# CS/ECE 3810: Computer Organization

Lecture 2: Introduction (Continued)

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## Recap (see in-class drawing)



### **Computer Components**

- Input/output devices
- Secondary storage: non-volatile, slower, cheaper (HDD/SSD)
- Primary storage: volatile, faster, costlier (RAM)
- CPU/processor (datapath and control)

# Chip manufacturing process



#### Wafers and Dies



- Silicon wafers undergo many processing steps so that different parts of the wafer behave as insulators, conductors, and transistors (switches)
- Multiple metal layers on the silicon enable connections between transistors
- The wafer is chopped into many dies the size of the die determines yield and cost

#### **Processor Technology Trends**

- Shrinking of transistor sizes: 250nm (1997) 130nm (2002) 70nm (2008) 35nm (2014) 2019 transition to 10nm, now transitioning to 7nm
- Transistor density increases by 35% per year and die size increases by 10-20% per year... functionality improvements!
- Transistor speed improves linearly with size (complex equation involving voltages, resistances, capacitances)
- Wire delays do not scale down at the same rate as transistor delays

## Memory and I/O Technology Trends

- DRAM density increases by 40-60% per year, latency has reduced by 33% in 10 years (the memory wall!), bandwidth improves twice as fast as latency decreases
- Disk density improves by 100% every year, latency improvement similar to DRAM
- Networks: significant bandwidth and latency improvement

# Thank you!