

VHDL: Introduction

VHDL

- What is VHDL?

VH I S C = Very High Speed Integrated Circuit

Hardware

Description

IEEE Standard 1076-1993

Language

History of VHDL

- Designed by IBM, Texas Instruments, and Intermetrics as part of the DoD funded VHSIC program
- Standardized by the IEEE in 1987: IEEE 1076-1987
- Enhanced version of the language defined in 1993: IEEE 1076-1993
- Additional standardized packages provide definitions of data types and expressions of timing data
 - IEEE 1164 (data types)
 - IEEE 1076.3 (numeric)
 - IEEE 1076.4 (timing)

Traditional vs. Hardware Description Languages

- Procedural programming languages provide the *how* or recipes
 - for computation
 - for data manipulation
 - for execution on a specific hardware model
- Hardware description languages *describe* a system
 - Systems can be described from many different points of view
 - Behavior: what does it do?
 - Structure: what is it composed of?
 - Functional properties: how do I interface to it?
 - Physical properties: how fast is it?

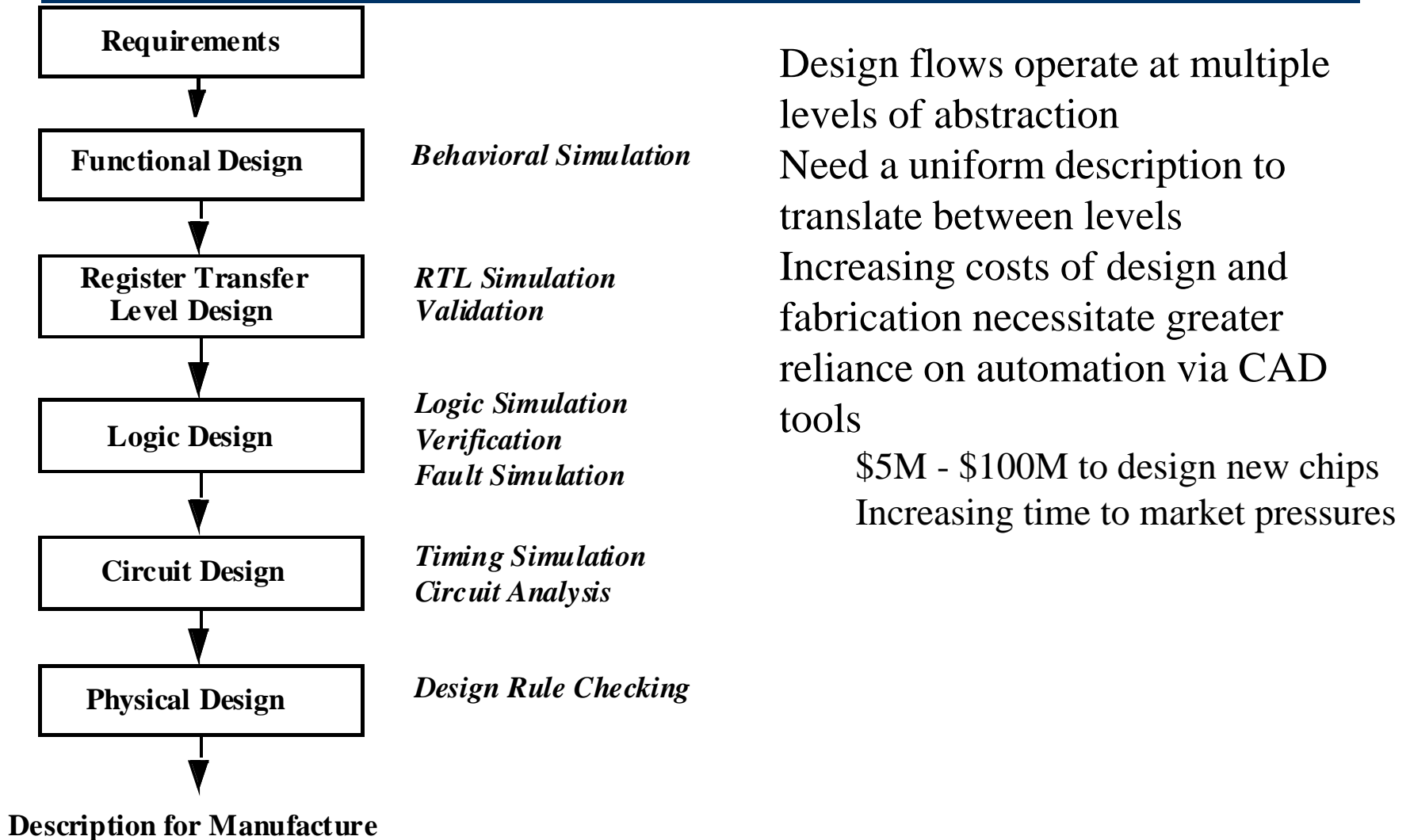
Usage

- Descriptions can be at different levels of abstraction
 - Switch level: model switching behavior of transistors
 - Register transfer level: model combinational and sequential logic components
 - Instruction set architecture level: functional behavior of a microprocessor
- Descriptions can be used for
 - Simulation
 - Verification, performance evaluation
 - Synthesis
 - First step in hardware design

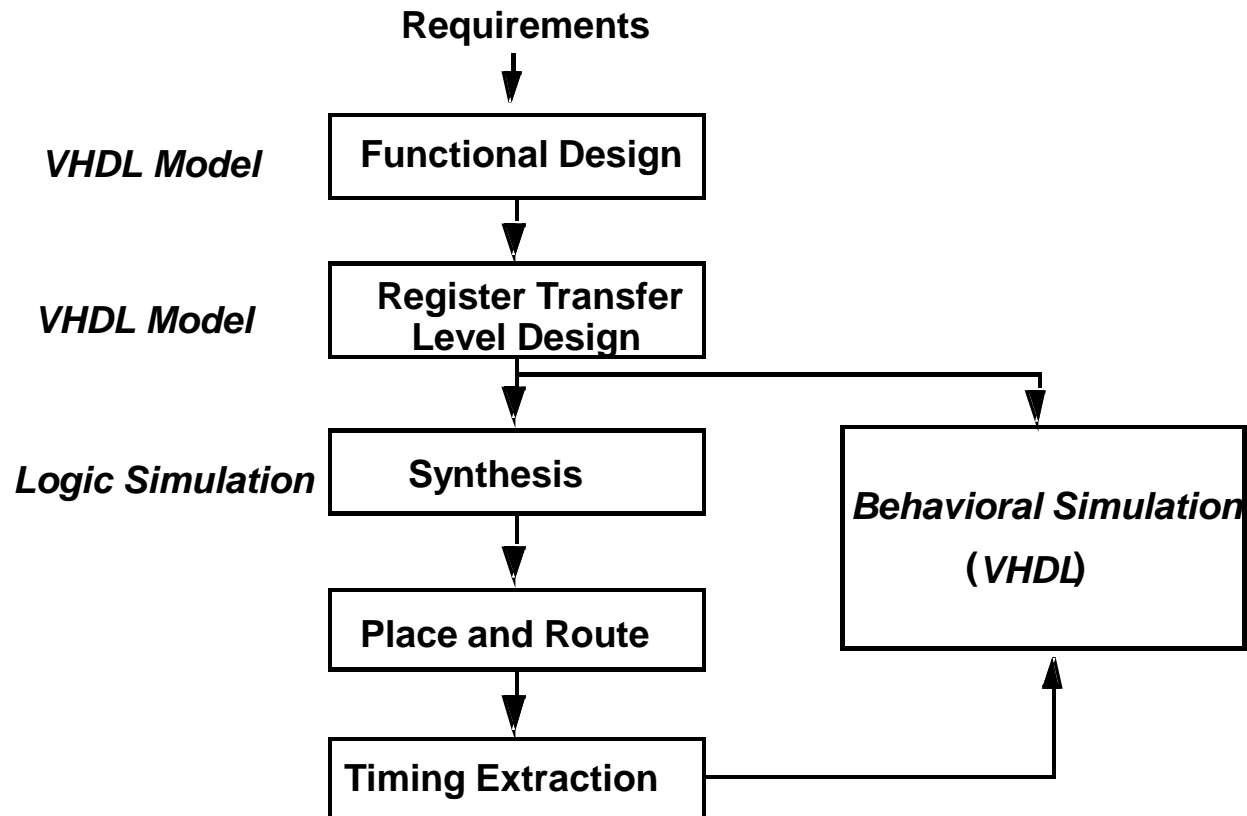
Why do we Describe Systems?

- Design Specification
 - unambiguous definition of components and interfaces in a large design
- Design Simulation
 - verify system/subsystem/chip performance prior to design implementation
- Design Synthesis
 - automated generation of a hardware design

Digital System Design Flow

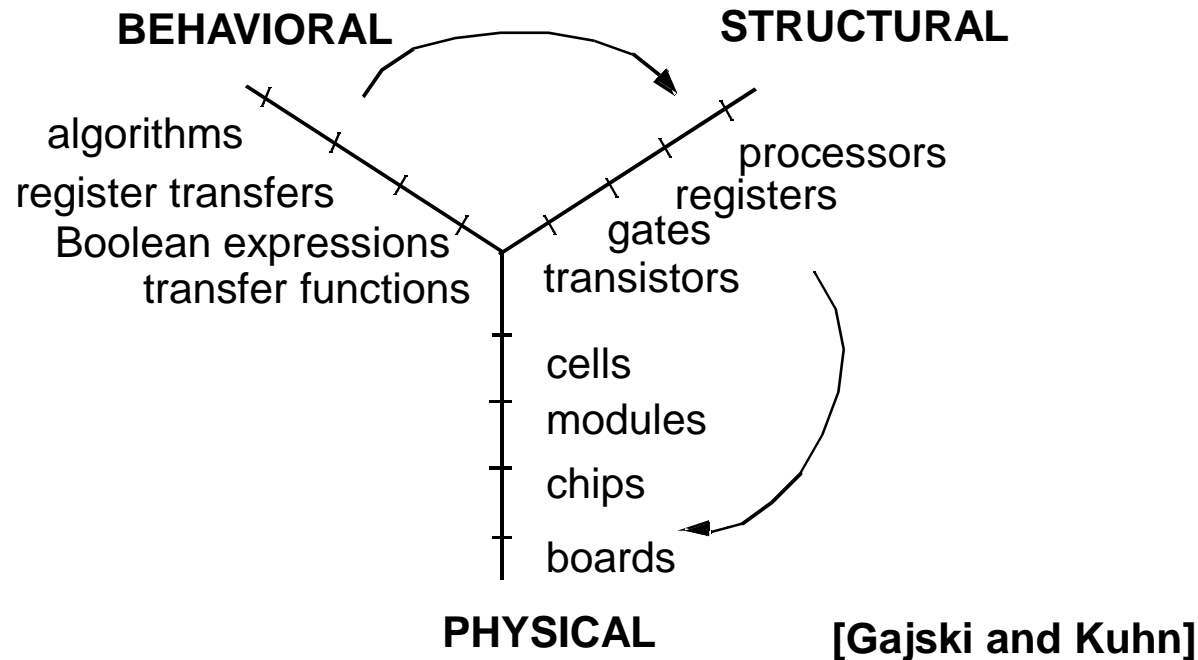


A Synthesis Design Flow



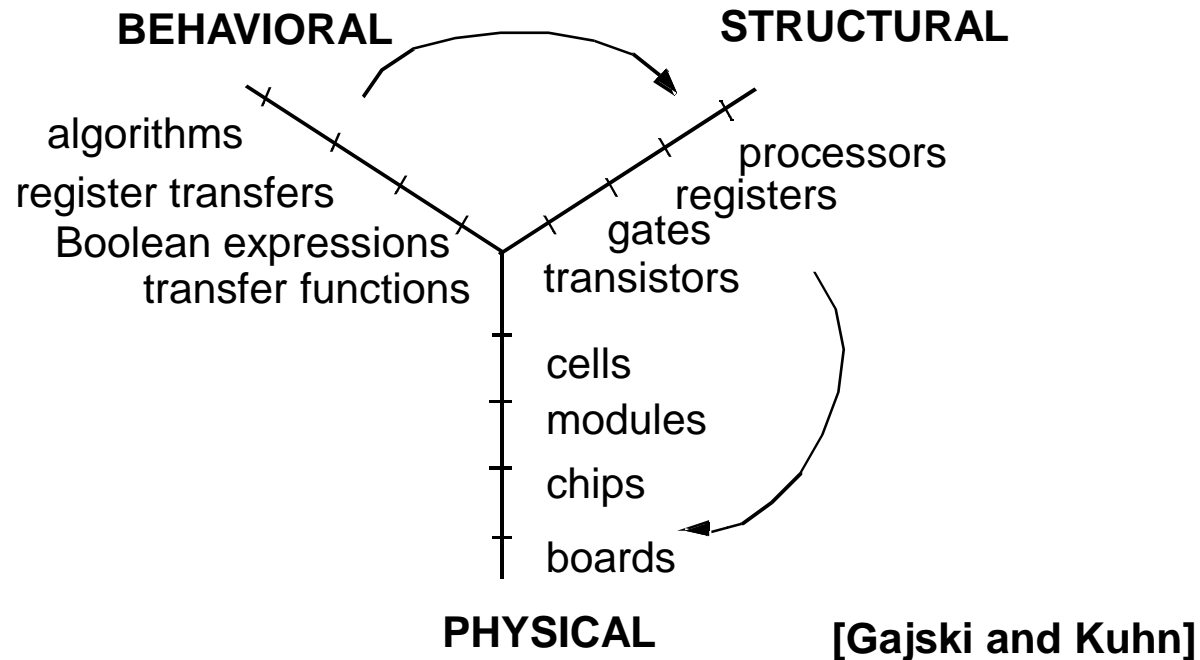
- Automation of design refinement steps
- Feedback for accurate simulation
- Example targets: ASICs, FPGAs

The Role of Hardware Description Languages



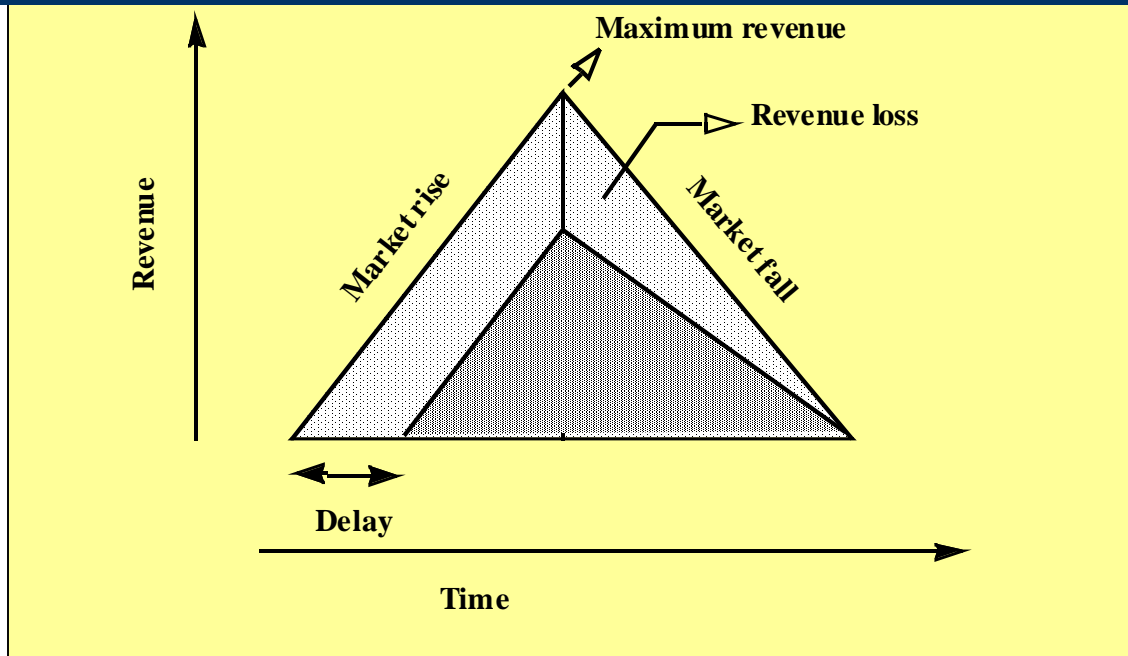
- Design is structured around a hierarchy of representations
- HDLs can describe distinct aspects of a design at multiple levels of abstraction

The Role of Hardware Description Languages



- Interoperability: models at multiple levels of abstraction
- Technology independence: portable model
- Design re-use and rapid prototyping

The Marketplace



*From V. K. Madisetti and T. W. Egolf,
"Virtual Prototyping of Embedded
Microcontroller Based DSP Systems,"
IEEE Micro, pp. 9-21, 1995.*

- Time to market delays have a substantial impact on product revenue
- First 10%-20% of design cycle can determine 70%-80% of the cost
- Costs are rising rapidly with each new generation of technology
- Need standards and re-use => automation centered around HDL based tools such as VHDL

Alternatives

- The Verilog hardware description language
 - Finding increasing use in the commercial world
 - SystemVerilog gaining prominence
 - VHDL dominates the aerospace and defense worlds
- Programming language based design flows
 - SystemC
 - C++ with additional hardware-based language elements
 - C-based design flows
 - C + extensions as well as ANSI C based
 - Other
 - Java, MATLAB, and specialized languages

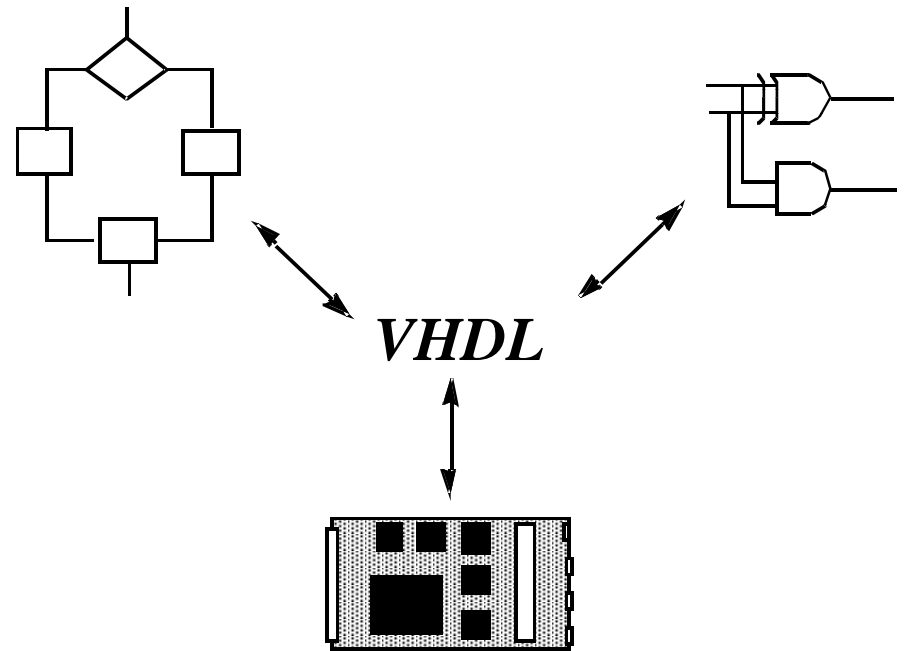
Role of VHDL

V *Very High Speed Integrated Circuit*

H *Hardware*

D *Description*

L *Language*



- System description and documentation
- System simulation
- System synthesis