



# CSCE 491 Computer Engineering Design

2005/8/23

## Week 1 Systems Design Using VLSI Custom Logic

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### CSCE 491 Week 1 - Outline

- Introduction
  - ✓ Drivers for VLSI Systems-On-a-Chip (SOC)
  - ✓ Example: Wireless Communications
  - ✓ The Widening Productivity Gap: Capacity vs. Capability
- Hardware Systems Design with VLSI
  - ✓ VLSI-based Design Space (Y-chart)
  - ✓ Designing with CPUs versus Custom Logic
  - ✓ Abstraction Levels and Representation Domains
- Example – 802.11 WLAN Project
  - ✓ Hardware Design Representation
  - ✓ The CSCE 491 Design Process



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## Introduction

*or*

***What's so important about this stuff anyway and why should we care?***



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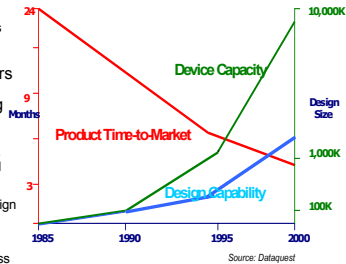
## The Capacity vs. Capability Gap

- Increasing capacity of the technology:

- ✓ The rate of new technology and associated silicon process changes has continued to follow Moore's Law.

- The capability of designers and design teams to use this capacity isn't keeping up.

- ✓ The Capacity versus Capability Gap is widening.
  - ✓ Each set of technology and process changes requires designers to manage ever more complexity in the design process.
  - ✓ New architectures, abstractions, methods and tools are required to address this increasing complexity.



Source: Dataquest

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## Course of Study

or

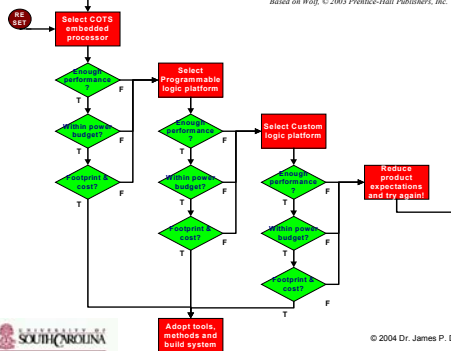
**What are we going to do about it?**



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## The Systems IC Development Decision Tree

Based on Wolf, © 2003 Prentice-Hall Publishers, Inc.



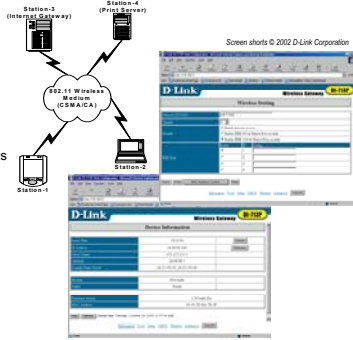
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## Mobile Computing - 802.11b/g WLAN MAC

### Wireless Local Networking (PCF)

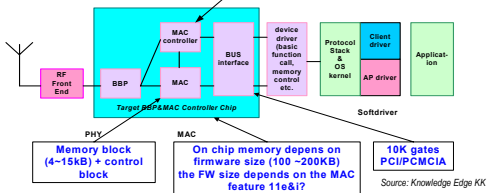
- Supports pervasive computing on PCs, laptops, PDAs and other Internet-enabled devices.
- Most Access Points support broadband access to a wired network.
- Personal network management screens access functions that control behavior of the MAC Layer.
- Example: wireless router from D-Link®.



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## Typical 802.11 Product Architecture

CPU core	Die area	Peak Power Consumption (mW/MHz)	Memory System	Clock frequency & MIPS performance
ARM9E / ARM946E-S cached processor with tightly coupled memory interfaces	4.3mm <sup>2</sup> on 0.18µm estimated size with 16KB instruction & 4KB data caches and no TCMs Using Artisan cell library & RAM compiler	1.1 mW/MHz @ 1.8V (estimated)	Selectable 1 & D cache sizes: 0.4K, 8K... 1M Selectable 1 & D TCM sizes: 0.4K, 8K... 1M	150MHz on TSMC 0.18µm (worst case) 230MHz on TSMC 0.18µm (typical)

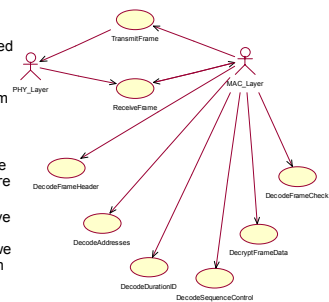


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## 802.11 WLAN – Example Use Case Diagram

### Operations

- Inventory of basic functions to be supported in our MAC layer Receiver architecture.
- Interaction at the system boundary with the PHY layer
- Each Use Case will be iterated using Sequence diagrams, then hardware block diagrams.
- Each Use Case will have a set of behaviors associated with it that we want to model as an RTL hardware description.



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# Tool Chain

Creating initial platform-independent designs for later retargeting to specific mobile computing footprint



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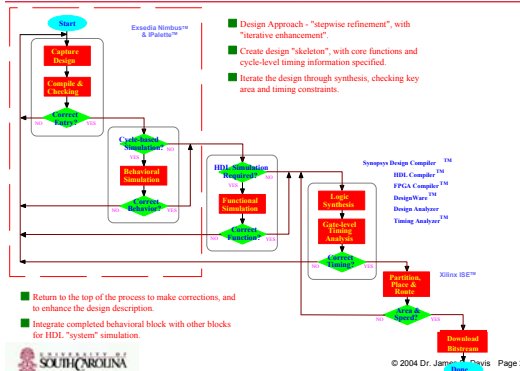
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## Exploration Process - Methods & Tools



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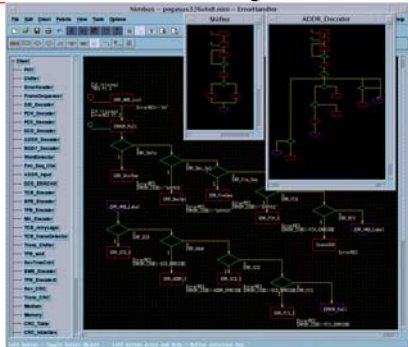
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## Model Creation using Nimbus™



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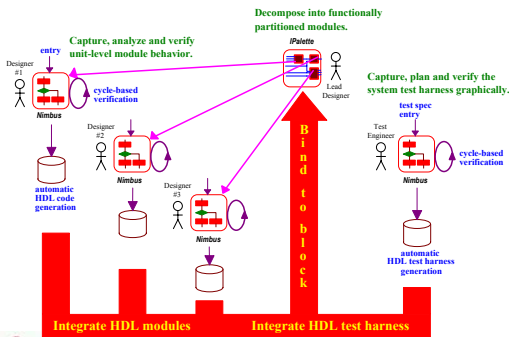
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## The CSCE 491 Design Process-2



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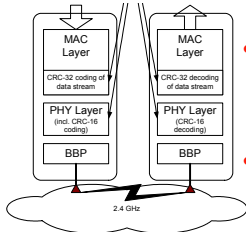
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## The CSCE 491 Design Process-3

We focus on MAC layer design and performance optimization, but we hide PHY layer in the test harness.



- Project teams of 2 or 4
  - ✓ Team of 4 works on both MAC Tx and Rcv blocks.
  - ✓ Team of 2 works on a single side—either Tx or Rcv.
- Team organization
  - ✓ Team pair #1 carries out design on Tx block, and test development for Rcv block.
  - ✓ Team pair #2 carries out design of Rcv block, and test development for Tx block.
- Outcomes:
  - ✓ All team members will get "down and dirty" with 802.11 protocol.
  - ✓ You will have digital systems and ad-hoc wireless networking protocol design experience.
  - ✓ THIS MAKES YOUR EXTREMELY MARKETABLE IN THE JOB MARKET.

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## Homework Assignment #1

- Topic:
  - Introduction to ASM modeling using the Nimbus tool set.
- Objective:
  - ✓ To learn to use the Nimbus tool set to carry out design entry and simulation activities.
  - ✓ To ramp the learning curve so you can be proficient using the ASM method as quickly as possible.
- Task:
  - ✓ Read the Nimbus Tutorial Guide, located at the link on my Tools web page: <http://www.cse.sc.edu/~jimdavis/Tools/exsedia/tutorial.pdf>
  - ✓ Start Nimbus on a Sun workstation (lab 1D39, 1D43), follow the steps in the tutorial, and turn in the printout of the design file you have created. Keep this file, as we will use it again in a later assignment. Do your own work!
  - ✓ Starting Nimbus, follow these steps explicitly: (1) logon to a Sun workstation, (2) cd \$HOME, (3) mkdir csce491; mkdir nimbus, (4) ./usr/local/nimbus/setup\_user (specify Printer as 'l39' and Acrobat Reader as 'acread'), (5) cd \$HOME/csce491/nimbus, (6) ./run\_nimbus& (note the './' in front of the command, and the '&').
  - ✓ Once you have completed the Tutorial: (1) put your name, "assignment #1" and date in fields accessed from Options -> Design Information menu, and (2) print "All Sheets" option from the File -> Print menu.

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