



ONERA

THE FRENCH AEROSPACE LAB

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Simulation Software Ecosystem Low-Level Architecture

simulation_software_ecosystem-> Low-level architecture

simulation_software_ecosystem-> Low-level architecture

ALU.xml

Frontend



Backend

simulation_software_ecosystem-> Low-level architecture

```
1 <?xml version="1.0" encoding="UTF-8"?>
2
3 <!-- Fichier de configuration local des points de connexion disponible pour le modele par le système Thetys -->
4 <ArithmeticLogicUnit uuid="1000" alias="Foo" lang="cxx">
5   <Input>
6     <Slot uuid="1" alias="test_boolean" type="bool" unit="SU" description="">false</Slot>
7     <Slot uuid="2" alias="test_char" type="char" unit="SU" description="">0</Slot>
8     <Slot uuid="3" alias="test_octet" type="octet" unit="SU" description="">0</Slot>
9     <Slot uuid="4" alias="test_short" type="short" unit="SU" description="">0</Slot>
10    <Slot uuid="5" alias="test_unsigned_short" type="ushort" unit="SU" description="">0</Slot>
11    <Slot uuid="6" alias="test_long" type="long" unit="SU" description="">0</Slot>
12    <Slot uuid="7" alias="test_unsigned_long" type="ulong" unit="SU" description="">0</Slot>
13    <Slot uuid="8" alias="test_long_long" type="longlong" unit="SU" description="">0</Slot>
14    <Slot uuid="9" alias="test_unsigned_long_long" type="ulonglong" unit="SU" description="">0</Slot>
15    <Slot uuid="10" alias="test_float" type="float" unit="SU" description="">0.0</Slot>
16    <Slot uuid="11" alias="test_double" type="double" unit="SU" description="">0.0</Slot>
17    <Slot uuid="12" alias="test_string" type="string" unit="SU" description="">test</Slot>
18    <Slot uuid="13" alias="test_vec2f" type="vec2f" unit="SU" description="">0.0 0.1</Slot>
19    <Slot uuid="14" alias="test_vec3f" type="vec3f" unit="SU" description="">0.0 0.1 0.2</Slot>
20    <Slot uuid="15" alias="test_vec4f" type="vec4f" unit="SU" description="">0.0 0.1 0.2 0.3</Slot>
21    <Slot uuid="16" alias="test_matrixf" type="matrixf" unit="SU" description="">0.0 0.1 0.2 0.3 1.0 1.1 1.2 1.3 2.0 2.1 2.2 2.3 3.0 3.1 3.2 3.3</Slot>
22    <Slot uuid="17" alias="test_vec2d" type="vec2d" unit="SU" description="">0.0 0.1</Slot>
23    <Slot uuid="18" alias="test_vec3d" type="vec3d" unit="SU" description="">0.0 0.1 0.2</Slot>
24    <Slot uuid="19" alias="test_vec4d" type="vec4d" unit="SU" description="">0.0 0.1 0.2 0.3</Slot>
25    <Slot uuid="20" alias="test_matrixd" type="matrixd" unit="SU" description="">0.0 0.1 0.2 0.3 1.0 1.1 1.2 1.3 2.0 2.1 2.2 2.3 3.0 3.1 3.2 3.3</Slot>
26  </Input>
27  <Output>
28    <Slot uuid="21" alias="test_boolean" type="bool" unit="SU" description="">false</Slot>
29    <Slot uuid="22" alias="test_char" type="char" unit="SU" description="">0</Slot>
30    <Slot uuid="23" alias="test_octet" type="octet" unit="SU" description="">0</Slot>
31    <Slot uuid="24" alias="test_short" type="short" unit="SU" description="">0</Slot>
32    <Slot uuid="25" alias="test_unsigned_short" type="ushort" unit="SU" description="">0</Slot>
33    <Slot uuid="26" alias="test_long" type="long" unit="SU" description="">0</Slot>
34    <Slot uuid="27" alias="test_unsigned_long" type="ulong" unit="SU" description="">0</Slot>
35    <Slot uuid="28" alias="test_long_long" type="longlong" unit="SU" description="">0</Slot>
36    <Slot uuid="29" alias="test_unsigned_long_long" type="ulonglong" unit="SU" description="">0</Slot>
37    <Slot uuid="30" alias="test_float" type="float" unit="SU" description="">0.0</Slot>
38    <Slot uuid="31" alias="test_double" type="double" unit="SU" description="">0.0</Slot>
39    <Slot uuid="32" alias="test_string" type="string" unit="SU" description="">test</Slot>
40    <Slot uuid="33" alias="test_vec2f" type="vec2f" unit="SU" description="">0.0 0.1</Slot>
41    <Slot uuid="34" alias="test_vec3f" type="vec3f" unit="SU" description="">0.0 0.1 0.2</Slot>
42    <Slot uuid="35" alias="test_vec4f" type="vec4f" unit="SU" description="">0.0 0.1 0.2 0.3</Slot>
43    <Slot uuid="36" alias="test_matrixf" type="matrixf" unit="SU" description="">0.0 0.1 0.2 0.3 1.0 1.1 1.2 1.3 2.0 2.1 2.2 2.3 3.0 3.1 3.2 3.3</Slot>
44    <Slot uuid="37" alias="test_vec2d" type="vec2d" unit="SU" description="">0.0 0.1</Slot>
45    <Slot uuid="38" alias="test_vec3d" type="vec3d" unit="SU" description="">0.0 0.1 0.2</Slot>
46    <Slot uuid="39" alias="test_vec4d" type="vec4d" unit="SU" description="">0.0 0.1 0.2 0.3</Slot>
47    <Slot uuid="40" alias="test_matrixd" type="matrixd" unit="SU" description="">0.0 0.1 0.2 0.3 1.0 1.1 1.2 1.3 2.0 2.1 2.2 2.3 3.0 3.1 3.2 3.3</Slot>
48  </Output>
49 </ArithmeticLogicUnit>
50
```

ALU.xml

the I/O model definition file

simulation_software_ecosystem-> Low-level architecture

ALU.xml

*my_awesome_code.**

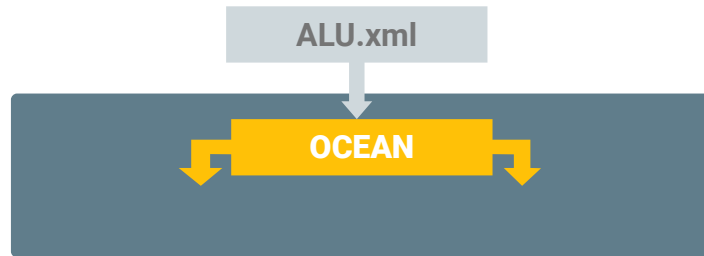
Frontend

Backend

simulation_software_ecosystem-> Low-level architecture



simulation_software_ecosystem-> Low-level architecture

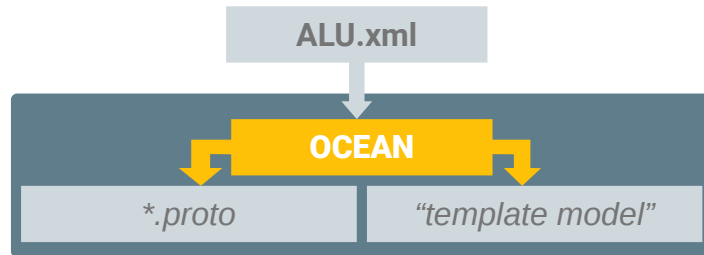


*my_awesome_code.**

Frontend

Backend

simulation_software_ecosystem-> Low-level architecture

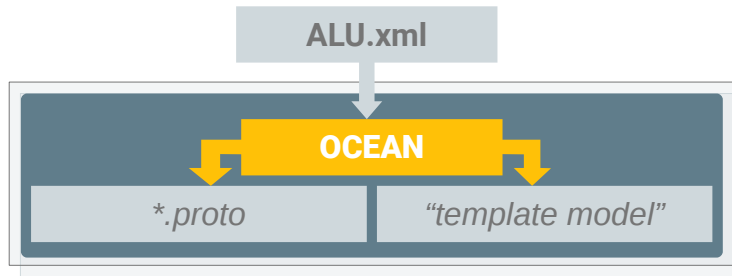


`my_awesome_code.*`

Frontend

Backend

simulation_software_ecosystem-> Low-level architecture

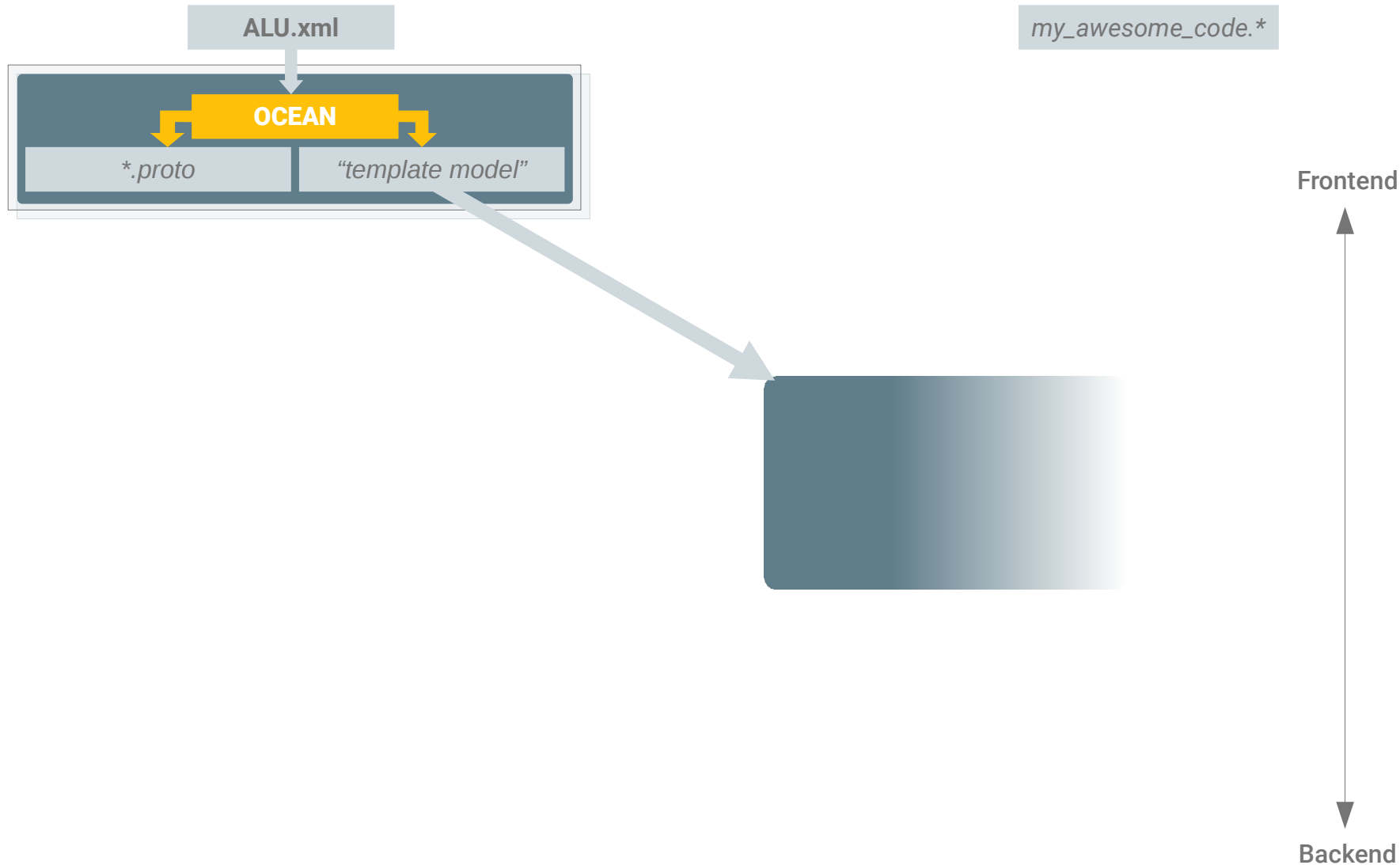


*my_awesome_code.**

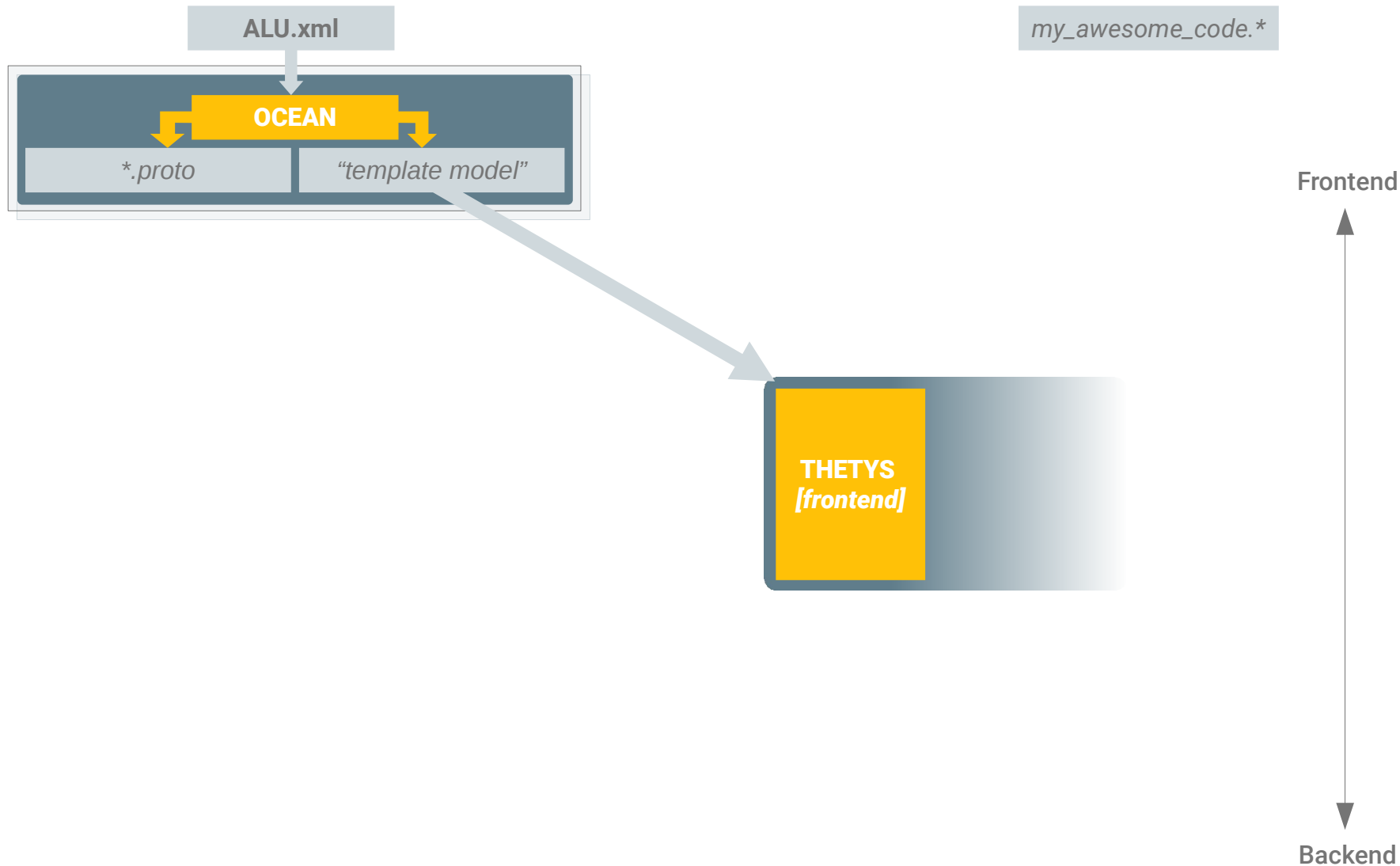
Frontend

Backend

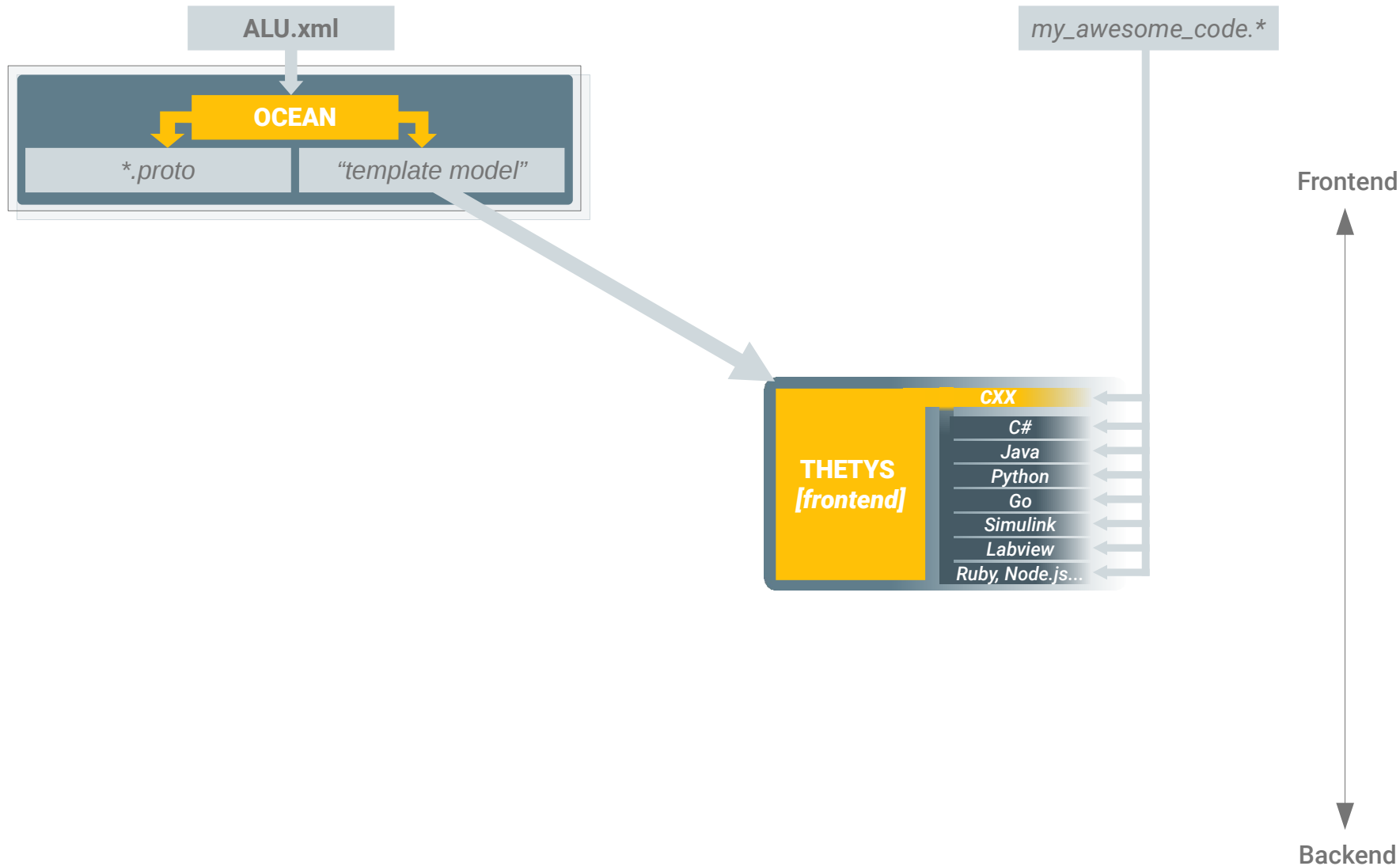
simulation_software_ecosystem-> Low-level architecture



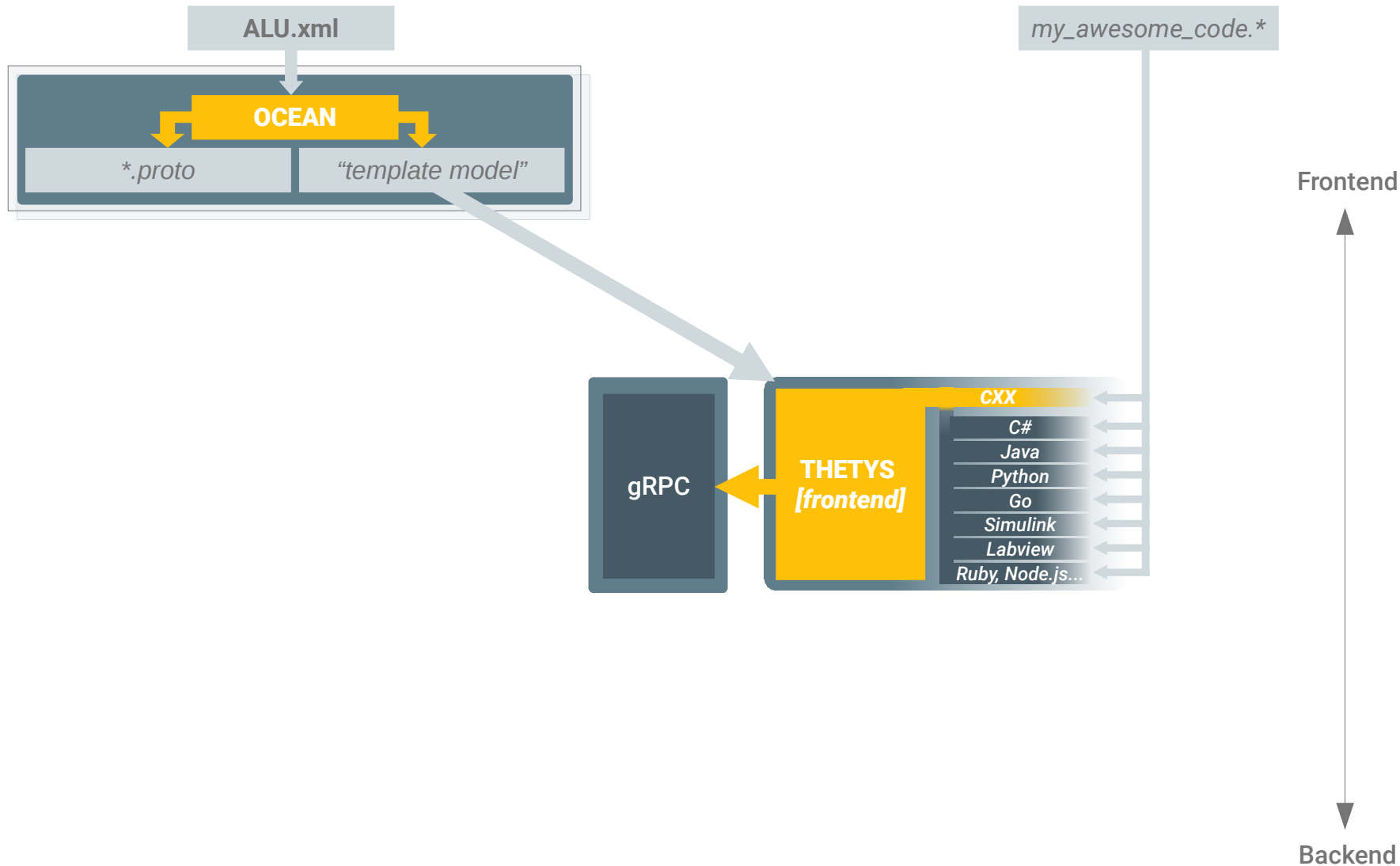
simulation_software_ecosystem-> Low-level architecture



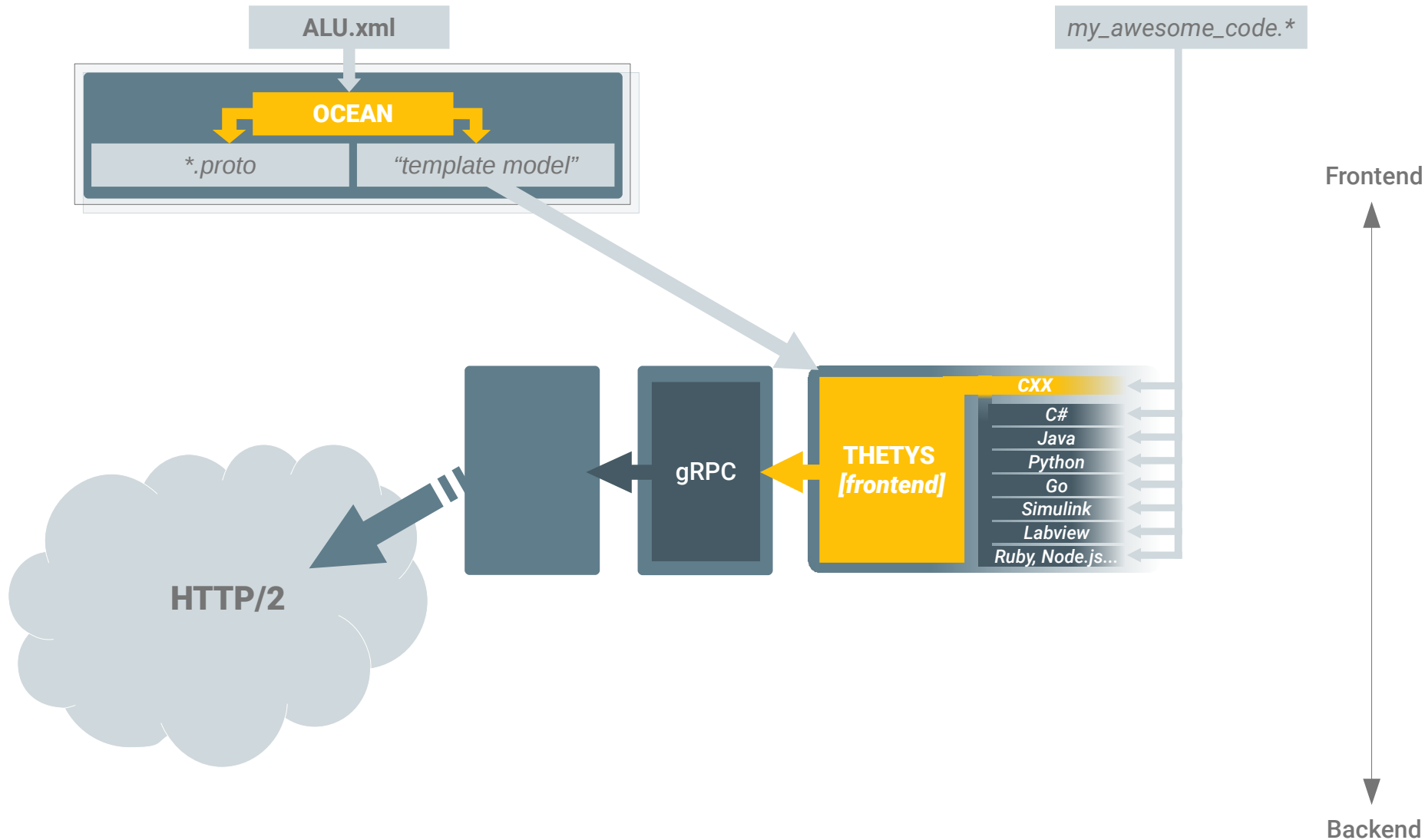
simulation_software_ecosystem-> Low-level architecture



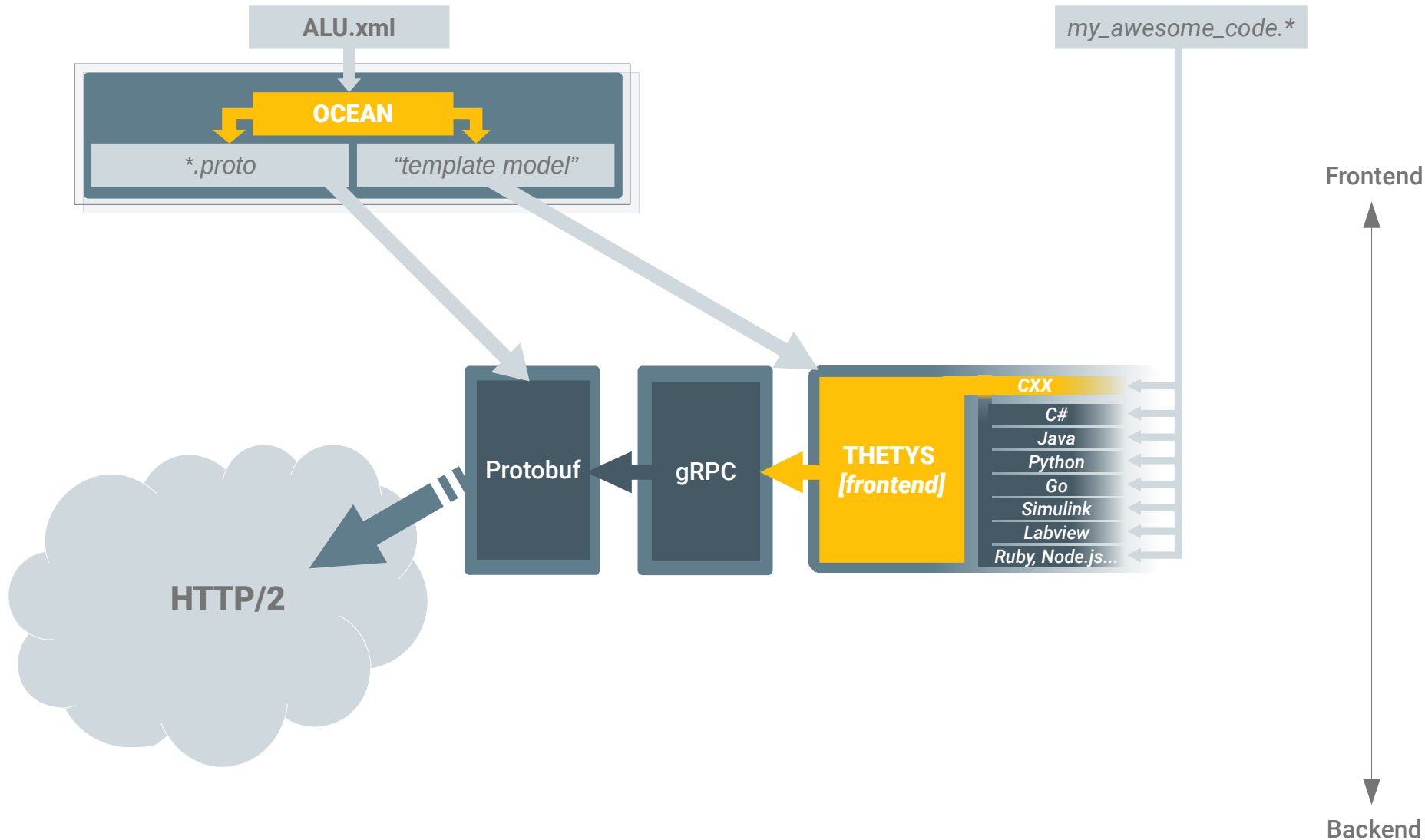
simulation_software_ecosystem-> Low-level architecture



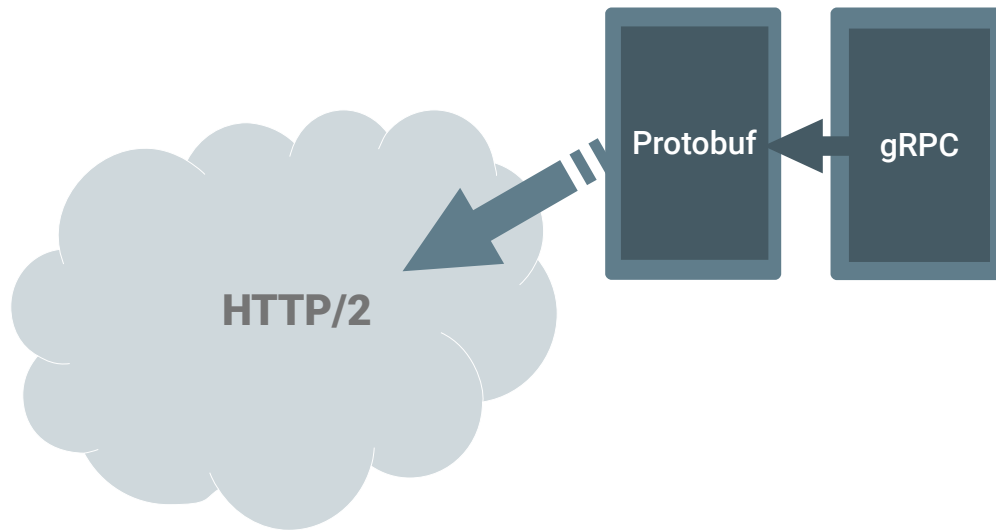
simulation_software_ecosystem-> Low-level architecture



simulation_software_ecosystem-> Low-level architecture



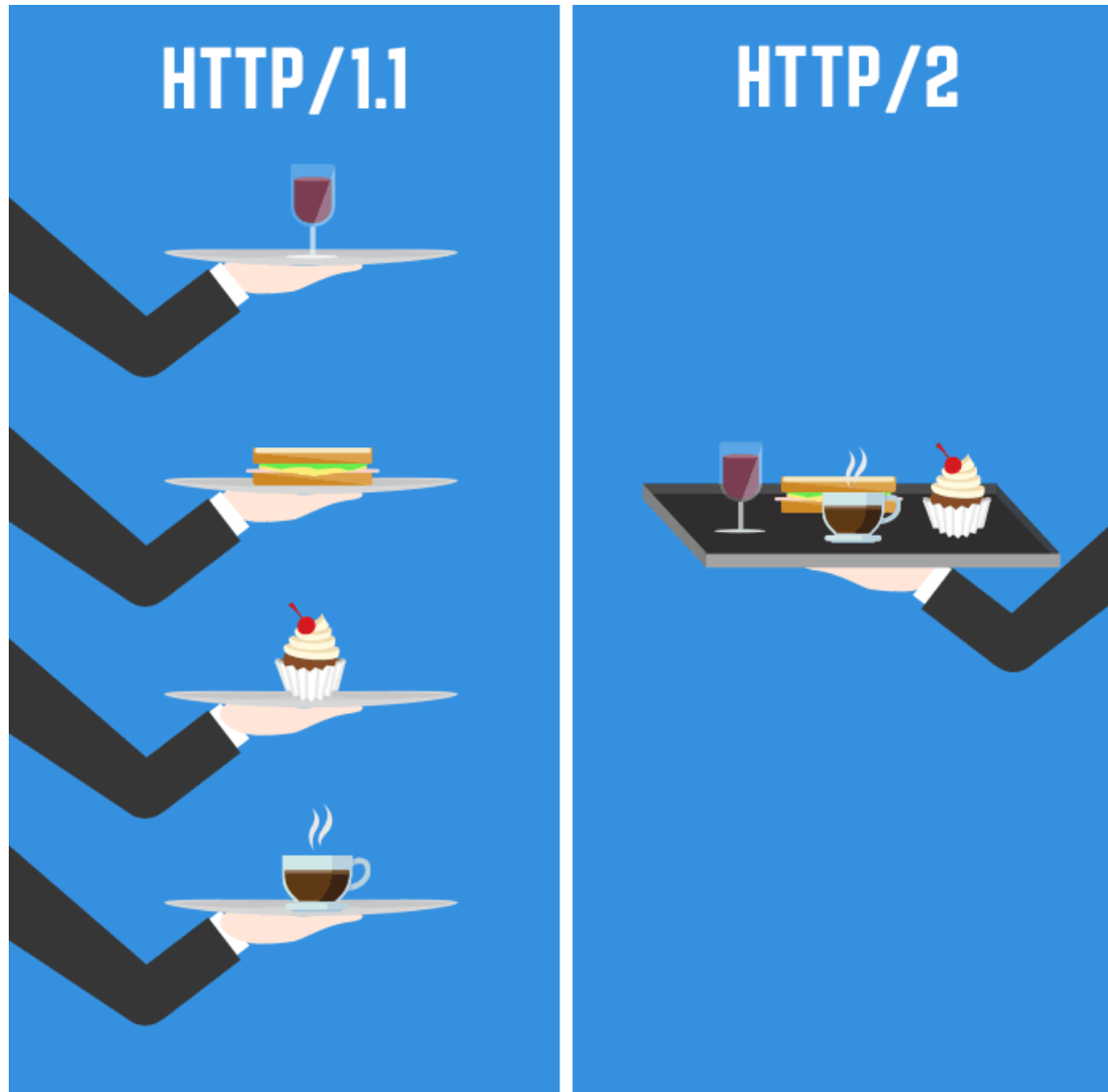
simulation_software_ecosystem-> gRPC & Protobuf overview



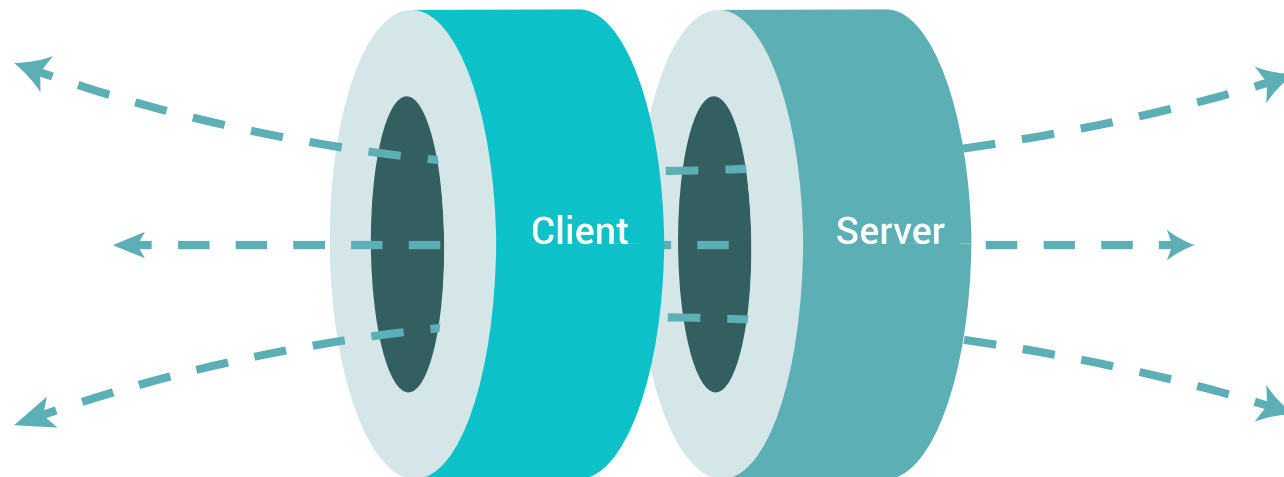


gRPC is an open source *remote procedure call* (RPC) system initially developed at Google. It uses *HTTP/2* for transport, *Protocol Buffers* as the interface description language, and provides features such as authentication, bidirectional streaming and flow control, blocking or nonblocking bindings, and cancellation and timeouts. It generates cross-platform client and server bindings for many languages.

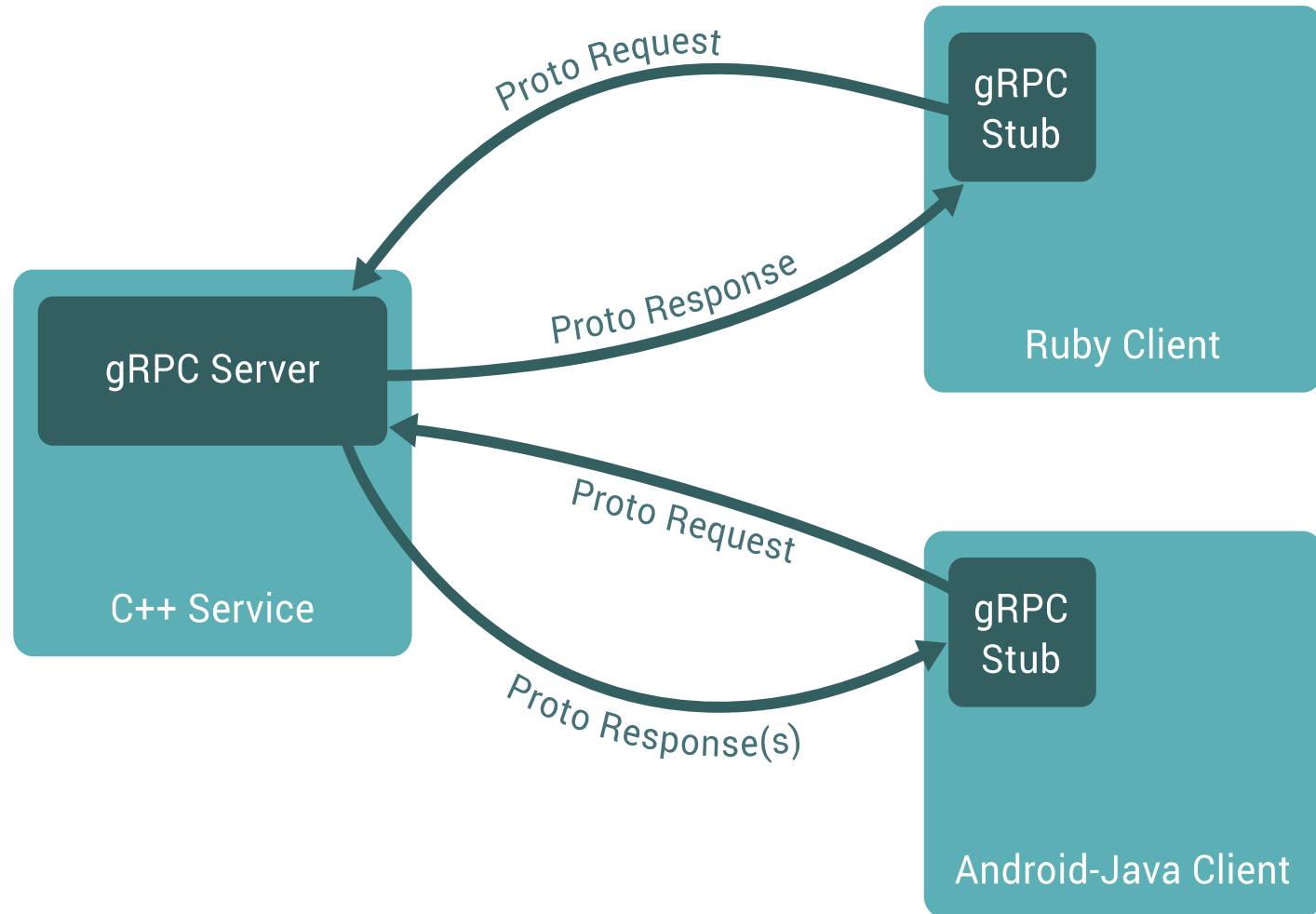
simulation_software_ecosystem-> gRPC & Protobuf overview



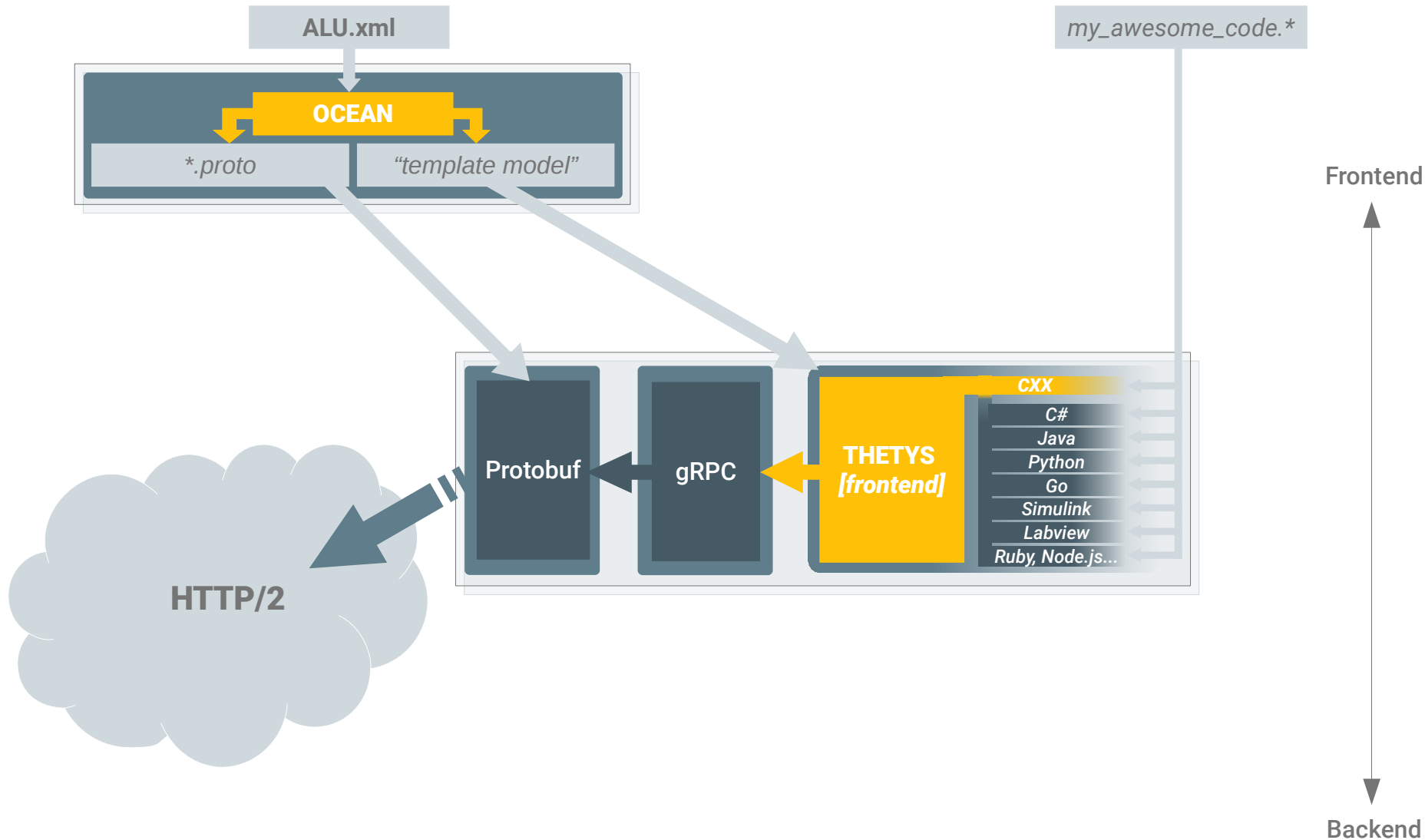
simulation_software_ecosystem-> gRPC & Protobuf overview



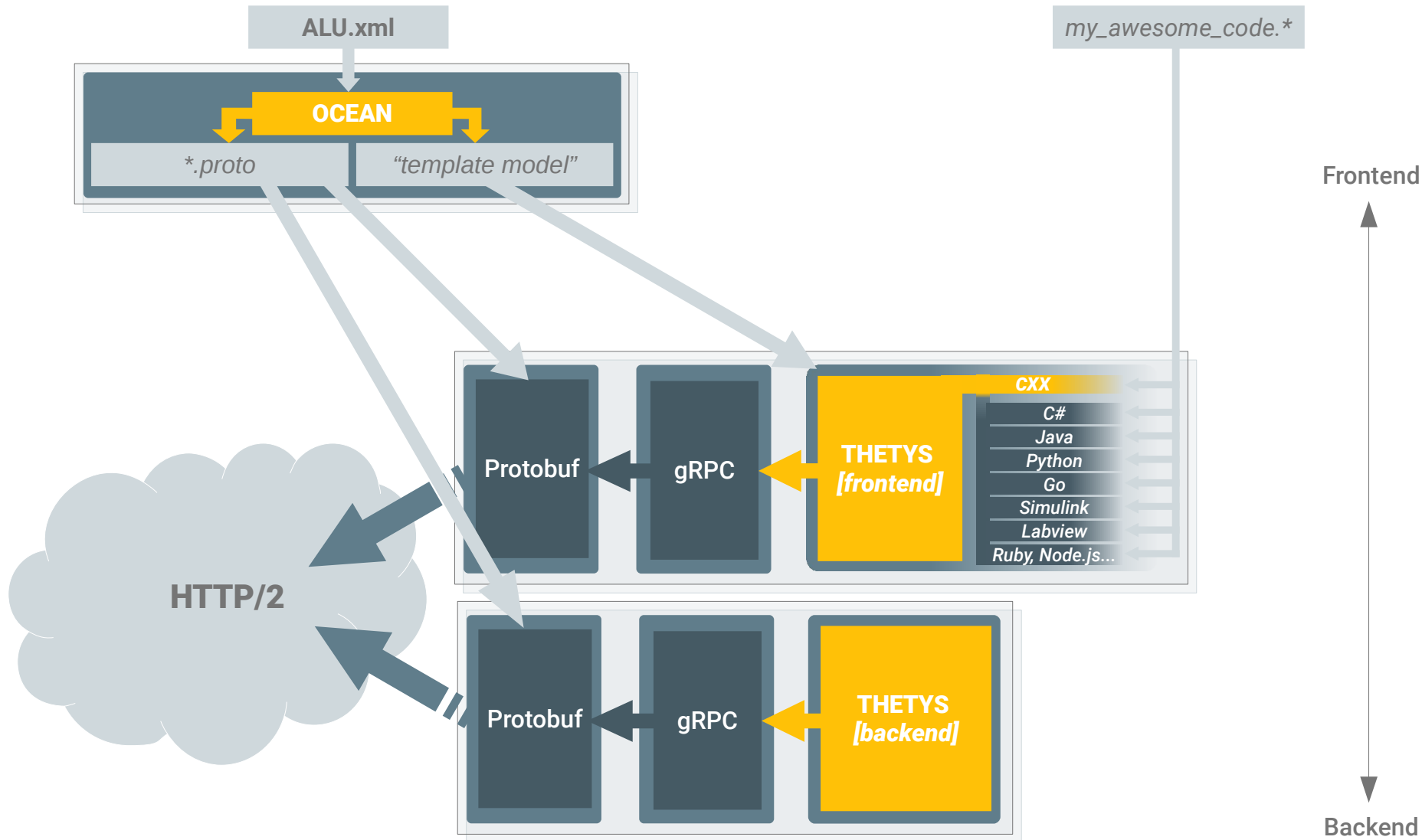
simulation_software_ecosystem-> gRPC & Protobuf overview



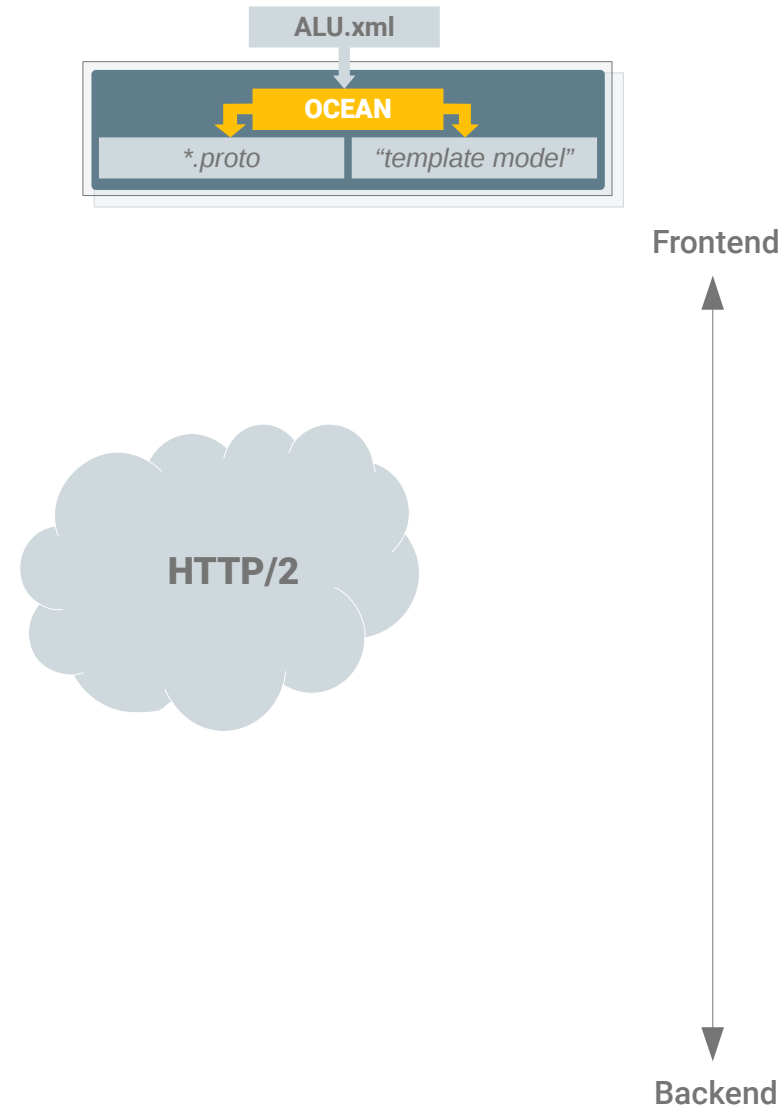
simulation_software_ecosystem-> Low-level architecture



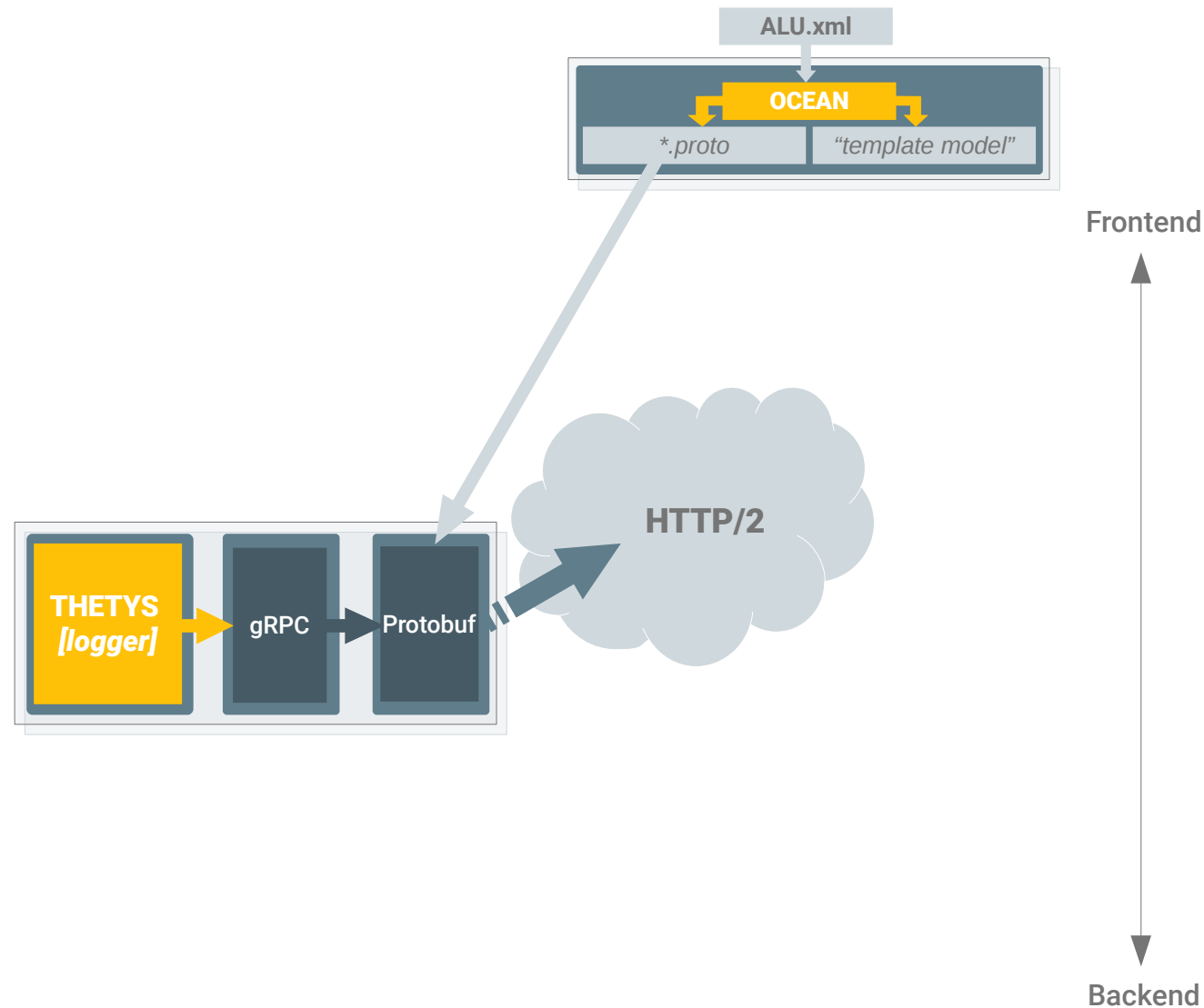
simulation_software_ecosystem-> Low-level architecture



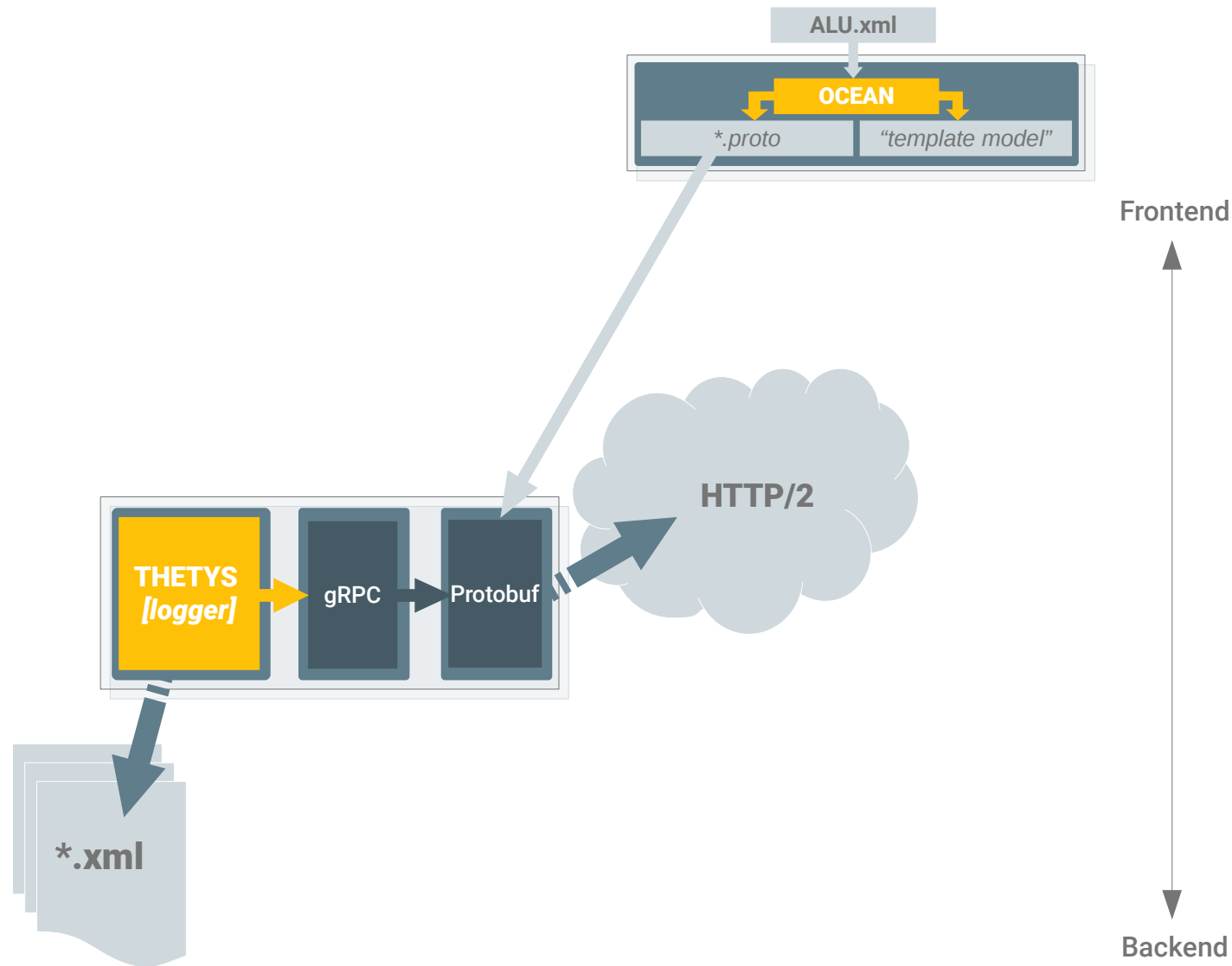
simulation_software_ecosystem-> Low-level architecture



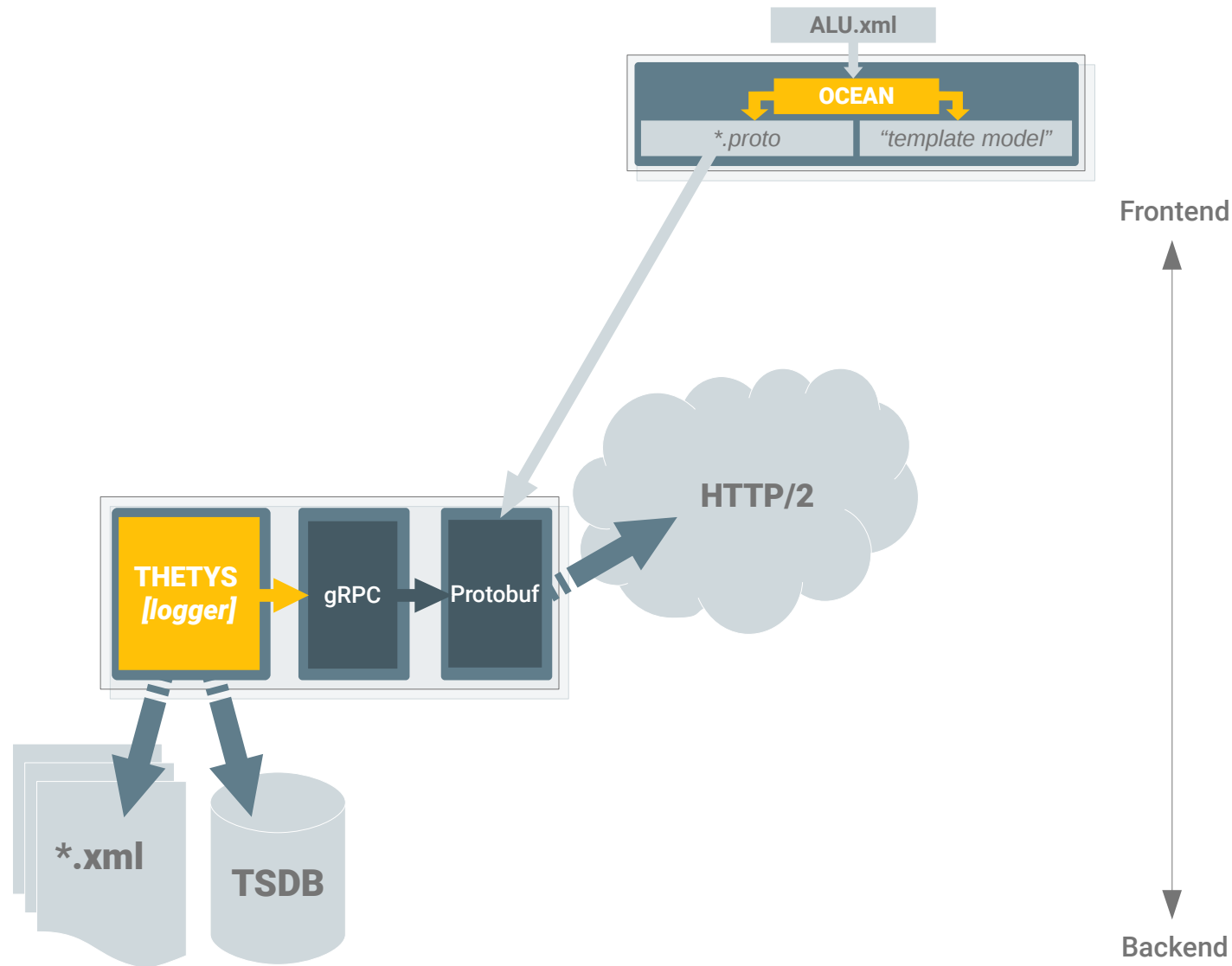
simulation_software_ecosystem-> Low-level architecture



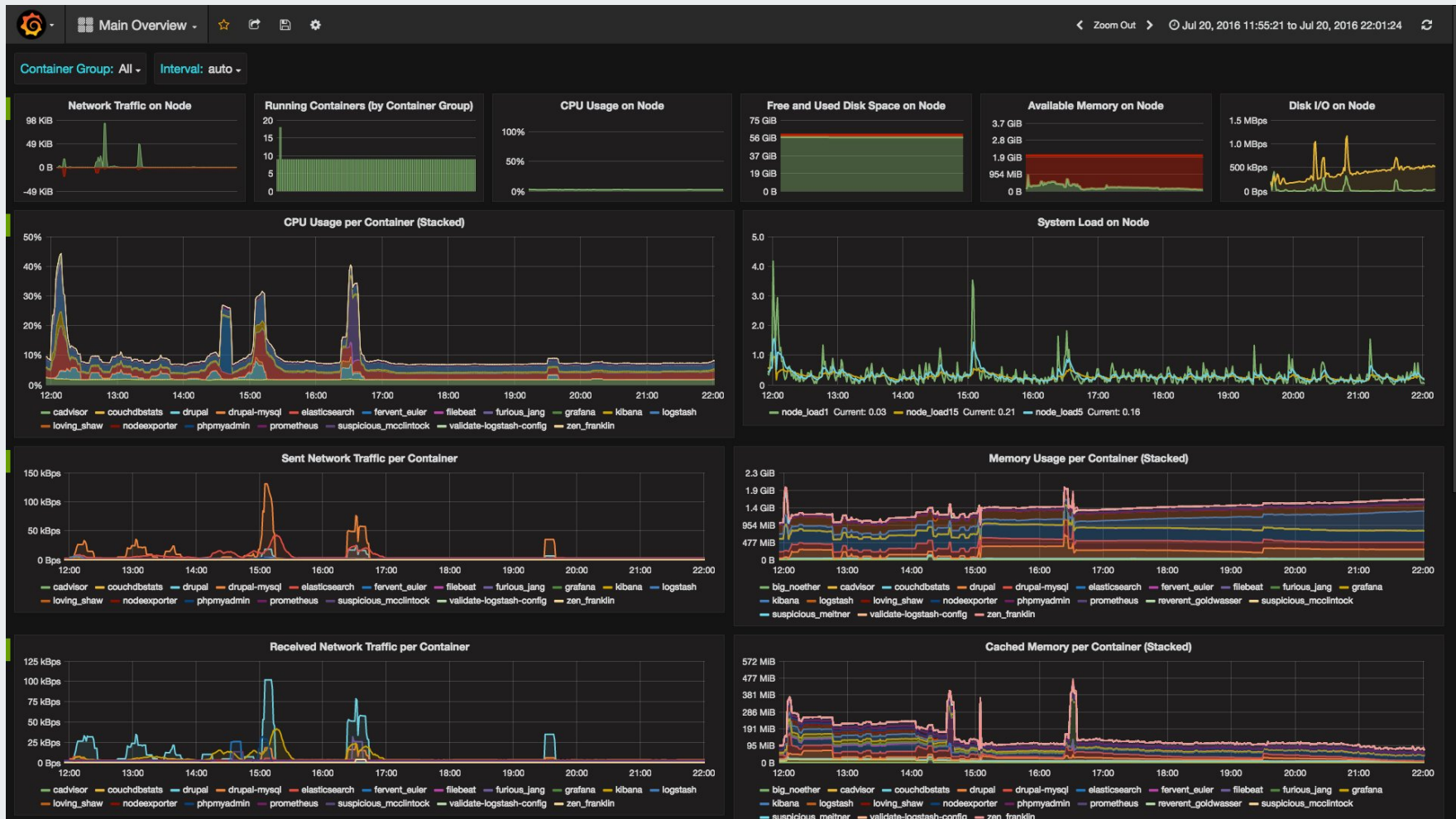
simulation_software_ecosystem-> Low-level architecture



simulation_software_ecosystem-> Low-level architecture

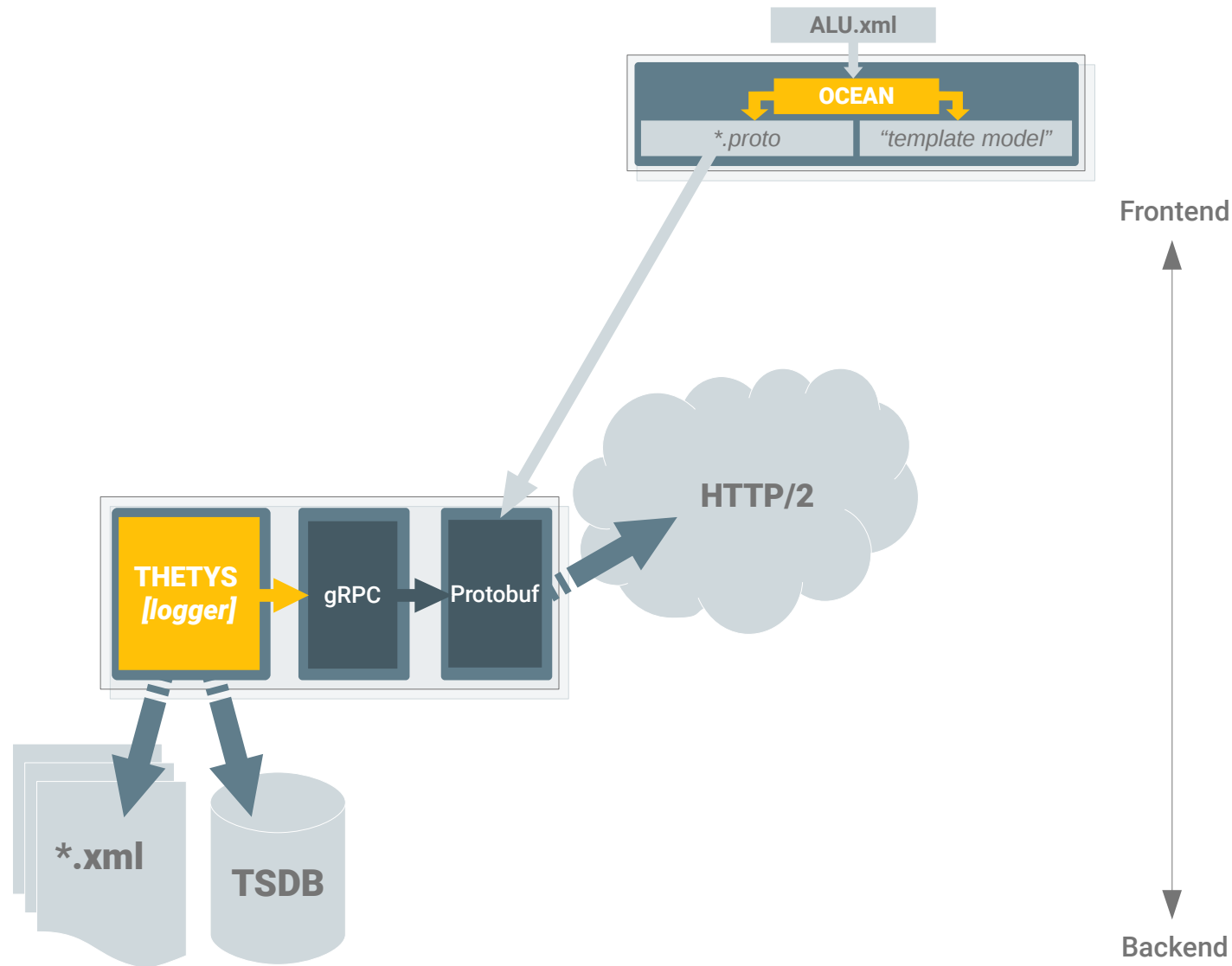


simulation_software_ecosystem -> Low-level architecture

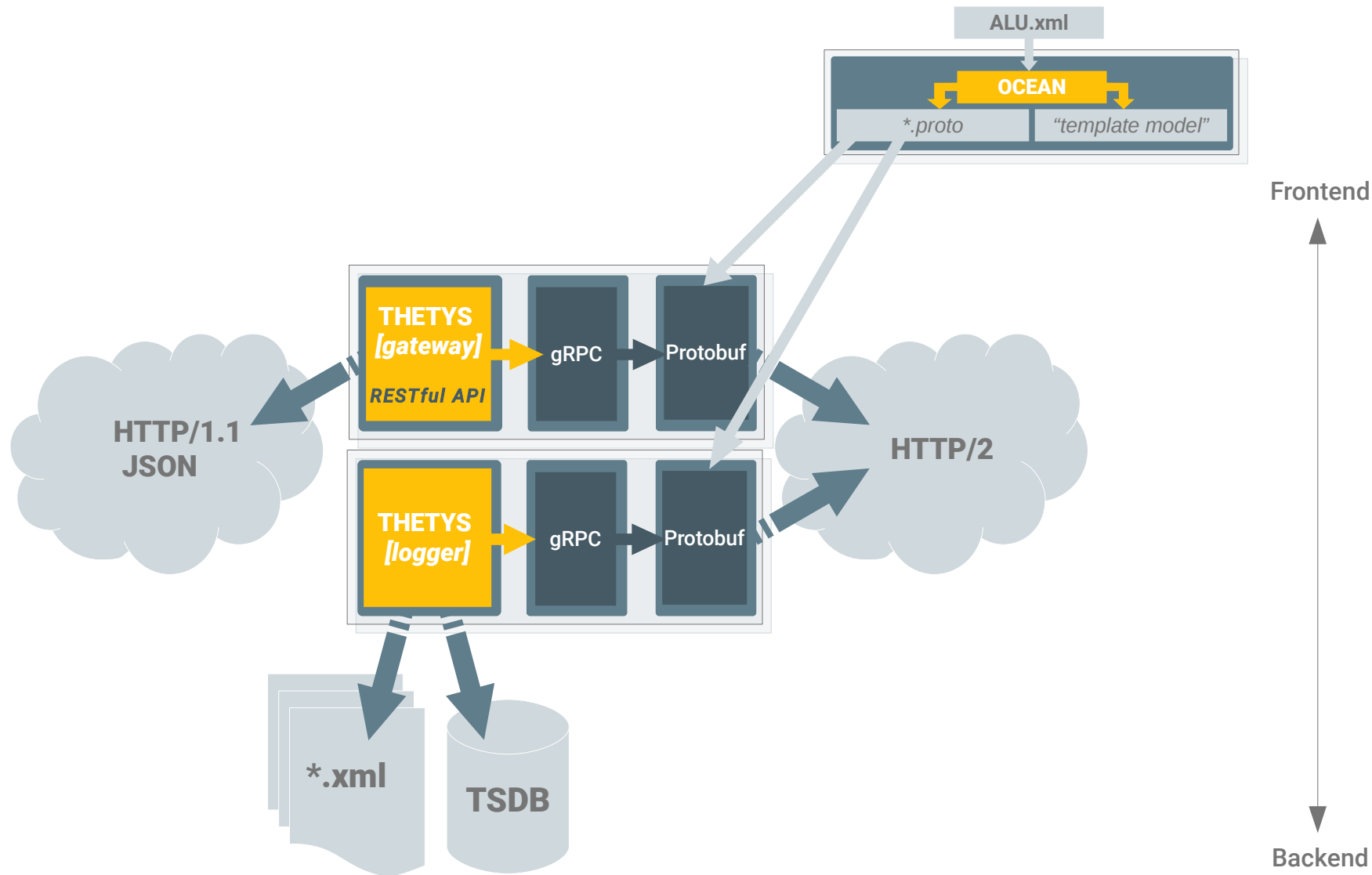


TSDB (Time Series DataBase) Toolchain → [InfluxDB + Graphana + Graphite (Web GUI)]

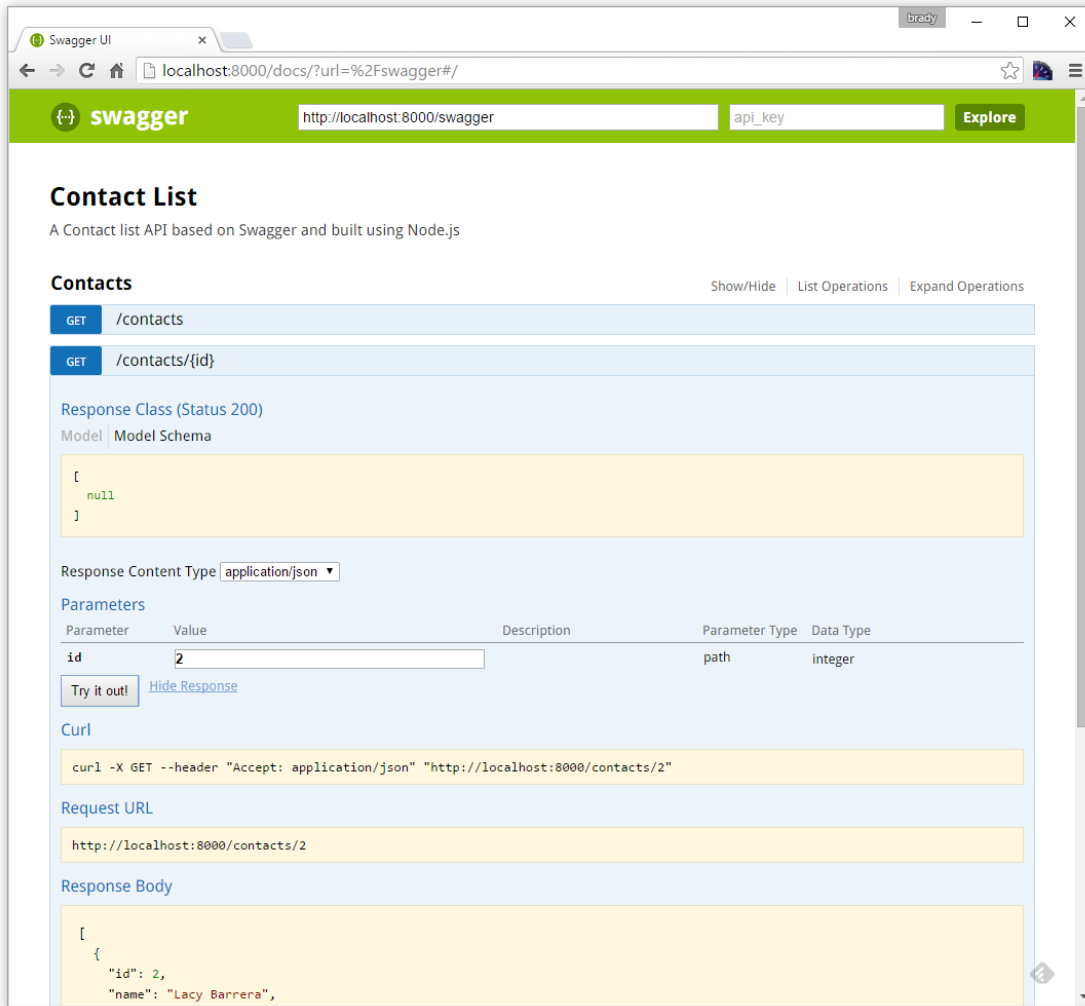
simulation_software_ecosystem-> Low-level architecture



simulation_software_ecosystem-> Low-level architecture



simulation_software_ecosystem -> Low-level architecture

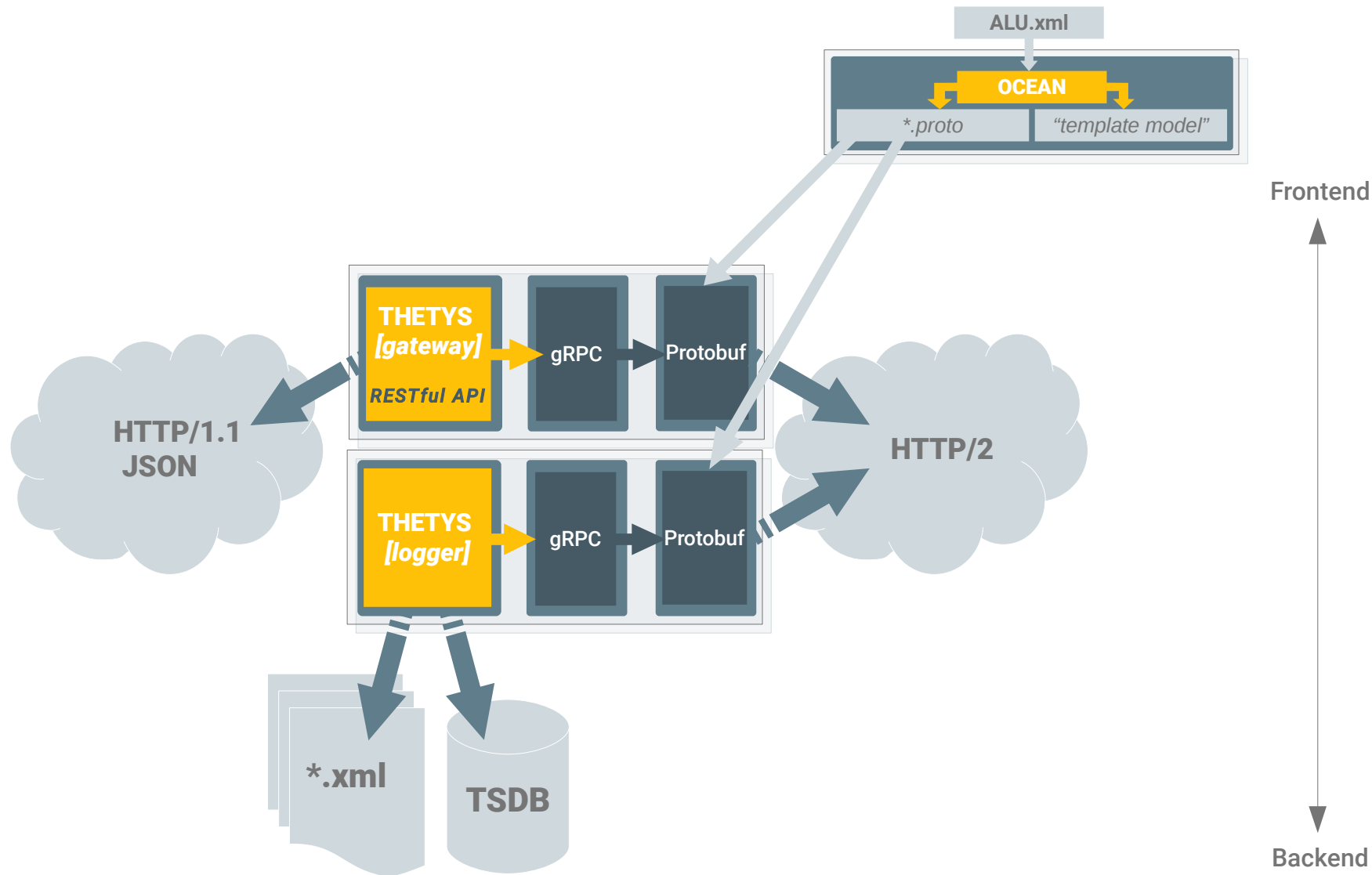


The screenshot shows the Swagger UI for a 'Contact List' API. The browser address bar is 'localhost:8000/docs?url=%2Fswagger#/'. The Swagger logo is in the top left, and the URL 'http://localhost:8000/swagger' is in the top bar. The API title is 'Contact List' with a subtitle 'A Contact list API based on Swagger and built using Node.js'. Below this, there are links for 'Show/Hide', 'List Operations', and 'Expand Operations'. The 'Contacts' section is active, showing two GET endpoints: '/contacts' and '/contacts/{id}'. The '/contacts/{id}' endpoint is expanded, showing a 'Response Class (Status 200)' with a 'Model Schema' of '[null]'. The 'Response Content Type' is set to 'application/json'. A table of 'Parameters' shows a path parameter 'id' with a value of '2'. Below the parameters, there are links for 'Try it out!' and 'Hide Response'. The 'Curl' section shows the command 'curl -X GET --header "Accept: application/json" "http://localhost:8000/contacts/2"'. The 'Request URL' is 'http://localhost:8000/contacts/2'. The 'Response Body' is a JSON object: '{ "id": 2, "name": "Lacy Barrera" }'.

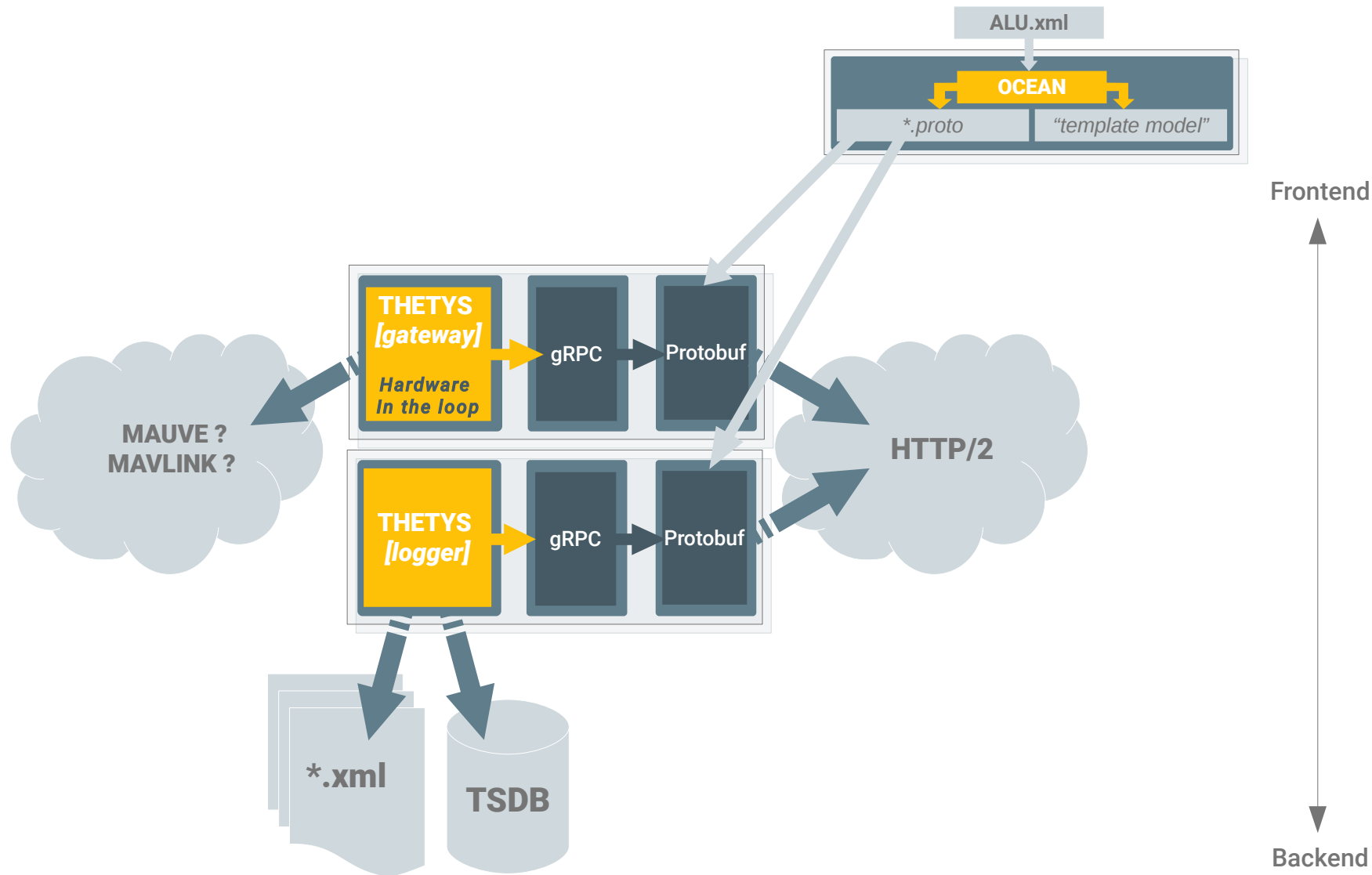


Supervisor Toolchain → [OpenAPI + SwaggerUI (Web GUI)]

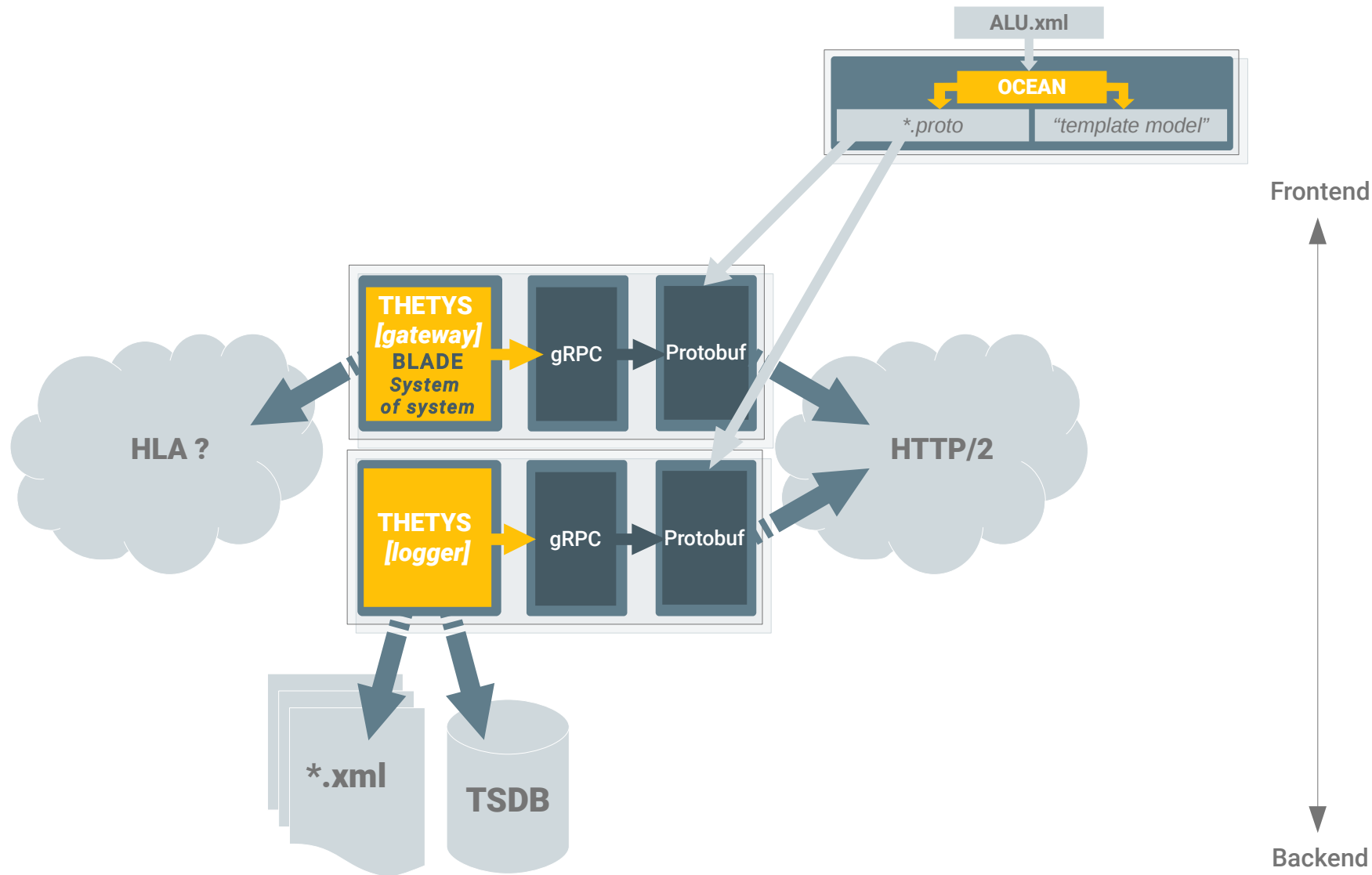
simulation_software_ecosystem-> Low-level architecture



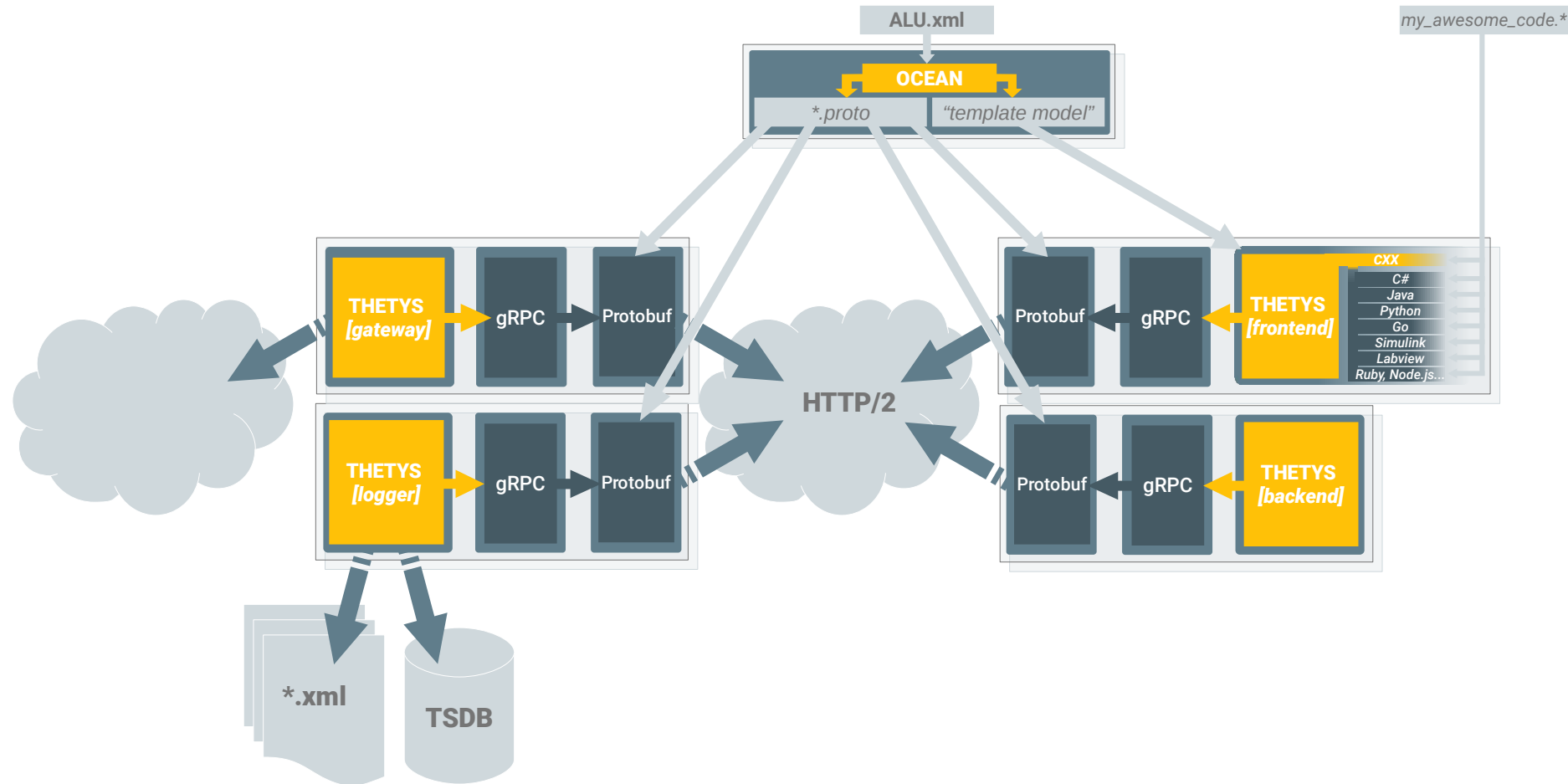
simulation_software_ecosystem-> Low-level architecture



simulation_software_ecosystem-> Low-level architecture



simulation_software_ecosystem-> Low-level architecture



simulation_software_ecosystem-> Low-level architecture

Frontend



Backend

simulation_software_ecosystem-> Low-level architecture

ISU.xml

SLU.xml

HCU.xml

Frontend



Backend

simulation_software_ecosystem-> Low-level architecture

```
1 <?xml version="1.0" encoding="utf-8"?>
2
3 <!-- Fichier de configuration de l'ensemble des points de connexion disponible pour chacun des modeles par le système KronosDDS -->
4 <InstructionSetUnit>
5   <ArithmeticLogicUnit uuid="1000" alias="Foo" lang="cxx">
6     <Input>
7       <Slot uuid="1" alias="test_boolean" type="bool" unit="SU" description=""></Slot>
8       <Slot uuid="2" alias="test_char" type="char" unit="SU" description=""></Slot>
9       <Slot uuid="3" alias="test_octet" type="octet" unit="SU" description=""></Slot>
10      <Slot uuid="4" alias="test_short" type="short" unit="SU" description=""></Slot>
11      [...]
12    </Input>
13    <Output>
14      <Slot uuid="11" alias="test_boolean" type="bool" unit="SU" description=""></Slot>
15      <Slot uuid="12" alias="test_char" type="char" unit="SU" description=""></Slot>
16      <Slot uuid="13" alias="test_octet" type="octet" unit="SU" description=""></Slot>
17      <Slot uuid="14" alias="test_short" type="short" unit="SU" description=""></Slot>
18      [...]
19    </Output>
20  </ArithmeticLogicUnit>
21  <ArithmeticLogicUnit uuid="1000" alias="Bar" lang="python">
22    <Input>
23      <Slot uuid="21" alias="test_boolean" type="bool" unit="SU" description=""></Slot>
24      <Slot uuid="22" alias="test_char" type="char" unit="SU" description=""></Slot>
25      <Slot uuid="23" alias="test_octet" type="octet" unit="SU" description=""></Slot>
26      <Slot uuid="24" alias="test_short" type="short" unit="SU" description=""></Slot>
27      [...]
28    </Input>
29    <Output>
30      <Slot uuid="31" alias="test_boolean" type="bool" unit="SU" description=""></Slot>
31      <Slot uuid="32" alias="test_char" type="char" unit="SU" description=""></Slot>
32      <Slot uuid="33" alias="test_octet" type="octet" unit="SU" description=""></Slot>
33      <Slot uuid="34" alias="test_short" type="short" unit="SU" description=""></Slot>
34      [...]
35    </Output>
36  </ArithmeticLogicUnit>
37 </InstructionSetUnit>
38
```

ISU.xml

the simulation logical I/O file

simulation_software_ecosystem-> Low-level architecture

```
1 <?xml version="1.0" encoding="UTF-8"?>
2
3 <!-- Fichier de configuration du cablage des liaisons exécuté par le système KronosDDS -->
4 <HardwareControlUnit>
5   <Sink uuid="SINK_0" alias="Host0" networkInterfaceAddress="192.168.41.236" networkInterfaceCard="eth0"/>
6   <Sink uuid="SINK_1" alias="Host0" networkInterfaceAddress="192.168.41.237" networkInterfaceCard="eth1"/>
7   [...]
8   <Strand uuid="STRAND_0" alias="trim">
9     <Wire uuid="WIRE_0-0" sourceAlias="Foo" sourcePlug="test_boolean" destinationAlias="Bar" destinationPlug="test_boolean"/>
10    <Wire uuid="WIRE_0-1" sourceAlias="Foo" sourcePlug="test_char" destinationAlias="Bar" destinationPlug="test_char"/>
11    <Wire uuid="WIRE_0-2" sourceAlias="Bar" sourcePlug="test_octet" destinationAlias="Foo" destinationPlug="test_octet"/>
12    <Wire uuid="WIRE_0-3" sourceAlias="Bar" sourcePlug="test_short" destinationAlias="Foo" destinationPlug="test_short"/>
13    [...]
14  </Strand>
15  <Strand uuid="STRAND_1" alias="sim">
16    <Wire uuid="WIRE_1-0" sourceAlias="Bar" sourcePlug="test_boolean" destinationAlias="Foo" destinationPlug="test_boolean"/>
17    <Wire uuid="WIRE_1-1" sourceAlias="Bar" sourcePlug="test_char" destinationAlias="Foo" destinationPlug="test_char"/>
18    <Wire uuid="WIRE_1-2" sourceAlias="Foo" sourcePlug="test_octet" destinationAlias="Bar" destinationPlug="test_octet"/>
19    <Wire uuid="WIRE_1-3" sourceAlias="Foo" sourcePlug="test_short" destinationAlias="Bar" destinationPlug="test_short"/>
20    [...]
21  </Strand>
22 </HardwareControlUnit>
23
```

{ HCU.xml
the simulation physical I/O file
}

simulation_software_ecosystem-> Low-level architecture

```
1 <?xml version="1.0" encoding="UTF-8"?>
2
3 <!-- Fichier de configuration de la séquence exécuté par le système KronosDDS -->
4 <SequentialLogicUnit>
5   <Participant>
6     <Backend uuid="BACKEND_0" alias="HW_Resources_0" sinkAlias="Host0"/>
7     <Backend uuid="BACKEND_1" alias="HW_Resources_1" sinkAlias="Host1"/>
8     [...]
9     <Frontend uuid="FRONTEND_0" alias="SW_Consumer_0" modelAlias="Foo"/>
10    <Frontend uuid="FRONTEND_1" alias="SW_Consumer_1" modelAlias="Bar"/>
11    [...]
12  </Participant>
13  <Stage uuid="STAGE_0" alias="trim" strandAlias="trim">
14    <Steps uuid="STEPS_0" alias="" mode="Sequential">
15      <Step uuid="STEP_0-0" alias="first_step_trim" backendAlias="HW_Resources_0" frontendAlias="SW_Consumer_0"/>
16      <Step uuid="STEP_0-1" alias="second_step_trim" backendAlias="HW_Resources_1" frontendAlias="SW_Consumer_1"/>
17      [...]
18    </Steps>
19    [...]
20  </Stage>
21  <Stage uuid="STAGE_1" alias="sim" strandAlias="sim">
22    <Steps uuid="STEPS_1" alias="" mode="Sequential">
23      <Step uuid="STEP_1-0" alias="first_step_sim" backendAlias="HW_Resources_0" frontendAlias="SW_Consumer_1"/>
24      <Step uuid="STEP_1-1" alias="second_step_sim" backendAlias="HW_Resources_1" frontendAlias="SW_Consumer_0"/>
25      [...]
26    </Steps>
27    [...]
28  </Stage>
29  [...]
30 </SequentialLogicUnit>
31
```

{ SLU.xml
the simulation orchestrator file }

simulation_software_ecosystem-> Low-level architecture

ISU.xml

SLU.xml

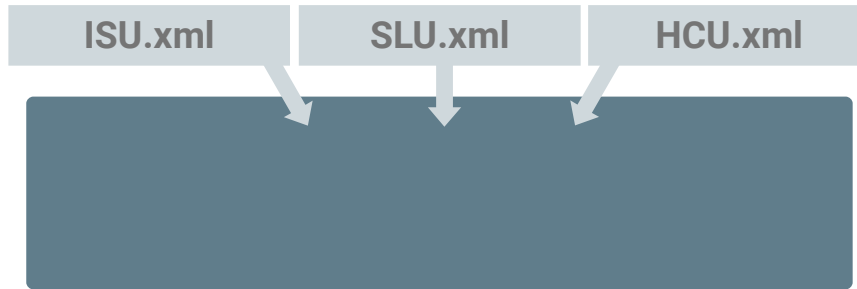
HCU.xml

Frontend



Backend

simulation_software_ecosystem-> Low-level architecture



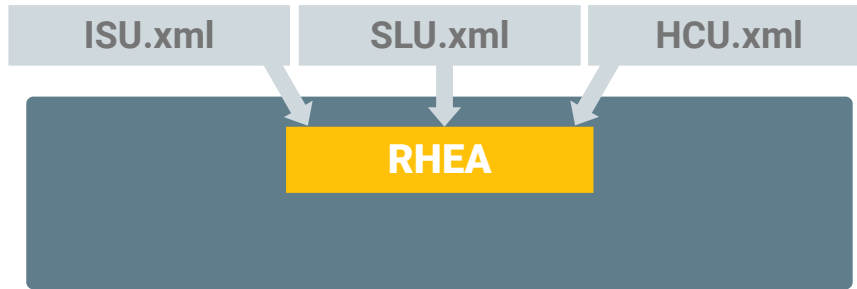
Frontend



Backend



simulation_software_ecosystem-> Low-level architecture



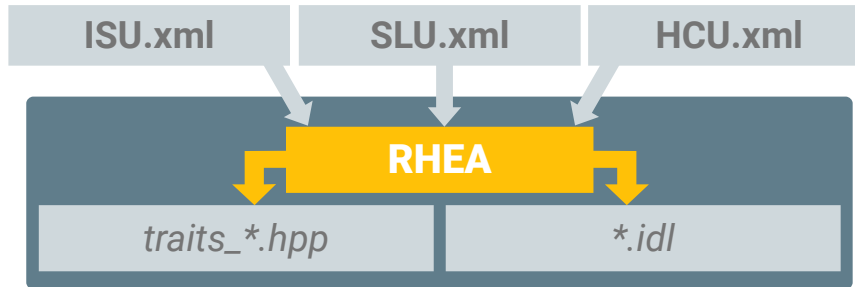
Frontend



Backend



simulation_software_ecosystem-> Low-level architecture



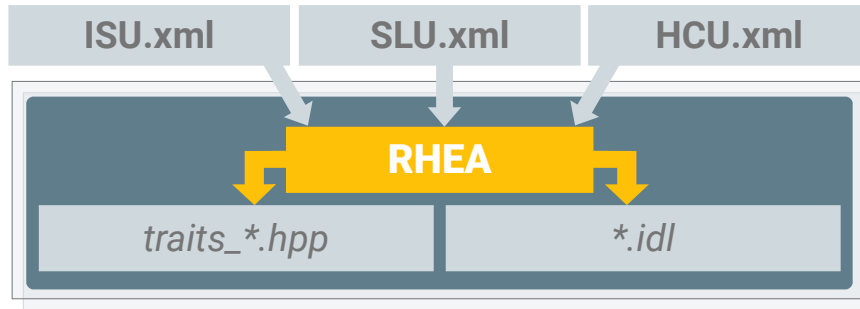
Frontend



Backend



simulation_software_ecosystem-> Low-level architecture



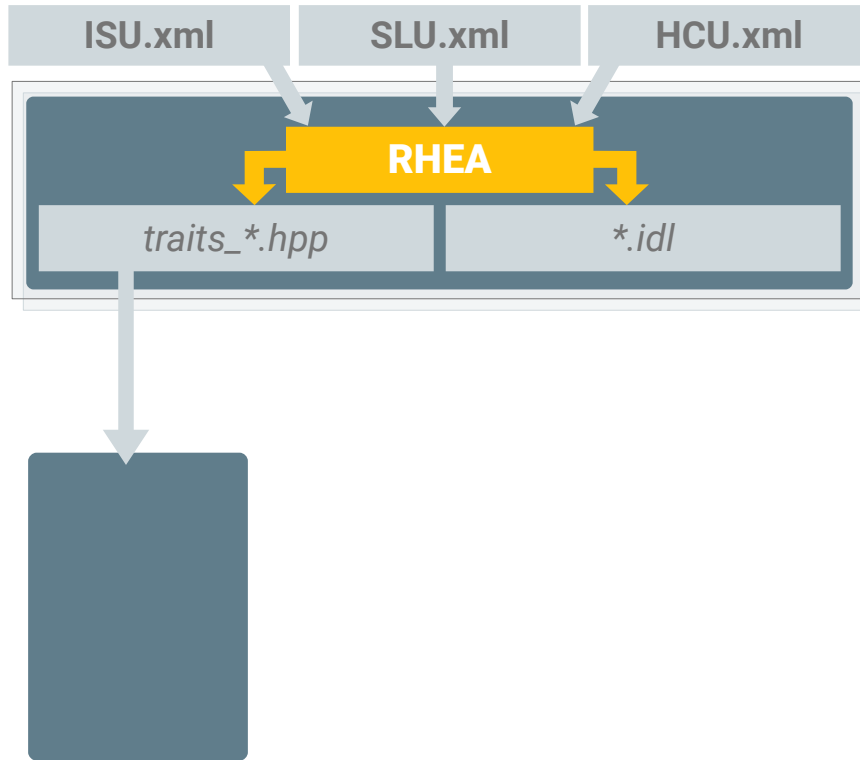
Frontend



Backend



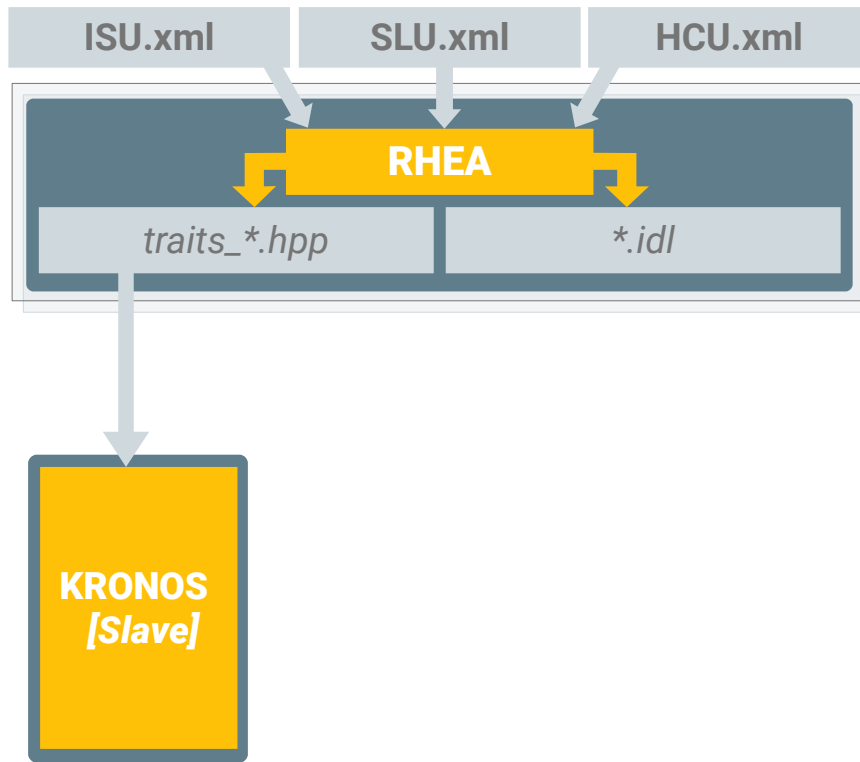
simulation_software_ecosystem-> Low-level architecture



Frontend

Backend

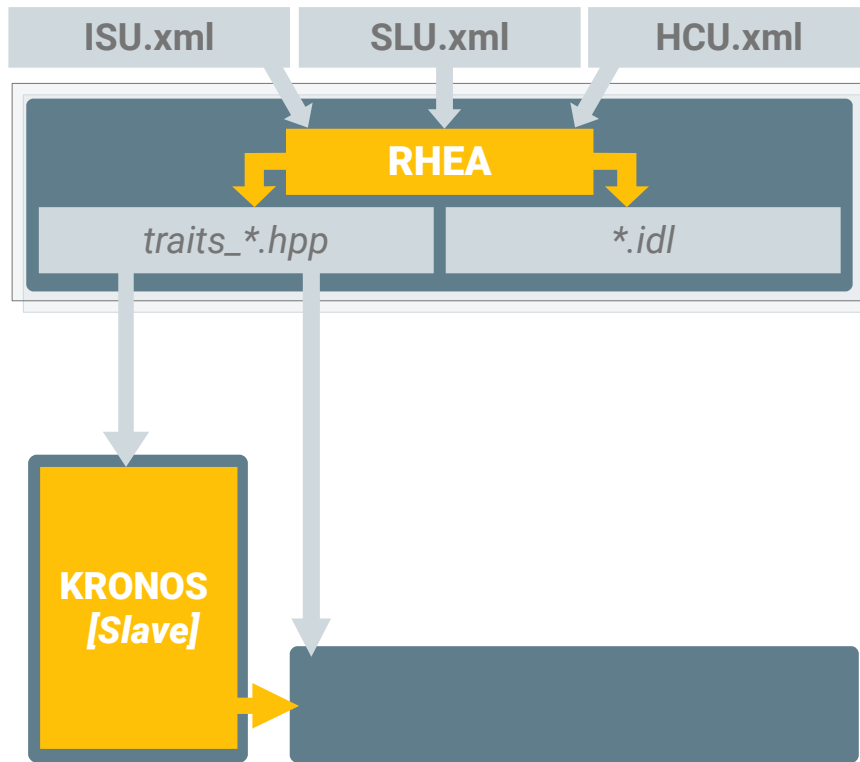
simulation_software_ecosystem-> Low-level architecture



Frontend

Backend

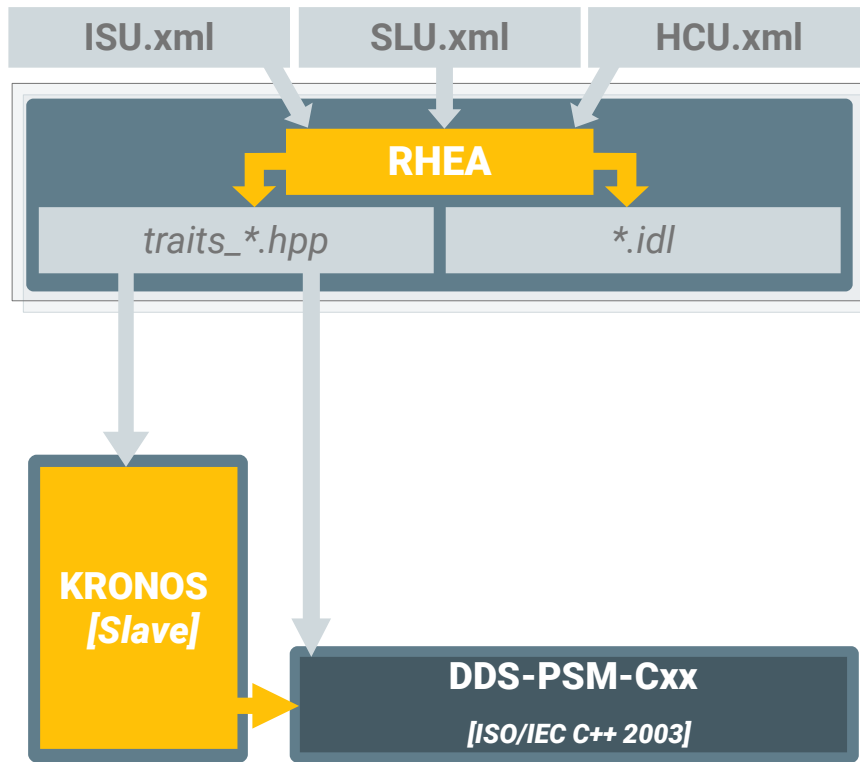
simulation_software_ecosystem-> Low-level architecture



Frontend

Backend

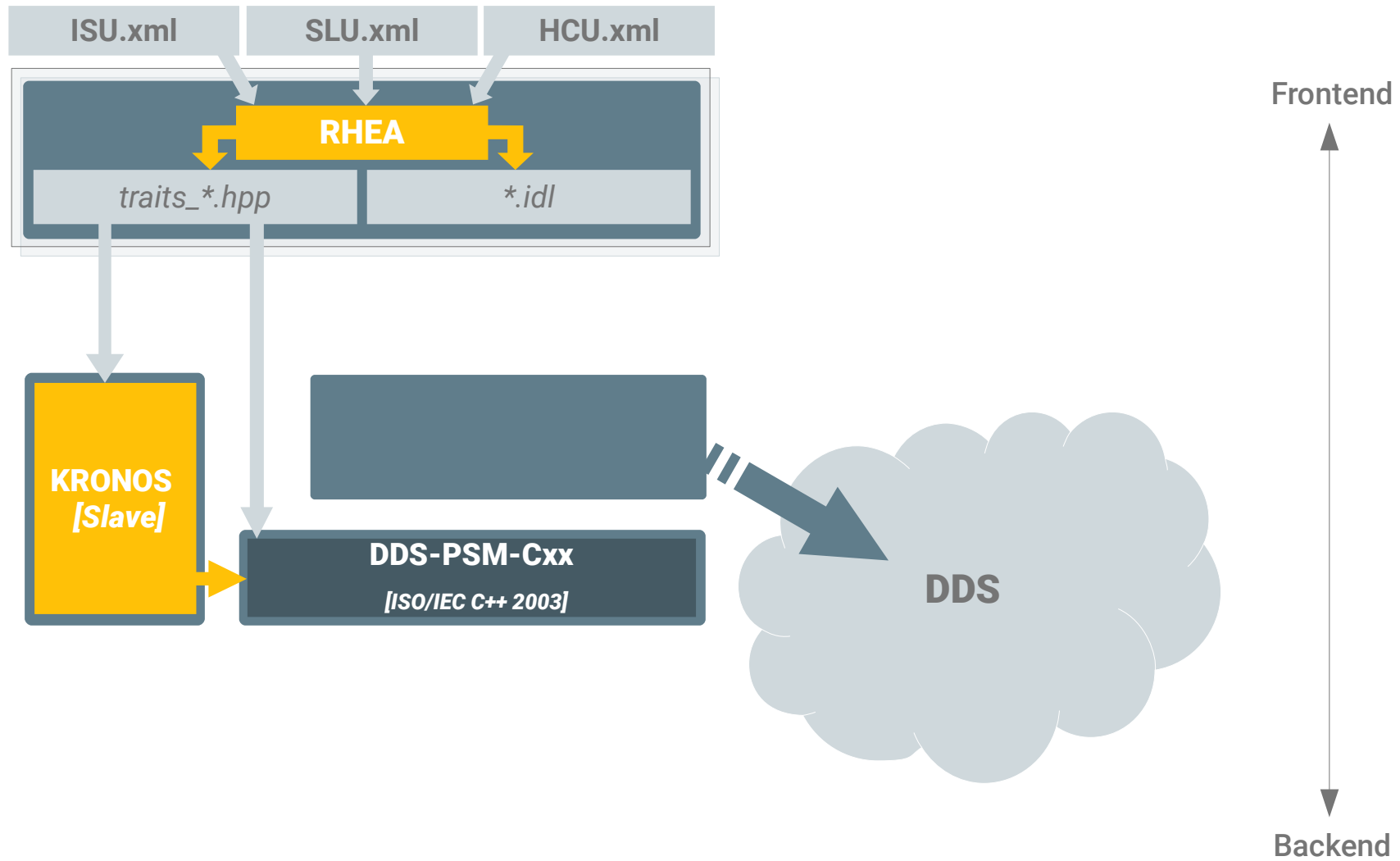
simulation_software_ecosystem-> Low-level architecture



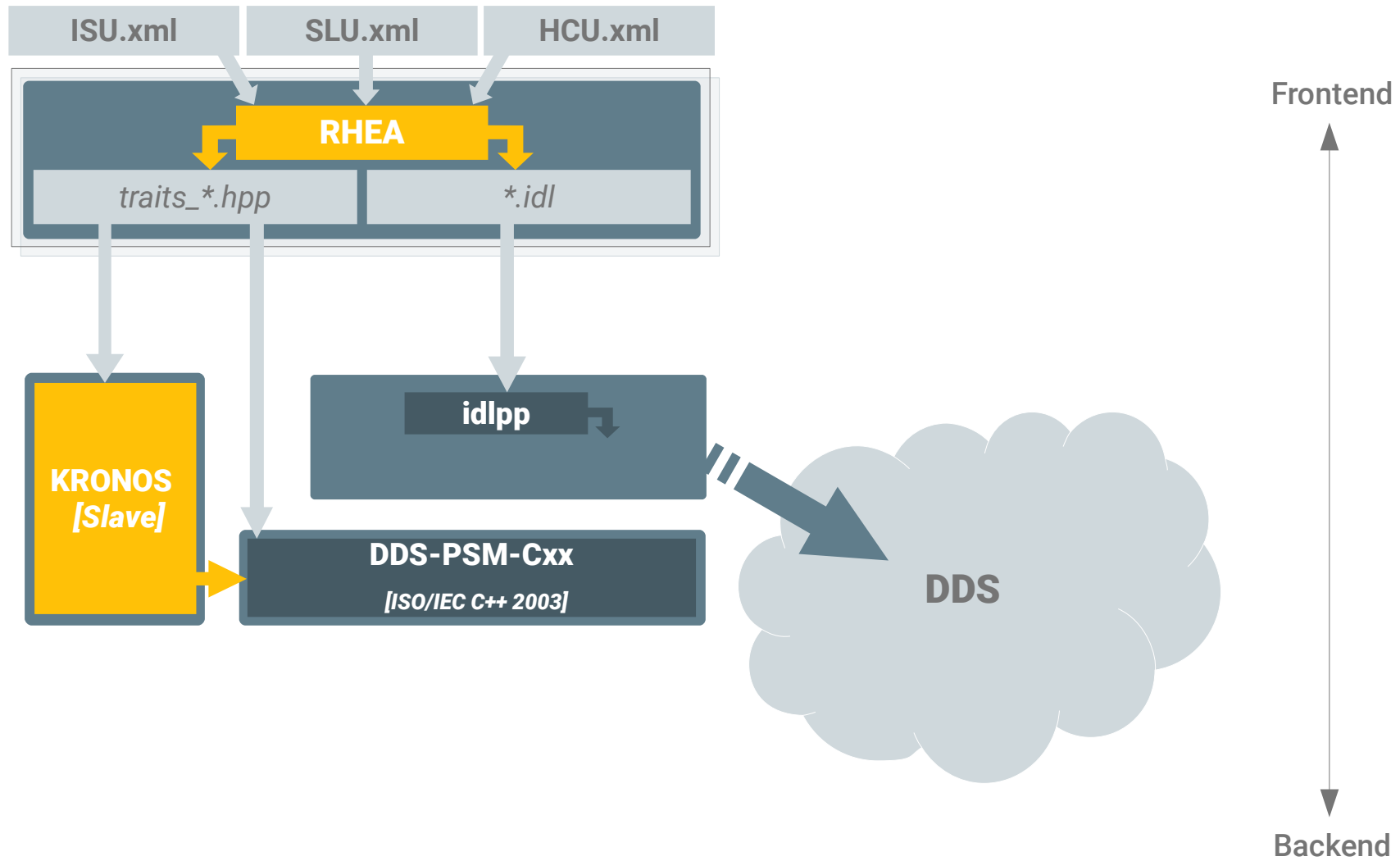
Frontend

Backend

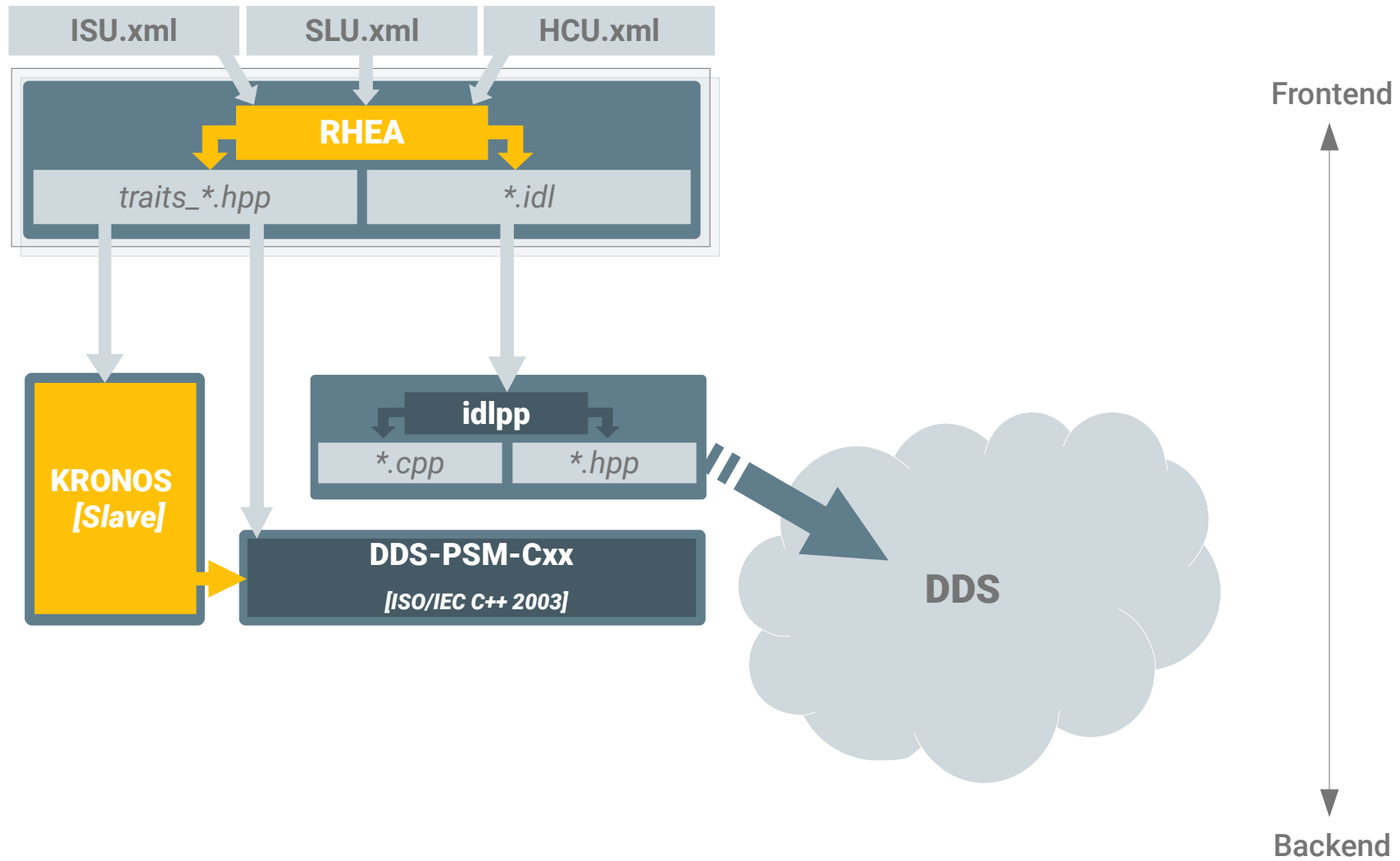
simulation_software_ecosystem-> Low-level architecture



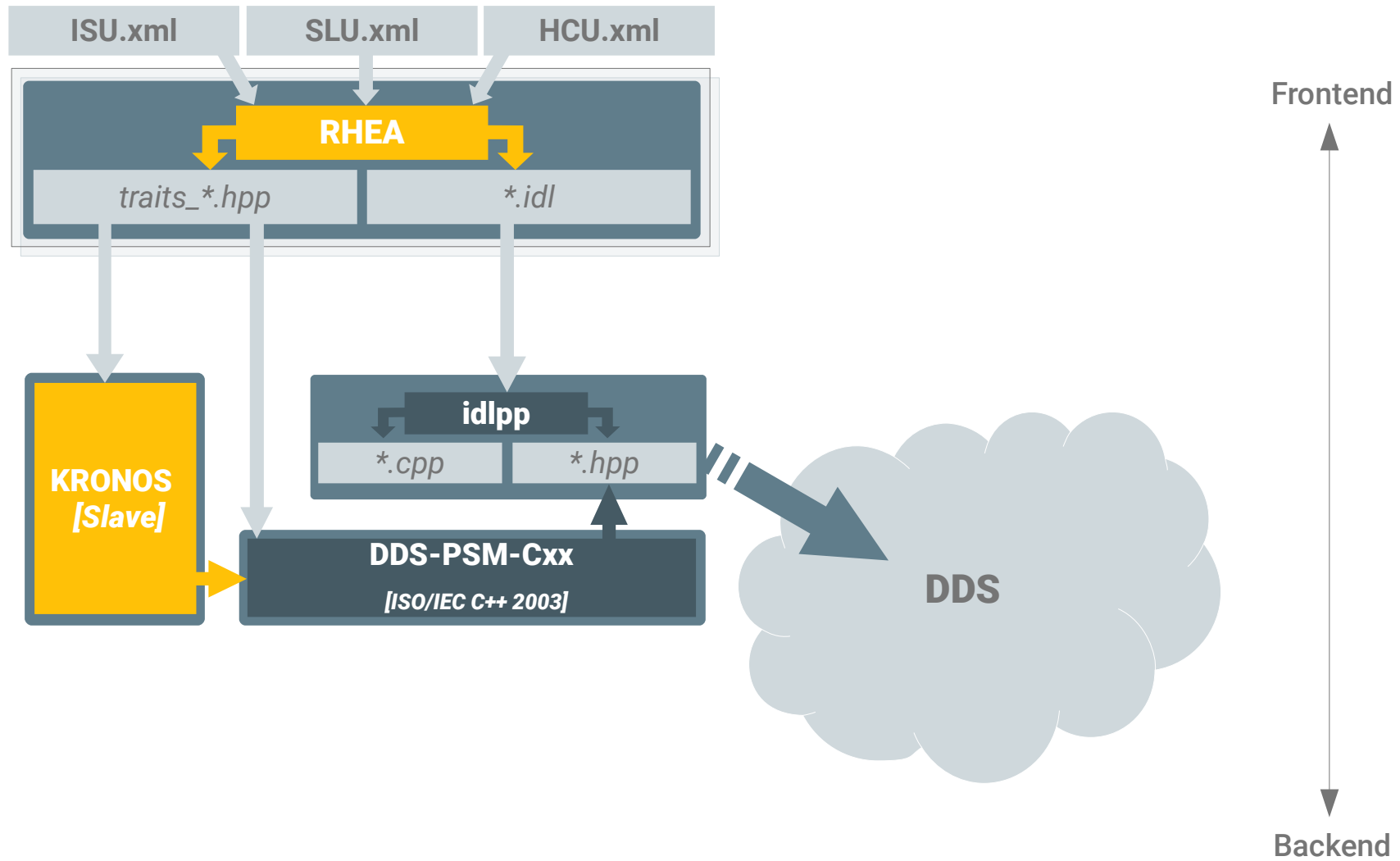
simulation_software_ecosystem-> Low-level architecture



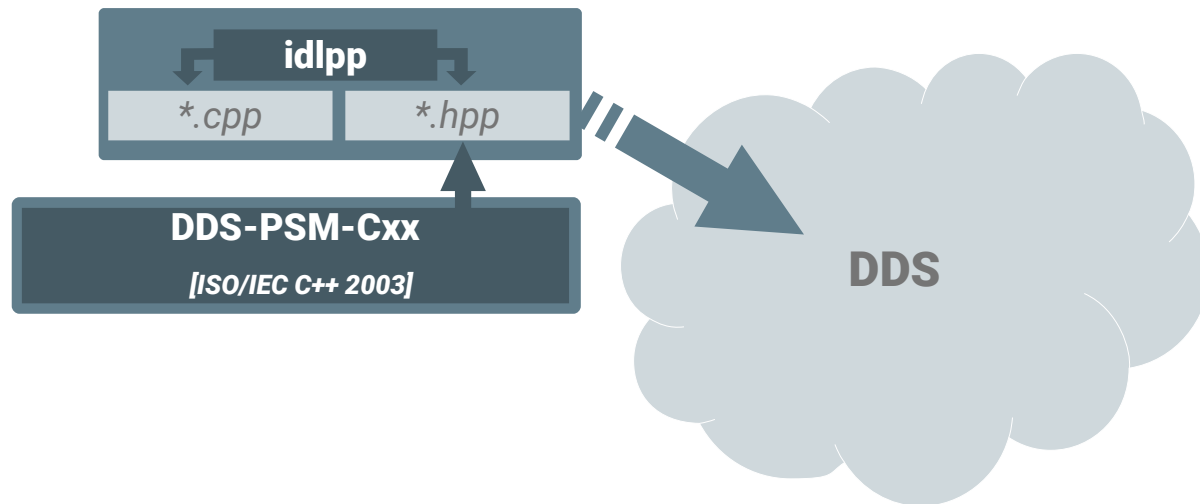
simulation_software_ecosystem-> Low-level architecture



simulation_software_ecosystem-> Low-level architecture



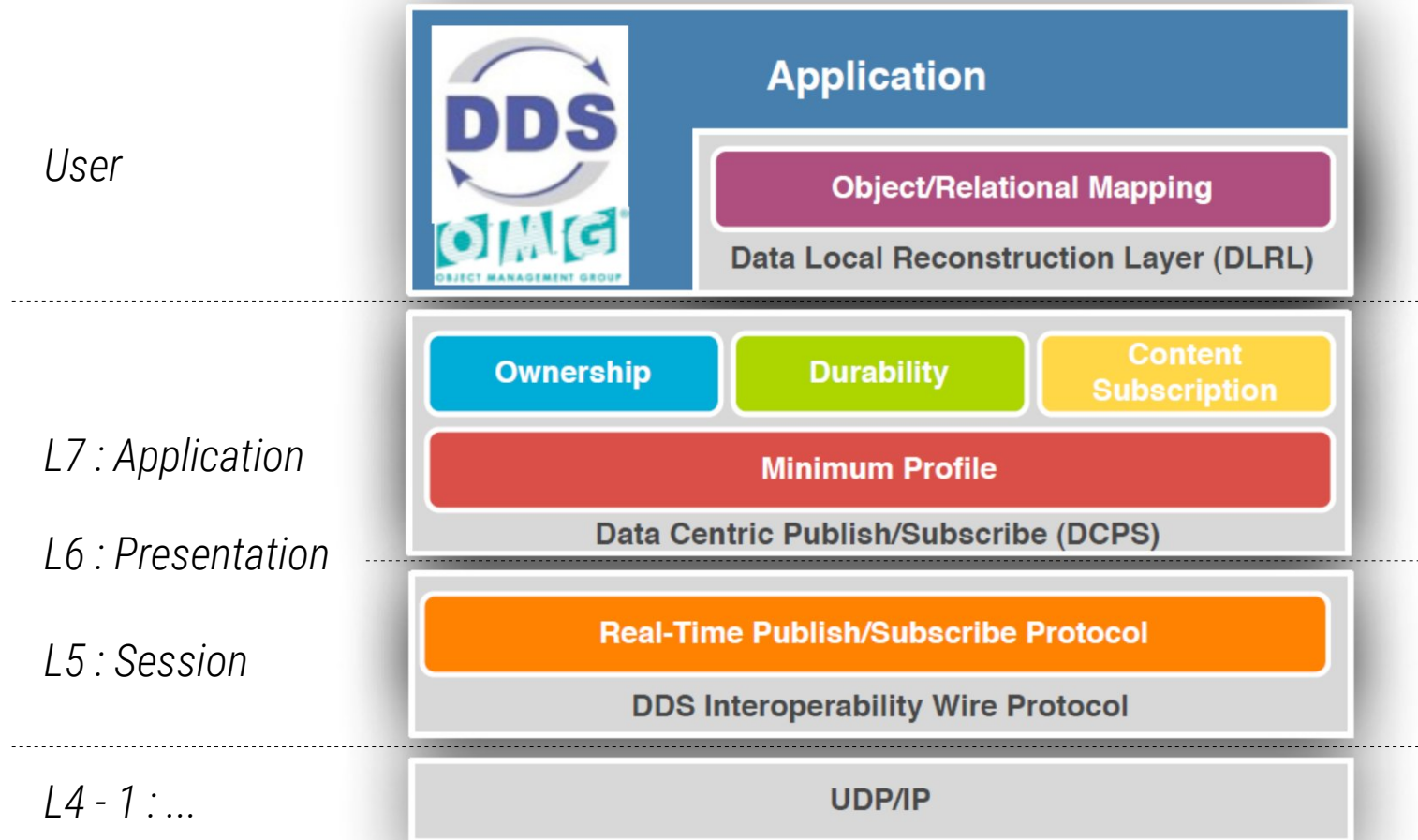
simulation_software_ecosystem-> DDS overview



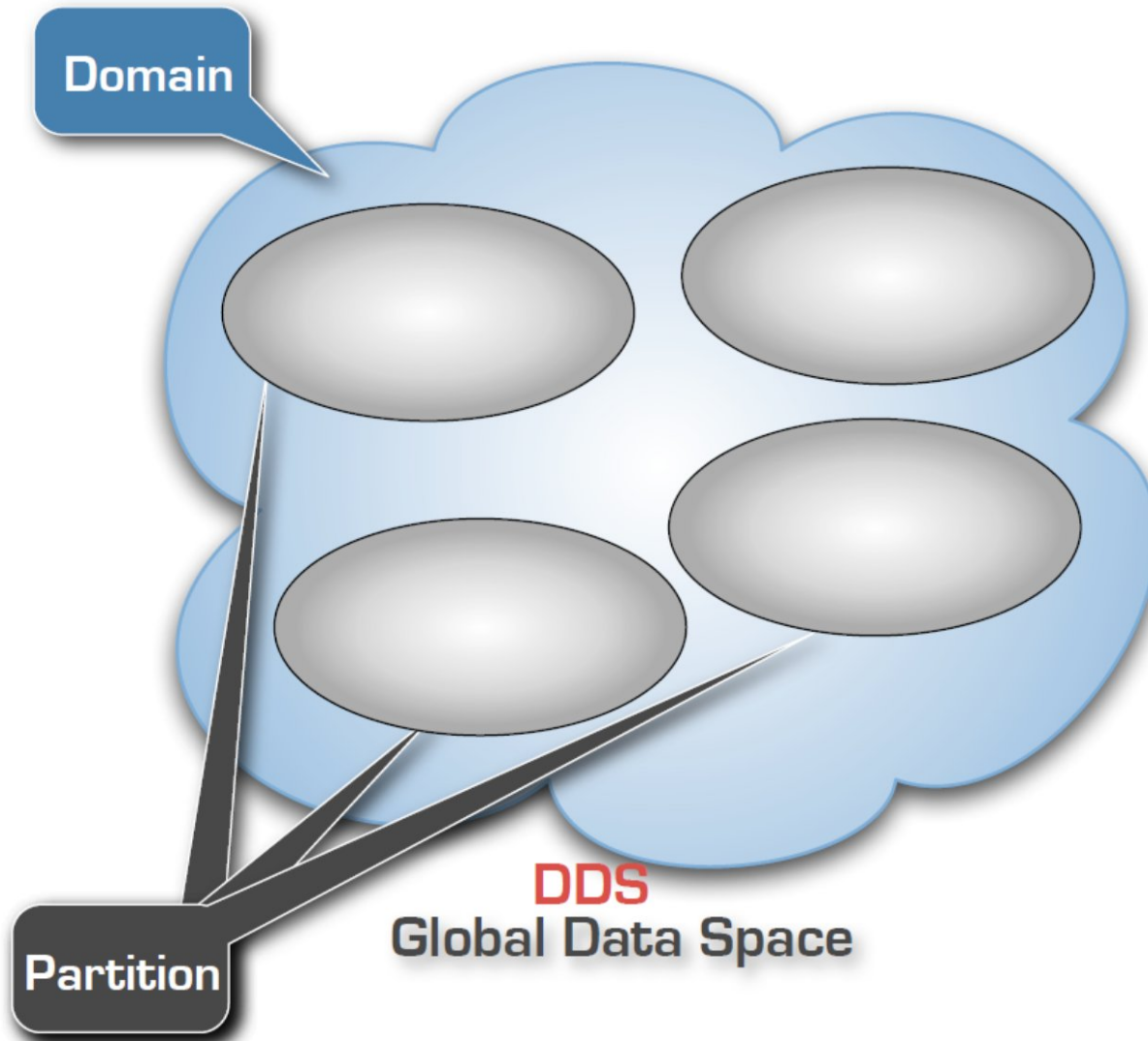


The **OMG** (*Object Management Group*) **DDS** (*Data Distribution Service*) standard is a cloud-based middleware introduced in **2004**. It stands as a standard technology for ubiquitous, interoperable, secure, platform independent, and real-time data sharing across network connected devices. DDS behaviour and semantics can be controlled via a rich set of **QoS** (*Quality of Service*) Policies.

simulation_software_ecosystem-> DDS overview

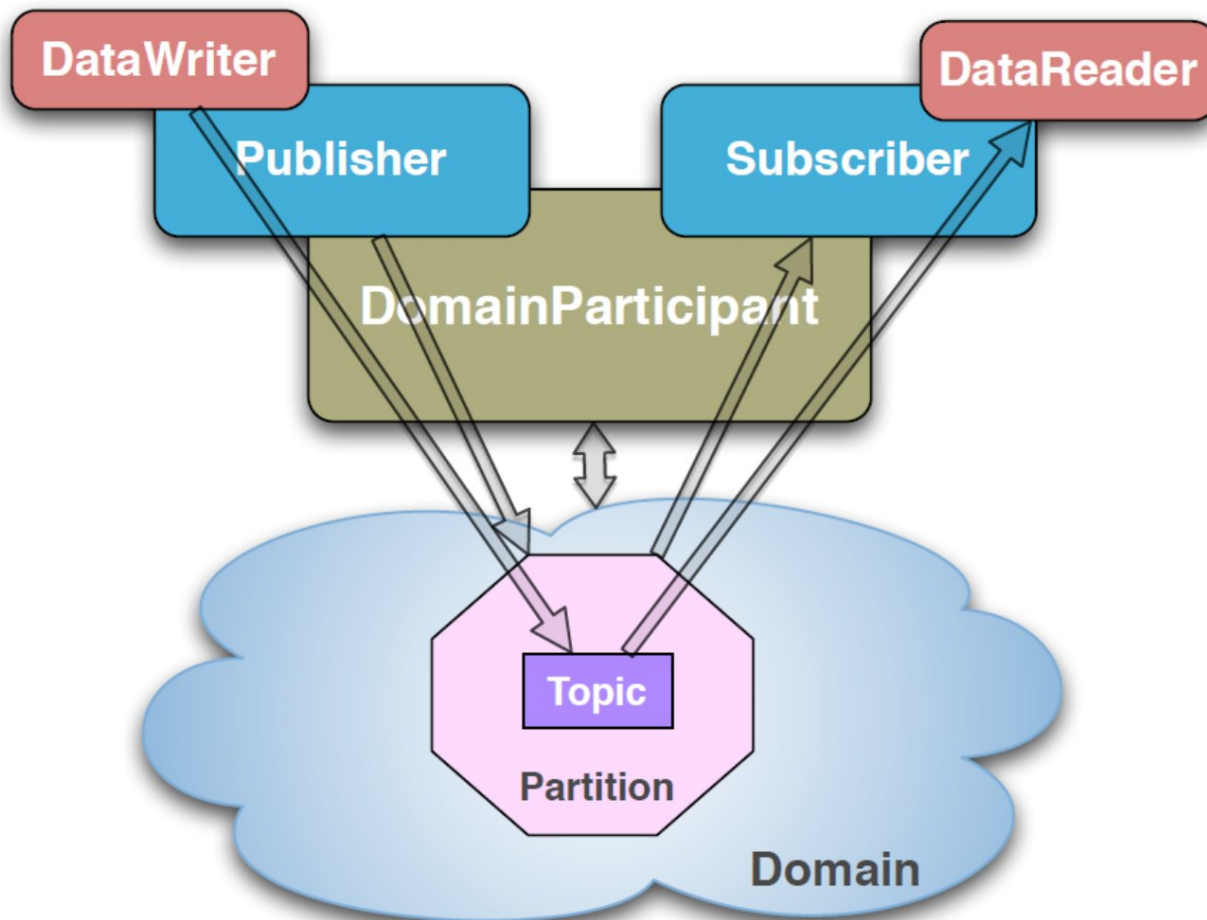


simulation_software_ecosystem-> DDS overview

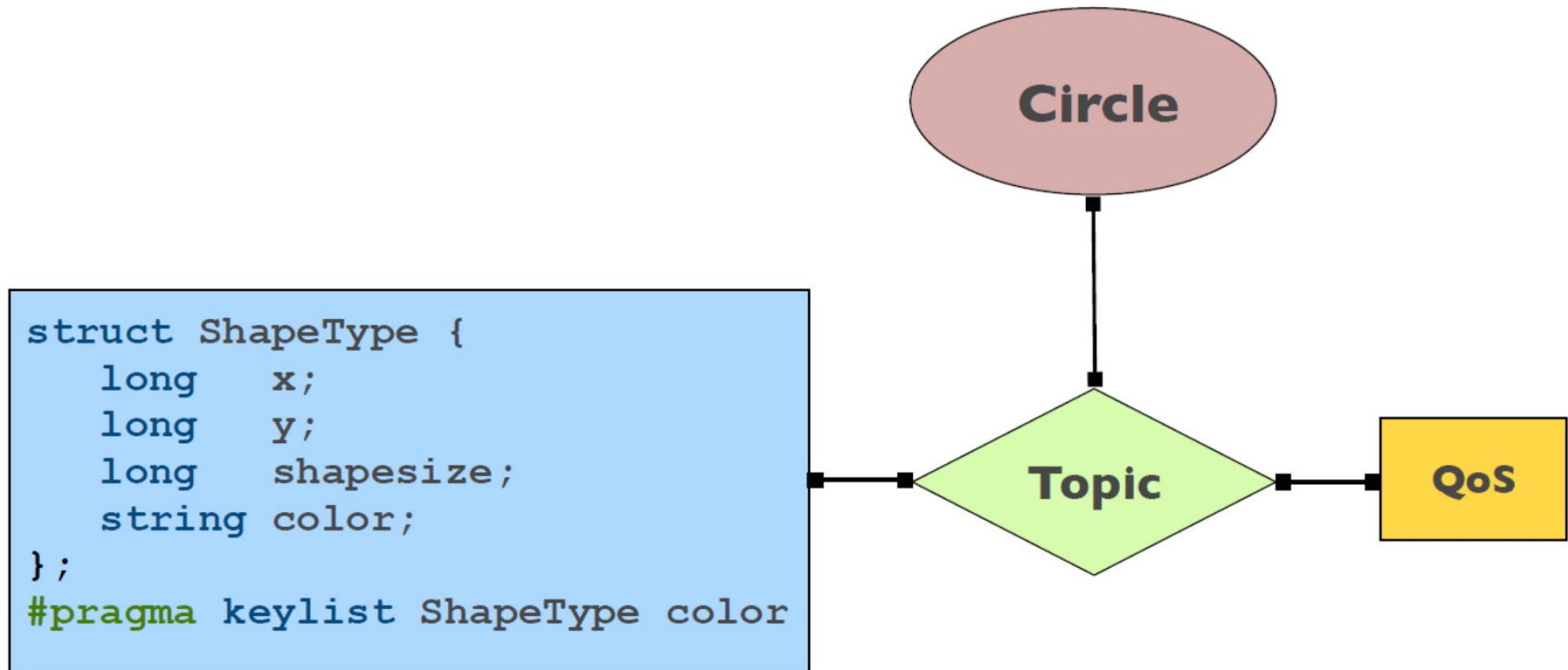


simulation_software_ecosystem-> DDS overview

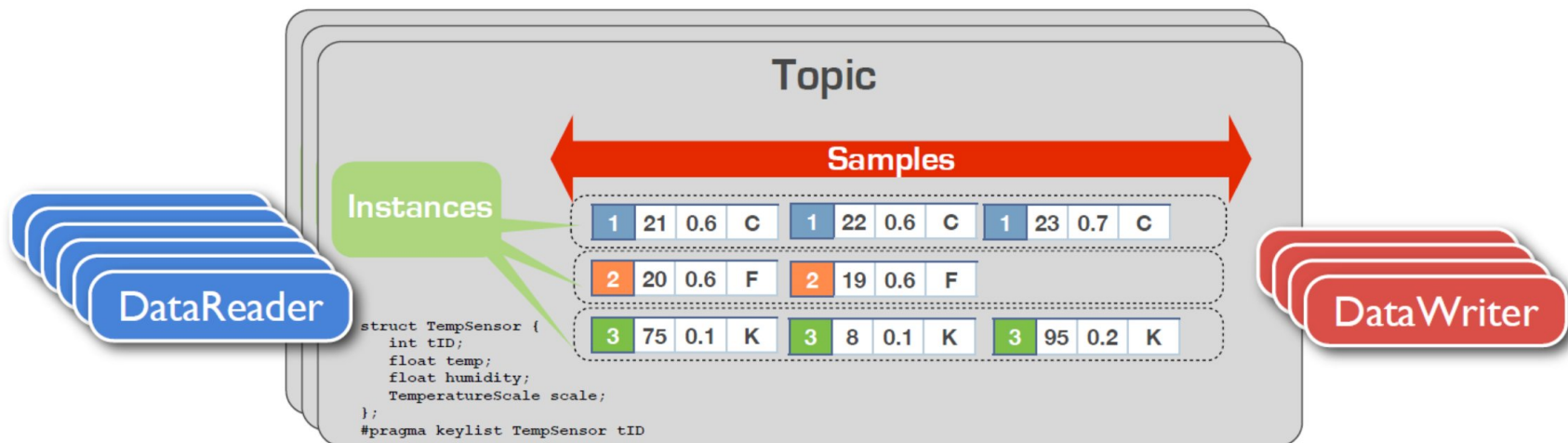
DP: DomainParticipant
P: Publisher
S: Subscriber
DR: DataReader
DW: DataWriter



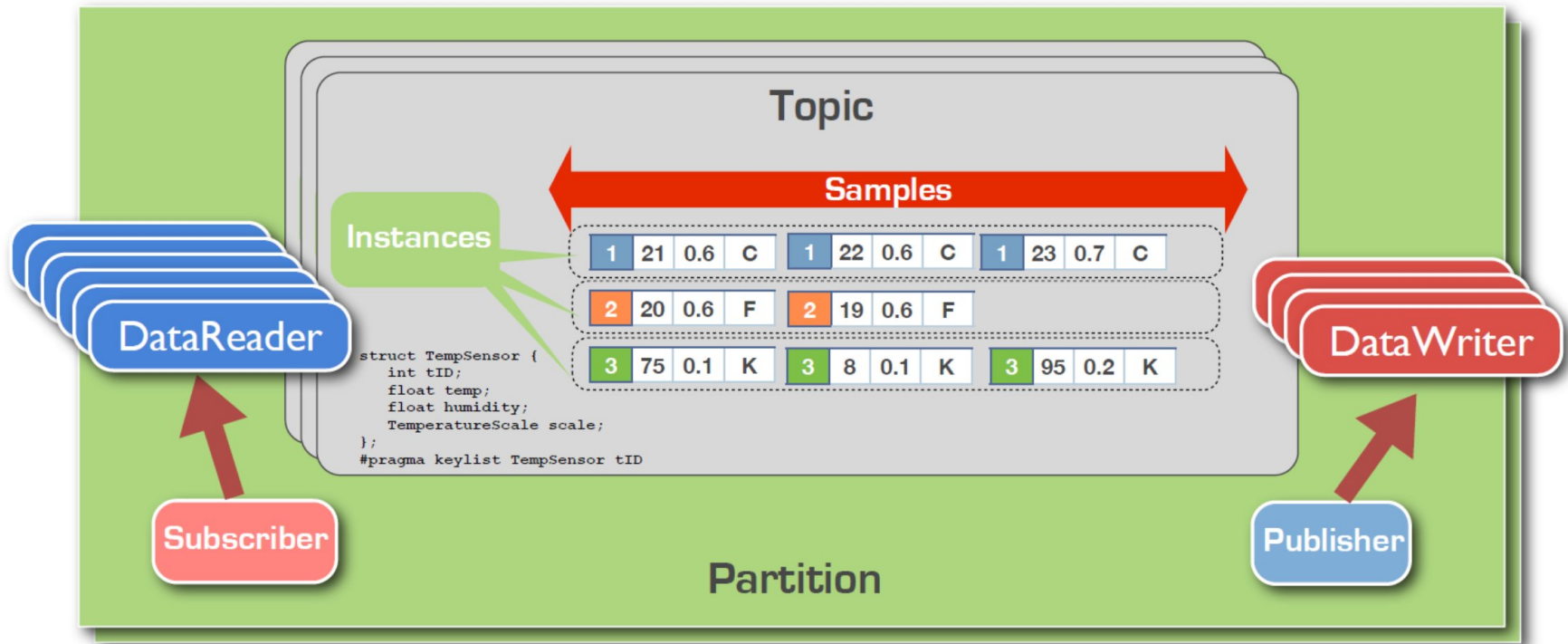
simulation_software_ecosystem-> DDS overview



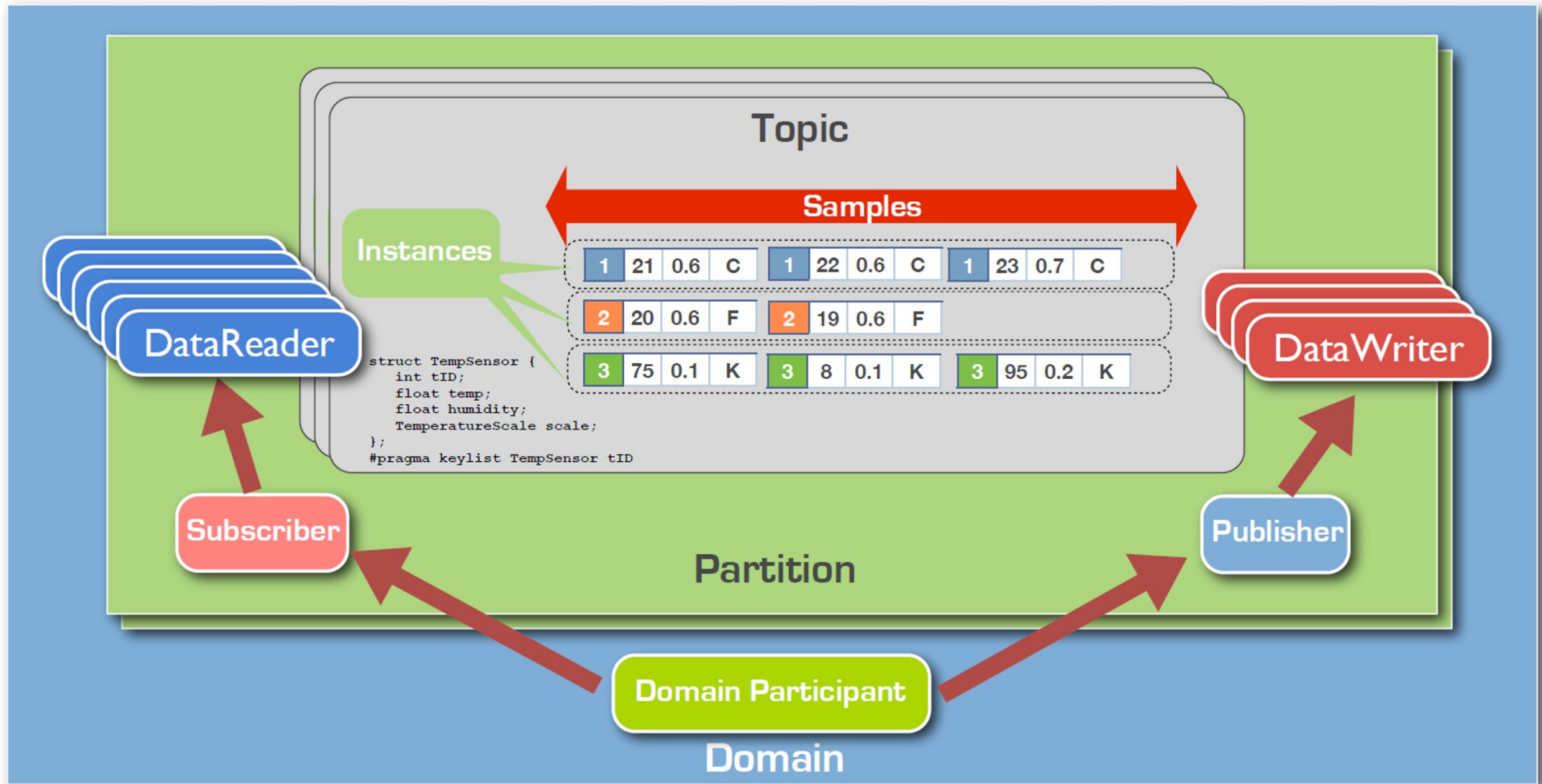
simulation_software_ecosystem-> DDS overview



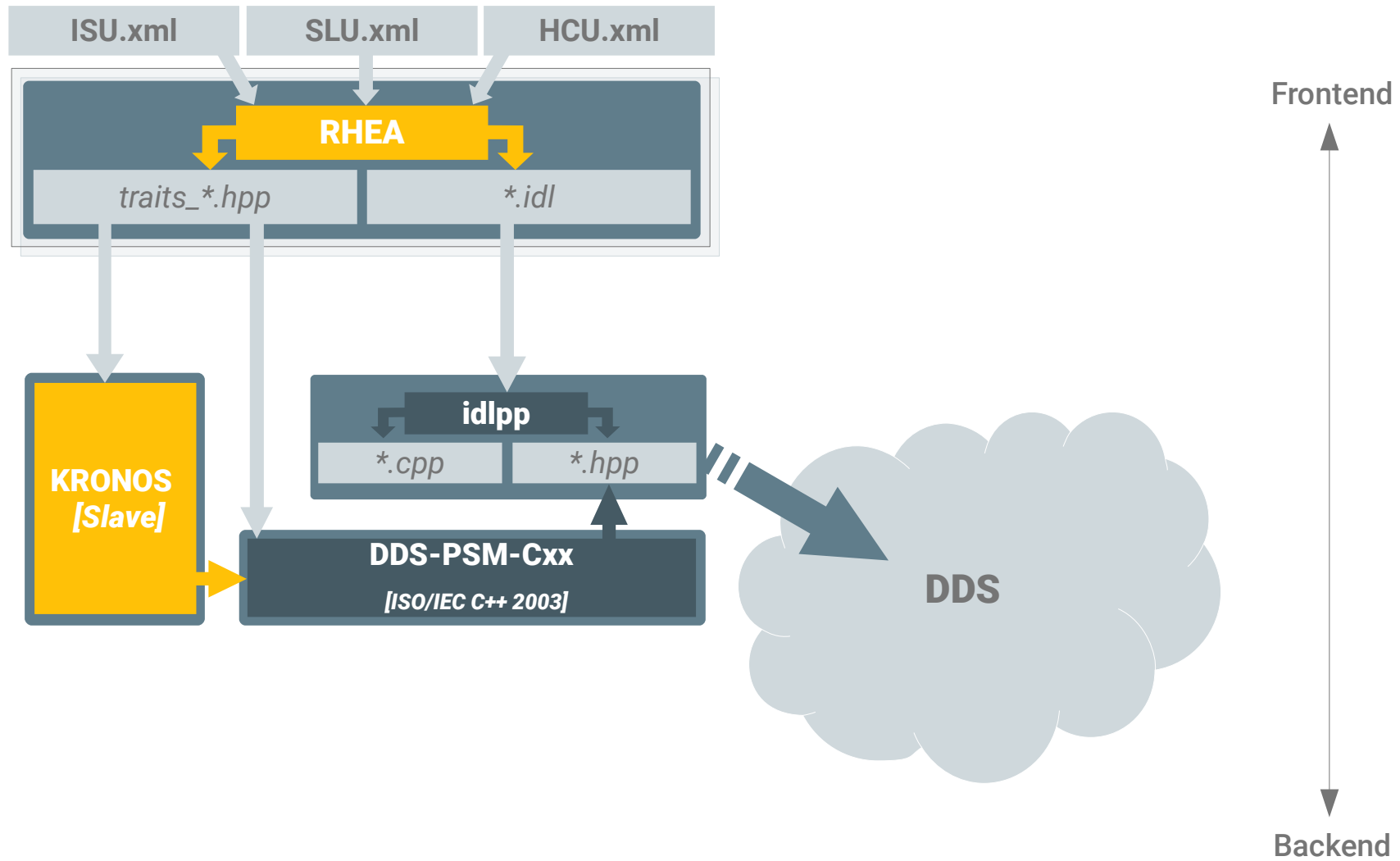
simulation_software_ecosystem-> DDS overview



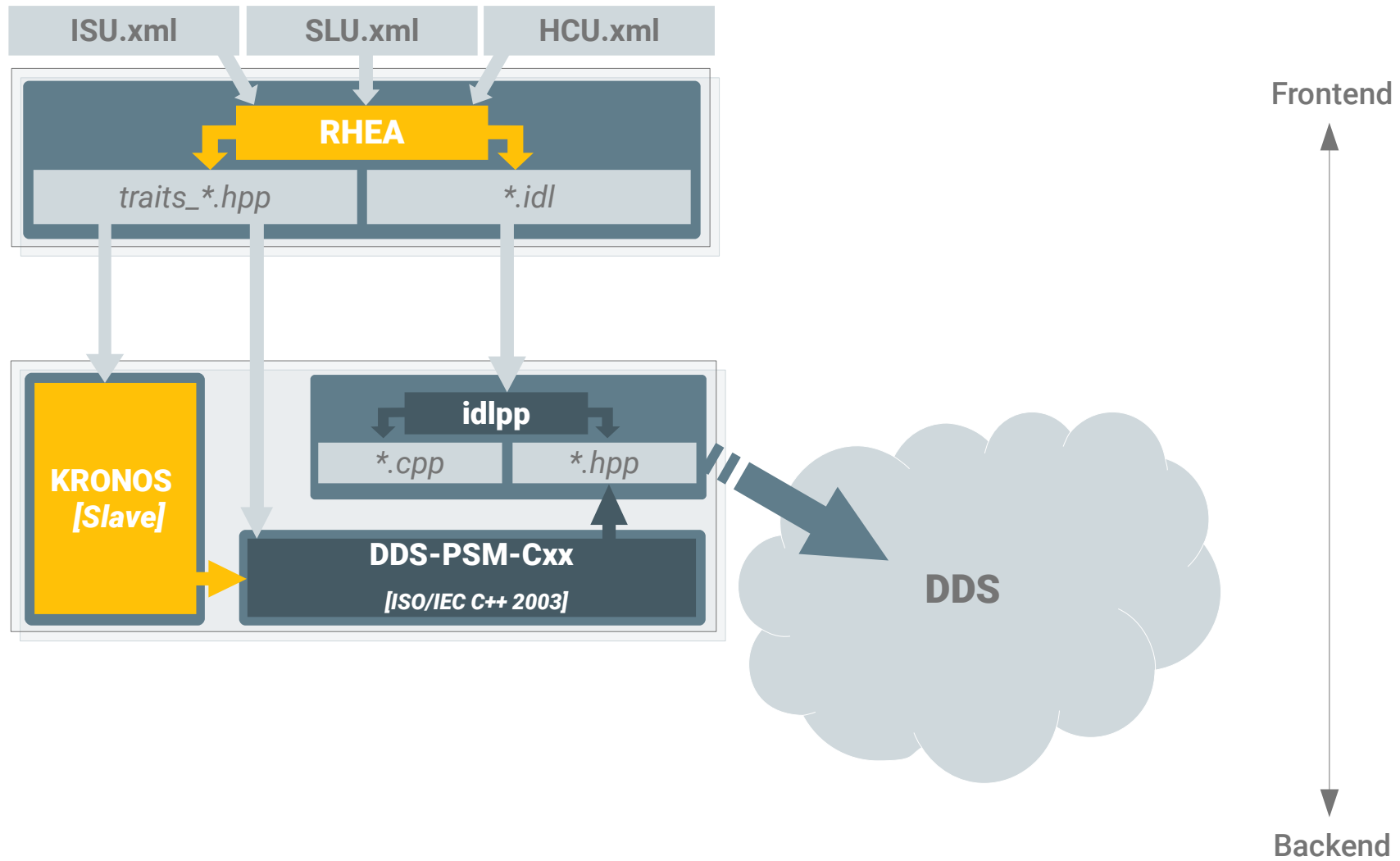
simulation_software_ecosystem-> DDS overview



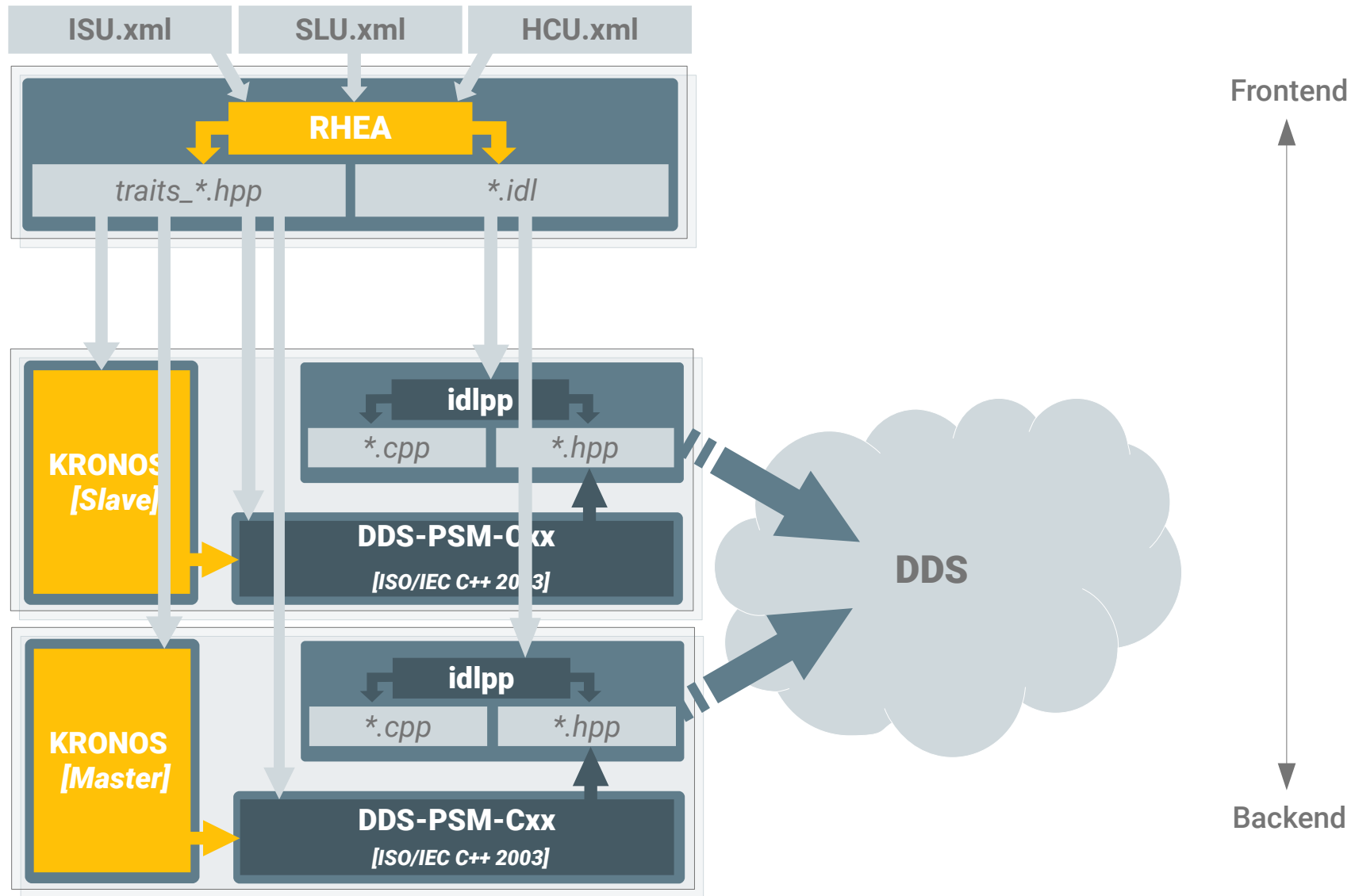
simulation_software_ecosystem-> Low-level architecture



simulation_software_ecosystem-> Low-level architecture



simulation_software_ecosystem-> Low-level architecture



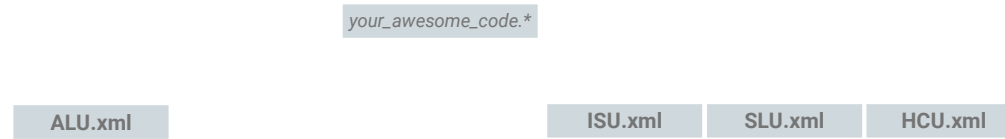
simulation_software_ecosystem-> Low-level architecture

simulation_software_ecosystem-> Low-level architecture

`your_awesome_code.*`

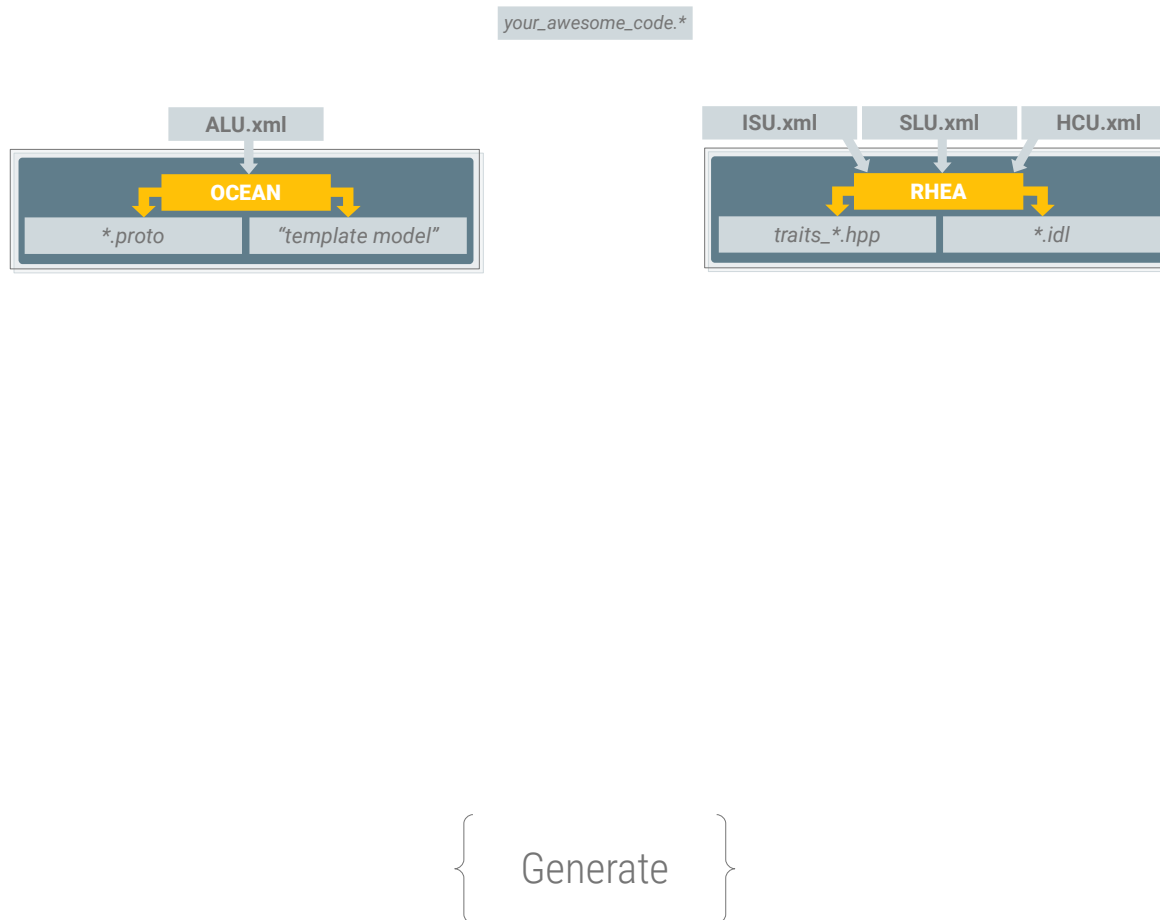
{ Modelize }

simulation_software_ecosystem-> Low-level architecture

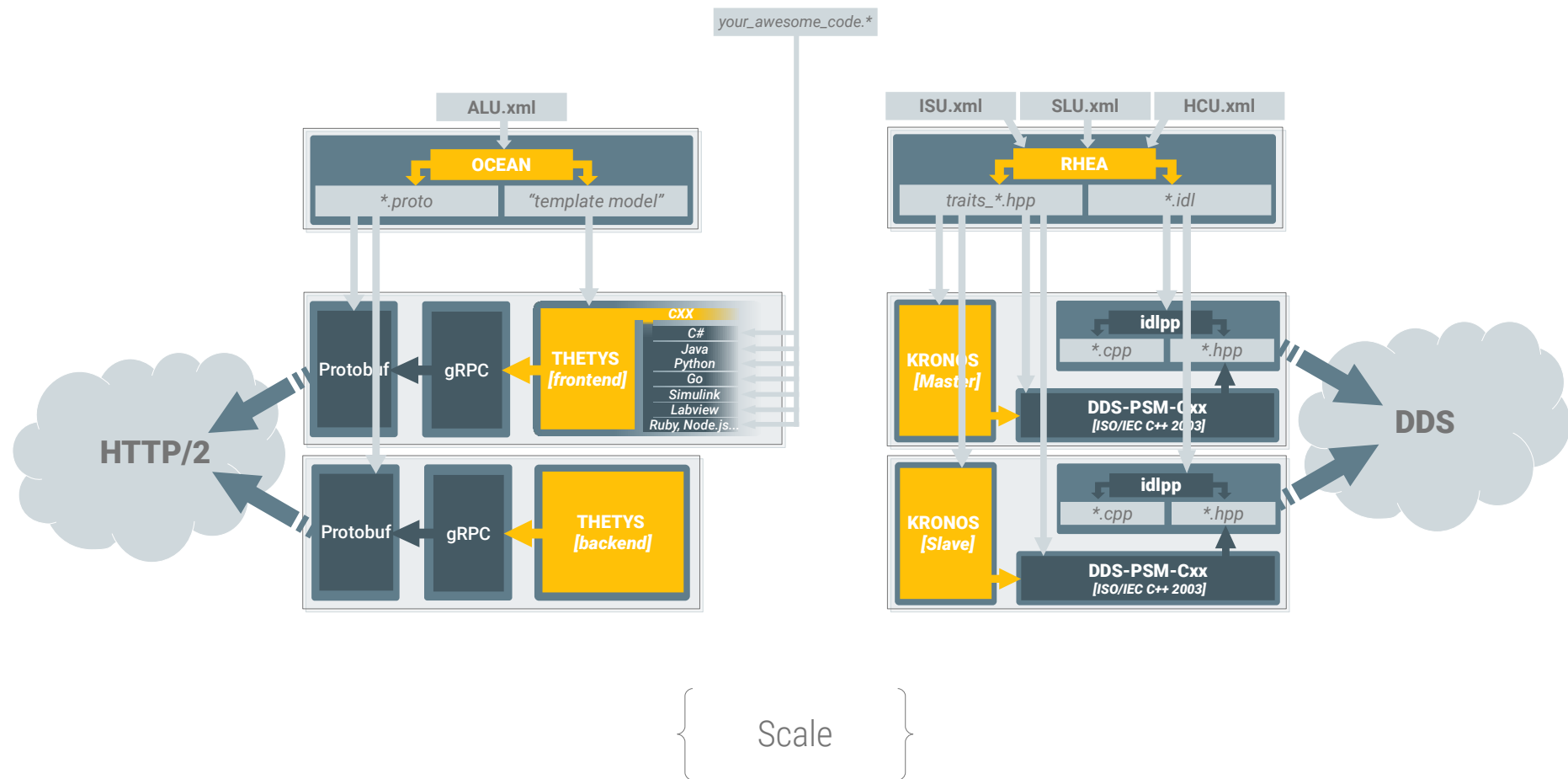


{ Configure }

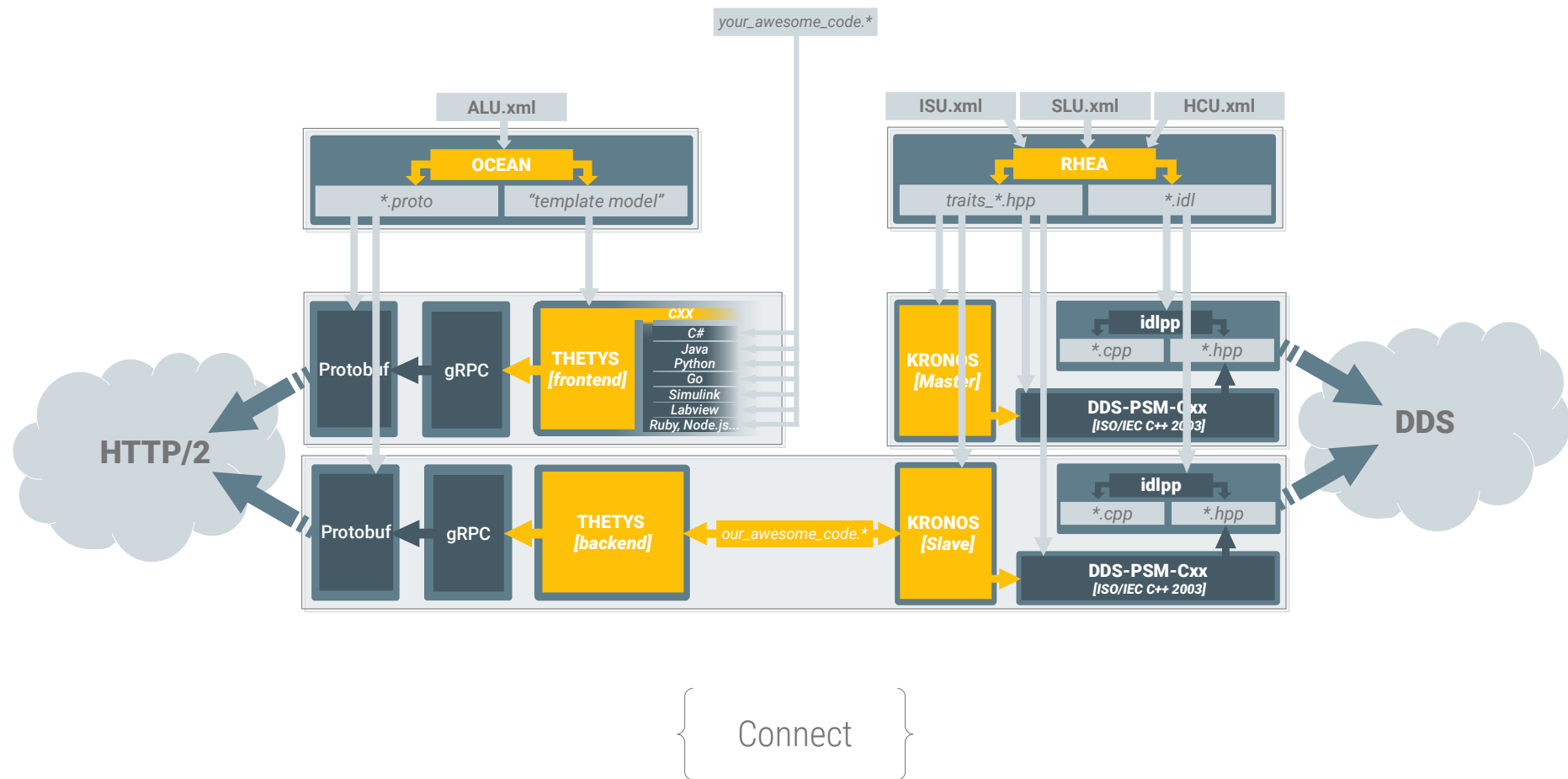
simulation_software_ecosystem-> Low-level architecture

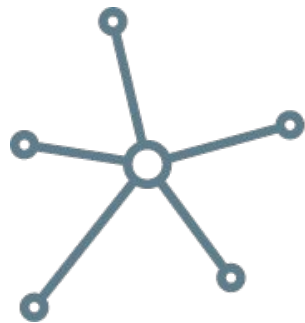


simulation_software_ecosystem-> Low-level architecture



simulation_software_ecosystem-> Low-level architecture





LABSIM

<http://www.labsim.github.io>