Instrument Control System and Operational Scheduler

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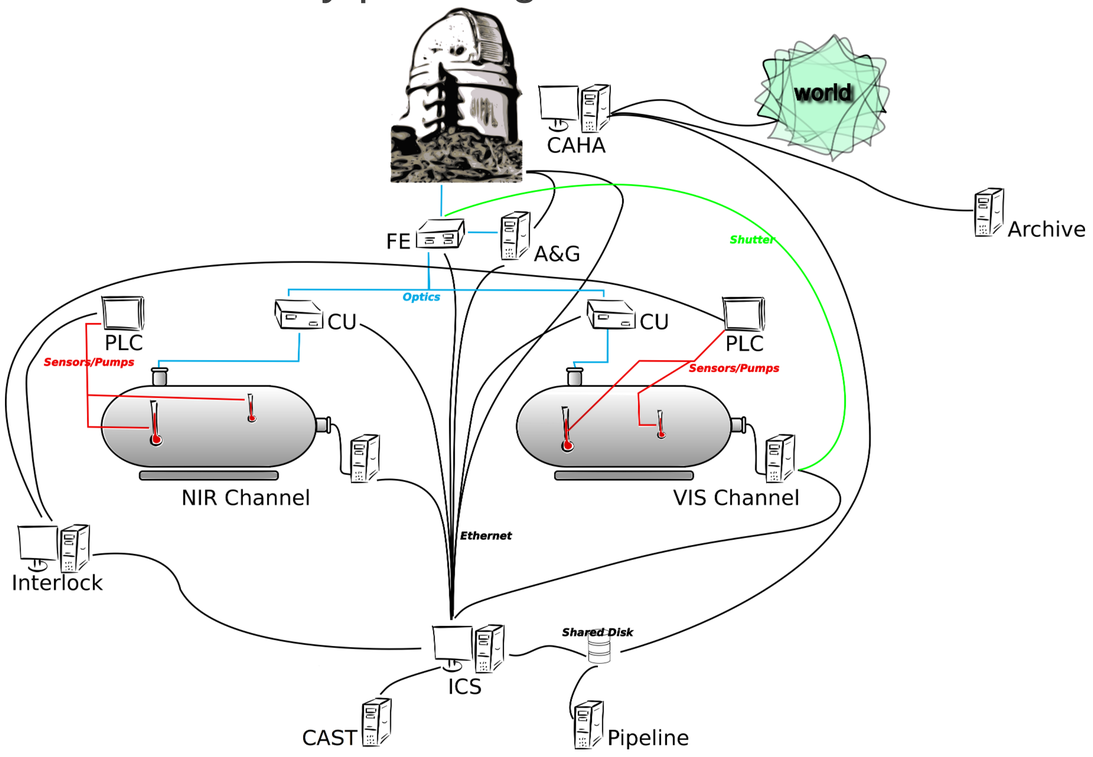
The main goal of the CARMENES instrument is to perform high accuracy measurements of stellar radial velocities (1 m/s) with long term stability. It will be installed in 2015 and will be equipped with two spectrographs covering from the visible to the near-infrared. We present two software packages that play a key role in the control layer for an efficient operation of the instrument: the Instrument Control System and the Operational Scheduler. The ICS handles the coordination and management of CARMENES, whereas the operational schedule recomputes the long-, mid- and short-term survey planning and it is based on Artificial Intelligence techniques.

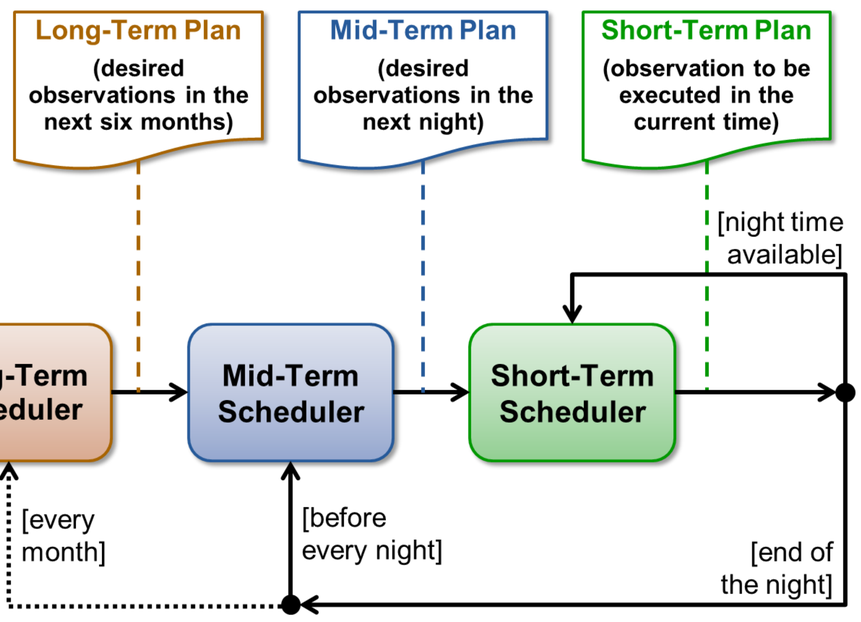


The Instrument Control System (ICS) is the central software application in the CARMENES control layer. It is based on a modular architecture and a high level of abstraction design motivated by the heterogeneity of the different subsystems. A master/slave model architecture is used to build the control layer, where the ICS acts as a master and almost every other subsystem is a slave. The ICS acts as a slave only for the User Interface subsystem, which controls and monitors the ICS functionalities. The main features of the ICS are:

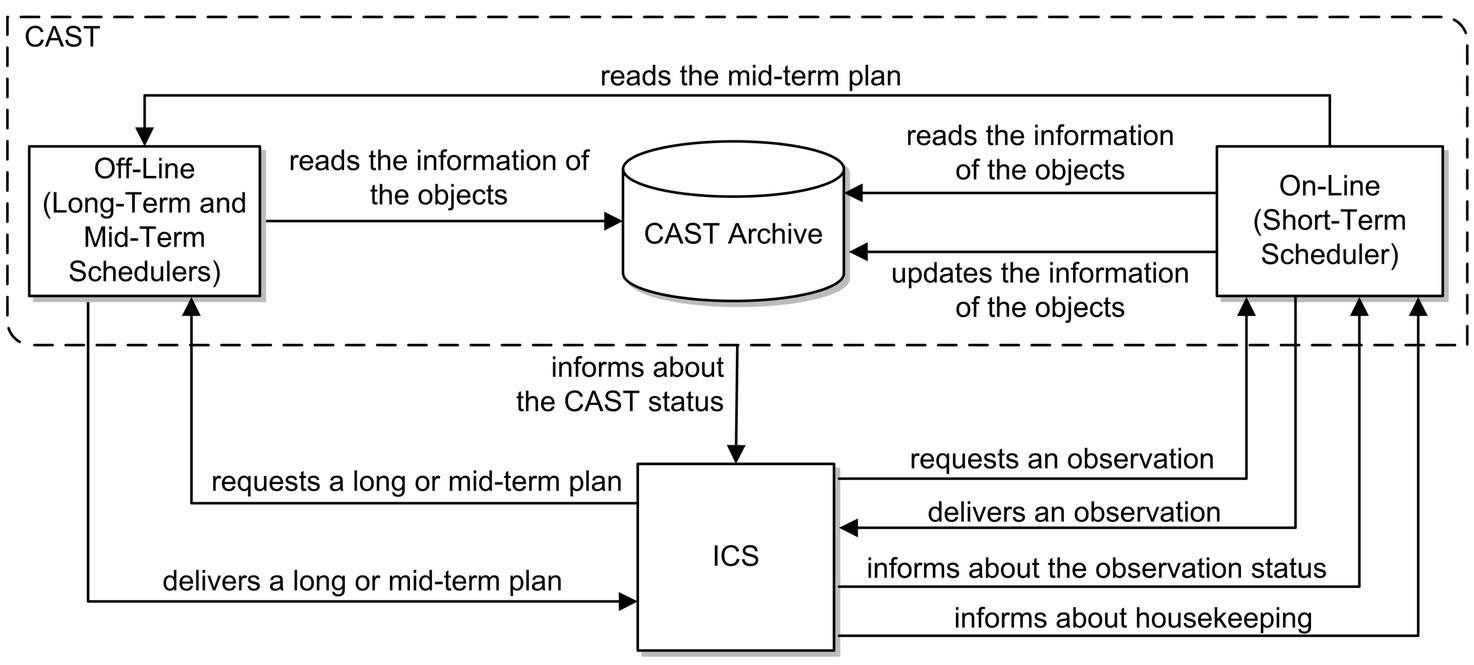
- Types of tasks to be executed. **Maintenance**, **calibration** and **science**.
- Control modes. **Interactive**, where the logged user has total control over the ICS; and **automatic**, where the ICS takes control of the instrument and will automatically execute the observations computed by CAST.
- Roles. **administrator**, **engineer** (who can command any subsystem or to configure the ICS), **observer** (who is able to execute CAST and start the automatic mode) and **visitor**.

The CArmenes Scheduling Tool (CAST) is based on Genetic Algorithms, which are an Artificial Intelligence approach for solving optimization problems. CAST combines three schedulers in two scheduling strategies:

- Off-line. Obtains a plan of objects to be observed in a period of time according to the CARMENES constraints that can be computed beforehand. This strategy contains two different types of planning, **long-term** to schedule object observations with a time scope of **several months**, and **mid-term** to schedule object observations for a **specific night**.
- On-line. Contains a **short-term** scheduler that returns the next observation to be executed, it **reacts to unexpected situations** by adapting the previously computed mid-term plan. It is time critical and the next observation must be calculated in less than five seconds.



The CAST Archive stores the CARMENES survey and the information of the observations done to each object (e.g., date and time, status).



The communications between the ICS and CAST are done by means of the Internet Communication Engine (ICE) protocol:

- The ICS can request the computation of each one of the plans to CAST. Moreover, the ICS sends information about the housekeeping to CAST every minute. This information will contain the environment conditions (e.g., weather) and the system conditions.
- CAST sends to the ICS the computed long- and mid-term plans, and the next observation to be executed. Furthermore, CAST sends a message to the ICS every minute with information about its status (e.g., running long-term scheduler, running mid-term scheduler, waiting for a new observation request...).

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