Example 1 (Embedded system). The embedded system comprises a processor, sensors and an actuator. The main processor, connected to ports M_{in} and M_{out}, reads data coming from sensors, and passes instructions to the actuator through port *Input* and *Output*, respectively. The system fails to get an input only when no data flows through each probabilistic filter. A complete round, which starts when a data comes in and stops when the output data is written successfully, should be accomplished in a certain period of time, otherwise the system sends out a timeout signal.
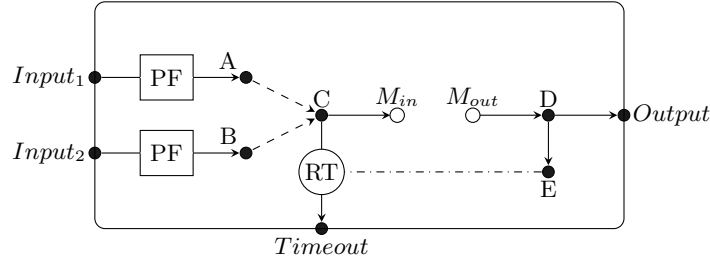

Fig. 1. Embedded System

A *probabilistic filter*, **PF** in short, drops data with a certain probability, i.e. $1 - p$; while **RT** with time bound t_{max}, which stands for *reset timer*, can be reset.
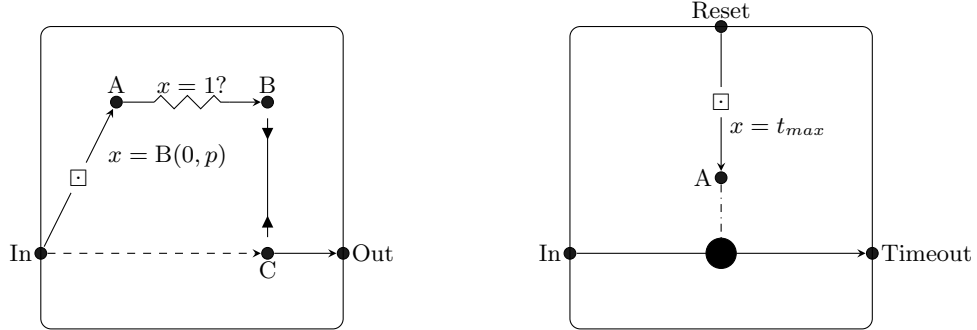

Fig. 2. Probablistic Filter (left) and Reset Timer (right)

There are 8 locations in the STA_r of the embedded system, consisting of triples which symbolizes the configuration of two probabilistic filters and the reset timer. The STA_r is represented by *JANI*; elements are ommited except locations and edges.

```
// the embedded system
{
  locations: [
    // loc_num  [inv] <initial> : loc_conf
    1 <initial >: (init , init , waiting),
    2: (init , ready, waiting),
    3: (ready, init , waiting),
    4: (ready, ready, waiting),
    5 [t <= t_max] : (init , init , timing),
    6 [t <= t_max] : (init , ready, timing),
    7 [t <= t_max] : (ready, init , timing),
    8 [t <= t_max] : (ready, ready, timing)
  ],
  edges: [
    // src_loc -> dst_loc (act) [guard] : update_func
    1 -> 2 (i) : buf_2 = B(1, p),
    2 -> 1 (Input_2),
    1 -> 3 (i) : buf_1 = B(1, p),
    3 -> 1 (Input_1),
    1 -> 4 (i) : buf_1 = B(1, p), buf_2 = B(1, p),
    4 -> 1 (Input_1, Input_2),
    2 -> 4 (i) : buf_1 = B(1, p),
    4 -> 2 (Input_1),
    3 -> 4 (i) : buf_2 = B(1, p),
    4 -> 3 (Input_2),
    2 -> 3 (i, Input_2) : buf_1 = B(1, p),
    3 -> 2 (i, Input_1) : buf_2 = B(1, p),

    5 -> 6 (i) : buf_2 = B(1, p),
    6 -> 5 (Input_2),
    5 -> 7 (i) : buf_1 = B(1, p),
    7 -> 5 (Input_1),
    5 -> 8 (i) : buf_1 = B(1, p), buf_2 = B(1, p),
    8 -> 5 (Input_1, Input_2),
    6 -> 8 (i) : buf_1 = B(1, p),
    8 -> 6 (Input_1),
    7 -> 8 (i) : buf_2 = B(1, p),
    8 -> 7 (Input_2)
    6 -> 7 (i, Input_2) : buf_1 = B(1. p),
    7 -> 6 (i, Input_1) : buf_2 = B(1, p),

    1 -> 1 (M_out, Output) : Output = M_out,
    2 -> 2 (M_out, Output) : Output = M_out,
    3 -> 3 (M_out, Output) : Output = M_out,
    4 -> 4 (M_out, Output) : Output = M_out,
```

7 -> 5 (Input_1, M_in, M_out, Output) [buf_1 = 1] :
    t = 0, M_in = Input_1, Output = M_out,
7 -> 5 (Input_1, M_in, M_out, Output, Timeout)
    [buf_1 = 1, t = t_max] :
    t = 0, M_in = Input_1, Output = M_out, Timeout = TIMEOUT,
6 -> 5 (Input_2, M_in, M_out, Output) [buf_2 = 1] :
    t = 0, M_in = Input_2, Output = M_out,
6 -> 5 (Input_2, M_in, M_out, Output, Timeout)
    [buf_2 = 1, t = t_max] :
    t = 0, M_in = Input_2, Output = M_out, Timeout = TIMEOUT,
8 -> 6 (Input_1, M_in, M_out, Output) [buf_1 = 1] :
    t = 0, M_in = Input_1, Output = M_out,
8 -> 6 (Input_1, M_in, M_out, Output, Timeout)
    [buf_1 = 1, t = t_max] :
    t = 0, M_in = Input_1, Output = M_out, Timeout = TIMEOUT,
8 -> 7 (Input_2, M_in, M_out, Output) [buf_2 = 1] :
    t = 0, M_in = Input_2, Output = M_out,
8 -> 7 (Input_2, M_in, M_out, Output, Timeout)
    [buf_2 = 1, t = t_max] :
    t = 0, M_in = Input_2, Output = M_out, Timeout = TIMEOUT,
8 -> 5 (Input_1, Input_2, M_in, M_out, Output) [buf_1 = 1] :
    t = 0, M_in = Input_1, Output = M_out,
8 -> 5 (Input_1, Input_2, M_in, M_out, Output) [buf_2 = 1] :
    t = 0, M_in = Input_2, Output = M_out,
8 -> 5 (Input_1, Input_2, M_in, M_out, Output, Timeout)
    [buf_1 = 1, t = t_max] :
    t = 0, M_in = Input_1, Output = M_out, Timeout = TIMEOUT,
8 -> 5 (Input_1, Input_2, M_in, M_out, Output, Timeout)
    [buf_2 = 1, t = t_max] :
    t = 0, M_in = Input_2, Output = M_out, Timeout = TIMEOUT,

5 -> 1 (M_out, Output) [t < t_max] : Output = M_out,
5 -> 1 (Timeout) [t = t_max] : Timeout = TIMEOUT,
5 -> 1 (M_out, Output, Timeout) [t = t_max] :
    Output = M_out, Timeout = TIMEOUT,
6 -> 2 (M_out, Output) [t < t_max] : Output = M_out,
6 -> 2 (Timeout) [t = t_max] : Timeout = TIMEOUT,
6 -> 2 (M_out, Output, Timeout) [t = t_max] :
    Output = M_out, Timeout = TIMEOUT,
7 -> 3 (M_out, Output) [t < t_max] : Output = M_out,
7 -> 3 (Timeout) [t = t_max] : Timeout = TIMEOUT,
7 -> 3 (M_out, Output, Timeout) [t = t_max] :
    Output = M_out, Timeout = TIMEOUT,
8 -> 4 (M_out, Output) [t < t_max] : Output = M_out,

```
        8 -> 4 (Timeout) [t = t_max] : Timeout = TIMEOUT,
        8 -> 4 (M_out, Output, Timeout) [t = t_max] :
            Output = M_out, Timeout = TIMEOUT,


        3 -> 5 (Input_1, M_in) [buf_1 = 1] : t = 0, M_in = Input_1,
        3 -> 5 (Input_1, M_in, M_out, Output) [buf_1 = 1] :
            t = 0, M_in = Input_1, Output = M_out,
        2 -> 5 (Input_2, M_in) [buf_2 = 1] : t = 0, M_in = Input_2,
        2 -> 5 (Input_2, M_in, M_out, Output) [buf_2 = 1] :
            t = 0, M_in = Input_2, Output = M_out,
        4 -> 6 (Input_1, M_in) [buf_1 = 1] : t = 0, M_in = Input_1,
        4 -> 6 (Input_1, M_in, M_out, Output) [buf_1 = 1] :
            t = 0, M_in = Input_1, Output = M_out,
        4 -> 7 (Input_2, M_in) [buf_2 = 1] : t = 0, M_in = Input_2,
        4 -> 7 (Input_2, M_in, M_out, Output) [buf_2 = 1] :
            t = 0, M_in = Input_2, Output = M_out,
        3 -> 6 (i, Input_1, M_in) [buf_1 = 1] :
            t = 0, M_in = Input_1, buf_2 = B(1, p),
        3 -> 6 (i, Input_1, M_in, M_out, Output) [buf_1 = 1] :
            t = 0, M_in = Input_1, buf_2 = B(1, p), Output = M_out,
        2 -> 7 (i, Input_2, M_in) [buf_2 = 1] :
            t = 0, M_in = Input_2, buf_1 = B(1, p),
        2 -> 7 (i, Input_2, M_in, M_out, Output) [buf_2 = 1] :
            t = 0, M_in = Input_2, buf_1 = B(1, p), Output = M_out
        4 -> 5 (Input_1, Input_2, M_in) [buf_1 = 1]: t = 0, M_in = Input_1
        4 -> 5 (Input_1, Input_2, M_in) [buf_2 = 1]: t = 0, M_in = Input_2
        4 -> 5 (Input_1, Input_2, M_in, M_out, Output) [buf_1 = 1]:
            t = 0, M_in = Input_1, Output = M_out,
        4 -> 5 (Input_1, Input_2, M_in, M_out, Output) [buf_2 = 1]:
            t = 0, M_in = Input_2, Output = M_out,
    ]
}
```