



COS40003 Concurrent Programming

Lecture 1: Introduction

Introduction of Concurrent Programming

What is “concurrent programming”?

- Concurrent programming
 - program to support concurrent computing
- Computing paradigms
 - Concurrent computing
 - Parallel computing
 - Distributed computing
 - Others:
 - Cluster computing, grid computing, cloud computing, fog/edge computing

Concurrent computing and Parallel computing

- In English:
 - Concurrent
 - happen at the same time
 - Parallel
 - happen at the same time
- In Computer Science
 - Concurrent computing
 - from observer's point of view whether computing tasks are done simultaneously
 - Parallel computing
 - from system's point of view whether computing tasks are done simultaneously

Concurrent computing

- Concurrent computing theory
 - Was developed on a single processor
 - Also applies to multiple processors
- Time-sharing
 - Scheduling computing tasks, i.e. how to improve response time, while ensure fairness
- Concurrency control
 - Race conditions
 - Deadlocks

Parallel computing

- What parallel computing means?
 - A type of computation in which many calculations or the execution of processes are carried out simultaneously.
- How parallel computing is done?
 - In parallel computing, a computational task is typically broken down into several, often many, very similar subtasks that can be processed independently and whose results are combined afterwards, upon completion.

Parallel computing example

- GPU Computing
 - <https://www.youtube.com/watch?v=-P28LKWTzrI>
- Attention:
 - Pause the recording when playing Youtube video

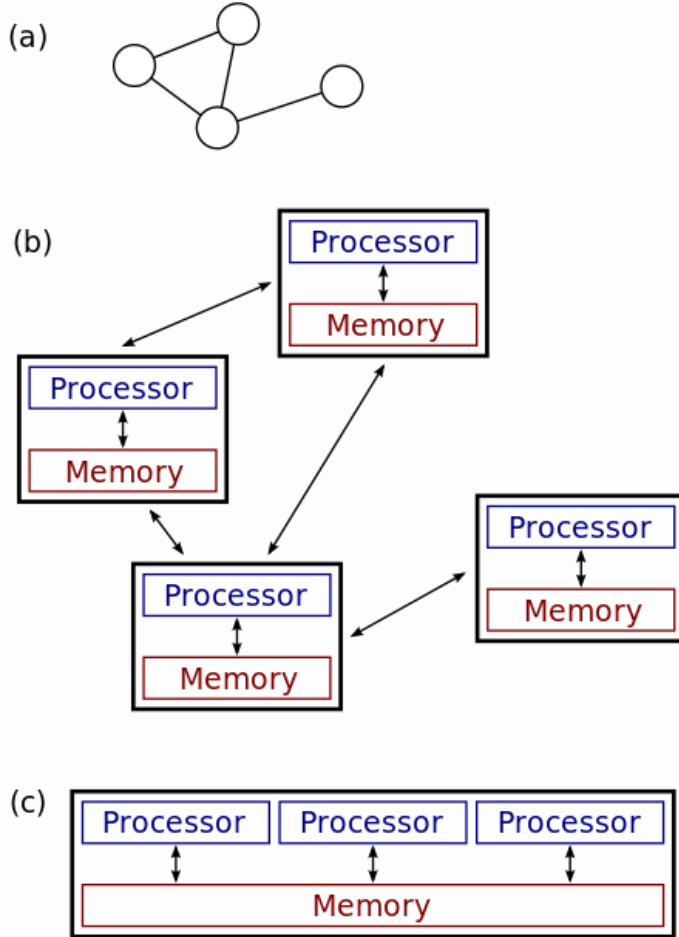
Distributed computing

- No single definition of a distributed system
- Commonly agreed properties:
 - (a) There are several autonomous computers, each of which has its own local memory.
 - (b) The computers communicate with each other by message passing.

Parallel computing and distributed computing

- A rough way to classify concurrent systems as "parallel" or "distributed":
 - In parallel computing, all processors may have access to a **shared memory** to exchange information between processors.
 - In distributed computing, each processor has its **own private memory** (distributed memory). Information is exchanged by passing messages between the processors.

Parallel computing and distributed computing



- Parallel example
 - Multi-core CPU
 - GPU
- Distributed example
 - Cluster computing
 - Grid computing

Cluster computing



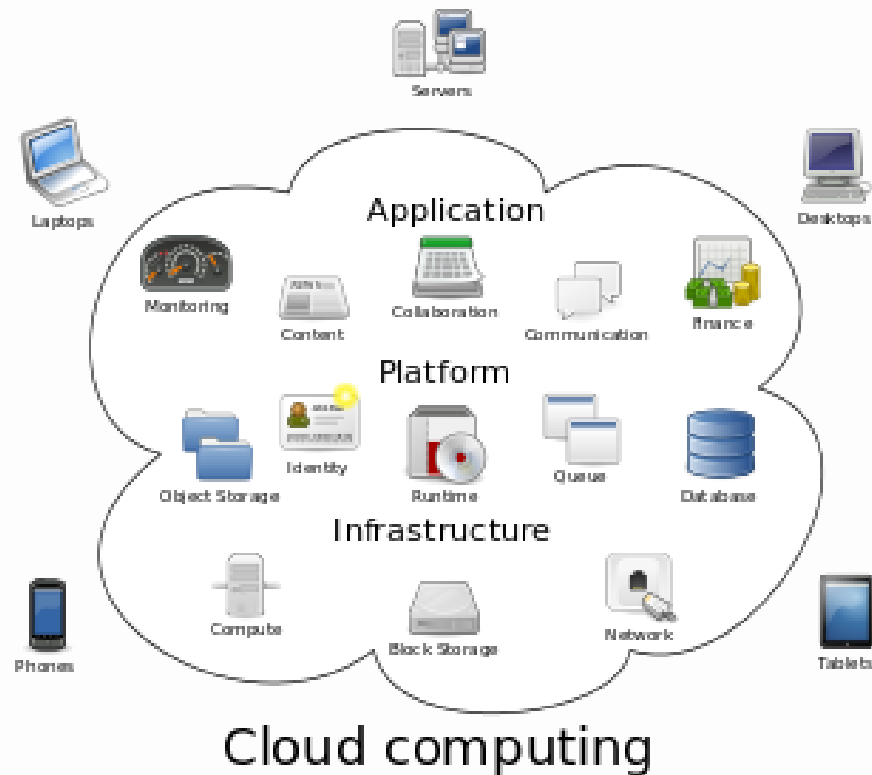
- The computer cluster usually (but not always) has a number of low-cost computers connected via a fast local area network to provide high-performance computing power.

Technicians working on a large [Linux](#) cluster at the [Chemnitz University of Technology](#), Germany. – photo from wiki

Grid computing

- Grid is composed of many networked loosely coupled computers acting together to perform large tasks.
- Generally believed:
 - Computer cluster: homogeneous, collocated;
 - Computer grid: heterogeneous, geographically dispersed
- Grid computing – sort of outdated
 - Cloud computing

Cloud computing

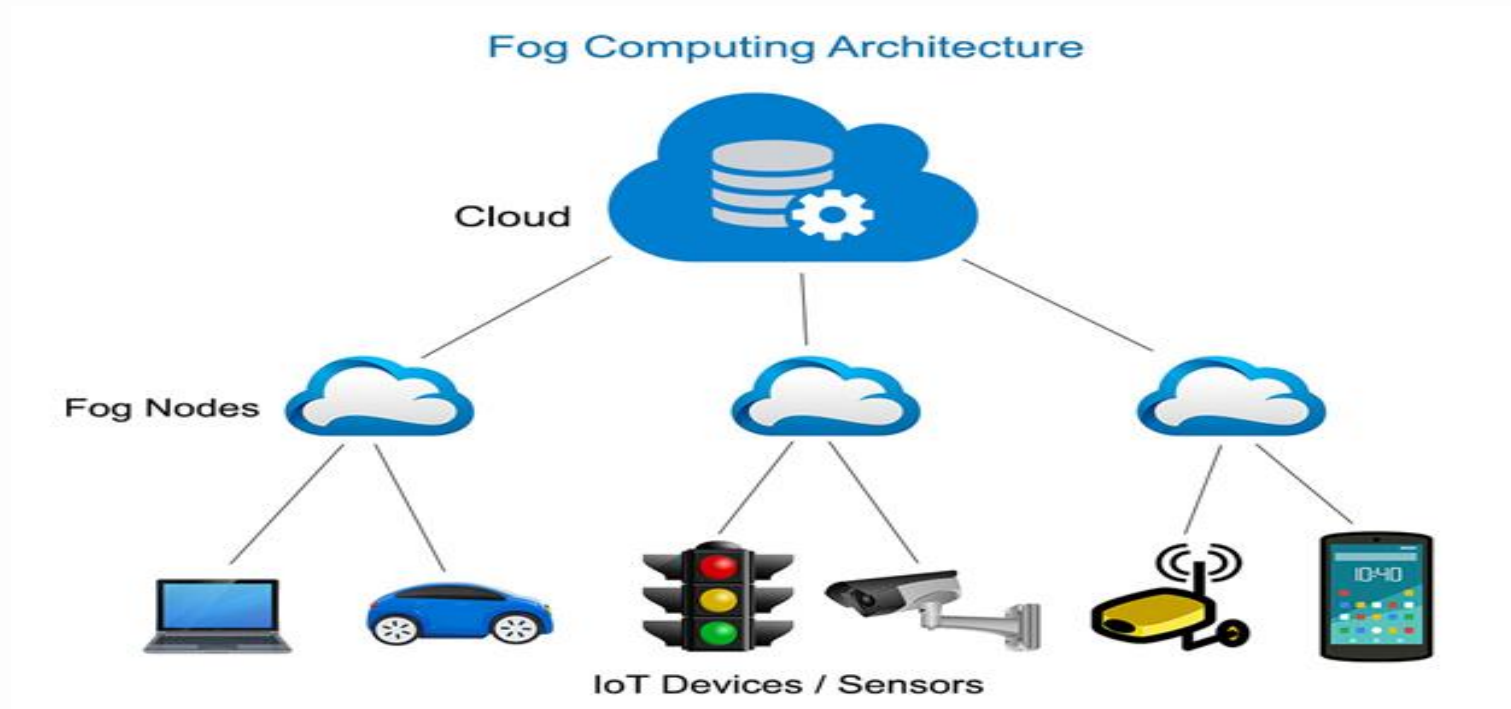


- Hide computing
- Providing services only
 - SaaS
 - PaaS
 - IaaS

Cloud computing

- The goal of cloud computing is to hide computation at server, with users no need to know the details. (not purely about distributed computing.)
- Distributed computing techniques become important because it supports cloud computing.

Fog/Edge computing



- The goal is to do as much processing as possible using computing units co-located or near the data-generating devices. In particular, supporting Internet of Things (IoT) application.

Review

- Concurrent computing VS Parallel computing
- (1) no clearly defined boundary
- (2) try to understand following the history of how technology developed
- The aim of both is to support multiple tasks to run simultaneously

Concurrent computing VS Parallel computing

- At the beginning, only one CPU in a computer, to support multiple tasks to run simultaneously, timing sharing and concurrency control have to be used.
 - Concurrent is the best word to describe
- As technology developed, we have multi-core, multi-processors, etc. Parallelism can be physically realized/implemented
 - Parallel computing realized true parallelism

Concurrent computing and Parallel computing

- In a simple way to summarize:
 - Concurrent computing
 - from observer/user's point of view whether computing tasks are done simultaneously
 - Parallel computing
 - from system/computer's point of view whether computing tasks are done simultaneously

(Note that, this is Lecturer's personal view.
More discussions welcome)

Lab 1 Task

- Read, understand, summarize the following computing paradigms
 - Concurrent, parallel, distributed, cluster, grid, cloud, fog/edge etc.
- Put it as part of your Report I. Make use of lab to get feedback early
- Feel free to express your own thoughts, disagreement with the established ideas (has to be reasonable)

Questions?