

aircraft

Tight Rope v0.6

29th November 2015

1 ID Files

1.1 MissionIds

section *MissionIds* **parents** *scj_prelude*, *MissionId*

MainMissionID : *MissionID*
TakeOffMissionID : *MissionID*
CruiseMissionID : *MissionID*
LandMissionID : *MissionID*

distinct(*nullMissionId*, *MainMissionID*, *TakeOffMissionID*,
CruiseMissionID, *LandMissionID*)

1.2 SchedulablesIds

section *SchedulableIds* **parents** *scj_prelude*, *SchedulableId*

MainMissionSequencerID : *SchedulableID*
ACModeChangerID : *SchedulableID*
EnvironmentMonitorID : *SchedulableID*
ControlHandlerID : *SchedulableID*
FlightSensorsMonitorID : *SchedulableID*
CommunicationsHandlerID : *SchedulableID*
AperiodicSimulatorID : *SchedulableID*
LandingGearHandlerTakeOffID : *SchedulableID*
TakeOffMonitorID : *SchedulableID*
TakeOffFailureHandlerID : *SchedulableID*
BeginLandingHandlerID : *SchedulableID*
NavigationMonitorID : *SchedulableID*
GroundDistanceMonitorID : *SchedulableID*
LandingGearHandlerLandID : *SchedulableID*
InstrumentLandingSystemMonitorID : *SchedulableID*
SafeLandingHandlerID : *SchedulableID*

distinct(*nullSequencerId*, *nullSchedulableId*, *MainMissionSequencerID*,
ACModeChangerID, *EnvironmentMonitorID*,
ControlHandlerID, *FlightSensorsMonitorID*,
CommunicationsHandlerID, *AperiodicSimulatorID*,
LandingGearHandlerTakeOffID, *TakeOffMonitorID*,
TakeOffFailureHandlerID, *BeginLandingHandlerID*,
NavigationMonitorID, *GroundDistanceMonitorID*,
LandingGearHandlerLandID, *InstrumentLandingSystemMonitorID*,
SafeLandingHandlerID)

1.3 ThreadIds

section *ThreadId* **parents** *scj_prelude, GlobalTypes*

distinct(*SafeletThreadId, nullThreadId,*
)

1.4 ObjectIds

section *ObjectIds* parents *scj_prelude*, *GlobalTypes*

ACSafeletObjectID : *ObjectID*
MainMissionObjectID : *ObjectID*
ACModeChangerObjectID : *ObjectID*
EnvironmentMonitorObjectID : *ObjectID*
ControlHandlerObjectID : *ObjectID*
FlightSensorsMonitorObjectID : *ObjectID*
CommunicationsHandlerObjectID : *ObjectID*
AperiodicSimulatorObjectID : *ObjectID*
TakeOffMissionObjectID : *ObjectID*
LandingGearHandlerTakeOffObjectID : *ObjectID*
TakeOffMonitorObjectID : *ObjectID*
TakeOffFailureHandlerObjectID : *ObjectID*
CruiseMissionObjectID : *ObjectID*
BeginLandingHandlerObjectID : *ObjectID*
NavigationMonitorObjectID : *ObjectID*
LandMissionObjectID : *ObjectID*
GroundDistanceMonitorObjectID : *ObjectID*
LandingGearHandlerLandObjectID : *ObjectID*
InstrumentLandingSystemMonitorObjectID : *ObjectID*
SafeLandingHandlerObjectID : *ObjectID*

distinct(*ACSafeletObjectID*, *MainMissionObjectID*,
ACModeChangerObjectID, *EnvironmentMonitorObjectID*,
ControlHandlerObjectID, *FlightSensorsMonitorObjectID*,
CommunicationsHandlerObjectID, *AperiodicSimulatorObjectID*,
TakeOffMissionObjectID, *LandingGearHandlerTakeOffObjectID*,
TakeOffMonitorObjectID, *TakeOffFailureHandlerObjectID*,
CruiseMissionObjectID, *BeginLandingHandlerObjectID*,
NavigationMonitorObjectID, *LandMissionObjectID*,
GroundDistanceMonitorObjectID, *LandingGearHandlerLandObjectID*,
InstrumentLandingSystemMonitorObjectID, *SafeLandingHandlerObjectID*)

2 Network

section *NetworkChannels* **parents** *scj_prelude, MissionId, MissionIds, SchedulableId, SchedulableIds, MissionChan, SchedulableChan, TopLevelMissionSequencerFWChan, FrameworkChan, SafeletChan*

channelset *TerminateSync* ==
 { *schedulables_terminated, schedulables_stopped, get_activeSchedulables* }

channelset *ControlTierSync* ==
 { *start_toplevel_sequencer, done_toplevel_sequencer, done_safeletFW* }

channelset *TierSync* ==
 { *start_mission ., done_mission ., done_safeletFW, done_toplevel_sequencer* }

channelset *MissionSync* ==
 { *done_safeletFW, done_toplevel_sequencer, register, signalTerminationCall, signalTerminationRet, activate_schedulables, done_schedulable, cleanupSchedulableCall, cleanupSchedulableRet* }

channelset *SchedulablesSync* ==
 { *activate_schedulables, done_safeletFW, done_toplevel_sequencer* }

channelset *ClusterSync* ==
 { *done_toplevel_sequencer, done_safeletFW* }

channelset *AppSync* ==
 { *SafeltAppSync, MissionSequencerAppSync, MissionAppSync, MTAAppSync, OSEHSync, APEHSync, getSequencer, end_mission_app, end_managedThread_app, setCeilingPriority, requestTerminationCall, requestTerminationRet, terminationPendingCall, terminationPendingRet, handleAsyncEventCall, handleAsyncEventRet* }

channelset *ObjectSync* ==
 { }

channelset *ThreadSync* ==
 { }

channelset *LockingSync* ==
 { *lockAcquired, startSyncMeth, endSyncMeth, waitCall, waitRet, notify* }

channelset *Tier0Sync* ==
 { *done_toplevel_sequencer, done_safeletFW, start_mission ., done_mission ., initializeRet ., requestTermination . ., start_mission ., done_mission ., initializeRet ., requestTermination . ., start_mission ., done_mission ., initializeRet ., requestTermination . .* }

section *Program* **parents** *scj_prelude, MissionId, MissionIds,*
SchedulableId, SchedulableIds, MissionChan, SchedulableMethChan, MissionFW,
SafeletFW, TopLevelMissionSequencerFW, NetworkChannels, ManagedThreadFW,
SchedulableMissionSequencerFW, PeriodicEventHandlerFW, OneShotEventHandlerFW,
AperiodicEventHandlerFW, ACSafeletApp, MainMissionSequencerApp,
ObjectFW, ThreadFW, MainMissionApp, ACModeChangerApp, ControlHandlerApp, CommunicationsHandlerApp

process *ControlTier* $\hat{=}$

$$\left(\begin{array}{l} \text{SafeletFW} \\ \llbracket \text{ControlTierSync} \rrbracket \\ \text{TopLevelMissionSequencerFW}(\text{MainMissionSequencer}) \end{array} \right)$$

process *Tier0* $\hat{=}$

$$\left(\begin{array}{l} \text{MissionFW}(\text{MainMissionID}) \\ \llbracket \text{MissionSync} \rrbracket \\ \left(\begin{array}{l} \text{SchedulableMissionSequencerFW}(\text{ACModeChangerID}) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \left(\begin{array}{l} \text{AperiodicEventHandlerFW}(\text{ControlHandlerID}) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{AperiodicEventHandlerFW}(\text{CommunicationsHandlerID}) \\ \llbracket \text{SchedulablesSync} \rrbracket \end{array} \right) \\ \left(\begin{array}{l} \text{PeriodicEventHandlerFW}(\text{EnvironmentMonitorID}, (10, 0, \text{NULL}, \text{nullSchedulableId})) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{PeriodicEventHandlerFW}(\text{FlightSensorsMonitorID}, (10, 0, \text{NULL}, \text{nullSchedulableId})) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{PeriodicEventHandlerFW}(\text{AperiodicSimulatorID}, (10, 0, \text{NULL}, \text{nullSchedulableId})) \end{array} \right) \end{array} \right) \end{array} \right)$$

process *Tier1* $\hat{=}$

$$\left(\begin{array}{l} \text{MissionFW}(\text{TakeOffMissionID}) \\ \llbracket \text{MissionSync} \rrbracket \\ \left(\begin{array}{l} \left(\begin{array}{l} \text{AperiodicEventHandlerFW}(\text{LandingGearHandlerTakeOffID}) \\ \llbracket \text{SchedulablesSync} \rrbracket \end{array} \right) \\ \text{AperiodicEventHandlerFW}(\text{TakeOffFailureHandlerID}) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{PeriodicEventHandlerFW}(\text{TakeOffMonitorID}, (0, 0, \text{NULL}, \text{nullSchedulableId})) \end{array} \right) \\ \llbracket \text{ClusterSync} \rrbracket \\ \left(\begin{array}{l} \text{MissionFW}(\text{CruiseMissionID}) \\ \llbracket \text{MissionSync} \rrbracket \\ \left(\begin{array}{l} \text{AperiodicEventHandlerFW}(\text{BeginLandingHandlerID}) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{PeriodicEventHandlerFW}(\text{NavigationMonitorID}, (0, 0, \text{NULL}, \text{nullSchedulableId})) \end{array} \right) \\ \llbracket \text{ClusterSync} \rrbracket \\ \left(\begin{array}{l} \text{MissionFW}(\text{LandMissionID}) \\ \llbracket \text{MissionSync} \rrbracket \\ \left(\begin{array}{l} \text{AperiodicEventHandlerFW}(\text{LandingGearHandlerLandID}) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{AperiodicEventHandlerFW}(\text{SafeLandingHandlerID}) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \left(\begin{array}{l} \text{PeriodicEventHandlerFW}(\text{GroundDistanceMonitorID}, (0, 0, \text{NULL}, \text{nullSchedulableId})) \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{PeriodicEventHandlerFW}(\text{InstrumentLandingSystemMonitorID}, (0, 0, \text{NULL}, \text{nullSchedulableId})) \end{array} \right) \end{array} \right) \end{array} \right) \end{array} \right)$$

process *Framework* $\hat{=}$

$$\left(\begin{array}{l} \text{ControlTier} \\ \llbracket \text{TierSync} \rrbracket \\ \left(\begin{array}{l} \text{Tier0} \\ \llbracket \text{Tier0Sync} \rrbracket \end{array} \right) \\ \text{Tier1} \end{array} \right)$$

process *Application* $\hat{=}$

ACSafeletApp
|||
MainMissionSequencerApp
|||
MainMissionApp
|||
ACModeChangerApp(*MainMissionID*)
|||
ControlHandlerApp
|||
CommunicationsHandlerApp
|||
EnvironmentMonitorApp(*MainMissionID*)
|||
FlightSensorsMonitorApp(*MainMissionID*)
|||
AperiodicSimulatorApp(*controlHandlerID*)
|||
TakeOffMissionApp
|||
LandingGearHandlerTakeOffApp(*TakeOffMissionID*)
|||
TakeOffFailureHandlerApp(*TakeOffMissionID*, 10.0)
|||
TakeOffMonitorApp(*TakeOffMissionID*, 10.0, *landingGearHandlerID*)
|||
CruiseMissionApp
|||
BeginLandingHandlerApp(*CruiseMissionID*)
|||
NavigationMonitorApp(*CruiseMissionID*)
|||
LandMissionApp
|||
LandingGearHandlerLandApp(*LandMissionID*)
|||
SafeLandingHandlerApp(*LandMissionID*, 10.0)
|||
GroundDistanceMonitorApp(*LandMissionID*)
|||
InstrumentLandingSystemMonitorApp(*LandMissionID*)

$$\begin{aligned}
& \text{Threads} \triangleq \\
& \left(\begin{array}{l}
\text{ThreadFW}(\text{SafeLandingHandlerThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{ACModeChangerThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{TakeOffFailureHandlerThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{InstrumentLandingSystemMonitorThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{FlightSensorsMonitorThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{TakeOffMonitorThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{AperiodicSimulatorThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{LandingGearHandlerLandThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{LandingGearHandlerTakeOffThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{GroundDistanceMonitorThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{ControlHandlerThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{CommunicationsHandlerThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{BeginLandingHandlerThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{NavigationMonitorThreadID}, 5) \\
\quad \llbracket \text{ThreadSync} \rrbracket \\
\text{ThreadFW}(\text{EnvironmentMonitorThreadID}, 5)
\end{array} \right)
\end{aligned}$$

$$\begin{aligned}
\text{Objects} \hat{=}& \\
& \left(\begin{array}{l}
\text{ObjectFW}(\text{ACSafeletObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{MainMissionObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{ACModeChangerObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{EnvironmentMonitorObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{ControlHandlerObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{FlightSensorsMonitorObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{CommunicationsHandlerObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{AperiodicSimulatorObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{TakeOffMissionObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{LandingGearHandlerTakeOffObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{TakeOffMonitorObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{TakeOffFailureHandlerObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{CruiseMissionObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{BeginLandingHandlerObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{NavigationMonitorObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{LandMissionObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{GroundDistanceMonitorObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{LandingGearHandlerLandObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{InstrumentLandingSystemMonitorObjectID}) \\
\quad \llbracket \text{ObjectSync} \rrbracket \\
\text{ObjectFW}(\text{SafeLandingHandlerObjectID})
\end{array} \right)
\end{aligned}$$

$$\text{Locking} \hat{=} \text{Threads} \parallel \text{Objects}$$

$$\mathbf{process} \text{ Program} \hat{=} \text{Framework} \llbracket \text{AppSync} \rrbracket \text{Application} \llbracket \text{LockingSync} \rrbracket \text{Locking}$$

3 Safelet

section *ACSafeletApp* **parents** *scj_prelude, SchedulableId, SchedulableIds, SafeletChan*

process *ACSafeletApp* $\hat{=}$ **begin**

InitializeApplication $\hat{=}$
 $\left(\begin{array}{l} \textit{initializeApplicationCall} \longrightarrow \\ \textit{initializeApplicationRet} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

GetSequencer $\hat{=}$
 $\left(\begin{array}{l} \textit{getSequencerCall} \longrightarrow \\ \textit{getSequencerRet} ! \textit{MainMissionSequencer} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

Methods $\hat{=}$
 $\left(\begin{array}{l} \textit{GetSequencer} \\ \square \\ \textit{InitializeApplication} \end{array} \right); \textit{Methods}$

$\bullet (\textit{Methods}) \triangle (\textit{end_safelet_app} \longrightarrow \mathbf{Skip})$

end

4 Top Level Mission Sequencer

section *MainMissionSequencerApp* **parents** *TopLevelMissionSequencerChan*,
MissionId, *MissionIds*, *SchedulableId*, *MainMissionSequencerClass*

process *MainMissionSequencerApp* $\hat{=}$ **begin**

<i>State</i> <i>this</i> : ref <i>MainMissionSequencerClass</i>

state *State*

<i>Init</i> <i>State</i> '
<i>this</i> ' = new <i>MainMissionSequencerClass</i> ()

GetNextMission $\hat{=}$ **var** *ret* : *MissionID* •
 $\left(\begin{array}{l} \textit{getNextMissionCall} . \textit{MainMissionSequencer} \longrightarrow \\ \textit{ret} := \textit{this} . \textit{getNextMission}(); \\ \textit{getNextMissionRet} . \textit{MainMissionSequencer} ! \textit{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

Methods $\hat{=}$
 $(\textit{GetNextMission}) ; \textit{Methods}$

• $(\textit{Init} ; \textit{Methods}) \triangle (\textit{end_sequencer_app} . \textit{MainMissionSequencer} \longrightarrow \mathbf{Skip})$

end

class *MainMissionSequencerClass* $\hat{=}$ **begin**

state *State*
returnedMission : \mathbb{B}

state *State*

initial *Init*
State'

protected *getNextMission* $\hat{=}$ **var** *ret* : *MissionID* •

$$\left(\begin{array}{l} \text{if } (\neg \text{returnedMission} = \mathbf{True}) \longrightarrow \\ \quad \left(\begin{array}{l} \text{this} . \text{returnedMission} := \text{true}; \\ \text{ret} := \text{MainMission} \end{array} \right) \\ \parallel \neg (\neg \text{returnedMission} = \mathbf{True}) \longrightarrow \\ \quad (\text{ret} := \text{nullMissionId}) \\ \text{fi} \end{array} \right)$$

• **Skip**

end

section *MainMissionSequencerMethChan* **parents** *scj_prelude, GlobalTypes, MissionId, SchedulableId*

channel *getNextMissionCall* : *SchedulableID*

channel *getNextMissionRet* : *SchedulableID* \times *MissionID*

5 Missions

5.1 MainMission

section *MainMissionApp* **parents** *scj_prelude*, *MissionId*, *MissionIds*,
SchedulableId, *SchedulableIds*, *MissionChan*, *SchedulableMethChan*, *MainMissionClass*
, *MainMissionMethChan*

process *MainMissionApp* $\hat{=}$ **begin**

State
this : **ref** *MainMissionClass*

state *State*

Init
State'

this' = **new** *MainMissionClass*()

InitializePhase $\hat{=}$

$$\left(\begin{array}{l} \textit{initializeCall} . \textit{MainMission} \longrightarrow \\ \textit{register} ! \textit{ACModeChanger} ! \textit{MainMission} \longrightarrow \\ \textit{register} ! \textit{EnvironmentMonitor} ! \textit{MainMission} \longrightarrow \\ \textit{register} ! \textit{ControlHandler} ! \textit{MainMission} \longrightarrow \\ \textit{register} ! \textit{FlightSensorsMonitor} ! \textit{MainMission} \longrightarrow \\ \textit{register} ! \textit{CommunicationsHandler} ! \textit{MainMission} \longrightarrow \\ \textit{register} ! \textit{AperiodicSimulator} ! \textit{MainMission} \longrightarrow \\ \textit{initializeRet} . \textit{MainMission} \longrightarrow \\ \textbf{Skip} \end{array} \right)$$

CleanupPhase $\hat{=}$

$$\left(\begin{array}{l} \textit{cleanupMissionCall} . \textit{MainMission} \longrightarrow \\ \textit{cleanupMissionRet} . \textit{MainMission} ! \textbf{True} \longrightarrow \\ \textbf{Skip} \end{array} \right)$$

getAirSpeedMeth $\hat{=}$ **var** *ret* : double •

$$\left(\begin{array}{l} \textit{getAirSpeedCall} . \textit{MainMission} \longrightarrow \\ \textit{ret} := \textit{this} . \textit{getAirSpeed}(); \\ \textit{getAirSpeedRet} . \textit{MainMission} ! \textit{ret} \longrightarrow \\ \textbf{Skip} \end{array} \right)$$

getAltitudeMeth $\hat{=}$ **var** *ret* : double •

$$\left(\begin{array}{l} \textit{getAltitudeCall} . \textit{MainMission} \longrightarrow \\ \textit{ret} := \textit{this} . \textit{getAltitude}(); \\ \textit{getAltitudeRet} . \textit{MainMission} ! \textit{ret} \longrightarrow \\ \textbf{Skip} \end{array} \right)$$

getCabinPressureMeth $\hat{=}$ **var** *ret* : double •

$$\left(\begin{array}{l} \textit{getCabinPressureCall} . \textit{MainMission} \longrightarrow \\ \textit{ret} := \textit{this} . \textit{getCabinPressure}(); \\ \textit{getCabinPressureRet} . \textit{MainMission} ! \textit{ret} \longrightarrow \\ \textbf{Skip} \end{array} \right)$$

$$\text{getEmergencyOxygenMeth} \hat{=} \mathbf{var} \text{ ret} : \text{double} \bullet \left(\begin{array}{l} \text{getEmergencyOxygenCall} . \text{MainMission} \longrightarrow \\ \text{ret} := \text{this} . \text{getEmergencyOxygen}(); \\ \text{getEmergencyOxygenRet} . \text{MainMission} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{getFuelRemainingMeth} \hat{=} \mathbf{var} \text{ ret} : \text{double} \bullet \left(\begin{array}{l} \text{getFuelRemainingCall} . \text{MainMission} \longrightarrow \\ \text{ret} := \text{this} . \text{getFuelRemaining}(); \\ \text{getFuelRemainingRet} . \text{MainMission} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{getHeadingMeth} \hat{=} \mathbf{var} \text{ ret} : \text{double} \bullet \left(\begin{array}{l} \text{getHeadingCall} . \text{MainMission} \longrightarrow \\ \text{ret} := \text{this} . \text{getHeading}(); \\ \text{getHeadingRet} . \text{MainMission} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{setAirSpeedMeth} \hat{=} \left(\begin{array}{l} \text{setAirSpeedCall} . \text{MainMission} ? \text{airSpeed} \longrightarrow \\ \text{this} . \text{setAirSpeed}(\text{airSpeed}); \\ \text{setAirSpeedRet} . \text{MainMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{setAltitudeMeth} \hat{=} \left(\begin{array}{l} \text{setAltitudeCall} . \text{MainMission} ? \text{altitude} \longrightarrow \\ \text{this} . \text{setAltitude}(\text{altitude}); \\ \text{setAltitudeRet} . \text{MainMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{setCabinPressureMeth} \hat{=} \left(\begin{array}{l} \text{setCabinPressureCall} . \text{MainMission} ? \text{cabinPressure} \longrightarrow \\ \text{this} . \text{setCabinPressure}(\text{cabinPressure}); \\ \text{setCabinPressureRet} . \text{MainMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{setEmergencyOxygenMeth} \hat{=} \left(\begin{array}{l} \text{setEmergencyOxygenCall} . \text{MainMission} ? \text{emergencyOxygen} \longrightarrow \\ \text{this} . \text{setEmergencyOxygen}(\text{emergencyOxygen}); \\ \text{setEmergencyOxygenRet} . \text{MainMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{setFuelRemainingMeth} \hat{=} \left(\begin{array}{l} \text{setFuelRemainingCall} . \text{MainMission} ? \text{fuelRemaining} \longrightarrow \\ \text{this} . \text{setFuelRemaining}(\text{fuelRemaining}); \\ \text{setFuelRemainingRet} . \text{MainMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{setHeadingMeth} \hat{=} \left(\begin{array}{l} \text{setHeadingCall} . \text{MainMission} ? \text{heading} \longrightarrow \\ \text{this} . \text{setHeading}(\text{heading}); \\ \text{setHeadingRet} . \text{MainMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$Methods \triangleq \left(\begin{array}{l} \textit{InitializePhase} \\ \square \\ \textit{CleanupPhase} \\ \square \\ \textit{getAirSpeedMeth} \\ \square \\ \textit{getAltitudeMeth} \\ \square \\ \textit{getCabinPressureMeth} \\ \square \\ \textit{getEmergencyOxygenMeth} \\ \square \\ \textit{getFuelRemainingMeth} \\ \square \\ \textit{getHeadingMeth} \\ \square \\ \textit{setAirSpeedMeth} \\ \square \\ \textit{setAltitudeMeth} \\ \square \\ \textit{setCabinPressureMeth} \\ \square \\ \textit{setEmergencyOxygenMeth} \\ \square \\ \textit{setFuelRemainingMeth} \\ \square \\ \textit{setHeadingMeth} \end{array} \right) ; Methods$$

- $(\textit{Init} ; Methods) \triangle (\textit{end_mission_app} . \textit{MainMission} \longrightarrow \mathbf{Skip})$

end

class *MainMissionClass* $\hat{=}$ **begin**

state *State*

ALTITUDE_READING_ON_GROUND : double
cabinPressure : double
emergencyOxygen : double
fuelRemaining : double
altitude : double
airSpeed : double
heading : double

state *State*

initial *Init*

State'

ALTITUDE_READING_ON_GROUND' = 0.0

public *getAirSpeed* $\hat{=}$ **var** *ret* : double •
(*ret* := *airSpeed*)

public *getAltitude* $\hat{=}$ **var** *ret* : double •
(*ret* := *altitude*)

public *getCabinPressure* $\hat{=}$ **var** *ret* : double •
(*ret* := *cabinPressure*)

public *getEmergencyOxygen* $\hat{=}$ **var** *ret* : double •
(*ret* := *emergencyOxygen*)

public *getFuelRemaining* $\hat{=}$ **var** *ret* : double •
(*ret* := *fuelRemaining*)

public *getHeading* $\hat{=}$ **var** *ret* : double •
(*ret* := *heading*)

public *setAirSpeed* $\hat{=}$
(*this.this.airSpeed* := *airSpeed*)

public *setAltitude* $\hat{=}$
(*this.this.altitude* := *altitude*)

public *setCabinPressure* $\hat{=}$
(*this.this.cabinPressure* := *cabinPressure*)

public *setEmergencyOxygen* $\hat{=}$
(*this.this.emergencyOxygen* := *emergencyOxygen*)

```
public setFuelRemaining  $\hat{=}$   
(this.this.fuelRemaining := fuelRemaining)
```

```
public setHeading  $\hat{=}$   
(this.this.heading := heading)
```

- **Skip**

```
end
```

section *MainMissionMethChan* **parents** *scj_prelude, GlobalTypes, MissionId, SchedulableId*

channel *getAirSpeedCall* : *MissionID*
channel *getAirSpeedRet* : *MissionID* \times *double*

channel *getAltitudeCall* : *MissionID*
channel *getAltitudeRet* : *MissionID* \times *double*

channel *getCabinPressureCall* : *MissionID*
channel *getCabinPressureRet* : *MissionID* \times *double*

channel *getEmergencyOxygenCall* : *MissionID*
channel *getEmergencyOxygenRet* : *MissionID* \times *double*

channel *getFuelRemainingCall* : *MissionID*
channel *getFuelRemainingRet* : *MissionID* \times *double*

channel *getHeadingCall* : *MissionID*
channel *getHeadingRet* : *MissionID* \times *double*

channel *setAirSpeedCall* : *MissionID* \times *double*
channel *setAirSpeedRet* : *MissionID*

channel *setAltitudeCall* : *MissionID* \times *double*
channel *setAltitudeRet* : *MissionID*

channel *setCabinPressureCall* : *MissionID* \times *double*
channel *setCabinPressureRet* : *MissionID*

channel *setEmergencyOxygenCall* : *MissionID* \times *double*
channel *setEmergencyOxygenRet* : *MissionID*

channel *setFuelRemainingCall* : *MissionID* \times *double*
channel *setFuelRemainingRet* : *MissionID*

channel *setHeadingCall* : *MissionID* \times *double*
channel *setHeadingRet* : *MissionID*

5.2 Schedulables of MainMission

section *ACModeChangerApp* **parents** *TopLevelMissionSequencerChan*,
MissionId, *MissionIds*, *SchedulableId*, *ACModeChangerClass*

process *ACModeChangerApp* $\hat{=}$
 • **begin**

GetNextMission $\hat{=}$ **var** *ret* : *MissionID* •
 $\left(\begin{array}{l} \text{getNextMissionCall} . \text{ACModeChanger} \longrightarrow \\ \text{ret} := \text{this} . \text{getNextMission}(); \\ \text{getNextMissionRet} . \text{ACModeChanger} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$

changeToMeth $\hat{=}$
 $\left(\begin{array}{l} \text{changeToCall} . \text{ACModeChanger} ? \text{newMode} \longrightarrow \\ (\text{this} . \text{currentMode} := \text{newMode}); \\ \text{changeToRet} . \text{ACModeChanger} \longrightarrow \\ \text{Skip} \end{array} \right)$

advanceModeSyncMeth $\hat{=}$
 $\left(\begin{array}{l} \text{advanceModeCall} . \text{ACModeChanger} ? \text{thread} \longrightarrow \\ \left(\begin{array}{l} \text{startSyncMeth} . \text{ACModeChangerObject} . \text{thread} \longrightarrow \\ \text{lockAcquired} . \text{ACModeChangerObject} . \text{thread} \longrightarrow \\ \left(\begin{array}{l} \text{Skip}; \\ \text{if } (\text{modesLeft} = 3) \longrightarrow \\ \quad \left(\begin{array}{l} \text{modesLeft} := \text{modesLeft} - 1; \\ \text{changeTo}(\text{launchMode}) \end{array} \right) \\ \square \neg (\text{modesLeft} = 3) \longrightarrow \\ \quad \text{if } (\text{modesLeft} = 2) \longrightarrow \\ \quad \quad \left(\begin{array}{l} \text{modesLeft} := \text{modesLeft} - 1; \\ \text{changeTo}(\text{cruiseMode}) \end{array} \right) \\ \square \neg (\text{modesLeft} = 2) \longrightarrow \\ \quad \quad \text{if } (\text{modesLeft} = 1) \longrightarrow \\ \quad \quad \quad \left(\begin{array}{l} \text{modesLeft} := \text{modesLeft} - 1; \\ \text{changeTo}(\text{landMode}) \end{array} \right) \\ \square \neg (\text{modesLeft} = 1) \longrightarrow \\ \quad \quad \quad (\text{changeTo}(\text{null})) \end{array} \right) \\ \text{fi} \\ \text{fi} \\ \text{fi} \end{array} \right) ; \\ \text{endSyncMeth} . \text{ACModeChangerObject} . \text{thread} \longrightarrow \\ \text{advanceModeRet} . \text{ACModeChanger} . \text{thread} \longrightarrow \\ \text{Skip} \end{array} \right)$

Methods $\hat{=}$
 $\left(\begin{array}{l} \text{GetNextMission} \\ \square \\ \text{changeToMeth} \\ \square \\ \text{advanceModeSyncMeth} \end{array} \right) ; \text{Methods}$

• $(\text{Methods}) \triangle (\text{end_sequencer_app} . \text{ACModeChanger} \longrightarrow \text{Skip})$

end

```
class ACModeChangerClass  $\hat{=}$  begin
```

```
  state State
```

```
    modesLeft :  $\mathbb{Z}$   
    ref currentModeClass : ModeClass  
    ref launchModeClass : ModeClass  
    ref cruiseModeClass : ModeClass  
    ref landModeClass : ModeClass
```

```
state State
```

```
  initial Init
```

```
    State'  
    modesLeft' = 3  
    ref currentModeClass' = new ModeClass()  
    ref launchModeClass' = new ModeClass()  
    ref cruiseModeClass' = new ModeClass()  
    ref landModeClass' = new ModeClass()
```

```
protected getNextMission  $\hat{=}$  var ret : MissionID •
```

```

  (
    if (modesLeft = 3)  $\longrightarrow$ 
      (
        modesLeft := modesLeft - 1;
        ret := TakeOffMission
      )
    []  $\neg$  (modesLeft = 3)  $\longrightarrow$ 
      if (modesLeft = 2)  $\longrightarrow$ 
        (
          modesLeft := modesLeft - 1;
          ret := CruiseMission
        )
      []  $\neg$  (modesLeft = 2)  $\longrightarrow$ 
        if (modesLeft = 1)  $\longrightarrow$ 
          (
            modesLeft := modesLeft - 1;
            ret := LandMission
          )
        []  $\neg$  (modesLeft = 1)  $\longrightarrow$ 
          (ret := nullMissionId)
    fi
    fi
    fi
  )
```

```
• Skip
```

```
end
```

section *ACModeChangerMethChan* **parents** *scj_prelude, GlobalTypes, MissionId, SchedulableId*

channel *changeToCall* : *SchedulableID* ×
channel *changeToRet* : *SchedulableID*

channel *advanceModeCall* : *SchedulableID* × *ThreadID*
channel *advanceModeRet* : *SchedulableID* × *ThreadID*

section *ControlHandlerApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds*

process *ControlHandlerApp* $\hat{=}$

• **begin**

handlerAsyncEvent $\hat{=}$

$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{ControlHandler} \longrightarrow \\ (\mathbf{Skip}) ; \\ \text{handleAsyncEventRet} . \text{ControlHandler} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

Methods $\hat{=}$

$(\text{handlerAsyncEvent}) ; \text{Methods}$

• $(\text{Methods}) \triangle (\text{end_app} . \text{ControlHandler} \longrightarrow \mathbf{Skip})$

end

class *ControlHandlerClass* $\hat{=}$ **begin**

- **Skip**

end

section *ControlHandlerMethChan* **parents** *scj_prelude, GlobalTypes, MissionId, SchedulableId*

section *CommunicationsHandlerApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds*

process *CommunicationsHandlerApp* $\hat{=}$

• **begin**

handlerAsyncEvent $\hat{=}$

$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{CommunicationsHandler} \longrightarrow \\ (\mathbf{Skip}) ; \\ \text{handleAsyncEventRet} . \text{CommunicationsHandler} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

Methods $\hat{=}$

$(\text{handlerAsyncEvent}) ; \text{Methods}$

• $(\text{Methods}) \triangle (\text{end_app} . \text{CommunicationsHandler} \longrightarrow \mathbf{Skip})$

end

class *CommunicationsHandlerClass* $\hat{=}$ **begin**

- **Skip**

end

section *CommunicationsHandlerMethChan* **parents** *scj_prelude, GlobalTypes, MissionId, SchedulableId*

section *EnvironmentMonitorApp* **parents** *PeriodicEventHandlerChan, SchedulableId, SchedulableIds* ,
MainMissionMethChan

process *EnvironmentMonitorApp* $\hat{=}$
 • **begin**

handlerAsyncEvent $\hat{=}$

$$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{EnvironmentMonitor} \longrightarrow \\ \left(\begin{array}{l} \mathbf{Skip}; \\ \text{setCabinPressureCall} . \text{controllingMission} ! 0 \longrightarrow \\ \text{setCabinPressureRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip}; \\ \text{setEmergencyOxygenCall} . \text{controllingMission} ! 0 \longrightarrow \\ \text{setEmergencyOxygenRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip}; \\ \text{setFuelRemainingCall} . \text{controllingMission} ! 0 \longrightarrow \\ \text{setFuelRemainingRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right) \\ \text{handleAsyncEventRet} . \text{EnvironmentMonitor} \longrightarrow \\ \mathbf{Skip} \end{array} \right) ;$$

Methods $\hat{=}$
 (*handlerAsyncEvent*) ; *Methods*

• (*Methods*) \triangle (*end_periodic_app* . *EnvironmentMonitor* \longrightarrow **Skip**)

end

class *EnvironmentMonitorClass* $\hat{=}$ **begin**

- **Skip**

end

section *FlightSensorsMonitorApp* **parents** *PeriodicEventHandlerChan, SchedulableId, SchedulableIds* ,
MainMissionMethChan

process *FlightSensorsMonitorApp* $\hat{=}$
 • **begin**

handlerAsyncEvent $\hat{=}$

$$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{FlightSensorsMonitor} \longrightarrow \\ \left(\begin{array}{l} \mathbf{Skip}; \\ \text{setAirSpeedCall} . \text{controllingMission} ! 0 \longrightarrow \\ \text{setAirSpeedRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip}; \\ \text{setAltitudeCall} . \text{controllingMission} ! 0 \longrightarrow \\ \text{setAltitudeRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip}; \\ \text{setHeadingCall} . \text{controllingMission} ! 0 \longrightarrow \\ \text{setHeadingRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right) ; \\ \text{handleAsyncEventRet} . \text{FlightSensorsMonitor} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

Methods $\hat{=}$
 $(\text{handlerAsyncEvent}) ; \text{Methods}$

• $(\text{Methods}) \triangle (\text{end_periodic_app} . \text{FlightSensorsMonitor} \longrightarrow \mathbf{Skip})$

end

class *FlightSensorsMonitorClass* $\hat{=}$ **begin**

- **Skip**

end

section *AperiodicSimulatorApp* **parents** *PeriodicEventHandlerChan*, *SchedulableId*, *SchedulableIds*

process *AperiodicSimulatorApp* $\hat{=}$

• **begin**

handlerAsyncEvent $\hat{=}$

$$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{AperiodicSimulator} \longrightarrow \\ \left(\begin{array}{l} \mathbf{Skip}; \\ \text{releaseCall} . \text{event} \longrightarrow \\ \text{releaseRet} . \text{event} ? \text{release} \longrightarrow \end{array} \right); \\ \mathbf{Skip} \\ \text{handleAsyncEventRet} . \text{AperiodicSimulator} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

Methods $\hat{=}$

(handlerAsyncEvent) ; *Methods*

• *(Methods)* \triangle *(end_periodic_app . AperiodicSimulator \longrightarrow Skip)*

end

class *AperiodicSimulatorClass* $\hat{=}$ **begin**

- **Skip**

end

5.3 TakeOffMission

section *TakeOffMissionApp* **parents** *scj_prelude*, *MissionId*, *MissionIds*,
SchedulableId, *SchedulableIds*, *MissionChan*, *SchedulableMethChan*, *TakeOffMissionClass*
, TakeOffMissionMethChan

process *TakeOffMissionApp* $\hat{=}$ **begin**

State
this : **ref** *TakeOffMissionClass*

state *State*

Init
State'

this' = **new** *TakeOffMissionClass*()

InitializePhase $\hat{=}$
 $\left(\begin{array}{l} \text{initializeCall} . \text{TakeOffMission} \longrightarrow \\ \text{register} ! \text{LandingGearHandlerTakeOff} ! \text{TakeOffMission} \longrightarrow \\ \text{register} ! \text{TakeOffMonitor} ! \text{TakeOffMission} \longrightarrow \\ \text{register} ! \text{TakeOffFailureHandler} ! \text{TakeOffMission} \longrightarrow \\ \text{initializeRet} . \text{TakeOffMission} \longrightarrow \\ \text{Skip} \end{array} \right)$

CleanupPhase $\hat{=}$
 $\left(\begin{array}{l} \text{cleanupMissionCall} . \text{TakeOffMission} \longrightarrow \\ \text{cleanupMissionRet} . \text{TakeOffMission} ! \text{True} \longrightarrow \\ \text{Skip} \end{array} \right)$

abortMeth $\hat{=}$
 $\left(\begin{array}{l} \text{abortCall} . \text{TakeOffMission} \longrightarrow \\ \text{this} . \text{abort}(); \\ \text{abortRet} . \text{TakeOffMission} \longrightarrow \\ \text{Skip} \end{array} \right)$

getControllingMissionMeth $\hat{=}$ **var** *ret* : *MissionID* •
 $\left(\begin{array}{l} \text{getControllingMissionCall} . \text{TakeOffMission} \longrightarrow \\ \text{ret} := \text{this} . \text{getControllingMission}(); \\ \text{getControllingMissionRet} . \text{TakeOffMission} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$

setControllingMissionMeth $\hat{=}$
 $\left(\begin{array}{l} \text{setControllingMissionCall} . \text{TakeOffMission} ? \text{controllingMission} \longrightarrow \\ \text{this} . \text{setControllingMission}(\text{controllingMission}); \\ \text{setControllingMissionRet} . \text{TakeOffMission} \longrightarrow \\ \text{Skip} \end{array} \right)$

cleanUpMeth $\hat{=}$ **var** *ret* : \mathbb{B} •
 $\left(\begin{array}{l} \text{cleanUpCall} . \text{TakeOffMission} \longrightarrow \\ \text{ret} := \text{this} . \text{cleanUp}(); \\ \text{cleanUpRet} . \text{TakeOffMission} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$

$$\text{stowLandingGearMeth} \hat{=} \left(\begin{array}{l} \text{stowLandingGearCall} . \text{TakeOffMission} \longrightarrow \\ \text{this} . \text{stowLandingGear}(); \\ \text{stowLandingGearRet} . \text{TakeOffMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{isLandingGearDeployedMeth} \hat{=} \mathbf{var} \text{ret} : \mathbb{B} \bullet \left(\begin{array}{l} \text{isLandingGearDeployedCall} . \text{TakeOffMission} \longrightarrow \\ \text{ret} := \text{this} . \text{isLandingGearDeployed}(); \\ \text{isLandingGearDeployedRet} . \text{TakeOffMission} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{deployLandingGearSyncMeth} \hat{=} \left(\begin{array}{l} \text{deployLandingGearCall} . \text{TakeOffMission} ? \text{thread} \longrightarrow \\ \left(\begin{array}{l} \text{startSyncMeth} . \text{TakeOffMissionObject} . \text{thread} \longrightarrow \\ \text{lockAcquired} . \text{TakeOffMissionObject} . \text{thread} \longrightarrow \\ (\text{this} . \text{landingGearDeployed} := \text{true}); \\ \text{endSyncMeth} . \text{TakeOffMissionObject} . \text{thread} \longrightarrow \\ \text{deployLandingGearRet} . \text{TakeOffMission} . \text{thread} \longrightarrow \\ \mathbf{Skip} \end{array} \right) \end{array} \right)$$

$$\text{Methods} \hat{=} \left(\begin{array}{l} \text{InitializePhase} \\ \square \\ \text{CleanupPhase} \\ \square \\ \text{abortMeth} \\ \square \\ \text{getControllingMissionMeth} \\ \square \\ \text{setControllingMissionMeth} \\ \square \\ \text{cleanUpMeth} \\ \square \\ \text{stowLandingGearMeth} \\ \square \\ \text{isLandingGearDeployedMeth} \\ \square \\ \text{deployLandingGearSyncMeth} \end{array} \right) ; \text{Methods}$$

$$\bullet (\text{Init} ; \text{Methods}) \triangle (\text{end_mission_app} . \text{TakeOffMission} \longrightarrow \mathbf{Skip})$$

end

class *TakeOffMissionClass* $\hat{=}$ **begin**

state *State*

SAFE_AIRSPPEED_THRESHOLD : *double*
TAKEOFF_ALTITUDE : *double*
abort : \mathbb{B}
landingGearDeployed : \mathbb{B}

state *State*

initial *Init*

State'

SAFE_AIRSPPEED_THRESHOLD' = 10.0
TAKEOFF_ALTITUDE' = 10.0
abort' = *false*

public *abort* $\hat{=}$
(*this* . *abort* := *true*)

public *getControllingMission* $\hat{=}$ **var** *ret* : *MissionID* •
(*ret* := *controllingMission*)

public *setControllingMission* $\hat{=}$
(*this* . *this.controllingMission* := *controllingMission*)

public *cleanUp* $\hat{=}$ **var** *ret* : \mathbb{B} •
(**Skip**;
ret := (\neg *abort* = **True**))

public *stowLandingGear* $\hat{=}$
(*this* . *landingGearDeployed* := *false*)

public *isLandingGearDeployed* $\hat{=}$ **var** *ret* : \mathbb{B} •
(*ret* := *landingGearDeployed* = **True**)

• **Skip**

end

section *TakeOffMissionMethChan* **parents** *scj_prelude, GlobalTypes, MissionId, SchedulableId*

channel *abortCall* : *MissionID*
channel *abortRet* : *MissionID*

channel *getControllingMissionCall* : *MissionID*
channel *getControllingMissionRet* : *MissionID* \times *MissionID*

channel *setControllingMissionCall* : *MissionID* \times *MissionID*
channel *setControllingMissionRet* : *MissionID*

channel *cleanUpCall* : *MissionID*
channel *cleanUpRet* : *MissionID* \times \mathbb{B}

channel *stowLandingGearCall* : *MissionID*
channel *stowLandingGearRet* : *MissionID*

channel *isLandingGearDeployedCall* : *MissionID*
channel *isLandingGearDeployedRet* : *MissionID* \times \mathbb{B}

channel *deployLandingGearCall* : *MissionID* \times *ThreadID*
channel *deployLandingGearRet* : *MissionID* \times *ThreadID*

5.4 Schedulables of TakeOffMission

section *LandingGearHandlerTakeOffApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,
TakeOffMissionMethChan, *ObjectIds*, *ThreadIds*

process *LandingGearHandlerTakeOffApp* $\hat{=}$
 • **begin**

handlerAsyncEvent $\hat{=}$

$$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ \left(\begin{array}{l} \text{Skip}; \\ \text{isLandingGearDeployedCall} . \text{mission} \longrightarrow \\ \text{isLandingGearDeployedRet} . \text{mission} ? \text{isLandingGearDeployed} \longrightarrow \\ \\ \text{var } \text{landingGearIsDeployed} : \mathbb{B} \bullet \text{landingGearIsDeployed} := \text{isLandingGearDeployed} \\ \text{if } \text{landingGearIsDeployed} = \text{True} \longrightarrow \\ \left(\begin{array}{l} \text{stowLandingGearCall} . \text{mission} \longrightarrow \\ \text{stowLandingGearRet} . \text{mission} \longrightarrow \\ \text{Skip} \end{array} \right) \\ \square \neg \text{landingGearIsDeployed} = \text{True} \longrightarrow \\ \left(\begin{array}{l} \text{deployLandingGearCall} . \text{mission} . \text{LandingGearHandlerTakeOffThread} \longrightarrow \\ \text{deployLandingGearRet} . \text{mission} . \text{LandingGearHandlerTakeOffThread} \longrightarrow \\ \text{Skip} \end{array} \right) \\ \text{fi} \end{array} \right) \text{handleAsyncEventRet} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ \text{Skip} \end{array} \right) ;$$

Methods $\hat{=}$
 (*handlerAsyncEvent*) ; *Methods*

• (*Methods*) \triangle (*end__app* . *LandingGearHandlerTakeOff* \longrightarrow **Skip**)

end

class *LandingGearHandlerTakeOffClass* $\hat{=}$ **begin**

- **Skip**

end

section *LandingGearHandlerTakeOffMethChan* **parents** *scj_prelude, GlobalTypes, MissionId, SchedulableId*

section *TakeOffFailureHandlerApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,
TakeOffMissionMethChan

process *TakeOffFailureHandlerApp* $\hat{=}$
 • **begin**

handlerAsyncEvent $\hat{=}$

$$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{TakeOffFailureHandler} \longrightarrow \\ \left(\begin{array}{l} \text{getControllingMissionCall} . \text{takeoffMission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{takeoffMission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \end{array} \right) \\ \\ \text{var } \text{currentSpeed} : \text{double} \bullet \text{currentSpeed} := \text{getAirSpeed} \\ \text{if } (\text{currentSpeed} < \text{threshold}) \longrightarrow \\ \quad \left(\begin{array}{l} \text{Skip}; \\ \text{abortCall} . \text{takeoffMission} \longrightarrow \\ \text{abortRet} . \text{takeoffMission} \longrightarrow \\ \text{Skip}; \\ \text{requestTerminationCall} . \text{takeoffMission} \longrightarrow \\ \text{requestTerminationRet} . \text{takeoffMission} ? \text{requestTermination} \longrightarrow \\ \text{Skip} \end{array} \right) \\ \quad \Box \neg (\text{currentSpeed} < \text{threshold}) \longrightarrow \\ \quad \quad (\text{Skip}) \\ \text{fi Skip} \end{array} \right) ;$$

Methods $\hat{=}$
 (*handlerAsyncEvent*) ; *Methods*

• (*Methods*) \triangle (*end_app* . *TakeOffFailureHandler* \longrightarrow **Skip**)

end

class *TakeOffFailureHandlerClass* $\hat{=}$ **begin**

state <i>State</i> <i>threshold</i> : <i>double</i>

state *State*

initial <i>Init</i> <i>State'</i>

- **Skip**

end

section *TakeOffFailureHandlerMethChan* **parents** *scj_prelude, GlobalTypes, MissionId, SchedulableId*

section *TakeOffMonitorApp* **parents** *PeriodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,
TakeOffMissionMethChan

process *TakeOffMonitorApp* $\hat{=}$
 • **begin**

handlerAsyncEvent $\hat{=}$

$$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{TakeOffMonitor} \longrightarrow \\ \left(\begin{array}{l} \mathbf{Skip}; \\ \text{getControllingMissionCall} . \text{takeoffMission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{takeoffMission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \\ \\ \mathbf{var} \text{altitude} : \text{double} \bullet \text{altitude} := \text{getAltitude} \\ \mathbf{if} (\text{altitude} > \text{takeOffAltitude}) \longrightarrow \\ \left(\begin{array}{l} \mathbf{Skip}; \\ \text{releaseCall} . \text{landingGearHandler} \longrightarrow \\ \text{releaseRet} . \text{landingGearHandler} ? \text{release} \longrightarrow \\ \text{requestTerminationCall} . \text{takeoffMission} \longrightarrow \\ \text{requestTerminationRet} . \text{takeoffMission} ? \text{requestTermination} \longrightarrow \\ \mathbf{Skip} \end{array} \right) \\ \square \neg (\text{altitude} > \text{takeOffAltitude}) \longrightarrow \mathbf{Skip} \\ \mathbf{fi}; \\ \mathbf{Skip} \end{array} \right) \\ \text{handleAsyncEventRet} . \text{TakeOffMonitor} \longrightarrow \\ \mathbf{Skip} \end{array} \right) ;$$

Methods $\hat{=}$
 (*handlerAsyncEvent*) ; *Methods*

• (*Methods*) \triangle (*end_periodic_app* . *TakeOffMonitor* \longrightarrow **Skip**)

end

class *TakeOffMonitorClass* $\hat{=}$ **begin**

state *State*

takeOffAltitude : *double*

state *State*

initial *Init*

State'

• **Skip**

end

5.5 CruiseMission

section *CruiseMissionApp* **parents** *scj_prelude*, *MissionId*, *MissionIds*,
SchedulableId, *SchedulableIds*, *MissionChan*, *SchedulableMethChan*, *CruiseMissionClass*
CruiseMissionMethChan

process *CruiseMissionApp* $\hat{=}$ **begin**

<i>State</i> <i>this</i> : ref <i>CruiseMissionClass</i>
--

state *State*

<i>Init</i> <i>State'</i>
<i>this'</i> = new <i>CruiseMissionClass</i> ()

InitializePhase $\hat{=}$

$$\left(\begin{array}{l} \textit{initializeCall} . \textit{CruiseMission} \longrightarrow \\ \textit{register!BeginLandingHandler!CruiseMission} \longrightarrow \\ \textit{register!NavigationMonitor!CruiseMission} \longrightarrow \\ \textit{initializeRet} . \textit{CruiseMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

CleanupPhase $\hat{=}$

$$\left(\begin{array}{l} \textit{cleanupMissionCall} . \textit{CruiseMission} \longrightarrow \\ \textit{cleanupMissionRet} . \textit{CruiseMission!True} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

getControllingMissionMeth $\hat{=}$ **var** *ret* : *MissionID* •

$$\left(\begin{array}{l} \textit{getControllingMissionCall} . \textit{CruiseMission} \longrightarrow \\ \textit{ret} := \textit{this} . \textit{getControllingMission}(); \\ \textit{getControllingMissionRet} . \textit{CruiseMission!ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

Methods $\hat{=}$
$$\left(\begin{array}{l} \textit{InitializePhase} \\ \square \\ \textit{CleanupPhase} \\ \square \\ \textit{getControllingMissionMeth} \end{array} \right); \textit{Methods}$$

• (*Init* ; *Methods*) \triangle (*end_mission_app* . *CruiseMission* \longrightarrow **Skip**)

end

class *CruiseMissionClass* $\hat{=}$ **begin**

public *getControllingMission* $\hat{=}$ **var** *ret* : *MissionID* •
(*ret* := *controllingMission*)

• **Skip**

end

section *CruiseMissionMethChan* **parents** *scj_prelude, GlobalTypes, MissionId, SchedulableId*

channel *getControllingMissionCall* : *MissionID*

channel *getControllingMissionRet* : *MissionID* \times *MissionID*

5.6 Schedulables of CruiseMission

section *BeginLandingHandlerApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds*

process *BeginLandingHandlerApp* $\hat{=}$
 • **begin**

handlerAsyncEvent $\hat{=}$

$$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{BeginLandingHandler} \longrightarrow \\ \left(\begin{array}{l} \mathbf{Skip}; \\ \text{requestTerminationCall} . \text{controllingMission} \longrightarrow \\ \text{requestTerminationRet} . \text{controllingMission} ? \text{requestTermination} \longrightarrow \\ \mathbf{Skip} \end{array} \right); \\ \text{handleAsyncEventRet} . \text{BeginLandingHandler} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

Methods $\hat{=}$
 (*handlerAsyncEvent*); *Methods*

• (*Methods*) \triangle (*end__app* . *BeginLandingHandler* \longrightarrow **Skip**)

end

class *BeginLandingHandlerClass* $\hat{=}$ **begin**

- **Skip**

end

section *BeginLandingHandlerMethChan* **parents** *scj_prelude, GlobalTypes, MissionId, SchedulableId*

section *NavigationMonitorApp* **parents** *PeriodicEventHandlerChan, SchedulableId, SchedulableIds* ,
CruiseMissionMethChan

process *NavigationMonitorApp* $\hat{=}$
 • **begin**

handlerAsyncEvent $\hat{=}$

$$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{NavigationMonitor} \longrightarrow \\ \left(\begin{array}{l} \text{getControllingMissionCall} . \text{mission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{mission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \end{array} \right) \\ \\ \text{var heading : double} \bullet \text{heading} := \text{getHeading} \\ \text{getControllingMissionCall} . \text{mission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{mission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \\ \\ \text{var airSpeed : double} \bullet \text{airSpeed} := \text{getAirSpeed} \\ \text{getControllingMissionCall} . \text{mission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{mission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \\ \\ \text{var altitude : double} \bullet \text{altitude} := \text{getAltitude} \\ \text{Skip} \end{array} \right) ; \\ \text{handleAsyncEventRet} . \text{NavigationMonitor} \longrightarrow \\ \text{Skip}$$

Methods $\hat{=}$
 (*handlerAsyncEvent*) ; *Methods*

• (*Methods*) \triangle (*end_periodic_app* . *NavigationMonitor* \longrightarrow **Skip**)

end

class *NavigationMonitorClass* $\hat{=}$ **begin**

- **Skip**

end

5.7 LandMission

section *LandMissionApp* **parents** *scj_prelude*, *MissionId*, *MissionIds*,
SchedulableId, *SchedulableIds*, *MissionChan*, *SchedulableMethChan*, *LandMissionClass*
, LandMissionMethChan

process *LandMissionApp* $\hat{=}$ **begin**

<i>State</i> <i>this</i> : ref <i>LandMissionClass</i>
--

state *State*

<i>Init</i> <i>State'</i>
<i>this'</i> = new <i>LandMissionClass</i> ()

InitializePhase $\hat{=}$

$$\left(\begin{array}{l} \text{initializeCall} . \text{LandMission} \longrightarrow \\ \text{register} ! \text{GroundDistanceMonitor} ! \text{LandMission} \longrightarrow \\ \text{register} ! \text{LandingGearHandlerLand} ! \text{LandMission} \longrightarrow \\ \text{register} ! \text{InstrumentLandingSystemMonitor} ! \text{LandMission} \longrightarrow \\ \text{register} ! \text{SafeLandingHandler} ! \text{LandMission} \longrightarrow \\ \text{initializeRet} . \text{LandMission} \longrightarrow \\ \text{Skip} \end{array} \right)$$

CleanupPhase $\hat{=}$

$$\left(\begin{array}{l} \text{cleanupMissionCall} . \text{LandMission} \longrightarrow \\ \text{cleanupMissionRet} . \text{LandMission} ! \text{True} \longrightarrow \\ \text{Skip} \end{array} \right)$$

stowLandingGearMeth $\hat{=}$

$$\left(\begin{array}{l} \text{stowLandingGearCall} . \text{LandMission} \longrightarrow \\ \text{this} . \text{stowLandingGear}(); \\ \text{stowLandingGearRet} . \text{LandMission} \longrightarrow \\ \text{Skip} \end{array} \right)$$

isLandingGearDeployedMeth $\hat{=}$ **var** *ret* : \mathbb{B} •

$$\left(\begin{array}{l} \text{isLandingGearDeployedCall} . \text{LandMission} \longrightarrow \\ \text{ret} := \text{this} . \text{isLandingGearDeployed}(); \\ \text{isLandingGearDeployedRet} . \text{LandMission} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

getControllingMissionMeth $\hat{=}$ **var** *ret* : *MissionID* •

$$\left(\begin{array}{l} \text{getControllingMissionCall} . \text{LandMission} \longrightarrow \\ \text{ret} := \text{this} . \text{getControllingMission}(); \\ \text{getControllingMissionRet} . \text{LandMission} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

$$\text{abortMeth} \hat{=} \left(\begin{array}{l} \text{abortCall} . \text{LandMission} \longrightarrow \\ \text{this} . \text{abort}(); \\ \text{abortRet} . \text{LandMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{cleanUpMeth} \hat{=} \mathbf{var} \text{ ret} : \mathbb{B} \bullet \left(\begin{array}{l} \text{cleanUpCall} . \text{LandMission} \longrightarrow \\ \text{ret} := \text{this} . \text{cleanUp}(); \\ \text{cleanUpRet} . \text{LandMission} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{deployLandingGearSyncMeth} \hat{=} \left(\begin{array}{l} \text{deployLandingGearCall} . \text{LandMission} ? \text{thread} \longrightarrow \\ \left(\begin{array}{l} \text{startSyncMeth} . \text{LandMissionObject} . \text{thread} \longrightarrow \\ \text{lockAcquired} . \text{LandMissionObject} . \text{thread} \longrightarrow \\ (\text{this} . \text{landingGearDeployed} := \text{true}); \\ \text{endSyncMeth} . \text{LandMissionObject} . \text{thread} \longrightarrow \\ \text{deployLandingGearRet} . \text{LandMission} . \text{thread} \longrightarrow \\ \mathbf{Skip} \end{array} \right) \end{array} \right)$$

$$\text{Methods} \hat{=} \left(\begin{array}{l} \text{InitializePhase} \\ \square \\ \text{CleanupPhase} \\ \square \\ \text{stowLandingGearMeth} \\ \square \\ \text{isLandingGearDeployedMeth} \\ \square \\ \text{getControllingMissionMeth} \\ \square \\ \text{abortMeth} \\ \square \\ \text{cleanUpMeth} \\ \square \\ \text{deployLandingGearSyncMeth} \end{array} \right) ; \text{Methods}$$

$$\bullet (\text{Init} ; \text{Methods}) \triangle (\text{end_mission_app} . \text{LandMission} \longrightarrow \mathbf{Skip})$$

end

class *LandMissionClass* $\hat{=}$ **begin**

state *State*

SAFE_LANDING_ALTITUDE : *double*

abort : \mathbb{B}

landingGearDeployed : \mathbb{B}

state *State*

initial *Init*

State'

SAFE_LANDING_ALTITUDE' = 10.0

abort' = *false*

public *stowLandingGear* $\hat{=}$

(*this* . *landingGearDeployed* := *false*)

public *isLandingGearDeployed* $\hat{=}$ **var** *ret* : \mathbb{B} •

(*ret* := *landingGearDeployed* = **True**)

public *getControllingMission* $\hat{=}$ **var** *ret* : *MissionID* •

(*ret* := *controllingMission*)

public *abort* $\hat{=}$

(*this* . *abort* := *true*)

public *cleanUp* $\hat{=}$ **var** *ret* : \mathbb{B} •

(**Skip**;
ret := (\neg *abort* = **True**))

• **Skip**

end

section *LandMissionMethChan* **parents** *scj_prelude, GlobalTypes, MissionId, SchedulableId*

channel *stowLandingGearCall* : *MissionID*
channel *stowLandingGearRet* : *MissionID*

channel *isLandingGearDeployedCall* : *MissionID*
channel *isLandingGearDeployedRet* : *MissionID* \times \mathbb{B}

channel *getControllingMissionCall* : *MissionID*
channel *getControllingMissionRet* : *MissionID* \times *MissionID*

channel *abortCall* : *MissionID*
channel *abortRet* : *MissionID*

channel *cleanUpCall* : *MissionID*
channel *cleanUpRet* : *MissionID* \times \mathbb{B}

channel *deployLandingGearCall* : *MissionID* \times *ThreadID*
channel *deployLandingGearRet* : *MissionID* \times *ThreadID*

5.8 Schedulables of LandMission

section *LandingGearHandlerLandApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,
LandMissionMethChan, *ObjectIds*, *ThreadIds*

process *LandingGearHandlerLandApp* $\hat{=}$
 • **begin**

handlerAsyncEvent $\hat{=}$

$$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{LandingGearHandlerLand} \longrightarrow \\ \left(\begin{array}{l} \text{Skip}; \\ \text{isLandingGearDeployedCall} . \text{mission} \longrightarrow \\ \text{isLandingGearDeployedRet} . \text{mission} ? \text{isLandingGearDeployed} \longrightarrow \\ \\ \text{var } \text{landingGearIsDeployed} : \mathbb{B} \bullet \text{landingGearIsDeployed} := \text{isLandingGearDeployed} \\ \text{if } \text{landingGearIsDeployed} = \text{True} \longrightarrow \\ \left(\begin{array}{l} \text{stowLandingGearCall} . \text{mission} \longrightarrow \\ \text{stowLandingGearRet} . \text{mission} \longrightarrow \\ \text{Skip} \end{array} \right) \\ \square \neg \text{landingGearIsDeployed} = \text{True} \longrightarrow \\ \left(\begin{array}{l} \text{deployLandingGearCall} . \text{mission} . \text{LandingGearHandlerLandThread} \longrightarrow \\ \text{deployLandingGearRet} . \text{mission} . \text{LandingGearHandlerLandThread} \longrightarrow \\ \text{Skip} \end{array} \right) \\ \text{fi} \end{array} \right) \text{handleAsyncEventRet} . \text{LandingGearHandlerLand} \longrightarrow \\ \text{Skip} \end{array} \right);$$

Methods $\hat{=}$
 (*handlerAsyncEvent*) ; *Methods*

• (*Methods*) \triangle (*end__app* . *LandingGearHandlerLand* \longrightarrow **Skip**)

end

class *LandingGearHandlerLandClass* $\hat{=}$ **begin**

- **Skip**

end

section *LandingGearHandlerLandMethChan* **parents** *scj_prelude, GlobalTypes, MissionId, SchedulableId*

section *SafeLandingHandlerApp* **parents** *AperiodicEventHandlerChan*, *SchedulableId*, *SchedulableIds* ,
LandMissionMethChan

process *SafeLandingHandlerApp* $\hat{=}$
 • **begin**

handlerAsyncEvent $\hat{=}$

$$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{SafeLandingHandler} \longrightarrow \\ \left(\begin{array}{l} \text{getControllingMissionCall} . \text{landMission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{landMission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \end{array} \right) \\ \\ \text{var } \text{altitude} : \text{double} \bullet \text{altitude} := \text{getAltitude} \\ \text{if } (\text{altitude} < \text{threshold}) \longrightarrow \\ \quad (\text{Skip}) \\ \quad \square \neg (\text{altitude} < \text{threshold}) \longrightarrow \\ \quad \quad (\text{Skip}) \\ \text{fi} \\ \text{handleAsyncEventRet} . \text{SafeLandingHandler} \longrightarrow \\ \text{Skip} \end{array} \right) ;$$

Methods $\hat{=}$
 (*handlerAsyncEvent*) ; *Methods*

• (*Methods*) \triangle (*end__app* . *SafeLandingHandler* \longrightarrow **Skip**)

end

class *SafeLandingHandlerClass* $\hat{=}$ **begin**

state <i>State</i> <i>threshold</i> : <i>double</i>

state *State*

initial <i>Init</i> <i>State</i> '
--

- **Skip**

end

section *SafeLandingHandlerMethChan* **parents** *scj_prelude, GlobalTypes, MissionId, SchedulableId*

section *GroundDistanceMonitorApp* **parents** *PeriodicEventHandlerChan, SchedulableId, SchedulableIds* ,
LandMissionMethChan

process *GroundDistanceMonitorApp* $\hat{=}$
 • **begin**

handlerAsyncEvent $\hat{=}$

$$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{GroundDistanceMonitor} \longrightarrow \\ \left(\begin{array}{l} \mathbf{Skip}; \\ \text{getControllingMissionCall} . \text{mission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{mission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \\ \\ \mathbf{var} \text{ distance} : \text{double} \bullet \text{ distance} := \text{getAltitude} \\ \mathbf{if} (\text{distance} = \text{readingOnGround}) \longrightarrow \\ \left(\begin{array}{l} \mathbf{Skip}; \\ \text{requestTerminationCall} . \text{mission} \longrightarrow \\ \text{requestTerminationRet} . \text{mission} ? \text{requestTermination} \longrightarrow \\ \mathbf{Skip} \end{array} \right) \\ \square \neg (\text{distance} = \text{readingOnGround}) \longrightarrow \mathbf{Skip} \\ \mathbf{fi}; \\ \mathbf{Skip} \end{array} \right) \\ \text{handleAsyncEventRet} . \text{GroundDistanceMonitor} \longrightarrow \\ \mathbf{Skip} \end{array} \right) ;$$

Methods $\hat{=}$
 (*handlerAsyncEvent*) ; *Methods*

• (*Methods*) \triangle (*end_periodic_app* . *GroundDistanceMonitor* \longrightarrow **Skip**)

end

class *GroundDistanceMonitorClass* $\hat{=}$ **begin**

state *State*

readingOnGround : *double*

state *State*

initial *Init*

State'

• **Skip**

end

section *InstrumentLandingSystemMonitorApp* **parents** *PeriodicEventHandlerChan, SchedulableId, SchedulableIds*

process *InstrumentLandingSystemMonitorApp* $\hat{=}$

• **begin**

handlerAsyncEvent $\hat{=}$

$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{InstrumentLandingSystemMonitor} \longrightarrow \\ (\mathbf{Skip}) ; \\ \text{handleAsyncEventRet} . \text{InstrumentLandingSystemMonitor} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

Methods $\hat{=}$

$(\text{handlerAsyncEvent}) ; \text{Methods}$

• $(\text{Methods}) \triangle (\text{end_periodic_app} . \text{InstrumentLandingSystemMonitor} \longrightarrow \mathbf{Skip})$

end

class *InstrumentLandingSystemMonitorClass* $\hat{=}$ **begin**

- **Skip**

end