Multi-Paradigm Modeling

– From Functional Model to Implementation

CAMPaM Workshop, Bellairs

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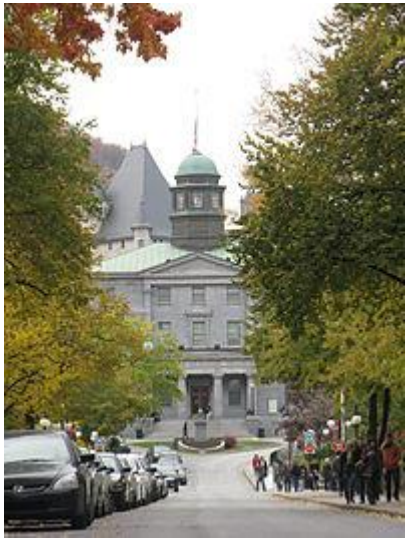
About Myself

- PhD, University of California at Berkeley, 2008

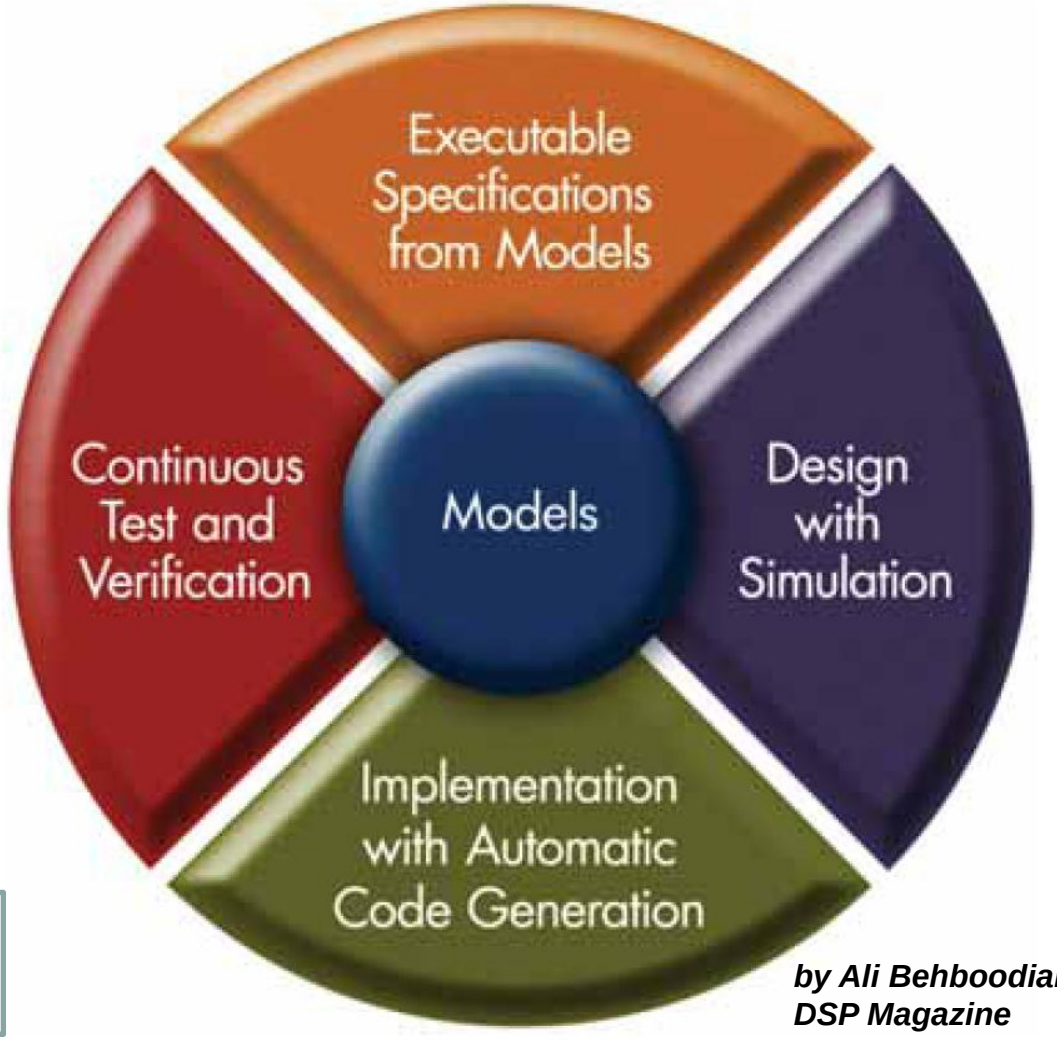
- Working Experiences
  - August 2008 – October 2011
    - Senior Researcher, General Motors R&D
  - November 2011 – Present
    - Assistant Professor, McGill University

McGill



My Research Focus w.r.t. MPM

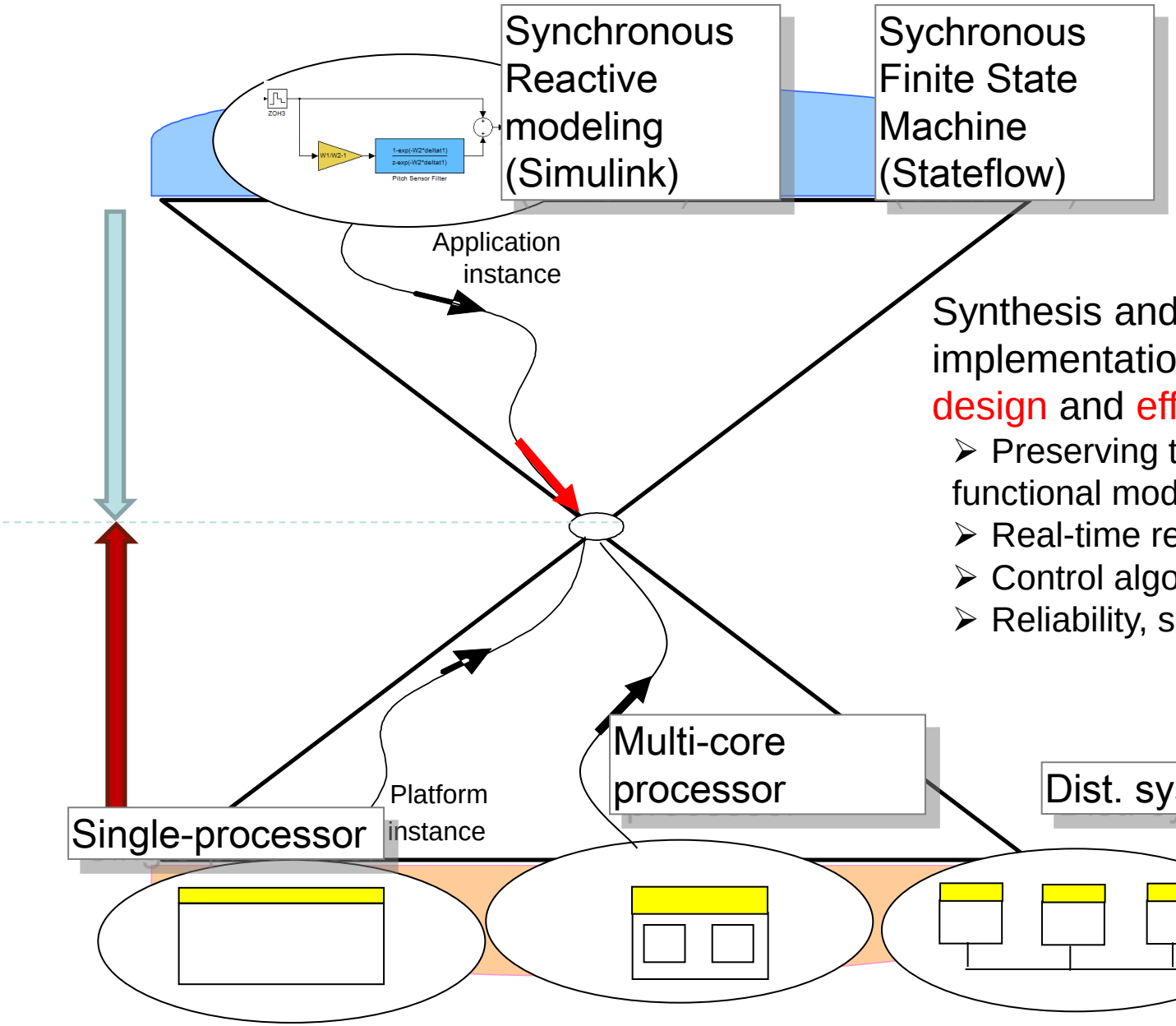
- The four tenets on the right are fundamental to model-based design
- Of course, you must select modeling languages that allow to do things in the most natural and easy way…
- ***It is also essential for***
  - ***testing***
  - ***verification***
  - ***simulation***
  - ***validation***
  - ***automatic deployment and code generation***



by Ali Behboodian, DSP Magazine

Figure 1 – Elements of model-based design

My Research Contributions and Plans



Synthesis and optimization of implementation that is correct-by-design and efficient w.r.t.

- Preserving the behavior in functional model
- Real-time requirement
- Control algorithm performance
- Reliability, safety, security, energy

Related Recent Publications

- Stateflow on Single-Processor Platforms
  - H. Zeng and M. Di Natale. ***Schedulability Analysis of Periodic Tasks Implementing Synchronous Finite State Machines***. In Proc. 24th Euromicro Conference on Real-Time Systems, July 2012.
  - M. Di Natale and H. Zeng. "***Task Implementation of Synchronous Finite State Machines***." Conference on Design, Automation, and Test in Europe, March 2012

- Simulink/AUTOSAR on Single-Processor Platforms
  - M. Di Natale, L. Guo, H. Zeng, and A. L. Sangiovanni-Vincentelli. "**Synthesis of Multi-task Implementations of Simulink Models with Minimum Delays**." IEEE Transaction on Industrial Informatics, 6(4): 637-651, November 2010.
  - H. Zeng and M. Di Natale. "**Efficient Implementation of AUTOSAR Components with Minimal Memory Usage**." In Proceedings of Workshop on Synthesis and Optimization Methods for Real-time Embedded Systems, in conjunction with the 32nd IEEE RTSS, November 2011.

- Simulink/AUTOSAR on Multi-core Platforms
  - H. Zeng and M. Di Natale. "**Mechanisms for Guaranteeing Data Consistency and Time Determinism in AUTOSAR Software on Multi-core Platforms**." In Proceedings of the IEEE Symposium on Industrial Embedded Systems, July 2011.

Related Recent Publications

- Simulink/AUTOSAR on Distributed Systems Platforms
  - C. Lin, M. Di Natale, H. Zeng, and A. Sangiovanni-Vincentelli. "**Performance Analysis of Synchronous Models Implementations on Loosely Time-Triggered Architectures**." In Work-in-Progress session, IEEE Real-Time and Embedded Technology and Application Symposium, April 2011.
  - M. Di Natale and H. Zeng. "**Time Determinism and Semantics Preservation in the Implementation of Distributed Functions over FlexRay**." In Society of Automotive Engineers World Congress, April 2010.

- Deployment Space Exploration and Optimization
  - H. Zeng and M. Di Natale. "**An Efficient Formulation of the Real-time Feasibility Region for Design Optimization**". To appear in IEEE Transaction on Computers.
  - Q. Zhu, H. Zeng, W. Zheng, M. Di Natale, and Alberto Sangiovanni-Vincentelli. **Optimization of Task Allocation and Priority Assignment in Hard Real-time Distributed Systems**. To appear in the ACM Transactions in Embedded Computing Systems, special issue on the Synthesis of Cyber-Physical Systems.
  - H. Zeng, M. Di Natale, A. Ghosal, and A. Sangiovanni-Vincentelli. **Schedule Optimization of Time-Triggered Systems Communicating over the FlexRay Static Segment**. IEEE Transactions on Industrial Informatics, Vol. 7, No. 1, February 2011, 1-17.

Potential Topics / Expected Results

- Modeling Deployment
  - How to choose the modeling languages for
    - Architecture Platforms Description
    - Design Constraint Description
    - Cost Description
    - Mapping/Deployment Description

Potential Topics / Expected Results

- Model Transformation
  - Whether/how transformation-based modeling infrastructure can support deployment space exploration
    - refine the pure functional models to deployed ones
    - produce models at the same level of abstraction
      - to evaluating the feasibility and/or fitness of a deployment candidate.
    - backtrack from a refined deployment candidate to a coarser level one
  - How to support the plugging of legacy algorithms
    - deployment candidate generation
    - selection of optimal deployment candidates

Criteria for Success

- Nice tourism at Barbados!!

- Discuss and understand better on possibility of transformation-based deployment space exploration

thank you!

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