

# Software Architecture in Action

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# Chapter 15

## Feedback-Control-Loop Architectural Style

# Learning outcomes of this chapter

## ■ You will learn:

- what is a Feedback Control Loop architectural style
- what are its elements, structure and behavior

# The structure of this chapter

- Conceptual Overview
- Feedback Control Loop structural viewpoint
- Feedback Control Loop behavioral viewpoint
- Summary



# Conceptual Overview

# Feedback Control Loop

## Conceptual overview – 1/2

- In a Feedback Control Loop style components and connectors are configured to allow a central component to control several actuators by analyzing information from sensors
  - Sensors read information from environment
  - Actuators change the environment
  - Information from controller is a feedback loop that the controller use to act in the environment

# Feedback Control Loop

## Conceptual overview – 1/2

- An example of the Feedback-Control-Loop style is the RTC System that we have been using in this book.
  - The sensors monitor the temperature and the presence of persons in the room.
  - The heater and cooler are the actuators that change the temperature heating or cooling the room.
  - The controller controls the temperature by turning the heater or the cooler on or off according to the current temperature, the desired temperature and the presence of a person in the room.

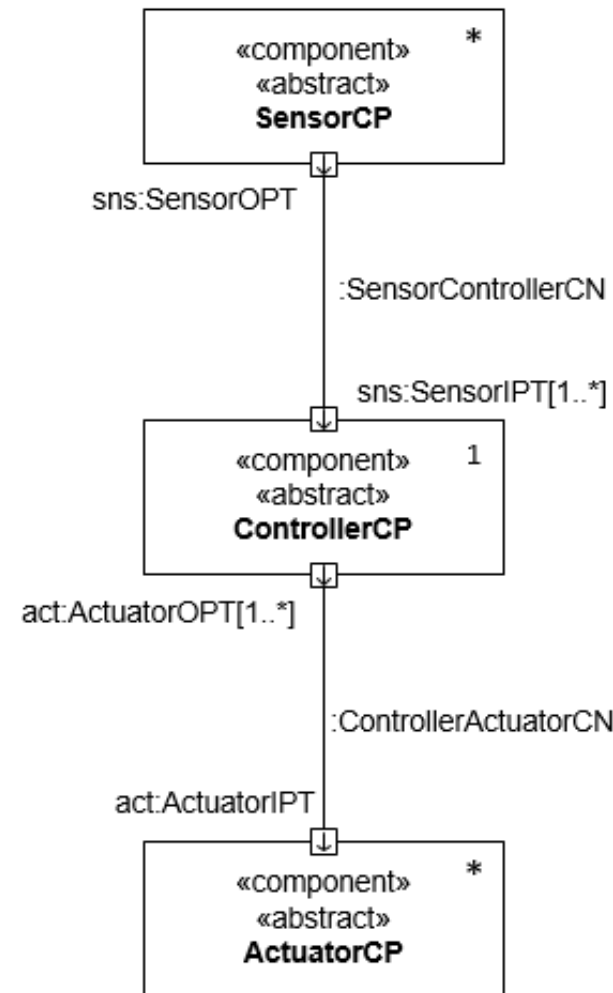
# Feedback Control Loop

## Use in SysADL

### Feedback Control Loop Use

- We can use the Feedback Control Loop style to model a part of the system that has a central controller to control one or more actuators by using data from one or more sensors.
- the ControllerCP component receives data from one or more SensorCP components
- the ControllerCP component sends data to one or more

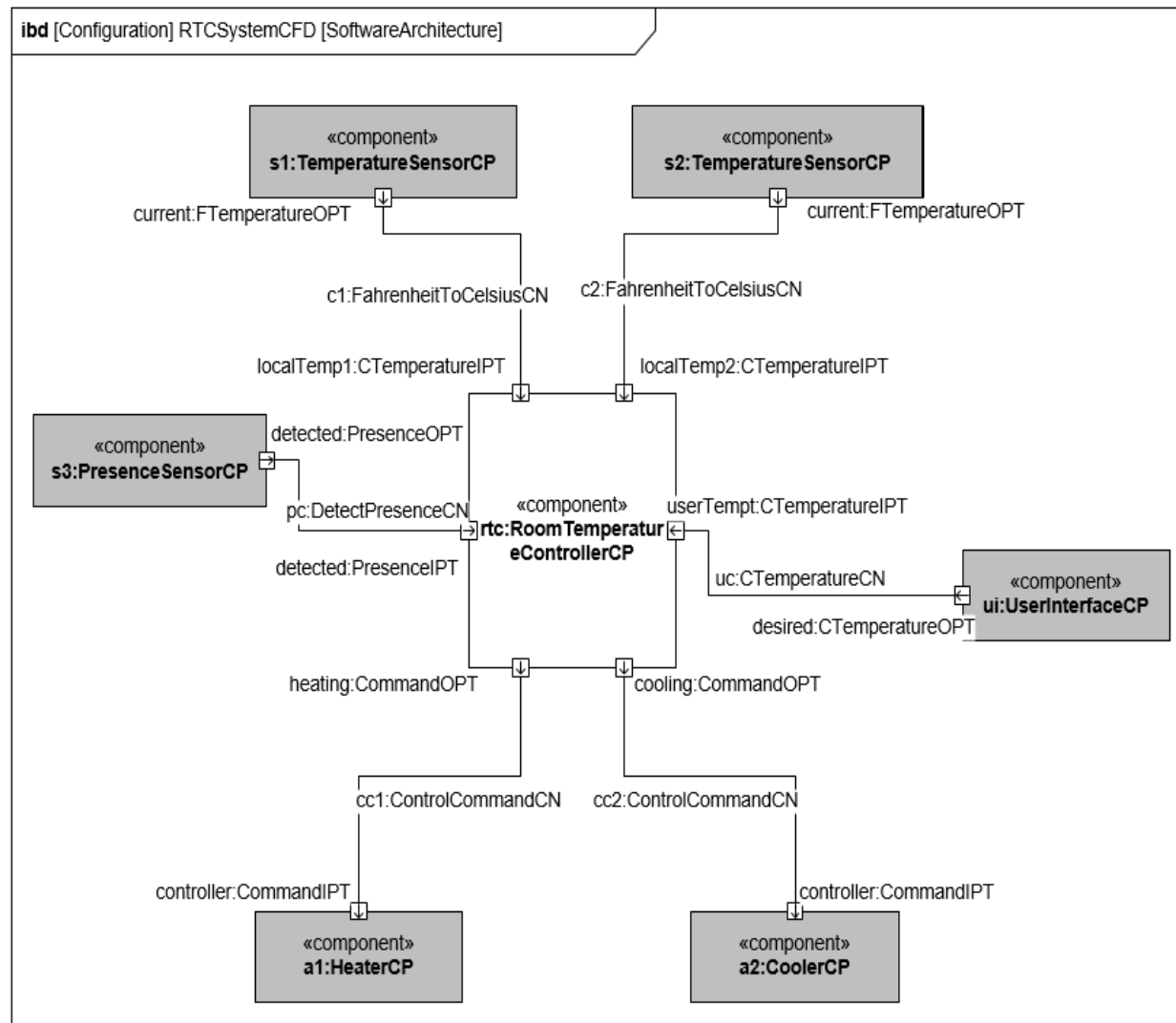
### Use in SysADL





# Feedback Control Loop

## Example in SysADL





# Feedback Control Loop Structural Viewpoint

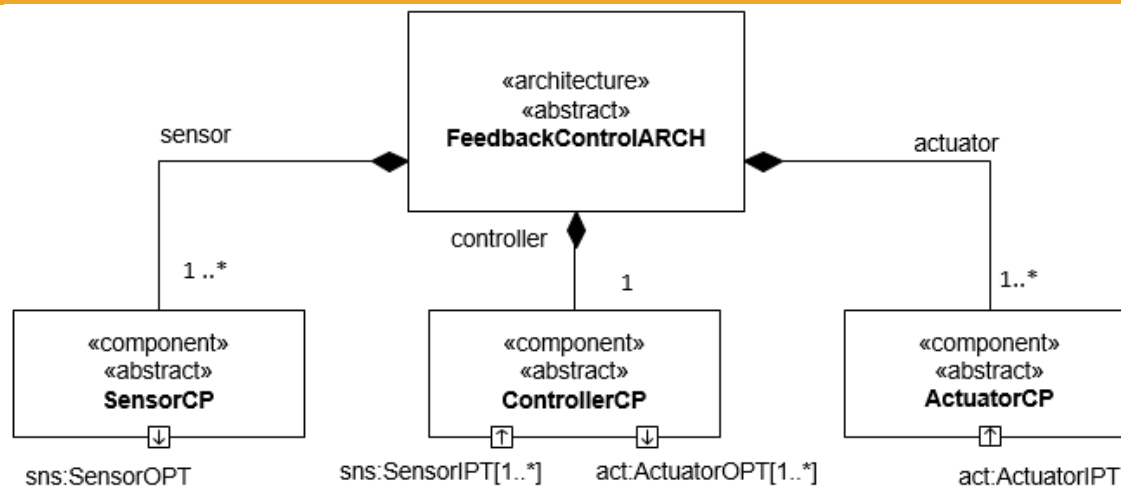
# Feedback Control Loop

## Components in SysADL

### Feedback Control Loop Component

- We define the Feedback Control Loop architectural style using the bdd
  - The Feedback Control Loop Architecture Style (FeedbackControlARCH) is composed by
    - one central ControllerCP component
    - one or more SensorCP component
    - one or more ActuatorCP component

### Component Definition in SysADL



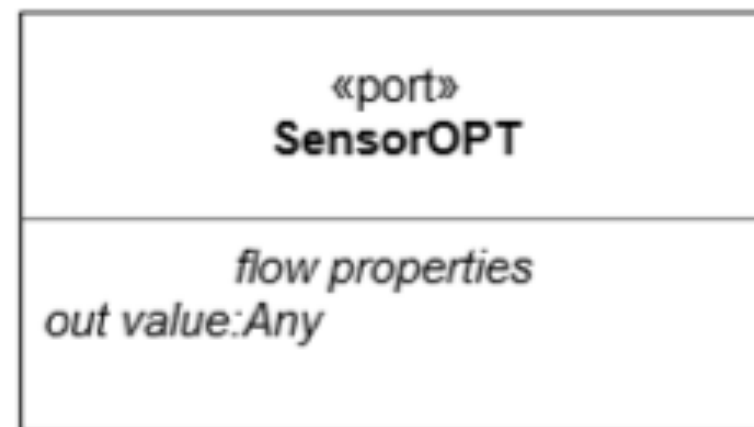
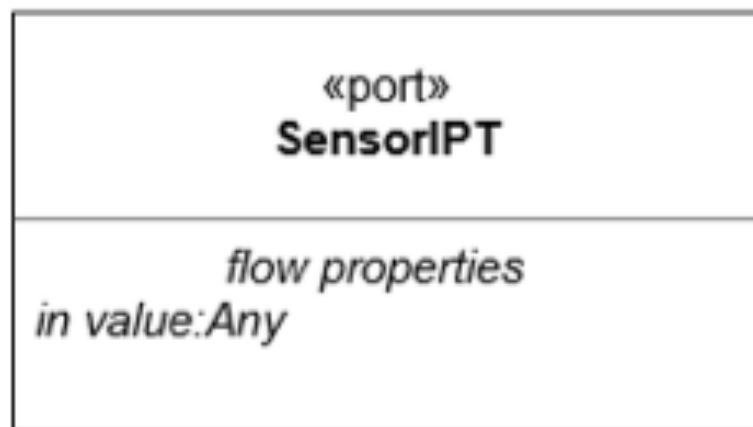
# Feedback Control Loop Ports

## Ports Definition in SysADL – 1/2

### Feedback Control Loop r Ports Definition

- In the Feedback Control Loop architectural style definition, we must also define the ports
  - the SensorCP component has an out port (SensorOPT) to provide data of any type
  - The ControllerCP component has one or more SensorIPT in port to receive data from.

### Ports in SysADL



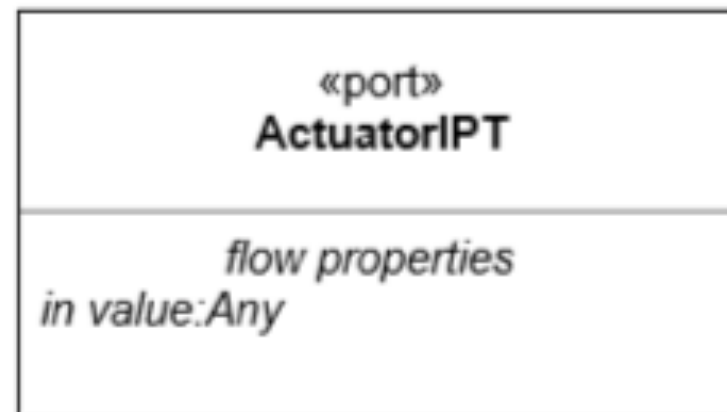
# Feedback Control Loop Ports

## Ports Definition in SysADL – 2/2

### Feedback Control Loop r Ports Definition

- In the Feedback Control Loop architectural style definition, we must also define the ports
  - the ActuatorCP component has an in port (ActuatorIPT) to receive data of any type
  - The ControllerCP component has one or more ActuatorOPT out port to send data to one or more actuators.

### Ports in SysADL

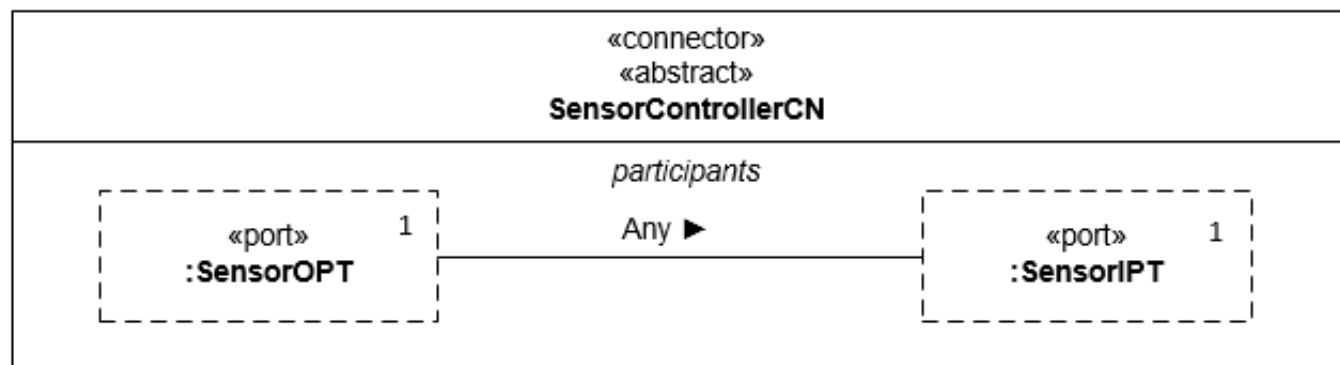


### Connectors in SysADL – 1/2

#### Feedback Control Loop Connectors Definition

- In the Feedback Control Loop architectural style definition, we must also define the connectors that link the ControllerCP to the other two components
- the SensorControllerCN connector conveys data of any type from the SensorOPT out port of the SensorCP component to the SensorIPT in port of the ControllerCP component

#### Definition in SysADL

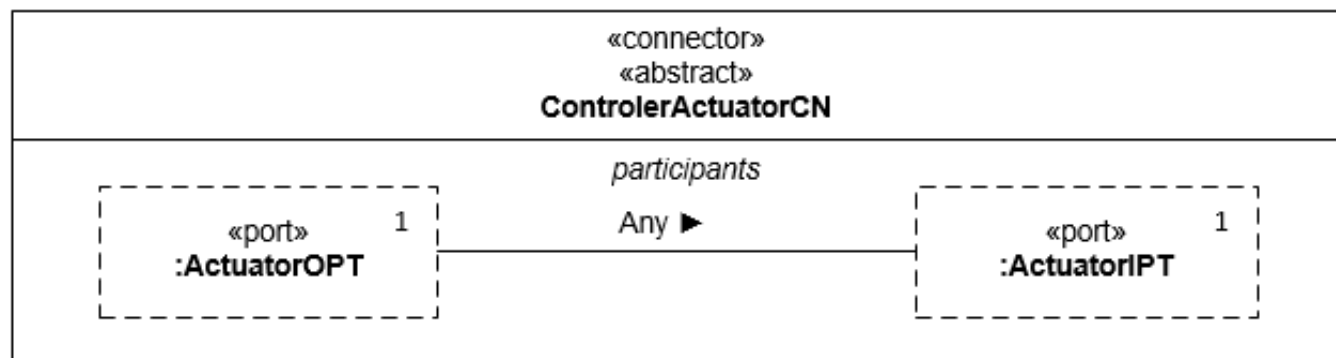


### Connectors in SysADL – 2/2

#### Feedback Control Loop Connectors Definition

- In the Feedback Control Loop architectural style definition, we must also define the connectors that link the ControllerCP to the other two components
- the ControllerActuatorCN connector conveys data of any type from the ActuatorOPT out port of the ControllerCP component to the ActuatorIPT in port of the ActuatorCP component

#### Definition in SysADL





# Feedback Control Loop Behavioral Viewpoint



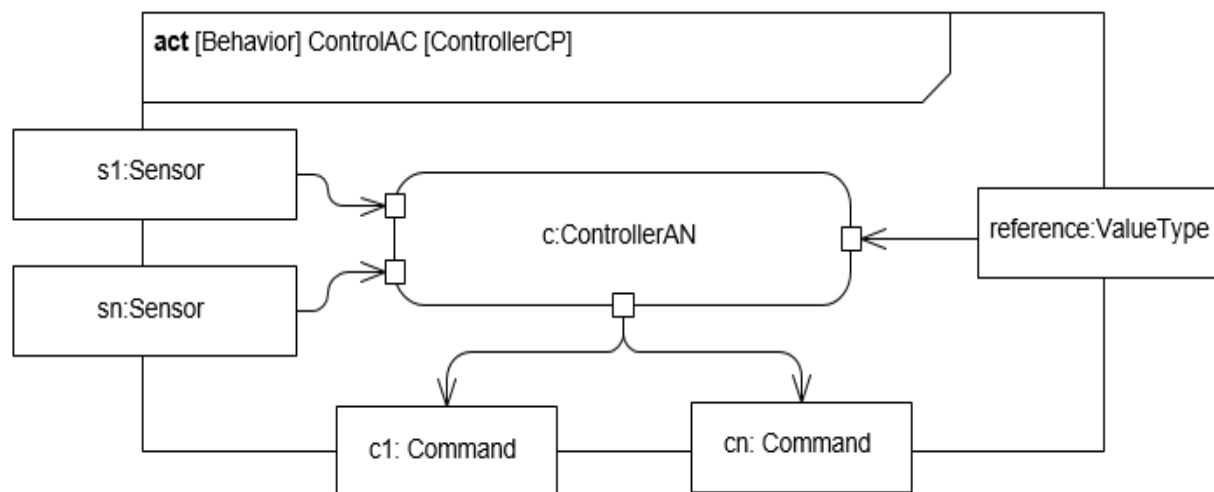
# Feedback Control Loop Behavior

## Behavior specification using activity diagram

### Feedback Control Loop Activity Diagram

- We can specify the behavior of a Feedback Control Loop style using activity diagrams
  - The behavior of the controller can be depicted in terms of one action, called *ControllerAN*
  - This action waits to read the data from all sensors, then decide the commands to send to the actuators.

### Behavior in SysADL



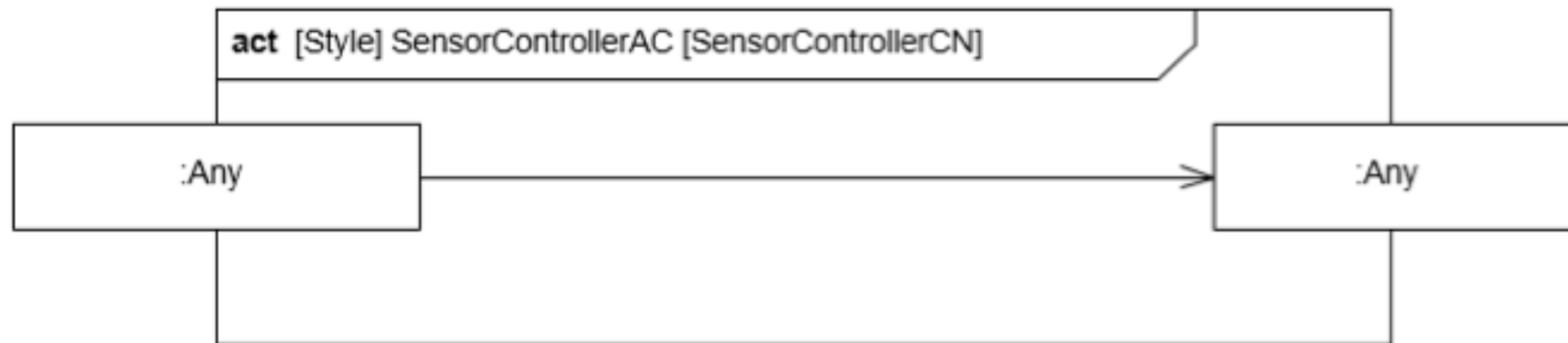
# Feedback Control Loop Behavior

## Connector Behavior in SysADL – 1/2

### Feedback Control Loop Connector Behavior

- We define two type of connectors
  - One of them is the SensorControllerCN connector links the sensors to the controller
  - Its behavior is very simple. It sends to its *out* pin any data received in its *in* pins

### Behavior in SysADL



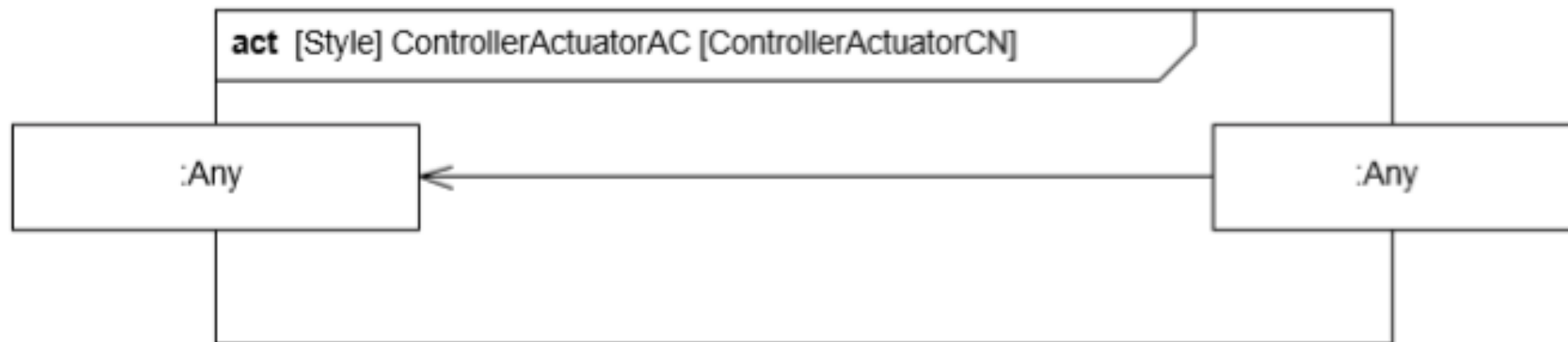
# Feedback Control Loop Behavior

## Connector Behavior in SysADL – 2/2

### Feedback Control Loop Connector Behavior

- The other component is the ControllerActuatorCN connector links the controller to the actuators.
- Its behavior is also very simple sending to its *out* pin any data received in its *in* pins

### Behavior in SysADL



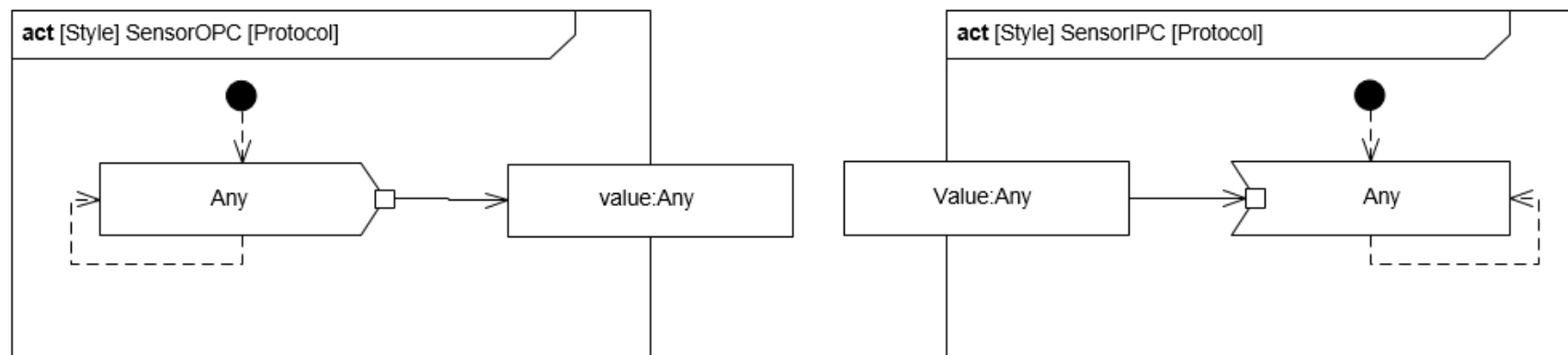
# Feedback Control Loop Behavior

## Port Protocol in SysADL – 1/2

### Port Protocol

- We define the protocols of the ports using activity diagrams
  - the SensorOPT port sends data to its out pin in sequence
  - the SensorIPT port receives data from its in pin in sequence

### Feedback Control Loop Ports Protocol



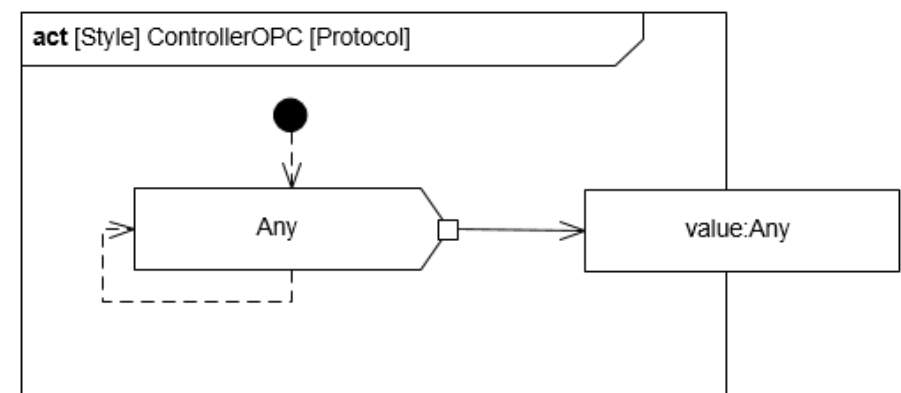
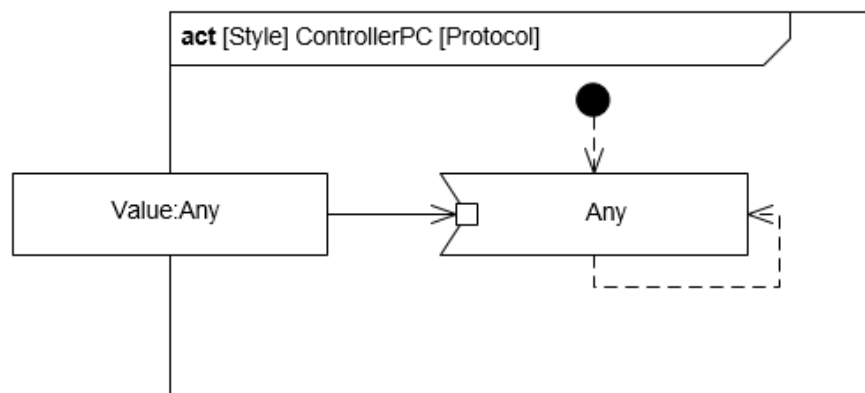
# Feedback Control Loop Behavior

## Port Protocol in SysADL – 2/2

### Port Protocol

- We define the protocols of the ports using activity diagrams
  - the ActuatorOPT port sends data to its out pin in sequence
  - the ActuatorIPT port receives data from its in pin in sequence

### Feedback Control Loop Ports Protocol



# Summary

- In this chapter you learnt
  - the Feedback Control Loop architectural style
  - the elements, structure and behavior of the Feedback Control Loop style
- You learnt how to
  - apply the Feedback Control Loop style in an 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).
- Vogel, O.; Arnold, I.; Chughtai, A.; Kehrer, T. Software Architecture: A Comprehensive Framework and Guide for Practitioners. Springer (2011)