



IL2212 EMBEDDED SOFTWARE

Practical Homework 1

VERSION 1.0

The total amount of points in this first homework is 8 points. To pass the practical homework, 17 points out of 24 points in all three homework examinations are required.

1. (1 POINT) Synchronous data flow (SDF) has a lower expressiveness than cyclo-static data flow (CSDF).
 - (a) Implement the tutorial CSDF application described in Section G.3 and in Listing G.2 of the lecture notes with only SDF actors using the **ForSyDe.Shallow** library. Try to be as close as possible to the original CSDF model regarding the implemented functionality.
 - (b) Is it possible to achieve exactly the same functionality as in the original CSDF model? Please give a convincing explanation or a counter-example.
2. (1 POINT) Implement the same scenario-aware data flow application described in Section G.4 and in Listing G.3 of the lecture notes in **ForSyDe.Shallow**, but only using one detector and one kernel process.
3. (2 POINTS) Section 5.2.4 in the lecture notes describes the Boolean data flow (BDF) model of computation (MoC).
 - (a) Implement the BDF actors **SWITCH** and **SELECT** using the scenario-aware MoC in **ForSyDe.Shallow**.
 - (b) Implement the BDF graph in the dashed box of Figure 5.20 in **ForSyDe.Shallow**. The actors C and D shall implement the identity function (C) and negation function (D). The actors A and B shall be replaced by input signals s_a and s_b , and the actor E by an output signal s_e .
4. (2 POINTS) Implement a scenario-aware data flow application of an adaptive system that uses one detector and one kernel using **ForSyDe.Shallow**.

The kernel shall execute the following operation:

- In *slow operation* the kernel shall consume 3 input tokens and produce one output token during each firing, which value is the sum of the consumed tokens.
- In *fast operation* the kernel shall consume 2 input tokens and output one output token during each firing, which value is the sum of the consumed tokens.
- The kernel shall start in *slow operation* mode.

- The kernel shall switch from *slow operation* mode to *fast operation* mode, when the sum of the consumed tokens is larger than 20.
- The kernel shall switch from *fast operation* mode to *slow operation* mode, when the sum of the consumed tokens is less than 10.

The following simulation example shows the desired functionality.

```
1 *SADF_Adapter> s_test = signal [4,5,6,8,8,9,9,8,2,4,8,5,2]
2 *SADF_Adapter> system s_test
3 {15,25,17,6,15}
```

5. (2 POINTS) Consider the following specification of a vending machine. The vending machine receives coins of the values 5 SEK and 10 SEK. The machine returns a bottle, when the right amount (10 SEK) is inserted. If too much money is inserted, a bottle and a coin (5 SEK) shall be returned. The machine has only a single coin injection slot, so it is not possible to inject two coins at the same time.

Use the **ForSyDe.Shallow** library to create the following models for the control system of the vending machine. In all subtasks, the synchronous model of computation shall be used.

- (a) Create a model that has the following type:

```
1 vendingMachine :: Signal Bool -- Signal of 5 SEK coins
2               -> Signal Bool -- Signal of 10 SEK coins
3               -> Signal (Bool, Bool) -- Signal of
4                                   -- (Bottle, Return)
```

The system shall have the following behaviour during simulation.

```
1 *VendingMachine> s_coin5 = signal [False,True,True,
2   True,False,False]
3 *VendingMachine> s_coin10 = signal [True,False,False,
4   False,True,False]
5 *VendingMachine> vendingMachine s_coin5 s_coin10
6 {(True,False),(False,False),(True,False),(False,False),
7  (True,True),(False,False)}
8 *VendingMachine> unzipSY $ vendingMachine s_coin5 s_coin10
9 ({True,False,True,False,True,False},
10 {False,False,False,False,True,False})
```

- (b) Create a model that has the following type:

```
1 data Coin = C5 | C10 deriving (Show, Eq, Ord)
2 data Bottle = B deriving (Show, Eq, Ord)
3 data Return = R deriving (Show, Eq, Ord)
4
5 type Coin_Event = AbstExt Coin
6 type Bottle_Event = AbstExt Bottle
7 type Return_Event = AbstExt Return
8
9 vendingMachine :: Signal Coin_Event -- Signal of Coins
10               -> Signal (Bottle_Event, Return_Event)
11               -- Signal of (Bottle, Return)
```

The system shall have the following behaviour during simulation.

```
1  *VendingMachine> s_coin = signal [Prst C10, Prst C5, Prst C5,  
2    Prst C5, Prst C10, Abst]  
3  *VendingMachine> vendingMachine s_coin  
4  { (B,_) , (,_) , (B,_) , (,_) , (B,R) , (,_) }  
5  *VendingMachine> unzipSY $ vendingMachine s_coin  
6  ({B,_,B,_,B,_,}, {,_,_,_,_,R,_,})
```