7.8 AO Non Real-time Control Functional Requirements

The AO non real-time control system is defined as the AO control functions that are not directly concerned with the high speed measurement and correction of atmospherically distorted wavefronts. The functions concerned with correction of the wavefront are part of the AO real time control (RTC) system discussed in section 7.7. Although the non real time control system properly includes all mechanisms and associated control computers inside the AO enclosure, the main optical relays, the LGS WFS, LOWFS, etc. the required mechanical and electrical functionality required of these system are detailed with the specific subsystems requirements sections, see section 7.2-7.6. This section of the AO system functional requirements focuses on the software and interface aspects of the non real-time control system. For simplicity, in the rest of this section of the requirements, the non-real time control is simply referred to as, AO control or the AO control system.

The AO control is responsible for the following roles in the AO system:

- A coordination role during setup, calibration, and observations.
- Interface role between the AO system, the laser facility, the instruments, the data archive, and the telescope.
- User interfaces including graphical, command line, and scripts.
- Monitoring completion of commands inside the AO system.
- Monitoring the health of the AO sub-systems and relaying the information to the observer or telescope operator.
- Logging data about the AO system into an observatory data system for NGAO.
- Control of AO enclosure and subsystem mechanisms.

7.8.1 Architectural Assumptions and Overall Requirements

No overall AO control requirements are directly traceable to the System Requirements Document or the wavefront error budgets.

The following architectural assumptions are made about the AO non real-time control system:

User interfaces:
AO control will have graphical, command line, and script based user interfaces.

Monitoring:
AO control will monitor health of the AO system including the AO RTC.

Mechanism Control:
AO control system will provide control of all AO mechanisms. This will include the following functions:

a) Initialize all device mechanisms.

b) *Control all devices that track the telescope position such as: the rotators for LGS subsystem, K-mirror, and atmospheric dispersion correctors (ADC).*
c) *Control calibration devices (integrating spheres, point source simulators, etc).*
d) *Provide tracking control to the LGS WFS pickoff/selection mechanism.*
e) *Provide tracking control to the LGS focus and aberration correction mechanisms.*
f) *Provide tracking control to the LOWFS pickoffs.*
g) *Provide tracking control to the d-NIRIR pickoffs.*

Truth Wavefront Sensor:
AO control is responsible for control of the TWFS and interfacing the information to the AO RTC.

Acquisition Camera:
AO control is responsible for control of acquisition cameras, including selection of optics and setting the exposure time. AO control will determine when acquisition is successful in an automatic fashion with limited operator oversight.

AO intersystem coordination:
AO control will perform the coordination tasks for setup, calibration and observations.

AO control system will be able to configure (setup) the AO system for observation. This will include selecting the instrument, the AO mode, the configuration and location of LGS wavefront sensors, as well as the configuration of the NGS LOWFS and location of the LOWFS pickoffs.

AO control will also request from the laser facility the correct LGS locations and orientation of the LGS constellation. AO control will request startup of LGS rotation mechanism.

AO control will setup the acquisition mode for science targets and LOWFS natural guider stars.

AO control will setup the RTC by either loading pre-computed reconstruction matrices or initializing an iterative algorithm.

AO control will star/stop the altitude tracking mechanism in LGS WFS (in LGS mode).

If the instrument is d-NIRI, the AO control system will configure the pick off and MOAO system in each d-NIRI input beam train.

AO control will coordinate daily calibration tasks for the AO facility including: calibrating the deformable mirror actuator gains, calibrating the WFS non-linearity, measuring the deformable mirror to wavefront sensor registration.

AO control will coordinate the background calibration (sky and dark frames) for LGS wavefront sensors, NGS wavefront sensors, the LOWFS, truth wavefront sensors, and acquisitions sensors.

AO control will coordinate the motion control and other tasks need to perform dithering and chopping for science observation.

AO control will initiate recovery steps from a laser traffic control event.

AO control will coordinate the achieving of AO data for science data calibration (i.e. PSF estimation, determine quality of AO correction).

7.8.2 Optical Requirements

None

7.8.3 Mechanical Requirements

See AO enclosure and WFS sections, sections 7.2-7.6 inclusive.

7.8.4 Electronic/Electrical Requirements

See AO enclosure and WFS sections 7.2-7.6.

7.8.5 Safety Requirements

Safety requirements have not been determined at this time

7.8.6 Software Requirements

Software requirements have not been determined at this time

7.8.7 Interface Requirements

Telescope:

The AO control system will transfer the focus and tip tilt offloads from the AO RTC to the Keck telescope drive control system (DCS).

Data Archive:

AO control system will record configuration and status information about the AO system in the observatory data system. An architectural assumption is that NGAO instrument data, AO RTC engineering data and AO RTC data for calibrating scientific data (i.e. PSF estimation) will be archived in an observatory data system.

d-NIRI instrument:

The AO control system will receive information about the d-NIRI targets and configure the MOAO channels. The AO control system will control the d-NIRI pickoff and other non real-time mechanisms of the MOAO input to each d-NIRI channel.

AO RTC:

The AO control system will interface with the AO RTC system. The AO control system will be able to make the following requests:

Configure RTC mode to LGS or NGS mode.

Configure the RTC reconstruction as required: this could include providing the RTR with previously computed reconstruction matrices or initialization of an iterative RTR algorithm.

In LGS/NGS mode, set the frame rates for the sensors directly interfaced to the RTC (LGS, NGS, and LOWFS).

In LGS and NGS mode, request dark and background frames be recorded for any of the sensors directly interfaced to the RTC sensor (LGS, NGS, and LOWFS).

In LGS mode, open and close the LOWFS tip tilt control loop on any of the three NGS LOWFS channels.

In LGS mode, open and close the first stage higher order AO atmospheric compensation loop.

In LGS mode, open and close the second stage higher order AO atmospheric compensation control loop.

In LGS mode, open and close the MOAO atmospheric correction in any of the LOWFS channels.

In LGS mode, open and close the MOAO atmospheric correction in any of the d-NIRI instrument channels.

In LGS and NGS associate a time stamp on the AO RTC engineering data with the start of science instrument exposure.

In NGS mode open and close the AO loops.

Check the health and status of the AO RTC system.

LGS Facility:

AO control system will initiate configuration of the LGS constellation. AO control will initiate rotation compensation for the LGS constellation. AO control will be able to open and close the up link tip tilt compensation loop.

AO control facility will receive status and diagnostics (i.e. laser power, polarization etc) from the laser facility control system.

Turbulence Profiler:

AO control system will get atmospheric turbulence profile (C_n^2) information from an onsite monitor. The information will be transferred to the AO RTC for its tomography algorithm. The data will also be transferred to the observatory data archive for calibration of science and AO engineering data.

7.8.8 Reliability Requirements

The AO control system will be designed to minimize downtime.

The AO control system will provide built-in diagnostics and be fully operable and maintainable by observatory staff. The system shall be designed for operation on a TBD basis. The system shall be designed to be deployed at night with TBD hours of preparation for setup and calibration, so that it can support both classical and semi queue scheduled modes

Setup and preparation times:
Daytime prep time TBD
Nighttime setup time TBD
Object setup TBD

Scalability and Upgrades
These requirements are TBD

7.8.9 Spares Requirements

TBD pending results of failure analysis of system.

7.8.10 Service and Maintenance Requirement

TBD pending results of failure analysis of system.

7.8.11 Documentation

Standard documentation provided including:
Mechanical drawings
Electrical schematics
Software documentation