SYSTEM#: HIGH-LEVEL SYNTHESIS OF PHYSICAL SIMULATIONS FOR FPGA-BASED REAL-TIME EXECUTION

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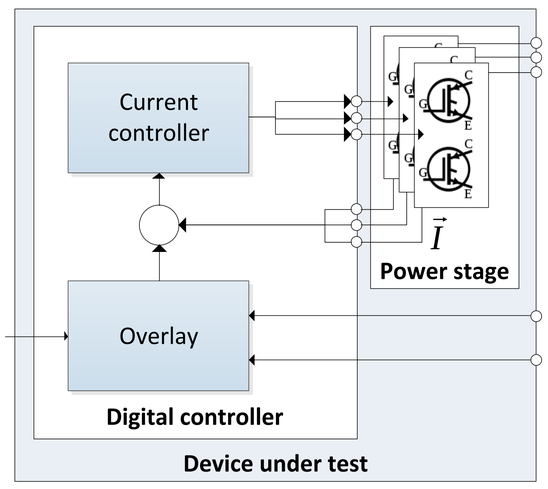


HARDWARE-IN-THE-LOOP TEST AND ELECTRIC MOTOR EMULATION

Electrified vehicular powertrains undergo exhaustive test procedures during development. In order to test an electric motor controller, motor and vehicle mechanics are replaced by a virtual device - the electric motor emulator (EME). An EME computes motor currents and rotor position from repeated voltage measurements and recreates these currents with a power stage. An EME involves a built-in real-time model requiring a challenging reaction time of approximately 1 µs. This is achieved by executing the model on an FPGA.

THE PROBLEM

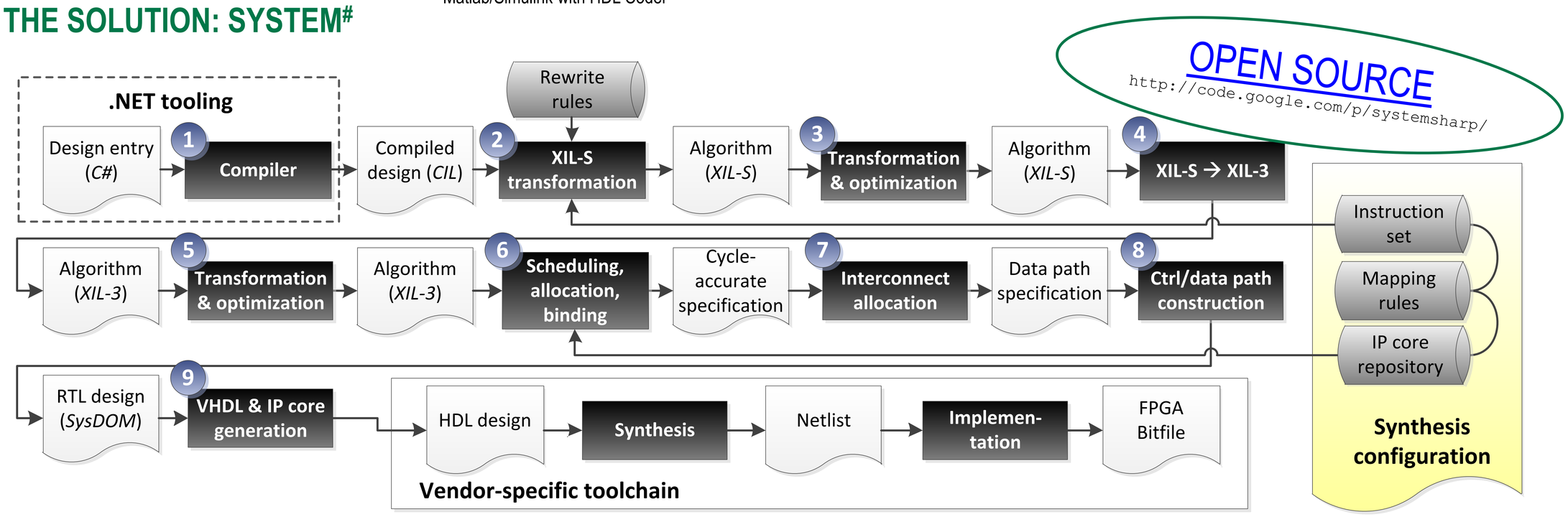
- Mapping such models to FPGAs requires tremendous engineering efforts.
- Can automation simplify the engineering task?

TOOL COMPARISON

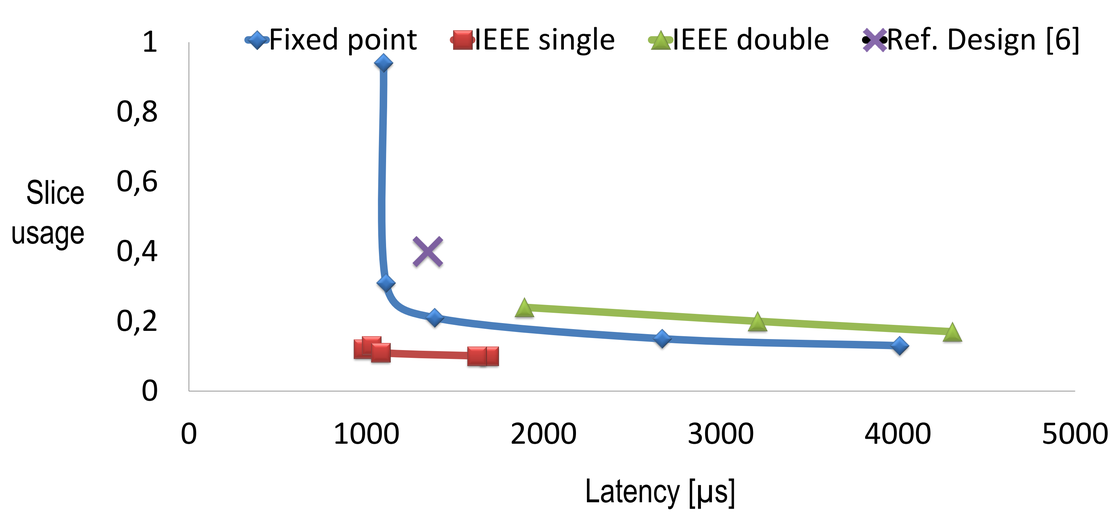
	*Matlab**	*AutoESL*	*DIME-C*	*Trident* [1]	*Legup* [2]	*Gaut* [3]	*Spark* [4]	*Kiwi* [5]	*System#*
Input languages	Proprietary	C, C++, SystemC	C	C	C	C, C++	C	C#	C#
Infers microarchitecture?	✗	✓	✓	✓	✓	✓	✓	✓	✓
Arbitrary-witdth fixed point arithmetic?	✓	✓	✗	✗	✗	✓	✗	✗	✓
Supports floating point arithmetic?	✗	✓	✓	✓	✗	✗	✗	✓	✓
Open source?	✗	✗	✗	✓	✓	✗	✗	✗	✓

*Matlab/Simulink with HDL Coder

THE SOLUTION: SYSTEM#



CASE STUDY: SQUIRREL-CAGE INDUCTION MACHINE



TUNING PARAMETERS

- Arithmetic: 56 bit fixed point, IEEE single/double
- Scheduling: Force-directed scheduling with various schedule lengths
- Xilinx IP cores with various latency settings

CONCLUSIONS

- Broad range of performance/area tradeoff is achievable.
- Quality of hand-coded design was attained.
- Floating-point arithmetic is affordable.

REFERENCES

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[2] A. Canis, J. Choi, M. Aldham, V. Zhang, A. Kammoona, J. H. Anderson, S. Brown, and T. Czajkowski, “Legup: high-level synthesis for fpga-based processor/accelerator systems,” in Proc. 19th ACM/SIGDA Intl. symposium on Field programmable gate arrays, 2011.

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http://code.google.com/p/systemsharp/

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