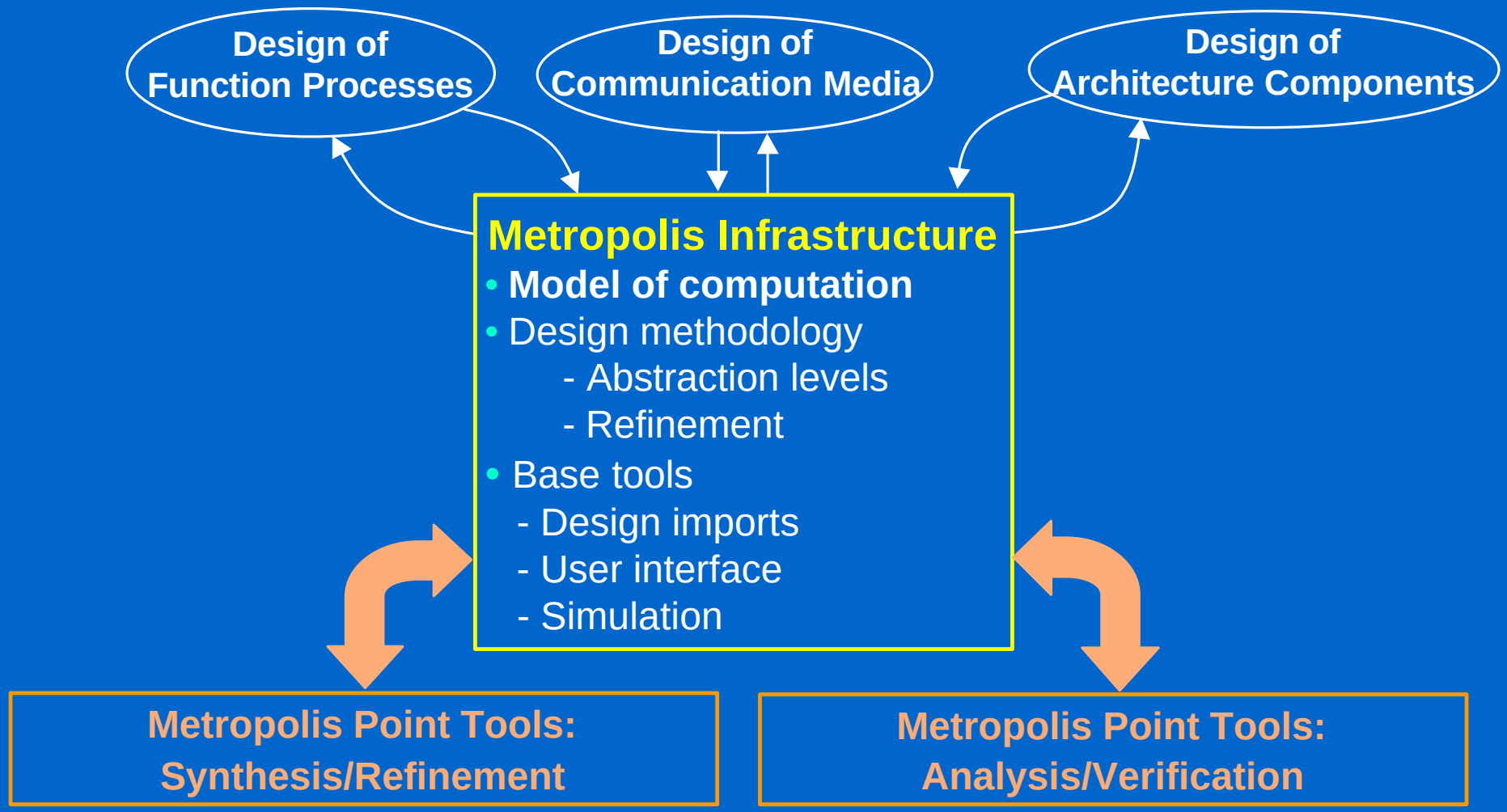
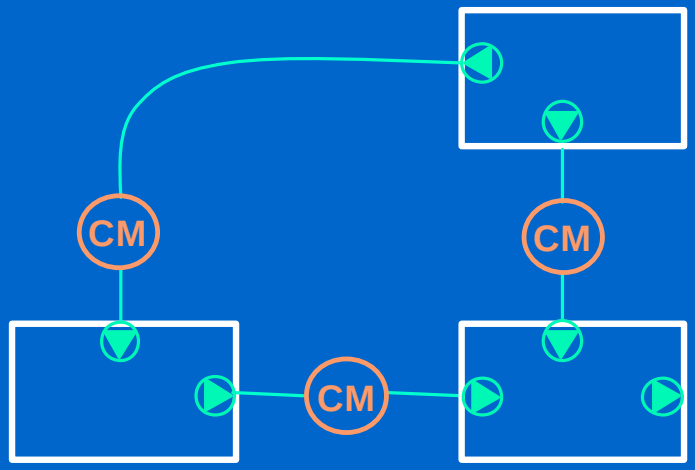
Metropolis Framework



Metropolis: Model of Computation

- **System: a network of concurrent processes**
  - **process: sequential function + ports**
- **Do not commit to particular communication semantics**
  - **processes communicate through communication media**
  - **communication media: define communication semantics**
    e.g. queues, shared memory, … , generic, ...
- **Do not commit to particular firing rules of processes**
  - **a special construct to define firing rules and atomicity**



Communication

- **Communication medium:**
  - **state: snapshot of the medium**
  - **interfaces implementation: the means to access the medium**
  - **properties: # of writers, transaction, arbitration, ...**

State: # of elements, values, ...

Interfaces:

reader{ read(), num() }
writer{ write(), num() }
...

Properties: 1 writer, 1 reader, ...

- **The state changes only by the execution of interface functions.**
- **An interface may be implemented by more than one media.**
- **Interface functions at different abstraction levels to support refinement.**

- **Library of pre-defined media**

Computation

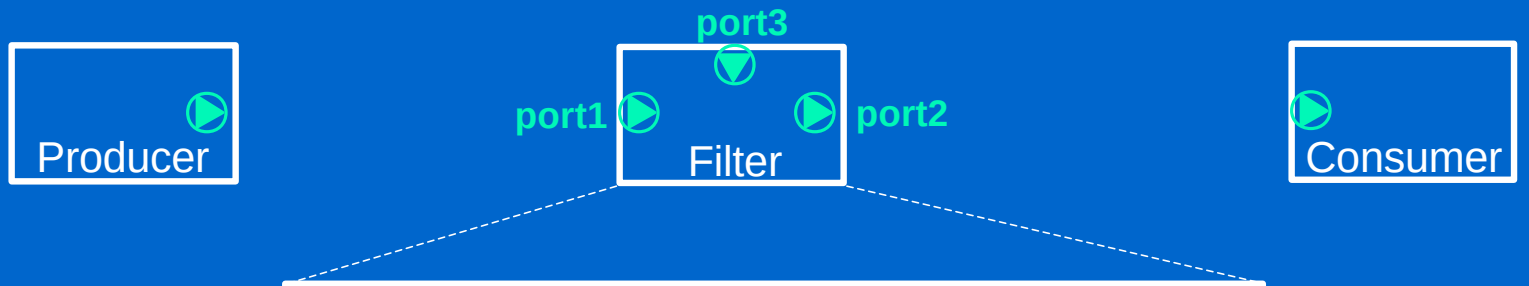
- **Ports:**
  - Interaction with communication is always through ports.
  - Each port is specified with an interface it has access to.

    All and only the functions of the interface can be used through the port.
- **Sequential program:**
  - Firing rules and atomic execution

    await(cond){ st1; st2; … stk;}

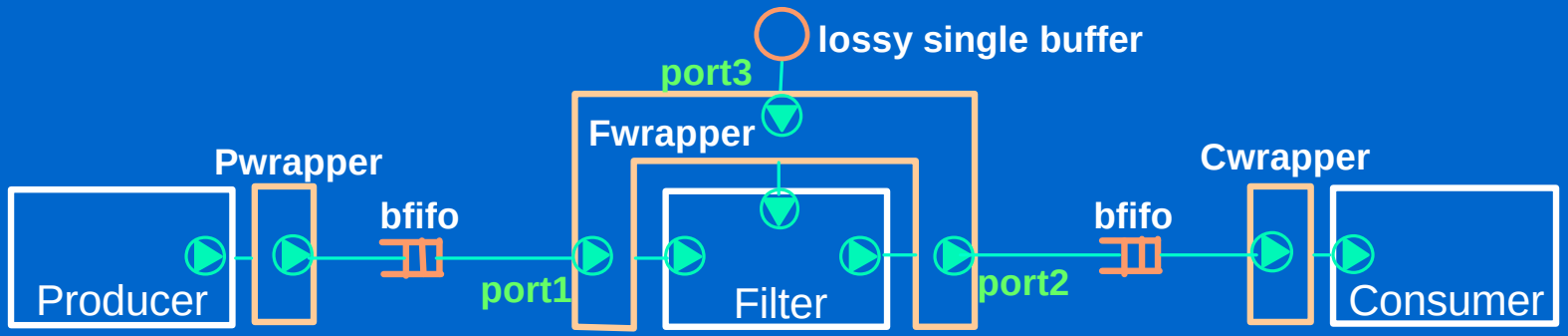
    "if cond is TRUE, then atomically execute {st1; … stk;}."
  - Non determinism
  - Bounded loops
  - Parameters

Metropolis: Design Example




```
process Filter {
      filter_interface port1, port2, port3;

      coeff = 1;
      while(TRUE){
         dataready = FALSE;
         await(port1.dataready() || port3.cfready()) {
               if(port3.cfready())  coeff = port3.cfread();
               if(port1.dataready())  dataready = TRUE;
         }

         if(dataready)
               bounded_loop(i, 0, LINES_IN_FRAME, 1){
                  port1.dataread(line, PIX_IN_LINE);
                  filtering(line, coeff);
                  port2.datawrite(line, PIX_IN_LINE);
               }
      }
}
```

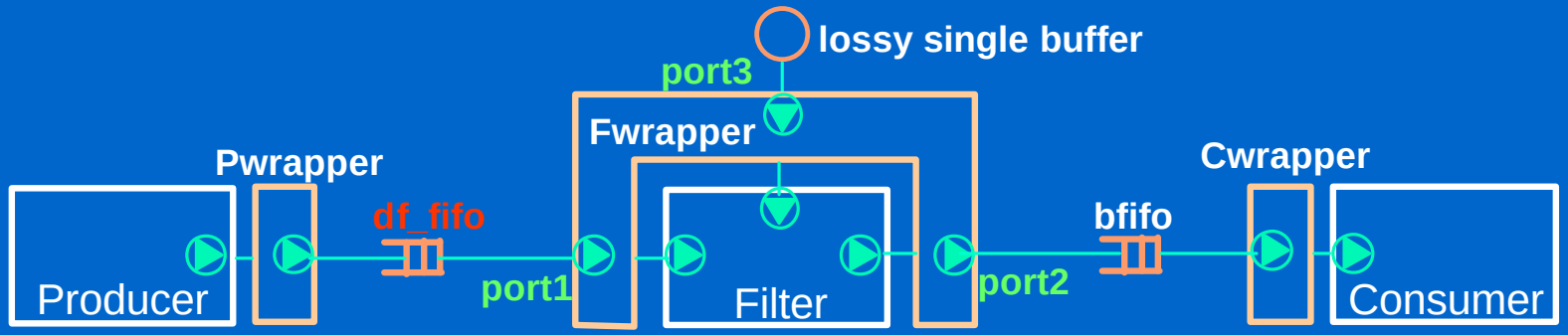
Interface with Communication




```
medium bfifo breader bwriter{
    state int size, space, n, storage[];

    void write(data, N){
        await(N <= space)
            do_write(storage, data, N);
    }

    void read(data, N){
            ...
    }

    void n(){ // the number of elements
        return n;
    }
}
```

```
medium Fwrapper filter_interface{
    breader port1;
    bwriter port2;
    lsreader port3;

    bool dataready(){
        return (port1.n() >= PIX_IN_LINE);
    }

    bool cfready(){
        return (port3.n() > 0);
    }

    void dataread(data, N){
        port1.read(data, N);
    }
            . . .
```

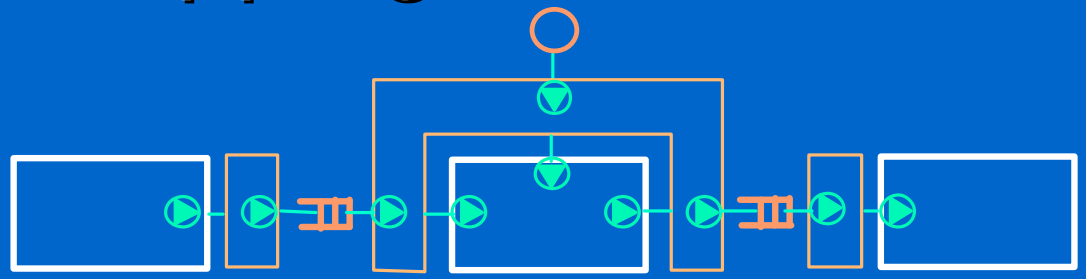
Communication Refinement



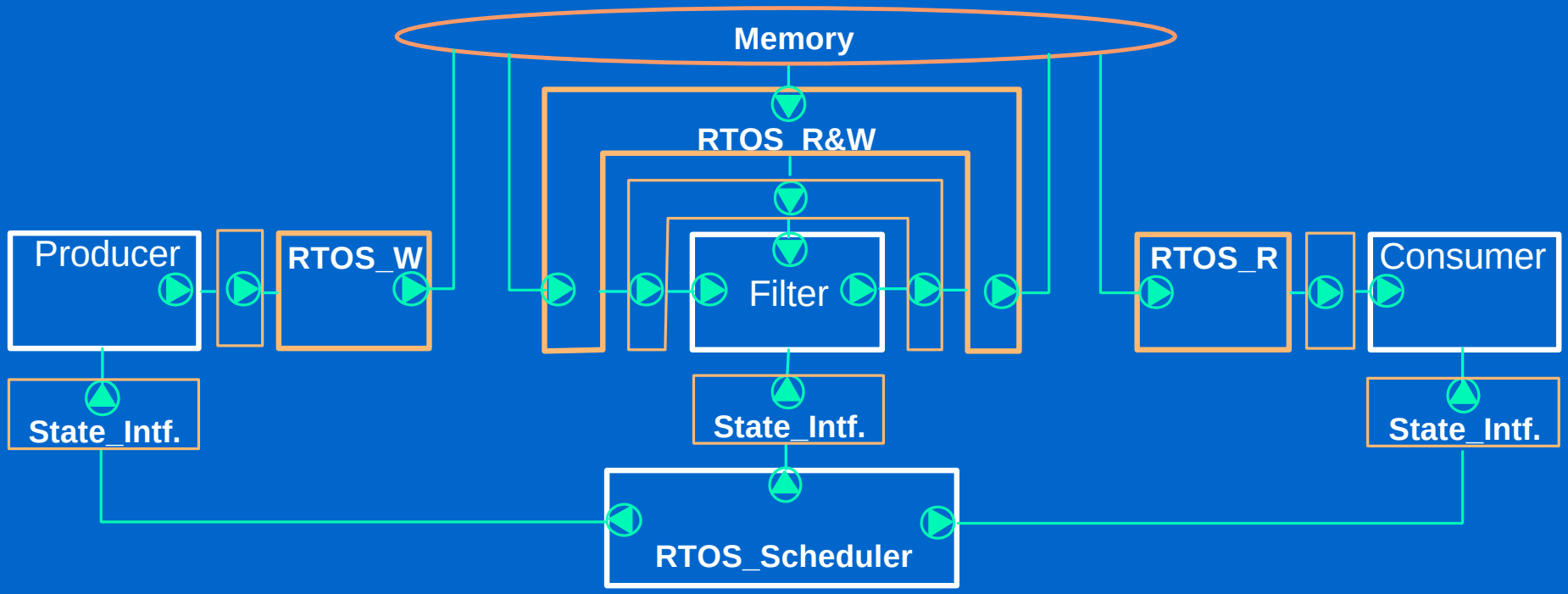

```
medium df_fifo df_reader df_writer{
    state int size, space, n, storage[];
    state bool req_wr, req_rd, wake_wr, wake_rd;

    void write(data, N){
      req_wr = TRUE;  num = N;
      while(num > 0)
        await(num <= space || wake_wr ||
              req_rd && space > 0){
          do_write(data, min(num,space));
          num = num - min(num,space);
          if(req_rd)  wake_rd = TRUE;
          wake_wr = FALSE;
        }
      req_wr = FALSE;
    }

    bool req_wr(){ return req_wr;}
```

```
medium Fwrapper filter_interface{
    df_reader port1;
    bwriter port2;
    lsreader port3;

    bool dataready(){
      return (port1.n() > 0 || port1.req_wr());
    }

    bool cfready(){
      return (port3.n() > 0);
    }

    void dataread(data, N){
      port1.read(data, N);
    }
                ....
```

Mapping to Architecture



- **All software mapping**
- **The states of the media to the system memory.**

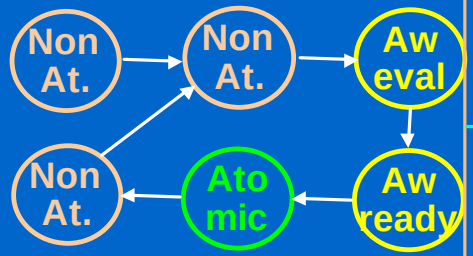


Mapping to Architecture

- RTOS_W : implements df_writer using RTOS API, e.g. memcpy().
- RTOS_R&W: implements df_reader, bwriter, lsreader using RTOS API.
- RTOS_R : implements breader using RTOS API.
- Memory : implements the memory interface (used by RTOS API functions).
- RTOS_Scheduler and State_Interfaces:

```
process Filter {
      coeff = 1;
      while(TRUE)
         dataready = FALSE;
         await(port1.dataready() || port3.cfready()){
               if(port3.cfready())  …
         }
         if(dataready) ...
}
```

State_Interface:
- keep state info of Filter
- report the info to Scheduler
- tell Scheduler's command to Filter



RTOS_Scheduler:
- access state info of processes
- make a schedule decision
- tell Scheduler's command to State_Interfaces