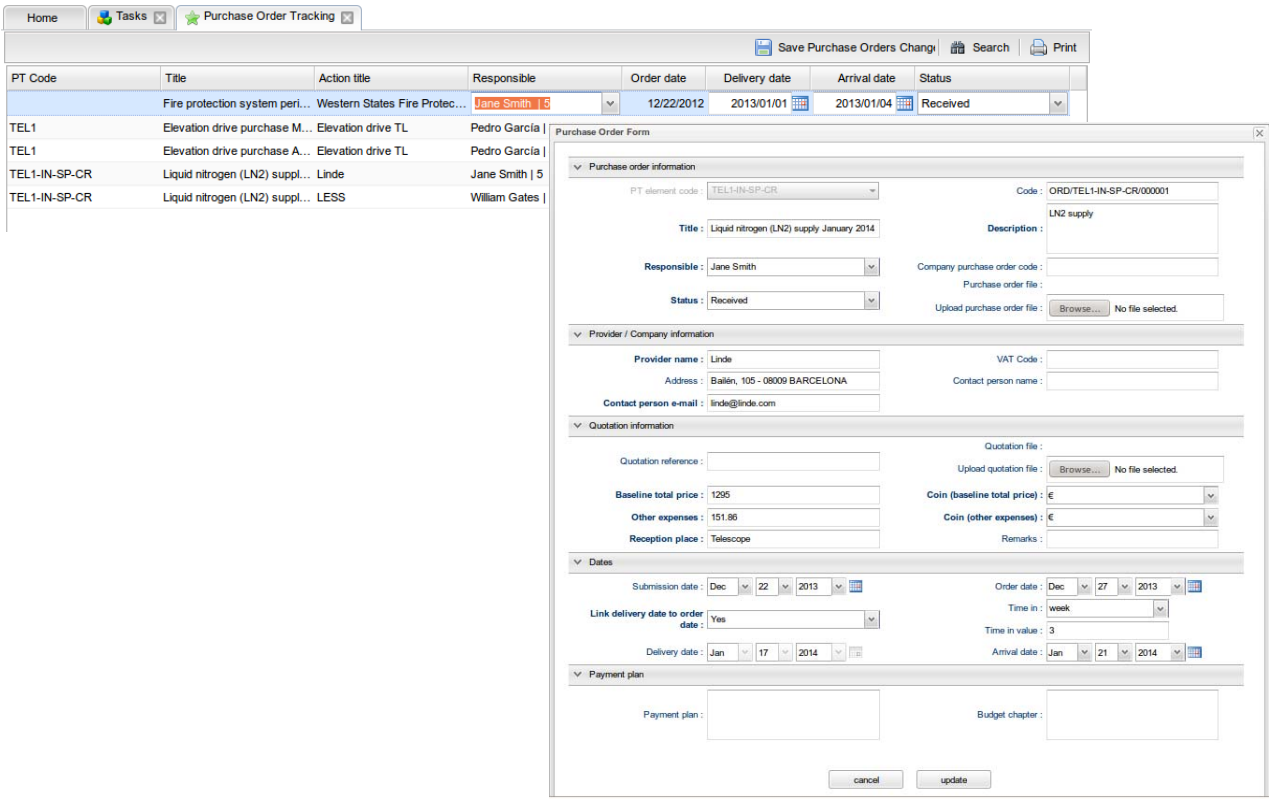

Fig. 8. Purchase order form and purchase order tracking view

3.4 Operation and maintenance scheduler

SUMO generates an operation and maintenance schedule for a given period of time taken into account all tasks that can be automatically programmed. The schedule generation includes several utilities as described in the following lines:

- The tool generates the schedule automatically, including the periodical tasks and the corresponding linked tasks. Periodical tasks shall be scheduled taken into account the latest programming dates.
- The tool allows to introduce non-periodical tasks manually (i.e., non-foreseen tasks as corrective ones)
- The schedule can be edited manually. The task execution date automatically suggested can be changed by hand.
- The tool provides the means to analyze that the generated schedule can be performed with the available resources. Warning are displayed to identify potential resource conflicts.

In the short term (i.e., in a weekly or daily basis), SUMO allows editing the schedule manually to assign all the details (responsible, task hours, etc.) to the scheduled tasks.

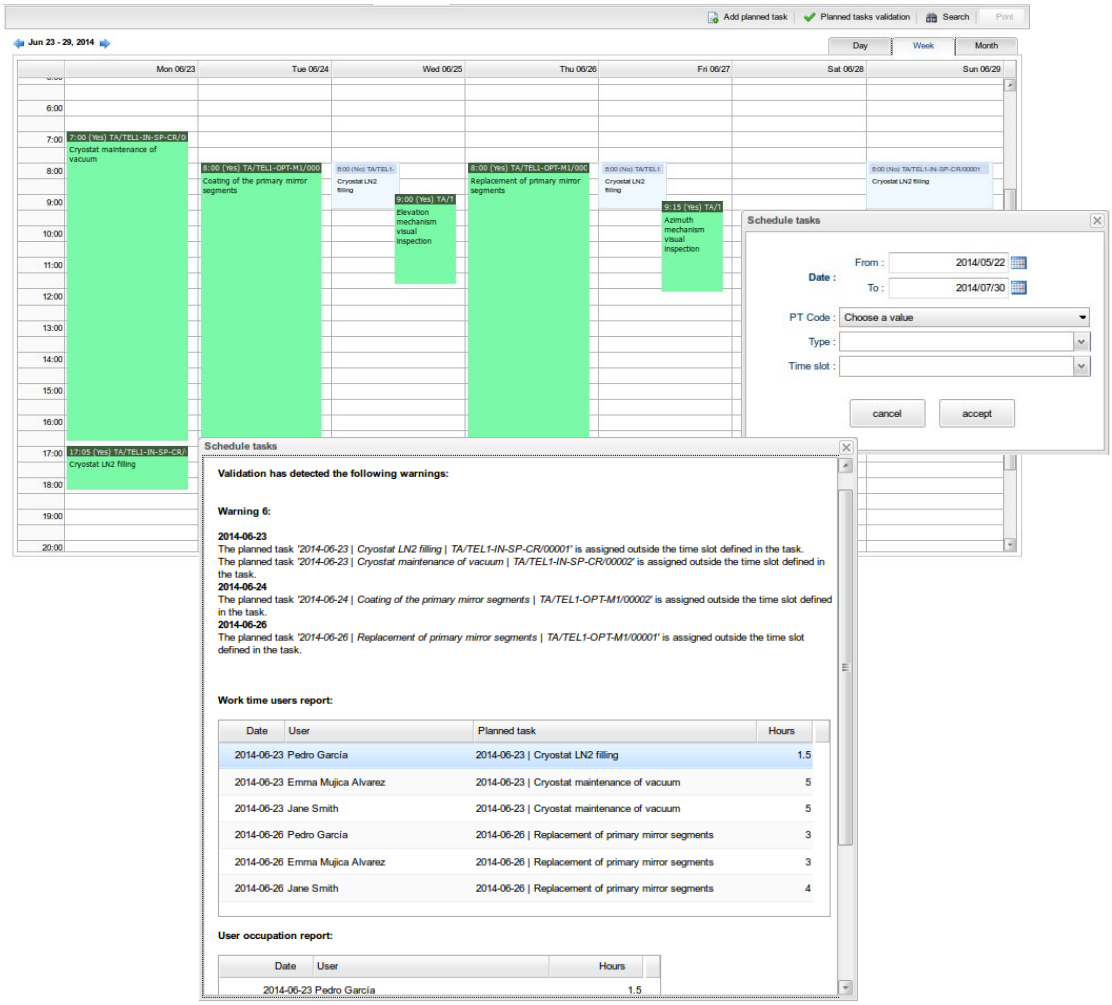

Fig. 9. Weekly schedule view and weekly validation report

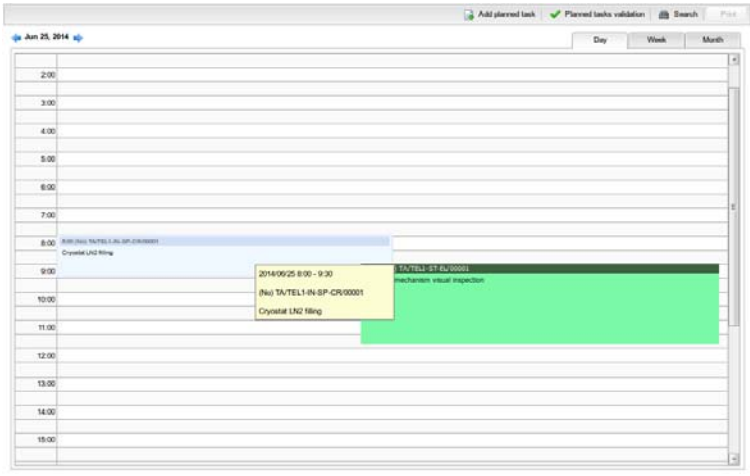

Fig. 10. Daily schedule view

3.5 SUMO users access rights

All persons that must have access to the tool must be registered as a user. User rights (according to the predefined user profiles) are granted to each user.

SUMO provides the following predefined profiles to be assigned to the users:

- *Viewer*

  Viewer users can visualize all the data but cannot modify/add/delete any data.

- *Doer*

  Doer users can visualize all the data; add/modify/delete documents, equipments, supplies; add and modify problems; and modify the tasks, planned tasks and spares.

- *System Engineer*

  System Engineer users have doer's permissions and besides can modify/add/delete the users, PT elements, tasks, planned tasks, spares, purchase orders, workshops, external services, skills, time slots and problems.

- *Scheduler*

  Scheduler users have all system engineer's permissions and in addition they can generate/modify the maintenance and operation plan.

- *Administrator*

  The administrator has all rights in the tool.

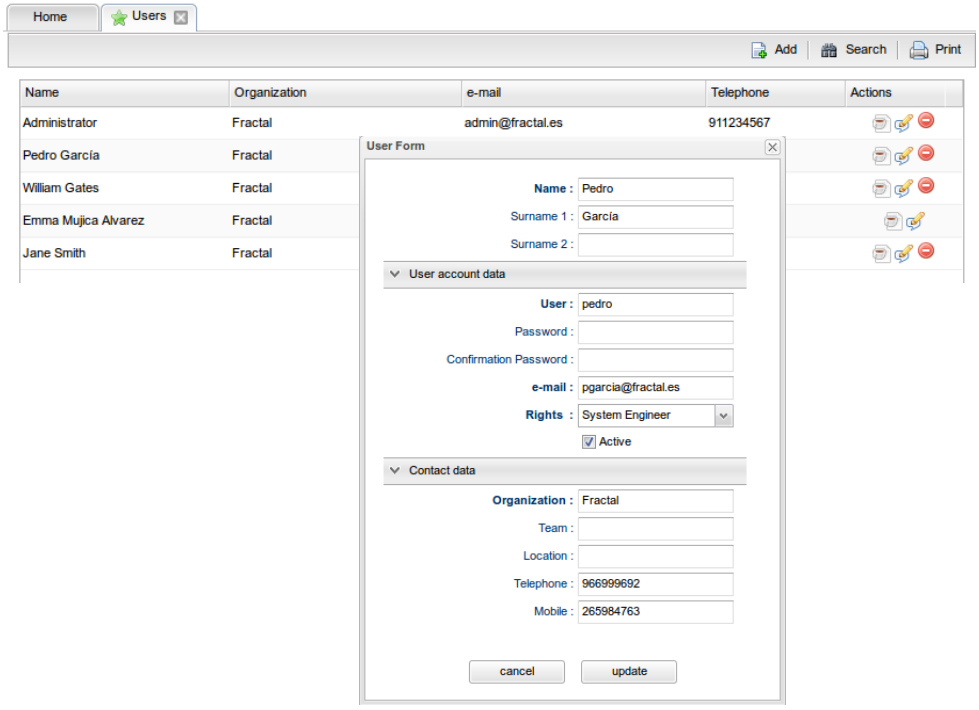

Fig. 11. User list and user form view

3.6 Additional features

To finalize SUMO functionality overview, just to mention that SUMO provides additional features to the ones described before:

- Notification manager

  Different warnings shall be sent if a non-desired situation arises (e.g. if the due date of a pending task is reached, if the spare stock has been consumed, etc.).

- Anomaly manager

  Any problem found during the operation and maintenance of the system can be reported through SUMO problems form, which will allow tracking the anomaly troubleshooting and program the actions to analyze it.

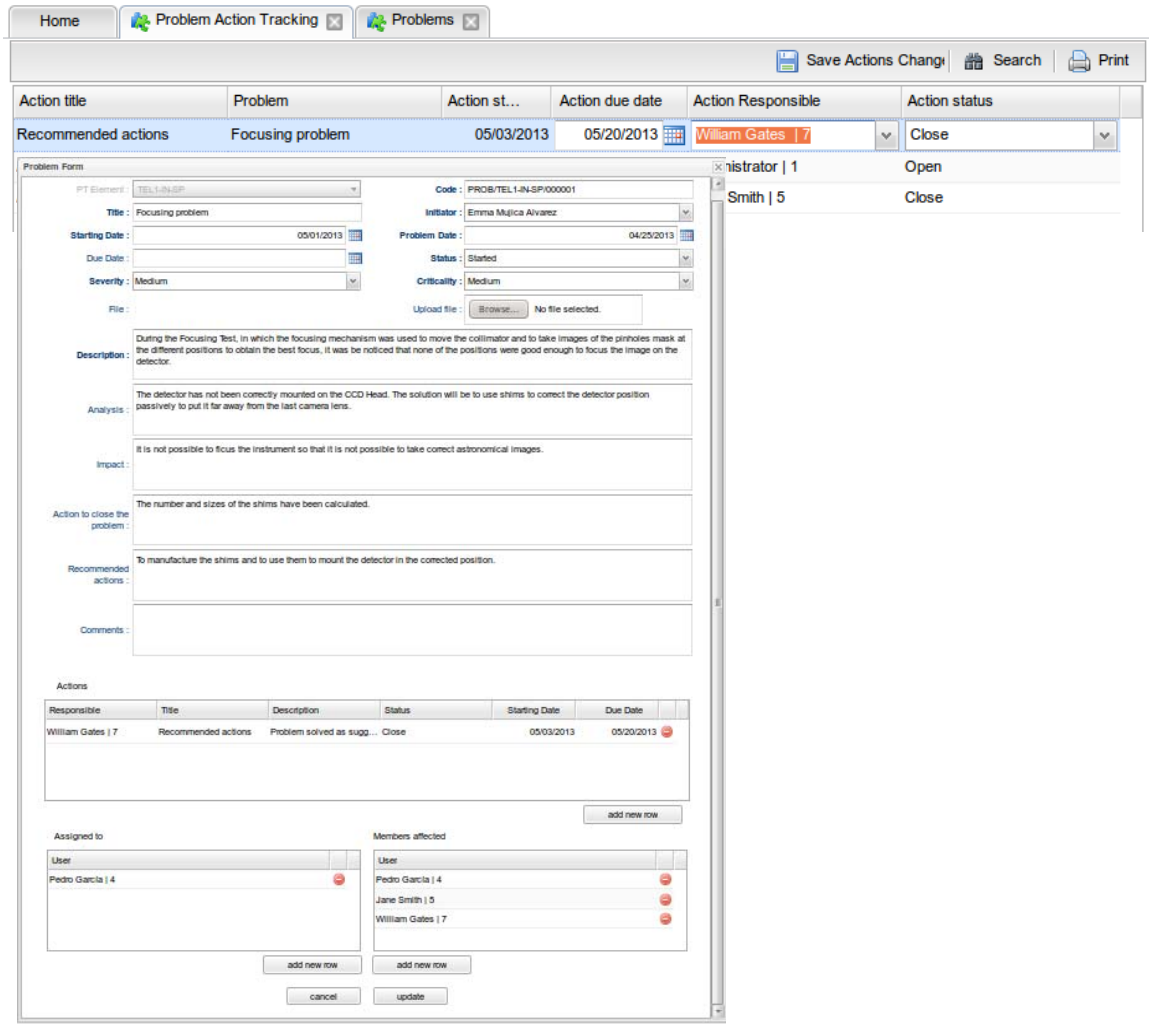

Fig. 12. Problem action tracking and problem form view

4. CONCLUSIONS

This paper describes SUMO, the Operation and Maintenance Management tool developed by FRACTAL to facilitate the management of the operation and maintenance tasks and resources and the tasks planning of a scientific facility during the operational phase.

SUMO is one of the four tools of the FRACTAL System & Project Suite, which is composed also by GECO (System Engineering Tool), DOCMA (Documentation Management Tool) and MANATEE (Project Management Tool). These tools are especially suited for those consortia and teams collaborating in a multi-discipline, complex project in a geographically distributed environment.

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