MURANG'A UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF IT

SIT407: CLOUD COMPUTING
CREDIT HOURS: 3 HOURS

COURSE NOTES – 2021/2022

OVERVIEW OF DISTRIBUTED COMPUTING

Sub-topics

- Trends of computing
- Introduction to distributed computing
- Cloud computing

TRENDS OF COMPUTING

The Age of Internet Computing

- Billions of people use the Internet every day.
- As a result, supercomputer sites and large data centers must provide high-performance computing services to huge numbers of Internet users concurrently.
- The emergence of computing clouds instead demands high-throughput computing (HTC) systems built with parallel and distributed computing technologies .

INTRODUCTION TO DISTRIBUTED COMPUTING

We have to upgrade data centers using fast servers, storage systems, and high-bandwidth networks.

The purpose is to advance network-based computing and web services with the emerging new technologies.

TRENDS OF COMPUTING

The Platform Evolution

Computer technology has gone through five generations of development, with each generation lasting from 10 to 20 years.

Successive generations are overlapped in about 10 years. For instance, from 1950 to 1970, a handful of mainframes, including the IBM 360 and CDC 6400, were built to satisfy the demands of large businesses and government organizations.

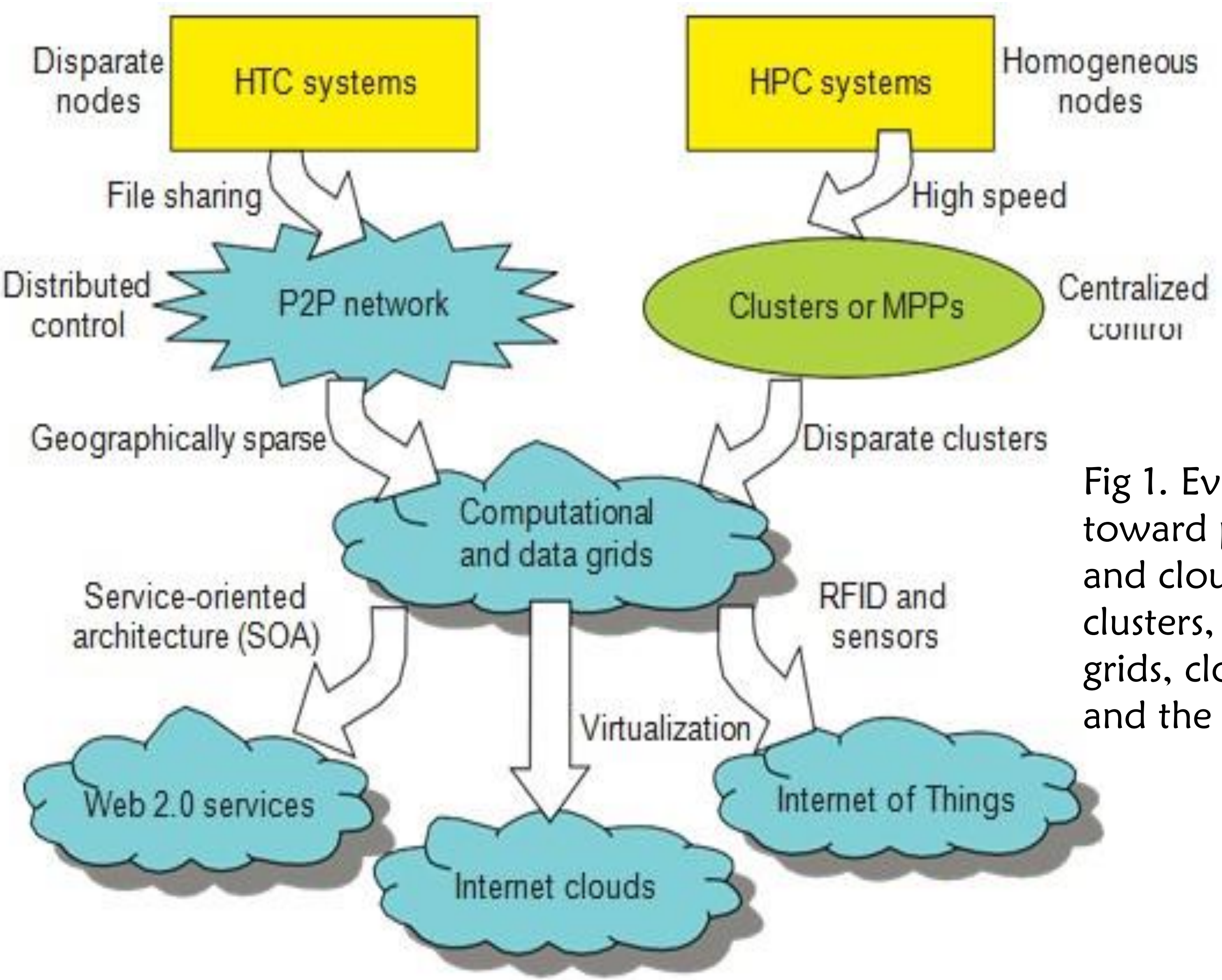

Fig 1. Evolutionary trend toward parallel, distributed, and cloud computing with clusters, MPPs, P2P networks, grids, clouds, web services, and the Internet of Things.

TRENDS OF COMPUTING CONT'D

Fig 1. illustrates, with the introduction of service oriented architecture (SOA), Web 2.0 services become available.

Advances in virtualization make it possible to see the growth of Internet clouds as a new computing paradigm.

The maturity of radio-frequency identification (RFID), Global Positioning System (GPS), and sensor technologies has triggered the development of the Internet of Things (IoT).

TRENDS OF COMPUTING CONT'D

High-Performance Computing

For many years, HPC systems emphasize the raw speed performance. The speed of HPC systems has increased from Gflops in the early 1990s to now Pflops in 2010. This improvement was driven mainly by the demands from scientific, engineering, and manufacturing communities.

For example, the Top 500 most powerful computer systems in the world are measured by floating-point speed in Linpack benchmark results. However, the number of supercomputer users is limited to less than 10% of all computer users

TRENDS OF COMPUTING CONT'D

High-Throughput Computing

The development of market-oriented high-end computing systems is undergoing a strategic change from an HPC paradigm to an HTC paradigm. This HTC paradigm pays more attention to high-flux computing.

The main application for high-flux computing is in Internet searches and web services by millions or more users simultaneously. The performance goal thus shifts to measure high throughput or the number of tasks completed per unit of time.

TRENDS OF COMPUTING CONT'D

Computing Paradigm Distinctions

The high-technology community has argued for many years about the precise definitions of centralized computing, parallel computing, distributed computing, and cloud computing.

In general, distributed computing is the opposite of centralized computing.

The field of parallel computing overlaps with distributed computing to a great extent, and cloud computing overlaps with distributed, centralized, and parallel computing.

TRENDS OF COMPUTING CONT'D

i) Centralized computing.

This is a computing paradigm by which all computer resources are centralized in one physical system.

All resources (processors, memory, and storage) are fully shared and tightly coupled within one integrated OS. Many data centers and supercomputers are centralized systems, but they are used in parallel, distributed, and cloud computing applications

TRENDS OF COMPUTING CONT'D

ii) Parallel computing

In parallel computing, all processors are either tightly coupled with centralized shared memory or loosely coupled with distributed memory. Some authors refer to this discipline as parallel processing.

Inter-processor communication is accomplished through shared memory or via message passing. A computer system capable of parallel computing is commonly known as a parallel computer.

TRENDS OF COMPUTING CONT'D

iii) Distributed computing

This is a field of computer science/engineering that studies distributed systems.

A distributed system consists of multiple autonomous computers, each having its own private memory, communicating through a computer network. Information exchange in a distributed system is accomplished through message passing.

TRENDS OF COMPUTING CONT'D

iv) Cloud computing

An Internet cloud of resources can be either a centralized or a distributed computing system.

The cloud applies parallel or distributed computing, or both.

Clouds can be built with physical or virtualized resources over large data centers that are centralized or distributed.

Some authors consider cloud computing to be a form of utility computing or service computing

INTRODUCTION TO CLOUD COMPUTING

Cloud is a parallel and distributed computing system consisting of a collection of inter-connected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements (SLA) established through negotiation between the service provider and consumers.

CLOUD COMPUTING CONT'D

Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services).

These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization.

This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized Service Level Agreements

CLOUD COMPUTING CONT'D

ROOTS OF CLOUD COMPUTING

The roots of clouds computing by observing the advancement of several technologies, especially in hardware (virtualization, multi-core chips), Internet technologies (Web services, service-oriented architectures, Web 2.0), distributed computing (clusters, grids), and systems management (autonomic computing, data center automation).

CLOUD COMPUTING CONT'D

i) From Mainframes to Clouds

We are currently experiencing a switch in the IT world, from in-house generated computing power into utility supplied computing resources delivered over the Internet as Web services.

This trend is similar to what occurred about a century ago when factories, which used to generate their own electric power, realized that it is was cheaper just plugging their machines into the newly formed electric power grid.

CLOUD COMPUTING CONT'D

Computing delivered as a utility can be defined as on demand delivery of infrastructure, applications, and business processes in a security-rich, shared, scalable, and based computer environment over the Internet for a feel

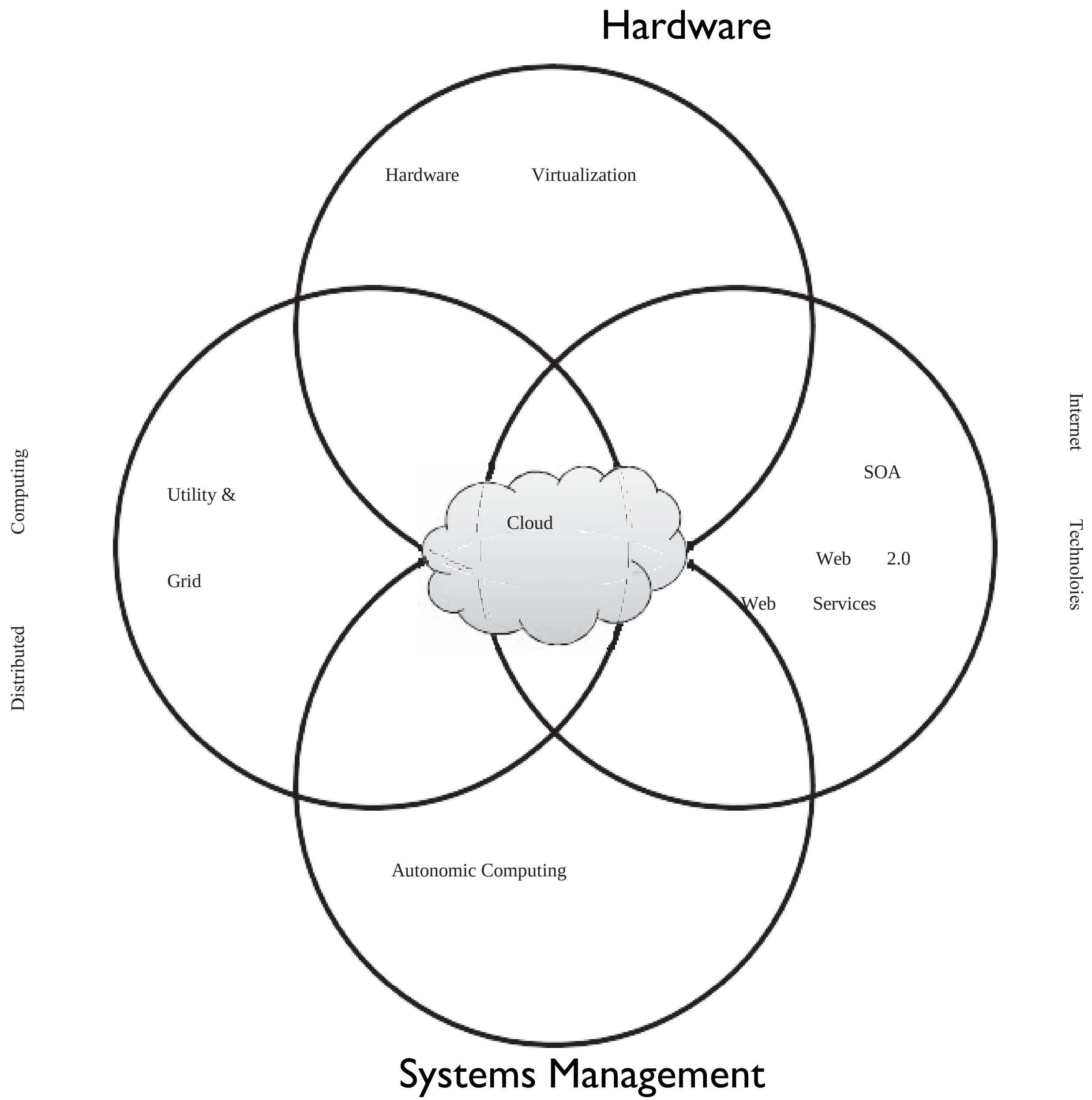

Figure 2.1 Convergence of various advances leading to the advent of cloud computing.

CLOUD COMPUTING CONT'D

This model brings benefits to both consumers and providers of IT services.

Consumers can attain reduction on IT-related costs by choosing to obtain cheaper services from external providers as opposed to heavily investing on IT infrastructure and personnel hiring.

The on-demand component of this model allows consumers to adapt their IT usage to rapidly increasing or unpredictable computing needs.

CLOUD COMPUTING CONT'D

Providers of IT services achieve better operational costs; hardware and software infrastructures are built to provide multiple solutions and serve many users, thus increasing efficiency and ultimately leading to faster return on investment (ROI) as well as lower total cost of ownership (TCO).

The benefits of economies of scale and high utilization allow providers to offer computing services for a fraction of what it costs for a typical company that generates its own computing power.

CLOUD COMPUTING CONT'D

ii) SOA, WEB SERVICES, WEB 2.0, AND MASHUPS

The emergence of Web services (WS) open standards has significantly contributed to advances in the domain of software integration.

Web services can glue together applications running on different messaging product platforms, enabling information from one application to be made available to others, and enabling internal applications to be made available over the Internet.

CLOUD COMPUTING CONT'D

Over the years a rich WS software stack has been specified and standardized, resulting in a multitude of technologies to describe, compose, and orchestrate services, package and transport messages between services, publish and discover services, represent quality of service (QoS) parameters, and ensure security in service access.

CLOUD COMPUTING CONT'D

WS standards have been created on top of existing ubiquitous technologies such as HTTP and XML, thus providing a common mechanism for delivering services, making them ideal for implementing a service-oriented architecture (SOA).

The purpose of a SOA is to address requirements of loosely coupled, standards-based, and protocol independent distributed computing.

CLOUD COMPUTING CONT'D

In a SOA, software resources are packaged as a services, which are well defined, self-contained modules that provide standard business functionality and are independent of the state or context of other services. Services are described in a standard definition language and have a published interface.

The maturity of WS has enabled the creation of powerful services that can be accessed on-demand, in a uniform way. While some WS are published with the intent of serving end-user applications, their true power resides in its interface being accessible by other services.

CLOUD COMPUTING CONT'D

An enterprise application that follows the SOA paradigm is a collection of services that together perform complex business logic.

In the consumer Web, information and services may be programmatically aggregated, acting as building blocks of complex compositions, called *service mashups*.

Many service providers, such as Amazon, del.icio.us, Facebook, and Google, make their service APIs publicly accessible using standard protocols such as SOAP and REST

CLOUD COMPUTING CONT'D

In the Software as a Service (SaaS) domain, cloud applications can be built as compositions of other services from the same or different providers.

Services such user authentication, e-mail, payroll management, and calendars are examples of building blocks that can be reused and combined in a business solution in case a single, readymade system does not provide all those features.

Many building blocks and solutions are now available in public marketplaces

CLOUD COMPUTING CONT'D

For example, Programmable Web is a public repository of service APIs and mashups currently listing thousands of APIs and mashups. Popular APIs such as Google Maps, Flickr, YouTube, Amazon e-commerce, and Twitter, when combined, produce a variety of interesting solutions, from finding video game retailers to weather maps.

Similarly, Salesforce.com's offers AppExchange, which enables the sharing of solutions developed by third-party developers on top of Salesforce.com components.

The end.

Q & A