

aircraft

Tight Rope v0.6

November 1, 2015

1 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, MTAppSync, 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* $\hat{=}$

$$\left(\begin{array}{l} \text{MissionFW}(\text{MainMission}) \\ \llbracket \text{MissionSync} \rrbracket \\ \left(\begin{array}{l} \text{SchedulableMissionSequencerFW}() \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \left(\begin{array}{l} \text{AperiodicEventHandlerFW}() \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{AperiodicEventHandlerFW}() \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \left(\begin{array}{l} \text{PeriodicEventHandlerFW}() \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{PeriodicEventHandlerFW}() \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{PeriodicEventHandlerFW}() \end{array} \right) \end{array} \right) \end{array} \right)$$

process *Tier1* $\hat{=}$

$$\left(\begin{array}{l} \text{MissionFW}(\text{TakeOffMission}) \\ \llbracket \text{MissionSync} \rrbracket \\ \left(\begin{array}{l} \left(\begin{array}{l} \text{AperiodicEventHandlerFW}() \\ \llbracket \text{SchedulablesSync} \rrbracket \end{array} \right) \\ \text{AperiodicEventHandlerFW}() \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \text{PeriodicEventHandlerFW}() \end{array} \right) \\ \llbracket \text{ClusterSync} \rrbracket \\ \left(\begin{array}{l} \text{MissionFW}(\text{CruiseMission}) \\ \llbracket \text{MissionSync} \rrbracket \\ \left(\begin{array}{l} \text{AperiodicEventHandlerFW}() \\ \llbracket \text{SchedulablesSync} \rrbracket \end{array} \right) \\ \text{PeriodicEventHandlerFW}() \end{array} \right) \\ \llbracket \text{ClusterSync} \rrbracket \\ \left(\begin{array}{l} \text{MissionFW}(\text{LandMission}) \\ \llbracket \text{MissionSync} \rrbracket \\ \left(\begin{array}{l} \left(\begin{array}{l} \text{AperiodicEventHandlerFW}() \\ \llbracket \text{SchedulablesSync} \rrbracket \end{array} \right) \\ \text{AperiodicEventHandlerFW}() \\ \llbracket \text{SchedulablesSync} \rrbracket \\ \left(\begin{array}{l} \text{PeriodicEventHandlerFW}() \\ \llbracket \text{SchedulablesSync} \rrbracket \end{array} \right) \\ \text{PeriodicEventHandlerFW}() \end{array} \right) \end{array} \right)$$

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(*hijac.tools.tightrope.environments.VariableEnv* • 71c27ee8, *hijac.tools.tightrope.environments.VariableEnv* • 71c27ee8)
|||
ACModeChangerApp(*MainMission*, *MainMission*)
|||
ControlHandlerApp
|||
CommunicationsHandlerApp
|||
EnvironmentMonitorApp(*MainMission*)
|||
FlightSensorsMonitorApp(*MainMission*)
|||
AperiodicSimulatorApp(*AperiodicEventHandler*)
|||
TakeOffMissionApp(*hijac.tools.tightrope.environments.VariableEnv* • 6e950bcf, *hijac.tools.tightrope.environments.VariableEnv* • 6e950bcf)
|||
LandingGearHandlerTakeOffApp(*TakeOffMission*)
|||
TakeOffFailureHandlerApp(*TakeOffMission*)
|||
TakeOffMonitorApp(*TakeOffMission*, *AperiodicEventHandler*)
|||
CruiseMissionApp(*hijac.tools.tightrope.environments.VariableEnv* • 46dffd3, *hijac.tools.tightrope.environments.VariableEnv* • 46dffd3)
|||
BeginLandingHandlerApp(*Mission*)
|||
NavigationMonitorApp(*CruiseMission*)
|||
LandMissionApp(*hijac.tools.tightrope.environments.VariableEnv* • 53dbe163, *hijac.tools.tightrope.environments.VariableEnv* • 53dbe163)
|||
LandingGearHandlerLandApp(*LandMission*)
|||
SafeLandingHandlerApp(*LandMission*)
|||
GroundDistanceMonitorApp(*LandMission*)
|||
InstrumentLandingSystemMonitorApp(*LandMission*)

$$\begin{aligned}
\text{Locking} \hat{=} & \left(\begin{array}{l} \text{ThreadFW}(\text{LandingGearHandlerLandThread}, \text{MinPriority}) \\ \quad \llbracket \text{ThreadSync} \rrbracket \\ \text{ThreadFW}(\text{SafeLandingHandlerThread}, \text{MinPriority}) \\ \quad \llbracket \text{ThreadSync} \rrbracket \\ \text{ThreadFW}(\text{GroundDistanceMonitorThread}, \text{MinPriority}) \\ \quad \llbracket \text{ThreadSync} \rrbracket \\ \text{ThreadFW}(\text{InstrumentLandingSystemMonitorThread}, \text{MinPriority}) \end{array} \right) \\
& \parallel \\
& \left(\begin{array}{l} \text{ObjectFW}(\text{ACSafeletObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{MainMissionObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{TakeOffMissionObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{CruiseMissionObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{LandMissionObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{ACModeChangerObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{EnvironmentMonitorObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{ControlHandlerObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{FlightSensorsMonitorObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{CommunicationsHandlerObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{AperiodicSimulatorObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{LandingGearHandlerTakeOffObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{TakeOffMonitorObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{TakeOffFailureHandlerObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{BeginLandingHandlerObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{NavigationMonitorObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{GroundDistanceMonitorObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{LandingGearHandlerLandObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{InstrumentLandingSystemMonitorObject}) \\ \quad \llbracket \text{ObjectSync} \rrbracket \\ \text{ObjectFW}(\text{SafeLandingHandlerObject}) \end{array} \right)
\end{aligned}$$

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

2 ID Files

2.1 MissionIds

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

MainMission : *MissionID*
TakeOffMission : *MissionID*
CruiseMission : *MissionID*
LandMission : *MissionID*

distinct(*nullMissionId*, *MainMission*,
TakeOffMission,
CruiseMission,
LandMission)

2.2 SchedulablesIds

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

MainMissionSequencer : *SchedulableID*
ACModeChanger : *SchedulableID*
EnvironmentMonitor : *SchedulableID*
ControlHandler : *SchedulableID*
FlightSensorsMonitor : *SchedulableID*
CommunicationsHandler : *SchedulableID*
AperiodicSimulator : *SchedulableID*
LandingGearHandlerTakeOff : *SchedulableID*
TakeOffMonitor : *SchedulableID*
TakeOffFailureHandler : *SchedulableID*
BeginLandingHandler : *SchedulableID*
NavigationMonitor : *SchedulableID*
GroundDistanceMonitor : *SchedulableID*
LandingGearHandlerLand : *SchedulableID*
InstrumentLandingSystemMonitor : *SchedulableID*
SafeLandingHandler : *SchedulableID*

distinct(*nullSequencerId*, *nullSchedulableId*, *ACModeChanger*,
EnvironmentMonitor,
ControlHandler,
FlightSensorsMonitor,
CommunicationsHandler,
AperiodicSimulator,
LandingGearHandlerTakeOff,
TakeOffMonitor,
TakeOffFailureHandler,
BeginLandingHandler,
NavigationMonitor,
GroundDistanceMonitor,
LandingGearHandlerLand,
InstrumentLandingSystemMonitor,
SafeLandingHandler)

2.3 ThreadIds

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

ACModeChangerThread : *ThreadID*
EnvironmentMonitorThread : *ThreadID*
ControlHandlerThread : *ThreadID*
FlightSensorsMonitorThread : *ThreadID*
CommunicationsHandlerThread : *ThreadID*
AperiodicSimulatorThread : *ThreadID*
LandingGearHandlerTakeOffThread : *ThreadID*
TakeOffMonitorThread : *ThreadID*
TakeOffFailureHandlerThread : *ThreadID*
BeginLandingHandlerThread : *ThreadID*
NavigationMonitorThread : *ThreadID*
GroundDistanceMonitorThread : *ThreadID*
LandingGearHandlerLandThread : *ThreadID*
InstrumentLandingSystemMonitorThread : *ThreadID*
SafeLandingHandlerThread : *ThreadID*

distinct(*SafeletThreadId*, *nullThreadId*,
ACModeChangerThread,
EnvironmentMonitorThread,
ControlHandlerThread,
FlightSensorsMonitorThread,
CommunicationsHandlerThread,
AperiodicSimulatorThread,
LandingGearHandlerTakeOffThread,
TakeOffMonitorThread,
TakeOffFailureHandlerThread,
BeginLandingHandlerThread,
NavigationMonitorThread,
GroundDistanceMonitorThread,
LandingGearHandlerLandThread,
InstrumentLandingSystemMonitorThread,
SafeLandingHandlerThread)

2.4 ObjectIds

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

ACSafeletObject : ObjectID
MainMissionObject : ObjectID
TakeOffMissionObject : ObjectID
CruiseMissionObject : ObjectID
LandMissionObject : ObjectID
ACModeChangerObject : ObjectID
EnvironmentMonitorObject : ObjectID
ControlHandlerObject : ObjectID
FlightSensorsMonitorObject : ObjectID
CommunicationsHandlerObject : ObjectID
AperiodicSimulatorObject : ObjectID
LandingGearHandlerTakeOffObject : ObjectID
TakeOffMonitorObject : ObjectID
TakeOffFailureHandlerObject : ObjectID
BeginLandingHandlerObject : ObjectID
NavigationMonitorObject : ObjectID
GroundDistanceMonitorObject : ObjectID
LandingGearHandlerLandObject : ObjectID
InstrumentLandingSystemMonitorObject : ObjectID
SafeLandingHandlerObject : ObjectID

distinct⟨*ACSafeletObject*,
MainMissionObject,
TakeOffMissionObject,
CruiseMissionObject,
LandMissionObject,
ACModeChangerObject,
EnvironmentMonitorObject,
ControlHandlerObject,
FlightSensorsMonitorObject,
CommunicationsHandlerObject,
AperiodicSimulatorObject,
LandingGearHandlerTakeOffObject,
TakeOffMonitorObject,
TakeOffFailureHandlerObject,
BeginLandingHandlerObject,
NavigationMonitorObject,
GroundDistanceMonitorObject,
LandingGearHandlerLandObject,
InstrumentLandingSystemMonitorObject,
SafeLandingHandlerObject⟩

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

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

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 <i>State</i> <i>returnedMission</i> : \mathbb{B}
--

state *State*

initial <i>Init</i> <i>State</i> '
<i>returnedMission</i> ' = <i>false</i>

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

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

• **Skip**

end

5 Missions

5.1 MainMission

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

process *MainMissionApp* $\hat{=}$ *storageParameters* : *MissionID*, *storageParametersSchedulable* : *MissionID*, *aCModeChange*

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* •

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

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

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

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

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

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

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

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

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

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

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

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

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

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

process *ACModeChangerApp* $\hat{=}$ *controllingMission* : *MissionID*, *controllingMission* : *MissionID* • **begin**

State

```

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

```

state *State*

Init

```

State'

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

```

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

$$\begin{aligned}
& \text{getNextMissionMeth} \hat{=} \mathbf{var} \text{ ret} : \text{MissionID} \bullet \\
& \left(\begin{array}{l}
\text{getNextMissionCall} . \text{ACModeChanger} \longrightarrow \\
\left(\begin{array}{l}
\mathbf{if} (\text{modesLeft} = 3) \longrightarrow \\
\quad \left(\begin{array}{l} \text{modesLeft} := \text{modesLeft} - 1; \\ \text{ret} := \text{TakeOffMission} \end{array} \right) \\
\Box \neg (\text{modesLeft} = 3) \longrightarrow \\
\quad \mathbf{if} (\text{modesLeft} = 2) \longrightarrow \\
\quad \quad \left(\begin{array}{l} \text{modesLeft} := \text{modesLeft} - 1; \\ \text{ret} := \text{CruiseMission} \end{array} \right) \\
\Box \neg (\text{modesLeft} = 2) \longrightarrow \\
\quad \mathbf{if} (\text{modesLeft} = 1) \longrightarrow \\
\quad \quad \left(\begin{array}{l} \text{modesLeft} := \text{modesLeft} - 1; \\ \text{ret} := \text{LandMission} \end{array} \right) \\
\Box \neg (\text{modesLeft} = 1) \longrightarrow \\
\quad \quad (\text{ret} := \text{nullMissionId}) \\
\mathbf{fi} \\
\mathbf{fi} \\
\mathbf{fi}
\end{array} \right) ; \\
\text{getNextMissionRet} . \text{ACModeChanger} ! \text{ret} \longrightarrow \\
\mathbf{Skip}
\end{array} \right)
\end{aligned}$$

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

$$\begin{aligned}
& \text{getNextMissionMeth} \hat{=} \mathbf{var} \text{ ret} : \text{MissionID} \bullet \\
& \left(\begin{array}{l}
\text{getNextMissionCall} . \text{ACModeChanger} \longrightarrow \\
\left(\begin{array}{l}
\mathbf{if} (\text{modesLeft} = 3) \longrightarrow \\
\quad \left(\begin{array}{l} \text{modesLeft} := \text{modesLeft} - 1; \\ \text{ret} := \text{TakeOffMission} \end{array} \right) \\
\Box \neg (\text{modesLeft} = 3) \longrightarrow \\
\quad \mathbf{if} (\text{modesLeft} = 2) \longrightarrow \\
\quad \quad \left(\begin{array}{l} \text{modesLeft} := \text{modesLeft} - 1; \\ \text{ret} := \text{CruiseMission} \end{array} \right) \\
\Box \neg (\text{modesLeft} = 2) \longrightarrow \\
\quad \mathbf{if} (\text{modesLeft} = 1) \longrightarrow \\
\quad \quad \left(\begin{array}{l} \text{modesLeft} := \text{modesLeft} - 1; \\ \text{ret} := \text{LandMission} \end{array} \right) \\
\Box \neg (\text{modesLeft} = 1) \longrightarrow \\
\quad \quad (\text{ret} := \text{nullMissionId}) \\
\mathbf{fi} \\
\mathbf{fi} \\
\mathbf{fi}
\end{array} \right) ; \\
\text{getNextMissionRet} . \text{ACModeChanger} ! \text{ret} \longrightarrow \\
\mathbf{Skip}
\end{array} \right)
\end{aligned}$$

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

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

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

end

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

◦ **sync** *advanceMode* $\hat{=}$

$$\left(\begin{array}{l} ; \\ \textbf{if} (modesLeft = 3) \longrightarrow \\ \quad \left(\begin{array}{l} modesLeft := modesLeft - 1; \\ changeTo(launchMode) \end{array} \right) \\ \parallel \neg (modesLeft = 3) \longrightarrow \\ \quad \textbf{if} (modesLeft = 2) \longrightarrow \\ \quad \quad \left(\begin{array}{l} modesLeft := modesLeft - 1; \\ changeTo(cruiseMode) \end{array} \right) \\ \parallel \neg (modesLeft = 2) \longrightarrow \\ \quad \textbf{if} (modesLeft = 1) \longrightarrow \\ \quad \quad \left(\begin{array}{l} modesLeft := modesLeft - 1; \\ changeTo(landMode) \end{array} \right) \\ \parallel \neg (modesLeft = 1) \longrightarrow \\ \quad \quad (changeTo(\textbf{null})) \\ \textbf{fi} \\ \textbf{fi} \\ \textbf{fi} \end{array} \right)$$

• **Skip**

end

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

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

channel *getNextMissionCall* : *SchedulableID*
channel *getNextMissionRet* : *SchedulableID* × *MissionID*

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

channel *getNextMissionCall* : *SchedulableID*
channel *getNextMissionRet* : *SchedulableID* × *MissionID*

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

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

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

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

releaseMeth $\hat{=}$ **var** *ret* : *void* •
 $\left(\begin{array}{l} \text{releaseCall} . \text{ControlHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{ControlHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

releaseMeth $\hat{=}$ **var** *ret* : *void* •
 $\left(\begin{array}{l} \text{releaseCall} . \text{ControlHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{ControlHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

releaseMeth $\hat{=}$ **var** *ret* : *void* •
 $\left(\begin{array}{l} \text{releaseCall} . \text{ControlHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{ControlHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

releaseMeth $\hat{=}$ **var** *ret* : *void* •
 $\left(\begin{array}{l} \text{releaseCall} . \text{ControlHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{ControlHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

releaseMeth $\hat{=}$ **var** *ret* : *void* •
 $\left(\begin{array}{l} \text{releaseCall} . \text{ControlHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{ControlHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

releaseMeth $\hat{=}$ **var** *ret* : *void* •
 $\left(\begin{array}{l} \text{releaseCall} . \text{ControlHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{ControlHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

releaseMeth $\hat{=}$ **var** *ret* : *void* •
 $\left(\begin{array}{l} \text{releaseCall} . \text{ControlHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{ControlHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet$$

$$\left(\begin{array}{l} \text{releaseCall} . \text{ControlHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{ControlHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet$$

$$\left(\begin{array}{l} \text{releaseCall} . \text{ControlHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{ControlHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet$$

$$\left(\begin{array}{l} \text{releaseCall} . \text{ControlHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{ControlHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet$$

$$\left(\begin{array}{l} \text{releaseCall} . \text{ControlHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{ControlHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{Methods} \hat{=}$$

$$\left(\begin{array}{l} \text{handlerAsyncEvent} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \end{array} \right) ; \text{Methods}$$

$$\Delta(\text{end_aperiodic_app} . \text{ControlHandler} \longrightarrow \mathbf{Skip})$$

end

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

- **Skip**

end

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

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

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

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

handlerAsyncEvent $\hat{=}$

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

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{CommunicationsHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{CommunicationsHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{CommunicationsHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{CommunicationsHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{CommunicationsHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{CommunicationsHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{CommunicationsHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{CommunicationsHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{CommunicationsHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{CommunicationsHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{CommunicationsHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{CommunicationsHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{CommunicationsHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{CommunicationsHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet$$

$$\left(\begin{array}{l} \text{releaseCall} . \text{CommunicationsHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{CommunicationsHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet$$

$$\left(\begin{array}{l} \text{releaseCall} . \text{CommunicationsHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{CommunicationsHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet$$

$$\left(\begin{array}{l} \text{releaseCall} . \text{CommunicationsHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{CommunicationsHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet$$

$$\left(\begin{array}{l} \text{releaseCall} . \text{CommunicationsHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{CommunicationsHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{Methods} \hat{=}$$

$$\left(\begin{array}{l} \text{handlerAsyncEvent} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \end{array} \right) ; \text{Methods}$$

$$\triangle(\text{end_aperiodic_app} . \text{CommunicationsHandler} \longrightarrow \mathbf{Skip})$$

end

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

- **Skip**

end

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

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

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

process *EnvironmentMonitorApp* $\hat{=}$ *controllingMission* : *MissionID* • **begin**

handlerAsyncEvent $\hat{=}$

$$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{EnvironmentMonitor} \longrightarrow \\ ; \\ \text{setCabinPressureCall} . \text{controllingMission0} \longrightarrow \\ \text{setCabinPressureRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip}; \\ \text{setEmergencyOxygenCall} . \text{controllingMission0} \longrightarrow \\ \text{setEmergencyOxygenRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip}; \\ \text{setFuelRemainingCall} . \text{controllingMission0} \longrightarrow \\ \text{setFuelRemainingRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right) \text{handleAsyncEventRet} . \text{EnvironmentMonitor} \longrightarrow$$

Skip

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

$\triangle(\text{end_periodic_app} . \text{EnvironmentMonitor} \longrightarrow \mathbf{Skip})$

end

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

- **Skip**

end

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

process *FlightSensorsMonitorApp* $\hat{=}$ *controllingMission* : *MissionID* • **begin**

handlerAsyncEvent $\hat{=}$

$$\left(\begin{array}{l} \text{handleAsyncEventCall} . \text{FlightSensorsMonitor} \longrightarrow \\ ; \\ \text{setAirSpeedCall} . \text{controllingMission0} \longrightarrow \\ \text{setAirSpeedRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip}; \\ \text{setAltitudeCall} . \text{controllingMission0} \longrightarrow \\ \text{setAltitudeRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip}; \\ \text{setHeadingCall} . \text{controllingMission0} \longrightarrow \\ \text{setHeadingRet} . \text{controllingMission} \longrightarrow \\ \mathbf{Skip} \end{array} \right) \text{handleAsyncEventRet} . \text{FlightSensorsMonitor} \longrightarrow \\ \mathbf{Skip}$$

Methods $\hat{=}$
(*handlerAsyncEvent*) ; *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* $\hat{=}$ *event* : *MissionID* • **begin**

handlerAsyncEvent $\hat{=}$

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

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

$\triangle(\text{end_periodic_app} . \text{AperiodicSimulator} \longrightarrow \mathbf{Skip})$

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* $\hat{=}$ *storageParametersSchedulable : MissionID, landingGearHandler : MissionID, takeOffMonitor*

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

state *State*

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

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

state *State*

initial *Init*

State'

SAFE_AIRSPEED_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} •
 $\left(\begin{array}{l} ; \\ \text{ret} := (\neg \text{abort} = \mathbf{True}) \end{array} \right)$

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

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

process *LandingGearHandlerTakeOffApp* $\hat{=}$ *mission* : *MissionID* • **begin**

handlerAsyncEvent $\hat{=}$

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

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerTakeOff} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerTakeOff} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerTakeOff} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerTakeOff} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerTakeOff} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerTakeOff} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerTakeOff} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerTakeOff} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerTakeOff} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerTakeOff} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerTakeOff} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerTakeOff} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{Methods} \hat{=} \left(\begin{array}{l} \text{handlerAsyncEvent} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \end{array} \right) ; \text{Methods}$$

$\Delta(\text{end_aperiodic_app} . \text{LandingGearHandlerTakeOff} \longrightarrow \mathbf{Skip})$

end

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

- **Skip**

end

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

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

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channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

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

process *TakeOffFailureHandlerApp* $\hat{=}$ *takeoffMission* : *MissionID* • **begin**

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

state *State*

<i>Init</i>
<i>State</i> ′
<i>threshold</i> ′ = <i>threshold</i>

handlerAsyncEvent $\hat{=}$

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

Skip

releaseMeth $\hat{=}$ $\mathbf{var} \text{ ret} : \text{void} \bullet$

$$\left(\begin{array}{l} \text{releaseCall} . \text{TakeOffFailureHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{TakeOffFailureHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ $\mathbf{var} \text{ ret} : \text{void} \bullet$

$$\left(\begin{array}{l} \text{releaseCall} . \text{TakeOffFailureHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{TakeOffFailureHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ $\mathbf{var} \text{ ret} : \text{void} \bullet$

$$\left(\begin{array}{l} \text{releaseCall} . \text{TakeOffFailureHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{TakeOffFailureHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{TakeOffFailureHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{TakeOffFailureHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{TakeOffFailureHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{TakeOffFailureHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{TakeOffFailureHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{TakeOffFailureHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{TakeOffFailureHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{TakeOffFailureHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{TakeOffFailureHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{TakeOffFailureHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{TakeOffFailureHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{TakeOffFailureHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{TakeOffFailureHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{TakeOffFailureHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{TakeOffFailureHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{TakeOffFailureHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\begin{array}{l}
\textit{Methods} \hat{=} \\
\left(\begin{array}{l}
\textit{handlerAsyncEvent} \\
\Box \\
\textit{releaseMeth} \\
\Box \\
\textit{releaseMeth} \\
\Box \\
\textit{releaseMeth} \\
\Box \\
\textit{releaseMeth} \\
\Box \\
\textit{releaseMeth} \\
\Box \\
\textit{releaseMeth} \\
\Box \\
\textit{releaseMeth} \\
\Box \\
\textit{releaseMeth} \\
\Box \\
\textit{releaseMeth} \\
\Box \\
\textit{releaseMeth}
\end{array} \right) ; \textit{Methods}
\end{array}$$

$$\Delta(\textit{end_aperiodic_app} . \textit{TakeOffFailureHandler} \longrightarrow \mathbf{Skip})$$

end

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

- **Skip**

end

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

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

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

process *TakeOffMonitorApp* $\hat{=}$ *takeoffMission* : *MissionID*, *landingGearHandler* : *MissionID* • **begin**

State

takeOffAltitude : double

state *State*

Init

State′

takeOffAltitude′ = *takeOffAltitude*

handlerAsyncEvent $\hat{=}$

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

Methods $\hat{=}$

(*handlerAsyncEvent*) ; *Methods*

$\triangle(\text{end_periodic_app} . \text{TakeOffMonitor} \longrightarrow \mathbf{Skip})$

end

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

- **Skip**

end

5.5 CruiseMission

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

process *CruiseMissionApp* $\hat{=}$ *storageParametersSchedulable* : *MissionID*, *beginLandingHandler* : *MissionID*, *navigationM*

State
this : **ref** *CruiseMissionClass*

state *State*

Init
State'
this' = **new** *CruiseMissionClass*()

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

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

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

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

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

process *BeginLandingHandlerApp* $\hat{=}$ *controllingMission* : *MissionID* • **begin**

handlerAsyncEvent $\hat{=}$

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

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{BeginLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{BeginLandingHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{BeginLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{BeginLandingHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{BeginLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{BeginLandingHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{BeginLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{BeginLandingHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{BeginLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{BeginLandingHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{BeginLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{BeginLandingHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{BeginLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{BeginLandingHandler} ! \text{ret} \longrightarrow \\ \text{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet$$

$$\left(\begin{array}{l} \text{releaseCall} . \text{BeginLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{BeginLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet$$

$$\left(\begin{array}{l} \text{releaseCall} . \text{BeginLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{BeginLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet$$

$$\left(\begin{array}{l} \text{releaseCall} . \text{BeginLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{BeginLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet$$

$$\left(\begin{array}{l} \text{releaseCall} . \text{BeginLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{BeginLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{Methods} \hat{=}$$

$$\left(\begin{array}{l} \text{handlerAsyncEvent} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \end{array} \right) ; \text{Methods}$$

$$\triangle(\text{end_aperiodic_app} . \text{BeginLandingHandler} \longrightarrow \mathbf{Skip})$$

end

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

- **Skip**

end

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

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

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

process *NavigationMonitorApp* $\hat{=}$ *mission : MissionID* • **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*

$\triangle(\text{end_periodic_app} . \text{NavigationMonitor} \longrightarrow \text{Skip})$

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* $\hat{=}$ *storageParametersSchedulable* : *MissionID*, *groundDistanceMonitor* : *MissionID*, *landingHar*

State

this : **ref** *LandMissionClass*

state *State*

Init

State'

this' = **new** *LandMissionClass*()

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* •

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

abortMeth $\hat{=}$

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

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

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

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

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

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} •

(
;
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

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

process *LandingGearHandlerLandApp* $\hat{=}$ *mission* : *MissionID* • **begin**

handlerAsyncEvent $\hat{=}$

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

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerLand} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerLand} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerLand} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerLand} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerLand} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerLand} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerLand} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerLand} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

releaseMeth $\hat{=}$ **var** *ret* : *void* •

$$\left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerLand} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerLand} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerLand} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerLand} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerLand} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerLand} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerLand} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerLand} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerLand} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerLand} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerLand} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerLand} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{LandingGearHandlerLand} \longrightarrow \\ ; \\ \text{releaseRet} . \text{LandingGearHandlerLand} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{Methods} \hat{=} \left(\begin{array}{l} \text{handlerAsyncEvent} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \\ \square \\ \text{releaseMeth} \end{array} \right) ; \text{Methods}$$

$\triangle(end_aperiodic_app . LandingGearHandlerLand \longrightarrow \mathbf{Skip})$

end

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

- **Skip**

end

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

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

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

$$\text{process } \textit{SafeLandingHandlerApp} \hat{=} \textit{landMission} : \textit{MissionID} \bullet \text{begin}$$

State _____
 threshold : double

state *State*

<i>Init</i>	
<i>State'</i>	
	$threshold' = threshold$

$$\text{handlerAsyncEvent} \triangleq \left(\begin{array}{l} \text{handleAsyncEventCall} . \text{SafeLandingHandler} \longrightarrow \\ \left(\begin{array}{l} \text{getControllingMissionCall} . \text{landMission} . \text{getControllingMission}() \longrightarrow \\ \text{getControllingMissionRet} . \text{landMission} . \text{getControllingMission}() ? \text{getControllingMission} \longrightarrow \end{array} \right) \\ \mathbf{var} \textit{altitude} : \textit{double} \bullet \textit{altitude} := \textit{getAltitude} \\ \mathbf{if} (\textit{altitude} < \textit{threshold}) \longrightarrow \\ \quad)(\phantom{\text{getControllingMission}}) \\ \quad \Box \neg (\textit{altitude} < \textit{threshold}) \longrightarrow \\ \quad)(\phantom{\text{getControllingMission}}) \\ \mathbf{fi} \\ \mathbf{Skip} \end{array} \right) \text{handleAsyncEventRet}$$
$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \mathbf{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{SafeLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{SafeLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$
$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{SafeLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{SafeLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$
$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{SafeLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{SafeLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$
$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \mathbf{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{SafeLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{SafeLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{SafeLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{SafeLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{SafeLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{SafeLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{SafeLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{SafeLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{SafeLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{SafeLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{SafeLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{SafeLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{SafeLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{SafeLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$$\text{releaseMeth} \hat{=} \mathbf{var} \text{ ret} : \text{void} \bullet \left(\begin{array}{l} \text{releaseCall} . \text{SafeLandingHandler} \longrightarrow \\ ; \\ \text{releaseRet} . \text{SafeLandingHandler} ! \text{ret} \longrightarrow \\ \mathbf{Skip} \end{array} \right)$$

$Methods \hat{=}$
 $\left(\begin{array}{l} handlerAsyncEvent \\ \square \\ releaseMeth \\ \square \\ releaseMeth \\ \square \\ releaseMeth \\ \square \\ releaseMeth \\ \square \\ releaseMeth \\ \square \\ releaseMeth \\ \square \\ releaseMeth \\ \square \\ releaseMeth \\ \square \\ releaseMeth \\ \square \\ releaseMeth \end{array} \right) ; Methods$

$\triangle(end_aperiodic_app . SafeLandingHandler \longrightarrow \mathbf{Skip})$

end

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

- **Skip**

end

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

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

channel *releaseCall* : *SchedulableID*
channel *releaseRet* : *SchedulableID* \times *void*

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

process *GroundDistanceMonitorApp* $\hat{=}$ *mission* : *MissionID* • **begin**

<i>State</i> <i>readingOnGround</i> : double

state *State*

<i>Init</i> <i>State</i> '
<i>readingOnGround</i> ' =

handlerAsyncEvent $\hat{=}$

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

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

$\triangle(\text{end_periodic_app} . \text{GroundDistanceMonitor} \longrightarrow \mathbf{Skip})$

end

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

- **Skip**

end

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

process *InstrumentLandingSystemMonitorApp* $\hat{=}$ *mission : MissionID* • **begin**

handlerAsyncEvent $\hat{=}$

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

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

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

end

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

- **Skip**

end