TCU: high-level control software of LST

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cherenkov telescope array

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Introduction and overview

The Large-Sized Telescope (LST) is one of the three main types of telescopes populating the CTA Southern and Northern sites. There will be four LST on each site. Each LST telescope has a 23-meters parabolic segmented mirror and is sensitive to γ-rays from 20 to 150 GeV. The LST camera is comprised of 1855 vacuum photomultipliers-pixels resulting in raw data flow of about 24 Gbps during observations, when the LST camera is triggering at about 7 kHz. The prototype of Large-Sized Telescope LST-1 is located at CTA Nothern site on La Palma and is in commissioning since late 2018.

CTA telescope control

The CTA control software is either directly based on the ALMA Common Software (ACS) framework or is interacting with the components running within the ACS. Array Control and Data Acquisition System (ACADA) defines an interface (API) for all telescopes. This API allows any CTA telescope to be automatically compliant with the requirements imposed by CTA use cases. CTA controls the telescopes via the Telescope Manager, which implements CTA state machine and orchestrates Structure and Camera Managers, which connect to actual telescope subsystems.

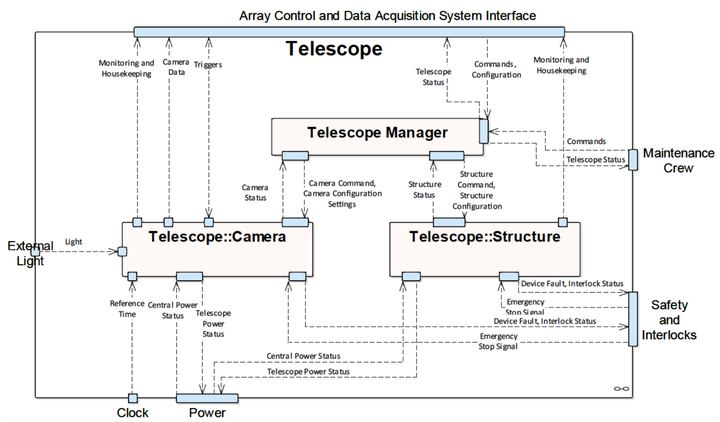

Fig. 1: CTA telescope control software diagram (ACADA telescope control ICD).

Telescope Control Unit (TCU)

Telescope Control Unit (TCU) is a high level control software of LST-1 telescope, which consists of Telescope Manager, Structure and Camera. TCU connects to all telescope subsystems, including camera, drive, active mirror control, etc, and implements their control logic based on the procedures developed by the teams. TCU also includes basic troubleshooting capabilities by constantly monitoring all the relevant telescope subsystems. The TCU software is extensively used by the LST-1 operators to control the telescope during calibrations, maintenance and normal observations.

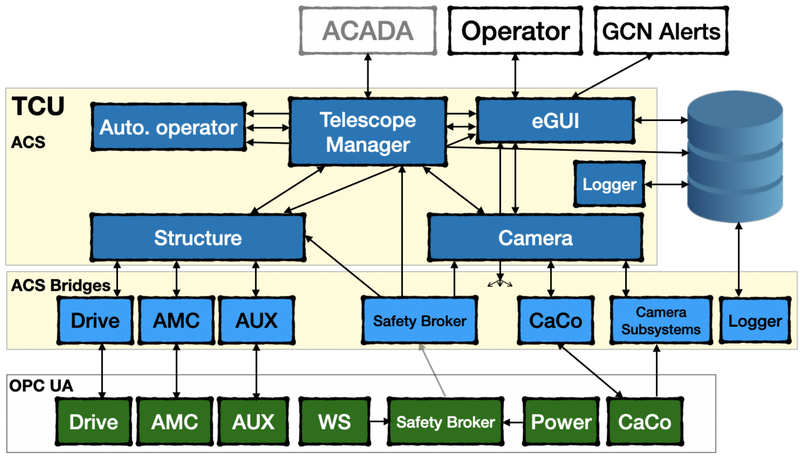

Fig. 2: LST control software diagram. TCU consists of Telescope Manager, Structure and Camera. TCU is built using ACS.

While CTA central control (ACADA) is not available, the automatic operator (Scheduler) software was developed to perform observations in fully automatic and robotic mode. Telescope operators in advance create a list of actions (telescope movement, sky object tracking, parking, unparking, etc) and the software takes care of proper timing and sequencing of such tasks.

Engineering GUI (eGUI)

To facilitate operations and enhance overall usability of the telescope for operators the engineering web-based GUI (eGUI) was developed. eGUI is based on Python Pyramid framework.

All communication is done in asynchronous mode using websockets. Server notifies clients about the updated data points. eGUI incorporates all currently available telescope hardware subsystems, TCU components and automatic operator software. Operators can control the telescope through high level commands to TCU or, in case of maintenance, control each subsystem independently.

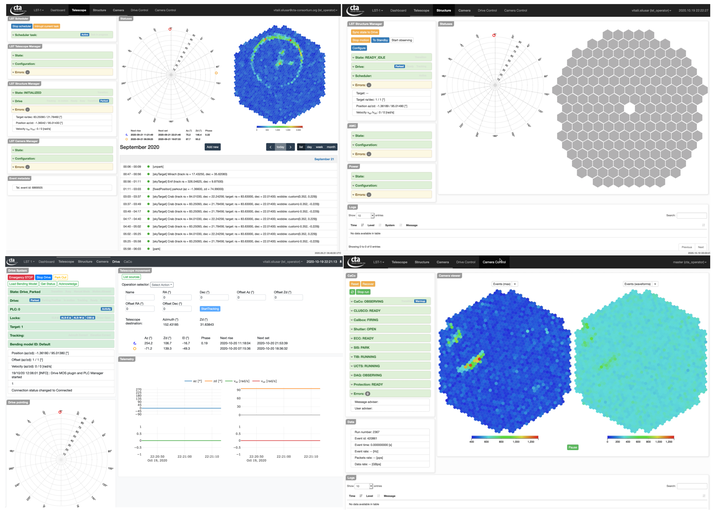

Fig. 3: LST engineering web-based GUI (eGUI). Telescope Manager and automatic operator (top left), LST structure (top right), drive (bottom left), camera control (bottom right).

eGUI includes raw data events viewer, which allows operators to see in real-time extensive air shower events as they are observed by the camera. The data for such viewer is obtained directly from the telescope data acquisition system (DAQ) Zfitswriter software via ZeroMQ protocol.

Conclusions

The LST control software is capable of controlling the telescope in fully automatic and robotic mode. TCU executes all the control procedures, while operators can follow and supervise the operations using the engineering web-based GUI. eGUI can also be used for maintenance, when control of individual telescope subsystems is required.