03 ICT Architecture

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Foreword

- This module introduces the technologies and components related to data storage in the ICT infrastructure. The main goal of enterprises is to provide services to customers, and data provides the support required for enterprises to achieve this goal.
- In this module, we shall first try to understand why enterprises need data, and then learn how these data are generated and stored.

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Objectives

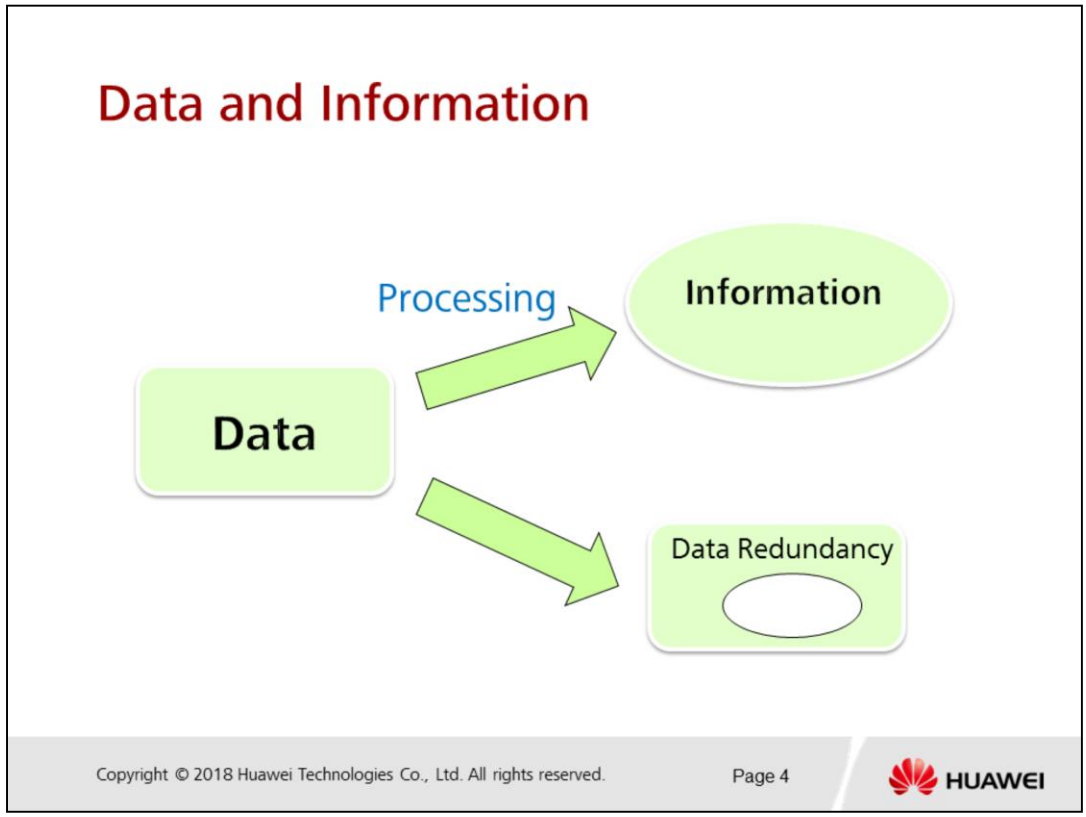
- Upon completion of this module, you will be able to:
  - Describe the differences between data and information.
  - Understand what is information lifecycle management.
  - Understand the definition of ICT, its architecture and knowledge of its components.

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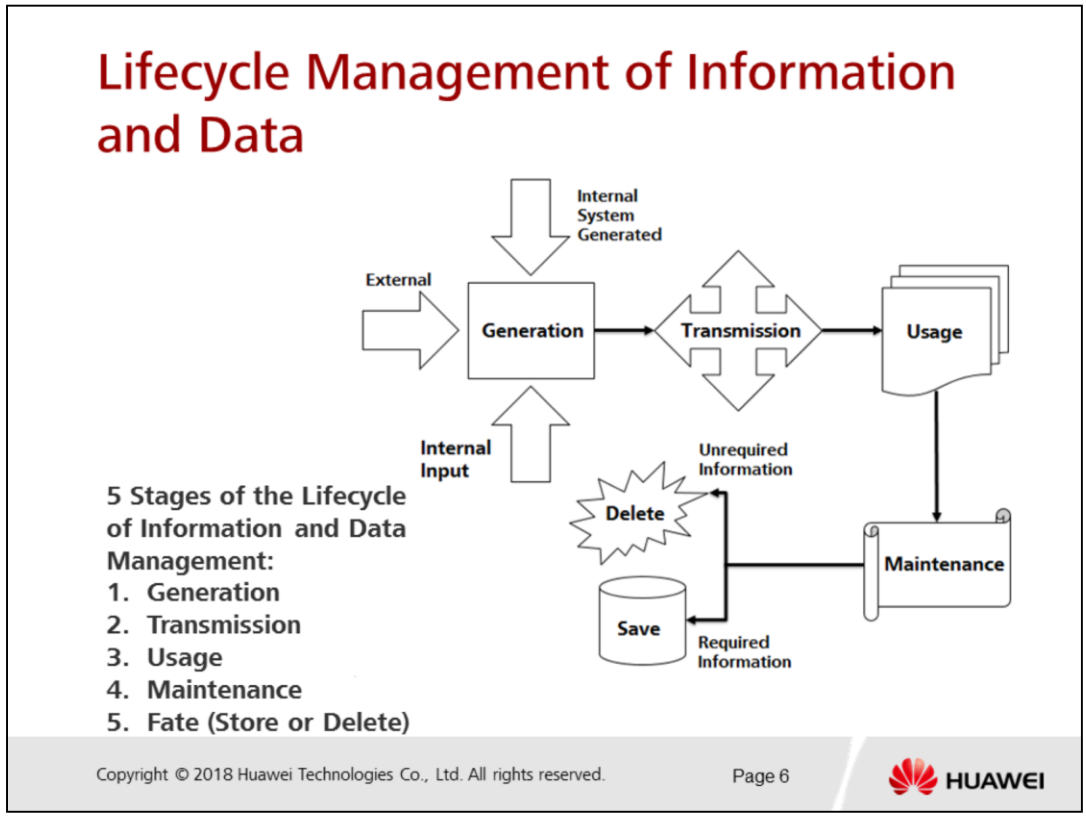
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- Data and information are interrelated. Data is the record that reflects the attributes of objective things and is the physical manifestation of information. Data becomes information after it has undergone processing, and information needs to be digitized into data before it can be stored or transmitted.
- So, does this mean that data refers to information that can be stored and transmitted? Not necessarily! Data and information has their differences. For the perspective of information theory, data that describes the source of information is the sum of the information and data redundancy, namely Data= Information + Data Redundancy.
- There is a subtle difference between data and information. Data are the facts or details from which information is derived. Individual pieces of data are rarely useful alone. For data to become information, data needs to be put into context. Data are simply facts or figures or bits of information, but not the information itself. When data are processed, interpreted, organized, structured or presented so as to make them meaningful or useful, they are called information. Information provides context for data.
- Data is obtained during the data collection process, information is the meaningful context that is derived from the collected data. For an example, a list of dates which is the data is meaningless without a context such as list of holiday dates which makes it into an information that you could understand.

- Hence, information can be understand simply as useful content that is obtained from data. Not strictly speaking, anything that you didn't know before, but you have known it now, is the information that you have obtained.
- SNIA (Storage Networking Industrial Association) defined data as: "The digital representation of anything in any form.". This definition may seem abstract, but when you look at the operations of today's enterprises, you find that an enterprise generates a lot of data every day. All of this data is used to maintain business operations and profitability.
- Data management consist of:
    - Enterprises uses or generates large amount of data for its business operations.
    - Based on requirements, data needs to be stored for a long period of time.
    - When data is no longer in use, it can or must be deleted.
- Information is processed data that is used to satisfy the needs of user decision making process. Information is derived from the collected data.
- Information can:
    - Provide information on the market and customer behaviors to enterprises.
    - Helps enterprises to manage their operations more efficiently.
    - Helps enterprises to identify certain risk factors.

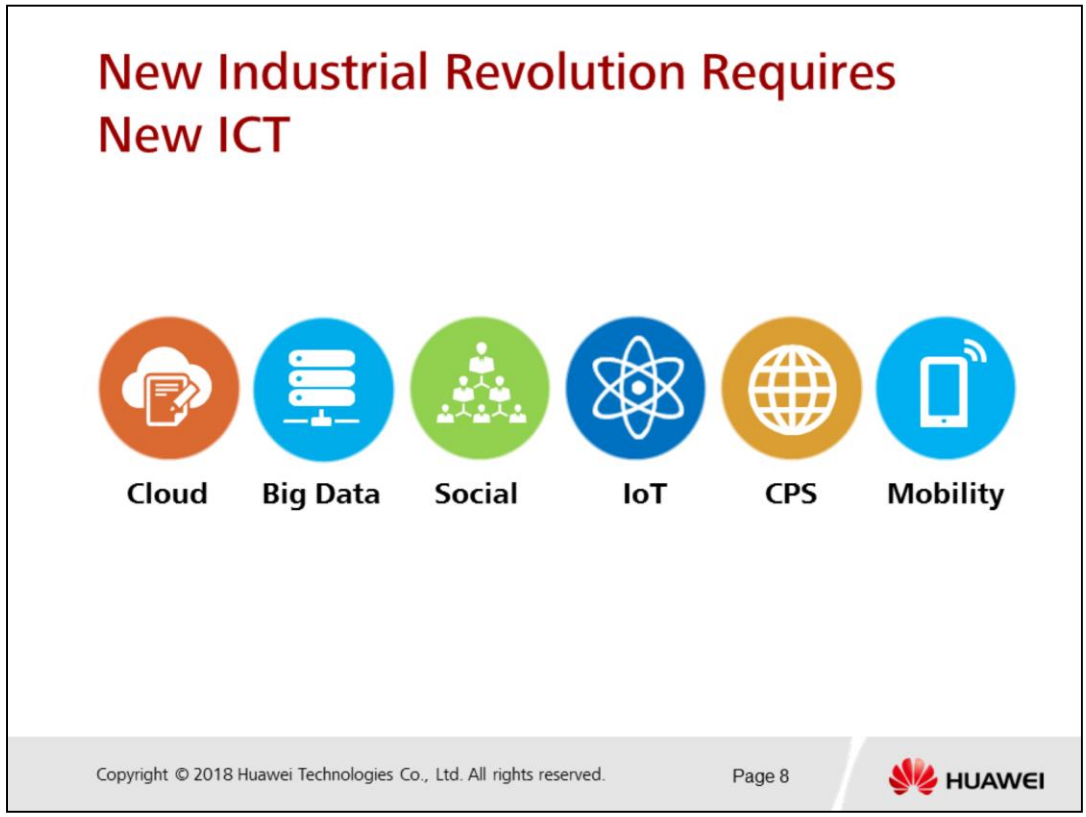


- Information lifecycle refers to the lifecycle where data and information is generated, used, undergone maintenance, saved and until it is finally deleted.
- In another meaning: Information lifecycle refers to the six stages of information collection, storage, processing, maintenance, usage and deletion.
- The information generation phase refers to the origin of information from scratch. Information can be created by one or more person within the organization, it can also be accepted from external sources or even generated by the systems that exists internally within the organization. For example, variety of business files and mails, input and output of computer systems, various reports, charts and statistics created by the staffs.
- Transmission phase refers to the stage where once the data is generated, it is transmitted in a certain way that reach the end user either internally within the organization or externally.
- The usage phase refers to the analysis of the data once it reach the end users to help in the commercial, political and ethical decision making.
- The maintenance phase refers to the management of the data, which includes storing, reading, transmit, copying and backup of those data.
- The fate phase refers to the final handling of the data that has already been used. This might be storing of those data such as in the scenario of legal compliance where data needs to be stored and archived for a certain point of time. This might also mean deletion of those data after it has been used and no longer required. For example, data such as personal emails after being read can be either stored or deleted. In fact, period of data storage also depends on the value of the information such as legal value, historical value, emotional value, commercial value, military value and political value. The higher the value of the information often leads to longer storage period.

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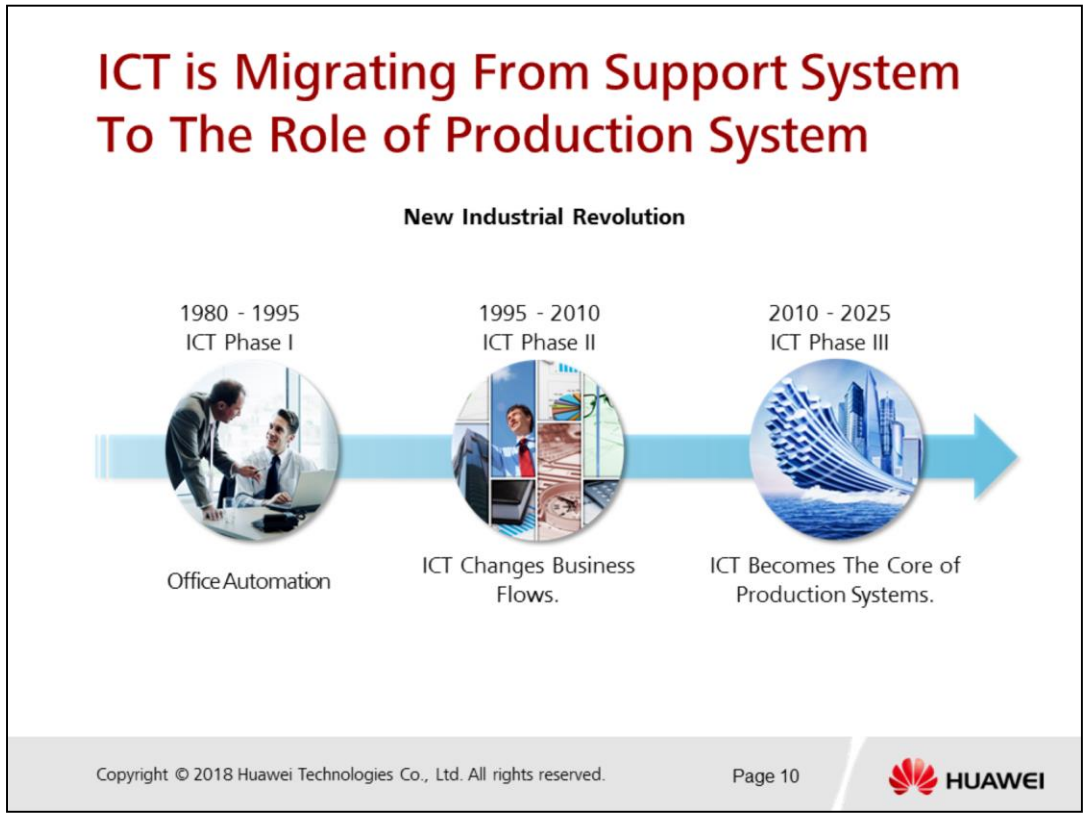
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- Internet of Things (IoT): It is the interconnection via the Internet of computing devices embedded in everyday objects, which enables them to send and receive data. The internet of things (IoT) is also a computing concept that describes the idea of everyday physical objects being connected to the internet and being able to identify themselves to other devices, and exchange data between them.
- Cloud refers to the addition, usage and delivery model of related internet-based services that typically involves the provision of dynamically scalable and often virtualized resources over the Internet. According to the official NIST definition, "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
- Big Data refers to the collection of data that cannot be retrieved, managed and processed by conventional software and tools within a certain period of time. Amount of these data are too big for conventional software and tools to process within a short period of time that makes it useful. Big Data refers to technologies that are able to quickly obtain valuable information from a variety of data types. Among the technologies that are used in Big Data includes MPP(Massively Parallel Processing), data mining grids, distributed file systems, cloud computing platforms, Internet of Things(IoT), and scalable storage systems.

- Social media refers to the virtual communities or web platform where users can create, share and interact with each other. Social media can manifest in different forms such as text, images, sound and videos. Popular social media platforms includes blog, podcast, Wikipedia, Facebook, Twitter, Google+ and web forums.
- CPS (Cyber Physical System), is the essence of IoT. It represents the reflection and mapping relationship between the virtual and the physical world. CPS consists of environmental sensors, embedded computing, network communication, and web control elements, which allows CPS to have computing, communication, precise control, remote collaboration and self healing features. It focuses on the close combination and coordination of computing resources and physical resources, and are mainly used in intelligent systems such as robots, navigation systems etc. Currently, CPS is still relatively a new area of research.
- Mobility refers to the mobile devices and the network that connects all these devices together. With the growth of more and more mobile devices, it has created a large ecosystem of mobile devices and mobile users. This represents various opportunities for enterprises to tap into the potential of data and businesses in this sector.



- The above diagram shows the transition of the role of ICT during the new Industrial Revolution. In the first phase back in the 1980s to 1995, the role of ICT was more focused towards office automation and increasing productivity in the office. In the second phase, which is in the period of 1995 to 2010, ICT has gained importance in the daily operation of the businesses that it gradually changed the flow of businesses. It helped the transformation of traditional business to a much modern way of business operations with the application of ICT. Finally, at the third phase between 2010 to present and up to short period of future, ICT has become and will still be the core of production systems in enterprises. ICT has enabled many possibilities for increasing and managing the production process in terms of efficiency and speed, making ICT the core of modern day businesses.

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What is ICT ?

- ICT is the abbreviation of Information, Communication and Technology. It is a new concept and technological area formed from the combination of communication technology and information technology.

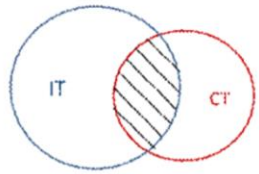


Figure 1: Narrow Definition Theory: ICT is the intersection of IT and CT (ICT=IT∩CT).

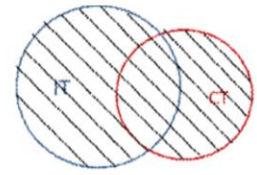


Figure 2: Combination Theory: ICT is the union or combination of IT and CT (ICT=IT∪CT).

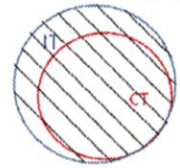


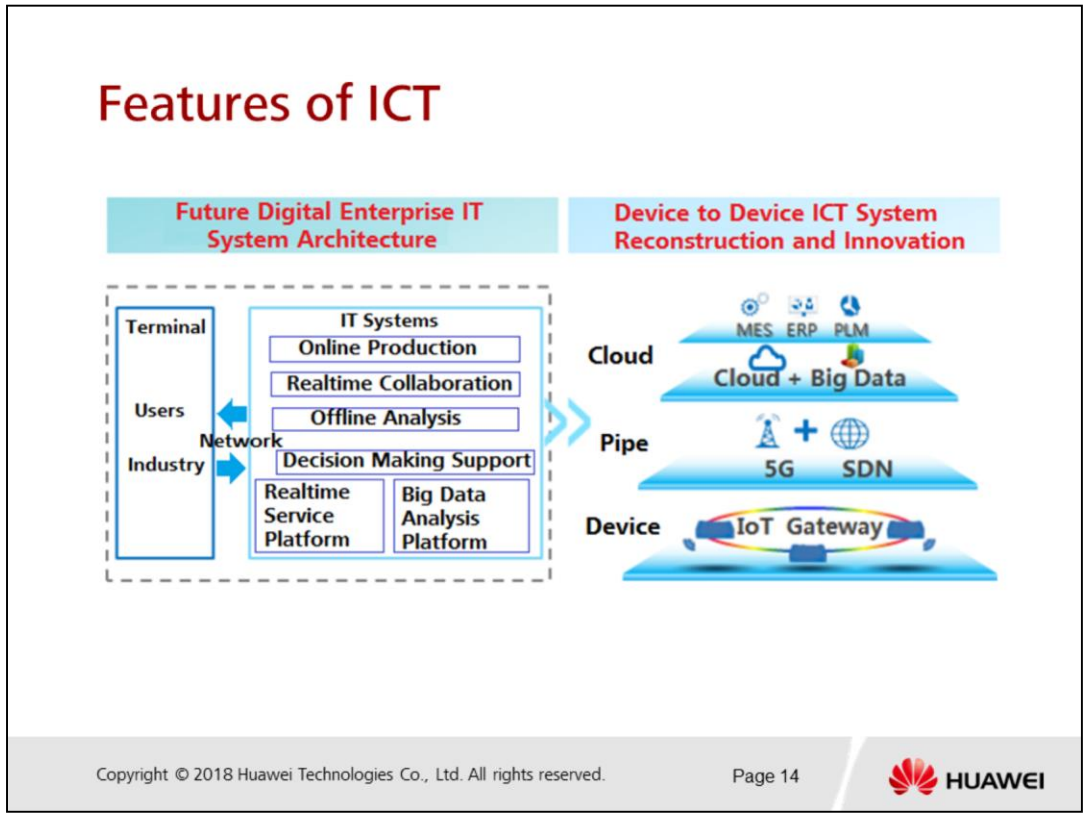
Figure 3: General IT Theory: CT is a part of the wider definition of IT(CT⊆IT,ICT=IT∪CT=IT).

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- In order to have a better understanding of ICT, we must first look into the meaning of ICT(including all the nature-specific attributes of the concepts and thought models). Let us first define the concepts of IT and CT before we look into the definition of ICT.
- IT (Information Technology), refers to technologies that are related to information. (Huawei 3ms: mainly uses computer science and communication technology to design, develop, install and implement information systems and application systems.) There is varying explanation and definition of information technology based on different people and different books. But one viewpoint in common is that IT has 3 major components which is: sensor technology, communication technology and computing technology.
- CT(Communication Technology), refers to technologies that enables information exchange and information transmission through some kind of behavior or media between human and humans or between humans and nature. Communication technology's main purpose is to serve information, and its main goal is to transmit and exchange variety of information in a high speed, high quality, accurate, timely, secure and reliable manner.
- From the connotation of the concepts mentioned above, we can clearly see that IT technologies consist of basic information collection, information processing, information transmission(communication), and information application. The purpose of communication technologies is also to serve IT.

- Lets look further into the extension of the ICT concept:
- From a narrow definition point of view, ICT is the intersection of IT and CT which is ($ICT=IT \cap CT$) as shown in Figure 1. This definition is close to the definition of ICT by Baidu.
- From a wide definition point of view, ICT is the union or combination of IT and CT which is ($ICT=IT \cup CT$) as shown in Figure 2. This definition is close to the definition of ICT by Huawei.
- On the other hand, a lot of people think that CT belongs as a part of IT, which means that CT is a subset of IT, and ICT is just part of a wider definition of IT which is ($CT \subseteq IT, ICT=IT \cup CT=IT$) as shown in Figure 3.
- Baidu's definition of ICT: ICT refers to the prefix combination of the 3 words Information, Communication and Technology. It is a new concept and a new technological field formed by the combination of Information Technology and Communication Technology.
- Huawei's definition of ICT: ICT is the integration of IT and CT, which is the integration of information transmission technology, information encoding and decoding, transmission media and transmission methods.
- Although it looks the same at the surface, but the keyword and meaning of these two definitions are quite different. Baidu defines ICT as a new field, while Huawei defines it as an integration which refers to a trend.

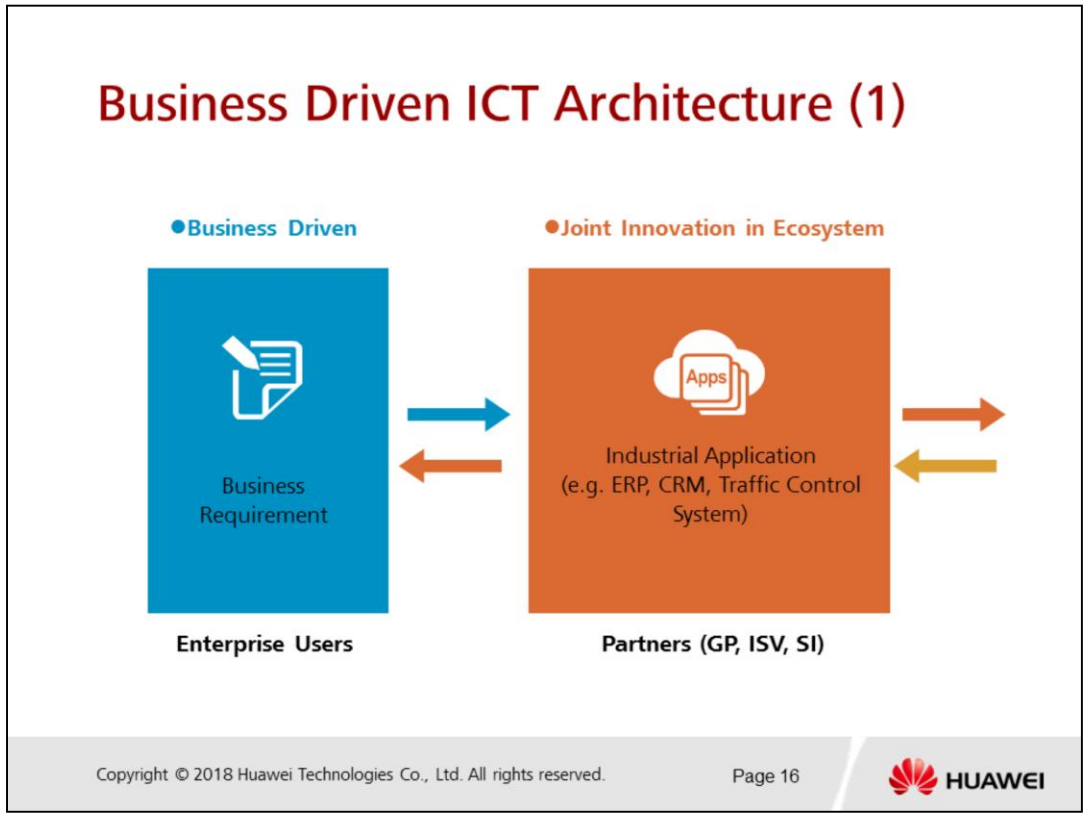


- One of the features of ICT is that it is cross domain and convergence. ICT uses CT as the basic infrastructure and presents the services provided by IT in a direct and relatable content to the customers such as remote learning, remote healthcare, IoT, Internet of Vehicles, and remote maintenance of elevator industries etc.
- Production systems of customers in the industry are deeply converging with ICT, Cloud, IoT technologies that are compatible with their industrial applications.
- The application of ICT has been the fundamental of business thinking, it focuses on the customers as the core of the business, bringing together new customer experiences in ways that was never possible before to help rebuild industries in education, logistics, and banking.
- ICT enterprises not only just focus on their own resources, business models, competitive advantage, but also focus on their positioning in the business ecosystem and their relationship with partners to complement each other in terms of resources, cross border innovation, and mutual development.
- ICT industry in a new industry that has continuous integration of technologies, which has become a catalyst and enabler for the transformation of businesses and industries.

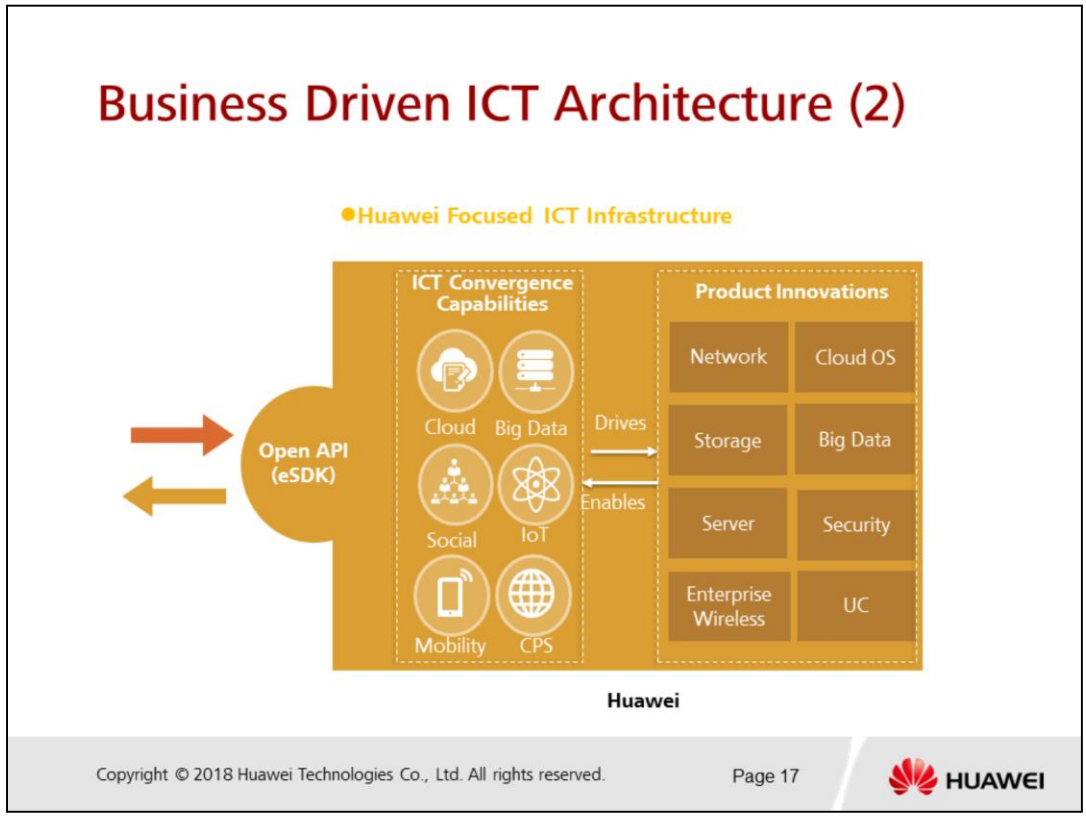
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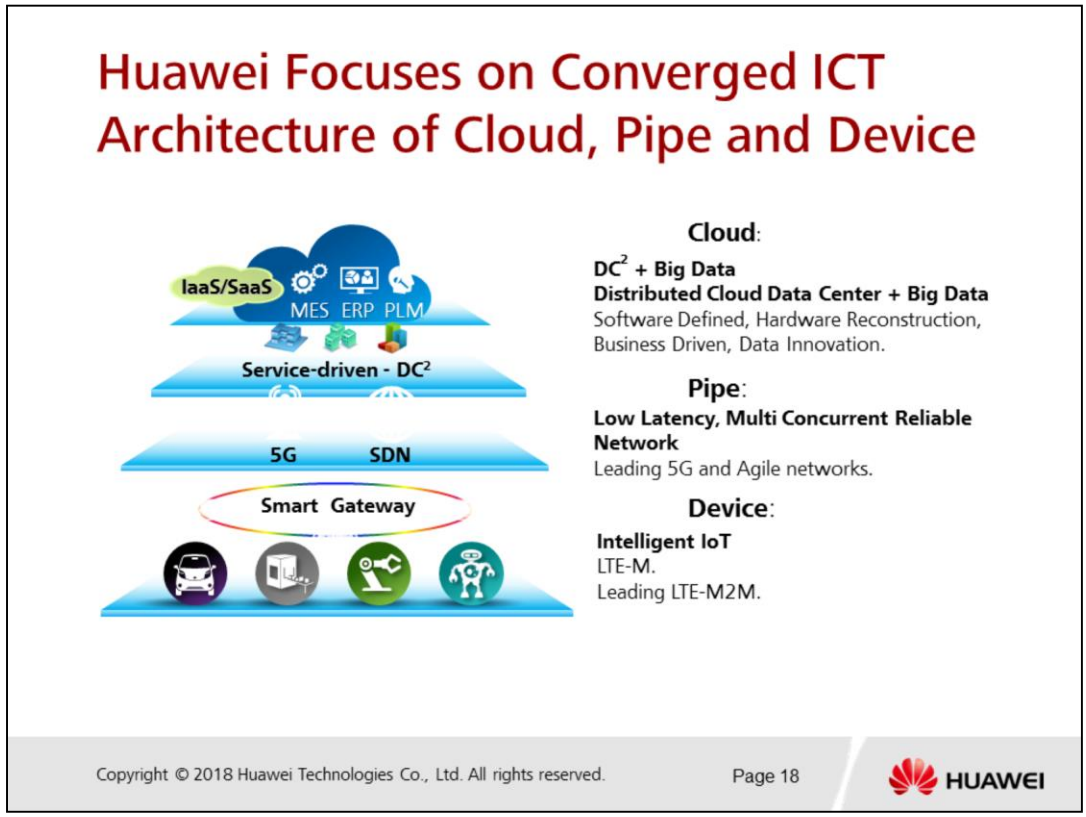
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- BDII： Business-Driven ICT Infrastructure, which is an ICT infrastructure that is driven by the business demands and requirements.
- ERP： Enterprise Resource Planning, which was originally proposed by Gartner Group Inc. in the United States in 1990 that was first defined as an application software but quickly accepted by commercial enterprises around the world and has now become one of the modern theories of business management.
- CRM： Customer Relationship Management refers to technologies that enterprises use to manage and analyze customer interactions and data throughout the customer lifecycle, with the goal of improving customer service relationships and assisting in customer retention and driving sales growth.
- GP： Global Partner refers to global business partners.
- ISV： Independent Software Vendors is an individual or business that builds, develops and sells consumer or enterprise software.
- SI： Service Integrators or System Integrators is an individual or business that builds computing systems for clients by combining hardware, software, networking and storage products from multiple vendors.



- Unified communications (UC) is a framework for integrating various asynchronous and real-time communication tools, with the goal of enhancing business communication, collaboration and productivity. Unified communications does not represent a singular technology; rather, it describes an interconnected system of enterprise communication devices and applications.
- Application program interface (API) is a set of routines, protocols, and tools for building software applications. Basically, an API specifies how software components should interact.
- Software Development Kit (SDK) is a programming package that enables a programmer to develop applications for a specific platform. Typically an SDK includes one or more APIs, programming tools, and documentation.



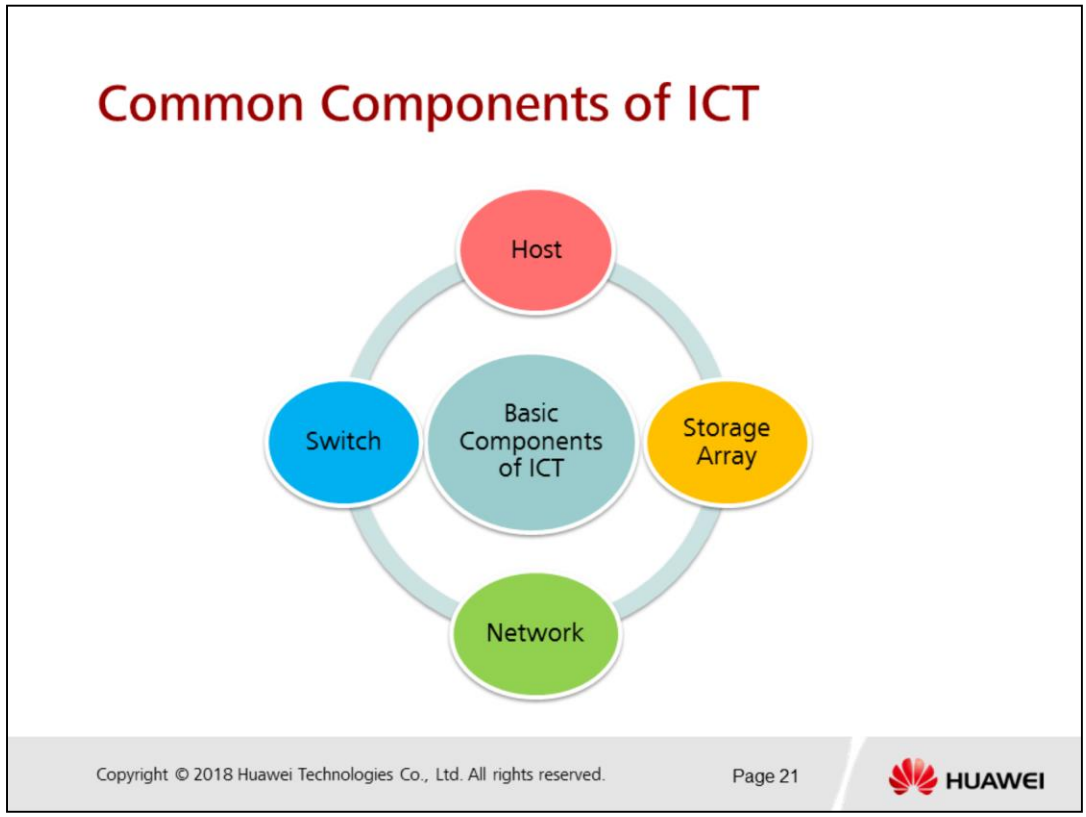
- LTE-M (LTE for Machines), is a IoT technology that evolved from LTE. LTE-M is the abbreviation for LTE Cat-M1 or Long Term Evolution (4G) Category M1. This technology is for Internet of Things devices to connect directly to a 4G network, without a gateway and on batteries. LTE is the generic term for all of 4G.
- LTE-M2M (LTE Machine-to-Machine) refers to the IoT technology where IoT devices are connected and able to communicate from one machine to another machine using LTE network.
- SDN (Software Defined Network) is a concept of network design, or a revolutionary design thought. A network can be considered as SDN if the network devices can be centrally managed, programmable, and with control plane and data plane separation. SDN is not a physical technology or protocol, but it is more of a thought model and framework. The concept of software defined network also gave birth to other software defined technologies such as software defined security and software defined storage etc. In fact, SDN and software defined technologies are a trend that swept across the IT industry.

- MES (Manufacturing Execution System) is a production information management system for manufacturing oriented enterprises. It is a computerized system used in manufacturing, to track and document the transformation of raw materials to finished goods. MES provides information that helps manufacturing decision makers understand how current conditions on the plant floor can be optimized to improve production output. MES works in real time to enable the control of multiple elements of the production process (e.g. inputs, personnel, machines and support services).
- PLM (Product Lifecycle Management), is the process of managing the entire lifecycle of a product from inception, through engineering design and manufacturing, to service and disposal of manufactured products. PLM integrates people, data, processes and business systems and provides a product information backbone for companies and their extended enterprises.

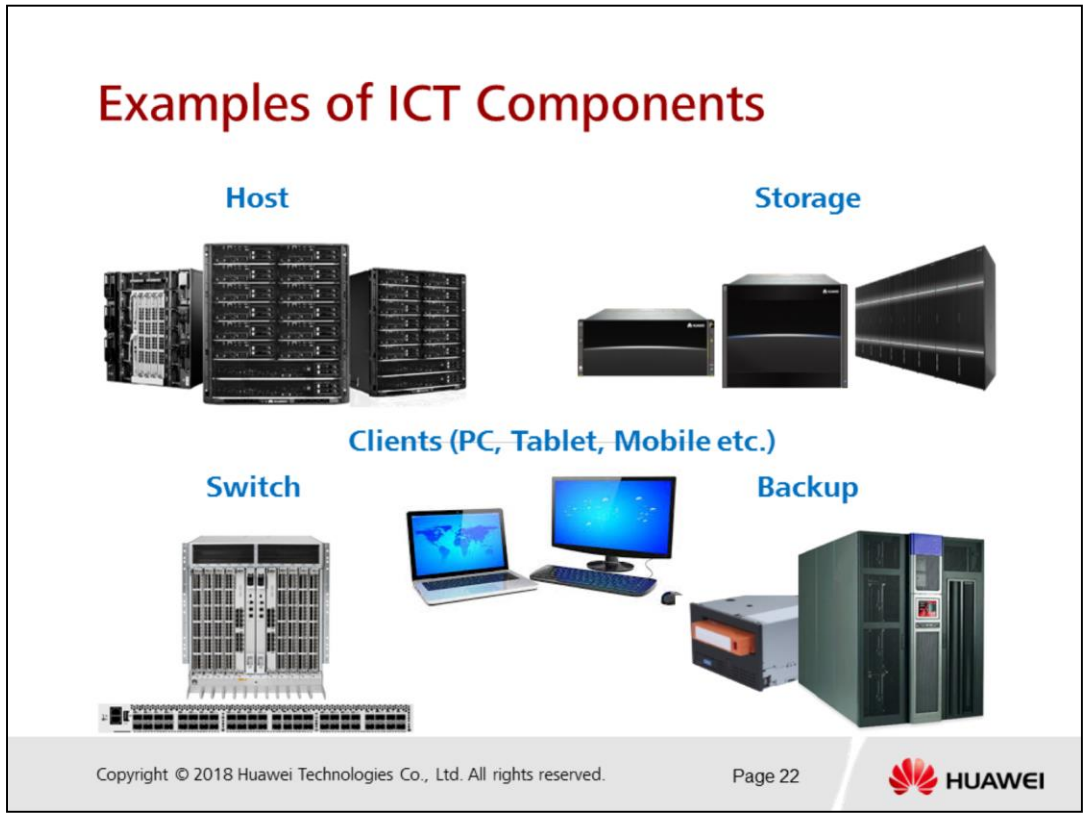
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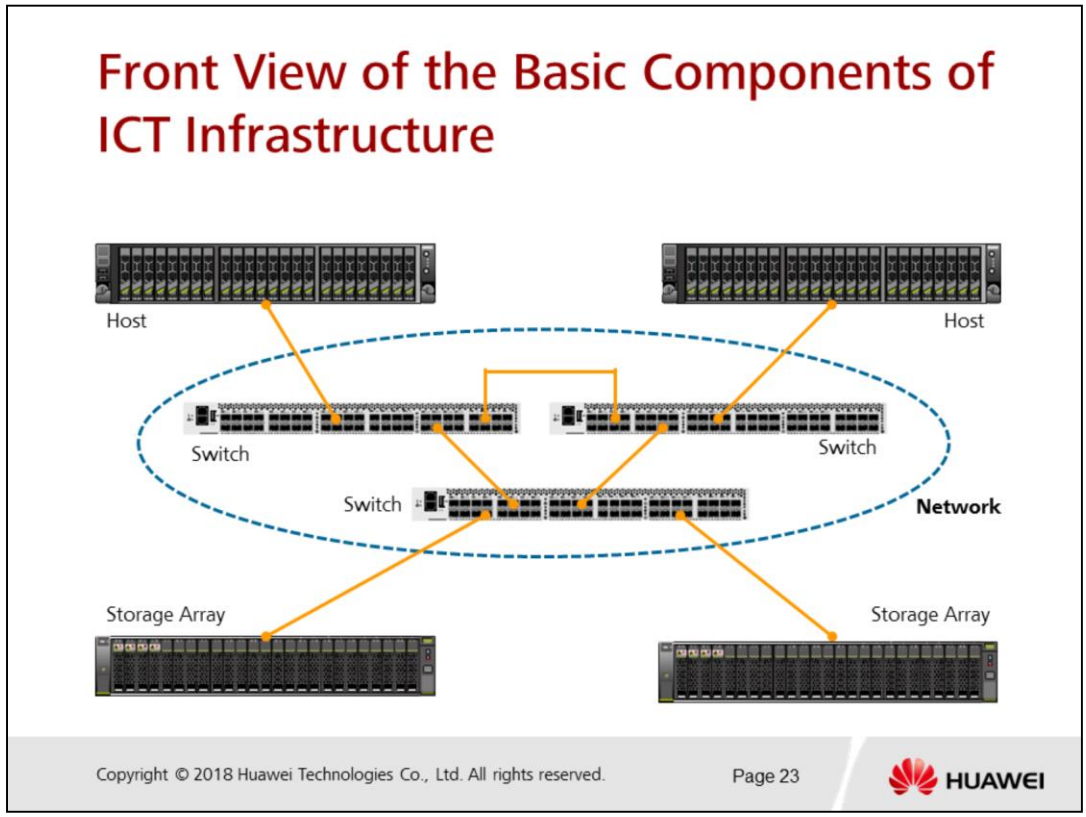
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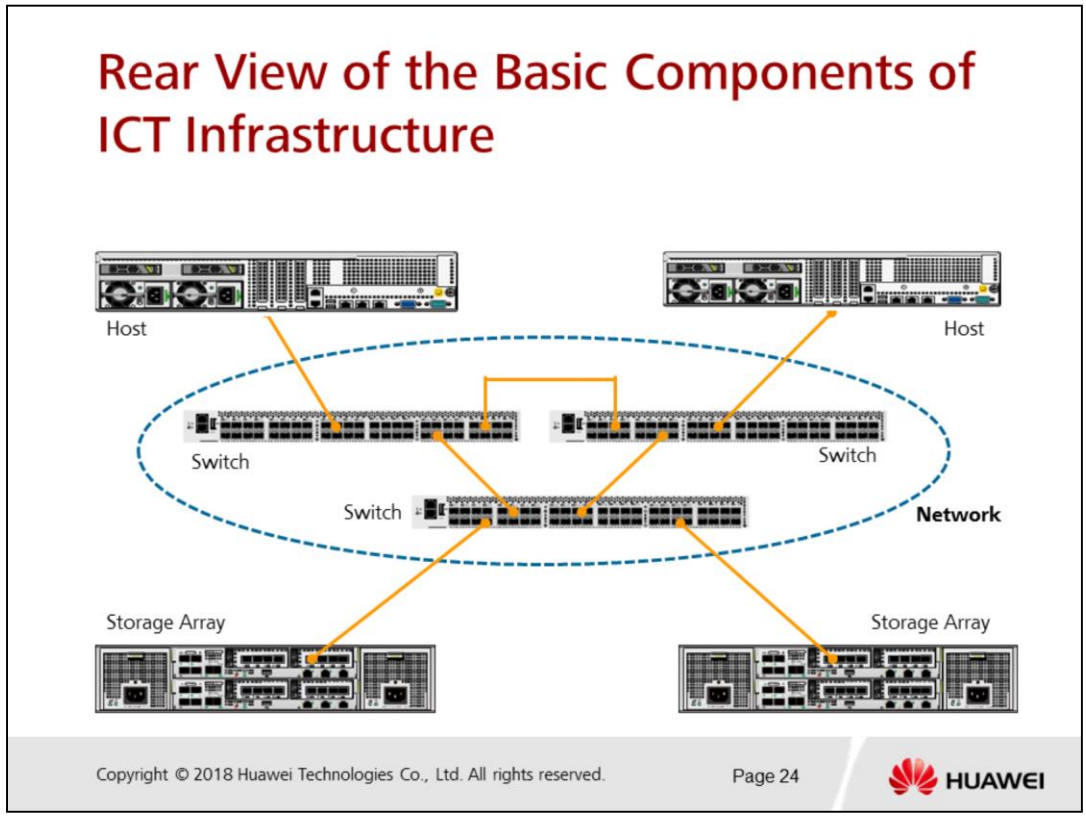
- The following are the common terminologies used in ICT infrastructure:
- Host: A computing system consisting of hard drives or file system that can provide data access and storage. Hosts typically do not include intermediary network devices like switches and routers, which are instead often categorized as nodes.
- Storage Array: A system that has the management software that can provide access to its sets of hard drives or tape libraries for the purpose of data access and storage. It is a hardware element that contains a large group of hard disk drives (HDDs). It may contain several disk drive trays and has an architecture which improves speed and increases data protection. The system is run via a storage controller, which coordinates activity within the unit.
- Network: It provides connection between sets of nodes and allows the connected devices(nodes) to communicate with each other.
- Switch: A network device used to switching network signals or data. It can provide a dedicated communication channel between any 2 nodes in the network that is connected to the switch. It is a networking device that connects devices together on a computer network by using packet switching to receive, process, and forward data to the destination device.



- The term host (sometimes also called servers) are commonly used to describe the computing device that has high specification within an enterprise, these devices usually have the important enterprise software installed within them, and are responsible for running important services. Desktop and laptops are simpler version of hosts. Hosts are commonly required to run 24x7 for many years before they reach their end of life(EOL) and replaced.
- Storage arrays commonly refers to the devices that handles data storage. Some of the storage arrays are quite small just like the size of a host, but some are much bigger and can be configured with thousands of hard drives.
- Switches are the network devices used for network interconnection between the devices in the network. Switches have many ports, and devices connects to each other by connecting through cables to these ports. The devices mentioned here can be hosts, storage arrays or even other switches.



- The diagram above shows the front view of the common components of ICT such as hosts, switches and storage arrays connected to each other within the network.

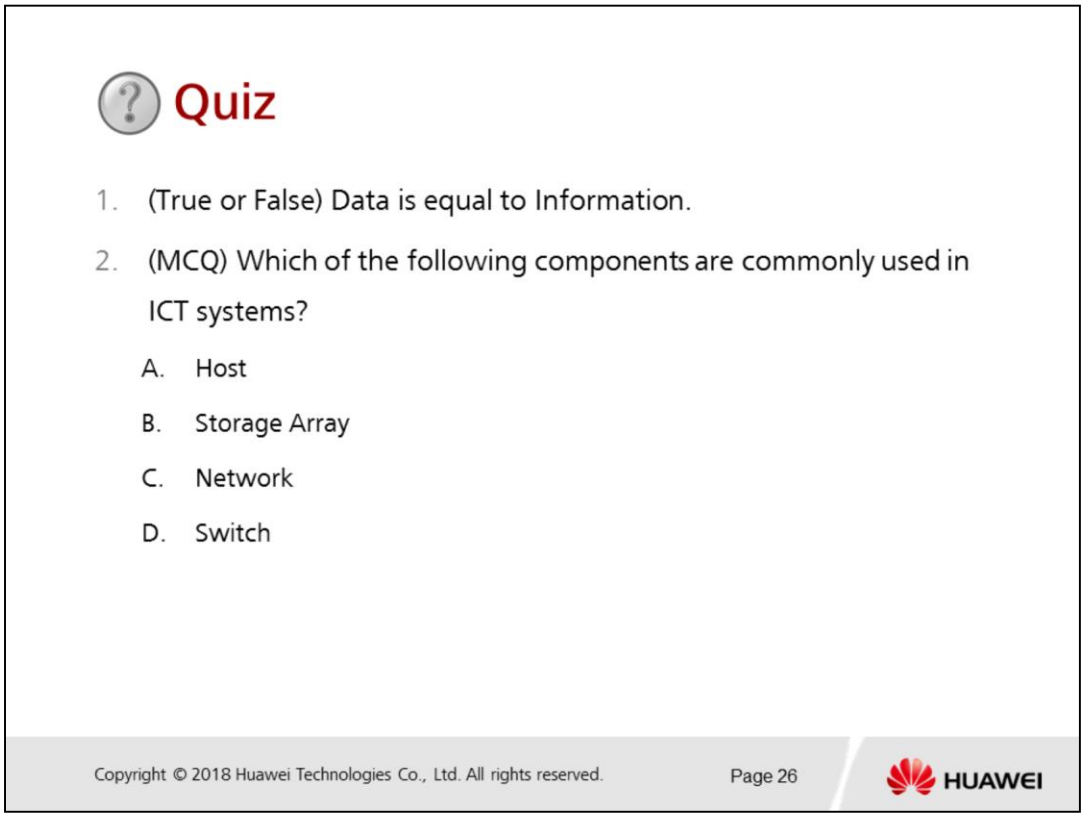


- The diagram above shows the rear view of the common components of ICT such as hosts, switches and storage arrays connected to each other within the network.

Summary

- This module introduced:
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- Answers:
  - F.
  - ABCD.

Thank You

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