System-Level Design for Heterogeneous Embedded Systems

Gabriela Nicolescu

Ecole Polytechnique de Montréal

Tel : (514) 340 4711 ext 5434

Fax: (514) 340 3240

Email : gabriela.nicolescu@polymtl.ca

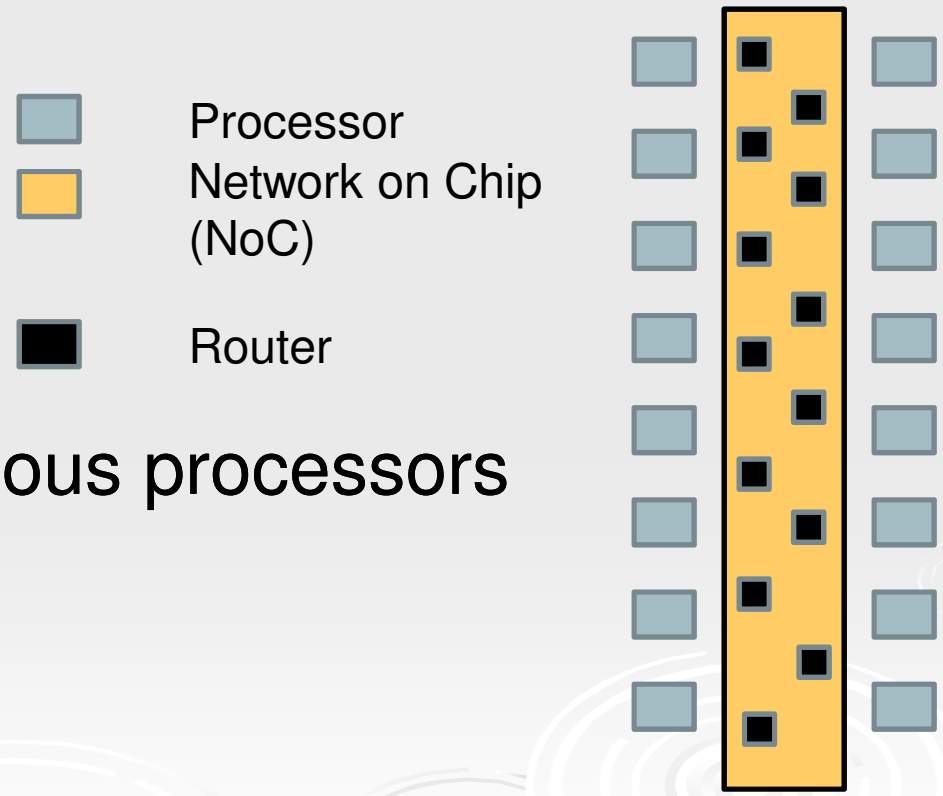
ÉCOLE POLYTECHNIQUE MONTRÉAL

G. Nicolescu

- Associate professor at Ecole Polytechnique de Montreal, Canada (since August 2003)
  - Currently in sabbatical at STMicroelectronics Canada
- Research interest
  - Embedded systems
  - System-level design
  - Heterogeneous models, integration & refinement
  - (Co-)Simulation – global validation
  - Abstractions

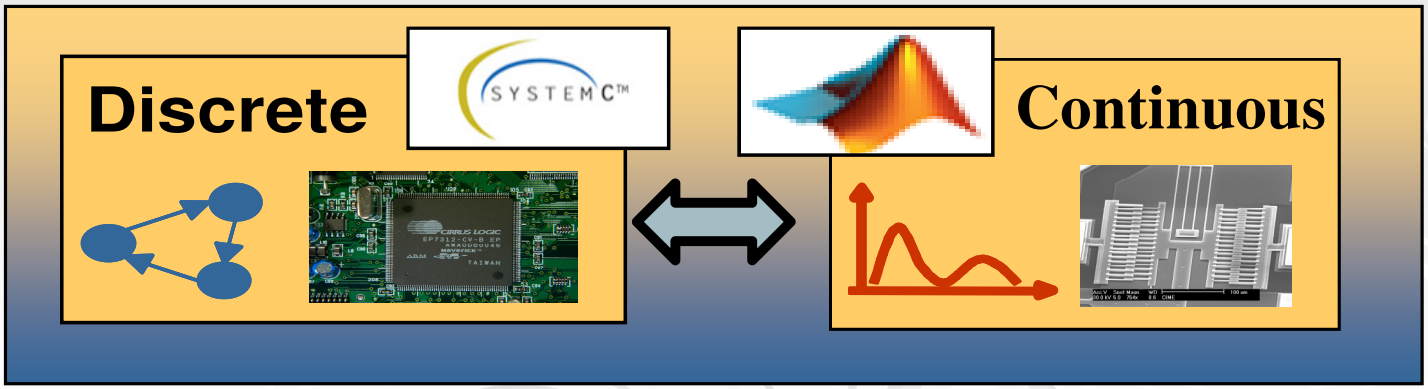
Heterogeneous Embedded Systems

- Systems including Multi-Domains components
  - Electronic
    - Hardware
      - Analog
      - Discrete
    - Software
      - Heterogeneous processors
  - Optic
  - Mechanic



Global Simulation

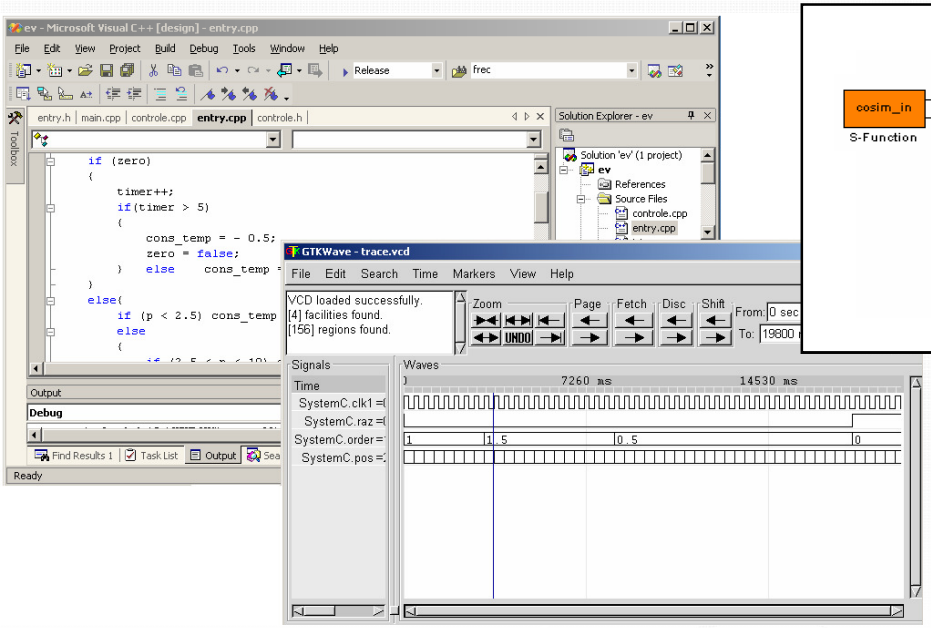
- Continuous/Discrete Interfacing
- Synchronization models
  - Formalized using timed-automata and DEVS
  - Formally verified using UPPAAL
  - Implemented for Simulink and SystemC Models



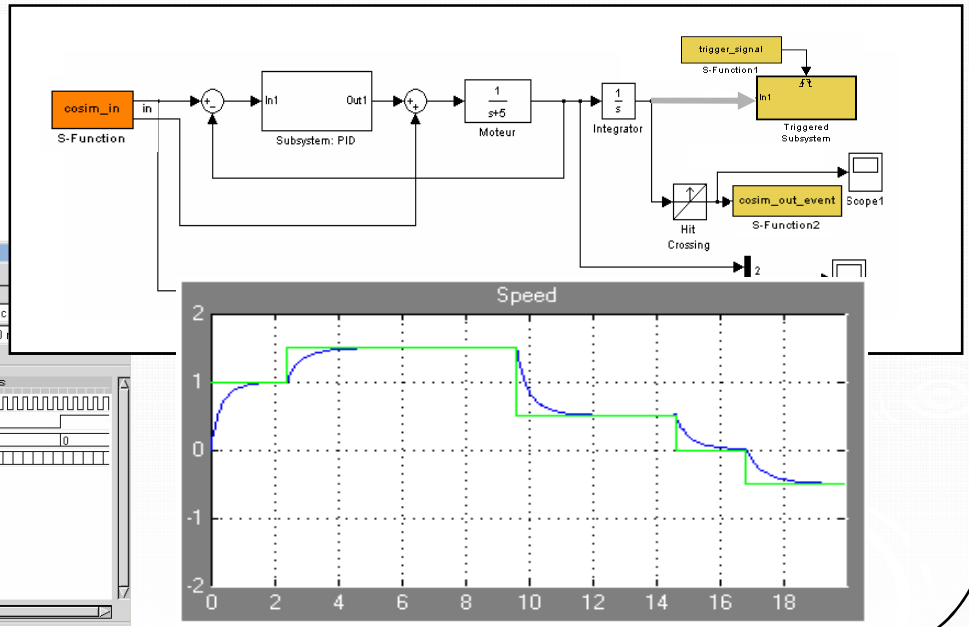
Continuous/Discrete Simulation

- SystemC/Simulink accurate simulation
  - Easy integration, generic library elements

Systemc



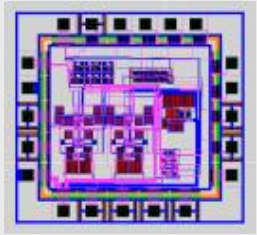
Simulink



Applications

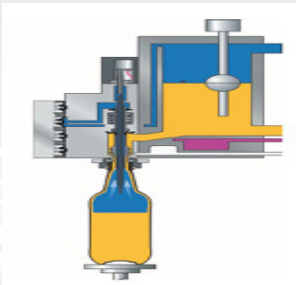
- Glycemia regulator

- Mixed signal application
  - Σ/Δ Converter



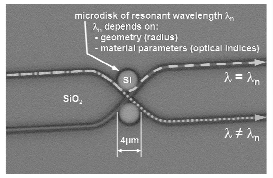
- Wireless application
  - Radar syste

- Control applications
  - Robot arm manipulator, Bottle filling



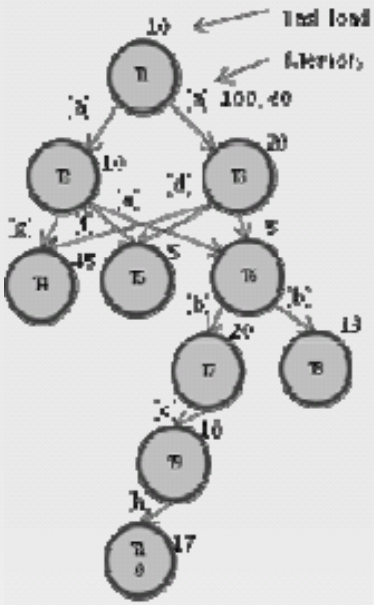
- Optical Network on chip

  Cooperation with ECL Lyon



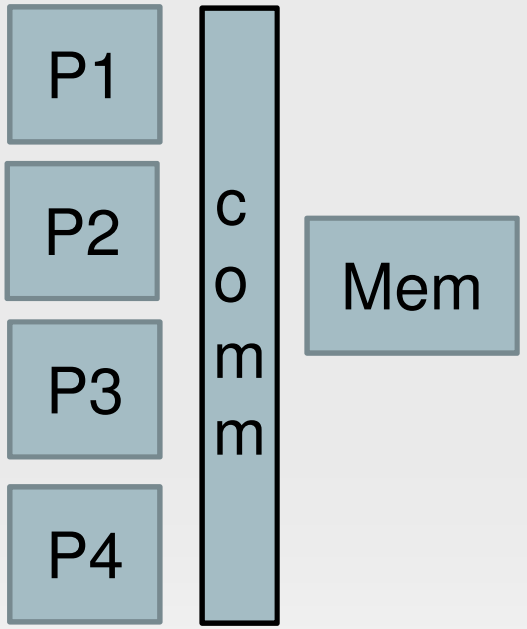
Mapping Application on Architectures

Application



Load Balancing
Minimize Comm. Cost
Minimize Memory Size

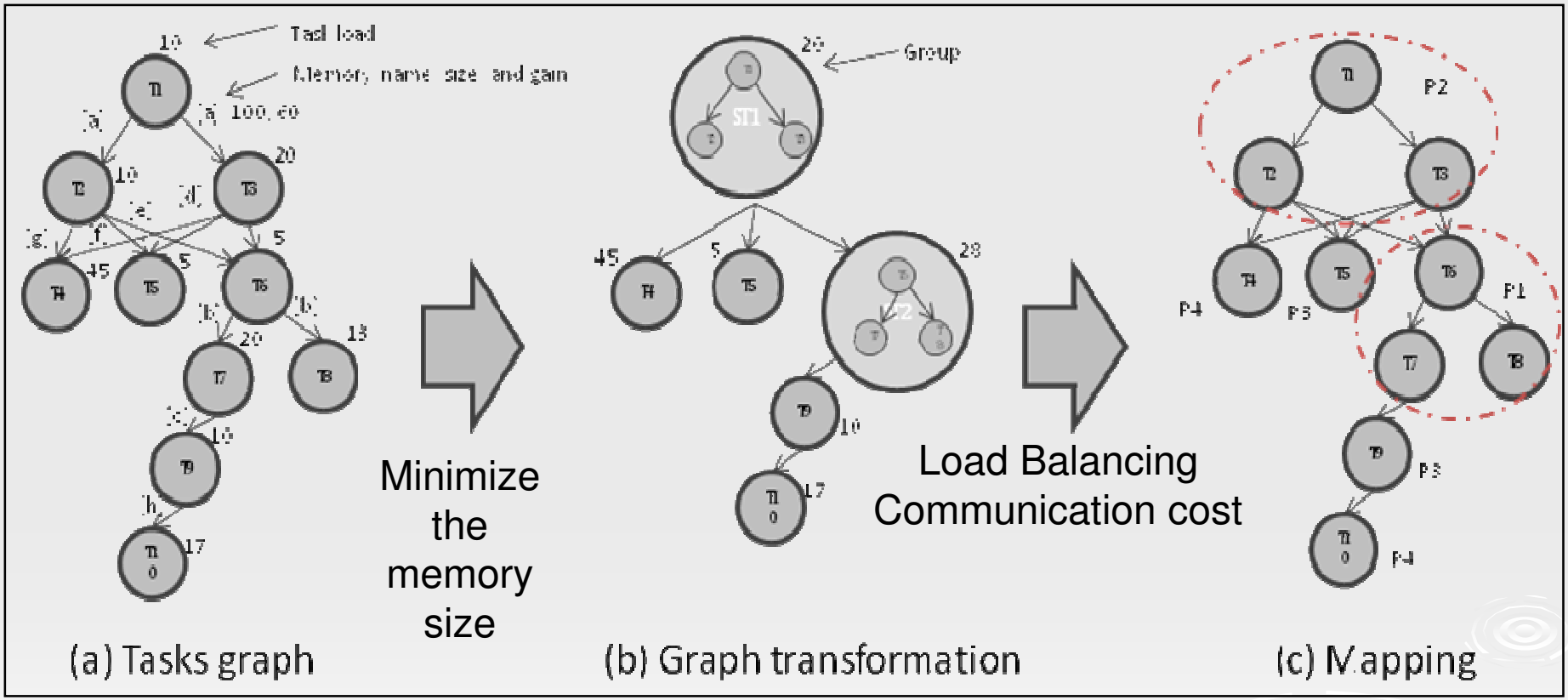
Architecture



Graph Annotations
-For nods – load of processor
-For edges – data size

High-Level Specification
- No and type of processors
- Communication and storage ressources

Mapping Application on Architectures



Mapping Application on Architectures

Code Transformation - example -

```
L1: do i =  0, 7
        do j = 0, 7
            S1:A(i,j) = F(In);
        end
    end

L2: do i = 0, 7
        do j = 0, 7
            S2:B(i,j) = A(i,j) + A(i-1, j-1);
        end
    end
```

(a) Initial Code

```
do i =  0, 7
    do j = 0, 7
        S1: A(i,j) = F(In);
        S2: B(i,j) = A(i,j) + A(i-1, j-1);
    end
end
```

(b) Loop Fusion

Applications and results

- Multimedia applications
  - MPEG4
  - Demosaik
  - Cavity detection
- Wireless applications
  - WIMAX – 802.16
- Automatically Model Transformation
  - 60% gain in memory size
- Integration with STMicroelectronics platforms

Expectations

- Combining foundations and applications
- Models vs. Applications
- Models vs. Tools
- Models vs. Domains
- Collaborations