

**Electrical Engineering and Computer Science Dept**
College of Engineering




# STEP BY STEP TO CREATE A SUT (AND MUTANTS)

Prepared by Prof. Christopher S. Cerqueira

# Tools

# Tools

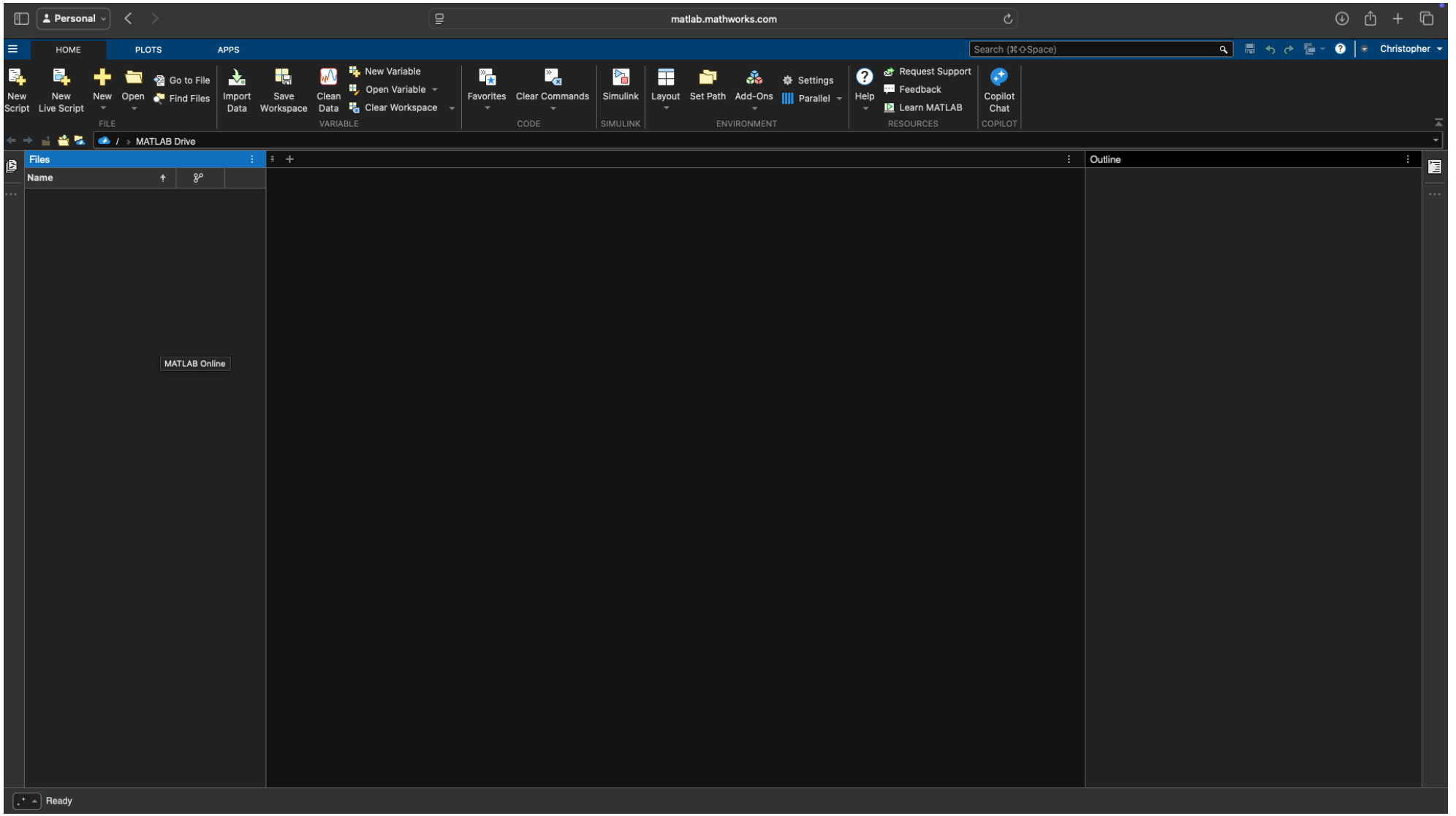
- Matlab/Simulink Web - https://matlab.mathworks.com
  - Simulink
  - Requirements
  - State flow

# Today’s objectives

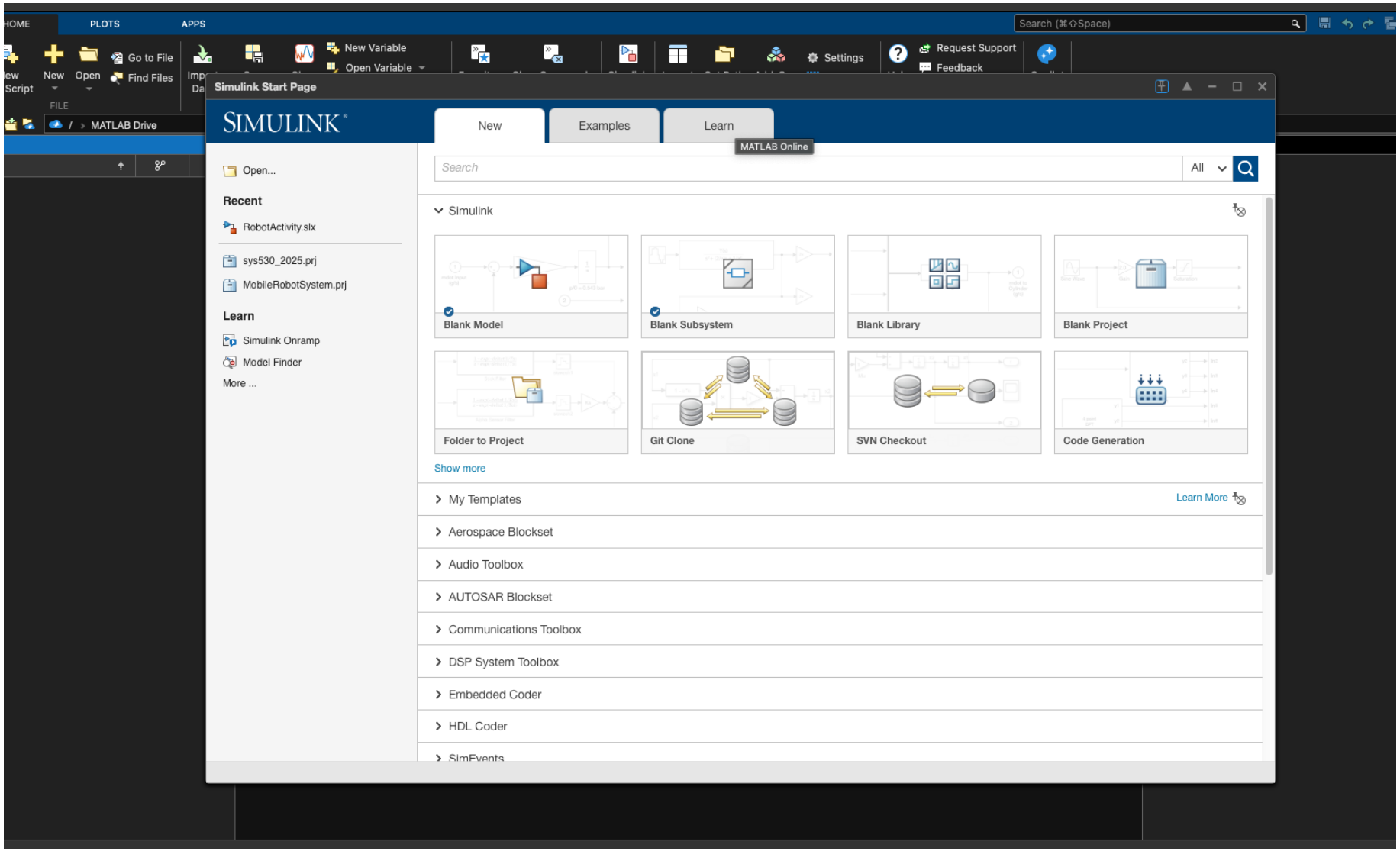
- Create a system architecture
- Organize verifiable requirements
- Create the system behavior
- Create and Point state-driven requirements to the state machine

# Create the SuT

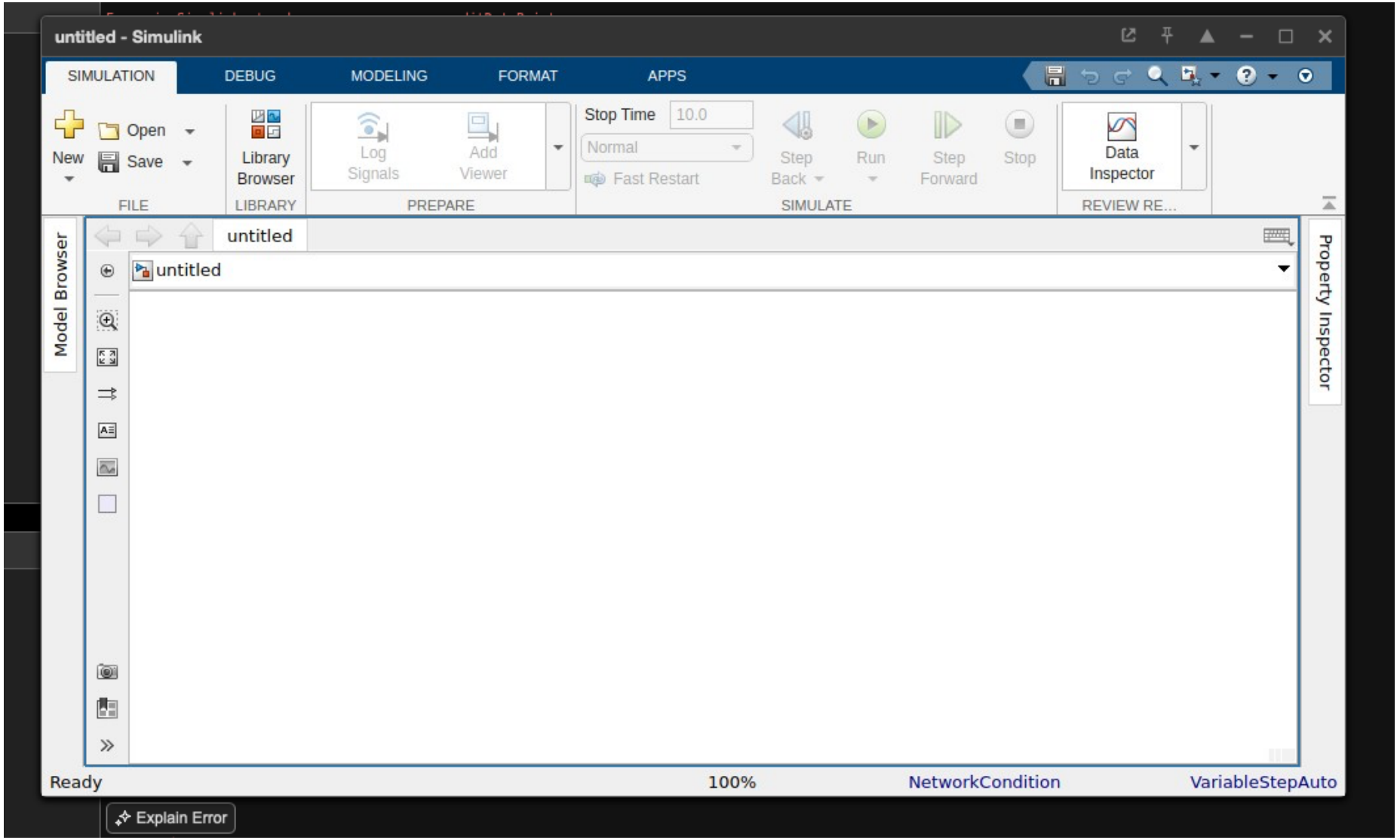
# Open Matlab Web - https://matlab.mathworks.com



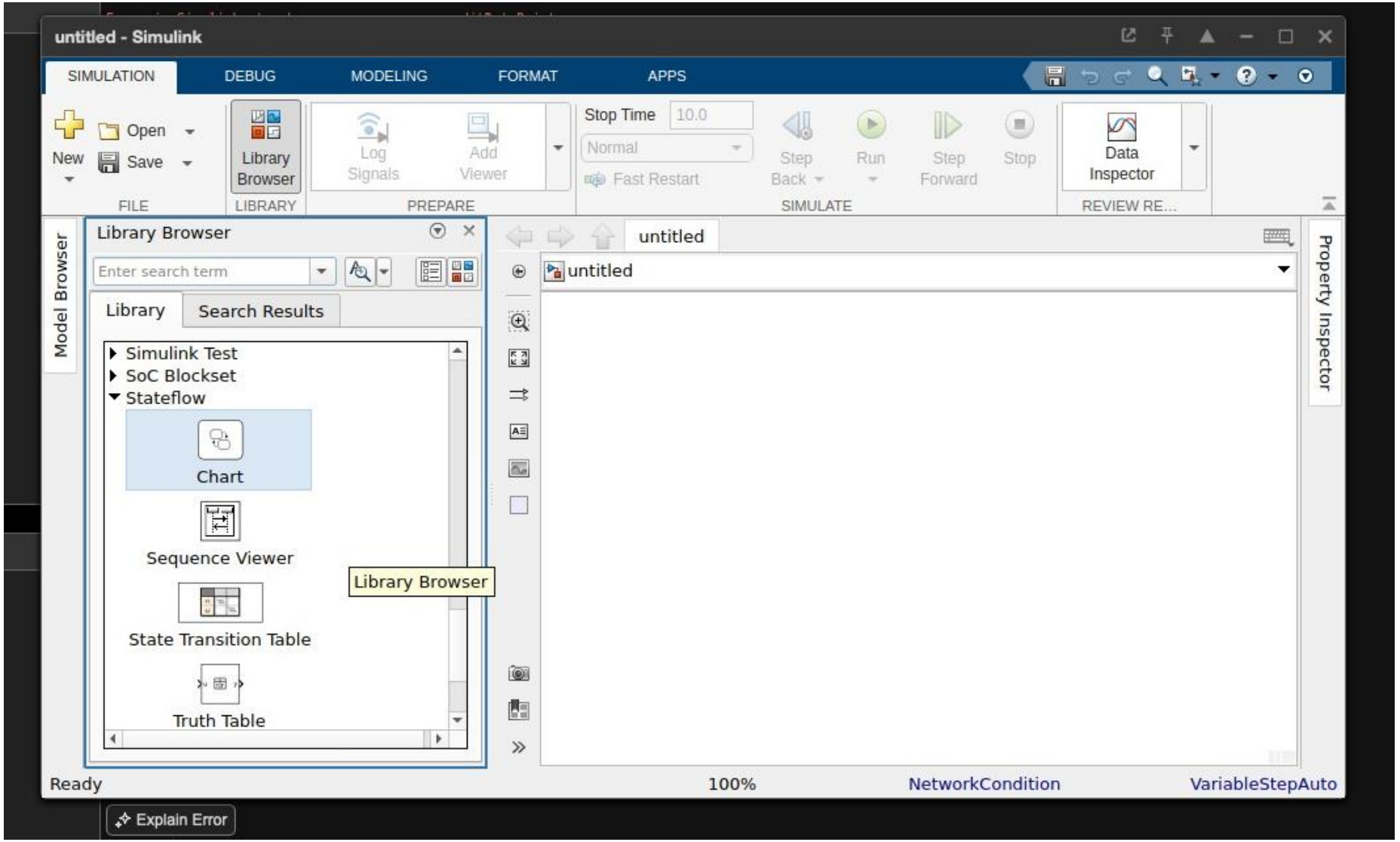
# Start the Simulink



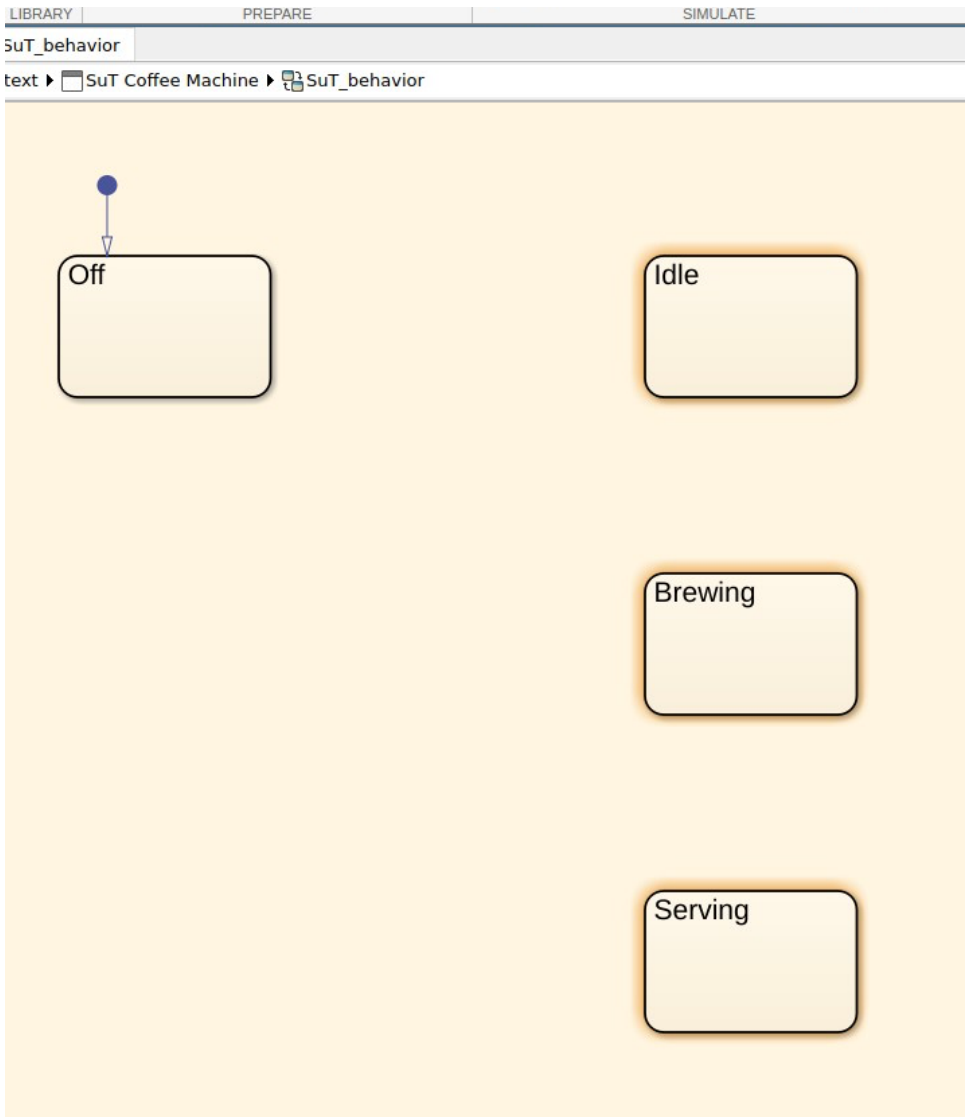
# Create a blank model



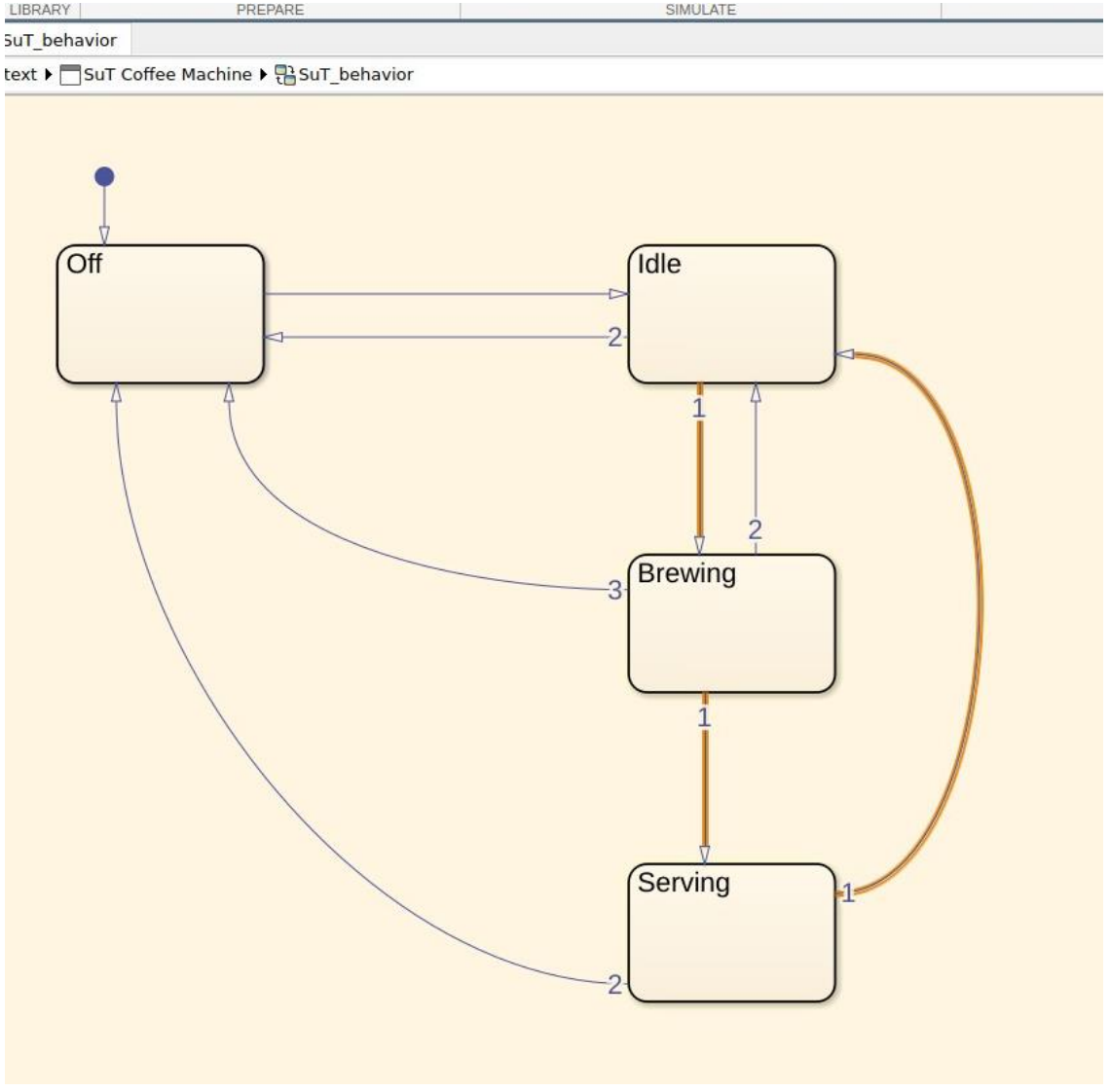
# Open the behavior



# Create four states



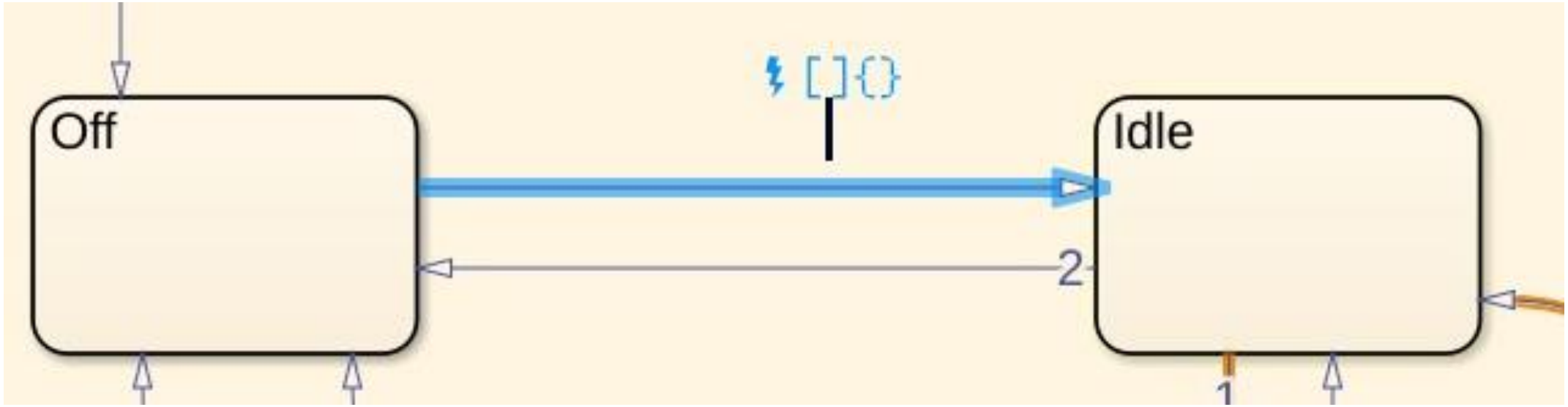
# Create the transitions



# Specify the event [guard] / action

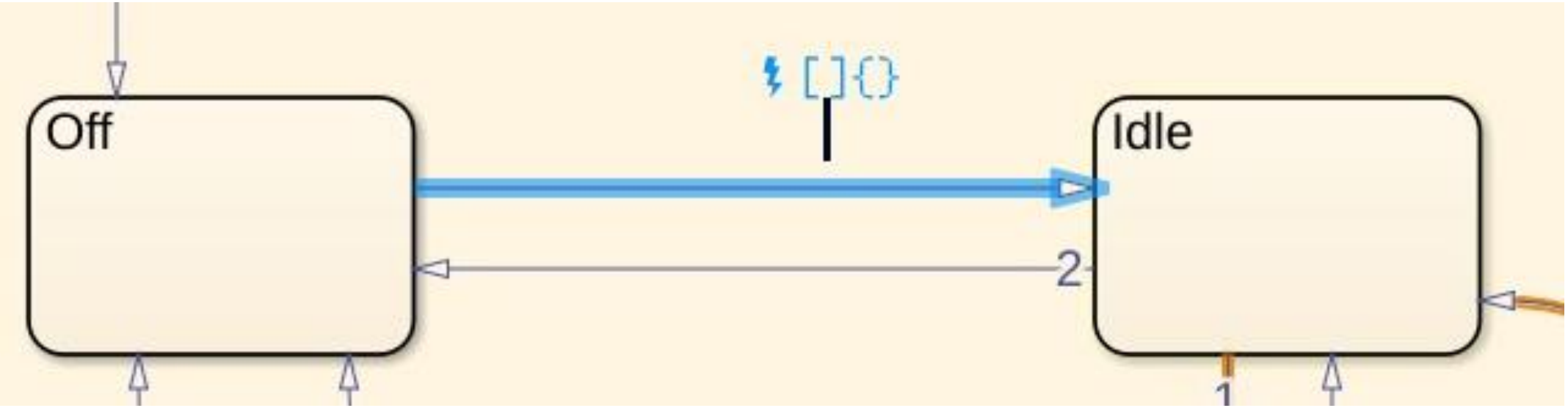
- Events:
  - Turn on / off
  - Press “prepare coffee”
  - Press “release coffee”
  - Press “stop”

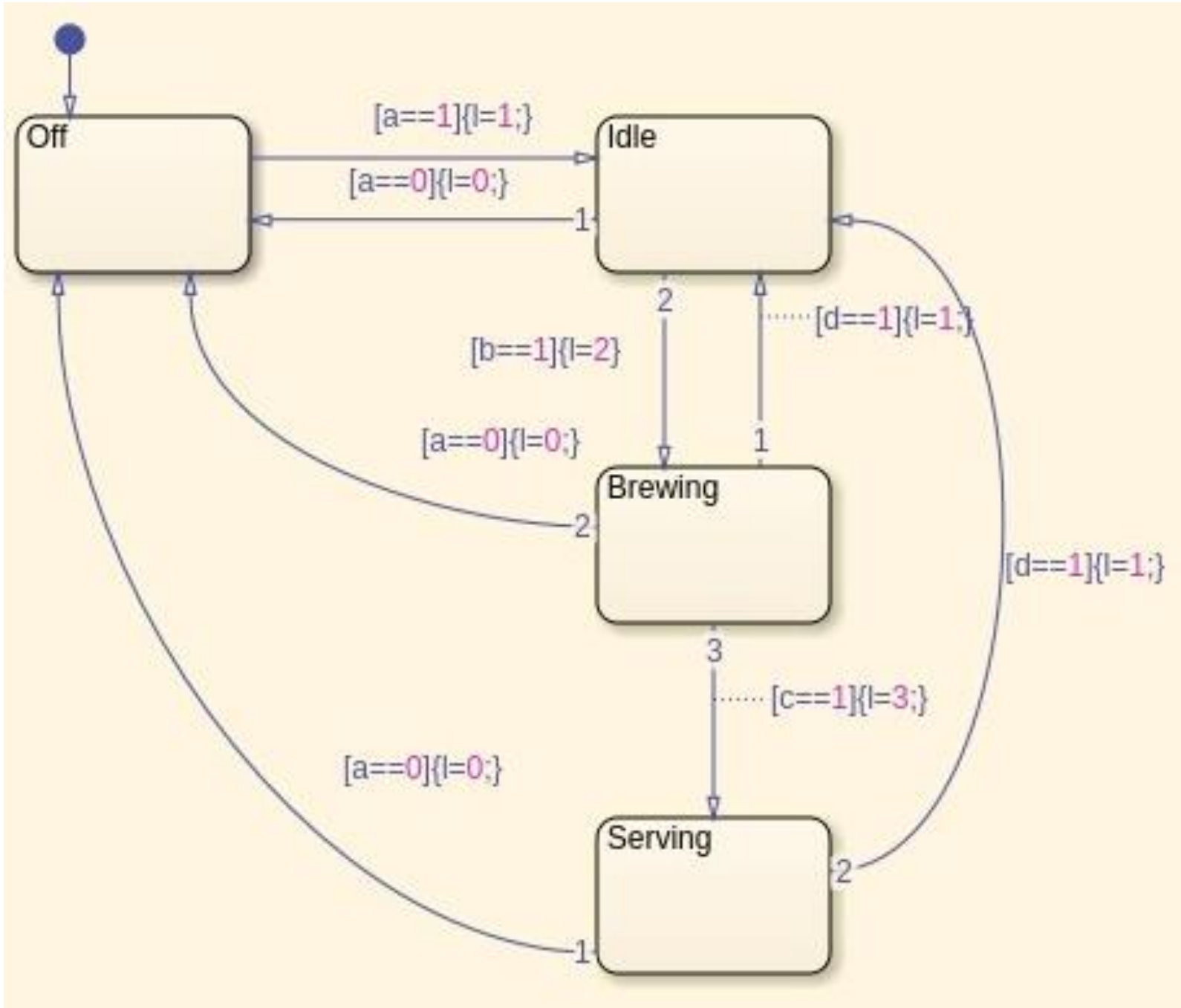
- Actions
  - Machine On/Off LED
  - Grinding noise – blinking LED
  - Coffee out – fast blinking LED

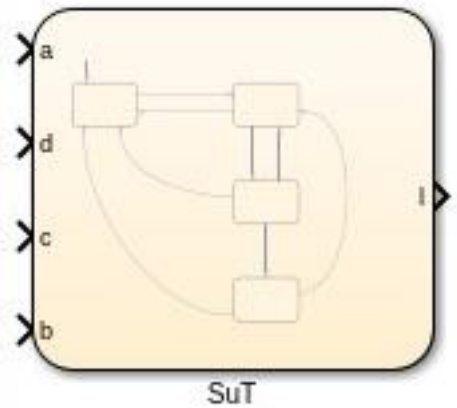


# Specify the event [guard] / action

- Events:
  - Turn on / off a = 0 / a = 1
  - Press “prepare coffee” b = 1
  - Press “release coffee”. c = 1
  - Press “stop” (return to idle) d = 1
- Actions
  - Machine On/Off LED l= 0 / l=1
  - Grinding noise – blinking LED. l= 2
  - Coffee out – fast blinking LED. l= 3




Off
Idle
Brewing
Serving
[a==1]{l=1;}
[a==0]{l=0;}
[b==1]{l=2}
[d==1]{l=1;}
[a==0]{l=0;}
[d==1]{l=1;}
[c==1]{l=3;}
[a==0]{l=0;}
1
2
1
2
3
2
1

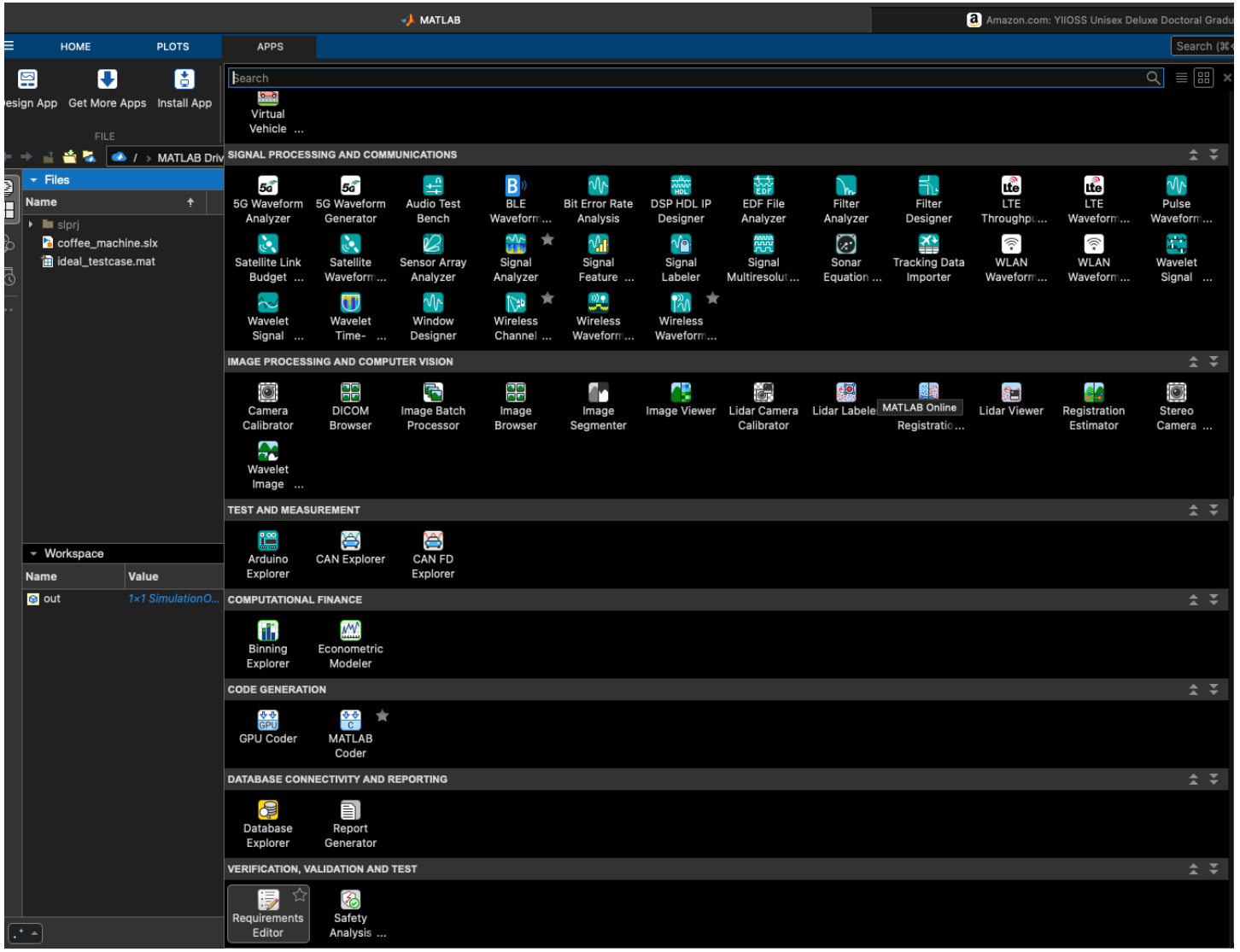

a
d
c
b
l
SuT

# What is the nominal operation

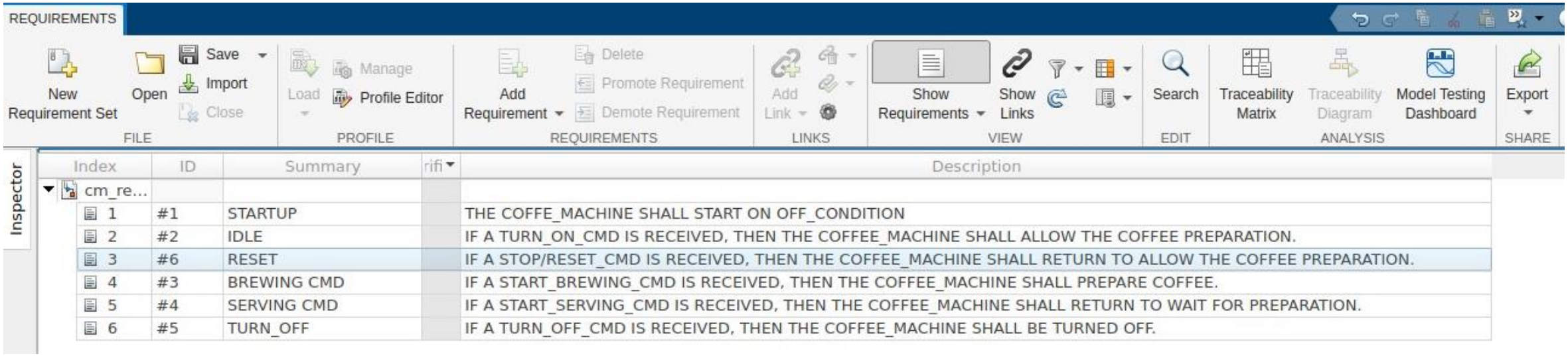
- Turn on
- Press prepare coffee
- Press release coffee
- Return to idle
- Turn off

- Turn on
- Press prepare coffee
- Press release coffee
- Return to idle
- Turn off

# Open the requirement Editor App



# Create a set of requirements




THE COFFE_MACHINE SHALL START ON OFF_CONDITION.

IF A TURN_ON_CMD IS RECEIVED, THEN THE COFFEE_MACHINE SHALL ALLOW THE COFFEE PREPARATION.

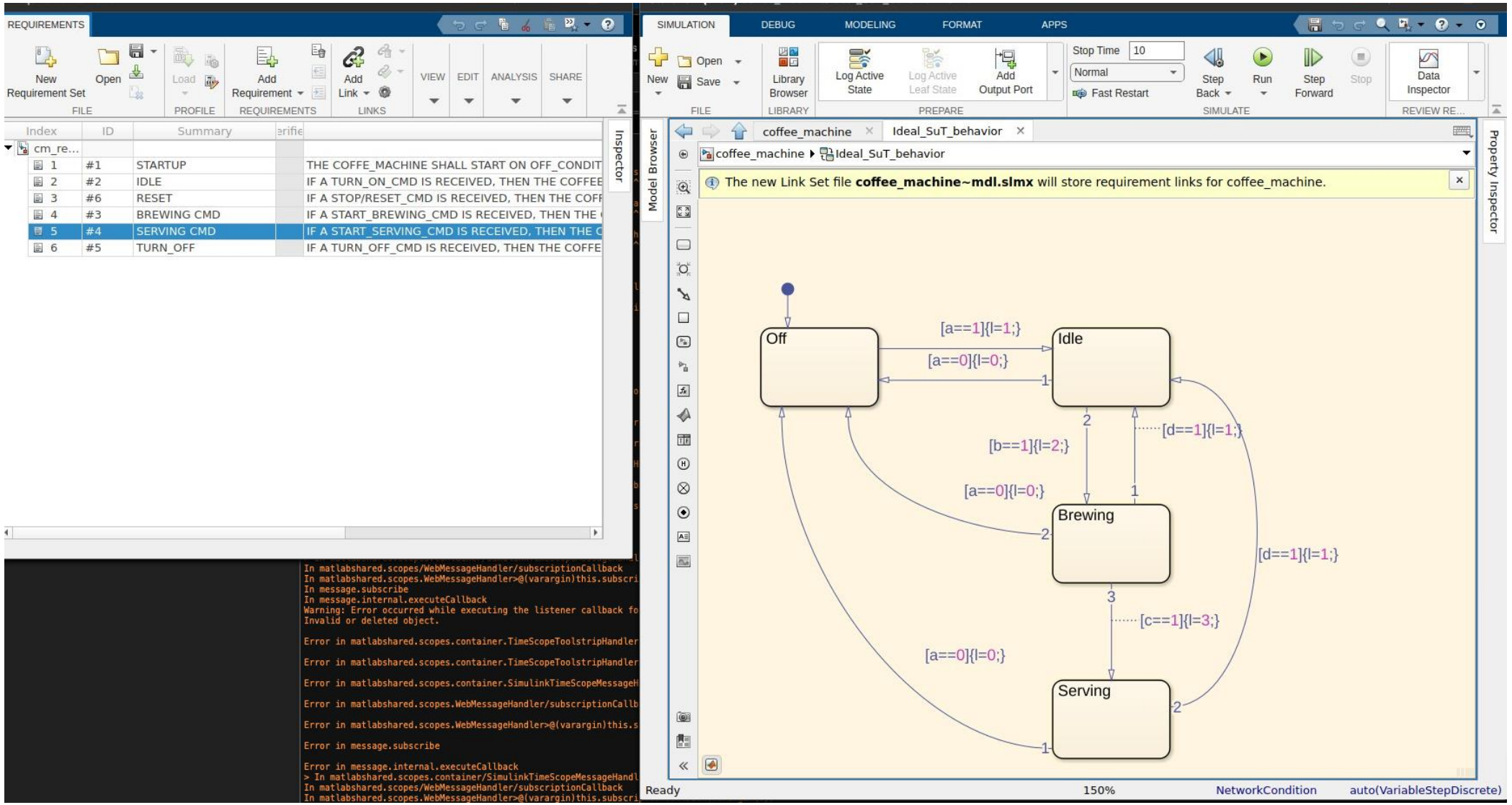
IF A START_BREWING_CMD IS RECEIVED, THEN THE COFFEE_MACHINE SHALL PREPARE COFFEE.

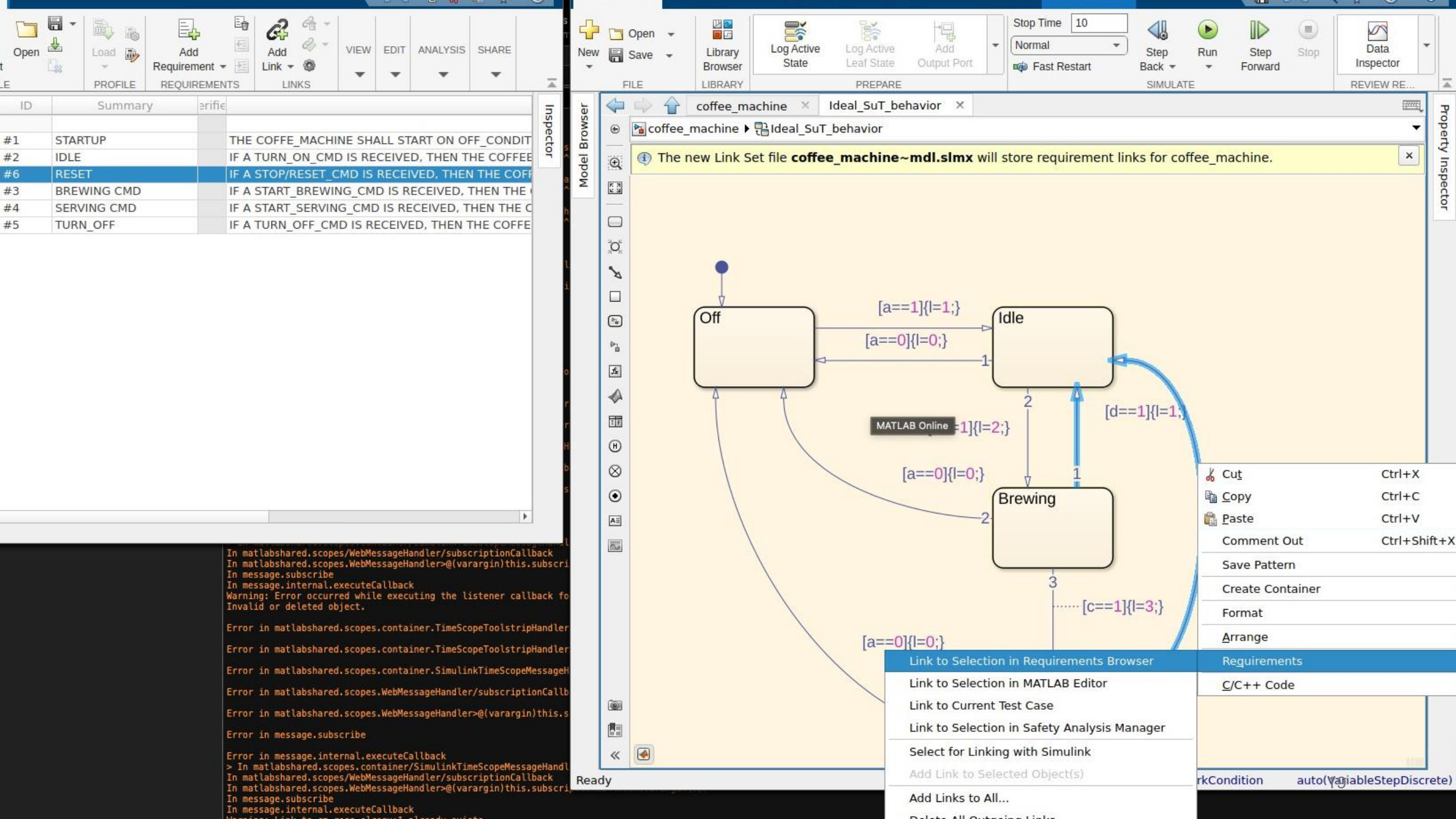
IF A START_SERVING_CMD IS RECEIVED, THEN THE COFFEE_MACHINE SHALL SERVE COFFEE.

IF A STOP/RESET_CMD IS RECEIVED, THEN THE COFFEE_MACHINE SHALL RETURN TO ALLOW THE COFFEE PREPARATION.

IF A TURN_OFF_CMD IS RECEIVED, THEN THE COFFEE_MACHINE SHALL BE TURNED OFF.

# With both windows opened map the requirements to the transitions / states.






```
In matlabshared.scopes/WebMessageHandler/subscriptionCallback
In matlabshared.scopes.WebMessageHandler>@(varargin)this.subscri
In message.subscribe
In message.internal.executeCallback
Warning: Error occurred while executing the listener callback fo
Invalid or deleted object.

Error in matlabshared.scopes.container.TimeScopeToolstripHandler

Error in matlabshared.scopes.container.TimeScopeToolstripHandler

Error in matlabshared.scopes.container.SimulinkTimeScopeMessageH

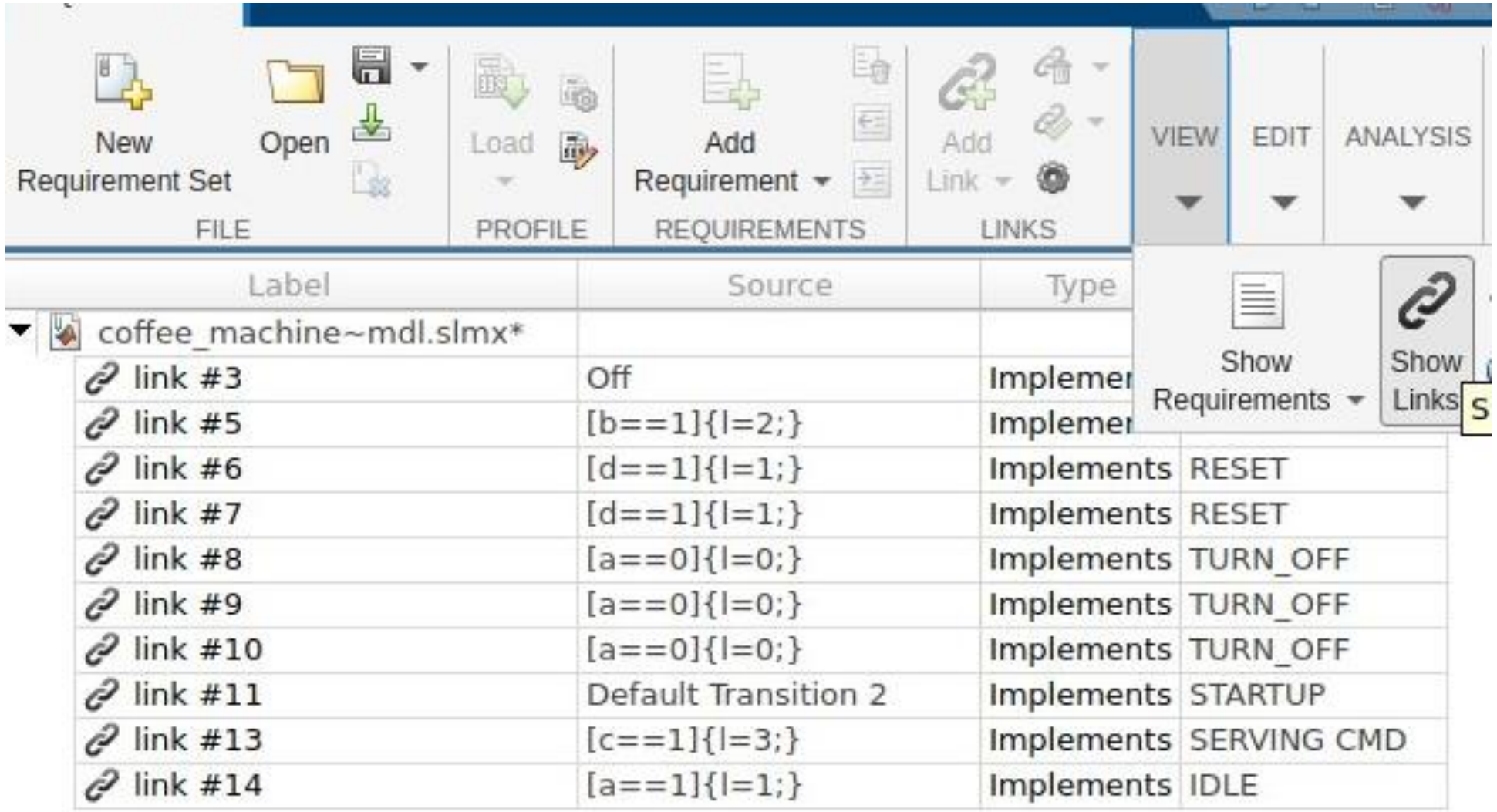
Error in matlabshared.scopes.WebMessageHandler/subscriptionCallb

Error in matlabshared.scopes.WebMessageHandler>@(varargin)this.s

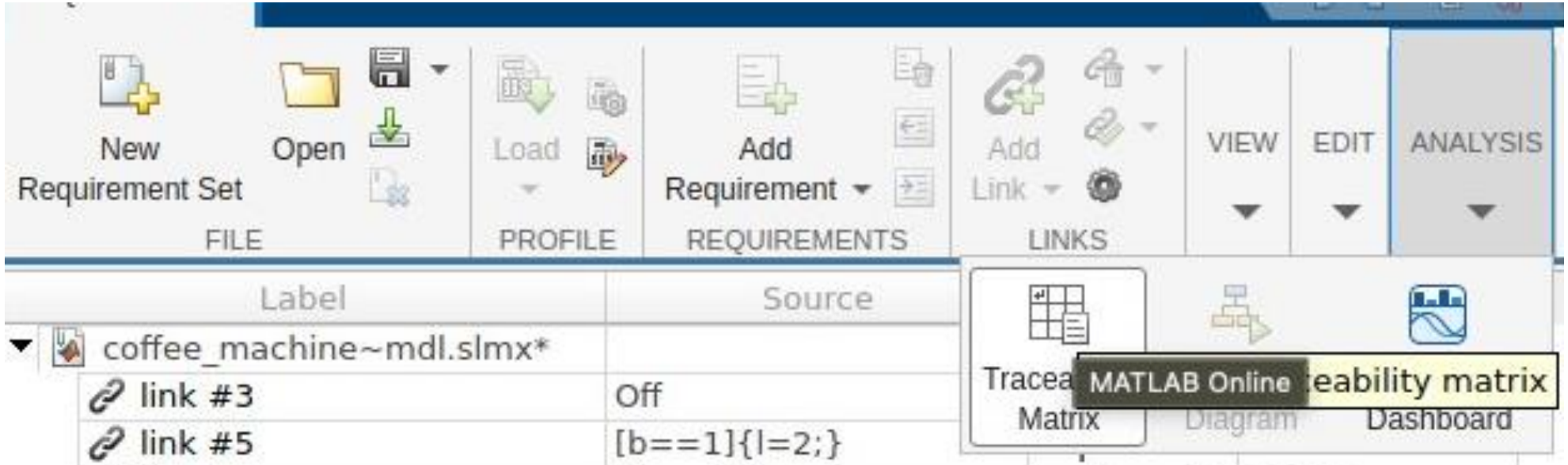
Error in message.subscribe

Error in message.internal.executeCallback
> In matlabshared.scopes.container/SimulinkTimeScopeMessageHandl
In matlabshared.scopes/WebMessageHandler/subscriptionCallback
In matlabshared.scopes.WebMessageHandler>@(varargin)this.subscri
In message.subscribe
In message.internal.executeCallback
```

# See the links and the requirements



# Show the traceability matrix



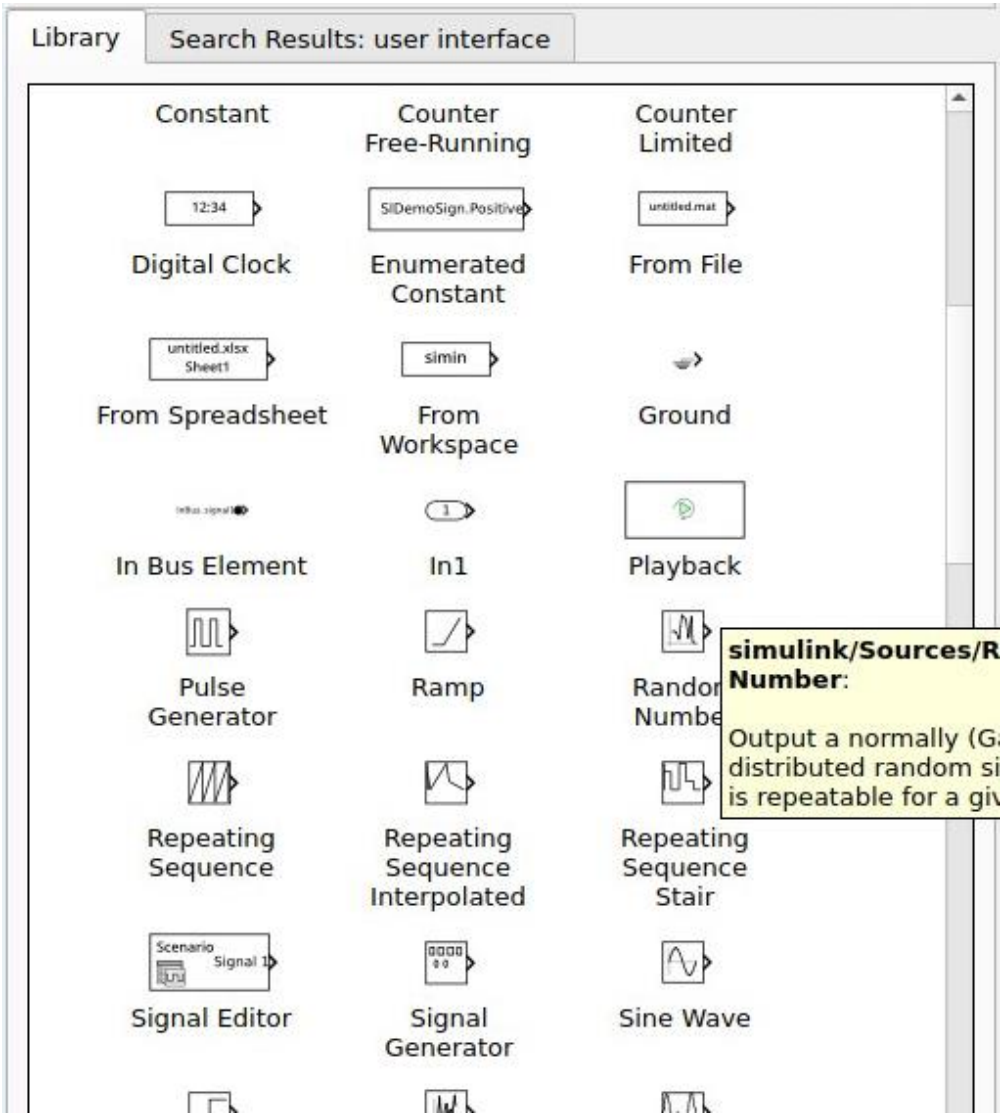

| Label | Source | | |
|---|---|---|---|
| coffee_machine~mdl.slmx* | | | |
| link #3 | Off | | |
| link #5 | [b==1]{l=2;} | | |
| link #6 | [d==1]{l=1;} | Implements | RESET |
| link #7 | [d==1]{l=1;} | Implements | RESET |
| link #8 | [a==0]{l=0;} | Implements | TURN_OFF |
| link #9 | [a==0]{l=0;} | Implements | TURN_OFF |
| link #10 | [a==0]{l=0;} | Implements | TURN_OFF |
| link #11 | Default Transition 2 | Implements | STARTUP |
| link #13 | [c==1]{l=3;} | Implements | SERVING CMD |
| link #14 | [a==1]{l=1;} | Implements | IDLE |

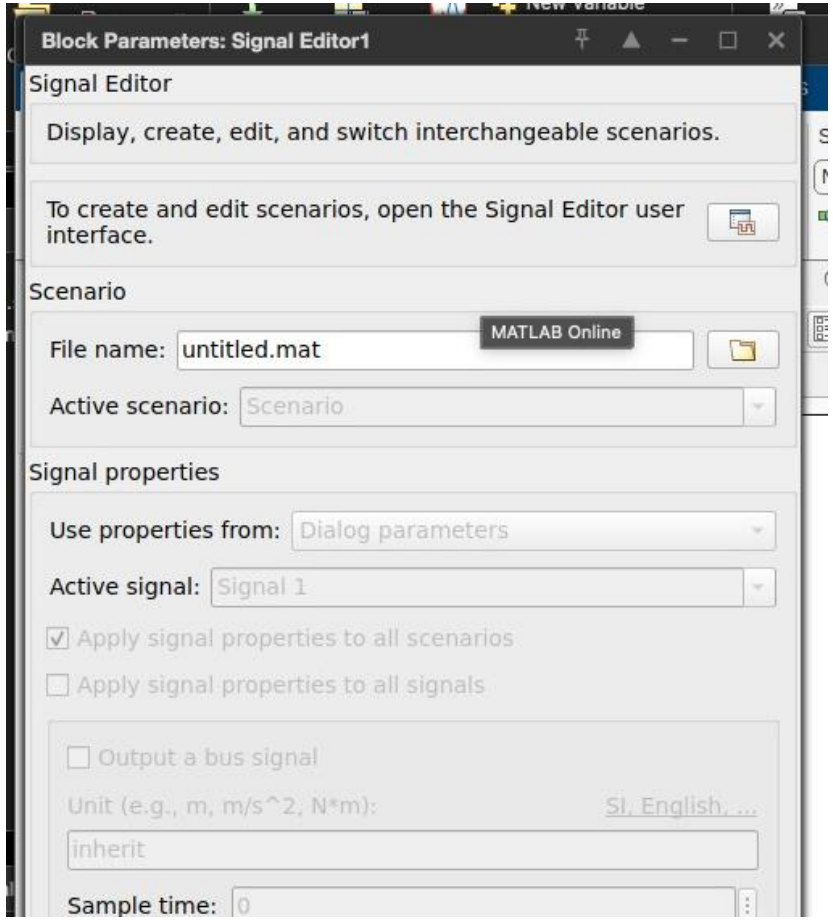
coffee_machine
Ideal_SuT_behavior
Off
[a==0]{l=0;}
[a==0]{l=0;}
[c==1]{l=3;}
[d==1]{l=1;}
?
Idle
Brewing
Serving
[a==1]{l=1;}
[a==0]{l=0;}
[b==1]{l=2;}
[d==1]{l=1;}
Signal Editor
Scope
cm_reqs
STARTUP
IDLE
RESET
BREWING CMD
SERVING CMD
TURN_OFF



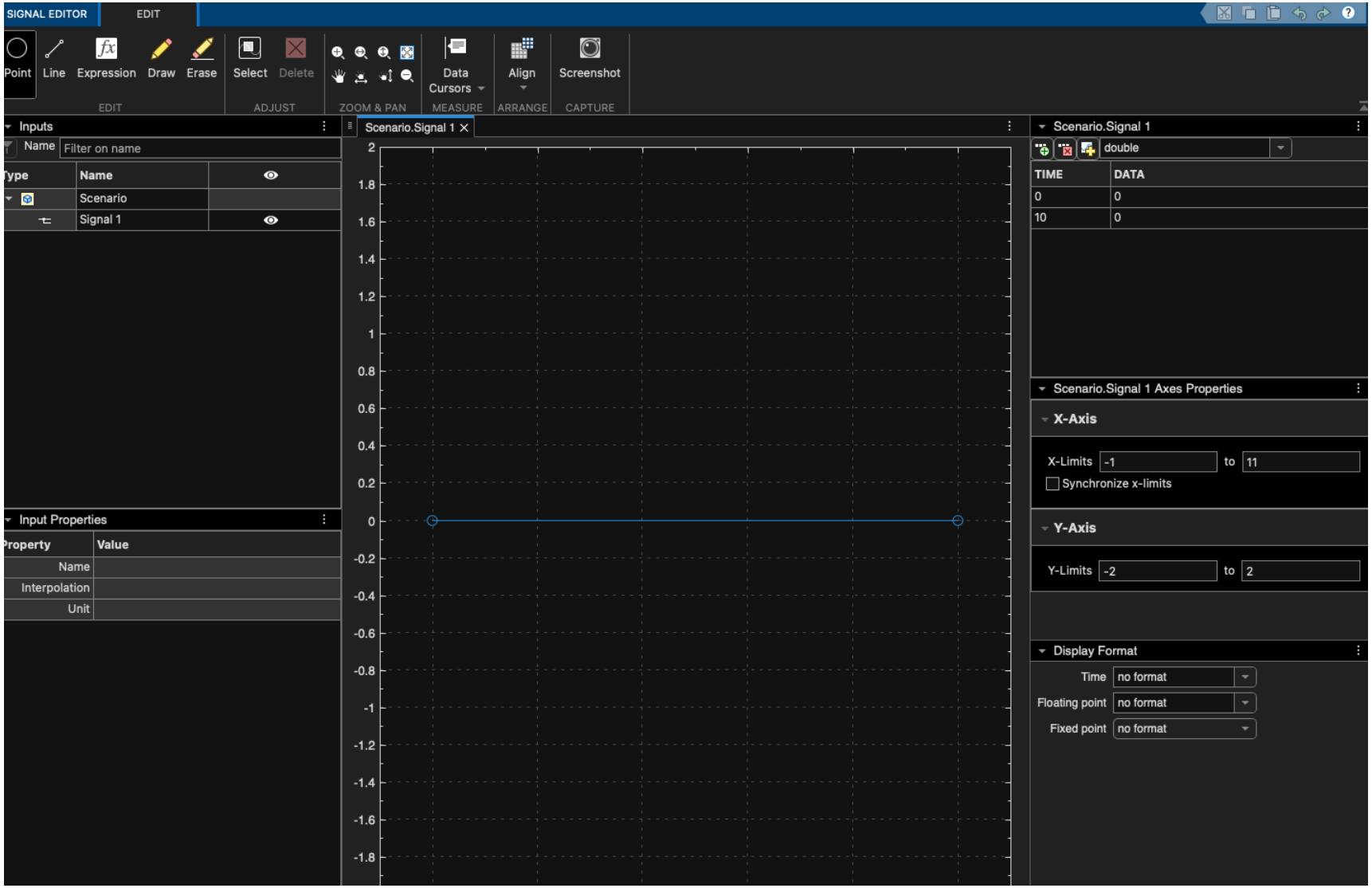

# Create a simple “user” model

# The “easiest” way is to create a signal



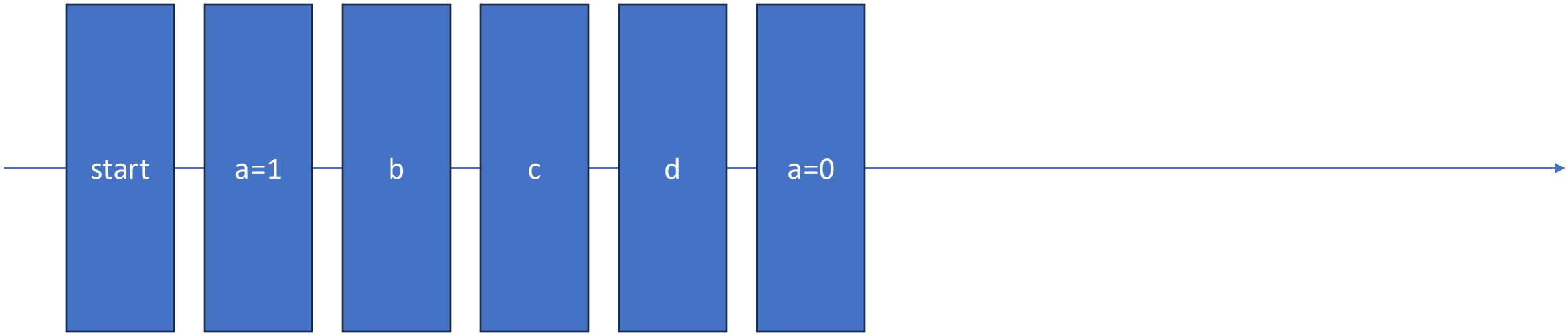



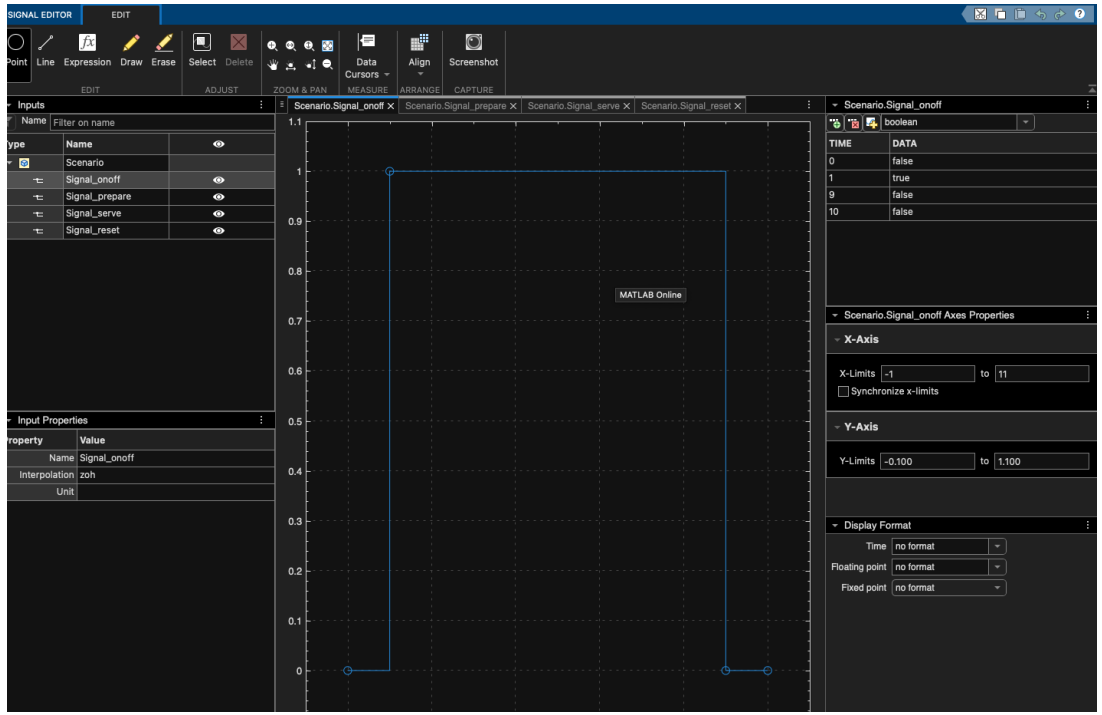
# Signal Editor

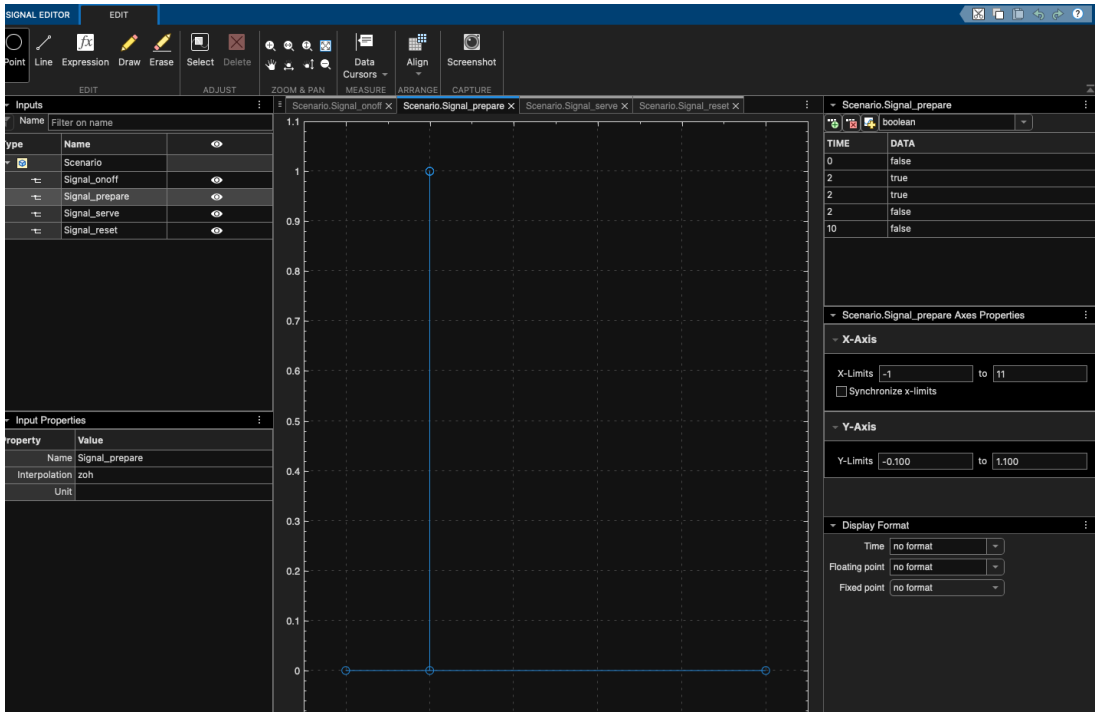


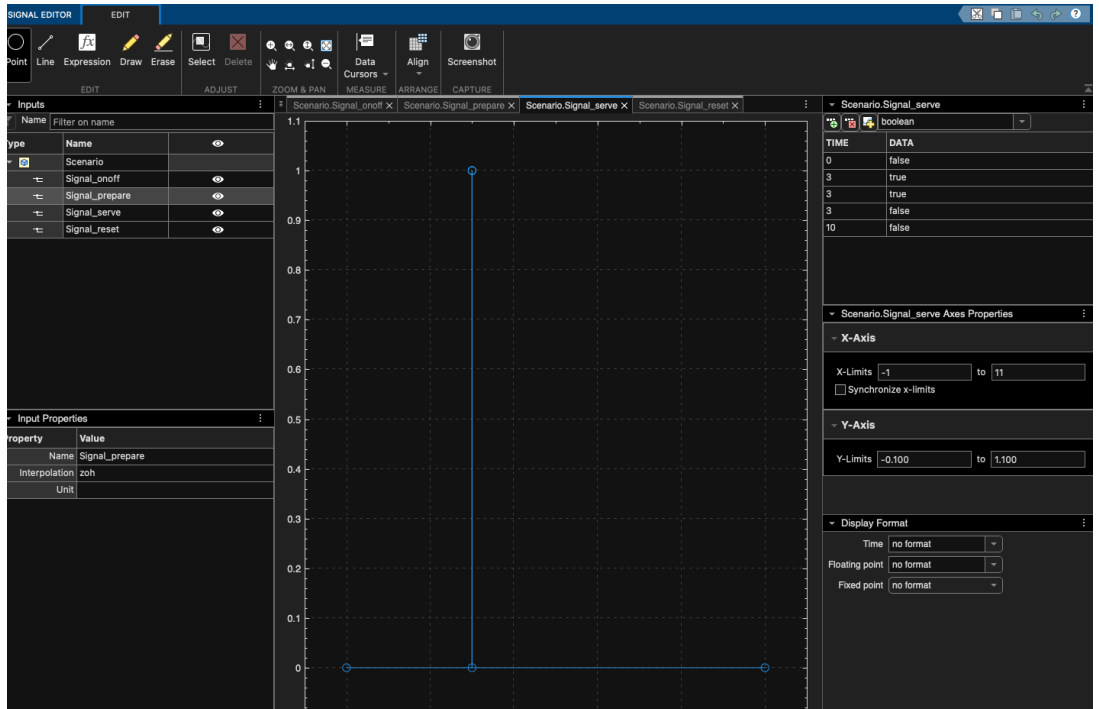
# So….. we can map a sequence

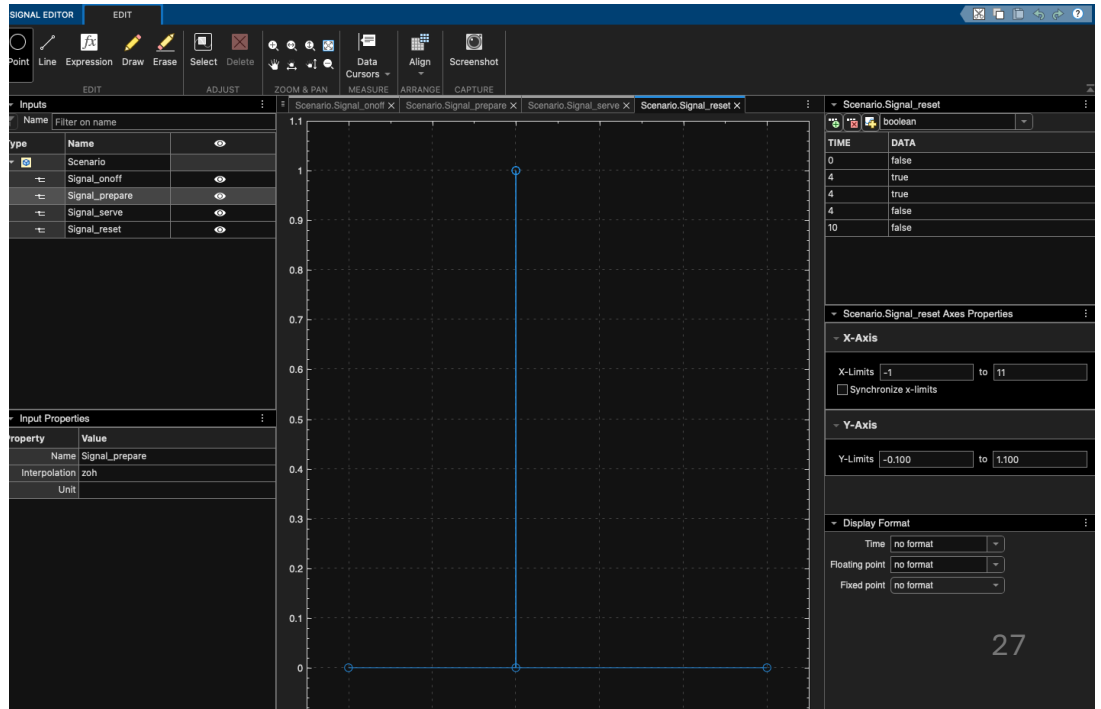
- Start, a=1, b, c, d, a=0 -> 0,1,2,3,1,0



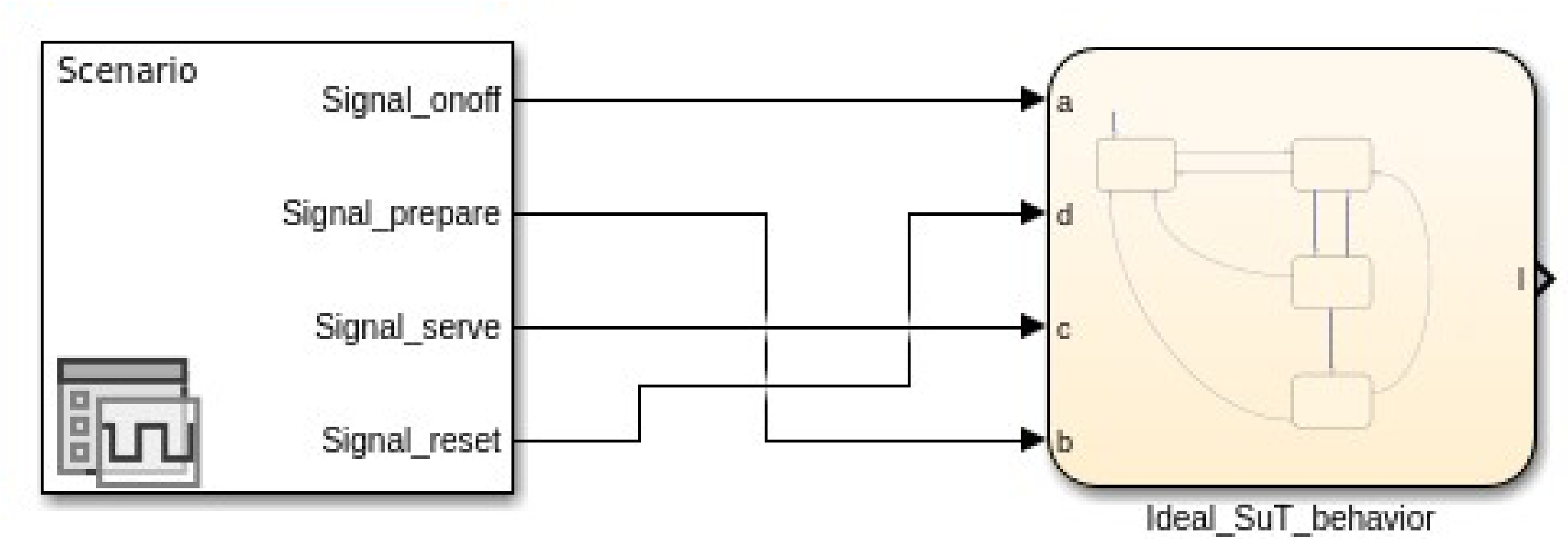

SIGNAL EDITOR
EDIT
Point
Line
Expression
Draw
Erase
Select
Delete
Data Cursors
Align
Screenshot
Inputs
Name
Filter on name
Type
Name
Scenario
Signal_onoff
Signal_prepare
Signal_serve
Signal_reset
Input Properties
Property
Value
Name Signal_onoff
Interpolation zoh
Unit
Scenario.Signal_onoff
Scenario.Signal_prepare
Scenario.Signal_serve
Scenario.Signal_reset
MATLAB Online
boolean
TIME
DATA
0 false
1 true
9 false
10 false
Scenario.Signal_onoff Axes Properties
X-Axis
X-Limits -1 to 11
Synchronize x-limits
Y-Axis
Y-Limits -0.100 to 1.100
Display Format
Time no format
Floating point no format
Fixed point no format


SIGNAL EDITOR
EDIT
Point
Line
Expression
Draw
Erase
Select
Delete
Data Cursors
Align
Screenshot
Inputs
Name
Filter on name
Type
Name
Scenario
Signal_onoff
Signal_prepare
Signal_serve
Signal_reset
Input Properties
Property
Value
Name Signal_prepare
Interpolation zoh
Unit
Scenario.Signal_onoff
Scenario.Signal_prepare
Scenario.Signal_serve
Scenario.Signal_reset
boolean
TIME
DATA
0 false
2 true
2 true
2 false
10 false
Scenario.Signal_prepare Axes Properties
X-Axis
X-Limits -1 to 11
Synchronize x-limits
Y-Axis
Y-Limits -0.100 to 1.100
Display Format
Time no format
Floating point no format
Fixed point no format


SIGNAL EDITOR
EDIT
Point
Line
Expression
Draw
Erase
Select
Delete
Data Cursors
Align
Screenshot
Inputs
Name
Filter on name
Type
Name
Scenario
Signal_onoff
Signal_prepare
Signal_serve
Signal_reset
Input Properties
Property
Value
Name Signal_prepare
Interpolation zoh
Unit
Scenario.Signal_onoff
Scenario.Signal_prepare
Scenario.Signal_serve
Scenario.Signal_reset
boolean
TIME
DATA
0 false
3 true
3 true
3 false
10 false
Scenario.Signal_serve Axes Properties
X-Axis
X-Limits -1 to 11
Synchronize x-limits
Y-Axis
Y-Limits -0.100 to 1.100
Display Format
Time no format
Floating point no format
Fixed point no format


SIGNAL EDITOR
EDIT
Point
Line
Expression
Draw
Erase
Select
Delete
Data Cursors
Align
Screenshot
Inputs
Name
Filter on name
Type
Name
Scenario
Signal_onoff
Signal_prepare
Signal_serve
Signal_reset
Input Properties
Property
Value
Name Signal_prepare
Interpolation zoh
Unit
Scenario.Signal_onoff
Scenario.Signal_prepare
Scenario.Signal_serve
Scenario.Signal_reset
boolean
TIME
DATA
0 false
4 true
4 true
4 false
10 false
Scenario.Signal_reset Axes Properties
X-Axis
X-Limits -1 to 11
Synchronize x-limits
Y-Axis
Y-Limits -0.100 to 1.100
Display Format
Time no format
Floating point no format
Fixed point no format

# Interconnect the signal source to the SuT state machine



# Add a scope to verify (visually) the result

