5 System Configurations

Chapter Objectives

The objective of this chapter is to learn about the classification of the information processing systems, which have largely permeated the daily life of the current society. Likewise, the system evaluation method will also be studied.

① Understand system characteristics based on the configuration, processing modes, using modes and other viewpoints.
② Understand meanings and calculation methods regarding the evaluation method of system performance.
③ Understand the meaning of the terminology related to system reliability as well as the reliability calculation methods.

5.1 System classification and configurations

5.1.1 System classification

Basically, "information processing system" refers to the diverse systems composed of hardware, communication equipment and software.

① Classification based on the difference in using modes

- Batch processing system
  - Center batch processing system
  - Remote batch processing system
- Online transaction processing system
- Real-time control processing system

② Classification based on the difference in processing modes

- Centralized data processing system
  - Batch processing system
  - Centralized online transaction processing system
- Distributed processing system
  - Computer network system (LAN, WAN)
  - Client/server system
  - Peer-to-peer system

③ Classification based on the difference in operating modes

- Non-interactive processing system (Batch processing system, etc.)
- Interactive processing system

④ Classification based on the difference in system configurations

- Reliability
  - Simplex system
  - Dual system
  - Duplex system
    - Cold standby
    - Hot standby
- Process efficiency
  - Multiprocessor system
    - Loosely coupled multiprocessor system
    - Tightly coupled multiprocessor system
  - Tandem multiprocessor system

5.1.2 Client/server system

The client/server system is the most representative system among the distributed processing systems. Computers scattered across the network are divided into clients and servers, and their respective roles are distributed as follows:

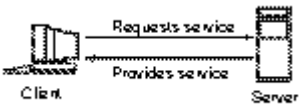
① Client

The client is the computer that receives a service from other computer (server). This term indicates terminal devices, workstations, and other devices.

② Server

The server is the computer that provides a service to other computer (client). This term indicates host computers, workstations and other devices.

Figure 5-1-1
Client/server model



(1) Characteristics of the client/server system

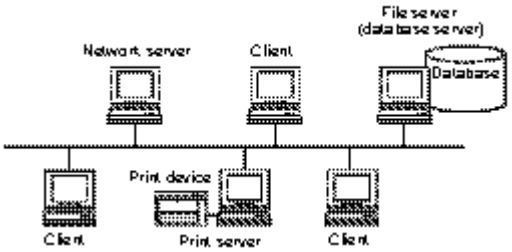
Among the strong points of the client/server system, the following can be mentioned:

- Since, in a great number of cases, interfaces have been standardized, systems can be made open. Therefore, the most suitable hardware or software can be selected without having to stick to a single manufacturer or vendor.
- The expansion of system functions and performance, as well as capacity, etc., is easy.
- System reliability regarding failures can be improved.
- By adopting a client machine with high processing efficiency, application programs using GUI (Graphical User Interface), which has good operability, can be developed.

On the other hand, among the weak points of the client/server system, the following can be mentioned:

- Due to distributed processing, several functions become redundant and system performance declines.
- The system manager is required to have a wide range of knowledge regarding hardware, software and networks of different manufacturers and vendors.
- System development methodologies have not been established.

Figure 5-1-2
Client/server system



(2) Platform functions

A platform is the hardware and software that serve as the base for the operation of a system. Regarding the functions of the platform of the client/server system, the following two can be mentioned:

- Data access function: Function that enables data exchange between computers.
- Program processing function: Function that enables processing request between computers.

These functions are implemented by the protocols and systems mentioned below.

① FTP (File Transfer Protocol)

FTP is the protocol used for the transmission and reference of files between computers connected to a network. Even if the operating systems of the computers differ, file transmission or reference can be performed oblivious to it.

② NFS (Network File System)

NFS is a network file system that enables the free use of files contained in other computers in the network.

③ RPC (Remote Procedure Call)

RPC sets an environment that enables the client's free use of various functions held by the server.

(3) Server types

The following are the main servers that provide service at the client's request:

① Print server

The print server temporarily stores the print data requested by the client and directs the printer to print.

② File server

The file server specializes in file input and output in order to share files and control them in a standard way.

③ Database server

The database server is a server that specializes in database management and is equipped with functions to search large capacity databases at high speed.

④ User interface server

The user interface server sends the commands that allow the user to direct processing to other servers using GUI.

⑤ Communication server

The communication server is the server that uses the network to communicate with another computer. It is equipped with interfaces supporting diverse networks such as LAN, WAN, and ISDN lines.

(4) Client server system application

① Three-tier architecture

Three-tier architecture is the architecture that divides the client/server system into the following three functional modules:

a. Data tier

In the data tier, the database is accessed and the needed data is referenced.

b. Function tier

In the function tier, message or data processing is performed.

c. Presentation tier

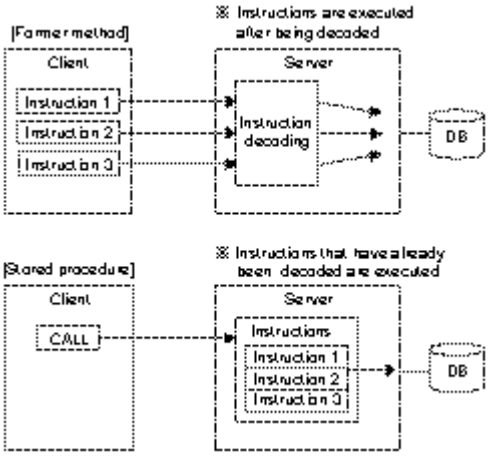
In the presentation tier, the user interface to exchange data with the users is implemented.

In the previous two-tier architecture, only database access was performed on the server side, and all of the remaining functions were performed on the client side. However, since in the three-tier architecture the server side is in charge of the functions of the data tier as well as the function tier, the volume of data transmitted between the client and the server can be reduced, lightening the transmission load. Likewise, since each function can be developed independently, it is also advantageous in the aspect of development efficiency. Currently, n-tier architecture, in which the functions are further subdivided, has also been implemented.

② Stored procedure

The stored procedure is one of the techniques to speed up the client/server system, and is a method that consists of storing in the server the instructions that are frequently used by the client (SQL statements, etc.). Since the client can execute the instructions stored in the server by just calling them, the volume of transmission data and transmission frequency can be reduced. Likewise, by translating beforehand the instructions stored on the server side into an executable format, execution efficiency can be further improved.

Figure 5-1-3
Stored procedure



5.1.3 System configurations

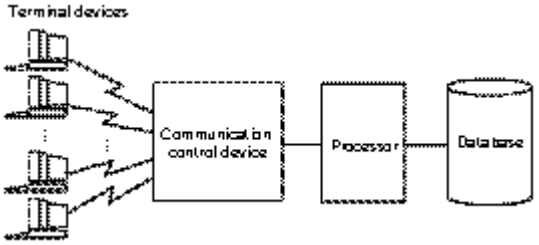
Information processing systems can also be classified according to the configurations of the main devices composing a system. Here, the explanation will be focused on the system configuration of online transaction processing systems.

(1) Systems that emphasize reliability

① Simplex system

The simplex system, which has a configuration that forms the nucleus of online transaction processing systems, operates without spare hardware. The cost to construct this system is low, but if one device breaks down, the whole system goes down. The weak points of the simplex system are overcome by the dual system and the duplex system.

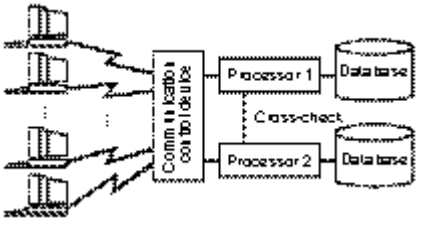
Figure 5-1-4
Simplex system



② Dual system

The dual system is a system in which each device is duplicated to compose a system that performs perfect parallel running of two courses (Figure 5-1-5). In this way, execution is performed while comparing the processing results of the devices of both courses at specific intervals in order to verify whether or not the processing is correct. This operation is called cross-check and is performed in ratios of 1 time every 10 milliseconds or 1 time every 100 milliseconds, etc. In the event of failure of any of the devices, the failed system is separated and processing is continued with the other processing system.

Figure 5-1-5
Dual system

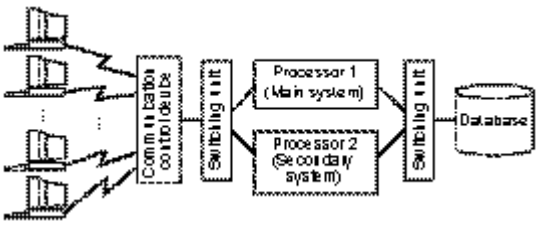


Since the dual system is constantly performing cross-checks of the processing results, it has high reliability and is used in areas in which any failure might endanger human life, such as medical care systems and aircraft control systems. However, due to the performance of cross-checks, the operating cost becomes high.
For example, the flight control system with which the space shuttle is equipped is a system that is expanding even more the idea of the dual system, with a multiple dual configuration of five processors.

③ Duplex system

The duplex system is also called the standby redundancy system. It is a system in which the processor, the main storage unit, the auxiliary storage devices, etc., each have their respective spare machines.
Under normal conditions, while one system (the main system) performs online processing and other high-priority functions, the other system (secondary system) performs batch processing, system development, etc. In the event that the main system fails, the secondary system interrupts processing in order to perform online processing.
Compared to the simplex system, duplex system reliability is much higher, but the equipment investment expenses are almost double. For that reason, few systems have this configuration, and it is used in banking systems or seat reservation systems in which the whole society would be affected if a system failure occurred.

Figure 5-1-6
Duplex system



According to the operating mode of the secondary system under normal circumstances, the duplex system is classified as follows:

- Cold standby mode
- Hot standby mode

a. Cold standby mode

In the cold standby mode, the main system performs online processing while the secondary system remains on standby without being turned on. For that reason, when a failure occurs, it takes time to switch to the secondary system.

b. Hot standby mode

In the hot standby mode, the main system performs online processing while the secondary system remains turned on and on standby, so that it can continue the main system processing at any time. For that reason, compared to the cold standby mode, switching time after a failure occurs is shorter.

The three system configurations mentioned above are compared in Figure 5-1-7.

Figure 5-1-7 Comparison of the three systems which were composed putting emphasis on reliability

	Simplex system	Dual system	Duplex system
Configuration (Spare machines existence)	No (Composed of the minimum equipment required)	Yes (In duplicate)	Yes (In duplicate)
Features	In the event one device breaks down, the whole system is stopped.	Perfectly identical processing is performed in two courses that are cross-checked at specific intervals. When a failure occurs, the system that broke down is separated and processing is continued.	Of the two systems, the main system performs the main functions and the secondary system performs batch processing, etc. When a failure occurs, processing is switched to the system working normally.
Reliability	Low	High	High
Realtimeness	Low	Highest	High
Construction cost	Low	High	High
Operating cost	Low	Most expensive	High
Application field	General work	Medical care systems, flight control systems, etc.	Banking systems, seat reservation systems, etc.

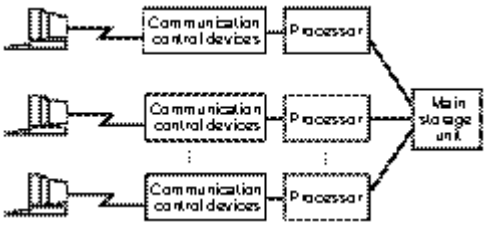
It should be noted that the systems such as the dual and duplex systems in which, due to the duplication of their configuration, processing can be continued as a whole even if one part breaks down, are called fault tolerant systems.

(2) Systems that emphasize processing efficiency

① Multiprocessor system

In the multiprocessor system, multiple processors share one main storage unit and auxiliary storage device, and each of the processors performs parallel processing under one operating system. For that reason, processing efficiency is high.

Figure 5-1-8
Multiprocessor system



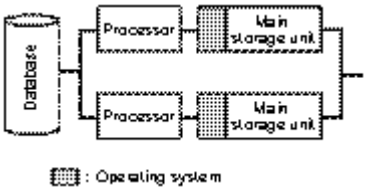
According to the type of processor coupling, multiprocessor systems can be divided into the following two:

- Loosely coupled multiprocessor system
- Tightly coupled multiprocessor system

a. Loosely coupled multiprocessor system (LCMP)

The loosely coupled multiprocessor system is a system in which the processors are loosely coupled so that, in the event of failure, the processor in which the failure occurred can be separated and the operation can be continued. For that reason, the system reliability is high.

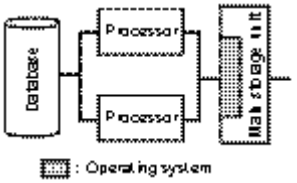
Figure 5-1-9
Loosely coupled
multiprocessor system



b. Tightly coupled multiprocessor system (TCMP)

In the tightly coupled multiprocessor system, multiple processors share the main storage unit. For that reason, synchronization and information transmission between processors can be performed at high speed, and complex communication control programs are not required.

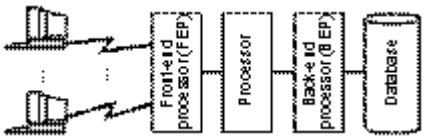
Figure 5-1-10
Tightly coupled
multiprocessor system



② Tandem multiprocessor system

The tandem multiprocessor system is a multiprocessor system that connects multiple processors in series (tandem) and distributes the load by assigning functions to each of the processors.
Figure 5-1-11 shows an example of a tandem multiprocessor system in which a front-end processor and a back-end processor are placed in front and behind the main processor.

Figure 5-1-11
Tandem
multiprocessor system



a. Front-end processor (FEP)

The front-end processor mainly performs the communication control of a large number of terminal devices. When a front-end processor is in place, the main processor does not have to perform communication control processing, and, as a result, improvement of processing efficiency is enabled.

b. Back-end processor (BEP)

The back-end processor mainly controls a database in which an immense amount of data is stored. Through use of this database-dedicated machine, database access can be performed at higher speed.

(3) Back-up system

In order to be prepared for earthquakes, fires or other disasters, it is necessary to prepare in advance backup systems for computer systems. There are three methods to implement backup systems:

① Mirror site

A mirror site is a method by which files are simultaneously updated. As a result, a backup system in which switching can be performed in extremely short time is prepared.

② Hot site

In the hot site method, files are not simultaneously updated as in the mirror site. However, identical system environments are prepared, and a backup system in which switching can be performed in a comparatively short period of time is prepared.

③ Cold site

In the cold site method, hardware for backup is provided, but it is necessary to start construction of the system environment and other operations once the backup becomes necessary. Therefore, it takes time to perform switching.

(4) Cluster computing

Cluster computing is a method that, using communication media, connects multiple computers for use as a single computer. This configuration is called the cluster system, or simply cluster.
Clusters are classified into the following two types:

① Dedicated cluster

In the dedicated cluster, multiple computers of the same type (same OS and same architecture) are connected and used as a single computer.

② Distributed cluster

In the distributed cluster, multiple computers of different types are connected and, basically, each of the users uses one of these computers. However, in this configuration method, computer resources that are not being used by the formal users can be used by other users.

5.2 System modes

Here, the characteristics, differences, operating systems, etc., of the most representative systems in terms of the system processing mode, using mode, operating mode and system configuration will be explained.

5.2.1 System processing mode

According to the processing method, the information processing system can be divided as follows:

- Centralized processing system: By connecting multiple terminals to one host computer, processing is centralized in one location.
- Distributed processing system: By connecting multiple computers with communication lines, a network is constructed, and processing is distributed and performed by each of them.

Figure 5-2-1 Comparison between the centralized processing system and the distributed processing system

	Centralized processing system	Distributed processing system
Host computer load	Extremely heavy	Relatively light
Development and maintenance cost	High	Relatively low
Resource use	Limited	All of the resources can be effectively used
Data update	Real-time update is possible	Real-time update is not possible
Reliability	Low. If the host computer breaks down, the whole system is stopped.	High. If the host computer breaks down, other computers can cover it.
Flexibility	Low. When the amount of data increases, the hardware is switched.	High. Even if the amount of data increases, substitution by other computers can be performed.
Security	High	Low

(1) Centralized processing system

The operational aspect of the centralized processing system, which performs processing by concentrating data and information in one location, is extremely efficient. However, in batch processing systems and centralized online transaction processing systems the following problems exist:

- When the data subject to processing increases, switching to a computer with a processing capacity that fits that increase is required.
- When a failure occurs in the host computer, which is placed at the center of the system, all of the connected terminal devices are affected.
- Since most of the functions are concentrated in the host computer, when the software scale grows, the development cost, not to mention the maintenance cost, becomes enormous.

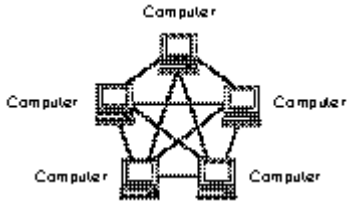
(2) Distributed processing system

The achievement of high performance in personal computers, etc., as well as the progress of network technology enabled the construction of computer networks in which multiple computers are connected using communication lines. As a result, the distributed processing system was conceived. In this system, data is distributed into each of the computers and the user can perform processing using all of the system resources through the network.
Here, the most representative computer network systems will be explained.

① Computer network system

The distributed processing system is a system that is implemented by the computer network system.
The computer network system, as is shown in Figure 5-2-2, is a system in which multiple independent computers are connected using communication lines.

Figure 5-2-2
Fully coupled computer network system



② Characteristics of the computer network system

The characteristics of the computer network system are also the characteristics of the distributed processing system.

- The processing functions and resources of the whole network can be efficiently used.
- Since even if a computer breaks down, processing can be continued in another computer, and the reliability of the system as a whole is high.
- When the work load of one computer is heavy, processing can be transferred to another computer with a light work load, providing flexibility to the system.

Currently, as a convention to implement computer networks, the OSI (Open Systems Interconnection) basic reference model established by ISO has been standardized.

③ Computer network system configuration

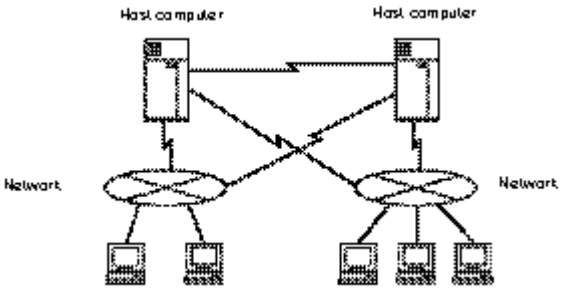
According to the connection method of each computer, computer network systems are roughly divided as follows:

- Vertically distributed configuration
- Horizontally distributed configuration

a. Vertically distributed configuration

Vertically distributed configuration is a configuration method that was widely used in the computer network systems constructed through the 1980s. In this configuration, data transfer among multiple host computers can be performed at high speed from the terminal devices through the switching network and LAN. Likewise, by providing intelligent functions to the terminal devices themselves, one processing can be divided between the host computer and the terminal devices, however the processing core is always in the host computer (Figure 5-2-3).

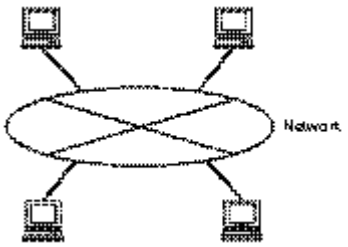
Figure 5-2-3
Vertically distributed configuration



b. Horizontally distributed configuration

In the 1990s, as a result of the appearance of high-performance workstations and personal computers, dependency between host computers and terminal devices connected to the network became extinct. In other words, the core of the computer network in the horizontally distributed configuration is the network, and the mainframes, workstations and personal computers are all connected to the network as host computers. Therefore, in the horizontally distributed configuration system, the user can select the host computer that suits him/her best.

Figure 5-2-4
Horizontally distributed configuration



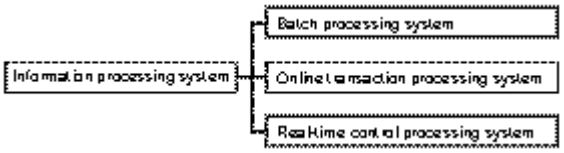
5.2.2 System usage mode

When diverse data and information is processed in a computer, the processing mode depends on the timing in which the data is to be processed, or the processor in which the data is to be processed.
According to the processing mode, the information processing system can be roughly classified as follows (Figure 5-2-5):

- Batch processing system
- Online transaction processing system
- Real-time control processing system

Here, the characteristics, use examples, OS, etc., of these information processing systems will be explained.

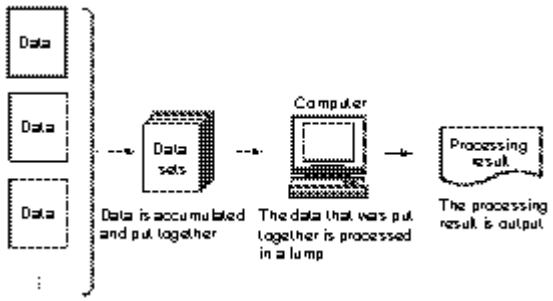
Figure 5-2-5
Using mode of the information processing system



(1) Batch processing system

In order to execute a job, it is necessary to process multiple data and information. If a central computer exists when one job is processed, the system is called a centralized processing system. The most representative of the centralized processing systems is the batch processing system.
For example, when the aggregation processing of a national census is performed, if the data of the all prefectures is not gathered in one location to be processed, correct aggregation results regarding population trends, etc., of the whole country could not be obtained. Likewise, when calculating the sales of one month of a convenience store, if all the sales data of the month subject to calculation is not collected, the sales of that month cannot be calculated.
In this way, the processing mode in which processing is performed after all of the data needed is gathered and lumped together is called batch processing. Batch processing is the oldest processing method, which has been in placed since computers were created.

Figure 5-2-6
Batch processing system



① Batch processing application example

Batch processing is most suitable to perform the following jobs:

- Payroll calculation, sales account and other processing that must be performed by daily or monthly
- Marking and aggregation of examinations such as for the University Testing Center Examination
- All sorts of statistical analysis processing

② Batch processing characteristics

When processing a job that substantially exceeds the processing capacity of the computer system, among the diverse processing modes, batch processing is the most efficient. This is because there is no human intervention during processing. However, as once processing starts, no human intervention is allowed up to processing completion, the establishment of processing order must be performed beforehand.
Likewise, since programs and data sharing can be performed, and the standardization of processing procedures is easy, the adoption of this processing expanded, especially in mainframe computers. At the time that "Grosch's law," which said that computers are expensive and computing power increases as the

square of the cost, held good, it was the best method. However, now that hardware prices have fallen and performance has increased, it cannot be said that centralized processing is the best processing method.

③ Batch processing modes

In batch processing, data is processed in a lump. Depending on whether processing is performed offline or online, it can be divided into the following two types:

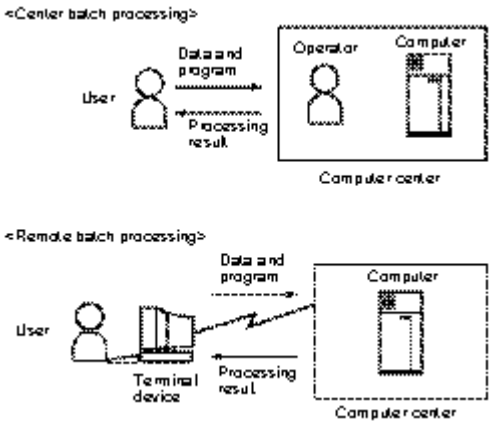
a. Center batch processing

In center batch processing, the data stored beforehand by the user, and the program of the processing procedure, are executed offline. In other words, data is transported by a human, input by an operator, etc., and processing is performed in a computer center.

b. Remote batch processing

In remote batch processing, data is sent from remote locations through communication lines (online), and once all of the data is gathered, processing is performed in a computer center. This processing is also called remote job entry (RJE).

Figure 5-2-7
Center batch processing and remote batch processing



Center batch processing can be further classified as follows:

- Open batch processing
  In open batch processing the user does everything, from data storage to computer manipulation.
- Closed batch processing
  In closed batch processing, the user hands over the processing procedure and the data to the operator and asks him/her to perform the computer processing.
- Cafeteria system
  In the cafeteria system, the user registers the processing procedure and the data in the computer and leaves the remaining operation to the operator.

④ Batch processing operating system

Considering that batch processing is the oldest processing system, it can be said that operating systems have been expanded in order to improve batch processing efficiency. Here, the functions of the operating system aiming at efficient batch processing performance will be briefly described.

a. Job control language (JCL)

Job control language was designed in order to implement automatic job processing. Processing is executed through the definition of the following:

- Job name
- Storage location of the program to be used
- Storage location of the data subject to processing
- Area of the work file and the output file

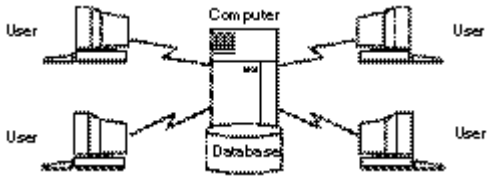
b. SPOOL (Simultaneous Peripheral Operations On Line)

Operating speed differs depending on the configuration of each of the devices composing the computer system. For example, the processor performs processing at an electronic speed (using nanosecond as a unit), while the printer only operates at a mechanical speed (using "second" as a unit). Considering speed differences of this kind, SPOOL, which is one of the techniques to effectively operate the system, is applied.
SPOOL is a function that enhances processing speed by separating low-speed input and output devices from high-speed processors. The data subject to processing, as well as the processing results, are stored at high speed in an auxiliary storage device, which is the only device with which the processor exchanges data.

(2) Online transaction processing system

The opposite of batch processing is real-time processing. Online processing system is the generic name for systems in which terminal devices at remote locations and computers are connected through communication lines. A great number of these systems are online transaction processing (OLTP) systems, in which the data generated as a result of a transaction is processed in real time.

Figure 5-2-8 Online transaction processing system



For example, in a bank's computer system, we perform a transaction to withdraw money from a cash dispenser and, based on that transaction data, the computer installed in the bank computer center performs the money withdrawal processing. Likewise, in a train seat reservation system, when the train to be boarded and the number of seats required are specified, it is instantaneously determined whether or not there are vacant seats in the requested train, and if there are vacant seats, booking can be performed.
In this way, there are many online transaction processing systems that support corporate activities as well as the foundations of daily life. It can be said that this type of system has a great impact on society.

① Characteristics of online transaction processing

In the online transaction processing system, the data and information subject to processing is normally managed as a centrally controlled database. For example, this is the case of the depositors' database of bank online transaction processing systems and the train seats database of train seat reservation systems. As conditions to control these databases, ACID attributes, Atomicity, Consistency, Isolation, and Durability, are required.

② Job contents of the online transaction processing system

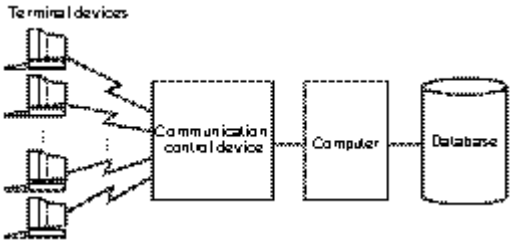
The main job contents of the online transaction processing system, adopted as a social and corporate infrastructure, are listed below.

- Production line control system and production management system in the manufacturing industry
- Seat reservation and ticketing system in the transportation business
- Deposit and money order systems as well as investment and loan systems in the finance sector
- Insurance system in the insurance business
- Stock exchange system in the securities sector
- Sales inventory management system and customer information control system in wholesale and retail businesses
- The public taxation system, social insurance system, car inspection registration system, postal savings and money order system, meteorological information system.

③ Configuration of the online transaction processing system

The system shown in Figure 5-2-9 is a centralized online transaction processing system. However, in order to emphasize system reliability, hardware duplication, etc., is necessary.

Figure 5-2-9 Centralized online transaction processing system



④ Conditions for online transaction processing

In order to implement the online transaction processing system, simultaneous execution control (exclusive control), which enables simultaneous response to the requests of multiple users, is an indispensable condition.
For that reason, the programs performing the online transaction processing must be reentrant programs. Reentrant programs are programs that can be executed again before their former execution is completed. The condition to run these programs is that the program area and the data area be separated. Based on this characteristic, simultaneous processing of multiple requests can be performed, and, moreover, correct results can be returned for each of these processing requests.
Likewise, since the resources are simultaneously shared by multiple users, it is necessary to perform simultaneous execution control (exclusive control) of the resources.

⑤ Failure recovery

In online transaction processing, hardware (processor, disk, printer, etc.) breakdowns, as well as application failures, must be detected and coped with promptly. For that reason, in the online transaction processing system, failure detection and failure recovery functions are robust, and when failures are detected, in many cases processing is abended (abnormally ended). Likewise, as methods to recover database physical and logical failures, the rollback and the roll forward methods are adopted.

(3) Real-time control processing system

In new jet airliners, in order to support the pilot, computers have been introduced and computer-controlled automatic piloting from takeoff to landing has been enabled.
In order to perform automatic piloting, it is necessary to provide operation instructions to perform the most suitable flight control based on the data related to air speed, outside temperature, wind direction, wind power, engine thrust, etc., obtained using the different sensors. Therefore, if it takes time to provide the operation instructions, correct flight control in ever-changing conditions will not be possible. The performance of immediate (real-time) calculation processing of the information obtained and the output of the results as control information is called real-time control. The system adopting the real-time approach is generically known as the real-time processing system.

Figure 5-2-10 Flow of the real-time control processing system

① Characteristics of the real-time control processing system

Since the real-time control processing system is mostly used as part of one device, it seldom uses input devices such as a keyboard or output devices such as a printer. In most cases, the input devices consist of diverse sensors, and the output devices of actuators and other control devices.
Likewise, the processors, mainly miniaturized microprocessors, are often composed of main storage units that store programs and data.

② Application examples of the real-time control processing system

Besides the flight control system adopted by jet airliners, real-time control processing systems are applied in such diverse fields as the ones mentioned below.

- Air-traffic control system
- Power supply monitoring system
- Industrial robot control
- Motor fuel control system and braking system
- Household electric appliances such as rice cookers, washing machines and air conditioners

③ Operating system implementing real-time control processing

In real-time control processing systems whose nucleus is a microprocessor, there are application programs and operating systems to control the programs. These operating systems are called real-time operating systems or real-time monitors. Real-time monitors have the following functions:

- Multi-task processing function
- Task switching function
- Function to minimize the load of the monitor itself

④ Interfaces needed for real-time processing

In the real-time control processing system, the data obtained using the different sensors is processed, and the electrical signals of the processing results are converted into mechanical operations by the actuators. The main interfaces used in the real-time control devices are listed below:

- RS-232C (Recommended Standard-232C)
- USB (Universal Serial Bus)
- Centronics interface
- SCSI (Small Computer Systems Interface)
- GPIB (General Purpose Interface Bus)

5.2.3 System operating mode

According to the operations (relations) generated when humans use computers to perform processing, the information processing systems can be further classified as follows:

- Non-interactive processing systems (batch processing systems, etc.):
  In non-interactive processing systems-- since processing is performed after the procedure is indicated, once it has started, humans cannot intervene in the processing.
- Interactive processing systems:
  In interactive processing systems, humans can provide indications or perform changes while interacting with the computer.

Here, only interactive processing systems will be explained.

(1) Interactive processing systems

Since at the time work processing is instructed to the computer, it looks as though computer and human are "talking" while performing the operation jointly, this system is called the interactive processing system.
TSS, in which one uses the computer as though one were the only user, and online transaction processing cases in which the next processing content is determined according to the processing results of the work requested to the computer by the terminal devices, among others, can be considered interactive processing. Needless to say, the operations performed in game software, word processing and spread sheet software, etc., can also be considered interactive processing.

① Characteristics of interactive processing

In batch processing the processing procedure is determined beforehand, but in interactive processing, since the processing content can be changed during processing, the indication of the procedure before processing starts can be vague.

② Functions of the software implementing the interactive processing

In interactive processing it is necessary to have a robust user interface. Therefore, the following are used:

- Window system
- GUI

In practice, without using the keyboard, the mouse is used to select the processing from the following.

- Title bar
- Menu bar
- Pull-down menu
- Pop-up menu

5.2.4 Web computing

In former client/server systems, data processing and other processing was performed on the client side. Compared to this, Web computing does not provide processing functions to the client side, and all processing is performed on the server side (Figure 5-2-11). As a result, only the browser function that displays the information sent by the server side becomes necessary for the client side.

This mode has the drawback that the server load is increased, but the performance requirements of the client side can be low. Therefore, this mode is suitable for cases where multiple client terminals are required.

Exercises

Q1 **Which of the following corresponds to the function that is most suitable for processing on the server side in the client/server system?**

A. Output data display processing
B. Database update processing
C. Format checking of input data
D. Pull-down menu display processing

Q2 **Consider that computers A and B are connected using LAN, and the printer is connected only to computer A. When computer B is to print data, it sends the data to the computer A. Regarding this system, which of the following is the most suitable description?**

A. The same operating system must run in computers A and B.
B. The MIPS value of computer A must be higher than that of computer B
C. Printing can be performed even if computer A is not turned on.
D. The role of computer A is to be the print server for the client server model.
E. Until printing is completed, computer B cannot perform any other processing.

Q3 **Which of the following descriptions related to the computer system corresponds to the duplex system?**

A. Multiple processors share the main storage unit and are controlled by a single operating system. Even if one processor breaks down, processing can be continued with the rest of processors.
B. In order to improve processing capacity by distributing the processing load, multiple processors are connected in series.
C. Under normal conditions, one of the processors is on standby, and when the processor in operation breaks down, after switching to the processor on standby, processing is continued.
D. Multiple processors connected in parallel simultaneously perform the same processing and compare mutual results. In the event that a failure occurs, the processor that broke down is separated and processing is continued.

Q4 **Among the three jobs listed below, which is the most suitable combination of processing modes?**

[Jobs]
1. One-month salary calculation
2. Industrial robot automatic operation
3. Airplane seat reservation

[Processing mode]
A. Online transaction processing
B. Batch processing
C. Real-time processing

	1	2	3
A	A	B	C
B	A	C	B
C	B	C	A
D	C	A	B

Q5 **Which of the following is the most suitable description of the centralized processing system, when compared to the distributed processing system?**

A. In the event of disaster or failure, since the center can perform centralized recovery operations, the danger of having the system stopped for a long time can be avoided.

B. Since batch management is conducted in the system, it is easy to comply with requests for the addition, modification, etc., of system functions, and probabilities of the occurrence of backlog stacking are low.
C. By taking centralized measures in the center, the security and data consistency can easily be maintained and controlled.
D. The operation and management of the hardware and software resources become complicated, but expansion supporting new technology is easy.

Q6 **Which of the following is the appropriate term to represent the processing mode in which computer users exchange information with the computer by selecting the icons displayed on the screen, and entering commands using the keyboard, adding human judgement to the information processing?**

A. Online transaction processing
B. Time sharing processing
C. Interactive processing
D. Batch processing

Q7 **Which of the following is the term that represents the time elapsed between when a series of works is requested to the computer and the processing results are received, in the batch processing mode?**

A. Overhead
B. Throughput
C. Turnaround time
D. Response time

Q8 **Which of the following is the description of system performance evaluation?**

A. In OLTP (Online Transaction Processing), the MIPS value is used in system performance evaluation.
B. Response time and turnaround time are performance indexes from the point of view of the system operations manager.
C. Generally speaking, as the activity ratio of the system resources increases, the response time also improves.
D. The number of transactions and jobs that can be processed within the time unit is important for system performance evaluation.

Q9 **Which of the following is a correct explanation of the Gibson mix used for system performance evaluation?**

A. It is the average operating ratio based on the values of the failure occurrence record of a specific time period obtained through the online diagnostic program.
B. It is the estimated average processing capacity per time unit at the online transaction processing.
C. It is the average weighting value of the instruction execution time for scientific computation.
D. It is the record average execution time of multiple standard programs for business calculation.
E. It is the record processing capacity obtained by monitoring with measuring devices the internal signals generated when a monitoring program is executed.

Q10 **In a processor whose basic operating time (clock time) is 0.05 microseconds, when the values of the clock number required to execute an instruction and the instruction frequency rate are the ones shown in the table, approximately what is the MIPS average value of the processor performance?**

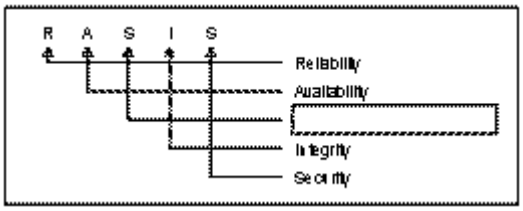
Instruction type	Clock number required for instruction execution	Use frequency
Operation between registers	4	40 %
Operation between memory and register	8	50 %
Unconditional branch	10	10 %

A. 3 B. 10 C. 33 D. 60 E. 132

Q11 Among the following descriptions related to computer performance evaluation criteria, which is the description related to SPEC-int?

A. It is the number of times floating point operations can be executed in one second. It is mainly used to measure scientific computation performance, but it is also used as the performance index of massive parallel processing computers.
B. It is the average number of times an instruction is executed in one second. It is not suitable for performance comparison between computers with different architectures.
C. It is an integer arithmetic benchmark whose main targets are computers in which UNIX can run. It was developed by the System Performance Evaluation Association and has expanded as a standard benchmark.
D. It is an online transaction processing system benchmark. According to the target models, four types of benchmark specifications, A, B, C, and D have been developed.

Q12 In the term "RASIS," which is related to system reliability, integrity and security, what does the third character, "S," stand for?

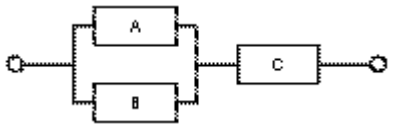


A. Safety
B. Selectivity
C. Sensitivity
D. Serviceability
E. Simplicity

Q13 Which of the following descriptions related to computer system reliability is correct?

A. System remote maintenance improves the operating ratio, by improving the MTBF.
B. The system operating ratio is improved by extending the MTTR and MTBF.
C. The more complicated the system configuration is, the longer the MTBF becomes.
D. System preventive maintenance is performed in order to extend the MTBF.

Q14 **When three computers, A, B and C are connected as displayed in the diagram, what is the operating ratio of the system as a whole? Here, the operating ratio is considered to be 0.8 for A, B, and C. Likewise, regarding the parallel connection part constructed by computers A and B, even when one computer, either A and B, is operating, the said parallel connection part is considered to be operating.**

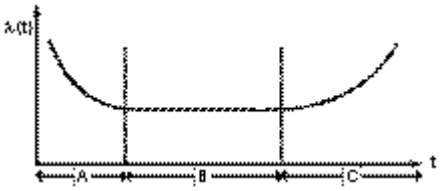


A. 0.512 B. 0.768 C. 0.928 D. 0.992

Q15 **Which of the following is the fail-safe measure taken when industrial robots are controlled with microcomputers?**

A. The circuits are designed to automatically stop when an abnormal operation signal is detected.
B. By making the circuits of each function easy to exchange, the failure recovery time is reduced to the utmost.
C. Using two hard disks, the same data is stored in each of the disks.
D. A manufacturer maintenance hot line is set up to give immediate assistance in case of emergency conditions.

Q16 **When the relation between the failure ratio, l (t), of the equipment composing the system, and the time elapsed since the equipment started to be used, t, is represented in a graph, generally, the following bath-tub curve is drawn. Generally speaking, in which of the ranges do the failures generated by design/manufacture defects and inappropriate environments occur frequently?**



A. A B. A and C C. B D. C