Cloud Computing Basics

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Foreword

The IT sector is a fast-changing industry. Cloud computing has been developing rapidly in recent years and has become the foundation of a wide range of major applications. So, what is cloud computing all about? What are the service models for cloud computing? This course will provide a brief introduction to cloud computing.

Objectives

- Upon completion of this course, you will be able to:
  - Describe what cloud computing is.
  - Describe the benefits of cloud computing.
  - List services and deployment modes for cloud computing.
  - Understand mainstream cloud computing vendors and technologies.

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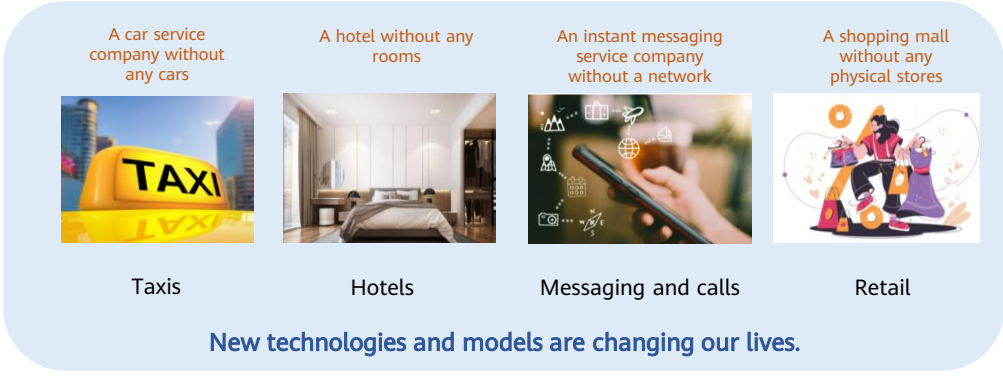
IT All Around Us

"IT" is the common term for an entire spectrum of technologies for information processing, including software, hardware, communications, and related services.



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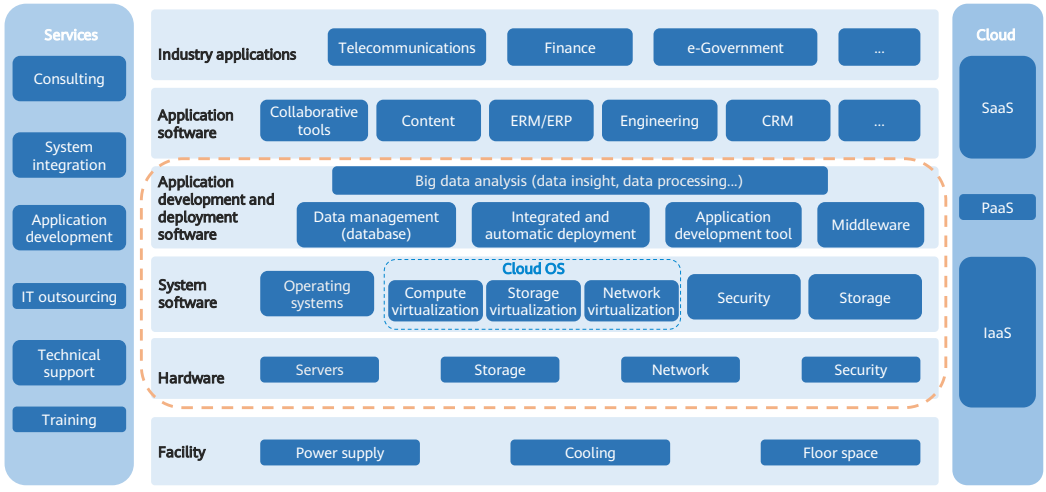
- IT technologies around us are changing the way we live, for example, taxi hailing software that enables online booking and dispatch of cabs, communications software that enables real-time voice calls over the Internet, and e-malls that provide online shopping experience.
- Taxi hailing: Uber and DiDi
- Hotel: Airbnb
- Messaging and calls: WeChat and Viber
- Retail: Taobao and Amazon

Data Center - Based IT Architecture



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Traditional IT infrastructure consists of common hardware and software components, including facilities, data centers, servers, network hardware, desktop computers, and enterprise application software solutions.

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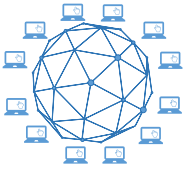
The Information Explosion Is Here

With the proliferation of mobile Internet in today's fully connected era, more devices are getting connected every day. The amount of data being processed has been growing exponentially, which has created unprecedented challenges to traditional ICT infrastructure.

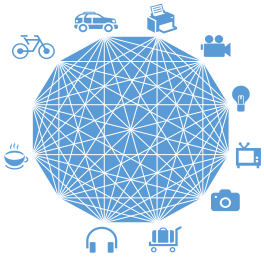


PCs
Computers using x86 architecture

Windows/Linux

Mobile internet
Mobile phones using Advanced RISC Machines (ARM) architecture

Android/iOS



IoT
Terminals running x86/Arm/DSP/MIPS/FPGA/...

IoT operating systems

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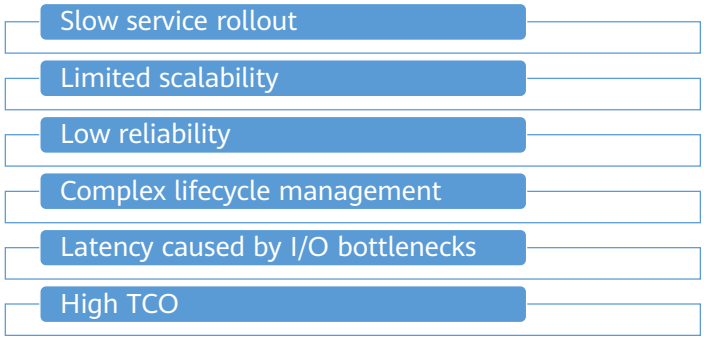
- In the PC era, computers are connected to each other through servers. Now, in the mobile era, we can assess the Internet through mobile phones. In the 5G era, all computers, mobile phones, and smart terminals are connected to each other, and we are in the era of Internet of Everything (IoE).
- In the IoE era, the entire industry will compete for ecosystem. From the PC era to the mobile era, and then to the IoE era, the ecosystem changes fast at the beginning, then tends to be relatively stable, and rarely changes when it is stable. In the PC era, a large number of applications run on Windows, Intel chips, and x86 architecture. Then, browsers come with the Internet. In the mobile era, applications run on iOS and Android systems that use the ARM architecture.
- The Internet has gone through two generations and is now ushering in the third generation, the Internet of Everything. Compared with the previous generation, the number of devices and the market scale of each generation increase greatly, presenting future opportunities. As the Intel and Microsoft in the PC era and the ARM and Google in the mobile era, each Internet generation has its leading enterprises who master the industry chain. In the future, those who have a good command of core chips and operating systems will dominate the industry.

Challenges to Traditional IT

As the Internet has grown, massive volumes traffic, users, and data have been generated. The traditional IT architecture has been unable to meet the demands of fast developing enterprises.



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- The growing popularity of the Internet brings an influx of traffic, users, and data to enterprises. To keep up with the rapidly developing businesses, enterprises need to continuously purchase traditional IT devices. Therefore, the disadvantages of traditional IT devices gradually emerge.
  - Long procurement period slows rollout of new business systems.
  - The centralized architecture has poor scalability and can only increase the processing performance of a single node.
  - Traditional hardware devices are isolated from each other, and their reliability mainly depends on software.
  - Devices and vendors are heterogeneous and hard to manage.
  - The performance of a single device is limited.
  - Low device utilization leads to high total cost of ownership (TCO).

Discussion

How can IT enterprises overcome these challenges?

- **IT infrastructure transformation**
- **Resource integration and comprehensive utilization**
- **Business collaboration and continuous optimization**

How do we solve these pain points? Think over advantages of cloud computing that can solve these pain points, so you can have a better understanding of cloud computing.

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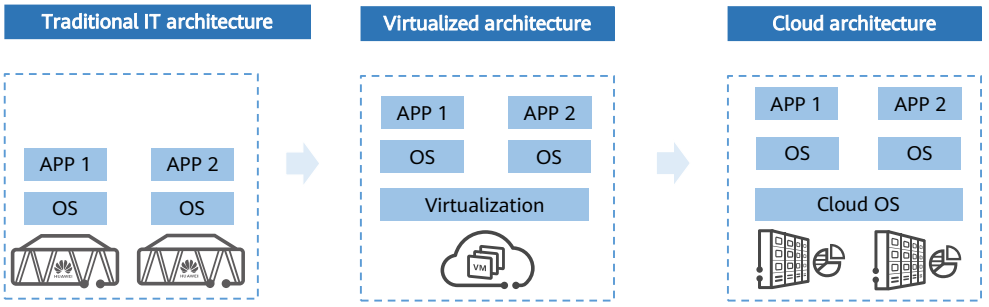
Enterprises Are Migrating to the Cloud



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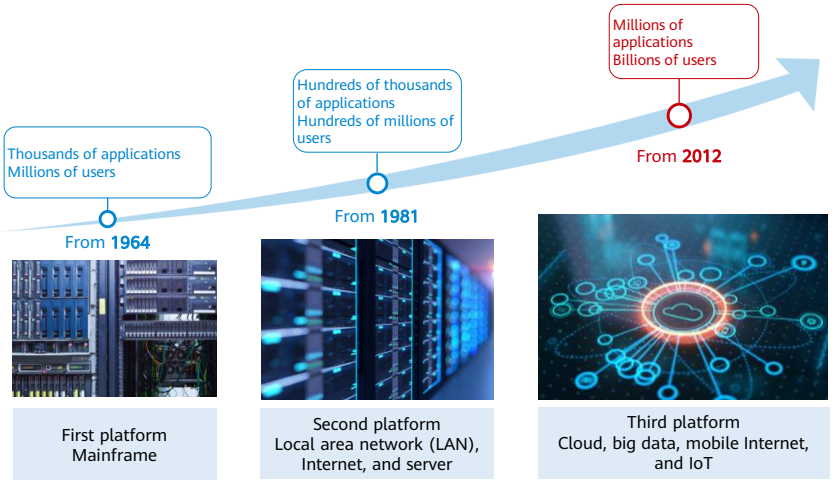
- The traditional IT architecture consists of hardware and software, including infrastructure, data centers, servers, network hardware, desktop computers, and enterprise application software solutions. This architecture requires more power, physical space, and money and is often installed locally for enterprise or private use only.
- With the virtualization technology, computer components can run on the virtual environment rather than the physical environment. Virtualization enables maximum utilization of the physical hardware and simplifies software reconfiguration.
- Enterprise data centers are transformed from resource silos to resource pooling, from centralized architecture to distributed architecture, from dedicated hardware to software-defined storage (SDS) mode, from manual handling to self-service and automatic service, and from distributed statistics to unified metering. These are the key features of cloud migration of enterprise data centers.

Cloud Computing Is Now the Preferred Choice for IT Enterprises



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- In 2015, the third platform gained prominence over the second platform.
- The third platform accounts for one-third of the global IT spending and 100% of IT spending growth.
- Cloud computing has changed the business and construction mode of the IT industry. Big data assists enterprises in exploring business benefits and promoting the construction of the second data plane.

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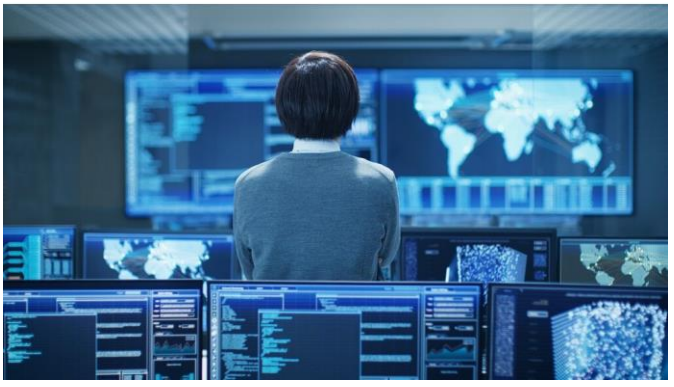
As what we have learnt from the previous slides, the third platform built on cloud computing has become the mainstream of the IT industry. Computer and virtualization technologies are the foundation of the third platform. Before we get into cloud computing, let's take a quick look at the evolution of computer and virtualization technologies.

What Is a Computer?

A computer is a high-speed electronic device capable of performing numerical and logical calculations. It automatically stores and processes data according to a set of programming instructions given to it.



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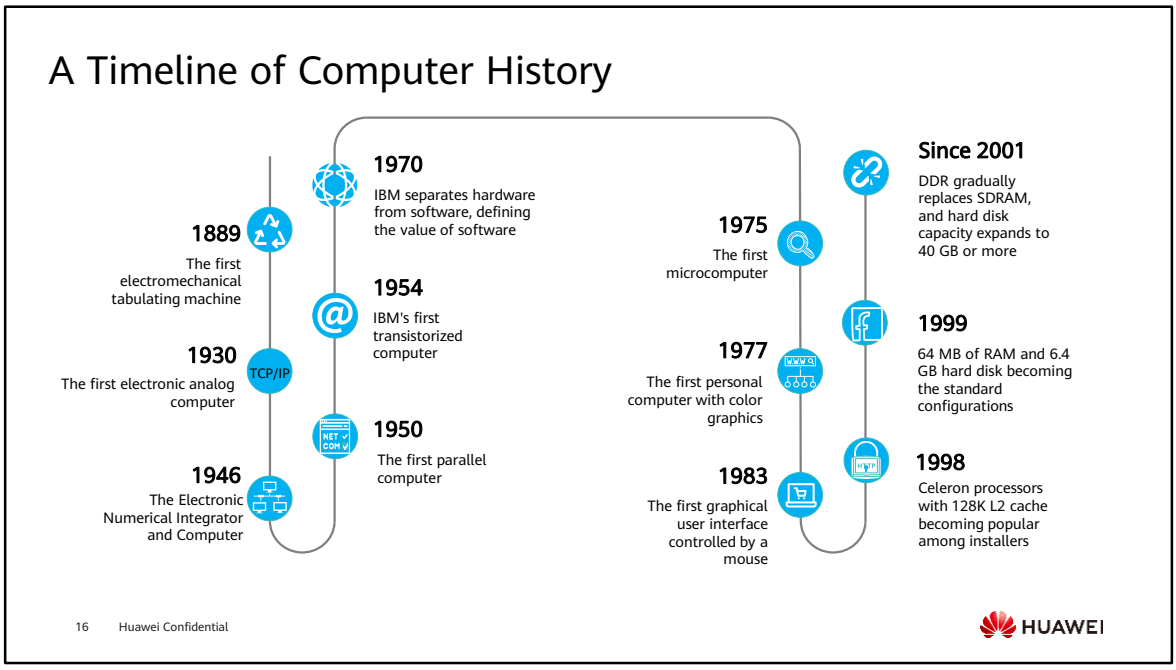
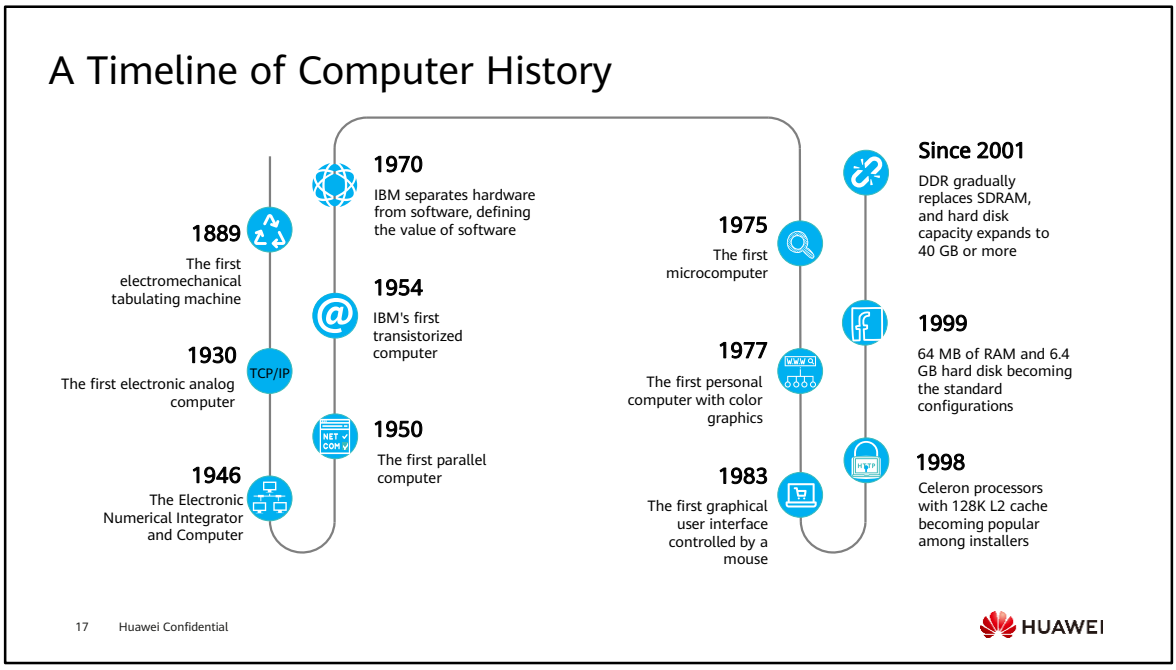
When it comes to computers, we immediately think of desktops, laptops, and servers. Actually, storage devices, network devices, and security devices in a data center are all computer devices.



- Computing tools progressed from simple to complex and from low to high level, such as knotting to abacus and calipers, and then mechanical computers. They played historical roles in different periods and also inspired the development of modern electronic computers.
- In 1889, American scientist Herman Hollerith developed an electromechanical tabulating machine for storing accounting data.
- In 1930, American scientist Vannevar Bush built the world's first analog computer with some digital components.
- In 1946, the U.S. military customized the world's first electronic computer, the Electronic Numerical Integrator and Computer.
- In 1950, the first parallel computer was invented, using von Neumann architecture: binary format and stored programs.
- In 1954, IBM made the first transistorized computer, using floating-point arithmetic for improved computing capabilities.
- In 1970, IBM System/370 was announced by IBM. It replaces magnetic core storage with large-scale integrated circuits, uses small-scale integrated circuits as logical components, and applies virtual memory technology to separate hardware from software, thereby defining the value of software.



- In 1975, MITS developed the world's first microcomputer.
- In 1977, the first personal computer with color graphics was invented.
- In 1998, Celeron processors with 128K L2 cache became popular among installers, and 64 MB of RAM and 15-inch displays became standard configurations.
- In 1999, Pentium III CPUs became a selling point for some computer manufacturers. The 64 MB of RAM and 6.4 GB hard disk became standard configurations.
- Since 2001, Pentium 4 CPUs and Pentium 4 Celeron CPUs have been the standard configurations for computers. DDR has gradually replaced SDRAM as the common type of memory. In addition, 17-inch CRT or 15-inch LCD displays have been the preferred choice for customers. The capacity of hard disks has gradually expanded to 40 GB or more.

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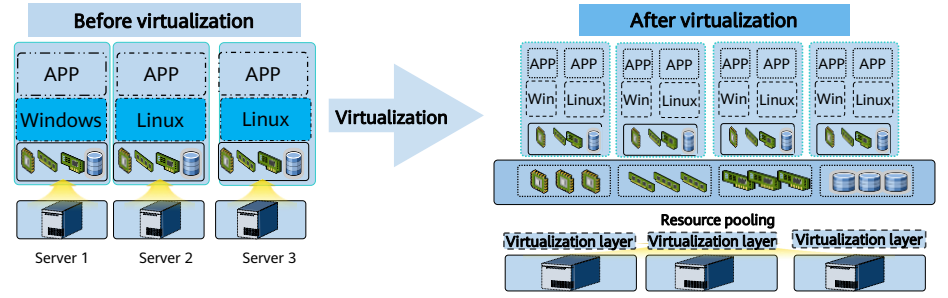
What Is Virtualization?

- Virtualization is the act of creating a virtual version of something, a logical representation of resources.



- IT resources are independent.
- The operating system (OS) is tightly coupled to the physical hardware.

- Resources are virtualized and placed in a shared resource pool.
- Resources are decoupled from the physical hardware, so the OS can allocate resources more flexibly.

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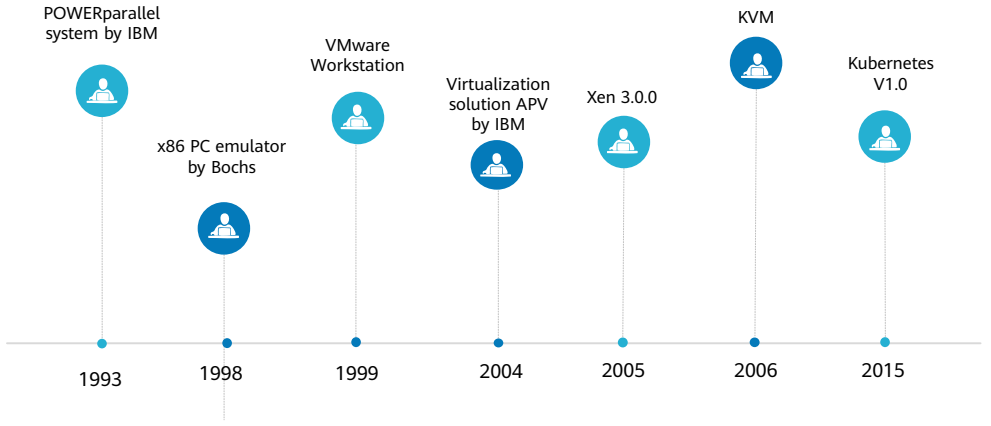
- Virtualization is the fundamental technology that powers cloud computing. Simply speaking, virtualization allows multiple virtual machines (VMs) to run on a physical server. The VMs share the CPU, memory, and I/O hardware resources on the physical server, but they are logically isolated from each other.
- In computer science, virtualization creates an abstraction layer over computer hardware for resource simulation, isolation, and sharing by one or multiple operating systems.
- In essence, virtualization is a process that a lower-layer software module provides a virtual software or hardware interface that is completely consistent with what an upper-layer software module requires so that the upper-layer software module can directly run in the virtual environment. Virtualization abstracts a resource into one or more parts by means of space division, time division, and simulation.
- Virtualization creates an isolation layer to separate hardware from upper-layer applications so that multiple logical applications can run on one hardware.

A Timeline of Virtualization History



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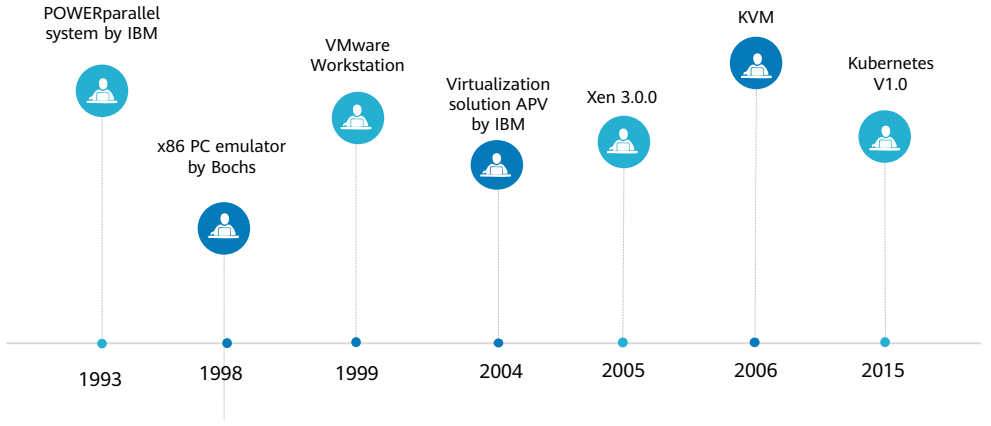
- In 1993, IBM launched an upgradeable POWERparallel system, the first microprocessor-based supercomputer using RS/6000 technology.
- In 1998, Bochs, a x86 PC emulator was released.
- In 1998, VMware was founded. In 1999, the company launched its first product, VMware Workstation, the commercial virtualization software that allows to run multiple operating systems on a single physical server.
- In 1999, IBM first proposed the LPAR (logical partition) virtualization technology on AS/400.
- In 2000, Citrix released XenDesktop, a desktop virtualization product.
- In 2004, IBM announced the virtualization solution APV (Advanced Power Virtualization), which supports resource sharing. This solution was renamed PowerVM in 2008.
- In 2005, Xen 3.0.0 was released as the first hypervisor with Intel® VT-x support. Xen 3.0.0 can run on 32-bit servers.

A Timeline of Virtualization History



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- In 2006, Qumranet, an Israeli startup, officially announced Kernel-based Virtual Machine (KVM).
- 2006–present: cloud computing and big data era.
- In 2007, German company InnoTek developed VirtualBox, a virtualization software.
- In 2008, Linux Container (LXC) 0.1.0 was released to provide lightweight virtualization.
- In 2010, Red Hat released RHEL 6.0, removing Xen and leaving KVM as the only bundled virtualization option.
- In 2015, Kubernetes v1.0 was released, and the cloud native era started.
- In 2019, 12 national regulations for cloud computing were approved and officially released.

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In the previous two chapters, we have learned about the development of computers and virtualization technology. Now, let's see what cloud computing is.

Definition of Cloud Computing

- The National Institute of Standards and Technology (NIST) defines cloud computing as follows:
  - Cloud computing is a model for enabling **ubiquitous, convenient, on-demand** network access to **a shared pool** of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be **rapidly provisioned and released with minimal** management effort or interaction with service providers.
- Wikipedia:
  - Cloud computing is the on-demand availability of computer system resources, especially data storage and computing power, without direct active management by the user.

- Key points:
  - Cloud computing is a model rather than a technology.
  - With cloud computing, users can access IT resources such as networks, servers, storage, applications, and services easily.
  - Simply put, the cloud is a metaphor for the Internet. It is an abstraction of the Internet and the infrastructure underpinning the Internet. Computing refers to computing services provided by a sufficiently powerful computer, including a range of functionalities, resources, and storage. Cloud computing can be understood as the delivery of on-demand, measured computing services over the Internet.

Cloud Services and Applications All Around Us (Personal)

Cloud albums

Cloud music

Cloud video

Cloud Docs

What other cloud services and applications are parts of our lives?

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- What are the data sources of cloud computing in daily life?
  - Cloud album, such as Baidu Cloud and iCloud Shared Album
  - Cloud music, such as NetEase Cloud Music, Kugou Music, Kuwo Music, and Xiami Music
  - Cloud video, such as Baidu Cloud and Tencent Cloud Video
  - Cloud documents, such as Youdao Note, and Shimo document
- From the applications we use in our life, we can see that cloud computing makes our life more convenient. Enterprises also use cloud computing to provide better products for better user experience.

Cloud Services and Applications All Around Us (Enterprise)

Huawei Cloud Meeting provides an all-scenario, device-cloud synergy videoconferencing solution for intelligent communication and collaboration on different terminals, in different regions, and with collaborators in other companies.

Videoconferencing

Livestreaming

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- Driven by the requirements of the government, transportation, electric power, medical care, education, finance, and military industries and enterprises, the video conferencing market in China has an average annual growth beyond 20%. Currently, only less than 5% of enterprises in China have video conference rooms, and more enterprises are aware of the importance of efficient collaboration. Therefore, the video conferencing system has become indispensable for efficient office work.
- Huawei Cloud Meeting can be used by enterprise office, telemedicine, smart education, and enterprise organization construction.

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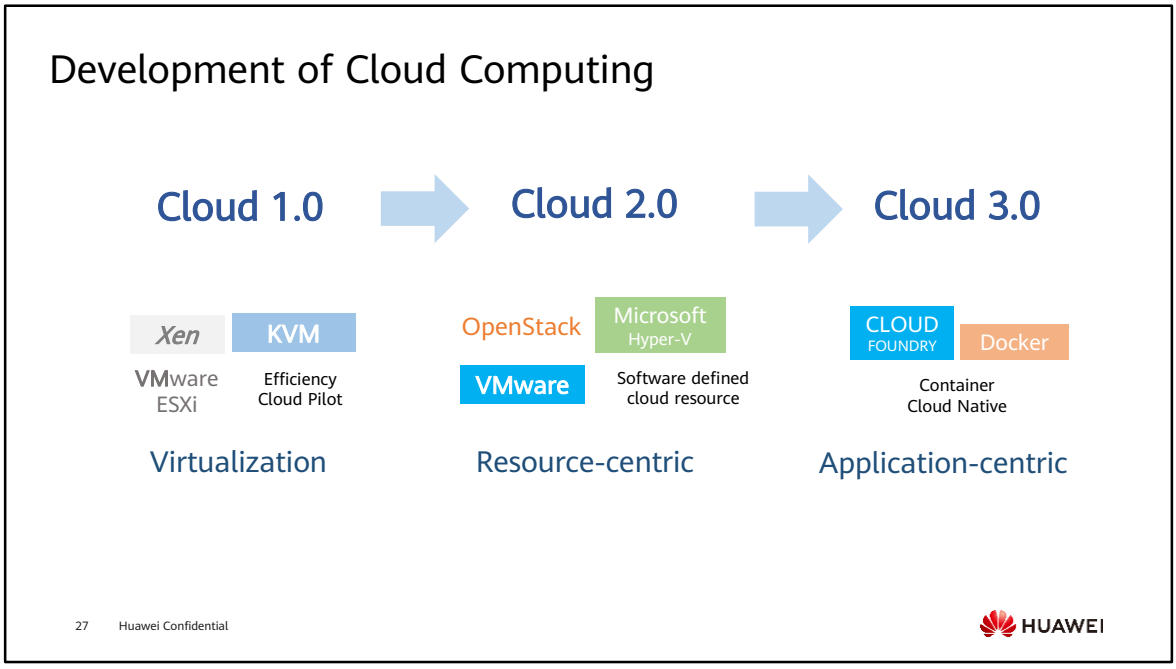

- Looking back on the history of cloud computing, Cloud 1.0 is out of date. Some enterprises adopt Cloud 2.0 for commercial use and are considering expanding the scale and evolving to Cloud 3.0. The other enterprises are evolving from Cloud 1.0 to 2.0, and are even evaluating and implementing the evolution from Cloud 2.0 to 3.0.
- Cloud 1.0: virtualization for higher resource utilization
- Cloud 2.0: resource-centric for cloud-based infrastructure, as well as standardized and automated services
- Cloud 3.0: application-centric for cloud-based applications, agile application development, and easier lifecycle management

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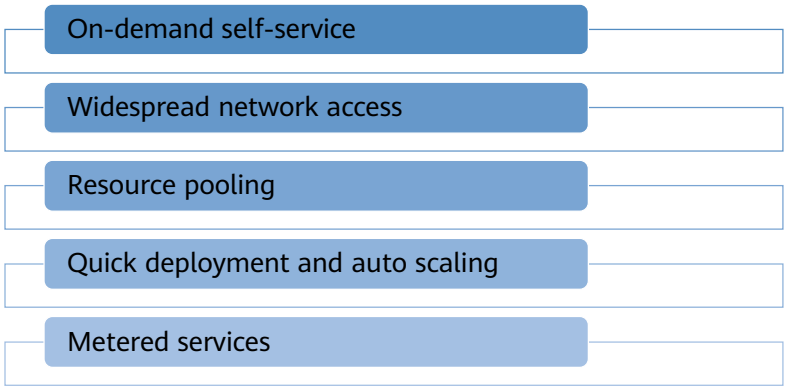
Benefits of Cloud Computing



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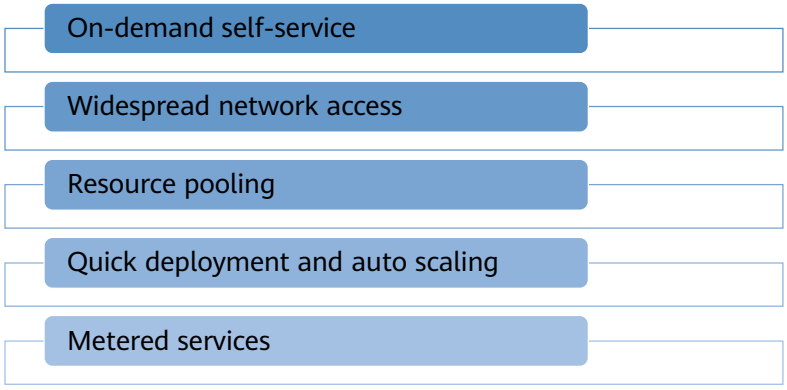
- Cloud computing integrates hardware resources in software mode and then allocates them to applications for improved resource utilization. Cloud computing helps you run your infrastructure more efficiently, and scale as your business needs change. You can build a cloud data center and use automatic scheduling technology for more unified data storage. In this way, you can use data assets more effectively to save energy, reduce emission, and make maintenance easier. It helps you lower costs and improve efficiency.
- Five benefits:
  - On-demand self-service: Consumers can deploy processing capabilities on demand, such as server running time and network storage, and do not need to communicate with each service provider.
  - Widespread network access: Users can access various services over the Internet via different clients, such as mobile phones, laptops, and tablets.

Benefits of Cloud Computing



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- Resource pooling: The computing resources are pooled and provisioned in a multi-tenant model. In addition, physical and virtual resources are dynamically assigned based on user demand. Users do not need to know or control the exact location of resources, including storage, processors, memory, network bandwidth, and virtual machines (VMs).
- Quick deployment and auto scaling: Computing resources can be rapidly and elastically provisioned, expanded, and released. A user can rent unlimited resources at any time.
- Metered services: Users pay as per use of cloud server resources, such as CPU, memory, storage, and network bandwidth. You can pay by hour, or you can also buy yearly or monthly package.

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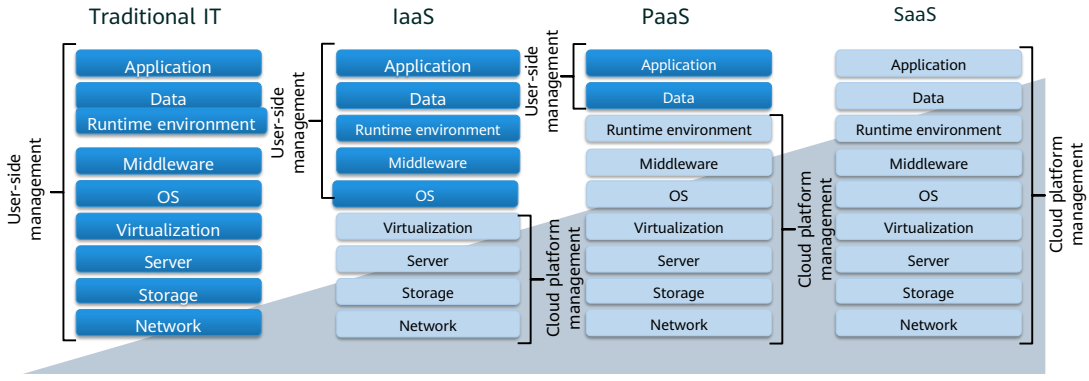
Service Models for Cloud Computing



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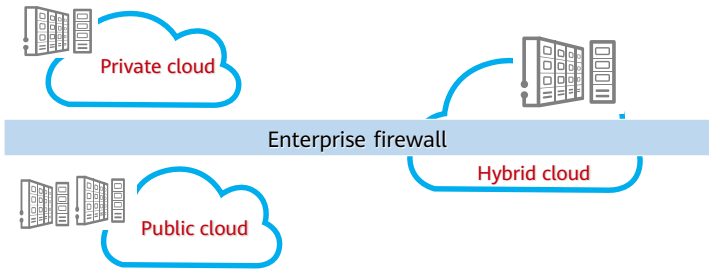
- Infrastructure as a Service (IaaS): The cloud platform provides infrastructure (such as servers, storage devices, networks, and virtual resources) and maintains related resources. Users only need focus on systems and applications.
- Platform as a Service (PaaS): The cloud platform provides infrastructure (such as servers, storage devices, networks, and virtual resources) and application deployment environment (such as the operating system, middleware, and software running environment) and maintains related resources. Users only need to focus on applications and data.
- Software as a Service (SaaS): The cloud platform provides all resources, services, and maintenance. Users only need to use applications.
- Compared with the conventional IT entire-process and all-device procurement mode, the cloud service-oriented mode provides IT devices as services that allow customers to select on demand, which has more advantages in flexibility, and low cost.

Deployment Models for Cloud Computing



Private cloud: The cloud infrastructure is owned and managed for exclusive use by a single organization.
Public cloud: The cloud infrastructure is owned and managed by a third-party cloud service provider and shared with multiple organizations using the Internet.
Hybrid cloud: This is a combination of public and private clouds viewed from the outside as a single cloud.

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- Private cloud is a cloud infrastructure operated solely for a single organization. All data of the private cloud is kept within the organization's data center. Attempts to access such data will be controlled by ingress firewalls deployed for the data center, offering maximum data protection.
- Public cloud service provider owns and operates the cloud infrastructure and provides cloud services open to the public or enterprise customers. This model gives users access to convenient, on-demand IT services, comparable to how they would access utilities like water and electricity.
- A hybrid cloud is a combination of a public cloud and a private cloud or on-premises resources, that remain distinct entities but are bound together, offering the benefits of multiple deployment models. Users can migrate workloads across these cloud environments as needed.

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AWS

Amazon Web Services (AWS) provides users with a set of cloud computing services, including scalable computing, storage, database, and applications, helping enterprises reduce IT investment and maintenance costs.

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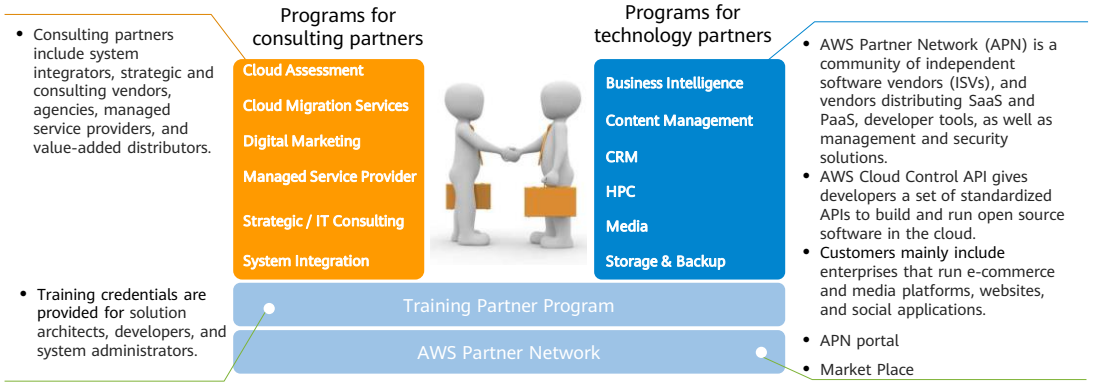
AWS provides a complete set of infrastructure and application services, enabling users to run almost all applications on the cloud, including enterprise applications, big data projects, social games, and mobile applications.

Extensive Partner Ecosystem

AWS partners can get support through a set of programs, including VMware Cloud on AWS, Distribution Program for Resellers, Managed Service Provider (MSP) Program, SaaS Factory Program, Competency Program, Public Sector Program, Marketplace Channel Programs.



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- Partner Ecosystem: AWS launched eight new partner programs for government and finance sectors.
- VMware on AWS enables partners to deploy and run VMware software on AWS.
- AWS service value:
  - Low price
  - More usage
  - Infrastructure expansion
  - Economies of scale
  - Technological innovation and ecosystem construction

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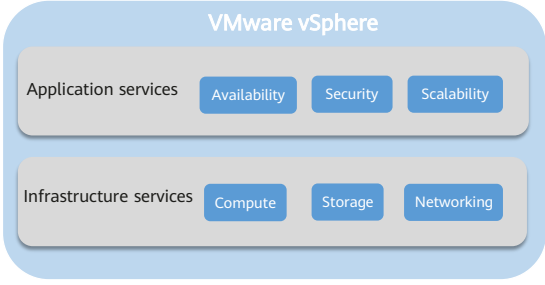
VMware

- VMware is a leading provider of multi-cloud services for all apps, enabling digital innovation through enterprise control.
- VMware vSphere helps you run, manage, connect and secure your applications in a common operating environment across its hybrid clouds and cloud native public clouds.



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- In 1998, VMware was founded. One year later, the company launched the commercial virtualization software VMware Workstation that can run smoothly on the x86 platform, marking its first step forward towards virtualization. In 2009, VMware launched VMware vSphere, the industry's first cloud operating system, and then launched the vCloud plan to build new cloud services.
- VMware delivers private, public, and hybrid cloud solutions designed for specified service requirements.
- VMware offers hybrid cloud products and services built based on the software-defined data center that brings together virtualized compute, storage, and networking.
- VMware Cloud Foundation provides integrated cloud native infrastructure, making it easy to run enterprise applications in private environment.
- For details about the VMware hybrid cloud solution, visit https://www.vmware.com/hk/cloud-solutions/hybrid-cloud.html?src=WWW_HK_HPS2_Multi-Cloud_SiteLink.

VMware

Since its inception in 1998, VMware has been dedicated to providing customers with the flexibility and diversity required for building the future through disruptive technologies such as edge computing, artificial intelligence, blockchain, machine learning, and Kubernetes.

Digital workspace

Cloud environment

Application modernization

Telco cloud

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- Application modernization: Modernize applications to accelerate digital innovation.
- Cloud environment: Build, run, manage, connect, and secure all applications on any cloud.
- Telco cloud: Build, run, manage, connect, and secure all applications on any cloud.
- Digital workspace: Enable any employees to work from anywhere, anytime with seamless employee experiences.

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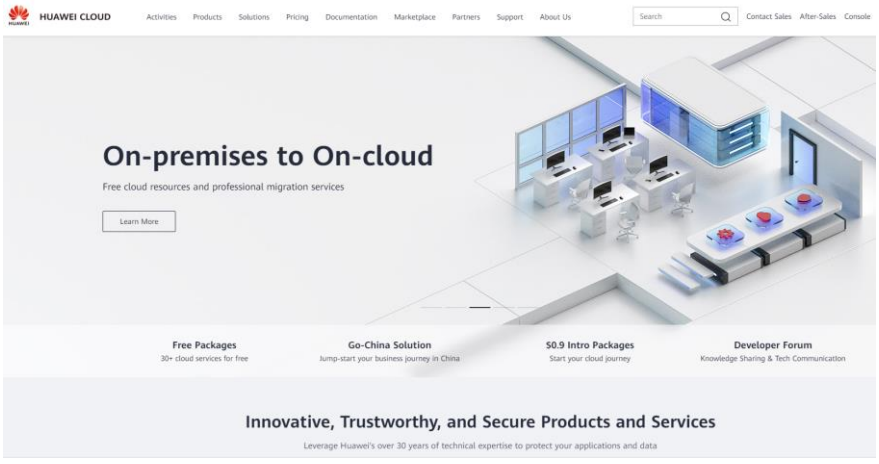
Huawei Cloud

Official website: https://www.huaweicloud.com/intl/en-us/



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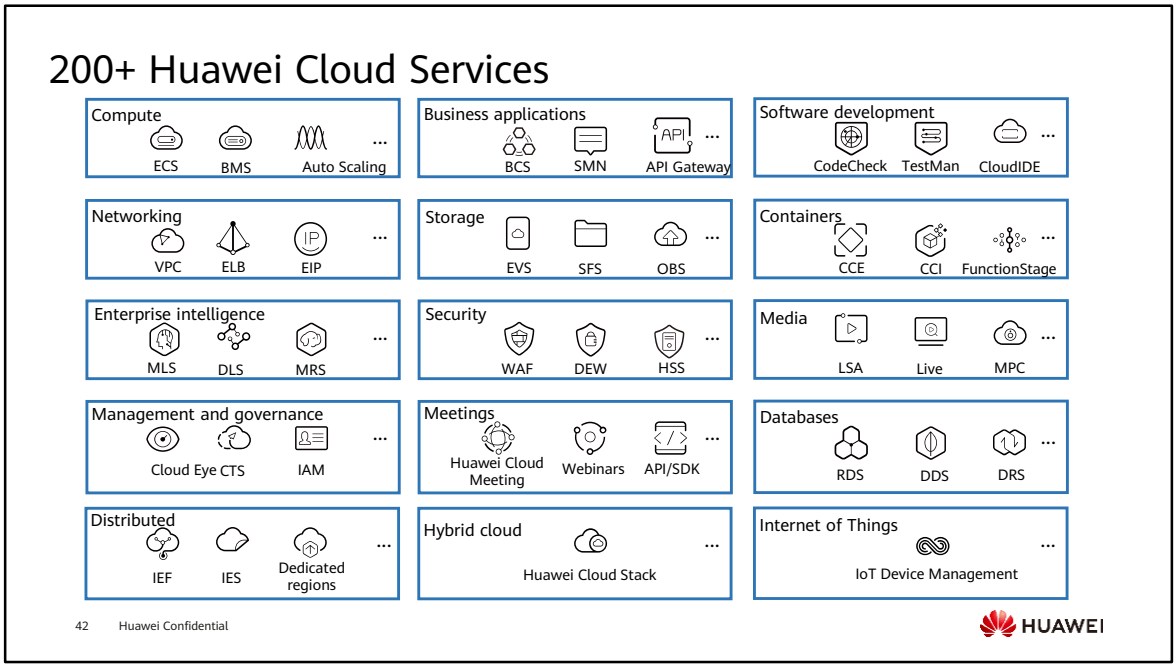
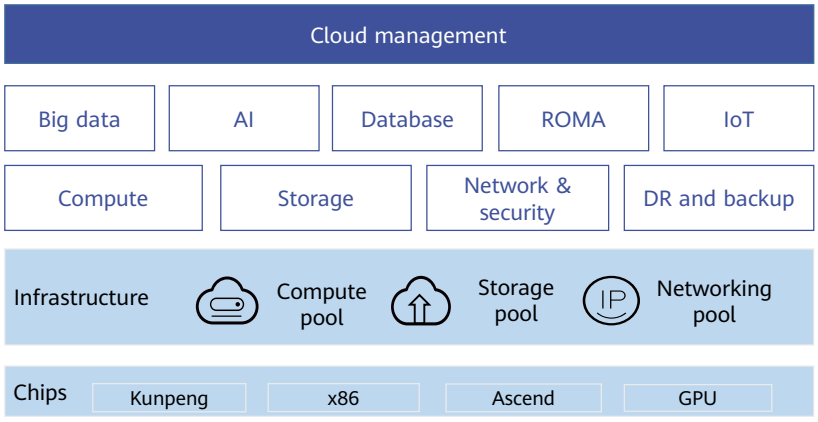
- Huawei Cloud is a public cloud service brand that leverages Huawei's more than 30 years of expertise in the ICT field to provide innovative, secure, and cost-effective cloud services.
- Huawei Cloud video: http://3ms.huawei.com/documents/docinfo/524738282517131264.



Huawei Cloud has continuously upgraded its full-stack cloud native technologies. So far, they have launched more than 220 cloud services and more than 210 solutions.

Huawei Cloud Stack

Huawei Cloud Stack is cloud infrastructure deployed at the on-premises data centers of government and enterprise customers.



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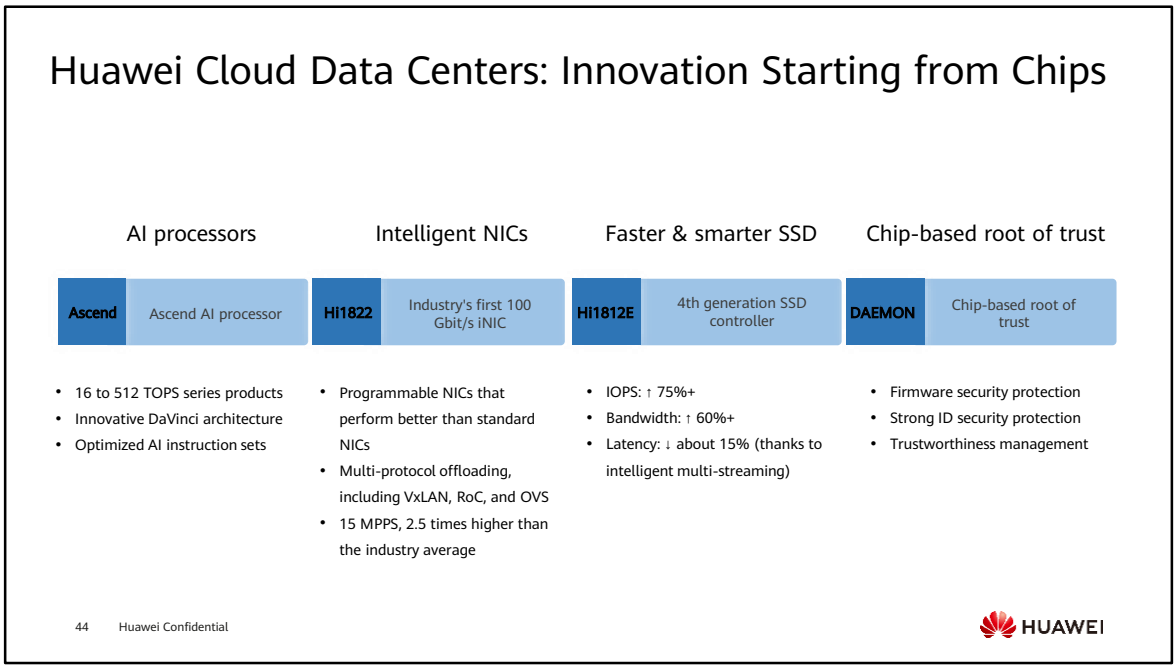
- Huawei Cloud Stack combines the advantages of private cloud and public cloud, allowing you to quickly launch innovative services like you always do on the public cloud and to manage your resources like you always do on the private cloud. Huawei Cloud Stack can adjust to your organizational structure and business processes, serving you as a single cloud.
- Huawei Cloud Stack is ideal for medium- and large-sized enterprises that require local data storage or physical isolation of devices.
- Huawei Cloud Stack can be used for cloud migration, cloud native transformation, big data analysis, AI applications, industry clouds, and city clouds.
- Advantages:
  - AI enablement, data enablement, and application enablement: on-premises deployment of public cloud services
  - Multi-level cloud management: matching the enterprise governance architecture, featuring cloud federation, multi-level architecture, and intelligent O&M
  - Cloud-edge collaboration: extending intelligence to the edge, featuring unified framework, out-of-the-box edges, and video AI/IoT access
  - Secure and reliable: leading functions and performance, featuring full-stack security, one cloud with two pools, and strong ecosystem



- Chips are the core and most difficult part of R&D in the IT industry, which requires long-term investment.
- Huawei has over 20 years of experience in chip R&D and is constantly innovating chips for the Cloud 2.0 era. We have launched a full series of chips for next-generation cloud data centers.
    - Compute chips: full series of AI processors
    - Network chips: Huawei's next-generation network chips Hi822 use the NP-like programmable architecture and support offloading of multiple protocols.
    - Storage chips: The fourth generation of storage chips improves the performance by over 75% and bandwidth by over 60%. Thanks to the intelligent multi-stream technology, the latency was decreased by about 15%.
    - Security chips: Huawei has built security and trustworthiness into chips. They provide comprehensive protection for firmware, identities, software systems, and data management.
- The three vendors provide cloud solutions featuring resource pooling, unified management, and on-demand self-service. They leverage virtualized computing, storage, and networking technologies to provide users with ultimate experience.

- In the subsequent courses, let's take a closer look at these technologies and dig deeper into the principles of cloud computing.

Quiz

1. Which of the following statements are true about challenges faced by traditional IT?
   A. Service rollout is slow.
   B. Expansion is difficult.
   C. It is not reliable enough.
   D. The TCO is too high.
2. Cloud computing deployment scenarios include public cloud, private cloud, and hybrid cloud.
   A. True
   B. False

Answers:

- ABCD
- A

Summary

- In this course, we have learned:
  - What IT is
  - IT development trend
  - Development of computing and virtualization technologies
  - What cloud computing is
  - The benefits of cloud computing
  - The service and deployment models for cloud computing
  - About technologies such as virtualization and resource pooling
  - What some of the main cloud computing vendors and technologies in the industry are
- In the subsequent courses, we will start with basic technologies to help you get a closer look at cloud computing.

Recommendations

- Huawei iLearning
  - https://e.huawei.com/en/talent/portal/#/
- Huawei Support Knowledge Base
  - https://support.huawei.com/enterprise/en/knowledge?lang=en

Acronyms and Abbreviations

- APV: Advanced Power Virtualization
- IaaS: Infrastructure as a Service
- KVM: Kernel-based Virtual Machine
- LPAR: Logical Partition
- PaaS: Platform as a Service
- SaaS: Software as a Service

Thank you.

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每个组织，构建万物互联的智能世界。

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