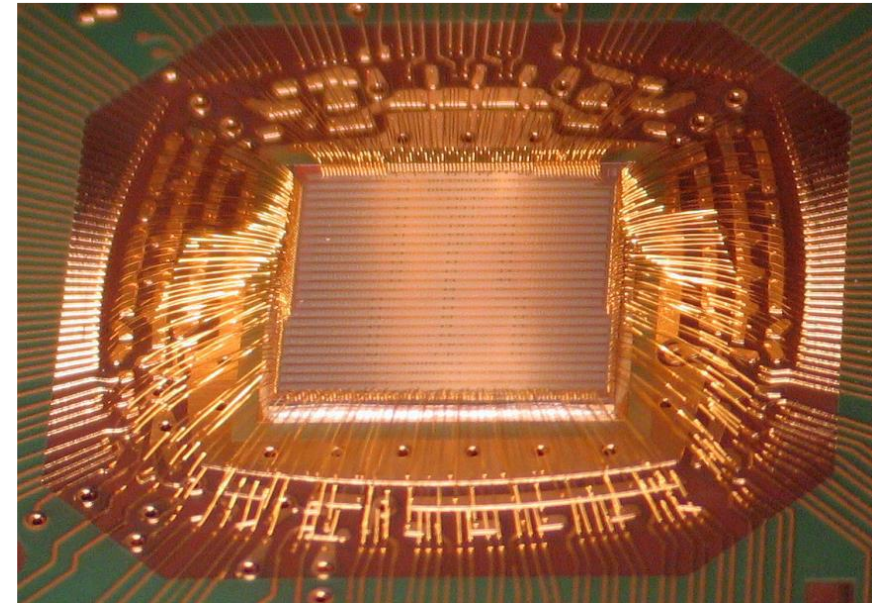


Design of Digital Circuits and Systems

Winter 2024

Design of Integrated Circuits

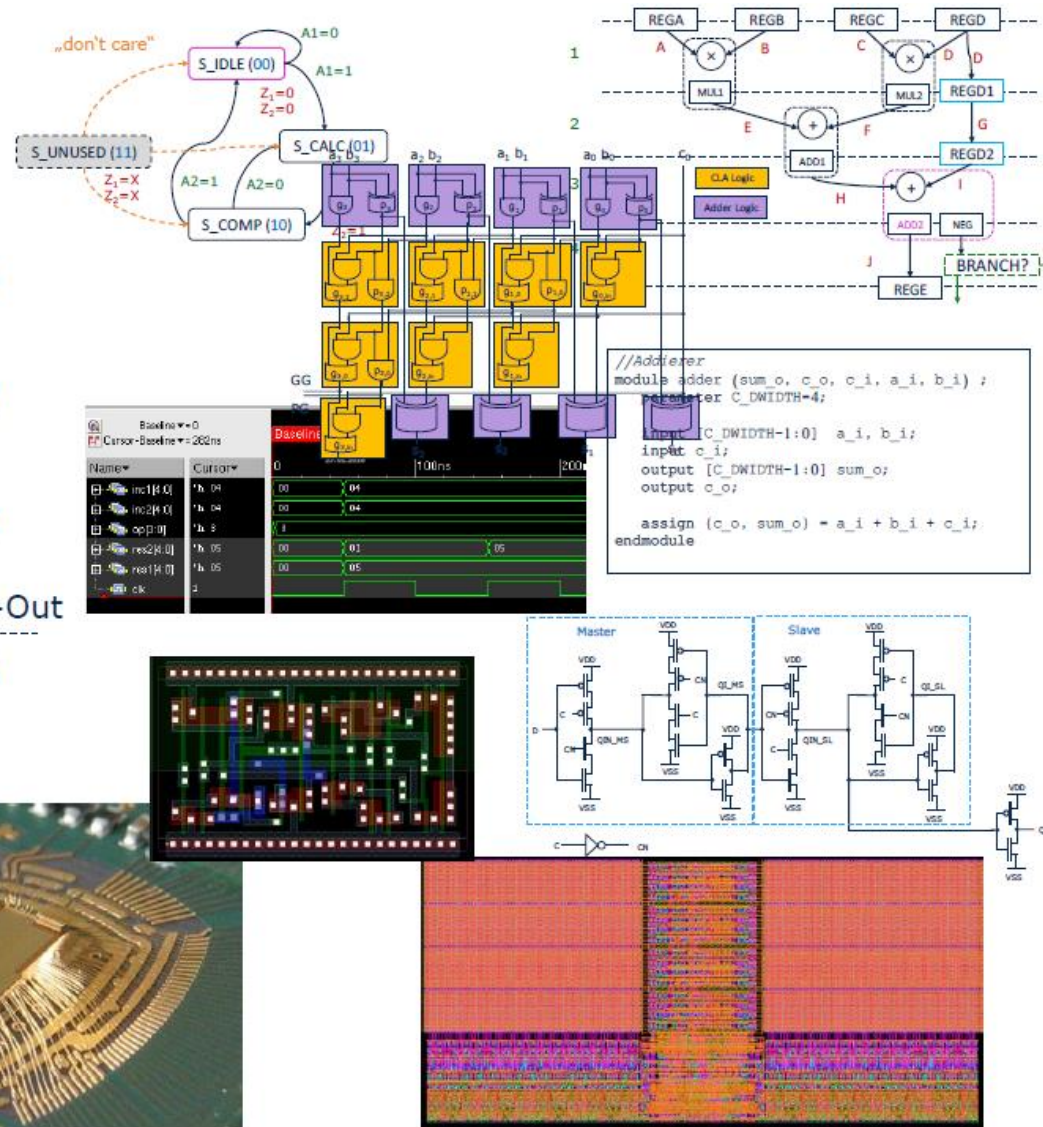
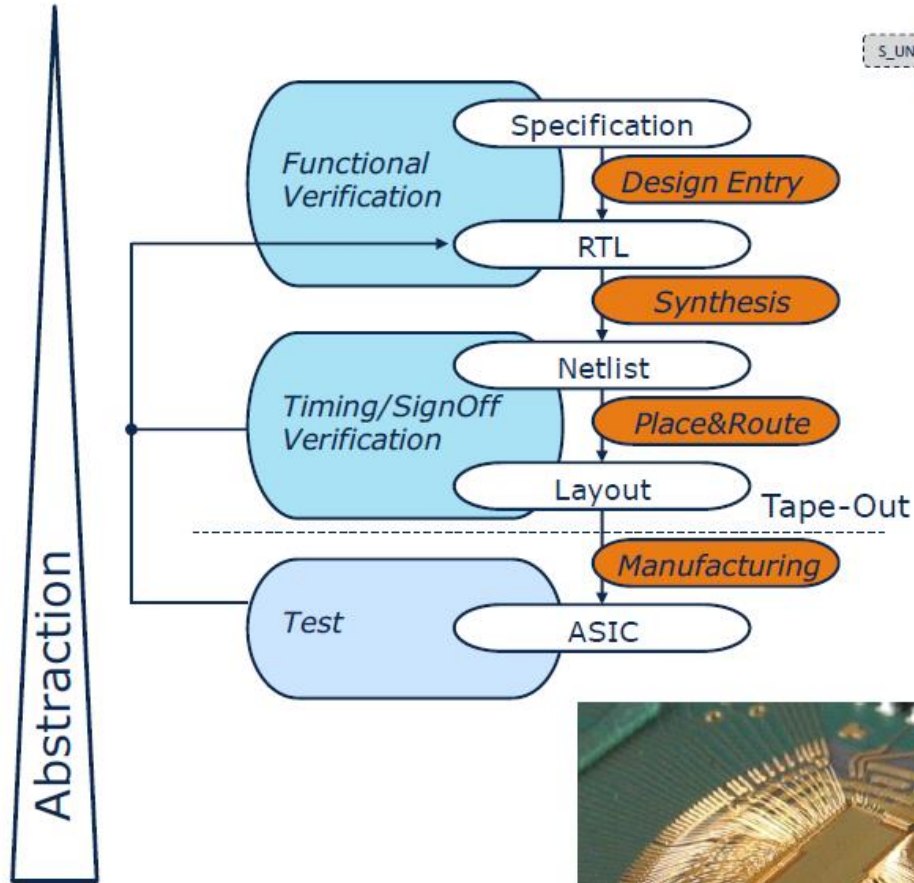
- Design of integrated circuits („Chips“) as a core component of modern electronic products.
- Implementation of complex circuits on a chip makes it possible to have:
 - High Functionality
 - High Integration Density
 - Low Power Consumption
 - High Reliability
- The downsizing of fabrication technologies (Miniaturisation) enables the integration of more complex systems.
- Challenge in design and verification.



Overview

- Design Flow of Digital Integrated Circuits
- Hardware Implementation of Algorithms
- VHDL Hardware Description Language
- Circuit Simulation and Verification
- Digital Circuits in CMOS Technology

Circuit Design



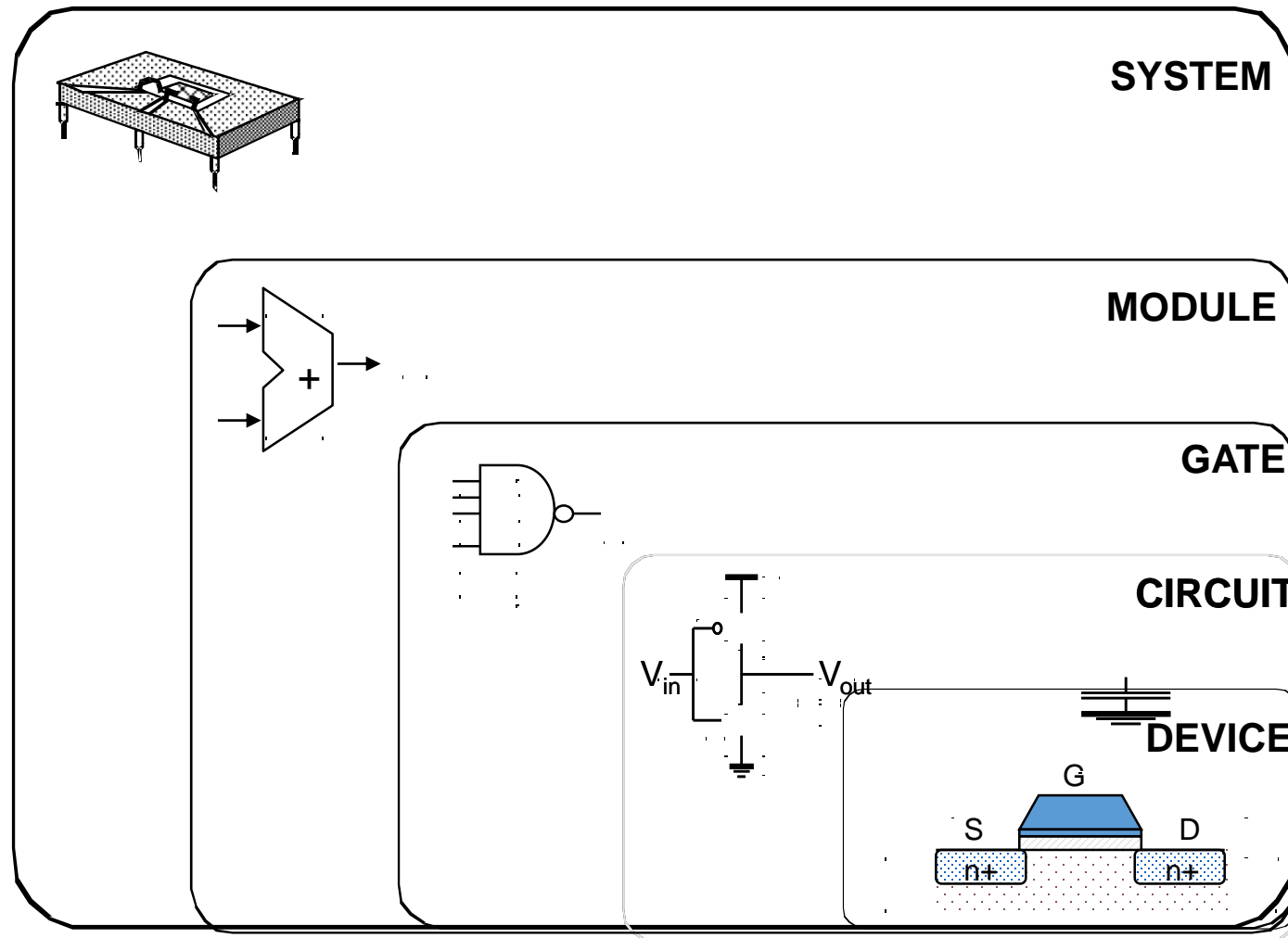
Objectives

- present digital flow for digital integrated circuits
- present methods of Hardware implementation for algorithms
- give basics and concepts of VHDL HDL
- present verification strategies
- help you deeply understand the basics of implementing digital circuits in CMOS technology
- practical experience for implementing a digital circuit on FPGA

Why Scaling

- Technology shrinks by ~ 0.7 per generation
- With every generation can integrate 2x more functions on a chip; chip cost does not increase significantly
- Cost of a function decreases by 2x
- But ...
 - How to design chips with more and more functions?
 - Design engineering population does not double every two years...
- Hence, a need for more efficient design methods
 - Exploit different levels of abstraction

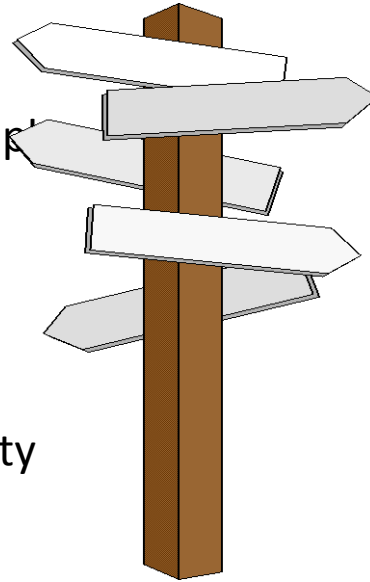
Design Abstraction Levels



Major Design Challenges

□ Microscopic issues

- ultra-high speeds
- power dissipation and supply rail drop
- growing importance of interconnect
- noise, crosstalk
- reliability, manufacturability
- clock distribution



□ Macroscopic issues

- time-to-market
- design complexity (millions of gates)
- high levels of abstractions
- reuse and IP, portability
- systems on a chip (SoC)
- tool interoperability

Year	Tech.	Complexity	Frequency	3 Yr. Design Staff Size	Staff Costs
1997	0.35	13 M Tr.	400 MHz	210	\$90 M
1998	0.25	20 M Tr.	500 MHz	270	\$120 M
1999	0.18	32 M Tr.	600 MHz	360	\$160 M
2002	0.13	130 M Tr.	800 MHz	800	\$360 M