Coordinating Simultaneous Instruments at the Advanced Technology Solar Telescope

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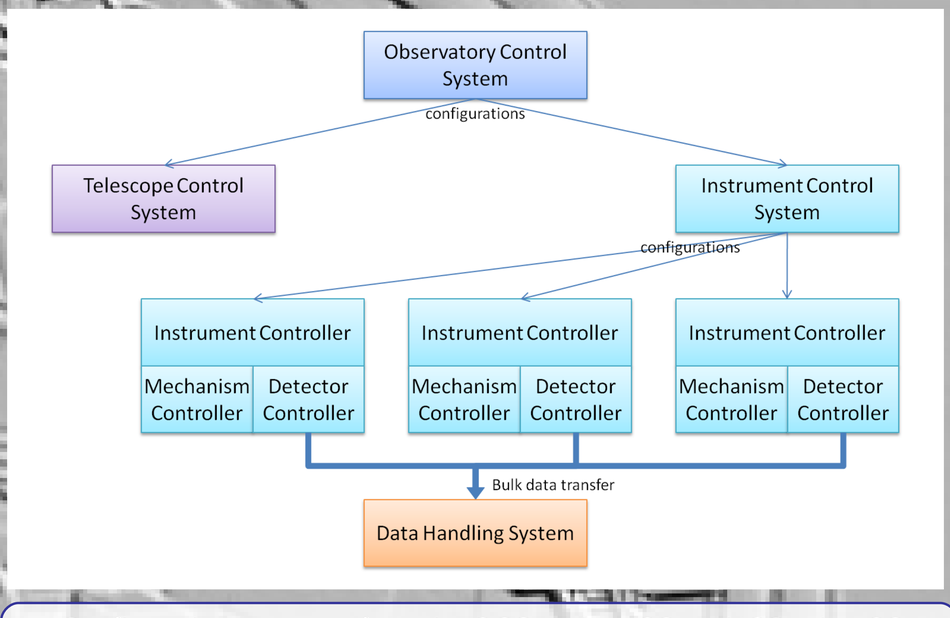
The Advanced Technology Solar Telescope (ATST) is designed to support the execution of observations on multiple instruments operating simultaneously while performing laboratory style experiments. The light beam supplied via adaptive optics from the telescope structure is fed to a 16m counter-rotating coudé platform where the beam is divided among one to five instruments each with one to four cameras. Each camera delivers up to 1GBps of data to a camera line for data reduction before transport off-site.

Efficient operation mandates that independent actions be overlapped and interwoven. Additionally, some instruments are critical to the observation and must complete their data collection prior to the next telescope motion while other instruments may function in a complementary role – collecting data continuously until all the critical instruments are complete.



Configurations are sent from the OCS to the TCS and ICS. The ICS coordinates the start and stop of data collection in the active instruments.

```
from atst.ocs.util import Mosaics

connect to ICS and TCS

get current TCS target and sequence of relative offsets
icsB = None        # track previous ICS configuration

for each relative offset:
    compute absolute position from target and offset
    construct and submit ICS configuration icsA
    wait for ICS configuration icsB (if any) to complete
    construct and submit TCS configuration tcsA
    wait for TCS configuration tcsA to complete
    construct and submit 'tcsConfigured' configuration icsB

wait for ICS configuration icsB (if any) to complete
move TCS back to original target

disconnect from ICS and TCS
```

Pseudo-code for typical Observing Block script showing overlapping and interleaving of telescope and instrument actions.

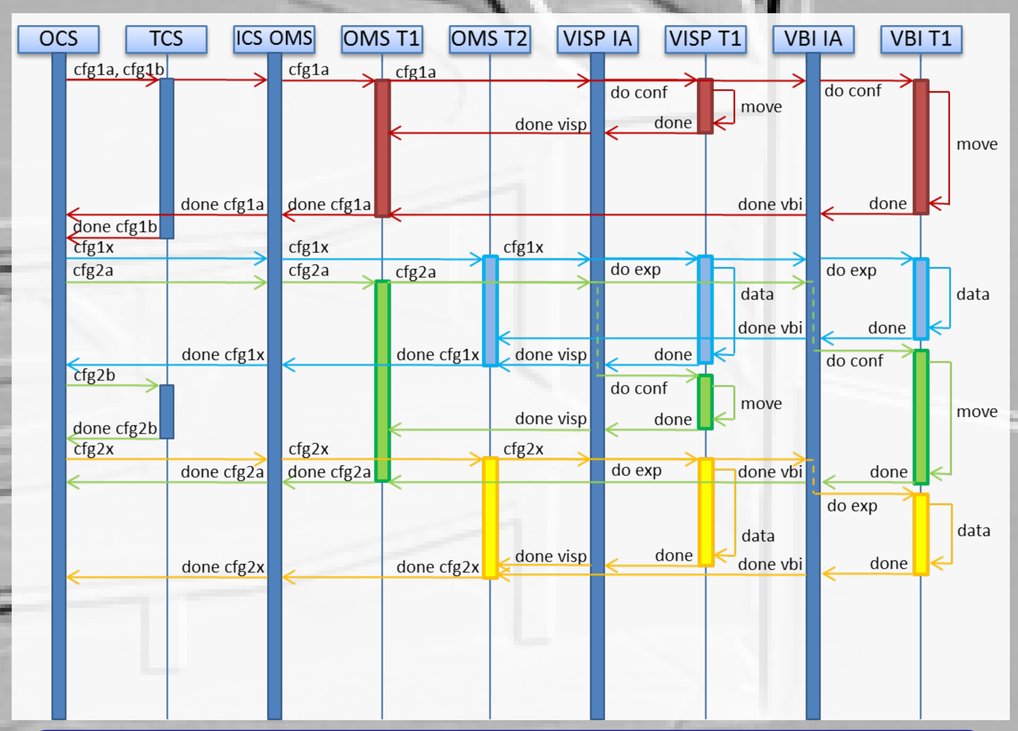
ATST manages the coordination of telescope and instrument actions using a tiered control system. The Observatory Control System (OCS) is responsible for sequencing the telescope actions with the instruments as a whole, with no knowledge of individual instruments. The OCS operates on Observing Blocks (the smallest unit scheduled within an experiment). Each Observing Block encapsulates a script that allows maximal flexibility in sequencing telescope and instrument actions within the block.

The Instrument Control System (ICS) coordinates the individual instruments with each other and responds to directives (configurations) from the OCS that signal when the telescope is 'in position' for the next step in the Observing Block. Each instrument coordinates its mechanism motions and data collection with its various cameras.

An end-to-end simulator has been used to verify the correct interactions between the OCS, ICS, and the telescope and instrument systems. The simulator also allows performance checking of the software interactions.

The ATST control system is built on top of the ATST Common Services Framework (CSF) which provides an asynchronous Command/Action/Response distributed environment built on top of a Container/Component Model. The OCS and ICS are written in Java while the telescope and instrument control systems are a blend of Java and C++ code. Scripts are written in Python and executed using Jython embedded in Java components.

CSF currently provides peer-to-peer and publish/subscribe messaging using ICE but presents a middleware-neutral interface to the upper layers of software. DDS is used for the efficient transport of the large science images.



Sequencing of two steps in above script showing details of ICS control (OMS) threads and actions of two instruments (VISP and VBI).

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