ESS'96, Genoa, Italy

Design and Simulation of Asynchronous Micropipeline Circuits in Rainbow

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THE UNIVERSITY
of MANCHESTER

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Background

Hardware design:

- enhanced performance, functionality
- speed-to-market

Need:

- fast prototyping
- simulation
- early design analysis

Asynchronous design:

- increased speed
- reduced power
- easier design (compositional)

AMULET microprocessor (Steve Furber, Manchester)

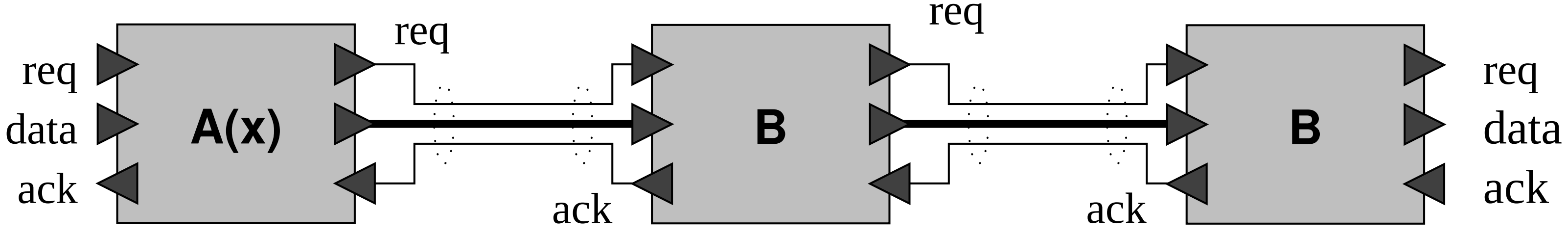
Problems facing asynchronous design:

- lack of specialised design tools
- design analysis

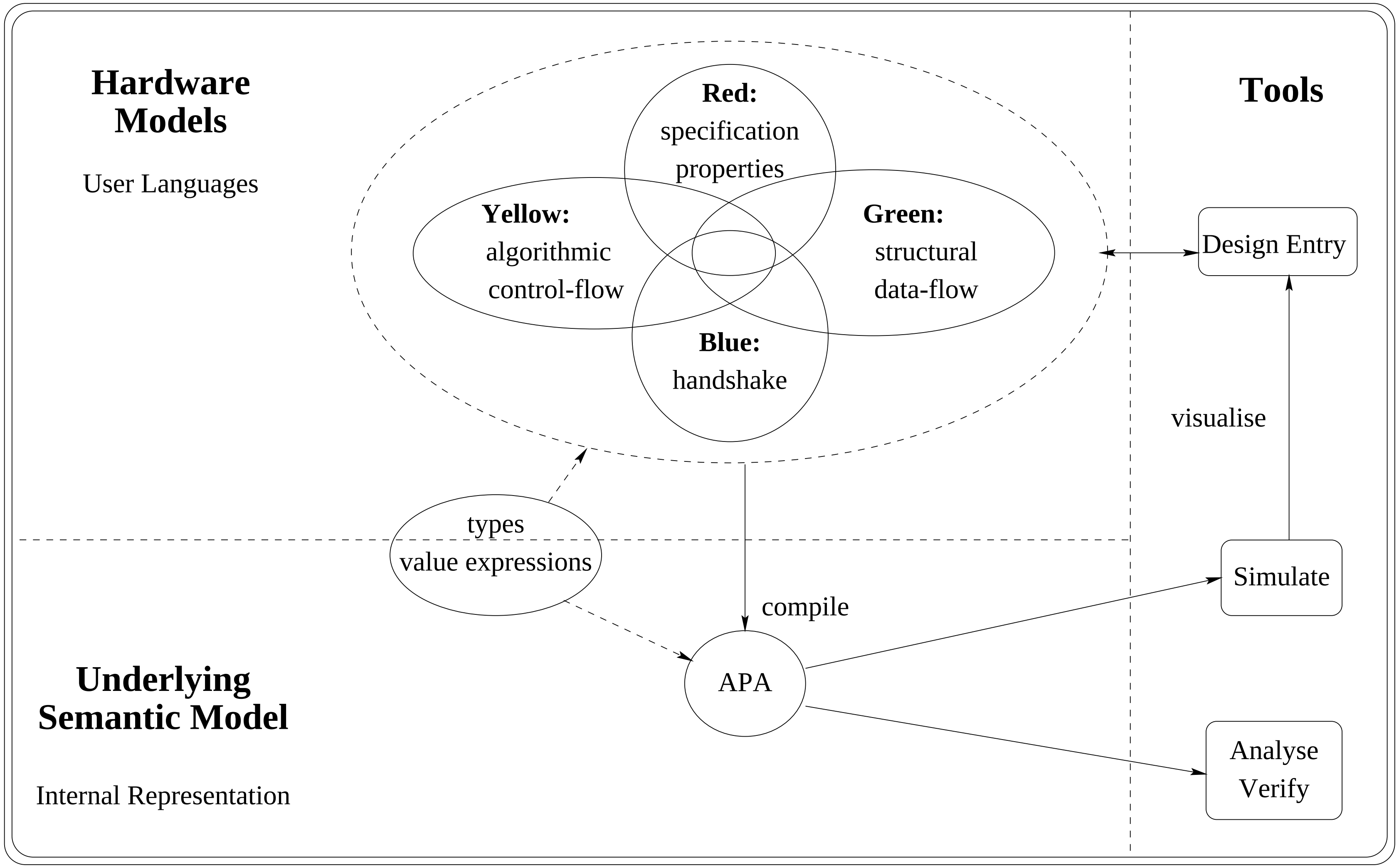
Require:

- design methodology
- suitable design representation
- analysis tools
  - deadlock detection
  - high level power, speed estimation
  - functional verification

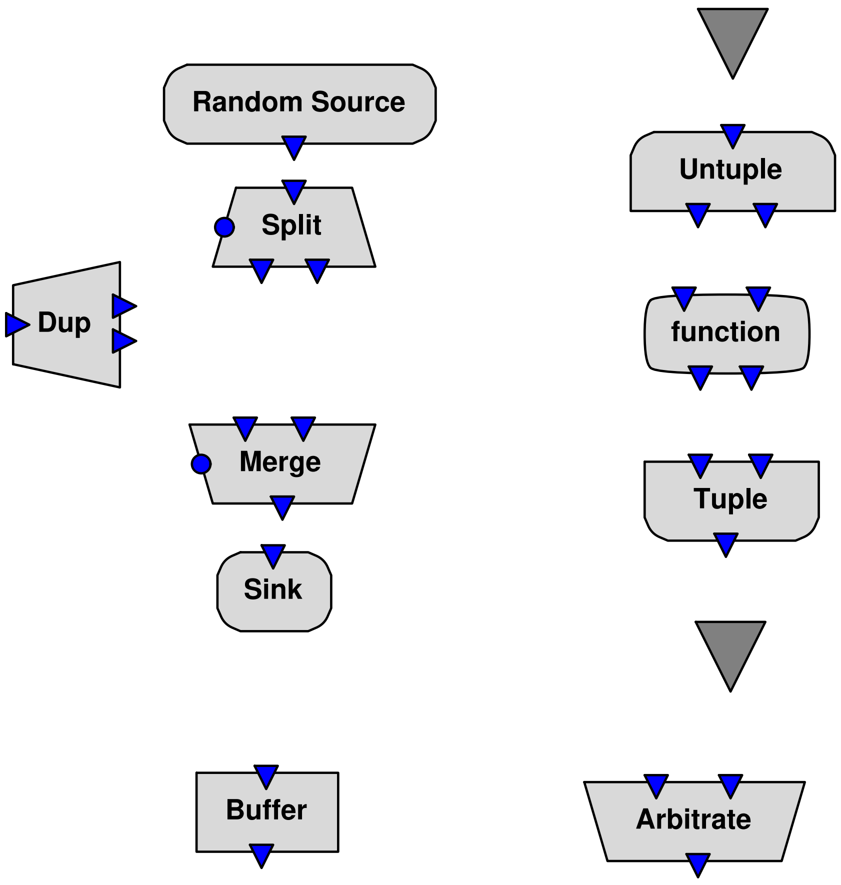
Micropipelines

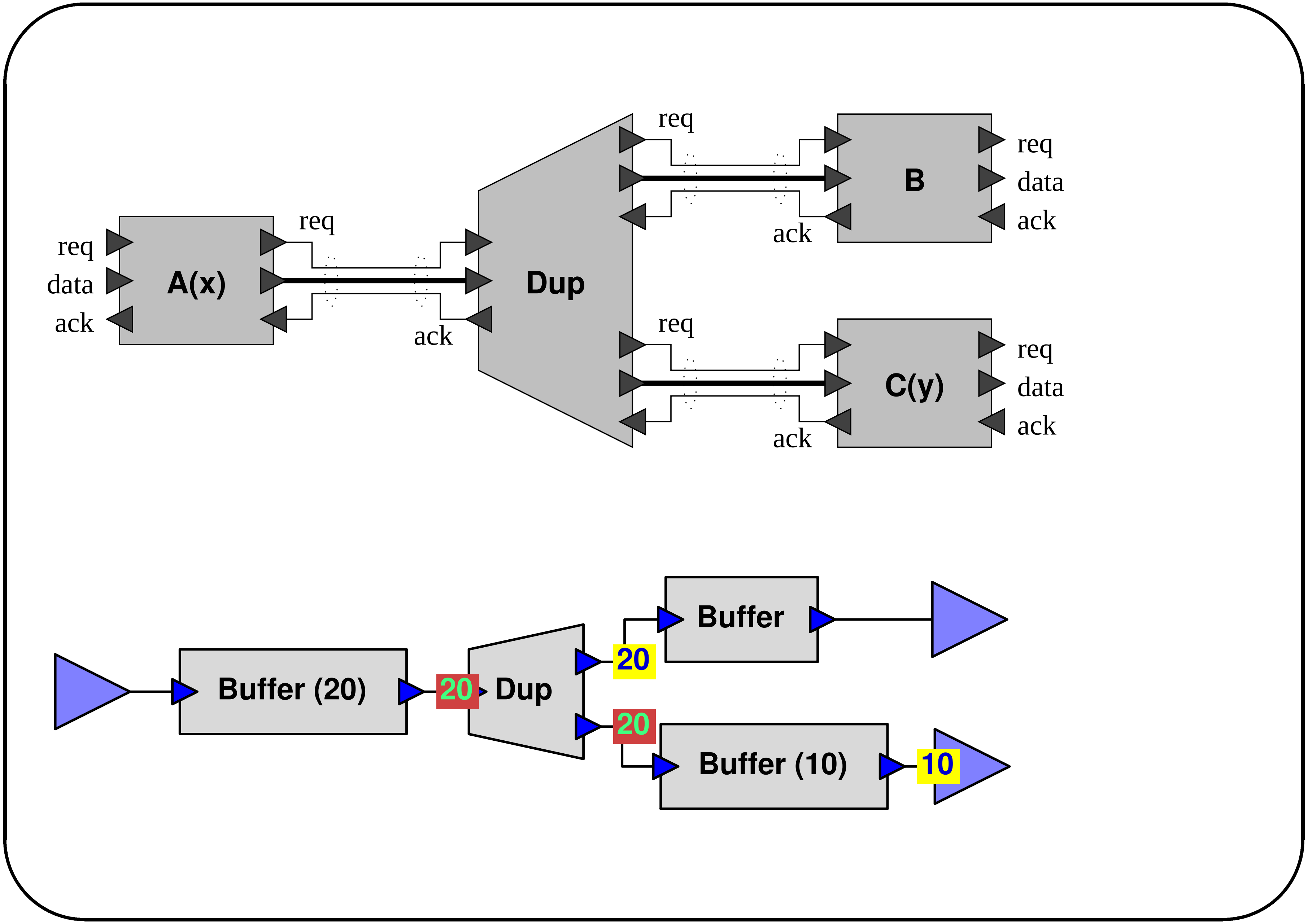


Rainbow Design Framework

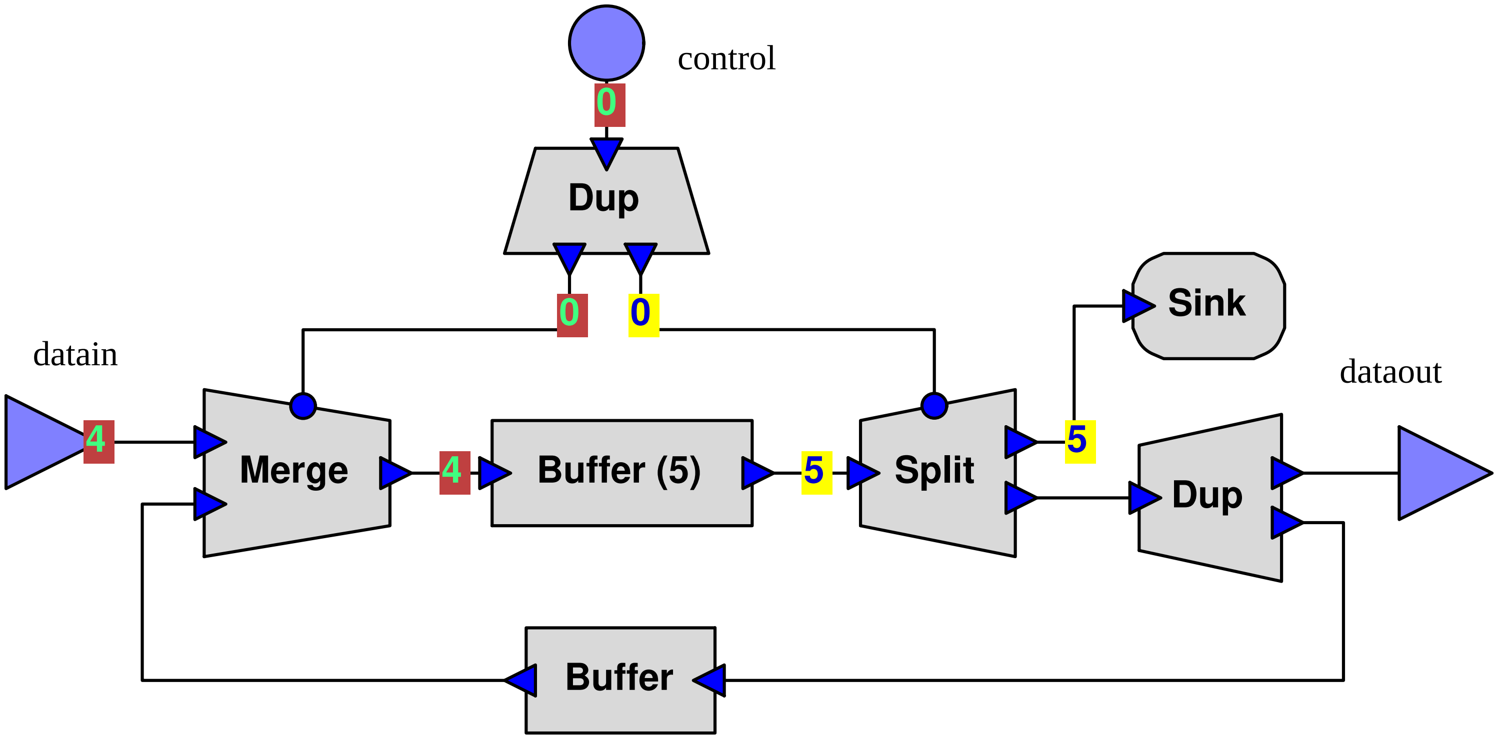


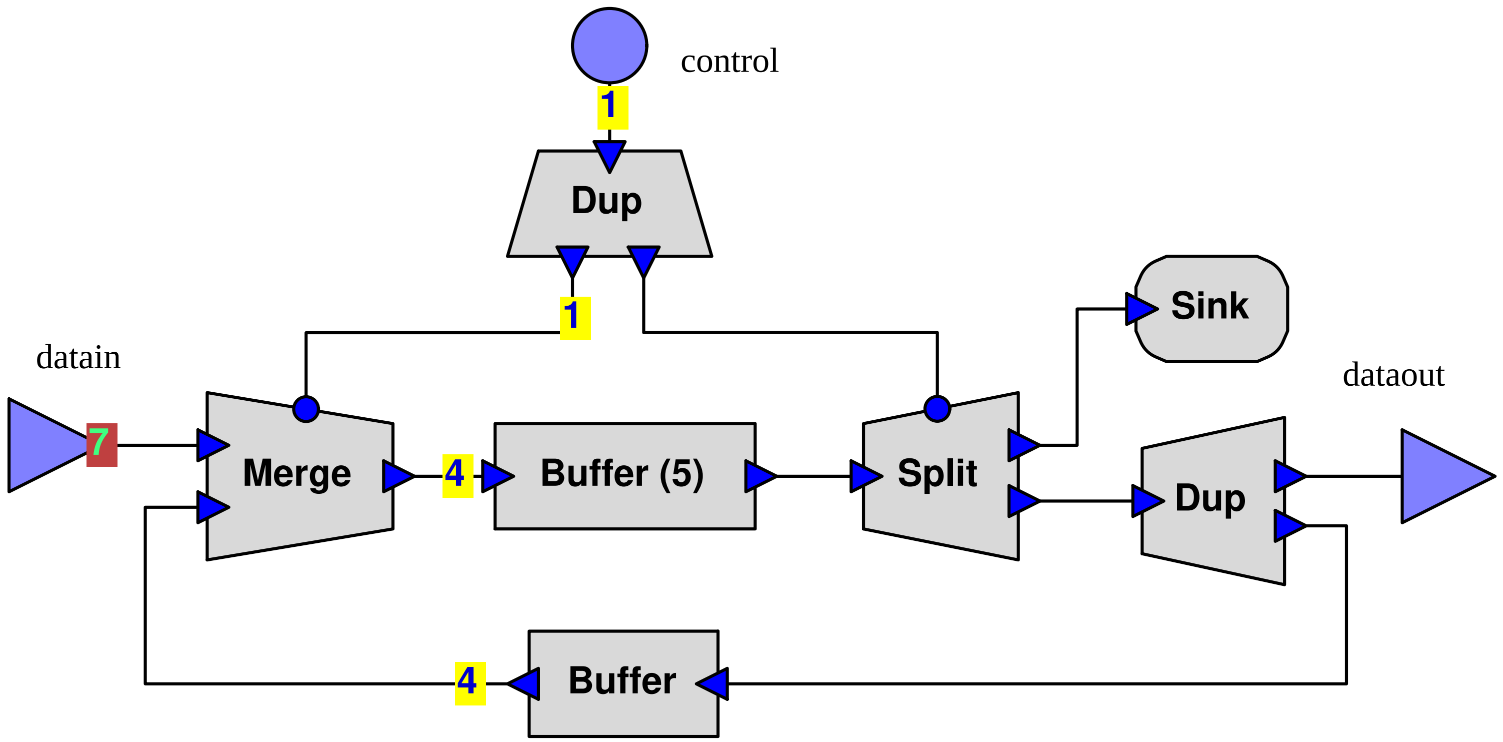
- Application-specific
- User-oriented language design
  - AMULET
- Abstract representation of bundled data
- Mixed-view modelling
- Hierarchical design
- Underlying formal semantics


Random Source
Split
Dup
Merge
Sink
Buffer
Untuple
function
Tuple
Arbitrate

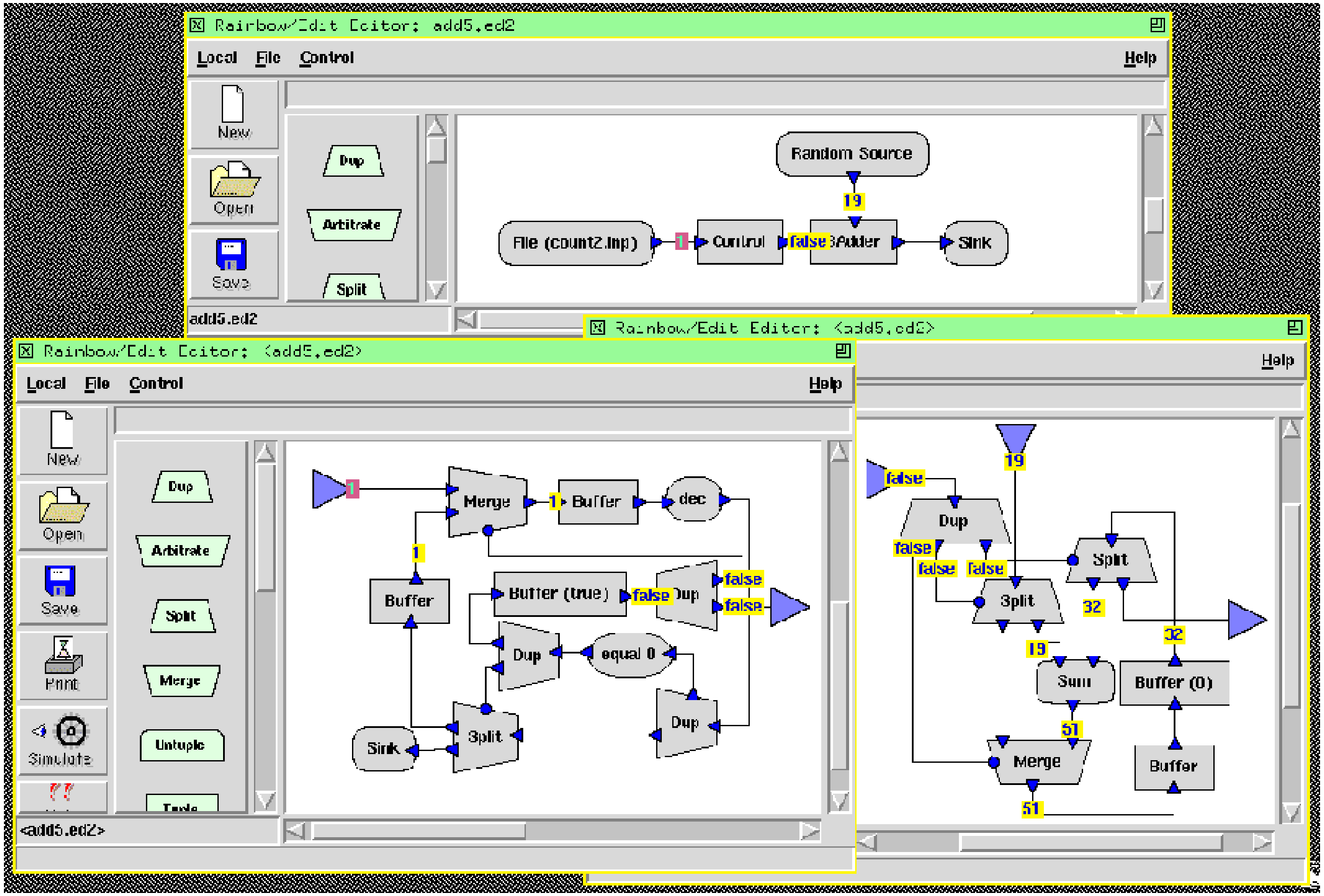

req
data
ack
A(x)
req
ack
Dup
req
ack
B
req
data
ack
req
ack
C(y)
req
data
ack
Buffer (20)
20
Dup
20
Buffer
20
Buffer (10)
10

Simulation

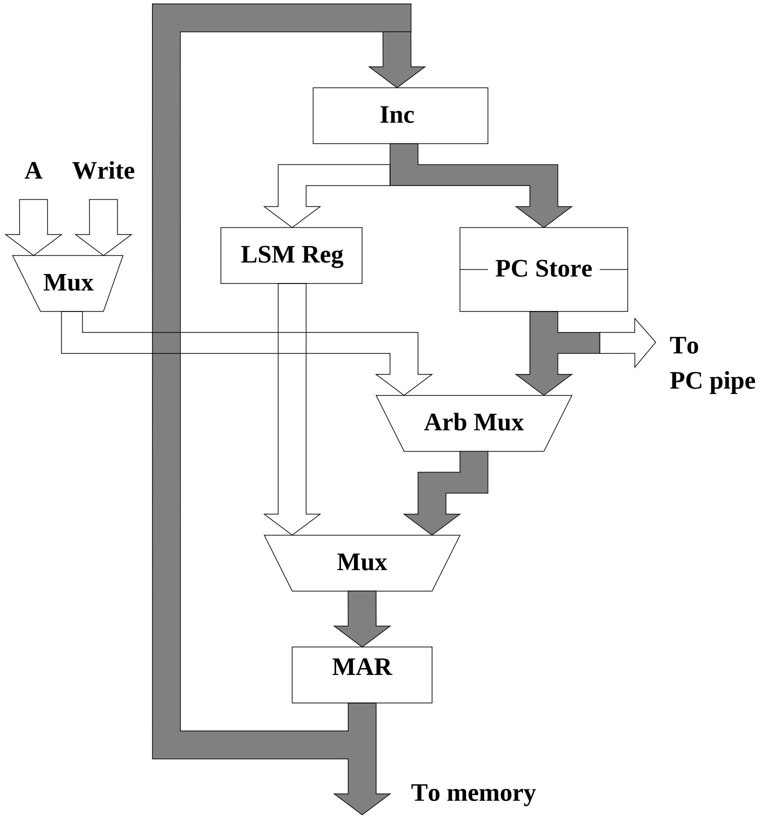

control
0
Dup
0
0
Sink
datain
dataout
4
Merge
4
Buffer (5)
5
Split
5
Dup
Buffer

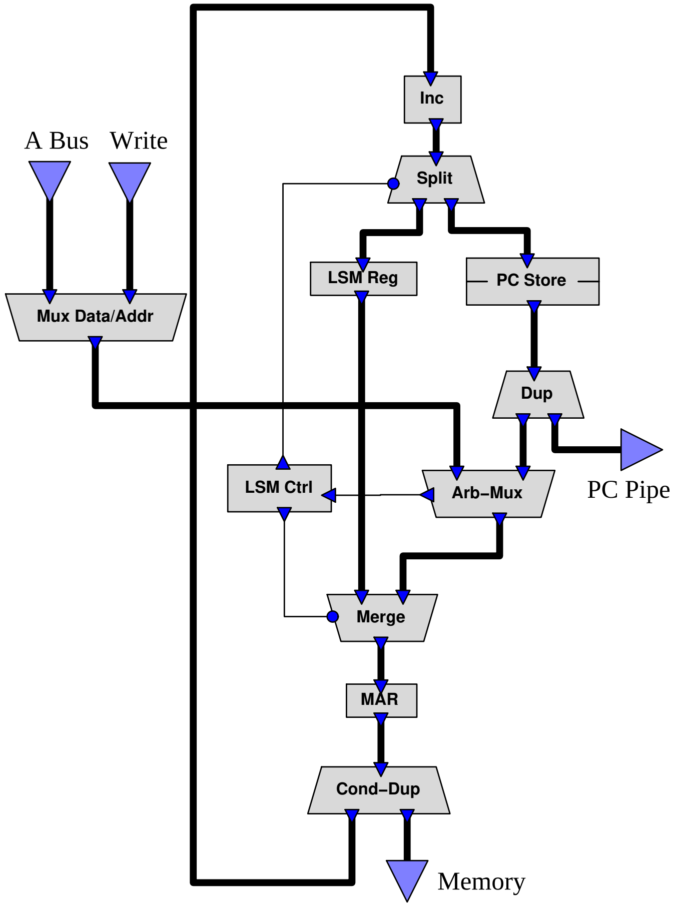

control
1
Dup
1
datain
7
Merge
4
Buffer (5)
Split
Sink
dataout
Dup
4
Buffer

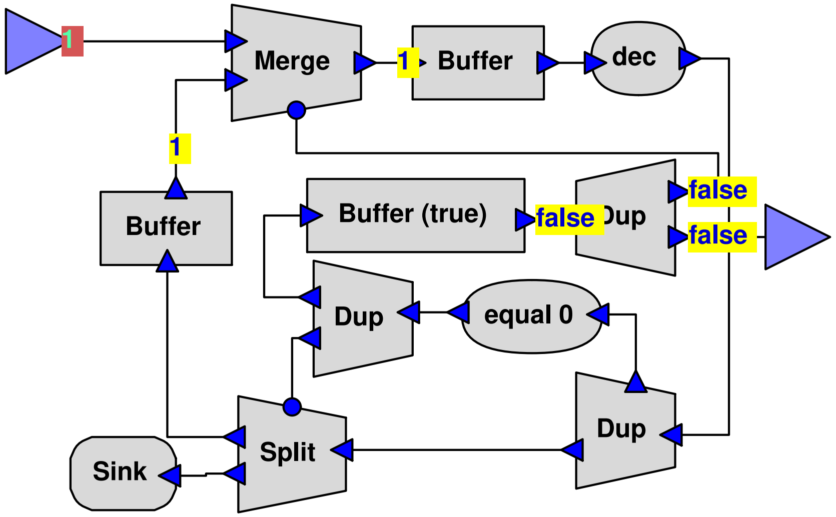
Hierarchy


Rainbow/Edit Editor: add5.ed2
Local File Control
Help
New
Open
Save
Dup
Arbitrate
Split
Random Source
File (count2.inp)
Control
Adder
Sink
add5.ed2
Rainbow/Edit Editor: <add5.ed2>
Merge
Buffer
dec
Buffer (true)
Dup
equal 0
Print
Simulate
Untuple
Sum
Buffer (0)
<add5.ed2>

Current Work








```
yellow control (input size: integer;
                output ctrl: boolean) = {
   reg count: integer end
   call ctrl!true;
   loop true ->
     {accept size?x do count:=x end;
      loop (count > 0) ->
        {call ctrl!false;
         count := count - 1}
      end;
      call ctrl!true}
   end
} end
```

Summary

- micropipeline design methodology
- Rainbow Design Framework
- abstract modelling
- design hierarchy
- application-specific methods
- prototype tool implementation
  - Visual Green editor/simulator
  - Rainbow expression compiler/evaluator
  - embedded into extensible design environment
- formal semantics
- analysis

URL:

`http://www.cs.man.ac.uk/fmethods/projects/AHV-PROJECT/ahv-project.html`