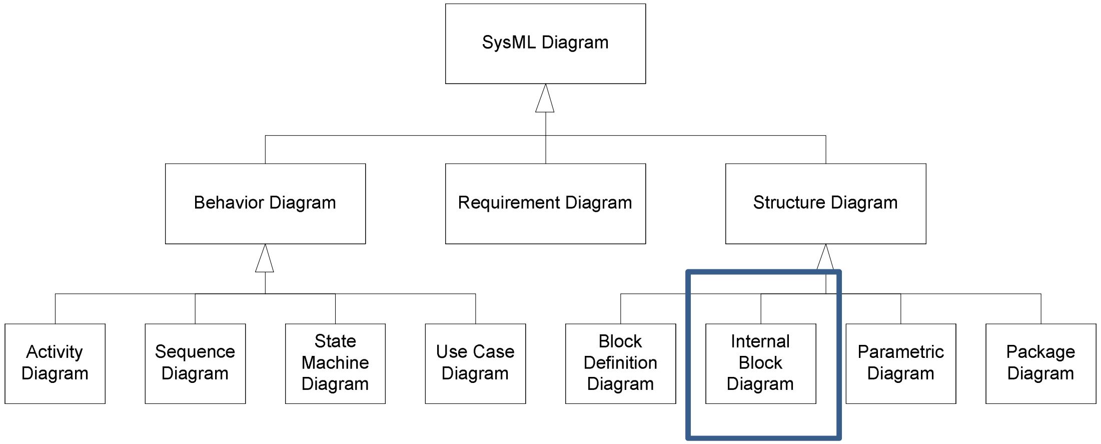
SysML Structural Diagrams 2

Introduction to Systems Engineering

I2ISE

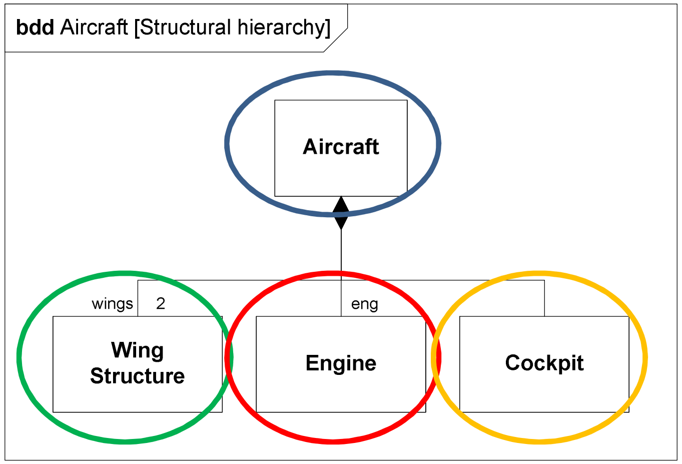
SysML
Internal Block Diagrams

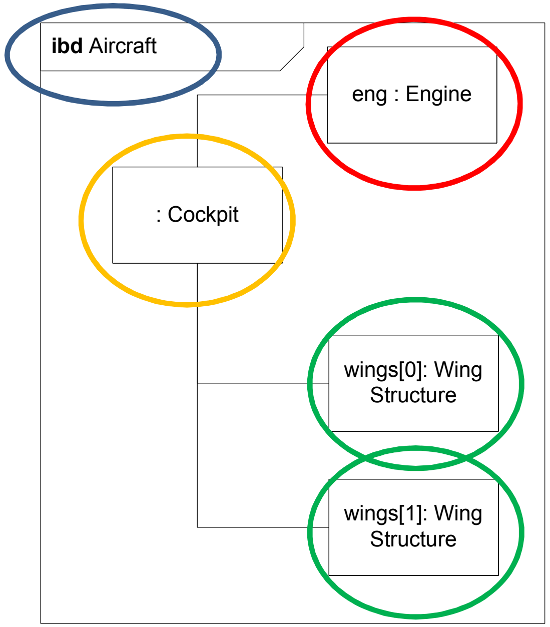


SysML: Internal Block Diagram

- An *Internal Block Diagram* (*ibd*) is used to define
  - the *interconnection* and *interfaces* of the parts of a block, and
  - the *information flow* between parts

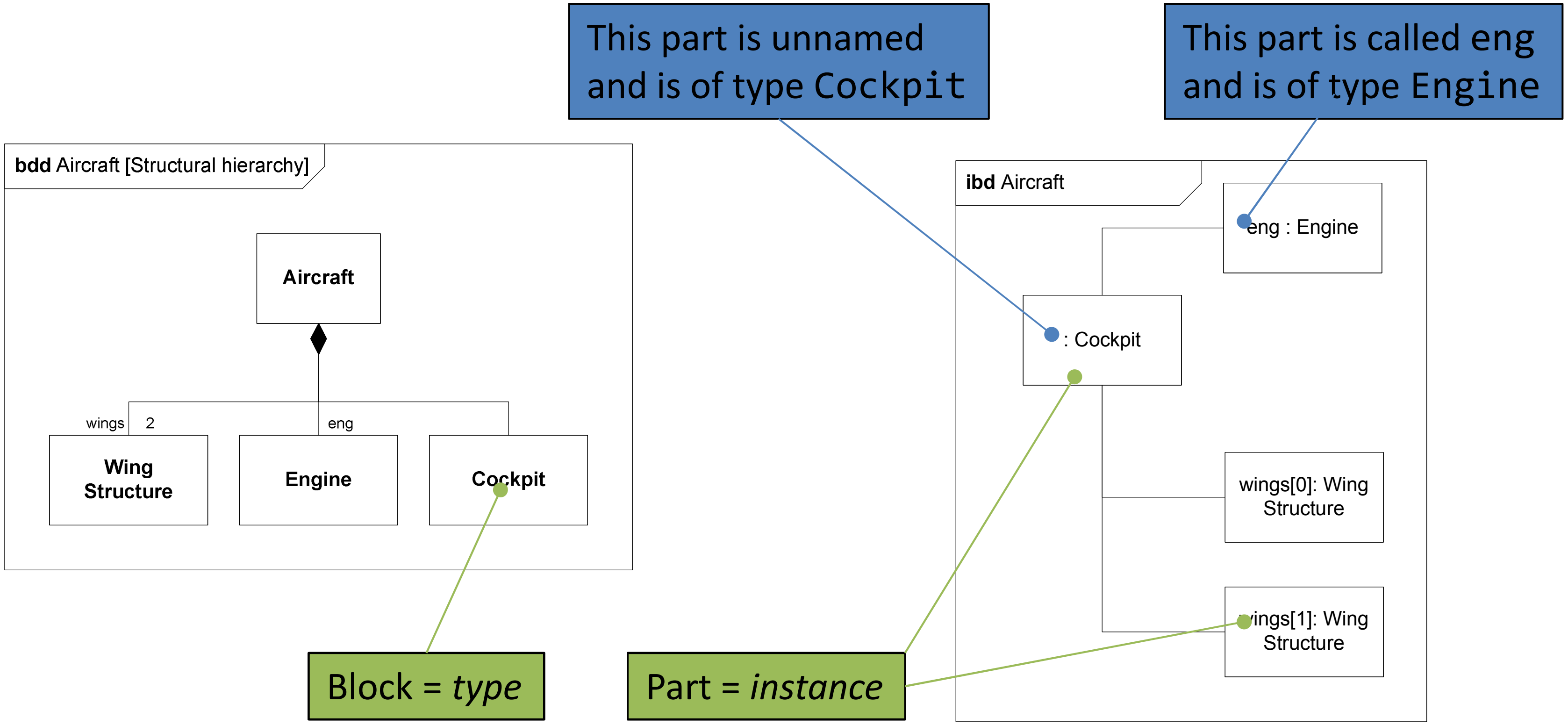
- An ibd always relates to a block on a bdd. It shows the internal connections of the block's constituents





SysML: Blocks and parts

- A block is a *type definition* – there can be only one block with a given name
- A part is an *instance* of a block – there can be many instances of the same block



This part is unnamed and is of type `Cockpit`

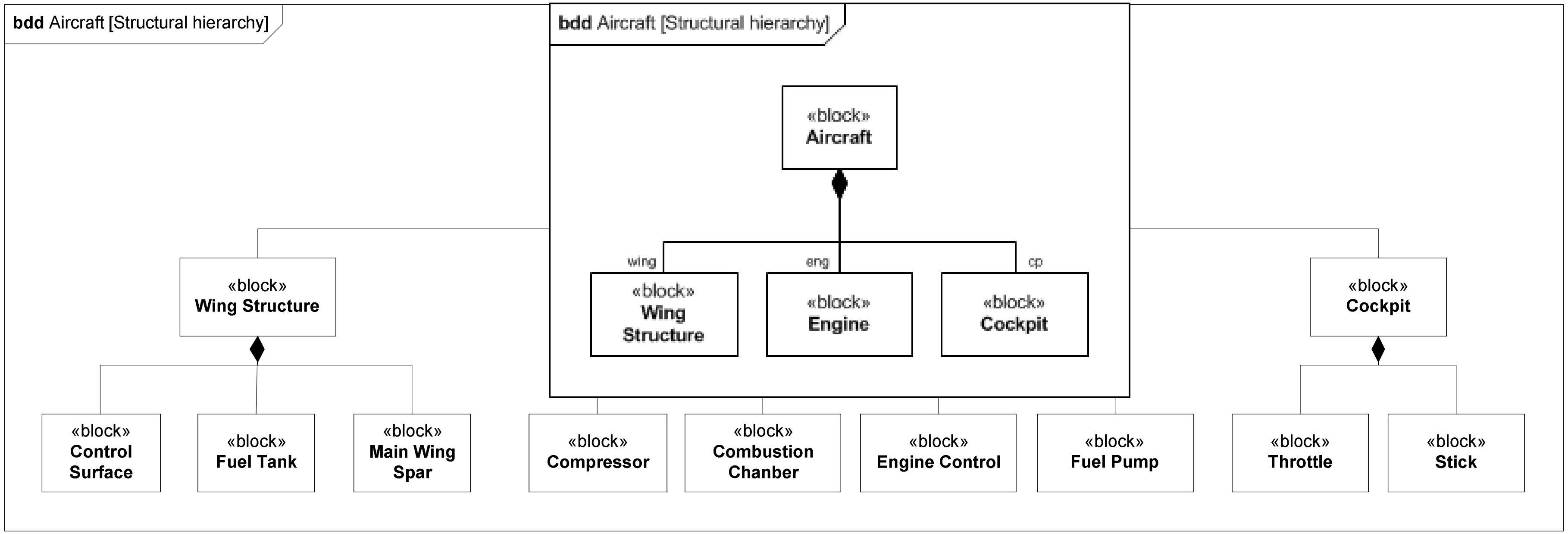
This part is called eng and is of type `Engine`

Block = *type*

Part = *instance*

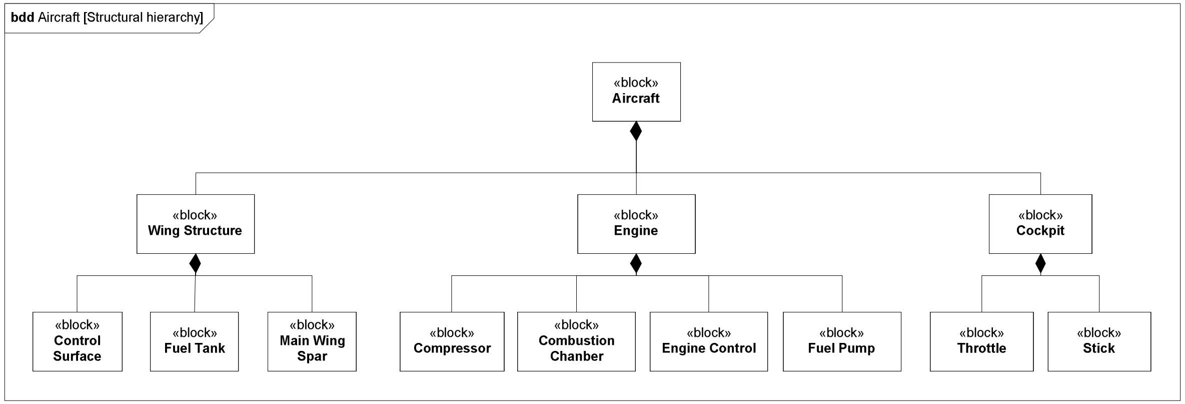
ibd: Aircraft - deep structure

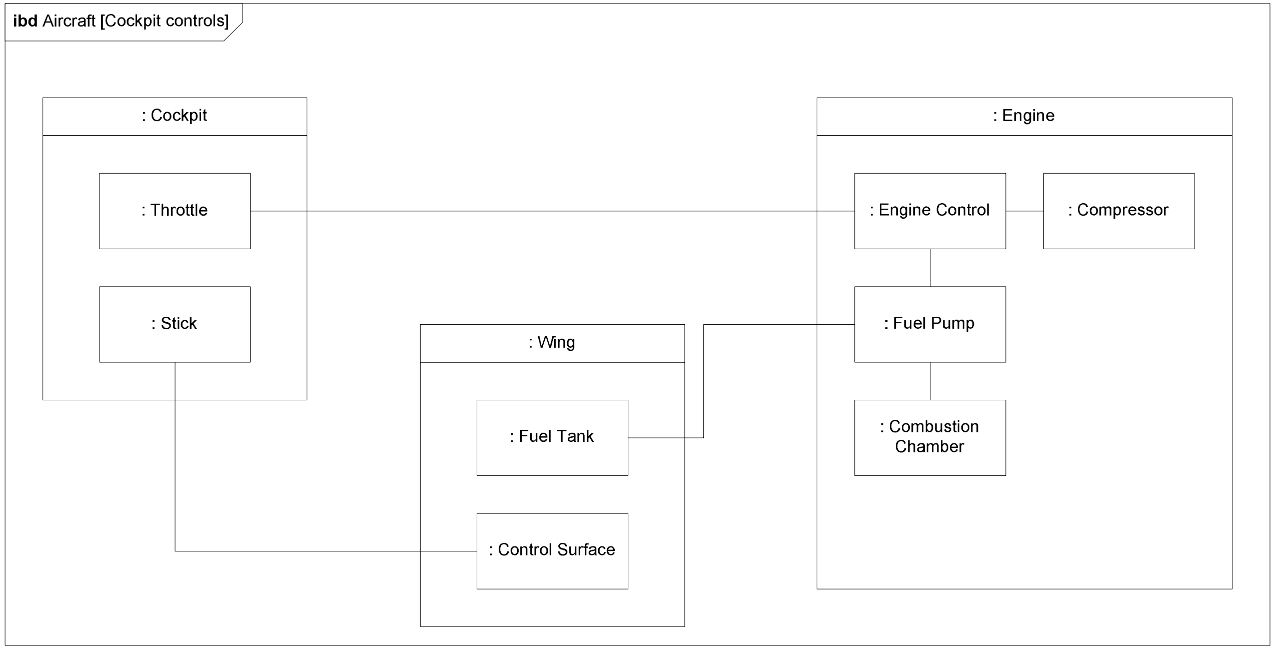
- Deep structure on a bdd can be shown in an ibd:



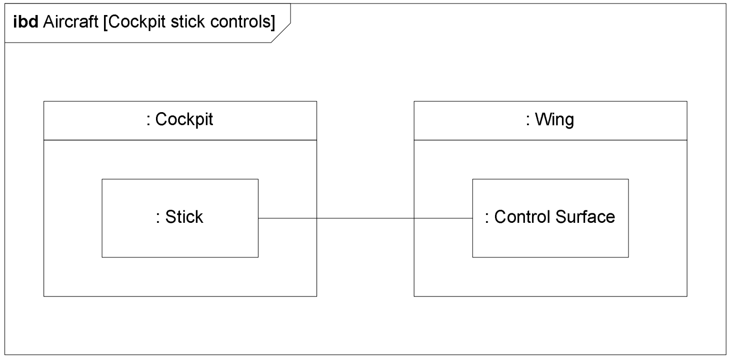
bdd Aircraft [Structural hierarchy]
bdd Aircraft [Structural hierarchy]
«block» **Aircraft**
wing
eng
cp
«block» **Wing Structure**
«block» **Engine**
«block» **Cockpit**
«block» **Wing Structure**
«block» **Cockpit**
«block» **Control Surface**
«block» **Fuel Tank**
«block» **Main Wing Spar**
«block» **Compressor**
«block» **Combustion Chanber**
«block» **Engine Control**
«block» **Fuel Pump**
«block» **Throttle**
«block» **Stick**

ibd: Aircraft - deep structure





ibd: Aircraft – better deep structure



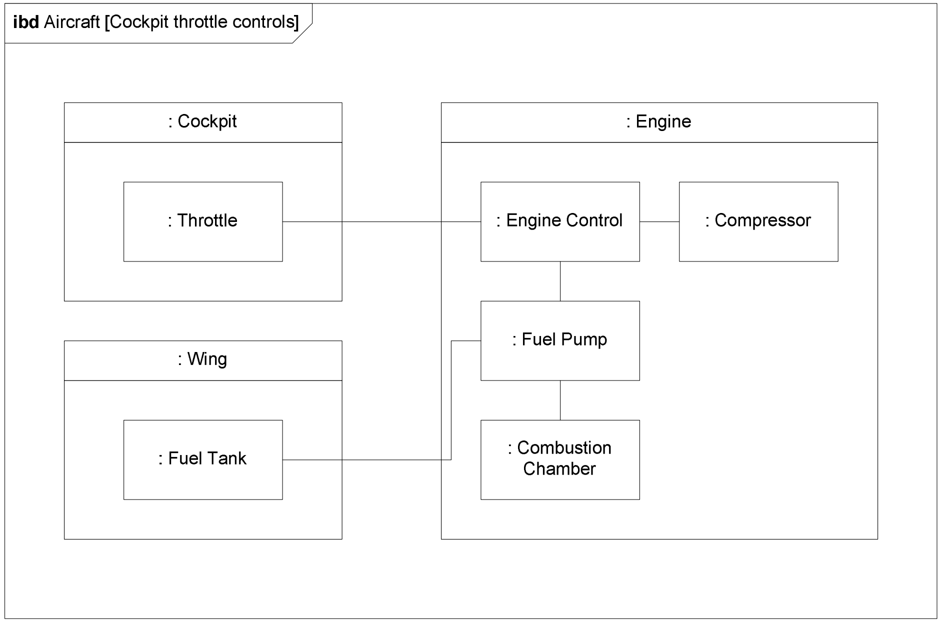
ibd Aircraft [Cockpit stick controls]

: Cockpit

: Stick

: Wing

: Control Surface



ibd Aircraft [Cockpit throttle controls]

: Cockpit

: Throttle

: Wing

: Fuel Tank

: Engine

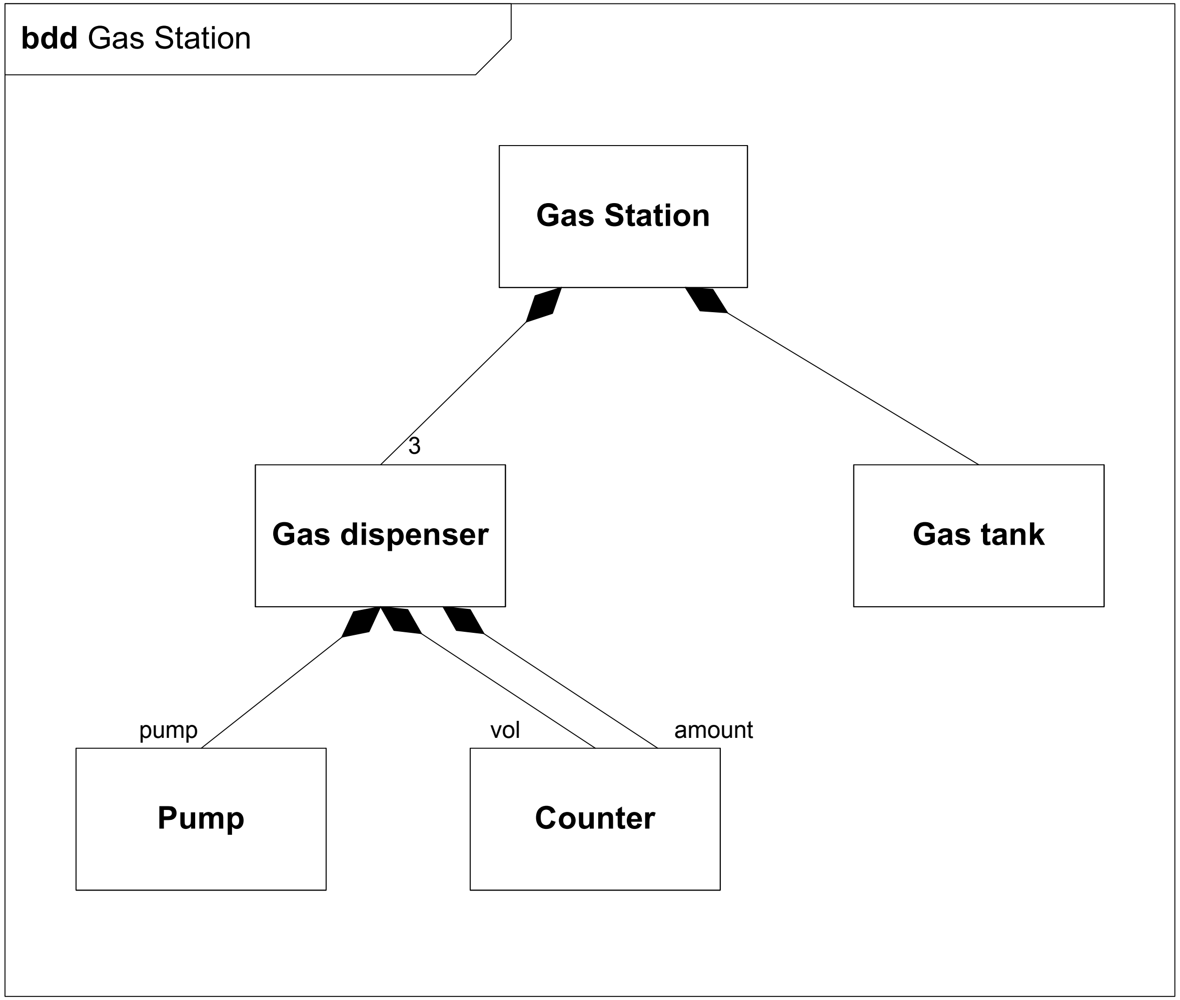
: Engine Control

: Compressor

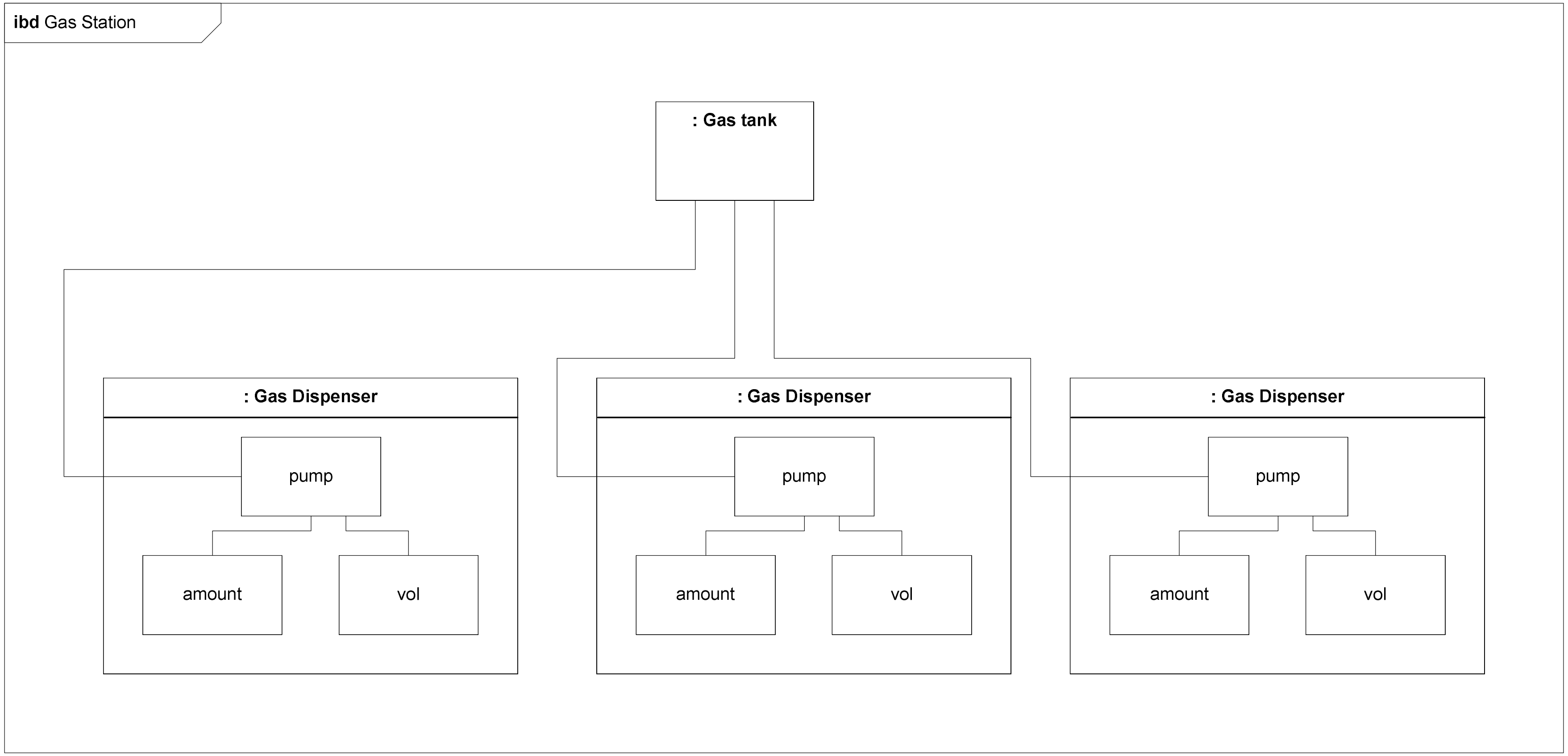
: Fuel Pump

: Combustion Chamber

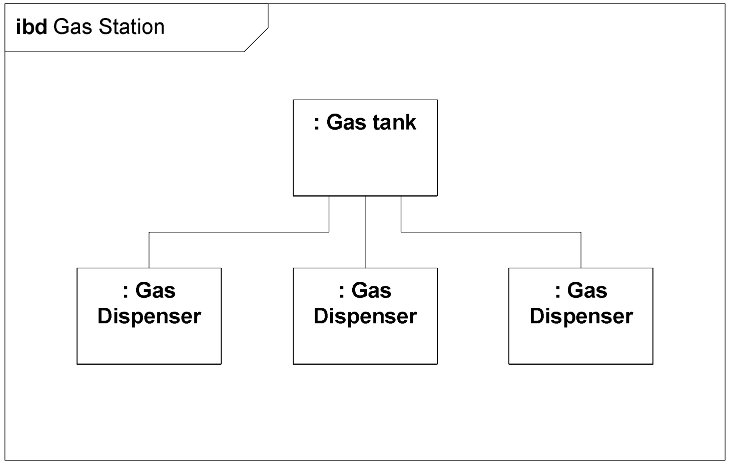
ibd: Gas station example



ibd: Gas station example



ibd: Better Gas station example



ibd Gas Station

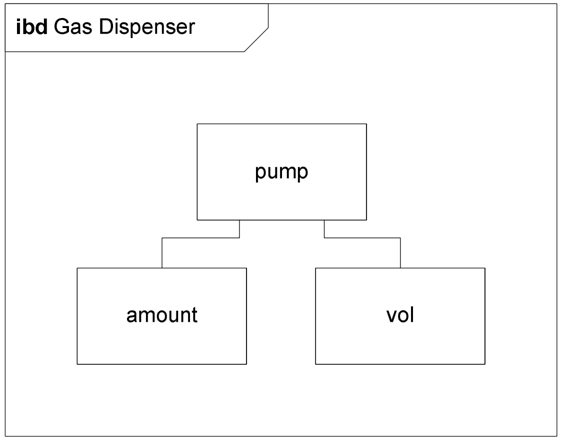
: Gas tank

: Gas Dispenser

: Gas Dispenser

: Gas Dispenser

+



ibd Gas Dispenser

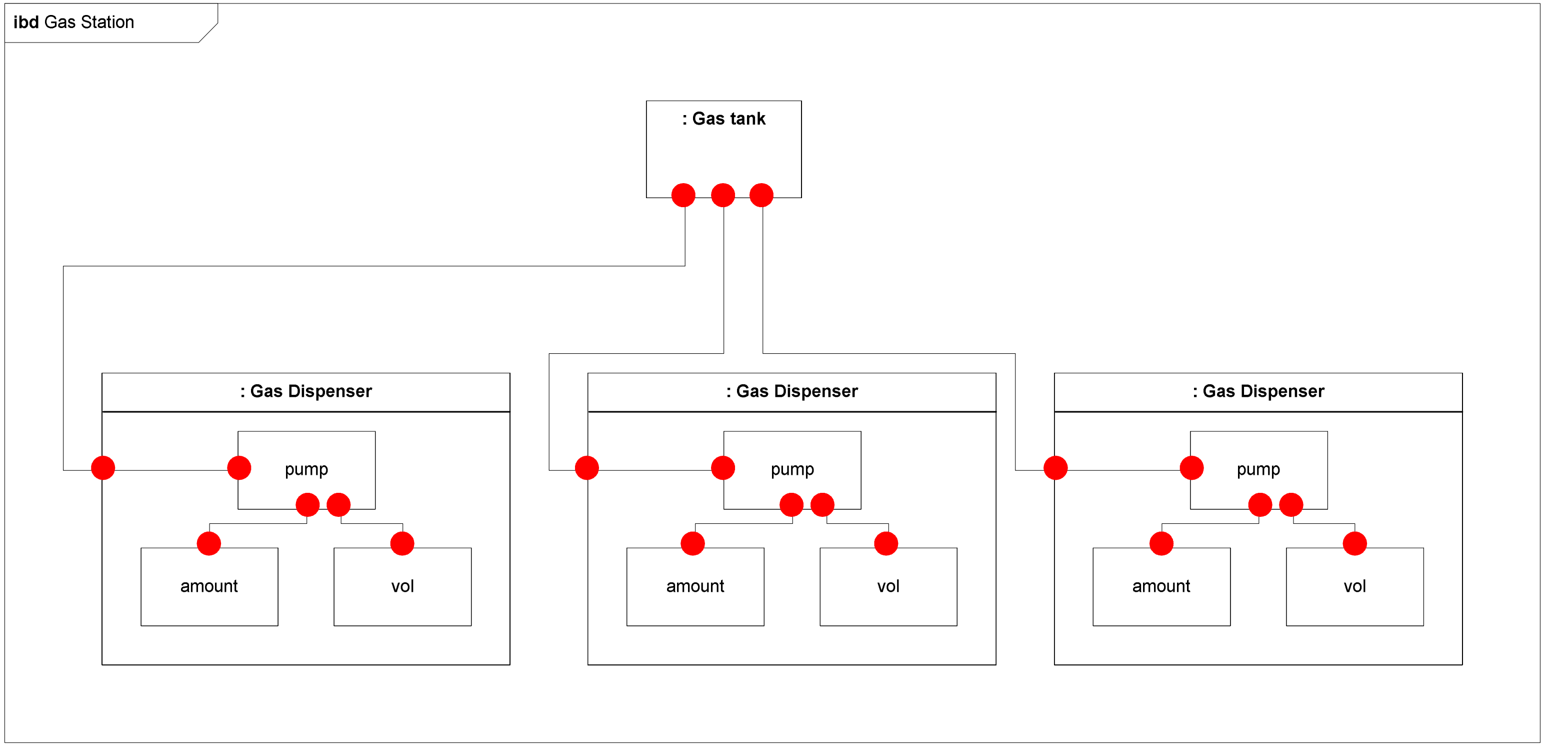
pump

amount

vol

So far, so good…

- We can say a lot about the structure of a system in terms of *blocks* and *parts*…but what about their *interfaces*?



SysML

Modeling interfaces using *items*, *item flows* and *ports*

Modeling interfaces

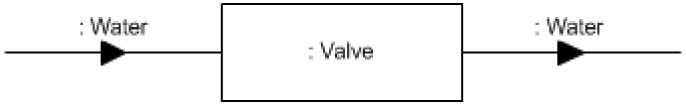
- We would like to express more about the *connection* between parts on the ibd
  - This would help us to define the *interface* of the parts

- To do this, we must define *items*, *item flows* and *ports*!

Items and item flows

- An *item* describes an entity that flows through a system (blocks, value types or signals*)*
  - Physical flow, information flow, energy, …
  - Simple or complex

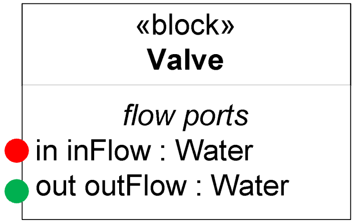
- An *item flow* is used to describe a flow of items (!) on a connector between two blocks on an ibd
  - Item flow = item *type* + flow *direction*



Ports

- A *port* is an interaction point on the boundary of a block
  - Ports are where the items flow into / out of
  - One block can have many ports

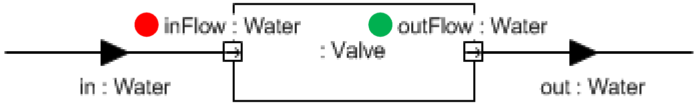
- Ports are *defined* on the blocks on a bdd and used to connect *parts* on ibds



«block»
Valve

flow ports
🔴 in inFlow : Water
🟢 out outFlow : Water

bdd

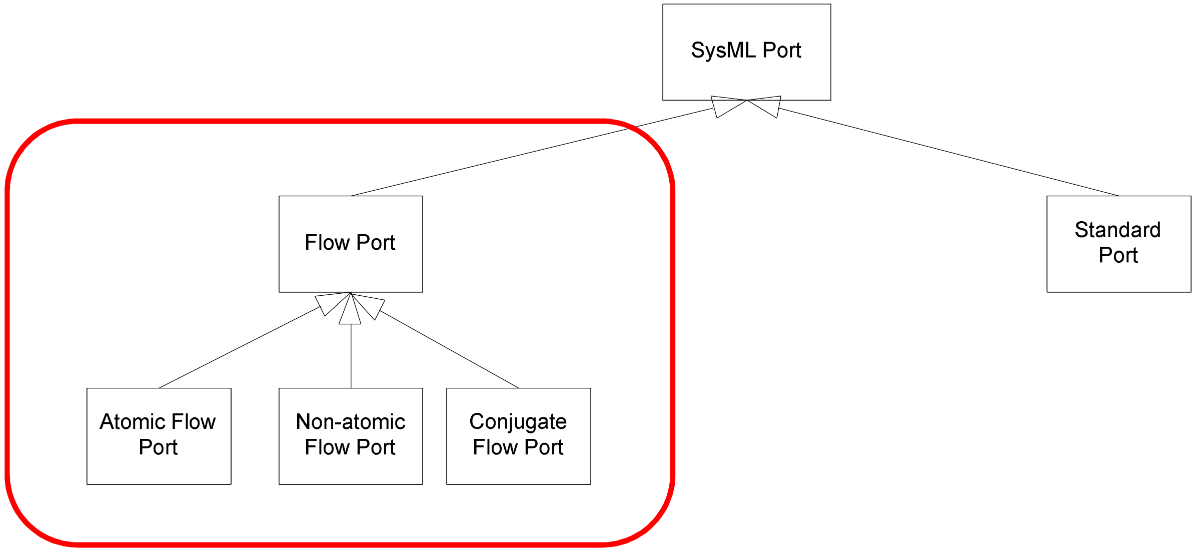


ibd

Ports

- Ports come in different flavours, each with different meaning and use

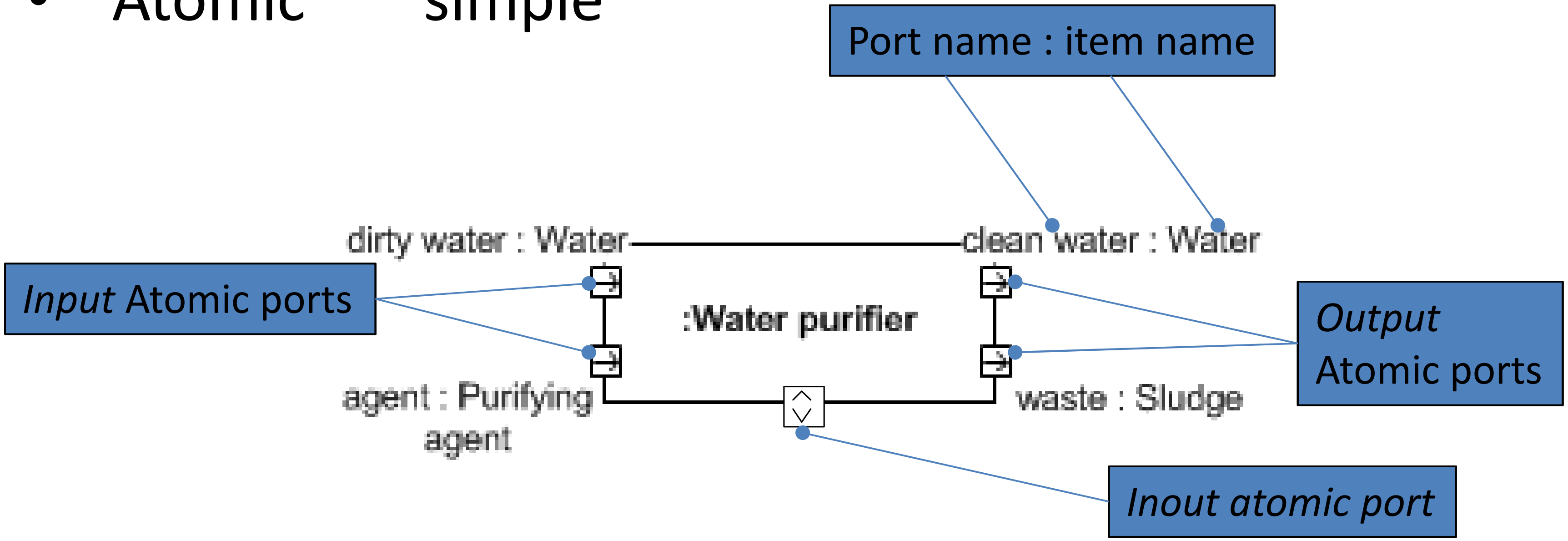
- We will concentrate on *flow* ports



Atomic flow ports

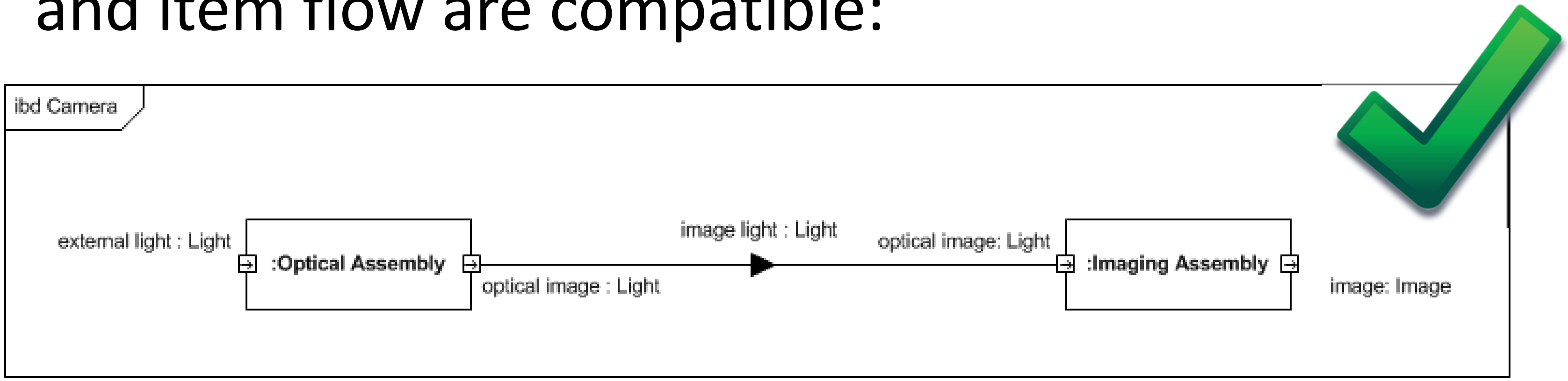
- *Atomic flow ports* are used to describe flows of a single, simple type of item flow to/from a block
  - Directions: In, out or inout

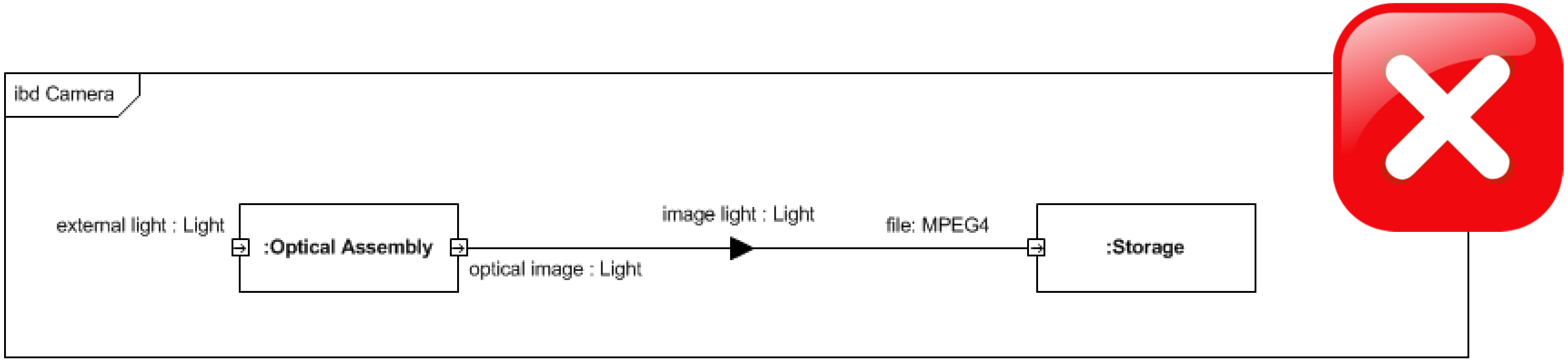
- ”Atomic” ~ ”simple”



Atomic flow ports

- Atomic flow ports can be connected only if directions and item flow are compatible:





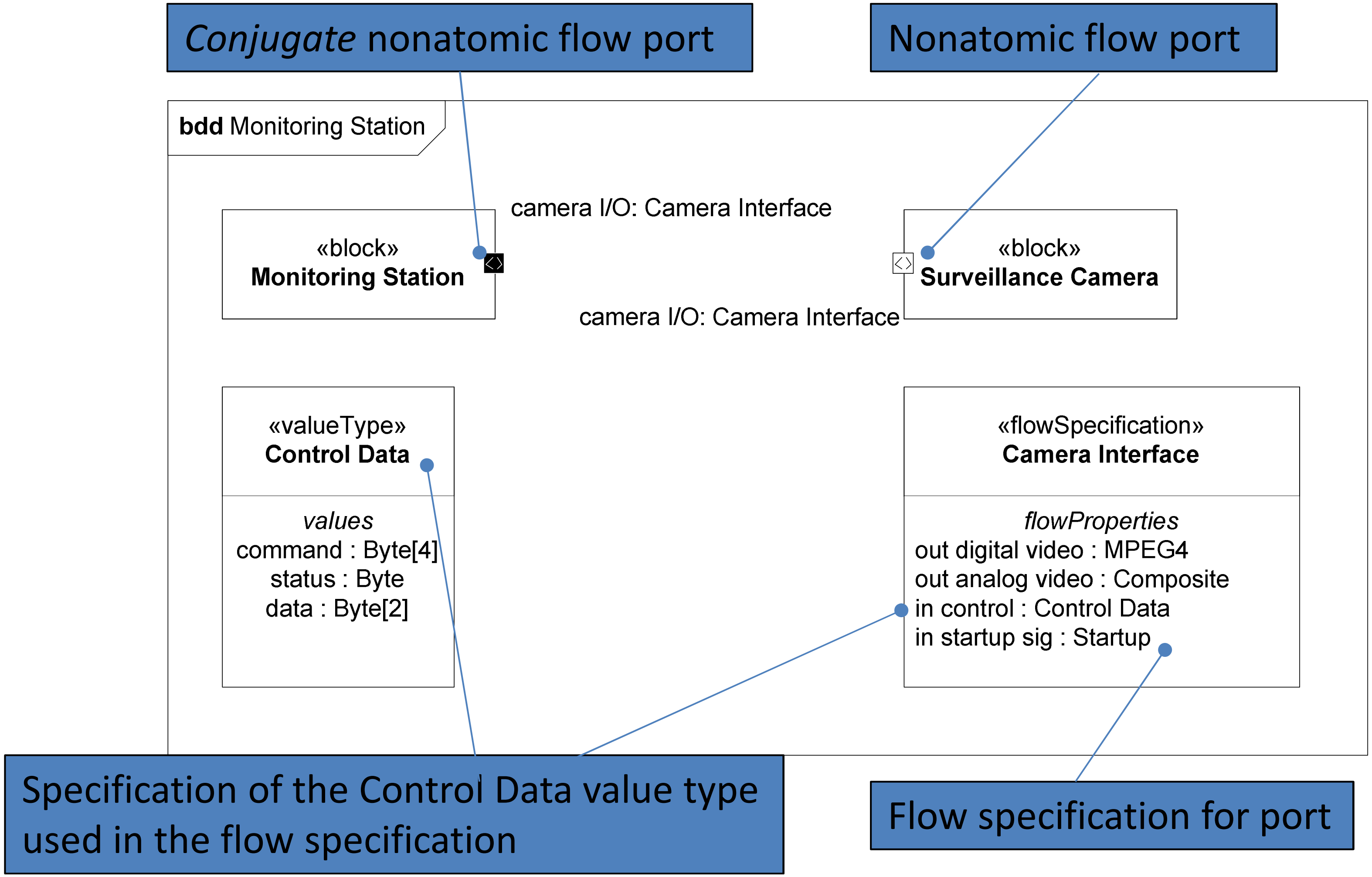
Nonatomic flow ports

- Nonatomic flow ports are used for composite interfaces
  - ”Nonatomic” ~ ”composed of several things”

- A nonatomic flow port must be matched by a *flow specification* on a bdd
  - Each component given as a flow property (type and direction)

- You may also use a *conjugate flow port* (see next slide)

Nonatomic flow ports



Conjugate nonatomic flow port

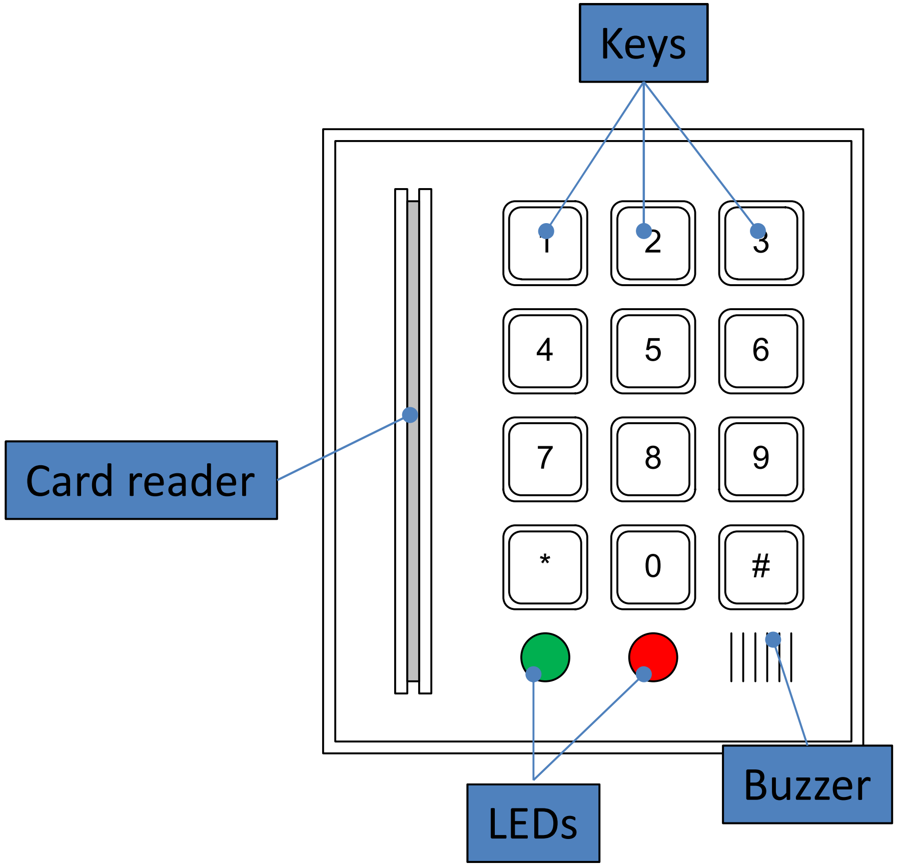
Nonatomic flow port

Specification of the Control Data value type used in the flow specification

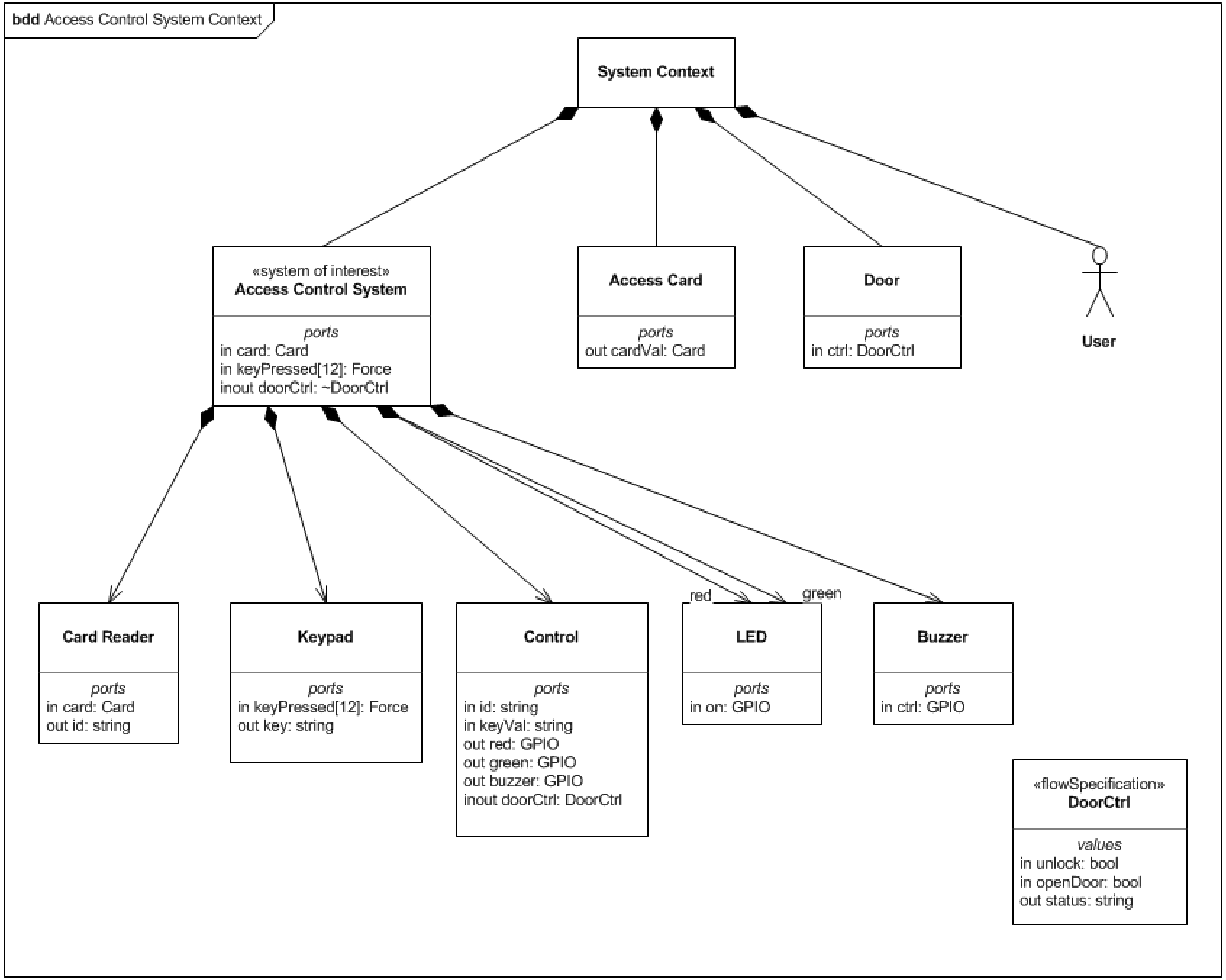
Flow specification for port

Your turn!

- Given a bdd for an access control system, create ibd incl. ports and item flows



Your turn!



bdd Access Control System Context
System Context
«system of interest»
Access Control System
ports
in card: Card
in keyPressed[12]: Force
inout doorCtrl: ~DoorCtrl
Access Card
ports
out cardVal: Card
Door
ports
in ctrl: DoorCtrl
User
Card Reader
ports
in card: Card
out id: string
Keypad
ports
in keyPressed[12]: Force
out key: string
Control
ports
in id: string
in keyVal: string
out red: GPIO
out green: GPIO
out buzzer: GPIO
inout doorCtrl: DoorCtrl
red
green
LED
ports
in on: GPIO
Buzzer
ports
in ctrl: GPIO
«flowSpecification»
DoorCtrl
values
in unlock: bool
in openDoor: bool
out status: string