
Control Software for the VERITAS Čerenkov Telescope System

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Abstract

The VERITAS collaboration is developing a system of initially 4 and eventually 7 Čerenkov Telescopes of the 12 m diameter class for high sensitivity gamma-ray astronomy in the >50 GeV energy range. In this contribution we describe the software that controls and monitors the various VERITAS sub-systems. The software uses an object-oriented approach to cope with the complexities that arise from using sub-groups of the 7 VERITAS telescopes to observe several sources at the same time. Inter-process communication is based on the CORBA Object Request Broker protocol and watch-dog processes monitor the sub-system performance.

1. Introduction

Systems of Imaging Atmospheric Čerenkov Telescopes have emerged as the technique of choice to detect gamma rays in the energy region from 50 GeV to 50 TeV. The images of air showers taken with fast cameras made of typically 500 Photo-Multiplier Tubes (PMTs) within a couple of nano-seconds allow one to determine the direction and energy of individual GeV photons to an accuracy of 6 arcmin and 10%, respectively, and to achieve a high 100 GeV sensitivity of $\simeq 5$ milli-Crab (4 VERITAS telescopes, 50 hrs on-source).

The operation of the experiments requires the following major software tasks: (i) control of the various hardware components, (ii) readout of the digitized data, (iii) archiving of data and housekeeping information, and (iv) data reduction. In this paper we describe the implementation of the first of these tasks for the VERITAS Čerenkov telescope system. A certain complexity of this task arises from the large number of sub-systems that are involved in the operation of the telescopes (Table 1). The VERITAS telescope system is described by Wakely et al., in these proceedings. Other aspects of the telescope software are given in the contributions by Cui et al., Kosack et al., and Fegan and et al.

Table 1. List of VERITAS sub-systems.

| Name | Function |
|----------------------------|---|
| Telescope Positioner | Tracks celestial sources with sub-groups of telescopes. |
| Central Trigger | Fires on coincident telescopes triggers. |
| Data Harvester | Collects data from all telescopes and builds events. |
| Central Calibration | Sends calibration laser pulses to telescopes. |
| Atmospheric Monitors | Various systems to monitor the atmosphere. |
| Data Base/Archive | Archive housekeeping, science and calibration data. |
| Telescope Data Acquisition | Collects data at individual telescopes. |
| VME Readout | Reads out flash-digitized data. |
| Charge Injection | Calibrates readout electronics and pattern trigger. |

2. The Central Control Software

The VERITAS software is hierarchically structured as shown in Fig. 1.. The user controls the experiment via the program “Array Control”. This program controls a number of “global” tasks that are unique to the experiment including the central trigger system, a central calibration system, the data harvester program, the telescope positioner system, and atmospheric monitoring systems. Furthermore, it controls the so-called “Telescope Control” programs that run on computers located at each telescope (telescopes are located at a next-neighbor distance of ~ 100 m).

The Telescope Control programs monitor all the systems that run locally at the individual telescopes, namely the local data acquisition, the PMT High Voltage and Current Monitor systems, the local trigger logic, a charge injection system used for calibration of the readout electronics, the telescope trigger logic, and CCDs used to determine the pointing of the telescopes. The telescope positioner system would naturally fit into the hierarchy “below” the level of the Telescope Control program; however, for security reasons, we decided to treat it as an independent “global” system.

The software is designed to support the usage of arbitrary sub-telescope systems. For example 2 times 2 telescopes might be used to track 2 sources in stereoscopic observation mode, while 3 other telescopes are used in stand-alone mode to monitor 3 other sources.

The design of the Array Control and Telescope Control programs is shown in Fig. 2.. The software is written in C++, using the *Zthread* library, version 2.2.10 [1] for the implementation of concurrent processes. The communication between the distributed software components is facilitated by the *omniORB3.0*

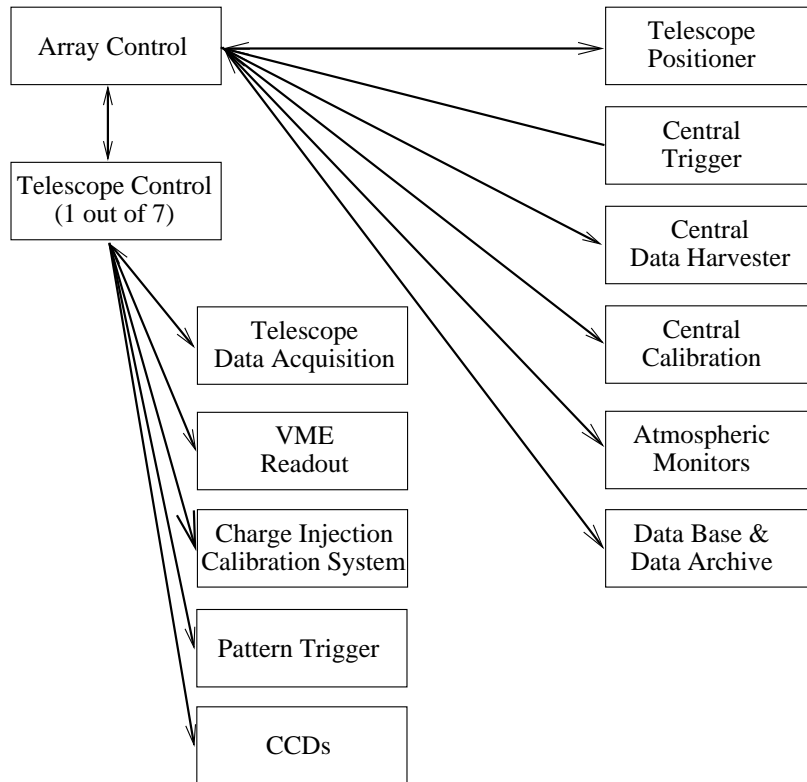


Fig. 1. Control hierarchy of VERITAS software processes. The program Array Control launches and monitors all VERITAS sub-systems. Processes that run at individual telescopes, are controlled by the program “Telescope Control”.

implementation [2] of the CORBA protocol.

The user works with a Graphical User Interface (GUI) based on the *Qt*-package, version 3.1.1 [3] that allows him or her to start server on the remote computers, to initialize and shut down sub-systems, and to take calibration and science data.

The software is fully object oriented with a “night-object” performing diurnal initialization and shut down processes, “run-objects” that log run-information in the *MySQL* data base [4] and start and stop sub-systems, as well as “sub-system objects”. The latter include watch-dog processes that poll the status and key-performance parameters of a sub-system in regular time intervals to monitor their proper functioning.

Error situations are handles based on CORBA time-outs, function return values and a well defined exception class.

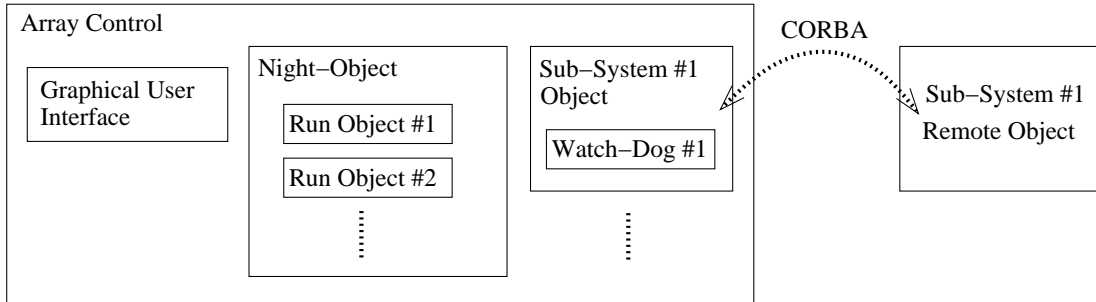


Fig. 2. Object oriented design of the Array Control program. The user steers the telescopes with the help of a Graphical User Interface (GUI) that also displays diagnostic information about the performance of the telescopes and about the gamma-ray emission of the observed sources. The telescopes can be divided into several sub-groups, each one observing a different astrophysical source. So-called run-objects invoke observation runs with different telescope sub-groups. For each major software (and hardware) component, a sub-system objects remotely invokes object methods via CORBA and monitors their status with watch-dog processes.

3. Status and Outlook

The Array Control and Telescope Control programs described in this paper will be used to take data with the first VERITAS prototype telescope in September, 2003. Subsequent development will aim at the full implementation of the multi-telescope capabilities, and at the improvement of the display of diagnostic information that will help the shift personnel to locate and remedy irregularities. It is foreseen that between 1 and 2 persons will steer one sub-system using one or more terminals. Comprehensive display of the results from the online-analysis will enable the shift crew to rapidly react to the detection of gamma-ray flares.

4. References

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2. <http://omniorb.sourceforge.net/>
3. <http://www.trolltech.com/products/qt/>
4. <http://mysql.he.net/>