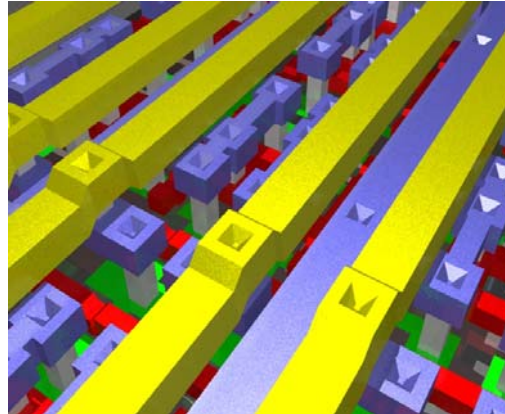


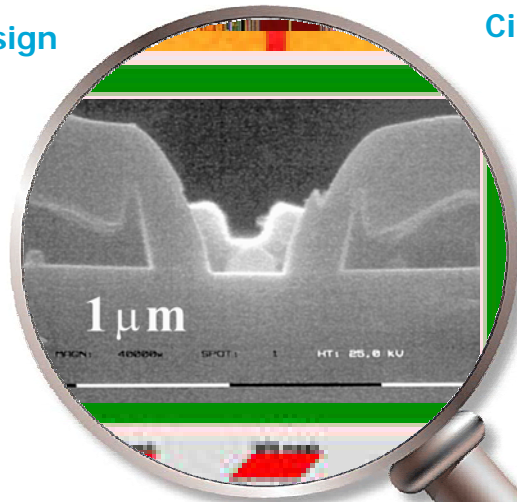
ET4293 **Digital IC Design**

N.P. (Nick) van der Meijs



System Design

Circuit Design



Devices

Process
Technology
Physics

[Lina Sarro]

Design Challenge

■ System Complexity

Dealing with the sheer size of the system

- $> 10^8$ components (transistors)
- Compare boeing 747-400: 6×10^6 components
- $>> 10$ km of interconnect
- Compare boeing 747-400: 274 km wiring, 8 km tubing

■ Silicon Complexity

Dealing with circuit and physical aspects

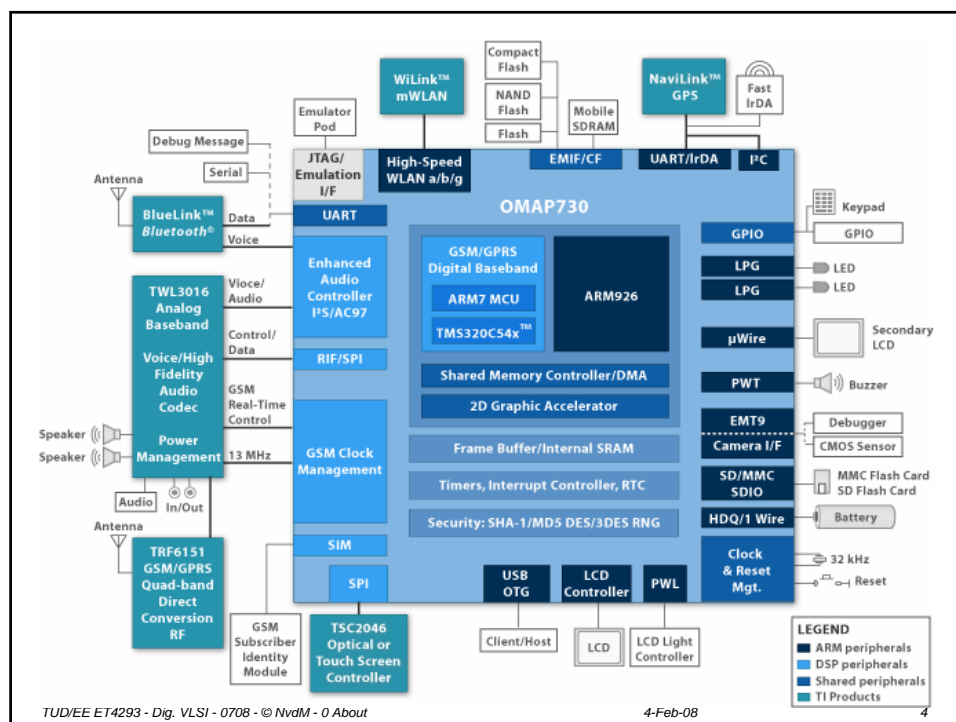
- Features < 0.0000001 m = 100nm
- Actually far from ideal behavior
More like building spaghetti bridges than steel bridges
- Lots of unwanted parasitics
- Manufacturing tolerances, ...

[http://www.boeing.com/commercial/747family/pf/pf_facts.html]

TUD/EE ET4293 - Dig. VLSI - 0708 - © NvdM - 0 About

4-Feb-08

3



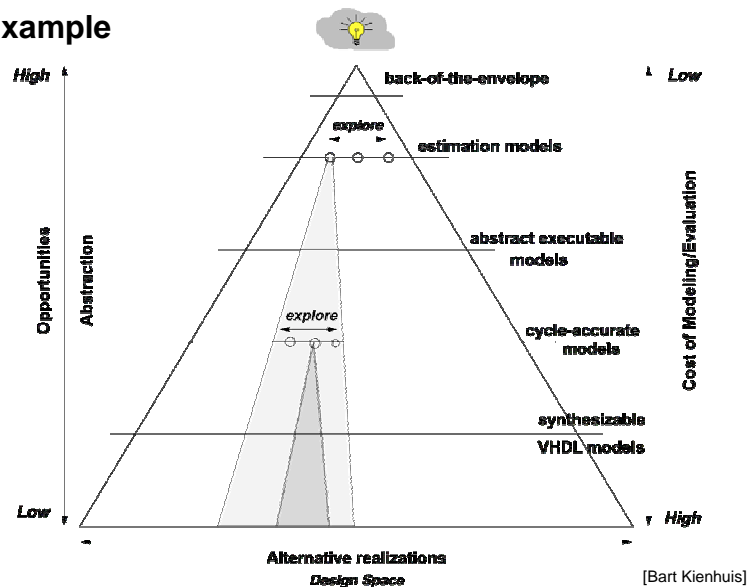
TUD/EE ET4293 - Dig. VLSI - 0708 - © NvdM - 0 About

4-Feb-08

4

Dealing with System Complexity (1)

Example



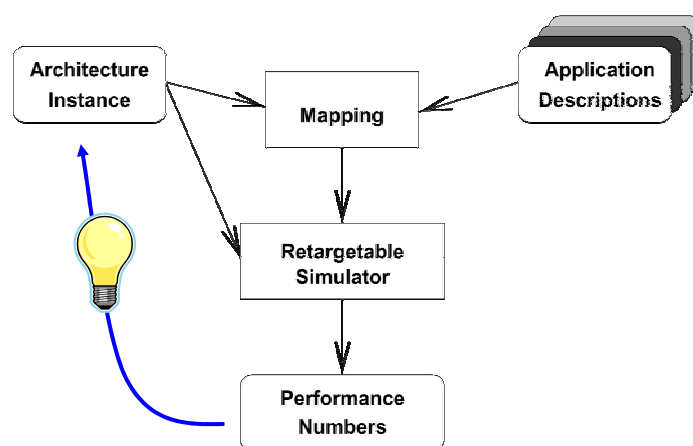
TUD/EE ET4293 - Dig. VLSI - 0708 - © NvdM - 0 About

4-Feb-08

5

Dealing with System Complexity (2)

Example



[Bart Kienhuis]

TUD/EE ET4293 - Dig. VLSI - 0708 - © NvdM - 0 About

4-Feb-08

6

More System Complexity Concepts

- High-level architecture design
 - processors, busses, caches, cache sizes, instruction sets, IP blocks, ...
- System on chip design
- Cycle-accurate simulation
- Network-on-chip, protocols,

Course Contents

- **System Complexity (Size of the system)**
 - This course does not deal with this aspect of VLSI design
 - But it can't overlook this issue either – many of the real issues relate to the interplay of system and silicon complexity
- **Silicon Complexity (circuit and physical)**
 - This course will focus on these aspects
 - Goal is to enable design of large systems

Contents (2)

- How to realize the full potential of advanced manufacturing technologies in realizing digital circuits and systems
- Show how circuit-level techniques help improve the overall design properties
- Show how properties from physical design create opportunities (and limitations)

Digital Electronics

- Electronics
 - Behavior of electronic circuits from an electrical perspective
 - Not from an algorithmic perspective
- Digital
 - Not opamps, but logic gates (etc.)

Digital vs Analog

- Fundamentally, all circuits are analog, they are just 'overdriven' to achieve digital behavior
- 'Digital' is just an abstraction
 - Way of looking at circuits and signals
- Understanding range of validity of digital abstraction is essential
- Deep-submicron evokes many unwanted 'analog' effects:
 - Crosstalk, delay, overshoot, reflection, supply noise, substrate noise, ...

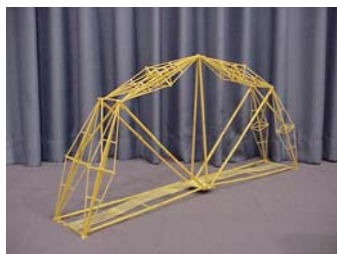
TUD/EE ET4293 - Dig. VLSI - 0708 - © NvdM - 0 About

4-Feb-08

11

Scaling

- All features become smaller and smaller
- Smaller means faster but also less ideal
- Deep-submicron design becomes more like building spaghetti bridges than steel bridges

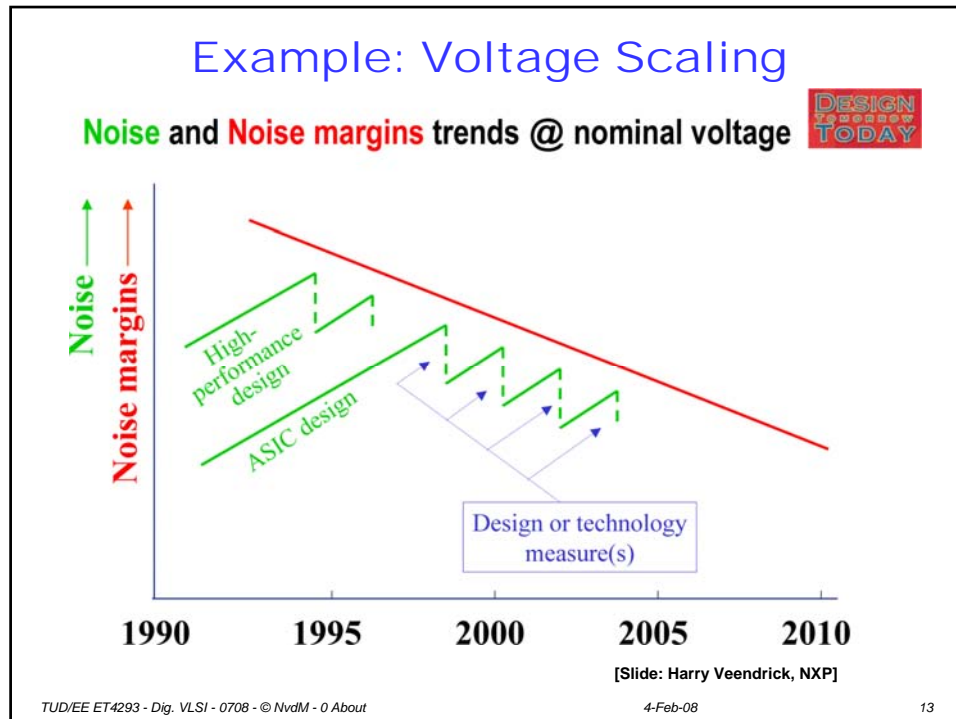


paris.thover.com/photos/2569.jpg
www.jhu.edu/virtlab/image/MVC-007X.jpg)

TUD/EE ET4293 - Dig. VLSI - 0708 - © NvdM - 0 About

4-Feb-08

12



Why 'Electronic' insight for VLSI

- Someone needs to design and implement libraries
- Creating a model of a (standard) cell and modules requires deep understanding
- Library-based design and standard abstractions partially avoided for very high performance designs
- Deep scaling defeats many standard practices and abstractions
 - New design issues arise
- Troubleshooting requires in-depth knowledge of all issues involved

Prerequisites

- **Circuit Theory**
 - Resistor, capacitor, voltage, current, kirchoff laws, power, ...
- **Digital circuits**
 - Boolean logic, logic gates, flip-flops, state-machines, clocking, ...
- **Part 1 of the Rabaey book is helpful**
 - MOS devices, technology, ...
 - Summary in first lectures

Instructor

Instructor	Dr. ir. N.P. (Nick) van der Meijs (HB 17.300) ☎ 86258 ✉ nick@cas.et.tudelft.nl
Secretary	Laura Bruns (HB 17.230) ☎ 81372 ✉ lbruns@cas.et.tudelft.nl
Section	Circuits and Systems http://ens.ewi.tudelft.nl/
Department	Microelectronics & Computer Engineering http://me.its.tudelft.nl

circuits  systems

Course Material

Book:

Jan M. Rabaey - Digital Integrated Circuits, A Design Perspective, 2nd ed, Prentice Hall, 2003 (via ETV)

Web site:

<http://cas.et.tudelft.nl/~nick/courses/vls>

Bi-directional link with blackboard

Announcements, etc.

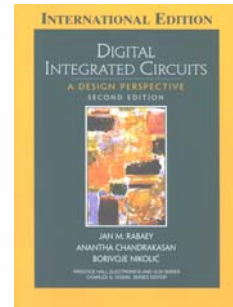
Blackboard Discussion Forum (!)

Syllabus:

website

Slides / Presentation Material:

website



Agenda

- Lectures on Monday and Wednesday
- Lab exercises / Design project
 - Competition: bonus points to be gained for best designs
 - Includes report and presentation
 - Cadence design system
 - Details will follow
- Written (?) exam April 3
- Mark determined for 50% by exam, 50% by design project