Welcome to the Webinar Offered by:

National Microelectronics Security Training (MEST) Center

Sponsors:

Introduction to System on Chip

Development of a Basic System-on-Chip Architecture in FPGA

Abigail Butka, Kawser Ahmed Muhammed, Christophe Bobda

Agenda

- Introduction and Motivation
- System on Chip
  - Introduction and Motivation
  - Definition
  - Examples
  - Benefits
  - Challenges
- Basic Lab Architecture
- Conclusion and Discussion

Introduction and Motivation - Moore's law

- The most important trend in computer systems
- Predicted in 1965 by Intel co-founder Gordon Moore
- IC transistor capacity has doubled roughly every 18 months for the past several decades

- Today's high-end chips may contain Billions transistors
  - Transistor gate lengths (feature size) are now in term of nanometers
  - From 180nm in the 2000s to 40nm in 2014 and 3nm today
  - In 2020, Samsung and TSMC entered volume production of 5 nm chips, manufactured for companies including Apple, Marvell, Huawei and Qualcomm
  - Approximately every 18 months the number of transistors on a chip doubles – Moore's law

- The Consequences
  - Components formerly connected on a Printed Circuit Board can now be integrated onto a single chip
  - Hence the development of System-On-Chip

SoC- Definition

- System: A collection of all kinds of components and/or subsystems that are appropriately interconnected to perform the specified functions for end users.
- System-on-Chip (SoC): Complete system on a single chip?
- SoC not only chip, but more on “system”
- SoC = Chip + Software + Integration

SoC- Definition

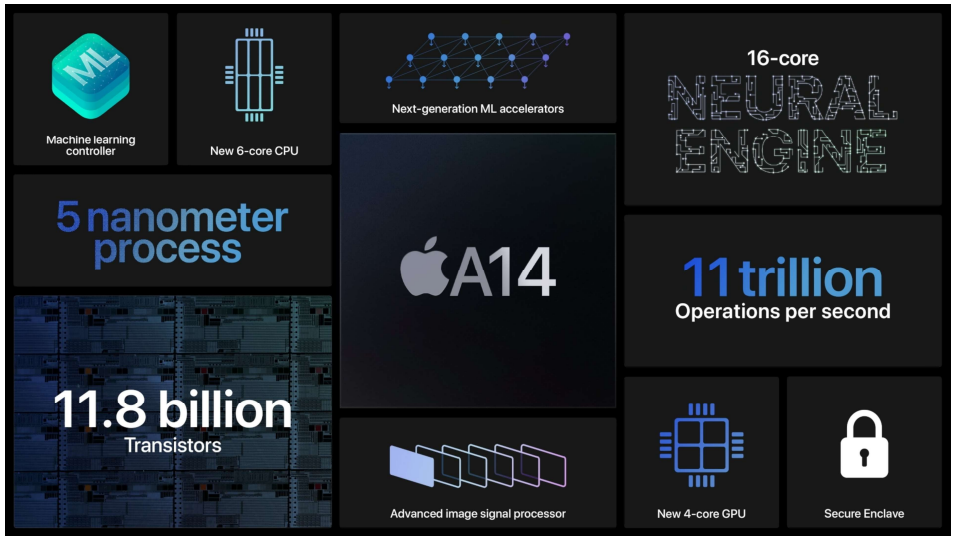
- The SoC Hardware includes
  - Embedded processor
  - Hardware IPs
  - Peripherals and analog circuitry
  - Embedded memory
  - Interconnect

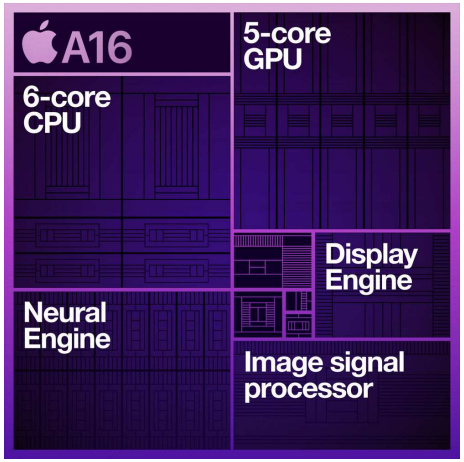
- The SoC Software includes:
  - OS, compiler, simulator, firmware, driver, protocol stack, Integrated development environment (debugger, linker), Application interface (C/C++, assembly)

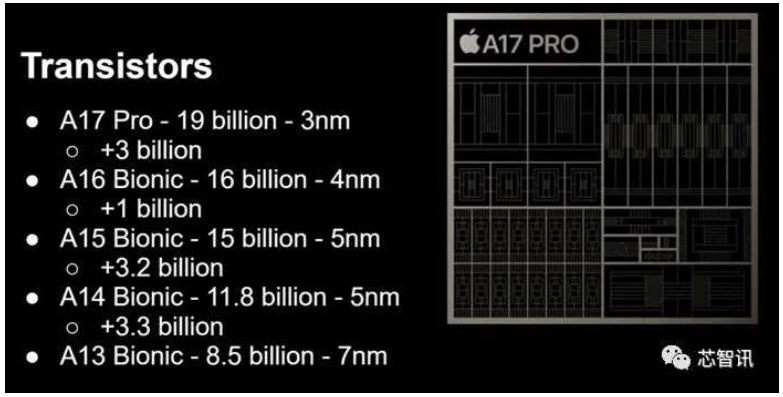
- A key benefit of SoCs is the concept of IP Reuse
  - IP reuse allows hardware designers to reduce development time by not re-making the wheel

SoC- Examples

- Apple A14 Bionic







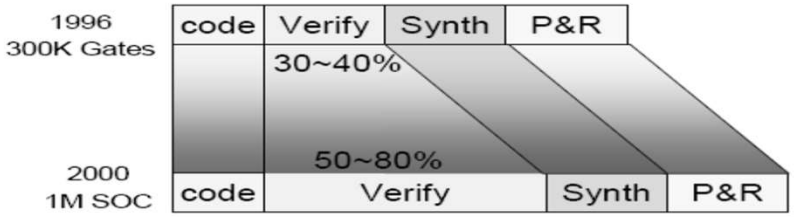
SoC- Benefits

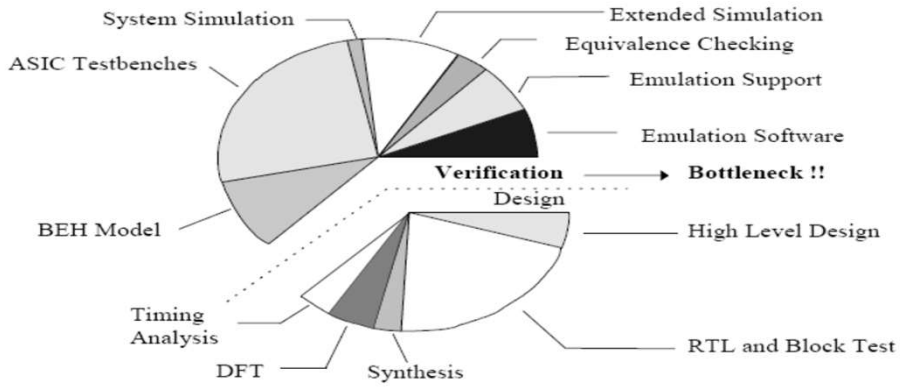
- Reduced size
- Reduced overall system cost
- Lower power consumption
- Increased performance
- Increased functionality/performance in reduced footprint
- Simplified PCB design
- Increased product mechanical robustness
- And more and more advantages …

SoC- Challenges

- Increasing complexity
  - Hardware/Software integration!
  - Time-to-market pressure
    - Shorter product lifespan
    - Shorter design cycles
  - Verification bottleneck
    - Assume you must 100% verify a two-input 32'bit multiplier. This is 2^64 = 18,446,744,073,709,551,616 test cases!!
    - If it takes 1ns to perform one test, fully testing this simple multiplier would take over 500,000 years

	1997	1998	1999	2002
Applications	Cellar, PDA, DVD	Set-top boxes, wireless PDA	Internet applications, anything portable	Ubiquitous computing, intelligent, interconnected controllers
Design cycle (month)	18 - 12	12 - 10	10 - 8	8 - 6





SoC- Application Challenges

- Speech Signal Processing
- Image and Video Signal Processing
- Information Technologies
  - PC interface (USB, PCI,PCI-Express, IDE,..etc) Computer peripheries (printer control, LCD monitor controller, DVD controller,.etc) .
- Data Communication
  - Wireline Communication: xDSL, Gigabit Ethernet, Etc…
  - Wireless communication: BlueTooth, WLAN, 2G/3G/4G, WiMax, UWB, etc…
- Consumer
  - Game box
  - Digital Camera
- Automotive

Case Study and Tutorial