A Reference Architecture Specification of a Generic Telescope Control System

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ABSTRACT

A Telescope Control System (TCS) is a software responsible of controlling the hardware that an astronomical observation needs. The automation and sophistication of these observations has produced complex systems. Currently, a TCS is compounded by software components that interact with several users and even with other systems and instruments.

Each observatory has successfully developed a wide spectrum of TCS solutions for their telescopes. Regardless the mount, there are common patterns in the software components that all these telescopes use. As almost every telescope is custom designed, these patterns are reimplemented again and again for each telescope. This is indeed an opportunity of reuse and collaboration.

The Generic Telescope Control System (gTCS) pretends to be a base distributed framework for the development and deployment of the TCS of any telescope, independent of its physical structure, the type of mount and instrumentation that they use. This work presents an architecture specification explained through two complementary approaches: the layers perspective and the deployment perspective. The first approach defines a set of layers, one on the top of the other, offering different levels of abstraction. Meanwhile the deployment perspective intends to illustrate how the system could be deployed, focused on the distributed nature of the devices.

The Generic TCS Problem

Overview

Control systems have two basic entry points: the user and the device. In a TCS domain, users and devices are heterogeneous: users with various levels of expertise, and devices with different protocols and access levels. Therefore, to understand the problem we must identify the diverse nature of users and devices.

The Devices

The devices of a telescope are diverse. Only in the axis control domain each telescope mount/technology has different high-level domains, but including the specific details of the telescope.

The Maintenance

The low-level variables of the telescope, with a detailed control of all the devices and software states, can be a mixture of specific logos with general information of the observation.

The problem is that several users could use more than one profile. Then, building an application for each profile is not the most desired approach. Therefore, the existing TCSs often build very complex user interfaces that have all the information that the user may need. This turns the application unmanageable for inexperienced users. Fortunately, defining these profiles helps to identify which is the scope of the TCS and select the features that the system will need in a user-independent fashion.

Devices Scope

The devices of a telescope are diverse. Only in the axis control domain each telescope mount/technology has different devices with different protocols and configurations. Even if two telescopes have the same hardware, the firmware or other vendor software could vary. If we add the situation when control, actuate optics and meteorological statistics, the set of devices turns unmanageable. Therefore, defining the possible set of devices is not a practical approach.

A strict approach is to group the devices into instruments that do a specific task. In an observatory there are two general types of hardware devices:

- Technical Instruments: All instrument that does not directly produce scientific data, such as the telescope, a meteorology-station, the active optics, an autoguiding CCD, etc.

- Scientific Instruments: All instrument that produces scientific data that the astronomer will use, such as the main CCD, a spectrograph, an interferometer, filter wheels, etc.

The scope of a TCS is limited to technical instruments and their devices. Also, a TCS must provide all the interfaces to connect the software in charge of managing the scientific instruments.

Reference technologies

The Control System for an Amateur Telescope [1] project, a TCS constructed over ALMA Common Software (ACS) [2][3] was used as an initial approach to the problem and reference architecture. To exemplify the proposed reference, existing technologies that are implementing some aspects of the proposal are analyzed.

ALMA Common Software

If we consider the Container/Component [4] model present on ACS, each composite device can be managed by an ACS Characteristic component. Through the use of states, exceptions and a container lifecycle we are able to manage the lifecycle of the whole gTCS. Currently ACS uses CORBA, which is a basis for communication. The information service can be obtained through the Manager (responsible for the management of containers, components and clients) and the information provided by the Interface Repository (IR) and the Configuration Database (CDB).

Acknowledgements

This work was supported by ALMA-CONICYT Fund project 13100008 “Software Development for ALMA: Building Up Expertise to Meet ALMA Software Requirements within a Chilean University”, under development at Universidad Técnica Federico Santa María.

References


Atacama Large Millimeter Array