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A programming model and a NoC-based architecture for streaming applications

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Programming model

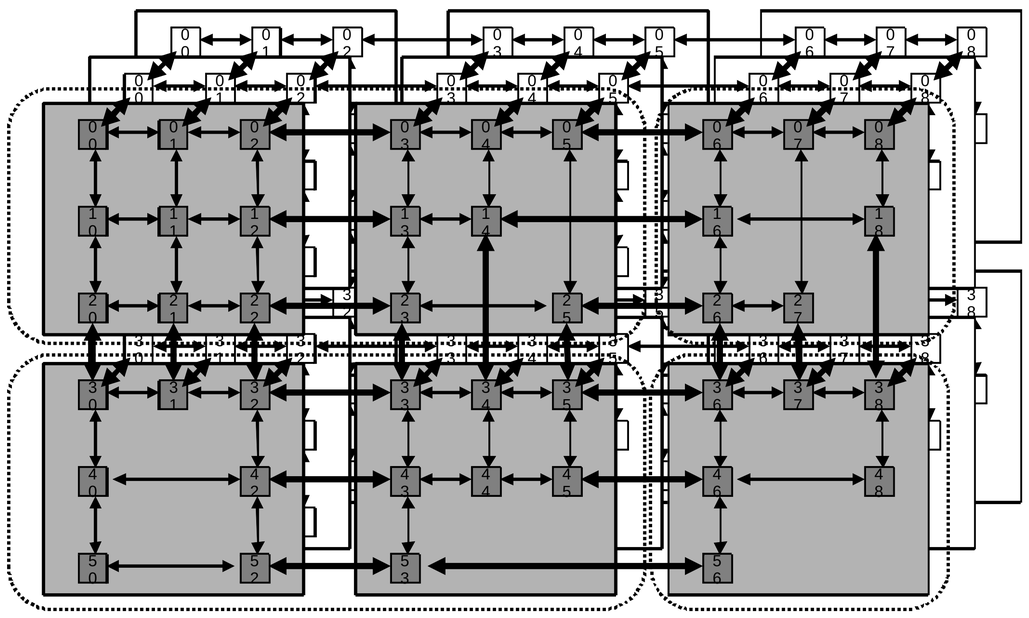
```
class producer1 : public sc_module {

public:
  sc_out <int> a1;
  sc_in <bool> clk;

  SC_HAS_PROCESS(producer1);

  producer1(sc_module_name name) :sc_module(name) {
    SC_THREAD(main22);
    sensitive_pos << clk;
  }

  void main22() {

    int  nb1;
    nb1=1;

    while(1) {
      if ((nb1%2)==0) {
        a1.write(nb1++);
        wait();
      }
      else {
        a1.write(nb1);
        nb1=nb1+3;
        wait();
      }
    }
  }
};
```

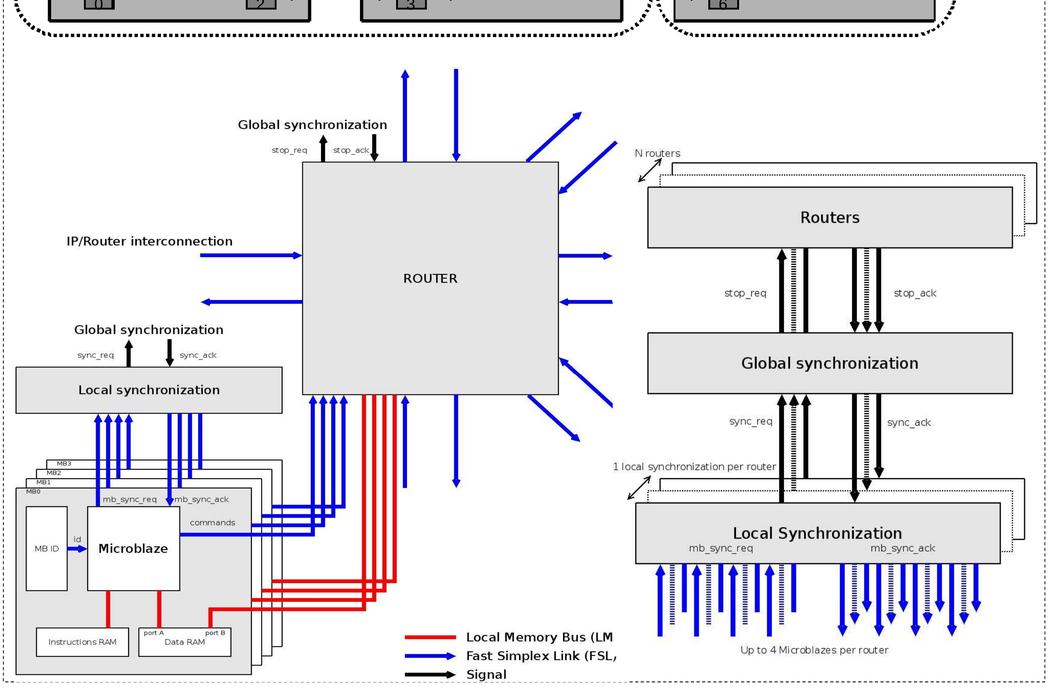
Generated code from SystemC code

```
{
    int nb1;
    nb1=1;

    while(1) {
        if ((nb1%2)==0) {
            write_signal(
            F1,1,0,nb1++);
            wait(5);
        }

        else {
            write_signal(
            F1,1,0,nb1);
            nb1=nb1+3;
            wait(6);
        }
    }
}
```

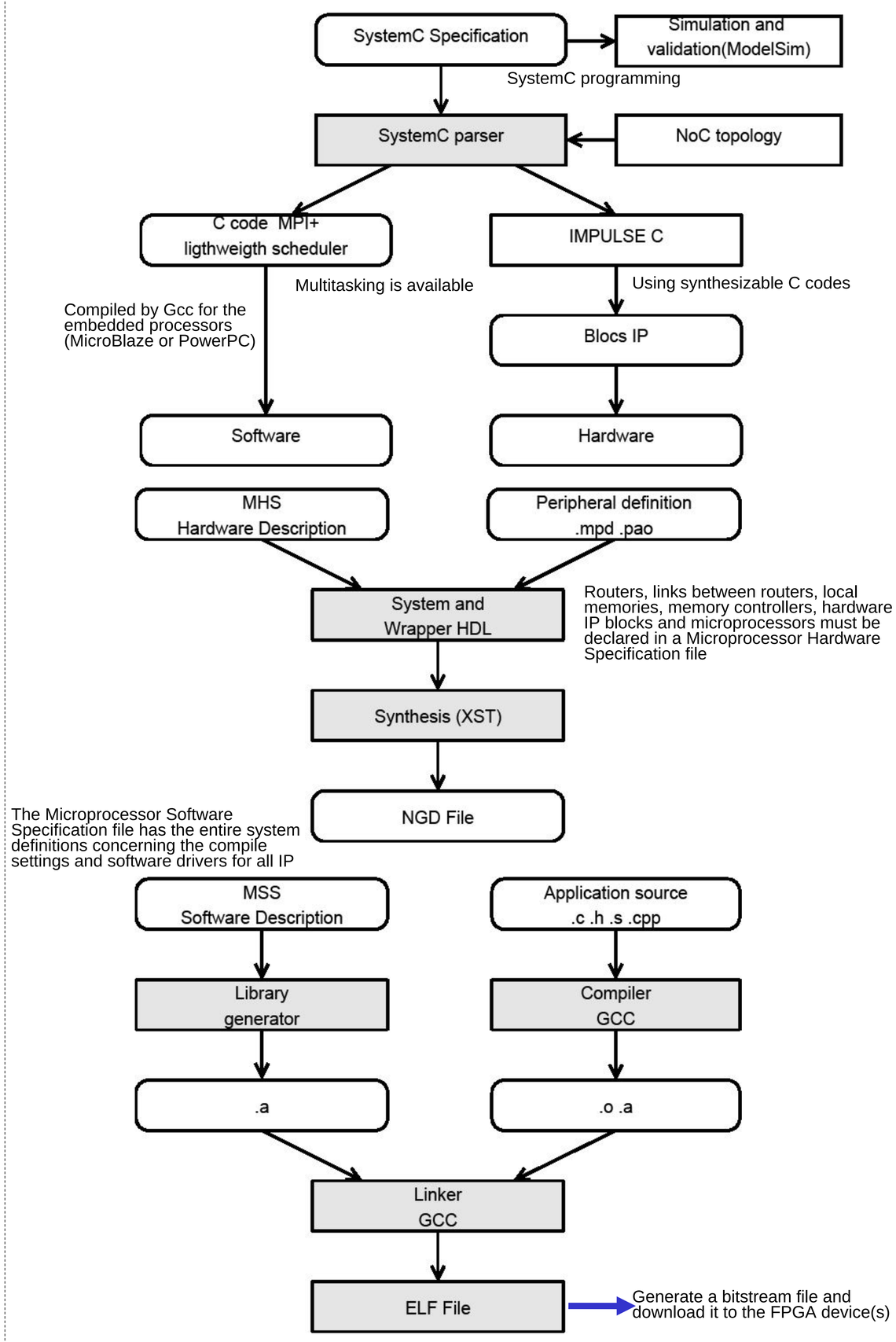
An example of NoC topology

A clustered hierarchical composed of several irregular meshes of N x M





Design flow



Results

Router Cost in function of the number of connected microblazes

Num. of MB	IOs	Funct. gen.	CLB Slices	DFFs or Latches	Freq. (Mhz)
1	497	2987	1494	628	173.3
2	582	3277	1639	609	178.6
4	743	3987	1994	668	203.3

The router cost is almost the cost of a MicroBlaze with the same frequency

We can build a large SoC with tens or hundreds of processors implemented on multi-FPGAs

Timing Results in clock cycles

Timing (in clock cycles) results for the execution of the producer-consumer application for packets with 4, 8 and 16 words

Primitive	4 words	8 words	16 words
System initialization	1385	2281	4057
MPI_init()	426	426	426
MPI_Comm_Rank()	2	2	2
Scheduling (wait())	60	60	60
write_signal	86	133	175
MPI_Barrier()	2	2	2

Latency formula to compute the total time T : $T = (ST + (NF + 2) * TF + NH) * NP + (NP - 1)$

ST = number of clock cycles to generate the header, that is 4 clock cycles
NF = number of flits, 16 for instance + 2 for the header and the end of packet
TF = 1, each flit spends one clock cycle to be transmitted to the next switch
NH = number of hops: each time a packet crosses a switch one clock cycle is needed
NP = number of packets