

# CS6560: Parallel Computer Architecture

## Introduction to Parallel Computer Architecture

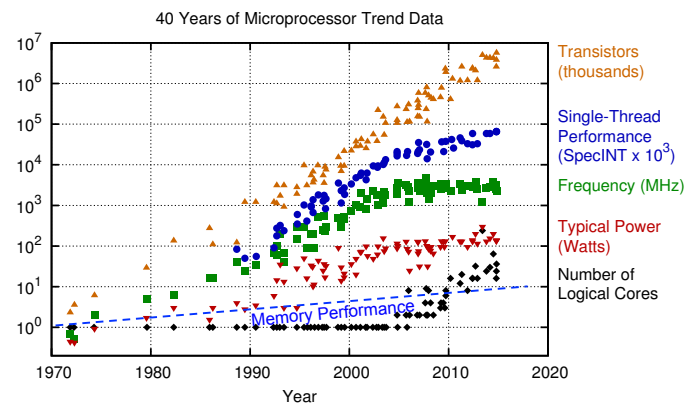


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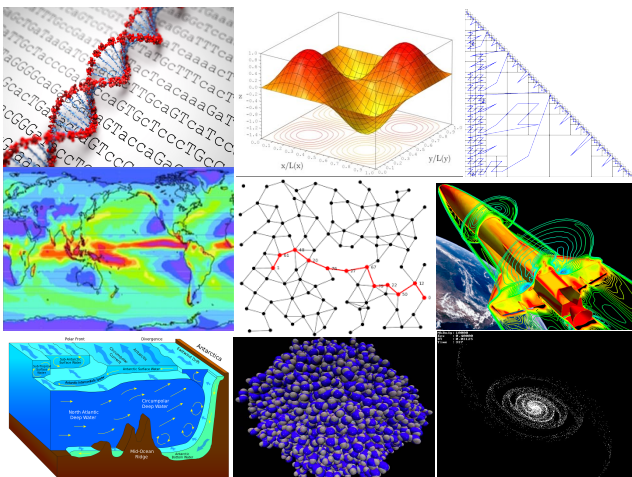


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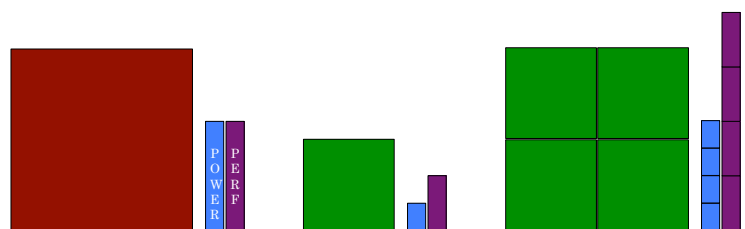
## Driving Forces for Multiprocessor/Multicore Systems



## Computational Demands are Ever Increasing

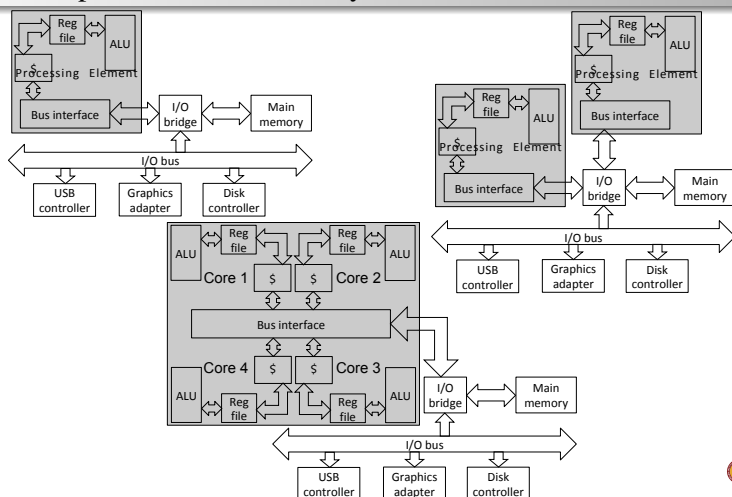


## Uniprocessor to Multiprocessor Systems

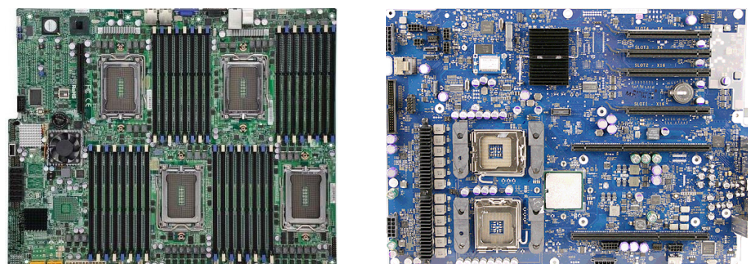


- Multiple slower cores instead of a faster/powerful processor

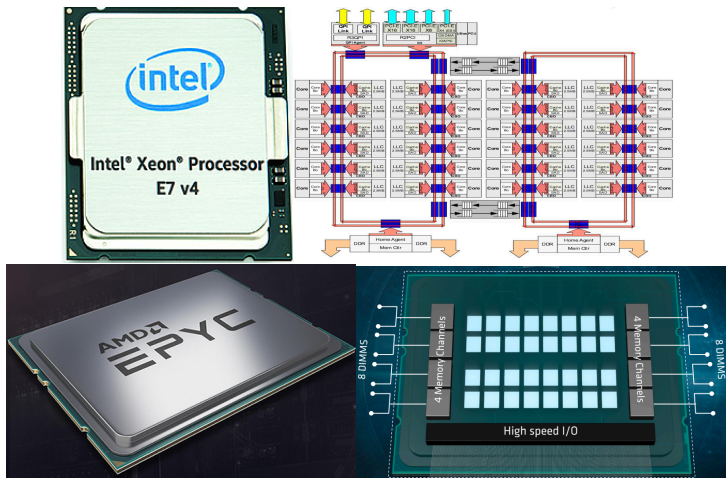
## Multiprocessor/Multicore Systems



## Multiprocessor Examples



## Multicore Examples



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## Parallel Computer

*A parallel computer is a collection of processing elements that can communicate and cooperate to solve a large problem fast.*  
— Almasi & Gottlieb

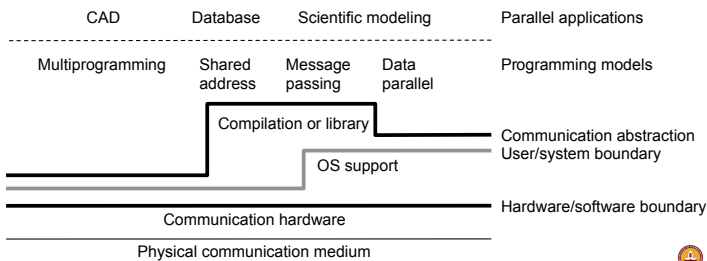
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## Parallel Computer Architecture

- PCA = Computer Architecture + Communication Architecture
- Communication Architecture:
  - Communication operations
  - Synchronization operations
  - Implementation



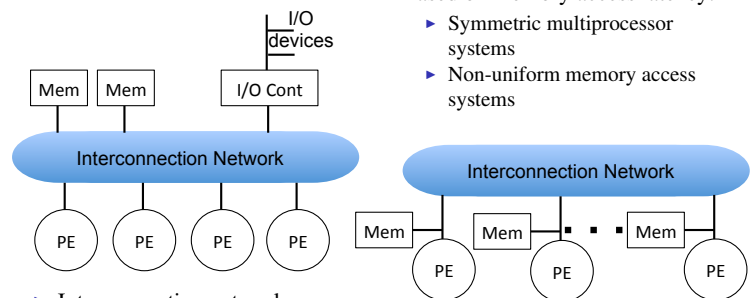
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## Communication Hardware for Shared Memory Systems

- Based on memory access latency:
  - Symmetric multiprocessor systems
  - Non-uniform memory access systems



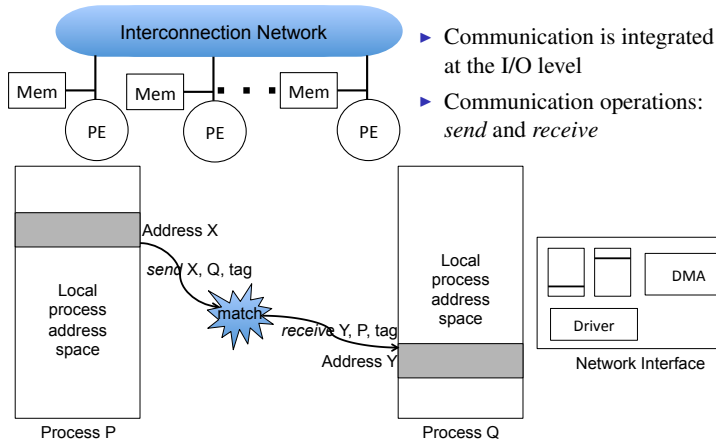
- Interconnection networks: Bus, Crossbar, Ring, Mesh, ...
- Communication operations: load and store
- Effectiveness of shared memory system depends on:
  - memory access latency
  - bandwidth of data transfer

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## Communication Hardware for Message Passing Systems

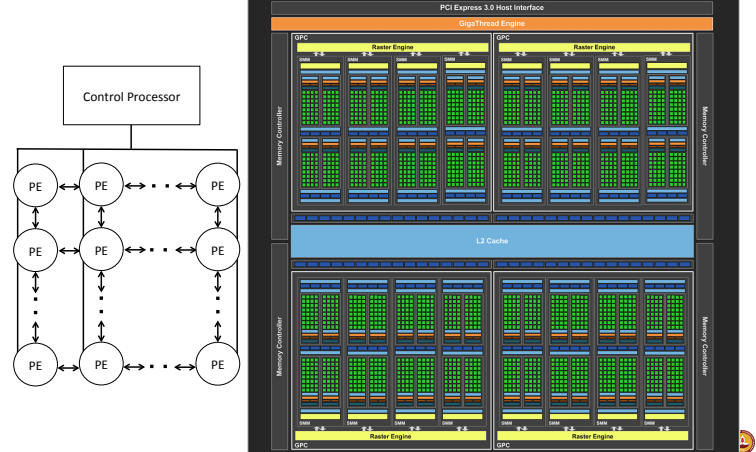


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## Communication Hardware for Data Parallel Systems

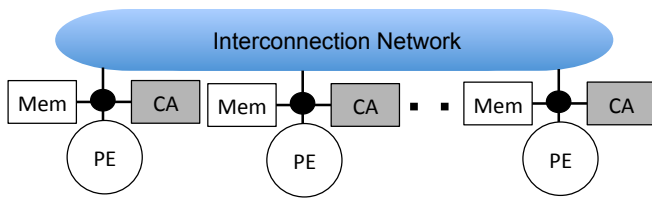


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## A Generic Parallel Architecture



- ▶ For shared memory systems:
  - ▶ the CA (Communication Assist) is tightly integrated with the memory system
- ▶ For message passing systems:
  - ▶ the CA needs to initiate the messages quickly and respond to incoming messages
- ▶ For data parallel systems:
  - ▶ the CA needs to support fast global synchronization



Thank You

