Dynamic Reconfiguration and Collaborative Synchronous Programming

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Synchron'2011

Motivations

Dynamicity everywhere :

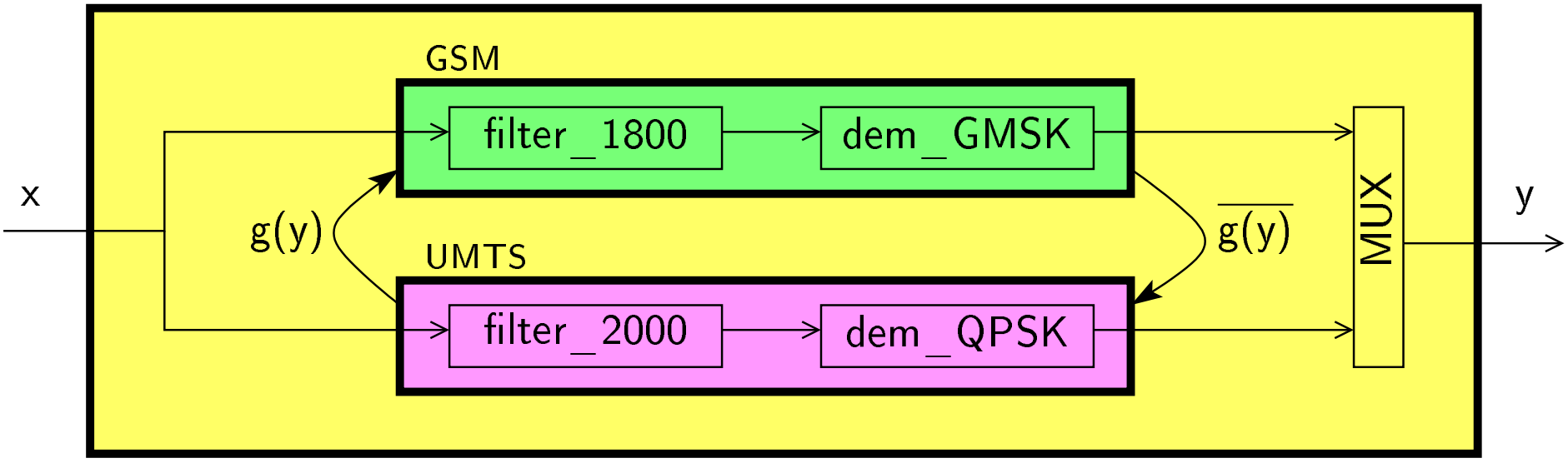
- cellphones
- internet boxes

How to express dynamic reconfiguration with a synchronous language ?

Proposal : combination of synchronous (for the time model) and higher-order (for “computations” seen as “values”) features

A first example : software radio

Reception channels in a software radio



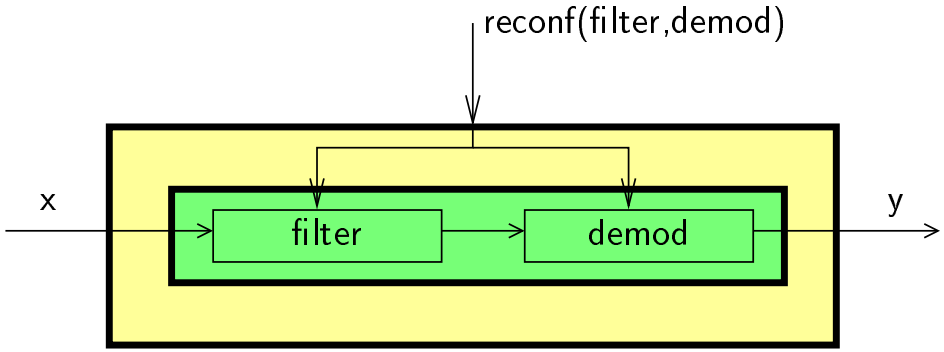
Reception channel :

- composed of a filter and a demodulator
- dynamic reconfiguration depending of the protocol used

Dynamic reconfiguration using higher-order

- only one "reception channel" component, parameterized with the nodes `filter` and `demod`

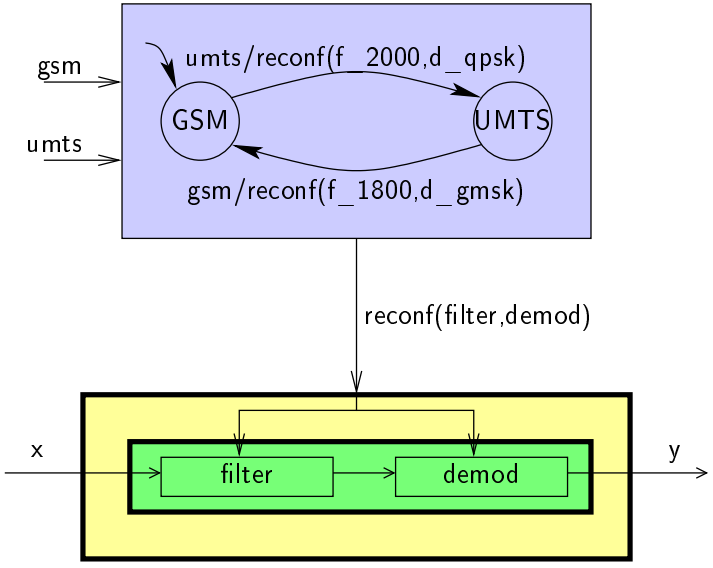
```
let node channel (reconfigure,x) = y where
  rec automaton
      | Init ->
          do y = x
          until reconfigure(filter,demod)
          then Configure(filter,demod)
      | Configure(filter,demod) ->
          let f = run filter x in
          do y = run demod f
          until reconfigure(filter',demod')
          then Configure(filter',demod')
      end
```



Dynamic reconfiguration using higher-order

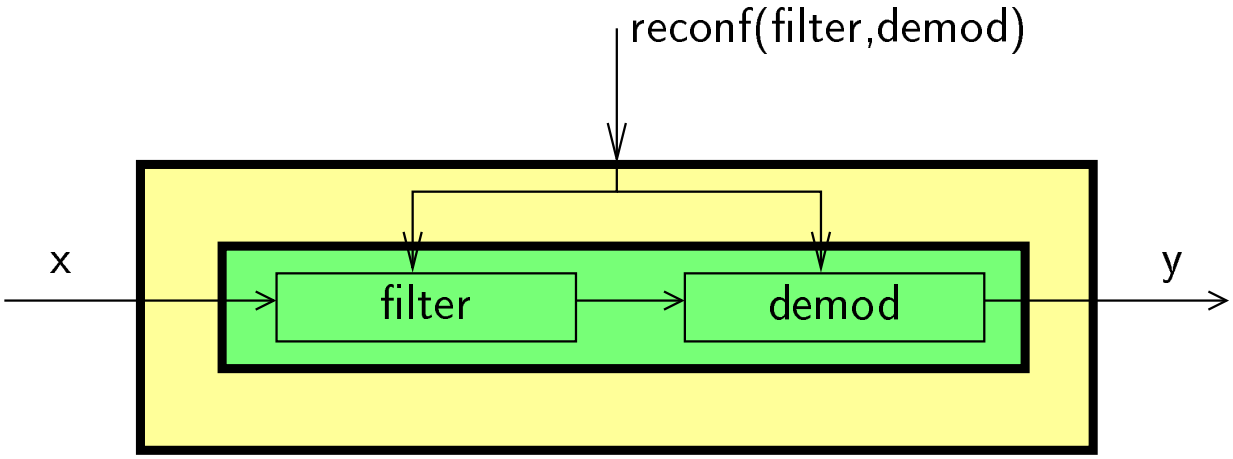
- only one "reception channel" component, parameterized with the nodes `filter` and `demod`
- one reconfiguration component, sending dynamically the values for `filter` et `demod` (stream of nodes)

```
let node multichannel_sdr (x,umts,gsm) = y where
  rec y = channel (switch_channel,x)
  and automaton
      | Reconfigure_GSM ->
          do emit switch_channel = (filter_1800,demod_gmsk)
          then GSM
      | GSM -> do until umts then Reconfigure_UMTS
      | Reconfigure_UMTS ->
          do emit switch_channel = (filter_2000,demod_qpsk)
          then UMTS
      | UMTS -> do until gsm then Reconfigure_GSM
      end
```



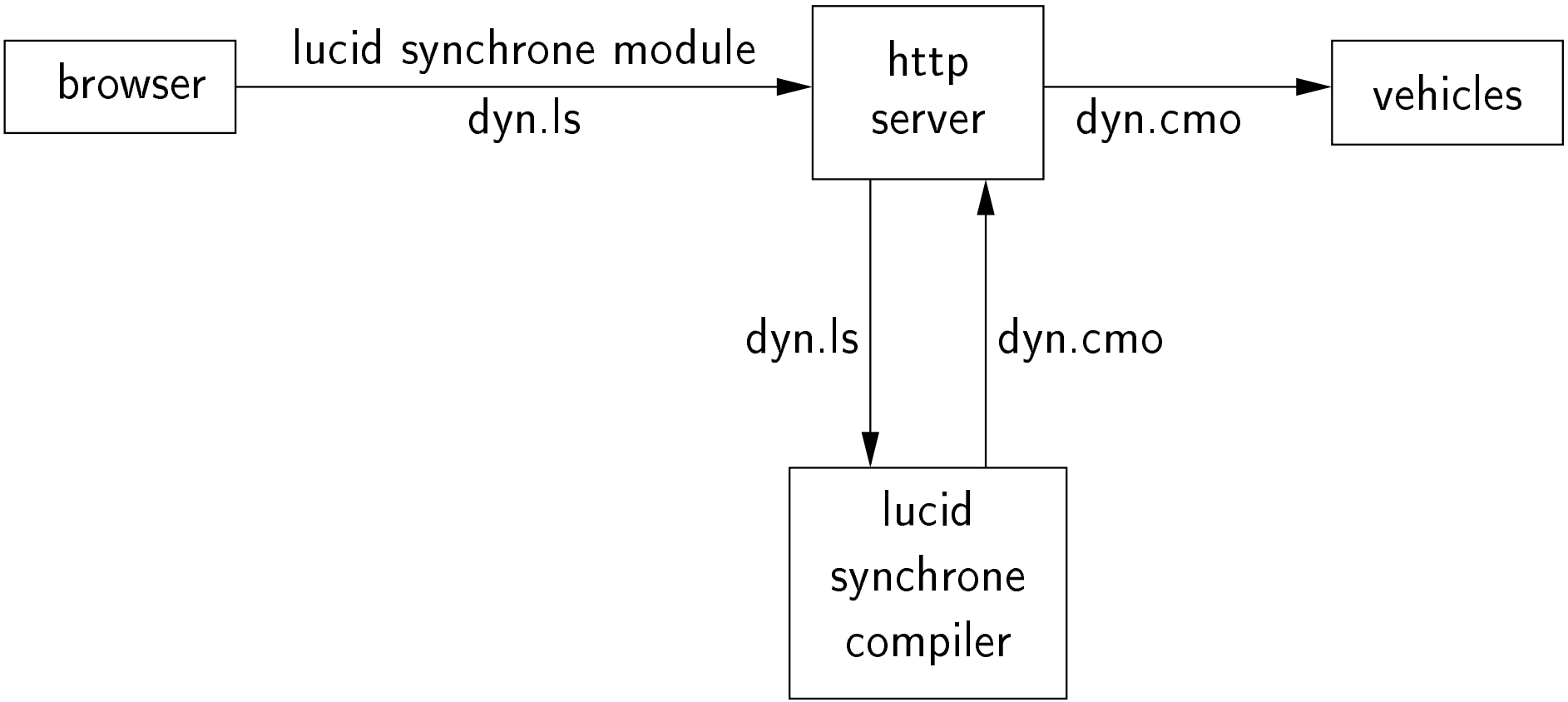
Limits

- Everything known at compilation time
- What about programming only the “server” ?



Demo

Server architecture

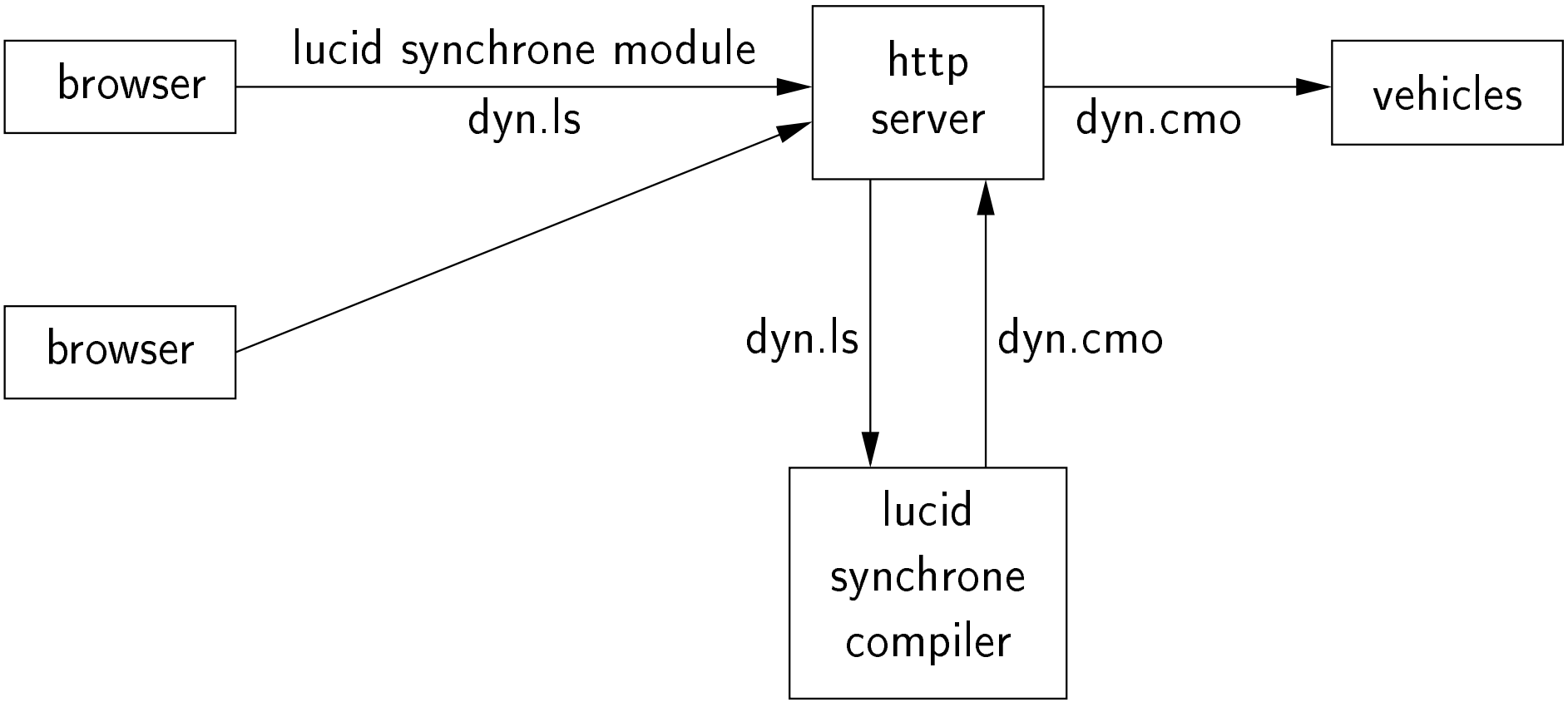


Server node

```
let node server (static yinit) reconfigure = (x,y,cap) where
  rec automaton
        Init ->
          do
            acc = 0.
          and brake = false
          and left = false
          and right = false
          until reconfigure(g) then Configure((fun x => run (g f_init) x))
      | Configure(f) ->
          do
            (acc,brake,left,right) = run f(last x, last y, last cap)
          until reconfigure(g) then Configure((fun x => run (g f) x))
      end

...
```

Collaborative programming



Conclusion

- Higher-order allows the (quite) easy expression of dynamic behaviors

- Dynamic reconfiguration can be useful :
  - esay experiments with the language
  - for live prototyping
  - for teaching ?

Perspectives

Limits of this approach :

- Lost of some usual properties of synchronous languages : e.g., bounded memory and reaction time
- Programs not reductibles to finite models (finite state automata, symbolic transition systems, . . .) : usual analysis/verification/synthesis tools non appliables
- Expression of mobility, use of actual marshalling

Thanks !

... a last demo ?