Interface Control Document

TELESCOPE CONTROL SYSTEM(TCS)

TMT

THIRTY METER TELESCOPE

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TELESCOPE CONTROL SYSTEM(TCS)

This document describes the API for the TMT Telescope Control System. The main functions of the TCS are: 1) A command sequencer to control, synchronize, and monitor the telescope subsystems. 2) A pointing model to convert target RA and DEC positions into corrected subsystem demands. 3) wavefront control software for seeing limited instruments and blending AO offloads. The TCS provides high level control for the telescope mount, enclosure, M1, M2, M3, instrument components (rotators, WFS probes, ADCs),the Global Metrology System (GMS), and the Commissioning and Acquisition System (CAGS). The TCS provides coordination of the following operating modes: initialization, slewing, pointing, acquisition, tracking, guiding, nodding/dithering, and halting. The TCS is synchronized with the instruments and AO systems via the Observatory Control Software.

Telescope Pointing Kernel Assembly

Pointing Kernel Assembly is responsible for receiving target and offset commands. Based on targets received assembly will produce stream of target demands that will be used by tracking mechanism in Mount,Enclouser,Rotator,Guiders,Probes etc. Pointing Kernel Assembly utilizes C++ based third party libraries like tpk,slalib,tcspk.

Subsyatem	Name	Prefix	Type	WBS ID
TCS	PointingKernelAssembly	TCS.PK.PKA	Assembly	tmt.tel.cont.tcs.tpk

Items Published by PointingKernelAssembly

Events Published by PointingKernelAssembly

Events: MountDemandPosition

This event describes target positions for mount AZ and EL axis.

Archive
no

Attributes for MountDemandPosition

Name	Description	Type	Units
trackID	This is the Tracking ID for Demand Generated	string	
az_pos	This is the Mount Azimuth Position in Degree	double	deg
el_pos	This is the Mount Elevation Position in Degree	double	deg
time	This is the Time at which the demand will be valid	double	

Events: EnclosureDemandPosition

This event describes target base and cap positions for enclosures

Archive
no

Attributes for EnclosureDemandPosition

Name	Description	Type	Units
trackID	This is the Tracking ID for Demand Generated	string	
BasePosition	This is the ENC Base Position in Degree	double	deg
CapPosition	This is the ENC Cap Position in Degree	double	deg
time	This is the Time at which the demand will be valid	double	

Events: M3DemandPosition

This event describes target position for M3 mirror

Archive
no

Attributes for M3DemandPosition

Name	Description	Type	Units
trackID	This is the Tracking ID for Demand Generated	string	
RotationPosition	This is the M3 Rotation Position in Degree	double	deg
TiltPosition	This is the M3 tilt Position in Degree	double	deg
time	This is the Time at which the demand will be valid	double	

Events: RotatorDemandPosition

This event describes target position for rotator

Archive
no

Attributes for RotatorDemandPosition

Name	Description	Type	Units
trackID	This is the Tracking ID for Demand Generated	string	
RMA	This is the Rotator Mechanical Angle	double	deg
time	This is the Time at which the demand will be valid	double	

Events: GuiderDemandPosition

This event describes target position for guider

Archive
no

Attributes for GuiderDemandPosition

Name	Description	Type	Units
trackID	This is the Tracking ID for Demand Generated	string	
XPosition	This is the x Position for guider	double	deg
YPosition	This is the y Position for guider	double	
time	This is the Time at which the demand will be valid	double	

Events: Probe1DemandPosition

This event describes target position for Probe1

Archive
no

Attributes for Probe1DemandPosition

Name	Description	Type	Units
trackID	This is the Tracking ID for Demand Generated	string	
XPosition	This is the x Position for probe1	double	deg
YPosition	This is the y Position for probe1	double	
time	This is the Time at which the demand will be valid	double	

Events: Probe2DemandPosition

This event describes target position for Probe2

Archive
no

Attributes for Probe2DemandPosition

Name	Description	Type	Units
trackID	This is the Tracking ID for Demand Generated	string	
XPosition	This is the x Position for Probe2	double	deg
YPosition	This is the y Position for Probe2	double	
time	This is the Time at which the demand will be valid	double	

Events: Probe3DemandPosition

This event describes target position for Probe3

Archive
no

Attributes for Probe3DemandPosition

Name	Description	Type	Units
trackID	This is the Tracking ID for Demand Generated	string	
XPosition	This is the x Position for Probe3	double	deg
YPosition	This is the y Position for Probe3	double	
time	This is the Time at which the demand will be valid	double	

Events: AssemblyState

This event describes operational and lifecycle state of pointing kernel assembly

Archive
no

Attributes for AssemblyState

Name	Description	Type
OperationalState	This is the operational state for Pointing Kernel	enum: (Ready, Running, Slewing, Halted, Tracking, Degraded, Disconnected, Faulted)
LifecycleState	This is the lifecycle state for Pointing Kernel.	enum: (Initalized, Running, RunnuingOnline, RunningOffline, Shutdown)
time	This is the Time at which assembly state is published	double

Events: TimeToLimits

Pointing Kernel will publish time to limits i.e. Zenith blind spot, Elevation lower limit, Azimuth limit and Cable wrap limits through this event

Archive
no

Attributes for TimeToLimits

Name	Description	Type
ZenithBlindSpot	This is the time left to reach Zenith Blind Spot Limit	double
ElevationLowerLimit	This is the time left to reach Elevation Lower Limit	double
AzimuthLimit	This is the time left to reach Azimuth Limit	double
CableWrapLimit	This is the time left to reach Cable Wrap Limit	double

Events: CurrentPosition

Pointing Kernel will publish current telescope position through this event

Archive
no

Attributes for CurrentPosition

Name	Description	Type	Units
Epoch	This is the current Epoch value	double	
Equinox	This is the current Equinox value	double	
telfocus	This is the Telescope focus value	double	
Fratio	This is the F-Ratio value	double	
Ut	This is the current Universal Time	double	
Lst	This is the current Local Sidereal Time	double	
Mjd	This is the current Modified Julian Date	double	
Date	This is the current Date	double	
Ratel	This is the current telescope RA	double	
Dectel	This is the current telescope DEC	double	
Ha	This is the current telescope Hour Angle	double	
telaz	This is the current telescope Azimuth	double	deg
telat	This is the current telescope Altitude	double	deg
Airmass	This is the current Airmass value	double	
parang	This is the current Parallactic Angle value	double	deg
pa	This is the current Position Angle with reference to whether slit aligned or not slit aligned	double	deg
time	This is the timestamp for the data	double	

Events: NewTelescopePosition

Pointing Kernel will publish destination telescope position through this event

Archive
no

Attributes for NewTelescopePosition

Name	Description	Type	Units
counter	This is the time left to reach Zenith Blind Spot Limit	double	
ra	This is the New target right ascension	double	deg
dec	This is the New target declination	double	deg
Az	This is the New target Azimuth	double	deg
El	This is the New target Elevation	double	deg
z	This is the New target Zenith Angle	double	deg
time	This is the timestamp for the data	double	

Events: WCSFITSHeader

Pointing Kernel will publish steady state stream of WCS FITS headers through this event

Archive
no

Attributes for WCSFITSHeader

Name	Description	Type	Units
CTYPE1	This is the Projection type RA---TAN	double	
CTYPE2	This is the Projection type DEC—TAN	double	
CRPIX1	This is the X coordinate of the reference pixel in the image	double	deg
CRPIX2	This is the Y coordinate of the reference pixel in the image	double	deg
CRVAL1	This is the Right ascension at the reference pixel	double	
CRVAL2	This is the Declination at the reference pixel	double	
CD1_1	This is the Transformation matrix element 1,1	double	
CD1_2	This is the Transformation matrix element 1,2	double	
CD2_1	This is the Transformation matrix element 2,1	double	
CD2_2	This is the Transformation matrix element 2,2	double	
RADECSYS	This is the Frame type	double	

Events: OnDemandWCSFITSHeader

Pointing Kernel will publish WCS FITS headers in response to Get WCS Snapshot command through this event

Archive
no

Attributes for OnDemandWCSFITSHeader

Name	Description	Type	Units
CTYPE1	This is the Projection type RA---TAN	double	
CTYPE2	This is the Projection type DEC—TAN	double	
CRPIX1	This is the X coordinate of the reference pixel in the image	double	deg
CRPIX2	This is the Y coordinate of the reference pixel in the image	double	deg
CRVAL1	This is the Right ascension at the reference pixel	double	
CRVAL2	This is the Declination at the reference pixel	double	
CD1_1	This is the Transformation matrix element 1,1	double	
CD1_2	This is the Transformation matrix element 1,2	double	
CD2_1	This is the Transformation matrix element 2,1	double	
CD2_2	This is the Transformation matrix element 2,2	double	
RADECSYS	This is the Frame type	double	

Alarms published by PointingKernelAssembly

Name	Description	Severity	Archive
pointingKernelCommunicationFailure	Pointing Kernel will be configured to generate an alarm in case it is not able to access tpk or slalib library or there is some error in communication with same	major	true
cablewrapLimitReached	Pointing Kernel will be configured to generate an alarm in case cable wrap limit is reached or is within some configured limits	major	true
azLimitReached	Pointing Kernel will be configured to continuously monitor the current Az position and compares it to the configured limit. If the current position surpasses or is reaching the configured limits, it raises an alarm	major	true
elLimitReached	Pointing Kernel will be configured to continuously monitor the current El position and compares it to the configured limit. If the current position surpasses or is reaching the configured limits, it raises an alarm	major	true

Commands for PointingKernelAssembly

TCS Pointing Kernel Assembly commands.

Configuration: SlewToTarget

Requirements:

This command slews telescope to target position.

Arguments:

Name	Description	Type	Required
Type	Its value can be science target or guide start target	enum: (science, guide)	no
Refframe	Its value can be ICRS/FK5/AZEL/APPT/ or Planet/AsAmajorPlanet	enum: (ICRS, FK5, AZEL, APPT, Planet, AsAmajorPlanet)	no
RA	ra paramter value	string	no
DEC	dec paramter value	string	no
Epoch	epoch paramter value	string	no
ProperMotionInRA	ProperMotionInRA paramter value	string	no
ProperMotionInDEC	ProperMotionInDEC paramter value	string	no
RadialVelocity	RadialVelocity paramter value	string	no

Configuration: SetOffSet

Requirements:

This command sets offset to target position.

Arguments:

Name	Description	Type	Required
Type	Its value can be target/guider/instrument/pointingorigin	enum: (Target, Guider, Instrument, PointingOrigin)	yes
Refframe	This is the reference frame system that needs to be applied on offset values. It will be required only in case of type is target	string	yes
Xcoordinate	This is the offset value for x coordinate	double	yes
Ycoordinate	This is the offset value for y coordinate	double	yes
Relativeto	Its value can be base or current. In case parameter value is not provided, then the value for “Offset relative to” assembly configuration will be considered for applying the offset	enum: (Base, Current)	yes

Configuration: SetPointingModel

Requirements:

This command selects specific pointing model file from the configuration service.

Arguments:

Name	Description	Type	Required
Name	Name of the pointing model file	string	yes

Configuration: SetCollimationOffset

Requirements:

This command applys the collimation offsets to the pointing model

Arguments:

Name	Description	Type	Required
Ca	This is the offset to the CA term	double	no
Ce	This is the offset to the CE term	string	no
CollimationSource	Its value can be current or session. In case of "current", ca/ce values being passed will be used and in case of "session", ca/ce values stored using absorb offset command will be used.	enum: (Current, Session)	no

Configuration: SetPointingOrigin

Requirements:

This command sets or changes pointing origin.

Arguments:

Name	Description	Type	Required
Name	Name of selected pointing origin	enum: (Azimuth, Elevation, BOTH)	yes
Xposition	This is the position in focal planes x axis where pointing origin needs to be set.	double	yes
Yposition	This is the position in focal planes y axis where pointing origin needs to be set.	double	yes

Configuration: SetInstrument

Requirements:

This command sets an instrument for observation

Arguments:

Name	Description	Type	Required
Name	Axes whose servo needs to be turned on or off	enum: (Azimuth, Elevation, BOTH)	yes

Configuration: SetRotatorMode

Requirements:

This command sets rotator mode i.e. either Vertical or Position Angle mode

Arguments:

Name	Description	Type	Required
mode	This parameter will help in setting the rotator mode.	enum: (Vertical, Position)	yes

Configuration: SetInstrumentPositionAngle

Requirements:

This command sets instrument position angle for instrument to be used for observation

Arguments:

Name	Description	Type	Required
angle	This parameter sets instrument position angle.	double	yes

Configuration: SetGuiderTarget

Requirements:

This command sets target specific to guider.

Arguments:

Name	Description	Type	Required
Refframe	This parameter sets instrument position angle.	enum: (ICRS, FK5, AZEL, APPT, Planet, AsAmajorPlanet)	yes
RA	RA parameter value	string	no
DEC	DEC parameter value	string	no
Epoch	Epch parameter value.	string	no
ProperMotionInRA	proper motion in RA param value	string	no
ProperMotionInDEC	proper motion in DEC value	string	no
RadialVelocity	Radial velocity value	string	no
ReferenceTime	Reference time value	double	no
DifferentialTrackingRateInRA	Differential tracking rate in RA	string	no
DifferentialTrackingRateInDEC	Differential tracking rate in DEC	string	no

Configuration: SetTargetWavelength

Requirements:

This command sets instrument position angle for instrument to be used for observation.

Arguments:

Name	Description	Type	Required
targettype	Target Type can be either a Science target or Guide Star	enum: (Science, Guide)	no
wavelength	This parameter sets the wavelength.	double	yes

Configuration: SetDifferentialTrackRate

Requirements:

This command sets differential track rate for Science or Guide Star Target

Arguments:

Name	Description	Type	Required
targettype	Target Type can be either a Science target or Guide Star.	enum: (Science, Guide)	yes
radiff	This parameter will have value for differential tracking rates in RA in arcsec/sec.	string	yes
decdiff	This parameter will have value for differential tracking rates in DEC in arcsec/sec.	string	yes

Configuration: GETWCSSnapshot

Requirements:

This command generates FITS Header on request. FITS Header will be appended to FITS file by the requesting subsystem

Arguments:

n/a

Configuration: AzWrap

Requirements:

This command forces azimuth to override shortest slew and go Counter Clockwise (CCW) or Clockwise (CW). If azwrap is SP,then Shortest Path will be followed.

Arguments:

Name	Description	Type	Required
value	It can have values as CW, SP or CCW. In case CCW, mount will select counter clockwise manner for movement. In case CW, mount will move in counter clockwise manner. For SP, mount will move in Shortest Path possible.	enum: (SP, CW, CCW)	yes

Configuration: Rotwrap

Requirements:

This command forces rotator to override shortest slew and go Counter Clockwise (CCW) or Clockwise (CW). If rotwrap is “SP”, then Shortest Path will be followed.

Arguments:

Name	Description	Type	Required
value	It can have values as CW, SP or CCW. In case CCW, rotator will select counter clockwise manner for movement. In case CW, rotator will move in counter clockwise manner. For SP, rotator will move in Shortest Path possible.	enum: (SP, CW, CCW)	yes

Configuration: MarkBase

Requirements:

This command folds the current offsets into the base coordinates, effectively making the current position the base position

Arguments:

n/a

Configuration: GotoBase

Requirements:

This command clears the offset values, moving the telescope back to the base position.

Arguments:

n/a

Configuration: AbsorbOffset

Requirements:

This command help absorbing offsets to the base value.

Arguments:

Name	Description	Type	Required
type	Its value can be target/guider/instrument/pointingorigin/pointingmodel.	enum: (target, guider, instrument, pointingorigin, pointingmodel)	yes

Configuration: ClearOffset

Requirements:

This command clears the offset values.

Arguments:

Name	Description	Type	Required
type	Its value can be target/guider/instrument/pointingorigin/pointingmodel.	enum: (target, guider, instrument, pointingorigin, pointingmodel)	yes

Configuration: SetDawdling

Requirements:

This command is used to start or stop the telescope Dawdle mode.

Arguments:

Name	Description	Type	Required
operation	Its value will be On/Off	enum: (On, Off)	no
tuneparam	It represents the tuning parameter, i.e. maximum rate of change for the target position and the pointing origin	double	no

Configuration: TuneDawdling

Requirements:

This command is used to set the tuning parameter value for Dawdle mode

Arguments:

Name	Description	Type	Required
tuneparam	It represents the tuning parameter, i.e. maximum rate of change for the target position and the pointing origin	double	yes