Organization, management and risk analysis of the MAORY project

Ciliegi, Paolo, Diolaiti, Emiliano, Bellazzini, Michele, Cortecchia, Fausto, Lombini, Matteo, et al.

Paolo Ciliegi, Emiliano Diolaiti, Michele Bellazzini, Fausto Cortecchia, Matteo Lombini, Renata Abicca, Simone Esposito, P. Feautrier, Eric Stadler, Enrico Giro, Roberto Ragazzoni, "Organization, management and risk analysis of the MAORY project," Proc. SPIE 10705, Modeling, Systems Engineering, and Project Management for Astronomy VIII, 107051S (10 July 2018); doi: 10.1117/12.2313138

SPIE.

Event: SPIE Astronomical Telescopes + Instrumentation, 2018, Austin, Texas, United States

Organization, management and risk analysis of the MAORY project

Paolo Ciliegi[*,a], Emiliano Diolaiti[a], Michele Bellazzini[a], Fausto Cortecchia[a] , Matteo Lombini[a], Renata Abicca[a], Simone Esposito[b], P. Feautrier[c], Eric Stadler[c], Enrico Giro[d], Roberto Ragazzoni[d]
[a] INAF – Osservatorio di Astrofisica e Scienza dello Spazio di Bologna, via Gobetti 93/3, 40129 Bologna, Italy
[b] INAF – Osservatorio Astrofisico di Arcetri, Largo Enrico Fermi 5, 50125 Firenze, Italy
[c] Institut de Planétologie et d'Astrophysic de Grenoble, 414 Rue de la Piscine, Domaine Universitaire, 38400 St-Martin d'Hères, France
[d] INAF Osservatorio Astronomico di Padova, Vicolo dell' Osservatorio 5, 35122 Padova, Italy

ABSTRACT

In this paper we present the structure, organization and risk management of the MAORY Consortium, an Italian-French collaboration for the design and construction of the adaptive optics module for the European Large Telescope.

1. INTRODUCTION

The Multi Conjugate Adaptive Optics RelaY[1] (MAORY) is the adaptive optics module for the European Extremely Large Telescope (ELT). MAORY is one of the ELT first light instruments approved for construction and it must provide, from the beginning of its operations, a multi-conjugate (MCAO) and a single conjugate compensation mode (SCAO).

In this paper we report an overview of the management activities of the MAORY project. We start with a description of the Consortium (an Italian (INAF) French (IPAG-Grenoble) collaboration) and then we describe the guidelines used to manage the project and its associated risks.

2. INSTRUMENT OVERVIEW

The main function of MAORY is to relay the light beam from the ELT focal plane to the client instrument while compensating the effects of the atmospheric turbulence and other disturbances affecting the wavefront from the scientific sources of interest.

MAORY has two operation modes.

- In MCAO mode, wavefront sensing is performed by up to six LGS and three NGS. The NGS are used for both Low-Order and Reference (LOR) sensing; wavefront compensation is performed by means of the telescope's M4/M5 mirrors and by post-focal deformable mirrors inside MAORY. The choices to implement the MCAO technique and to use LGS for wavefront sensing have been taken to improve the performance uniformity over the field of view and the sky coverage. The MCAO technique has already been demonstrated on sky by MAD on VLT and, together with multiple LGS, by GeMS on the Gemini Telescope.
- In SCAO mode, wavefront sensing is performed by a single NGS as close as possible to the direction of the scientific target in the sky; wavefront compensation is performed in this mode by means of the telescope's M4/M5 mirrors only. The SCAO mode is a joint development between the MAORY and the MICADO[2] consortia (see Clénet et al. [3]).

MAORY has to be installed on the ELT Nasmyth platform. It feeds two focal stations: the gravity invariant port underneath the MAORY bench for MICADO and the lateral port for another instrument yet undefined. The light from the telescope

[*] paolo.ciliegi@inaf.it

Modeling, Systems Engineering, and Project Management for Astronomy VIII
edited by George Z. Angeli, Philippe Dierickx, Proc. of SPIE Vol. 10705
107051S · © 2018 SPIE · CCC code: 0277-786X/18/$18

enters MAORY through the Main Path Optics (Lombini et al. [4]). Upon wavefront compensation by the Post-focal Deformable Mirrors (which complement the telescope's M4/M5), the light is split by a Beam-splitter, which is still part of the Main Path Optics.

The light of wavelength shorter than about 600 nm is propagated from the Beam-splitter through the LGS Path Optics and then to the LGS Wavefront Sensor sub-system (Schreiber et al. [5]). The LGS sub-system is in use only in the MCAO mode. The light of wavelength longer than about 600 nm is propagated from the Beam-splitter through the last segment of the Main Path Optics to the Exit Port, where the MAORY exit focal plane is made available to the scientific instrument, while the light of the required NGSs is picked off by the LOR Wavefront Sensor (Bonaglia et al. [6]) or by the SCAO Wavefront Sensor (Clenet et al. [3]) depending on the MAORY operation mode.

The wavefront measurements performed by the LGS and LOR Wavefront Sensors in the MCAO mode or by the SCAO Wavefront Sensor in the SCAO mode are collected by the MAORY Real Time Control System, which drives in closed loop the MAORY Post-focal Deformable Mirrors and the telescope's M4/M5.

All instrument operations are controlled by the MAORY Instrumentation Software (Salasnich et al. [7]), which also provides interfaces to the Telescope Control System and to the MICADO (or other) client instrument. A more detailed description of the technical characteristic and performance is available in Ciliegi et al. [1] and Cortecchia et al. [8].

3. MAORY CONSORTIUM ORGANIZATION

The MAORY Consortium is constitute by two Institutes : Istituto Nazionale di Astrofisica (INAF) in Italy and Institut de Planétologie et d'Astrophysique de Grenoble (IPAG) in France. The lead institute is INAF which provide the MAORY Principal Investigator (PI) and the MAORY Project Office (PO). Within INAF, 6 different local Observatories are actually (June 2018) involved in the MAORY project : Osservatorio di Astrofisica e Scienza dello Spazio (Bologna), Osservatorio Astroficico di Arcetri (Firenze), Osservatorioa Astronomico di Brera (Milano), Osservatorio Astronomico di Capodimonte (Napoli), Osservatorio Astronomico di Padova (Padova) and Osservatorio dell' Abruzzo (Teramo).

The management of the MAORY Consortium is organized as described in Figure 1.

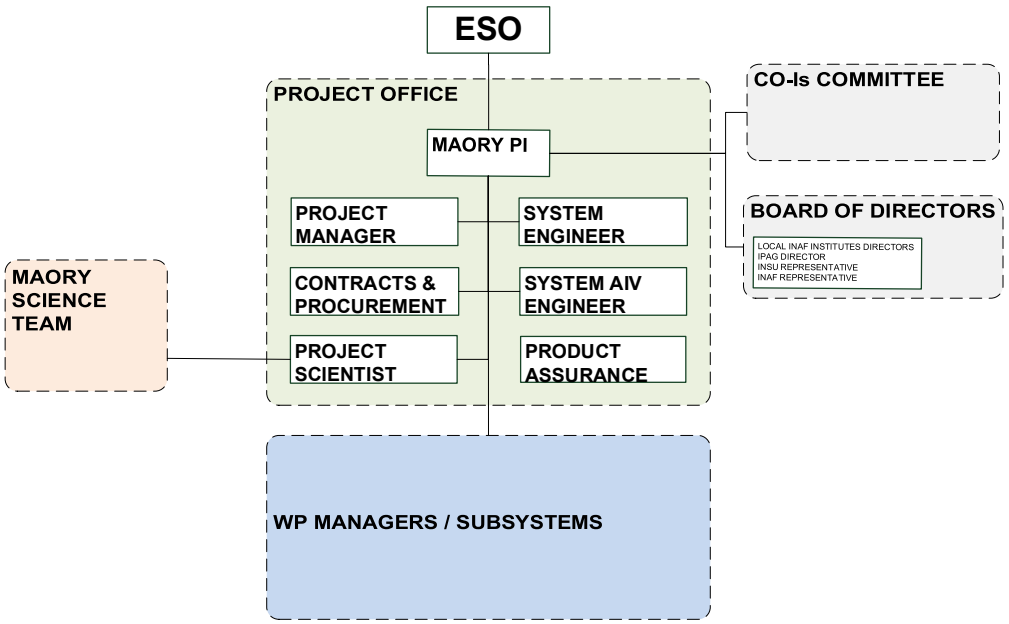

Figure 1 : MAORY management diagram

3.1 MAORY PROJECT OFFICE

The MAORY Project Office provides all the necessary functions to ensure the correct system development of the instrument at system and sub-system level with the exception of the sub-systems that have their own Local Project Offices (LPO). In the current plan, the sub-systems with a Local Project Office are the LGS WFS module and the LOR WFS module.

Member of the MAORY PO are the PI (chair), the Project Manager (PM), the System Engineer (SE), the System AIV Engineer, the responsible for contract and procurements the Project Scientist and the Product Assurance (PA) manager which, although within the PO, is not direct connect to the PI (see Figure 1) since the PA manager has an independent role within the team and has the right to act independently of the PM in the PA matters when necessary towards the PI and ESO.

3.2 CO-Is COMMITTEE

The Co-Is are individuals who, either personally or as representatives of major research teams involved in the project, can provide advice to the PI. They form a scientific and technical advisory Co-I Committee, chaired by the PI, which plays a fundamental role in the experiment definition of MAORY and in ensuring that MAORY meets its science objectives

3.3 BOARD OF DIRECTORS

The Board of Directors supports the PI for ensuring that adequate level of funding, manpower resources and infrastructures necessary to the MAORY Project are obtained

3.4 MAORY SCIENCE TEAM

The MAORY Science Team manages the Announcement of Opportunity for Guaranteed Time (GTO) related to MAORY, as defined in the MAORY Agreement for ELT and is actively involved in the definition of the scientific targets of interest. The Science Team operates to maximise the scientific exploitation and return of the ELT-MAORY-MICADO system.

4. PROJECT BREAK DOWN STRUCTURE

4.1 PRODUCT TREE

The MAORY Product Tree (PT) forms the basis of the MAORY Work Breakdown Structures (WBS) and demonstrates the current MAORY Project baseline as agreed between all the MAORY Consortium Partner. The MAORY PT is shown in Figure 2.

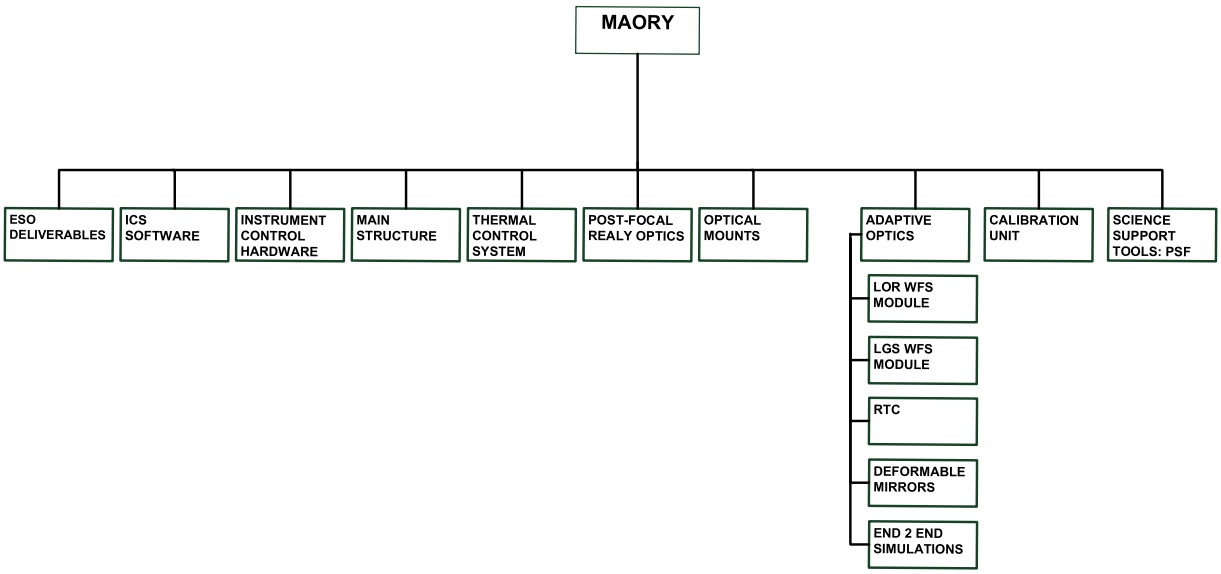

Figure 2 : MAORY Product Tree

4.2 WORK BREAKDOWN STRUCTURE

The MAORY Work Breakdown Structure (WBS) contains the structured breakdown of the whole project based on the analysis of the tasks required to achieve the products identified in the MAORY PT. Due the complexity of the project and the different necessities during the various phases, different WBS could be necessary passing from the preliminary design phase (Phase B) to the integration and commissioning on site (Phase E). The main purposes of the WBS are :

- To identify all the tasks necessary for the creation of the deliverable MAORY products.
- To define all the work packages (WP) necessary for MAORY project management.
- To establish the basis for the MAORY project schedule and cost planning and management.
- To identify all the interfaces and other relationships within the MAORY Project during the overall life cycle of the project.

The MAORY WBS for the Phase B is reported in Figure 3. A WP manager is associated at each WP. If necessary, WP Managers will complete their own WBS to a lower level than that shown in the MAORY Project WBS to ensure the criteria listed above are fulfilled within their own project

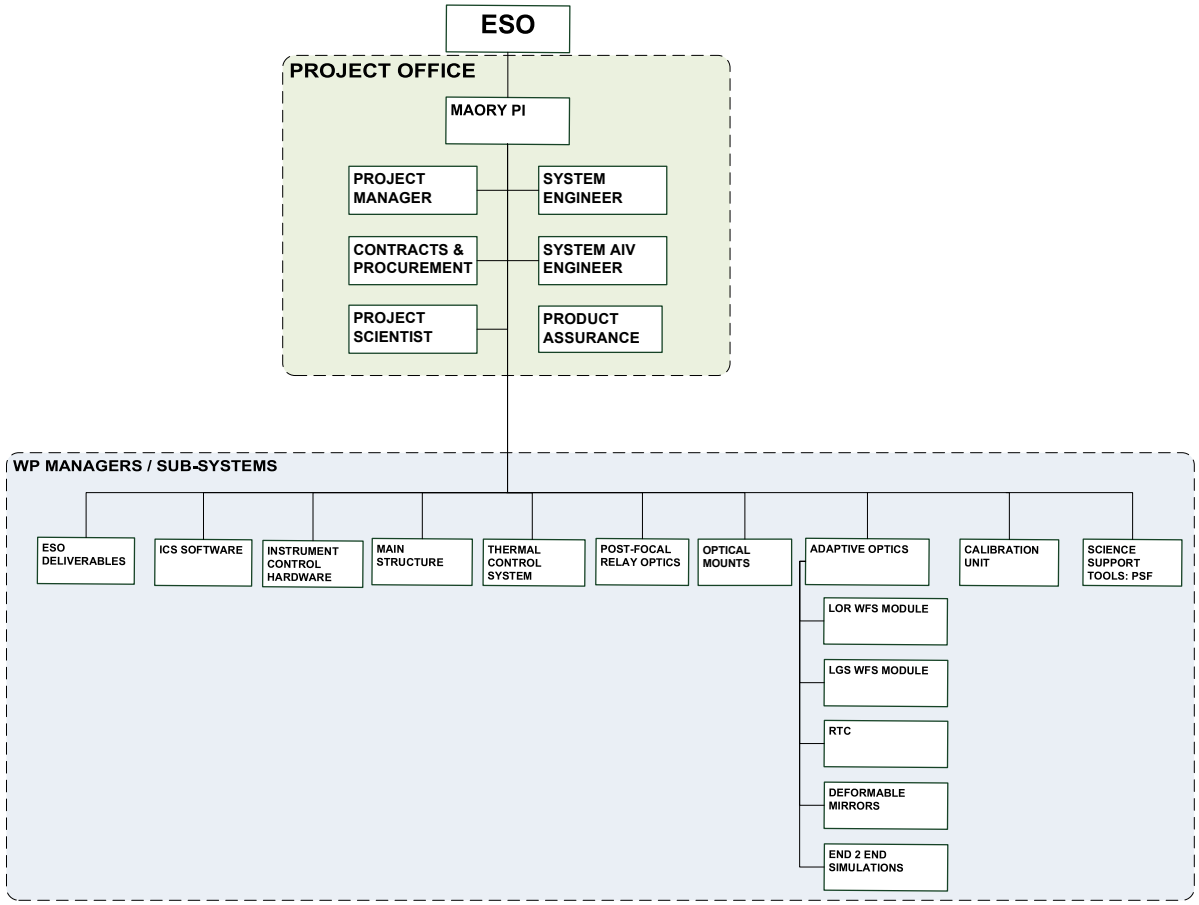

Figure 3 : Phase B MAORY WBS

The WP managers have local responsibility for the activities within a particular WP. They report to the PM and PI. In particular, the WP managers are expected to collaborate with the MAORY PM to maintain a detailed schedule of activities with clear links to the overall integrated master schedule. They collaborate with the MAORY PM and System Engineer to ensure compliance with the risk management plan, identifying and tracking risks relevant to the WP scope.

The WP managers work with the System Engineer and the System AIV Engineer to ensure technical compliance of the work package deliverables by agreeing requirements, interface control documents, technical performance budgets, AIV plans and execution of the verification tests.

5. COMMUNICATION

The scope of the communication within and externally to MAORY is to ensure a clear and unambiguous working environment for the development of MAORY. Day to day contact and meetings between small MAORY consortium member groups are needed for specific arguments, while general meetings are organized in order to provide an overview of the project to the whole consortium and to plan the activities. Short (~ 1hr) briefing meeting with the relevant people of all WP are organized every Monday morning, while general Consortium meetings (2-3 days) are organized every 2-3 months. The communication and relationship with ESO are assured through regular teleconference every two weeks, by progress meeting every 4-5 months and by dedicated teleconference or face to face meetings whenever needed.

6. PRODUCT ASSURANCE AND CONFIGURATION MANAGEMENT

A system for product assurance, configuration management and control is established and implemented within the MAORY Project. All the requirements and procedures are described in internal documents (MAORY Product Assurance Plan and MAORY Configuration Management Plan) that shall be observed by all personnel involved in the project. A detailed description of these procedure is beyond the scope of this paper.

7. RISK ANALYSIS

The objective of risk management is to identify and assess the entire spectrum of risks, classify undesired events for their severity and likelihood of occurrence and perform trade-offs among different options for mitigating the risks in order to optimize the final project outcome, in terms of schedule, cost and performance

Risks identified and assessed during the project life-cycle are reported in the Risk Analysis document, which contains the Risk Register (RR). The RR is the basis for communicating the identified and assessed risks, as well as the subsequent follow-up actions and their results. The RR is a list of all of the identified risks (at all MAORY level), their root cause, categories and responses. Because the assessment of the risk is an ongoing activity, the register is updated continuously throughout the life of MAORY project.

Although the MAORY Project Manager acts as the final integrator of the risk management documentation, the risk management is implemented as a team effort, with tasks and responsibilities being assigned to the functions and individuals within the project organization with the most relevant expertise in the areas concerned by a given risk. It is a collaborative effort of all project actors from the different disciplines, who shall be encouraged to identify risks in an iterative process throughout the project duration, as new risks may become known as the project progresses.

In general individual risk items domains are:

- **Technical**: technology maturity (e.g. TRL); definition status of requirements, system-subsystem ICD, MAORY/MICADO ICD, MAIT operations; availability of margins, project team; etc.
- **Cost**: overall project cost definition status; cost margins; insurance costs; availability of funding, independent cost assessment, industrial offers; human resources aspects; etc.
- **Schedule**: procurement planning; availability of planning of phases and activities interfacing with third parties; etc.
- **Other**: internal organizational aspects; public image; political constraints; risk sharing between actors; etc.

7.1 RISK SCORING SCHEMES

The scoring schemes for the severity of consequences and likelihood of occurrence for the relevant tradable resources are shown in Table 1 and Table 2

Score	Severity	Severity of consequence
4	Critical	Unacceptable performance. Project delay > 6 months . Critical project cost increase.
3	Major	Performance requirement(s) not met. Project delay 3-6 months. Major project cost increase.
2	Significant	Performance degradation. Project delay < 3 months. Significant project cost increase.
1	Negligible	Minimal or no impact.

Table 1. Severity of consequence scoring scheme.

Score	Likelihood	Likelihood of occurrence
E	Maximum	> 80%
D	High	60% - 80%
C	Medium	30% - 60%
B	Low	10% - 30%
A	Minimum	< 10%

Table 2. Likelihood scoring scheme.

7.2 RISK INDEX SCHEME

The risk index scheme shown in Table 3 denotes the magnitudes of the risks of a given risk scenario.

A risk scenario is a sequence or combination of events leading from the initial cause to the unwanted consequence (the cause can be a single event or something activating a dormant problem).

Risk magnitude for a given risk scenario is defined on the basis of the combination of the severity of consequence and likelihood of occurrence, according to the scale defined in section 7.1.

Likelihood				
E	Medium	High	High	High
D	Low	Medium	High	High
C	Low	Low	Medium	High
B	Very Low	Low	Medium	High
A	Very Low	Low	Medium	High
	1	2	3	4 Severity

Table 3. Risk index and magnitude scheme.

7.3 ACTION CRITERIA

The criteria to determine the actions to be taken on risks of various risk magnitudes and the associated risk decision levels in the project structure are shown in Table 4. Criteria for individual risk acceptance are also defined.

Risk index	Magnitude	Proposed actions
E2, E3, E4, D3, D4, C4, B4, A4	High risk	Unacceptable risk: Actions to reduce the likelihood and seriousness mandatory. Consider alternative process or change of baseline – seek project management attention at appropriate high management level. Identify appropriate actions to implement.
D2, C3, B3, A3	Medium risk	Actions to reduce the likelihood and seriousness to be identified and costed for possible action if funding permit. Consider alternative process or change of baseline.
D1, C1, C2, B2, A2	Low risk	Acceptable risk: Control, monitor – seek responsible work package management attention. No further action is needed unless magnitude rank increases over time.
B1, A1	Very Low risk	Acceptable risk: No action is needed unless magnitude rank increases over time.

Table 4. Risk magnitude designations and proposed actions for individual risks.

REFERENCE

[1] Ciliegi, P., *et al*. "MAORY for ELT: preliminary design overview," Proc. SPIE 10703 (2018)
[2] Clénet, Y., *et al*. "MICADO-MAORY SCAO: towards the preliminary design review," Proc. SPIE 10703 (2018)
[3] Davies, R., *et al*. "The MICADO first light imager for ELT: overview and operation," Proc. SPIE 10702 (2018)
[4] Lombini, M., *et al.* "Optical design of the post focal relay of MAORY," Proc. SPIE 10690-51 (2018)
[5] Schreiber, L., *et al.* "The MAORY laser guide star wavefront sensor: design status," Proc. SPIE 10703 (2018)
[6] Bonaglia, M., *et al.* "Design status of the LOR Module subsystem of MAORY," Proc. SPIE 10703 (2018)
[7] Salasnich, B., *et al.* "The MAORY ICS software architecture," Proc. SPIE 10707 (2018)
[8] Cortecchia, F., *et al.* "MAORY requirements flow down and technical budgets, " Proc. SPIE 10703 (2018)