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The High-Level Interface Definitions in the ASTRI/CTA Mini Array Software System (MASS)

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Abstract. ASTRI (Astrofisica con Specchi a Tecnologia Replicante Italiana) is a Flagship Project funded by the Italian Ministry of Education, University and Research, and led by INAF, the Italian National Institute of Astrophysics. Within this framework, INAF is currently developing an end-to-end prototype, named ASTRI SST-2M, of a Small Size Dual-Mirror Telescope for the Cherenkov Telescope Array, CTA. A second goal of the project is the realization of the ASTRI/CTA mini-array, which will be composed of seven SST-2M telescopes placed at the CTA Southern Site. The ASTRI Mini Array Software System (MASS) is designed to support the ASTRI/CTA mini-array operations. MASS is being built on top of the ALMA Common Software (ACS) framework, which provides support for the implementation of distributed data acquisition and control systems, and functionality for log and alarm management, message driven communication and hardware devices management. The first version of the MASS system, which will comply with the CTA requirements and guidelines, will be tested on the ASTRI SST-2M prototype. In this contribution we present the interface definitions of the MASS high level components in charge of the ASTRI SST-2M observation scheduling, telescope control and monitoring, and data taking. Particular emphasis is given to their potential reuse for the ASTRI/CTA mini-array.

1. Introduction

ASTRI is a flagship project of the Italian Ministry of Education, University and Research, which aims to develop an end-to-end prototype of one of the three types of telescopes to be part of the Cherenkov Telescope Array (CTA), an observatory which will be the main representative of the next generation of Imaging Atmospheric Cherenkov Telescopes (Acharya et al. 2013)(Actis et al. 2011). The ASTRI project, led by the Italian National Institute of Astrophysics (INAF), has proposed an original design for the Small Size Telescope (Pareschi et al. 2013) whose prototype, named ASTRI SST-2M, is currently under installation at the INAF observing station located at Serra La Nave in Italy (Maccarone et al. 2013). A second goal of the ASTRI project is the implementation of the ASTRI/CTA mini-array (Pareschi et al. 2014) composed of seven SST-2M telescopes to be located at final CTA Southern site. In the framework of the ASTRI project, the Mini-Array Software System (MASS) is under development to support the telescopes in various operations, from the movement, monitoring and control to the preparation and activation of the observational scheduler, to the data acquisition till the on-line and off-line data analysis and archiving. The design of the MASS system (Tosti et al. 2014) has been defined to comply with the CTA requirements and it will be firstly tested with the ASTRI SST-2M prototype. The design and the implementation of the MASS system involve heterogeneous developer teams (in terms of distance, education and working domain) therefore it is crucial to agree to a contract that spells out how its own software interacts. Each group should be able to write its code with minimal knowledge of the internals of another group's code. Interfaces are such contracts. Our goal is to support the interaction among developer teams to define the interfaces in order to exploit the maximum components capabilities and to satisfy the ASTRI MASS requirements.

2. ASTRI MASS high-level components

The ASTRI MASS architecture has three levels of abstraction for the software design (Figure 1). The hardware level refers to the inner or proprietary software for each device; it is interfaced to the high-level components software through the industrial standard Process Control Unified Architecture (OPC-UA 2014). The application level is implemented by components that comply with the MASS software requirements. The user level does not consider components but only the Graphical User Interfaces (GUI). The high-level component interfaces presented in this paper are highlighted in Figure 1. They provide the interface to the user GUI and allow the interaction among the high-level components. The application level is built on the ALMA Common Software (ACS)(Chiozzi et al. 2006) framework which has been adopted as the standard middleware for the development of the CTA array control and data acquisition (CTA-ACTL)(Fussling et al. 2014). ACS implements the distributed architecture through the Container-Component model in which Containers provide the support for basic services like centralized logging and alarm, configuration database, persistence and security. The analysis of the ASTRI user requirements and ASTRI SST-2M Prototype operational procedures led to the identification of the main packages and their ACS components for the application level shown in Figure 2. The Environment package is devoted to retrieving the current state of the environment in which the telescope is operated, e.g., ICT infrastructure, sky or weather conditions. The Observatory Control System (OCS) package provides the proposal and archive data management. The Telescope Control Software package role is to control the telescope and its subsystems.

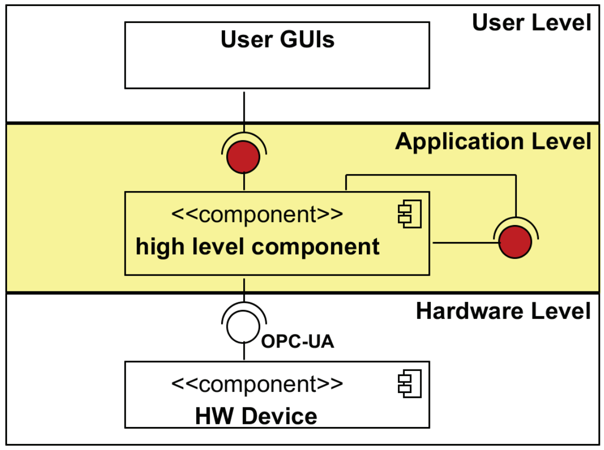

Figure 1. ASTRI MASS Architecture

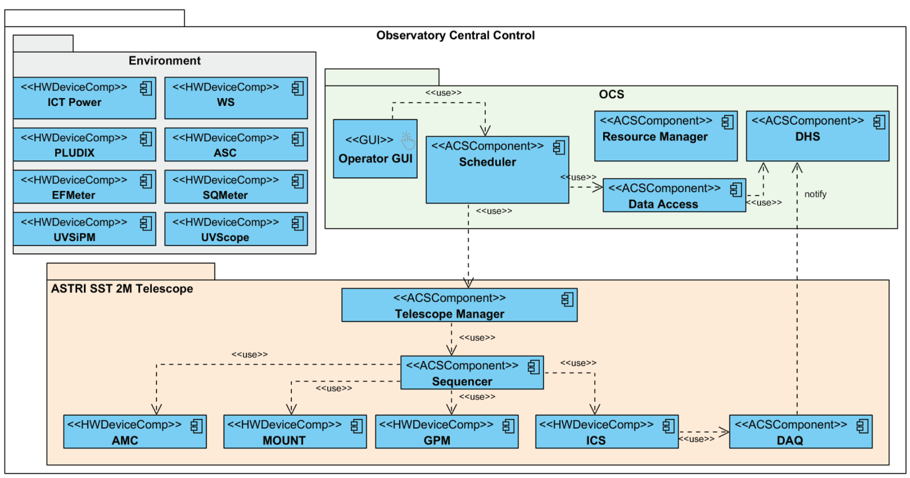

Figure 2. UML High Level Component Diagram

3. High Level components interface definition

ACS enables components to interact through remote synchronous and asynchronous calls. It also provides a publish/subscribe mechanism to implement event-driven programming. ACS interfaces are defined through the CORBA Interface Definition Language (IDL). We adopted the Unified Modeling Language (UML) class diagram in order to detail the interfaces of the ACS components identified for each package of Figure 2. For each class, we have identified the attributes (parameter data types) and the operations that are needed for the implementation of the required functionality. In addition, by inclusion or inheritance from ACS classes, each class exploits the ACS basic services mentioned above. The environment package components support access to the hardware device data. The OCS package in the ASTRI SST-2M prototype context implements the set of interfaces required to operate a single telescope. This interface definition for a single telescope can be easily extended to the ASTRI/CTA mini-array context. Indeed, the case of different telescopes could be shown by a similar component diagram, including one telescope package for each telescope type. The proposed design should facilitate the definition of a common interface even in the presence of different telescope types, thus simplifying the implementation of the OCS package. By using the Visual Paradigm UML modeling tool (VP (2014)), we performed two functional analysis steps: a) the impact analysis, which exploits the matrix diagram showing the relationships between component and class elements; and b) the verification of the classes representing the interfaces respect to the use cases identified in the requirement analysis (supported by the sequence and activity diagrams).

4. Conclusions

We presented the workflow applied to the ASTRI SST-2M prototype in order to identify the high-level component interfaces. The same approach is currently foreseen for the ASTRI/CTA mini-array and, eventually, it could be applied to the CTA at large.

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