GMT Software and Controls Work Breakdown Structure

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Contents

CHAPTER

ONE

INTRODUCTION

This document includes the definition of the Software and Controls System (SWCS) Work Breakdown Structure (WBS).

The SWCS is breakdown in subsystems, packages and components. For each SWCS subsystem the following information is included:

- A short description of the subsystem
- A diagram of the subsystem packages
- A listing of the components that conform each package. For each

component the component id and a short desciption are listed. Each component id includes a suffix that represents the component class. Component classes are defined formaly in the SWCS metamodel. For each component class a workflow for producing instances of those components is included in the SWCS Handbook.

CHAPTER

TWO

SOFTWARE AND CONTROLS WBS

The GMT Software and Controls System (SWCS) provides the software and hardware necessary to operate the GMT observatory and to control and monitor the GMT optomechanical subsystems. Additionally the SWCS provides a set of observatory services common to all the software subsystems.

2.1 Software System Engineering and Management

The Engineering and Management Domaing provides support for the system engineering level tasks necessary for the development of th GMT Software and Controls System.

2.1.1 System Engineering and Management

The System Engineering and Management System includes the resources and activities for the overall management of the activities necessary for the development of the GMT SWC System.

2.1.1.1 SWC System Travel Package

SWC System Travel Package includes the resources for the travel of group members during the life of the project. Travels include coordination meeting with partner institutions, oversight of software deliverables procured by external parties, Factory and Site Acceptance Testing and system commissioning.

2.1.1.2 SWC System Management Package

The SWCS Management Package includes the activities for the coordination and planning of the SWCS development effort.

2.1.1.3 SWC System Engineering Package

The SWC System Engineering Package includes the resources necessary for the system engineering effort during the inception phase and for the coordination between the project and the SWCS system engineering activities.

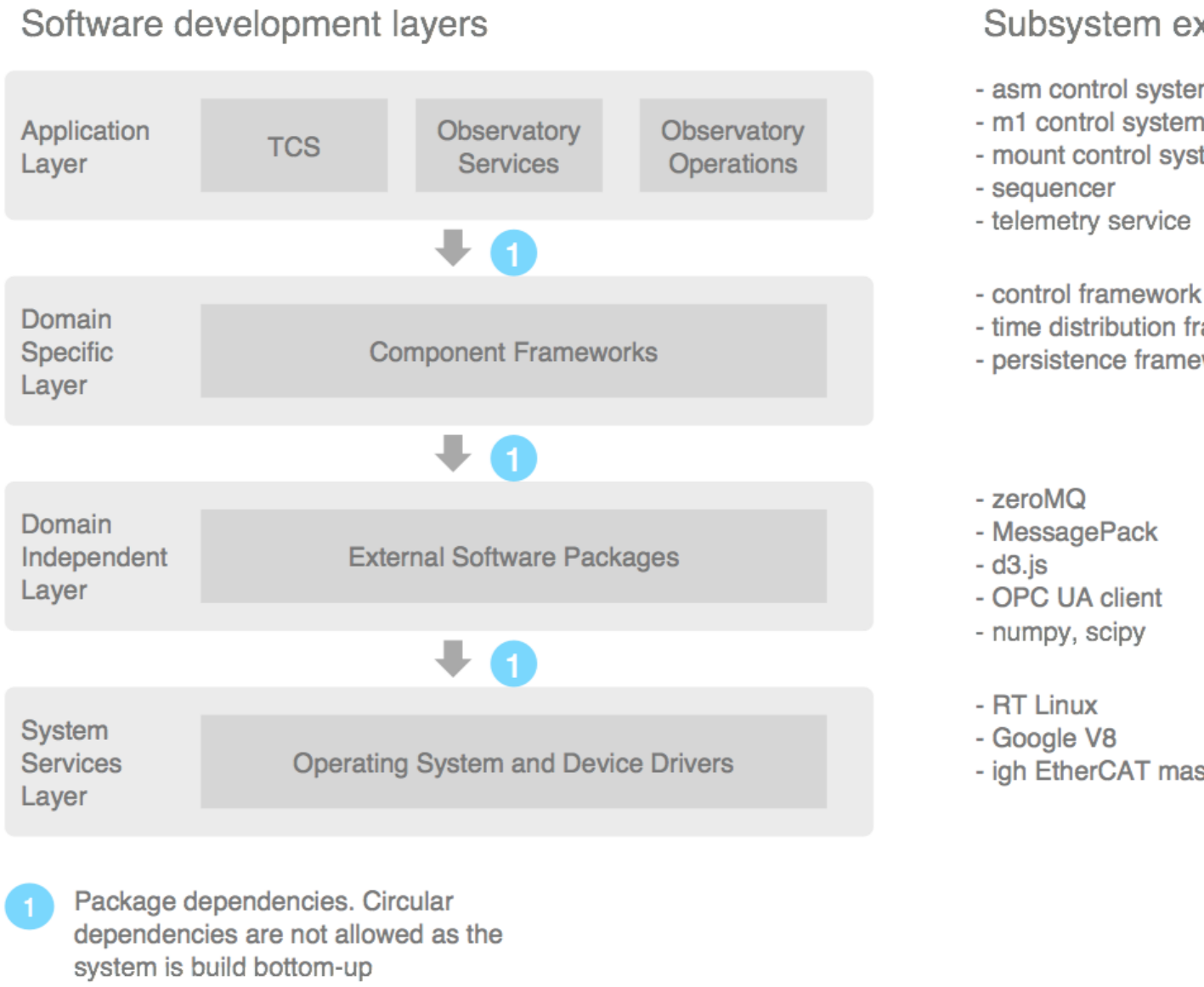

Fig. 2.1: SWC development view

2.1.1.4 SWC System Shipping Package

SWCS Shipping Package includes the resources for the delivery of SWCS hardware systems to the GMT site before the integration of the system on site.

2.1.2 Software Device System

Software Device System

2.1.2.1 SWC Development Environment Package

The SWC Development Environment Package provides the software tools, both OTS and developed in-house, to support the development of the GMT SWC System.

2.1.2.2 Software Development Modeling Package

The Software Development Modeling Package includes the resources necessary for the development of the GMT SWC models.

2.1.2.3 Software Development Process Package

The Software Development Process Package includes the resources and tools necessary to define and specify the GMT SWC development process. Several factors are worth considering: - The software effort involves both developers inside the project office and project partners. Is important to provide an specific definition of the development workflows to ensure that all the product developed are consistent, compatible and are integrated in a seamless way. - The GMT project is a classical stage-gate project, where several reviews, often external, open the gates to further financing. On the other hand, the last decade has seen an almost general adoption of agile [bib] software development processes. Special care has to be taking in ensuring that the project benefits from the use of Agile techniques while supporting the reporting and documentation needs common in stage-gate projects. .. todo:: Short description of GMT process strategy .. todo:: Add Agile references

2.1.2.4 Software Device Document Package

Software Device Document Package

2.1.2.5 Software Development Simulation Package

The Software Development Simulation Package includes the resources and tools necessary to develop several integration simulators. The use of simulators is often required to facilitate the integration and test of subsystem that are developed in parallel by different groups. (e.g. TCS simulator for science instruments)

2.1.3 Hardware Development System

The Hardware Development System provides the hardware tools and enviroment necessary for the development of the GMT SWC system.

2.1.3.1 Hardware Device Simulator Package

Hardware Device Simulator Package

2.1.4 Architectural Prototype

The Architectural Prototype Subsystem includes software, hardware and manpower resources to develop SWC prototypes.

2.1.4.1 Architecture Simulator Package

Architecture Simulator Package

2.1.4.2 Instrument Simulator Package

Instrument Simulator Package

2.2 Observatory Common Frameworks

The Observatory Compnent Frameworks implements reusable frameworks that implement the skeleton of a solution to a common problem and a set of components libraries that can be reused in the implementation of several subsystems.

2.2.1 Core Framework

The Core Framework (CF) implements the GMT distributed component model. The CF supports different communication patterns, connection ports and transports. The CF hides implementation details, like the middelware software used or the transport protocol. The CF defines the BaseComponent class that injects cross-cutting concerns with the use features that provide a native API to the Observatory Services.

2.2.1.1 Core Ext Software Wrapper Package

Core Ext Software Wrapper Package

2.2.1.2 Core Component Package

Core Component Package

2.2.1.3 Core Visualization Package

Core Visualization Package

2.2.1.4 Core Sequence Package

Core Sequence Package

2.2.1.5 Core Analysis Package

Core Analysis Package

2.2.1.6 Core Workflow Package

Core Workflow Package

2.2.1.7 Core Management Package

Core Management Package

2.2.2 Device Control Framework

The Device Control Framework (DCF) provides a set of specialized components to solve recurrent problems in Device Control Subsystems. The DCF defines the classess BaseController and BaseSupervisor that provide the basis for the control and supervisory hierarchy of the SWCS. The DCF also includes a library of controllers that address common control system configurations based on the IEC 61800-7-201 standard

2.2.2.1 Control Framework Component Package

Control Framework Component Package

2.2.2.2 Control Framework Visualization Package

Control Framework Visualization Package

2.2.2.3 Ctrl Sequence Package

Ctrl Sequence Package

2.2.2.4 Ctrl Analysis Package

Ctrl Analysis Package

2.2.2.5 Ctrl Workflow Package

Ctrl Workflow Package

2.2.2.6 Ctrl Management Package

Ctrl Management Package

2.2.3 Persistence Framework

The Persistence Framework (PF) provides support for the storage of data structures and files. It acts as a data access layer between the components and the databases and file systems, and provides a mapping between application data structures and the database.

2.2.3.1 Persistence Hardpoint File System Wrapper Package

Persistence Hardpoint File System Wrapper Package

2.2.3.2 Persistence Component Package

Persistence Component Package

2.2.3.3 Persistence Visualization Package

Persistence Visualization Package

2.2.3.4 Persistence Sequence Package

Persistence Sequence Package

2.2.3.5 Persistence Analysis Package

Persistence Analysis Package

2.2.3.6 Persistence Workflow Package

Persistence Workflow Package

2.2.3.7 Persistence Management Package

Persistence Management Package

2.2.3.8 Persistence Hardware Package

Persistence Hardware Package

2.2.4 Data Processing Framework

The Data Processing Framework (DPF) provides support for the development of data processing pipelines. Specific examples of data processing pipelines include: statistics (image noise and S/N estimation, sky brightness, seeing estimation, number of sources), astrometry (computing WCS for imaging detectors), image matching (coordinate transformation, image registration), data filtering, image cube construction, data extraction (e.g., IFS wavelength slices), image manipulation (masking, interpolation), image analysis, PSF creation (AO PSF simulation), spectral analysis, photometric calibration, spectral reduction, image reduction, image mosaic creation, etc.

2.2.4.1 Ext Software Wrapper Package

Ext Software Wrapper Package

2.2.4.2 Data Processing Component Package

Data Processing Component Package

2.2.4.3 Visualization Package

2.2.4.4 Sequencing Package

2.2.4.5 Data Processing Analysis Package

A processing pipeline is a chain of processing elements (processes, threads, etc.) arranged so that the output of one task feeds the input of the next. Data pipelines perform preprocessing of raw or reduced data (images, spectra, data cubes), information extraction, analysis on the outcome, post-processing, visualization, storage, and propagation of the results to other algorithms. Preprocessing may involve identifying relevant data sets, masking, data curation, etc., while information extraction may involve data processing steps to identify, filter, and fit features depending on the types of data (e.g. lines, stars, galaxies).

2.2.4.6 Data Processing Workflow Package

Data Processing Workflow Package

2.2.4.7 Data Processing Management Package

Data Processing Management Package

2.2.4.8 Data Processing Hardware Package

Data Processing Hardware Package

2.2.5 Time Distribution Framework

The Time Distribution Framework (TDF) provides the capability to obtain absolute timestamps. The TDF uses the IEEE 1588 standard for time distribution and provides a wrapper around the PTP version 2 protocol

2.2.5.1 Ext Software Package

Ext Software Package

2.2.5.2 Time Cmp Package

Time Cmp Package

2.2.5.3 Time Visualization Package

Time Visualization Package

2.2.5.4 Time Sequence Package

Time Sequence Package

2.2.5.5 Time Analysis Package

Time Analysis Package

2.2.5.6 Time Workflow Package

Time Workflow Package

2.2.5.7 Time Management Package

Time Management Package

2.2.5.8 Time Hardware Package

Time Hardware Package

2.2.6 User Interface Framework

The User Interface Framework (UIF) provides a set of common reusable Widgets (user interface graphic elements) and Panels. Widgets and Panels are the building blocks used to construct the GMT user interfaces. The UIF facilities a consistent design and documentation, improves system predictability as all widgets operate consistently in different scenarios, and reduces development costs.

2.2.6.1 User Interface Ext Software Wrapper Package

User Interface Ext Software Wrapper Package

2.2.6.2 User Interface Component Packages

User interface components define how observers and telescope operators interface with the telescope, instruments, software, and how they may visualize data. [TBC]

2.2.6.3 User Interface Visualization Package

User Interface Visualization Package

2.2.6.4 User Interface Analysis Package

User Interface Analysis Package

2.2.6.5 User Interface Workflow Package

User Interface Workflow Package

2.2.6.6 User Interface Management Package

User Interface Management Package

2.2.6.7 User Interface Hardware Package

User Interface Hardware Package

2.2.7 IO Framework

The I/O Framework (IOF) provides the infrastructure to develop observatory compliant Device Controllers based on EtherCAT technology.

2.2.7.1 Io EtherCAT Package

Io EtherCAT Package

2.2.7.2 Io Component Package

Io Component Package

2.2.7.3 Io Visualization Package

Io Visualization Package

2.2.7.4 Io Sequence Package

Io Sequence Package

2.2.7.5 Io Analysis Package

Io Analysis Package

2.2.7.6 Io Workflow Package

Io Workflow Package

2.2.7.7 Io Management Package

Io Management Package

2.3 Device Control Systems

The telescope control system (TCS) provides the software and hardware necessary to efficiently operate, monitor, calibrate, diagnose and control the optomechanical system of the GMT system.

2.3.1 Primary Mirror Control System

The Primary Mirror (M1) Control System (m1_cs) consists of a set of components organized in a hierarchy. A global controller acts as a front-end to the seven segments, dispatching commands and combining status to and from its underlying sub-systems; and provides a unified, simplified interface to the telescope's single 24.5m aperture optical surface. The segment controller holds its mirror segment so that the forces of gravity, wind and telescope acceleration do not significantly distort its surface. Segment position is controlled by six hardpoints, constraining the six degrees of freedom of solid body motion of the mirror segment. The hardpoints are actively controlled to keep the mirror segment aligned with the other parts of the telescope optical system. The segment active support consists of one hundred sixty five pneumatic actuators. The control system serves two purposes: firstly, it actively holds the mirror segment to the definition set by the hardpoints, effectively floating the segment blank at its nominal position; secondly, it applies figure corrections to the segment optical surface as provided by the active optics system. Each segment resides in its own independent cell. Thermal management is handled on a per segment basis and follows a similarly layered concept.

2.3.1.1 M1 Controller Package

M1 Controller Package

2.3.1.2 Primary Mirror Visualization Package

Primary Mirror Visualization Package

2.3.1.3 Primary Mirror Sequence Package

Primary Mirror Sequence Package

2.3.1.4 M1 Diagnostics Package

M1 Diagnostics Package

2.3.1.5 M1 Calibration Package

M1 Calibration Package

2.3.1.6 Primary Mirror Workflow Package

Primary Mirror Workflow Package

2.3.1.7 Primary Mirror Management Package

Primary Mirror Management Package

2.3.1.8 Primary Mirror Hardware Package

Primary Mirror Hardware Package

2.3.1.9 M1 Safety Package

M1 Safety Package

2.3.2 Secondary Mirror Positioner Control System

The Secondary Mirror (M2) Positioner Control System (m2pos_cs) provides the capability to operate and control the M2 Positioning system integrated with the rest of the observatory.

2.3.2.1 M2 Positioner Controller Package

M2 Positioner Controller Package

2.3.2.2 M2 Positioner Visualization Package

M2 Positioner Visualization Package

2.3.2.3 M2 Positioner Sequencing Package

M2 Positioner Sequencing Package

2.3.2.4 M2 Positioner Diagnosis Package

M2 Positioner Diagnosis Package

2.3.2.5 M2 Positioner Calibration Package

M2 Positioner Calibration Package

2.3.2.6 M2 Positioner Workflow Package

M2 Positioner Workflow Package

2.3.2.7 M2 Positioner Management Package

M2 Positioner Management Package

2.3.2.8 M2 Positioner Hardware Package

M2 Positioner Hardware Package

2.3.3 Fast Steering Mirror Control System

The Fast Steering Mirror (FSM) Control System (fsm_cs) consists of a set of components organized in a hierarchy: - The FSM Supervisors are responsible for the startup and shutdown procedures, overall health status, fault management and coordination of the components of the FSM Control System. They also provide a high level interface that receives new position demands and new commands from the WFC System and allows sending the telemetry samples for operator feedback and persistent storage. - The FSM piezo actuators and pressure/vacuum controllers, access the state variables of the plant through the EtherCAT master. These controllers read the input state variables; apply the control, alarm detection and logic functions; and update the output state variables to implement the control of the corresponding mechanisms. The EtherCAT fieldbus communication refreshes with a cycle time of 0.5 ms, generating time stamping at 2 kHz and telemetry accordingly.

2.3.3.1 FSM Controller Package

FSM Controller Package

2.3.3.2 Fast Steering Mirror Visualization Package

Fast Steering Mirror Visualization Package

2.3.3.3 Fast Steering Mirror Sequence Package

Fast Steering Mirror Sequence Package

2.3.3.4 Fast Steering Mirror Diagnostics Package

Fast Steering Mirror Diagnostics Package

2.3.3.5 Fast Steering Mirror Calibration Package

Fast Steering Mirror Calibration Package

2.3.3.6 Fast Steering Mirror Workflow Package

Fast Steering Mirror Workflow Package

2.3.3.7 Fast Steering Mirror Management Package

Fast Steering Mirror Management Package

2.3.3.8 Fast Steering Mirror Hardware Package

Fast Steering Mirror Hardware Package

2.3.4 Adaptive Secondary Mirror Control System

Adaptive Secondary Mirror Control System

2.3.4.1 Adaptive Secondary Mirror Ctrl Package

Adaptive Secondary Mirror Ctrl Package

2.3.4.2 Adaptive Secondary Mirror Visualization Package

Adaptive Secondary Mirror Visualization Package

2.3.4.3 Adaptive Secondary Mirror Sequence Package

Adaptive Secondary Mirror Sequence Package

2.3.4.4 Adaptive Secondary Mirror Diagnostics Package

Adaptive Secondary Mirror Diagnostics Package

2.3.4.5 Adaptive Secondary Mirror Calibration Package

Adaptive Secondary Mirror Calibration Package

2.3.4.6 Adaptive Secondary Mirror Workflow Package

Adaptive Secondary Mirror Workflow Package

2.3.4.7 Adaptive Secondary Mirror Management Package

Adaptive Secondary Mirror Management Package

2.3.4.8 Adaptive Secondary Mirror Hardware Package

Adaptive Secondary Mirror Hardware Package

2.3.5 Tertiary Mirror Control System

The Tertiary Mirror (M3) Control System (m3_cs) provides the capability to operate and control the M3 subsystem integrated with the rest of the observatory.

2.3.5.1 M3 Controller Package

Controls Overview

2.3.5.2 M3 UI Panels

M3 UI Panels

2.3.5.3 M3 Sequence Packages

M3 Sequence Packages

2.3.5.4 M3 Diagnostics Package

M3 Diagnostics Package

2.3.5.5 M3 Calibration Utilities

M3 Calibration Utilities

2.3.5.6 M3 Observatory Workflows Package

M3 Observatory Workflows Package

2.3.5.7 M3 Process and Management Workflows

M3 Process and Management Workflows

2.3.5.8 M3 Hardware Package

M3 Hardware Package

2.3.6 Mount Control System

The Mount Control System (mount_cs) provides the capability to operate and control the telescope mount integrated with the rest of the observatory.

2.3.6.1 Mount Control Package

Mount Control System Controllers

2.3.6.2 Mount UI Panels Package

Mount UI Panels Package

2.3.6.3 Mount Sequence Packages

Mount Sequence Packages

2.3.6.4 Mount Diagnostics Package

Mount Diagnostics Package

2.3.6.5 Mount Calibration Utilities

Mount Calibration Utilities

2.3.6.6 Mount Observatory Workflows Package

Mount Observatory Workflows Package

2.3.6.7 Mount Process and Management Workflows

Mount Process and Management Workflows

2.3.6.8 Mount Hardware Package

Mount Hardware Package

2.3.7 Corrector-ADC Control System

The Corrector-ADC Control System (cadc_cs) consists of a set of Supervisor and Controllers organized in a hierarchy. The Corrector-ADC Supervisor is responsible for the startup and shutdown procedures, overall health status, fault management and coordination of the components of the Corrector-ADC control system. It also provides a high level interface that receives new position demands from the TCS or new commands from the Sequencer and allows sending telemetry samples for operator feedback and persistent storage. The Corrector-ADC Controllers for the two-prism rotation and stage deployment, access the state variables of the Corrector-ADC through the EtherCAT master. The controllers read the input-state variables; apply the control, alarm detection and logic functions; and update the output-state variables to implement the control of the corresponding mechanism. The EtherCAT fieldbus refreshes with a cycle time of 0.5 ms, generating telemetry at 2 kHz and time stamping accordingly.

2.3.7.1 Corrector and Atmospheric Dispersion Ctrl Package

Corrector and Atmospheric Dispersion Ctrl Package

2.3.7.2 Corrector and Atmospheric Dispersion Visualization Package

Corrector and Atmospheric Dispersion Visualization Package

2.3.7.3 Corrector and Atmospheric Dispersion Sequence Package

Corrector and Atmospheric Dispersion Sequence Package

2.3.7.4 Corrector and Atmospheric Dispersion Diagnostics Package

Corrector and Atmospheric Dispersion Diagnostics Package

2.3.7.5 Corrector and Atmospheric Dispersion Calibration Package

Corrector and Atmospheric Dispersion Calibration Package

2.3.7.6 Corrector and Atmospheric Dispersion Workflow Package

Corrector and Atmospheric Dispersion Workflow Package

2.3.7.7 Corrector and Atmospheric Dispersion Management Package

Corrector and Atmospheric Dispersion Management Package

2.3.7.8 Corrector and Atmospheric Dispersion Hardware Package

Corrector and Atmospheric Dispersion Hardware Package

2.3.8 Acquisition Guiding and Wavefront Sensing Control System

The Acquisition Guiding and Wavefront Sensing (AGWS) Control System (agws_cs) consists of a set of Supervisors and Controllers organized in a hierarchy (**Figure 1**). The AGWS Supervisors are responsible for the startup and shutdown procedures, overall health status, fault management and coordination of the components of the AGWS Control System. The AGWS Supervisors also provide a high level interface that receives new position demands and new commands from the Pointing Kernel and allows sending telemetry samples for operator feedback and persistent storage. Individual unit supervisors are responsible for stages positioning, mirror tilts and optics rotation, via the state variables of the AGWS through the EtherCAT master. These Controllers read the input-state variables; apply the control, alarm detection and logic functions; and update the output-state variables to implement the control of the corresponding mechanisms.

2.3.8.1 AGWS Controller Package

AGWS Controller Package The Controllers and Supervisory components of the AGWS Control System are deployed in a GMT standard Device Control Computer (DCC) that is installed in the electronics room. The DCC runs the EtherCAT bus master in RT Linux and connects with the AGWS input/output modules by means of an EtherCAT fieldbus in ring topology that supports cable redundancy. Each AGWS Unit contains three dual-axis motion drives, two voice coil controllers and two piezo controllers, all of them with the proper feedback attached. Refer to **Figure 1** for a layout on each of the 4 AGWS Units and the Phasing Camera. The On-axis AGWS is constructed in a similar way.

2.3.8.2 AGWS Data Acquisition Package

AGWS Data Acquisition Package

2.3.8.3 AGWS visualization package

AGWS visualization package

2.3.8.4 Acquisition Guiding and Wavefront System Sequence Package

Acquisition Guiding and Wavefront System Sequence Package

2.3.8.5 Acquisition Guiding and Wavefront System Diagnostics Package

Acquisition Guiding and Wavefront System Diagnostics Package

2.3.8.6 Acquisition Guiding and Wavefront System Calibration Package

Acquisition Guiding and Wavefront System Calibration Package

2.3.8.7 AGWS workflow package

AGWS workflow package

2.3.8.8 Acquisition Guiding and Wavefront System Management Package

Acquisition Guiding and Wavefront System Management Package

2.3.8.9 Acquisition Guiding and Wavefront System Hardware Package

Acquisition Guiding and Wavefront System Hardware Package

2.3.9 Facility Calibration Control System

The Facility Calibration Control System (fac_cal_cs) provides the supervision and control of the Facilityo Calibration System, which is formed by the AO Retro-reflector and the LTAO Calibration Source. The AO Retro-reflector positioned at the telescope prime focus, is used to test the optical layout when a source at the Gregorian focal plane is reflected by the ASM. The LTAO Calibration Source provides the means to calibrate and verify the performance of both the NGSAO and LTAO observing modes. The AO Retro-reflector shares the same deployment system as the LTAO Calibration Source.

2.3.9.1 Facility Calibration System Ctrl Package

Facility Calibration System Ctrl Package

2.3.9.2 Facility Calibration System Visualization Package

Facility Calibration System Visualization Package

2.3.9.3 Facility Calibration System Sequence Package

Facility Calibration System Sequence Package

2.3.9.4 Facility Calibration System Diagnostics Package

Facility Calibration System Diagnostics Package

2.3.9.5 Facility Calibration System Calibration Package

Facility Calibration System Calibration Package

2.3.9.6 Facility Calibration System Workflow Package

Facility Calibration System Workflow Package

2.3.9.7 Facility Calibration System Management Package

Facility Calibration System Management Package

2.3.9.8 Facility Calibration System Hardware Package

Facility Calibration System Hardware Package

2.3.10 Enclosure Control System

The Enclosure Control System (enc_cs) provides the monitoring and control for all enclosure related functions including: rotation, shutters, wind vents, ventilation, lift platforms, hatches, cranes and building functions, such as HVAC and lighting. The enclosure systems are controlled with a series of PLCs interconnected with the EtherCAT industrial Ethernet fieldbus. The PLC system consists of Industrial PCs (IPCs), remote PCs, and remote I/O stations located in the enclosure. The ECS communicates with the GMT Telescope Control System using the communications standard OPC Unified Architecture (OPC UA).

2.3.10.1 Enclosure Control Package

The Enclosure control system will operate the Enclosure drive bogies using variable frequency drives (*VFD*), adjust the ventilation doors, and open and close the vertical and horizontal shutters.

2.3.10.2 Enclosure UI Panels Package

Enclosure UI Panels Package

2.3.10.3 Enclosure Sequencing Package

Enclosure Sequencing Package

2.3.10.4 Enclosure Diagnostics Package

Enclosure Diagnostics Package

2.3.10.5 Enclosure Calibration Utilities

Enclosure Calibration Utilities

2.3.10.6 Enclosure Workflow Package

Enclosure Workflow Package

2.3.10.7 Enclosure Management Package

Enclosure Management Package

2.3.10.8 Enclosure Hardware Package

Enclosure Hardware Package

2.3.11 Facilities Control System

The Facilities Control System (fac_cs) provides the monitoring and control for all building and facilities related functions including HVAC and lighting.

2.3.11.1 Facilities Ctrl Package

Facilities Ctrl Package

2.3.11.2 Facilities Visualization Package

Facilities Visualization Package

2.3.11.3 Facilities Sequence Package

Facilities Sequence Package

2.3.11.4 Facilities Diagnostics Package

Facilities Diagnostics Package

2.3.11.5 Facilities Calibration Package

Facilities Calibration Package

2.3.11.6 Facilities Workflow Package

Facilities Workflow Package

2.3.11.7 Facilities Management Package

Facilities Management Package

2.3.11.8 Facilities Hardware Package

Facilities Hardware Package

2.3.12 Environmental Monitoring Control System

The Environmental Monitoring Control System (env_mon_cs) is responsible for providing the services for monitoring, logging, and displaying all environmental data. The GMT Environmental Monitoring Facility (GEMF) will provide the required capabilities to monitor weather conditions and integrated seeing conditions using: - weather tower and equipment, - MASS/DIMM facility, - dust monitoring, - seismic sensor.

2.3.12.1 Environment Monitoring Ctrl Package

Environment Monitoring Ctrl Package

2.3.12.2 Environment Monitoring Visualization Package

Environment Monitoring Visualization Package

2.3.12.3 Environment Monitoring Sequence Package

Environment Monitoring Sequence Package

2.3.12.4 Environment Monitoring Diagnostics Package

Environment Monitoring Diagnostics Package

2.3.12.5 Environment Monitoring Calibration Package

Environment Monitoring Calibration Package

2.3.12.6 Environment Monitoring Workflow Package

Environment Monitoring Workflow Package

2.3.12.7 Environment Monitoring Management Package

Environment Monitoring Management Package

2.3.12.8 Environment Monitoring Hardware Package

Environment Monitoring Hardware Package

2.3.13 Natural Guidestar Wavefront Sensor Control System

The Natural Guidestar AO Wavefront Sensor (NGWS) Control System (ngws_cs) is composed of a series of Controllers and Supervisors that interact with the various subsystems within the NGWS optical path: Main arm, Adaptive Optics arm, Technical Viewer arm and 2nd Wavelength arm.

2.3.13.1 NGWS Controller Package

NGWS Controller Package

2.3.13.2 NGWS Data Acquisition Package

NGWS Data Acquisition Package

2.3.13.3 NGWS slope processor Package

NGWS slope processor Package

2.3.13.4 Natural Guide Star Wavefront Sensor FAT Package

Natural Guide Star Wavefront Sensor FAT Package

2.3.13.5 Natural Guide Star Wavefront Sensor Calibration Package

Natural Guide Star Wavefront Sensor Calibration Package

2.3.13.6 Natural Guide Star Wavefront Sensor Visualization Package

Natural Guide Star Wavefront Sensor Visualization Package

2.3.13.7 Natural Guide Star Wavefront Sensor Sequence Package

Natural Guide Star Wavefront Sensor Sequence Package

2.3.13.8 Natural Guide Star Wavefront Sensor Diagnostics Package

Natural Guide Star Wavefront Sensor Diagnostics Package

2.3.13.9 Natural Guide Star Wavefront Sensor Workflow Package

Natural Guide Star Wavefront Sensor Workflow Package

2.3.13.10 Natural Guide Star Wavefront Sensor Management Package

Natural Guide Star Wavefront Sensor Management Package

2.3.13.11 NGWS Hardware Package

NGWS Hardware Package

2.3.14 Laser Tomography Wavefront Sensor Control System

The Laser Tomography AO Wavefront Sensor (LTWS) Control System (ltws_cs) consists of a set of Supervisor and Controllers organized in a hierarchy. The LWFS Supervisor receives commands and also passes status and other requested data to the LTAO Wavefront Controller. The LTWS Controller uses data received from the LTAO Wavefront Controller to drive the mechanisms, which are controlled by a local EtherCAT based control system. The LTWS Controller will interface with both the Telescope Control Network and the Low-Latency Network.

2.3.14.1 LTAO Wavefront Sensor Ctrl Package

LTAO Wavefront Sensor Ctrl Package

2.3.14.2 LTAO Wavefront Sensor Data Acquisition System Package

LTAO Wavefront Sensor Data Acquisition System Package

2.3.14.3 LTAO Wavefront Sensor Slp Package

LTAO Wavefront Sensor Slp Package

2.3.14.4 LTAO Wavefront Sensor FAT Package

LTAO Wavefront Sensor FAT Package

2.3.14.5 LTAO Wavefront Sensor Calibration Package

LTAO Wavefront Sensor Calibration Package

2.3.14.6 LTAO Wavefront Sensor Sequence Package

LTAO Wavefront Sensor Sequence Package

2.3.14.7 LTAO Wavefront Sensor Diagnostics Package

LTAO Wavefront Sensor Diagnostics Package

2.3.14.8 LTAO Wavefront Sensor Workflow Package

LTAO Wavefront Sensor Workflow Package

2.3.14.9 LTAO Wavefront Sensor Visualization Package

LTAO Wavefront Sensor Visualization Package

2.3.14.10 LTAO Wavefront Sensor Management Package

LTAO Wavefront Sensor Management Package

2.3.14.11 LTAO Wavefront Sensor Hardware Package

LTAO Wavefront Sensor Hardware Package

2.3.14.12 Electronic Cabinet Ctrl Package

Electronic Cabinet Ctrl Package

2.3.14.13 Electronic Cabinet Sequence Package

Electronic Cabinet Sequence Package

2.3.14.14 Electronic Cabinet Calibration Package

Electronic Cabinet Calibration Package

2.3.14.15 Electronic Cabinet Diagnostics Package

Electronic Cabinet Diagnostics Package

2.3.14.16 Electronic Cabinet Workflow Package

Electronic Cabinet Workflow Package

2.3.14.17 Electronic Cabinet Visualization Package

Electronic Cabinet Visualization Package

2.3.14.18 Electronic Cabinet Management Package

Electronic Cabinet Management Package

2.3.14.19 Electronic Cabinet Hardware Package

Electronic Cabinet Hardware Package

2.3.15 Adaptive Optics Commissioning Camera Control System

The Adaptive Optics (AO) Commissioning Camera (ao_com_cam_cs) provides Pupil Lens and Temperature control, as well as Supervisory functions for the AO Camera used during the commissioning phase of GMT.

2.3.15.1 Adaptive Optics Commissioning Camera Ctrl Package

Adaptive Optics Commissioning Camera Ctrl Package

2.3.15.2 Adaptive Optics Commissioning Camera Data Acquisition System Package

Adaptive Optics Commissioning Camera Data Acquisition System Package

2.3.15.3 Adaptive Optics Commissioning Camera FAT Package

Adaptive Optics Commissioning Camera FAT Package

2.3.15.4 Adaptive Optics Commissioning Camera Sequence Package

Adaptive Optics Commissioning Camera Sequence Package

2.3.15.5 Adaptive Optics Commissioning Camera Calibration Package

Adaptive Optics Commissioning Camera Calibration Package

2.3.15.6 Adaptive Optics Commissioning Camera Diagnostics Package

Adaptive Optics Commissioning Camera Diagnostics Package

2.3.15.7 Adaptive Optics Commissioning Camera Workflow Package

Adaptive Optics Commissioning Camera Workflow Package

2.3.15.8 Adaptive Optics Commissioning Camera Visualization Package

Adaptive Optics Commissioning Camera Visualization Package

2.3.15.9 Adaptive Optics Commissioning Camera Management Package

Adaptive Optics Commissioning Camera Management Package

2.3.15.10 Adaptive Optics Commissioning Camera Hardware Package

Adaptive Optics Commissioning Camera Hardware Package

2.3.16 On Instrument Wavefront Sensor Control System

The On Instrument Wavefront Sensor (OIWFS) Control System (oiws_cs) will interface with both the TCS (control, status, and telemetry) and the AO RTS (for real time slopes from the WFS and real time DM actuator commands). The main OIWFS subsystems are the Detector Controller, the Deformable Mirror controller and the Mehanisms control.

2.3.16.1 On Instrument Wavefront Sensor Ctrl Package

On Instrument Wavefront Sensor Ctrl Package

2.3.16.2 On Instrument Wavefront Sensor Data Acquisition System Package

On Instrument Wavefront Sensor Data Acquisition System Package

2.3.16.3 On Instrument Wavefront Sensor Slp Package

On Instrument Wavefront Sensor Slp Package

2.3.16.4 On Instrument Wavefront Sensor FAT Package

On Instrument Wavefront Sensor FAT Package

2.3.16.5 On Instrument Wavefront Sensor Calibration Package

On Instrument Wavefront Sensor Calibration Package

2.3.16.6 On Instrument Wavefront Sensor Diagnostics Package

On Instrument Wavefront Sensor Diagnostics Package

2.3.16.7 On Instrument Wavefront Sensor Workflow Package

On Instrument Wavefront Sensor Workflow Package

2.3.16.8 On Instrument Wavefront Sensor Visualization Package

On Instrument Wavefront Sensor Visualization Package

2.3.16.9 On Instrument Wavefront Sensor Management Package

On Instrument Wavefront Sensor Management Package

2.3.16.10 On Instrument Wavefront Sensor Hardware Package

On Instrument Wavefront Sensor Hardware Package

2.3.17 Phasing Camera Control System

The Phasing Camera Control System (ph_cam_cs) comprises several Supervisors and Controllers that interact with the Phasing Camera at the AGWS. The Phasing Camera System is a dispersed Hartmann wavefront sensor and associated control electronics, which allow the relative phase difference between M1 segments to be determined. The phasing camera will be mechanically and electronically integrated into the AGWS. The relevant controlled mechanisms consist of a deployment stage with azimuth, elevation and focus adjustments, along with pick-off mirror and fold mirror tilts.

2.3.17.1 Phasing Camera Ctrl Package

Phasing Camera Ctrl Package

2.3.17.2 Phasing Camera Data Acquisition System Package

Phasing Camera Data Acquisition System Package

2.3.17.3 Phasing Camera Slp Package

Phasing Camera Slp Package

2.3.17.4 Phasing Camera FAT Package

Phasing Camera FAT Package

2.3.17.5 Phasing Camera Calibration Package

Phasing Camera Calibration Package

2.3.17.6 Phasing Camera Sequence Package

Phasing Camera Sequence Package

2.3.17.7 Phasing Camera Diagnostics Package

Phasing Camera Diagnostics Package

2.3.17.8 Phasing Camera Workflow Package

Phasing Camera Workflow Package

2.3.17.9 Phasing Camera Visualization Package

Phasing Camera Visualization Package

2.3.17.10 Phasing Camera Management Package

Phasing Camera Management Package

2.3.17.11 Phasing Camera Hardware Package

Phasing Camera Hardware Package

2.3.18 M1 Edge Sensors Control System

The baseline for the Primary Mirror Edge Sensors (M1ES) Control System (m1es_cs) is a hybrid metrology system with fine interferometric sensors that are supplemented with a coarse absolute optical position sensor with large capture range. The interferometric type sensors have high nm range resolution, measuring displacement by counting interference fringes in quadrature, but are inherently relative. The coarse sensors will make it possible to quickly align M1 to within the capture range of the AGWS (for tip-tilt) and Phasing Camera (for piston). Once initial alignment and phasing has been achieved, the interferometric metrology system will maintain the alignment of the M1 segments with high precision and bandwidth, with its absolute reference point updated continuously by the Integrated Optics Piston Sensor or the Phasing Camera.

2.3.18.1 M1 Edge Sensors Ctrl Package

M1 Edge Sensors Ctrl Package

2.3.18.2 M1 Edge Sensors Data Acquisition System Package

M1 Edge Sensors Data Acquisition System Package

2.3.18.3 M1 Edge Sensors Pipeline Package

M1 Edge Sensors Pipeline Package

2.3.18.4 M1 Edge Sensors Calibration Package

M1 Edge Sensors Calibration Package

2.3.18.5 M1 Edge Sensors Sequence Package

M1 Edge Sensors Sequence Package

2.3.18.6 M1 Edge Sensors Diagnostics Package

M1 Edge Sensors Diagnostics Package

2.3.18.7 M1 Edge Sensors Workflow Package

M1 Edge Sensors Workflow Package

2.3.18.8 M1 Edge Sensors Visualization Package

M1 Edge Sensors Visualization Package

2.3.18.9 M1 Edge Sensors Management Package

M1 Edge Sensors Management Package

2.3.18.10 M1 Edge Sensors Hardware Package

M1 Edge Sensors Hardware Package

2.3.19 Secondary Mirror Edge Sensors Control System

The Secondary Mirror (M2) Edge Sensor (M2ES) Control System (m2es_cs) provides the measurement of relative displacements between the ASM reference bodies, with sufficient precision and bandwidth to sense wind-induced disturbances of the ASM segments. In addition to segment piston, the M2 Edge Sensors must also accurately measure segment tilt to avoid field-dependent segment piston (phasing) error. The M2ES sensor layout developed by Microgate Corp. is based on the measured sensitivity of currently-available capacitive sensors, and results in an arrangement of 24 sensors total, each measuring two axes of relative motion. Each sensor measures relative ξ displacement with one capacitor, and relative η displacement with two capacitors (one on each side of the sensor).

2.3.19.1 M2 Edge Sensors Ctrl Package

M2 Edge Sensors Ctrl Package

2.3.19.2 M2 Edge Sensors Data Acquisition System Package

M2 Edge Sensors Data Acquisition System Package

2.3.19.3 M2 Edge Sensors Pipeline Package

M2 Edge Sensors Pipeline Package

2.3.19.4 M2 Edge Sensors Calibration Package

M2 Edge Sensors Calibration Package

2.3.19.5 M2 Edge Sensors Sequence Package

M2 Edge Sensors Sequence Package

2.3.19.6 M2 Edge Sensors Diagnostics Package

M2 Edge Sensors Diagnostics Package

2.3.19.7 M2 Edge Sensors Workflow Package

M2 Edge Sensors Workflow Package

2.3.19.8 M2 Edge Sensors Visualization Package

M2 Edge Sensors Visualization Package

2.3.19.9 M2 Edge Sensors Management Package

M2 Edge Sensors Management Package

2.3.19.10 M2 Edge Sensors Hardware Package

M2 Edge Sensors Hardware Package

2.3.20 Adaptive Optics Calibration Interferometer Control System

The Adaptive Optics (AO) Calibration Interferometer Control System (ao_cal_interferometer_cs), used in conjunction with the AO retro-reflector at the prime focus forms a critical component of the AO System calibration suite. Used on the M2 Calibration Stand, it will provide the following functions: - Measure the figure of the ASM and FSM segments. - Test the functionality and performance of the M2 Positioner. - Verify the functionality and measure the influence functions of ASM actuators. - Measure the reference ASM flat shape. - Provide the ability to independently phase the ASM segments.

2.3.20.1 Adaptive Optics Calibration Interferometer Ctrl Package

Adaptive Optics Calibration Interferometer Ctrl Package

2.3.20.2 Adaptive Optics Calibration Interferometer Sequence Package

Adaptive Optics Calibration Interferometer Sequence Package

2.3.20.3 Adaptive Optics Calibration Interferometer Workflow Package

Adaptive Optics Calibration Interferometer Workflow Package

2.3.20.4 Adaptive Optics Calibration Interferometer Visualization Package

Adaptive Optics Calibration Interferometer Visualization Package

2.3.20.5 Adaptive Optics Calibration Interferometer Management Package

Adaptive Optics Calibration Interferometer Management Package

2.3.20.6 Adaptive Optics Calibration Interferometer Hardware Package

Adaptive Optics Calibration Interferometer Hardware Package

2.3.21 Laser Guide Star Facility Control System

The Laser Guide Star Facility (LGSF) Control System (lgsf_cs) includes seven independent control systems in total: six LGS Unit (LGSU) Control Systems and one LGS Acquisition System (LAS) Control System. Each LGSU has its own Control System which interfaces with the TCS, this Control System coordinates all internal operations for its LGSU. Each LGSU interacts with the Beam Conditioning and Diagnostic System through the shutter, jitter loop mirror and focus stage controllers; and with the Laser Launch Telescope through the LLT mechanism controller. The LAS Control Systems operates the LAS focuser motor and LAS shutter mechanism.

2.3.21.1 Laser Guidestar Facility Ctrl Package

Laser Guidestar Facility Ctrl Package

2.3.21.2 Laser Guidestar Facility Pipeline Package

Laser Guidestar Facility Pipeline Package

2.3.21.3 Laser Guidestar Facility Calibration Package

Laser Guidestar Facility Calibration Package

2.3.21.4 Laser Guidestar Facility Sequence Package

Laser Guidestar Facility Sequence Package

2.3.21.5 Laser Guidestar Facility Diagnostics Package

Laser Guidestar Facility Diagnostics Package

2.3.21.6 Laser Guidestar Facility Workflow Package

Laser Guidestar Facility Workflow Package

2.3.21.7 Laser Guidestar Facility Visualization Package

Laser Guidestar Facility Visualization Package

2.3.21.8 Laser Guidestar Facility Management Package

Laser Guidestar Facility Management Package

2.3.21.9 Laser Guidestar Facility Hardware Package

Laser Guidestar Facility Hardware Package

2.3.21.10 Las Ctrl Package

Las Ctrl Package

2.3.21.11 Las Data Acquisition System Package

Las Data Acquisition System Package

2.3.21.12 Las Pipeline Package

Las Pipeline Package

2.3.21.13 Las Calibration Package

Las Calibration Package

2.3.21.14 Las Sequence Package

Las Sequence Package

2.3.21.15 Las Diagnostics Package

Las Diagnostics Package

2.3.21.16 Las Workflow Package

Las Workflow Package

2.3.21.17 Las Visualization Package

Las Visualization Package

2.3.21.18 Las Management Package

Las Management Package

2.3.21.19 Las Hardware Package

Las Hardware Package

2.3.22 Secondary Mirror Calibration Facility Control System

The Secondary Mirror (M2) Calibration Facility Control System (m2cf_cs) supports the Fold Mirror 1 and Fold Mirror 2 adjustments at the Calibration Facility. The M2 Calibration Facility is a vertically-oriented optomechanical test stand which can support the GMT Top End Assembly, a Folded Port (FP) Science Instrument, and calibration sources. Its major functions are: - Optical testing and calibration of the ASM and FSM. - Integration and system-level testing of the Adaptive Optics System,

including the ASM, Visible Wavefront Sensor Subsystem, and On-Instrument Wavefront Sensor Subsystem.

- Integration of the Adaptive Optics System with an FP AO instrument.

2.3.22.1 M2cf Ctrl Package

M2cf Ctrl Package

2.3.22.2 M2cf Data Acquisition System Package

M2cf Data Acquisition System Package

2.3.22.3 M2cf Pipeline Package

M2cf Pipeline Package

2.3.22.4 M2cf Calibration Package

M2cf Calibration Package

2.3.22.5 M2cf Sequence Package

M2cf Sequence Package

2.3.22.6 M2cf Diagnostics Package

M2cf Diagnostics Package

2.3.22.7 M2cf Workflow Package

M2cf Workflow Package

2.3.22.8 M2cf Visualization Package

M2cf Visualization Package

2.3.22.9 M2cf Management Package

M2cf Management Package

2.3.22.10 M2cf Hardware Package

M2cf Hardware Package

2.3.23 Interlock and Safety System Control System

The Interlock and Safety System (ISS) Control System (iss_cs) interfaces with the GMT ISS, providing a supervisor to monitor the safety of the Observatory. The ISS provides an indication of any unsafe condition, and automatically controls safety interlocks, through a distributed safety network to remote I/O controllers that make discrete interface connections to various observatory systems. The ISS will communicate with the iss_cs using the cross-platform framework Open Process Control Unified Architecture (OPC UA) for coordinating control functions, and providing status information.

2.3.23.1 Interlock and Safety System Ctrl Package

Interlock and Safety System Ctrl Package

2.3.23.2 Interlock and Safety System Visualization Package

Interlock and Safety System Visualization Package

2.3.23.3 Interlock and Safety System Sequence Package

Interlock and Safety System Sequence Package

2.3.23.4 Interlock and Safety System Diagnostics Package

Interlock and Safety System Diagnostics Package

2.3.23.5 Interlock and Safety System Workflow Package

Interlock and Safety System Workflow Package

2.3.23.6 Interlock and Safety System Management Package

Interlock and Safety System Management Package

2.3.23.7 Interlock and Safety System Hardware Package

Interlock and Safety System Hardware Package

2.4 Pointing and Wavefront Control Kernels

The telescope control system (TCS) provides the software and hardware necessary to efficiently operate, monitor, calibrate, diagnose and control the optomechanical system of the GMT system.

2.4.1 Pointing Kernel System

The telescope pointing kernel is the Subsystem that performs essential services to point the telescope to a desired sky location, to track the sky rotation, and to provide fine guiding on a target. The outputs of the pointing kernel are mechanical encoder values that are used to command repositioning of the mount and the instrument rotator. The GMT pointing kernel is built on the TCSpk, tpk, and SLALIB, packages developed by Tpoint Software.

2.4.1.1 Pointing Kernel Control Package

2.4.1.2 Pointing Kernel System Visualization Package

Pointing Kernel System Visualization Package

2.4.1.3 Pointing Kernel System Sequence Package

Pointing Kernel System Sequence Package

2.4.1.4 Pointing Kernel System Diagnostics Package

Pointing Kernel System Diagnostics Package

2.4.1.5 Pointing Kernel System Calibration Package

Pointing Kernel System Calibration Package

2.4.1.6 Pointing Kernel System Workflow Package

Pointing Kernel System Workflow Package

2.4.1.7 Pointing Kernel System Management Package

Pointing Kernel System Management Package

2.4.1.8 Pointing Kernel System Hardware Package

Pointing Kernel System Hardware Package

2.4.2 Wavefront Control Active Optics (ACO) System

Wavefront Control Active Optics (ACO) System

2.4.2.1 Active Optics Controller Package

The WFC Active Optics Controller Package includes active optics controller components that are common to the different GMT wavefront control modes.

2.4.2.2 Wavefront Control Active Optics (ACO) Calibration Package

Wavefront Control Active Optics (ACO) Calibration Package

2.4.2.3 Wavefront Control Active Optics (ACO) Diagnostics Package

Wavefront Control Active Optics (ACO) Diagnostics Package

2.4.2.4 Wavefront Control Active Optics (ACO) Sequence Package

Wavefront Control Active Optics (ACO) Sequence Package

2.4.2.5 Wavefront Control Active Optics (ACO) Analysis Package

Wavefront Control Active Optics (ACO) Analysis Package

2.4.2.6 Wavefront Control Active Optics (ACO) Visualization Package

Wavefront Control Active Optics (ACO) Visualization Package

2.4.2.7 Wavefront Control Active Optics (ACO) Workflow Package

Wavefront Control Active Optics (ACO) Workflow Package

2.4.2.8 Wavefront Control Active Optics (ACO) Management Package

Wavefront Control Active Optics (ACO) Management Package

2.4.2.9 Wavefront Control Active Optics (ACO) Hardware Package

Wavefront Control Active Optics (ACO) Hardware Package

2.4.3 Wavefront Control Natural Seeing (NS) System

Wavefront Control Natural Seeing (NS) System

2.4.3.1 GMT WFC Natural Seeing package

The GMT WFC Natural Seeing package provides the software and hardware necessary to implement the wavefront control in the natural seeing mode.

2.4.3.2 Wavefront Control Natural Seeing (NS) Calibration Package

Wavefront Control Natural Seeing (NS) Calibration Package

2.4.3.3 Wavefront Control Natural Seeing (NS) Diagnostics Package

Wavefront Control Natural Seeing (NS) Diagnostics Package

2.4.3.4 Wavefront Control Natural Seeing (NS) Analysis Package

Wavefront Control Natural Seeing (NS) Analysis Package

2.4.3.5 Wavefront Control Natural Seeing (NS) Visualization Package

Wavefront Control Natural Seeing (NS) Visualization Package

2.4.3.6 Wavefront Control Natural Seeing (NS) Workflow Package

Wavefront Control Natural Seeing (NS) Workflow Package

2.4.3.7 Wavefront Control Natural Seeing (NS) Management Package

Wavefront Control Natural Seeing (NS) Management Package

2.4.4 Wavefront Control Natural Guidestar Ground Layer Adaptive Optics System

Wavefront Control Natural Guidestar Ground Layer Adaptive Optics System

2.4.4.1 GLAO Controller Package

The WFC NGLAO Controller Package includes controller components that implement functionality specific to the GMT NGLAO observing mode.

2.4.4.2 Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Supervisor Package

Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Supervisor Package

2.4.4.3 Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Calibration Package

Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Calibration Package

2.4.4.4 Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Diagnostics Package

Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Diagnostics Package

2.4.4.5 Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Analysis Package

Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Analysis Package

2.4.4.6 Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Visualization Package

Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Visualization Package

2.4.4.7 Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Workflow Package

Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Workflow Package

2.4.4.8 Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Management Package

Wavefront Control Natural Guidestar Ground Layer Adaptive Optics Management Package

2.4.5 Wavefront Control Natural Guidestar Adaptive Optics System

Wavefront Control Natural Guidestar Adaptive Optics System

2.4.5.1 NGSAO Controller Package

The WFC NGSAO Controller Package includes controller components that implement functionality specific to the GMT NGSAO observing mode.

2.4.5.2 Wavefront Control Natural Guidestar Adaptive Optics Supervisor Package

Wavefront Control Natural Guidestar Adaptive Optics Supervisor Package

2.4.5.3 Wavefront Control Natural Guidestar Adaptive Optics Calibration Package

Wavefront Control Natural Guidestar Adaptive Optics Calibration Package

2.4.5.4 Wavefront Control Natural Guidestar Adaptive Optics Diagnostics Package

Wavefront Control Natural Guidestar Adaptive Optics Diagnostics Package

2.4.5.5 Wavefront Control Natural Guidestar Adaptive Optics Analysis Package

Wavefront Control Natural Guidestar Adaptive Optics Analysis Package

2.4.5.6 Wavefront Control Natural Guidestar Adaptive Optics Visualization Package

Wavefront Control Natural Guidestar Adaptive Optics Visualization Package

2.4.5.7 Wavefront Control Natural Guidestar Adaptive Optics Workflow Package

Wavefront Control Natural Guidestar Adaptive Optics Workflow Package

2.4.5.8 Wavefront Control Natural Guidestar Adaptive Optics Management Package

Wavefront Control Natural Guidestar Adaptive Optics Management Package

2.4.6 Wavefront Control Laser Tomography Adaptive Optics System

Wavefront Control Laser Tomography Adaptive Optics System

2.4.6.1 Wavefront Control Laser Tomography Adaptive Optics Fast Ctrl Package

Wavefront Control Laser Tomography Adaptive Optics Fast Ctrl Package

2.4.6.2 Wavefront Control Laser Tomography Adaptive Optics Supervisor Package

Wavefront Control Laser Tomography Adaptive Optics Supervisor Package

2.4.6.3 Wavefront Control Laser Tomography Adaptive Optics Calibration Package

Wavefront Control Laser Tomography Adaptive Optics Calibration Package

2.4.6.4 Wavefront Control Laser Tomography Adaptive Optics Diagnostics Package

Wavefront Control Laser Tomography Adaptive Optics Diagnostics Package

2.4.6.5 Wavefront Control Laser Tomography Adaptive Optics Analysis Package

Wavefront Control Laser Tomography Adaptive Optics Analysis Package

2.4.6.6 Wavefront Control Laser Tomography Adaptive Optics Visualization Package

Wavefront Control Laser Tomography Adaptive Optics Visualization Package

2.4.6.7 Wavefront Control Laser Tomography Adaptive Optics Workflow Package

Wavefront Control Laser Tomography Adaptive Optics Workflow Package

2.4.6.8 Wavefront Control Laser Tomography Adaptive Optics Management Package

Wavefront Control Laser Tomography Adaptive Optics Management Package

2.5 Observatory Operations System

The Observatory Operations System (OPS) provides the high level software to support an efficient operation of the GMT observatory.

2.5.1 Operations User Interface

The Operations User Interface (OPUI) provides an integrated way to support GMT operations. While the engineering user interfaces provide comprehensive access to the functionality of any subsystem, the OPUI supports the operational workflows of the Observatory.

2.5.1.1 User Interface Service Package

User Interface Service Package

2.5.1.2 User Interface Visualization Package

User Interface Visualization Package

2.5.1.3 User Interface Diagnostics Package

User Interface Diagnostics Package

2.5.1.4 User Interface Workflow Package

User Interface Workflow Package

2.5.1.5 User Interface Management Package

User Interface Management Package

2.5.1.6 User Interface Hardware Package

User Interface Hardware Package

2.5.2 Observing Tools

The Observing Tools subsystem (OT) is composed of several components that can be invoked in different context during the observation life cycle. The OT components provide the following capabilities like model synthesis, astronomy source catalog database interface, sky calculator, overhead time calculator, airmass calculator, asterism facility, guide star finder, object observability, positional astronomy facility, mosaic creation, model database, AO PSF simulator, spectroscopy mask facility and observing data management.

2.5.2.1 Observing Tools Visualization Package

Observing Tools Visualization Package

2.5.2.2 Observing Tools Sequence Package

Observing Tools Sequence Package

2.5.2.3 Observing Tools Diagnostics Package

Observing Tools Diagnostics Package

2.5.2.4 Observing Tools Workflow Package

Observing Tools Workflow Package

2.5.2.5 Observing Tools Management Package

Observing Tools Management Package

2.5.2.6 Observing Tools Hardware Package

Observing Tools Hardware Package

2.5.3 Scheduler

The scheduling system facilitates the creation and maintenance of the operational schedule of the telescope, including observing schedules, engineering, and maintenance schedules.

2.5.3.1 Scheduling Server

2.5.3.2 Visualization Package

2.5.3.3 Scheduler Diagnostics Package

Scheduler Diagnostics Package

2.5.3.4 Scheduler Workflow Package

Scheduler Workflow Package

2.5.3.5 Scheduler Management Package

Scheduler Management Package

2.5.3.6 Scheduler Hardware Package

Scheduler Hardware Package

2.5.4 Sequencer

The sequencer subsystem provides the capability to automate high-level observatory operations that involve the coordination of many subsystems.

2.5.4.1 Sequence Service Package

Sequence Service Package

2.5.4.2 Sequence Visualization Package

Sequence Visualization Package

2.5.4.3 Sequence Natural Seeing (NS) Package

Sequence Natural Seeing (NS) Package

2.5.4.4 Sequence Natural Guidestar Ground Layer Adaptive Optics Package

Sequence Natural Guidestar Ground Layer Adaptive Optics Package

2.5.4.5 Sequence Natural Guidestar Adaptive Optics Package

Sequence Natural Guidestar Adaptive Optics Package

2.5.4.6 Sequence Laser Tomography Adaptive Optics Package

Sequence Laser Tomography Adaptive Optics Package

2.5.4.7 Sequence Diagnostics Package

Sequence Diagnostics Package

2.5.4.8 Sequence Workflow Package

Sequence Workflow Package

2.5.4.9 Sequence Management Package

Sequence Management Package

2.5.4.10 Sequence Hardware Package

Sequence Hardware Package

2.5.5 Aircraft Safety System

The Aircraft Safetu System (as_sys) provides and interface with the VITRO system. The VITRO system (Visualizacion de Transito Aereo Oceanico) shows in real-time a feed of aircraft locations, with their altitude, velocity and flight direction, similar the one used by air traffic controllers. The VITRO system is available from accredited vendors by the Chilean Direccion General de Aeronautica Civil (DGAC), the Chilean equivalent of the Federal Aviation Administration (FAA) in US. GMTO will contract with VITRO system vendors to provide the system, and to explore the possibility of interfacing with the data feed. This could allow for automation of the telescope control system to trigger appropriate alarms and shuttering of the laser beacons in the event of an impending collision between a laser beam and an aircraft.

2.5.5.1 Aircraft Safety System Service Package

Aircraft Safety System Service Package

2.5.5.2 Aircraft Safety System Visualization Package

Aircraft Safety System Visualization Package

2.5.5.3 Aircraft Safety System Sequence Package

Aircraft Safety System Sequence Package

2.5.5.4 Aircraft Safety System Diagnostics Package

Aircraft Safety System Diagnostics Package

2.5.5.5 Aircraft Safety System Workflow Package

Aircraft Safety System Workflow Package

2.5.5.6 Aircraft Safety System Management Package

Aircraft Safety System Management Package

2.5.5.7 Aircraft Safety System Hardware Package

Aircraft Safety System Hardware Package

2.5.6 Laser Traffic Control System

Distributed among participating telescopes, the LTCS collects pointing data, laser propagating and laser impact status for all the telescopes. The information is made available by all the telescopes at predefined URLs. The LTCS predicts whether beam collision will occur between observatories based on a geometric model of the telescopes and their pointing field of view.

2.5.6.1 Laser Traffic Control System Service Package

Laser Traffic Control System Service Package

2.5.6.2 Laser Traffic Control System Visualization Package

Laser Traffic Control System Visualization Package

2.5.6.3 Laser Traffic Control System Sequence Package

Laser Traffic Control System Sequence Package

2.5.6.4 Laser Traffic Control System Diagnostics Package

Laser Traffic Control System Diagnostics Package

2.5.6.5 Laser Traffic Control System Workflow Package

Laser Traffic Control System Workflow Package

2.5.6.6 Laser Traffic Control System Management Package

Laser Traffic Control System Management Package

2.5.6.7 Laser Traffic Control System Hardware Package

Laser Traffic Control System Hardware Package

2.5.7 Spacecraft Safety System

The Spacecraft Safety System includes the software to integrate the interface with the LCH in the observatory operation workflow during observations that require laser guide stars. Basic compliance requires the observatory to send a list of LGS targets a few days in advance, and to obtain clearance, from the Laser Clearinghouse (LCH). The process is handled by e-mail using a data format that can seamlessly integrate into the observatory database, planning tool, and sequencer.

2.5.7.1 Spacecraft Safety System Service Package

Spacecraft Safety System Service Package

2.5.7.2 Spacecraft Safety System Visualization Package

Spacecraft Safety System Visualization Package

2.5.7.3 Spacecraft Safety System Sequence Package

Spacecraft Safety System Sequence Package

2.5.7.4 Spacecraft Safety System Diagnostics Package

Spacecraft Safety System Diagnostics Package

2.5.7.5 Spacecraft Safety System Workflow Package

Spacecraft Safety System Workflow Package

2.5.7.6 Spacecraft Safety System Management Package

Spacecraft Safety System Management Package

2.5.7.7 Spacecraft Safety System Hardware Package

Spacecraft Safety System Hardware Package

2.5.8 Quality Monitoring System

The quality monitoring system watches over data being produced or coming from the telescope to facilitate proper and efficient operations. Quality monitoring entails performing analysis on data coming from telescope subsystems, telemetry, detectors, facility, and instruments, and compares the results against baseline, nominal, benchmarks that are established for each subsystem. In normal circumstances, the performance results are time stamped and stored in the database for future reference. However, in critical circumstances, the results of quality monitoring may trigger warnings or alarms that call for immediate attention.

2.5.8.1 Quality Monitoring Server Package

2.5.8.2 Quality Monitoring Visualization Package

2.5.8.3 Quality Monitoring Sequencing Package

2.5.8.4 Quality Monitoring Diagnostics Package

Quality Monitoring Diagnostics Package

2.5.8.5 Quality Monitoring Workflow Package

Quality Monitoring Workflow Package

2.5.8.6 Quality Monitoring Management Package

Quality Monitoring Management Package

2.5.8.7 Quality Monitoring Hardware Package

Quality Monitoring Hardware Package

2.5.9 Data Archiving System

The data archiving system (DAS) manages, stores, and distributes all data products related to the operations of the observatory. All the data in the DAS are maintained on-site at the observatory for operations, and are backed up in at least one off-site location.

2.5.9.1 Data Archiving Server

2.5.9.2 Visualization Package

2.5.9.3 Sequencing Package

2.5.9.4 Diagnosis Package

2.5.9.5 Data Archiving Workflow Package

Data Archiving Workflow Package

2.5.9.6 Data Archiving Management Package

Data Archiving Management Package

2.5.9.7 Data Archiving Hardware Package

Data Archiving Hardware Package

2.5.10 Data Processing System

Data from the observatory, whether science data, engineering, environment, facility, etc., often need to be processed before being used. The data processing system comprises a set of components that takes input data, then performs processing, analysis, summary, or conversion, to produce useful information. For raw science and detector data, this may mean applying calibrations to the data. For telescope pointing information, that may mean performing statistical summary of the pointing accuracy.

2.5.10.1 Data Processing Server

2.5.10.2 Visualization Package

2.5.10.3 Sequencing Package

2.5.10.4 Data Processing Diagnostics Package

Data Processing Diagnostics Package

2.5.10.5 Data Processing Workflow Package

Data Processing Workflow Package

2.5.10.6 Data Processing Management Package

Data Processing Management Package

2.5.10.7 Data Processing Hardware Package

Data Processing Hardware Package

2.6 Observatory Common Services

The Observatory Services System (OBS_SRV) provides the common infrastructure that enables TCS and Observatory Operations components to communicate and collaborate in order to perform high-level operations, control and monitoring. Additionally, some of these services include components that allow self-monitoring of their own operation.

2.6.1 Engineering User Interface Service

The Engineering user interface subsystem provides a low level detailed graphical interface to the GMT system. This interface is not optimized for scientific operations, and is used in collaboration with the Command Line Interface (CLI) service during the development, testing, integration, and commissioning phases of the GMT subsystems.

2.6.1.1 Engineering User Interface Service Package

Engineering User Interface Service Package

2.6.1.2 Engineering User Interface Visualization Package

Engineering User Interface Visualization Package

2.6.1.3 Engineering User Interface Sequence Package

Engineering User Interface Sequence Package

2.6.1.4 Engineering User Interface Diagnostics Package

Engineering User Interface Diagnostics Package

2.6.1.5 Engineering User Interface Workflow Package

Engineering User Interface Workflow Package

2.6.1.6 Engineering User Interface Management Package

Engineering User Interface Management Package

2.6.1.7 Engineering User Interface Hardware Package

Engineering User Interface Hardware Package

2.6.2 Logging Service

Logging messages are informative messages. They inform that a relevant event concerning the GMT normal operation has occurred. They do not presume any abnormal behaviour. For example, a User has logged on the GMT, or an observation has just been completed.

2.6.2.1 Log Service Package

Log Service Package

2.6.2.2 Logging Visualization Package

Logging Visualization Package

2.6.2.3 Logging Sequence Package

Logging Sequence Package

2.6.2.4 Logging Analysis Package

Logging Analysis Package

2.6.2.5 Logging Workflow Package

Logging Workflow Package

2.6.2.6 Logging Management Package

Logging Management Package

2.6.2.7 Logging Hardware Package

Logging Hardware Package

2.6.3 Alarm Service

The alarm system in combination with the system supervisor and the ISS are provide functions to guarantee the overall health of the system.

2.6.3.1 Alarm Service Package

Server, adapter specification

2.6.3.2 Alarm Service Visualization Package

The visualization package provides custom panels that allow observatory operators to monitor and manage the alarms of the system. This is done implementing several optimize visulizations.

2.6.3.3 Alarm Sequence Package

Alarm Sequence Package

2.6.3.4 Alarm Analysis Package

Alarm Analysis Package

2.6.3.5 Alarm Workflow Package

Alarm Workflow Package

2.6.3.6 Alarm Management Package

Alarm Management Package

2.6.3.7 Alarm Hardware Package

Alarm Hardware Package

2.6.4 Telemetry Service

The Telemetry Service provides the ability to observe the value of any selected magnitudes. The magnitude whose value is to be observed may belong to any hardware or software subsystem.

2.6.4.1 Telemetry Service Package

Telemetry Service Package

2.6.4.2 Telemetry Visualization Package

Telemetry Visualization Package

2.6.4.3 Telemetry Sequence Package

Telemetry Sequence Package

2.6.4.4 Telemetry Analysis Package

Telemetry Analysis Package

2.6.4.5 Telemetry Workflow Package

Telemetry Workflow Package

2.6.4.6 Telemetry Management Package

Telemetry Management Package

2.6.4.7 Telemetry Hardware Package

Telemetry Hardware Package

2.6.5 Configuration Service

The properties / behaviors of all SWC Subsystems and Components are stored as sets of static properties or metadata in a Configuration Database. Operators or subsystem specialists need to change these properties, so it is not convenient to have them hardcoded. Instead, the configuration Service manages and modifies the behavior of the subsystems and components. Configurations can be changed as a whole, depending on the operation mode (e.g., different values on limits may be used for testing and calibration than during nominal operation).

2.6.5.1 Configuration Service Package

Configuration Service Package

2.6.5.2 Configuration Visualization Package

Configuration Visualization Package

2.6.5.3 Configuration Sequence Package

Configuration Sequence Package

2.6.5.4 Configuration Analysis Package

Configuration Analysis Package

2.6.5.5 Configuration Workflow Package

Configuration Workflow Package

2.6.5.6 Configuration Management Package

Configuration Management Package

2.6.5.7 Configuration Hardware Package

Configuration Hardware Package

2.6.6 Command Execution Service

The Command Line Interface (CLI) complements the graphic user interfaces used for both engineering and operations. It provides low-level access to all the system functionality, and the flexibility often required during testing and commissioning phases. The CLI also provides a way to operate subsystems in early stages of development, when the UI is still being developed and does not provide all the functionality.

2.6.6.1 Command Line Interface Service Package

Command Line Interface Service Package

2.6.6.2 Command Line Interface Visualization Package

Command Line Interface Visualization Package

2.6.6.3 Command Line Interface Sequence Package

Command Line Interface Sequence Package

2.6.6.4 Command Line Interface Management Package

Command Line Interface Management Package

2.6.7 On-line Documentation Service

The on-line documentation subsystem provides access to the user guides and manual necessary for the operation of the SWCS system. It also provides access to the runtime metadata.

2.6.7.1 Document Service Package

Document Service Package

2.6.7.2 Document Visualization Package

Document Visualization Package

2.6.7.3 Document Sequence Package

Document Sequence Package

2.6.7.4 Document Analysis Package

Document Analysis Package

2.6.7.5 Document Workflow Package

Document Workflow Package

2.6.7.6 Document Management Package

Document Management Package

2.6.8 System Supervisor Service

The GMT has a large number of distributed Subsystems and Components that are deployed in different computers or embedded units to implement telescope control functions. Each Subsystem is required to deploy a Supervisor to coordinate, monitor, and manage, the health status of its respective software and hardware Components. In order to guarantee reliability it is important to monitor and manage the overall health of these Supervisors and Components. The System Supervisor is thus in charge of the overall health of the system by watching over the hierarchy. It ensures that the system as a whole can handle fault tolerance, service availability, and failure detection, thus ensuring the overall robustness.

2.6.8.1 Supervisor Service Package

Supervisor Service Package

2.6.8.2 SuperVisualizationor vis Package

SuperVisualizationor vis Package

2.6.8.3 Supervisor Sequence Package

Supervisor Sequence Package

2.6.8.4 Supervisor Analysis Package

Supervisor Analysis Package

2.6.8.5 Supervisor Workflow Package

Supervisor Workflow Package

2.6.8.6 Supervisor Management Package

Supervisor Management Package

2.6.8.7 Supervisor Hardware Package

Supervisor Hardware Package

2.6.9 Network Infrastructure

The Network Infrastructure subsystem provides the network equipment and cabling neccessary for the operation of the SWCS. It also includes the software neccesary to manage and interface networking equipment. A combination of multi-fiber trunks and breakout cables provides galvanic isolation between the different equipment installed in the electronics room and the telescope enclosure. The network layout is based on a switching fabric layout common in High Performance Computing applications.

2.6.9.1 Network Service Package

Network Service Package

2.6.9.2 Network Visualization Package

Network Visualization Package

2.6.9.3 Network Sequence Package

Network Sequence Package

2.6.9.4 Network Analysis Package

Network Analysis Package

2.6.9.5 Network Workflow Package

Network Workflow Package

2.6.9.6 Network Management Package

Network Management Package

2.6.9.7 Network Hardware Package

Network Hardware Package

2.7 Instrument Device Control System

Instrument Device Control System

2.7.1 GCLEF Device Control System

GMTIFS Data Acquisition Package

2.7.1.1 GMTIFS Calibration Package

GMTIFS Calibration Package

2.7.1.2 GMTIFS Diagnostics Package

GMTIFS Diagnostics Package

2.7.1.3 GMTIFS Observing Tools Package

GMTIFS Observing Tools Package

2.7.1.4 GMTIFS Visualization Package

GMTIFS Visualization Package

2.7.1.5 GMTIFS Sequence Package

GMTIFS Sequence Package

2.7.1.6 GMTIFS Workflow Package

GMTIFS Workflow Package

2.7.1.7 GMTIFS Management Package

GMTIFS Management Package

2.7.1.8 GMTIFS Hardware Package

GMTIFS Hardware Package

2.7.1.9 GMTIFS FAT Package

GMTIFS FAT Package

2.7.2 GCLEF Device Control System

2.7.3 Hardware Developer Kit Control System

The Hardware Developers Kit (HDK) is a hardware platform that embodies a basic Device Control System that complies with the GMT DCS Reference Architecture (RA)

2.7.3.1 HDK Controller Package

HDK Controller Package

2.7.3.2 HDK Calibration Package

HDK Calibration Package

List of Figures

List of Tables