BEHAVIOURAL MODELS@ESO

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European Southern Observatory

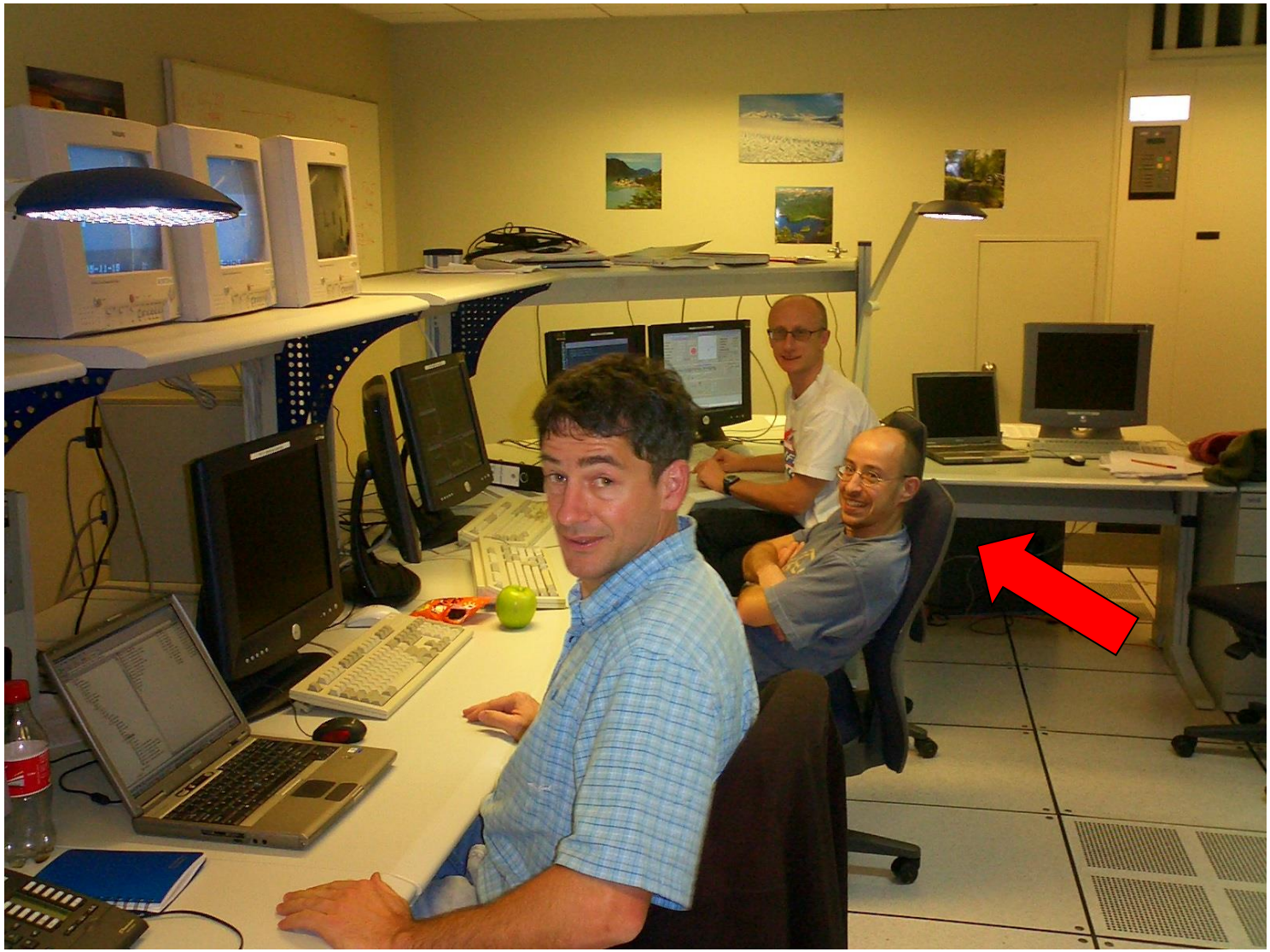
ALMA

Atacama Large Millimeter Array, 5000m, Atacama desert

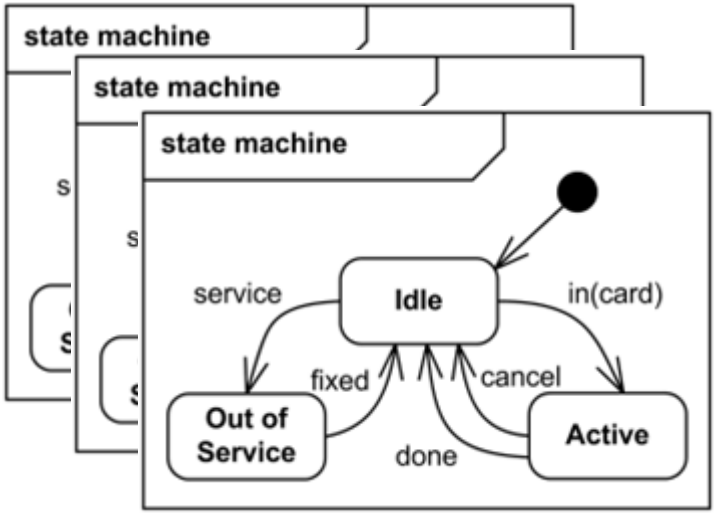
Very Large Telescopes

Cerro Paranal, 2635m, Atacama desert, Chile.

System Commissioning



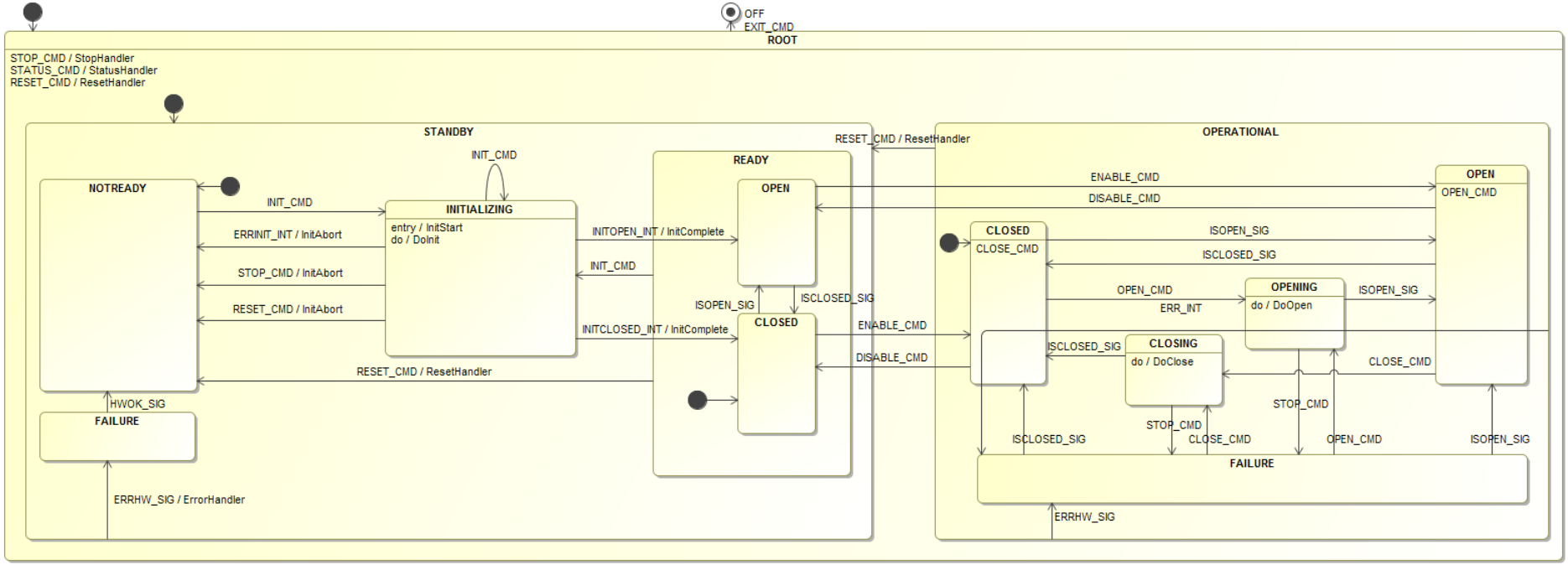
“BEHAVIOURAL MODELS FOR DEVICE CONTROL”



ICALEPCS2017
Barcelona · Spain, October 8-13 · Palau de Congressos de Catalunya

- Digitally controlled shutters
- Lamps with intensity control
- DC and stepper motors
- Multi-axis analog piezos

Shutter


OFF
EXIT_CMD
ROOT
STOP_CMD / StopHandler
STATUS_CMD / StatusHandler
RESET_CMD / ResetHandler
STANDBY
NOTREADY
INIT_CMD
ERRINIT_INT / InitAbort
STOP_CMD / InitAbort
RESET_CMD / InitAbort
INITIALIZING
entry / InitStart
do / DoInit
INITOPEN_INT / InitComplete
INIT_CMD
INITCLOSED_INT / InitComplete
READY
OPEN
ISOPEN_SIG
ISCLOSED_SIG
CLOSED
ENABLE_CMD
DISABLE_CMD
RESET_CMD / ResetHandler
HWOK_SIG
FAILURE
ERRHW_SIG / ErrorHandler
RESET_CMD / ResetHandler
OPERATIONAL
ENABLE_CMD
DISABLE_CMD
OPEN
OPEN_CMD
CLOSED
CLOSE_CMD
ISOPEN_SIG
ISCLOSED_SIG
OPEN_CMD
ERR_INT
OPENING
do / DoOpen
ISOPEN_SIG
ISCLOSED_SIG
CLOSING
do / DoClose
CLOSE_CMD
STOP_CMD
STOP_CMD
ISCLOSED_SIG
CLOSE_CMD
OPEN_CMD
ISOPEN_SIG
FAILURE
ERRHW_SIG

How easy is to reuse models?

MODELS

RE-USE

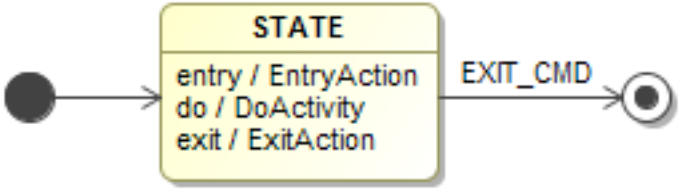
Exchanging Models

Requires:

1) A precise modeling language
2) An open exchange format
3) Avoiding any project specific detail. (When not possible, explicitly state the constraints.)

Precise Semantics

"When **exiting a state**, the do-activity should terminate."

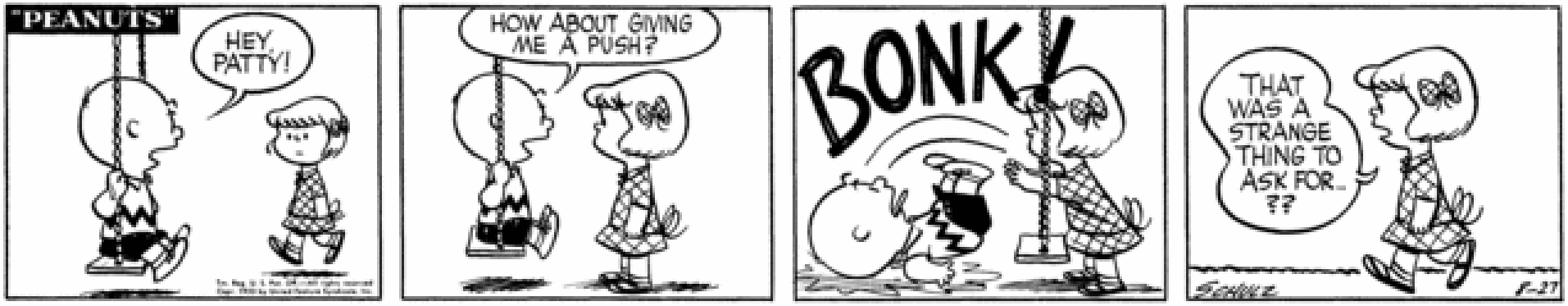


Upon the EXIT_CMD event:

1) Stop DoActivity
2) Invoke ExitAction

or

1) Invoke ExitAction
2) Stop DoActivity



Open Formats

XMI

XMI

SCXML

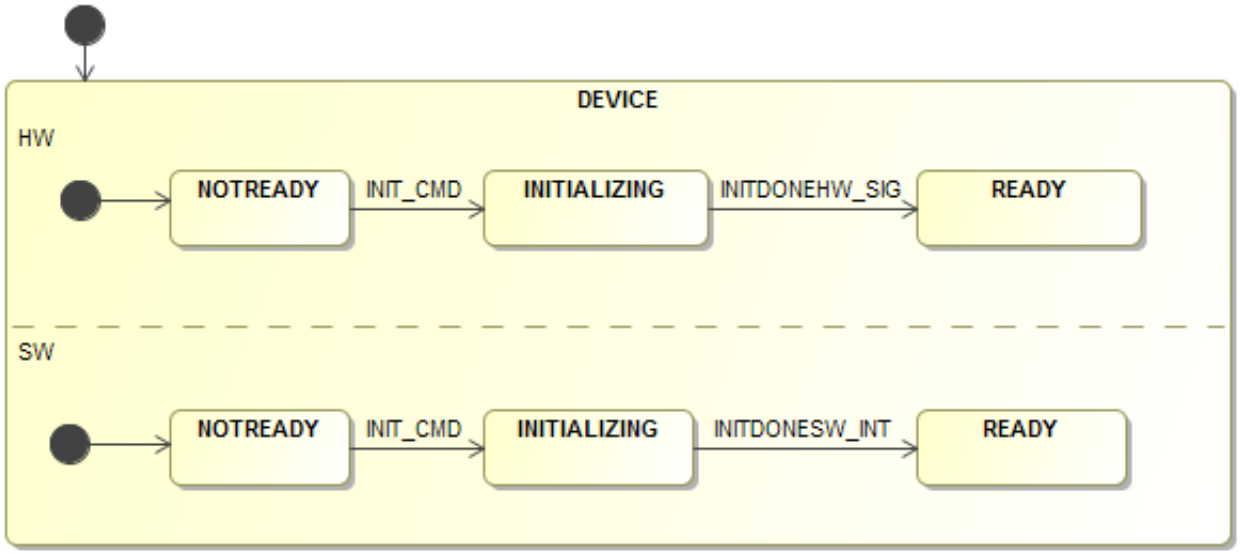
Project Specific Information

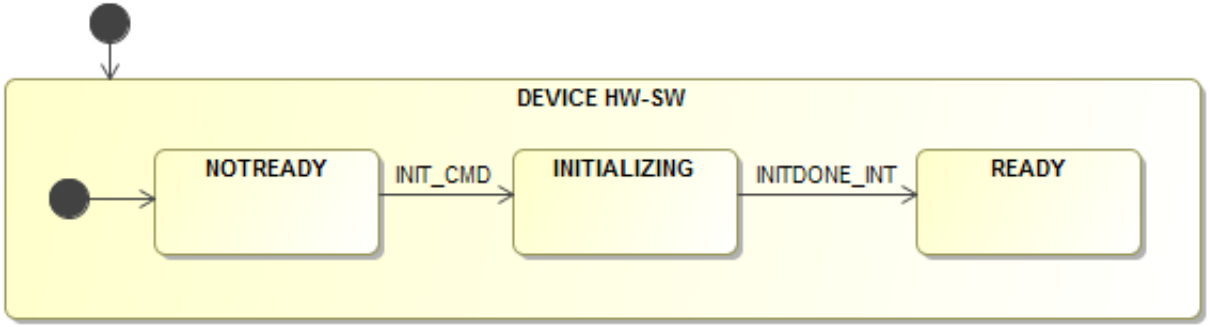
- Platform Independent Models (PIM): models should avoid assumptions on specific technologies/services.

- Explicitly state the context and the driving forces behind the architectural / modeling decisions (like for the Design Patterns).

State Semantic

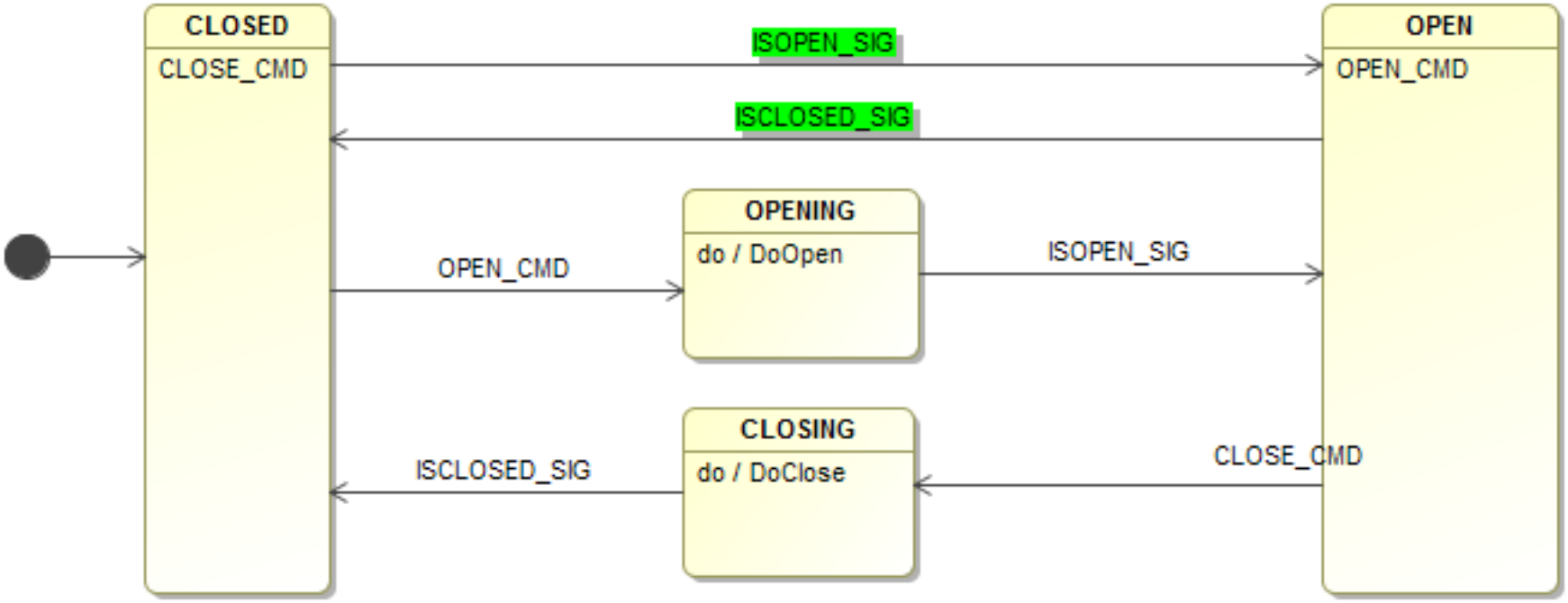
HW and SW have dedicated States in different orthogonal regions.





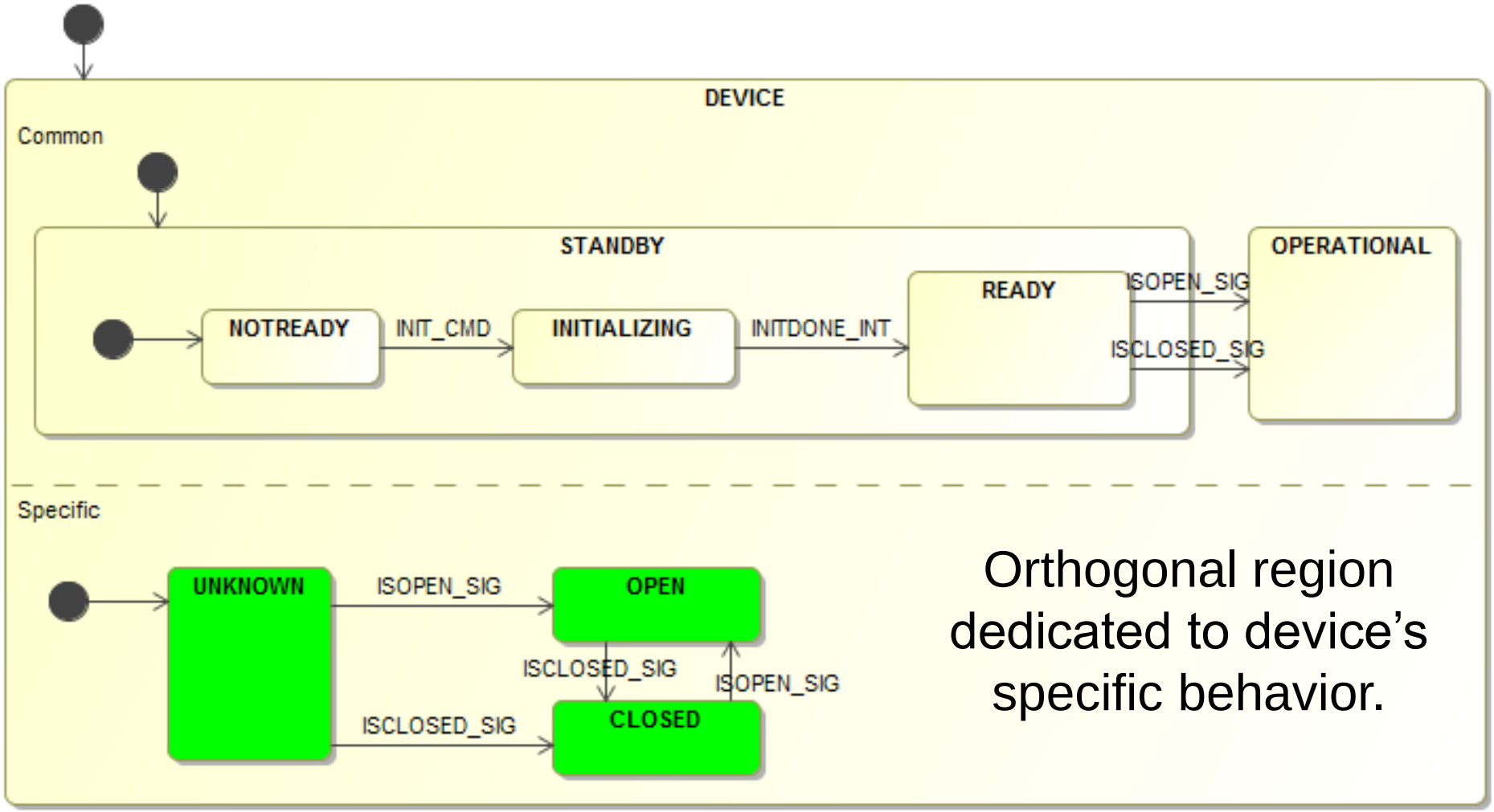
States represent "**HW and SW** together".

Events Priority



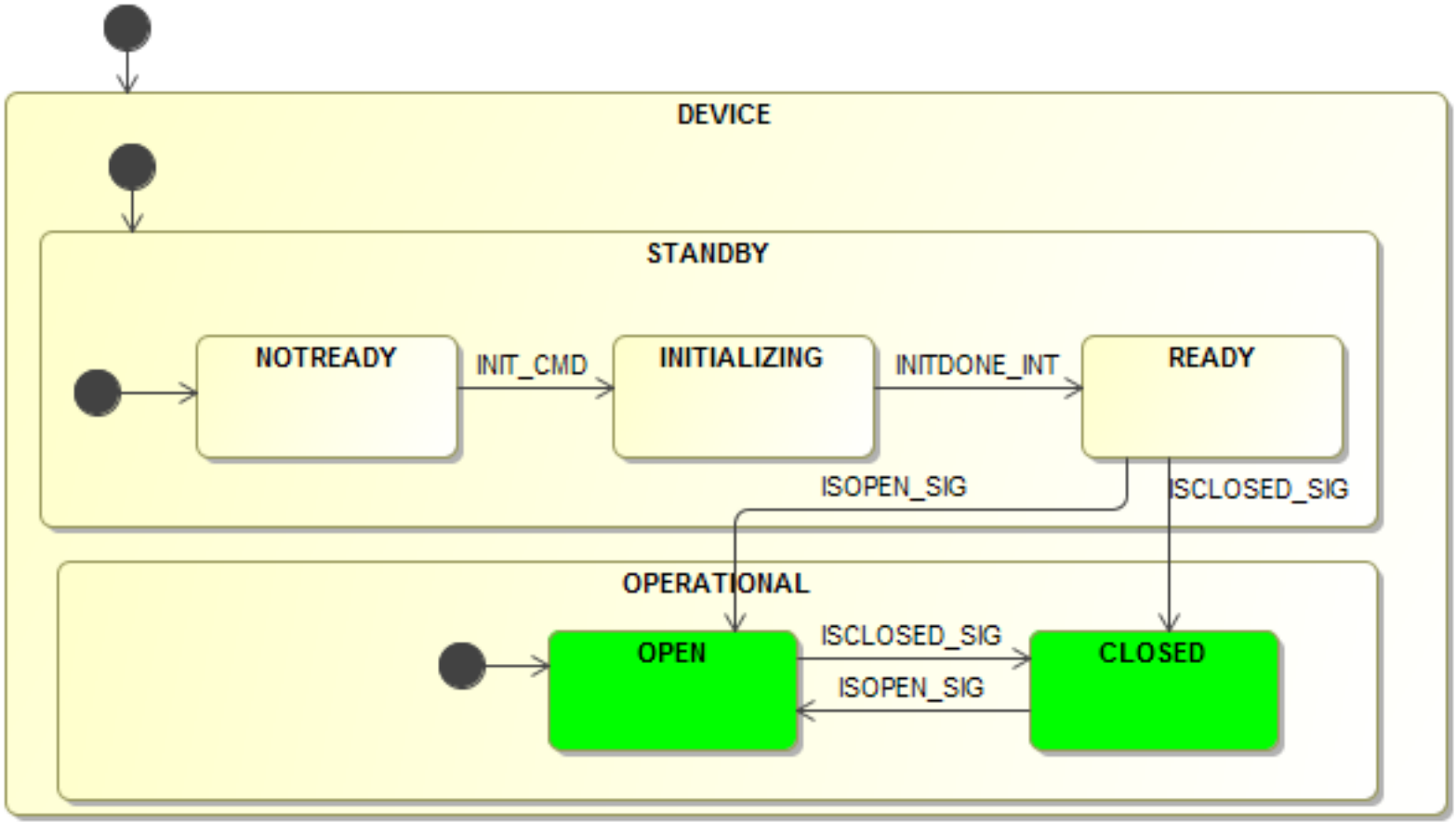
States represent “HW and SW together” with **priority given to HW** events/signals.

Common & Specific Behavior (using orthogonal regions)



Orthogonal region dedicated to device's specific behavior.

Common & Specific Behavior (using composite states)

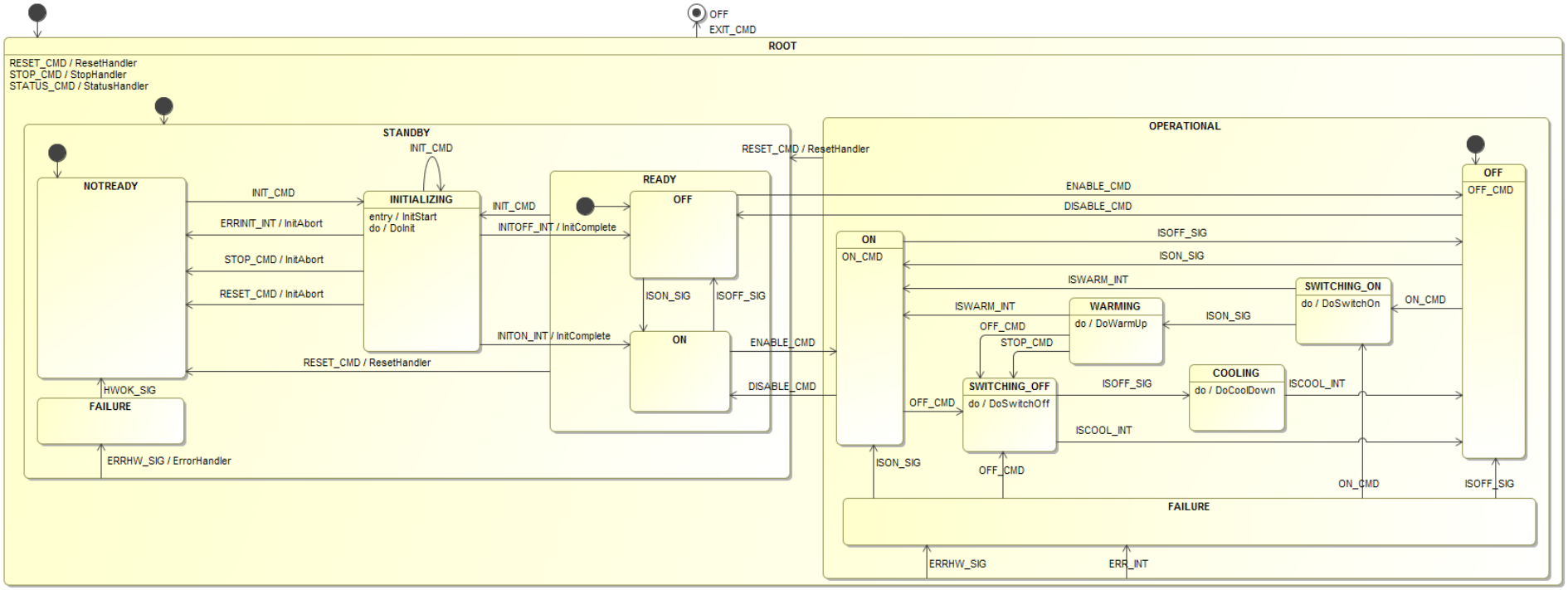


Sub-states of OPERATIONAL are specific to the device.

Failure Management Strategies

Phase	Goal	Failure Effect
Startup / Initialization	Increase System Reliability	Triggers system re-initialization.
Operation	Increase System Availability	Allows for retries (does not force a re-initialization).

Lamp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entry / InitStart
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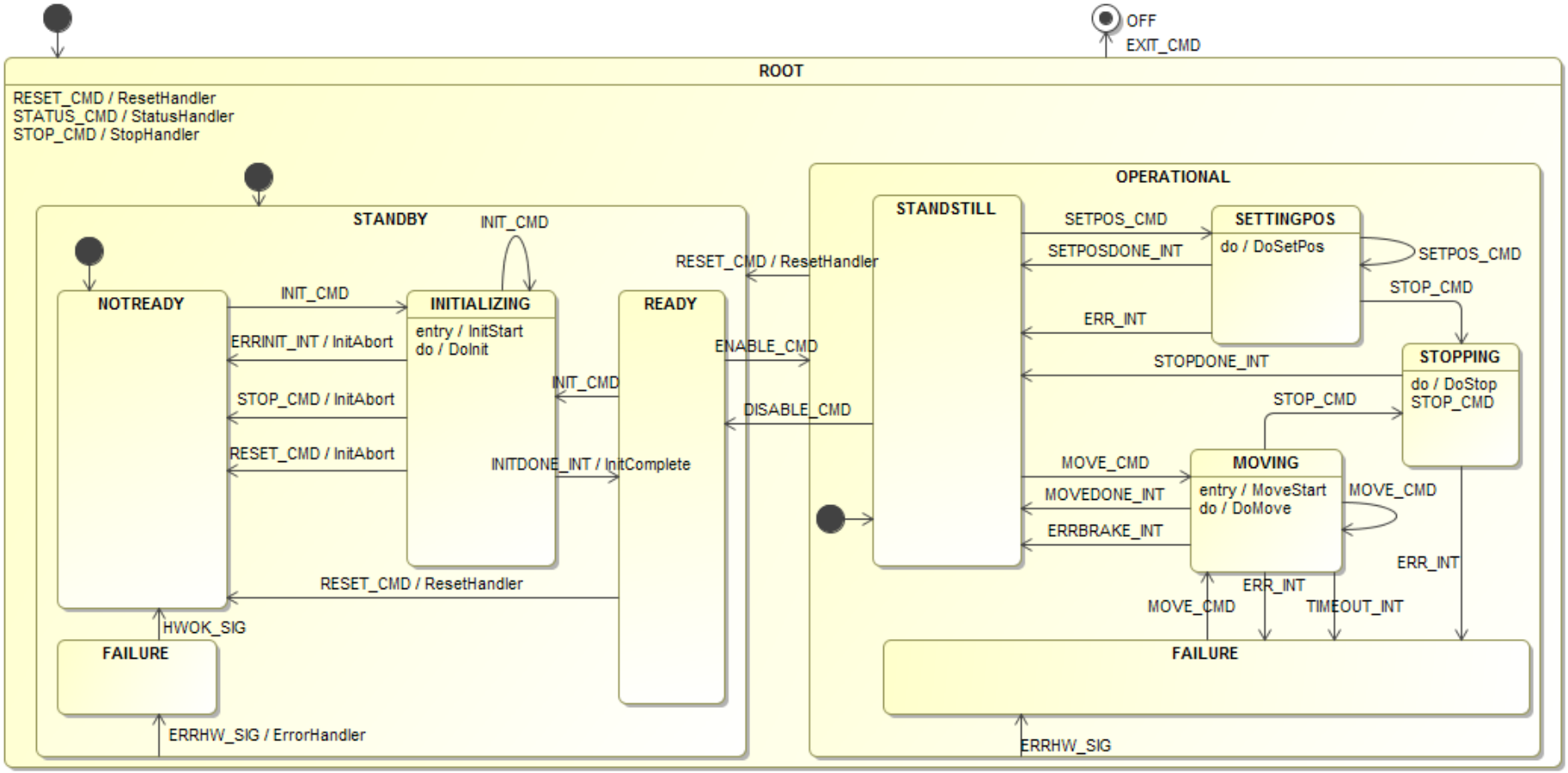
ERRINIT_INT / InitAbort
STOP_CMD / InitAbort
RESET_CMD / InitAbort
INIT_CMD
INITOFF_INT / InitComplete
READY
OFF
ISON_SIG
ISOFF_SIG
INITON_INT / InitComplete
ON
RESET_CMD / ResetHandler
HWOK_SIG
FAILURE
ERRHW_SIG / ErrorHandler
ENABLE_CMD
DISABLE_CMD
RESET_CMD / ResetHandler
OPERATIONAL
ON
ON_CMD
OFF
OFF_CMD
ENABLE_CMD
DISABLE_CMD
ISOFF_SIG
ISON_SIG
ISWARM_INT
SWITCHING_ON
do / DoSwitchOn
ON_CMD
ISWARM_INT
WARMING
do / DoWarmUp
ISON_SIG
OFF_CMD
STOP_CMD
COOLING
do / DoCoolDown
ISCOOL_INT
OFF_CMD
SWITCHING_OFF
do / DoSwitchOff
ISOFF_SIG
ISCOOL_INT
ISON_SIG
OFF_CMD
ON_CMD
ISOFF_SIG
FAILURE
ERRHW_SIG
ERR_INT

Motor


OFF
EXIT_CMD
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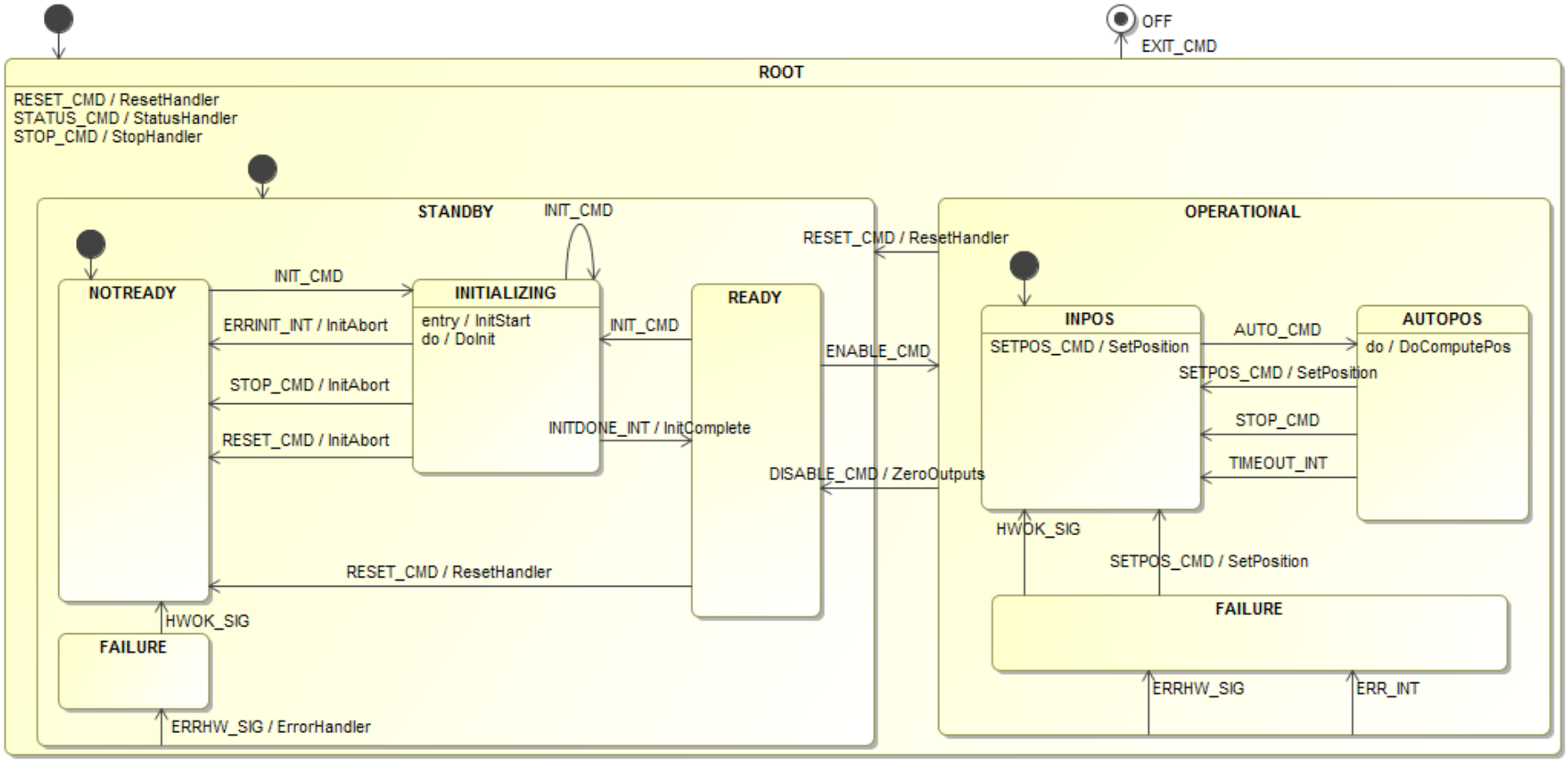
STOP_CMD / StopHandler
STANDBY
INIT_CMD
NOTREADY
INIT_CMD
ERRINIT_INT / InitAbort
STOP_CMD / InitAbort
RESET_CMD / InitAbort
INITIALIZING
entry / InitStart
do / DoInit
INIT_CMD
INITDONE_INT / InitComplete
READY
RESET_CMD / ResetHandler
RESET_CMD / ResetHandler
ENABLE_CMD
DISABLE_CMD
HWOK_SIG
FAILURE
ERRHW_SIG / ErrorHandler
OPERATIONAL
STANDSTILL
SETPOS_CMD
SETPOSDONE_INT
SETTINGPOS
do / DoSetPos
SETPOS_CMD
STOP_CMD
ERR_INT
STOPDONE_INT
STOPPING
do / DoStop
STOP_CMD
STOP_CMD
MOVE_CMD
MOVEDONE_INT
ERRBRAKE_INT
MOVING
entry / MoveStart
do / DoMove
MOVE_CMD
ERR_INT
ERR_INT
MOVE_CMD
TIMEOUT_INT
FAILURE
ERRHW_SIG

Piezo


OFF
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STOP_CMD / StopHandler
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INIT_CMD
NOTREADY
INIT_CMD
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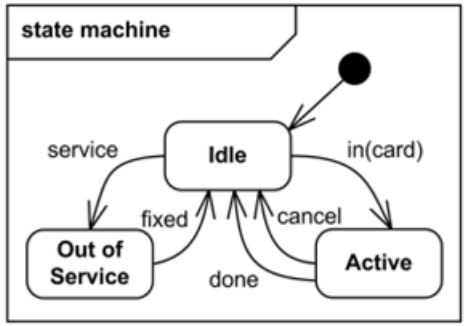
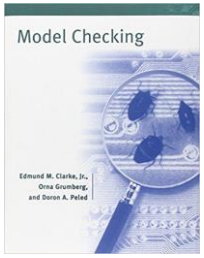
entry / InitStart
do / DoInit
ERRINIT_INT / InitAbort
INIT_CMD
STOP_CMD / InitAbort
RESET_CMD / InitAbort
INITDONE_INT / InitComplete
READY
RESET_CMD / ResetHandler
HWOK_SIG
FAILURE
ERRHW_SIG / ErrorHandler
OPERATIONAL
RESET_CMD / ResetHandler
ENABLE_CMD
DISABLE_CMD / ZeroOutputs
INPOS
SETPOS_CMD / SetPosition
AUTO_CMD
AUTOPOS
do / DoComputePos
SETPOS_CMD / SetPosition
STOP_CMD
TIMEOUT_INT
HWOK_SIG
SETPOS_CMD / SetPosition
FAILURE
ERRHW_SIG
ERR_INT

COMODO M2T Tool



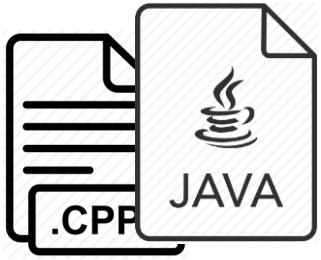
SysML Model
+ cmdoProfile
(EMF XMI)

COMODO



Formal Verification
Java Pathfinder

SCXML Model

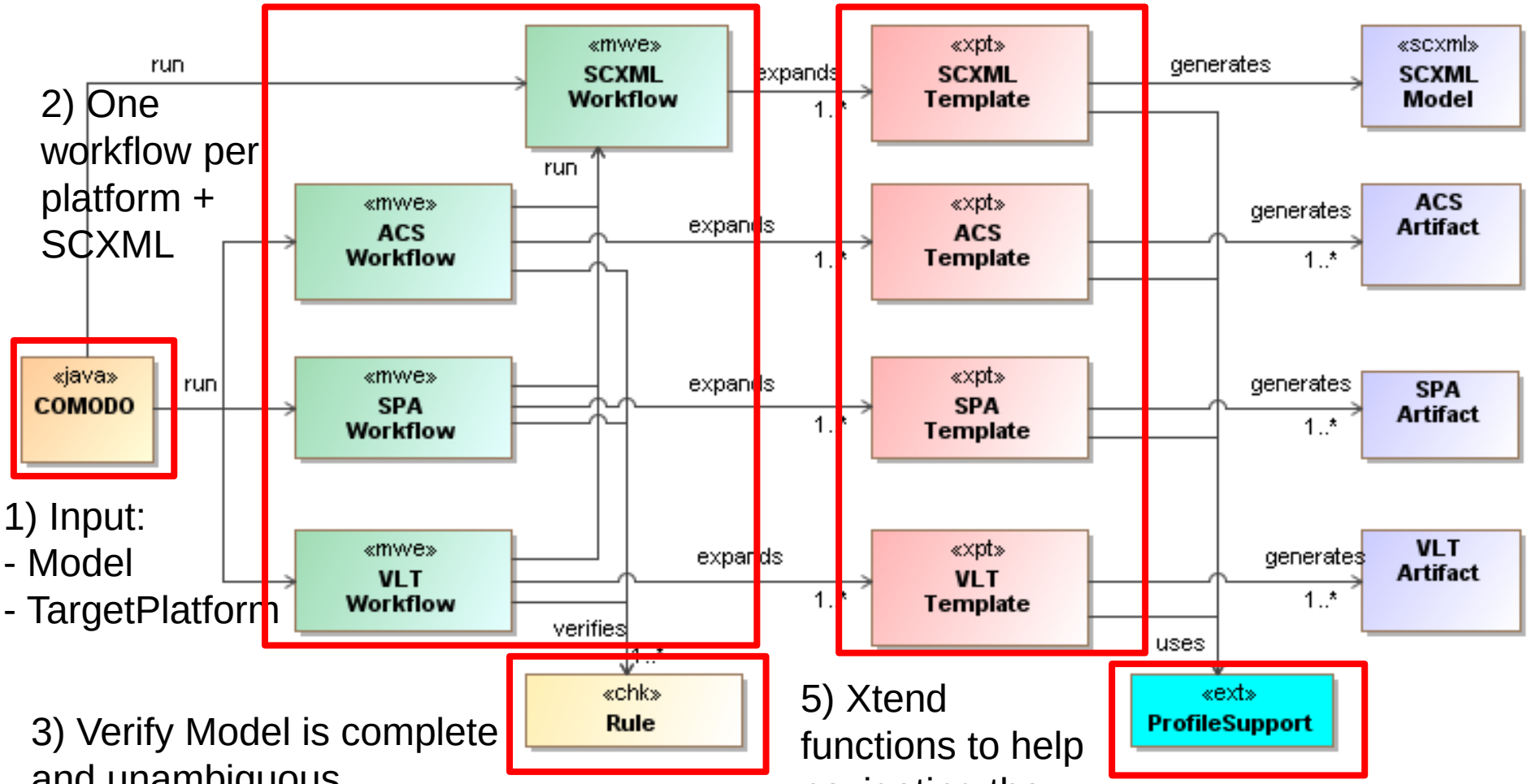


Transform into Code and Simulators for project specific SW Platforms

Execute the SCXML Model

COMODO Insight

4) Xpand Templates generates the artifacts using Xtend functions



2) One workflow per platform + SCXML

1) Input:
- Model
- TargetPlatform

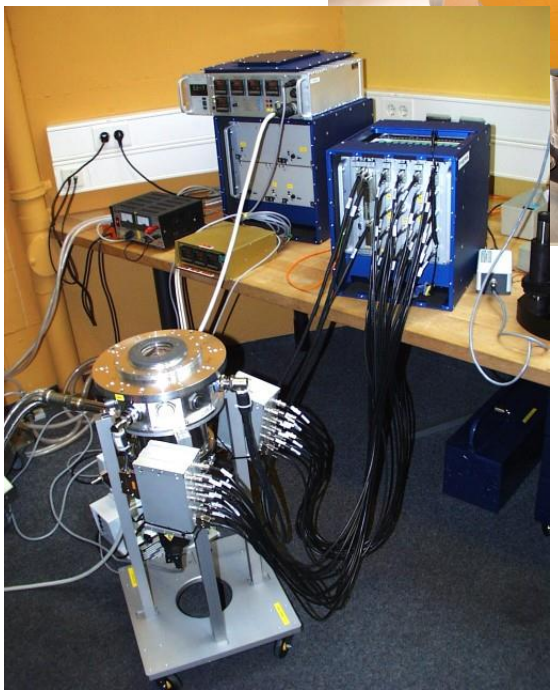
3) Verify Model is complete and unambiguous

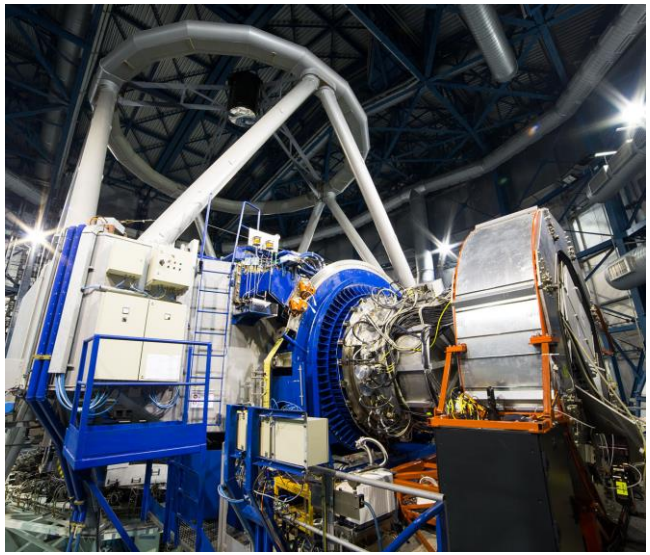
5) Xtend functions to help navigating the model

Projects using COMODO (Control SW Development)

ESO

- Interferometer (AT, DL, …)
- Active Phasing Experiment
- Detectors Control
- Instruments Control

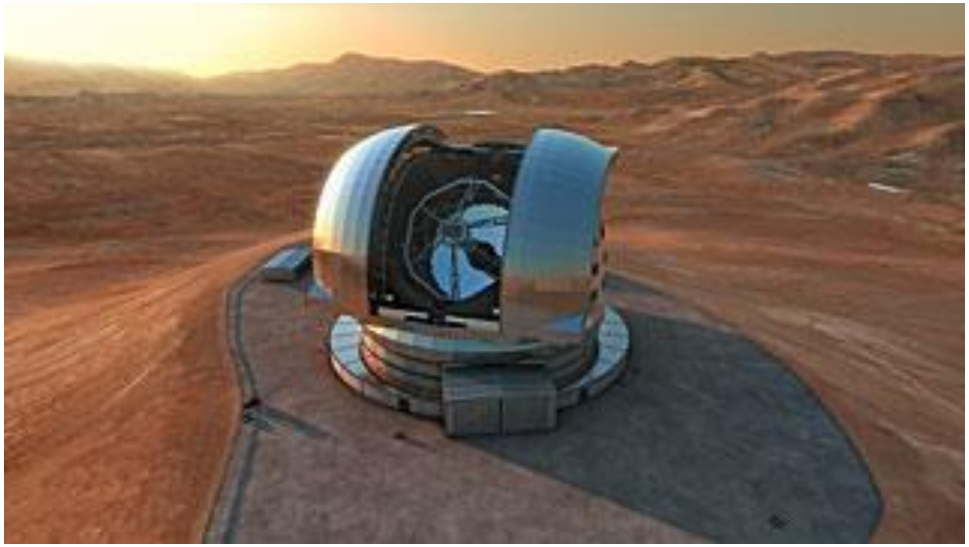




Projects using COMODO (Rapid Prototyping)

ESO

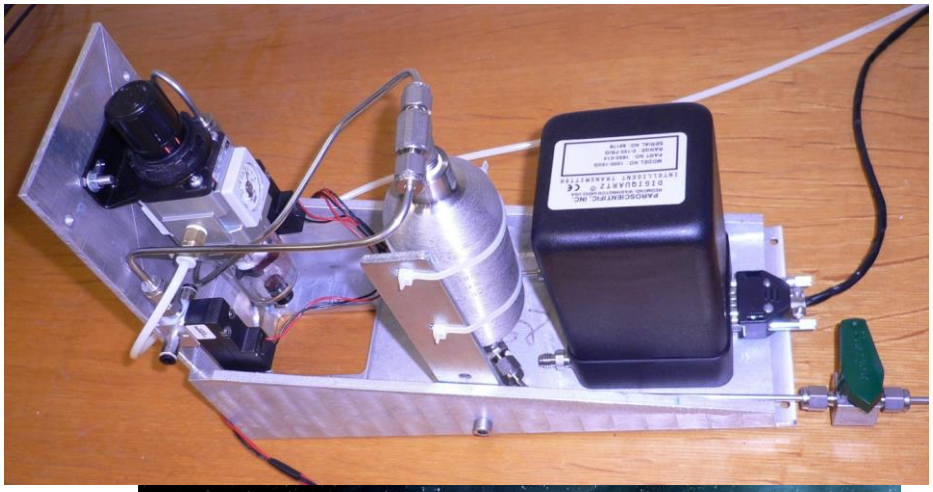
- VLT/ALMA (cross-platform prototyping)
- ELT LSV prototype (prototyping platform Java + RabbitMQ)



Projects using COMODO (Formal Verification)

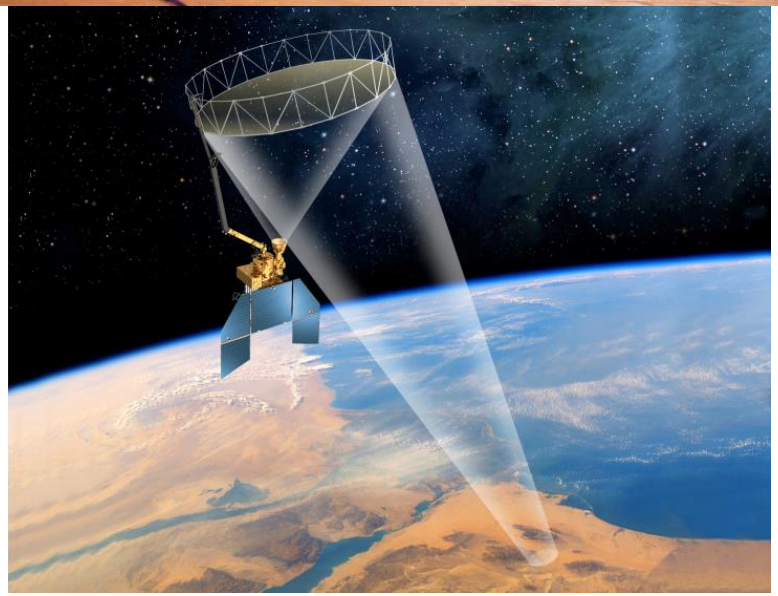
ESO

- Variable Curvature Mirror

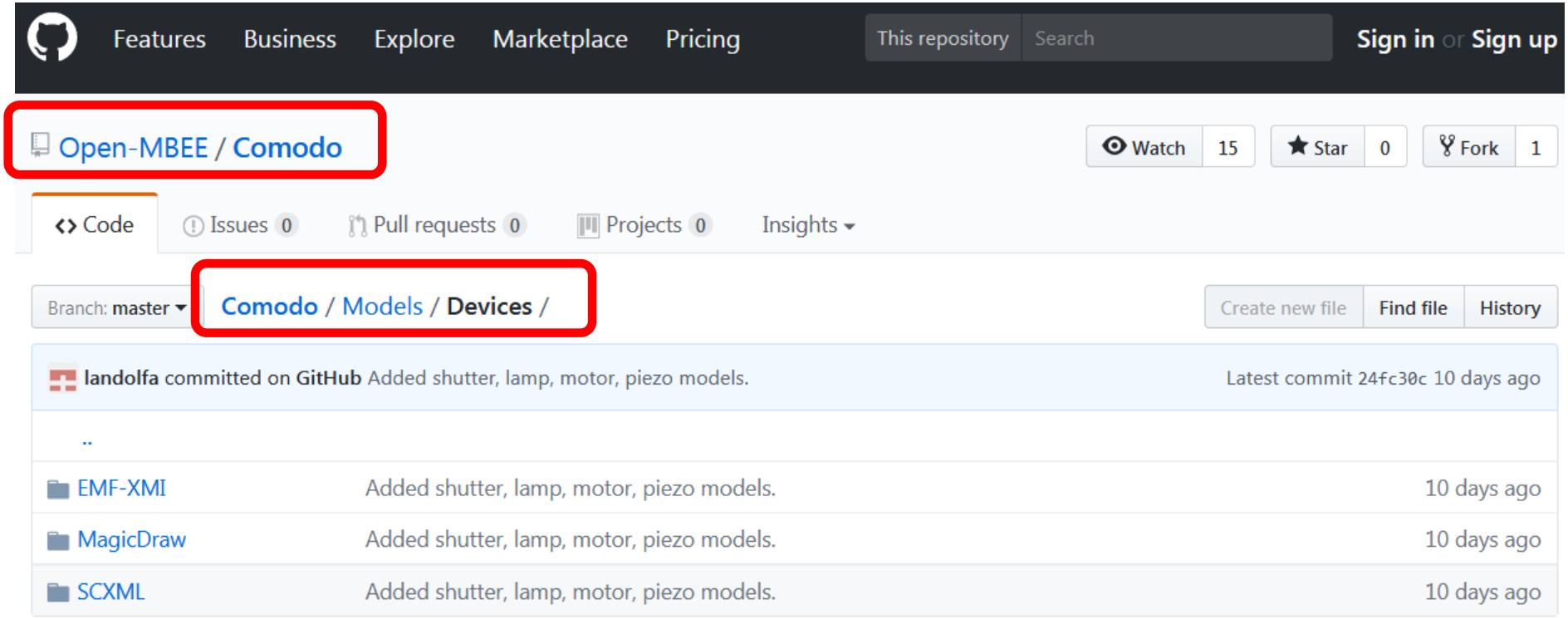


NASA/JPL

- Soil Moisture Active Passive



Where are the models / COMODO?



https://github.com/Open-MBEE/Comodo