# Computer Engineering

**Department of Electrical and Computer Engineering**

**Garrett S. Rose**
**Assistant Professor**

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

**2009 – 2010**

# Outline

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

- Computer Engineering: what and why
- Curriculum Overview
- Some CompE Research

# Defining CompE

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

- **Computer Engineering – the study of designing, developing and building computers (http://dictionary.babylon.com)**

# Defining CompE

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

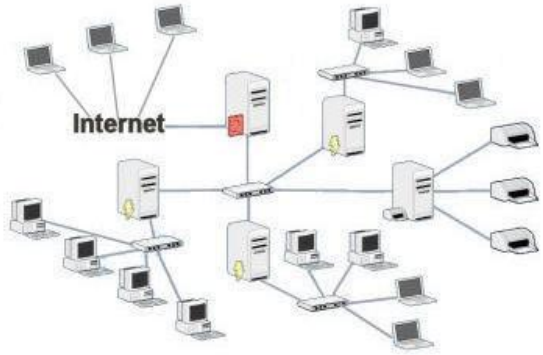
- Computer Engineering – the study of designing, developing and building computers (http://dictionary.babylon.com)
- Computer engineering is much more than just the PC
- At NYU-Poly, computer engineering covers digital design, VLSI circuits, computer architecture, embedded systems, hardware and software security, network architecture, etc.

# Defining CompE

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

IBM PC

Intel Pentium 4



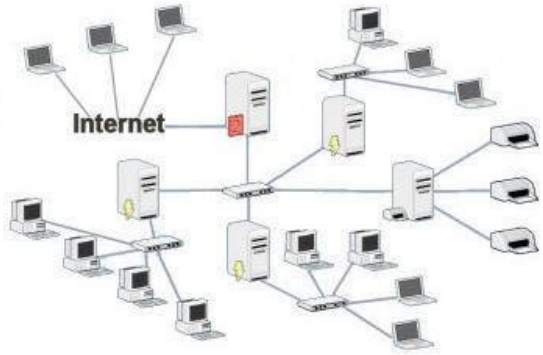

Computer Networks

# Defining CompE

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

IBM PC

Intel Pentium 4




Computer Networks

Apple iPhone


GPS Navigation

Siemens Portable Ultrasound Machine

Lab-on-Chip (STMicro)

# Computer Engineering MS Curriculum

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

- 30 credits required – minimum 18 EL, 6 CS
- Must take 3 core courses and two 2-course sequences
- CompE MS students must choose to take either a 3 credit project or a 6 credit thesis
- Project/thesis credits count toward 30 required credits
- Advice: discuss project or thesis with advisor *before* beginning the project

# Computer Engineering MS Curriculum - *Sample*

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

- **First Semester:**
  **EL5493 – Advanced Hardware Design (VHDL) – core**
  **EL5473 – Introduction to VLSI Design – core**
  **CS6313 – Computer Architecture I – core**

- **Second Semester:**
  **EL6443 – VLSI Systems and Architectures – sequence**
  **CS6323 – Computer Architecture II – sequence**
  **EL5363 – Principles of Communications Networks**
  **EL5483 – Embedded Systems**

- **Third Semester:**
  **EL7373 – High Performance Switches and Routers**
  **EL9413 – Advanced VLSI Circuits**
  **EL9953 - *Project***

# Computer Engineering Research

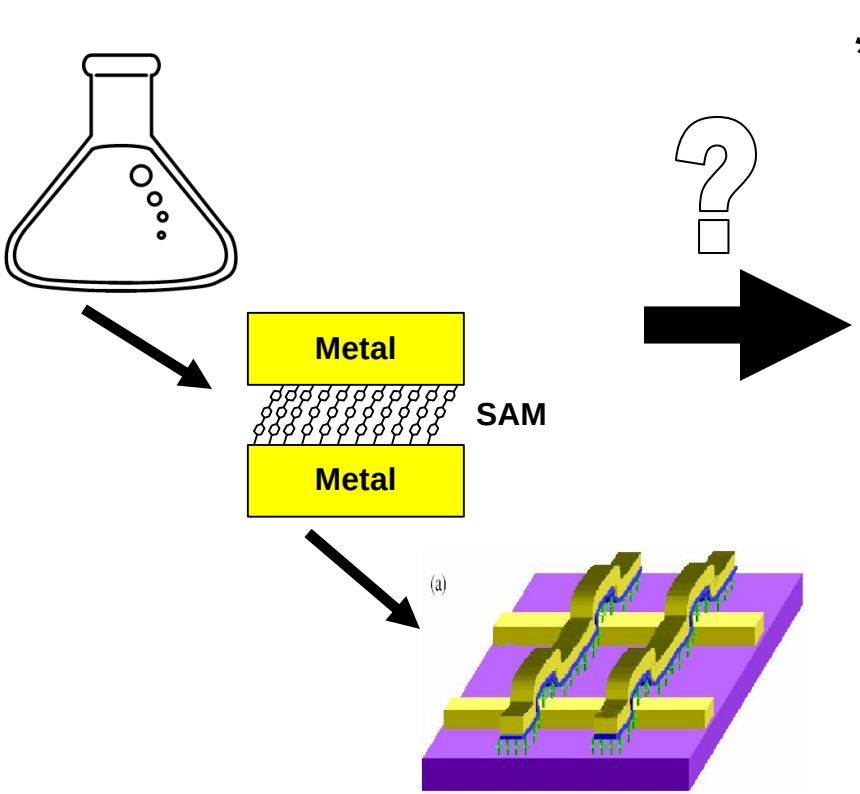
NYU·poly
POLYTECHNIC INSTITUTE OF NYU

- Several on-going research projects in computer engineering area
- Faculty conducting computer engineering related research:
  - Ramesh Karri – security, fault tolerance, nanoelectronics
  - Jonathan Chao – network architecture, HPC, NOC
  - Garrett Rose – VLSI circuits, nanoelectronics, CMP/NOC
  - Helen Li – low-power VLSI, memory, nanoelectronics

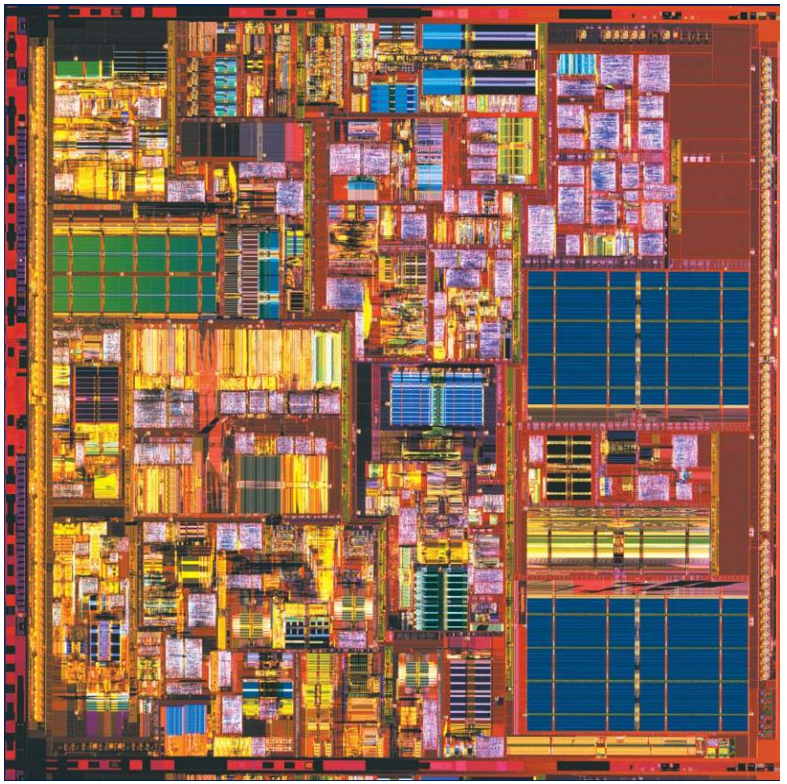
# Example: Nanoelectronics

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

**Just as in any processor, must build logical units and memory**




**

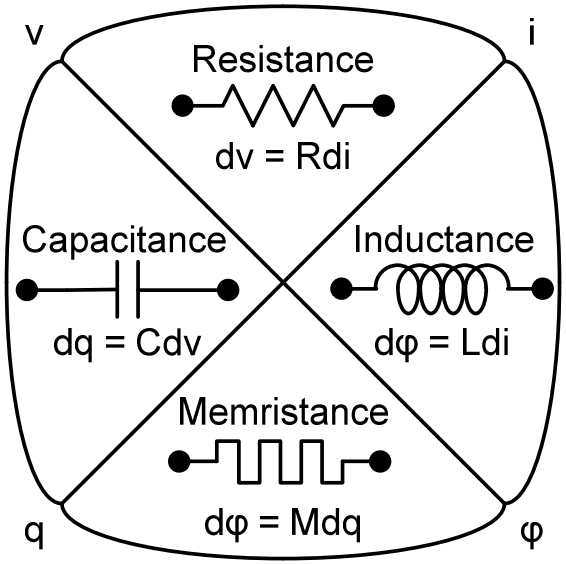


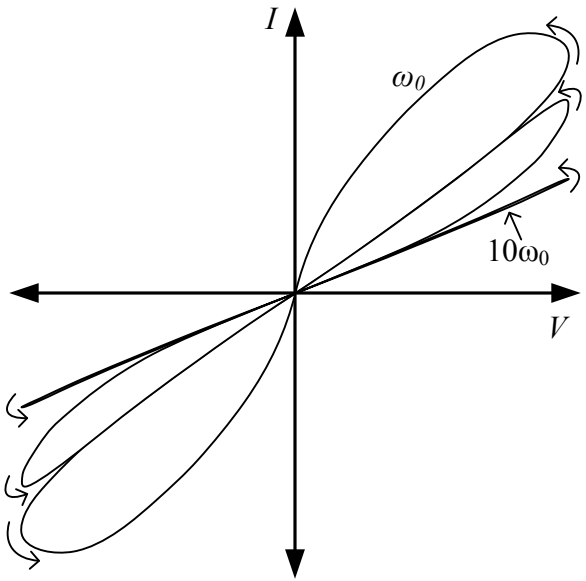
* Source: S. Williams and Phil Kuekes, HP labs; ** Intel (Pentium 4)

# Example: Nanoelectronics

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

- Currently exploring the uses of a recently discovered device: the memristor
- A memristor ("memory resistor") is similar to a variable resistor that can be made to operate in one of many states
- Memristors have many interesting applications: nanoscale digital logic, memory, neuromorphic architecture

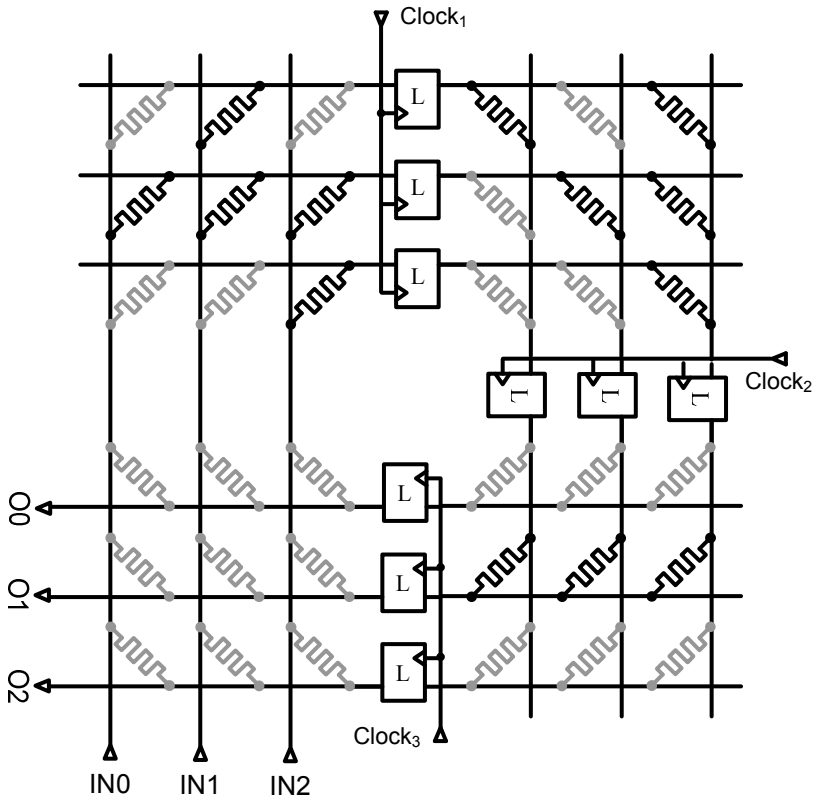


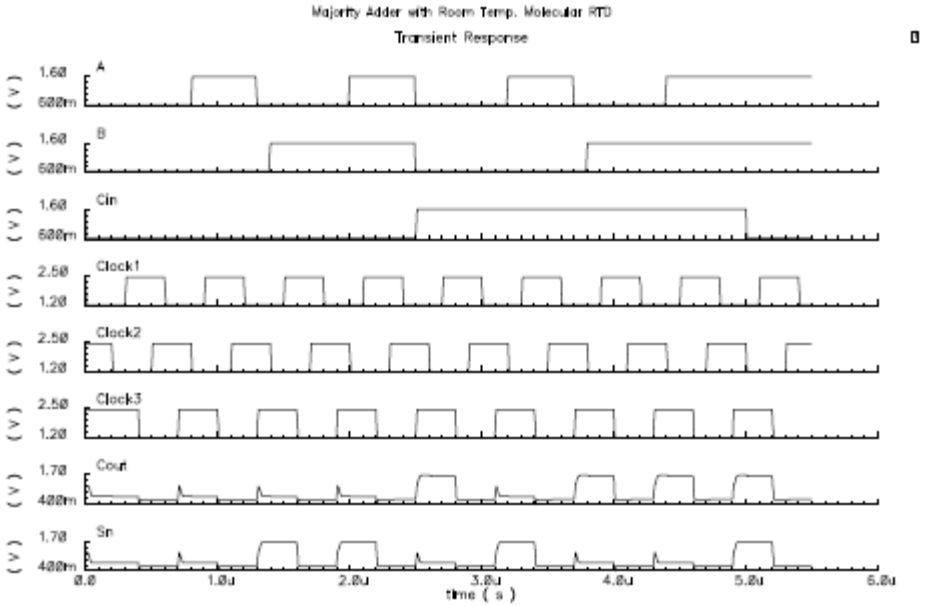



# Example: Nanoelectronics

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

- We are looking into circuits that can exploit memristance for high density memory and logic
- An important challenge is integration with CMOS

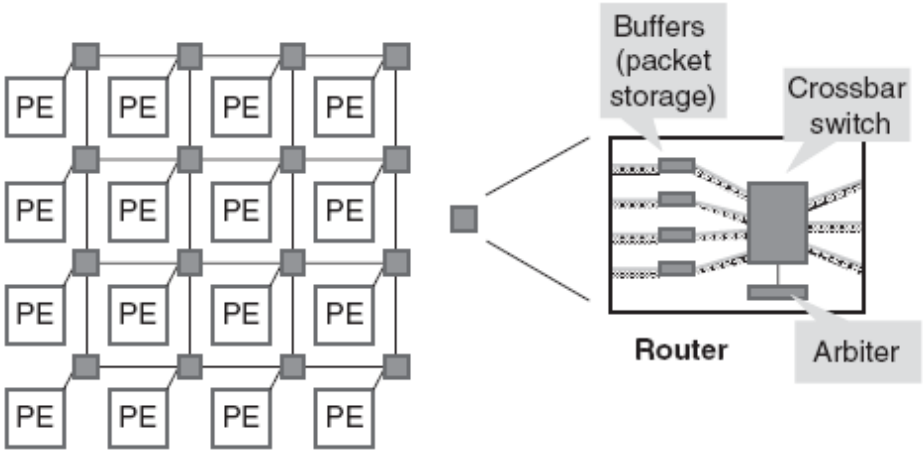


# Example: Network on Chip

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

- Network-on-chip (NoC) is a packet switched on-chip communication network designed using a layered methodology
  - "routes packets, not wires"
- NoCs use packets to route data from the source to the destination PE via a network fabric that consists of
  - switches (routers)
  - interconnection links (wires)

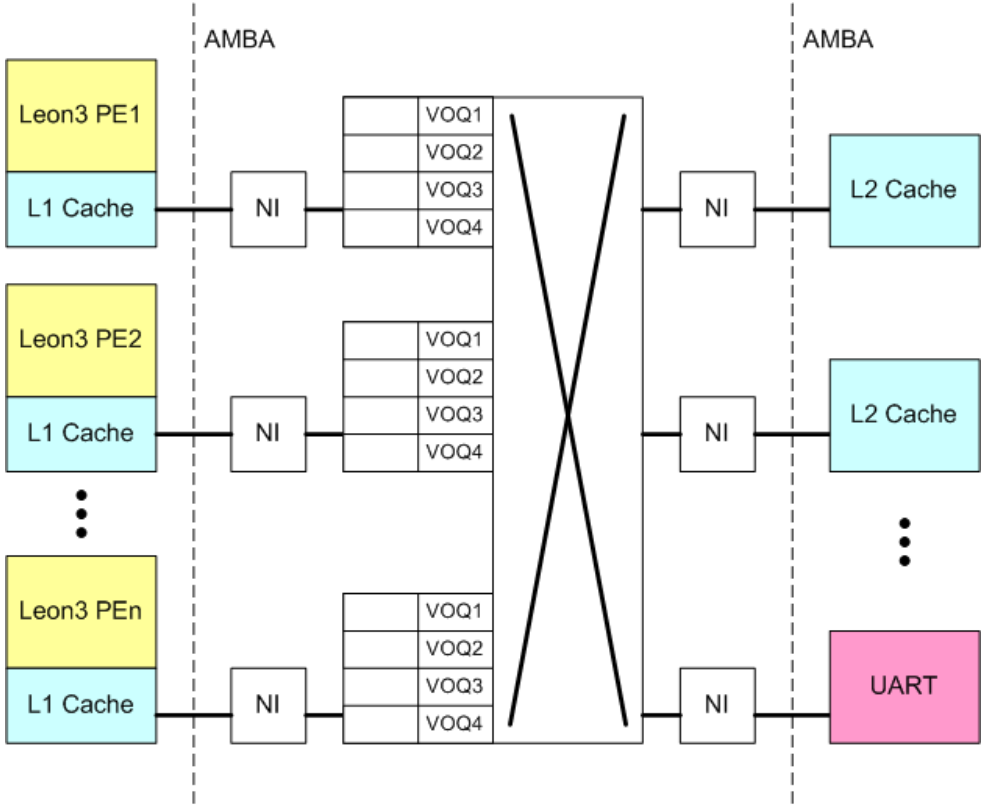



Source: S. Pasricha and N. Dutt, On-Chip Comm. Arch. – SOC Interconnect, Morgan Kaufmann, 2005.

# Example: Network on Chip

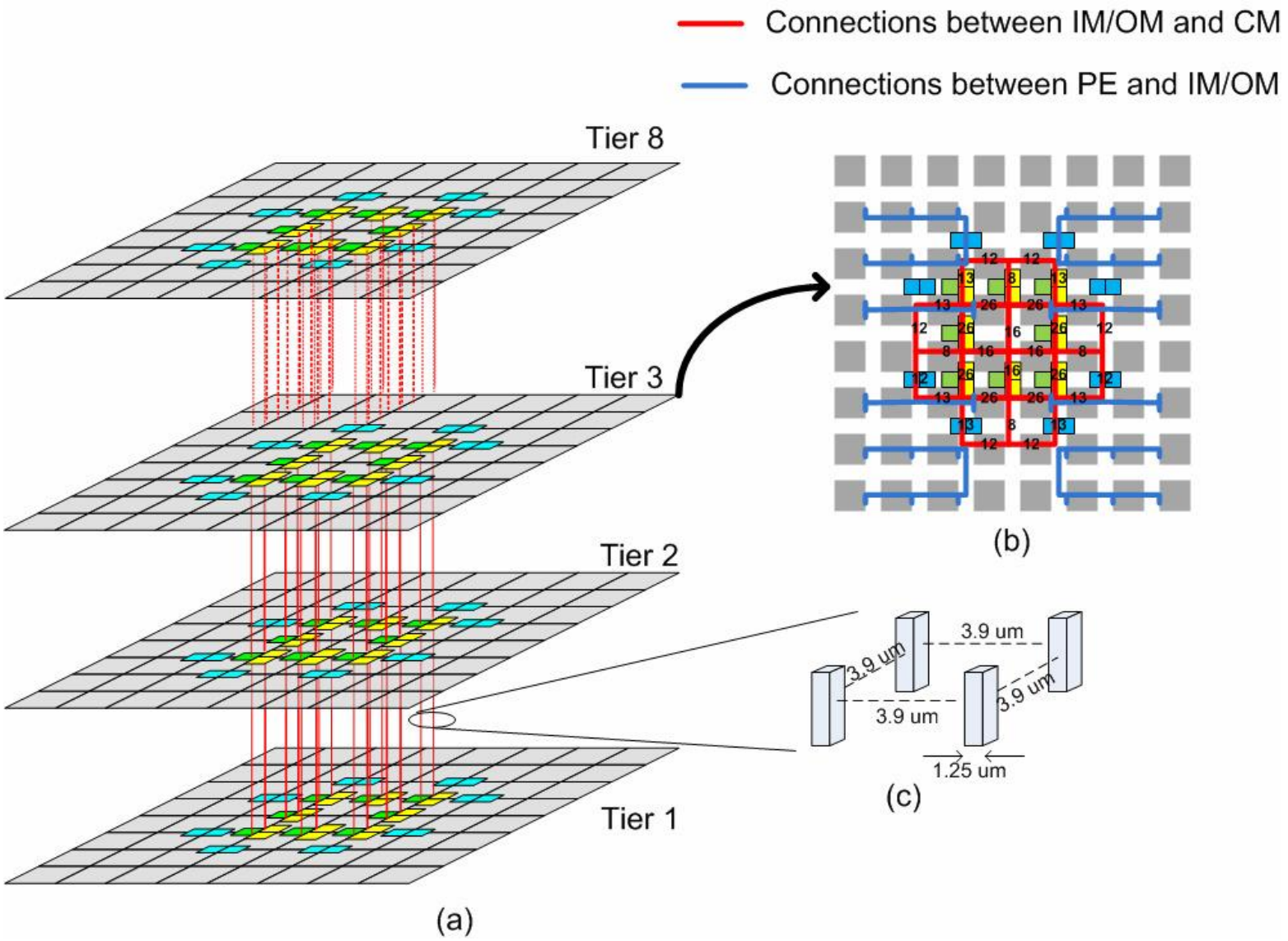
NYU·poly
POLYTECHNIC INSTITUTE OF NYU

- At NYU-Poly, we're considering high-speed, yet energy efficient, solutions for NOC architectures for chip multiprocessors
- Research topics:
  - Data encoding
  - Power gating
  - Routing strategies
  - Floorplanning for minimum delay
  - 3D NOC architectures



# Example: 3D NOC Design

NYU·poly
POLYTECHNIC INSTITUTE OF NYU



# Summary

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

- **Computer engineering is ubiquitous**
  **-- computing systems are found in cell phones, cars, medical devices, even items such as toaster ovens**

- **NYU-Poly has a strong course offering in CompE for both undergraduate and graduate students**

- **Several faculty actively pursuing CompE research in nanoelectronics, security, network architecture, HPC, etc.**

- **Talk to us about research opportunities – if a GA position isn't available it may be possible to volunteer**