Simple Example

Introduction

This document describes an ECOA® client-server example named "*Simple Example*".

The client-server model (ref. [2]) is one of the most basic data, task, or workload, distribution mechanisms in computing. Clients and servers may be distributed across a network, or they may reside on the same computing system. Service oriented concepts, which form a basis behind the ECOA, naturally fit with the client-server model, the clients referencing (using) the services provided by the server. Service orientation, and therefore the ECOA, goes on a step extra, in that a component can be a client (service user) to one or more other components, whilst simultaneously being a server (service provider) to others.

This document presents the principal user generated artefacts required to create the "*Simple Example*" client-server example using the ECOA. It is assumed that the reader is conversant with the ECOA Architecture Specification (ref. [1]) and the process of defining and declaring ECOA Assemblies, ASCs (components), Modules, and deployments in XML, and then using code generation to produce Module framework (stub) code units and ECOA Container and Platform code.

Aims

This ECOA "*Simple Example*" client-server example is intended to demonstrate a minimum effort example of request response from a single data server to a single client.

ECOA Features Exhibited

- Composition of an ECOA Assembly of multiple ECOA ASCs (components).
- Contention-free resource sharing within an ECOA Assembly.
- Use of the ECOA runtime logging API.

Design and Definition

Client-Server Functional Design

The "Simple Example" client-server example will simply demonstrate a basic request-response mechanism. The client will periodically perform a request, from the server and will receive a data item in return (Figure 1).

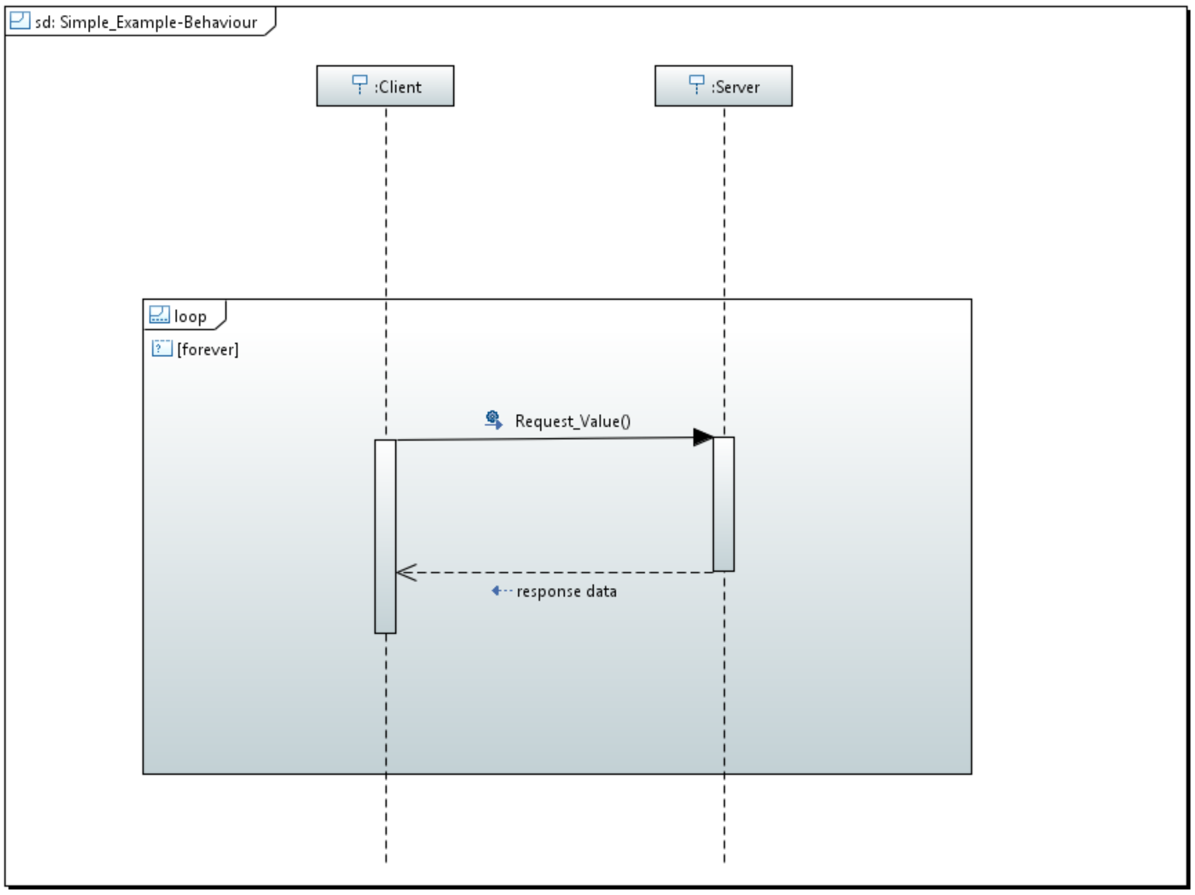


Figure 1 - ECOA "Simple Example" Client-Server Behaviour

The data content of the request will be the current absolute time and the response will be of a user defined type.

The Client will set a local variable to zero and output this to the log prior to performing the request. The result will be returned into this variable and logged.

The Client will be periodically activated at a rate of 0.5Hz (once every 2 seconds).

ECOA Assembly Design and Definition

This ECOA "*Simple Example*" client-server example ECOA Assembly comprises two ECOA ASCs named "*Client*" and "*Server*". The "*Client*" ASC type is instantiated once within the ECOA Assembly as "*Client_Inst*". The "*Server*" ASC is instantiated once within the ECOA Assembly as "*Server_Inst*" and provides the "*Provide_Value_Service*" ECOA Service, which is referenced (used) by the "*Client_Inst*" ASC (Figure 2).

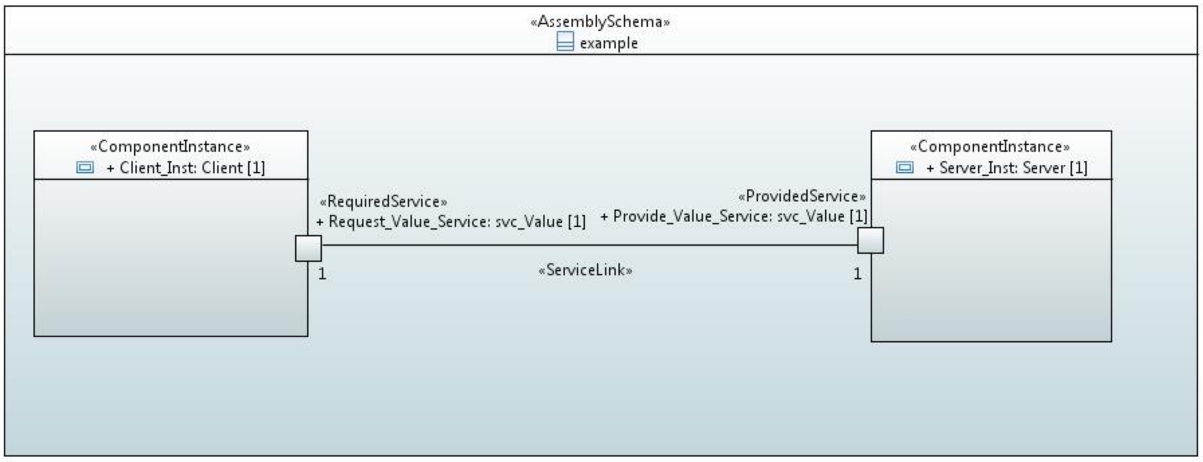

«AssemblySchema»
example
«ComponentInstance»
+ Client_Inst: Client [1]
«RequiredService»
+ Request_Value_Service: svc_Value [1]
«ProvidedService»
+ Provide_Value_Service: svc_Value [1]
«ComponentInstance»
+ Server_Inst: Server [1]
1
«ServiceLink»
1

Figure 2 - ECOA "Simple Example" Assembly Diagram

This ECOA Assembly is defined in an Initial Assembly XML file, and declared in a Final Assembly (or Implementation) XML file (which is practically identical). The Final Assembly XML for the ECOA "*Simple Example*" Assembly is as follows (file *example.impl.composite*):

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<csa:composite xmlns:csa="http://docs.oasis-open.org/ns/opencsa/sca/200912"
       xmlns:ecoa-sca="http://www.ecoa.technology/sca-extension-2.0"
name="example"
       targetNamespace="http://www.ecoa.technology">

       <csa:component name="Client_Inst">
              <ecoa-sca:instance componentType="Client" />
       </csa:component>

       <csa:component name="Server_Inst">
              <ecoa-sca:instance componentType="Server" />
       </csa:component>

       <csa:wire source="Client_Inst/Request_Value_Service"
target="Server_Inst/Provide_Value_Service" />

</csa:composite>
```

The *Server* ASC type is defined in XML as follows (file *Server.componentType*):

```
<?xml version="1.0" encoding="UTF-8"?>
<componentType xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200912"
       xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:ecoa-
sca="http://www.ecoa.technology/sca-extension-2.0">

       <service name="Provide_Value_Service">
              <ecoa-sca:interface syntax="svc_Value" />
       </service>
```

```
</componentType>
```

The ASC definition (the *<componentType>* XML element) declares the provision (by the ASC) of the *Provide_Value_Service* ECOA Service.

The *Client* ASC type is defined in XML as follows (file *Client.componentType*):

```
<?xml version="1.0" encoding="UTF-8"?>
<componentType xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200912"
       xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:ecoa-
sca="http://www.ecoa.technology/sca-extension-2.0">

       <reference name="Request_Value_Service">
              <ecoa-sca:interface syntax="svc_Value" />
       </reference>

</componentType>
```

This ASC definition (the *<componentType>* XML element) declares a reference (by the ASC) to the *Request_Value_Service* ECOA Service.

ECOA Service and Types Definition

The *svc_Value* Service, which is provided by the *Server* ASC and referenced by the *Client* ASC, is defined in a XML file (*svc_Value.interface.xml*):

```
<serviceDefinition xmlns="http://www.ecoa.technology/interface-2.0">

       <use library="example" />

       <operations>
              <requestresponse name="Request_Value">
                     <input name="Time" type="global_time" />
                     <output name="Value" type="example:value_type" />
              </requestresponse>
       </operations>

</serviceDefinition>
```

The Service comprises a single ECOA Request-Response Operation called *Request_Value* which has one input parameter (*Time* which is passed from the requesting client to the server), and one output parameter (*Value* which is the response from the server to the client). The first parameter is defined as being of type *global_time*, which is a pre-defined ECOA type. The second parameter is defined as being of type *example:value_type*, where *example* names a data types library *used* by the service definition. The data types library is, unsurprisingly, also defined in XML (file *example.types.xml*):

```
<?xml version="1.0" encoding="UTF-8"?>
<library xmlns="http://www.ecoa.technology/types-2.0">
```

```
        <types>
                <simple name="value_type" type="uint32" />
        </types>

</library>
```

The data type *example:value_type* is therefore an unsigned 32 bit integer type.

ECOA Module Design and Definition

The implementations of the *Server* and *Client* ASC are composed of a single ECOA Module each (Module Implementations *Server_Module_Im* and *Client_Module_Im* of Module Types *Server_Module_Type* and *Client_Module_Type* respectively) as illustrated in UML in Figure 3 and Figure 4 respectively.

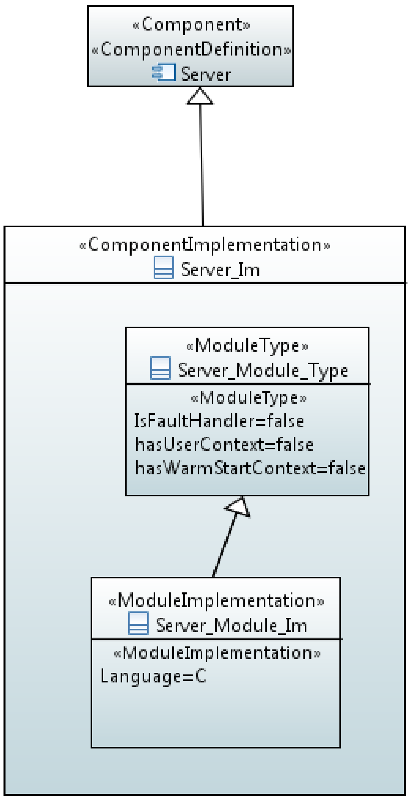


Figure 3 "Server" Module Design (as UML Composite Structure Diagram)

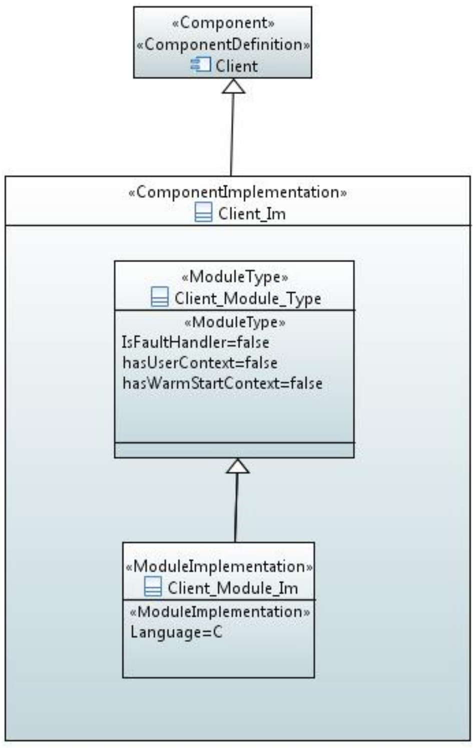


Figure 4 – "Client" Module Design (as UML Composite Structure Diagram)

Figure 5 and Figure 6 depict in UML the internal design of the `Server` ASC (component) ***providing*** the `svc_Value` ECOA Service, whilst the `Client` ASC ***references*** the Service. As always in the ECOA, the Module Implementations implement the Module Lifecycle operations defined by the ECOA.

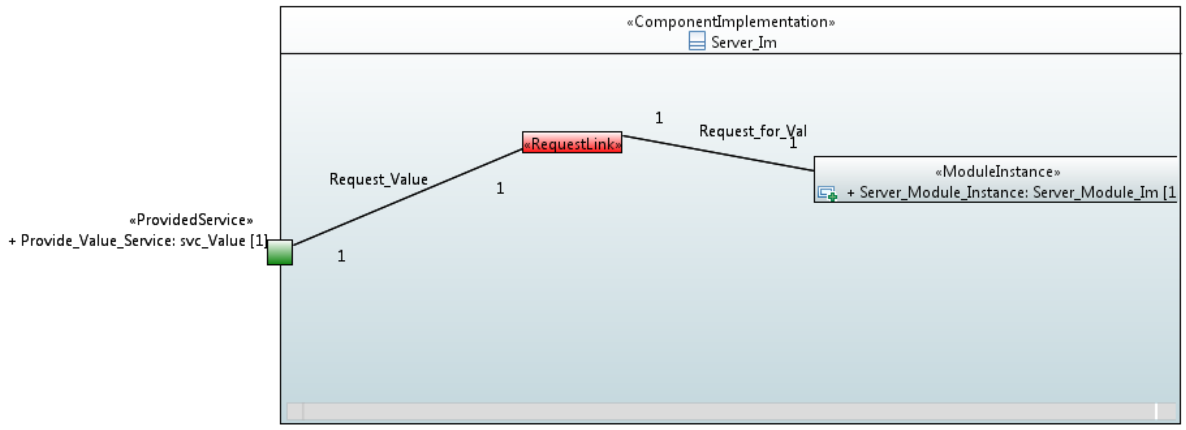

«ComponentImplementation»
Server_Im
«RequestLink»
Request_Value
Request_for_Val
«ModuleInstance»
+ Server_Module_Instance: Server_Module_Im [1
«ProvidedService»
+ Provide_Value_Service: svc_Value [1]
1

Figure 5 - "Server” Component Design (as UML Composite Structure Diagram)

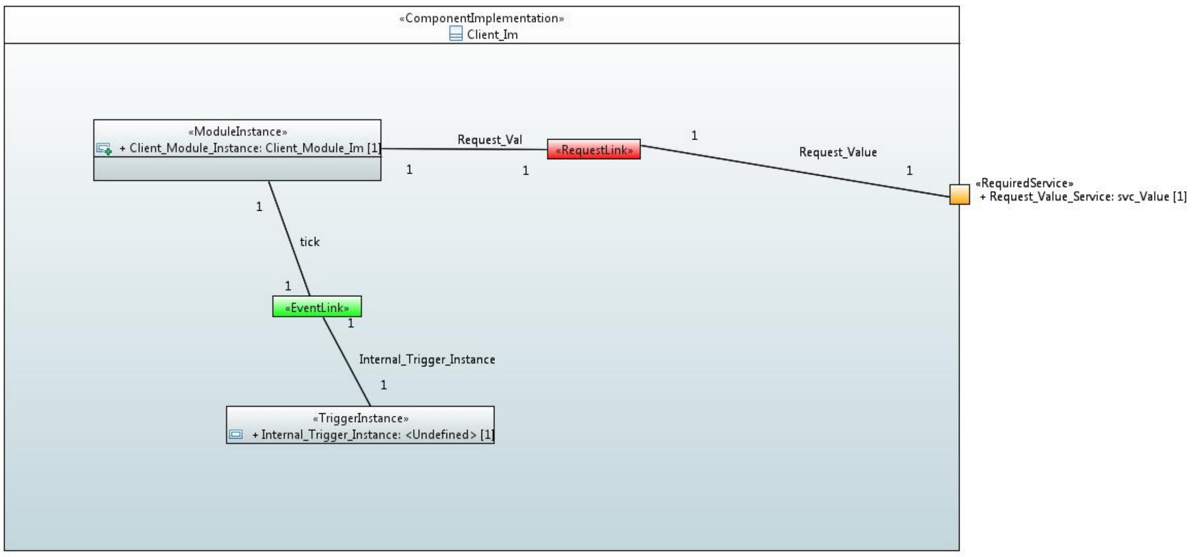

«ComponentImplementation»
Client_Im
«ModuleInstance»
+ Client_Module_Instance: Client_Module_Im [1]
Request_Val
«RequestLink»
Request_Value
«RequiredService»
+ Request_Value_Service: svc_Value [1]
tick
«EventLink»
Internal_Trigger_Instance
«TriggerInstance»
+ Internal_Trigger_Instance: <Undefined> [1]
1

Figure 6 - "Client” Component Design (as UML Composite Structure Diagram)

The Server ASC

The *Server* ASC is declared in XML as follows (file *Server_Im.impl.xml*):

```
<componentImplementation xmlns="http://www.ecoa.technology/implementation-2.0"
        componentDefinition="Server">

        <use library="example" />

        <moduleType name="Server_Module_Type" hasUserContext="false"
                hasWarmStartContext="false">

                <operations>
                <requestReceived name="Request_for_Val">
                      <input name="time" type="global_time" />
                      <output name="val" type="example:value_type" />
                </requestReceived>
          </operations>
      </moduleType>

      <moduleImplementation name="Server_Module_Im"
            language="C" moduleType="Server_Module_Type" />
      <moduleInstance name="Server_Module_Instance"
            implementationName="Server_Module_Im" relativePriority="1" />

      <requestLink>
            <clients>
                  <service operationName="Request_Value"
instanceName="Provide_Value_Service" />
            </clients>
            <server>
                  <moduleInstance instanceName="Server_Module_Instance"
                        operationName="Request_for_Val" />
            </server>
      </requestLink>

</componentImplementation>
```

That is, a Module Type (*Server_Module_Type*) is declared which has a *requestReceived* operation "*Request_for_Val*". This Module Type is implemented by a concrete Module Implementation *Server_Module_Im* which in turn is instantiated once as the Module Instance *Server_Module_Instance*.

The *<requestLink>* XML logically associates the specific concrete operations of the Module Instance with the abstract Service operations. In this example, the "*Request_for_Val*" module operation is connected to the "*Request_Value*" service operation of the "*Provide_Value_Service*" service instance.

A single functional code unit will be produced by the code generation process, implementing in code the concrete *Server_Module_Im* class, and named "*Server_Module_Im.c*" (assuming the Module Implementation declaration has set the *Language* property to "C").

The Client ASC

The *Client* ASC is declared in XML as follows (file *Client_Im.impl.xml*):

```
<componentImplementation xmlns="http://www.ecoa.technology/implementation-2.0"
      componentDefinition="Client">

      <use library="example" />

      <moduleType name="Client_Module_Type" hasUserContext="false"
            hasWarmStartContext="false">
            <operations>
                <eventReceived name="tick" />

                <requestSent name="Request_Val" isSynchronous="true"
                    timeout="2">
                    <input name="time" type="global_time" />
                    <output name="val" type="example:value_type" />
                </requestSent>
            </operations>
        </moduleType>

        <moduleImplementation name="Client_Module_Im"
            language="C" moduleType="Client_Module_Type" />
        <moduleInstance name="Client_Module_Instance"
            implementationName="Client_Module_Im" relativePriority="1" />
        <triggerInstance name="Internal_Trigger_Instance"
            relativePriority="2" />

        <requestLink>
            <clients>
                <moduleInstance instanceName="Client_Module_Instance"
                    operationName="Request_Val" />
            </clients>
            <server>
                <reference instanceName="Request_Value_Service"
                    operationName="Request_Value" />
            </server>
        </requestLink>

        <eventLink>
            <senders>
                <trigger instanceName="Internal_Trigger_Instance" period="2"
/>
            </senders>
            <receivers>
                <moduleInstance instanceName="Client_Module_Instance"
                    operationName="tick" />
            </receivers>
        </eventLink>

</componentImplementation>
```

That is, a Module Type (*Client_Module_Type*) is declared which has two operations:

- A "*Request_Val*" *requestSent* operation;
- The *eventReceived* operation "*tick*".

A timeout is defined for the "*Request_Val*" operation. This is to ensure that if the response is never received, the Module will not be blocked indefinitely. This scenario may occur if the request or response is lost, or if the Server Module fails to respond

The *Internal_Trigger_Instance* Trigger Instance is introduced because the Client needs to "*periodically request a data item*" and so an ECOA periodic trigger is required. Once every period (2 seconds as set in the *<eventLink>* XML) the Trigger will fire and the Module Operation *tick* will be invoked.

This Module Type is implemented by a concrete Module Implementation *Client_Module_Im*, which in turn is instantiated once as the Module Instance *Client_Module_Instance*.

The *<requestLink>* XML logically associates the specific concrete operations of the Module Instance with the abstract Service operations. In this example, the "*Request_Val*" module operation is connected to the "*Request_Value*" service operation of the "*Request_Value_Service*" service instance.

A single functional code unit will be produced by the code generation process, implementing in code the concrete *Client_Module_Im* class, and named "*Client_Module_Im.c*" (assuming the Module Implementation declaration has set the *language* property to "C").

ECOA Deployment Definition

The ECOA "*Simple Example*" Assembly is deployed (that is, the declared Module and Trigger Instances are allocated to a single ECOA Protection Domain, which is then allocated to a computing node) by the following XML (file *example.deployment.xml*):

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<deployment xmlns="http://www.ecoa.technology/deployment-2.0"
      finalAssembly="example" logicalSystem="example">

      <protectionDomain name="Ex1">
            <executeOn computingPlatform="Example_Platform"
                  computingNode="card1_bae" />

            <deployedModuleInstance componentName="Client_Inst"
                  moduleInstanceName="Client_Module_Instance"
modulePriority="11" />
            <deployedTriggerInstance componentName="Client_Inst"
                  triggerInstanceName="Internal_Trigger_Instance"
triggerPriority="12" />

            <deployedModuleInstance componentName="Server_Inst"
                  moduleInstanceName="Server_Module_Instance" modulePriority="3"
/>

      </protectionDomain>

      <platformConfiguration
            faultHandlerNotificationMaxNumber="8"
computingPlatform="Example_Platform"></platformConfiguration>

</deployment>
```

Thus in this case, a single ECOA Protection Domain is declared (*Ex1*) executing on an ECOA Computing Node, on a single ECOA Computing Platform.

Implementation

The Server ASC

The "Request_Value_Service" Service request handler is implemented by the code function *Server_SM_Im__Request_for_Val__request_received*:

```
void
Server_Module_Im__Request_for_Val__request_received(Server_Module_Im__context*
context, const ECOA__uint32 ID, const ECOA__global_time* time)
{
   ECOA__return_status return_status;

   return_status =
Server_Module_Im_container__Request_for_Val__response_send(context, ID, 10);
}
```

This function replies to the request with a data value of *10* by invoking the ECOA Container API function *Server_Module_Im_container__Request_for_Val__response_send*.

The Client ASC

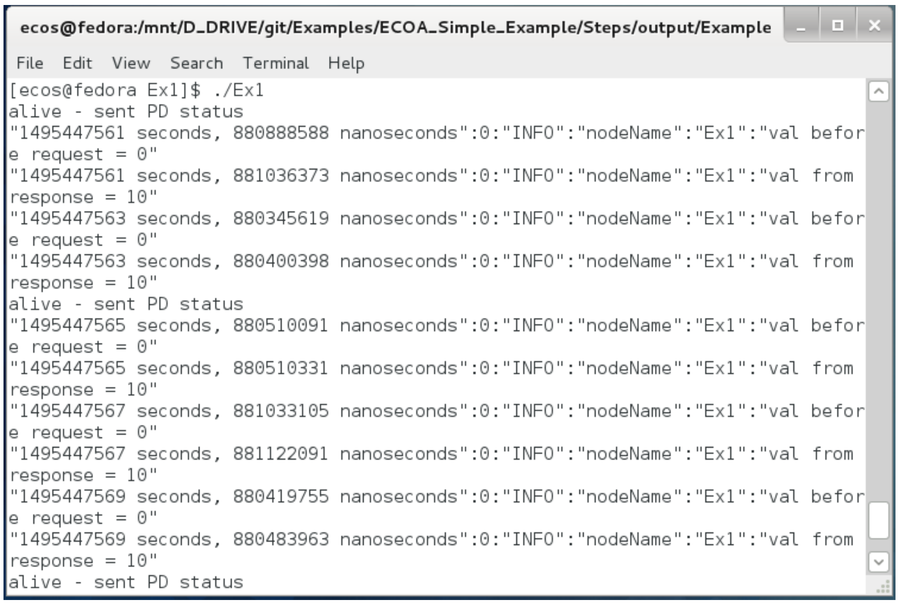
All we need to do is to program what to do when the *Internal_Trigger_Instance* Trigger Instance fires, i.e. to populate the *Client_SM_Im__tick__received* function stub.

```
void Client_Module_Im__tick__received(Client_Module_Im__context *context)
{
   ECOA__global_time time;
   ECOA__return_status return_status;
   example__value_type val;
   ECOA__log log;

   return_status = Client_Module_Im_container__get_absolute_system_time(context,
&time);

   val = 0;

   log.current_size = sprintf((char *) &log.data, "val before request = %d", val);
   Client_Module_Im_container__log_info(context, log);

   return_status = Client_Module_Im_container__Request_Val__request_sync(context,
&time, &val);

   log.current_size = sprintf((char *) &log.data, "val from response = %d", val);
   Client_Module_Im_container__log_info(context, log);
}
```

That is, the *val* variable is zeroed and logged prior to invoking the *Client_Module_Im_container__Request_Val__request_sync* API, and because a synchronous Request-Response call is made, the response (in variable *val*) is immediately available to log.

Program Output

When the ECOA "*Simple Example*" Assembly is built and run (in a single Node deployment), an output similar to Figure 7 should be achieved. The *Client* ASC outputs, at each iteration, both the value before sending the request message, and the value after receiving the response.


ecos@fedora:/mnt/D_DRIVE/git/Examples/ECOA_Simple_Example/Steps/output/Example
File Edit View Search Terminal Help

```
[ecos@fedora Ex1]$ ./Ex1
alive - sent PD status
"1495447561 seconds, 880888588 nanoseconds":0:"INFO":"nodeName":"Ex1":"val befor
e request = 0"
"1495447561 seconds, 881036373 nanoseconds":0:"INFO":"nodeName":"Ex1":"val from
response = 10"
"1495447563 seconds, 880345619 nanoseconds":0:"INFO":"nodeName":"Ex1":"val befor
e request = 0"
"1495447563 seconds, 880400398 nanoseconds":0:"INFO":"nodeName":"Ex1":"val from
response = 10"
alive - sent PD status
"1495447565 seconds, 880510091 nanoseconds":0:"INFO":"nodeName":"Ex1":"val befor
e request = 0"
"1495447565 seconds, 880510331 nanoseconds":0:"INFO":"nodeName":"Ex1":"val from
response = 10"
"1495447567 seconds, 881033105 nanoseconds":0:"INFO":"nodeName":"Ex1":"val befor
e request = 0"
"1495447567 seconds, 881122091 nanoseconds":0:"INFO":"nodeName":"Ex1":"val from
response = 10"
"1495447569 seconds, 880419755 nanoseconds":0:"INFO":"nodeName":"Ex1":"val befor
e request = 0"
"1495447569 seconds, 880483963 nanoseconds":0:"INFO":"nodeName":"Ex1":"val from
response = 10"
alive - sent PD status
```

Figure 7 - ECOA "*Simple Example*" in Execution

References

1	European Component Oriented Architecture (ECOA) Collaboration Programme: Architecture Specification (Parts 1 to 11) "ECOA" is a registered trade mark.
2	Client-server model *https://en.wikipedia.org/wiki/Client%E2%80%93server_model*