

Software Architecture in Action

Flavio Oquendo, Jair C Leite, Thais Batista



Chapter 14

Client-Server Architectural Style

Learning outcomes of this chapter

■ You will learn:

- what is a Client-Server architectural style
- what are its elements, structure and behavior

The structure of this chapter

- Conceptual Overview
- An Example of Client-Server in RTC System
- Client-Server structural viewpoint
- Client-Server behavioral viewpoint
- Summary



Conceptual Overview

Client-Server

Conceptual overview

- In a Client-Server style, components and connectors have a particular behavior
 - Components called “clients” send requests to the server and wait for a reply
 - A component called “server” receives a request from a client and sends it the reply
- An example of client-server style is the use of a component – the client – that requests to the controller the average temperature. The controller is a server that provides the temperature value as a reply to the client component.

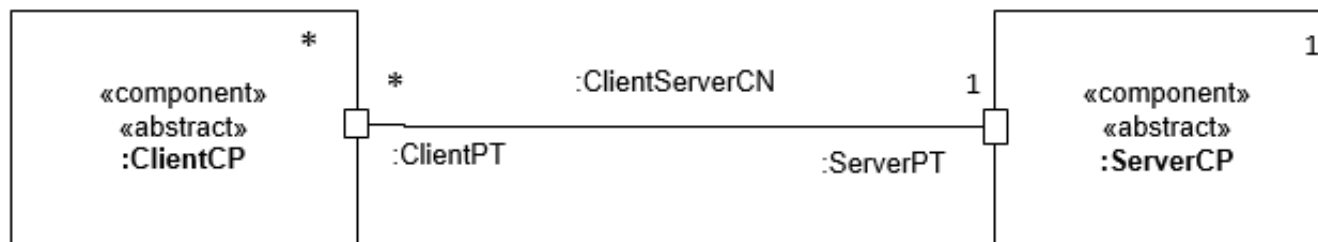
Client-Server

Use in SysADL

Client-Server Use

- We can use the Client/Server style to model a part of the system that has many components sending requests to another that offer services
 - The ClientCP component sends requests to a server using the ClientServerCN connector
 - The ServerCP component offers services to reply the clients requests
 - There is only one server and zero or more clients
 - The ClientServerCN is a composite connector (next slide)

Use in SysADL



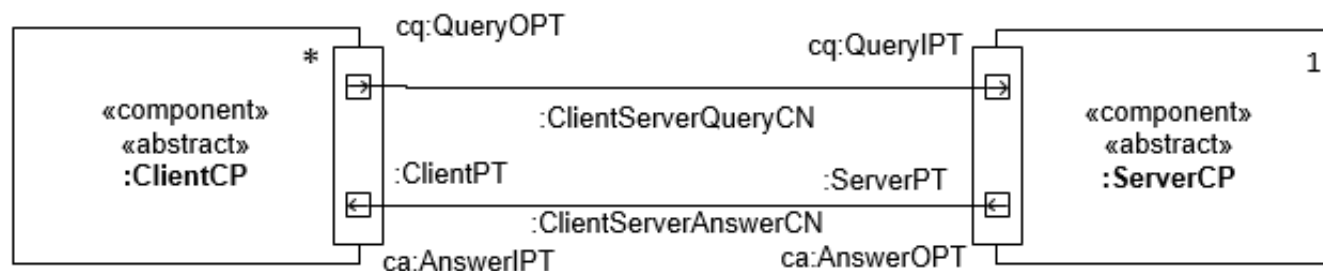
Client-Server

Use in SysADL

Client-Server Use (continued)

- The *ClientPT* port is composed by one out port, *cq:QueryOPT*, and one in port *ca:AnswerIPT*
- The *ServetPT* port is composed by one out port, *cq:QueryIPT*, and one in port *ca:AnswerOPT*
- The *ClientServerQueryCN* connector links the *cq:QueryOPT* port to the *cq:QueryIPT* port
- The *ClientServerAnswerCN* connector links the *cq:AnswerOPT* port to the *cq:AnswerIPT* port

Use in SysADL



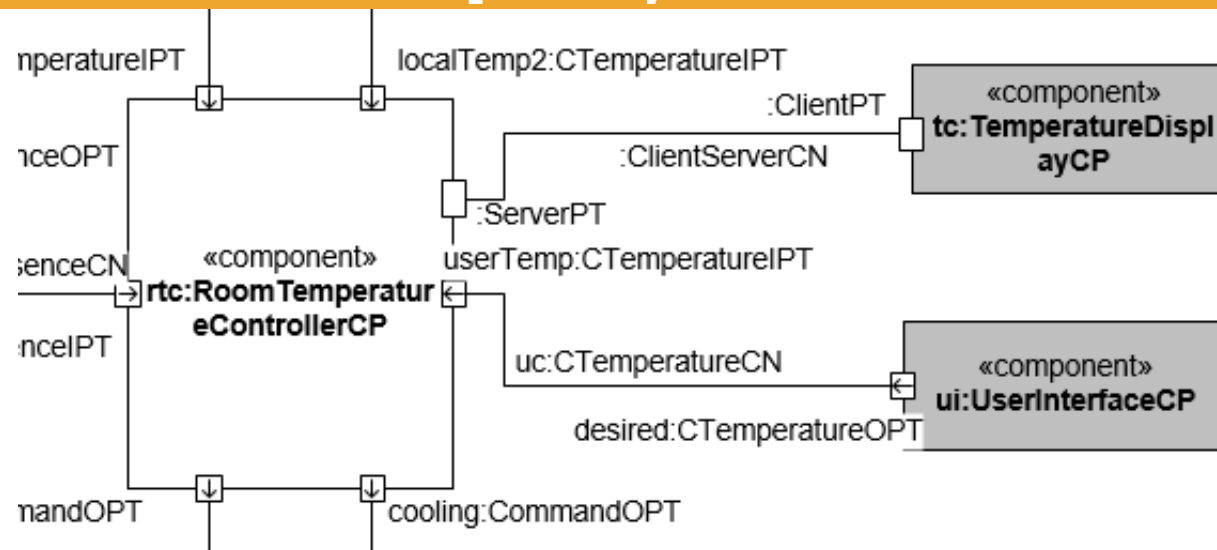
Client-Server

Example in SysADL – 1/2

Client-Server Example

- In this example, we add a new component that is a client to display the current room average temperature
- TemperatureDisplayCP sends a query via the ClientServerCN composite connector and waits for the answer
- The ServerPT port is a composite proxy port to an internal component that store the last current average temperature (next slide)

Example in SysADL



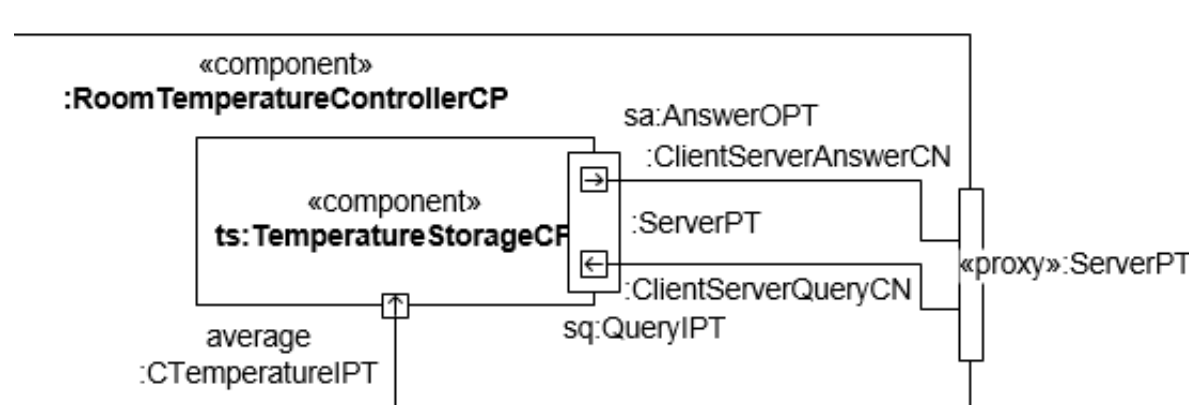
Client-Server

Example in SysADL

Client-Server Example

- The TemperatureStorageCP internal component is the server in this example
 - it receives the average temperature from the SensorsMonitorCP (not shown here) in its average port
 - when it receives a query in its sq:QueryIPT port, it sends the average temperature in its sa:QueryOPT port

Example in SysADL





Client-Server Structural Viewpoint

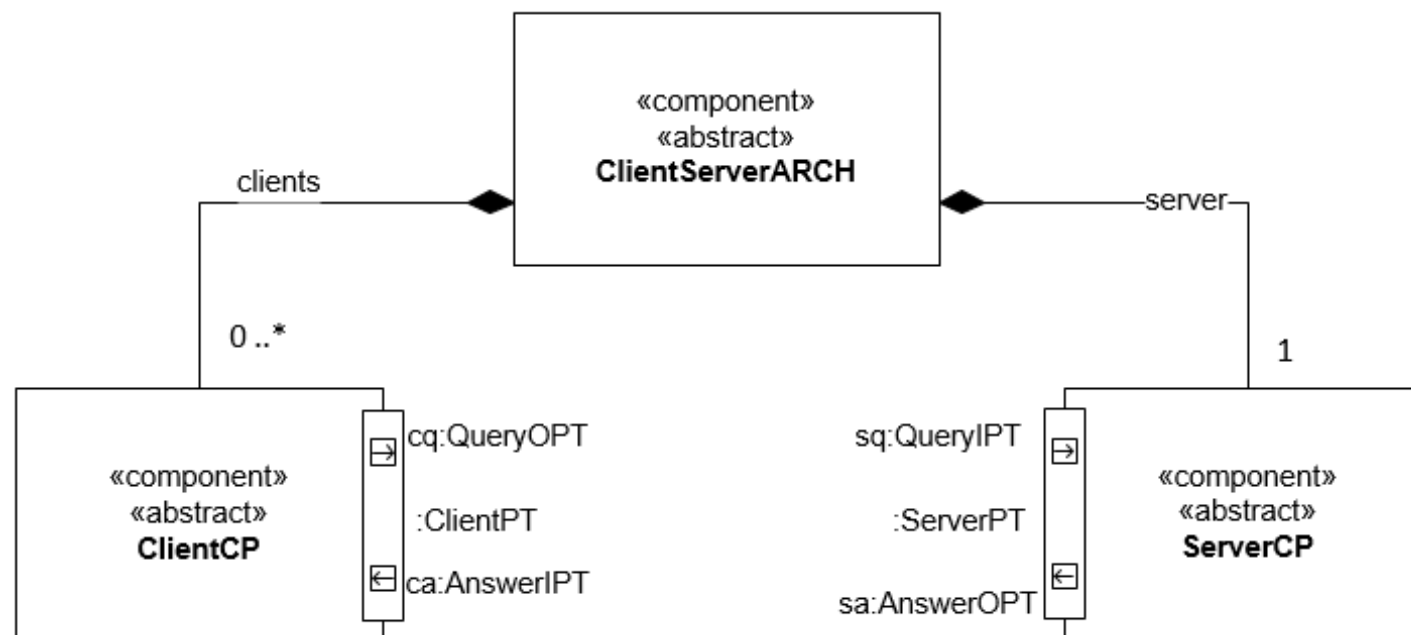
Client-Server Components

Components in SysADL

Client/Server Component

- We define the Client-Server architectural style using the bdd
 - The Client-Server Architecture Style (ClientServerARCH) is composed of one ServerCP component and zero or more ClientCP

Component Definition in SysADL



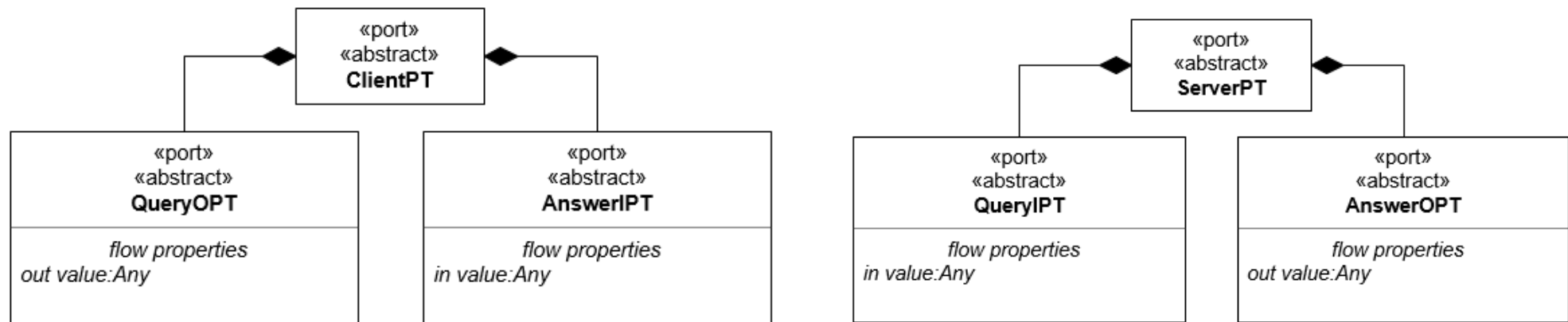
Client-Server Ports

Ports Definition in SysADL

Client-Server Ports Definition

- In the Client-Server architectural style definition, we must also define the ports
 - The ClientPT port is composed by a QueryOPT out port and an AnswerIPT in port. Both ports allow values of any type
 - The ServerPT port is composed by an AnswerOPT out port and a QueryIPT in port. Both ports allow values of any type

Ports in SysADL



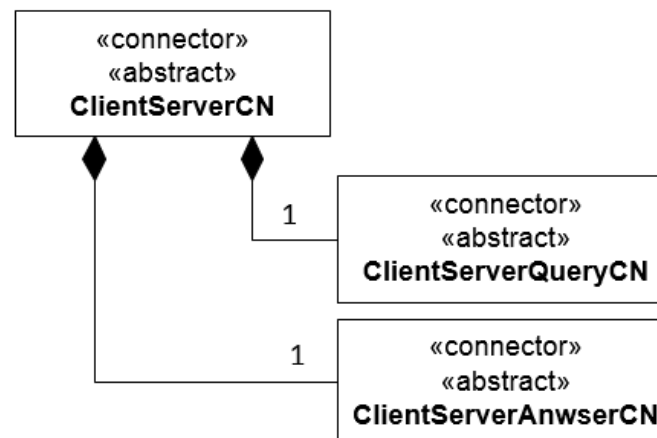
Client-Server Connectors

Connectors in SysADL – 1/3

Client-Server Connectors Definition

- In the Client-Server architectural style definition, we must also define the ClientServerConnectorCN connector
 - it is composed of two connectors: ClientServerQueryCN and ClientServerAnswerCN
 - each connector is linked to the composite ports of the ClientCP and ServerCP components

Client-Server Connectors in SysADL



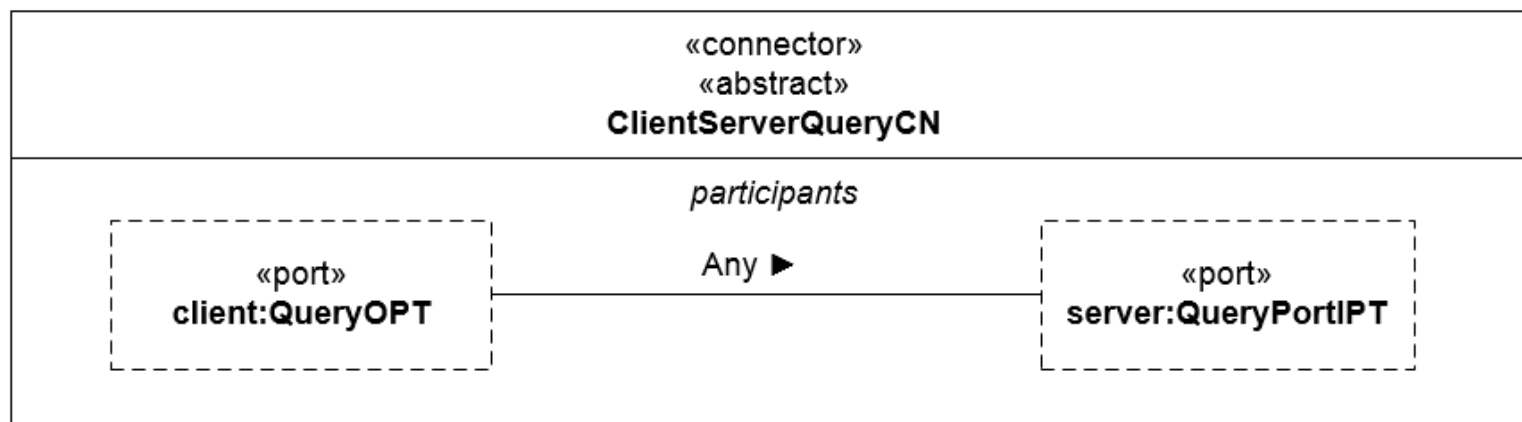
Client-Server Connectors

Connectors in SysADL – 2/3

Client-Server Connectors Definition

- Continued...
 - the *ClientServerQueryCN* connector has two participants ports: *client:QueryOPT* and *server:QueryPortIPT*
 - the connector conveys data of any type from the *client* port to the *server* port.

Client-Server Connectors in SysADL



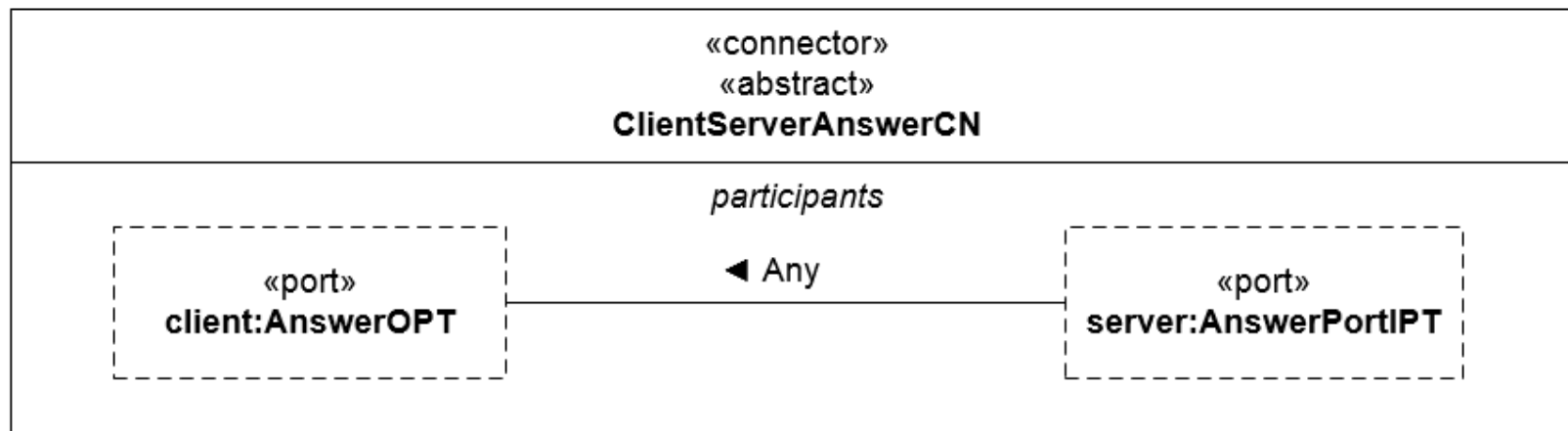
Client-Server Connectors

Connectors in SysADL – 3/3

Client-Server Connectors Definition

- Continued...
 - the *ClientServerAnswerCN* connector has two participants ports: *client:AnswerOPT* and *server:QueryAnswerIPT*
 - the connector conveys data of any type from the *server* port to the *client* port.

Client-Server Connectors in SysADL





Client-Server Behavioral Viewpoint

Client-Server Behavior

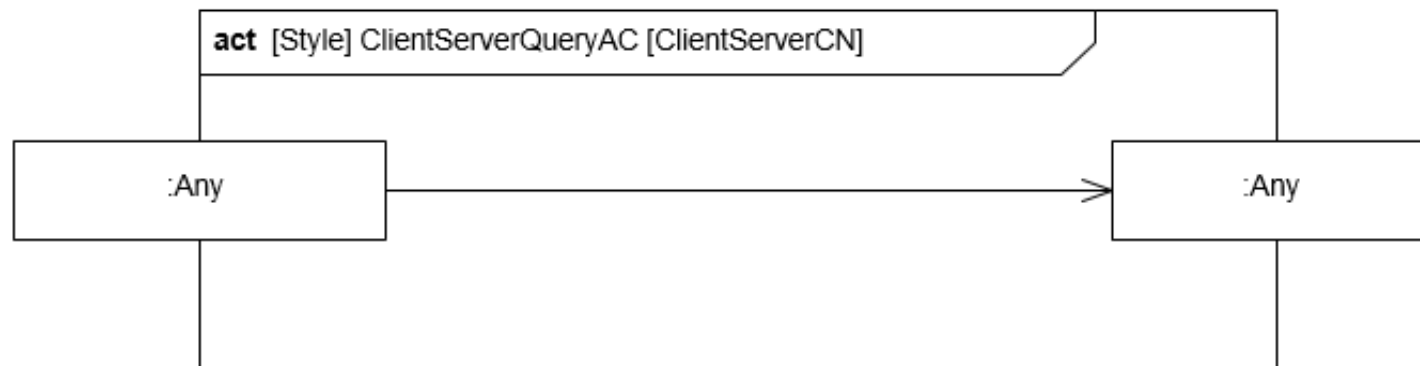
Connector Behavior in SysADL

Client-Server Connector Behavior

- We define the behavior of the ClientServerCN connector by defining the behavior of two compound connectors:
 - we define the behavior ClientServerQueryCN connector using the activity diagram (ClientServerQueryAC)
 - The connector sends to its out pin any data received in its in pin

Client-Server Behavior in SysADL

■



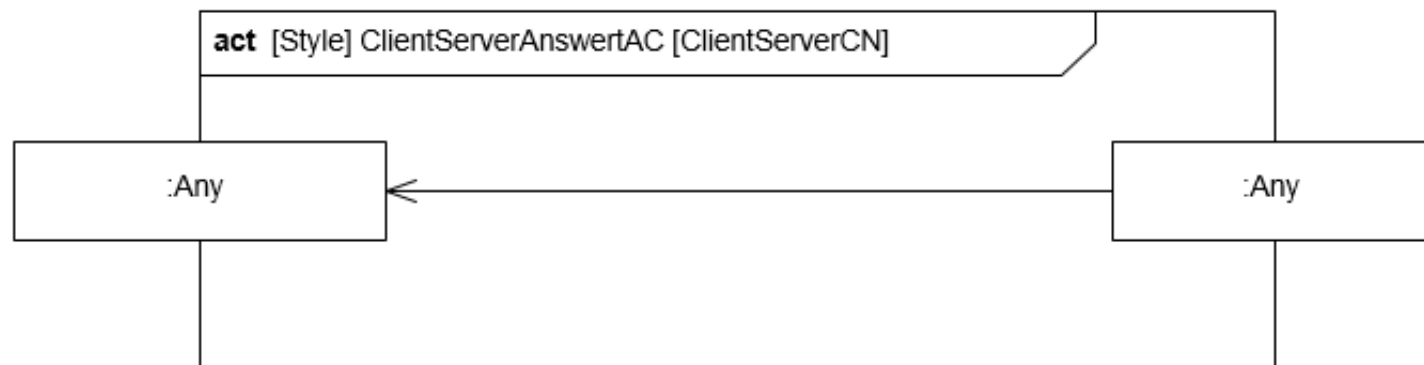
Client-Server Behavior

Connector Behavior in SysADL

Client-Server Connector Behavior

- Here we define the other connector:
 - we define the behavior ClientServerAnswerCN connector using the activity diagram (ClientServerAnswerAC)
 - The connector sends to its out pin any data received in its in pin

Client-Server Behavior in SysADL



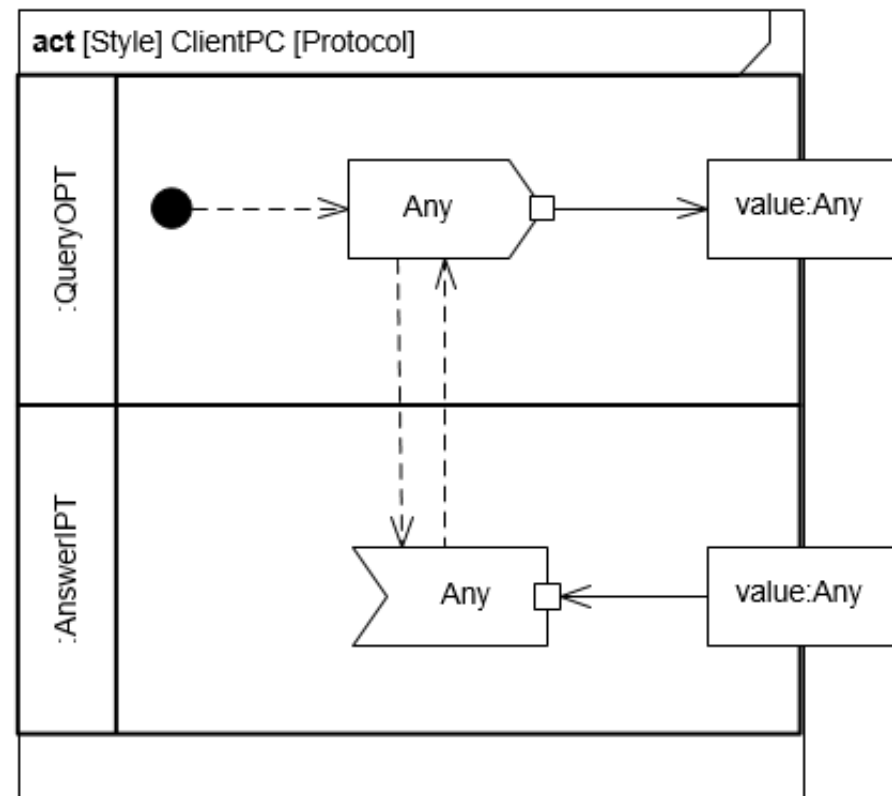
Client-Server Behavior

Port Protocol – 1/4

Client-Server Ports Protocol

- We define the protocols of the ports using activity diagrams
- Since we have two composite ports, we define the protocol of the composite port and the protocols of the individual ports
- Here, we define the protocol of the ClientPT port
 - the QueryOPT internal port initiates by sending a value of any type to its out pin and it waits until the AnswerIPT receives data
 - the AnswerIPT internal port receives data from its in pin and gives the control to the QueryOPT port

Port Protocol in SysADL



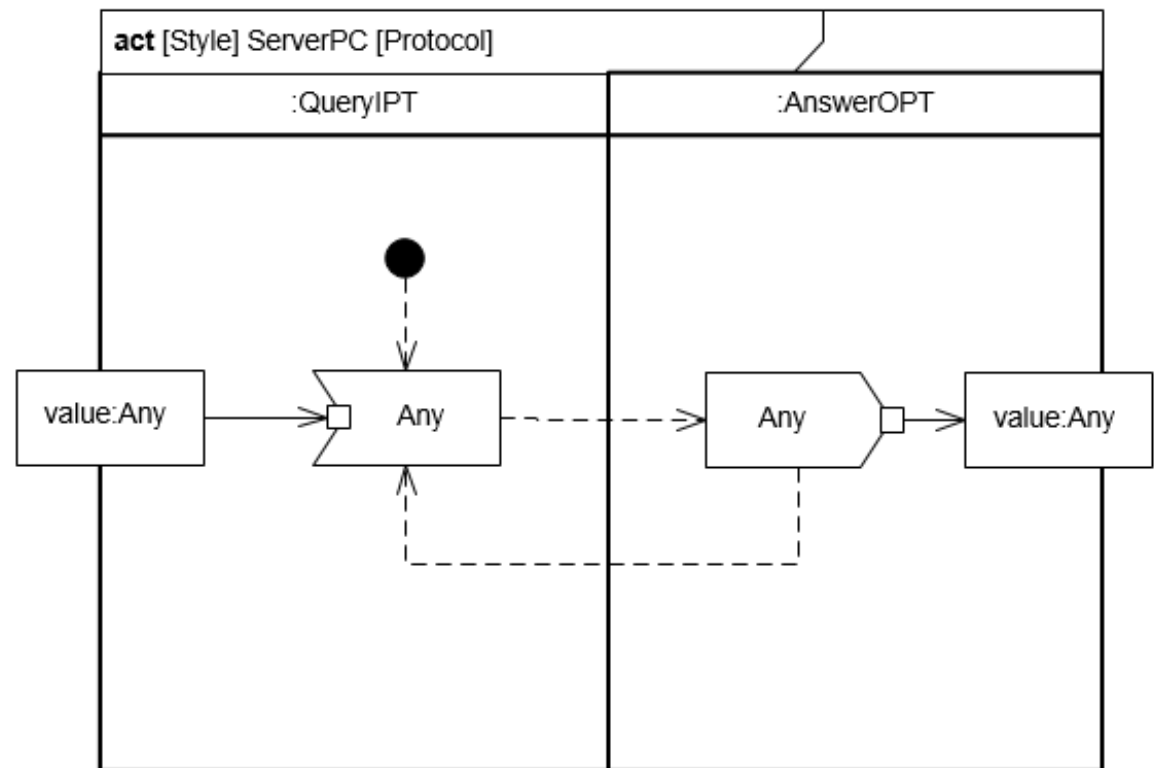
Client-Server Behavior

Port Protocol – 2/4

Client-Server Ports Protocol

- Continued...
- Here, we define the protocol of the ServerPT port
 - the QueryIPT internal port initiates by receiving a value of any type from its in pin
 - then, the control is given to the AnswerOPT internal port to send data (the answer) to its out pin
 - finally, it gives back the control to the QueryIPT port

Port Protocol in SysADL



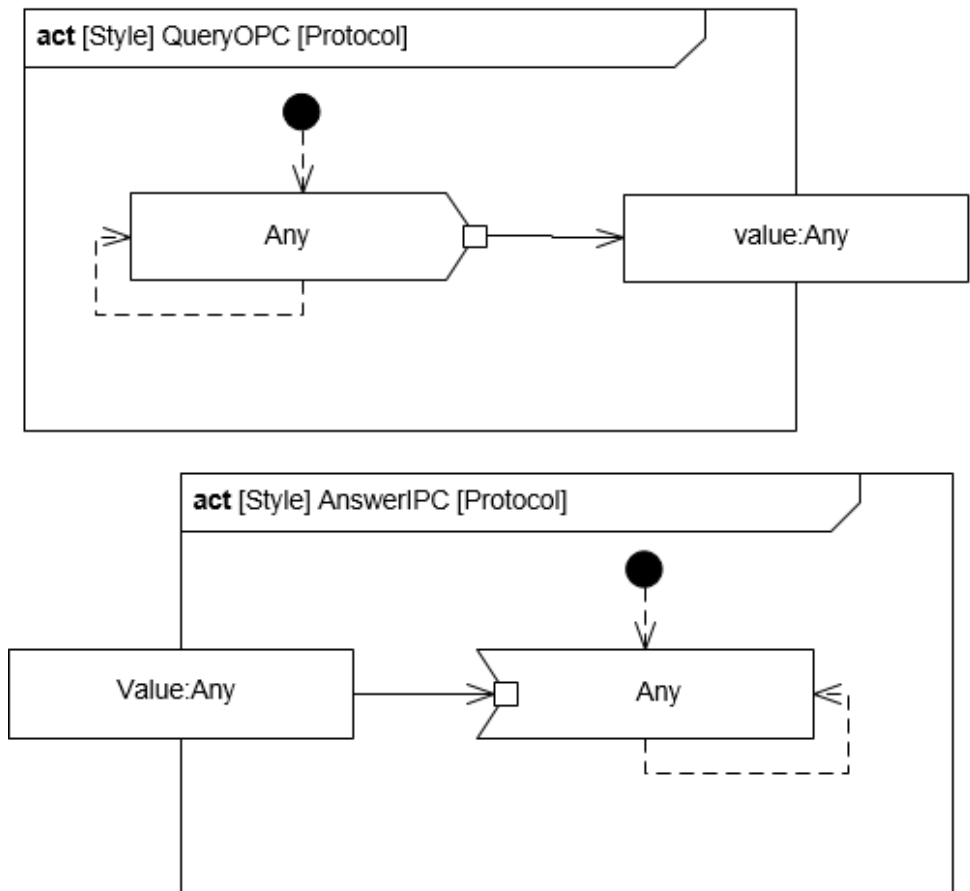
Client-Server Behavior

Port Protocol – 3/4

Client-Server Ports Protocol

- Continued...
- Here, we define the protocol of the internal ports
 - the QueryOPT internal port initiates by sending a value of any type to its out pin, and then it waits to send another value
 - the AnswerIPT internal port initiates by receiving data from its in pin, and then it waits to receive another value

Port Protocol in SysADL



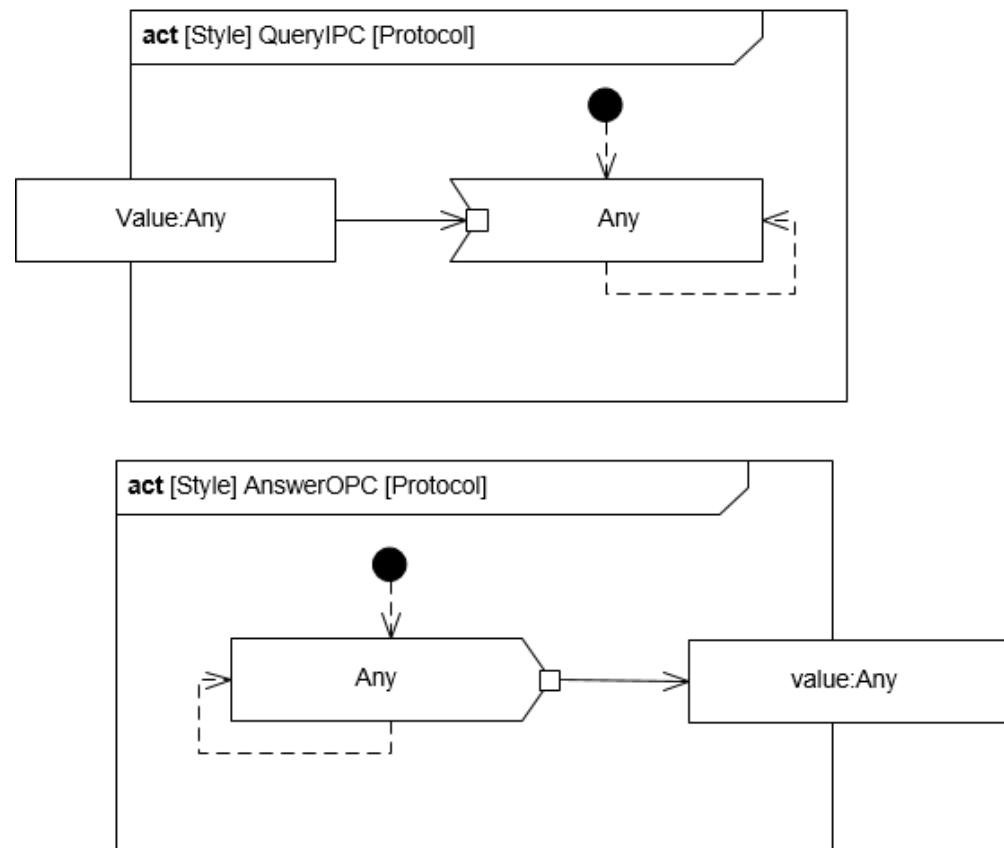
Client-Server Behavior

Port Protocol – 4/4

Client-Server Ports Protocol

- Continued...
- Here, we define the protocol of the internal ports
 - the QueryIPT internal port initiates by receiving a value of any type from its in pin, and then it waits to receive another value
 - the AnswerOPT internal port initiates by sending data to its out pin, and then it waits for another value to send

Port Protocol in SysADL



Summary

- In this chapter you learnt
 - the Client-Server architectural style
 - the elements, structure and behaviour of the Client-Server style
- You learnt how to:
 - apply the Client-Server in a software architecture design

For Further Reading

- Clements, P.; Bachmann, L.; Garlan, D.; Ivers, J.; Little, R.; Merson, P.; Nord, R. Documenting Software Architecture: Views and Beyond. SEI Series in Software Engineering. (2003)
- Buschmann, F., Meunier, R., Rohnert, H. Sommerlad, P., Michael Stal, M. Pattern-Oriented Software Architecture Volume 1: A System of Patterns. Vol. 1. Wiley (1996).