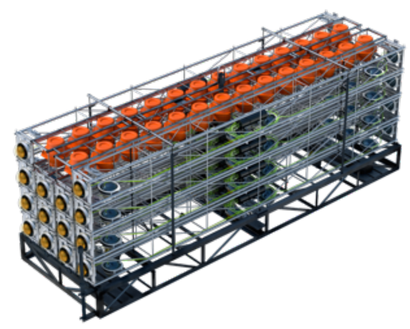
The Trigger and Data Acquisition system of the KM3NeT-Italy detector

Tommaso Chiarusi [1], Matteo Favaro [1 2 4], Francesco Giacomini [2], Matteo Manzali [2 4], Annarita Margiotta [1 3] and Carmelo Pellegrino [1 3] on behalf of the KM3NeT-Italy Collaboration

[1] INFN Bologna, [2] INFN CNAF, [3] Università degli Studi di Bologna, [4] Università degli Studi di Ferrara

KM3NeT-Italy is an INFN project supported with Italian PON fundings for carrying out the inner core of the multi-km3 size KM3NeT-ARCA neutrino telescope [1] [2]. The detector will be placed in the Ionian Sea (Italy) at 3500 m of depth (see the picture on the left). The KM3NeT-Italy detector will be made of ~700 optical modules (OMs), each one containing a 10" PMT and the readout electronics. The OMs are organized in vertical structures called towers. Each tower supports 14 layers with 6 OMs each. The detection principle is based on the measurement of the Cherenkov light from high-energy neutrino induced charged particles produced within a fiducial volume around the telescope [3].

The "all data to shore" approach is assumed to reduce the complexity of the submarine detector, demanding for an on-line trigger integrated in the data acquisition system running in the shore station, called TriDAS [4]. Due to the large optical background in the sea from 40K decays and the bioluminescence, the throughput from the sea can range up to 30 Gbps. This put strong constraints on the performances of the TriDAS processes and the related network infrastructure [5].



FCMServer

The FCMServer (Floor Control Module Server) represents the interface of TriDAS with the data from the off-shore detector. It performs the read-out of data coming from a number (up to 4) of floors through a dedicated ASIC [6]. After having performed a consistency check, it sends the data to the connected HM.

TriDAS SuperVisor (TSV)

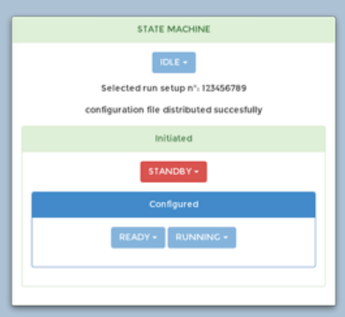
The TSV supervises the data exchange between HM and TCPU, taking note of the processed TSs. When a TCPU is ready to handle new data, it sends a token to the TSV. The TSV selects a TS ID among those not yet processed and communicates to all HMs to send the STS for the selected TS ID to that TCPU.

TriDAS Controller (TSC)

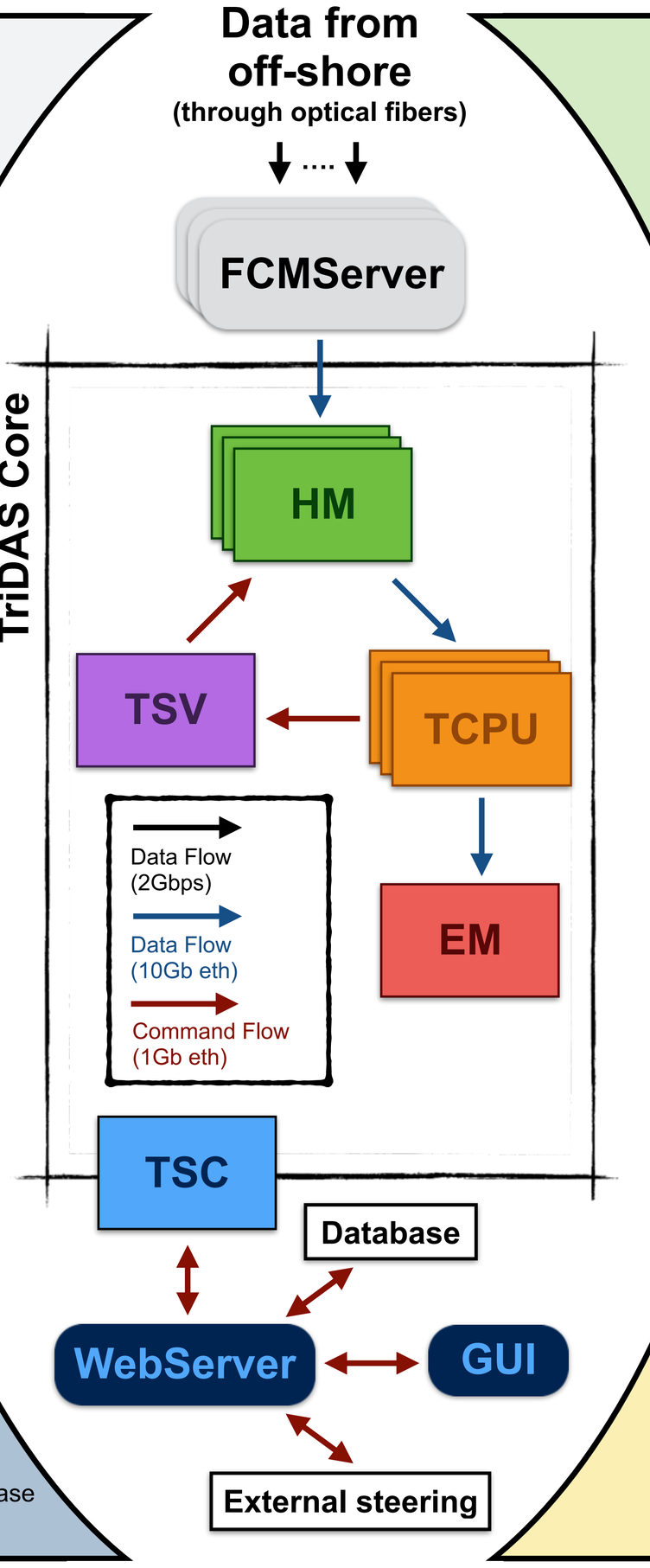
The TSC is the software interface that permits to control the entire TriDAS environment. Its purpose is to organize and control the launch of each software, allowing a correct acquisition and real time analysis of the data. In order to achieve this functionality the TSC implements a State Machine.

WebServer and GUI

The WebServer is the unique entry point for the TSC, which can be steered either via the GUI or other external application. The GUI is a web application that graphically represent information provided by the WebServer and acts as control interface for the user.



The WebServer is also used to interface the TriDAS with the Database for retrieving the running configurations.



Hit Manager (HM)

The HMs represent the first aggregation stage for the incoming data-stream. Each HM handles a number of floors, which is called "Sector", slicing data in subsequent TimeSlices (TS) of the same fixed duration and referred to a common time origin. Each HM organizes its own sliced data in special structures called SectorTimeSlices (STSs) and send them to the TCPUs.

Trigger CPU (TCPU)

TCPUs are responsabile for the last step of data aggregation and online analysis. Each TCPU receives from HMs the STSs creating a TelescopeTimeSlice (TTS), then it applies triggers to this new object and finally sends it to the Event Manager.

Event Manager (EM)

The EventManager (EM) is the software component of TriDAS dedicated to the storage of triggered data. A single EM process collects triggered data from the whole TCPU set and performs data writing on local storage.

Tools and Libraries

New tools for software development and modern design solutions have been adopted in order to continuously improve software quality at decreasing cost [7].

boost C++ LIBRARIES · Jenkins · git · AngularJS · Crossbar.io · Atlassian Bitbucket · CMake · ØMQ

The TriDAS implementation is currently beign tested with a setup realized in the KM3NeT DAQ laboratory at the INFN-Sezione di Bologna. The various TriDAS processes run on a dedicated computing farm interconnected according to the same network layout that will be used in production. The data stream incoming to the TriDAS is obtained with both an experimental setup, with the real electronics for two complete floors attached to 2 real FCMServers, and a set of FCMServer simulators which can run on the farm, allowing to simulate the data flow from all the towers.

[1] T. Chiarusi, M. Spurio, "High-Energy Astrophysics with Neutrino Telescopes", Eur. Phys. J. C65, 649 (2010)
[2] KM3NeT web site: http://www.km3net.org/home.php
[3] S. Aiello et al., "Measurement of the atmospheric muon depth intensity relation with the NEMO Phase-2 tower", Astroparticle Physics, Vol. 66, Pag. 1-7 (2015)
[4] C. Pellegrino, F. Simeone, T. Chiarusi, "The Trigger and Data Acquisition for the NEMO-Phase 2 tower", AIP Conference Proceedings 1630, 158 (2014)
[5] Video about the KM3NeT-Italy project: https://vimeo.com/116656904
[6] A. Lonardo et al., "NaNet: a configurable NIC bridging the gap between HPC and real-time HEP GPU computing" JINST 10 C04011 (2015)
[7] F. Giacomini et al., "An integrated infrastructure in support of software development", Journal of Physics: Conference Series 513 (2014) 062018.