UC-PACT: Universal Composability for Preventing Adversarial Composition Techniques

Tool Overview

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12 August 2025

This material is based upon work supported by the Defense Advanced Research Projects Agency (DARPA) and Naval Information Warfare Center Pacific (NIWC Pacific) under N66001-22-C-4020.

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Overview

- Released tools to make your life easier in using the UC DSL
- **UC-PACT WebApp**: UC model designer GUI to make it easier to start designing UC models
- **ucdsl-tools-docker**: some dockerfiles that make using the uc-dsl typechecker and interpreter easier (including setting up Emacs)
- Breakout session on webapp (Wednesday, 1:30pm)

UC-PACT WebApp

ucdsl-tools-docker

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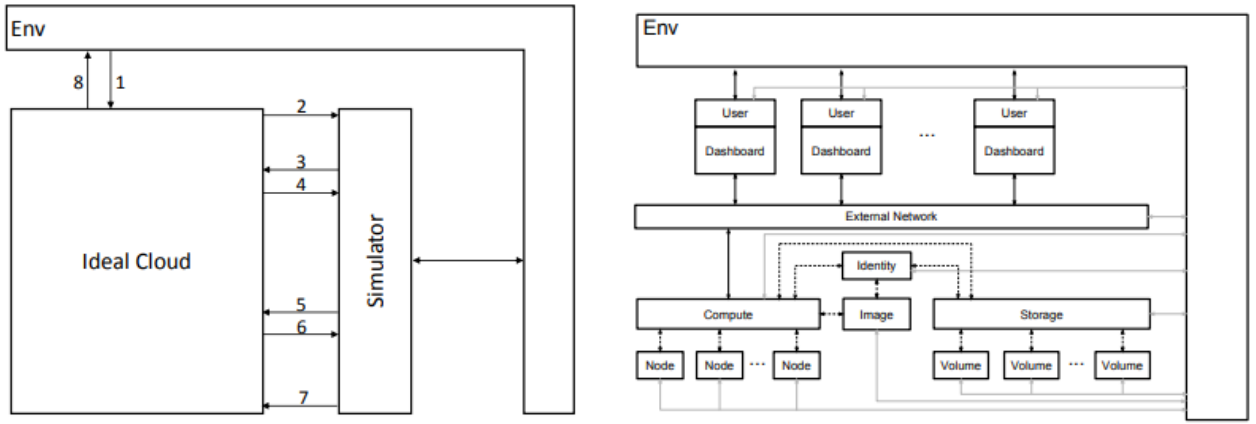
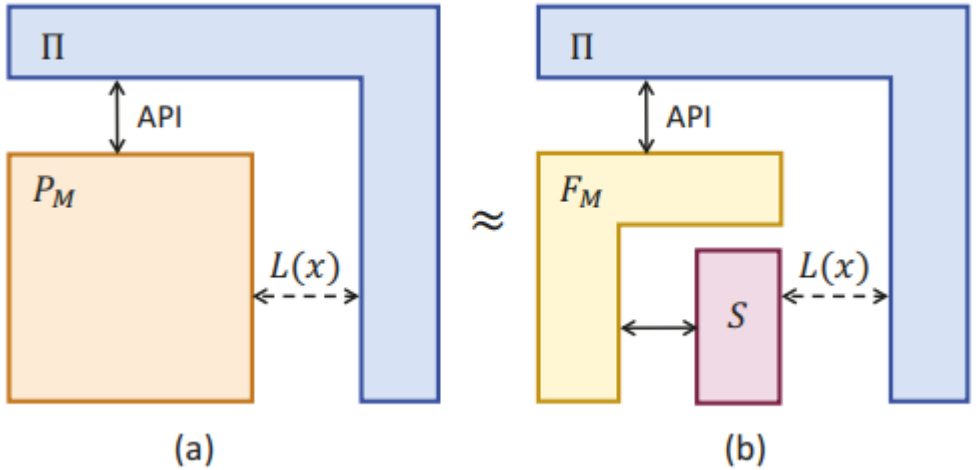
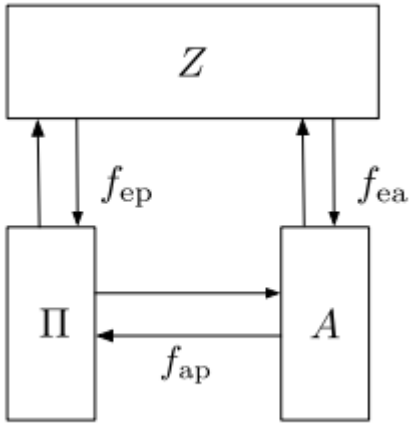
Motivating the problem



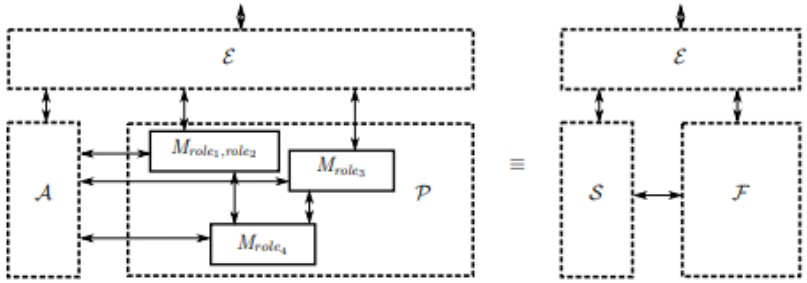
On the universally composable security of OpenStack, Hogan, et al.



Using Universal Composition to Design and Analyze Secure Complex Hardware Systems, Canetti, et al.

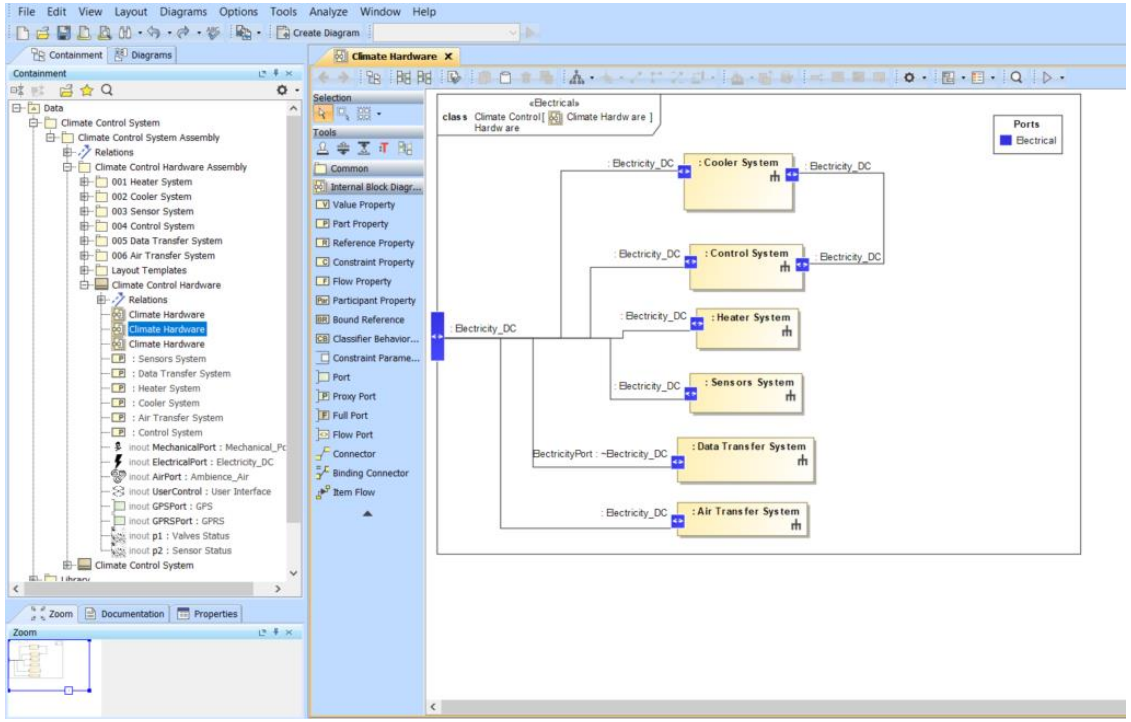


GNUC: A New Universal Composability Framework, Hofheinz, et al.

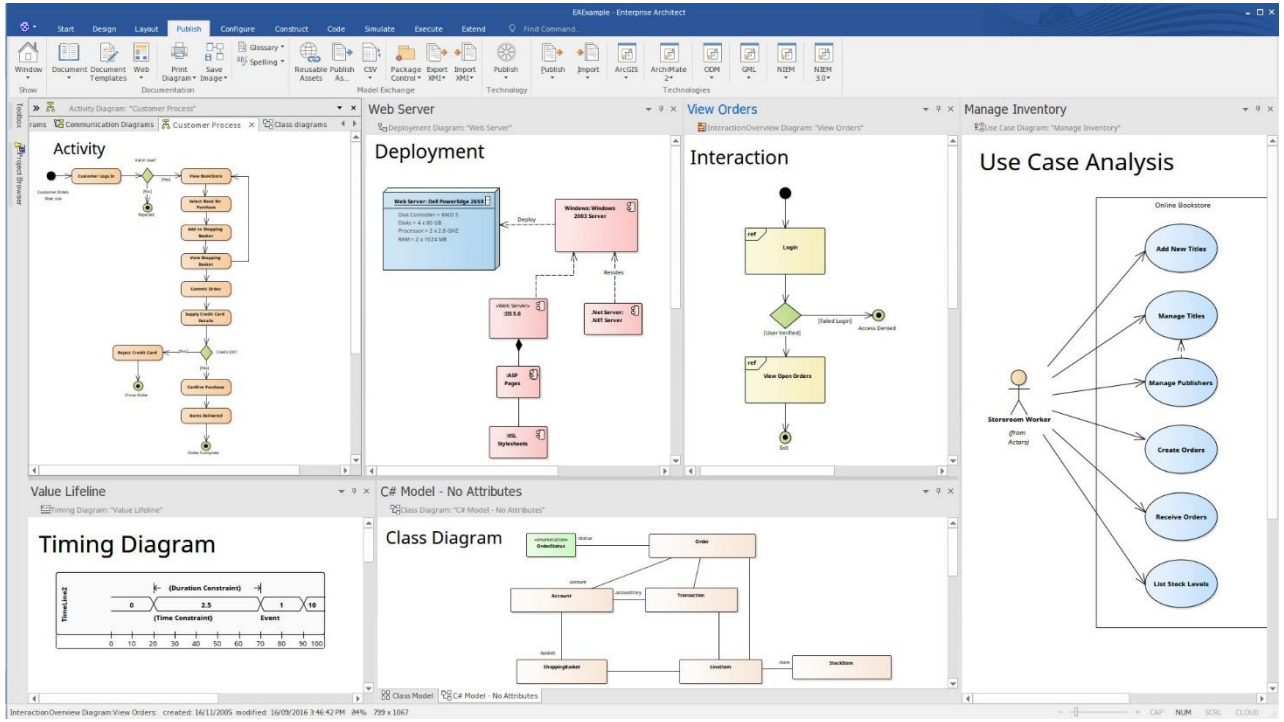


iUC: Flexible Universal Composability Made Simple, Camenisch, et al.

Motivating the problem

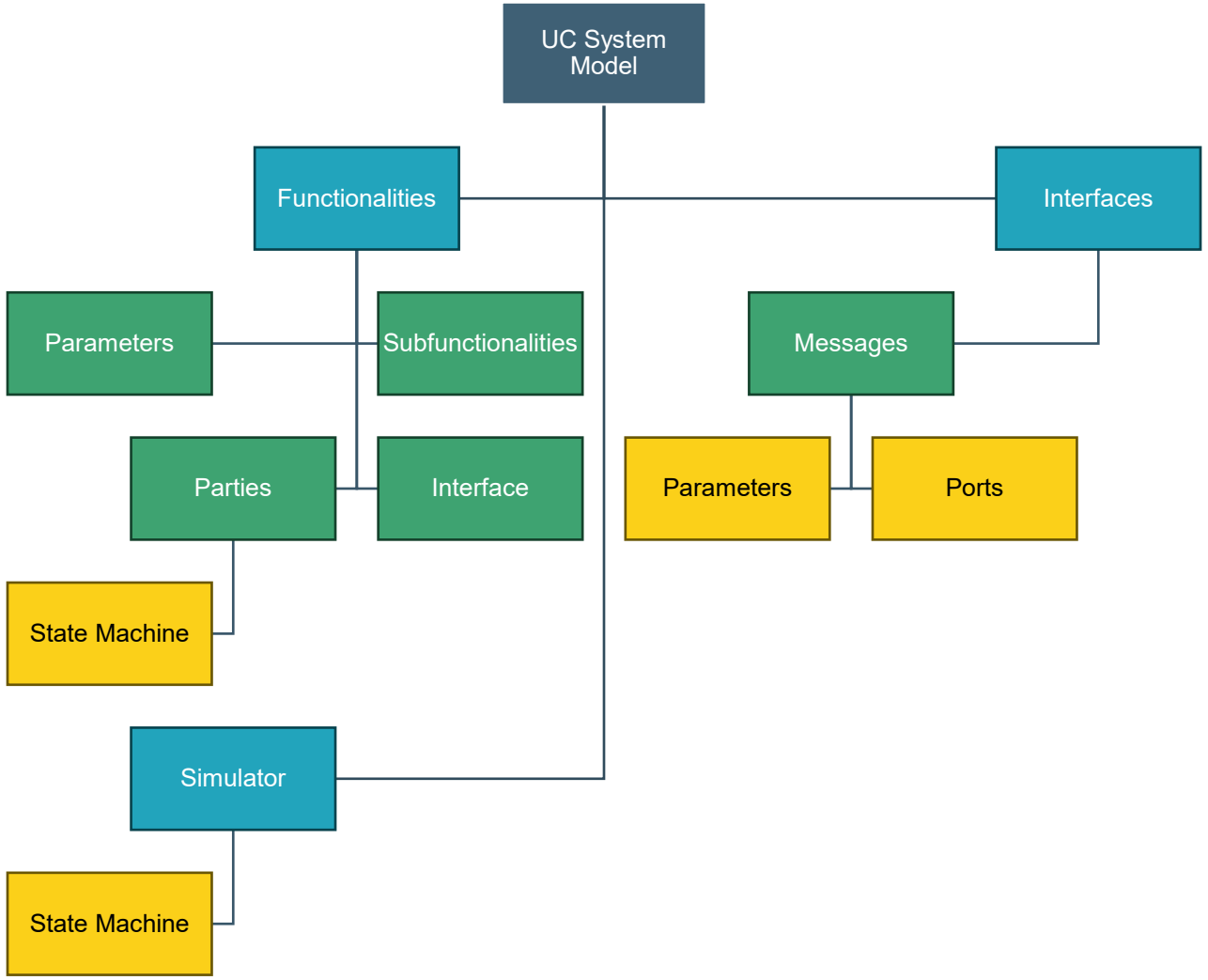


https://www.qualicen.de/real-magic-building-custom-interface-tables-with-cameo-magic-draw-and-generic-tables/



https://en.wikipedia.org/wiki/Enterprise_Architect_%28software%29

Building Blocks of a UC Model



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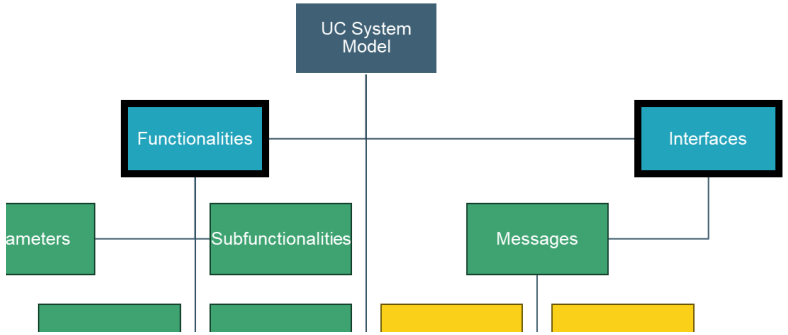
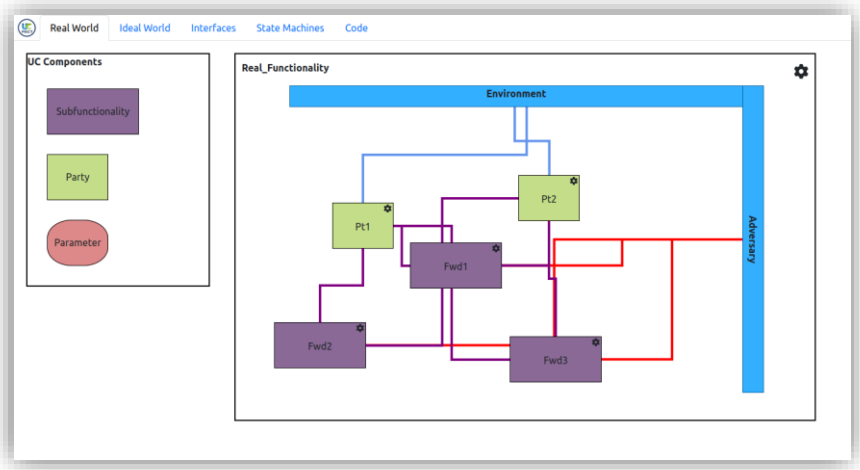
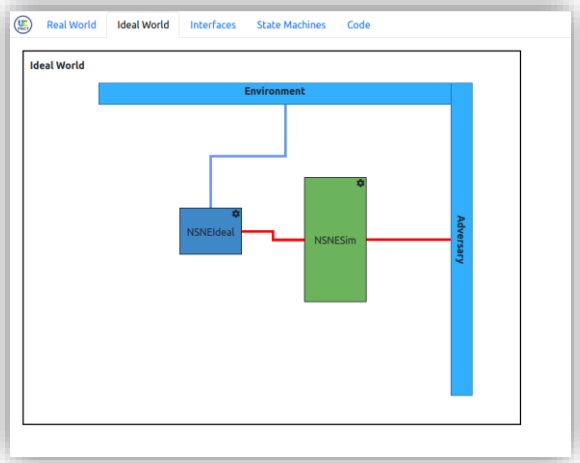
Modeling Basics

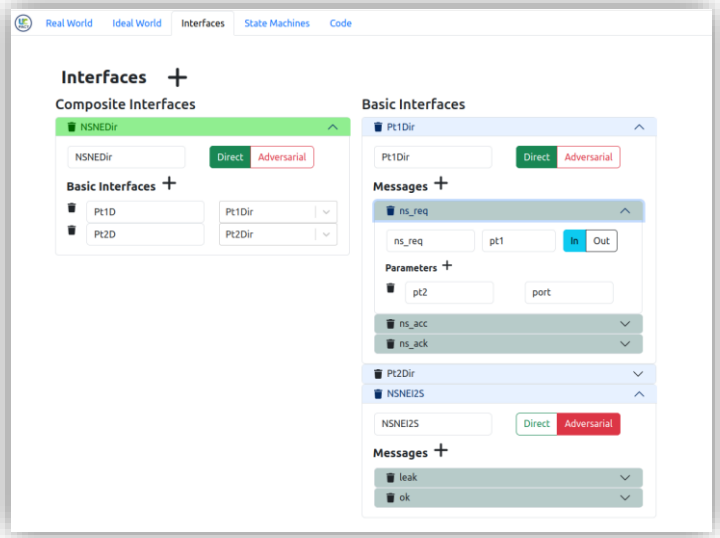




Real World Tab



Ideal World Tab

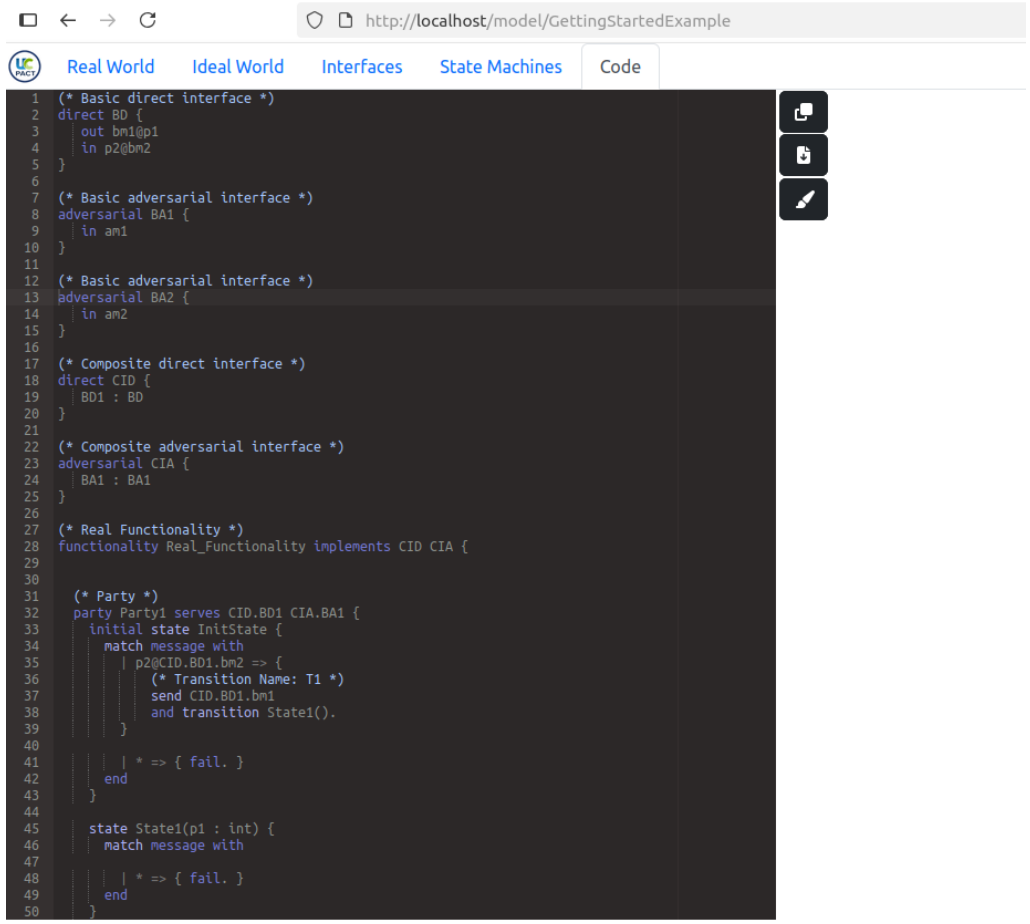


Interfaces Tab

Automatically Generated uc-dsl Code

- What it does
  - Automatically generate a skeleton of the DSL code
  - As much fidelity as you create in the app

- What it doesn't do
  - Allow you to specify ec files
  - Allow you to specify uci files
  - Typecheck



Running Example

- Authenticated Messaging
  - Two parties (Sender and Receiver)
  - Establish authentication token using Lamport's One-time password scheme
  - Sender then includes authentication token with subsequent messages so Receiver knows they are valid

- Subfunctionalities
  - Channel for Sender to push messages to Receiver
    - First-in, First-out messaging
  - Random Oracle for computing hashes

- Adversary capabilities
  - No access to parties
  - No access to RO
  - Channel leaks all messages, authentication tokens, etc. to the adversary
    - Adversary can also inject messages into the channel

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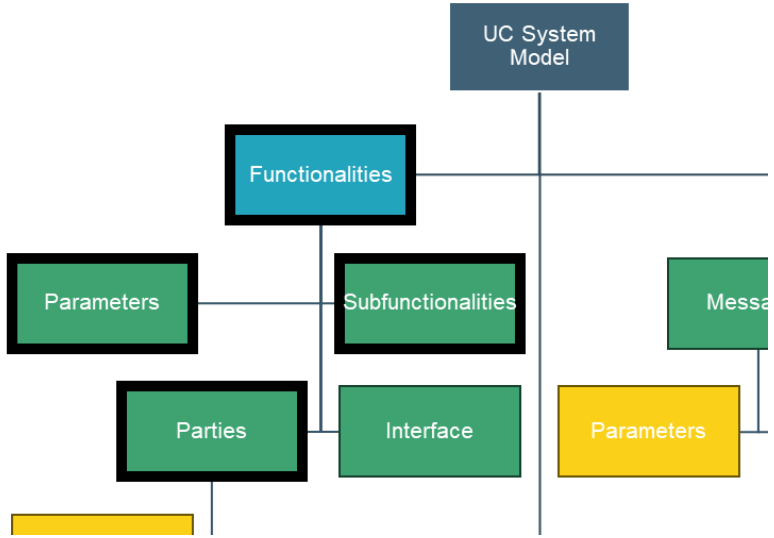
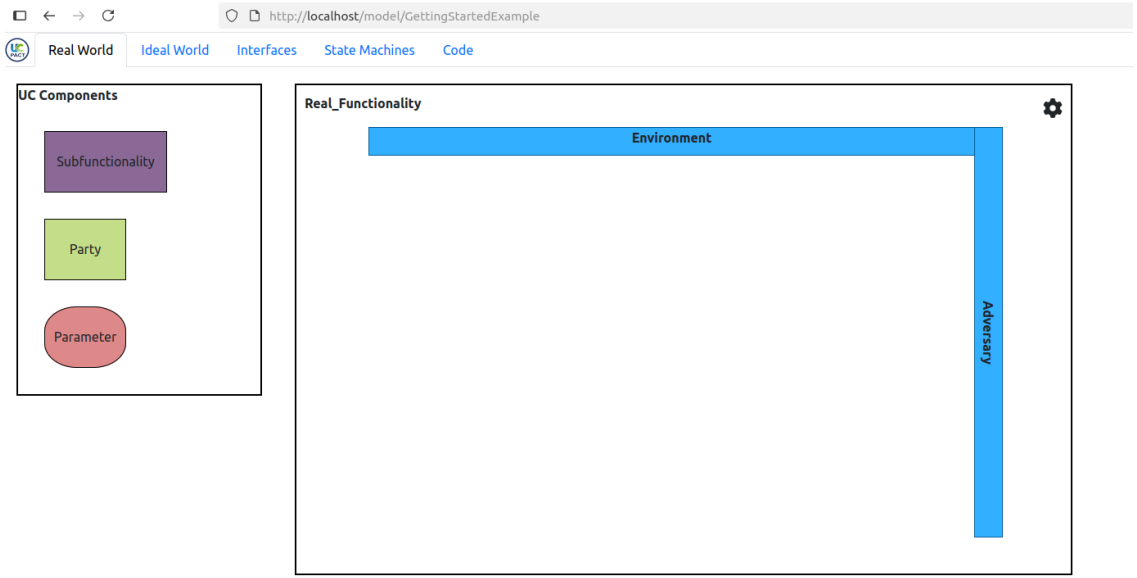
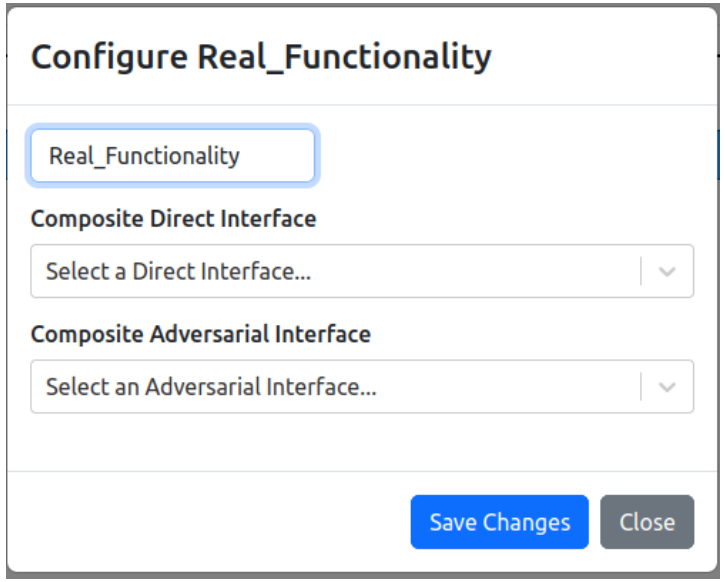
Real World Deep Dive

› Real Functionalities must implement an interface

› Real Functionalities must have at least one party



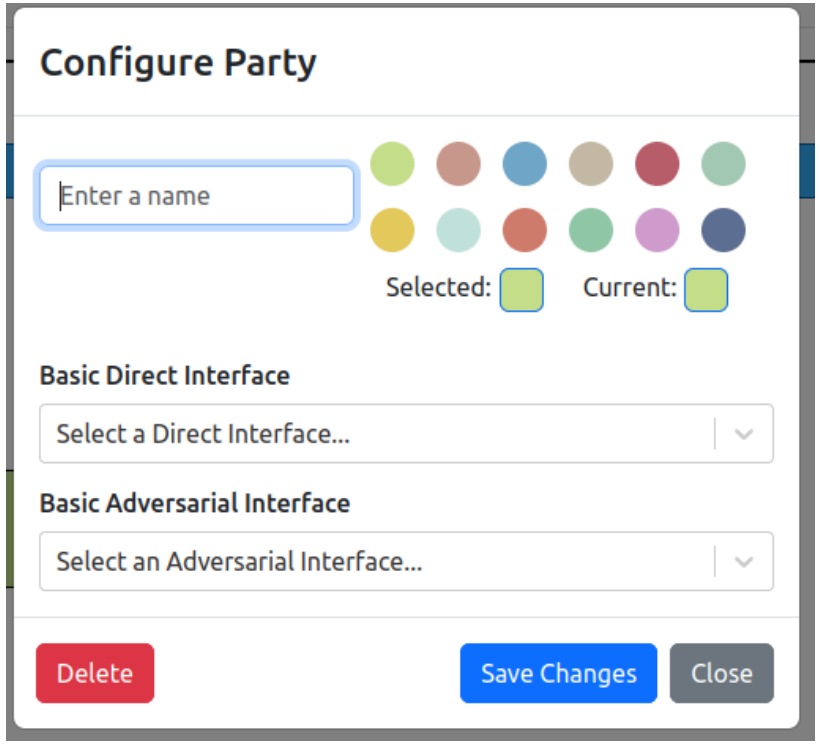


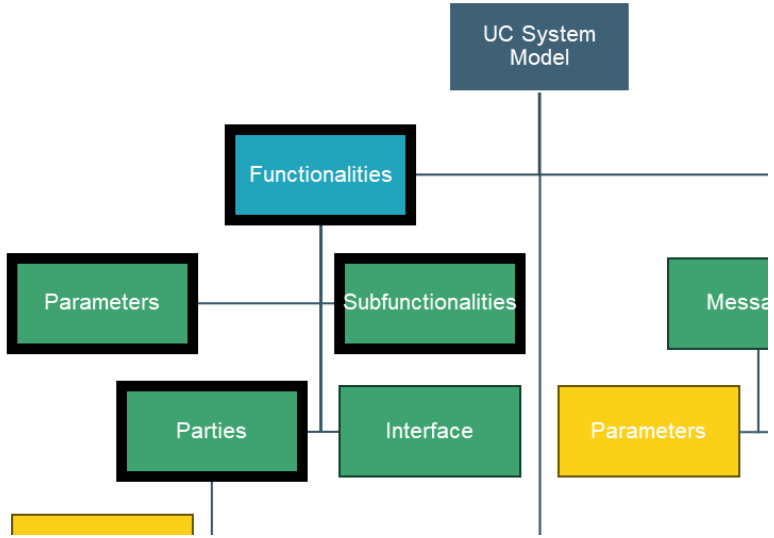


Real World Deep Dive

› Parties are named

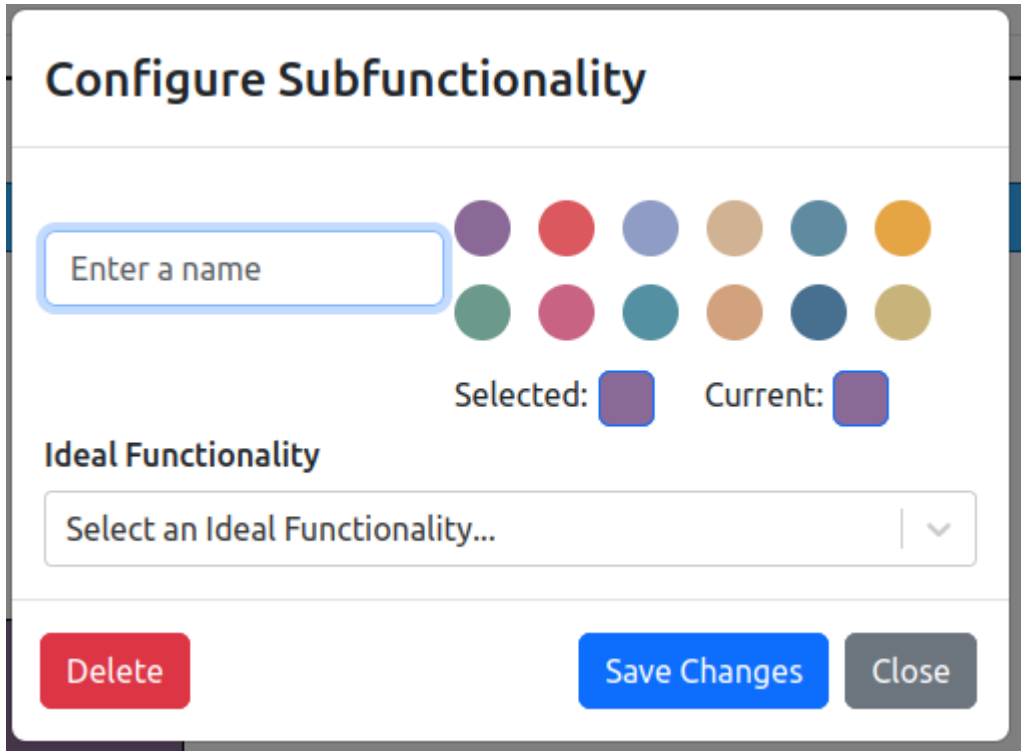
› Parties serve interfaces

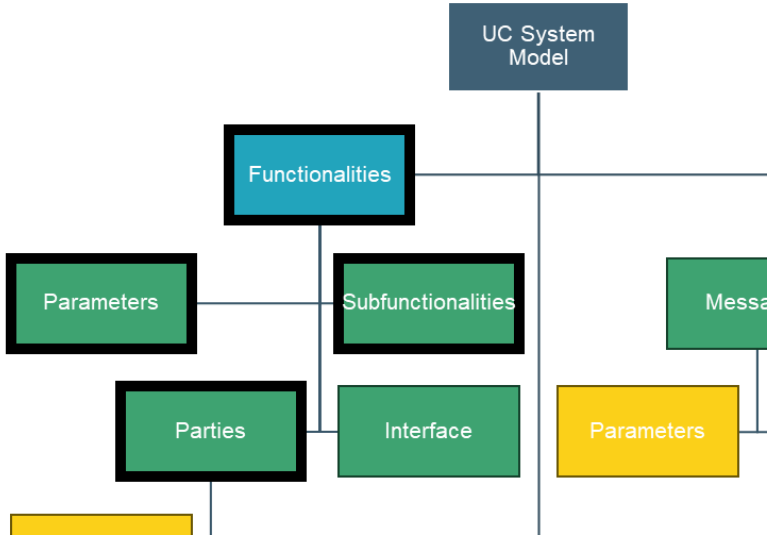




Real World Deep Dive

› Subfunctionalities are idealized components





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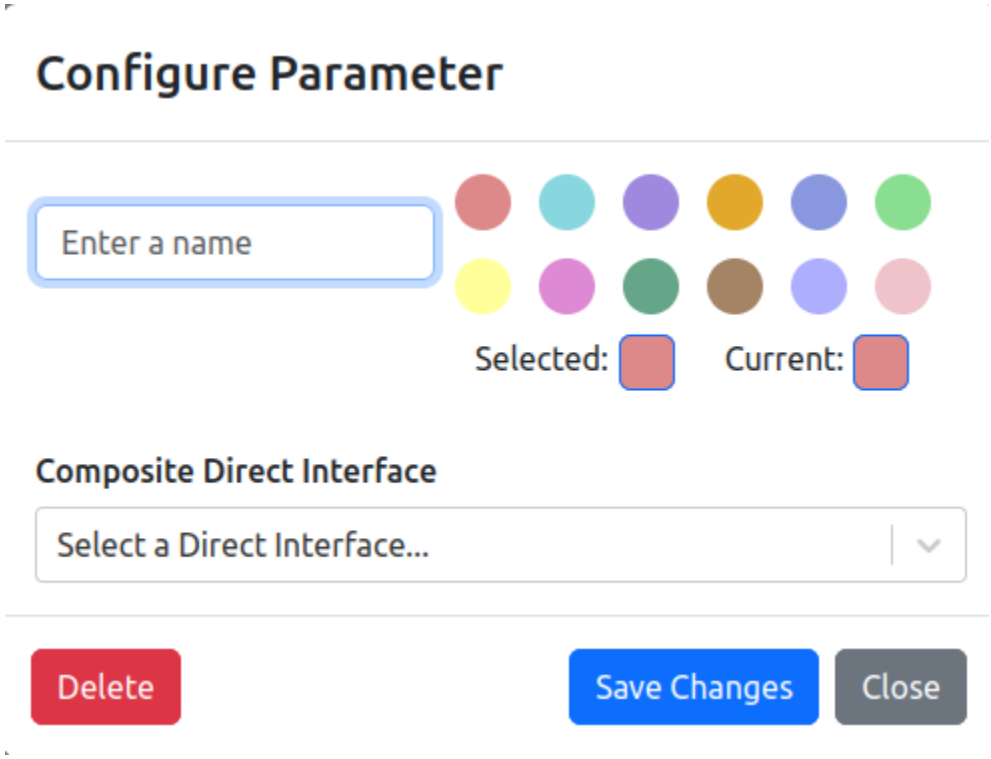
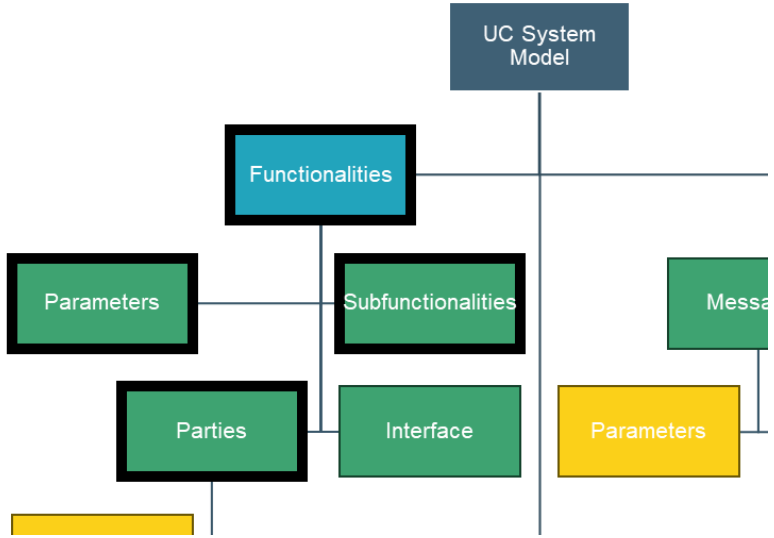
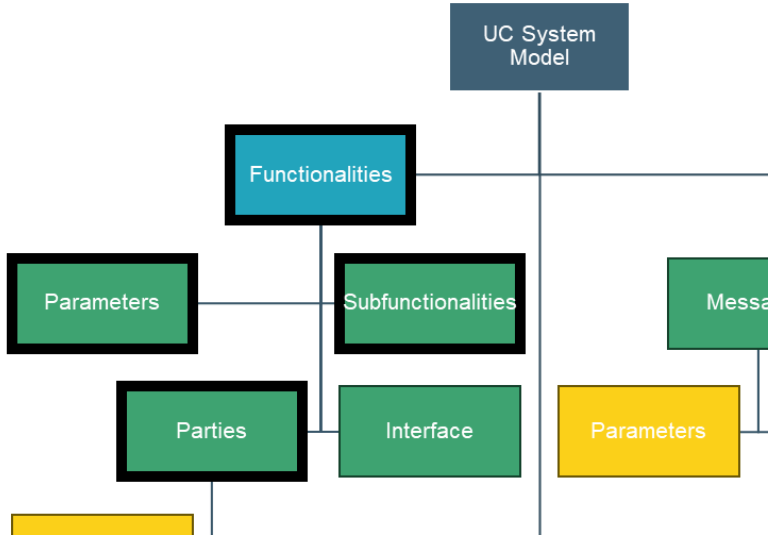
Real World Deep Dive

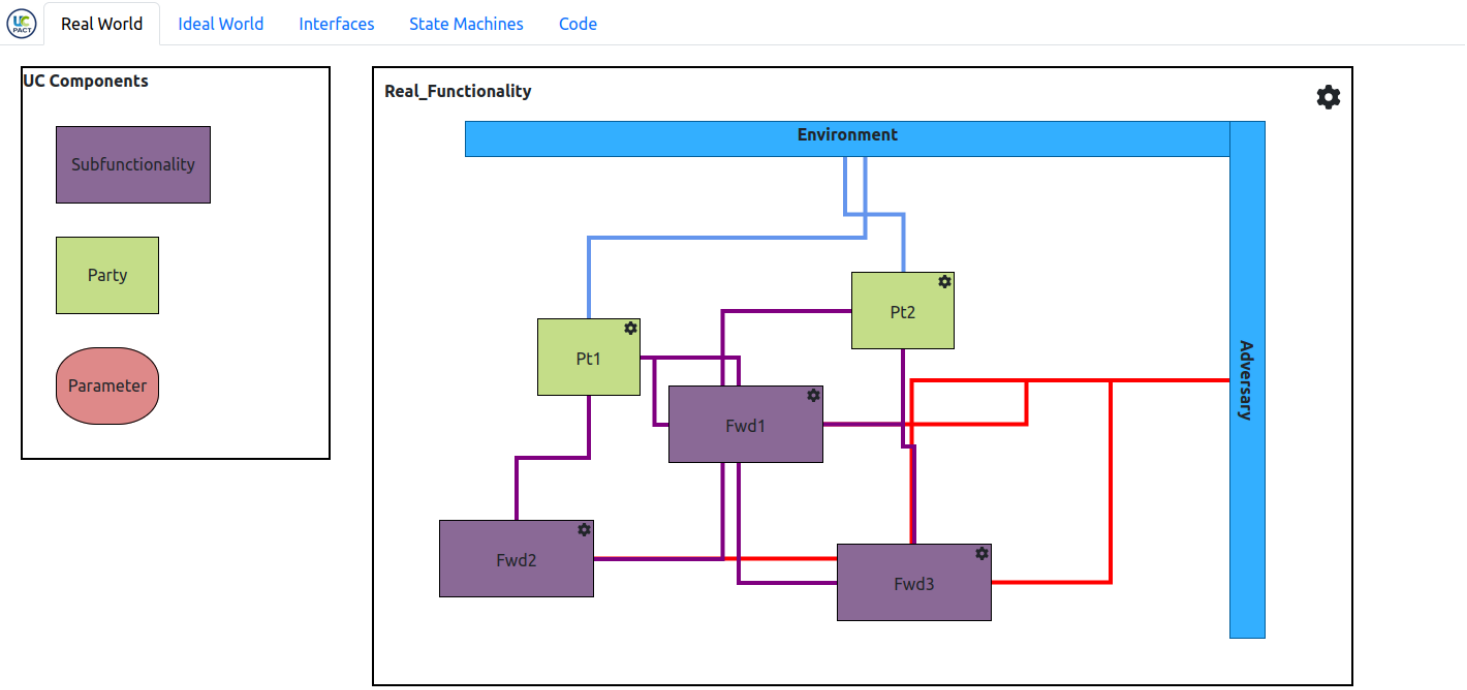
› Parameters are components the parties can pass messages to





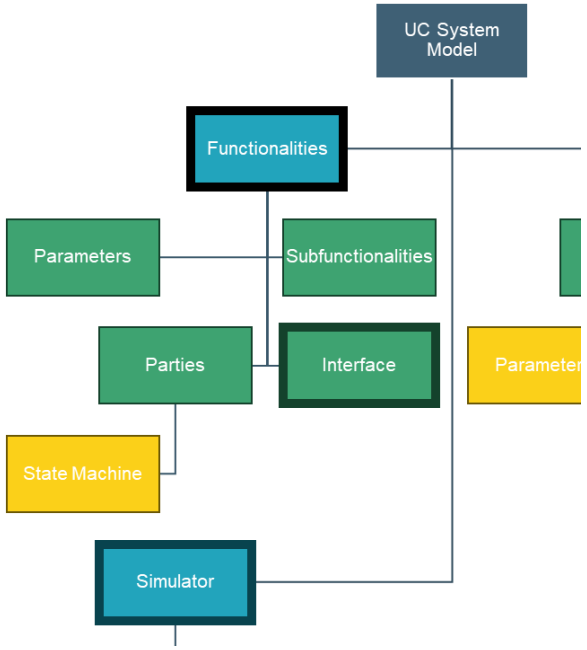
Real World Deep Dive

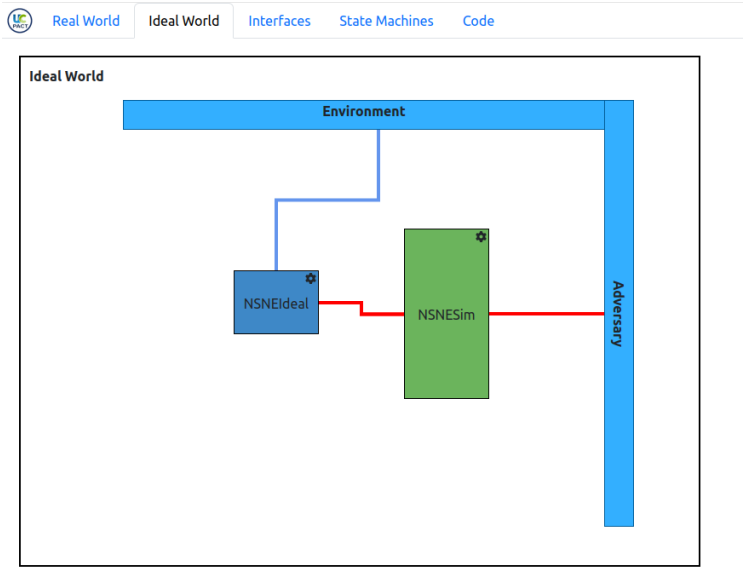


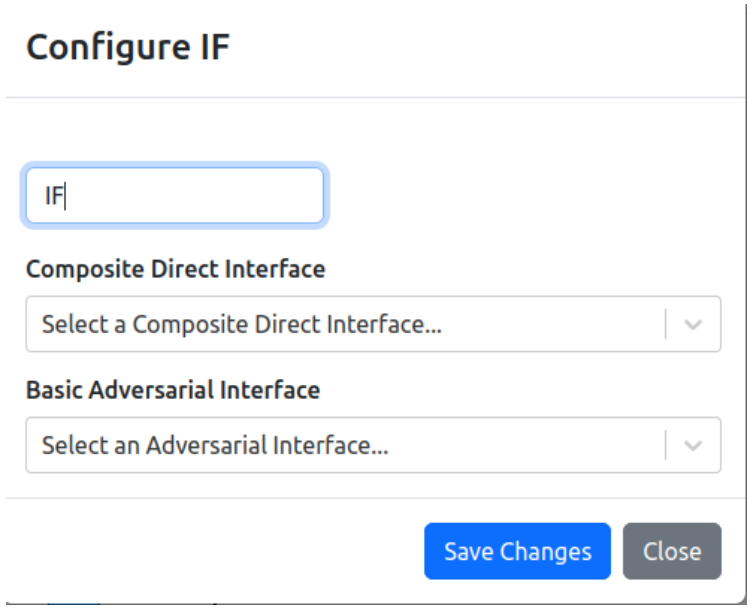


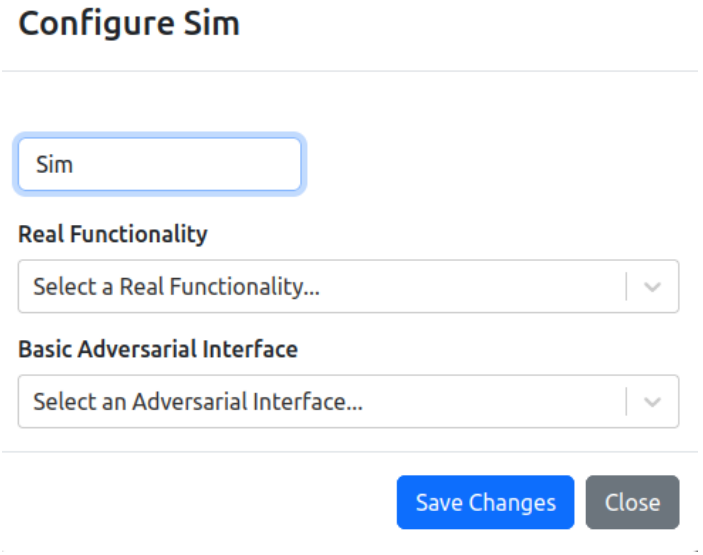
Ideal World Deep Dive

- Ideal World design is static; there is an ideal functionality and a simulator
- Ideal Functionality implements interfaces
- Simulator uses an interface to communicate with ideal functionality and simulates a Real Functionality





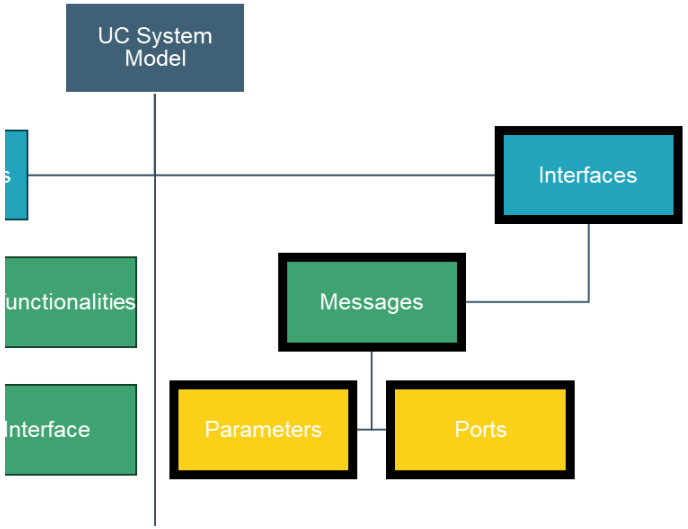


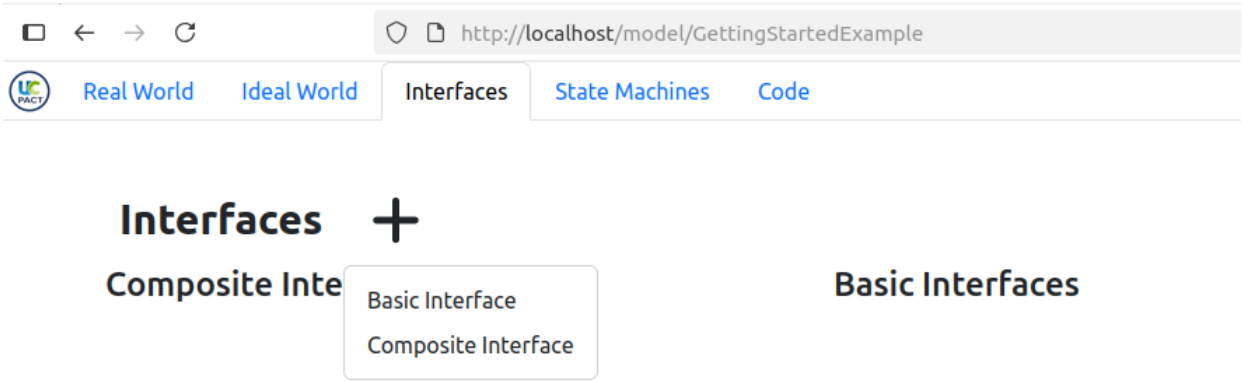


Interfaces Deep Dive

› Interfaces are either Adversarial or Direct

› Interfaces are either Basic or Composite

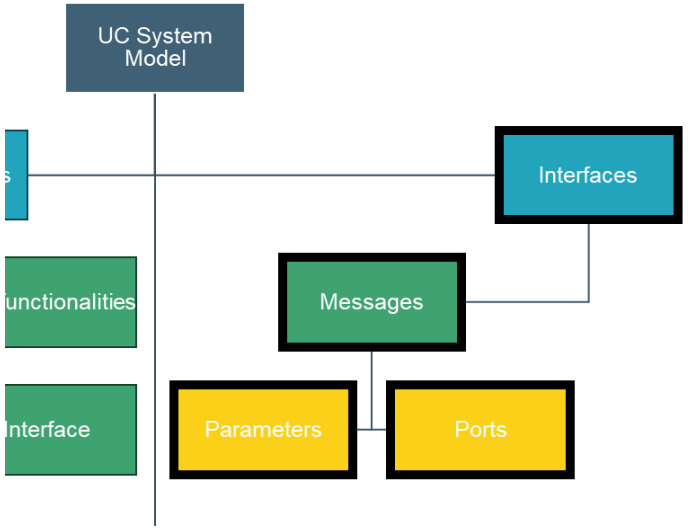


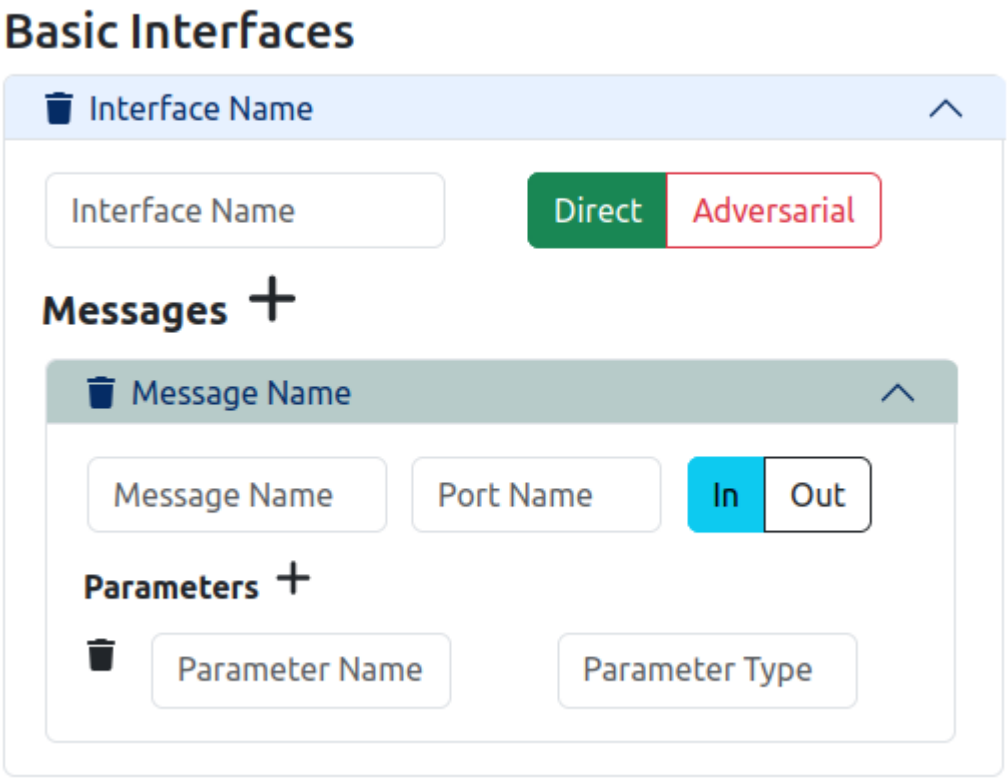


Interfaces Deep Dive

› Parties serve basic interfaces

› The messages form the API for that party

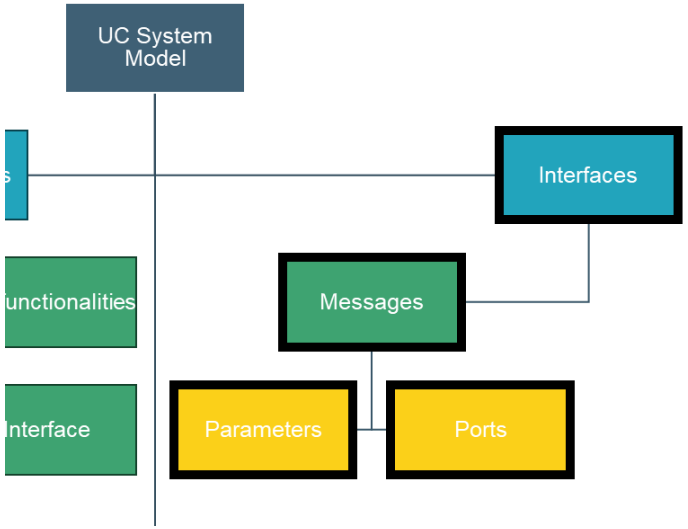


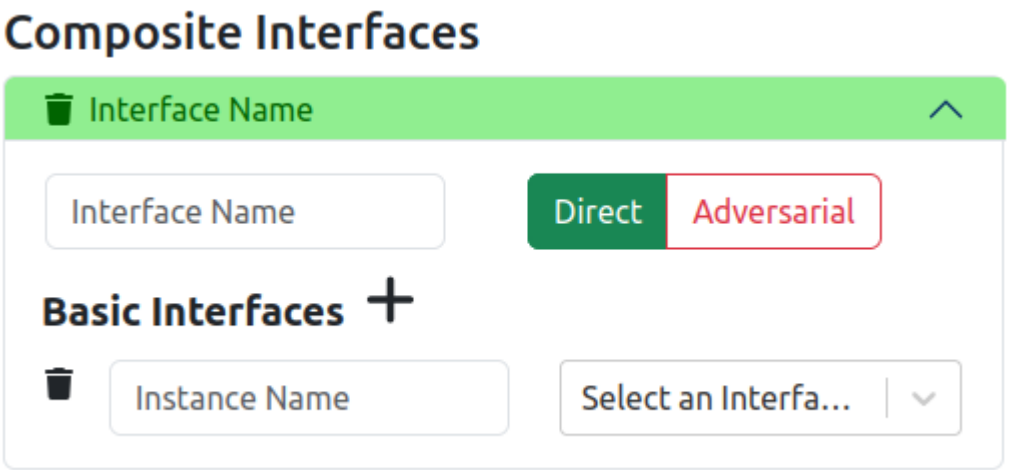


Interfaces Deep Dive

› Functionalities implement composite interfaces

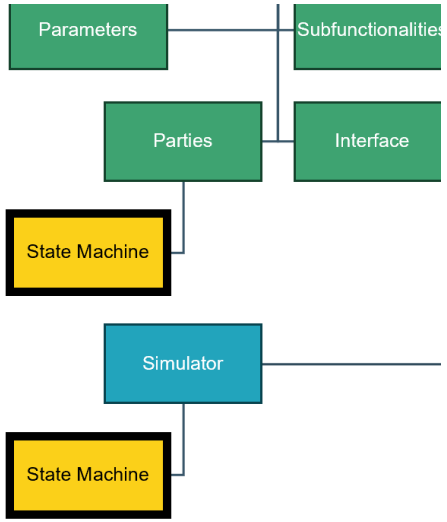
› These are a collection of basic interfaces

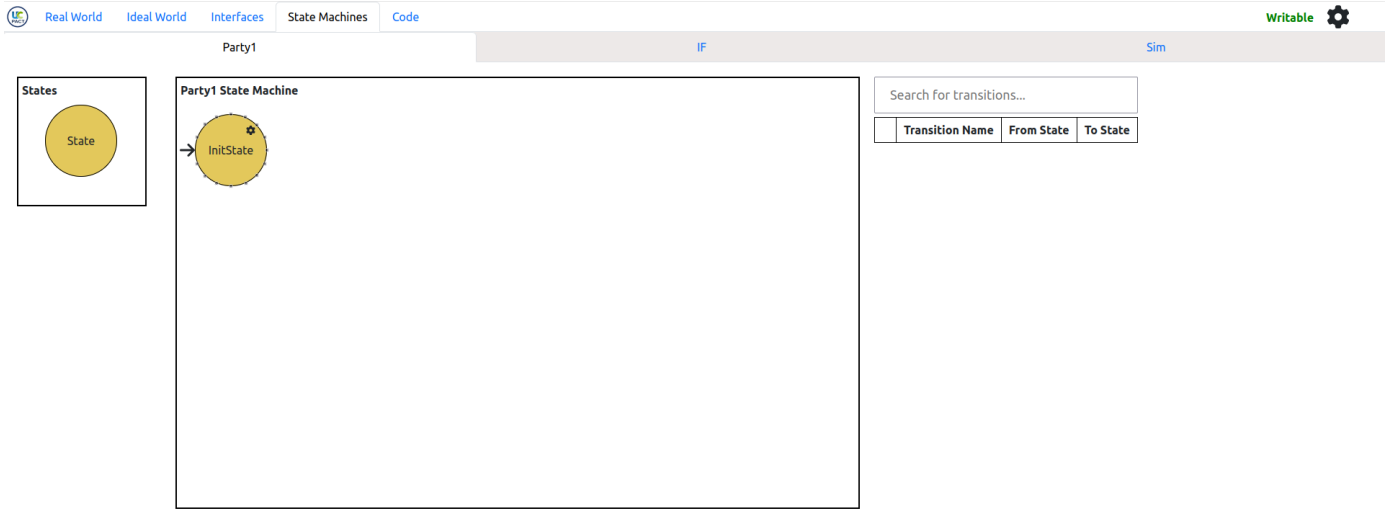


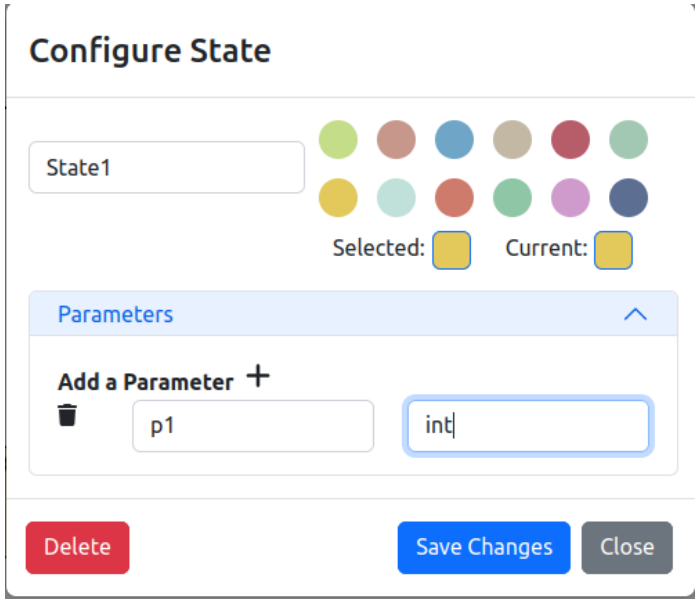


State Machines Deep Dive

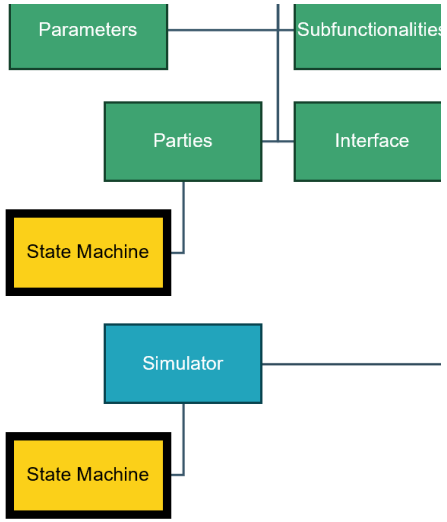
- Parties, Ideal Functionalities, and Simulators have state machines
- State machines identify the behavior of a component when acting on a message



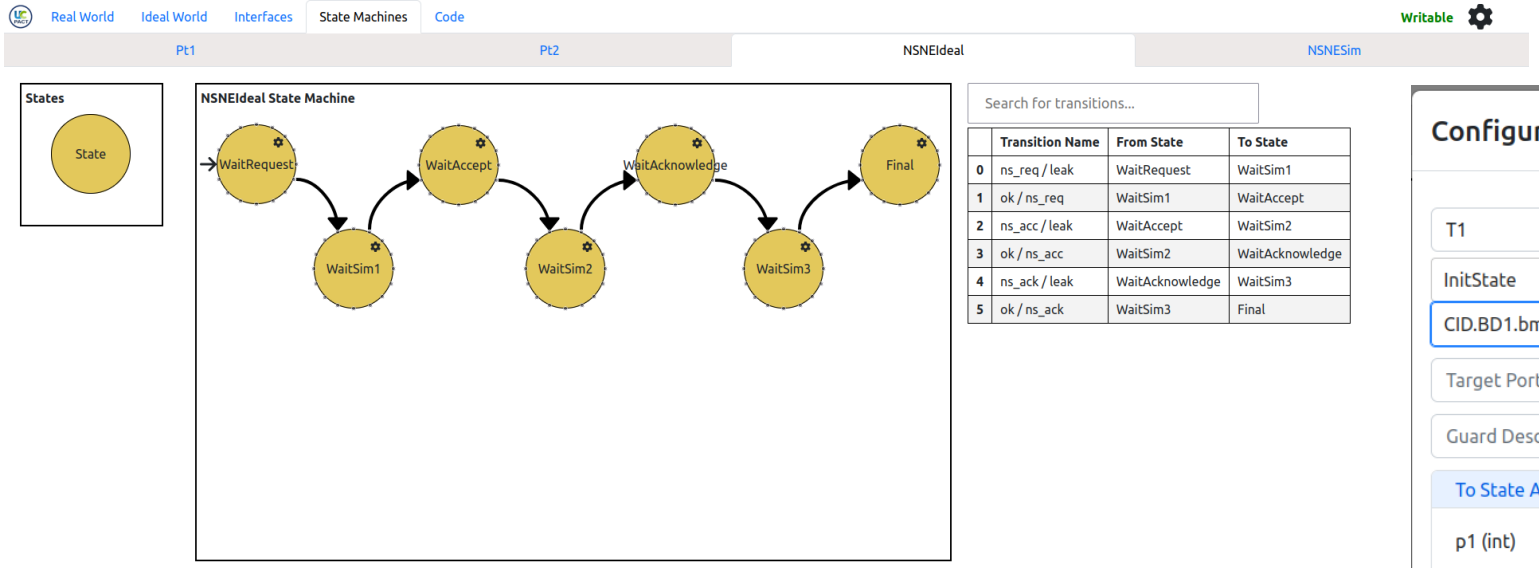




State Machines Deep Dive

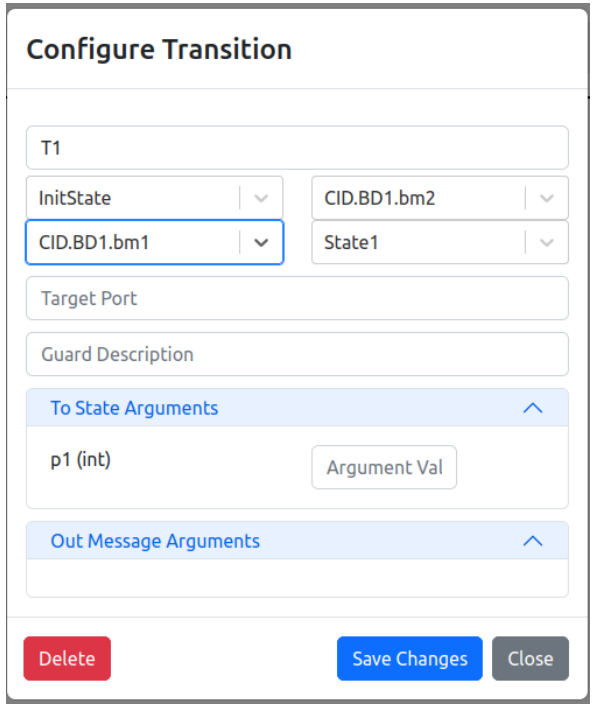


- Processing of a message ends either in a failure or by sending a message somewhere else and transitioning to a new state
- This is configured by adding transitions



Search for transitions...

	Transition Name	From State	To State
0	ns_req / leak	WaitRequest	WaitSim1
1	ok / ns_req	WaitSim1	WaitAccept
2	ns_acc / leak	WaitAccept	WaitSim2
3	ok / ns_acc	WaitSim2	WaitAcknowledge
4	ns_ack / leak	WaitAcknowledge	WaitSim3
5	ok / ns_ack	WaitSim3	Final



Code Generator

- Allows for export of the generated code so that it can be pulled into the other tools (typechecker and interpreter)
- Any new types will need to be declared
- Conditional transitions will need to be configured
- Additional logic around variables or other processing will need to be added

http://localhost/model/GettingStartedExample

Real World | Ideal World | Interfaces | State Machines | Code

```
(* Basic direct interface *)
direct BD {
  out bm1@p1
  in p2@bm2
}

(* Basic adversarial interface *)
adversarial BA1 {
  in am1
}

(* Basic adversarial interface *)
adversarial BA2 {
  in am2
}

(* Composite direct interface *)
direct CID {
  BD1 : BD
}

(* Composite adversarial interface *)
adversarial CIA {
  BA1 : BA1
}

(* Real Functionality *)
functionality Real_Functionality implements CID CIA {


  (* Party *)
  party Party1 serves CID.BD1 CIA.BA1 {
    initial state InitState {
      match message with
        | p2@CID.BD1.bm2 => {
            (* Transition Name: T1 *)
            send CID.BD1.bm1
            and transition State1().
        }

        | * => { fail. }
      end
    }

    state State1(p1 : int) {
      match message with

        | * => { fail. }
      end
    }
```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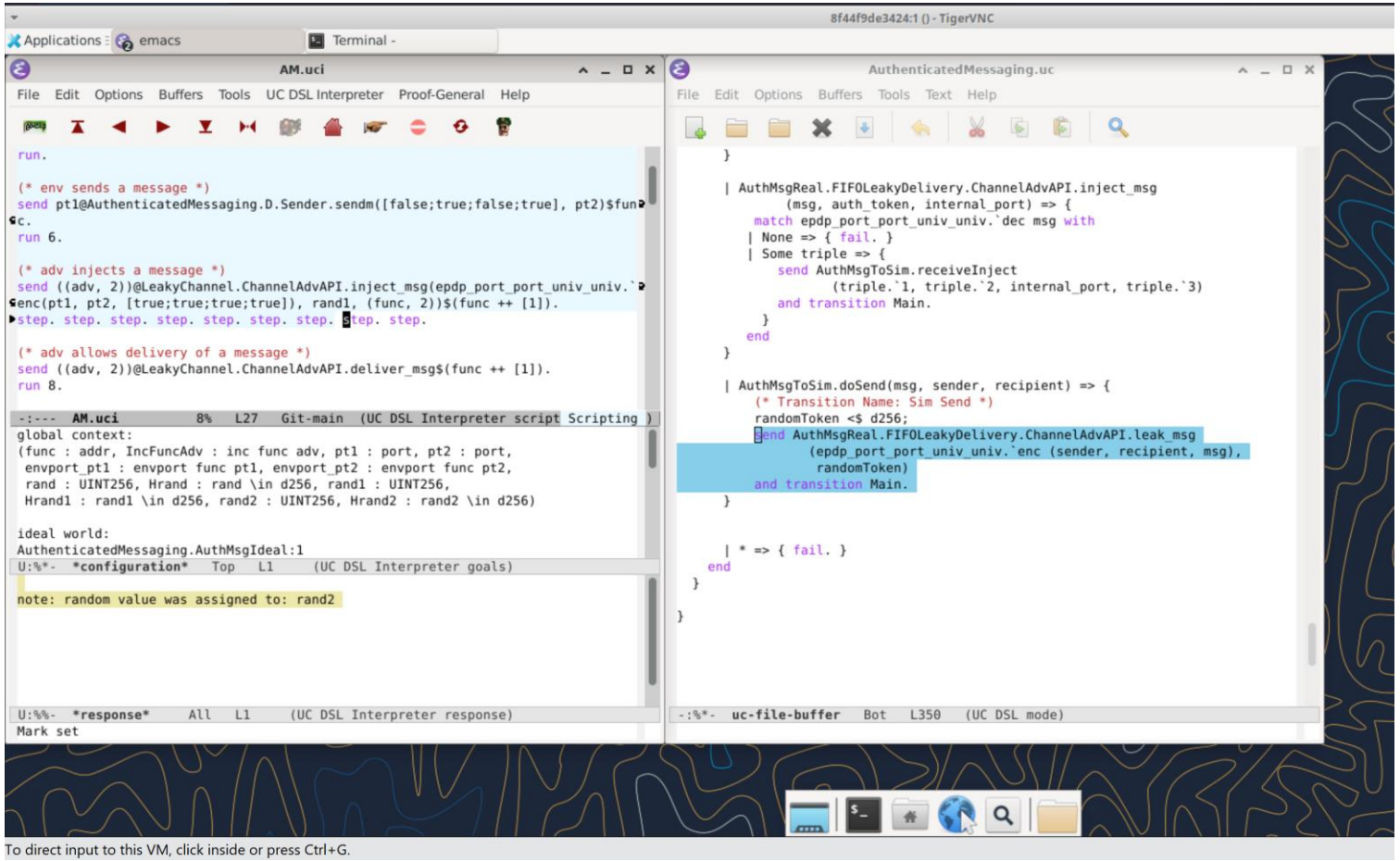
What next?

› **ucdsl-tools-docker**: some dockerfiles that make using the uc-dsl typechecker and interpreter easier (including setting up Emacs)



ucdsl-tools-docker

Easy UC User Guide

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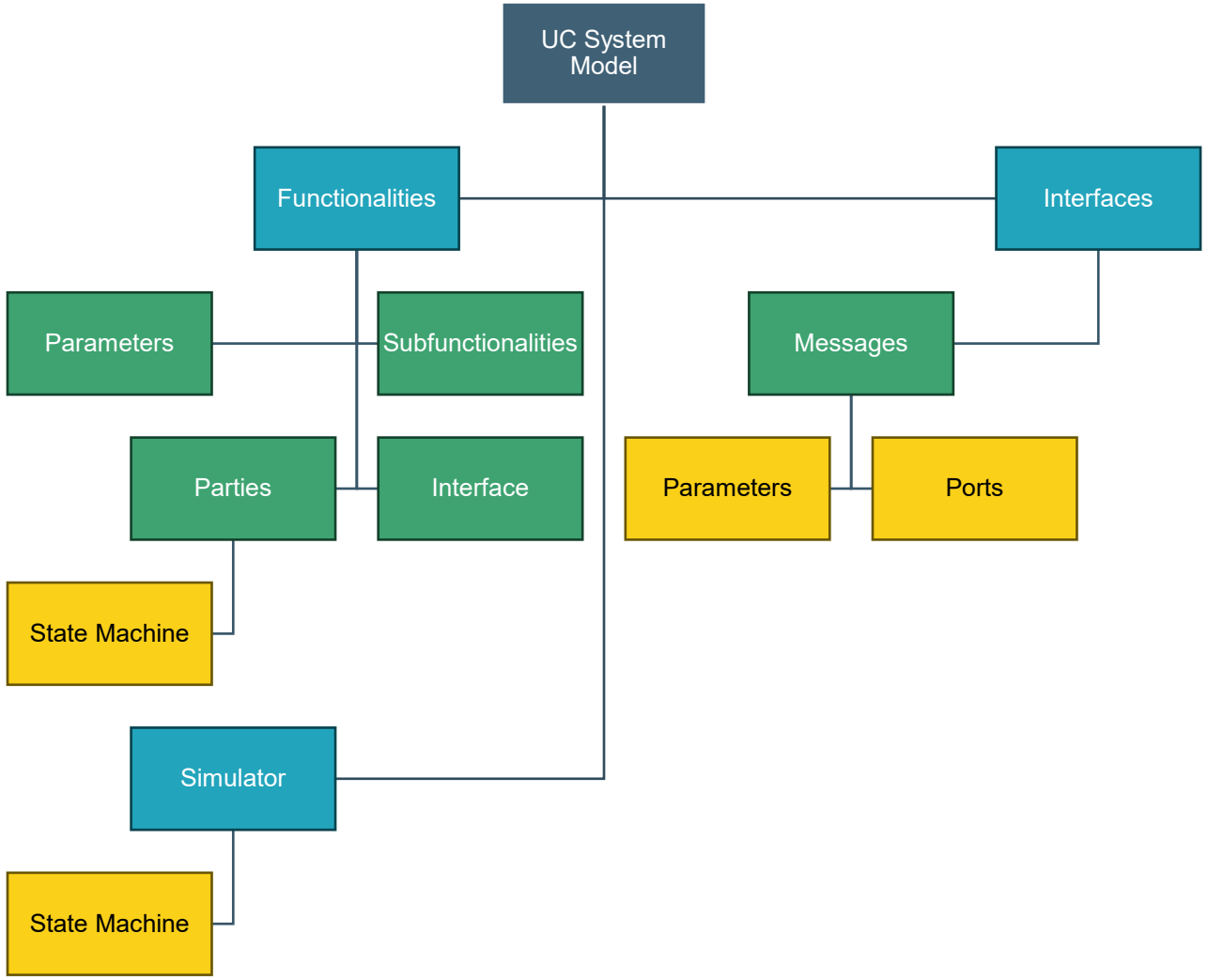
Questions?


UC System Model
Functionalities
Interfaces
Parameters
Subfunctionalities
Messages
Parties
Interface
Parameters
Ports
State Machine
Simulator
State Machine