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# Before Using This Book

## 1 About the Structure of This Book

Below is the structure of this book.

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### Overview of Examination

This section explains typical examinees, level of technical knowledge, and examination implementation guidelines, etc. for IT Passport Examination.

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### Scope of Questions

This section explains the basic concept for examination questions and the scope of the questions.

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### Chapter 1 Corporate and Legal Affairs

This chapter explains basic knowledge on corporate activities, business management, compliance with laws and the concept of rules on a corporation.

---

### Chapter 2 Business Strategy

This chapter explains the typical systems, etc. in each field including information analysis techniques, marketing techniques, business management systems, and technological strategies.

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### Chapter 3 System Strategy

This chapter explains the understanding of business processes, methods for business improvement, the flow of information system construction, and the creation of requirements definitions for computerization, on the basis of information system strategy.

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### Chapter 4 Development Technology

This chapter explains the processes and test methods of system development, as well as the processes and development methods of software development.

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## **Chapter 5 Project Management**

This chapter explains project management processes and methods.

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## **Chapter 6 Service Management**

This chapter explains basic roles and structure of IT service management and service support that manage information system operation, how to consider system environment arrangement, and basic knowledge of system audit.

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## **Chapter 7 Basic Theory**

This chapter explains the fundamental way of comprehending radix, set, probability, and statistics, and digitalization of information and algorithms.

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## **Chapter 8 Computer System**

This chapter explains computer components and system components, hardware, software, and types of components and their characteristics.

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## **Chapter 9 Technology Element**

This chapter explains about the characteristics of human interface, characteristics of multimedia technology, basic knowledge of database design and network, and security measures.

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## **Chapter 10 Spreadsheet**

This chapter explains basic knowledge of spreadsheet software and calculation methods using functions.

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## **Appendix Answers and Explanations for End of Chapter Exercises**

This appendix includes answers and explanations for the end of chapter exercises (chapters 1 through 10).

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## 2 About the Notation in This Book

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Below are the meanings of the symbols that are used in this book.

Reference

A short summary of useful information and explanation of terminology

### 3 About the Appendix “Answers and Explanations for the Chapter Quiz”

At the end of each chapter, anticipated questions are included as the chapter quiz.

The appendix at the end of this book contains the answers and explanations of the chapter quiz.

## Chapter Quiz Answers and Explanations

(1) **Chapter 1 Corporate and Legal Affairs**

**Q 1-1 Answer c)**

**Explanation**

"Copyright" is a right to protect something represented creatively by a creator. When program is created, its copyright generally belongs to the creator. Therefore, the copyright originally belongs to Employee D; however, when a program is developed as a task, unless otherwise specified, its copyright belongs to the company (Company C).

a) and b): They do not actually develop program; therefore, the copyright does not belong to them.  
c) It is the person who developed program; however, because it was developed at work, and no other contract was concluded concerning copyrights, the copyright does not belong to Employee D.

---

**Q 1-2 Answer a)**

**Explanation**

Accounts receivable is the money not collected yet at the time when sales are made, and generally, the collection deadline is clearly stated in the accounts receivable. In this table, payment delays where the payment cannot be confirmed after the collection deadline has passed are divided into four (4) categories. "Accounts receivable that passed the collection deadline" means all uncollected money that payment cannot be confirmed; therefore, the amount is 120,000 yen. The question states "a long-term bond is defined as the account that payment delay is 91 days or more"; therefore, the long-term bond amount of Company D is 18,000 yen.

The ratio of the long-term bond amount against the accounts receivable that passed the collection deadline is as follows:

$$18,000 \text{ yen} \div 120,000 \text{ yen} = 0.15 (15\%)$$

	Payment confirmed	Payment delayed (1 to 30 days)	Payment delayed (31 to 60 days)	Payment delayed (61 to 90 days)	Payment delayed (91 days or more)	Units: ¥1,000
1st Sales Department	880	12	5	5	3	
2nd Sales Department	97	15	8	4	10	
3rd Sales Department	550	10	7	3	3	
4th Sales Department	390	21	10	2	2	
		Total: 120,000 yen			Total: 18,000 yen	

(2) (3)

#### (1) Answer

This shows the correct answer for the question.

#### (2) Explanation

This shows an explanation of the answer.

#### (3) Category

This shows the middle category of the scope of questions.



# **Overview of Examination**

This section explains typical examinee, level of technical knowledge, and examination implementation guidelines, etc. for the IT Passport Examination.

# Overview of Examination

## 1 Typical Examinees

Individuals who have basic knowledge of information technology that all business workers should commonly possess, and who are doing information technology related tasks, or trying to utilize information technology in their tasks in charge.

## 2 Tasks and Roles

Individuals who have acquired common basic knowledge of information technology that a business worker should possess, and utilize information technology in their tasks as well as perform the following activities:

- a) Understand information devices and systems to use, and utilize them.
- b) Understand the tasks in charge, identify problems of those tasks, and act to provide required solutions.
- c) Perform acquisition and utilization of information safely.
- d) Support task analysis and systemization activities under the guidance of superiors.

## 3 Expected Technology Level

The following basic knowledge is required as a business worker in order to determine information devices and systems, and to perform his/her tasks in charge as well as facilitate systemization.

- a) Knowledge of computer systems and networks to determine the information devices and systems to use, and knowledge of how to utilize office tools.
- b) Knowledge of corporate activity and related tasks in order to understand the tasks in charge. Also, in order to identify issues of the tasks in charge and provide required solutions, systematic thinking and logical thinking as well as knowledge of problem analysis and problem solving methodologies are required.
- c) Ability to act in accordance with relevant laws and regulations as well as various information security provisions in order to utilize information safely.
- d) Knowledge of development and operations of information systems in order to support analysis and systemization of tasks.

## 4 Additional Explanation of Expected Technology Level

The basic knowledge below is required of professionals in order to understand information devices and systems, to do the work they are responsible for, and to implement computerization.

### [1] Understanding and utilizing information devices and systems

- Understanding the performance, characteristics, and functions of information devices that are used in one's workplace, and utilizing them appropriately
- Understanding the meaning of OS settings and the operations and functions of application software such as office tools that are used in one's workplace, and utilizing them appropriately
- Utilizing application software and groupware such as office tools and others used in one's workplace in consideration of the efficiency of one's own work

### [2] Understanding the work they are responsible for, understanding the problems in such work, and resolving the problems

- Organizing the processes of the work one is responsible for with the use of methods such as workflow, and identifying problems
- Using a simple analysis method and information technology to analyze data relating to the work one is responsible for, and identifying problems
- Investigating one's own solution proposals for identified problems, or asking for the opinion of supervisors and colleagues for investigation

### [3] Securely collecting and utilizing information

- Utilizing various information relating to the work one is responsible for in accordance with relevant laws and regulations
- Understanding the aim of internal compliance programs and complying with them
- Using company information devices and systems, and especially the Internet, in a way that ensures there are no information leakages, loss, or damage

### [4] Supporting computerization of work under the supervision of a superior

- Participating in investigations of the filtering and organization of data for the work one is responsible for under the supervision of a superior
- Participating in investigations of the computerization of processes for the work one is responsible for under the supervision of a superior



# **Scope of Questions**

This section explains the basic concept for examination questions in the examination and the scope of the questions.

# Scope of Questions

## 1 Basic Concepts for Examination Questions

In the IT Passport Examination, questions are set in each of the fields of strategy, management, and technology in accordance with the concepts below.

### [1] Strategy

Questions that test the examinee's knowledge, such as basic terminology and concepts, required to perform analysis concerning computerization and corporate activities, and knowledge on basic terminology and concepts to appear in high school's information subject, general newspapers, books, and magazines are set. Questions that test methods for understanding and analyzing familiar work and solving problems, and test basic knowledge of utilization of office tools for data analysis and problem solving are also set.

### [2] Management

Questions that test knowledge such as basic terminology and concepts and others relating to system development and project management processes are set, but questions that test knowledge such as highly specialized and specific terminology and concepts are not set. Questions that test basic knowledge to consider the improvement of business operations environment by using computers, networks, office tools, and others such things are set.

### [3] Technology

Questions that test knowledge such as basic terminology and concepts, and logical thinking are set, but questions with a high level of technical specialization are not set. Questions that test basic knowledge on secure use of familiar systems are also set.

## 2 Scope of Questions

Common Career/Skill Framework			Scope of questions to be asked (Field Major Category Middle Category Concept of exam questions)
Field	Major category	Middle category	
Strategy	1 Corporate and legal affairs	1 Corporate activities	<ul style="list-style-type: none"><li>Ask about the fundamental concepts about corporate activities and business management.</li><li>Ask about the techniques for analyzing familiar business tasks and resolving issues, the concept of PDCA, and operational planning using techniques such as Pareto charts.</li><li>Ask about the visual expressions used for understanding business tasks, such as workflow.</li><li>Ask about the fundamental concepts of accounting and financial affairs, such as financial statements and break-even points.</li></ul>
		2 Legal affairs	<ul style="list-style-type: none"><li>Ask about the familiar laws of workplaces, such as intellectual property rights (copyright law, industrial property rights related laws, etc.), security related laws (act on the prohibition of unauthorized computer access, etc.), Act on the Protection of Personal Information, Labor Standards Act, and Act for Securing the Proper Operation of Worker Dispatching Undertakings and Improved Working Conditions for Dispatched Workers.</li><li>Ask about the concepts and characteristics of software license, such as license types and license management.</li><li>Ask about the concepts of corporate rules and regulations, such as compliance and corporate governance.</li><li>Ask about the significance of standardization.</li></ul>

Common Career/Skill Framework				Scope of questions to be asked (Field Major Category Middle Category Concept of exam questions)
Field	Major category	Middle category		
Strategy	2 Business strategy	3 Business strategy management	<ul style="list-style-type: none"> <li>Ask about the fundamental concepts about typical management information analysis techniques and business management systems, such as SWOT analysis, PPM (Product Portfolio Management), customer satisfaction, CRM, and SCM.</li> <li>Ask about the understanding of the use of office tools (software packages) such as spreadsheet software, database software, etc.</li> </ul>	
		4 Technological strategy management	<ul style="list-style-type: none"> <li>Ask about the understanding of the significance and purpose of technology development strategy.</li> </ul>	
		5 Business industry	<ul style="list-style-type: none"> <li>Ask about the characteristics of typical systems in various business fields such as e-commerce, POS systems, IC cards, and RFID application systems.</li> <li>Ask about the characteristics of typical systems in the engineering field and e-business.</li> <li>Ask about the characteristics and trends of intelligent home appliances and embedded systems.</li> </ul>	
	3 System strategy	6 System strategy	<ul style="list-style-type: none"> <li>Ask about the significance and purpose of information system strategies and the concepts of strategic goals, business improvement, and problem solving.</li> <li>Ask about the concepts of typical modeling in business models.</li> <li>Ask about the effective use of groupware for communication and of office tools.</li> <li>Ask about the purpose and concepts of increasing operational efficiency by using computers and networks.</li> <li>Ask about the concepts of solution business through typical services, such as cloud computing.</li> <li>Ask about the significance and purpose of the promotion and evaluation activities of system utilization.</li> </ul>	
		7 System planning	<ul style="list-style-type: none"> <li>Ask about the purpose of computerization planning.</li> <li>Ask about the purpose of the operational requirements definition based on the analysis of current state.</li> <li>Ask about the fundamental flow of procurement, such as estimates, RFPs, and proposals.</li> </ul>	
	4 Development technology	8 System development technology	<ul style="list-style-type: none"> <li>Ask about the fundamental flow of the process of system development such as requirements definition, system design, programming , testing, and software maintenance.</li> <li>Ask about the concepts of the estimate in system development.</li> </ul>	
		9 Software development management techniques	<ul style="list-style-type: none"> <li>Ask about the significance and purpose of typical development models and development methods.</li> </ul>	
Management	5 Project management	10 Project management	<ul style="list-style-type: none"> <li>Ask about the significance, purpose, concepts, processes, and methods of project management.</li> </ul>	
	6 Service management	11 Service management	<ul style="list-style-type: none"> <li>Ask about the significance, purpose, and concepts of IT service management.</li> <li>Ask about the understanding of related matters such as service desks (help desks).</li> <li>Ask about the concepts about system environment maintenance, such as computers and networks.</li> </ul>	
		12 System audit	<ul style="list-style-type: none"> <li>Ask about the significance, purpose, concepts, and target of systems audit.</li> <li>Ask about the flow of systems audit, such as planning, investigating, and reporting.</li> <li>Ask about the significance, purpose, and concepts of internal control and IT governance.</li> </ul>	
	7 Basic theory	13 Basic theory	<ul style="list-style-type: none"> <li>Ask about the fundamental concepts about radix including the characteristics and operations of binary numbers.</li> <li>Ask about the fundamental concepts about sets, such as Venn diagrams, probability, and statistics.</li> <li>Ask about the fundamental concepts of how to express information content, such as bits and bytes, and of digitization.</li> </ul>	
		14 Algorithm and programming	<ul style="list-style-type: none"> <li>Ask about the fundamental concepts of algorithms and data structures, and how to draw flow charts.</li> <li>Ask about the roles of programming.</li> <li>Ask about the types and fundamental usage of markup languages, such as HTML and XML.</li> </ul>	

Common Career/Skill Framework				Scope of questions to be asked (Field Major Category Middle Category Concept of exam questions)
Field	Major category	Middle category		
Technology	8 Computer system	15 Computer Component	<ul style="list-style-type: none"> <li>Ask about the fundamental configuration and roles of computers.</li> <li>Ask about the performance and fundamental mechanism of processors, and the types and characteristics of memory.</li> <li>Ask about the types and characteristics of storage media.</li> <li>Ask about the types and characteristics of input/output interfaces, device drivers, etc.</li> </ul>	
		16 System component	<ul style="list-style-type: none"> <li>Ask about the characteristics of system configurations, of the types of processing, and of the types of usage.</li> <li>Ask about the characteristics of client/server systems and virtual systems.</li> <li>Ask about the characteristics of Web systems.</li> <li>Ask about the concepts of system performance, reliability, and economic efficiency.</li> </ul>	
		17 Software	<ul style="list-style-type: none"> <li>Ask about the necessity, functions, types, and characteristics of OSs.</li> <li>Ask about the concepts and use of basic functions of file management, such as access methods and search methods, and the fundamental concepts of backups.</li> <li>Ask about the characteristics and fundamental operations of software packages, such as office tools.</li> <li>Ask about the characteristics of OSS (Open Source Software).</li> </ul>	
		18 Hardware	<ul style="list-style-type: none"> <li>Ask about the types and characteristics of computers.</li> <li>Ask about the types and characteristics of input/output devices.</li> </ul>	
	9 Technical element	19 Human interface	<ul style="list-style-type: none"> <li>Ask about the concept and characteristics of interface design, such as GUI and menus.</li> <li>Ask about the concepts of Web design.</li> <li>Ask about the concepts of universal design.</li> </ul>	
		20 Multimedia	<ul style="list-style-type: none"> <li>Ask about the types and characteristics of encodings such as JPEG, MPEG, and MP3.</li> <li>Ask about the purpose and characteristics of application of multimedia technology, such as AR (Augmented Reality), VR (Virtual Reality) and CG (Computer Graphics).</li> <li>Ask about the characteristics of media, and compression and decompression of information data.</li> </ul>	
		21 Database	<ul style="list-style-type: none"> <li>Ask about the significance, purpose, and concepts of database management systems (DBMS).</li> <li>Ask about the concepts of data analysis and design, and the characteristics of database models.</li> <li>Ask about the manipulation methods such as data extraction.</li> <li>Ask about database processing methods such as exclusive control and recovery processing.</li> </ul>	
		22 Network	<ul style="list-style-type: none"> <li>Ask about the types and configurations of LAN and WAN regarding networks, and the roles of Internet and LAN connection devices.</li> <li>Ask about the necessity of communication protocols, and the roles of typical protocols.</li> <li>Ask about the characteristics and fundamental mechanism of the Internet.</li> <li>Ask about the characteristics of e-mail and Internet services.</li> <li>Ask about the understanding of the types and characteristics, accounting, and transmission rates of communication services, such as mobile communication and IP phones.</li> </ul>	
		23 Security	<ul style="list-style-type: none"> <li>Ask about the fundamental concepts of information security from the viewpoint of safe and secure activities in a network society.</li> <li>Ask about the information assets, the purpose of risk management, and the concepts of information security policy.</li> <li>Ask about the concepts, types, and characteristics of technological security measures, such as measures against malware (computer viruses, bots, spyware, etc.) and various attacks (phishing, targeted attacks, etc.)</li> <li>Ask about the concepts, types, and characteristics of physical and human security measures, such as entrance/exit control and access control.</li> <li>Ask about the types and characteristics of authentication technologies such as ID, password, digital signature, and biometric authentication.</li> <li>Ask about the mechanisms and characteristics of encryption technology, such as common key cryptography, public key cryptography, and public key infrastructure (PKI).</li> </ul>	

# Annual Report

## Strategy

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# Chapter 1

# Corporate and Legal Affairs

This chapter explains basic knowledge on corporate activities, business management, compliance with laws and the concept of rules on a corporation.

1-1	Corporate Activities .....	17
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## 1-1-1 Management and Organization

In order to grasp and solve issues on assigned works, and proceed business activities smoothly, it is important to understand the general view of a corporation such as activity contents, purposes, and ordinances of the corporation.

### ① Corporate activities

To conduct corporate activities, it is important to clarify the meaning of existence and values of a corporation. If these are not clear, it becomes ambiguous to which direction corporate activities should be conducted. Even if all employees make the best effort in their assigned work, when its direction is wrong, work cannot be conducted efficiently. Understanding the objectives and responsibilities a corporation defines makes it possible to conduct corporate activities smoothly.

#### (1) Business philosophy

The purposes of corporate activities are to increase profit and contribute to society. For that reason, many corporations conduct activities following their **“business philosophy.”** The business philosophy is a fundamental way of thinking that provides a guideline when a corporation conducts activities, and that indicates the meaning of existence and values of a corporation. It is also called a **“corporate philosophy.”** This business philosophy is a general ideal that does not change fundamentally. However, the environment surrounding a corporation, such as society and technology, changes significantly. In order to achieve business philosophy, it is important to keep creating the ability to adapt to changes from a long-term perspective.

#### (2) CSR (Corporate Social Responsibility)

“CSR” refers to the responsibilities that a corporation must fulfill in society. Many corporations publicize their thinking on CSR and their CSR reports through web pages in order to gain interest from society and trust from interested parties.

A corporation needs to create business from the perspective of all interested parties in addition to pursuing its own profit. As the term “corporate citizen” implies, there is demand for actions as a member of society. Through these actions, a corporation can gain trust from society, and new corporate values are generated.

#### Reference

##### Stakeholder

“Stakeholder” is interested parties on the business activities of a corporation. In addition to shareholders and investors, employees, clients, and consumers are also included.

To pursue corporate activities without injustice, comply with legal affairs, and implement convenience and safety by providing products and services are the most basic responsibilities; however, the time has come to define CSR by including such factors as ways of maintaining contributions to society, giving consideration to the environment, promoting social welfare activities, and connecting with local communities.

## 2 Organization structure of a corporation

A “**corporation**” is an organization whose general purpose is to make profit, and which conducts economic activities such as productions, sales, and services. The narrow definition indicates a private corporation such as a “**stock company**” or “**limited company**”; however, the broad definition includes public corporations owned by a country.

An “**organization**” is an entity gathered with certain orders to achieve common purposes.

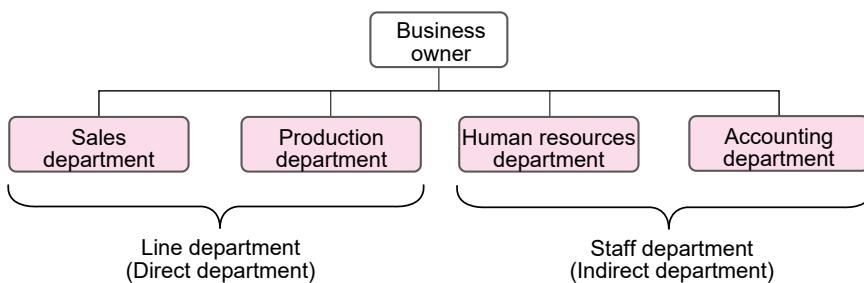
A corporation puts together organizations according to each purpose in order to conduct business efficiently.

Organization forms are as follows:

### ● Functional organization

“**Functional organization**” is an organization structured according to business skills such as manufacturing, marketing, sales, accounting, and human resources, also called a “**matrix organization**.“ Each business skill can pursue its specialty and efficiency; therefore, its characteristics are that high quality results can be achieved, and it is suitable for relatively small-scale corporations as well as single business corporations. On the other hand, there is a problem in that a distance is generated in business skills, and there is a tendency to prioritize the convenience of one’s own department.

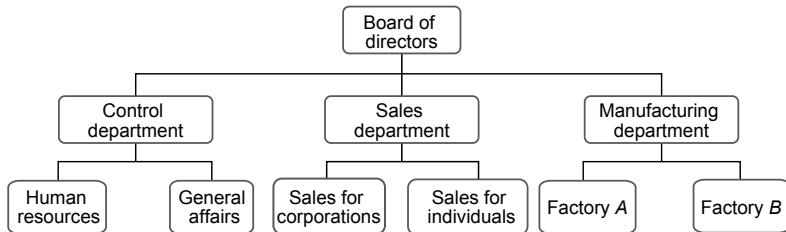
A functional organization is categorized into “**line departments (direct departments)**” that deal with sales, production, and materials relating directly to profits, and “**staff departments (indirect departments)**” that deal with human resources, accounting, general affairs, and information systems to support the line departments.



### ● Hierarchical organization

“**Hierarchical organization**” is a form of organization that has a hierarchical structure, and usually has one line of command. For example, its relationship is such that there are many departments under a president, and under the departments, there are sections responsible for different areas of work.

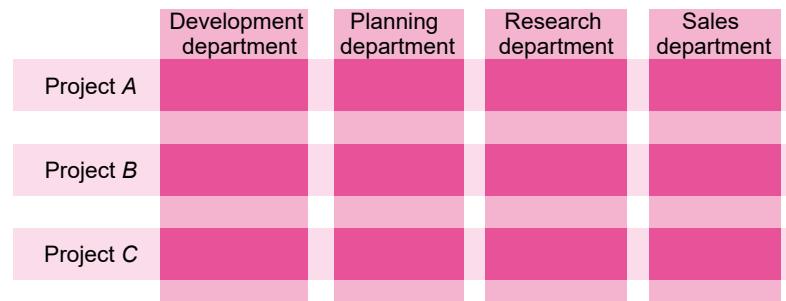
The characteristic of a hierarchical organization is that its corporate policies can permeate comprehensively.



### ● Matrix organization

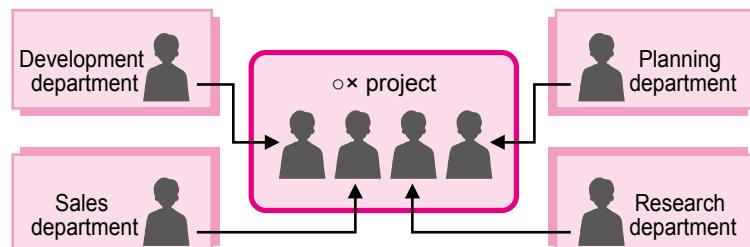
“**Matrix organization**” is an organization that has a multidimensional structure by combining different lines of command such as business skills, business, products, regions, and projects.

Tasks are conducted under multiple managers such as products, regions, business skills, and projects; therefore, there is a risk of confusion in the line of command. However, its advantage is to remove the distance between departments, and be able to gain harmony in the organization.



### ● Project organization

“**Project organization**” is a temporarily structured organization by people with various special abilities separated from the original organization. This is a temporary organization; therefore, it breaks up after achieving its purpose.

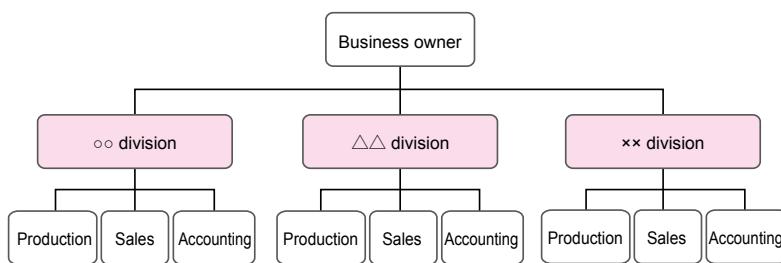


## ● Divisional system organization

“**Divisional system organization**” is an organization in which an organization is divided for each product it handles, region, and market, and consists of some or all staff departments in each division.

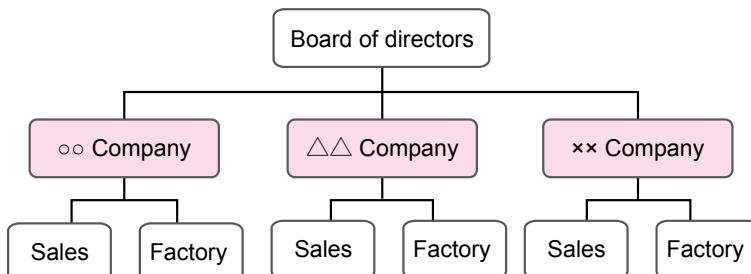
One division possesses all necessary functions; therefore, a line of command can be unified, and its characteristic is that changes in market needs can be reacted to promptly.

Also, each division adopts a self-supporting accounting system in principle, is responsible for profit individually, and conducts business.



## ● In-house company system

“**In-house company system**” is a system to operate business by dividing each department as an independent corporation. By raising integration of the system, its environment adaptability can be increased. The system structure resembles a Divisional system organization; however, stronger personnel affairs authority and discretion are given in the in-house company system.



### ③ Management resources

Three major resources essential to corporate management are “people (personnel),” “things,” and “money (assets).” Recently, “information” is included sometimes as the fourth resource.

Reference

#### Green IT

Green IT is a concept to use IT devices to energy saving and environment protection of society as a whole, in addition to applying energy conservation and effective use of IT devices. It aims to ensure establishment of environmental protection and economic growth. One example is implementing electronic meeting systems and reducing business trips, which leads to reduction of CO<sub>2</sub> emissions in society as a whole.

Resource	Description
People	This refers to employees and is the most important resource in all corporate activities. Ensuring that business principles and objectives reach every employee, providing proper training, and enhancing human resource capability lead to increased profits.
Things	This refers to products and merchandise. In case of manufacturing industry, production facilities belong to this category. Even in the service industries that may not be related to products, various products are necessary in order to conduct corporate activities smoothly. For example, computers, printers, and copying machines are essential things for corporate activities.
Money	This refers to assets. Money is necessary to buy and manufacture products, and secure people. Money is an essential resource as an asset with which to conduct corporate activities.
Information	This refers to resources and data used to make correct decisions and acquire competitiveness. Adequate utilization of information results in improvement of productivity and added value, as well as ideas to generate business plans.

Reference

#### Business objectives

Medium and long-term objectives to actualize business principles.

Reference

#### BCP (Business Continuity Plan)

“BCP” is a plan that a company prepares in advance so as to continue its business in a stable way even when certain risks occur.

Reference

#### BCM (Business Continuity Management)

“BCM” is a business management method for a company to continue stable business. Continuous improvement is designed by performing a series of efforts like planning and implementing BCP policies, operation, and review.

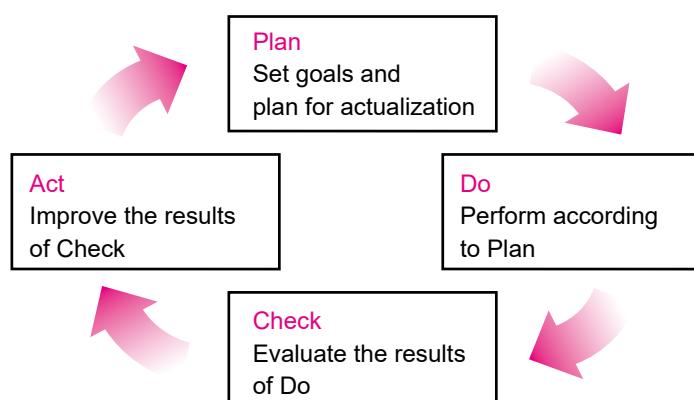
### ④ Business management

“Business management” refers to activities to adjust and integrate business resources (people, things, money, and information) to achieve objectives of a corporation. When the factors of business resources are replaced with business management, people = human resources, things = assets, money = finance, and information = information management.

It is important to elicit effects by making best use of the resources a corporation possesses. For the purpose, business objectives are determined, and managed with a cycle called “PDCA.”

“PDCA” is a basic concept by which to conduct business management.

A cycle consists of four steps, Plan → Do → Check → Act, and it continuously improves quality and work. By repeating PDCA, business management creates better products/services.



## 5 Human resource management

“Human resource management” is to manage people who are business resources. In order to implement various activities in a corporation, business execution abilities of employees are essential. Therefore, it is necessary to organize training systems and personnel systems.

### (1) Training systems

Typical training systems are as follows:

Name	Description
OJT (On the Job Training)	OJT is a system to acquire knowledge, skills and technology on the basis of guidance from supervisors and skilled personnel by engaging in actual work on a job site.
Off-JT (Off the Job Training)	Off-JT is a system to acquire knowledge, skills, and technology intensively in a specific duration of time at training facilities and educational institutes outside a job site. Methods for training include e-learning and case studies.

### (2) Personnel development

Typical personnel development systems are as follows:

Name	Description
Coaching	Coaching is to support a worker to achieve objectives through spontaneous actions to extract the inherent abilities and possibilities of an individual by using the question-answer communication method. It is common for supervisors and managers to provide coaching to junior personnel; however, there are also cases of outsourcing to external special institutes.
Mentoring	In mentoring, a leader called a mentor, who has a wealth of experience, provides communication continuously to junior personnel and less experienced personnel inside an organization. By supporting spontaneous growth of personnel through communication and advice, the productivity inside an organization is maximized.

### (3) Personnel systems

Typical personnel systems are as follows:

Name	Description
CDP (Career Development Program)	CDP is a system to design the future of employees and make them achieve according to the design plan on the basis of the experience gained through work and acquisition of special skills.
MBO (Management by Objectives)	MBO is a system to set objectives on work, and evaluate according to the level of achievement of the objectives. Evaluation results are reflected in salary increases, bonuses, and promotions.

#### Reference

#### Diversity

“Diversity” is a concept to raise productivity by utilizing various human resources actively regardless of differences in nationality, gender, age, educational background, and values.

#### Reference

#### Talent management

“Talent management” is to recognize employees as human resource, and conduct strategic personnel assignment and encourage human resource development by performing integrated management of information on individual skills, experience, and capacity.

#### Reference

#### e-Learning

“e-Learning” is to conduct education by using electronic devices. Many use the Internet, and its merit is no restriction by time and location.

#### Reference

#### Work-life balance

“Work-life balance” is the balance between work and personal life. In a more specific definition, it refers to an environment in which fulfilling life can be selected and realized for a family and a community while achieving work responsibilities in a company.

#### Reference

#### Mental health

“Mental health” is the health of one’s mind.

Recently, the number of people who experience mental health problems because of work related stress such as complicated human relations at work and heavy responsibility is increasing. It is important for a company from the perspective of human resource management to systematically provide planned care for the mental health of employees.

## 6 Production management

“Production management” refers to comprehensive activities to plan and control production activities in accordance with business strategies. Production management is the most important activity for corporations that manufacture and sell products.

Production management methods are as follows:

Name	Description
JIT (Just In Time)	JIT is a method for producing required products at the necessary time in the required quantity. It is also called the “Kanban” method. According to the production condition of post-processing (the side that uses parts), necessary parts are supplied from pre-processing (the side that creates and supplies parts). This method can minimize the intermediate inventory quantity.
FMS (Flexible Manufacturing System)	FMS is a method for producing various types of products by adopting flexibility in production lines in order to respond to changes in consumers’ needs. It is also called a “flexible production system” or “integrated production system.” This method is suitable for high-mix low-volume production.
MRP (Material Requirements Planning)	MRP is a method for producing by calculating a net required quantity (amount) of parts that needs to be procured as new on the basis of a production plan. In MRP, a total required quantity that becomes necessary is calculated on the basis of a production plan, and by subtracting the allowable inventory amount, the net required quantity is obtained.

Expression to obtain a net required quantity

$$\text{Net required quantity} = \text{Total required quantity} - \text{Allowable inventory amount}$$

### Example

70 Product A must be manufactured. Product A consists of 4 Component B and 3 Component C. When the inventory of Component B is 32, and the inventory of Component C is 29, what is the net required quantity of Component B and Component C respectively?

To create 1 Product A, 4 Component B and 3 Component C are necessary; therefore, to create 70 Product A, 280 Component B ( $4 \times 70$ ), and 210 Component C ( $3 \times 70$ ) are necessary. Subtract 32 on Component B in inventory and 29 on Component C in inventory respectively to obtain the net required quantity.

$$\text{Net required quantity of Component B: } 280 - 32 = 248$$

$$\text{Net required quantity of Component C: } 210 - 29 = 181$$

Therefore, Component B is 248 and Component C is 181.

## 7 Inventory control

“Inventory control” is a significant activity to support the business foundation of a corporation.

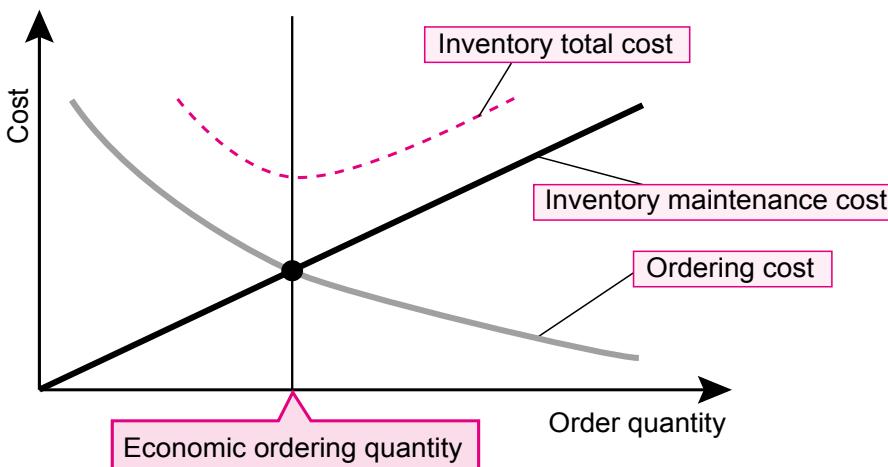
A balance between demand and supply is disrupted if inventory is either excessive or inadequate. Also, when the inventory is excessive, it stresses the capital of a corporation, and results in increased costs. Therefore, it is necessary to constantly maintain an adequate amount of inventory in inventory control.

### (1) Economic ordering quantity

“Economic ordering quantity” is a method for calculating an adequate order quantity when filling an inventory.

By minimizing the “**ordering cost**” and the “**inventory maintenance cost**” relating to filling an inventory, a corporation can secure profit in its business activities. Therefore, an adequate ordering quantity is calculated in order to secure inventory with the minimum cost.

Cost	Description
Ordering cost	This is a cost applied for ordering once. The total cost is less when the ordering quantity per order is large (meaning the number of ordering reduces).
Inventory maintenance cost	This is a cost such as management cost on a warehouse necessary to maintain inventory. When the number of inventory is large and the retention period is long, the cost increases.
Inventory total cost	This is a cost combining the inventory maintenance cost and the ordering cost.



#### Example

On the basis of the following conditions, what is the order quantity (number of lots) for the inventory total cost to be minimum?

[Conditions]

- (1) Ordering is performed in units of lots, and 1 lot contains 500 items.
- (2) The inventory maintenance cost is proportional to the order quantity, and it is 160 dollars per lot.
- (3) The ordering cost for 1 time is 50 dollars.
- (4) The used quantity within the period is 40,000 items.

#### Reference

##### Lot

“Lot” is a group of same products to form the unit for production and shipping.

The procedure to obtain an ordering quantity (number of lots) is as follows:

[1] Obtain the number of ordering.

Used amount ÷ (Ordering quantity × number of items in 1 lot) ...

Digits after a decimal point are rounded up

[2] Obtain the ordering cost

Number of orders to make × Ordering cost for 1 time

[3] Obtain the inventory maintenance cost

Ordering quantity × Inventory maintenance cost per lot

[4] Obtain the inventory total cost

Ordering cost + Inventory maintenance cost

Order quantity	Number of orders to make	Ordering cost	Inventory maintenance cost	Inventory total cost
2	$40,000 \div (2 \times 500) = 40$	$40 \times \$50 = \$2,000$	$2 \times \$160 = \$320$	$\$2,000 + \$320 = \$2,320$
3	$40,000 \div (3 \times 500) = 27$	$27 \times \$50 = \$1,350$	$3 \times \$160 = \$480$	$\$1,350 + \$480 = \$1,830$
4	$40,000 \div (4 \times 500) = 20$	$20 \times \$50 = \$1,000$	$4 \times \$160 = \$640$	$\$1,000 + \$640 = \$1,640$
5	$40,000 \div (5 \times 500) = 16$	$16 \times \$50 = \$800$	$5 \times \$160 = \$800$	$\$800 + \$800 = \$1600$
6	$40,000 \div (6 \times 500) = 14$	$14 \times \$50 = \$700$	$6 \times \$160 = \$960$	$\$700 + \$960 = \$1,660$

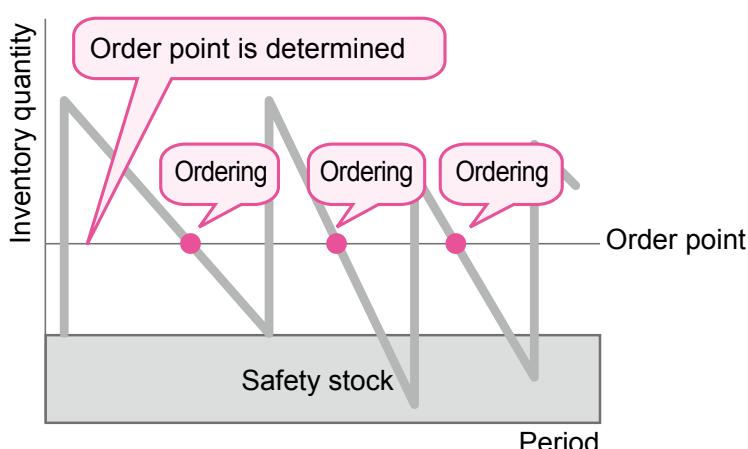
Therefore, the ordering quantity to minimize the inventory total cost is 5 lots.

## (2) Ordering method

There are the “fixed quantity ordering method” and the “periodic ordering method” as the inventory ordering method.

### ● Fixed quantity ordering method

“Fixed quantity ordering method” is a method to determine a fixed order quantity and examine the timing of each order. The timing of orders is determined according to the order point.



### Reference

#### Order point

“Order point” is the inventory quantity on which the timing of ordering is based. When the inventory quantity is reduced to an order point, an order is made.

### Reference

#### Safety stock

“Safety stock” is to secure additional inventory overseeing a demand change in order to avoid lack of inventory.

## Expression to obtain an order point in the fixed quantity ordering method

**Order point = Average usage quantity per day × Delivery lead time + Safety stock**

### Reference

#### Delivery lead time

“Delivery lead time” is the period from ordering products until the delivery of the products.

### Example

Cosmetics Company A controls inventory by the fixed quantity ordering method.

The lead time is 3 days from ordering materials until their delivery, and the average usage quantity per day is 5 items. What is the order point when calculated with the safety stock quantity is 5 items?

Necessary values to obtain an order point are as follows:

Average usage quantity per day	: 5 items
Delivery lead time	: 3 days
Safety stock	: 5 items

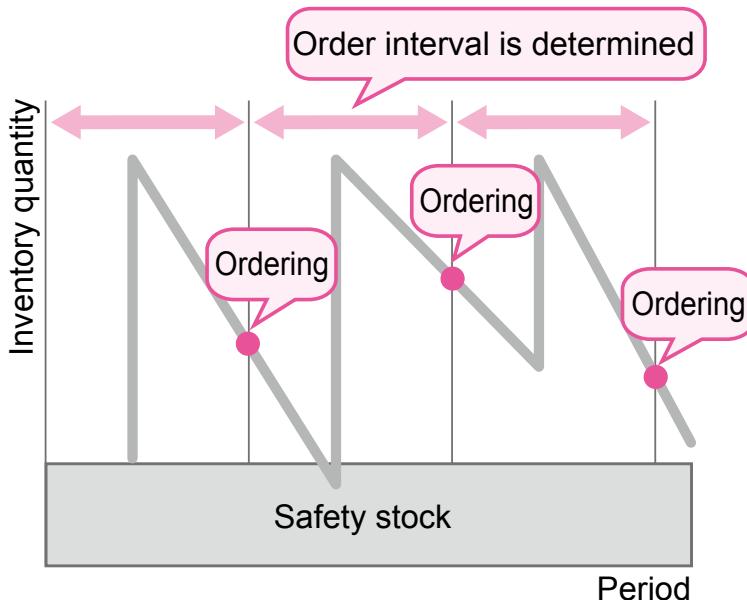
When these values are substituted into the expression to obtain an order point, it will appear as follows:

$$5 \text{ items} \times 3 \text{ days} + 5 \text{ items} = 20 \text{ items}$$

Therefore, the order point is 20 items.

### ● Periodic ordering method

“Periodic ordering method” is a method to determine the time (interval) to order and examine the quantity of each order. In this method, demand forecasting used to decide an order quantity must be accurate.



Reference

### Ordering cycle

“Ordering cycle” is a cycle to make an order.

Reference

### Current inventory quantity

“Current inventory quantity” is the usable inventory quantity at the time of ordering.

Reference

### Current order remaining

“Current order remaining” is the number of remaining items ordered the previous time but not yet delivered.

### Expression to obtain an order quantity in the periodic ordering method

Ordering quantity = (Ordering cycle + Delivery lead time) × Average planned usage quantity + Safety stock – Current inventory quantity – Current order remaining

#### Example

Foods Company B controls its inventory by the periodic ordering method.

The lead time is 3 days from ordering to delivery, and the order of materials is made once a week, every 7 days.

What is the order quantity when calculated with 15 safety stock quantity and the average planned usage quantity per day is 20 items?

However, the inventory quantity at the time of ordering is 150 items, and there is no order remaining.

Necessary values to obtain an order quantity are as follows:

Ordering cycle	: 7 days
Delivery lead time	: 3 days
Average usage quantity per day	: 20 items
Safety stock	: 15 items
Current inventory quantity	: 150 items
Current order remaining	: 0 items

Substitute these values to the expression to obtain an order quantity, and it looks as shown next.

$$(7 \text{ days} + 3 \text{ days}) \times 20 \text{ items} + 15 \text{ items} - 150 \text{ items} = 65 \text{ items}$$

Therefore, the order quantity for this time is 65 items.

## 8 Asset management

“Asset management” refers to managing assets such as the remaining inventory and facilities a corporation possesses. When asset management is overlooked, it may lead to loss of assets, illegal asset usage, and appropriation mistakes in relation to depreciation, etc.

### (1) Inventory evaluation

An inventory can be evaluated by replacement with money as assets.

Typical evaluation methods are as follows:

Type	Description
First-in first-out method	The inventory evaluation value on the end of term inventory products is calculated with sales being deemed as having been made from old products. (New products are the inventory)
Last-in first-out method	The inventory evaluation value on the end of term inventory products is calculated with sales being deemed as having been made from new products. (Old products are the inventory)
Average cost method	The inventory evaluation value on the end of term inventory products is calculated on the basis of the average cost of purchased products.
Specific identification method	The inventory evaluation value on the end of term inventory products is calculated on the basis of the individual acquisition cost.

**Example**

How much is the inventory evaluation value when end of term inventory items are evaluated by the first-in first-out method, and by the last-in first-out method?

	Number of units	Unit price	First-in first-out method			Last-in first-out method		
			Shipment	Inventory	Inventory evaluation value	Shipment	Inventory	Inventory evaluation value
Initial inventory	3 units	10 dollars	3 units	0 units			3 units	$3 \text{ units} \times 10 \text{ dollars} = 30 \text{ dollars}$
April purchase	1 unit	11 dollars	1 unit	0 units			1 unit	$1 \text{ unit} \times 11 \text{ dollars} = 11 \text{ dollars}$
June purchase	2 units	12 dollars	1 unit	1 unit	$1 \text{ unit} \times 12 \text{ dollars} = 12 \text{ dollars}$		2 units	$2 \text{ units} \times 12 \text{ dollars} = 24 \text{ dollars}$
July purchase	3 units	13 dollars		3 units	$3 \text{ units} \times 13 \text{ dollars} = 39 \text{ dollars}$	1 unit	2 units	$2 \text{ units} \times 13 \text{ yen} = 26 \text{ dollars}$
Sep. purchase	4 units	14 dollars		4 units	$4 \text{ units} \times 14 \text{ dollars} = 56 \text{ dollars}$	4 units	0 units	
End of term inventory	8 units				107 dollars			91 dollars

Consider ones purchased first are shipped

Consider ones purchased last are shipped

Therefore, the inventory evaluation value in the first-in first-out method is 107 dollars, and the inventory evaluation value in the last-in first-out method is 91 dollars.

**Example**

When the delivery and shipping in May is as shown in the table, how much is the inventory evaluation value on May 20th? The unit price is 980 dollars for the delivery portion from Company A, and 990 dollars for the delivery portion from Company B, and the delivered portion from Company B is retrieved as priority. When delivery and shipping occur on the same day, delivery to the warehouse is prioritized. Also, the original inventory is not considered.

Month	Day	Delivery		Shipping
		Company A	Company B	
May	3		12	
	6	15		
	9		20	
	10		27	
	11			8
	14		23	
	15			31
	16	20		
	18	10		
	19			26
	20		8	20

Month	Day	Delivery		Shipping
		Company A	Company B	
May	21		12	
	22			
	23	6	6	
	24		5	
	25			18
	26	10		9
	27	8		20
	28	12		
	29			10
	30		15	13
	31			8

The summarized conditions are as follows:

- The unit price from Company A on delivery is 980 dollars, and from Company B is 990 dollars.
- When shipping, the products delivered from Company B have priority.
- When delivery and shipping occur on the same day, delivery to the warehouse is prioritized.

According to the conditions above, a calculation is made of the evaluation value up to the May 20th, as shown in the table below, and the inventory evaluation value on the May 20th is 9,800 dollars.

Month	Day	Delivery		Shipping	Evaluation value on delivery	Evaluation value on shipping	Inventory Evaluation value	Itemized inventory
		Company A	Company B					
May	3		12		$12 \times 990 = 11,880$		11,880	Company A: 0 Company B: 12
	6	15			$15 \times 980 = 14,700$		26,580	Company A: 15 Company B: 12
	9			20		$12 \times 990 = 11,880$ $8 \times 980 = 7,840$	6,860	Company A: 7 Company B: 0
	10		27		$27 \times 990 = 26,730$		33,590	Company A: 7 Company B: 27
	11			8		$8 \times 990 = 7,920$	25,670	Company A: 7 Company B: 19
	14		23		$23 \times 990 = 22,770$		48,440	Company A: 7 Company B: 42
	15			31		$31 \times 990 = 30,690$	17,750	Company A: 7 Company B: 11
	16	20			$20 \times 980 = 19,600$		37,350	Company A: 27 Company B: 11
	18	10			$10 \times 980 = 9,800$		47,150	Company A: 37 Company B: 11
	19			26		$11 \times 990 = 10,890$ $15 \times 980 = 14,700$	21,560	Company A: 22 Company B: 0
	20		8	20	$8 \times 990 = 7,920$	$8 \times 990 = 7,920$ $12 \times 980 = 11,760$	9,800	Company A: 10 Company B: 0

## (2) Depreciation

The asset value on fixed assets such as machines and buildings decreases as time passes. This is called “**depreciation**.” It is necessary to calculate this depreciation every term with a fixed method, and note as costs by dividing by the duration determined by tax laws. The “**straight-line method**” and the “**declining balance method**” are normally used for calculation of depreciation.

Method	Description
Straight-line method	This is a method for depreciating a specific amount every term against the acquisition cost (price required to purchase a facility).
Declining balance method	This is a method for obtaining a depreciation cost that is calculated by multiplying the non-depreciated balance which is the remaining amount after subtracting all depreciation costs to the end of term from the acquisition cost (price required to purchase a facility) by a specific depreciation rate every term.

### Reference

#### Useful life designated by law

“Useful life designated by law” is the “number of durable years that fixed assets such as machines, buildings, and facilities can be used” as determined by a ministerial ordinance. It is determined for each type of assets by the tax laws.

### Reference

#### Useful life and depreciation of software

Useful life of software is three years for the original that is copied and sold, and used for research and development, and five years for other software. Also, the depreciation of software is determined to conduct with the straight-line method by the tax laws.

### Reference

#### Salvage value

“Salvage value” is the expected value of an asset after its useful life designated by law passed. Generally, it is 10% of the acquisition cost.

### Reference

#### Depreciation ratio

“Depreciation ratio” is a constant ratio determined according to the useful life designated by law for tax purposes.

## 9 Credit control

Production activities and sales activities of a corporation are established on a basis of trust with various business partners such as suppliers, customers, subcontractors, and lenders. For example, in the sales format to ship a product first and then collect its money later, a corporation makes transactions by trusting the customer while the product is shipped and its money is collected. Such transactions can be of significant risk for a corporation. If a customer becomes bankrupt, and the money cannot be collected, the corporation suffers loss.

In order to avoid such a risk, “**credit control**” is essential. Credit control is to evaluate a customer’s business condition, decide on whether to continue credit transactions, and manage the price limit for credit transactions.

The following two details should be evaluated in credit control.

Details	Description
Transaction acceptance/rejection	Consider “if credit transactions should be entered into with the customer.” Collect information on all customers, and when there is information with a high emergency level, take measures such as stopping transactions and collecting credit.
Size of transactions	Consider “the price limit for credit transactions.” Depending on the size of customer risk, control a balance on sales credit such as accounts receivable and bills.

### Reference

#### Setting a security guarantee

In order to prepare for irrecoverable debts, by setting a security on the property of a customer, the security can be used for accounts receivable in case the accounts receivable are no longer collectible. For securities, there are impersonal security (mortgage and pledge) and personal security (joint liability and joint obligation).

## 1-1-2 OR (Operations Research) and IE (Industrial Engineering)

“**OR (Operations Research)**” is a method to find solutions through totaling and analyzing for problem-solving and decision making. On the other hand, “**IE (Industrial Engineering)**” is a method of grasping and improving a work process for efficient and rational production.

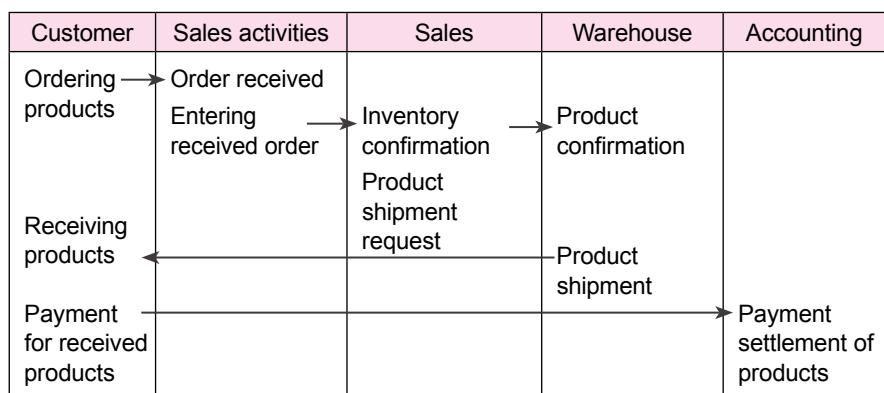
In OR and IE, analysis, solution, and improvement of business operations are conducted by using various illustrations.

## 1 Understanding business operations

The methods to understand business operations are as follows:

### ● Workflow

“Workflow” is to represent a sequence of flows relating to business operations in a figure. Using a workflow makes it easy to grasp which departments are responsible for which areas of work, and how a department is related to other departments in conducting work process.



## 2 Analysis of business operations and operational planning

By visualizing data with tables and graphs, business operations can be analyzed.

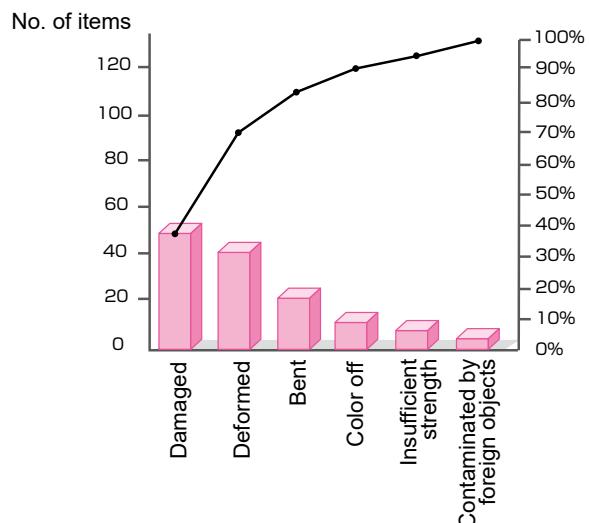
The methods for analysis of business operations are as follows:

### ● Pareto chart

“Pareto chart” is a method that summed data per item are represented in a bar graph sorted from larger values to smaller values, and its accumulated value percentage is represented with a line graph.

It is mainly used in quality management representing causes of quality failures, inventory control representing a frequency on delivery and shipping, and sales management representing a sales state, and is used to find which item should be focused on in order to solve problems.

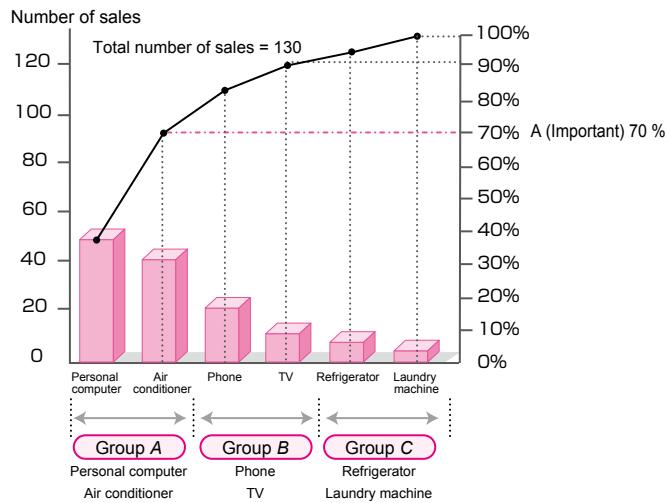
For example, in the graph showing the causes of quality failure, “**damages**” and “**deformation**” compose 70% of the total.



## ● ABC analysis

“ABC analysis” is a method of clarifying a significant level and a priority level of an element and item (products, etc.). It can be utilized in many business perspectives such as sales strategy, sales management, and inventory control. Adapting the tool of a Pareto chart, sort the elements and items from the importance level (large), and then divide into three, A, B, and C. In general, the group occupying the upper 70% is managed as Group A, 70 to 90% as Group B, and the rest as Group C.

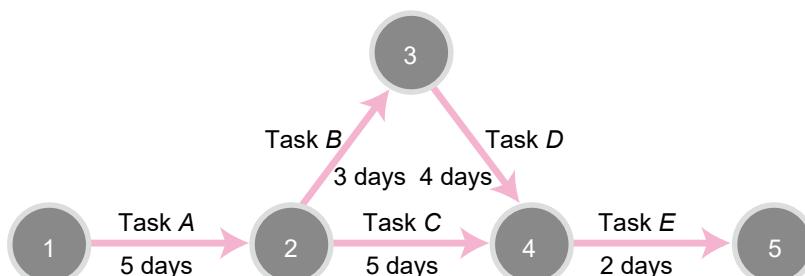
For example, this graph shows that the number of sales on personal computers and air conditioners compose 70% of the total, and it is clear that product management should be conducted by focusing on the two products as Group A.



## ● Arrow diagram

“Arrow diagram” is a method to create a better work plan. Work order relationship and necessary number of days are represented with arranged arrows. It is also used as a figure of a schedule plan table (PERT).

For example, the following diagram shows that Task E can be started when both Task C and Task D are completed.



### Reference

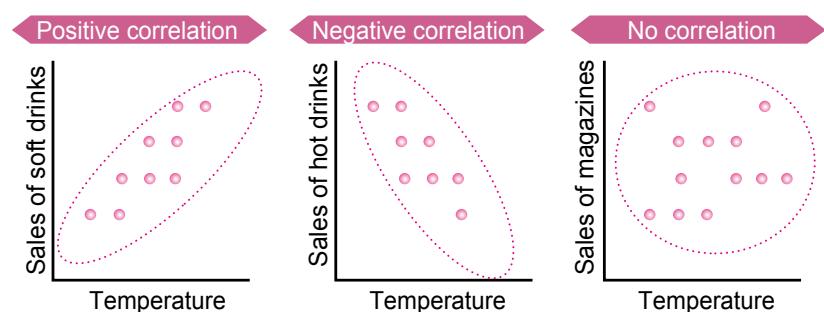
#### Critical path

“Critical path” is a route where the longest number of days is required in the whole schedule in planning. It must be managed with caution, because when some tasks in a critical path are delayed, the whole schedule will be delayed.

### ● Scatter diagram

“**Scatter diagram**” is a method to represent correlation between two types of data by setting two attribute values to the vertical axis and the horizontal axis. “**Correlation**” is a relationship whereby, when an attribute value increases, the other attribute value decreases.

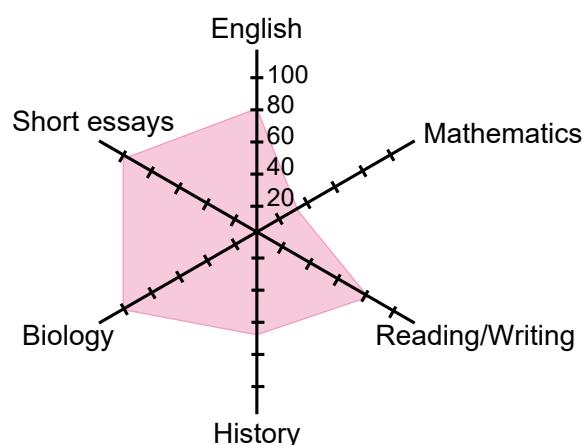
For example, a positive correlation graph shows a relationship between a cause and a phenomenon that on a hot day, the sales of soft drinks increase. A negative correlation graph shows a relationship whereby, when the temperature rises, the sales decrease, because on a hot day, the sales of hot drinks decrease. A graph showing no correlation clarifies that a relationship between temperature and the sales of magazines has no correlation.



### ● Radar chart

“**Radar chart**” is a graph to represent a comparison and a balance among multiple items.

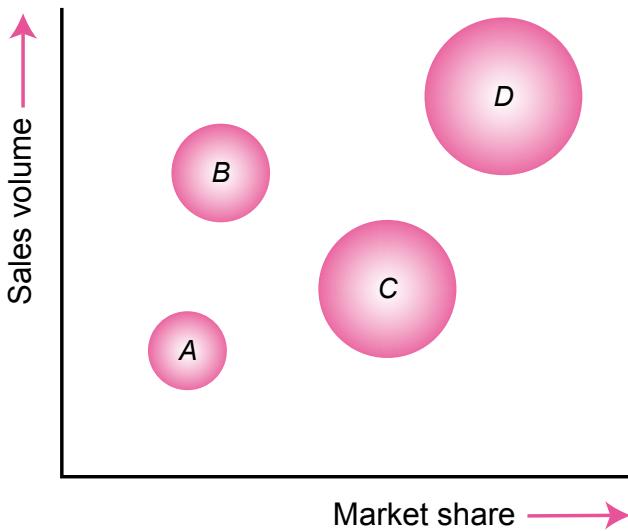
For example, this graph shows a balance of scores on each test subject.



## ● Bubble chart

“Bubble chart” is a method to represent correlation among three attribute values applied to the vertical axis, horizontal axis and a size of bubble. This is a type of scatter diagram used to represent distribution.

For example, this graph shows the number of sales in the vertical axis, market share in the horizontal axis, and net sales of products as the size of the bubble. It is clear that a product with large net sales has a large market share and large number of sales.



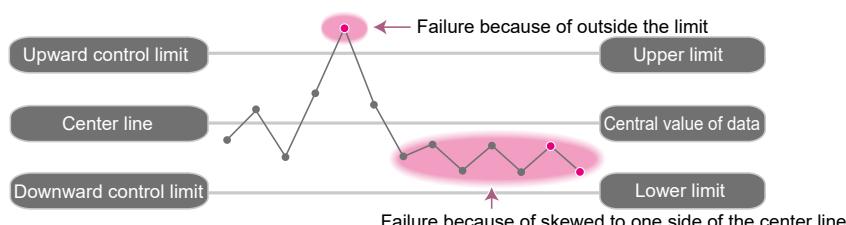
## ● Control chart

“Control chart” is a method of showing a process status with a line graph. Measured data are plotted, and when the plots go outside of a limit or a distribution is skewed to one side of the center line, a process failure can be detected.

For example, plots are determined as a failure on the basis of the following criteria.

- Plots emerging outside the upward and downward control limits
- When six or more plots emerge successively on the top side or the bottom side of the center line, the 6th and later plots

In this case, there are three plots to be judged as failure.

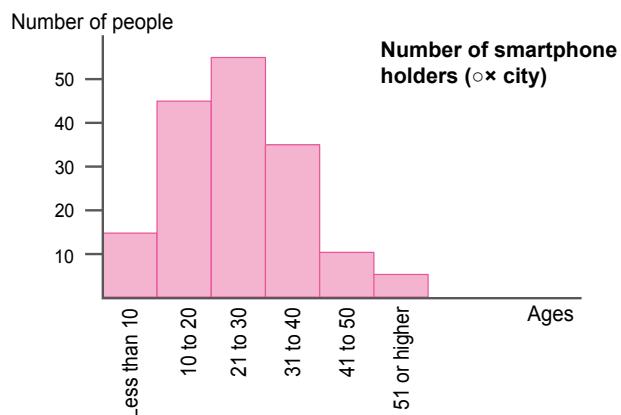


## ● Histogram

“Histogram” is a method to divide a collected data range into several intervals, and the number of data fit into the intervals are represented with a bar graph.

When a histogram is created, a total image of data, the position of the center, and the size of dispersion can be checked.

For example, this graph showing the number of people who possess a smartphone by age in ○× city is investigated, the largest number is in 21 to 30 years old, then in 10 to 20 years old and in 31 to 40 years old, and the smallest number is in 51 years old or more.



### Reference

#### Least square method

“Least square method” is a method to obtain a straight line where the total of squared difference from each point and the regression line is minimized.

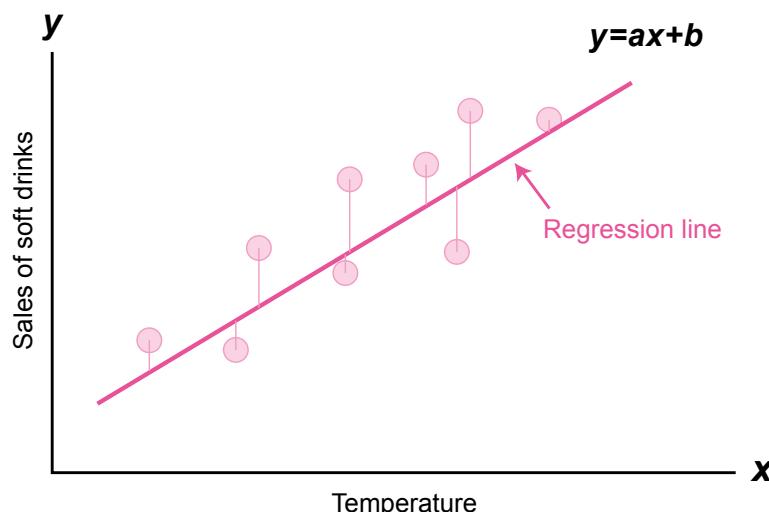
## ● Regression analysis

“Regression analysis” is an applied scatter diagram that represents a relationship in a straight line when correlation is present between two types of data.

When two types of data are substituted to  $x$  and  $y$ , a regression line can be represented by the expression,  $y = ax + b$ . In this case,  $a$  is called the “slope” and  $b$  is the “intercept.”

For example, from this graph, if the annual average temperature can be predicted, the sales of a product can be predicted, and the quantity of products ordered can be determined.

Regression line obtains a straight line with the shortest distance from each point. This is called the “least square method.”



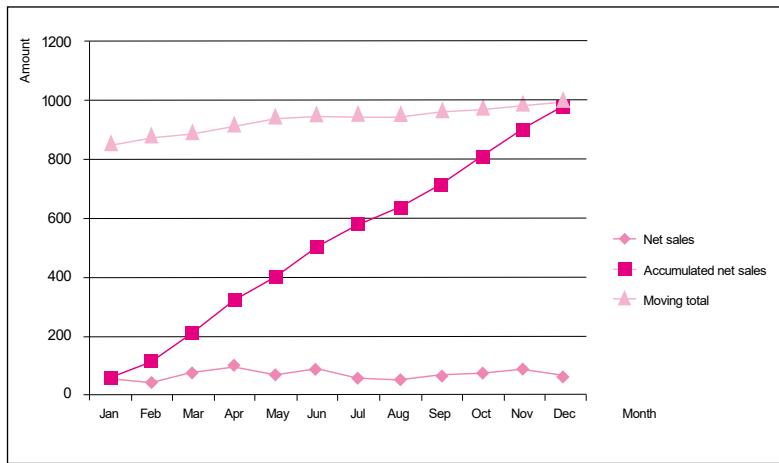
## ● Z graph

“Z graph” is a graph to represent transition through the passage of time. Its graph is **Z-shaped**; hence, it is called a “Z graph.”

For example, in this graph, the net sales, the accumulated net sales, and the moving total (accumulation including the past one year) are plotted in the graph and analyzed. When the moving total rises diagonally to the right, the sales performance is good, and when it slopes downward to the right, the sales performance is poor.

### Sales record table

		This year													
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sales		90	70	70	50	90	110	80	100	70	60	80	90	100	80
Total		790	860	70	120	210	320	400	500	570	630	710	800	900	980
Moving total		820	860	860	880	890	910	930	940	940	940	950	960	970	980



## ● Gantt chart

“Gantt chart” represents work schedules and results in horizontal bars. On the horizontal direction, set a time scale such as time, day, week, and month, and enter work items and projects in the vertical direction to manage the state of progress.

	1	2	3	4	5	6	7	8	(week)
Plan									
Design									
Operation									

## ③ Decision making

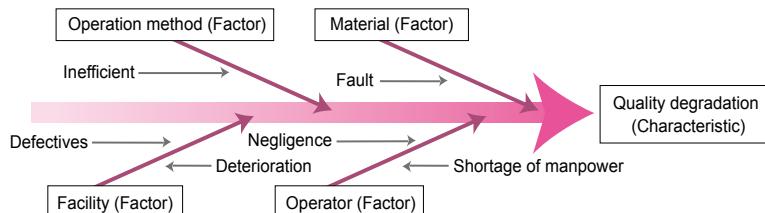
A corporation needs to make effort to conduct business activities efficiently to reduce cost in order to gain profit.

The methods to conduct decision making to solve a problem efficiently are as follows:

### ● Cause and effect diagram

“Cause and effect diagram” is a method of representing a characteristic (result) that is a problem in business, and related factors (causes) in a fishbone like diagram. It is also called a “fishbone diagram.” It is suitable to organize many causes systematically.

For example, this diagram shows the relationship among the causes by classifying multiple causes that reduce quality in four systems (operation method, materials, facilities, and operators).



### ● Simulation

“Simulation” is a method to create a simulated condition close to the actual condition by adopting assumed conditions in reality, and conduct an experiment.

A typical simulation method is the “queueing theory.”

The queueing theory is a theory that analyzes the waiting time of customers and the length of a waiting line in an area of work such as a service window through the arrival time of customers, the number of windows, and the average service time. The waiting time of customers and the number of people in a line can be represented by the expected value.

#### Example

Supermarket Y plans a special discount campaign of ice cream for the summer only. Compare product A to D, and offer a product such that the highest sales can be estimated as the sales target. The estimated numbers of sales when the temperature is higher than average, average, and lower than average are shown in the following table. Which product has the highest expected value in terms of estimated number of sales? Also, what is its expected value?

Here, the probability for the number of days when the temperature is higher than average, average, and lower than average is 0.5, 0.3, and 0.2 respectively.

The expected values are rounded off at the first decimal place, and compared as integer values.

(Unit: item)

Products	Higher	Average	Lower
Product A	35	18	11
Product B	28	10	8
Product C	34	15	7
Product D	56	12	9

The expected value on the estimated number of sales can be obtained by summing the values which are calculated by multiplying the estimated number of sales by the probability of each weather.

The expected values of the estimated number of sales for each product are as follows:

$$\text{Product A: } (35 \text{ items} \times 0.5) + (18 \text{ items} \times 0.3) + (11 \text{ items} \times 0.2) = \\ 25.1 \rightarrow 25 \text{ items}$$

$$\text{Product B: } (28 \text{ items} \times 0.5) + (10 \text{ items} \times 0.3) + (8 \text{ items} \times 0.2) = \\ 18.6 \rightarrow 19 \text{ items}$$

$$\text{Product C: } (34 \text{ items} \times 0.5) + (15 \text{ items} \times 0.3) + (7 \text{ items} \times 0.2) = \\ 22.9 \rightarrow 23 \text{ items}$$

$$\text{Product D: } (56 \text{ items} \times 0.5) + (12 \text{ items} \times 0.3) + (9 \text{ items} \times 0.2) = \\ 33.4 \rightarrow 33 \text{ items}$$

Therefore, the expected value of estimated sales for Product D is the highest, and its expected value is 33 items.

## 4 Problem-solving techniques

The basic methods to solve a problem are as follows:

### ● Brainstorming

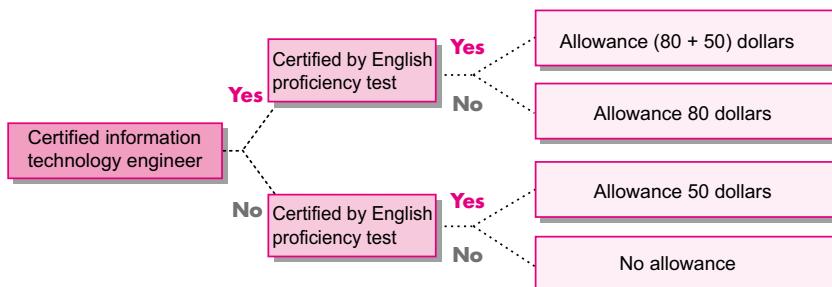
“**Brainstorming**” is a method to generate new ideas and come up with problem-solving measures by exchanging opinions in a group following rules.

Brainstorming rules are as follows:

Rule	Details
No criticism	Members of a group do not criticize and oppose to others' opinions. They ensure that opinions are not prevented from being expressed because of criticism or opposition.
Quantity over quality	Members of a group attempt to bring out as many opinions as possible in a short time. The probability of finding good quality solutions is higher as the number of opinions is larger.
Free and unrestrained	Members of a group promote free expression of opinions without fear of preconceptions or stereotypes. Surprising ideas may be hidden in opinions not restricted to the theme.
Linking and utilization	Members of a group improve an idea by linking ideas, and using other people's ideas. It is expected that new ideas are created.

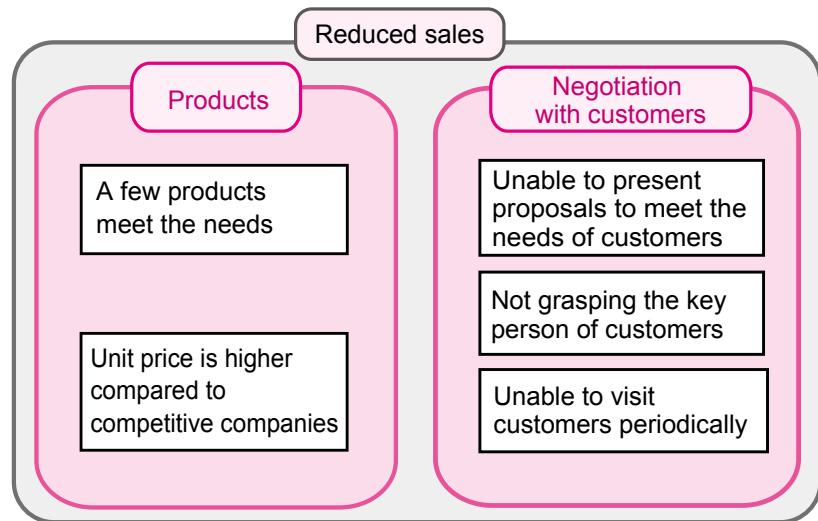
### ● Decision tree

“**Decision tree**” is a hierarchical repetition of selections and branches, and drawn as a tree diagram (diagram represented in a branching format).



### ● Affinity diagram

“Affinity diagram” is a method of organizing data on the basis of mutual affinity, and arranging and analyzing by attaching a nameplate to each group. Unarticulated issues can be organized, and issues can be clarified.



## ■ 1-1-3 Accounting and Financial Affairs

“Accounting” is to record, calculate and arrange generated losses and profits. Its operation tasks are called “financial affairs.”

### ① Types of accounting

There are two types of accounting within a corporation: “**financial accounting**” and “**management accounting**.”

#### (1) Financial accounting

“**Financial accounting**” is accounting to report to the concerned parties such as stockholders, clients, and tax authorities. This is the accounting necessary to report the financial condition of a corporation externally. Accounts are settled in each specific term, and financial statements such as a balance sheet and an income statement are created.

#### (2) Management accounting

“**Management accounting**” is accounting to report information necessary for decision-making to the concerned parties inside a corporation (business owners and managers). This is the accounting necessary from the perspective of business management of a corporation.

Reports such as profit management per department, cost control on products, and budget and actual management accompanied with production activities necessary for performance evaluation and business judgment are created.

## 2 Sales and profits

Business owners and business managers of a corporation need to conduct business activities constantly considering “**sales**” and “**volume of sales**.” Therefore, the aim is to gain the maximum “**profit**” from the least “**cost**” by managing profit and loss, and adjusting the inventory.

### (1) Cost

“**Cost**” is money to be paid by a corporation in order to conduct business activities. The main types of cost are as follows:

Type	Description
Cost price	This is a cost of manufacturing and purchasing products.
Variable cost	This is a cost that becomes necessary according to sales, such as sales cost and product shipment cost.
Fixed cost	This is a cost that becomes necessary regardless of sales, such as facility cost and human resource cost.
Selling, general and administrative expenses	These are all costs used on selling products and manufacturing products such as sales activities and general administrative works. It is also called the “operating cost.”

### (2) Profit

“**Profit**” refers to sales after deduction of costs. When accounting is managed, a profit is calculated by several methods. The main types of profit are as follows:

Type	Description
Gross profit	Profit gained from sales subtracted by the “cost price.” <b>Gross profit = Sales – Cost price</b>
Operating profit	Profit gained from gross profit after deducting “selling, general and administrative expenses.” <b>Operating profit = Gross profit – Selling, general and administrative expenses</b>
Current profit	Profit gained by adding “non-operating income” to operating profit, and then subtracting “non-operating expenses.” <b>Current profit = Operating profit + Non-operating income – Non-operating expenses</b>

These profits are calculated by means of a **income statement**.

### (3) Profit ratio

“**Profit ratio**” is the ratio of profit in relation to sales.

The main types of profit ratio are as follows:

Type	Description
Gross profit ratio	Ratio of gross profit to sales. <b>Gross profit ratio = Gross profit ÷ Sales</b>
Operating profit ratio	Ratio of operating profit in relation to sales. <b>Operating profit ratio = Operating profit ÷ Sales</b>
Current profit ratio	Ratio of current profit in relation to sales. <b>Current profit ratio = Current profit ÷ Sales</b>

The profitability of a product can be clarified by these profit ratios.

#### Reference

##### Non-operating income

“Non-operating income” is income gained through methods other than a company’s business, such as interest income and dividends.

#### Reference

##### Non-operating expenses

“Non-operating expenses” are costs used for things other than a company’s business, such as interest expenses.

## (4) Break-even point

“Break-even point” is the point where sales equal costs, and therefore, the profit and loss are both “0.” The sales at this point are described as “**break-even point sales.**”

A break-even point is calculated to find the “**profitable line of business**” to gain profit. When sales go beyond a break-even point, this means that profit is made.

Reference

### Contribution profit

“Contribution profit” is profit obtained by subtracting variable cost from sales. It is also called “marginal profit.”

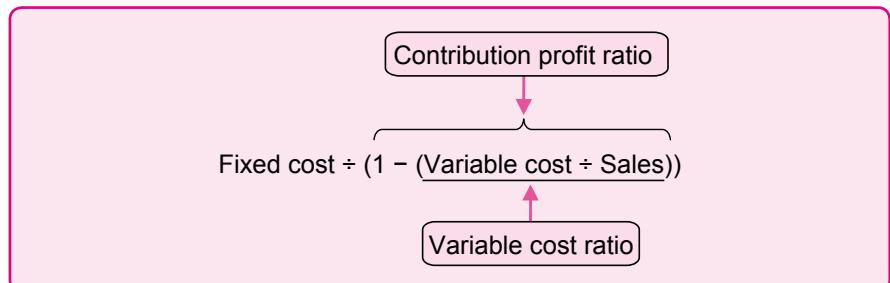
Reference

### Target profit

“Target profit” is profit to be the objective aimed for when manufacturing and selling products.

It is used to calculate the break-even point, such as how many items should be sold to achieve a target profit.

### Expression to obtain break-even point sales



Type	Description
Variable cost ratio	Ratio of variable cost in relation to sales. <b>Variable cost ratio = Variable cost ÷ Sales</b>
Contribution profit ratio	Ratio of sales contribution to profit. <b>Contribution profit ratio = 1 - variable cost ratio</b>

### Example

When the total sales are one million (1,000,000) dollars, the variable cost is 800,000 dollars, and the fixed cost is 100,000 dollars, what are the variable cost ratio, contribution profit ratio, and the break-even sales amount?

#### ● Variable cost ratio

$$800,000 \div 1,000,000 = 0.8$$

This means that 0.8 dollars is generated as the variable cost when 1 dollars of sales is made.

#### ● Contribution profit ratio

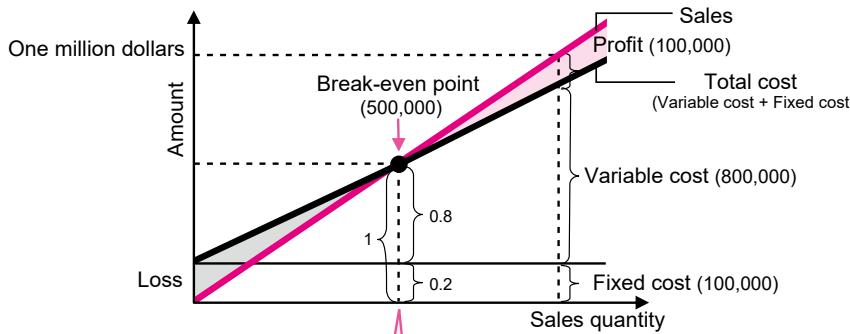
$$1 - 0.8 = 0.2$$

This means 0.2 dollars is contributed to the profit when 1 dollars sales is made. (Profit and fixed cost are contained in the 0.2 dollars).

### ● Break-even point sales

$$100,000 \div 0.2 = 500,000$$

This means that when 500,000 dollars is exceeded, it becomes profit, and when the amount is under 500,000 dollars, it becomes a loss.



In the break-even point, when the sales is 1, the proportion of the variable cost and fixed cost becomes the variable cost ratio : contribution profit ratio = 0.8 : 0.2

## ③ Types and roles of financial statements

In financial accounting, “**financial statements**” are created to report its financial condition to those who have interests in the corporation, such as stockholders, banks, clients, and public institutes.

Financial statement types are as follows:

### (1) Balance sheet (B/S)

“**Balance sheet**” represents financial status at a specific time of a corporation. Debit (left side) shows “**assets**” and credit (right side) shows “**liability**” and “**net assets**” in a balance sheet. “**Balance check**” is to verify the final total of the debit and the credit matches.

#### ● Assets

“**Assets**” are properties including cash. Besides cash, properties include buildings such as stores and offices, goods such as automobiles and products, and rights to collect “**credits**.”

Typical titles of accounts are as follows:

Asset	Title of accounts
Current assets	Cash, securities, and account receivables
Fixed assets	<ul style="list-style-type: none"> <li>• Tangible fixed assets, land, buildings, and equipment</li> <li>• Intangible fixed assets, patent rights, leasehold, and goodwill</li> </ul>
Deferred assets	Initial expenses, development cost, and bonds issuing cost

#### Reference

### Net asset

“Net asset” is the total amount of assets minus total liabilities.

#### Reference

### Title of accounts

“Title of accounts” refers to journalized items used as the title in financial statements. Examples of title of accounts are cash, costs, products, account payable, and accounts receivable.

“Accounts payable” means a transaction with credit, not cash, and on the other hand, “accounts receivable” means to receive the payment of sold products later.

#### Reference

### Current ratio

“Current ratio” is an index to show how much current assets exceed current liabilities. It is obtained from “ $\text{Current ratio} (\%) = \text{Current assets} \div \text{Current liabilities} \times 100 (\%)$ .”

The higher this ratio, the greater the stability with which the corporation’s business is conducted.

### ● Liability

"**Liability**" is owed payments. It refers to "**debts**" that have to be paid.

Typical liability titles of accounts are as follows:

Liability	Title of accounts
Current liability	Bill payable, accounts payable, and short-term debt
Fixed liability	Corporate bonds, long-term debts, and allowance for employee retirement benefits

A balance sheet is shown in the table format as follows:

Item	Amount	Item	Amount
(Assets part)		(Liability part)	
Cash	1,000,000	Debt	70,000
Accounts receivable	50,000	Accounts payable	40,000
Products	60,000		
		Total: Liability part	110,000
		(Net assets part)	
		Capital	800,000
		Profit	200,000
		Total: Net assets part	1,000,000
Total: Assets part	1,110,000	Total: Liability and net assets part	1,110,000

In a balance sheet, products, etc. are all converted to a monetary value, and journalized. When a lease is contracted, no money transaction is made simply through execution of a contract; therefore, it is not recorded.

### (2) Income statement (P/L)

"**Income statement**" shows profit and loss in a specific term. By showing costs (loss) and profits (income), the business result of a corporation can be clarified.

Income statement	
From April 1, XXXX	To March 31, XXXX
(Unit: thousand dollars)	
Sales	1,000
Cost of sales	650
Gross profit	350
Selling, general and administrative expense	200
Operating profit	150
Non-operating income	30
Non-operating profit and loss	50
Current profit	130
Extraordinary profit	10
Extraordinary loss	20
Profit before tax	120
Corporate tax, etc.	50
Net profit for the fiscal year	70

### (3) Cash flow statement

“Cash flow statement” is a flow of capital (cash) in a specific term showing how much cash there is at the beginning of a term, and how much cash will remain at the end of the term. By creating a cash flow statement, a flow of cash can be clarified. Also, by referring to an income statement, and a balance sheet together, stable capital management and capital operation plan can be decided, and efficient business is possible.

Cash flow statement	
	(Unit: thousand dollars)
Category	Amount
<b>Cash flow based on sales activities</b>	
Net profit for the fiscal year	120
Depreciation	40
Increased amount of accounts receivable	-30
Decreased amount of accounts payable	-13
Increased amount of inventory asset	-10
...	
<b>Cash flow based on sales activities</b>	<b>107</b>
<b>Cash flow based on investment activities</b>	
Expenditure based on acquisition of tangible fixed assets	-75
Income based on sales of tangible fixed assets	32
<b>Cash flow based on investment activities (Total)</b>	<b>-43</b>
<b>Cash flow based on financial activities</b>	
Increased or decreased amount of short-term debt	95
Payment amount of dividends	-6
<b>Cash flow based on financial activities (Total)</b>	<b>89</b>
Increased or decreased amount of cash and cash equivalents	153
Opening balance of cash and cash equivalents	283
<b>Ending balance of cash and cash equivalents</b>	<b>436</b>

### (4) Closing account

“Closing account” is to calculate annual income and cost, and clarify financial conditions. In business accounting, information is disclosed by creating financial statements such as a balance sheet, an income statement, and cash flow statement in addition to calculation of simple profit and loss.

In principle, created financial statements are given the final approval at a stockholders meeting after being audited by an auditor and a certified public accountant.

Reference

#### Consolidated closing account

“Consolidated closing account” is for a parent company to put together financial statements of its subsidiaries and conduct financial closing as a whole group.

Reference

#### Consolidated financial statements

“Consolidated financial statements” are to put together consolidated closing accounts as a whole group, and create financial statements to report financial conditions, business results, and cash flow conditions comprehensively.

A balance sheet in consolidated closing accounts is called a “consolidated balance sheet,” an income statement is called a “consolidated income statement,” and a cash flow statement is called a “consolidated cash flow statement.”

Reference

#### Disclosure

“Disclosure” is to disclose various information of a company to the public. By disclosing accounting information to the interested parties, such as stockholders and investors, in a timely and appropriate manner, business transparency is increased, leading to establishment of a relationship of trust and improvement of corporate values.

Reference

#### IPO (Initial Public Offering)

“Initial public offering” is to enable an unspecified number of investors to buy and sell unlisted stocks of a company in the stock market.

Reference

#### Annual securities report

“Annual securities report” is a report created to disclose corporate information externally. In accordance with the Financial Instruments and Exchange Act in Japan, for listed companies and companies where the number of people who hold securities is 1,000 or more, there is an obligation to submit this report.

The annual securities report describes corporate information such as general conditions of the company, business conditions, facility conditions, accounting conditions, and audit reports.

## ④ Profit indicator

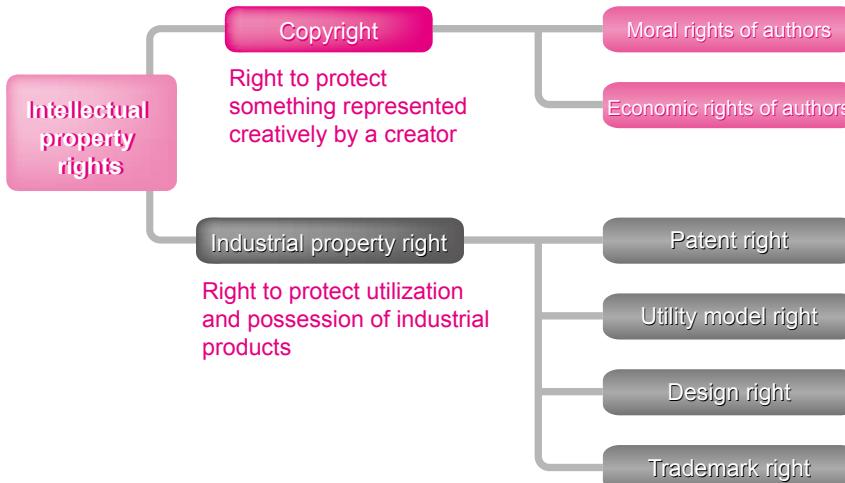
The “ratio of net profit to capital” is an indicator of a corporation’s profitability. The ratio of net profit to capital is a ratio showing how much capital is used and how much profit is gained. The main types of ratio of net profit to capital are as follows:

Type	Description
ROA (Return on Assets)	<p>It is also called the “net capital-profit ratio” that shows the ratio on how much profit is made from all capital possessed by a corporation.</p> $\text{ROA} = \text{Current profit} \div \text{Total capital} \times 100$ <p>It is obtained by dividing the current profit in an income statement by the total capital in a balance sheet. Including activities except for main business, current profit is used for calculation in order to view the profitability of overall corporate activities.</p>
ROE (Return on Equity)	<p>It is also called the “owned capital-profit ratio” that shows the ratio of how much profit is made from the owned capital of a corporation.</p> $\text{ROE} = \text{Net profit for the fiscal year (After tax profit)} \div \text{Equity capital} \times 100$ <p>It is obtained by dividing the net profit for the term in a income statement by the equity capital in an balance sheet. Equity capital is the total of the net assets part excluding stock options and minority interests. For calculation, the net profit for the term is used, that is, the profits distributable to shareholders.</p>
ROI (Return on Investment)	<p>It is also called the “return on investment ratio” or “investment return ratio” and shows the ratio of how much profit is made from the capital spent on business.</p> <p>It is used to check how much profit is gained from a specific investment, such as business conducted in a project unit.</p> $\text{ROI} = \text{Business profit} \div \text{Invested capital} \times 100$ <p>It is obtained by dividing the business profit with the invested capital. Business profit and invested capital are calculated by a method uniquely adopted by a corporation.</p>

[Note] This section explains the laws and regulations in Japan. And this can be used for your reference only

## 1-2-1 Intellectual Property Rights

“Intellectual property rights” are rights provided in order to protect generated entities through the intellectual creative activities of humans. Intellectual property rights can be classified as follows:



### ① Copyright

“Copyright” is a right to protect something represented creatively by a creator. Originally, it was created for the purpose of protecting a creator’s right on paintings and novels, and has since been applied to programs and data as computers spread. A copyright protects something creatively represented, while an industrial property right protects ideas. Also, a copyright becomes present at the time a copyrighted work is created; therefore, it is not necessary to apply and register in order to obtain a right. A copyright has the “moral rights of authors” and “economic rights of authors.”

#### (1) Moral rights of authors

“Moral rights of authors” are specific rights that only an author can have in order to protect his/her feelings, emotions, and conscience. This right belongs to an author, and is basically not subject to transfer and inheritance. Also, the protection period is considered permanent.

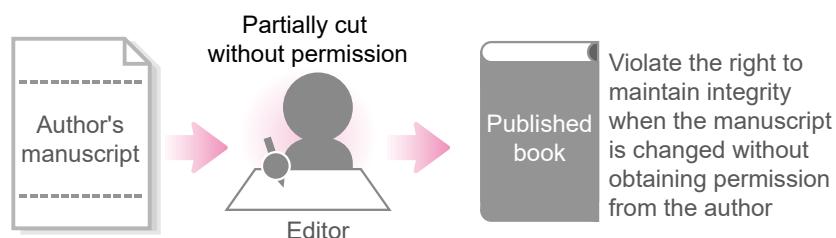
The types of moral rights of authors are as follows:

Moral rights of authors	Details
Right to make the work public	Right to determine a publicizing time and method.
Right to indicate a name	Right to determine to display a name and use a real name at publicizing.
Right to maintain integrity	Right to prevent a copyrighted work from being changed without the author's knowledge.

#### Reference

### Neighboring rights

“Neighboring rights” are rights possessed by a person who plays an important role in the transmission of copyrighted works, such as players and broadcasting business owners. For example, neighboring rights are violated if one records concerts of singers without permission. The protection period is 50 years after actual performance.



## (2) Economic rights of authors

“Economic rights of authors” are rights to protect the financial aspect on a copyrighted work. Economic rights of authors are generally represented as “copyright.” The protection period is in principle 50 years after the death of an author, and 50 years after publicizing in case of a corporation. Also, from the perspective of a property, a part or whole can be transferred and inherited.

The types of economic rights of authors are as follows:

Economic rights of authors	Details
Reproduction right	Right to reproduce by methods such as copying, taking pictures, sound recording, and video recording.
Translation right	Right to translate and arrange a copyrighted work.
Lending right	Right to provide duplicates of a copyrighted work (excluding movies).
Public transmission right	Right to broadcast a copyrighted work, and automatically send information from servers on the basis of a request from the public.
Screen presentation right	Right to show movies of a copyrighted work.
Recitation right	Right to communicate a copyrighted work through methods such as reading aloud.

## (2) Intellectual property rights of web pages

Web pages are not included in the concrete exemplification of a copyrighted work as determined by the Copyright Act Article 10 (1). However, if a copyrighted work is “entities that ideas or emotions are creatively represented and belong to the range of literature, science, arts or music” as defined in the same Act Article 2 (1)(i), web pages consisting of creative expression can be considered to be protected as a copyrighted object. When web page creation is outsourced, it is important to clarify to whom its copyright belongs.

Also, it is important not to violate others’ copyrights on information written on web pages.

## ② Laws on industrial property rights

“Industrial property rights” are rights to protect from imitation by providing the right to use ideas, findings, designs, and logos of industrial products in a monopolistic way. These rights are under the jurisdiction of the Patent Office. The types of industrial property rights are as follows:

Industrial property rights	Protection target	Associated law	Protection period
Patent right	Ideas and inventions	Patent Act	20 years from application
Utility model right	Ideas and new devices on the shape and structure of goods	Utility Model Act	10 years from application
Design right	Design (including designs and decorations on goods)	Design Act	20 years from registration
Trademark right	Trademark (symbols and product name on goods that represent products)	Trademark Act	10 years from registration (can be extended repeatedly)

## ③ Unfair Competition Prevention Act

“Unfair Competition Prevention Act” is the laws enacted to regulate unfair competition behaviors. Specifically, applicable behaviors are stealing trade secrets and ideas, imitation of commodities, and spreading disadvantageous rumors. When competition by these fraudulent behaviors is allowed and neglected, the adequate competition principal is damaged causing market confusion and significant damage to consumers.

While the intellectual property rights are to protect rights, the Unfair Completion Prevention Act was enacted with the purpose of controlling illegal behavior that destroys adequate competition on the basis of the idea that it exists only when an adequate market is secured.

Main behaviors applicable to unfair competition acts are as follows:

- The act of utilizing its advertisement effect by using others' famous brands
- The act of selling counterfeit products that look identical to genuine products on the date three years or less from the date on which genuine products were put on sale
- The act of acquiring and using confidential information such as manufacturing technology information and customer information of other companies through wrongful methods such as fraud and theft
- The act of displaying false information on products concerning place of origin, quality, contents, manufacturing method, usage, quantity, etc.
- The act of stating a false fact and starting a rumor that harms confidence in sales of others who are in a competitive relationship
- The act of acquiring a domain name of a well-known enterprise and abusing it

Under this Act, it is possible to stop illegal behavior by the offenders, claim measures to recover trust, claim for damage easily according to an estimate of damaged value, and lodge a criminal complaint depending on illegal acts.

### Reference

#### Trademark and service mark

“Trademark” is used on goods, and “service mark” is used on services.

### Reference

#### Business model patent

“Business model patent” is a patented business system. Especially because of advancement in IT, IT is adopted in business methods, and such things as what to conduct as business and where to gain profit are materialized. It began from applying a case to actualize a new business model as a patent, and the application was not denied. The Japan Patent Office calls this a “patent of a business method.”

### Reference

#### Trade secrets

Trade secrets in the Unfair Competition Prevention Act indicates trade and technical information managed as confidential inside a company, and includes know-how and customer lists that the company does not disclose, sales manuals, transaction conditions, and system design documents.

## 4 Software license

“Software license” is a software usage authorization. It is prohibited to copy and change software exceeding the range of usage authorization. In the case of software, a “license agreement” is generally made when a user purchases the product.

### (1) Software and copyright

Software is subject to protection by the Copyright Act. Making illegal copies of software are evidently a violation of the copyright, and a criminal act; therefore, users must be cautious.

Protection targets by the Copyright Act are as follows:

Field	Protection target	Out of protection target
Program related	<ul style="list-style-type: none"> <li>• Program itself (source program/ object-oriented program/ application program/ operating system)</li> </ul>	<ul style="list-style-type: none"> <li>• Solution method for program</li> <li>• Algorithm</li> <li>• Language for program creation</li> <li>• Rules</li> </ul>
Data related	<ul style="list-style-type: none"> <li>• Database</li> </ul>	<ul style="list-style-type: none"> <li>• Data itself</li> </ul>
Multimedia related	<ul style="list-style-type: none"> <li>• Web page</li> <li>• Still images, videos, and voice as materials</li> </ul>	

In software, there is “public domain software” in which a copyright is abandoned. A manufacturer abandons all rights in this type of software; therefore, people can use the software freely, copy, and modify freely.

### (2) Prohibition of copying software

It is prohibited to copy software without permissions of owners of its copyright. Usually when software is purchased from a supplier, it includes a contract that states provision of a license to use software only when a user agrees with the contents, such as the scope of use described in the contract.

Generally, copying is allowed within a limited scope, such as making a backup.

### (3) Volume license agreement

“Volume license agreement” is a purchased software license contract according to the number of personal computers used, when companies and schools install software in large quantities.

Generally, a license for one software package is limited to one computer (or one user), however, when a volume license agreement is made, one software package can be used by the determined number of computers (users). The price tends to be less than purchasing software packages for the actual number of computers, and it can prevent uneconomical packages and manuals. The contents of a contract differ depending on the software manufacturer.

## 5 Other rights

When not stated clearly in laws, there are acknowledged rights effectively on the basis of judicial precedents as follows:

Name	Description
Privacy right	<p>It is a right to conceal individual's private life, and to protect dignity as a person. One can violate the privacy right when wiretapping others' conversations, monitoring others' behaviors, and exposing individuals' private lives. The privacy right is based on the “respect of individuals” in the constitution, and is distinguished from the “Act on the Protection of Personal Information” that protects data.</p>
Portrait right	<p>It is a right to protect an individual's image when it is taken as pictures and movies, and drawn in pictures.</p> <p>The copyright of pictures, movies, and images belongs to those who took pictures and drew images; however, the portrait right that is an individual image belongs to the person who is the subject thereof. The portrait right is violated if these are disclosed without the permission of the subject.</p>
Publicity right	<p>It is a right provided to entertainers, sports players, and other famous people, protecting profitability (economic profit) against names and portraits.</p> <p>The publicity right is violated when one uses a name and portrait of a famous person without permission.</p>

## 1-2-2 Laws on Security

Recently the laws related to security have become very important, as computer-related crime has been on the increase.

The representative laws on security are “**Act on the Prohibition of Unauthorized Computer Access**” and “**Basic Act on Cybersecurity**.”

### Reference

#### Free software and shareware

“Free software” is software distributed free of charge.

“Shareware” is software that can be purchased after a user tries the software for a specified period, and decides to purchase it.

The copyright of free software, shareware, and program created by outsourcing belongs to the creator unless a special contract is made, and copying, redistribution, and modification are not allowed.

## ① Act on the Prohibition of Unauthorized Computer Access

The "Act on the Prohibition of Unauthorized Computer Access" is a law to control crimes by the act of unauthorized access. Punishment is possible without actual damage. The following actions are defined as criminal act.

Action	Details
Act of unauthorized access	Action to use other's identification code (user ID and password) without permission, release a set usage restriction pretending to be the valid user, and make a computer usable.
Act to illegally obtain and save another's identification code	Action to obtain and save another's identification code (user ID and password) in order to conduct unauthorized access.
Act to make requests to enter identification codes illegally	Action to make people to enter their identification code (user ID and password) illegally like a phishing fraud.
Acts of facilitating unauthorized computer access	Action to facilitate unauthorized access by providing another's identification code (user ID and password) to someone other the legal user and the administrator.

Measures to prevent unauthorized access are as follows:

- Thorough management of user ID and password
- Sealing security holes (security bugs)
- Utilization of encryption
- Utilization of electronic signature
- Setting the access right

## ② Basic Act on Cybersecurity

"Basic Act on Cybersecurity" is a law enacted in November 2014, defining basic policy on the strategy, system, and measures as a nation to handle the threat of cyberattacks.

### (1) Background of Basic Act on Cybersecurity

The background of enactment of this law is a response to rapidly increasing "cyberattacks" as the arrangement and popularization of information communication networks, such as progress of the Internet.

Targets of cyberattacks are not limited to the government and public institutes, but now extend to significant infrastructure business operators such as power plant, gas, chemicals, and petroleum.

In order to handle rapidly increasing the threat of cyberattacks, it became imperative to clarify the roles and responsibilities concerning the cyber security of the government, and enhance frameworks and functions.

### Reference

#### Cyberattack

"Cyberattack" is a general term for attacks on computers by accessing computer systems and networks without proper authorization, and stealing, destroying, and modifying data, or destroying a system so as to make it unusable. To take measures against cyberattacks is called "cyber security."

## (2) Basic measures

In the Basic Act on Cybersecurity, it is determined that measures related to cyber security are a State obligation.

Specific measures are to secure cyber security in administrative institutes and significant infrastructure business operators etc., promote spontaneous handling of private business owners and educational research institutes, control crimes, prevent damage expansion, encourage education and learning, and provide public awareness.

# 1-2-3 Laws on Labor

In order to arrange conditions concerning labor, there are laws and regulations on labor.

## ① Labor Standards Act

“**Labor Standard Act**” is the basic act concerning labor conditions, and determines a minimum criteria of necessary working conditions on the basis of the Constitution of Japan Article 27 (2) (Standards for working conditions). Working conditions relating to daily work, such as work hours being eight hours a day, overtime payment, payment of salaries, and annual paid vacation must satisfy the standards determined by this Labor Standards Act.

### (1) Background of Labor Standards Act

In Japan, shortening work hours, diffusion of complete five-day workweek system, complete consumption of annual paid vacation, and reduction of overtime work have been significant problems.

However, it has been difficult to improve working conditions just through individual company effort because of such problems as competitions between companies and other companies in the same business, business practice, and excessive service. This act was legally enacted for the purpose of making it easier to proceed with organization of an environment that shortens work hours.

### (2) Purpose of Labor Standards Act

The purpose of the Labor Standards Act is to protect those workers who are socially and economically weak against their employers (business owners).

### (3) Scope of Labor Standards Act

Regardless of nationality, it is applied to all types of jobs. When one worker outside of relatives is hired, the Labor Standards Act is applied. However, the protection is for workers; therefore, it is not applied to employers (business owners).

### Reference

#### **Labor Contract Act**

The “**Labor Contract Act**” is a law that determines basic items concerning labor contracts.

The purpose is to protect workers and secure stable labor relationship, and it determines conclusion and changes of a labor contract, continuing and ending a labor contract, a labor contract with a specified period, and exceptions. Different from the **Labor Standards Act**, no punishment is defined, nor are there any inspections or guidance by the **Labor Standards Inspection Office**.

### Reference

#### **Flexible working hours system**

“**Flexible working hours system**” is a system employees can select a time to come to and depart from work even though they must be at work during a certain time range (core time).

### Reference

#### **Discretionary labor system**

“**Discretionary labor system**” is a system where employees determine task performance methods and working hours. Regardless of the length of working hours, labor is evaluated by specified results.

## ❷ Labor management agreement

“Labor management agreement” is a document where concluded contents are determined between employers (business owners) and workers concerning the items determined by the Labor Standards Act. Conclusion of Labor management agreement is conducted in units of each business office, and it is necessary to notify the workers adequately. Also, a document created in the contract must be stamped by the president or the head of each business office, and the representative of the workers, and it must then be submitted to the Labor Standards Inspection Office. However, some are not required to submit a document depending on the type of agreement.

### (1) Labor management agreement that has obligation of notification

- Labor management agreement concerning overtime work and work on holidays
- Labor management agreement concerning savings inside a company
- Labor management agreement concerning professional work type discretionary labor system
- Labor management agreement concerning variable working hours system in units of one year

### (2) Labor management agreement that does not have obligation of notification

- Labor management agreement concerning flexible working hours system
- Labor management agreement concerning planned assignment of annual paid vacation
- Labor management agreement concerning exempt employees of child care leave system and family care leave system
- Labor management agreement concerning payroll deduction

### (3) Validity of labor management agreement

By concluding a labor management agreement, items prohibited by the Labor Standards Act can be accepted as exceptions. For example, the Labor Standards Act determines the work hours in a day should be eight hours. When workers must work beyond the determined hours, the employers (business owners) are punished for violating the Labor Standards Act. However, when the rules for working overtime and working on holidays are submitted in the labor management agreement, this shall not be applied. Thus, labor management agreement is effective for avoiding punishment, and this effect is called the “punishment exempt effect.”

## ❸ Act for Securing the Proper Operation of Worker Dispatching Undertakings and Improved Working Conditions for Dispatched Workers

As the law to protect the rights of workers, there is the Labor Standards Act that is applied to all workers including regular employees, dispatched temporary workers, and part-time workers. On the other hand, the

### Reference

#### Article 36 agreement

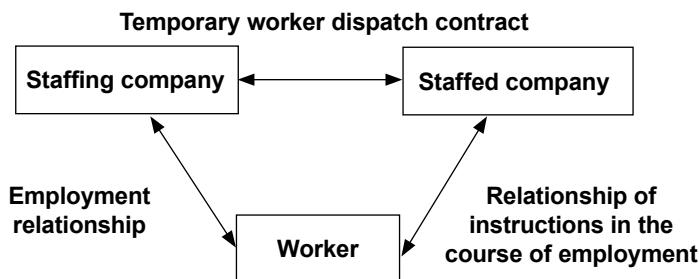
“Article 36 agreement” is an agreement that labor exceeding the working hours (eight hours a day, 40 hours a week) determined by the Labor Standards Act becomes possible.

characteristic of the Act for Securing the Proper Operation of Worker Dispatching Undertakings and Improved Working Conditions for Dispatched Workers is to cover the “**right for a worker who is dispatched from a staffing company**” that cannot be covered by the existing laws.

### (1) Act for Securing the Proper Operation of Worker Dispatching Undertakings and Improved Working Conditions for Dispatched Workers

“Act for Securing the Proper Operation of Worker Dispatching Undertakings and Improved Working Conditions for Dispatched Workers” is the law that determine the rules staffing companies and staffed companies should follow in order to protect the right of a worker sent from a staffing company.

When dispatching a worker to a company, a “**temporary worker dispatch contract**” is concluded between the staffing company and the staffed company. The worker employed by a staffing company then works under the instructions of the staffed company.

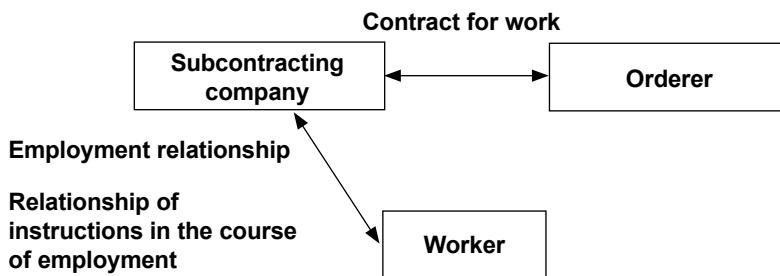


### 4 Contract for work

“Contract for work” is a contract stating the orderer commissions a task to a subcontracting company, and makes payment when the task is complete. Task completion is the purpose; therefore, if no results (deliverables) are made, no payment is made.

A subcontracting company gives the task to subcontractors.

In the contract for work, the workers employed by a subcontracting company work on the task of orderer under instructions of the subcontracting company. Therefore, the line of command is as shown in the following figure.



## **5 Time and material contract**

“Time and material contract” is a contract that a mandator outsources a task to a mandatory, and is concluded by the mandatory accepting the task. Task completion is not always the purpose; therefore, payment is made if some works are completed.

Examples are medical acts (doctors and patients), and an agent for real estate buying and selling (real estate company, customers, and homeowners). A doctor examines a patient, but he/she does not have obligation to cure the patient. A real estate company introduces customers to a room/house, but the company does not have obligation to the homeowner to complete a contract.

## **6 Employment agreement**

“Employment agreement” is a contract to promise that a company makes to pay an individual who provides labor to the company. On concluding a contract, an employer (a business owner) is obligated to clarify the wage, work hours, and other work conditions.

The types of employment are “**regular employee**,” “**contract employee**,” “**part-time worker**,” etc., and the way of working is diversified.

## **7 Nondisclosure agreement (NDA)**

“Nondisclosure agreement” is a contract to promise made by an individual who may have an access to confidential information shall not use information gained from the job except for specified purposes, and does not leak to the third parties.

When a worker is dispatched and a task is outsourced, it is a general practice to conclude a nondisclosure agreement.

The typical conditions in a contract are as follows:

- Specified information to be protected
- Management method
- Disclosure condition to third parties accompanying outsourcing
- Duplication allowed/prohibited
- Usage purpose
- Return of materials and obligation/no obligation to discard

## 1-2-4 Laws on Transaction

In order to arrange conditions concerning transactions, there are transaction-related laws.

### ① Subcontract Act

Under the condition that tasks are outsourced to subcontractors, it can be considered that an outsourcing company is in the superior position to subcontractors. This often leads to unlawful deals such as delayed payment and partial payment not made due to the unilateral reasoning of an outsourcing company.

In order to improve such conditions, maintain fairness in subcontracting transactions, and protect the profit of subcontractors, “**Subcontract Act**” was enacted.

To be more exact, the “**Act Against Delay in Payment of Subcontract Proceeds, Etc. to Subcontractors**” was revised, and enacted in April 2004. Because of this revision, the application of the law is expanded to “**information-based product creation outsource**” (software, program, database, and web content), and punishment for illegal actions is enhanced.

### ② PL Act (Product Liability Act)

The “**PL Act**” is a law determining that a manufacturer is liable for damages when the consumers suffer loss of life or injury to life, body, or property because of a defective product.

Until this law was enacted, it was necessary to prove that an accident occurred because of a fault by the manufacturer, and then the manufacturer was held liable for damages for a victim. After the PL Act was enacted, the manufacturer became liable for damage compensation when it is proved that the product is at fault.

### ③ Specified Commercial Transactions Law

The “**Specified Commercial Transactions Law**” is a regulation concerning door-to-door sales, mail order sales and telemarketing sales. It is also applied to online shopping through the Internet. This law applies specific regulations for mail order sales business owner, and regulates the obligation to display the business owner’s name and address, prohibition of an extravagant advertisement, and the need of a cooling-off system.

#### Reference

##### Cooling off system

“Cooling off system” is a system that a contract can be released without conditions from the consumer side in the specific period after a purchase contract on products and services are concluded through door-to-door sales and telemarketing sales.

## 1-2-5 Other Laws and Guidelines

Besides the laws and regulations on labor and laws on transaction, there are also other laws and guidelines related to corporate activities.

## **1 Act on the Protection of Personal Information**

The “Act on the Protection of Personal Information” is a law to protect the rights and profits of individuals by determining obligations that a business owner who handles personal information must comply with while considering the practicability of personal information. “Personal information” refers to information such as a name, a date of birth, and address that can identify a specific individual. Also, the occupations, salary, family information, and health condition are included in individual information.

Based on this Act, business owners who handle personal information are subject to punishment in case of illegal conduct.

The Act on the Protection of Personal Information prohibits the following actions.

- Handling in excess of the usage purpose of personal information
- Acquiring personal information through unauthorized methods
- Not notifying and disclosing usage purposes when acquiring personal information
- Managing Personal information in conditions that may present a danger of leakage, loss, and damage
- Incomplete supervising on workers in organizations and outsourced destination that handling personal information  
(Taking personal information outside freely)
- Providing personal information to third parties without the person’s agreement
- Not processing requests for personal information disclosure, modification, and suspension of use from the person
- Not disclosing personal information to the person
- Not processing request which is made to modify personal information from the person with a reason conflicting with facts
- Ignoring requests of usage of personal information or provision thereof to a third party, even when the person request
- Handling fee to disclose personal information not within the rational price range

## **2 Act on Regulation of Transmission of Specified Electronic Mail**

The “Act on Regulation of Transmission of Specified Electronic Mail” is to prevent trouble by sending a large number of DM and advertisement e-mails to many and unspecified people.

## **3 Act on the Limitation of Liability for Damages of Specified Telecommunications Service Providers and the Right to Demand Disclosure of Identification Information of the Senders**

“Act on the Limitation of Liability for Damages of Specified Telecommunications Service Providers and the Right to Demand Disclosure of Identification Information of the Senders” is a law that the responsible range of a provider on damage compensation is limited (exemption from responsibility) and victims can ask to disclose the name of originators, when

personal information leakage and slander are publicized in web pages that are present in rental servers operated by the specified telecommunications service providers.

## ④ Whistleblower Protection Act

The “Whistleblower Protection Act” is a law to protect workers who reported a company’s violation of the law whether internally or externally. It prohibits disadvantage actions such as firing, demotion, and salary cut for those who reported.

Revealing a company’s deplorable acts results in loss of trust in the company; however, it is an advantage for the whole of society and consumers. Also, in the long-term view, it can lead to purification of stagnated abuses and healthy corporate activities for a company.

## ⑤ Act on Access to Information Held by Administrative Organs

The “Act on Access to Information Held by Administrative Organs” is a law to protect the right for everybody to request disclosure of all administrative documents possessed by the administrative institutes. When one wishes to view documents created by administrative institutes and submits the information disclosure request, the individual can view those documents. However, if a document contains confidential information (personal information to identify individuals and information such that the property right may be violated if publicized), it cannot be viewed.

## ⑥ Guidelines for information security

Guidelines for information security of a company are as follows:

Guideline	Description
Standards for measures against computer viruses	These are measures coordinated for preventing computer virus infection, finding infection, exterminating, and restoring.
Standards for measures against unauthorized access to computers	These are measures coordinated for protecting, finding, preventing, restoring, and recurring unauthorized access to information systems. Its characteristic is that it includes posteriori measures, education, and audit not only from the perspective of management but also in terms of unauthorized access prevention.
Information security management standards	These are standards to determine if risk management is conducted effectively in order to protect information assets. Its purpose is to provide the measures for securing information security in an organization both from aspects of management and technology during system development.
Information security audit standards	These are a system to audit information security adequately. The code of conduct required for system security auditors when performing information security audit is described.

### Reference

#### System management standards

“System management standards” are coordinated standards on what measures a company that has information system should apply. A wide range of guidelines on a whole system from information strategy, planning, developing, operating, maintaining to shared tasks is presented, and standards on more than 280 check items are determined.

## 1-2-6 Code of Ethics

In addition to laws and guidelines, it is necessary to pay sufficient attention to code of ethics.

### ① Compliance

“Compliance” is to follow various rules including the legal system, corporate ethics, and code of conduct. It is essential to follow the laws and regulations concerning corporate activities; however, in reality, deplorable events keep occurring caused by lack of moral and sense of significance, taking corporate profits as a priority, and neglecting recognition for criminal acts and social responsibility.

Compliance management is in demand in order to conduct healthy corporate activities that do not cause disadvantages to the interested parties such as investors, clients, and customers.

### ② Corporate governance

“Corporate governance” is a system to prevent deplorable events by business owners and organizations by monitoring corporate activities, and checking management transparency and soundness.

Recently, deplorable events occur successively by corporations and government offices; therefore, it is necessary to govern companies by conducting selection of adequate outside directors, and enhancement of the information disclosure framework and the audit department.

The main purposes of corporate governance are as follows:

- Checking and preventing runaway of a business owner from being blinded by self-interest
- Checking and preventing illegal acts as a group of the company
- Securing transparency, soundness, and compliance of business
- Realizing responsibility for thorough explanation to the interested parties
- Disclosing information promptly and adequately
- Clarifying responsibilities of business owners and business managers of each hierarchy

### ③ Information ethics

“Information ethics” is the information moral and information manner to pay attention in the information society.

In society today, where information can be obtained through different methods, it is necessary to be cautious of intellectual property rights such as copyrights, and privacy rights. Also, the Internet occupies the significant position as a place to handle information where ethical problems are likely to occur because of its characteristic of anonymity and therefore, we need to be cautious of the “netiquette.”

The “**netiquette**” is etiquette when using a network. Examples of the netiquette are as follows:

- E-mail that needs to secure confidentiality is sent by means of encryption.
- Clarify the identity such as names in public e-mail.
- Do not send large data. When large data is sent, compress the data.
- Do not send advertising e-mail to many and unspecified persons.
- Do not send chain mail
- Do not use machine-dependent characters such as single-byte Katakana characters and special symbols.
- Do not handle images that violate public order and morality.
- Do not post derogatory remarks against others.

#### Reference

### Netiquette

“Netiquette” is a coined word combining “Network” and “Etiquette.”

#### Reference

### Chain mail

“Chain mail” is e-mail that is instructed to send e-mail with the same content to many and unspecified persons, and forward it in a chain successively.

## 1-2-7 Standardization

Each standardization organization sets “**standardization**” in order to improve quality, reduce cost, and conduct commonization and optimization.

### ① Standardization

The purpose of “**standardization**” is to determine business accessibility and communication, and to effectively prevent divergence and complication. It is defined by international standardization organizations and major domestic standardization groups such as “**ISO**.”

Standardization is utilized often in manufacturing industry, design document writing of software development, and software development. As the results, it provides advantages to raise the level of employees and quality, and be able to proceed business activities smoothly; therefore, it is regarded to have merits on economic effects and consumers.

#### Reference

### De facto standard

“De facto standard” refers to industrial standards in the practical sense. They are not official standards; however, their rate of usage is high in specific industries, and actually treated as industrial standards.

## ② Standardization organizations

Representative standardization organizations are as follows:

All organizations are non-profits, and their purposes are to promote standardization of technology.

Organization name	Description
ISO (International Organization for Standardization)	ISO is an organization to perform standardization in a wide range of fields for the purpose of promoting distribution of international goods and services smoothly.
IEC (International Electrotechnical Commission)	IEC is an organization to perform standardization in the electric and electronic fields.
IEEE (Institute of Electrical and Electronics Engineers)	IEEE is an organization to perform standardization of electronic components and communication methods. “IEEE 802 committee” is a subcommittee to standardize LAN, “802.3 committee” for Ethernet, and “802.11 committee” for wireless LAN.
W3C (World Wide Web Consortium)	W3C is an organization to perform standardization of the web technology. It determines specifications for HTML and XML.

## ③ International standards

Representative international standards are as follows:

International standards	Description
ISO 9000	<p>It is a series of international standards concerning “Quality management system” in a company. In Japan, it is regulated as “JIS Q 9000.” It is regulated that a corporation establishes a system to supply products and services to meet the needs of customers in a stable way, together with continuous maintenance and improvement.</p> <p>Based on this standard, the corporate side self-evaluates the quality of supplied products, and obtains objective evaluations by requesting a third-party examination institute to gain authorization. On the other hand, the customer side uses the standard to estimate if a company can be trusted.</p>
ISO 14000	<p>It is a series of international standards concerning “Environment management system” in a company. In Japan, it is regulated as “JIS Q 14000.” It specifies the conducting of measures for environment maintenance through the PDCA cycle of planning, doing, checking, and acting.</p>
ISO/IEC 27000	<p>It is a series of international standards concerning “Information security management system (ISMS)” in a company. In Japan, it is regulated as “JIS Q 27000.” It specifies evaluation of information security risks, and applies adequate measures by using adequate guidelines. Also, a threat to information security is constantly changing; therefore, it specifies the change of measures continuously through the PDCA cycle.</p>

### Reference

#### JIS (Japanese Industrial Standards)

“JIS” refers to the standards determined to promote standardization of industrial products in Japan. It determines standards concerning types, shapes, dimensions, and structures of industrial products.

## ④ Examples of standardization in IT

The following standardizations are applied in IT.

### (1) JAN code

“JAN code” is the JIS standard on one-dimensional code (bar code) that can be read information to the side direction, and from the left. Two digits represent a country, five digits for manufacturer code, five digits for product code, and one digit for check code, giving a total of 13 digits. Recently, bar codes have been printed on parts of most product packages, and used daily at cash registers in supermarkets and convenience stores. By placing a reading device to bar codes, product names and prices are entered in cash registers.

Also, numbers are printed together under a bar code, and when the bar code cannot be read, the numbers can be entered from a keyboard.

Sample of JAN code



Reference

### Types of JAN code

The standard JAN code is 13 digits, and the short version is eight digits.

Reference

### ISBN code

“ISBN code” is the identification code given to books. It is used as the world standard to specify books.

### (2) QR code

“QR code” is JIS standard of code that has information in two directions, vertical and horizontal. It is also called a “**Two-dimensional code symbol**.”

In a QR code, there are cutting out symbols on three corners of the code, and the code can be read quickly and accurately from any direction, across 360°.

QR code is used in a wide range of fields from industrial field such as components and product management, inventory control, and our daily life environment such as name cards and leaflets.

Sample of QR code



[Note] Answers can be found on page 2 of the appendix "Answers and Explanations for the Chapter Quiz" at the end of this book.

 Q 1-1

**Company A outsourced work to construct a product management database system for in-company use to System Company B , which is a subsidiary of Company A. After requirements are defined on the system with Company A, Company B outsourced the tasks from system designing to programming, and testing to Company C. Company C assigned the sequence of tasks to Employee D. In this case, to whom does the copyright of the product management database system of Company A belong? No special agreement was made beforehand concerning copyright ownership.**

- a) Company A
- b) Company B
- c) Company C
- d) Employee D

 Q 1-2

The state of collection of accounts receivable in each sales department of Company D is shown in the table below. When a long-term bond is defined as an account that payment delay is 91 days or more, which of the following is the ratio of the long-term bond value in accounts receivable that passed the collection deadline?

		Units: \$1,000			
	Payment confirmed	Payment delayed (1 to 30 days)	Payment delayed (31 to 60 days)	Payment delayed (61 to 90 days)	Payment delayed (91 days or more)
1st Sales Department	880	12	5	5	3
2nd Sales Department	97	15	8	4	10
3rd Sales Department	550	10	7	3	3
4th Sales Department	390	21	10	2	2

- a) 15%
- b) 18%
- c) 5%
- d) 8%

**Q 1-3**

Which of the following is an appropriate description concerning a temporary dispatched worker?

- a) Complaint from the dispatched temporary worker is handled by the staffing company that dispatched the worker, not by the staffed company.
- b) The staffed company is able to dispatch the temporary worker dispatched from the staffing company if the worker engages in tasks at a group company of the staffed company.
- c) Regardless of the staffing company that dispatches the temporary worker concludes and submitted Article 36 agreement, the staffed company cannot make the temporary worker work overtime or work on holidays.
- d) When the staffed company is employing the temporary worker for a task whose period is limited to three (3) years, if the temporary worker is changed during the period, the staffed company needs to give notification of the remaining period when concluding the employment agreement.

**Q 1-4**

An ABC analysis was conducted on the products below that are handled by Company G, which products become the object of focus and priority management?

Product code	Sales volume	Unit price
1	480	150
2	600	65
3	860	900
4	465	180
5	2,200	250
6	680	90
7	905	320
8	1,570	320
9	640	150
10	345	350

- a) Product code 3, 5, and 8
- b) Product code 3, 4, and 7
- c) Product code 7, 9, and 10
- d) Product code 1, 2, 4, and 6

**Q 1-5**

In the Act on the Prohibition of Unauthorized Computer Access that controls actions of unauthorized access, which of the following is regulated as the action to encourage unauthorized access?

- a) Providing other's user ID and password obtained illegally to a third party without permission
- b) Sending a large amount of data that servers cannot process, and stopping function of the servers
- c) Sending e-mails pretending to be an existing company and organization, leading its recipient to a fake web site, and making the recipient enter user ID and password to obtain the information
- d) An administrator's rewriting salary data by logging into the system with his own user ID and password that has administrator privileges

**Q 1-6**

How much is the inventory evaluation value when the end of term inventory items of Product A is evaluated by the first-in first-out method?

	Count	Unit price
Initial inventory	4 units	100 dollars
Oct. purchase	2 units	110 dollars
Nov. purchase	4 units	120 dollars
Jan. purchase	3 units	130 dollars
Feb. purchase	5 units	140 dollars
End of term inventory	10 units	

- a) 1,010 dollars
- b) 1,100 dollars
- c) 1,220 dollars
- d) 1,330 dollars

**Q 1-7**

Which of the following is the law that protects from stealing the trade secrets and ideas that a company has not disclosed?

- a) Copyright Act
- b) Unfair Competition Prevention Act
- c) Act on Specified Commercial Transactions
- d) Act on the Prohibition of Unauthorized Computer Access

**Q 1-8**

Company A makes an order of novelty goods for sales promotion every week with the periodical ordering method. In the conditions described below, what is the ordering quantity at this time?

[Conditions]

- (1) The inventory quantity at the point of ordering this time is 210 units.
- (2) On average, 70 units are consumed in one week.
- (3) The safety stock quantity is 35 units.
- (4) The delivery lead time is three (3) weeks.
- (5) There is no order remaining.

- a) 40
- b) 65
- c) 105
- d) 250

# Chapter 2

# Business Strategy

This chapter explains the typical systems, etc. in each field including information analysis techniques, marketing techniques, business management systems, and technological strategies.

## 2-1-1 Business Strategy Techniques

“Business strategy” refers to a concept that is shown from a long-term viewpoint for adapting to all changes surrounding a company, thus allowing the company to grow ahead of other companies.

A company creates its business strategy according to the steps shown below.

Clarification of the management concept

The meaning of existence of the company and the action guidelines are clarified.



Clarification of business objectives

The ultimate goal aimed by the company is clarified.



Definition of the corporate domain

The positioning of the company in the market is defined.



Deciding the business strategy

The future concept for continued existence while adapting to changes is decided.

### ① Analysis methods of management information

In order to decide a business strategy, it is necessary to understand the company's capabilities and analyze the position where it is currently placed, as well as the status.

The data analysis techniques for a business strategy include the following:

#### (1) SWOT analysis

“SWOT analysis” refers to the analysis and evaluation of the strengths, weaknesses, opportunities, and threats.

Strengths and weaknesses clearly identify the strengths that must be utilized and weaknesses that must be overcome by analyzing the “internal environment” of the company. The internal environment includes the manpower, sales capabilities, product strength, sales force, technological capability, brand, competitiveness, and financial condition.

Threats and opportunities assess the opportunities that must be used and the threats that must be stood up to by analyzing the “**external environment**” surrounding the company. The external environment includes changes in the political, economic, and social conditions, and also in laws, marketability, and price, as well as the customer trend and competitors.

SWOT analysis is also used when deciding the marketing plan and risk management policies, and can be called the typical analysis technique for analyzing the business environment.

External environment			
Internal environment	Opportunities		Threats
	Strengths	What are the social opportunities that make use of the company's strengths?	Can the social threats be overcome by the company's strengths?
	Weaknesses	What are the social opportunities that seem to be lost due to the company's weaknesses?	What are the social threats that could be actualized due to the company's weaknesses?

## (2) Product life cycle (PLC)

“**Product life cycle**” is the cycle from the time the sales of a product are started and the product appears in the market until the time the sales of the product end and it is lost from the market.

The product life cycle is divided into the below-mentioned four stages, and is useful for examining the sales strategy in each stage by analyzing the sales and profit of a product.

### ● Introduction stage

This is the stage when a product is introduced in the market. It involves advertising activities and sales promotion activities for increasing awareness about the product. Since there is more investment in the sales strategies than the sales of the product themselves, there is almost no profit.

### ● Growth stage

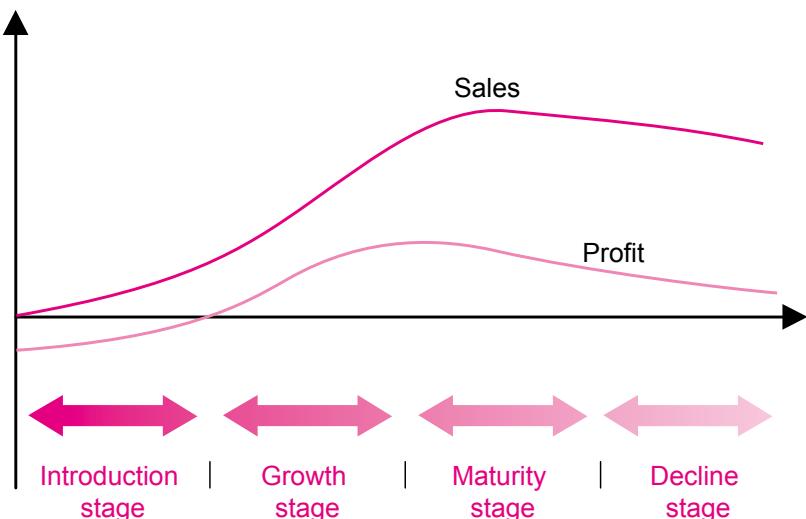
As a result of investments in the introduction stage, the awareness about the product increases resulting in an increase in sales. At the same time, there is an increase in competing products. This is the stage when the demand from consumers also increases, and differentiation from competitors' products as well as version upgrade (improvement) of products is examined.

### ● Maturity stage

In this stage, the product floods the market and consumer demand drops down. As a result, there is no growth in both sales and profit, and a change in strategy is examined. For a product having a high sales share, a strategy for retaining the market (reduction in price as a result of lowering of product cost) is examined, and for a product that cannot secure a market share, a niche strategy (securing profitability in a niche market) is examined.

### ● Decline stage

In this stage, the consumers' demand starts fluctuating depending on the price and the price war intensifies. Therefore, both the sales and profit tend to drop, and the future progress, including withdrawal from the market, is examined. It is examined whether to retain the market by complying with the existing consumer demands without multiplying the cost, or whether to perform re-investment in order to switch to follow-on products while retaining the value of existing products.



### (3) Product portfolio management (PPM)

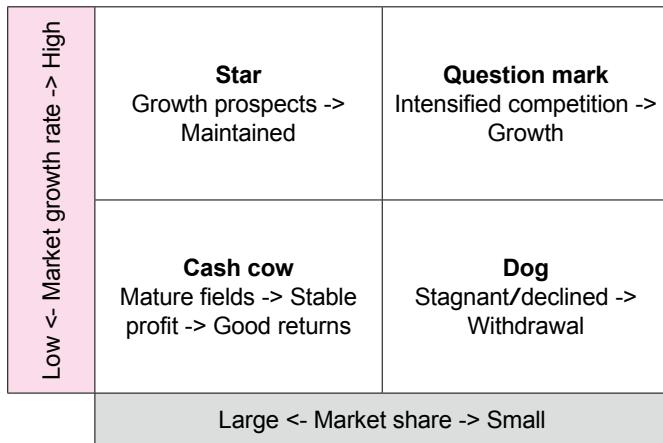
“Product portfolio management” is a technique of business analysis in which the businesses and products handled by a company are plotted on a graph with the market rate share and market growth rate as the axes, and are classified into the four categories of “Star,” “Cash cow,” “Question mark,” and “Dog.” By allocating the management resources to four categories, the most appropriate combinations of businesses and products are analyzed effectively and efficiently.

Category	Details
Star	This refers to businesses and products that are profitable but require investment. These are grown and mature businesses and products that require funds for retaining the market, but the rate of return is high.
Cash cow	This refers to businesses and products that generate profit with a small investment. These are mature businesses and products with a high rate of return that do not require much investment (funds) since the market share is large. It is better to suppress surplus investment.
Question mark	This refers to businesses and products that are unprofitable, but that are expected to grow in future through additional investment. While the growth rate is high, the investment (funds) is large since the market share is small. These are businesses and products that are expected to grow in future, and a strategy for converting them to “Star” is needed.
Dog	This refers to businesses and products that have low growth prospects and that must be basically withdrawn from the market. These are businesses and products that are on a decline, and both the outflow of investment and the inflow of funds are low. Unless an income that is in excess of the investment is expected, they must be withdrawn or scaled down.

#### Reference

##### Benchmarking

“Benchmarking” refers to the analysis of the best methods of the superior companies and superior examples, and the use of the hints acquired from the analysis results for the improvement of management and business operations.



#### (4) Growth matrix analysis

The “Growth matrix analysis” was proposed by the economist H. Igor Ansoff, and is therefore, also referred to as the “**Ansoff growth matrix**.” It is a technique by which the orientation of the growth strategy of a company is derived from the relationship between the “**Products and services**” of the company and the “**Markets**.” Analysis is performed by using a matrix classified into four categories by setting “**Products and services**” on the horizontal axis and “**Markets**” on the vertical axis, and further setting “**New**” and “**Existing**” on each axis.

Markets	New	<b>Market Development</b> Deploying existing products for new customer segments	<b>Diversification</b> Foraying into new areas
	Existing	<b>Market Penetration</b> Increasing competitive superiority by acquiring competitive superiority	<b>Product Development</b> Deploying new products for existing customer segments
	Existing	New	
Products and services			

## 2 Terms on business strategy

In order to implement business objectives and enable the company to grow ahead of other companies, it is important to create a “**business strategy that serves as competitive superiority**.”

### (1) Business strategy

“**Competitive superiority**” refers to positioning by which it is determined whether or not a company has an advantage over its competitors. In the modern society where information can be acquired by all means, most of the differentiation strategies may be copied by other companies. In order to offer customers value better than competitors, it is necessary to create a business strategy that is based not only on independent predominance such as a low price, but also on several factors that are a combination of design, quality, production system, and brand, etc.

### Reference

#### Corporate brand

“Corporate brand” refers to the brand with respect to the company name. It expresses the image and degree of reliability of the company, and plays an important role in establishing competitive superiority.

A typical business strategy has the items described below.

Reference	Strategy	Details
<b>Core competence</b> It refers to the “capability (competence) that acts as the core that cannot be imitated by another company, such as technologies and capital strength.” It is a management resource differentiated from other companies by which businesses and products that are the strength of one’s company and that cannot be achieved by another company are created. Moreover, it leads to a competitive edge over competitors in terms of the business strategy, and acts as the key for the impact and guidance provided to the other party when collaborating with other companies.	Strategy by competitive position	<p>It is a competitive strategy that is optimally selected by focusing on the position of a company in the industry and determining the position into which it is classified. The position of a company in the industry is classified into the following four categories.</p> <ul style="list-style-type: none"> <li>• <b>Leader</b> It is a company with the maximum market share. The leader performs investment for expansion of the market size and works towards maintaining the market share.</li> <li>• <b>Challenger</b> It is a company that aims at acquiring the top share by expanding its share. The challenger employs a strategy of differentiation by aiming at acquisition of share from the leader and other companies.</li> <li>• <b>Follower</b> It is a company that aims at the creation of new customers while retaining its share. It mimics the products of the leader company, and employs the strategy of creating new customers so as not to snatch the share of its competitors.</li> <li>• <b>Nicher</b> It is a company that aims at acquiring the share in a niche market where competitors have not entered. It employs the strategy of exhibiting unique characteristics by gaining specialty in a niche market, and aiming at acquiring profit in such a market.</li> </ul>
	Brand strategy	It is a strategy for improving the image of customers with regard to a company or the products and services provided by the company.
	Push strategy	It is a strategy by which a company aggressively sells its products to consumers by providing several merits such as sampling sales and contests.
	Pull strategy	It is a strategy of making consumers buy the products of one’s company by arousing consumer willingness to purchase through media such as television and magazines.
	Niche strategy	“Niche” refers to a “gap.” It is a strategy by which the focus is set on a specific market (niche market) rather than markets where large companies have already entered, and the profitability in such a market is checked and maintained. This strategy is also called “Focus strategy.”
	Innovation strategy	It is a strategy that generates a new market value through not only technological innovation, but also through new technologies, as well as concepts and services that did not exist until now.
	Blue ocean strategy	It is a strategy that aims at maximizing profit by developing new markets and providing products and services with a high added value to customers at a low cost.

## (2) Alliance

“Alliance” refers to cooperation and collaboration between companies. As a result of an alliance, it is possible to implement competitive superiority by effectively utilizing the resources of other companies in addition to the resources of one’s own company to perform management. The forms of alliance include the form of collaborating only in specific fields without involving capital ties, and the form of integration of companies with the involvement of capital ties.

### Reference

#### Alliance

Generally the alliance is strong when it involves capital ties and weak when it does not involve capital ties.

Alliance has the following forms:

### ● M&A (Mergers and Acquisitions)

“**M&A**” is a general term for “**Merger and acquisition**” of companies, and while “**Merger**” refers to combining of several companies into a single company, “**Acquisition**” means buying an entire or a part of a company.

An “**Absorption-type merger**” in which one company continues to exist while the other is terminated is also a type of this form. Through M&A, it is possible to develop new businesses in a short period of time by acquiring technologies and know-how that one’s own company does not have. Its merits include the fact that risks associated with business investment can be suppressed and unnecessary competition can be done away with.

The purpose of an M&A is entry in to new businesses and markets, business collaborations, corporate reorganization, business rescue, etc.

### ● Integration by holding companies

A “**Holding company**” is a company that holds a large number of stocks of another stock company with the purpose of controlling the company. The advantages of integration by a holding company include the fact that it is possible to implement a business strategy while always keeping in mind the profit of the entire group, and also improve the speed of decision-making.

### ● Capital participation

“**Capital participation**” refers to acquisition of the stocks of a counterpart company to become its stockholder in order to strengthen the cooperation with the company. Due to possession of capital of the counterpart company, this form gives rise to a cooperative relationship.

### ● Collaboration

“**Collaboration**” refers to implementation of business activities through cooperation between companies. This form includes sales collaboration restricted to specific areas and production collaboration (such as OEM production, etc.), and is also spreading across to collaboration of technologies and joint recycling of waste products.

### ● Fabless

“**Fabless**” refers to a company that does not have its own factory (fabrication) and outsources manufacturing to a subcontractor. Since there is no factory, this form does not involve any initial investment of equipment and maintenance cost. A fabless company locally performs product planning and research and development, and provides products manufactured by OEMs.

### ● Franchise chain

“**Franchise chain**” refers to a segment of the retail industry according to which the head office offers the business rights, trademarks, and business knowhow to stores, and collects loyalty (compensation) from member stores. It is very often seen in convenience stores and the food service industry, and has the advantage of enabling an increase in the number of stores at a low cost.

### Reference

#### **TOB (Take Over Bid)**

“TOB” is one of the means of M&A and involves the purchase of large quantities of stocks by several unidentified stockholders outside the stock exchange by publishing the tender period and price.

### Reference

#### **MBO (Management Buyout)**

“MBO” is one of the means of M&A, and refers to the purchase of stocks by executives and management, who are not the owners (stockholders), from the owners or parent company, and thus leads to the acquisition of the management rights of the company.

### Reference

#### **Vertical integration**

“Vertical integration” is a strategy of integrating the business areas from the top to the bottom through an alliance or M&A in order to expand the business area of one’s company. For example, a retail company may even deal in manufacturing, and a manufacturer may engage in wholesale business too. By performing vertical integration, the sale trend can be understood fast, and production can be implemented without any waste.

### Reference

#### **OEM (Original Equipment Manufacturer)**

“OEM” refers to the manufacture of products that are sold under the brand of a partner company.

### Reference

#### **Commoditization**

“Commoditization” refers to equalization of the functions and quality of products so that the consumer gets the feel of buying the same product no matter which company the product is bought from. Since it is difficult to differentiate between the products of one’s own company and the competitor products on the basis of the functions and quality of products, the company may be led to lowering of price, thus making it difficult to make profit.

## Matters requiring the resolution of the stockholders meeting

The followings are matters requiring the resolution of the stockholders' meeting:

- Decision regarding remuneration of directors
- Appointment or dismissal of directors
- Dissolution, merger, or division of the company

## (3) Business execution body

The highest decision-making body for Japanese stock companies is the “**stockholders meeting**,” and the business operations in-charge is the “**managing director**,” who represents the company externally, and is also the chief executive officer.

The classification of the business execution body in America is as described below.

Category	Description
CEO (Chief Executive Officer)	It is the position responsible for management as a representative of the company.
COO (Chief Operating Officer)	It is the position responsible for operations management under the leadership of the CEO.
CIO (Chief Information Officer)	It is the position responsible for information-related operations.
CFO (Chief Financial Officer)	It is the position responsible for financial affairs such as procurement of capital and finance, etc.
CCO (Chief Compliance Officer)	It is the position responsible for adherence to the legal system and corporate ethics.

## (4) Scale economy and experience curve

“**Scale economy**” is a concept according to which since the fixed cost decreases as a result of expansion of the production scale, the total cost per unit also reduces.

In contrast, “**Experience curve**” is a concept according to which the experience of workers with respect to work gets accumulated as a result of an increase in the cumulative production of the product, because of which improvement in work efficiency proceeds and the total cost per unit reduces.

If a reduction in the total cost can be estimated by the scale economy and experience curve, the product can be provided strategically at a low cost, and a competitive superiority can be established.

## ③ Using office tools

Rather than using a full-scale business system, it is possible to take advantage of a commercially-available “**Office tool (software package)**” and use it for a business strategy.

A typical office tool includes the following types:

Type	Description
Word processing software	It is equipped with extensive functions of creating, editing, and printing documents in order to configure and print them in an easy-to-read manner.
Spreadsheet software	It is equipped with extensive functions of creating tables and graphs, and analyzing data, etc.
Presentation software	It is equipped with extensive functions of inserting illustrations, graphs, tables, pictures, etc. in presentation materials, and creating or implementing the presentation material.
Database software	It compiles different types of data (information) in a unit having a particular purpose, and stores it centrally at one location to enable efficient management and operation of data.

## 2-1-2 Marketing

“Marketing” refers to activities performed for creating a mechanism for manufacturing and selling products that adequately reflect the demands of the customers. “Marketing research,” “sales; product, and purchase plan,” “sales promotion,” and “customer satisfaction survey” are included as a part of marketing activities.

### ① Marketing research

“Marketing research” refers to collection of different types of information concerning the market for enabling the company to proceed effectively with marketing activities.

Marketing research is performed through various methods, such as research using the Internet, research conducted by gathering consumers and holding discussions, research conducted by distributing questionnaires by post and collecting the answers, etc.

Particularly, marketing research conducted by using the Internet has the advantage of enabling a quick reflection of consumer needs in the product since huge amounts of data can be collected quickly as compared to the other research methods, thus keeping the cost to the minimum, and also because marketing research can be conducted in a short period of time as compared to the postal method.

No matter which method is adopted, how to analyze the data obtained through marketing research and put it to use constitutes a major key of the strategy to be created thereafter.

### (1) Marketing mix

“Marketing mix” refers to the most appropriate combination of the “Four Ps,” namely “Product,” “Price,” “Place,” and “Promotion” in order to achieve the purpose of marketing. While these four Ps are taken into consideration from the viewpoint of the sales side, there are “Four Cs” that are considered from the viewpoint of the customer side in response to the four Ps. The four Cs are “Customer Value,” “Cost,” “Convenience,” and “Communication.”

Four Ps	Contents to be examined	Four Cs
Product	Quality, lineup, design, etc.	Customer Value
Price	Listed price, discounted rate, etc.	Cost
Place	Store location condition, sales path, transportation, etc.	Convenience
Promotion	Advertising, publicity, marketing, etc.	Communication

#### Reference

##### Example of four Ps

For example, the sales policy regarding a vitamin drink of an ABC food corporation is as follows on the basis of the marketing mix (Four Ps).

###### • Product

It is a safe and healthy vitamin drink that is free from artificial flavors and coloring by which the nutrients of vegetables and vitamins, etc. that are lacking in the modern person's diet can be easily acquired.

###### • Price

A handy and easy-to-drink 150-ml bottle is provided at a low price of 1 dollar.

###### • Place

It is placed at the limited item section in convenience stores, and displayed at an easy-to-locate position.

###### • Promotion

It is extensively advertised through a commercial featuring an upcoming young actor.

**Innovator theory**

The "Innovator theory" is a theory by which the attitude of the consumer with regard to the new products is classified into five categories. The consumer layer is classified into the five categories of the innovator, opinion leader (early adopter), early majority, late majority, and laggard.

**Opinion leader**

An "opinion leader" is a person who has a significant impact on the purchase activity of the customers through his/her opinion and actions with regard to the new products and services. Since a new product starts penetrating the market due to the appearance of the opinion leader, the opinion leader is considered important as a marketing strategy of the new product.

**(2) Other marketing analysis and techniques**

The other marketing analysis and techniques include the following:

Type	Description
Segment marketing	It is a technique of classifying markets according to customer needs and the customer layer. It is also called "Segmentation."
Target marketing	It is a technique of narrowing down markets in terms of a target of one's company. It is also called "Targeting."
Direct marketing	It is a technique of approaching only persons who are highly concerned (potential customers) about the products and services of one's company. Telephone, fax, e-mails, postal service, etc. are generally used either individually or in combination.
Positioning	It is a technique of considering how to promote the worth of one's company to the target markets.
3C analysis	It is a technique of analyzing the three Cs, namely Company, Competitor, and Customer, to find out the elements important for achieving the business objectives.
RFM analysis	It is one of the customer analyses for finding out the prime customers in which customers are analyzed from the three viewpoints of "Recency (last purchase day)," "Frequency (purchase frequency)," and "Monetary (Cumulative purchase amount)." By scoring each viewpoint and giving a ranking, the top-level customers are determined to be prime customers, and are decided as the destination of direct e-mails.
Basket analysis	It is a technique of analyzing that a customer who has purchased a particular product has purchased what other products at the same time. The result of analysis can be used for improving sales by exhibiting products that were purchased simultaneously at a close-by location.

**2 Sales, product, and purchase plan**

According to the "Sales, product, and purchase plan," activities are performed strategically based on the analysis result of market survey and the demand and supply forecast.

**(1) Sales plan**

A "Sales plan" refers to planning of who to sell what kind of products and services, and how. Once the sales plan has been decided, the product and purchase plan are established thereafter on its basis.

The below-mentioned "4W2H" are considered the standard for establishing the sales plan.

4W2H	Description
What	The products and services to be sold are decided specifically.
How Much	The price is decided by assuming the volume of sales.
Where	The regions to be targeted are decided.
Whom	The customers to whom the products and services can be sold are predicted.
How	The sales method to be adopted is decided.
Who	Who will sell the products and services is decided.

## (2) Product plan

A “**Product plan**” is a plan by which the consumer needs are understood accurately so as to provide those products and services in the market that can help secure an income. It is decided while taking into consideration the number and configuration of products that are already circulating in the market as well as the new product.

## (3) Purchase plan

A “**Purchase plan**” is a plan for deciding what to purchase from where and under what conditions in order to achieve the sales plan. Since purchase significantly affects sales and profit, it must be examined carefully so that proper cash management can be performed.

If the inventory is reduced too much, it may result in a shortage of products, and if the inventory is increased too much, it may result in surplus inventory. It is important to efficiently rotate the inventory as much as possible to reduce the capital burden, and also make the plan to prevent obsolescence and degradation of inventory.

### Example

The product purchase management is performed by using the spreadsheet software. When a conditional expression that is determined on the basis of the below-mentioned conditions [1] to [3] in the table is set up, what will the computation expression be like?

#### [Conditions]

- [1] “Emergency order” is indicated for a product with a market inventory count of less than 1,000 units.
- [2] “Normal order” is indicated for a product with a market inventory count of 1,000 units or more and less than 3,000 units.
- [3] “No order” is indicated for a product with a market inventory count of 3,000 units or more.

[Note] If characters are entered in arguments, they must be enclosed within single quotation marks (').

### Reference

#### IF conditional expression

`IF(conditional expression,   ,   )`

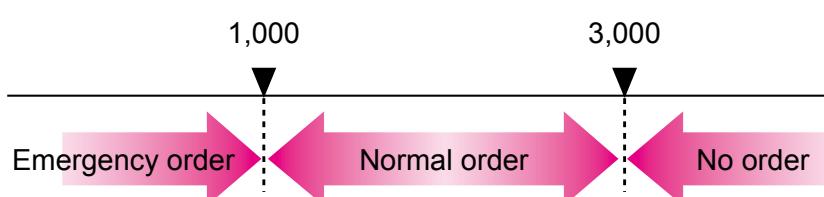
[1]	[2]	[3]
-----	-----	-----

- [1] Numerical formula for determining true or false
- [2] Processing in the case of true
- [3] Processing in the case of false
- [Note] Enter a numerical formula or characters in [2] and [3].

When performing conditional judgment by using the spreadsheet software, use the IF conditional expression.

Here, the below-mentioned three conditional branches are applicable:

- [1] Less than 1,000 units
- [2] 1,000 units or more and less than 3,000 units
- [3] 3,000 units or more

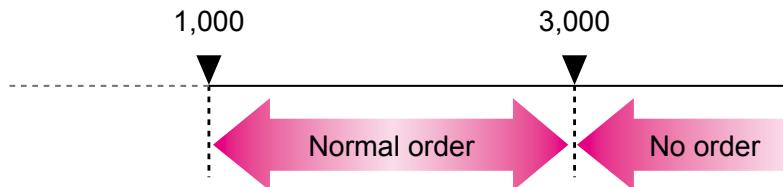


First of all, it is determined whether the inventory is less than 1,000 units. If the inventory is less than 1,000 units, “**Emergency order**” is indicated, and in other cases (1,000 units or more), it is necessary to again establish a conditional expression.

The conditional expression until now is as described below.

IF (Market inventory count < 1000, 'Emergency order', )  
Conditional expression      When true      When false

Enter the conditional expression for the case  
when the inventory count is 1,000 units or  
more.



Next, it is determined whether or not the inventory is 3,000 units or more, and if yes, "**No order**" is indicated, and in other cases (less than 3,000 units), "**Normal order**" is indicated. Note that this value of less than 3,000 units does not include less than 1,000 units. (This is because it has already been processed by the earlier conditional branch.)

Here, the conditional expression is as described below.

IF (Market inventory count  $\geq$  3000, 'No order', 'Normal order')

If the above two conditional expressions are combined together, it results in the following:

IF (Market inventory count < 1000, 'No order', IF (Market inventory count  $\geq$  3000, 'No order', 'Normal order'))

The IF conditional expression is used to determine whether or not a condition is satisfied by using a "**comparison operator**".

The comparison operator used in the IF conditional expression is of the following types:

Type (reading)	Example	Description
= (Equal)	A1 = B1	A1 and B1 are equal
$\neq$ (Not equal)	A1 $\neq$ 3	A1 is not equal to 3
> (Greater than)	B1 > A1	B1 is greater than A1
< (Less than)	B1 < 3	B1 is less than 3 (below)
$\geq$ (Greater than or equal to)	B1 $\geq$ A1	B1 is equal to or more than A1
$\leq$ (Less than or equal to)	A1 $\leq$ 3	A1 is equal to or less than 3

### 3 Sales promotion

"Sales promotion" refers to activities performed with the purpose of arousing the consumers' willingness to buy and the distributors' willingness to sell by using advertisements and campaigns, etc.

Sales promotion must involve various activities to be performed depending on the target such as those for consumers, distributors, and the company (sales department), etc.

Sales promotion is performed by the techniques described below.

Type	Description
Omnichannel	It refers to activities performed to enable purchase of products from all distribution channels and sales channels, without any differentiation, such as actual stores and online stores, etc. For example, it enables the receipt of products ordered from an online store at an actual store, or the instant online purchase of products for which there is no inventory in the actual store.
Cross-selling	It is a technique for expanding sales by convincing a customer to buy not only an individual product, but recommending other products and services, etc. related to that product and convincing the customer to buy those too together.
Up-selling	It is a technique of recommending products with a better quality and higher price than the product that a customer wishes to buy, thus increasing the purchase amount.

## 4 Customer satisfaction survey

“Customer satisfaction survey” refers to quantitatively examining customers’ level of satisfaction with the products and services of one’s company.

The examination of customer satisfaction proves to be useful as a strategy for future business deployment and product development.

The survey methods include the method of making entries in a questionnaire, and holding interview and discussion meetings.

Survey method	Characteristics
Questionnaire survey	It enables the analysis of the trend and needs of the entire market since a large number of responses can be collected.
Interview / discussion meetings	It enables the analysis of the sense of values and needs of an individual since specific and frank responses can be acquired.

Customer satisfaction is generally examined according to the procedure described below.

Decide the product and service to be examined



Decide the survey method



Prepare the questionnaire or interview items



Implement survey



Collect and analyze survey results

Reference

### Sales channel

The “Sales channel” refers to the sales path of a product. It includes sales through stores and mail orders, as well as direct sales.

Reference

### Distribution channel

The “Distribution channel” refers to the path of distribution of products from manufacturers to consumers. It includes commission houses, wholesalers, and retailers.

Reference

### UX (User Experience)

“UX” refers to the experience acquired through products and services. It includes not only the ease of use, but also the feeling of satisfaction and impression.

Reference

### Customer loyalty

“Customer loyalty” refers to the degree of reliability and attachment of the customer to a product and service. That is, it refers to the state of mind according to which a customer who has purchased an item from a specific store buys the item from the same store the next time too. If a customer has a strong loyalty, he/she will buy the same product over and over again, and spread around a good word about the product, which is a favorable action for the company.

## 2-1-3 Business Management Strategy

In order to improve performance in each business, a company must create a relatively specific “**business management strategy**” on the basis of the business management strategy and marketing strategy.

A business management strategy is a strategy that is created by embodying the business strategy and marketing strategy at the business level in order to achieve the objectives of each business.

The general procedure of creating a business management strategy is as described below.



## 2-1-4 Business Management Strategy and Goal/Evaluation

When creating and implementing a business management strategy, it is important to not only set clear objectives, but also perform accurate evaluation by using efficient and appropriate techniques. The typical techniques of analyzing information include the following:

### ① BSC (Balanced Scorecard)

“BSC” is a technique of performing a balanced performance evaluation by evaluating business not only on the basis of the performance displayed in numeric values but also from various viewpoints by clarifying the objectives and strategies of the company. It is used as a technique for creating, implementing, and managing a business management strategy.

In BSC, the business management strategy is incorporated into specific measures for daily business operations from the four viewpoints of “Finance,” “Customer,” “Business process,” and “Learning and growth,” and thus evaluated.

Viewpoint	Details
Finance	It aims at the achievement of objectives from financial viewpoints such as net sales, profitability, closing account, operating profit, etc.
Customer	It aims at the achievement of objectives from the customer viewpoint such as consumers and clients in terms of customer satisfaction, needs, quality, etc. in order to implement the financial viewpoints.
Business process	It aims at the achievement of objectives from the financial viewpoint and customer viewpoint by analyzing what kind of processes are important and what kind of improvement is needed in order to achieve financial objectives and improve the customer satisfaction.
Learning and growth	It aims at the achievement of objectives concerning capability development and personnel development, such as how a company must improve the capability of its employees and maintain the environment in order to have business processes that are superior to those of competitors, achieve customer satisfaction, and achieve financial objectives.

## ② CSF (Critical Success Factors)

“CSF” refers to the critical success factors that are necessary for differentiation from competitors and achievement of competitive superiority. The technique of clarifying the most critical success factor from among the several success factors is called “**CSF analysis**,” and is used as the basis of business management strategy.

Moreover, how much and by when expressed as numerical goals are indicated by “**KGI (Key Goal Indicator)**.” In addition, the more specific goals for achieving the KGI are expressed as “**KPI (Key Performance Indicator)**,” and these are derived from the CSF analysis results. Thus, in order to implement the business management strategy by making use of the CSF, the process of examining the goals in a step-wise manner is followed.

## ③ Value engineering

“**Value engineering**,” which is also called “**VE**,” refers to a technique aiming at improvement of functions and cost-down in order to improve the value of products. It involves performing functional analysis of the product, improving materials and services, and revising the development process.

The implementation of value engineering brings about not only cost-down, but also other effects such as the display of creative ability with regard to new areas, and the acquisition of the thinking power that is always focused on the achievement of objectives. Since analysis is performed in diverse fields, specialists from different areas are gathered together and an organization having diversified knowledge is configured.

## 2-1-5 Business Management System

In order to implement efficient business management, it is necessary to create a system that matches the business management.

Systems managed from a business viewpoint include the following:

Type	Description
SFA (Sales Force Automation)	It is a concept for supporting sales activities by using a computer, etc., or a system for implementing such a concept. An improvement in efficiency and standardization of sales activities is achieved by managing the history of sales negotiations (contact) with customers or sharing customer information or knowhow such as sales techniques, etc.
CRM (Customer Relationship Management)	It is a concept for strengthening relationship with customers across the entire company and not only in regard to sales activities by developing the concept of SFA, or a system for implementing such a concept.
SCM (Supply Chain Management)	It refers to comprehensive management of the flow of activities from placement and receipt of orders between the company and customers, and procurement of materials (raw materials and components) up to inventory control and dispatch of products (supply chain) by using computers and the Internet. By performing consolidated management of information, surplus inventory can be reduced, and the distribution cost can be brought down.
Logistics	It is a mechanism of distribution of goods by which the raw material is procured in accordance with the market demand, and the product is provided to the customer at the appropriate timing. It constitutes one of the SCM.
Knowledge management	It refers to an improvement in business efficiency and quality through sharing of the knowledge, information, and knowhow of an individual across the entire organization and its effective utilization. A database and groupware are used as the mechanism for accumulating and sharing information.
Value chain management	It refers to the creation of value by each department within a company in the supply chain, and an improvement in the value brought about through cooperation between departments. The effectiveness of the business management strategy and the direction of improvement are searched by classifying the business operations into each function, and analyzing the parts that generate added value, and the parts that have strengths and weaknesses as compared to competitors.
Six sigma	It refers to analyzing the business processes by using statistical techniques and improving the problem areas by concentrating on deviations, so as to improve the efficiency of business operations. "Sigma" refers to the standard deviation, and this system aims at minimizing the deviation as much as possible.

Reference

### TOC

#### (Theory Of Constraints)

It is a concept by which the productivity of the entire process is improved through elimination or improvement of factors that hinder the process.

Reference

### TQM

#### (Total Quality Management)

"TQM" refers to the activities performed under the guidance of the management to achieve company-wide quality improvement.

Reference

#### TQC (Total Quality Control)

"TQC" refers to the activities implemented by all departments of the company to achieve company-wide quality improvement.

## 2-2

# Technological Strategy Management

### 2-2-1 Planning of Technological Strategy and Technology Development Plan

Developing new technologies and improving the existing technologies is considered to be the most important matter for the management and continued existence of a company. However, in the current scenario when the environment surrounding the companies and the markets change every second, it is necessary to perform research and development from a long-term standpoint and not just stick to the temporary trends and consumer needs, so as to develop the technical skills of the company.

#### ① Technology development strategy and technology development plan

A “**Technological strategy**” refers to clearly specifying the areas where research and development needs to be strengthened and the areas where research and development needs to be reduced, and deciding the directionality of research and development in the company and the important areas of investment with the purpose of securing a competitive edge in the market in future.

When the technological strategy is decided, the cooperation between the management department and the research and development department is indispensable. The management department contemplates the future of the company, while the research and development department contemplates the future of technology, and both departments set up an interconnected policy.

Once the areas where research and development needs to be strengthened have been decided according to the technological strategy, a “**Technology development strategy**” is decided in order to deploy the technology.

The technology development strategy is used to examine how to procure the necessary technologies. Specifically, it is necessary to estimate the profit brought about by research and development, such as deciding whether to perform in-house research and development of a technology or introduce it from outside, and decide the extent of investment as well as the effect expected to be seen from that investment. In addition, a road map and a technology portfolio reflecting these decisions and predictions are prepared, and specific technological development is promoted.

Sometimes, a technology development strategy may rescue weakened corporate management.

There is a need for a technology development strategy by which the value of a company improves through investment in research and development, leading to an improvement in the motivation of employees.

#### Reference

##### MOT (Management of Technology)

“MOT” refers to management performed for creating an economic value by ascertaining the possibilities of a technology and linking them with business. In order to make important investment decisions for sustainable development of one’s company, it is important to perform examination from the viewpoint of MOT, and improve the compatibility between the business strategy and the technology development strategy.

#### Reference

##### Patent strategy

It is a strategy for understanding the purpose of filing of patent applications and the methods of using patents so as to acquire the patents that can contribute to the profit of the company.

#### Reference

##### Road map

A “Road map” of a company shows the decisions necessary for implementing the technological strategy, as well as the changes and transition in predictions according to the time axis.

#### Reference

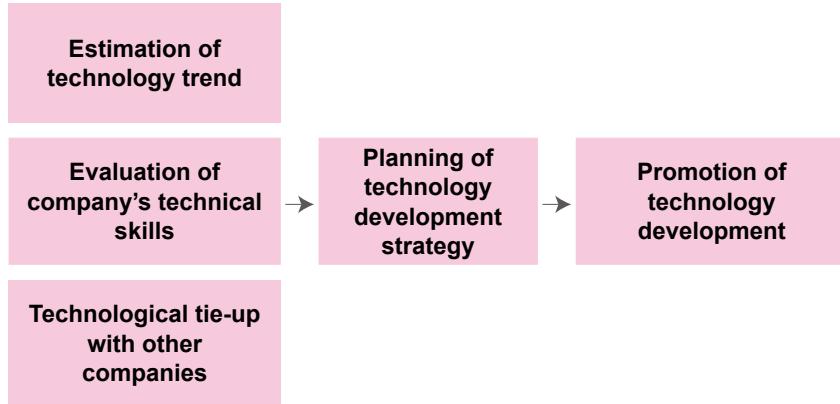
##### Technology portfolio

A “Technology portfolio” refers to the combination of technologies that one’s company possesses.

#### Reference

##### Technology estimate method

The “Technology estimate method” is a technique of predicting the phenomena that may occur in future, and thus predicting the development and necessity of technology.



#### Reference

### **Process innovation and product innovation**

“Process innovation” refers to innovation of business processes such as the development process and manufacturing process from the aspect of production technology. In contrast, “Product innovation” refers to the innovation from the aspect of product development such as the development of new products and new inventions.

#### Reference

### **Concurrent engineering**

“Concurrent engineering” refers to the participation of persons from the departments who are concerned with the post-processing stage of product development from the pre-processing stage itself, so as to concurrently perform each process from design to production preparation, and manufacturing. As a result, the production efficiency can be improved, which leads to shortening of the time period of product development.

## **2 Production system**

How to design the production process is an important element of business strategy management.

A production process is designed in view of the characteristics of the product to be manufactured, as well as requirements such as cost, quality, delivery schedule, etc. There is a need for the re-designing of a production system that can comply with each of the requirements of high-mix low-volume production, production at a short deadline, reduction in inventory, etc.

The main production systems include the following:

Name	Description
Cell production system	This is a production system according to which one operator to a few operators are responsible for all processes in the assembly manufacturing process, from installation of components to assembly, processing, and inspection. It derives its name from the fact that the components and tools are arranged in the form of cells, and work is thus performed. This system is advantageous since it can flexibly comply with several production types as the product to be assembled can be changed only by changing the operator, component, or work order.
Line production system	This is a continuous and repetitive form of production system in which a dedicated line, such as a belt conveyor, is set up, and several operators assemble each component that they are in charge of. This system has the advantage of being a highly productive system since a specific product can be manufactured repeatedly.
BTO (Built-to-Order)	This is a production system according to which the production of a product is started after an order from a customer is received. Since components are assembled and shipped in response to the customer order, it is possible to reduce the risk of maintaining surplus inventory. This production system is adopted in several manufacturing and sales companies such as those engaged in computers, automobiles, etc.

## 2-3

# Business Industry

### 2-3-1 Business System

As a result of development of information systems, businesses using information systems have been fast increasing, and the Internet and information systems, etc. are being used in various business fields.

#### ① Systems in typical business fields

A typical business system includes the following types:

##### ● POS system (Point of Sales system)

A “**POS system**” is one by which sales information (what was purchased, when, where, in how much quantity, and by whom) is collected when a product is sold.

A POS system makes use of bar codes as the standard for product management, and is used in “**distribution information systems**” in convenience stores, supermarkets, department stores, shopping centers, and restaurants, etc.

The advantages of this system include the fact that market survey and sales forecast can be performed on the basis of the collected sales data. The collected information is used in strategies such as product development and store deployment, and is useful for adjusting the ordering quantity and inventory amount depending on the season, region, and time of day. Currently, this information has been developed to the extent of product development of private brands by retailers, and is positioned in important information systems that are indispensable for the business strategy of retailers.

##### ● IC card

An “**IC card**” is a plastic card in which an “**IC chip (semiconductor integrated circuit)**” has been embedded. Since data can be encrypted, this card is being focused upon as one that cannot be forged easily. Moreover, when compared to a conventional magnetic card, the amount of information that can be stored ranges from a few tens of times to a few hundreds of times, indicating that a large amount of information can be recorded. In addition to the above, an IC card is functionally advanced than a magnetic card, because of which its installation is being promoted in various fields.

##### Reference

#### Distribution information system

A “**Distribution information system**” is a general term used for systems used in the distribution industry such as the POS system, order placing/receiving system, shipping system, etc.

##### Reference

#### Financial information system

A “**Financial information system**” is a general term used for systems used in the finance industry, such as the ATM system, stock trading system, foreign exchange trading system, etc.

The differences between an IC card and a magnetic card are as described below.

Item	IC card	Magnetic card
Storage media	IC chip	Magnetic stripes
Arithmetic function	○	×
Authentication using encryption	It is possible to perform authentication using encryption between an IC card and a reader	Not possible
Forging	Difficult	Relatively easy
Price	High	Cheap

The typical examples of an IC card include ATM cards and credit cards of financial institutions.



#### Reference

##### Radio chip

A “radio chip” is an IC chip provided with an antenna that can be read wirelessly.

#### Reference

##### Contact type and non-contact type

“Contact type” refers to the method of reading data by inserting an IC card in a device.

“Non-contact type” refers to the method of reading data through wireless communication using electromagnetic waves.

#### ● RFID (Radio Frequency IDentification)

“RFID” refers to a mechanism of identifying and managing persons and objects through a minute “radio chip.”

Since a radio chip can be processed into a label seal, an envelope, a key holder, a wrist band, etc. it has become easy to provide radio chips for humans and objects. In addition, a major characteristic is the function that enables simultaneous identification of several radio chips. Therefore, it is being used in several areas such as in the management of the entry and exit of persons through a key holder-type radio chip, or in “traceability systems” for managing the distribution history of vegetables, meat, etc. through a label seal-type radio chip. A radio chip is also called an “IC tag” or a “wireless IC.”

The communication distance between a radio chip and a reader ranges from a few centimeters to approximately 2 m, and power is supplied to the radio chip via an antenna.

Moreover, since wireless reading is enabled by providing a built-in antenna in an IC card, a non-contact type IC card is classified as a technology to which RFID is applied. Typical examples include electronic money, a ticket for a transportation facility, and a driver’s license, etc.



## ● Electronic money

“**Electronic money**” refers to the payment of the price of a product through a non-contact type IC card having the same value as cash through prior charging of the IC card with cash, or refers to such a mechanism. Recently, electronic money in the form of an IC tag embedded in a cell phone has been gaining popularity. Although its method of use is similar to a prepaid card or a gift coupon, the fact that the same IC card can be charged repeatedly is being focused as a payment method in view of the global environment.

In addition, since there is no need of handling small change, it has the advantage of being easy to use by elderly persons and handicapped persons.

## ● Credit card

A “**credit card**” is a card that is issued on the basis of an agreement between a consumer and a card company. A consumer can use this card to buy products and receive services within the scope of the conditions (such as the effective period and usage limit, etc.).

According to this mechanism, the used amount is paid later in that the user pays the used amount upon receiving a claim for the used amount from the credit card company.

Since the payment need not be made immediately, a person can make a purchase even if there is no balance in the account, and either a single payment or payment in installments can be selected as the payment method, which prove to be the merits of a credit card.

However, the credit card users must be careful enough since an interest rate is applicable depending on the number of installments, and the user may be tempted to over-use the credit card beyond his/her payment capacity.

## ● Debit card (J-Debit)

A “**debit card**” is a card by which a product can be purchased by the cash card of a financial institution that is currently being used. This is a mechanism by which the used amount is withdrawn from the bank account in real-time by presenting the cash card during the purchase of a product and entering the personal identification number in the terminal.

Since the payment needs to be made immediately and cannot be made unless there is some balance in the bank account, a person using a debit card need not worry about over-using the card beyond the available balance. Another benefit of this card is that no payment charges are applicable.

However, the number of franchise banks is less as compared to the credit card, and since there is also a usage time limit, it needs to be verified if the debit card can be used or not.

## ● GPS application system (Global Positioning System application system)

A “**GPS application system**” is a system that receives electromagnetic waves from a satellite by using an artificial satellite so that a person can accurately find out his/her location on earth.

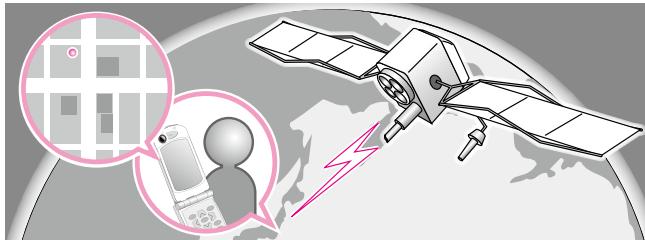
### Reference

#### Crowdfunding

“Crowdfunding” refers to the method of raising capital by calling for funding of a relatively low amount of funds from several unidentified persons over the Internet in order to develop products and services, and implement new ideas, etc.

It was developed as one of the defense technologies of the U.S. Armed forces that makes it possible to determine the latitude, longitude, and altitude of the receiver with an error of a few centimeters to a few tens of meters.

In addition to being used independently, a GPS application system is also frequently used in car navigation systems and cell phones.



#### Reference

##### **Smart grid**

A “smart grid” is a power network (grid) in which a dedicated device and software are embedded so that the demand and supply of power can be controlled. By using a smart grid, a power company can adjust the balance between the demand and supply of power so that wasteful power generation is prevented.

#### ● GIS (Geographic Information System)

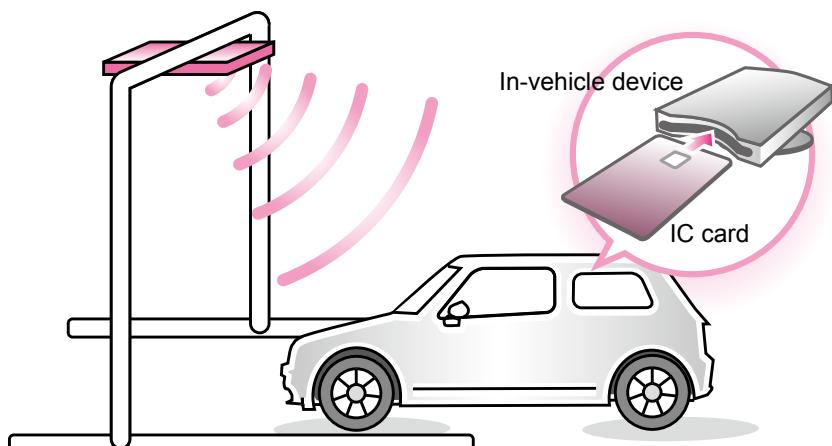
“GIS” is a system in which maps and topographic features are digitalized and various types of information is appended so that the geographic information can be managed, processed, and analyzed comprehensively. It is used for marketing corresponding to regional characteristics, such as the store opening planning for new stores and evaluation and revitalization planning for existing stores, etc.

#### ● ETC system (Electronic Toll Collection system) in Japan

An “ETC system” is a system for automating the payment of charges for a toll road in Japan.

The toll roads in each region across the entire country are chronically congested, and environmental pollution due to gases emitted by vehicles, as well as an increase in cost due to congestion are becoming increasingly serious. An ETC system has been developed with the purpose of reducing such economic losses, and preventing congestion that occurs frequently at the toll booths.

When using the ETC system, a driver uses a contact-type IC card issued by a credit card company. By inserting this IC card in an ETC in-vehicle device, the toll booth can be passed without having to stop the vehicle. According to this mechanism, the charges are claimed at a later date via the credit card company.



## ② Software packages in typical business systems

The software packages of a typical business system include the following types:

Type	Description
ERP package (Enterprise Resource Planning package)	<p>This is a software package that has been developed with the purpose of managing the management resources of a company (such as personnel, objects, money, and information) in a consolidated manner to improve the management efficiency.</p> <p>It integrates the systems managed in each department and enables their mutual referencing and usage, and since information can be managed in real time, it proves to be effective in improving the management speed.</p>
Software package for each job role	<p>This is a general-purpose software package used in the accounting service, sales support, inventory control, sales management, etc. This type of software package brings together the functions necessary for a job role common across all companies, such as the accounting work, sales management tasks, the employee payroll calculation work, the customer information management work, etc.</p> <p>For example, in the software package for accounting, the management material such as the trial balance sheets, closing account reports, etc., and financial statements can be created automatically only by making entries in the journal voucher.</p>
Software package for each industry	<p>This is a software package that is used in financial institutions, medical institutions, and industries such as the manufacturing industry and the transportation industry.</p> <p>For example, in medical institutions, there are several job roles that cannot be supported by the software package for each job role, such as management of medical equipment and devices, difference in cost due to the treatment method, management of NHI (National Health Insurance) points, etc., but this package is created in such a form that it can be used for each industry so that job roles matching each industry can be performed.</p>

### Reference

#### ERP (Enterprise Resource Planning)

“ERP” is a technique of improving the management of the entire company through the effective use of all management resources (such as personnel, objects, money, and information) of the company from production to sales, accounting, and personnel affairs. It is referred to as a management technique by which all management resources are managed comprehensively across the entire company, and arranged and distributed optimally so that effective management activities can be performed.

### Reference

#### DTP (DeskTop Publishing)

“DTP” refers to performing the design and layout available on paper for a published matter on a computer, and then transferring the created data to a printing company for publishing. In order to perform DTP, a dedicated software package is used for manipulating photographs, illustrations, paper layouts, etc.

## ③ Systems in other fields

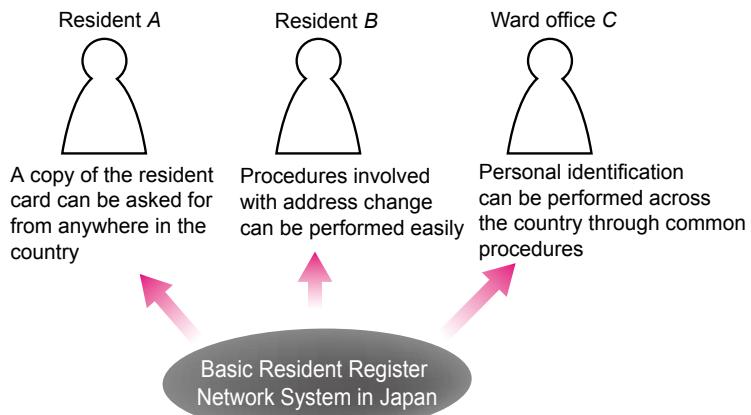
In addition to business fields, several systems that are in close contact with the life of the community are being used.

A typical system includes the following types:

### ● Basic Resident Register Network System in Japan

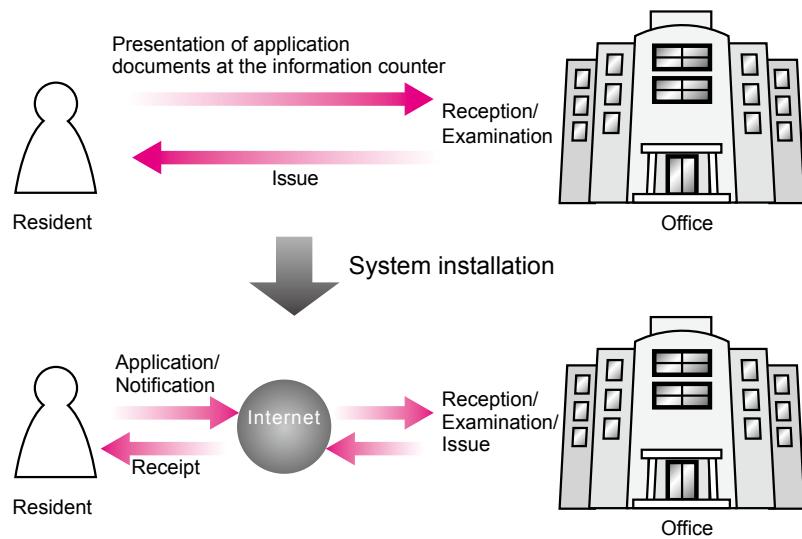
A “Basic Resident Register Network System” refers to a system that joins a country or government agencies such as the nation-wide local public organizations via a network, and enables sharing of a “**Basic resident register**” containing the name of a person, date of birth, gender, address, resident register code, etc. across Japan.

Since this system has enabled common personal identification across Japan, it has become possible to improve the efficiency of the administrative work involved in notification and a reduction in the labor since a copy of the resident card of a person can be taken from any city, town, and village across Japan, thus making it unnecessary to present a copy of the resident card while submitting an application or notification to a government agency.



### ● Electronic application and notification system in Japan

An “**Electronic application and notification system**” is a system by which applications or notifications are received in government agencies such as the government and municipalities by using the Internet from one’s own home or workplace. Since this system also enables the acquisition of the application format necessary for the procedures via the Internet, a person can perform the procedures at any suitable time of the day without taking the trouble of going to the government agency.



#### Reference

##### **Electronic bidding**

“Electronic bidding” refers to a bidding system implemented on the Internet. By electronically bidding for orders of the country and local public organizations, not only can operating expenses and personnel expenses be reduced, but the chances of consultations are also reduced. Electronic signatures are used for user authentication of electronic bidding.

#### Reference

##### **CTI (Computer Telephony Integration)**

“CTI” is a usage technology by which a telephone and FAX are connected to a computer. It enables automatically responding to phone and FAX, or routing them to their appropriate destinations in accordance with the sender.

## 2-3-2 Engineering System

In the engineering field too, various IT systems are being used with the purpose of supporting the design and manufacturing on the basis of automation, and improving the efficiency of production management and inventory control.

A typical system includes the following types:

Name	Description
CAD (Computer Aided Design)	CAD is a system that is used when designing machines, buildings, electronic circuits, etc. CAD enables the representation of design drawings in 3D, thus simplifying editing.
CAM (Computer Aided Manufacturing)	CAM is a system used for controlling the production line in a factory, etc. Moreover, a mechanism of using CAD and manufacturing with the help of CAM is called a “CAD/CAM system.” This system operates by incorporating the drawings data created by CAD into CAM, and then sending the information to the machine tools that are actually used for manufacturing.
CIM (Computer Integrated Manufacturing)	CIM is a system that manages the series of processes of manufacturing in a comprehensive manner. In CIM, by managing all information generated during the course of manufacturing on computers, and sharing this information across the entire company, the production efficiency is improved, and the cooperation between each department is strengthened.

Reference

### Sensing technology

“Sensing technology” is a technology by which a sensor is used to detect the status that is to be controlled. In computer control, the status of the light, temperature, and pressure to be controlled is detected by a sensor, and converted to an electric signal such as mechanical voltage, current, resistance, etc. that can be easily processed by the computer.

## 2-3-3 e-business

“Electronic Commerce (EC)” refers to the implementation of commercial activities by using a network. Since electronic commerce is likely to reduce the cost for stores or salesclerks and enable commencement of business with little investment, it is developing as a typical business using the Internet.

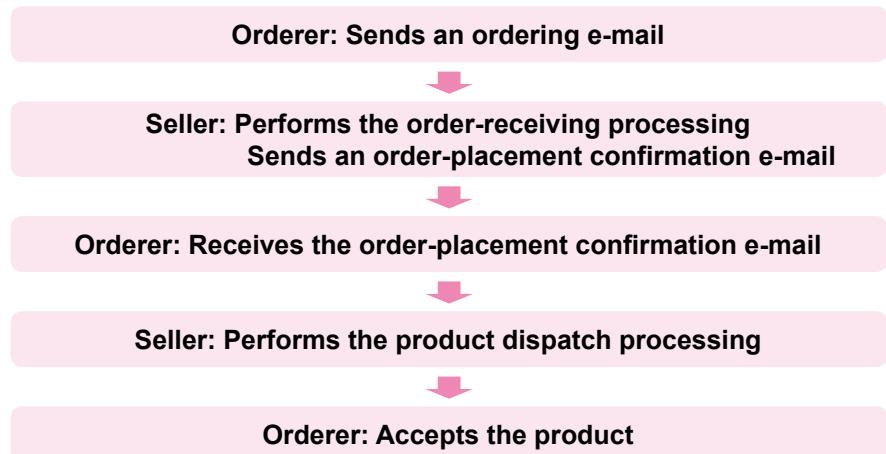
According to the Ministry of Economy, Trade, and Industry of Japan, electronic commerce is defined as “**Business transactions that are conducted via electronic media using the Internet technology.**” Generally, it can be called a “**Business system in which placing/receiving orders as well as settlement of bills is performed via the Internet.**”

Reference

### Catalog sales

“Catalog sales” is a form of sales in which products are sold without having stores. Internet sales, door-to-door sales, telephone shopping, etc. correspond to catalog sales.

Moreover, mail-order sales (online shopping) over the Internet are carried out according to the procedure described below. Generally, a transaction is established through consent between two persons, which means a transaction is established when the person placing the order receives an order-placement confirmation e-mail. An agreement based on such mail-order sales performed over the Internet is stipulated according to the Act on Special Provisions to the Civil Code Concerning Electronic Consumer Contracts and Electronic Acceptance Notice in Japan.



#### Reference

##### **O to O (Online to Offline)**

“O to O” refers to the interworking and convergence between online and offline. For example, attracting customers by using discount coupons issued in e-mail magazines and mobile sites, and promoting the willingness to buy by using a price comparison site.

#### Reference

##### **Long tail**

“Long tail” is a concept that enables the achievement of large profits through high-mix low-volume sales of products aiming at a niche without depending on large sales of the mainstay products in electronic commerce where a large number of products are handled at a low cost.

#### Reference

##### **Escrow service**

“Escrow service” refers to the entry of a third party between the seller and buyer in electronic commerce so as to intermediate the transfer of money and products after transactions have been established. Due to the frequent occurrences of problems between individuals and crimes as a result of the spread of electronic auctions, the demand for escrow service has been increasing.

## ① Classifications of electronic commerce

Depending on the business relationship, electronic commerce is classified as follows:

Name	Description	Example
B to B (Business to Business)	Transactions between two companies.	System for placement and receipt of orders between companies Electronic marketplace
B to C (Business to Consumer)	Transactions between a company and an individual.	Online mall Internet banking Internet trading Electronic auction
B to E (Business to Employee)	Transactions between a company and its employees.	In-house sales site for employees
C to C (Consumer to Consumer)	Transactions between two individuals.	Electronic auction
G to C (Government to Citizen)	Transactions between the government and individuals.	Electronic application and notification system

## ② Points to note in electronic commerce

When performing electronic commerce, it is necessary to take note of the points described below.

Position	Description
Buyer	<ul style="list-style-type: none"> <li>Information about the credit card and bank account (such as the password, storage location, etc.) must be managed separately.</li> <li>The credibility of product information must be confirmed.</li> <li>The contact destination, shipping charges and transfer of products must be clearly specified, and whether or not the store is reliable must be confirmed.</li> <li>The web page from which orders are placed and payments are made must be encrypted, and whether or not the web page can be used safely must be confirmed.</li> </ul>
Seller	<ul style="list-style-type: none"> <li>The store information (name of the company, location, contact address, etc.) and product information (price, shipping charges, payment method, etc.) must be clearly specified.</li> <li>There must not be a missed delivery of a product or dispatch of a wrong product.</li> <li>The personal information of the user must be managed safely.</li> </ul>

## ③ Internet advertising

“Internet advertising” is a common name for advertisements published on websites and in e-mails made available via the Internet. Internet advertising is closely related to electronic commerce that makes use of the features of the Internet.

Typical Internet advertising includes the following types:

Name	Description
Listing advertisement (Search advertising)	It is an advertisement that links with the search keywords of the search engine and displays contents related to the search results.
Banner advertisement	It is an image of an advertisement listed on a website. A link is set, which when clicked displays the website of the advertiser.
Opt-in mail advertisement	It is a service by which an e-mail containing an advertisement is sent to a user from whom consent is already received.

## ④ Other advertisements

The other advertisements include the following:

Name	Description
Recommendation	It refers to analyzing the desires of the user from the past purchase history, and recommending those products and services to each user in which he/she may be interested. The display of a different top page to each user through online mall, etc. is an example of recommendation.
Digital Signage	It is an advertising medium for transmitting information using display. It is used as a guide or advertisement either outdoors or in commercial facilities and transportation facilities. It includes several types ranging from large digital signages installed on the walls of buildings to small digital signages in trains, etc.

### Reference

#### EDI (Electronic Data Interchange)

“EDI” is a mechanism of interchanging electronic data for commercial transactions between companies via a communication line. The format of interchanged electronic data and the connection method of the network often vary from one business or industry to another, and recently, the standardization to the HTML and XML format through the use of the Internet is being promoted.

### Reference

#### Affiliate

“Affiliate” is a mechanism by which a remuneration is acquired from an advertising company depending on the frequency of leading viewers to a website and the purchase rate of the advertised products by publishing advertisements of the company and links to Websites on personal websites and blogs, etc.

### Reference

#### SEO (Search Engine Optimization)

“SEO” refers to measures taken to display the website of one’s company at the top of the search results of a search site.

The typical techniques of SEO include “appropriate keyword setting of a web page” and “addition of external links,” etc. If a website is displayed at the top of the search results, there is a high possibility of it being viewed by several persons, and thus, advertising effectiveness can be expected.

## 2-3-4 Consumer Appliances and Industrial Devices

Reference

### Real-time OS

“Real-time OS” is an OS that aims at real-time processing and prioritizes the data processing speed over the ease-of-use of the user, and is used in bank ATMs (Automatic Teller Machine) and seat reservation in trains, etc.

Reference

### Firmware

“Firmware” refers to software embedded in hardware for controlling devices. In order to improve the speed of processing, it is often written on ROM, etc.

Reference

### Robotics

“Robotics” refers to the study of the field related to robots.

It involves research related to the design, manufacture, and operation of robots, including the control functions and sensor technology. It is used for several purposes such as industrial robots used widely in the manufacturing industry, and home robots represented by robotic vacuum cleaners.

Reference

### AI (Artificial Intelligence)

“AI” refers to either an attempt to analyze the functions that a human brain can control and then artificially implement those functions, or a device or system that is equipped with those functions.

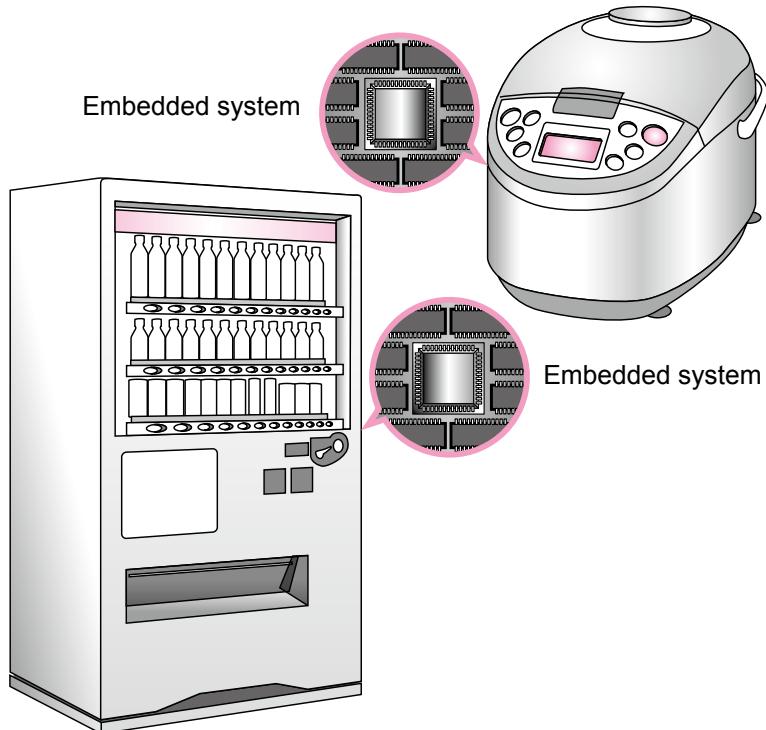
An “**Embedded system**” is a computer system that is embedded for implementing specific functions, and is also called a “**Microcomputer**.” It is configured by dedicated software called “**Embedded OS**” and hardware equipped with the minimum required memory, CPU, and ROM. In the recent years, real-time OS that operates in real time in accordance with the user operation has become mainstream, and as a result, fine-tuned control has become possible. Moreover, since the cost involved in embedded systems has reduced, these systems are also used as systems for controlling various “**consumer appliances**” and “**industrial devices**.”

### 1 Consumer appliances

“**Consumer appliances**” refers to electrical appliances used in general homes, such as rice cookers, washing machines, air conditioners, mobile devices, etc. In the recent years, there have been “**intelligent home appliances**” having communication functions that enable connection to a network over the Internet, etc.

### 2 Industrial devices

“**Industrial devices**” refers to devices used to achieve the purpose of several industries, such as industrial robots, industrial equipment, signals, elevators, etc. Moreover, vending machines used to sell articles such as beverages, etc., automatic service equipment used to provide services such as games and ATMs, etc., automated warehouses that support material flow such as marine vessels and tracks, etc. are also classified as industrial devices.



## 2-4

# Chapter Quiz

[Note] Answers can be found on page 5 of the appendix "Answers and Explanations for the Chapter Quiz, at the end of this book.

### Q 2-1

The activity described below is being performed in Store B with the aim of improving customer satisfaction and also improving average spending per customer. Which of the following is an appropriate sales technique for this situation?

Recommending the purchase of bite-size baked snacks and bread to customers ordering only beverages.

- a) Test marketing
- b) Pull strategy
- c) Cross-selling
- d) Up-selling

### Q 2-2

Which of the following is an appropriate explanation of the four (4) Ps in marketing mix?

- a) Product, Price, Place, Promotion
- b) Piece, Price, Period, Promotion
- c) Piece, Price, Place, Process
- d) Product, Price, Place, Process

### Q 2-3

Which of the following statements is the appropriate explanation of RFID?

- a) A mechanism for collecting sales information when a product is sold in a supermarket or convenience store, etc.
- b) A mechanism by which the product information managed until now through labels and seals is embedded in an IC chip as digital data, and used as a product tag
- c) A mechanism by which the position of a device is identified by transmitting and receiving electromagnetic waves to and from a satellite in a large-size system using an artificial satellite
- d) A mechanism of performing the payment processing by holding an IC chip up to a cash settlement system by pre-charging money in the IC chip

**Q 2-4**

Which of the following is an appropriate name of a technique of business analysis in which the businesses and products handled by a company are plotted on a graph with the market share rate and market growth rate as the axes, and are classified into the four (4) categories of "Star," "Cash cow," "Question mark," and "Dog"?

- a) SWOT analysis
- b) Product portfolio management
- c) Marketing research
- d) Basket analysis

**Q 2-5**

Which of the following is the appropriate name of a person who performs the role of supervising the information resources of a company while maintaining integrity with the business strategy.

- a) CEO
- b) CFO
- c) COO
- d) CIO

**Q 2-6**

Which of the following corresponds to a niche strategy?

- a) Planning a new product launch event by inviting a prominent figure who regularly uses the company's brand
- b) Planning a fast food product that uses organic vegetables and high-grade Japanese cattle as ingredients
- c) Planning sample sales of in-house products in department stores
- d) Planning a television commercial for a soft drink that has been developed on the basis of the concept of consumption across several generations

**Q 2-7**

Company A is planning to enter the EC business. Which of the following is an appropriate combination of terms or phrases to be inserted into blanks X and Y in the description below?

In order to develop new businesses in a short period of time by acquiring technologies and know-how that Company A does not have, Company A is planning an [X] with Company B that is strong in the EC business. Moreover, even if the [X] is unsuccessful, Company A is examining [Y] with Company B in order to deepen the association with Company B.

	X	Y
a)	OEM (Original Equipment Manufacturer)	Capital participation
b)	OEM (Original Equipment Manufacturer)	Benchmarking
c)	M&A (Mergers and Acquisitions)	Capital participation
d)	M&A (Mergers and Acquisitions)	Franchise chain

# Chapter 3

## System Strategy

This chapter explains the understanding of business processes, methods for business improvement, the flow of information system construction, and the creation of requirements definitions for computerization, on the basis of information systems strategy.

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<b>3-2</b>	System Planning .....	107
<b>3-3</b>	Chapter Quiz .....	115

# 3-1

# System Strategy

## 3-1-1 Concepts of Information Systems Strategy

With the evolution and expansion of IT, information systems have come to exert a critical presence in company management. In order for information systems to continue supporting the implementation of enterprise strategy and business strategy, a clear strategy is necessary.

### 1 Significance of information systems strategy

“Information systems strategy” is the effort to computerize business activities through the efficient use of IT and to increase business efficiency from a medium- to long-term perspective, in order to support the implementation of business strategy and enterprise strategy. The effectiveness and investment effect of systems are analyzed, and plans for system installation are organized.

Information systems strategy can be positioned as a part of a business strategy. Advantages of implementing computerization include the following:

Advantage	Description
Increase in business efficiency	When input of forms, management of inventory numbers, and other routine tasks that have been performed manually are computerized, work time can be shortened and calculation mistakes can be avoided.
Support for decision making	When the analysis of large volumes of data is computerized, the work of searching for and aggregating necessary data is made more efficient, and decision making in enterprise strategy and business strategy can be performed promptly and accurately.
Reduction of cost	When business activities are automated through computerization, productivity improves and costs can be reduced.

### 2 Objectives of information systems strategy

Accurate understanding of current business tasks and business flow is important in the planning of information systems strategy. In order to make specific objectives (i.e., the vision) for computerization clear, it is necessary to visualize the business flow and to consider rational and effective mechanisms. The business flow is referred to as “**business processes**,” and the visualization of which is referred to as “**modeling**.” Modeling facilitates the understanding and organizing of current business activities. Therefore, modeling is useful in the consideration of improvement measures.

#### Reference

##### EA (Enterprise Architecture)

#### Reference

“EA” is the concept of optimizing a company’s work and corresponding information systems in order to run an efficient organization.

##### Business process model

A “business process model” is a model of business flows. It is created to clarify the vision for computerization.

## 3-1-2 Concepts of Business Process

Computerization of an organization's business is considered in light of business strategy and enterprise strategy. Toward that end, it is necessary to perform modeling of the organization's business process (business flow) and to consider improvement measures.

### ① Representative modeling techniques

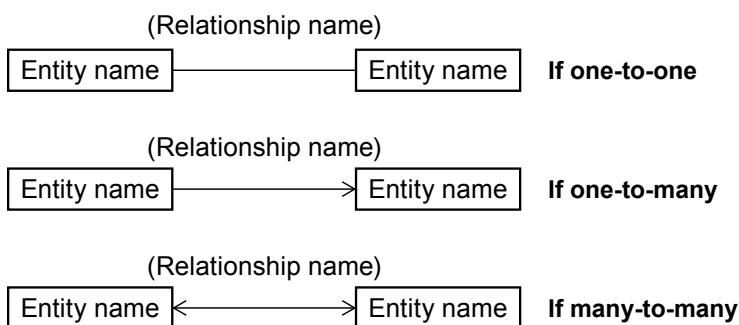
Representative modeling techniques include the following:

#### (1) E-R diagram (Entity Relationship diagram)

An "E-R diagram" is a technique that uses "entities" and "relationships" to represent relationships among data in a diagram. Entities and relationships possess several properties, which are known as "attributes."

There are three types of relationships: "one-to-one," "one-to-many," and "many-to-many."

Relationship names are noted as required.



- [1] An entity is shown by using a rectangle.
- [2] The entity's name is placed inside the rectangle.
- [3] A relationship between entities is shown by using a straight line or an arrow. The relationship name is written in parentheses next to the line.
- [4] A "one-to-one" relationship is shown by using a straight line.  
A "one-to-many" relationship is shown by using one-way arrows that points to the "many" side.  
A "many-to-many" relationship is shown by using two-way arrows.

#### Reference

##### Notation for relationships

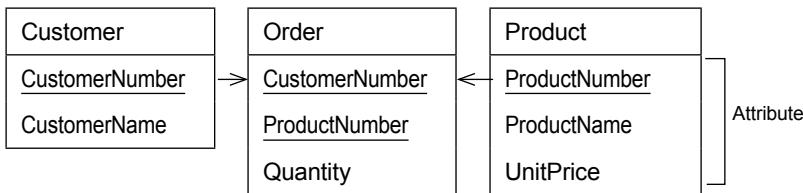
As shown below, "relationships" in an E-R diagram can be represented as "diamonds," and "one-to-many" can be represented by using "one-to-\*," "one-to-n," or "one-to-m."

[An E-R model representation (for one-to-n)]

Customer	1	Order receipt	n	Product
Symbol	Name			
	Entity			
	Relationship			
	Attribute			

### Example

An example of the relationships among customers, orders, and products, shown by using an E-R diagram



"Customer" is linked to "Order" by using a one-to-many link, which means that a single customer makes multiple orders.

"Product" is linked to "Order" by using a one-to-many link, which means that a single type of product is ordered in many orders.

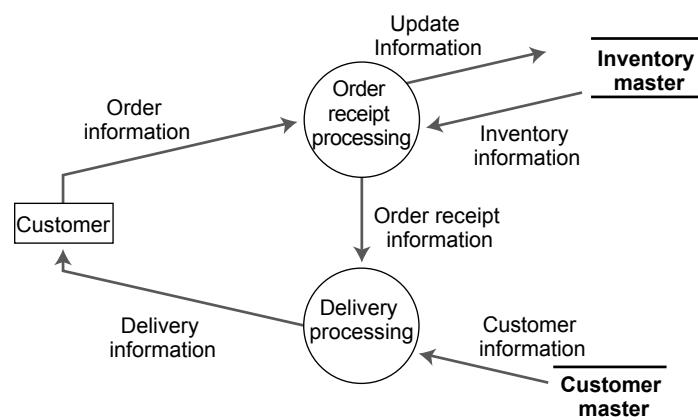
### (2) DFD (Data Flow Diagram)

A "DFD" is a technique that uses four elements – "data flows," "processes," "data stores," and "external entities" – to model business and systems, and represents the business flow as a flow of data.

Symbol	Name	Meaning
→	Data flow	Represents a flow of data or information.
○	Process	Represents the processing of data.
_____	Data store (file)	Represents a store of data.
□	External entity (source/absorption of data)	Represents the origin or destination of data.

### Example

An example of processes, from receipt of customer order to delivery, shown by using a DFD



### (3) UML (Unified Modeling Language)

A “UML” is a diagram notation technique that is used at the stage of deciding on the functions and structure of software. The use of a standardized diagram format enables the understanding of the targeted program despite differences in language or development methods.

A UML represents the functions and structure of software in a diagram composed of boxes and lines.

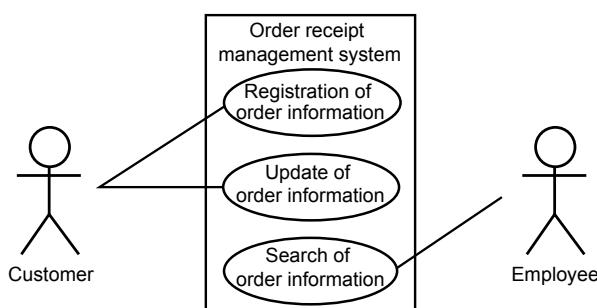
Representative UMLs include the following:

#### ● Use case diagram

A “use case diagram” shows the relationships between a system’s users, the functions provided by the system, and external systems. It enables rough understanding of an overall system by showing what sort of functions a system has, how it will react when it is operated, and the role of the system as seen from the outside, in an easily understood diagram. A use case diagram is normally used at the stage of requirements definition at the start of system development.

A use case diagram represents the roles of a system with symbols such as the following:

Symbol	Name	Role
Human form	Actor	Has some role in accessing the system.
Ellipse	Use case	Has a function that is provided by the system to external entities.
Straight line	Relationship	Represents the relationship between an actor and a use case.
Rectangle	System boundary	Has the role of dividing the inside and outside of the system.



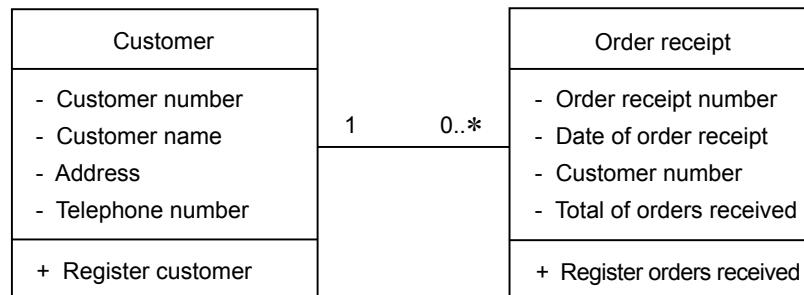
- [1] Actors are drawn outside the system boundary.
- [2] Use cases are drawn inside the system boundary.
- [3] Actors and use cases are connected by relationships.

**Class**

A “class” defines a template for objects that encapsulate data and the data’s methods (i.e., operational procedures).

**● Class diagram**

A “class diagram” is a diagram that represents the structure of a system. The representation of a class diagram is composed of three parts, with the class name at top, followed by attributes and then methods (operations).



- [1] When class relationships are described, “**one-to-many**” are represented as “**one-to-\***”.
- [2] When class relationships are described, “**0 or more**” are represented as “**0..\***”.
- [3] A “**+**” is placed before attributes that can be directly accessed by all classes.
- [4] A “**-**” is placed before attributes that cannot be accessed by classes other than the class that has the target attribute.

**2 Analysis of business processes**

Representative techniques for analyzing business processes include the following:

Technique	Description
BPR (Business Process Reengineering)	BPR is a concept that seeks to fundamentally restructure business processes, undertake quality improvements and cost reductions in products and services, and dramatically increase business performance.
BPM (Business Process Management)	BPM is a concept for continually engaging in problem discovery and improvements in business processes.
Workflow	This refers to mechanisms and systems for the smooth flow of work, which are achieved through rules and automation for clerical and other work.

**3 Business improvement and problem solving**

Computerizing familiar work and making efficient use of computers and networks makes it possible to efficiently proceed with business activities. However, as computerizing existing work without change does not increase business efficiency, points for improvement and problems in work are first identified by assessing business tasks and organizing business processes, which was performed on the basis of business strategy and enterprise strategy.

At that time, it is important to analyze problematic results in business processes and their causes, find means to resolve any problems, and consider what improvements will make them more efficient.

## 4 Effective use of IT

Many companies are now engaging in the adoption of IT to achieve business improvement and increase business efficiency. By making effective use of IT, it is possible to conduct communication smoothly within the company, and, at the same time, make effective use of tools. That brings business improvement and increases business efficiency.

### (1) Increasing business efficiency through computerization

Computerization can be achieved by many methods. Although there are differences according to the environment and the business tasks to be computerized, how to carry out computerization is decided on the basis of business strategy and enterprise strategy.

IT tools for increasing business efficiency include the following:

Method for using	Characteristics
Network development	Network development refers to connecting multiple computers by cable to share software resources such as programs and data, and hardware resources such as storage units and printers. Sharing software enables costs reductions, while sharing hardware and data increases in business efficiency. Not only text but also static images, audio, videos, and other multimedia information can be exchanged and used as means of communication that make use of a variety of representations.
Installation of office tools	Tools such as word processor software and spreadsheet software are commonly used widely. These can be installed easily and used on many PCs.
Installation of groupware	“Groupware” is software that supports work inside a company or organization. With multiple persons sharing information and efficiently engaging in joint work, it is possible to achieve a substantial paperless environment and share work know-how and basic information on corporate activities. As a result, unified information sources are ensured and information is shared. This achieves communication that is unbound by time and distance, which increases the speed and accuracy of information transfer.
Installation of software packages	Software packages specific to the business or industry are available and can be applied to standard business processes. They allow development cost to be kept lower than that of in-house system development.
System development	The development of individual systems allows required functions to be built in, and can be applied to specialized business processes. The cost can easily become high.

#### Reference

### BYOD (Bring Your Own Device)

“BYOD” refers to employees’ use of personally owned information devices (PCs, mobile devices, etc.) for work within the company. While this reduces the cost of device installation, BYOD increases risks including those of computer virus infection and information leaks.

#### Reference

### IoT (Internet of Things)

“IoT” refers to technology that connects not only computers and other IT devices but also home appliances, automobiles, and many other products to the Internet. The IoT is put to use in, for example, “smart meters” by which electric power meters with communications functions manage electricity usage, and “smart pill” drugs with embedded microchips that, when activated by contact with gastric acid, send data to a receiver worn by the patient.

#### Reference

### MtoM (Machine to Machine)

“MtoM” refers to a mechanism by which machines exchange information with each other through computer networks to perform control and operation autonomously, without human intervention. MtoM is used in machine tool control in factories, management of elevators’ operational status, remote inventory management of vending machines, and so on.

The term also has a meaning of “communication between devices.”

## (2) The use of systems for communication

The effective use of groupware, office tools, and so on enables various kinds of communication.

Tools that facilitate smooth communication include the following:

Reference	
<b>Forms of communication</b> Forms of communication include the following:	

Tool	Characteristics
E-mail	E-mail is a mechanism that allows the exchange of messages with people around the world over the Internet. Messages can be sent even when the other party is occupied so contact can be made without interrupting work. In addition, e-mail text is kept on storage, which enables the retaining of messages as records and preventing misheard content.
Electronic bulletin boards	This is a mechanism for exchanging thoughts and information on a variety of topics with an indefinite number of persons over the Internet, and for making contact through reports and notifications. It is also called "BBS". Shared files can also be uploaded and information can be communicated quickly and certainly within a company, which enables the reduction of paper for uses such as circular notices.
Video conference	This refers to electronic conferences conducted over a network. By sharing computers and using audio and video, multiple participants in separate locations can hold a virtual conference. Participants can hold a conference by arranging a time, without business travel for the purpose.
Chat	This refers to text-based conversation in real time between multiple participants over the Internet. Text typed by one party appears on other computers' screens. Comments can be typed on the spot and seen by all participants. Chat is a convenient tool for conversing with multiple persons at once.
Blog	This refers to the leaving of records (i.e., a log) on a website. Posts can be created easily and released on the Internet in a manner similar to writing a diary. Persons who read the released posts can attach comments or link to the post to communicate with many people.
SNS (Social Networking Service)	An SNS is a membership-based community website that provides a place for communication among acquaintances.

Reference	
<b>Trackbacks</b> "Trackbacks" are a function by which, when a blogger links to another party's blog, a link is provided with an automated notification to the other party.	

## (3) Promoting the adoption of IT

Activities to promote IT are necessary to achieve business improvement and increase business efficiency through IT. Promoting the adoption of IT requires that every user have "**information literacy**," which means the ability to make use of information. Specifically, this indicates the following capabilities:

- Ability to use computers, application software, and other information technology to collect information
- Ability to select the needed information from among collected information
- Ability to communicate information once gathered
- Ability to aggregate collected information and analyze the results
- Ability to read trends from collected information

Today, with the advancement of computerization, information can be collected with ease through the Internet and other means. However, finding reliable information among the collected information requires the acquisition of information literacy. By doing so, information literacy can be put to use in problem solving and decision-making. In addition to education, activities to promote information literacy are necessary for its acquisition.

#### (4) Problems in IT adoption

An issue that arises in the promotion of IT adoption is information ethics. “**Information ethics**” refers to the information morals and manners that must be heeded in a computerized society. Information ethics must be acquired together with information literacy.

The digital divide is another problem that exists. The “**digital divide**” refers to the economic or societal disparities that arise from the difference in the ability and the opportunity to use computers or the Internet. This term also carries the meaning of “**information disparity**.”

As an example, the Internet enables low-cost dissemination of information; as a result, much information in society is provided only over the Internet. Persons who cannot use computers nor the Internet are unable to obtain this information. In this way, differences in information collection capabilities result in inequalities, such as disadvantages or restricted potential for participation in society, because of the inability to use computers, the Internet, and other information tools.

Solving the problem of the digital divide requires education on information technology, along with activities for its promotion by the government, private enterprise, and other organizations.

### 3-1-3 Solution Business

In order to conduct business improvement, it is important to find clues to solving problems. Accurately locating those clues will determine the success or failure of computerization.

“**Solutions business**” refers to the business of providing aid in understanding issues in business and finding clues to solving them.

## 1 Solutions

The term “**solutions**” refers to problem solving through the use of information technology.

When business improvement is conducted, the end result will not be satisfactory computerization if there is not accurate understanding of what to solve and what is necessary in order to do so. To prevent this from happening, it is necessary to talk with customers to build relationships of trust and to properly understand their problems and issues. Solutions are then proposed and support is provided for problem solving, according to customers’ requests.

## 2 Forms of solutions

System development is one solutions business for solving problems.

System development is generally carried out at the company-wide level. When a system is developed, the content and scale of the targeted system, the organization and environments within the company, and the cost of development are considered in order to determine whether to perform the development in-house or entrust it to a professional firm.

When development is not performed in-house, the information systems department or other department gathers information so that the system can be outsourced to a system vendor that will undertake the system development or software packages specific to the business or industry can be installed.

Forms of solutions in computerization include the following:

Form	Description
SOA (Service Oriented Architecture)	SOA refers to the concept in which software functions and components are regarded as independent services and systems are developed by combining them. Services can be used individually or in combination, which enables flexible development of systems.
ASP (Application Service Provider) services	This term refers to services that deliver software over the Internet. Usage fees are charged according to factors such as the usage time of the software. These services eliminate the need for performing software installation or version control within the company. Therefore, ASP services reduce operational cost and facilitate efficient management.
Cloud computing	This is a form of solution that uses services over the Internet with minimal required equipment configuration. It enables the use of software and hardware that are hosted in the Internet without being aware of the physical location. Representative services include SaaS and IaaS.
SaaS (Software as a Service)	SaaS refers to services in which required functions of software are delivered over the Internet. Only the required functions of the software are used, with fees paid for those functions.
IaaS (Infrastructure as a Service)	IaaS refers to a form of solution that uses servers, CPUs, storage, networks, and other infrastructure required for information system operation over the Internet. This eliminates the need for a company to consider additional hardware.

Reference

### Installation of software packages

Management efficiency can be heightened and business improvement can be conducted through the installation of business system software packages that bundle general-purpose business functions. Such packages include accounting service software and sales management software.

Reference

### Online storage

“Online storage” refers to services by which server space on the Internet is rented for the purpose of data storage. Data stored on the Internet can be accessed at any time from a location with a connection to the Internet.

Reference

### On-premises

“On-premises” refers to the operation of servers, databases, and other information systems that uses equipment within the company. It is used in contrast to cloud computing, which has expanded widely in recent years.

Form	Description
PaaS (Platform as a Service)	PaaS refers to a form of solution by which a platform that consists of hardware, OS, etc. is used over the Internet to run application software. This enables cost reductions by eliminating a company's need to prepare its own platform, and lets the company entrust hardware maintenance, failure handling, and so on to another party.
DaaS (Desktop as a Service)	DaaS refers to a form by which a device's desktop environment is used over the Internet. Since the OS and application software run on a server, only the necessary functionality for displaying these on users' devices and for keyboards, mice, and other input operations need to be prepared.
SI (System Integration)	This form of business provides comprehensive services including the design, development, testing, operation, and maintenance of information systems. Even companies without system development experience can carry out optimal system development that integrates the products of multiple vendors.
Outsourcing	This term refers to the use of management resources outside the company. Outsourcing allows the effective use of a company's limited management resources through the entrusting of a portion of its work to businesses with expert capabilities and know-how.
Offshore Outsourcing	This is a form of outsourcing by which a company entrusts a portion of its work to service providers in overseas locations where personnel costs and other expenses are relatively low. "Offshore" carries the meaning of "overseas."
Hosting service	This is a form of outsourcing by which servers, communications equipment, and other equipment owned by a provider or other businesses are rented and used over a network. It is also known as "rental server service." It includes services by which users rent an entire server, and those by which users rent a portion of the space on a server. This eliminates the need for a company to prepare its own environment and secure professional engineers, which enables considerable reductions in cost and time.
Housing service	This is a form of outsourcing by which a company prepares its own servers, communications equipment, and other equipment, and entrusts these with a business provider that has a prepared environment with communication lines, power supply, etc. Relative to a hosting service, factors such as model of the server, OS environment, and security measures can be more flexibly configured.
BPO (Business Process Outsourcing)	BPO refers to the entrusting (i.e., outsourcing) of a portion of work to an external company. As an example, a company can entrust routine work such as payroll calculation or personnel-related work that requires considerable experience and know-how to a professional firm, and focus its management resources on its own core areas. As a result, competitiveness can be enhanced.

**Reference****BI (Business Intelligence) tools**

"BI tools" is a general term for a system equipped with functions for the visualization and analysis of accumulated data, as an aid to business strategy.

**Reference****Big data**

"Big data" refers to large-volume and diverse data that is difficult to handle by using conventional, general database management systems.

**Reference****Data warehouse**

A "data warehouse" is data accumulated by organizing and extracting large volumes of data from the databases used in normal work. Analyzing the accumulated data allows it to be used in decision-making.

**Reference****Data mining**

"Data mining" refers to the analysis of large volumes of data accumulated in a data warehouse, to obtain new information. It is used to discover correlations among multiple items, such as "Men who purchase product A on Sundays also purchase B."

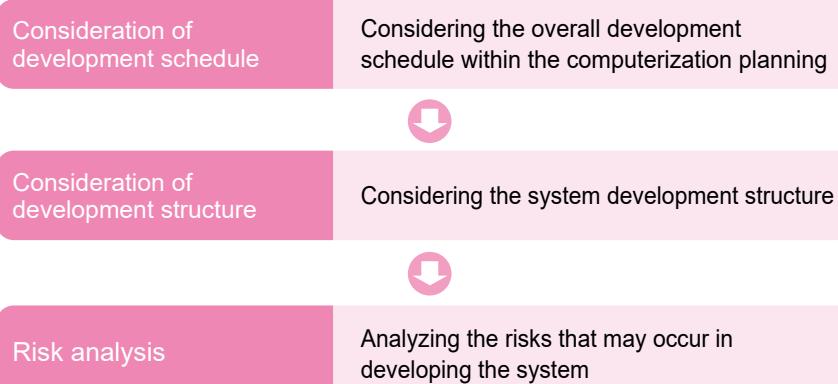
### 3-2-1 Computerization Planning

“Computerization planning” is the development and planning of information systems in order to draft computerization initiatives and computerization basic policy on the basis of business strategy and enterprise strategy, and to increase the efficiency of work. The term “computerization initiative” refers to conducting analysis of business operations before defining system requirements, and deriving the overall image, scope, schedule, budget, and other basic system requirements for computerization. Since computerization is developed on the basis of a company’s system strategy and business model, misjudging computerization initiative may cause work to become complex than it is and make efficacy unattainable.

The term “computerization basic policy” refers to basic development policy in the computerization of work. Computerization is carried out according to basic policy, including policy concerning objectives and issues in development. A computerization plan is designed at the final stage of implementing a system.

At the stage of drafting computerization, it is necessary to create a robust computerization plan that considers the overall image of the computerization, including what work is to be included in the scope of application and under what schedule and system, as well as whether the computerization is cost effective.

The procedures in planning and drafting computerization are as follows:



#### ① Consideration of development schedule

A total development schedule is considered in computerization planning. First, the deadline by which the system will be needed under the business strategy is set as a final target. A total development schedule is set, in which the system construction sequence, migration from existing work, and education and training are taken into account.

However, when the priority is set on a system deadline according to business strategy and the period for system construction is too short, the quality of the system may suffer. Management decisions may be required on matters such as whether to prioritize the deadline for the system or allow more time for development, even at the cost of some delay.

## ❷ Consideration of development structure

Once the total development schedule has been decided, a development structure is considered.

The development structure is considered not only by the system development department but also the business operations department that will actually use the system.

In order to prevent only one side from being involved, with the result that the system is detached from the actual work or does not achieve consistency with company-wide systems, both parties should be involved. This enables development of a system that is in line with business strategy. At this time, it is necessary to conduct appropriate personnel deployment, including deciding the persons responsible for overall development and for system development, and the person in charge of work.

## ❸ Risk analysis

“Risk analysis” is the measurement of where and how risks are present in the construction and operation of systems, as well as the degree of loss or impact in the event that a risk materializes. Conceivable risks are prioritized in order of the foreseen probability of occurrence and associated amount of loss, and are addressed in order of highest to lowest.

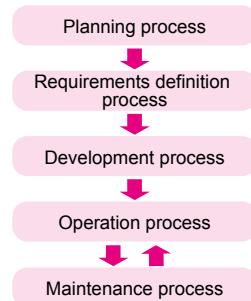
Risks conceivable in computerization and the causes thereof include the following:

Type of risk	Cause
Hardware fault	<ul style="list-style-type: none"> <li>• Power not switched on</li> <li>• Device configuration error</li> <li>• Poor physical device connection</li> <li>• Device fault, etc.</li> </ul>
Software fault	<ul style="list-style-type: none"> <li>• User operation error</li> <li>• OS and software configuration error</li> <li>• Software bugs</li> <li>• Computer virus, etc.</li> </ul>
Network fault	<ul style="list-style-type: none"> <li>• Broken cable</li> <li>• Network device configuration error</li> <li>• Network device failure</li> <li>• IP address configuration error</li> <li>• Constraint violation, etc.</li> </ul>
Data fault	<ul style="list-style-type: none"> <li>• Damage to data</li> <li>• Differing data formats</li> <li>• Differing formatting</li> <li>• Insufficient data storage space, etc.</li> </ul>
Performance fault	<ul style="list-style-type: none"> <li>• Insufficient memory</li> <li>• Insufficient disk space</li> <li>• Increase in data volume</li> <li>• File fragmentation, etc.</li> </ul>
Fault caused by disaster	<ul style="list-style-type: none"> <li>• Occurrence of fire or water damage, earthquake, etc.</li> </ul>

**Software life cycle**

When computerization is planned, it is important to take into account the “software life cycle,” or the flow of processes overall.

Specifically, planning must take into account cycles such as the following:



## 3-2-2 Requirements Definition

“**Requirements definition**” is the determination of matters including the framework for the system and work overall, the scope of computerization, the functions and performance required of the hardware and software that compose the system, and so on.

Requirements definition includes three types of definition: “**operational requirements definition**,” “**functional requirements definition**,” and “**non-functional requirements definition**.”

### ① Operational requirements definition

In “**operational requirements definition**,” the requirements that are necessary for the execution of the work targeted for computerization are defined. It is necessary to clarify when, where, by whom, toward what objectives, and by what procedures each business process is executed. In other words, operational requirements definition is the process of visualizing existing work. The flow of documents that arises in work, such as slips and forms, are organized too. The content that is defined in this step will become important material for determining the functions to be achieved in the system.

### ② Functional requirements definition

In “**functional requirements definition**,” the system behavior and processing needed to achieve business requirements are defined. The requirements of the user (i.e., the system user department) are analyzed alongside existing work, and the functions to be implemented in the system are made concrete. Whether the content listed in functional requirements is commensurate with cost must be determined, and prioritization must be performed to draw out maximum effect under a limited budget.

### ③ Non-functional requirements definition

In “**non-functional requirements definition**,” requirements other than the functions to be considered in the design of the system, such as processing time and security measures, are defined. Since defining these requirements requires knowledge and experience, clear requirements are typically not presented by the user (i.e., the system user department). This can become a pitfall, and if the project moves forward without sufficient consideration, trouble may result after the start of operation.

## 3-2-3 Procurement Planning and Implementation

Companies engage in business improvement and problem solving to achieve their business strategy.

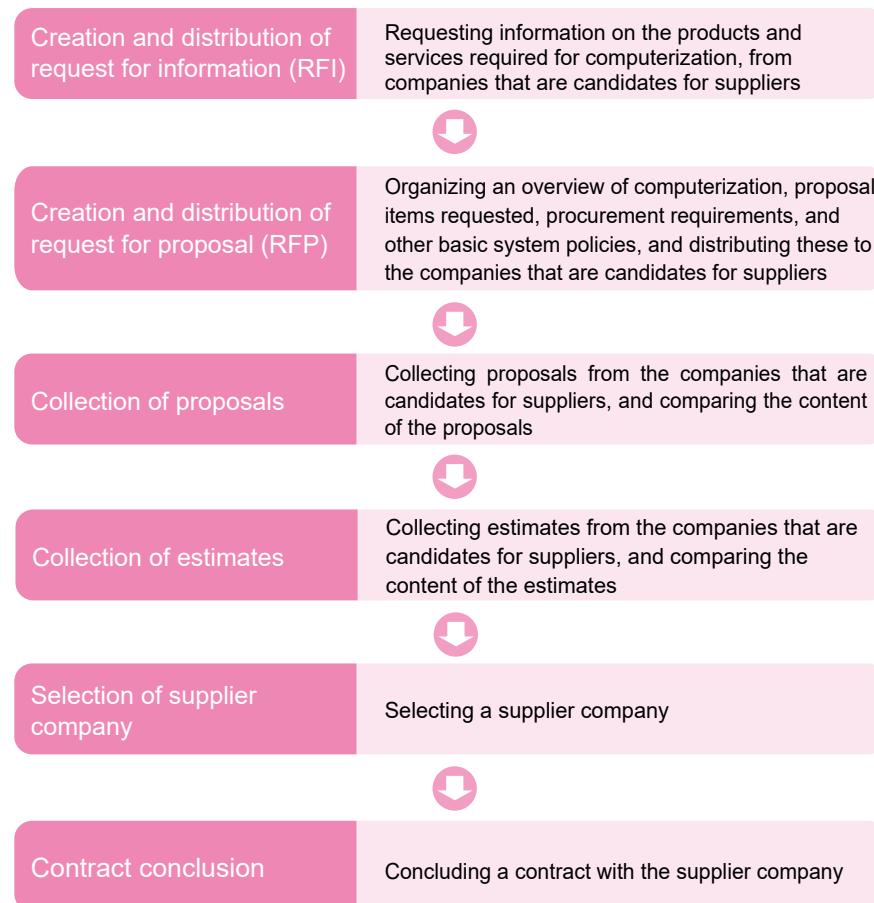
Business activities encompass a variety of formats, depending on field and objectives. In the conduct of business activities, each must be judged individually case-by-case. However, basic procurement planning is fixed and does not change.

In corporate activities, “**procurement**” refers to purchasing activities conducted for the purpose of arranging the products and services necessary for the execution of business. When computerization is promoted, the necessary hardware, software, network devices, equipment, and so on must be procured.

The procurement method – i.e., whether to purchase existing products and services, carry out system development internally, or outsource system development – is decided on the basis of the content of requirements definition. What to procure and how, the terms for procurement, and other matters are defined, and a “**procurement plan**” is created.

### 1 Procurement flow

The basic flow of procurement is as follows:



## **(1) Creation and distribution of RFI (Request For Information)**

An “RFI (Request For Information),” which comes before creation of the “RFP (Request For Proposal),” is a document used to request information related to computerization from system vendors or other supplier candidate companies.

Through the request for information, technical information such as the hardware and software required for computerization, examples of construction by competitors, information related to operation and maintenance, and other information can be collected from wide-ranging sources.

## **(2) Creation and distribution of RFP (Request For Proposal)**

An “RFP (Request For Information)” is a document used to ask system vendors or other supplier candidate companies to make specific system proposals.

The request for proposal incorporates the basic policy of the system, including system overview, objectives, necessary functions, requested system requirements, and contractual matters.

In addition to its role in requesting proposals from supplier candidate companies, the request for proposal plays a role in preventing confusion once the development stage is reached, by clarifying system requirements in advance.

## **(3) Obtaining proposals**

The “proposal” is a document that describes the items required by the request for proposal.

Supplier candidate companies consider system configuration, development methods, and other matters on the basis of the request for proposal, then create proposal documents and make proposals to the requesting company.

The requesting company evaluates the presented proposals and uses them as materials to select a company as the supplier.

## **(4) Obtaining estimates**

An “estimate” is a document that lists the costs required for system development, operation, maintenance, and so on, as well as the delivery date and other necessary matters.

In response to the requirements issued by the requesting company, supplier candidate companies present estimates that list costs, delivery date, and payment method.

## **(5) Selection of supplier company**

A supplier company is selected. In selecting a supplier company, the criteria to use in making the selection must be considered. Items required as selection criteria, including the content of the request for proposal, the implementation budget, services, and so on are listed and prioritized to enable comprehensive judging. Representative methods for selecting a supplier company include “proposal competition” and “open bidding.”

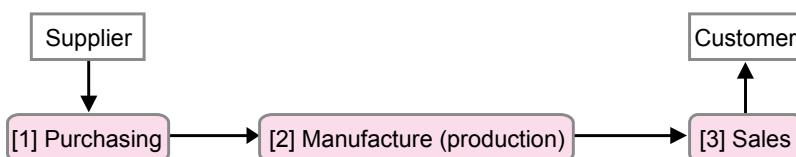
Name	Description
Proposal competition	Through this method, a company asks multiple system vendors or other companies to submit and present plans. Placing these vendors in competition with each other on the basis of proposal content, it then selects a supplier.
Open bidding	Through this method, a company openly solicits bids and requests the submission of estimates from all participants that meet the given qualifications. Placing these vendors in competition with each other on the basis of cost, it then selects a supplier.

## (6) Conclusion of a contract

The company concludes a contract with the supplier company. By clarifying the content of the contract in advance, the company can prevent trouble such as delayed delivery date, system faults, or confusion or disputes in development because of verbal agreements or unclear orders.

## 2 The business flow in the manufacturing industry

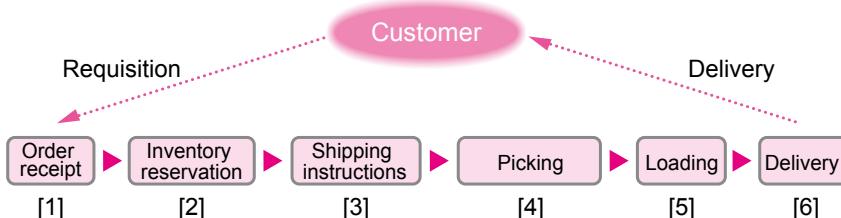
The business flow in the manufacturing industry is as follows:



Flow	Description
[1] Purchasing	The raw materials and equipment needed to manufacture (or produce) products are purchased.
[2] Manufacture (production)	Products are manufactured from raw materials.
[3] Sales	The manufactured products are sold to customers.

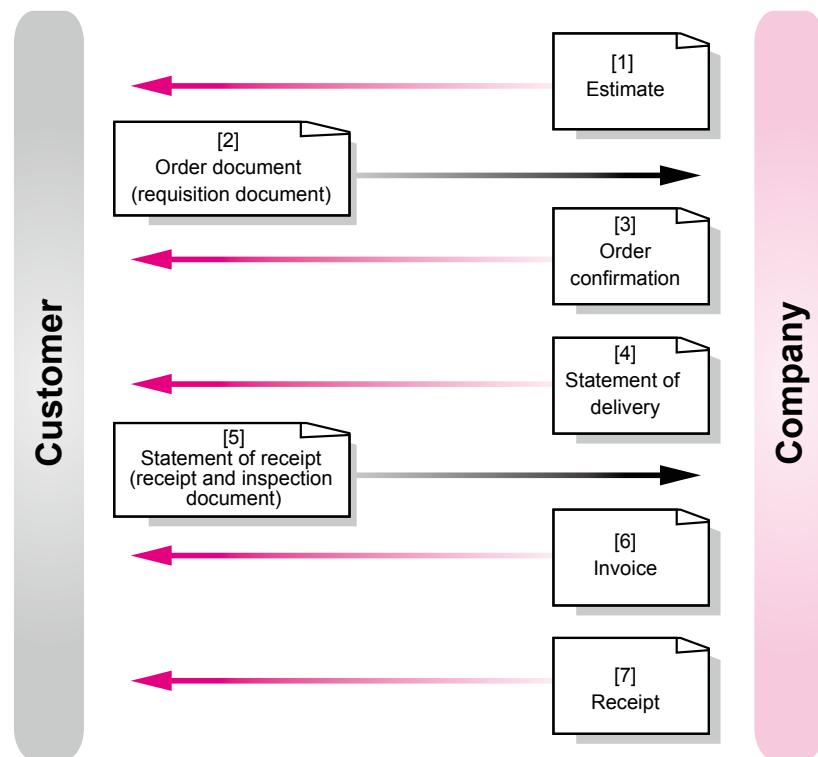
## 3 Flow of goods in sales

The flow of goods in sales is as follows:



Flow	Description
[1] Receipt of order	Orders that are received from customers are processed.
[2] Inventory reservation	The inventory of the ordered products is confirmed.
[3] Shipping instructions	If inventory exists, an instruction to ship is issued.
[4] Picking	The products are pulled out of inventory according to the shipping instructions.
[5] Loading	The products are loaded onto a truck or other transportation.
[6] Delivery	The products are delivered to customers.

In addition, the handling of documentation between the company and the customer in sales work is as follows:

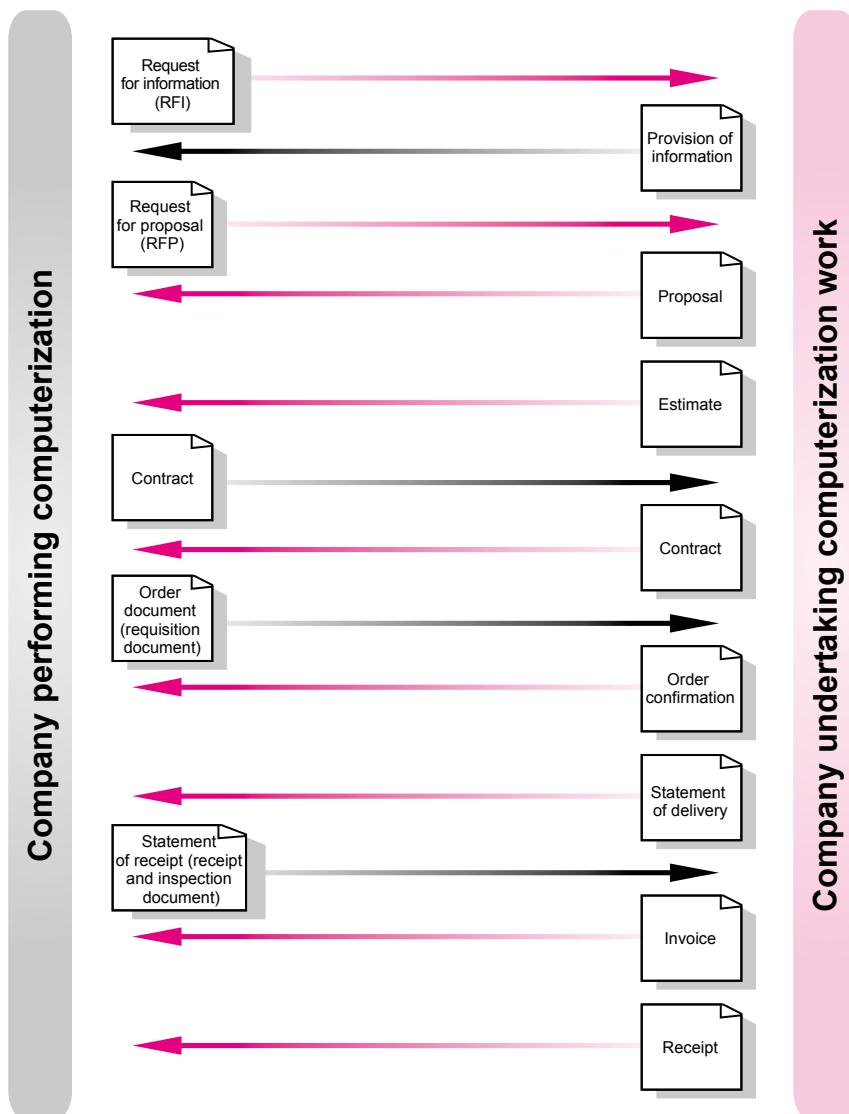


Flow	Description
[1] Estimate	In response to the customer's purchase requirements, the product price, delivery date, payment method, and so on are presented.
[2] Order document (requisition document)	The customer orders (requisitions) the product from the company.
[3] Order confirmation	The company issues notification that it has received the order from the customer.
[4] Statement of delivery	The company issues notification that it has performed delivery of the product to the customer.
[5] Statement of receipt (receipt and inspection document)	The customer notifies the company that it has received the product.
[6] Invoice	The company requests that the customer pay the price of the product.
[7] Receipt	The company issues notification that it has received payment of the price from the customer.

### Example

What sort of document flow takes place between a company that requests computerization and the company that undertakes the computerization work?

The flow of documentation is as follows:



## 3-3

# Chapter Quiz

[Note] Answers can be found on page 7 of the appendix "Answers and Explanations for the Chapter Quiz" at the end of this book.

### Q 3-1

Which of the following is an appropriate description concerning information systems strategy in companies?

- a) If information systems strategy succeeds, merits including increased business efficiency and support for decision-making can be obtained. However, increased costs cannot be avoided.
- b) Computerizing the analysis of large stores of data enables smooth and appropriate decision-making in business strategy, enterprise strategy, and elsewhere.
- c) In order to increase business efficiency, system installation should be planned for all work.
- d) With the COO at the center, the company establishes a computerization promotion system, and at first, on the basis of business strategy, creates a total computerization plan targeting work overall.

### Q 3-2

Which of the following is an appropriate example of offshore outsourcing?

- a) Company A has prepared an environment that will allow employees who work at multiple workplaces to access the latest data over the Internet and work from any workplace.
- b) Company B decided to relocate an entire customer management database server that it had operated on its own to a professional business so that the operation can be entrusted to the business.
- c) Company C has contracted to undertake all work involved in an information system, from design to development, testing, operation, and maintenance.
- d) Company D has entrusted its call center work to an overseas affiliated company.

### Q 3-3

Which of the following is an appropriate explanation of the digital divide?

- a) The occurrence of economic or societal gap because of differences in abilities and opportunities to use computers and the Internet.
- b) The active use of varied human resources, unbound by differences in nationality, gender, age, educational background, values, etc.
- c) The enabling of as many people as possible, including the elderly and disabled persons, to access information and obtain desired information and services.
- d) The information morals and manners that should be heeded in an information society.

**Q 3-4**

Company F is considering the development of a new system that requires an initial investment of 400,000 dollars. When the cost of system operation is 5,000 dollars per month and annual maintenance fees are 10% of the initial investment amount, which of the following is the most appropriate as the investment payout period? Assume that the investment effect following system launch is 25,000 dollars per month, and that the cost of interest and other matters are not taken into account.

- a) Two (2) years
- b) Three (3) years
- c) Four (4) years
- d) Five (5) years

**Q 3-5**

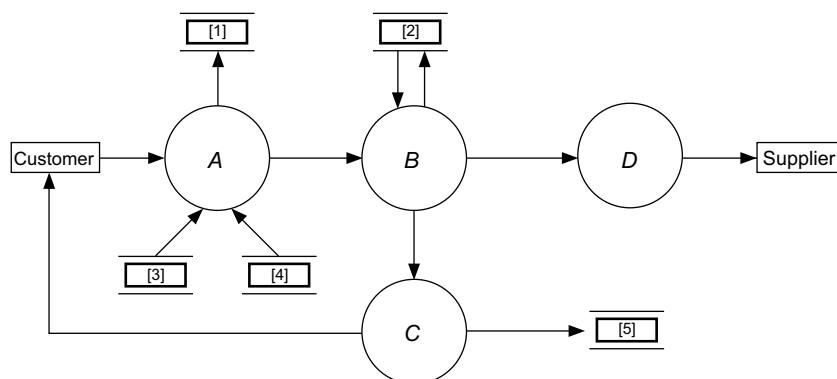
Company A plans to outsource the development of a payroll system. Concerning the system's procurement flow, which of the following is the appropriate combination corresponding to X and Y?

Company A presented an  X to a supplier candidate company, and requested the submission of information related to computerization. Afterward, it presented an  Y to supplier candidate companies and requested that they make specific system proposals.

	X	Y
a)	RFI	SLA
b)	RFI	RFP
c)	RFP	RFI
d)	SLA	RFP

**Q 3-6**

A company used a DFD to represent the processing steps, from receiving an order for product from a customer to inventory reservation and delivery. Which of the following is the appropriate combination that fits [1] to [5] in the diagram? Here, one of processing of order receipt, processing of requisition, processing of shipping, or processing of inventory reservation equates to each process in the diagram.



	[1]	[2]	[3]	[4]	[5]
a)	Product inventory data	Received order data	Customer master	Product master	Shipping data
b)	Received order data	Shipping data	Product master	Customer master	Product inventory data
c)	Received order data	Product inventory data	Customer master	Product master	Shipping data
d)	Customer master	Product inventory data	Product master	Received order data	Shipping data

## Which of the following is an appropriate explanation of SaaS?

- a) The operation of server and application software on a company's own equipment.
- b) A service by which a company connects to a service provider's system and, over the Internet, is able to use only the functions of application software that it needs and only when needed.
- c) A service by which a company installs servers and other devices usable by its own systems in facilities prepared by a service provider, and is able to use these over the Internet.
- d) A service by which a company constructs its own system using servers and OSs prepared by a service provider, and is able to use these over the Internet.

**Middle Question****Note**

**Middle questions have been abolished since April 2017.**

Read the following description concerning the analysis of a store's sales data, and then answer the questions 3-8 to 3-11.

In order to draft store deployment strategy for the current fiscal year, the sales division of fast food chain Company N analyzed its previous-year store sales performance in terms of net sales, seat turnover, and congestion rate. "Seat turnover" refers to the average daily number of customers divided by the number of store seats. The company decided to use spreadsheet software for its analysis, and created a table shown in the figure on the basis of sales-related materials from the previous fiscal year. Here, the business hours of stores are from 8:00 to 22:00.

[Store-specific sales analysis worksheet]

	A Store name	B Sales (10 dollars)	C Daily average number of customers (persons)	D Number of seats in the store (seats)	E Average spending per customer (dollars)	F Seat turnover (number of times)	G Congestion rate (%)	H Difference from average congestion rate	I Congestion status
1									
2	Store J	704	327	30	5	10.9	77.9%		
3	Store K	486	437	150	3	2.9	20.8%		
4	Store L	219	145	10	4	14.5	103.6%		
5	Store M	394	198	20	5	9.9	70.7%		
6	Store N	976	500	45	5	11.1	79.4%		
7	Store O	555	260	35	5	7.4	53.1%		
8	Store P	398	600	50	1	12.0	85.7%		
9	Store Q	878	405	50	5	8.1	57.9%		
10	Store R	619	250	40	6	6.3	44.6%		
11	Store S	1,156	350	60	9	5.8	41.7%		
12	Average								

**Q 3-8**

What is the break-even point for a new store when analysis has found that monthly sales are 800,000 dollars, variable costs are 200,000 dollars, and fixed costs are 120,000 dollars?

- a) 160,000
- b) 235,200
- c) 244,700
- d) 48,000

**Q 3-9**

Company N is implementing size reductions and expansions for its stores, along with deployment of personnel and other actions according to stores' congestion status (with congestion rate used as criteria). When the store-specific sales analysis worksheet is used under the conditions shown below to calculate stores' congestion status, which of the following expression should be entered to Cell I2?

[Note] Characters entered as arguments are enclosed in " " (single quotation mark).

[Conditions]

- (1) Enter an expression that calculates the average of Cells E2 through E11 to Cell E12, and copy it to Cells F12 through G12.
- (2) Enter the expression "G2-\$G\$12" to Cell H2, and copy it to Cells H3 through H11.
- (3) The criteria for congestion status is as shown in the table.

Congestion status	Categorization according to difference from the average
×	Stores with a difference from the average of -10% or more
○	Stores with a difference from the average of +10% or less
◎	Stores with a congestion status other than × or ○

- a) IF(H2<-0.1, '×', IF(H2≤0.1, '○', '◎'))
- b) IF(H2≤0.1, '◎', IF(H2<-0.1, '○', '×'))
- c) IF(H2≥-0.1, '×', IF(H2≥0.1, '○', '◎'))
- d) IF(H2≥0.1, '◎', IF(H2≥-0.1, '○', '×'))

**Q 3-10**

In drafting store deployment strategy for this fiscal year, Company N wishes to identify stores for which congestion status, calculated from the difference from average congestion rate, is "◎" and for which the average daily number of customers is 300 or fewer. It further wishes to designate these as key stores for enacting improvement in average number of customers. To how many stores does this apply?

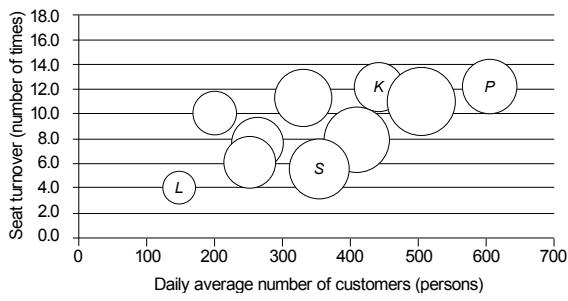
- a) 1
- b) 2
- c) 3
- d) 4

In analyzing sales, Company N judges stores for which daily average number of customers and seat turnover are both high to be stores with high operating efficiency. According to the store-specific sales analysis worksheet, the company described each store's net sales, daily average number of customers, and seat turnover as a bubble chart, and created [Rough draft of store deployment strategy]. Which of the following is a bubble chart that correctly represents the store-specific sales analysis worksheet?

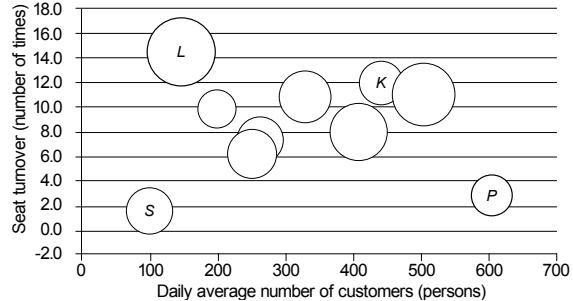
[Rough draft of store deployment strategy]

- (1) "Store K" has a high daily average number of customers but low seat turnover. Company N will reform the store and increase the number of seats.
- (2) "Store L" has a low daily average number of customers but high seat turnover. Company N will make Store L a key store for enacting improvement in daily average number of customers.
- (3) "Store P" has a high daily average number of customers and high seat turnover, but low sales. Company N will conduct a campaign to increase average spending per customer.
- (4) "Store S" has a low daily average number of customers and low seat turnover, but high sales. Company N will renew Store S as a high-grade concept store.

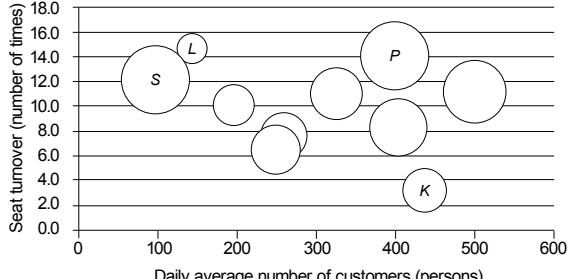
a)



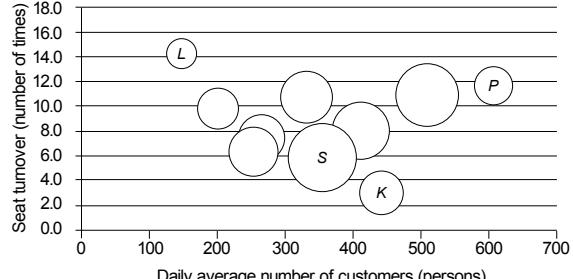
b)



c)



d)



# Management

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# Chapter 4

# Development Technology

This chapter explains the processes and test methods of system development, as well as the processes and development methods of software development.

### 4-1-1 System Development Processes

It is natural that in a system used in business operations, the necessary functions must operate normally, and in addition, such a system must be easy to use by users (system user departments).

It is important for the department developing a system to coordinate with various departments that would use the system, investigate and analyze their requirements, and reflect them in the system to be developed. Furthermore, a system need not necessarily be developed within one's own company, and can be outsourced to a company specializing in system development.

A “**contract for work**” is a typical contract method used at the time of outsourcing system development to another company.

The general procedure of developing a system is as described below.

#### Reference

##### Necessity of review

It is necessary to implement a “Review” for each process of system development. Review refers to checking and ensuring that there are no bugs (errors) in the design or system. The purpose of a review is to improve the quality by detecting and correcting latent bugs.

A review may be performed personally by a developer, or by a project team of a small number of persons, or else by all those who are concerned.

While a review is effective even if conducted by the developer him/herself, if it is performed by a person other than the developer, checking can be done objectively, and the bugs that went unnoticed by the developer him/herself may be detected.

##### Requirements definition

The functions required for a system are arranged.



##### System design

The system is designed on the basis of the requirements definition.



##### Development (programming)

The system is developed on the basis of the designed contents. A “unit test” is performed for each program that has been created, and the respective operations are verified.



##### Testing

All individual programs for which the unit test is completed are joined, and it is checked if the entire system is operating normally through tests performed in the order of “Join test” → “System test” → “Operational test.”



##### System installation and acceptance

The completed system is installed, and it is verified if the system is operating according to the requirements.



##### System operation and maintenance

The users (system user department) actually operate the system, and make improvements if any defects are found.

## 1 Requirements definition

The “**Requirements definition**” clarifies the functions, performance, and other details required for the system and software, and includes the “**System requirements definition**” and the “**Software requirements definition**.” The demands of the users (system user departments) are investigated and analyzed, and it is determined whether or not the demands are technically feasible, and thereafter, the requirements for achieving the demands are defined in detail, and arranged as a “**Requirements definition document**.”

At the time of investigating the demands of the users, the method of finding out the requirements through the way of interviews, etc., that is called “**Hearing**,” is effective. In order to implement the requirements definition smoothly without any omissions, items to be heard are clarified beforehand, and a plan is set up and implemented. Also, in order to enable checking the results of hearing at a later stage, it is important to maintain them as minutes, etc.

The requirements definition constitutes the first step of system design. Progression to the process of system design happens on the basis of the contents of the system requirements definition, and in this process, the requirements definition for software is performed.

In order to develop a superior system, it is necessary to define each requirement while cooperating with various departments that would be using the system.

In the “**System requirements definition**,” the functions that are necessary for computerization are clearly specified.

Generally, the requirements concerning system reliability (such as operation time and operation conditions) and security (such as countermeasures against a failure and maintenance) are specified.

Moreover, the performance of the hardware to be used for system operation and the conditions for education of users of the system are also specified together. In order to check if the contents specified in the system requirements definition meet the cost and achieve the maximum effect within a limited budget, it is necessary to prioritize the specified items.

## 2 System design

The system is designed on the basis of the requirements definition.

The procedure of designing a system is as described below.

### Reference

#### Quality characteristics

“**Quality characteristics**” can be criteria for evaluating the quality of software, and can be important indexes for improving the quality of software.

Quality characteristics include the following:

Quality characteristics	Description
Functionality	The extent of whether or not necessary functions have been incorporated
Reliability	The extent of whether or not a correct operation continues
Usability	The extent of whether or not it is easy to use (has good operability).
Efficiency	The extent of how small the amount of resources is required for operation
Maintainability	The extent of whether or not revisions are easy to make (whether or not the effect of revisions is confined)
Portability	The extent of whether or not transplanting into another environment is easy

### Systems architecture design (external design)

The architecture of the system, such as the hardware, etc. is designed in a specific manner on the basis of the requirements definition document. This task is implemented proactively by the user (system user department) in cooperation with the system development department.



### Software requirements definition (external design)

The software requirements to be developed from the user's perspective are designed on the basis of the systems architecture design document. This task is implemented proactively by the user (system user department) in cooperation with the system development department.



### Software architecture design (internal design)

The internal functions necessary for the system are designed on the basis of the software requirements definition document. This task is implemented by the system development department.



### Software detailed design (program design)

The internal structure of a program is designed on the basis of the software architecture design document. This task is implemented by the system development department.

## (1) Systems architecture design (External design)

In the "Systems architecture design," the system configuration is designed on the basis of the contents of the requirements definition. All system requirements in the requirements definition document are classified as shown below.

- Items to be implemented through hardware (hardware configuration)
- Items to be implemented through software (software configuration)
- Items to be implemented by the user manually (manual operation)

By thus classifying the requirements, the user work scope becomes clear, and it becomes possible to propose options in view of the risks, and also to design the system configuration on the basis of effective operation and maintenance, etc. The designed contents are arranged as a "Systems architecture design document."

## (2) Software requirements definition (External design)

In the "Software requirements definition" the software requirements as seen from the users are defined. Generally, the system interface is designed and data to be handled is identified. The contents defined here are arranged as a "Software requirements definition document."

### Reference

#### Joint review

The system requirements definition and systems architecture design, as well as the software requirements definition and software architecture design are reviewed jointly by the system development department and users (system user departments). The joint review involves prioritization of items from the viewpoint of cost effectiveness to achieve maximum results within a limited budget. It also involves checking whether the designed system architecture meets the system requirements, whether it is feasible to implement, etc.

Design	Details
Interface design	The part corresponding to the contact point between humans and computers is called a "user interface" or a "human interface." System input and output screens and printed formats of output forms are designed here.
Listing all the relevant data items	When table data is designed to use a relational database, all data items to be used in business operations are extracted and data that is overlapping as a result of data normalization is eliminated.

### (3) Software architecture design (Internal design)

In "Software architecture design," an internal design for the system, such as "how to implement" the functions necessary for the system is drawn. That is, the design is made from the viewpoint of performing programming in order to implement the functions determined in the systems architecture design and the software requirements definition. The contents designed here are arranged as a "**Software architecture design document.**"

Since internal functions of the system are to be designed, this task is performed by the system development department, but the users (system user departments) do not contribute to this designing.

### (4) Software detailed design (Program design)

The internal structure of a program is designed on the basis of the software architecture design. In the "**Software detailed design,**" the functional details of the program are defined, and the detailed processing units of the program structure, such as the access method (SQL statements) to the database, are designed. The contents designed here are arranged as a "**Software detailed design document.**" Thereafter, programming is implemented on the basis of this design document.

Since internal functions of the system are to be designed, this task is performed by the system development department, but the users (system user departments) do not contribute to this designing.

## 3 Development (Programming)

"**Programming**" refers to describing algorithms (procedures for problem solving) in accordance with the rules and grammar of the programming language. It also refers to others up to completing operation tests.

Each program module is created on the basis of the contents designed in the system design. In order to properly operate the system, it is important to write each module's procedures and processing contents, as well as the processed results, etc. exactly following the contents specified in the relevant design documents.

In addition, in order to ensure that each module that has been prepared operates normally according to the software detailed design document, a "**Unit test (module test)**" is implemented. A unit test is implemented to detect logical errors in every single module, and checks whether or not the modules function in accordance with predetermined specifications. Generally, unit tests are conducted mainly by the persons in charge of the software detailed design (program design) and by the persons in charge of program development.

Mainly, the "**White box test**" is used for unit tests. The program is converted to a program that can run on the computer by using a "**Compiler**," and the presence of bugs in the prepared program is ruled out.

#### Reference

##### **Improving the**

##### **maintainability of a program**

In order to improve the maintainability of a program, it is necessary to abide by programming rules, such as the way of naming variables and writing comments, restrictions on the usable characters and the maximum length of character strings, differentiation between upper- and lower-case characters, etc. These rules to be followed are called "Programming style." A program written in accordance with a given programming style allows anyone to easily understand the programmed processes and allows anyone to straightforwardly make revisions.

#### Reference

##### **Coding**

"Coding" refers to the creation of codes through writing algorithms and data processing logic in a programming language. The codes thus created are called "source codes."

#### Reference

##### **Code review**

"Code review" refers to reviewing created source codes. It involves checking whether the readability and maintainability of codes are high, and whether the codes are written in accordance with the software detailed design and programming style.

#### Reference

##### **Debugging**

"Debugging" refers to looking for and eliminating bugs from a computer program. It is different from a unit test in that when a bug is found, the location of the bug is focused upon, and only the part focused upon is corrected.

#### Reference

##### **Module**

A "module" is the smallest unit to configure a program. Generally, one program is made of one or more modules.

## 4 Testing

After unit tests are complete, the modules are combined together, and other tests are conducted to ensure that the designed and developed system operates normally, endures production operation, and other things. Testing is an important process for checking the quality of a program and system.

Testing is performed on the basis of a test plan, and work is carried on while evaluating test results.

### Reference

#### Program quality

The improvement in the quality of a program should be implemented in the design stage of the program rather than by repeatedly performing tests.

#### (1) Test implementation procedure

The procedure of testing is as described below.

##### Creation of test plan

The schedule, participants, and evaluation standard of the test are decided.  
Tests are not repeated with the purpose of improving the quality of the program.



##### Design of test specifications

The correspondence between the test data and expected results is designed on the basis of the design specifications.



##### Setting the test environment

The test data is created, and the test environment such as the devices, etc. used in testing are prepared. At this time, if the creator of the program performs tasks such as preparation of the test data and setting of the test environment, the sudden errors that can actually occur do not tend to occur. Therefore, this task is preferably performed by a person other than the creator of the program.



##### Implementation of the test

The test is implemented on the basis of the test specifications. If a program is revised after the completion of the test, the test is implemented again. At that time, the data for which the revised portion can be confirmed is added to the original test data.



##### Evaluation of test results

The system is evaluated on the basis of test results and it is ensured that there are no problems.

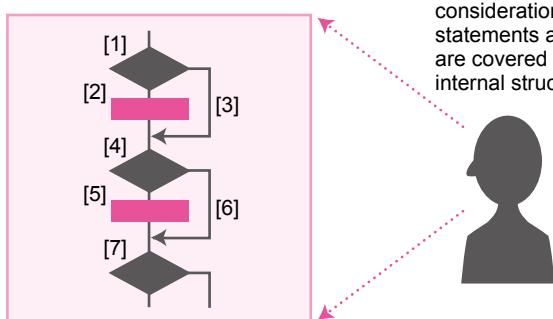
#### (2) Testing techniques

The main testing techniques in system development include the “White box test” and the “Black box test.”

##### ● White box test

The “White box test” is a technique to check the internal structure and logic of a program focusing on the control and flow of a program.

### Internal structure of the program



A test case is taken into consideration so that all operation statements and all branch conditions are covered while focusing on the internal structure.

### Reference

#### Test case

A “test case” refers to the test items and conditions in view of the pattern to be tested.

### Reference

#### Statement coverage

“Statement coverage” refers to the method of creating a test case so that all operations are executed at least once. It is one of the white box tests.

### Reference

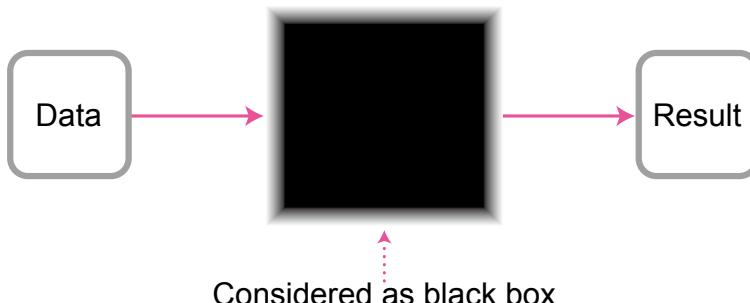
#### Condition coverage

“Condition coverage” refers to the method of creating a test case so that both true and false cases are covered for all decision conditions. It is one of the white box tests.

### ● Black box test

The “**Black box test**” is a technique to check whether functions are implemented in accordance with specifications focusing on the results generated with respect to entered data. This technique is used in many test processes.

### System and program



### (3) Test plan

In a test plan, data is prepared to verify if expected results are produced with respect to entered data. However, it is insufficient for completing a test if results are checked only for the case where correct data is entered. In the actual business operations, correct data is not necessarily entered at all times, and that the system is not always used under the normal condition. Therefore, the test data shown below is prepared in view of preparing for various cases.

Type	Description
Normal data	It is prepared to test if business operations are processed normally.
Exceptional data	It is prepared to test if exceptional data to occur in business operation is processed as an exception.
Error data	It is prepared to test if erroneous data is detected accurately as an error.

[Note] First of all, testing is performed by using normal data, and thereafter, testing is performed by using exceptional and error data.

## (4) Test implementation

Tests to be performed in system development include those described below.

### ● Integration test

In the “**Integration test**,” modules and programs are integrated, and it is verified if they can be executed correctly in accordance with the software architecture design. The integration test is implemented between modules and programs, for which unit tests are complete, to examine if data delivery between programs and screen transition are performed correctly. Generally, persons in charge of the software architecture design (internal design) prepare test cases, and integration tests are conducted in the system development department.

The integration test includes the tests described below.

Test	Details
Top down test	<p>It is a method by which testing is performed in an order starting from a higher-level module. Since in many cases all lower-level modules are not complete, provisional modules “stubs” are substituted to be called from upper-level modules.</p> <p>The diagram illustrates the top-down integration test process. At the top is a grey rounded rectangle labeled "Module A (already tested)". An arrow points down to a pink rounded rectangle labeled "Module to be tested". From this central module, two arrows point down to two separate dashed rectangles labeled "Stub". To the right of the central module, the text "Test in an order starting from the upper module" is written next to a vertical arrow pointing downwards.</p>
Bottom up test	<p>It is a method by which testing is performed in an order starting from a lower-level module. If the higher-level module is not complete, a provisional module “driver” to call the lower-level modules is substituted.</p> <p>The diagram illustrates the bottom-up integration test process. At the bottom are two grey rounded rectangles labeled "Module B (already tested)" and "Module C (already tested)". An arrow points up to a pink rounded rectangle labeled "Module to be tested". From this central module, two arrows point up to two separate dashed rectangles labeled "Driver". To the right of the central module, the text "Test in an order starting from the lower module" is written next to a vertical arrow pointing upwards.</p>

## ● System test (Overall test)

In the "System test," the programs for which integration tests are complete are combined together, and it is verified whether all functions satisfy the requirements specifications designed in the systems architecture design (external design). Generally, persons in charge of the systems architecture design (external design) prepare test cases, and the system development department and users (system user departments) conduct the test in cooperation with each other.

In the system test, the tests shown below are conducted depending on the purposes.

Test	Description
Function test	Verifying if all the necessary functions are incorporated
Performance test	Verifying if the processing performance such as the response time, turnaround time, and throughput satisfies the requirements
Exception handling test	Verifying if error handling functions and recovery functions work normally
Load test (Rush test)	Verifying if the system can withstand the load given through loading a large volume of data, increasing the number of terminals to operate concurrently, and other ways
Operability test	Verifying if a system can be operated easily by users (system user departments)
Regression test	Verifying if all program modules are unaffected after one or more errors detected in test processes are corrected or after specifications are changed
Penetration test	Detecting security holes of a system and the weak points (vulnerabilities) of the firewall by actually performing an attack or intrusion from outside

## ● Operational test

In the "Operational test," the actual business data is used to verify if the system corresponds to the actual form of business, and if it can be operated according to operation manuals. This test is implemented mainly by the users (system user departments).

The following items are tested during the operational test.

Item	Description
Business functions	Verifying if the functions necessary for performing business operations are implemented
Operability	Verifying if the system can be operated easily by users (system user departments)
Abnormality measures	Verifying if measures have been taken for cases such as data errors, abnormal operations, device errors, etc.
Throughput	Verifying if sufficient throughput is achieved under the current device configuration

**Test coverage**

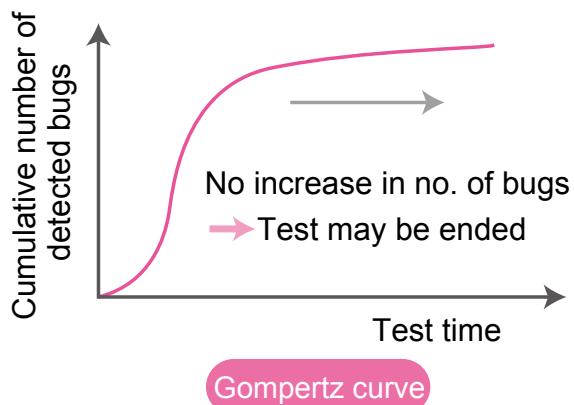
"Test coverage" refers to the proportion of coverage of a test. If this proportion becomes 100%, a test can be considered to be complete. It is also called the "Coverage rate" or "Coverage."

The quality of the deliverable can be evaluated on the basis of the test coverage.

**(5) Evaluation of test results**

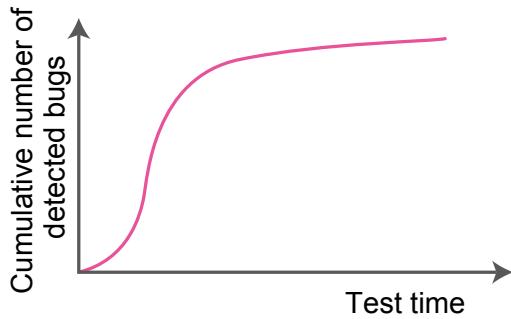
It is necessary to have good test results in order to accept a system. At this time, a standard for system evaluation must be taken into consideration on the basis of the test results.

A typical evaluation standard is the "**Bug control chart**." A bug control chart represents on a graph the relationship between the cumulative number of detected bugs and progress of the test. An ideal bug control chart is a curve in the form of a "**Gompertz curve (reliability growth curve)**."

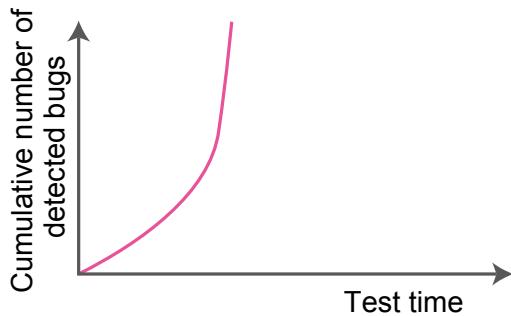
**Example**

Explain what the two graphs shown below imply respectively?

[1]



[2]



The graph shown in [1] is a Gompertz curve from which the situations shown below can be interpreted.

- In the initial stage, bugs come out and not much progress is made in terms of completion of test items.
- In the middle stage, a progress is seen in the course of completion of test items, and the number of bugs detected also increases.
- In the final stage, the number of bugs detected is converging.

From the above description, it is clear that the test can be finished. However, if incomplete test items remain even if the detection of bugs has converged, it can be assumed that the test has not progressed sufficiently. Therefore, when examining completion of a test, the progress status of the test also needs to be taken into consideration.

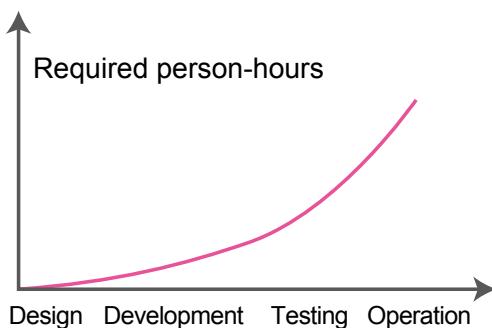
The graph shown in [2] is not a Gompertz curve, and the situations shown below can be interpreted from it.

- In the initial stage, bugs come out and not much progress is made in terms of completion of test items.
- In the middle stage, the number of bugs detected continues to increase, and there is no indication of convergence. Moreover, not much progress is made in terms of completion of test items.

From the above description, it can be assumed that there is a problem in the program quality and test method, since the number of incomplete test items is large. It is necessary to examine again if there are no defects in the program or the test method is appropriate.

#### Example

The graph shown below expresses the person-hours required for handling the errors that have occurred in each stage of system development. Explain what this graph tells?



While the occurrence of errors is unavoidable in system development, the number of person-hours required for handling the error varies depending on the time of detection and handling of the error. In the initial stage of system development, since program modules exist as individual entities, only the program module in which an error has occurred can be revised and the test can be implemented. Therefore, a comparatively lesser person-hours are required for handling errors. However, as system development progresses to a later stage, program modules are linked together, and it becomes necessary to perform a test for not only the program module in which an error has occurred, but also the surrounding program modules, which immensely increases the person-hours required for testing as compared to that in the initial stage.

Moreover, the increase in person-hours for development generates a large difference between the actual cost and its estimate. Since the person-hours for system development can be straight away considered as cost (personnel expenses), it is necessary to improve the quality of programs in the initial stage of development.

## 5 System installation and acceptance

Once a system is complete, it is shifted from the environment where it was developed to the environment where it will be actually operated.

### (1) Installation procedure

When you migrate to a new system, it is necessary to compile beforehand the detailed items such as how to handle the existing data and system, etc. Moreover, since unexpected errors are also likely to occur at the time of migration, it is necessary to set up a schedule in view of such errors.

A system migration should be done in such a procedure described below.

Deciding the migration data  
The data to be migrated from the old system to the new system is decided.



Deciding the migration method  
The data migration methods, such as whether the data to be migrated is used as is, or whether the data require conversion are clarified.



System installation plan  
Plans, such as the procedures and schedule for system installation are set up.



System installation  
The system is installed on the basis of the system installation plan.

## (2) System installation plan

A system installation plan clarifies the points described below. The installation plan prepared here is documented as a “**System installation plan document**.”

- System environment maintenance necessary for the operation of the system (hardware, software)
- Cost involved in system installation and operation
- Time of system migration
- Backup method for migrating data
- Impact of system installation on business operations and countermeasures to be taken
- Schedule for system installation
- Support framework for system installation

## (3) Installation

Once the procedure and framework for system installation have been put together, the system installation operation is performed on the basis of the installation plan. The results of the system installation operation are documented and maintained so that facts can be checked at a later stage.

## (4) Acceptance

When system development is outsourced to a specialized vendor, the development department that is entrusted with the development work hands over the system to the user (customer). At this time, the user accepts the system from the development department.

At the time of system acceptance, an “**Acceptance test (approval test)**” is performed to check if all user requirements have been satisfied, if the system is operating normally, and if the system has been completed in accordance with contract details.

If there is no problem in the acceptance test, the development department delivers the system to the user, and the user accepts the system.

In addition, the development department offers education and training, as well as support to the user. The support period and other details depend on the terms and conditions of the system maintenance contract.

## 6 System operation and maintenance

Once system development is complete, the users (system user departments) actually use the system. The users monitor the usage status and operation status of the system, and make improvements if any defects are found. Moreover, the users may also revise and change programs to meet the development of information technology and to comply with changes in the business strategy.

### Reference

#### Receiving inspection

“Receiving inspection” refers to the testing and acceptance of a system by a user.

### Reference

#### Warranty against defects

“Warranty against defects” refers to the responsibility taken by a seller (developer) to a buyer (user) to remedy any defect (such as flaws that are not known immediately) in a delivered system. For defects that are found within a certain period of time from the acceptance of a system, the seller is liable to perform correction work free of charge, or pay compensation.

### Reference

#### User manual

A “user manual” is an explanatory document that specifies how to use software or a system. Operational procedure for using a system and operation methods and operations regulations for a computer are described.

Before the start of production operation, operational training is performed by using a user manual, and also while the production operation is suspended, operational skills are acquired through checking a user manual and manipulating a system in accordance with the contents of business operations.

## Custody of documents

It is important to keep documents for each process of system development. Specific kinds of documents to keep include "Requirements definition document," "Design document," "developed programs," "Test implementation plan document," "Test implementation report," etc.

For example, the design document is an important document that persons in charge of development consult at all times as a blueprint of the system to be developed, and thus proceed with the development work. In addition, the test implementation report serves as the only document for understanding the current system when it becomes necessary to change the program in the operation and maintenance stage.

## (1) Points to consider with regard to operation and maintenance

The points to consider with regard to operation and maintenance of the system are as described below.

- Programs that are currently running in the production environment should not be modified directly. A backup must be taken for such programs before making modifications. Moreover, after modifying the program, testing must be performed in an environment that is of a level equivalent to the production environment.
- When a program is changed, every change must always be recorded as a revision history since they are useful for investigating the cause of future failures and others. Moreover, a regression test must be performed to ensure that other programs are not affected.
- The set of documents (such as the design document and the operation manual, etc.) concerning system development must always be maintained in the latest state.
- Matters such as whether the hard disk capacity has become insufficient because of a data volume increase and whether a performance degradation has occurred must always be monitored, and if necessary, remedy measures or actions must be taken.

## (2) System maintenance

The main maintenance activities for preventing failures include the following:

Type of maintenance	Description
Preventive maintenance	It involves removing the causes of failure beforehand to deal with the possible occurrence of failure in future.
Periodic maintenance	It involves daily checks performed on a regular basis. Moreover, a maintenance agreement is signed with a specialized vendor and the inspection of hardware is requested on a monthly basis, for example.
Remote maintenance	A maintenance agreement is signed with a specialized vendor to allow the connection of the user system with the specialized vendor over a communication line, and the causes of the failure are removed from a remote location (through remote operation).

## (3) Measures against system failures

An important point on maintaining the system operation is taking preventive measures to ensure that system failures do not occur. However, unexpected events are likely to occur.

At the time of system development, it is necessary to bear in mind that the occurrence of failures cannot be avoided. What is important is preparing in advance sufficient countermeasures in the development stage so that the entire system is not affected, or business operations are not discontinued as a result of the failure.

However, failures have various magnitudes, and when the probability of occurrence is extremely low, or the degree of damage during the occurrence of a failure is very small, prior countermeasures may not need to be prepared beforehand in view of the cost for implementing such prior countermeasures.

**Example**

In what way should prior countermeasures be taken against the three failures described below in the IT system (total system cost: 520,000 dollars) of a company?

[1]

Probability of occurrence: 0.07%

Damage situation at the time of failure occurrence: Employee search to be disabled (until 24:00 hours of the day of failure occurrence)

Cost involved in implementing prior countermeasures: Equivalent to 25% of the total system cost

[2]

Probability of occurrence: 0.56%

Damage situation at the time of failure occurrence:

Access to customer database to be disabled (until 24:00 hours of the day of failure occurrence)

Cost involved in implementing prior countermeasures: Equivalent to 3% of the total system cost

[3]

Probability of occurrence: 0.07 to 0.1%

Damage situation at the time of failure occurrence:

The server for an external website to fail (until the server is started again manually)

Cost involved in implementing prior countermeasures: Equivalent to 18% of the total system cost

Case [1] above

Since the probability of occurrence is comparatively low and the damage situation at the time of occurrence is confined to the company and is automatically recovered the next day, the decision should be made on the basis of whether or not these two points and the cost to implement prior countermeasures against the failure are in balance. Since the cost of prior countermeasures is as high as 25% (130,000 dollars) of the total system cost, deciding to put the prior countermeasures for this failure on hold can be said to lead to better cost performance.

Case [2] above

The probability of occurrence is comparatively high and the damage situation at the time of occurrence of the failure is the same as that in Case [1] above, where the damage is confined to the company and is recovered the next day. However, since the cost to implement prior countermeasures for the failure is 3% (1,560 dollars) of the total system cost, which is comparatively less expensive, it may be better to implement prior countermeasures against the failure.

Case [3] above

Since the probability of occurrence is comparatively low and the cost involved in implementing prior countermeasures for the failure is as high as 18% (93,600 dollars) of the total system cost, it may be desirable to put the prior countermeasures on hold in the same way as in Case [1] above. However, since the damage caused by the occurrence of the failure includes failure of the server for the external website, putting the prior countermeasures on hold may lead to a decline in the corporate image. Thus, in this case, it could be better to implement prior countermeasures.

## 7 Outsourcing of system development

When system development is outsourced, the types of contract to be concluded and the work instructions to be issued to the employees of the outsourced vendor are described below.

Contract	Details
Contract for work	The outsourced company (the company that receives an order for system development) proceeds with the work under its own management, and also takes the responsibility for accompanying risks. Therefore, the outsourced company issues work instructions to its employees, and can, in some cases, use subcontractors as well. In contrast, the outsourcing company (the company that places an order for system development) cannot issue work instructions to the employees of the outsourced company.
Time and material contract	The mandatory (the company that has been entrusted the system development work) receives a request from the mander (the company that has entrusted the system development work), and issues work instructions to its employees.
Dispatch contract	The dispatch source (the company that dispatches personnel) employs workers to be dispatched, and dispatches them to the dispatch destination (the company requesting the dispatch of personnel) with which a dispatch contract has been concluded. The dispatched workers perform work in accordance with the work instructions issued by the dispatch destination.

### 4-1-2 Estimate of Software

When business operations are computerized, it is necessary to decide the functions to be incorporated in a system in consideration of the cost. The methods of estimating the cost of system development include the following:

Type	Description
Program step method	It is a method to estimate the person-hours and costs of system development on the basis of the number of steps (number of lines) of the programs of the entire system. Estimation is made on the basis of the results of similar systems in the past. It is also called the "LOC (Lines Of Code) method."
FP (Function Point) method	It is a method to estimate the person-hours and costs of system development on the basis of quantified degree of difficulty in implementing input/output screens, files to be used, functions, etc. It is suitable for the estimation of GUI development and object-oriented program development.
Analogous estimate	It is a method to estimate the person-hours and costs for system development with reference to the records and performances of similar development in the past. The higher the similarity is, the more reliable estimation will be achieved.

## 4-2-1 Software Development Process and Methods

When software is to be developed, it is necessary to select a development process and a method in accordance with the size of the entire system and processing contents.

### ① Software development methods

A “Software development method” refers to the way of proceeding with the development process of software.

The typical development methods include the following:

Method	Description
Structured method	<p>It is a method of development in that a program is divided into subprograms, and they are arranged in a hierarchical structure. Through dividing a program into subprograms, you can easily perform their verification of behavior, correction, and maintenance.</p>
Object orientation	<p>It is a method of development in an object unit in that an “object” is defined by combining together data and operation. Since attributes (unique data) and methods (processes and operations for data) are integrated and handled as objects, modularization and reuse can be performed easily. Moreover, development can be performed easily by concealing the internal operation of objects and focusing only on the external operation. It is particularly suitable for the development of large-size systems.</p>
Data-oriented approach	<p>It is a method of creating a database by focusing on data to be used in business operations, and developing a system on its basis. Since in most cases the key data structure does not change even when the business operations change, the system can be modified easily.</p>
Process-oriented approach	<p>It is a method of developing a system by focusing on the business processes and functions. Since each system is created on the basis of business contents, there is a need to make significant modifications to the system when business contents are changed.</p>

#### Reference

#### Class

A “class” is one of the basic concepts of object orientation that defines a template of an object by compiling together attributes and methods. A class plays the role of a blueprint for creating an object.

#### Reference

#### Inheritance

“Inheritance” is one of the basic concepts of object orientation that refers to the creation of a new class (subclass) by adding functions to a class that acts as a standard (superclass).

### ② Software development model

A “software development model” is a development model that is used for the efficient development of high-quality software.

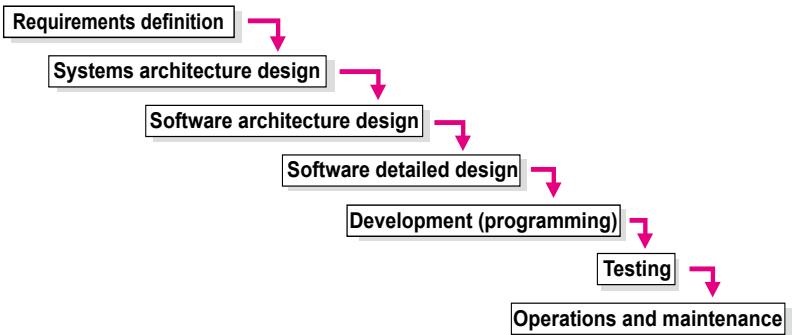
The typical software development models include the following:

#### ● Waterfall model

A “waterfall model” implies “falling water,” and is a development model in that a system development process is divided into subprocesses, and the development of one subprocess leads to that of another in a sequence starting from the upstream subprocess to the downstream subprocess, without return. Basically, the next subprocess starts after the previous subprocess is complete.

It is the most common development model in system development that is often used in large-scale developments since the estimation of the development cost and staff member management are comparatively easy to perform. However, in the case where a specification change is made or an error is found, the effect may extend to the previous subprocess that are already complete, and therefore, the load of reworking tends to increase enormously.

Moreover, since it is not possible to proceed with different subprocesses in parallel in order to minimize overall development time, only limited portions within each subprocess can be worked in parallel, that can shorten the work time only within individual subprocesses. However, it must be noted that the number of staff members required for performing work in parallel needs to be carefully managed, because it tends to increase the development cost.



### ● Spiral model

A “**spiral model**” is a development model in that a system is divided into multiple subsystems and the degree of perfection of the system is raised by repeating the cycle of “**Requirements definition**,” “**System design**,” “**Development**,” and “**Testing**” within each subsystem. It is also called an “**iterative model**.” A spiral model is used to develop a system with high independence.

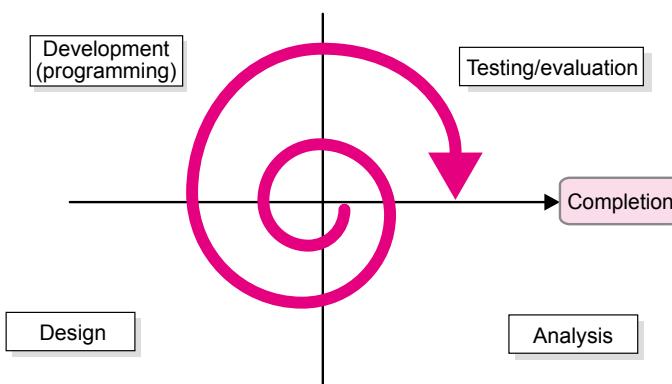
In a spiral model, the user (system user departments) verifies each subsystem so that the requirements of the user can be incorporated in the next cycle.

This model will make the degree of user satisfaction high, but the management of the development process tends to become complex.

#### Reference

#### Incremental model

An “**incremental model**” is a development model in that a system is divided into multiple subsystems and the degree of perfection of the system is raised in stages by repeating the cycle of “**Requirements definition**,” “**System design**,” “**Development**,” and “**Testing**” within each subsystem. The difference from the spiral model is that functions are created in stages within subsystems, and added up.

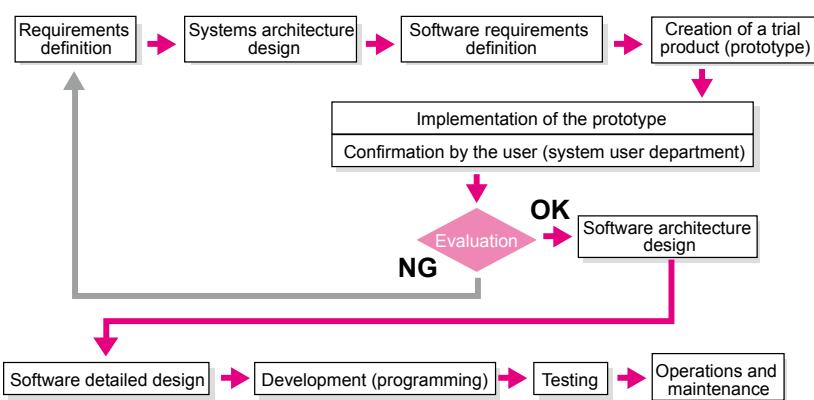


## ● Prototyping model

A “prototyping model” is a development model in that a prototype (trial product) is created in an early stage of system development, and development is proceeded with while obtaining the confirmation of the user (system user departments).

In the prototyping model, the misunderstandings about the system and the conflicts in perception between the user and the developer can be detected at an early stage. Moreover, it can be also expected to increase the degree of user interest in the system.

However, since user participation is necessary, the schedule adjustment is difficult, and the cost also increases if creation and evaluation of the prototype is repeated.

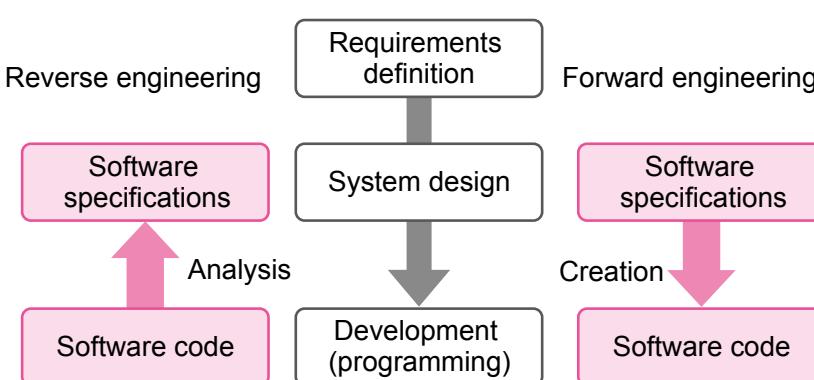


## ③ Reverse engineering

“Reverse engineering” refers to the analysis of existing software and the extraction of information such as the mechanism and the specifications of the software. Conversely, the creation of software codes by clearly specifying the mechanism and specifications is called “**forward engineering**.”

Documents such as the software design document are necessary in order for proper system maintenance, but if such documents do not exist, reverse engineering proves to be effective.

In addition, it may include clarification of the relationship between modules and analysis of the basic specifications of the system. This is performed to secure compatibility with the existing software.



### Reference

#### RAD (Rapid Application Development)

“RAD” refers to division of a system to be developed into multiple subsystems, and proceeding with development from a high-priority subsystem.

Its purpose is to develop a system in a short period of time and at a low cost by using high-function-rich software development tools. It is often used in a spiral model or a prototyping model.

### Reference

#### Agile

The method of developing a system in a fast and efficient manner is called “agile software development.”

In agile software development, first of all, the development period is segmented into short periods, and the system to be developed is divided into small functions. Next, in the segmented period, the development cycle is performed in a general way, and the functions are completed one at a time. By repeating this activity, the entire system is created in stages.

## 4 Common frame

A “**common frame**” is a common framework (frame) in that the work contents up to planning, development, operation, and maintenance are standardized, and terms, etc. are unified in software development. By having a common framework between the system vendor and the users, the transaction details such as mutual roles, scope of business operations, work details, and scope of responsibility, etc. are clearly specified, and both can have a common perception so that misunderstandings or trouble may not occur.

A typical example of a common frame is “**SLCP (Software Life Cycle Process)**.” This is a common frame for software-centered software development and transactions.

## 5 CMM (Capability Maturity Model)

The “**capability maturity model**” is an index for evaluating and/or improving the processes of system development and maintenance. It enables an objective evaluation of the software development capability of an organization.

There are some types of capability maturity model. The integration of them is called “**CMMI (Capability Maturity Model Integration)**.”

In CMMI, the degree of maturity is defined in the following five levels:

Level	Description
1	System development rules do not exist. Development capability is dependent on the skills of individuals (Initial state).
2	System development rules exist and managed as the rules of thumb for the organization (Managed state).
3	System development rules are defined for the organization, and systems of a certain level of quality can be steadily developed (Defined state).
4	In addition to Level 3, development performance can be evaluated quantitatively on the basis of certain criteria (Quantitatively managed state).
5	In addition to Level 4, the organization continuously works towards the improvement of development processes (Optimized state).

# 4-3

# Chapter Quiz

[Note] Answers can be found on page 11 of the appendix "Answers and Explanations for the Chapter Quiz" at the end of this book.

## Q4-1

**Which of the following quality characteristics of software products corresponds to the condition described below?**

Whether a system can restore the immediately preceding state without losing data after unexpected operation

- a) Portability
- b) Maintainability
- c) Usability
- d) Reliability

## Q4-2

**Company K, that is a system development company, is in a state where policies and procedures for system development are defined across the entire organization, and systems of a certain level of quality can be steadily developed. Which of the following CMMI maturity levels does this state correspond to?**

- a) 2
- b) 3
- c) 4
- d) 5

## Q4-3

**Which of the following is an appropriate description of software maintenance?**

- a) When the version of software is upgraded after the start of system operation, a defect occurs in some programs. The act of recording program revision contents in a document as history does not correspond to software maintenance.
- b) System development is complete and its environment has been changed from the development environment to the production environment. At that time, malfunction occurred in some programs. The correction of such programs corresponds to software maintenance.
- c) It corresponds to software maintenance to revise a program, after the start of system operation, in order to support the stable operation of the system, or in order to cope with the progress of information technology and changes in the business strategy.
- d) Revising program bugs discovered after the start of system operation does not correspond to software maintenance.

**Q4-4**

A turnkey contract is concluded for system development between an outsourcing company and an outsourced company. Which of the following is an appropriate relationship between an outsourcing company and an outsourced company?

- a) Since the designing of some functions of the system had started, the remuneration was paid.
- b) Since there was an urgent task, instructions were issued directly from the outsourcing company to the employees of outsourced company.
- c) Since the system developed by the outsourced company was not complete, the remuneration was not paid by the outsourcing company.
- d) Since the approval of the outsourcing company was not obtained, the outsourced company could not request a third party to develop the system.

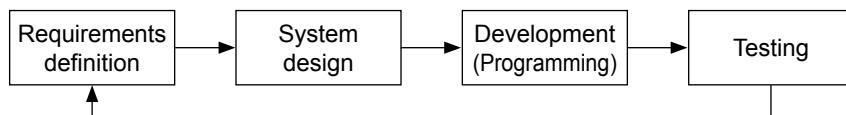
**Q4-5**

In order to confirm that input data is being processed in accordance with specifications, Mr. A, the in-charge of development, focuses on the internal structure of the program, and takes into consideration a test case where all operation statements and all branch conditions are covered. Which of the following is the test Mr. A is seeking to implement?

- a) Black box test
- b) White box test
- c) Top-down test
- d) Bottom-up test

**Q4-6**

Which of the following is a development model in that a system is divided into multiple subsystems and the degree of perfection of the system is raised by repeating the cycle shown in the figure below within each subsystem?



- a) Prototyping model
- b) Reverse engineering
- c) Waterfall model
- d) Spiral model

# Chapter 5

# Project Management

This chapter explains project management processes and methods.

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## 5-1-1 Project Management

When a company performs various company activities such as development of new information systems and services, it is important that the whole company has a sense of purpose and carries out a plan together. Generally, a plan can be carried out efficiently by structuring project organization and progressing a project systematically while managing project progress, cost, quality, and personnel.

### 1 Project

“Project” refers to activities that people carry out by gathering temporarily to achieve a specific purpose in a specified time frame.

The main characteristics of a project are as follows:

- It is a series of activities toward and an achievement of objectives.
- It is a limited time activity that have “Start” and “Finish.”
- It has obvious purposes and objectives.
- It organizes a group for a project.
- It gathers people who have special knowledge and rich experience from various fields.
- Members perform non-daily and non-repetitive tasks.
- Activities are conducted by using the determined business resources.
- It is a temporary group where members are dismissed after achieving objectives.

#### Reference

##### Benchmark

“Benchmark” is an evaluation method of a project’s quality by using the actual results of similar other projects as standard and comparing with them.

Different from daily repeated tasks, a project involves non-daily activities such as developing a new information system and unique service. In order to achieve such specific purposes in a certain time frame, it is necessary to use determined business resources (personnel, materials, money, and information) efficiently and promote a project smoothly.

## ② Project management

“Project management” is a management method to smoothly perform each process from project startup to completion determined in the company.

General project processes are as follows:

### Startup and planning

The project is started up and a plan is made for how it will proceed.



### Execution and understanding

The project is executed and the work schedule, cost, and quality, etc., are understood.



### End and evaluation

When the purpose is achieved, the project is ended and the work results and deliverables (completed items) are evaluated.

### (1) Project startup and planning

When a company starts up a project, a document called a “**project charter**” is created in order to acquire approval for the project. The project charter contains project purposes and overview, deliverable, constraints, prerequisites, summary schedule, estimate of approximate cost, etc.

After a project charter is approved by the client (purchaser) who requested the system development, a project starts with a “**project manager**” as the central person.

When the project starts, a meeting called a “**kick-off**” meeting is held with the “**project members**” selected for the project, to discuss the project’s important issues, organization, how to carry out tasks, and progress (schedule) management method. These detailed contents are put together into a “**project plan**.”

### (2) Execution and understanding of project

After the project plan is completed, the project is put into action, and tasks are performed. While the project is underway, the project manager constantly communicates with the project members and the client, and makes adjustment as necessary by grasping achievements such as project progress, cost, and quality.

### Reference

#### PMO (Project Management Office)

“Project Management Office” is a dedicated management organization where multiple projects are put together and strategic management is performed.

### Reference

#### Milestone

“Milestone” is a term used in project management. Milestones are major points (for example, integration test date, customer review date, etc.) on a work schedule in a project.

### Reference

#### Project manager

“Project manager” is a person who manages and supervises a project. It also refers to the national qualification that certifies the ability to supervise a project. In case of the first definition, a project manager coordinates project members and makes decisions on project progress management and work process management.

### Reference

#### Incentive system

“Incentive system” is a reward system to promote desired activities for the advancement of a project. “Incentive” refers to stimulation items such as bonus money, gifts, and points to be the motivator to promote specific behaviors.

### (3) End of project and evaluation

After a planned system is completed, the project is finished, and the members are dismissed. After the system is accepted by the client, the project manager creates a “**project completion report.**”

In the project completion report, all task results such as actual cost and progress, a list of final deliverables (completed items), and evaluation are described. The evaluation describes information that will benefit the next project such as difference between the plan and actual results, occurred changes and their factors, and occurred risks and measures taken.

## 5-1-2 Knowledge Areas of Project Management

As a guideline for a project manager to perform a project comprehensively, there is “**PMBOK (Project Management Body Of Knowledge).**” PMBOK is the systematized knowledge required for project management, also called the de facto standard and world standard of project management.

There are following ten knowledge areas in PMBOK.

Knowledge area	Details
Project scope management	Clarifies a deliverable and scope of work, and lists all necessary tasks.
Project time management	Adjusts work processes and schedules, and completes a project within a specified time frame.
Project cost management	Completes a project within a budget.
Project quality management	Determines quality objectives, and performs quality inspections.
Project human resource management	Secures project members, and develops human resources.
Project communication management	Promotes communication and information sharing among project members and between teams.
Project risk management	Assumes risks and determines how to avoid them, and how to take measures.
Project procurement management	Selects necessary resources, and performs ordering and makes contracts.
Project stakeholder management	Communicates with stakeholders, and promotes adequate involvement in the project.
Project integration management	Controls other knowledge areas and manages the whole project.

The characteristics of PMBOK are to keep total balance of these knowledge areas, and even when substantial changes are made on a deliverable and scope of work, a project manager can respond flexibly.

# 1 Project scope management

“Project scope management” is to clarify a final deliverable (deliverable scope) and necessary scope of work (project scope) to acquire the deliverable of a project, and manage the relationship of these two throughout the project.

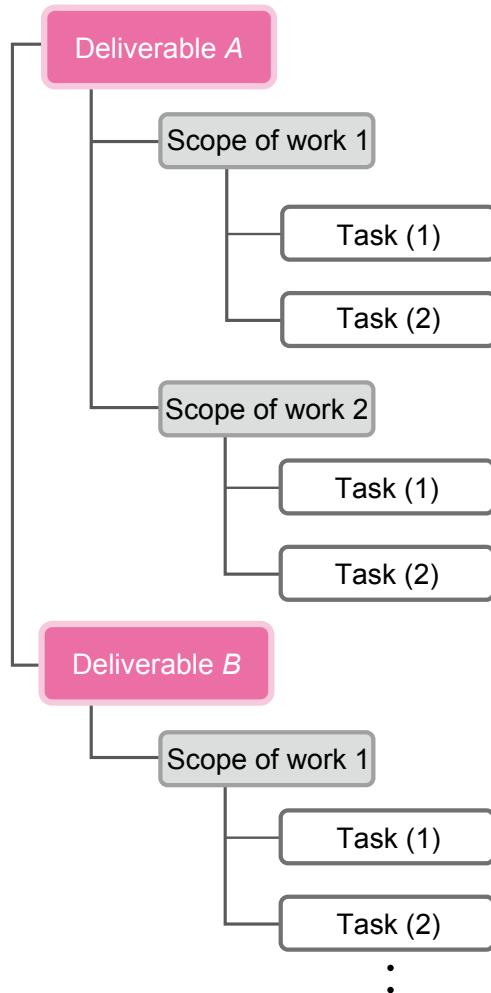
“WBS (Work Breakdown Structure)” is a hierarchical chart where the scope of work of a project is subdivided into detailed items.

The steps to create WBS are as follows:

Determine an individual deliverable in the project.

Determine a scope of work required to gain a deliverable.

Subdivide a scope of work and determine tasks.



Created WBS becomes a foundation of all knowledge areas in PMBOK and is utilized for planning and management of schedule, cost, human resources, quality, etc.

Also, when excess and deficiency are found during a project in progress and WBS, a project manager reviews constantly for the scope to be in the latest status and updates when there is a change accordingly.

## 2 Project time management

“**Project time management**” is to create and manage a highly accurate schedule to complete a project in the determined time frame by closely following the orders of tasks, work duration necessary for execution, and business resources.

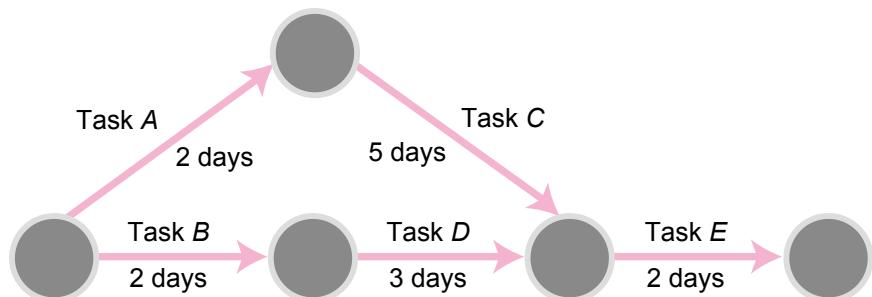
Schedule planning is determined by a calculated number of work days and clarifies progress check per task, a completion date of every task, and handover date.

When performing schedule planning, a project manager uses an “**arrow diagram**” and “**PERT diagram**,” and when showing a planned schedule in a figure, the project manager uses a “**Gantt chart**.”

There are various tasks in a project, and the number of necessary days is estimated per task.

When an arrow diagram is used, a “**critical path**” can be obtained. A critical path is a route where the longest number of days is required in the whole schedule in planning. When one of tasks on the course of a critical path is delayed, the whole schedule of the project is delayed.

For example, the following arrow diagram shows that Task E can be started when both Task C and Task D are completed.



The number of necessary days for Task E to be started is shown below.

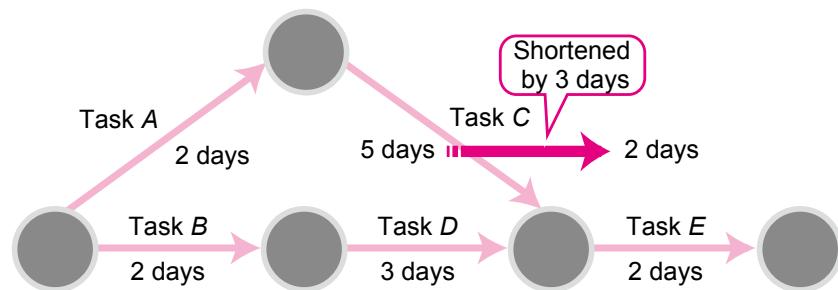
$$\text{Task A (2 days)} + \text{Task C (5 days)} = 7 \text{ days}$$

$$\text{Task B (2 days)} + \text{Task D (3 days)} = 5 \text{ days}$$

The critical path in this case is Task A → Task C. Task E can be started after seven days since the task is started.

### Example

When Task C in the arrow diagram shown below can be shortened by three days, what is the whole number of necessary days?



The critical path before shortening Task C for three days is Task A → Task C. The whole number of necessary days at this point is as follows:

$$\text{Task A (2 days)} + \text{Task C (5 days)} + \text{Task E (2 days)} = 9 \text{ days}$$

When Task C is shortened for three days, the critical path becomes Task B → Task D. Therefore, the whole number of necessary days is as follows:

$$\text{Task B (2 days)} + \text{Task D (3 days)} + \text{Task E (2 days)} = 7 \text{ days}$$

### Example

Based on the task schedule and the conditions to progress tasks shown below, is there a method to shorten the schedule?

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	day
Task A	■	■	■																
Task B				■	■	■													
Task C							■	■	■	■									
Task C'											■	■	■						
Task D														■	■	■	■		
Task E							■	■	■	■	■	■		■	■	■			
Task F														■	■	■			
Task G							■	■	■	■	■	■							

[Conditions to progress tasks]

- (1) Task A and Task B must be completed to start other tasks.
- (2) There is no order to start Task C and Task C', but they cannot be performed in parallel.
- (3) Task D and Task C can be performed in parallel; however, Task D and Task C' cannot be performed in parallel.
- (4) Task F cannot be started before Task D (they can be performed simultaneously).
- (5) Task G must be completed one day before Task F.

When the task schedule is reviewed according to the conditions, it can be shortened as follows:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	day
Task A	■	■	■																
Task B	■	■	■																
Task C							■	■	■	■									
Task C'				■	■	■													
Task D							■	■	■	■	■								
Task E				■	■	■	■	■	■	■		■	■	■					
Task F											■	■	■						
Task G				■	■	■	■	■	■	■									

Even when tasks are planned in order, it is possible to shorten the schedule by reviewing the condition, performing tasks in parallel (Task A and B, Task C and D, Task F and G), and switching the task order (Task C and C').

### Example

How does an arrow diagram look when created on the basis of the following task contents and task dependency relationship in replacing a system?

[Task contents]

Task No.	Task contents	Number of days required for the task
S1	System backup	2
D1	Data extraction	2
D2	Data conversion	2
H1	Procurement of hardware	3
H2	Hardware environment maintenance	2
S2	Software installation	1
S3	Software customization	2
D3	Loading data	1
S4	Operational test	4

[Conditions to progress tasks]

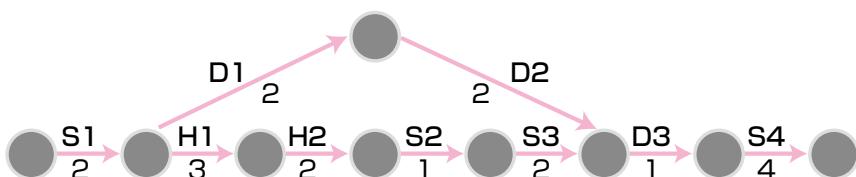
- (1) S1 must be performed before all the tasks.
- (2) D1 and D2 can be performed in parallel with hardware preparation.
- (3) After software preparation is completed, D3 can be performed and then S4.

From (2) of the conditions to perform tasks, it is clear that D1 and D2 can be performed in parallel with H1 and H2.

Also, to start software installation (S2) and customization (S3), because hardware preparation is essential, these must be started after H1 and H2 are completed.

Then, because it is stated in (3) of the conditions to perform tasks that D3 and S4 must start after software preparation is completed, they are started after S3 task is performed. At the same time, the data conversion task (D2) also must be completed.

Based on the above, the appearance of its arrow diagram is as follows:



### Example

In the following work plan, at first the assigned personnel was Mr. M only; however, work time reduction is necessary for Task H by adding more personnel. When the work plan is performed with the conditions below, how many people are necessary at minimum to shorten the work time? However, the work efficiency of personnel to add is 1/3 of Mr. M.

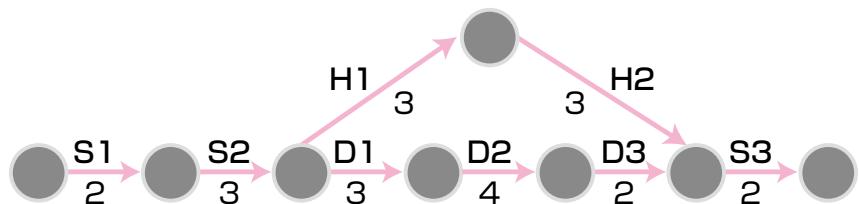
[Work plan]

Task No.	Number of days required for the task
S1	2
S2	3
S3	2
D1	3
D2	4
D3	2
H1	3
H2	3

[Conditions to perform tasks]

- (1) Task D and Task H can be performed in parallel.
- (2) Task D and Task H can be started after Task S2 is completed, and Task D and Task H must be completed before starting Task S3.

An arrow diagram created following the conditions on performing tasks is shown below.



A process where personnel can be added is Task *H*. Therefore, transfer the main personnel Mr. *M* to Task *D*, and add a member for six days in Task *H*. However, the followings need to be considered.

- The work efficiency of personnel to add is 1/3 of Mr. *M*.
- Nine days of Task *D* needs to pass before starting Task *S3*.

From above, the number of people who can finish the task in nine days with 1/3 the task efficiency of Mr. *M*, who can finish the task in six days, needs to be calculated.

The workload per day when performing a task for six person-day with nine person-day is:

$$6 \div 9 = \frac{6}{9}$$

The added personnel's task efficiency is 1/3. Therefore, the number of personnel to add is:

$$\frac{6}{9} \div \frac{1}{3} = 2 \text{ personnel}$$

### ③ Project cost management

“Project cost management” is to create an important standard to evaluate the progress status of a project and manage the cost throughout the project to complete the project within the determined budget.

For cost management, “EVMS (Earned Value Management System)” is used.

“EVMS” is a method to quantitatively evaluate project progress by comparing a budget and task progress. It is also called a “Production management system.”

In EVMS, a cost plan document is created on the basis of the estimated person-hours from the subdivided tasks in WBS, and the deviation between the schedule and cost is measured. Measured results are analyzed, task delays and budget excess are estimated, and the schedule and budget are adjusted.

#### Reference

##### Person-hours

“Person-hours” refers to the workload required for system development, etc. Generally, it is presented with the “person-months” unit.

#### Reference

##### Person-months

“Person-months” is the unit of workload. The amount of task performed by one person in one month is one person-month.

Example: A task that can be completed by one person for three months.

→3 person-months task

Example: A task that can be completed by two persons for three months.

→6 person-months task

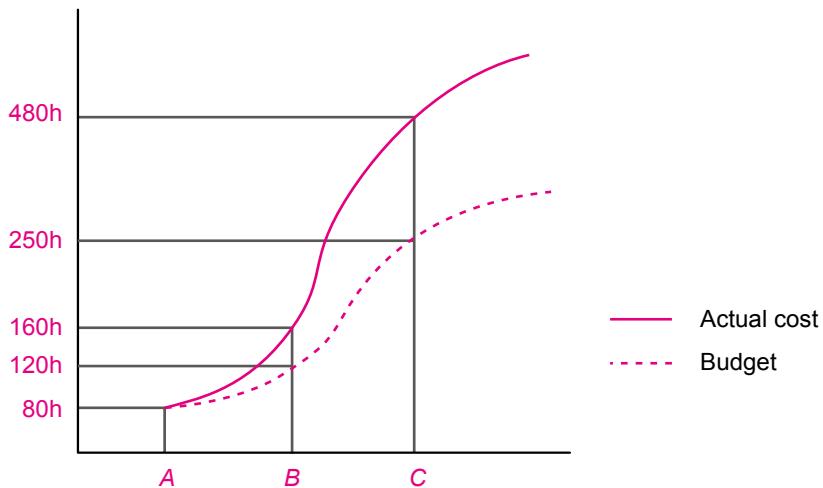
#### Reference

##### Contingency reserve

“Contingency reserve” is included in the initial project scope and countermeasure costs against events (risks) that can be predicted but whose occurrence is not certain. In case of an event occurs, it is recommended to estimate a certain amount of budget to progress a project without problems.

### Example

From the next figure, find the cost difference on Task C level in terms of monetary amount. The work unit price per one hour is 51 dollars up to Task B, and 26 dollars after that.



Find the budget, actual cost, and the person-hours required in each task level, and calculate the difference.

[Budget]

To Task B:  $120h \times 51 \text{ dollars} = 6,120 \text{ dollars}$

After Task B:  $(250h - 120h) \times 26 \text{ dollars} = 3,380 \text{ dollars}$

Total:  $6,120 \text{ dollars} + 3,380 \text{ dollars} = 9,500 \text{ dollars}$

[Actual cost]

To Task B:  $160h \times 51 \text{ dollars} = 8,160 \text{ dollars}$

After Task B:  $(480h - 160h) \times 26 \text{ dollars} = 8,320 \text{ dollars}$

Total:  $8,160 \text{ dollars} + 8,320 \text{ dollars} = 16,480 \text{ dollars}$

The difference is:

$16,480 \text{ dollars} - 9,500 \text{ dollars} = 6,980 \text{ dollars}$ .

## 4 Project quality management

“Project quality management” is to clarify quality management policies and objectives, responsibility, etc., and perform and manage necessary processes toward its achievement in order to satisfy required qualities on the project and its deliverable. The clarified contents are put together as a “quality management plan.”

## **5 Project human resource management**

“Project human resource management” is to manage an organization where each project member can perform his/her role and responsibility toward achieving purposes and objectives of the project and functions effectively as a project team.

Manpower and team strength are essential for project success. For all members involved in a project to display their ability effectively, a project manager selects project members while considering the following points.

- Duration the person can participate in the project
- Capability and specialized knowledge
- Past project experiences
- Level of interest in the project
- Procurement cost of project members

Furthermore, after organizing a project team, in addition to making sure to increase the skills of each member so as to raise performance as a project team, a project manager needs to plan and perform in order to enhance teamwork through promotion of communication inside the team, etc.

Also, a project manager evaluates the performance of project members and the team, grasps problems, and improves them. If necessary, while evaluating the degree of effects on schedule and cost, a project manager also reviews the human resources plan.

## **6 Project communication management**

“Project communication management” is to promote project success by binding stakeholders and information effectively through adequately managing from information generation to distribution and disposal of the project.

In order to maintain a good relationship with stakeholders, make sure to communicate with the stakeholders and provide information the stakeholders need, considering the adequate timing and means. A project manager shares problems and issues through communication with stakeholders and has a responsible role in solving them. Also, a project manager reports the progress status of a project periodically. Generally, the idea of EVMS is used to grasp progress status.

It is also important for the project members themselves to acknowledge the importance of communication and make an effort to improve their communication skills.

## **7 Project risk management**

“Project risk management” is to manage and control risks adequately throughout a project to reduce the probability of risk occurrence that would negatively affect the project and minimize the effect if such a risk does occur. Among the risks that can be considered, prioritize from the ones where probability of expected occurrence and loss of cost are high, and examine how to handle the high priority risks first. Also, it is necessary to come up with measures to avoid expected risks.

A project manager receives status reports from project members in regular meetings, monitors risks of the whole project, and continues controlling the project.

When a risk occurs, it is handled according to the policy planned with risk analysis and measures. In order to prepare for various risks on contracts, it is necessary to be ready to handle legal issues also.

## **8 Project procurement management**

“Project procurement management” is to manage contracts between purchasers and suppliers to purchase and acquire necessary items and services externally for execution of tasks.

Based on a deliverable and scope of work clarified through WBS, the technology and services to be procured externally are to be considered, and supplier candidates are to be selected accordingly. This is called “**dealing**.” Generally, a selection is made through bidding, estimation, and direct designating. Orders, contract processing, and acceptance are unified and managed as a series of events.

## **9 Project stakeholder management**

“Project stakeholder management” is to control stakeholders who influence a project to carry out a project plan. Stakeholders involved in a project are the clients, a project manager, project members, users, etc. of the project. In order to make a project successful, cooperation of stakeholders is essential, and it is important to promote their adequate involvement in the project.

## 10 Project integration management

“Project integration management” is to manage all knowledge areas together and balance as an integrated whole. In addition to establishing policies and planning the whole project, a project manager deals with changes that occurred during execution of the project. In case of a long-term project, because new technology and efficient technology may be developed while the project is underway, the ability to respond flexibly is required. Also, thorough discussion is necessary concerning significant schedule delays, extension of delivery date, and steep rise of cost. The whole needs to be managed to come up with a final objective deliverable.

### Example

Four months have passed since a program development task was started by five people, and approx. 40% of the entire process has been completed. In order to finish the remaining work in three months, it is determined to add more people. Under the following conditions, how many people are necessary to add?

[Conditions]

- (1) The work efficiency of the original five people remains the same.
- (2) The work efficiency of people to add is 80%.

Obtain the whole workload, and then find the remaining workload.

Completed workload:

$$5 \text{ people} \times 4 \text{ months} = 20 \text{ person-months}$$

Entire workload:

$$20 \text{ person-months} \div 40\% = 50 \text{ person-months}$$

Remaining workload:

$$50 \text{ person-months} - 20 \text{ person-months} = 30 \text{ person-months}$$

In order to complete 30 person-months remaining workload in 3 months, the following workload needs to be carried out per month.

$$30 \text{ person-months} \div 3 \text{ months} = 10 \text{ person-months}$$

The added personnel's task efficiency is 80%; therefore, the number of personnel to add is:

Workload assigned to added personnel:

$$10 \text{ person-months} - 5 \text{ person-months} = 5 \text{ person-months}$$

Number of personnel to add:

$$5 \text{ person-months} \div 80\% = 6.25 \text{ personnels}$$

→ 7 personnels

# 5-2

# Chapter Quiz

[Note] Answers can be found on page 13 of the appendix "Answers and Explanations for Chapter Quiz" at the end of this book.

## Q5-1

For a system development project, the number of programs to create is 8,000. Most of the programs are outsourced, and 25% of programs must be created in the company. How many person-months are necessary to create the programs in the company? The number of programs a person in charge can create in one (1) day is 0.2, and the work days are 20 days in one (1) month.

- a) 250
- b) 500
- c) 610
- d) 380

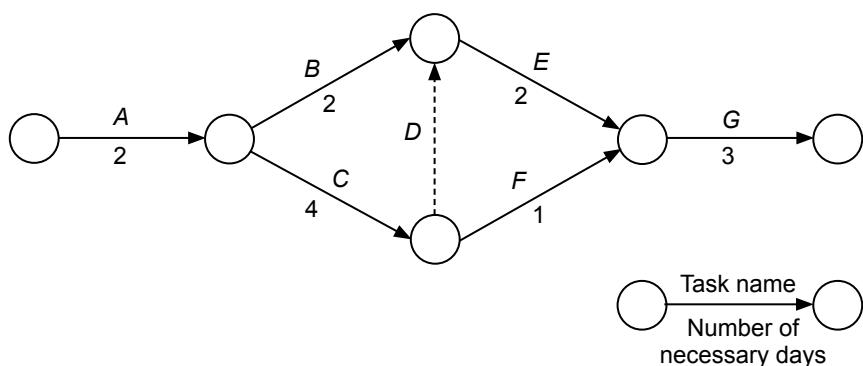
## Q5-2

Which of the following is an appropriate milestone in a system development project?

- a) Calculation of cost for system installation
- b) Proposal of a test plan
- c) System acceptance
- d) One (1) week attendance after full operation of the system is started.

## Q5-3

In the arrow diagram shown below, when Task F time frame is changed from one (1) day to three (3) days, how many days are extended in the whole number of necessary days?



- a) 1 day
- b) 2 days
- c) 3 days
- d) 4 days

**Q 5-4**

Which of the following is not an appropriate explanation of PMBOK?

- a) It is a guideline for a project manager to perform a project comprehensively.
- b) It is a systematized knowledge required for project management.
- c) It is an index to evaluate and improve system development and system maintenance processes.
- d) It subdivides management targets such as scope, time, and cost as knowledge areas.

**Q 5-5**

If Mr. A performs a software programming task alone, it takes 12 days, and if Mr. B does it alone, it takes six (6) days. When the two perform the task together, 10% of everyday's total work hours is necessary for discussion. When they perform the task together, how many days are necessary at least to complete the programming task?

- a) 4 days
- b) 5 days
- c) 9 days
- d) 10 days

**Q 5-6**

In a program development task, the workload required in each process is: Design = 20, Programming = 40, and Test = 18. When the workload that the potential person in charge of development Mr. A to Mr. D can do in one (1) day is as shown in the Table, which person would take the longest time to complete the development?

Person in charge	Design	Programming	Testing
A	2.5	8	9
B	2.5	6.25	5
C	5	8	6
D	2.5	12.5	5

- a) A
- b) B
- c) C
- d) D

**Q 5-7**

A project manager, Mr. A, subdivided the scope of work of a project into detailed items and created a hierarchical chart to utilize them for planning and management of schedule, cost, human resources, and quality. Which of the following is a chart created by Mr. A?

- a) Control chart
- b) DFD
- c) Arrow diagram
- d) WBS

**Q 5-8**

The table is a plan at the starting point when a group with six (6) members develops a system. On the 19th day from the start, 50% of coding task is completed. Approximately what % of the whole project does the remaining task constitute at the end of the 19th day?

Tasks	Planned person-hours
Specification creation	4 days
Program design	7 days
Test plan creation	2 days
Coding	6 days
Compiling	4 days
Testing	5 days

- a) 43%      b) 57%      c) 63%      d) 68%

**Q 5-9**

The budget of system development is 4,000 dollars that is evenly allocated to Process A to Process D. When Process A and B are completed and 40% of Process C is complete, it is decided to review the cost. The task progress rate and cost balance at this point are shown in the table below. When the cost is reviewed with the following conditions, how much is the overall cost?

[Conditions]

- (1) The cost consumption rate of Process C should remain the same.
- (2) The cost of Process D is reduced by 20%.

	Task progress rate	Cost balance (dollar)
Process A	100%	-100
Process B	100%	100
Process C	40%	480
Process D	0%	1,000

- a) 3,900 dollars  
b) 4,000 dollars  
c) 4,100 dollars  
d) 4,300 dollars

# Chapter 6

# Service Management

This chapter explains basic roles and structure of IT service management and service support that manage information system operation, how to consider system environment arrangement, and basic knowledge of system audit.

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<b>6-2</b>	System Audit .....	170
<b>6-3</b>	Chapter Quiz .....	175

## 6-1-1 Service Management

“Service management” refers to activities to maintain and improve service quality, and at the same time, provide necessary services promptly according to customers’ needs.

### ① IT service management

“IT service management” is a management method for acknowledgment of tasks of the IT Department as “IT services” and operate in a stable and efficient way.

For example, financial institutes and transportation industry support their business management and society as a whole by providing various IT services. When a problem occurs in an IT service, it may cause accidents and confusion significantly affecting society at large, and not only the company itself.

Therefore, IT services are managed with the aim of efficient operation and maintenance and improvement of service quality.

### ② ITIL

“ITIL (Information Technology Infrastructure Library)” is a framework that puts together best practices (successful cases) in order to ensure successful business utilizing IT services, and utilized as the “de facto standard” in IT service management.

ITIL is a comprehensive guideline for IT services; however, it is not necessary to match all IT service operations to ITIL. It is desirable to match actual tasks and operate by referencing its applicable parts.

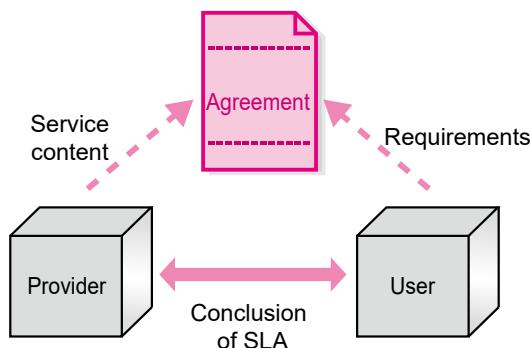
### ③ Service level management

“Service level management” is a process for maintaining and improving a service level on the basis of the agreement between an IT service provider and a user. In order to secure quality and provide stable IT service, “SLA (Service Level Agreement)” and “SLM (Service Level Management)” are performed, and operation and management are executed.

#### (1) SLA (Service Level Agreement)

“Service Level Agreement” is a “quality assurance contract” exchanged in order to operate and manage on the basis of the agreement between an IT service provider and a user by clarifying explicitly the quality and the range of IT service to be provided. A contract contains information on the range of system service, charging content, available hours for inquiries, and recovery target time in case of system failure.

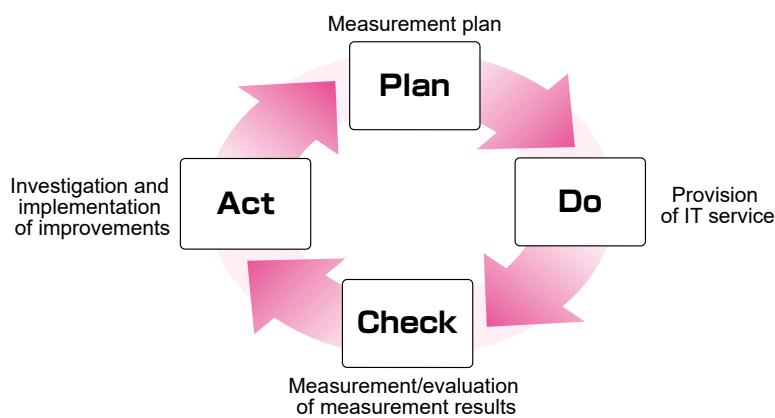
It is said to have spread originally as a form of contract that a communication operator made to ensure the communication quality of network services. A standard is defined for a lower limit of actual data transfer rate and an upper limit of down time at service failure, and a penalty and compensation are regulated when the set values are not followed. Today, it is utilized in various IT services.



## (2) SLM (Service Level Management)

**“Service Level Management”** is a management method to maintain and improve a service level by measuring whether the contracted service level is achieved.

The PDCA cycle of service level management is as follows:



## ④ IT service availability management

**“IT service availability management”** is a series of activities to maintain and manage individual function configuring IT service so that users can use the IT service whenever it is needed. In today's society, IT and business are inseparable, and therefore, interruption of IT services can lead to interruption of actual business. Therefore, securing the availability of IT services is extremely important in terms of ensuring business continuity.

## 6-1-2 Service Support

“Service support” is a process to support service operation, and one of the ITIL frameworks. Service support consists of five processes and a service desk, and by performing these processes, IT services are managed in the integrated style.

Service support processes are as follows:

### ① Incident management (fault management)

Reference

#### Incident

“Incident” is a phenomenon such as failure, accident, and unexpected happening in an information system that reduces or may reduce service quality.

Reference

#### Near-miss

“Near-miss” is a state that did not result in a significant incident, but which could have done so. In incident management, management to utilize lessons learned from a near-miss is also performed.

##### Detection and recording

Notification is received from the service desk, and the information required to respond to the incident is organized.



##### Category and initial support

On the basis of the degree of effects and urgency of the incident, the priority of the solution is decided, and initial support is provided.



##### Investigation and diagnosis

An incidents that cannot be solved with initial support is taken over by the person in charge.



##### Solution and recovery

The incident is solved with the solution presented by the person in charge, and the IT service is recovered.



##### Close

On the basis of agreement with the user, the IT service is restarted.

### ② Problem management

In “problem management,” causes of an incident are acknowledged as “problems,” and their causes are pursued. Measures to solve problems are examined, and succeeded to change management. The focus of problem management is to find a root cause and to eliminate it in order to prevent it from recurring. Problem management processes can be categorized into two. One is a passive activity to solve a problem when an incident occurs. The other is a positive activity to detect a potential problem and prevent an incident from occurring.

### ③ Configuration management

In “configuration management,” configuration information such as hardware and software that structures an IT service is managed accurately, and these are maintained in order to provide better IT services.

Merits of performing configuration management include the following items.

- Grasping information assets an organization possesses accurately
- Grasping maintenance cost of equipment accurately, and utilizing it for budget planning and cost reduction
- Making license management and information security management efficient
- Prohibiting using non-regulated information assets and making sure to strictly follow laws and ordinances

Reference

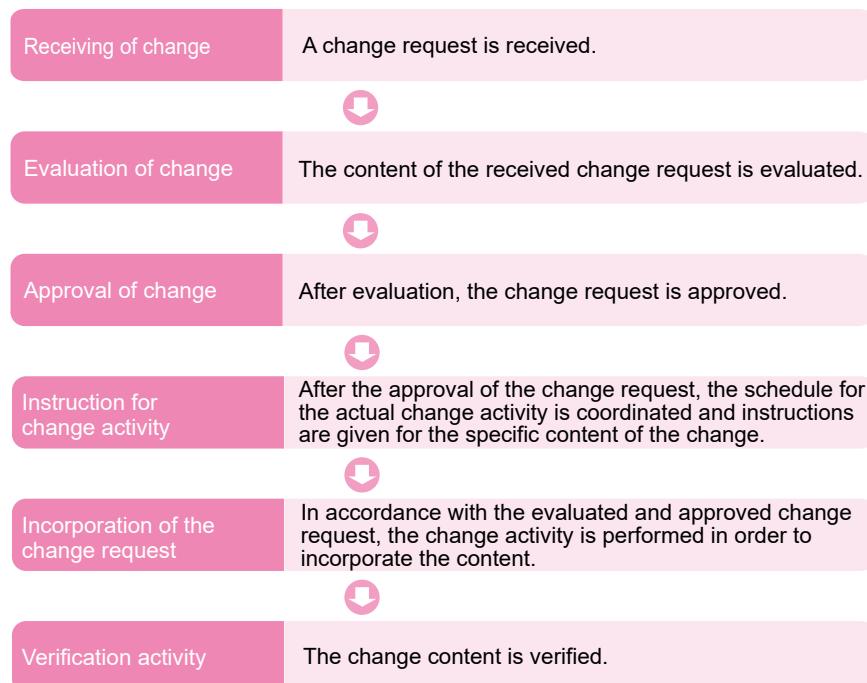
#### Version control

“Version control” is to record date, reviser, and revised contents performed on code and files as a version. It is conducted as a part of configuration management.

### ④ Change management

In “change management,” “change requests” are accepted concerning solutions clarified through problem management and configuration changes required according to life cycles, and activities are performed in order to evaluate and execute them. Approved change requests are fed into release management.

Change management processes are as follows:



Reference

#### Change request

“Change request” is to request changes concerning hardware, software, documents, and procedures. It is also called “RFC (Request For Change).”

## 5 Release management

In “**release management**,” a change task determined in change management is performed. Not only a change task is performed, but also it is necessary to ensure that stable IT services are provided after the change is implemented.

Also, when hardware and software necessary for a release (approved changes by change management) are newly procured, it is also necessary to handover to configuration management.

## 6 Service desk

### Reference

#### Escalation

“Escalation” is to notify a higher ranking personnel member and manager to pass correspondence when one cannot handle a question, claim, or complaint from a user.

“**Service desk**” is a window to respond to users’ inquiries. It is also called “**help desk**,” “**call center**,” or “**user support**.”

Generally, various inquiries are accepted, such as how to use a product, how to use a service, how to cope with problem, a repair request on failure, or responses are given to claims and complaints. There are many acceptance methods such as telephone, e-mail, fax, etc., but it is important to have a plan to unify contact windows, because if multiple windows are set depending on inquiry types, it becomes difficult to discern which window is appropriate for which inquiry, and more time may be necessary to look for contact windows.

Accepted inquiry contents are registered on a database, and published as “**FAQ**” (Frequently Asked Questions) in a web page, and analyzed to use for product and service improvement.

Merits of setting a service desk include the following items.

- Improving customer service and raising the level of customer satisfaction
- Collecting customers’ opinions on a product and a service, and utilizing them for the next strategy
- Sharing various information and know-how on support, and utilizing effectively
- Grasping a response status on an inquiry from a user accurately

### Example

Incident management and problem management are service support processes when users make contact concerning a problem. While these are kept in mind, what is the role of a service desk?

Incident management refers to activities on the basis of assumptions to return to a normal service as soon as possible by minimizing the impact on service interruption time and other tasks when an incident occurs. Also, problem management is activities to identify causes of a generated incident and present a recurrence prevention measure.

While these two points are taken into consideration, the activities of a service desk when a failure is notified by users are to check if a similar problem occurred in the past and communicate how the problem was handled. At the same time, the service desk contacts the department responsible for the part of failure and a system administrator in order to start the first step for recurrence prevention.

## 6-1-3 Facility Management

“Facility management” is a concept to maintain computers, network, facilities, equipment, and other things a company possesses in order to keep them in a better state.

It was originally a business method to operate and manage company-owned real estate properties and facilities like buildings. By applying this method to information system, the purposes are to maintain an environment along with facility management and manage information system in the most adequate state.

### ① System environment maintenance

An information system is supported by various system environments. In facility management of information systems, it is considered important to prepare for natural disasters such as earthquakes and flood damage, etc. as well as for accidents including fire, etc. Periodical checks are conducted on windows’ condition, air conditioning, noise, water leakage, and short circuits to make sure there is nothing that may lead to failure in equipment operation, and take measures as necessary.

#### Reference

#### Facility

“Facility” refers to buildings and equipment.

#### Reference

#### Free address

“Free address” is a form of an office setting that common seats are prepared as open space without a specific seat assigned for an employee, and an employee who comes in the office takes a vacant seat to his/her preference. It is used mostly as a space saving measure to reduce office rental cost and management expense.

Equipment to secure information system includes the following items.

Reference	Type	Description
<b>Server rack</b> “Server rack” is a shelf to store servers. By storing multiple servers, high maintainability and installation efficiency can be secured for servers.	UPS (Uninterruptible Power Supply)	This is a reserve power supply to prevent power supply from stopping by power outage and momentary power failure. During power outage, power is supplied through a battery; however, the time UPS can supply power continuously is 10 to 15 minutes in general. Therefore, it is necessary to save working data promptly and stop a system.
	Equipment with surge protect function	“Surge” is an abnormally high voltage generated momentarily. In case of a lightning strike in close proximity, current (several thousand to several 10 thousand A) generated by high voltage can flow through a wire and telephone line, and may damage computers. By using an OA tap equipped with the “surge protect function,” surge damage can be prevented.
	Private power generator	When the main power source cannot be used because of power outage, this device generates power to supply instead. There are multiple types, such as a solar power generator, a wind power generator, a diesel power generator, and a gas power generator. Generally, it is not used during normal operation, so it is important to perform periodical inspections to make sure it works in case of emergency.
	Seismic isolator	This is installed on the foundation of a data center and between different floors, and works to reduce shaking of the building from the earthquake. This device can protect equipment such as computers and network devices from shaking and avoid faults and damages from disasters; therefore, it is considered to be an effective business continuation measure. There is a “base isolation floor” type installed on the floor and a “base isolation apparatus” type installed under a device.
	Security cable	This is a cable to attach to a notebook computer to prevent theft. A security cable is attached to equipment such as a notebook computer, and fixed to a desk. Then the computer cannot be taken out of a room easily; therefore, it is suitable as an anti-theft measure.

## 2 System environment maintenance

After a system environment is set so as to be used in the most adequate condition, it is necessary to perform activities to maintain it in an adequate state. Check buildings and facilities, change to new ones for the assets with expired depreciation, and dispose old assets. The purpose of activities to maintain a system environment is to provide a comfortable and safe IT service continuously in addition to making buildings and facilities last for a long time.

It is necessary to perform activities surely and with adequate timing; therefore, a manager is assigned, manuals are prepared, a clear maintenance plan is proposed, and activities are performed on the basis of the above. Also, in order to verify planned maintenance activities are performed adequately, it is important to conduct periodical reporting and evaluation.

# 6-2

# System Audit

## 6-2-1 System Audit

System audit is an important activity for a company in order to conduct developmental business.

### ① System Audit

“System audit” is performed by a “system auditor” who is an independent third party to verify and evaluate a system comprehensively, and advise and give recommendations to the people concerned.

#### (1) Purpose of system audit

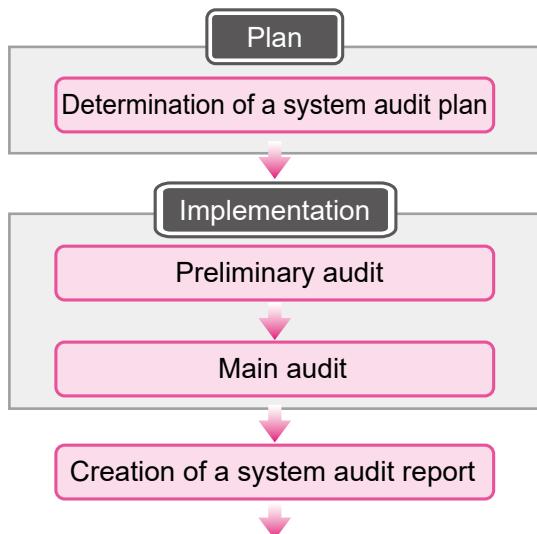
The purpose of a system audit is to investigate an information system from a broad viewpoint and to judge whether the system contributes to management.

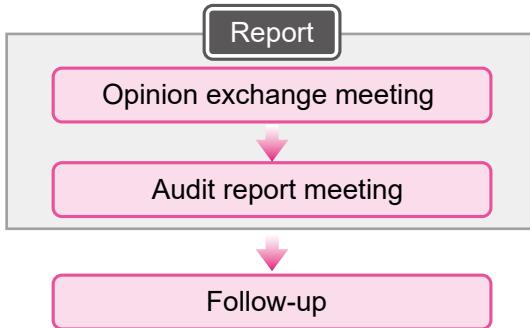
General audit items are as follows:

- If an information system secures reliability against failure.
- If an information system secures safety against natural disasters and unauthorized access.
- If an information system contributes to business policies and strategies of a company efficiently.

#### (2) Process of system audit

System audit processes are as follows:





## Reference

### System audit standard

"System audit standard" is a guideline to audit information system adequately. When a system audit is conducted, the code of conduct required for system auditors is described.

## Reference

### Audit evidence

"Audit evidence" is information such as information system, usage information, and error condition logs that enable tracking investigation. By closely examining these, reliability, safety, and efficiency of information system, which are the purposes of the audit, are verified so as to be secured. It is difficult to verify all logs; therefore, necessary audit evidences need to be selected in system audit planning.

### ● Determination of a system audit plan

A system auditor investigates business condition and business policies of a company and issues in the information system, and clarify audit purposes, departments to be audited, and target information systems. In this process, a "**documented audit plan**" is created. A documented audit plan contains a "**documented medium- and long-term plan**" in units of several years, a "**documented basic plan**" in units of fiscal year, and an "**individual documented plan**" in units of audit item.

### ● Preliminary audit

"**Preliminary audit**" is performed before a main audit in order to grasp the overview of target systems. In practice, verification is carried out by interviewing managers of audited departments and through the documents. As a result, items are divided into those where detailed investigations are necessary and not necessary in a main audit, and an individual audit plan created beforehand is corrected.

### ● Main audit

In "**main audit**," according to the set audit items and procedures in a system audit plan, specific investigation, analysis, and examination are performed.

General audit methods include hearings through interviews, onsite investigation, obtaining and matching materials such as documents and records, and investigation through questionnaires. Acquired information is secured as "**audit evidence**."

### ● Creation of a system audit report

After all system audits are completed, a "**system audit report**" is created in order to accurately communicate the results to the business owner, audited departments, and associated departments.

An audit report contains "**audit results**" and "**summarization**," "**excellent points**," "**findings**," and "**to be improved items**."

### ● Opinion exchange meeting

In an "**opinion exchange meeting**," opinions are exchanged with the representatives of audited departments to make sure there is no misunderstanding regarding the contents described in the audit report. The opinion exchange is a characteristic process in system audit.

By reflecting opinions of audited departments in the opinion exchange

meeting, the system audit report contents are added and corrected to completion.

### ● Audit report meeting

Based on the completed audit report, an “**audit report meeting**” is held in order to explain audit results to the business owner.

### ● Follow-up

Effectiveness of system audit is determined by implementing recommendations. Therefore, a system auditor checks improved conditions and supports implementation of improvement. This is called “**follow-up**.” An auditor performs periodical audits to check operation status, and if necessary, conducts a follow-up audit.

## ② Other audit tasks

Other typical audit tasks are as follows:

Accounting audit	To verify and evaluate financial statements on accounting and closing account by a third party. Performed by a certified public accountant or audit corporation.
Business operations audit	To verify and evaluate business activities, results, and management method inside a company by a third party. Performed by internal auditors or auditors.
Information security audit	To verify and evaluate countermeasure criteria and information security method by a third party. Performed by internal auditors or auditors.

## 6-2-2 Internal Control

As methods to actualize healthy company operation, there are “**internal control**” and “**IT governance**.”

### ① Internal control

“**Internal control**” is to structure a framework by a company itself to allow business to be conducted properly. In Japan, internal control is defined in the “**Practice Standards for Management Assessment and Audit concerning Internal Control Over Financial Reporting**,” as follows:

Internal control is a process that is embedded in business and performed by all employees in an organization in order to obtain rational assurance of four basic purposes: effectiveness and efficiency of business, reliability of financial statements, compliance with laws and ordinances concerning business activities, and securing assets. It consists of six fundamental elements: control environment, risk evaluation and treatment, control activities, information and communication, response to monitoring (monitoring activities) and IT (information technology).

(From Practice Standards for Management Assessment and Audit concerning Internal Control Over Financial Reporting)

## (1) Purposes of internal control

Internal control has four purposes to support business activities.

The purposes of internal control are as follows:

### ● Effectiveness and efficiency of business

“Business effectiveness” is an achievement degree of business objectives.

“Business efficiency” is to use time, human resources, and cost rationally for objectives. By arranging a framework to measure and evaluate the achievement level and rationality, achievement of business objectives are supported.

### ● Reliability of financial report

A framework is arranged in such a way that misrepresentation does not occur in financial reports, and the reliability of financial report is supported.

### ● Compliance with laws and ordinances for business activities

A framework is arranged so as to comply with laws and ordinances, criteria, and rules required to conduct business activities, and there is support for compliance with laws and ordinances in business activities.

### ● Securing assets

A framework is arranged to conduct acquisition, usage, and disposal of assets a company possesses with adequate procedure, and there is support to secure assets.

## (2) Basic elements of internal control

In internal control, there are six basic elements necessary to achieve internal control objectives.

The basic elements of internal control are as follows:

### ● Control environment

An environment (culture) in an organization is arranged to be a foundation to implement internal control. Specifically, objectives, guidelines, and code of conduct of an organization are clarified and awareness is increased by informing them to everybody within the organization. By arranging a better environment, the awareness of everybody in an organization is affected, which becomes the foundation of all basic elements.

### ● Risk evaluation and treatment

Risk responses is examined by identifying risks that are considered to prevent achievement of organization objectives, and by performing analysis and evaluation.

Reference

### Internal control report system

“Internal control report system” in Japan is a system obligated for listed companies in order to secure reliability of financial reports on the basis of Financial Instruments and Exchange Act.

“Internal control report” created by a business owner himself/herself is given an audit certificate through a certified public accountant or audit corporation, and the company submits this every fiscal year to the Prime Minister.

Reference

### IT control

“IT control” is internal control utilizing IT. The purpose is to monitor and control to make sure that information system and managed information are used by a company in healthy and effective ways. IT control can be classified into operation processing control and overall control. “Operation processing control” refers to control activities in order to ensure that approved tasks by a business managing system are all processed and recorded accurately. “Overall control” refers to control activities in order to arrange an environment for operation processing control to function effectively.

## ● Control activities

“Control activities” are policies and procedures in order to integrate internal control into business activities. In order to actualize these control activities, attention must be paid to the points below.

- Clarify business process, and risks for illegal and fraudulent behavior to occur.
- In addition to clarifying the authority and work duty of personnel, the aim is to execute separation of job duties.
- Set implementation rules for risk response, and establish a framework to check if they are conducted properly.

## ● Information and communication

A company arranges an environment where everybody in an organization can obtain, communicate, and share necessary information accurately.

## ● Monitoring

A company evaluates if internal control is functioning correctly.

The following types of monitoring are available.

Type	Description
Daily monitoring	Monitoring that is embedded into daily tasks and conducted continuously. For example, employees in the accounting section check billed amount and payment information.
Independent evaluation	Monitoring that is performed periodically from the perspective of a third party not associated with a business, such as a business owner, the board of directors, and auditors.

## ● Response to IT

“Response to IT” is to integrate an information system necessary for business execution adequately while policies and procedures for achieving organizational objectives are determined. A company implements information system, improves business effectiveness and efficiency, and structures a framework for better internal control.

## 2 IT governance

“IT governance” is an action or manner to plan an IT strategy in order to utilize information system, and to govern its execution.

How to utilize information system depends on the merits and competitiveness of a company. For example, when information system is implemented by using huge investment, sufficient investment effects cannot be obtained if there is no consistency with business policies, or if it does not meet the needs of users.

In order to avoid such conditions, IT governance supports implementation of business strategies by utilizing IT effectively, and aims to lead a business to success.

In IT governance, consistency is sought between business strategies and IT strategies; therefore, the leadership of business directors and a CIO (Chief Information Officer) are essential. Also, there are efforts to implement IT governance in the forms of “system audit” and “information security audit.”

### Reference

#### Separation of job duties

“Separation of job duties” is to separate one work responsibility (authority and work duty) into multiple employees.

### Reference

#### RCM (Risk Control Matrix)

“RCM” is a document in which risks expected per business process are clarified, and control activities (control) performed against individual risk are described.

### Reference

#### IT strategies

“IT strategies” refers to the direction and investment of information system a company aims for are determined in mid and long-term in order to utilize information system as a part of business strategies.

### Reference

#### IT governance

In the definition of The Ministry of International Trade and Industry (currently, Ministry of Economy, Trade and Industry), it is “organizational abilities to lead to an ideal direction of a company by controlling planning and execution of IT strategies with a purpose of building competitive superiority.”

# 6-3

# Chapter Quiz

[Note] Answers can be found on page 16 of the appendix "Answers and Explanations for Chapter Quiz" at the end of this book.

## Q 6-1

**Which of the following is an appropriate description concerning process that operation processing control is involved within IT control?**

- a) Consistency check with various types of masters when data is entered into an accounting system
- b) Planning of operation rules and procedure of company payroll system's backup
- c) Management concerning outsourcing contracts of a meeting reservation system in a company
- d) Regulation of system development on human resource database

## Q 6-2

**Among the facility management measures described below, which can be used when a large disaster strikes?**

- a) Clarify hot aisles and cold aisles in a data center.
- b) Utilize a backup center in a remote location to backup a data server.
- c) Recommend green IT.
- d) Adopt redundancy of power source in a data center.

## Q 6-3

**Company K is investigating how to establish a service desk along with implementation of a new system. The following items are examined for establishment of the service desk. Which of the following lists all adequate items as examined contents?**

- a) Prepare different service desk for each inquiry content in order to respond promptly to inquiries from users.
  - b) Accepted inquiry contents are completely deleted within two (2) days after they are solved from the standpoint of personal information protection.
  - c) Among inquiries sent to the service desk, solving methods on frequently asked questions are publicized in advance.
- a) a, b, and c    b) a and b    c) a    d) c

## Q 6-4

**Concerning an information system, which of the following is not appropriate as an implementation item of environment arrangement along with the facility management?**

- a) Use an OA tap with a surge protection function.
- b) Encrypt data that flows through the network.
- c) Attach security cable to notebook computers.
- d) In order to prepare for power outage and momentary power failure, install UPS (Uninterruptible Power Supply).

**Q 6-5****Which of the following is appropriate as a characteristic of a system audit?**

- a) system audit is to verify and evaluate a system comprehensively on the basis of an auditor's subjective perspective.
- b) A preliminary audit in the system audit standard is performed only when system audit cannot be conducted because of some special reason.
- c) A report created after a system audit is conducted can be viewed only by auditors.
- d) system audit is in principle what a third party system auditor performs on the basis of the system audit standard.

**Q 6-6****When the procedure elements of incident management at system operation are defined as "initial support," "investigation," "solution," and "detection," which of the following applies to Procedure A?**

- a) initial support
- b) investigation
- c) solution
- d) detection

**Q 6-7****Which of the following is an appropriate description concerning internal control?**

- a) In order to integrate internal control in business activities, clarify authority and work duty of personnel, and execute separation of job duties.
- b) A report concerning illegal/fraudulent behavior from inside a company does not serve as evaluation material to find if internal control is functioning correctly.
- c) Internal control is that an external and an independent third party audits if works are performed adequately.
- d) In internal control, an environment needs to be arranged so that necessary information can be shared among some of the employees who are involved.

**Middle Question**

**Note**  
Middle questions have been abolished since April 2017.

Read the description shown below concerning a production work in a factory, and then answer Subquestions 6-8 to 6-11.

Company F manufactures electronic parts. The production amount of Part A is 2,400 in average in one (1) week. Recently, the order amount has increased; therefore, a production system with a 50% increase is to be adopted from now on.

The number of current workers and the average work ability per worker are shown in the Table.

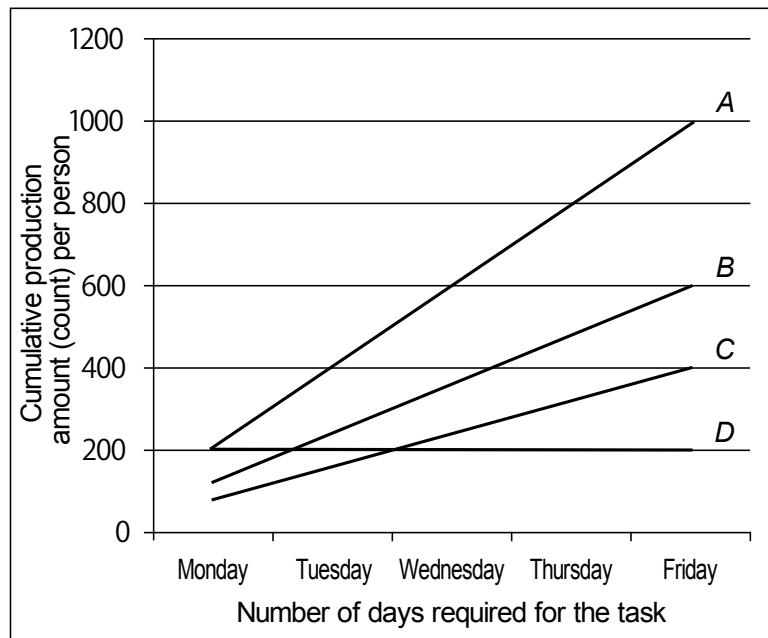
Table The number of workers and the average work ability of each worker

Worker	Number of workers	Average work ability of each worker (Number of pieces/hour)
Skilled worker	2	30
Non-skilled worker	3	20

[Note] Work days of workers are five (5) days from Monday to Friday, and the number of work hours in one (1) day is four (4) hours.

**Q 6-8**

When cumulative production amount in one (1) week is shown in the graph of the Figure, which line represents the cumulative production amount per one (1) non-skilled worker?



- a) A      b) B      c) C      d) D

**Q 6-9**

In order to increase production by 50% without adding more workers, how many hours must be added to the work hours in one (1) day?

- a) 1 hour  
b) 2 hours  
c) 3 hours  
d) 4 hours

**Q 6-10**

In order to increase production by 50% without adding more work hours, how many non-skilled workers must be added?

- a) 1 person  
b) 2 persons  
c) 3 persons  
d) 4 persons

**Q 6-11**

Without changing the current number of workers and work hours, in order to increase production by 50% by making the average work ability evenly through training of workers and making the work process more efficient, to what level should the average work ability per one (1) worker be increased?

- a) 30 pieces  
b) 33 pieces  
c) 36 pieces  
d) 39 pieces

# E- Passport Handbook

## Technology

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# Chapter 7

## Basic Theory

This chapter explains the fundamental way of comprehending radix, set, probability, and statistics, and digitalization of information and algorithms.

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### 7-1-1 Discrete Mathematics

Information handled by a computer is in a close relationship with “**discrete mathematics**” that handles digital quantity. Discrete mathematics is a foundation of a wide range of fields such as logical circuits, data structure, and language theory of computers.

#### 1 Numbers and representation

Inside a computer, instructions and data are all represented in the binary system. It is very important for your programming or others to understand the basic theory on the binary system and other numeral systems that are the foundation of data representation.

##### (1) Binary, octal, decimal, and hexadecimal numbers

Inside a computer, data are recognized and processed by the presence of current, or high/low of voltage. Data recognized through the presence of current or high/low of voltage are represented by values in combination of “0” and “1”. This method is called the “**binary system**.”

Since a binary number is a sequence of “0” and “1”, it is not easy for humans to handle. Therefore, it is converted to a “**decimal number**” to use 10 kinds of numbers (0 through 9) that humans normally use. Also, there are cases where numbers are represented by “**octal numbers**” to use “0” through “7”, “**hexadecimal numbers**” to use “0” through “9” and “A” through “F”, or other system numbers.

Binary number	Decimal number	Octal number	Hexadecimal number	Binary number	Decimal number	Octal number	Hexadecimal number
0	0	0	0	1001	9	11	9
1	1	1	1	1010	10	12	A
10	2	2	2	1011	11	13	B
11	3	3	3	1100	12	14	C
100	4	4	4	1101	13	15	D
101	5	5	5	1110	14	16	E
110	6	6	6	1111	15	17	F
111	7	7	7	10000	16	20	10
1000	8	10	8				

[Note] In the hexadecimal system, 10 through 15 are represented by A through F respectively.

## (2) Radix conversion

“Radix conversion” is to change the radix of a number to another radix.

The method of radix conversion is as follows:

### ● Converting a binary number to a decimal number

Just as each digit of a decimal number represents an increasing power of  $10, 10^0, 10^1, 10^2 \dots$ , each digit of a binary number represents an increasing power of  $2, 2^0, 2^1, 2^2 \dots$ . By using this characteristic, a binary number can be converted to a decimal number.

#### Example

Convert  $(1010)_2$  to a decimal number.

$$\begin{aligned} & (1 \quad 0 \quad 1 \quad 0)_2 \\ & = 2^3 \times 1 + 2^2 \times 0 + 2^1 \times 1 + 2^0 \times 0 \\ & = 8 \times 1 + 4 \times 0 + 2 \times 1 + 1 \times 0 \\ & = 8 + 0 + 2 + 0 \\ & = (10)_{10} \end{aligned}$$

### ● Converting a decimal number to a binary number

A simple conversion is possible by dividing a decimal number by 2.

#### Example

Convert  $(10)_2$  to a binary number.

$$\begin{array}{r} 2 \overline{) 10 \dots 0} \\ 2 \overline{) 5 \dots 1} \\ 2 \overline{) 2 \dots 0} \\ \hline 1 \end{array}$$

← Write the remainder.  
← Divide by 2 until the quotient becomes 1.  
  
 $(10)_{10} \rightarrow (1010)_2$  → Conversion to decimal is possible by arranging the final quotient and remainder from the front and writing in the order of the arrows.

#### Reference

### Radix

The “radix” is the number that can be represented in one digit. For example, a binary number has two types of digit, “0” and “1”, therefore, its radix is “2”.

#### Reference

### Numbers in the decimal system

$$\begin{aligned} & (1 \ 2 \ 0 \ 3)_{10} \\ & = 10^3 \times 1 + 10^2 \times 2 + 10^1 \times 0 + 10^0 \times 3 \\ & = 1000 \times 1 + 100 \times 2 + 10 \times 0 + 1 \times 3 \\ & = 1000 + 200 + 0 + 3 \\ & = 1203 \end{aligned}$$

#### Reference

### Writing and reading binary numbers

When written as “1010”, the number cannot be distinguished from a decimal number; therefore, in order to represent binary numbers, they are enclosed with parentheses and 2 is attached on the side as “ $(1010)_2$ ”. Also,  $(1010)_2$  is read as “one, zero, one, zero” per digit.

#### Reference

### $n^0$

Regardless of the value  $n$ , it is defined as  $n^0 = 1$  (the zero-th power of any value equals 1).

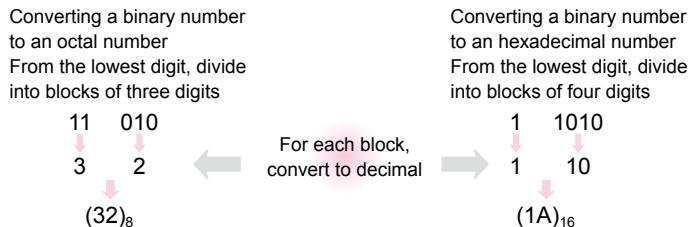
## ● Converting a binary number to an octal or hexadecimal number

A conversion from a binary number to an octal or hexadecimal number is shown below.

- A three-digit binary number can be converted to a one-digit octal number.
- A four-digit binary number can be converted to a one-digit hexadecimal number.

### Example

Convert  $(11010)_2$  to an octal number and a hexadecimal number.



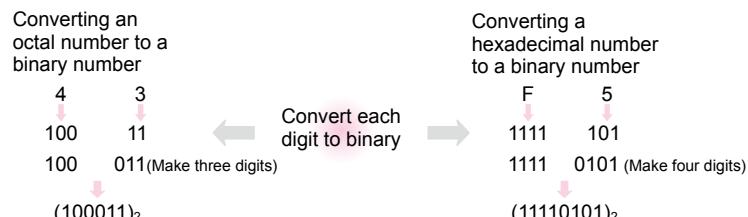
## ● Converting an octal or hexadecimal number to a binary number

A conversion from an octal or hexadecimal number to a binary number is shown below.

- A single digit octal number can be converted to a three-digit binary number.
- A single digit hexadecimal number can be converted to a four-digit binary number.

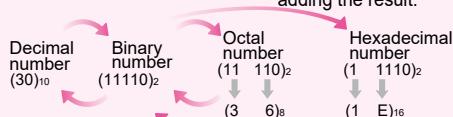
### Example

Convert  $(43)_8$  and  $(F5)_{16}$  to binary numbers respectively.



### Summary of radix conversion

Divide the decimal value by two to calculate the quotient and remainder. Repeat until the quotient becomes 1. Conversion to a binary number is possible by enumerating the final quotient and remainder from the bottom.



Conversion to a decimal number is possible by multiplying the value of each digit by  $2^0, 2^1, 2^2, \dots$  in order from the lowest digit, and adding the result.

Conversion to a octal number can be made by dividing a binary value into blocks of three digits from the lowest digit, multiplying the value of each digit by  $2^0, 2^1, 2^2$ , and adding the result. In the same way, conversion to a hexadecimal number is possible by dividing at every fourth digit, and multiplying the value of each digit by  $2^0, 2^1, 2^2, 2^3$ , and adding the result.

Divide the value of each digit in an octal or hexadecimal number by two, calculate the quotient and remainder, and repeat until the quotient becomes 1. Enumerate the final quotient and remainder from the bottom. Conversion to a binary number can be made by arranging the decimal values calculated for each bit in order from the highest digit.

[Note] If the value of each digit converted to binary number does not become three digits or four digits, concatenate 0 to the top in order to make it three digits in the case of octal or four digits in the case of a hexadecimal number.

### (3) Signed binary number

“Signed binary number” is a representation method to handle negative numbers in the binary system. In the signed binary number system, “+” and “-” signs are distinguished from each other through using the most significant bit as a “**sign bit**.” When the most significant bit is “0”, it represents a positive number, and when it is “1”, it represents a negative number.



0 represents a positive number,  
1 represents a negative number

In the unsigned binary number (ordinary binary number) system, decimal 0 through 255 can be represented in eight bits. In the signed binary number system, however, the number of digits that can be represented in eight bits are seven because the most significant bit is used as the sign bit. Therefore, in the signed binary number system, values from decimal -128 through 127 can be represented at maximum.

The representative types of the signed binary number systems are as follows:

#### ● One's complement

“One's complement” is to represent a negative number by reversing every bit of a positive number.

#### In case of - 3

- 1) Find the bits for a positive number 3    00000011
- 2) Reverse all the bits        11111100        ..... One's complement

#### ● Two's complement

“Two's complement” is to represent a negative number by adding 1 to a one's complement.

#### In case of - 3

- 1) Find the one's complement         $\begin{array}{r} 11111100 \\ + \quad \quad 1 \\ \hline \end{array}$
- 2) Add 1 to the one's complement         $\begin{array}{r} 11111101 \\ \hline \end{array}$  ..... Two's complement

#### Reference

#### Range of values to be represented

The ranges of values that can be represented in some number of bits are as follows:

Number of Bits	Unsigned binary number	Signed binary number
4	0 to 15	- 8 to 7
8	0 to 255	- 128 to 127
12	0 to 4095	- 2048 to 2047
16	0 to 65535	- 32768 to 32767
32	0 to 4294967295	- 2147483648 to 2147483647

#### Reference

#### Complement

“Complement” is a number whose digit is carried over by one when added to a certain number.

## (4) Addition and subtraction of binary numbers

When adding or subtracting binary numbers, align the digits (radix points) and calculate from the least significant digit just like decimal numbers.

### ● Addition

For addition, it is important to carry a digit to calculate as " $(1)_2 + (1)_2 = (10)_2$ ".

#### Example

What is the calculation result of  $(1001)_2 + (011)_2$ ?

$$\begin{array}{r} \boxed{1} \boxed{1} \leftarrow \text{Carry} \\ (1001)_2 \\ + \quad (011)_2 \\ \hline (1100)_2 \end{array}$$

### ● Subtraction

For subtraction, it is important to borrow a digit to calculate as " $(10)_2 - (1)_2 = (1)_2$ ".

#### Example

What is the calculation result of  $(1001)_2 - (011)_2$ ?

$$\begin{array}{r} \boxed{0} \boxed{1} \leftarrow \text{Borrow} \\ (\cancel{1})001_2 \\ - \quad (011)_2 \\ \hline (110)_2 \end{array}$$

#### Example

There is a table of giveaways encoded in 8 bit values. A type of winning giveaway is determined with the sum of the values written on Ticket A and B respectively. When the values on Ticket A and B are those shown in the table, what are the winning giveaways in cases a) through e) respectively?

[List of tickets]

	Ticket A	Ticket B
a)	01001000	01111001
b)	01000101	01100010
c)	00111111	10001000
d)	00101100	00111000
e)	00011111	00111001

[List of giveaways]

Giveaway	Number
Pocket tissues	00000001 to 01100100
Fragrance	01100101 to 10010110
Set of detergents	10010111 to 10110100
Coffee gift set	10110101 to 11000010
Travel coupon	11000011 to 11001000

- a)  $01001000 + 01111001 = 11000001$   
Therefore, the giveaway is the coffee gift set.
- b)  $01000101 + 01100010 = 10100111$   
Therefore, the giveaway is the set of detergents.
- c)  $00111111 + 10001000 = 11000111$   
Therefore, the giveaway is the travel coupon.
- d)  $00101100 + 00111000 = 01100100$   
Therefore, the giveaway is the pocket tissues.
- e)  $00011111 + 00111001 = 01011000$   
Therefore, the giveaway is the pocket tissues.

## 2 Set

“Set” is a collection of data grouped under well-defined conditions.

A set can be represented by an expression like “A OR B”, and such a representation method is called a “**proposition**.”

A set represented by a proposition can be visualized by using a “**Venn diagram**.”

In order to interpret a Venn diagram, a “**truth value**” needs to be obtained.

The “**truth value**” means “**True**” for 1, and “**False**” for 0.

For example, if an object is included in A but not in B, each truth value is A = 1 and B = 0.

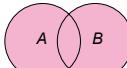
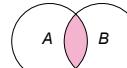
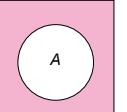
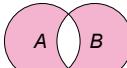
When this is applied to the proposition, “A OR B”, it becomes “**1 or 0**”, and the propositional logic is established. However, when it is applied to the proposition “A AND B”, it becomes “**1 and 0**”, and the propositional logic is not established.

The table of truth values is called a “**truth value table**.”

### Reference

#### Logical operation

The “logical operation” is a calculation method that a combination of multiple conditions (logic) is represented in an expression.

Proposition	A OR B	A AND B	NOT A	NOT A BUT B OR NOT B BUT A																																																			
Venn diagram																																																							
Representation with logical expression	$A + B$	$A \cdot B$	$\bar{A}$	$\bar{A} \cdot B + A \cdot \bar{B}$																																																			
Types of logical operations	Logical sum (OR)	Logical product (AND)	Negation (NOT)	Exclusive logical sum (XOR)																																																			
Truth value table	<table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>A OR B</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table>	A	B	A OR B	0	0	0	0	1	1	1	0	1	1	1	1	<table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>A AND B</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table>	A	B	A AND B	0	0	0	0	1	0	1	0	0	1	1	1	<table border="1"> <thead> <tr> <th>A</th> <th>NOT A</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> </tr> </tbody> </table>	A	NOT A	0	1	1	0	<table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>A XOR B</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	A	B	A XOR B	0	0	0	0	1	1	1	0	1	1	1	0
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## 7-1-2 Applied Mathematics

Through analyzing collected data, people find problems in business, and use them as clues for business improvement. In order to analyze data, people use “**applied mathematics**.” Applied mathematics is a branch of mathematics with a purpose to apply mathematical knowledge to other fields, and covers “**probability**” and “**statistics**.”

### 1 Probability

“**Probability**” is a method to determine a total and a degree of collected data.

#### (1) Permutation

“**Permutation**” is a total of sorting ways when an arbitrary number of items are extracted from a group of data, and sorted.

When  $r$  items are taken out arbitrarily from individually unique  $n$  items, and the number of permutations lined up in a row is represented as  $nPr$ , it can be obtained with the expression below.

**Expression to obtain permutation**

$$nPr = n \times (n - 1) \times (n - 2) \times \cdots \times (n - r + 1)$$

#### Example

Create a 4 digit number by taking out 4 different numbers from 1, 2, 3, 4, 5, and 6

#### Reference

!

“!” is a symbol that represents a factorial.  
For example, “ $3! = 3 \times 2 \times 1$ .”

#### (2) Combination

“**Combination**” is a total of methods of extraction when an arbitrary number of items are extracted from a group of data where their order is disregarded.

When  $nCr$  represents the number of combinations where  $r$  items are taken out arbitrarily from individually unique  $n$  items, it can be obtained with the expression below.

**Expression to obtain combination**

$$nCr = \frac{nPr}{r!} = \frac{n!}{(n-r)! r!}$$

#### Example

The number of cases to take out 4 different numbers from 1, 2, 3, 4, 5, and 6

$$\frac{6P_4}{4!} = \frac{6 \times 5 \times 4 \times 3}{4 \times 3 \times 2 \times 1} = 15 \text{ combinations}$$

### Example

The number of paths necessary for 8 participants in a meeting to make one-to-one contacts

The number of combinations can be calculated with either of the two methods shown below.

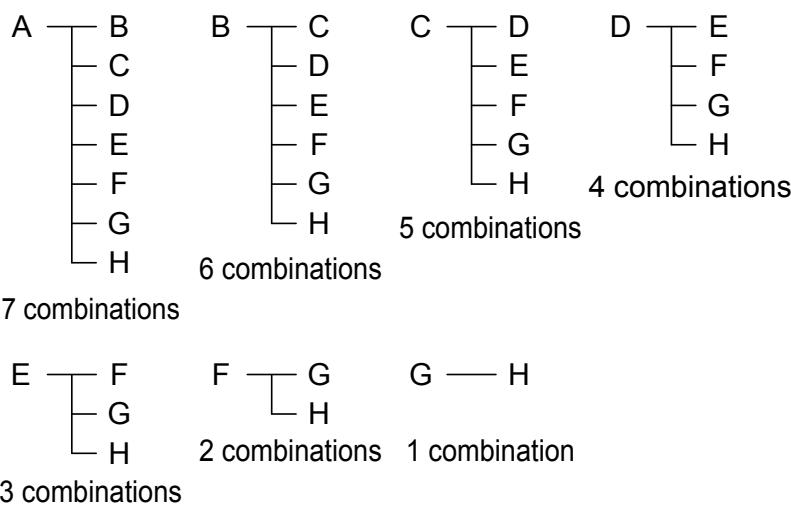
$$\frac{nPr}{r!} = \frac{8P_2}{2!} = \frac{8 \times 7}{2 \times 1} = 28 \text{ combinations}$$

Or

$$\frac{n!}{(n - r)!r!} = \frac{8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1}{6 \times 5 \times 4 \times 3 \times 2 \times 1 \times 2 \times 1} = 28 \text{ combinations}$$

Tree diagrams can be used to obtain the number of combinations as follows:

The number of participants is 8 and they are represented from A through H.



Therefore,  $7 + 6 + 5 + 4 + 3 + 2 + 1 = 28$  combinations

### (3) Probability

“Probability” is the ratio of the number of a certain case to occur to the number of all cases possible.

When the number of all cases possible is  $n$  ways, and the probability for case A to occur in  $r$  ways is represented by  $P(A)$ , it can be obtained with the expression shown below.

#### Expression to obtain probability

$$P(A) = \frac{r}{n}$$

**Example**

When there are 3 winning tickets in 10 tickets, and 2 tickets are drawn, what is the probability of the case where both tickets are winning tickets?

[Combinations of all cases possible]

Obtain the number of combinations to draw 2 tickets from 10 tickets.

$${}_{10}C_2 = \frac{10 \times 9}{2 \times 1} = 45 \text{ combinations}$$

[Combinations where both 2 tickets are winners]

Obtain the number of combinations to draw 2 winning tickets from 3 winning tickets.

$${}_3C_2 = \frac{3 \times 2}{2 \times 1} = 3 \text{ combinations}$$

Therefore, the probability in this case is as follows:

$$\frac{3}{45} = \frac{1}{15}$$

**Example**

When there are 3 winning tickets in 10 tickets, and 2 tickets are drawn, what is the probability of the case where both tickets are winning tickets? (Other method)

The probability for drawing a ticket once and it is a winning ticket is:

$$\frac{\text{Number of winning tickets}}{\text{Total number of tickets}}$$

Therefore, solve it by considering the two draws to be made.

$$\text{Probability to draw a winning ticket the first time} \cdots \frac{3}{10}$$

$$\text{Probability to draw a winning ticket the second time} \cdots \frac{2}{9}$$

Therefore, the probability in this case is as follows:

$$\frac{3}{10} \times \frac{2}{9} = \frac{1}{15}$$

## 2 Statistics

“Statistics” is a method to collect and examine data, and represent its characteristics quantitatively.

### (1) Representative data value

“Representative data value” is to represent a characteristic of whole data in a single value. Values shown below are used as the representative data value.

Value	Description
Mean	<p>The mean is the value calculated through dividing a sum of all items by the number of items. The value that is generally called an “averaged value” is an arithmetical mean.</p> <p>Example: Obtaining the mean of 19, 21, 23, 19, and 18</p> $\frac{19 + 21 + 23 + 19 + 18}{5} = 20$
Median (Middle value)	<p>The median is the middle value when data are sorted in ascending or descending order. When the number of data is even, find the mean of two values located in the center.</p> <p>Example: Obtaining the median of 19, 21, 23, 19, and 18</p> $18 \rightarrow 19 \rightarrow 19 \rightarrow 21 \rightarrow 23$ <p style="text-align: center;">Median</p>
Mode (Most frequent value)	<p>The mode is the value that appears most frequently in a series of data.</p> <p>Example: Obtaining the mode of 19, 21, 23, 19, and 18</p> $\underline{\underline{19 \ 21 \ 23 \ 19 \ 18}}$ <p style="text-align: center;">Mode</p>

### (2) Dispersion of data

“Dispersion of data” represents in a value how much individual data are dispersed around its mean value.

Even for groups of data that have the same mean value, their characteristics may be different as shown below.

	Data	Mean
Group A	20, 21, 22, 19, 18	$\frac{20 + 21 + 22 + 19 + 18}{5} = 20$
Group B	10, 30, 5, 25, 30	$\frac{10 + 30 + 5 + 25 + 30}{5} = 20$

The difference can be represented in values such as “variance,” “standard deviation,” “range,” etc. and they are used to indicate the dispersion of data.

Value	Description
Variance	The value of the sum of squares of (individual data value – mean) divided by the number of data.
Standard deviation	The square root of a variance.
Range	The difference between the maximum and the minimum values of data.

#### Reference

##### Work-sampling method

“Work-sampling method” is a method to analyze facilities, work time, etc. through observing a worker’s working conditions at random moments for a previously determined number of times. It is also called the “snap reading method.”

The mean values of Group A and Group B are identical; however, when their dispersions are calculated, they are as follows:

	Group A	Group B
Mean	20	20
Variance	$\begin{aligned} &\{(20 - 20)^2 + (21 - 20)^2 + (22 - 20)^2 \\ &+ (19 - 20)^2 + (18 - 20)^2\} \div 5 \\ &= (0 + 1 + 4 + 1 + 4) \div 5 \\ &= 10 \div 5 \\ &= 2 \end{aligned}$	$\begin{aligned} &\{(10 - 20)^2 + (30 - 20)^2 + (5 - 20)^2 \\ &+ (25 - 20)^2 + (30 - 20)^2\} \div 5 \\ &= (100 + 100 + 225 + 25 + 100) \div 5 \\ &= 550 \div 5 \\ &= 110 \end{aligned}$
Standard deviation	$\sqrt{2} \approx 1.414$	$\sqrt{110} \approx 10.488$
Range	$22 - 18 = 4$	$30 - 5 = 25$

With only a mean value, it is not possible to analyze data accurately; however, the whole distribution status can be grasped accurately through looking at the dispersion.

### (3) Normal distribution

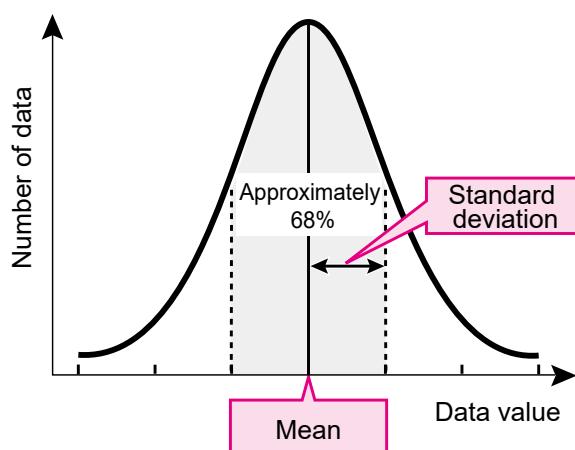
When the probability for a case to occur is determined by a function of a variable, the relationship between the variable and the probability for each case to occur is called “**probability distribution**,” and this variable is called a “**random variable**.” One of the representative probability distributions is the “**normal distribution**.”

Normal distribution is when the distribution status of data is displayed on a graph showing a curve called the “**normal distribution curve**.” The normal distribution curve is a bell-shaped symmetry curve with its mean value in the center.

The characteristics of normal distribution are such that approximately 68% of data falls in the range of the mean  $\pm$  standard deviation, 95% of data falls in the range of the mean  $\pm (2 \times \text{standard deviation})$ , and 99% of data falls in the range of the mean  $\pm (3 \times \text{standard deviation})$ .

Some well-known sets of data to form normal distribution are the height of many people, weight of many pieces of a product manufactured by the same process, and measurement errors.

The normal distribution, because of these characteristics, is used to estimate the number of data that deviates significantly from the mean value such as the number of defective parts in industrial products.



#### Reference

#### Frequency table

“Frequency table” shows the status of data analysis presented in a table format.

#### Reference

#### Histogram

In order to represent a distribution status of data, a histogram can be used to show its dispersion in a bar graph. A histogram can be used to check a whole image of data, the position of the center, and the degree of dispersion, etc.

**Example**

A player rolls a die, and is allowed to move his piece forward by the number of steps indicated by a pip. What is the expected number of steps when the die is rolled once? However, the player cannot move the piece when the number of pip is 1 or 2.

Also, the die is assumed to produce 1 through 6 as a uniform random number.

**Expected value**

“Expected value” is the mean of values obtained as a result of trials conducted under a certain condition. For example, the number of pip that shows up in average when a die is rolled.

An expected value can be obtained as the sum of products of a random variable value and its probability to occur.

**Uniform random number**

“Uniform random numbers” are a series of numerical values selected from a certain set where every value appears with equal probability when being selected from the set randomly.

Here, the probability for a pip to show by rolling a die is a uniform random number; therefore, the probability for each pip to appear becomes  $\frac{1}{6}$ .

Also, the random variable in this case is the number of steps the piece can move forward; therefore, the expression to obtain the expected value that pip 3 to pip 6 appear is as follows:

$$\text{Pip } 3 \cdots \frac{1}{6} \times 3 = \frac{3}{6}$$

$$\text{Pip } 4 \cdots \frac{1}{6} \times 4 = \frac{4}{6}$$

$$\text{Pip } 5 \cdots \frac{1}{6} \times 5 = \frac{5}{6}$$

$$\text{Pip } 6 \cdots \frac{1}{6} \times 6 = \frac{6}{6}$$

Therefore, the expected number of steps for the piece to move forward when a die is rolled once is as follows:

$$\frac{3}{6} + \frac{4}{6} + \frac{5}{6} + \frac{6}{6} = 3$$

## 7-1-3 Theory of Information

In order to know fundamental theories on numeric values and data handled by computers, it is necessary to understand the representation method of information quantity, the concept of digitalization, representation of characters, etc.

### ① Units of information

The “bit” and “byte” are used for the unit of information to represent memory capacity or computer performance. Knowing the unit of information will help to understand a PC’s performance, memory size, available area of a hard disk, etc.

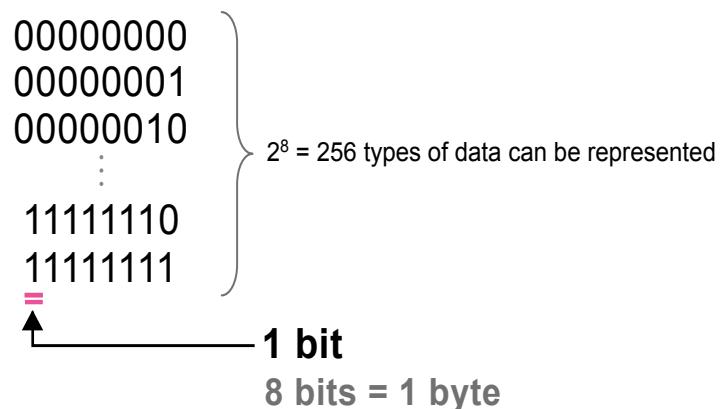
#### (1) Bit and byte

“Bit” is the minimum unit of data handled by computers. “One bit (1 bit or 1 b)” is represented by 0 or 1 like a binary number. Also, a set of 8 consecutive bits is represented by “one byte (1 Byte or 1 B).”

Reference

#### Types of data to be represented in bits

1 bit	$2^1 = 2$ types
2 bit	$2^2 = 4$ types
3 bit	$2^3 = 8$ types
4 bit	$2^4 = 16$ types
5 bit	$2^5 = 32$ types
6 bit	$2^6 = 64$ types
7 bit	$2^7 = 128$ types
8 bit	$2^8 = 256$ types



#### (2) Units representing information quantity

Units that represent values larger than a byte are as follows:

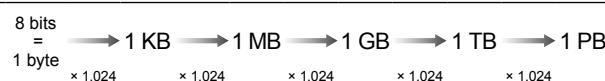
Reference

#### Prefix

“Prefix” refers to the units used to represent the size of bit or byte such as K (Kilo), M (Mega), G (Giga), T (Tera), P (Peta), m (milli),  $\mu$  (micro), n (nano), and p (pico). A prefix is not used independently by itself, but used with other unit, and represents a multiple of the power of 10 of its unit.

Unit	How to read	Meaning
KB	Kilobyte	$10^3 = 1,000$ bytes ( $1\text{ KB} = 2^{10} = 1,024\text{ B}$ )
MB	Megabyte	$10^6 = 1,000\text{k}$ bytes ( $2^{20} = 1,024\text{ KB}$ )
GB	Gigabyte	$10^9 = 1,000\text{M}$ bytes ( $2^{30} = 1,024\text{ MB}$ )
TB	Terabyte	$10^{12} = 1,000\text{G}$ bytes ( $2^{40} = 1,024\text{ GB}$ )
PB	Petabyte	$10^{15} = 1,000\text{T}$ byte ( $2^{50} = 1,024\text{ TB}$ )

[Note] When memory capacity is represented, it is common to convert the unit by  $2^{10}$  times. Usually, 1,000 times is represented in lower-case by the letter “k”; while a  $2^{10}$  is represented in upper-case by the letter “K” to distinguish it from “k.”



### (3) Units to represent a processing speed

Units to show a time that is less than one second are used to represent the processing speed of a computer. These are as follows:

Unit	How to read	Meaning
ms	millisecond	$1 \text{ ms} = 10^{-3} \text{ s} = \frac{1}{10^3} \text{ s}$
$\mu\text{s}$	microsecond	$1 \mu\text{s} = 10^{-6} \text{ s} = \frac{1}{10^6} \text{ s}$
Ns	nanosecond	$1 \text{ ns} = 10^{-9} \text{ s} = \frac{1}{10^9} \text{ s}$
Ps	picosecond	$1 \text{ ps} = 10^{-12} \text{ s} = \frac{1}{10^{12}} \text{ s}$

## ② Digitalization

In order to handle “analog data” such as reports, pictures, and paintings in a computer, it is necessary to “digitalize” or to convert data to digital signals (codes consisting of 0 and 1). Digitalization allows image processing, copying, and communication to be conducted at a high speed, and the range of data utilization can be widened.

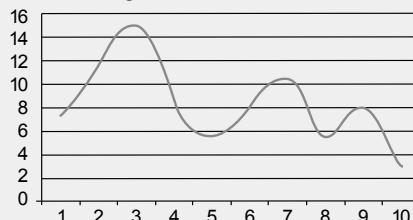
Utilizing digital data can prevent deterioration of original analog data, and can actualize efficiency of data utilization.

### (1) A/D conversion

“A/D conversion” is to convert analog signals to digital signals. On the other hand, to convert digital signals back to analog signals is called “D/A conversion.”

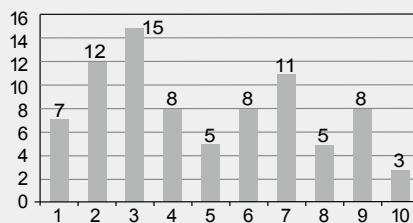
#### Sampling

To divide analog data such as music into certain time intervals and give it a numeric value.



#### Quantization

When an analog signal is converted to a digital signal, the analog volume is sampled and made into a bar graph shape, and this is represented with a numeric value (bits).



#### Reference

#### Encode

“Encode” is to convert data on the basis of a specific rule. Software that performs encoding is called an “encoder.”

#### Reference

#### Decode

“Decode” is to extract original data from encoded data through conversion on the basis of a specific rule. Software that performs decoding is called a “decoder.”

#### Reference

#### Sampling rate

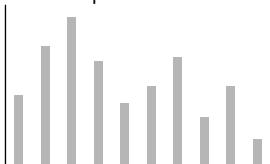
“Sampling rate” is a number of times to measure analog data in one second. It is also called “sampling frequency,” and is represented in “Hz.” The larger the sampling rate is, the better the sound quality that can be reproduced with digital data.

## Reference

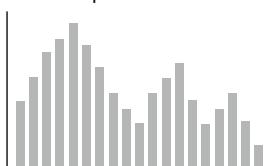
## Sampling and quantization

Analog signals are continuous data, and digital signals are individually separated data. In the process of A/D conversion, more precise values can be collected by shortening the sampling intervals and increasing quantization levels, that makes the sampled data closer to the analog data.

- The sampling interval is long and the number of quantization levels is small



- The sampling interval is short and the number of quantization levels is large



## Encoding

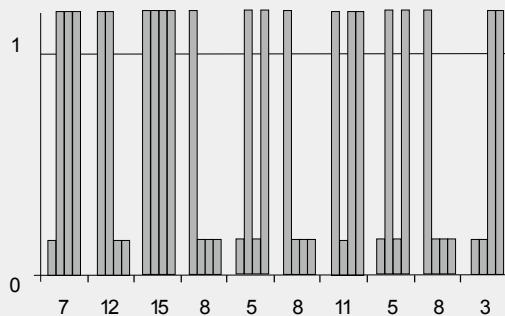
To convert data on the basis of a specific rule. For example, radix conversion is performed for data from decimal to binary in order to represent it.

7	0	1	1	1
12	1	1	0	0
15	1	1	1	1
8	1	0	0	0
5	0	1	0	1
8	1	0	0	0
11	1	0	1	1
5	0	1	0	1
8	1	0	0	0
3	0	0	1	1



Encoded data is converted to digital data.

Digital display  
of a code



## (2) Major characteristics of digital data

Major characteristics of digital data are as follows:

Item	Details
Data sending	Can be sent to a remote location
Data sharing	Data can be shared in a network
Data editing	Can be processed and edited for enlarging/reducing the size, trimming, etc.
Data quality	Does not deteriorate
Data compression	Possible
Data searching	Possible
Data copying	Possible

### ③ Representation of characters

Inside a computer, a character is handled as a binary number value. Binary number codes assigned to a set of characters are called “**character codes**.”

Type	Description
ASCII code	Character code set standardized by ANSI (American National Standards Institution). Alphanumeric characters and symbols are represented in a 7 bit code system with a one parity bit appended, and therefore, they are represented in one byte.
JIS code	Character code set standardized by JIS (Japanese Industrial Standards). This consists of a single byte code system to represent alphanumeric characters and symbols, and a double byte code system to represent Kanji and Hiragana characters.
Shift JIS code	Character code set standardized by Microsoft Corporation. It is also called “Extended JIS code.” Double byte code system with combined double byte JIS code and one byte ASCII code. This is used in many computers such as Windows, MacOS, etc.
EUC (Extended Unix Code)	Character code set standardized by AT&T. Double byte code system to allow to handle Kanji on UNIX.
Unicode	Character code set standardized by ISO (International Organization for Standardization) and IEC (International Electrotechnical Commission). Double byte code system that is applied to all characters in the world.

#### Reference

##### Parity bit

“Parity bit” is a bit used to check errors in a code such as a character code.

#### Example

How many bits are necessary to represent 10 Japanese characters?

Japanese characters are full-width characters; therefore, 2 bytes are necessary for each character.

The number of bytes necessary to represent 10 Japanese characters is as follows:

$$2 \text{ bytes} \times 10 \text{ characters} = 20 \text{ bytes}$$

1 byte = 8 bits; therefore, 20 bytes = 160 bits.

#### Example

A code field to indicate the department each employee belongs to is required to be added to the existing database. Up to 8 digits are used for the department code. The number of employees registered in the database is 25,000. How many KB is necessary at a minimum for the area to store all the department codes?

Data is not compressed.

The department code is limited to a combination of decimal digits; therefore, its one digit can be considered to require one byte. The department code consists of 8 digits; therefore, 8 bytes are necessary for the field of each department code. The number of registered employees is 25,000; therefore, the area size to secure for storing all the department codes is as follows.

$$8 \text{ bytes} \times 25,000 = 200,000 \text{ bytes}$$

1 kB = 1,000 bytes; therefore,

$$200,000 \div 1,000 = 200 \text{ kB.}$$

## 7-2-1 Data Structure

When developing a system, an engineer needs to create programs for necessary functions to work properly. In this section, data structures and algorithms necessary for programming are explained.

### 1 Data and data structure

“**Data**” is information handled inside a computer. “**Data structure**” is how to handle the data systematically.

In system development, a design of data structure is the foundation of everything. It is necessary to examine and design data structure beforehand in order to execute target tasks.

Basic data structure is as follows.

#### ● Variable

“**Variable**” is an area to temporarily store data handled in a program. When a variable is defined, a variable name is given by using alphanumeric letters and symbols in order to distinguish it from other data. Also, when a variable is used, a value is assigned to the variable.

For example, in the case of expression “ $y = a + 10$ ”, when  $a = 10$  is assigned, it becomes  $y = 20$ . The characteristic of a variable is that a different value can be assigned every time a program is executed; therefore, the program itself does not need to be rewritten.

#### Reference

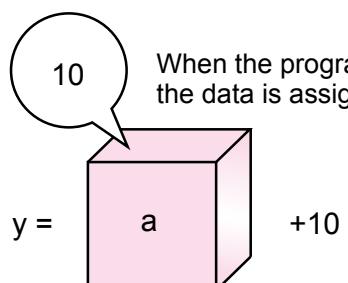
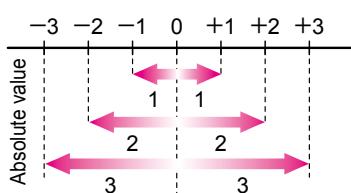
##### Constant

“Constant” is data fixed to a specific value. Antonym of a variable.

#### Reference

##### Absolute value

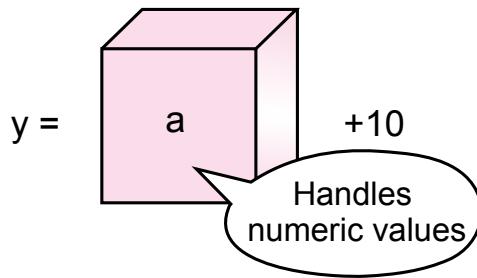
“Absolute value” is a value that shows the distance from 0. For example, the absolute value of +1 or -1 is 1, and +2 or -2 is 2. It is obtained by removing the plus or minus sign from a given number.



A variable is like a box into which data is inserted

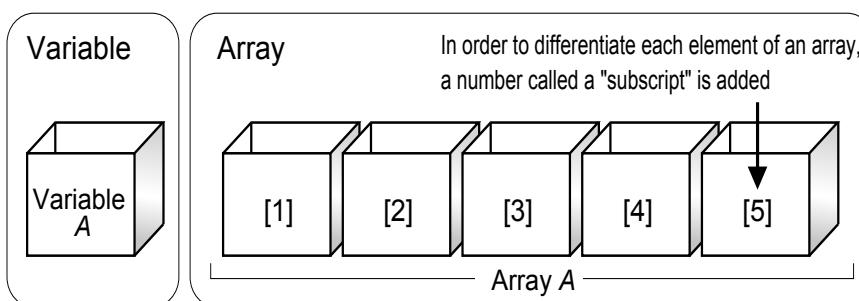
## ● Field type

“Field type” is a data type to be stored. It is also called a “**data type**.” For data handled in a program, a field type such as a numeric value or a character string is defined. When a field type is defined to a variable, the program’s accuracy improves because only appropriate data can be assigned.



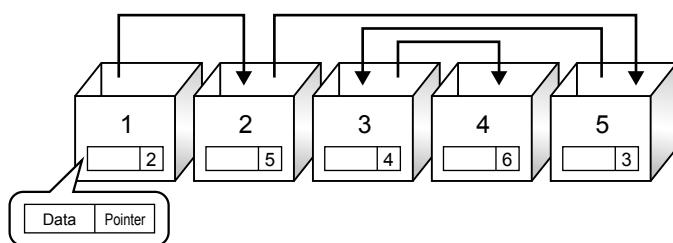
## ● Array

In order to handle a large amount of data, it is convenient to utilize a data structure called an “**array**” instead of variables. A variable stores a data; however, an array can store the same type of multiple data in one or more rows. Generally, data are consecutively stored in an array, with a “**subscript**” to identify individual data; therefore, specific data can be searched and data can be extracted in the order of a specified sequence.



## ● List

A list is a data structure where sparse multiple data are linked together. Unlike an array, data may not be stored consecutively. Along with data, each member of a list has information called a “**pointer**” that indicates the stored location of the next member. When a link is switched or a new member is added, the way members are linked can be redefined by changing a pointer.



### Reference

#### Caution when using array

When an array is used, it is necessary to predetermine the size of the array and the sequence of order of data to assign. In order to change them, the array needs to be redefined.

### Reference

#### Other data structures

- Record...Data for one row
- File...Consolidated data

## 2 Stack and queue

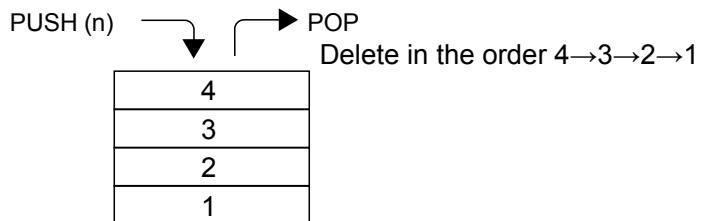
Two ways of thinking for data insertion and deletion in a list are shown below.

### ● Stack

“Stack” is a method to insert data into the end of a list, and to delete data inserted last. It is also called a “LIFO list.”

The basic syntax of stack is as follows.

**PUSH (n) : Insert data (n)**  
**POP : Delete the last data**

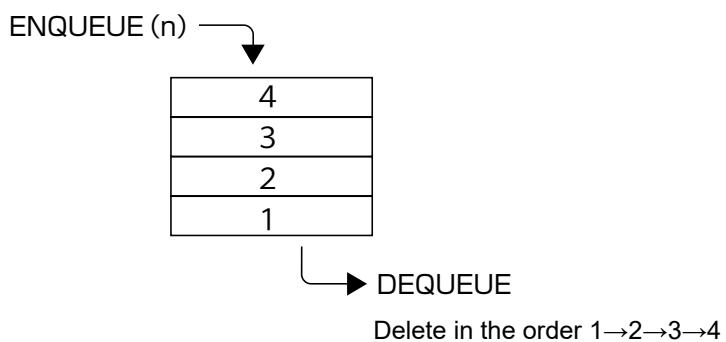


### ● Queue

“Queue” is a method to insert data into the end of a list, and to delete data inserted first. It is also called “scheduled queue” or “FIFO list.”

The basic syntax of queue is as follows.

**ENQUEUE (n) : Insert data (n)**  
**DEQUEUE : Delete the first data**



Reference

### LIFO (Last In First Out)

“LIFO” is the last-in first-out method.

Reference

### FIFO (First In First Out)

“FIFO” is a first-in first-out method.

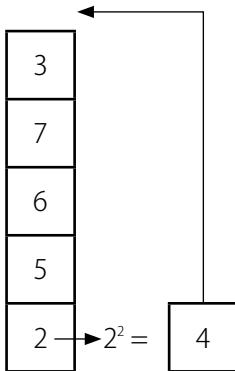
## Example

As shown in the figure, boxes marked with a number are piled up. These boxes are piled up according to Operations 1 through 4. After all operations have been performed, what is the total when the numbers marked on all boxes are added? Note that 5 boxes are always in the piled condition, and a box can be extracted from the bottom only. Also, when putting a new box on the top, discard the box at the bottom.

3
7
6
5
2

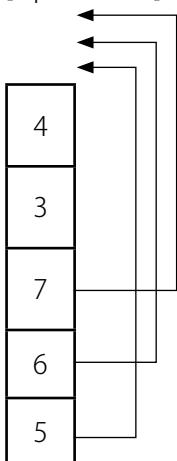
- Operation 1: Extract a box from the bottom, square the value on the box, and put a box marked with the value squared on the top.
- Operation 2: Sort the boxes so that the values on the boxes are in descending order.
- Operation 3: Put a box marked with the number of times of sorting in Operation 2 on the top.
- Operation 4: Extract two boxes from the bottom, find the value in the ones place of the product of the values on the two boxes, and put two boxes marked with the value on the top.

### [Operation 1]



- [1] Extract the box marked with 2 from the bottom.
- [2]  $2^2 = 4$
- [3] Put the box marked with 4 on the top.

### [Operation 2]

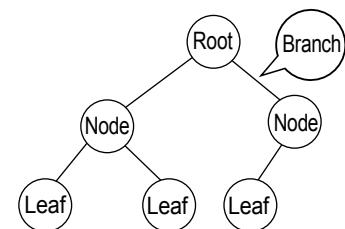


- [1] Extract the box marked with 5 from the bottom, and put it on the top.
- [2] Extract the box marked with 6 from the bottom, and put it on the top.
- [3] Extract the box marked with 7 from the bottom, and put it on the top.

## Reference

### Tree structure

"Tree structure" is a diagram used when data are managed in a hierarchical structure. Each element of a tree structure is called a "node," the top node is the "root," the bottom node is the "leaf," and the line to link two nodes is a "branch," and these are expressed as follows.

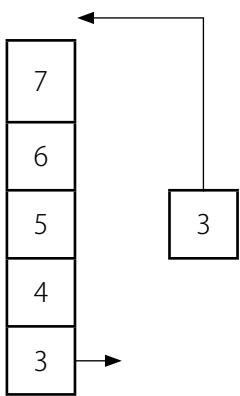


## Reference

### Binary tree

"Binary tree" is a tree structure where the number of branches to develop from a node is two or less.

[Operation 3]

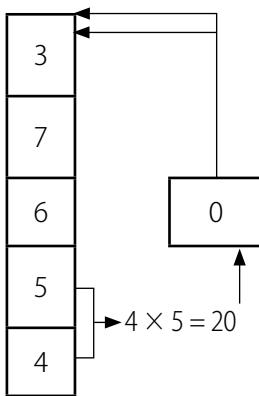


[1] Extract the box marked with 3 from the bottom, and discard.

[2] Put the box marked with 3 at the top.



[Operation 4]



[1] Extract the box marked with 4 from the bottom.

[2] Extract the box marked with 5 from the bottom.

$$[3] 4 \times 5 = 20$$

[4] Put 2 boxes marked with 0 written at the top together.



When all operations are completed, the boxes are in the order of "6→7→3→0→0".

Therefore, when the numbers marked to each box are added:

$$6 + 7 + 3 + 0 + 0 = 16$$

## 7-2-2 Algorithm

“Algorithm” are processing steps to solve a problem. When system development or work analysis is conducted, the algorithm is the first thing to figure out. By clarifying steps through an algorithm, a program can be created efficiently.

### 1 Flowchart

“Flowchart” is a diagram to graphically describe workflow or program operations by using symbols and arrows.

In a flowchart, a data route and control can be also shown in addition to a program operations, and therefore, it is utilized as a method to visualize algorithms.

#### (1) Symbols in flowchart

Symbols in a flowchart are defined by ISO (International Standardization Organization). Representative symbols are as follows.

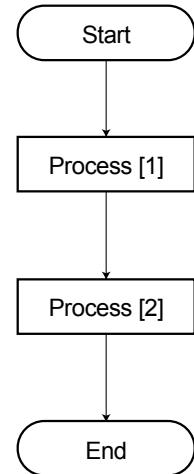
Symbol	Name	Description
	Terminal	Shows the start or the end of a flowchart
	Line	Shows a flow such as data, or control
	Process	Shows a process such as a calculation or substitution
	Data symbol	Shows input or output of data
	Decision	Shows a control function to select one of multiple processes by judging a given condition and its result
	Loop limit (Start)	Shows the beginning of a loop
	Loop limit (End)	Shows the end of a loop

## 2 Basic structures of algorithm

There are “**sequential structure**,” “**selection structure**,” and “**repetition structure**” in the basic structures of algorithm. By combining them, a complicated algorithm can be described.

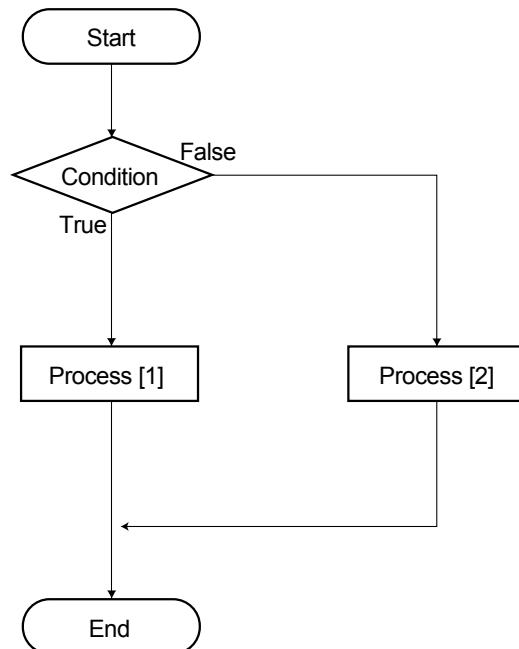
### (1) Sequential structure

The “**sequential structure**” shows a flow in sequential order.



### (2) Selection structure

The “**selection structure**” shows a flow to select a process on the basis of a given condition.



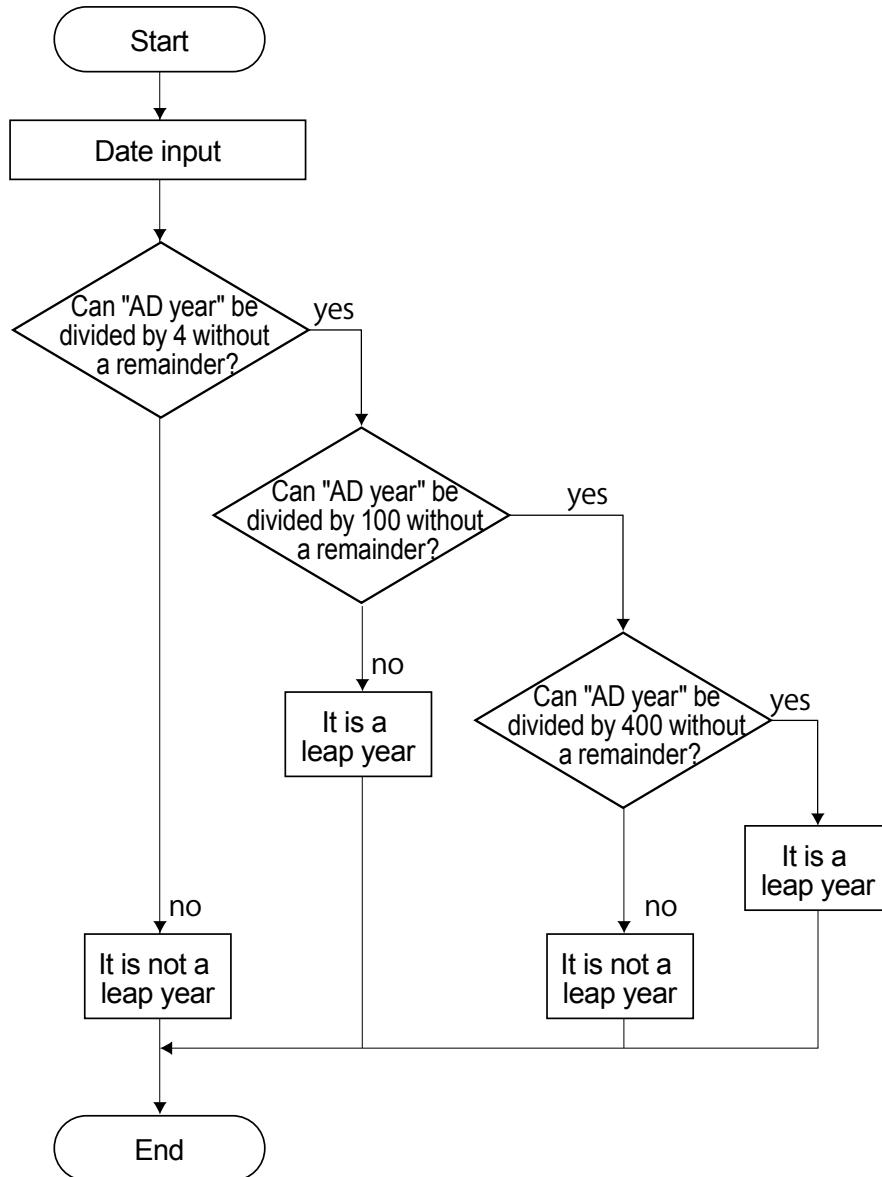
### Example

What does a flowchart of a date input system considering a leap year look like?

A leap year is defined as follows:

When an AD year can be divided by 4 without a remainder, the year is a leap year. However, when the year can also be divided by 100 without a remainder, the year is not a leap year. When the year can be divided by 100 and 400 without a remainder, the year is a leap year.

A flowchart created on the basis of the definition on a leap year will be as follows.

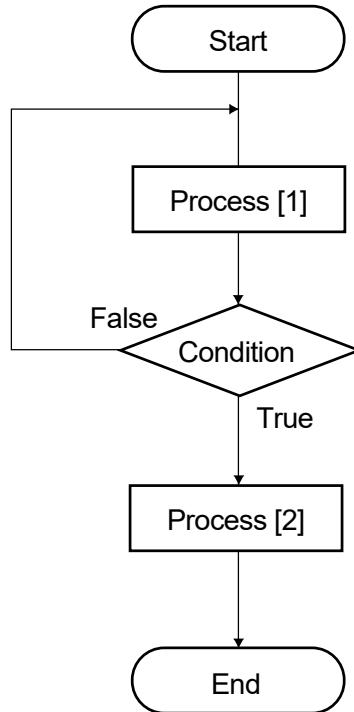


**Conditional loop**

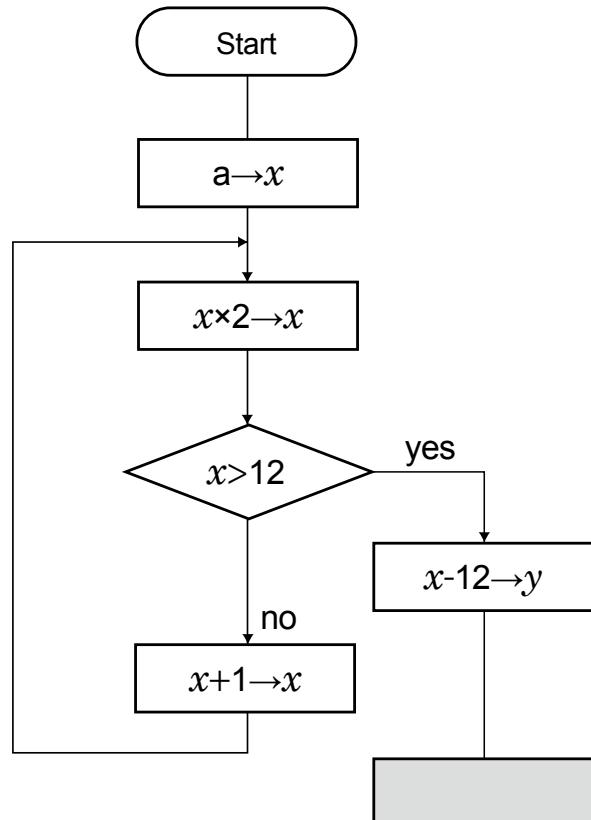
There are two types of conditional loop: one is to test a condition at the beginning of a loop (pre-test loop) and the other is to test a condition at the end of a loop (post-test loop).

**(3) Repetition structure**

The “**repetition structure**” shows a flow to repeat a process while or until a condition is satisfied, e.g. a specified number of times is reached.

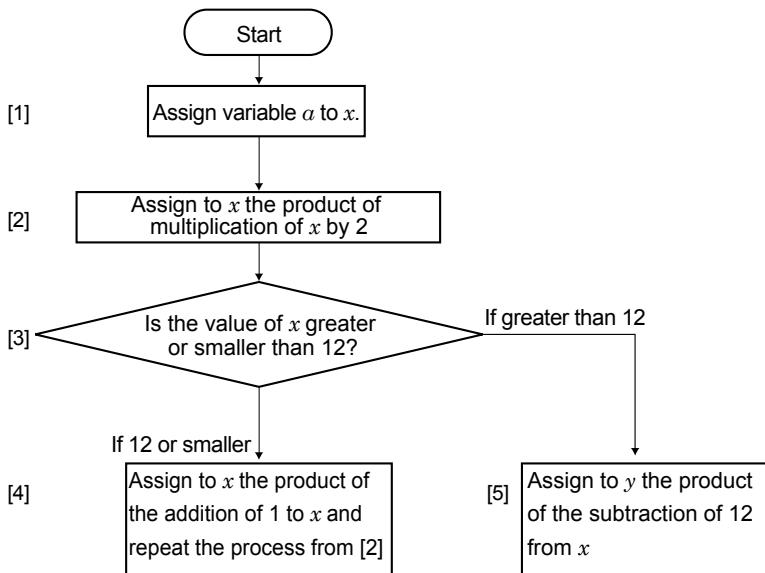
**Example**

When the variable  $a$  is 3 and the process shown in the flowchart below is executed, what is the value of  $y$ ?



[Note] The content of the shaded part is not shown.

The process flow will be as follows.



When the process is actually executed:

- [1] Assign 3 to  $x$ .
- [2]  $3 \times 2 = 6$ , therefore assign 6 to  $x$ .
- [3]  $x$  is 12 or less, go to [4].
- [4]  $6 + 1 = 7$ , therefore assign 7 to  $x$ .
- [2]  $7 \times 2 = 14$ , therefore assign 14 to  $x$ .
- [3]  $x$  is more than 12; therefore, go to [5].
- [5]  $14 - 12 = 2$ , therefore assign 2 to  $y$ .

Then the value of  $y$  becomes 2.

### ③ Typical algorithms

Some of the typical algorithms are shown below.

#### (1) Totaling

“Totaling” is to perform addition. When the number of additions is once or several times, it is described in a sequential structure. When it is more than several times, it is described in a selection or repetition structure. Totaling is the most fundamental algorithm.

##### Example of adding 2, 3, and 6: $y = y + x$

- [1] Assign 0 to  $y$  (initialization).  
 $y = 0 + x$
- [2] Assign 2 to  $x$ .  
 $y = 0 + 2$
- [3] Assign the calculation result to the solution  $y$ .  
 $2 = 2$

- [4] Assign 3 to  $x$ .  
 $y = 2 + 3$
- [5] Assign the calculation result to the solution  $y$ .  
 $5 = 5$
- [6] Assign 6 to  $x$ .  
 $y = 5 + 6$
- [7] Assign the calculation result to the solution  $y$ .  
 $11 = 11$

[Note] When there are more values to add, repeat (6) and (7).

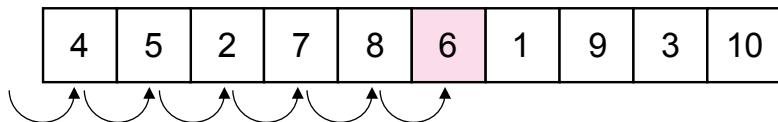
## (2) Search

“Search” is to find data to match a given condition. It is also called “Find.” Search types are as follows.

### ● Linear search

“Linear search” is a method to search data from the start to the end of data in order.

**Search for 6:**



- [1] Search if the first data is 6.  
[2] Search to find if the second data is 6.  
[3] Repeat above until 6 is found.

### ● Binary search

“Binary search” is a method to search data by narrowing down if it is in the forward or the backward direction from the central data.

**Search for 6:**

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

[1] Narrow down to the backward direction from the center.

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

[2] Narrow down further to the forward direction from the center between 6 and 10.

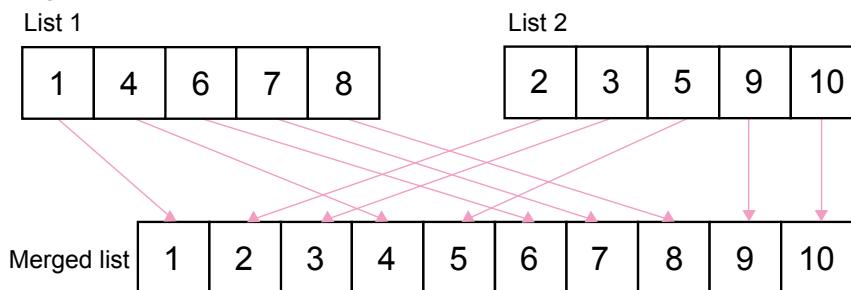
1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

[3] Narrow down further to the forward direction from the center between 6 and 7, and find 6.

### (3) Merge

“Merge” is to combine two files while maintaining their sequence of orders unchanged.

Merge two files:



Arrange the data in ascending order and repeat until the last item of data

### (4) Sort

“Sort” is to align the sequence of order of data.

#### ● Bubble sort

“Bubble sort” is a method to compare the adjacent data values, and sort from the start to the end of data in order. Bubble sort is the most typical sort algorithm.

Sort data in ascending order:

5	4	2	1	3
---	---	---	---	---

[1] When 1st > 2nd, switch the data.

4	5	2	1	3
---	---	---	---	---

[2] When 2nd > 3rd, switch the data.

4	2	5	1	3
---	---	---	---	---

[3] When 3rd > 4th, switch the data.

4	2	1	5	3
---	---	---	---	---

[4] When 4th > 5th, switch the data.

4	2	1	3	5
---	---	---	---	---

[5] Repeat [1] through [4] until the sort order is aligned.

#### Reference

#### Sorting algorithms

There are various types of sorting algorithms.

##### ● Comparison sort

“Comparison sort” is a method to sort in an order by comparing two data. Bubble sort is a variation of the comparison sort.

##### ● Insertion sort

“Insertion sort” is a method to compare two data and sort by inserting in between.

##### ● Merge sort

“Merge sort” is a method to merge after sorting.

## 7-2-3 Programming and Programming Languages

“Program” is a document that directs algorithms to a computer. “Programming language” is a collection of rules and grammar with which to write a program.

### ① Types of programming languages

There are various types of programming languages depending on the computer type, usage, and purpose. Writing an algorithm by using these programming languages is called “programming.”

Representative programming languages are as follows.

Type	Characteristics
Machine language	This is a language to use binary instruction codes that a CPU can understand. Machine languages differ for each CPU type.
Assembler language	This is a language to use mnemonic symbols for instruction codes of a machine language for easy reading by human.
C language	This is a language that is originally created to develop UNIX. This is used in various fields such as OS, application software, etc. “C++ (C plus plus)” is a version of C language developed for object-oriented programming.
Java	This is an object-oriented programming language widely used in the Internet and embedded systems. A program written in Java is executed under the environment called “Java virtual machine (JavaVM)”; therefore, it can be executed regardless of the type of hardware or OS. Programs and technical specifications developed by Java are as follows. <ul style="list-style-type: none"><li>- Java application This is a program written in Java that runs independently from a browser.</li><li>- Java applet This is a program written in Java that works together with a browser by downloading data from a web server.</li><li>- Java servlet This is a program written in Java to be executed on a web server in response to requests from a browser.</li><li>- JavaBeans These are technical specification to create modularized programs (Bean) in Java language. By reusing and combining modularized programs, a new program can be developed.</li></ul>
COBOL	This is a language suitable for business process-related program development.
FORTRAN	This is a language suitable for technology-related program development.
BASIC	This is a language widely used by beginners because it is comparatively easy to write. Visual Basic evolved for application software development that runs on Windows is widely used.

Reference

#### Low level language

“Low level language” is a generic name of programming languages that are used to write a program in a form for a computer to interpret easily.

Reference

#### High level language

“High level language” is a generic name of programming languages that are used to write a program without being conscious of hardware in a form close to human language.

Reference

#### Script language

“Script language” is a programming language that can be executed easily without translating into a machine language. Typical script languages are “JavaScript” and “Perl.”

Reference

#### JavaScript

“JavaScript” is a script language developed by Netscape Communications Corporation. It is an interpreter language embedded in HTML. It is run on a browser. It is a completely different language from Java.

Reference

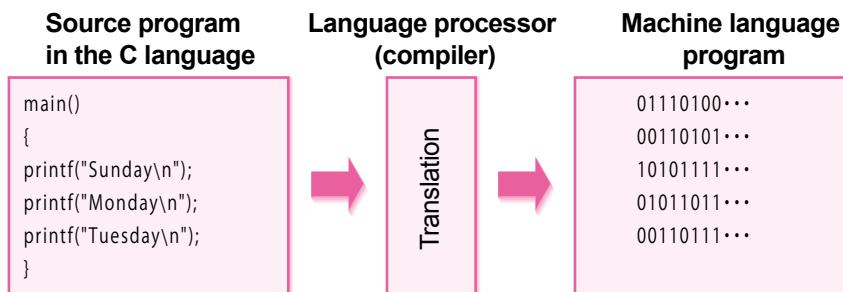
#### Perl (Practical Extraction and Report Language)

“Perl” is a script language suitable for text processing. It is utilized as CGI for a bulletin board and an access counter in a web page.

## ② Language processor

A program written in a high-level language cannot be executed as-is on a computer. In order to convert (translate) it to a machine language that a computer can understand, software called “language processor” is used. Typical language processors are as follows.

Type	Characteristics
Compiler	Compiler translates a source program into a machine language program (object program) as a batch. After translation is completed, the machine language is executed all together; therefore, its execution speed is faster than that of interpreter translation.
Interpreter	Interpreter executes a program by translating source program commands one by one into machine language codes. Translation and execution are repeated for each command; therefore, its execution speed is slower than that of a program translated by a compiler, but bugs in a program are easier to find.



### 7-2-4 Markup Languages

“Markup language” is a language used to write a document structure by using tags. By using tags, control characters that indicate elements to compose a sentence are embedded. “HTML” and “XML” are typical markup languages.

#### ① HTML

“HTML” developed on the basis of “SGML” is a language to create web pages. Control characters called “tags” are used to designate how to display pages. The part enclosed with <> is a tag.

Reference

#### CGI (Common Gateway Interface)

“CGI” is a mechanism to utilize a program on a web server side by using a web page. By using CGI, a dynamic page can be created, such as generating a new page every time a user visits a web page.

Reference

#### Load module

A machine language program (object program) translated by a compiler links up libraries (modules to use) as necessary. A machine language program that becomes executable through linking up libraries is called a “load module.”

Reference

#### HTML

(Hyper Text Markup Language)

Reference

#### SGML (Standard Generalized Markup Language)

“SGML” is one of the markup languages. It is a document format developed with the purpose of simplifying data exchange, and is used in electronic publishing and document databases.

## Reference

HTML5

Succeeding version of HTML 4.01

In HTML5, new tags like “audio” to play music and “video” to play movies are added. By using these tags, video and audio can be published only with HTML.

## Reference

## Style sheet

"Style sheet" is a registered set of web page design and layout. A style sheet allows unified management of the design of web pages; therefore, such designs can be set or changed efficiently, and the total size of a web site can be minimized.

A style sheet is written in a style sheet language.

## Reference

css

## **(Cascading Style Sheets)**

"CSS" is a "style sheet language" utilized to define the design and the layout of a web page such as character font, color, size, background, and margins.

## Reference

RSS

“RSS” is an XML-based file format where titles and summaries are described to make them visible at a glance if a web page is updated.

## Reference

## RSS reader

“RSS reader” is software to create a list of links through touring predetermined web sites to obtain feeds.

"Feed" is update information where titles and summaries of a web site are compactly organized.

## ● Basic tags

Tag	Description of tag
<html> - </html>	Start and end of HTML
<head> - </head>	Start and end of a header
<title> - </title>	Start and end of a title
<body> - </body>	Start and end of a text body
<p> - </p>	Start and end of a paragraph
<a> - </a>	Start and end of a link (specify a link destination with HREF attribute)
 	A line break

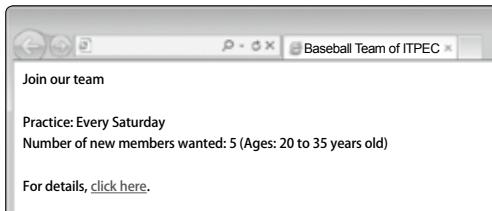
# Creating a web page by using HTML tags

```
<html>      ←Start of HTML
<head>      ←Start of a header
<title>      ←Start of a title
Baseball Team of ITPEC
<title>      ←End of the title
<head>      ←End of the header
<body>      ←Start of a text body
<p>Join our team</p>
<p>Practice: Every Saturday<br>
Number of new members wanted: 5 (Ages: 20 to 35 years old)</p>
<p>For details, <a href="recruit.html">click here.</a></p>
<body>      ←End of the text body
<html>      ←End of HTML
```

Diagram illustrating the structure of an HTML document:

- A horizontal line spans from the start of the first `<html>` tag to the end of the last `<html>` tag.
- A vertical bracket on the right side groups the entire content between the first `<body>` tag and the last `<html>` tag, labeled "Body".

When displayed on a WWW browser:



**2** XML

**“XML (eXtensible Markup Language)”** is a markup language used to write data optimized for the Internet. Tags can be individually defined; therefore, it is called an expandable markup language.

In XML, a document and information to define a document type (DTD) can be defined separately. A document written in XML is interpreted in accordance with the rules defined in DTD, and is displayed on the screen. Today, various companies in addition to the information service industry utilize XML for information disclosure on the Internet and for electronic commerce.

# 7-3

# Chapter Quiz

[Note] Answers can be found on page 20 of the appendix “Answers and Explanations for Chapter Quiz” at the end of this book.

## Q 7-1

A character string is replaced according to the string replacement rule shown below. When the replacement result is “00101110110”, which of the following is the string before the replacement?

Character	After replacement
A	10
B	11
C	0

- a) CABBAB      b) CCABABC      c) CCBCBAA      d) CAABABC

## Q 7-2

Which of the following is the correct combination of explanations on HTML and CSS?

	HTML	CSS
a)	A markup language used to describe document structures by using predefined tags, and used for web page creation	A style sheet language for HTML that defines character font, size, background, margins, etc.
b)	A markup language used to describe document structures by using individually defined tags, and used for web page creation	A file format used to present documents to look the same way as it looks on the application software to have created it in a manner independent of computer hardware and operational environment
c)	A script language suitable for text processing and utilized as CGI for a bulletin board and an access counter on a web page	An organization to perform standardization of markup languages
d)	An object-oriented programming language, that can be run on different hardware or different OS	A set of 2 byte character codes standardized by ISO and IEC to cover all characters all over the world

## Q 7-3

Search for both aquariums in City A and art museums in City B at the same time. Which of the following is an appropriate logical expression that represents the search condition?

- a) (“City A” OR “City B”) OR (“aquarium” OR “art museum”)  
b) (“City A” OR “City B”) AND (“aquarium” OR “art museum”)  
c) (“City A” AND “aquarium”) AND (“City B” AND “art museum”)  
d) (“City A” AND “aquarium”) OR (“City B” AND “art museum”)

**Q 7-4**

There is a baggage keeping system that can store up to 100 pieces of baggage by putting each piece of baggage in a box that is movable up and down. When a user leaves baggage, this system issues a numbered ticket, whose number is used for searching and retrieving his/her baggage. When baggage is searched with the steps shown below, which of the following is an appropriate method?

- (1) Narrow down whether the number on the ticket falls in the first half or latter half.
- (2) Narrow down whether the number falls in the new first half or latter half narrowed down in (1).
- (3) Similarly, repeat (2) above until the searched number is found.

- a) Bubble sort      b) Linear search      c) Binary search      d) Merge

**Q 7-5**

A voice is sampled 10,000 times in one (1) second, and each sampled value is recorded as eight (8) bit data. How many minutes at maximum can the voice be recorded in a CD with a capacity of 700 MB?

- a) 116 minutes      b) 666 minutes      c) 1,166 minutes      d) 1,666 minutes

**Q 7-6**

When the letters A, B, C, D, and E are lined up, how many ways are there for the letters A and D to be next to each other?

- a) 12 ways      b) 24 ways      c) 48 ways      d) 96 ways

**Q 7-7**

Which of the following is the decimal number to represent 10.011 in the binary system?

- a) 2.125      b) 2.25      c) 2.375      d) 2.625

**Q 7-8**

The table below is a score table of a game where a score is given according to the result of a fortune slip that a player draws once. What is the expected value of the score when a player draws the fortune slip once? Note that the probability of occurrence for each score is the same.

	Very lucky	Quite lucky	Little lucky	Lucky	Unlucky	Very unlucky
Score	5	4	3	2	1	None

- a) 0.4      b) 0.5      c) 2.5      d) 3

# Chapter 8

# Computer System

This chapter explains computer components and system components, hardware, software, and types of components and their characteristics.

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### 8-1-1 Processor

A “processor” is an important device that can be called the brain of the computer. It is the core of the computer. It is also called a “CPU (Central Processing Unit)” (hereinafter, CPU).

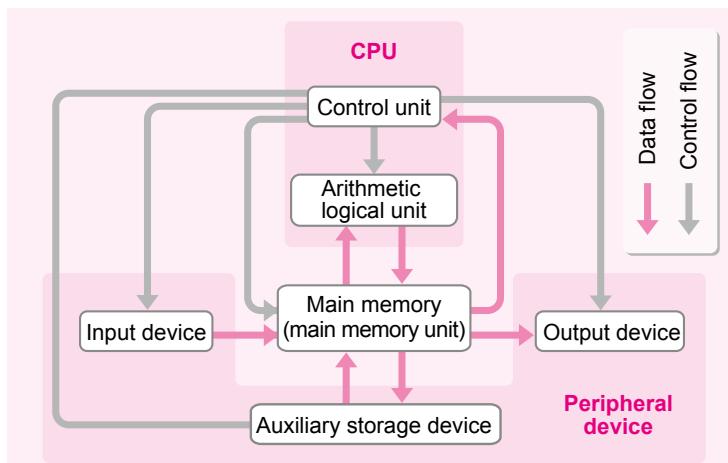
A computer is based on a CPU and includes other devices that have a range of functions. In order to use a computer, it is important to have an understanding of basic components and their mechanisms.

## 1 The configuration of a computer

A computer is made up of devices with five functions. These functions are “operation,” “control,” “memory,” “input,” and “output.”

Device	Role
Arithmetic logical unit	It performs computation according to instructions in a program. Together with the control unit, collectively called the CPU.
Control unit	It interprets a program and provides instructions to other devices.
Storage unit	It stores programs and data. It is divided into “main memory (main storage)” and “auxiliary storage device.”
Input device	It enters data into main memory.
Output device	It provides data from main memory (display, print, etc.).

The data and the control flow between each device is as follows:



For example, a program that processes “**1+2=**” that is entered via a keyboard operates with the order below.

- [1] “**1+2=**” is entered from the input device (keyboard).
- [2] “**1+2=**” is stored in the storage unit (main memory).
- [3] The arithmetic logical unit (CPU) calculates “**1+2=**.”
- [4] The result “**3**” of “**1+2=**” is stored in the storage unit (main memory).
- [5] “**3**” is displayed on the output device (display).

## 2 Basic mechanism of a CPU

Early computer CPUs were made up of multiple chips, but as technology advanced they were integrated onto a single chip. A CPU that is made up of a single chip is called a “**microprocessor**.”

The basic mechanism and functions of a CPU are as follows:

### (1) CPU

A CPU has an embedded “**control**” function to send instructions to devices, and an “**operation**” function to perform calculation according to the instructions in a program.

CPUs have become increasingly compact, and now some CPUs are the size of a fingertip.

The processing speed of a computer is greatly affected by the performance of the CPU, and CPUs are categorized as “**32-bit CPU**” or “**64-bit CPU**” depending on the volume of data they can process at once. A 32-bit CPU can process 32 bits at once, and a 64-bit CPU can process 64 bits at once. CPUs with a greater number of bits have a higher throughput, and can be called high performance CPUs.

### (2) Clock frequency

The periodic signal that is called “**clock**” matches the timing of operations inside the CPU and with external devices. The “**clock frequency**” indicates the number of signals per second.

The throughput of CPUs with the same number of bits differs depending on the clock frequency. The bigger the clock frequency number, the greater the number of times that data is processed, that is, the processing speed can be said to be higher.

Frequency is displayed in units of “**Hz (hertz)**,” and this is displayed after the CPU’s name in “**MHz (megahertz)**” or “**GHz (gigahertz)**,” as in “**Core i7 6700 (3.4 GHz)**.” For example, a 3.4 GHz CPU performs 3.4 billion operations per second.



#### Reference

### Compatible CPU

A “compatible CPU” is a CPU that has the same throughput as an original CPU. Even if the original CPU is replaced by a compatible CPU, the same OS and application software can be run on the compatible CPU.

#### Reference

### GPU (Graphics Processing Unit)

A “GPU” is a chip that processes and displays images. It has a higher throughput than a CPU, especially in cases such as the display of 3D graphics.

#### Reference

### Multi-core processor

A “multi-core processor” is a CPU that has multiple cores (arithmetic processing parts).

Processing can be distributed over multiple cores as if there were multiple CPUs.

#### Reference

### Program counter

A “program counter” in a CPU is a register that stores information about the instruction that is to be executed next (the storage location of the instruction in the main memory unit). It is also called an “instruction address register” or an “instruction counter.”

#### Reference

### Register

A “register” is a component of a CPU, and it is an area that temporarily stores things such as instructions that are being processed.

### Example

In a CPU that has a clock frequency of 2 GHz and can execute one instruction every 0.5 clocks on average, how many instructions can the CPU execute in one second?

Expression to calculate the number of instructions that can be executed per second

$$\text{Number of instructions} = \text{CPU clock frequency} \div \text{Number of clocks required to execute one instruction}$$

$$2 \text{ GHz} = 2,000,000,000 \text{ Hz}$$

$$2,000,000,000 \text{ Hz} \div 0.5 \text{ clocks} = 4,000,000,000 \text{ instructions}$$

Therefore, the result is 4,000,000,000 instructions.

### (3) Bus width

A “**bus**” is the path between devices for data that is used in data exchanges. Each device and the CPU are physically connected by a bus. “**Bus width**” shows how many signal lines form the bus, and it uses bits as the units. The wider a bus is, the higher the processing speed. The types of buses are as follows:

#### ● Internal bus

An “**internal bus**” is a transmission path that is used for data exchange in the CPU.

For example, in the case of a 32-bit CPU, for each clock (a period in which the clock circuit sends a single signal), a data exchange of 32 bits is performed in the CPU.

The clock frequency of the internal bus is called the “**core clock frequency**.”

#### ● External bus (FSB bus)

An “**external bus**” is a transmission path that is used for data exchange between the CPU and the memory or other peripheral devices.

The clock frequency for an external bus is called the “**external clock frequency**” or the “**FSB clock frequency**.”

## 8-1-2 Storage Unit

A “**storage unit**” is a device that stores data required for processing by a computer.

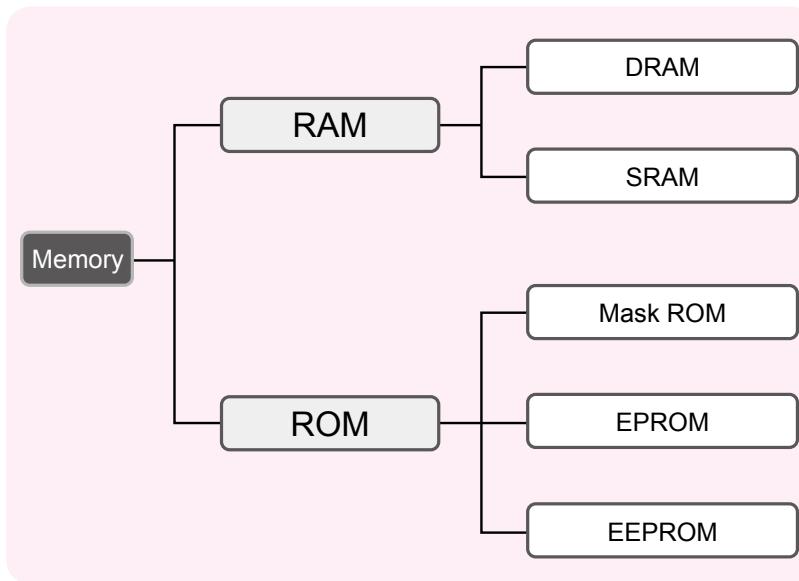
The storage unit can be categorized as “**memory**” and “**storage media**” on the basis of the type and the characteristics.

### ① Memory

“**Memory**” is a general term that refers to devices that store data and programs required for processing to make a computer run. ICs (semiconductors) are used in memory.

#### (1) Types of memory

Memory can be categorized as below depending on the method for storing data.



#### ● RAM

“**RAM**” is volatile memory that stored content disappears when the power supply is switched off. RAM can read and write data, and it is used for the main memory and the cache memory.

Comparison	DRAM	SRAM
Capacity	Large	Small
Processing speed	Slow	Fast
Cost	Cheap	Expensive
Refresh (electricity resupply)	Yes	No
Power consumption	More	Less

#### Reference

### Flash memory

“Flash memory” is a type of EEPROM that is electrically rewritable. In a PC, it is used in things such as BIOS and auxiliary storage devices.

#### Reference

### BIOS (Basic Input/Output System)

“BIOS” is a program that controls input and output between a computer and peripheral devices.

It is stored in ROM, and embedded on the motherboard.

#### Reference

### Memory address

A “memory address” is information about location in memory. It is also simply called an “address.” A unique number is allocated to each byte in memory, and the CPU uses this memory address to access information in memory.

### ● ROM

“ROM” is non-volatile memory that stored content is maintained when the power supply is switched off. There is a read-only ROM for reading data and programs and a rewritable ROM. ROM is used as the storage unit for the computer BIOS and the flash memory.

Type	Characteristics
Mask ROM	Data is written during manufacturing, and it cannot be re-written after.
EPROM	Data can be written at a later point in time. Data can be erased by using ultraviolet light.
EEPROM	It is an EPROM that can electrically erase data. Flash memory is a typical example, and this is used in digital cameras and IC cards.

### (2) Uses of memory

The uses of memory can be categorized as below.

Type	Characteristics
Main memory	It is a memory that stores programs and data that are processed by the CPU. DRAM is used.
Cache memory	It is a memory that absorbs the difference in access speed between the CPU and the main memory to increase speed. Many computers have multiple cache memories. The closest to the CPU is called “primary cache memory,” and the next one is called “secondary cache memory.” SRAM is used.
VRAM	It is a dedicated memory that temporarily stores image data to be shown on a display. This is called “graphics memory.” It is generally separate from main memory, and it is embedded on a graphics accelerator board. DRAM is used.

There is a difference in processing speed between the CPU (high speed) and the main memory (low speed), and “cache memory” is used to compensate for this difference.

Low speed main memory is not accessed every time, and instead data that has been accessed is stored in high speed cache memory. When the same data is next accessed, it is read from the cache memory.

Processing speed is increased by decreasing access to main memory.

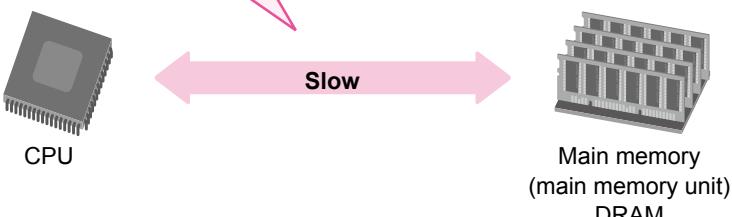
#### Reference

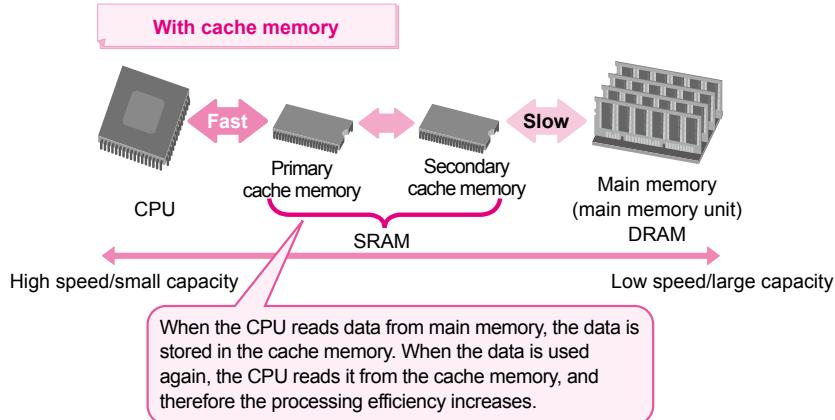
### Expanded memory

“Expanded memory” is memory that is later added to memory that is included as standard.

### Without cache memory

If there is no cache memory, data is exchanged between the CPU and main memory, and therefore waiting time occurs in the CPU, and processing efficiency decreases.



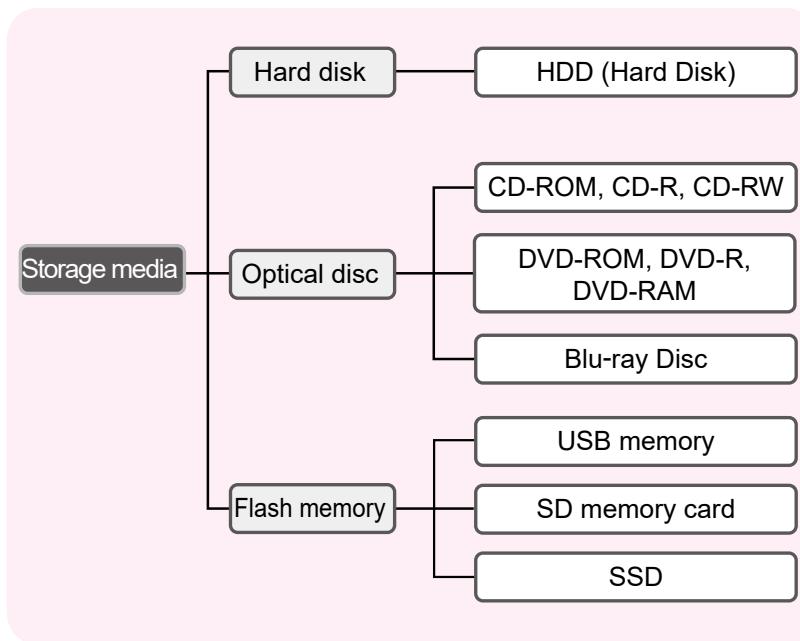


## ② Storage media

“Storage media” is a device that stores data and files that were created. It is also called an “auxiliary storage device.”

Since the data that is stored on storage media is maintained even after the power supply is switched off, it can be carried and distributed. It also has a large storage capacity, so is used for saving data and programs.

The types of storage media are as follows:



## Fragmentation and optimization

“Fragmentation” is when data on a hard disk is distributed and stored in multiple locations. Fragmentation occurs when data that is stored in a continuous area becomes fragmented because of repeated addition, deletion, and movement.

When fragmentation occurs, access speed decreases. Therefore, periodic repair is necessary for fragmentation. This is called “optimization” or “defragging,” and special software is used for the repair.

## Storage period of optical discs

Optical discs have a thin resin protection film above the recording layer on which data is stored in order to protect the data. If an optical disc is used for many years, the protection film may deteriorate and the stored data may be lost in some cases.

## (1) Hard disk

A “hard disk” is storage media that uses magnetism to read and write data.

The characteristics and storage capacities of typical hard disks are as follows:

Storage media	Characteristics	Storage capacity
Hard disk 	It reads and writes data to and from storage media that combines multiple metal discs that are coated with magnetic material. It is used as the standard storage media for computers. It is also called a “HDD (hard disk drive).”	A few tens of GB - a few tens of TB

[Note] The storage capacities shown are rough guides as of December 2015.

## (2) Optical disc

An “optical disc” is storage media that uses laser light to read and write data.

The characteristics and storage capacities of typical optical discs are as follows:

Storage media	Description	Storage capacity
CD 	Its diameter is 12 cm. Storage capacity is relatively large and low cost. Often used as a backup for daily work. The types of CDs are as follows: <ul style="list-style-type: none"><li>• <b>CD-ROM</b> Read-only, writing not possible. Often used as the distribution media for software packages.</li><li>• <b>CD-R</b> Writing is only possible once, and the data written becomes read-only. It is also called a “write-once disc.”</li><li>• <b>CD-RW</b> Rewriting is possible approximately 1,000 times.</li></ul>	650 MB 700 MB
DVD 	Its diameter is 12 cm, and its appearance is the same as a CD. The storage capacity is larger than a CD. Often used to store movies such as films and video. The types of DVDs are as follows: <ul style="list-style-type: none"><li>• <b>DVD-ROM</b> Read-only, writing not possible. Often used as the distribution media for movie software that includes films, etc.</li><li>• <b>DVD-R</b> Writing is only possible once, and the data written becomes read-only.</li><li>• <b>DVD-RAM</b> Rewriting is possible more than 100,000 times.</li></ul>	Single-sided single-layer 4.7 GB Single-sided double-layer 8.5 GB
Blu-ray Disc 	Its diameter is 12 cm, the same as a CD or a DVD, and storage capacity is larger than a DVD. Used as mass-storage media for movies, etc.	Single-sided single-layer 25 GB Single-sided double-layer 50 GB Single-sided triple-layer 100 GB

[Note] The storage capacities shown are rough guides as of December 2015.

### (3) Flash memory

“Flash memory” is a non-volatile memory that stored content is maintained even after the power supply is switched off. It is rewritable memory, and it uses semiconductor memory as a memory element. There is a limit to the number of times it can be rewritten, but under normal usage this limit is not exceeded.

The types of flash memory are as follows:

Storage media	Characteristics	Storage capacity
USB memory 	Combined with a connector for connecting to a computer, compact with excellent portability.	A few tens of GB - a few TB
SD memory card 	Used in things such as digital cameras and cell phones.	A few hundreds of MB - a few hundreds of GB
SSD 	Has better power consumption, data transfer rate, and impact durability than hard disks, and it is therefore gaining attention as a next generation drive to replace hard disks.	A few GB - a few TB

[Note] The storage capacities shown are rough guides as of December 2015.

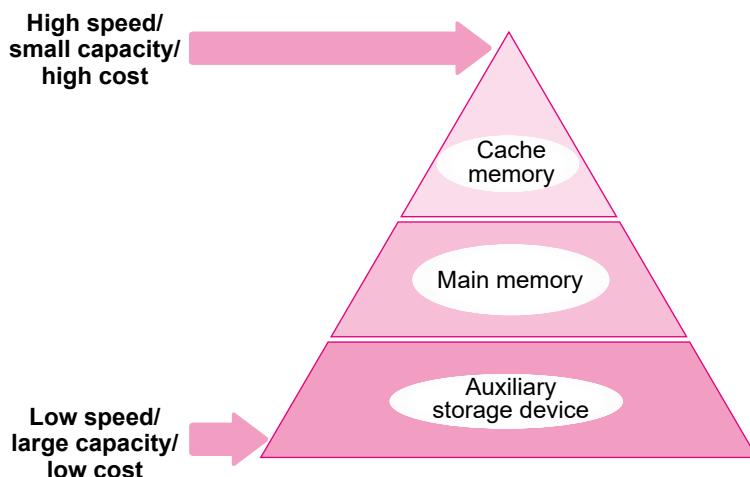
#### Reference

##### Compact flash memory card

A “compact flash memory card” is storage media that use flash memory to read and write data. Used in things such as digital cameras and notebook PCs.

### ③ Storage hierarchy

A “storage hierarchy” is a pyramid type hierarchy diagram that shows the structure of storage units that are used by a computer. Normally the lower down the diagram, the slower a storage unit’s access speed to data is. The higher up a storage unit is, the closer it is to the CPU and the faster its access speed.

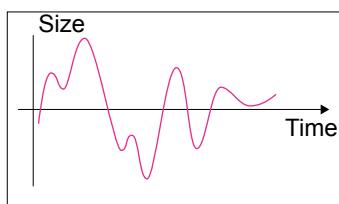


## 8-1-3 Input/Output Devices

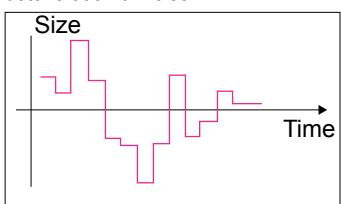
Peripheral devices such as printers and scanners can be connected to a computer. In order to connect, the “interface” type must be the same.

**Analog**

"Analog" means information is represented as a continuous value. Since analog information is temporally continuous, it changes in a wavelike pattern. The longer the transmission distance, the greater the effect of deterioration and noise.

**Digital**

"Digital" means information is represented specifically with a numeric value. Digital information is given a numeric value and changes in a bar graph pattern. Even if the transmission distance is long, it is not prone to the effect of deterioration or noise.

**DVI**

"DVI" is an interface that connects computers and displays. It is often used to connect to a liquid crystal display. There are three types of DVI: "DVI-D," "DVI-I," and "DVI-A." DVI-D can only transmit digital signals, DVI-I can transmit both digital and analog signals, and DVI-A can only transmit analog signals.

**HDMI**

"HDMI" is an interface that uses a single cable to transmit video and audio with a digital signal. Since it uses a digital signal that is not prone to deteriorating, it is suitable for high resolution video. HDMI can be used to display video from a PC on a digital television.

## ① Input/output interfaces

An "input/output interface" is a mediation device or a system for exchanging data (electrical signal) between two points such as a computer and peripheral devices.

A computer processes information on the basis of an electrical signal that is digitalized. In other words, it processes digital information. When digital information is processed, an interface mediates the electrical signal exchange between the computer and the peripheral devices.

Input/output interfaces are divided into "serial interfaces," "parallel interfaces," and "wireless interfaces" depending on the data transmission method.

Serial and parallel interfaces have wires, but a wireless interface has no wires.

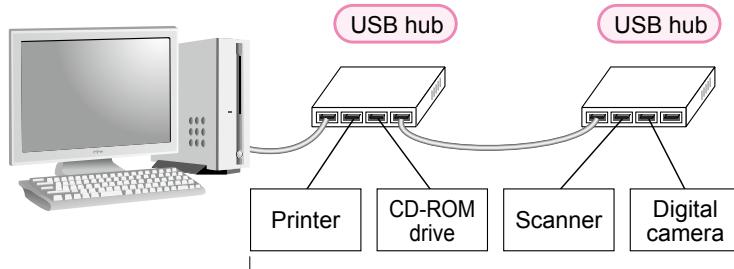
### (1) Serial interface

A "serial interface" transmits data one bit at a time. Since the number of signal lines is low and the deviation in the signal do not occur often, it is suitable for long distance transmission.

The standards for serial interfaces are as follows:

Standard	Characteristics
USB	<p>It is an interface that connects a range of peripheral devices such as a keyboard, mouse, printer, and display. With a USB hub, up to 127 peripheral devices can be connected. The devices can be connected or disconnected while the power supply is still switched on (hot plug), and it can provide electricity by using a cable.</p> 
IEEE1394	<p>It is an interface that connects devices such as digital video cameras and DVD-RAM. Up to 63 peripheral devices can be connected. The devices can be connected or disconnected while the power supply is still switched on (hot plug), and it can be used to supply electricity.</p> 

#### USB connections



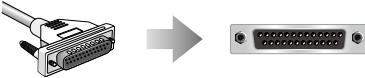
Up to 127 devices including a USB hub can be connected

[Note] It is also possible to connect peripheral devices such as a printer directly to the USB port on the computer itself.

## (2) Parallel interface

A “parallel interface” transmits multiple bits of data at once. Since the signal lines are bundled together to send data in parallel and the deviation in the signal are prone to occurring, it is not suitable for long distance transmission.

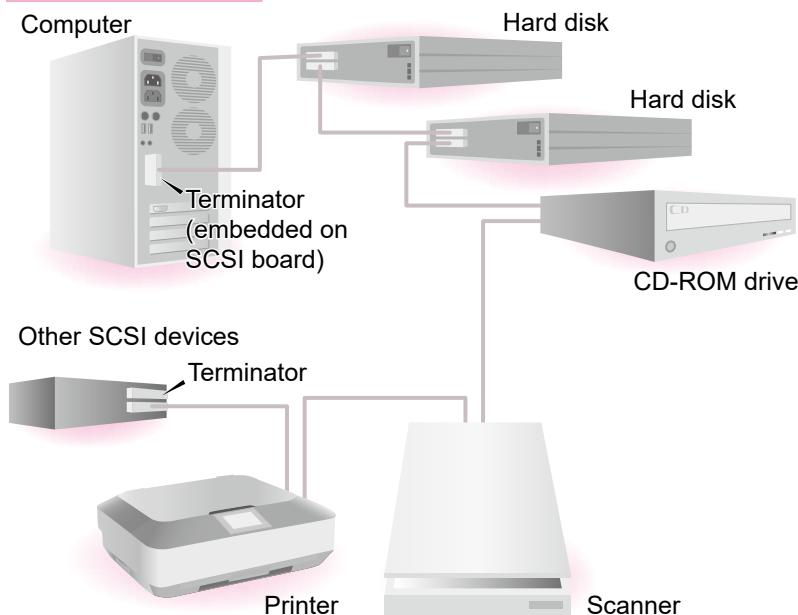
The standards for parallel interfaces are as follows:

Standard	Characteristics
IEEE1284	It is mainly an interface that connects computers and printers. As well as printers, it can also connect devices such as image scanners and MO devices. 
SCSI (Scuzzy)	It is an interface that connects computers and peripheral devices. Mainly connects external peripheral devices. Up to seven peripheral devices (eight including the SCSI board in the computer) can be connected in a daisy chain method (a method for connecting devices to each other in series). Up to 15 (16 including the SCSI board in the computer) devices can be connected in some cases depending on the standard. 

SCSI can be used to connect up to seven peripheral devices in a daisy chain method, and a resistor called a “terminator” is always attached (terminators are embedded on SCSI boards).

When SCSI is used, it is necessary to ensure that the SCSI ID allocated to each SCSI device is not a duplicate of another SCSI ID, because duplicate SCSI IDs can cause problems such as peripheral devices are not working.

### SCSI connections



### Reference

#### Analog RGB

“Analog RGB” is an interface that connects computers and displays.

It decomposes video colors into the red (R), green (G), and blue (B), and transmits them as analog signals.

### Reference

#### Bus power method

“Bus power method” is a method of supplying electricity to USB devices via a USB cable. The device operates with electricity supplied by USB through a USB cable, and does not need an AC adapter nor a power cord.

### Reference

#### PCMCIA (Personal Computer Memory Card International Association)

“PCMCIA” is a standards organization from the USA that creates standards for PC cards and other such things.

Types of PC card include SCSI cards and LAN cards, and they transmit data by parallel transmission method.

### Reference

#### Terminator

A “terminator” is a resistor that is connected to the end point of peripheral devices connected in a daisy chain method to ensure the electrical signal is not reflected. It is also called a “terminating resistor.”

Reference

### NFC (Near Field Communication)

“NFC” is a near field communication technology that is approved as an international standard.

Data can be transferred simply by “holding” an NFC device at a close distance of approximately 10 cm from an NFC reader.

For example, holding a smartphone with NFC close to a printer with NFC allows photographs to be printed.

Reference

### Device

A “device” is a peripheral device such as a keyboard, mouse, or display that connects to a computer.

Reference

### Plug and play

“Plug and play” is a function in which the OS automatically configures the optimum settings for any devices that are newly connected to a computer. The device driver that is required for the connected device is automatically added and configured. In order to perform plug and play, the peripheral device and the computer must both support plug and play.

### (3) Wireless interface

A “**wireless interface**” uses infrared rays or wireless transmission technology to transmit data. The transmission distance is short at a few tens of meters, and it is therefore suitable for transmission in small areas for example a room.

The standards for wireless interfaces are as follows:

Standard	Characteristics
IrDA	It is an infrared ray communication interface. The transmission distance is generally within 2 meters. Data transmission is disrupted in some cases if there is an obstruction between the devices.
Bluetooth	It is a wireless communication interface that uses the 2.4 GHz band to achieve a transmission speed of 1 Mbps within a range of 10 meters. It is incorporated in devices such as computers, printers, and cell phones. In comparison to IrDA, it is less prone to disruption from obstacles.

## 2 Device driver

A “**device driver**” is software that enables the use of a peripheral device. It is also simply called a “**driver**.” All peripheral devices require a device driver. Therefore, when a peripheral device is used, a device driver must be installed. Since the device driver requires the one corresponding to the type of OS and the model of computer, the device driver is included with the device or is available for download from the manufacturer’s website. However, recent OSs have a “**plug and play**” function, and therefore it is now possible to easily connect and use peripheral devices.

## 8-2-1 System Configuration

An “information system” enables the use of a computer for work activities. Information systems are categorized by the type of computer that is used and the type of processing, etc. In order to develop a system, a configuration is selected according to the purpose.

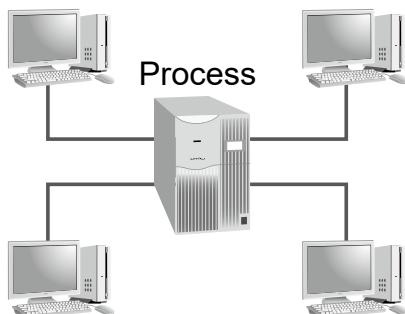
### ① Types of processing in information systems

The types of processing in information systems are as follows:

#### (1) Centralized processing

“Centralized processing” is where all processing is performed on a single computer (host computer). The characteristics of centralized processing are as follows:

- Since management is performed with a single machine, facilities and staff can be concentrated.
- Operations management, security management, and maintenance are easy to perform.
- If a fault occurs on the computer that is performing processing, the whole system stops.



#### (2) Distributed processing

“Distributed processing” is where processing is divided between multiple computers that are connected to a network. The characteristics of distributed processing are as follows:

- Function expansion is easy.
- The whole system does not stop even if a fault occurs on one computer.
- Since multiple computers perform processing, the operations management, security management, and maintenance become complex.
- If a problem occurs, it is difficult to identify where it occurred.

Reference

#### Online system

An “online system” is a system configuration where computers are connected by a communication line or other method and perform processing.

Reference

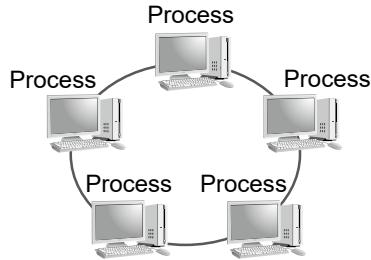
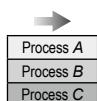
#### Standalone

“Standalone” is a system configuration where a single computer performs processing alone without being connected to a network.

#### Reference

### Parallel processing

Multiple computers are connected, and data is processed simultaneously in parallel.



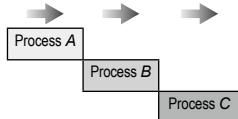
The types of distributed processing are as follows:

Type	Description
Horizontal distribution	Computers are linked in an equal relationship, and processing is distributed. It is also called "peer to peer."
Vertical distribution	Computers are linked in a layered relationship, and processing is distributed. It is used in "client/server systems."

#### Reference

### Sequential processing

Data is processed in order one at a time.



#### Reference

### Replication

"Replication" is a method of synchronization where a copy (replica) of a database is made on another computer on a network. When the database is updated, the result of the update is reflected in the replica.

#### Reference

### Server virtualization

Server virtualization is a technology where multiple virtual servers are run on a single computer. Hardware resources can be used efficiently by dividing the hardware resources such as the CPU and memory of a single computer and running different OS and application in each hardware resource. This has advantages including a reduction in purchase costs for hardware, a reduction of maintenance costs, and a reduction of power consumption.

## 2 Information system configuration

Typical types of configuration of information systems are as follows:

Configuration	Description
Dual system	In this system, two systems with the same configuration perform the same processing concurrently, and the systems perform checks such as whether there is an error in the results of processing while they perform the processing. If one of the systems suffers a failure, it is separated from the systems, and the other system continues the processing.
Duplex system	In this system, two systems are prepared, and one is used as the primary system (currently used system) and the other is used as the secondary system (backup system). The system usually performs processing with the primary system. If a failure occurs in the primary system, the secondary system takes over and continues the processing. Duplex systems are divided into the two types below. • <b>Cold standby system</b> A type of system that performs separate processing on the primary system and the secondary system. This has the advantage of enabling the resources of the secondary system to be used effectively while there are no failures in the primary system. However, when a failure occurs in the primary system, before switching over is performed, processing on the secondary system must be temporarily halted. Therefore, time is required to switch over. • <b>Hot standby system</b> A type of system that does not perform separate processing on the primary system and the secondary system, and always keeps the secondary system on standby in the same status as the primary system. Since the secondary system does not perform any processing, it can be switched to quickly if a failure occurs.
Thin client	In this system, a system where resources such as application software and files are managed on the server side, and computers on the client side have only the minimum necessary functions. Since the client side can be used by providing only a network function to connect to the server and a function to perform input and output, it is easy to manage and has good security.
Cluster	A system configuration where multiple computers (including a server) are connected to a network and operated as if it were a single system. It is a system configuration that aims to improve reliability by being able to continue provision of services without stoppage in the event of a failure during operation.

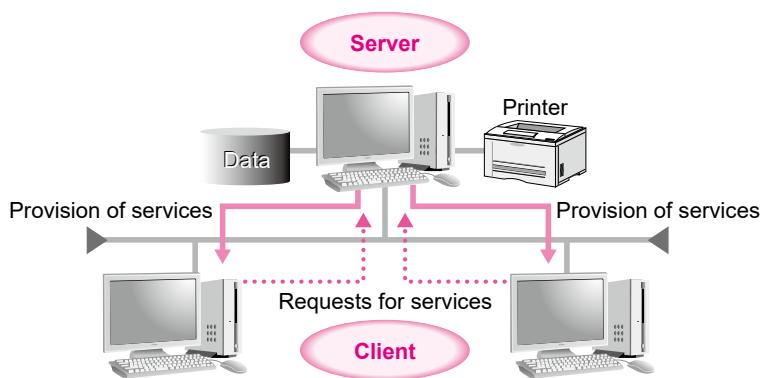
### ③ Usage of information systems

The usages of information systems are as follows:

Usage	Description
Real-time processing	It is a usage where processing is performed immediately when a processing request occurs. It can be used in combination with online systems such as a bank's ATMs or a reservation system for train seats.
Batch processing	It is a usage where data is stored for a certain period and processed in a batch. In batch processing, processing is performed automatically by simply configuring the processing. Therefore, the computer can be used in periods where it is usually not used. It can be used for administrative processing such as payroll calculation.
Interactive processing	It is a usage where processing is performed interactively by a computer and a user through a display in a similar way as a dialog. The user returns the operation requested by the computer through the display, and processing is performed interactively in the similar way as a dialog.

### ④ Client/server system

A “client/server system” is a system that is configured by dividing roles between a “server” that provides services to computers connected to a network, and a “client” that requests services from the server.



The characteristics of client/server systems are as follows:

Characteristics	Description
Reduction of load on the system	The load on the system can be reduced by dividing the roles (distributing the processing) between the clients and the server.
Reduction of implementation cost	Implementation cost can be reduced by sharing hardware resources (printers, hard disks, etc.).
More efficient activities	The required data can be retrieved at the required time for processing by sharing software resources (files, etc.). Therefore, activities can be made more efficient.
Ease of system expansion	The addition of a server or client is easy.
Increased complexity of system management	Since hardware and software resources must be managed for each server and client, the bigger the system is the more complex management is. It is also difficult to identify the cause and determine who is responsible when a problem occurs.

#### Reference

##### Peer to peer

“Peer to peer” is a type of system that composes a network. In peer to peer, the roles of the computers that are connected to a network are not divided, and they are connected in an equal relationship. This means there is no distinction between server and client.

#### Reference

##### Web system

A “web system” is a system that runs on a server and uses a WWW browser for bidirectional communication. The “shopping cart” and “mail form” that are seen on many shopping sites also use a web system.

## 8-2-2 System Evaluation Indexes

System evaluation indexes must look at the overall performance, reliability, and economical efficiency of a computer.

### ① System performance

System performance is measured in a “**performance test**” that is performed as part of a system test or an acceptance test. A performance test verifies whether processing requirements such as response time, turnaround time, and benchmarks are met.

Methods to check for evaluating the performance of a system are as follows:

Reference
<b>Throughput</b> “Throughput” is the volume of work that indicates how much data a system can process per unit of time. It is used to represent system processing capacity.
<b>Benchmark</b> A “benchmark” is an index for the measurement of system performance. It is used to measure things such as the response time and the CPU availability, and to compare and evaluate the performance of multiple computers.
<b>SPEC</b> “SPEC” is a non-profit organization for the standardization of performance indexes for CPUs and web servers, etc.

Performance indicator	Description
Response time	<p>The time from when a request for processing is made to a computer until when the first response is returned. It is used to evaluate the performance of online systems. If the load is low then the response time is shorter, and if the load is high the response time is longer.</p> <p style="text-align: center;">Response time</p> <pre>graph LR; A[Print instruction] --&gt; B[Processing]; B --&gt; C[Print result]</pre>
Turnaround time	<p>The time from when a request for a series of tasks is made to a computer until when all of the processing results are received. It is used to evaluate batch processing performance.</p> <p style="text-align: center;">Turnaround time</p> <pre>graph LR; A[Print instruction] --&gt; B[Processing]; B --&gt; C[Print result]</pre>

### ② System reliability

When a system is implemented, it is important that the system is reliable from the perspective of the user (system user department). System reliability increases by continuous operation without function stoppages while the system is operating.

#### (1) Indexes showing system reliability

“**Availability**” is used as an index to measure the reliability of a system. System availability represents the extent to which the system operates normally in a percentage. The larger the value of the availability, the more reliable the system is.

Availability can be represented as “**MTBF (Mean Time Between Failures)**” or “**MTTR (Mean Time To Repair)**.” The longer the MTBF and the shorter the MTTR, the higher the availability of the system.

Type	Details
MTBF	The average time that a system operates continuously between failures.
MTTR	The average time it takes to repair a system when a fault occurs.

The following is a method for the calculation of availability by using MTBF and MTTR.

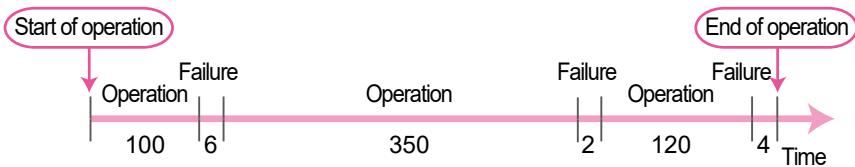
$$\text{Availability} = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}$$

Or

$$\text{Availability} = \frac{\text{Total operating time} - \text{fault time}}{\text{Total operating time}}$$

### Example

What is the availability of the system shown in the figure?



[MTBF]

$$(100 + 350 + 120) \text{ (hours)} \div 3 \text{ (times)} = 190 \text{ hours}$$

[MTTR]

$$(6 + 2 + 4) \text{ (hours)} \div 3 \text{ (times)} = 4 \text{ hours}$$

[Availability]

$$\frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}} = \frac{190}{190 + 4}$$

$$= 0.9793814\cdots \rightarrow \text{approximately } 0.979$$

Or

$$\frac{\text{Total operating time} - \text{fault time}}{\text{Total operating time}} = \frac{582 - 12}{582}$$

$$= 0.9793814\cdots \rightarrow \text{approximately } 0.979$$

## (2) Availability of complex systems

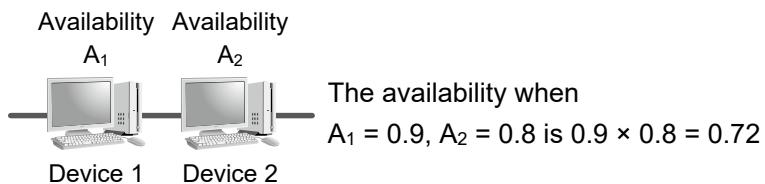
In the case of a system that is composed of multiple computers and devices, the method for calculation of the availability depending on whether it is a “**series system**” or a “**parallel system**”.

### ● Availability of series system

A “**series system**” is a system that operates when all of the devices that compose the system are operating. If a fault occurs even in a single device, the system stops operating.

Expression to calculate the availability of a series system

$$\text{Availability} = A_1 \times A_2$$



Reference

### Failure rate

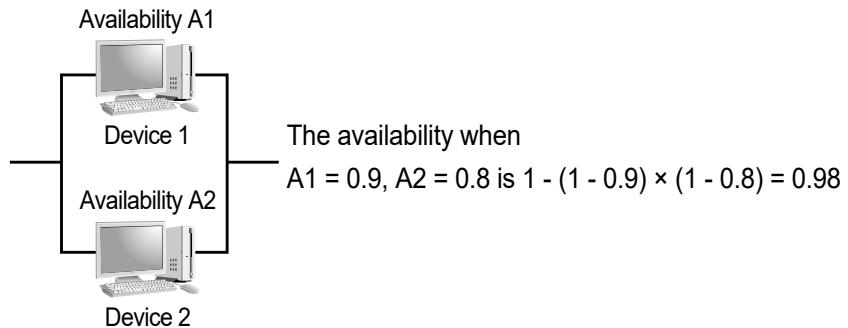
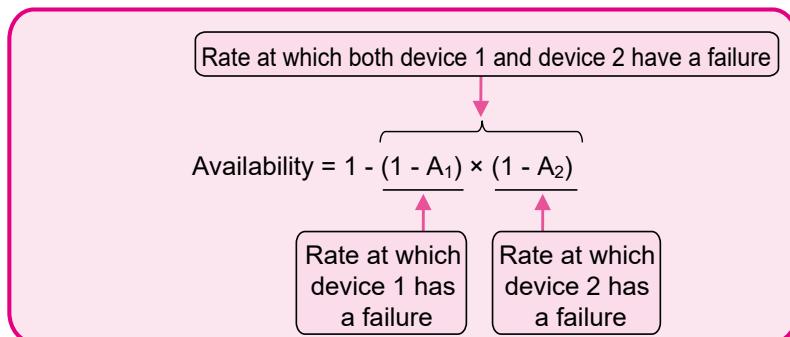
The “failure rate” is the number of times a fault occurs in a certain time.

$$\text{Failure rate} = \frac{1}{\text{MTBF}}$$

### ● Availability of parallel system

A “**parallel system**” is a system that operates if at least one device is operating. The system only stops operating if a fault occurs in all devices of the system.

Expression to calculate the availability of a parallel system



### (3) High reliability design

The followings are the approaches to constructing high reliability systems that allow users to use all the time without anxiety.

Approach	Description
Fault tolerant	Even if a fault occurs, all of the normal functions are maintained and processing continues. In general, methods for this include the duplexing of systems.
Fail-soft	When a fault occurs, the system does not completely stop and it maintains the minimum level of functions.
Fault avoidance	Faults are avoided by increasing the reliability of the devices themselves.
Fail-safe	When a fault occurs, the system is fixed in a stable status to limit the impact. For example, it is used in systems in which a fault or a malfunction leads to an accident, such as in traffic lights where if a fault occurs all lights are switched to red in order to stop all cars.
Foolproof	No fault occurs even if usage differs from the original specifications. The design takes into consideration user input mistakes and operation mistakes.

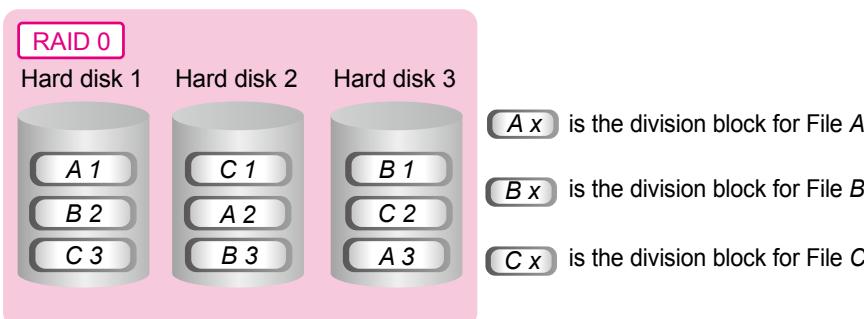
### (4) RAID

“RAID” is a technology that distributes and saves data by handling multiple hard disks as a single storage unit. RAID has a number of levels, and these are distinguished with the numbers such as RAID0, RAID1, and RAID5.

RAID0 is used to improve access speed to hard disks, and RAID1 and RAID5 are used to improve reliability of hard disks.

#### ● Aims to improve access speed

Since “RAID0” divides data and writes it to multiple hard disks, the access does not concentrate on one disk and the writing time of the data is reduced. It is also called “striping.”



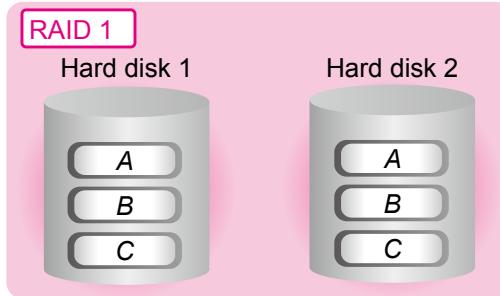
#### Reference

##### NAS (Network Attached Storage)

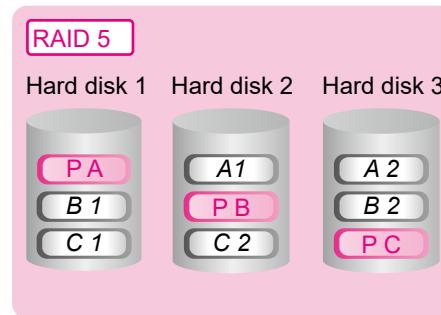
“NAS” is a file server that integrates things such as hard disks, communication control devices, and OSs, and it directly connects to a network. Some NAS have RAID functions. Since NAS supports multiple protocols, it enables the file sharing between servers with different OSs.

### ● Aims to improve disk reliability

“RAID1” writes the same data to two or more hard disks in preparation for a fault in one of the hard disks. It is also called “**mirroring**.” Even if a fault occurs in one hard disk, it improves reliability by reading data from another hard disk.



“RAID5” divides and records data and parity information for error detection and correction across multiple hard disks. If a failure occurs on one hard disk, data can be recovered from other hard disks. It is also called “**striping with parity**.”



#### Reference

##### Initial cost

“Initial cost” is the cost that is required when a system is introduced.

Hardware and software purchase costs, developer labor costs (outsourcing costs), training costs for users (system user department), maintenance costs, etc.

#### Reference

##### Operational cost

“Operational cost” is the cost that is required when a system is operated. It is also called “running cost.”

Facilities maintenance costs (lease, rent, upgrade costs, labor costs for system administrators), business losses because of operation stoppages, etc.

## 3 Economical efficiency of a system

When a system is implemented at a company, it is necessary to consider economical efficiency such as the effect and the evaluation. System installation incurs a range of costs such as initial costs and operational costs, but to consider the economical efficiency of a system, it is necessary to prioritize “**TCO (Total Cost of Ownership)**.”

TCO is the overall cost including purchase costs for computer hardware and software, training cost for users (system user department), operational costs, system maintenance costs, and losses resulting from the impact of system trouble. It is used for things such as decision making when a system is to be installed.

# 8-3 Software

## 8-3-1 OS (Operating System)

The OS is the minimum software required to run a computer.

### ① The necessity for the OS

The “OS” is software that manages and controls hardware and application software. It is also called “**basic software**.” It is an intermediary between hardware and software, and it does things including making settings for software to operate and conveying information from the user to peripheral devices such as a display or a printer.

Software that is used with a specific purpose such as word processing software or spreadsheet software is called “**application software**.”

The software that composes a computer can be categorized as follows:

Type	Description	Example
System software	Operating system	It is a software that manages and controls hardware and application software. Normally called an “OS.” In the broad definition, this sometimes includes utility programs, device drivers, and language processors. OS Utility program Language processor
	Middleware	It is a software that runs between the OS and the application software. Provides basic functions that are common to a variety of fields of use. Database management system Communication management system Operations management tool Software development support system
Application software	Common application software	It is a software that is used in common for a range of work and in a range of industries. Word processing software Spreadsheet software CAD/CAM Statistics processing program Graphics software Groupware
	Individual application software	It is a software that is used for specific work and in specific industries. Payroll software Finance and accounting software Sales management software Production management system

### Reference

#### Utility program

A “utility program” is software for the efficient use of a computer and the improvement of functions and operability. There are many types of utility program, from software to complement OS functions such as disk compression and optimization and memory management software to screensavers and anti-virus software. It is also called “utility software” and “service program.”

#### Reference

### Virtual memory

“Virtual memory” is a function that uses part of an auxiliary storage devices such as a hard disk in order to execute a program that is larger than the storage capacity of main memory. If the storage capacity of main memory is insufficient in cases such as the simultaneous execution of multiple programs or the editing of large amounts of data such as image files, virtual memory has the effect of making the capacity of main memory appear to be larger than it is by temporarily moving some data from main memory to a hard disk, etc.

#### Reference

### Hibernation

“Hibernation” is a function that returns a computer to the status immediately before the power supply was switched off by storing the contents of the main memory to a hard disk.

#### Reference

### Profile

A “profile” is a collection of information for each user account that is different in each environment. It manages information such as desktop layout, network settings, and human interface settings.

#### Reference

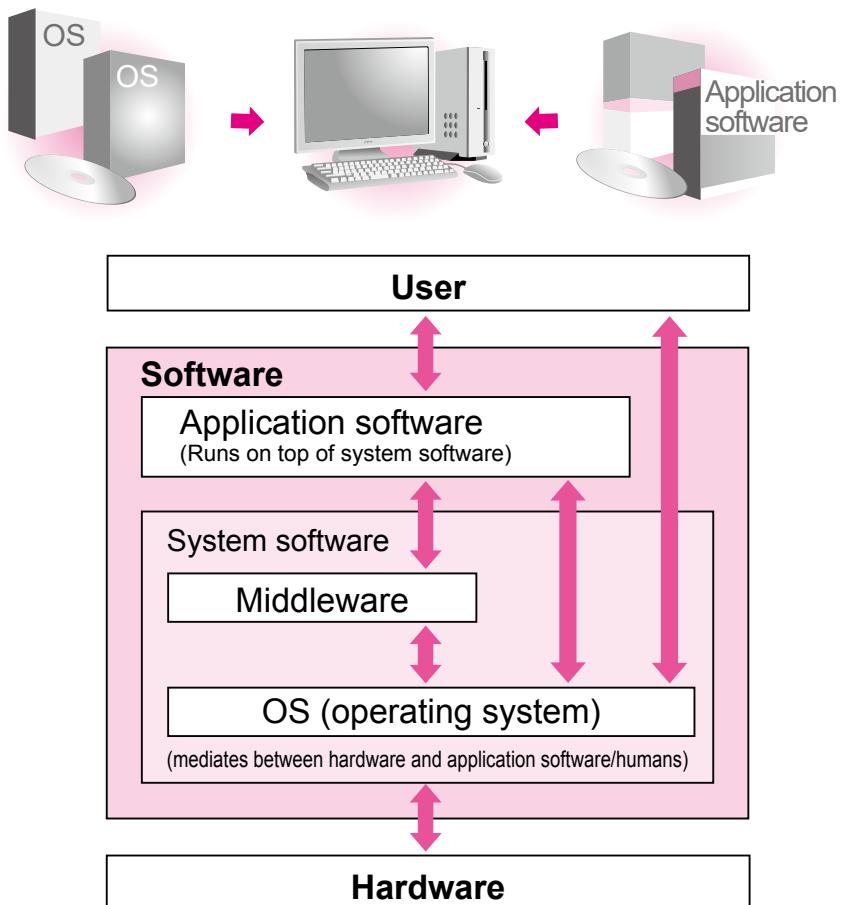
### User account

A “user account” is a collection of information that is required to use a computer, such as a user name and a password. It is also called an “account.” A single profile is linked to a user account, and when a user logs in the profile information is read.

#### Reference

### Multitasking

“Multitasking” is a function in which the CPU executes multiple tasks simultaneously. With this function, a user can run word processing software, spreadsheet software, etc. simultaneously, and use them alternatively. When a CPU can only execute a single task, this is called “single task.”



## 2 The functions of the OS

The functions of the OS are as follows:

Function	Description
User management	It enables the registration and deletion of multiple user accounts on a computer. Manages information such as access rights and a profile for each registered user account.
File management	It enables the writing and reading of files to and from media such as hard disks. Enables restriction of the use of files and folders on a computer for each user.
Input/output management (Device management)	It performs management and control of peripheral devices such as keyboards and printers. Some OSs have “plug and play” functions, and enable peripheral devices to be used easily.
Resources management	It performs allocation and management of resources in order to use computer resources (CPU, memory, hard disk, software) efficiently.
Memory management	It manages memory in order to ensure effective use of memory areas. Enables the use of memory that exceeds the actual memory capacity by using virtual memory.
Task management	It manages programs that are being executed. The unit of program execution is called a “task.” An OS with a multitasking function can execute multiple tasks in parallel.

### ③ The types of OSs

There are many types of OS and their management method differs for things such as files and folders. Therefore, in some cases, trouble occurs such as files not being displayed correctly on different OSs.

Types of OS that are used on PCs are as follows:

Type	Description
MS-DOS	It is an OS developed by Microsoft, and runs on 16-bit CPUs such as PC/AT compatible machines. It uses a CUI operating environment and operates with a single task.
Windows	It is an OS developed by Microsoft, and runs on 32-bit or 64-bit CPUs such as PC/AT compatible machines. It uses a GUI operating environment and operates with multitasking. Windows versions include "98," "ME," "NT," "2000," "XP," "Vista," "7," "8," and "10."
MacOS	It is an OS by Apple for Macintosh. The first implementation of a GUI operating environment on a PC.
UNIX	It is an OS developed by Bell Laboratories of AT&T. The CUI operating environment is the basic operating environment, but a GUI operating environment is also available by implementing a human interface called X-Window. It can handle multitasking and multiple users (many people using it at the same time), and has good network functions.
Linux	It is an OS that was created to be UNIX compatible for PC/AT compatible machines. It is available as open source software, and it can be freely improved and redistributed if certain rules are met. In strict terms, Linux refers to the core (kernel) of the OS. Linux is normally distributed in a format called a "distribution" that combines a kernel with application software, etc.

## 8-3-2 File Management

When files are managed, data must sufficiently be managed and preserved in preparation for the below.

- As the number of files increases, users forget where data is stored and the disk space becomes insufficient.
- Necessary data is accidentally deleted.
- Server data is accidentally overwritten or deliberately falsified.

Reference

#### Multithreading

"Multithreading" is the ability to execute multiple threads (a unit that breaks a task down into even smaller parts) within a single task in parallel. In a computer with a multi-core processor, multithreading can make effective use of the computer's throughput.

Reference

#### PC/AT compatible machine

A "PC/AT compatible machine" is a computer that is compatible with IBM's computer "PC/AT." This has spread as a standard for PCs. Except for Macintosh, most commercially available PCs are PC/AT compatible.

Reference

#### Multiboot

"Multiboot" is a system in which multiple OSs are installed on a single computer, and which OS to launch is selected when the computer is started.

Reference

#### CUI (Character User Interface)

"CUI" is an environment in which "commands" are entered through a keyboard to operate the computer.

Reference

#### GUI (Graphical User Interface)

"GUI" is an environment in which a computer is visually operated by using a mouse to click on graphical sections such as "icon."

Reference

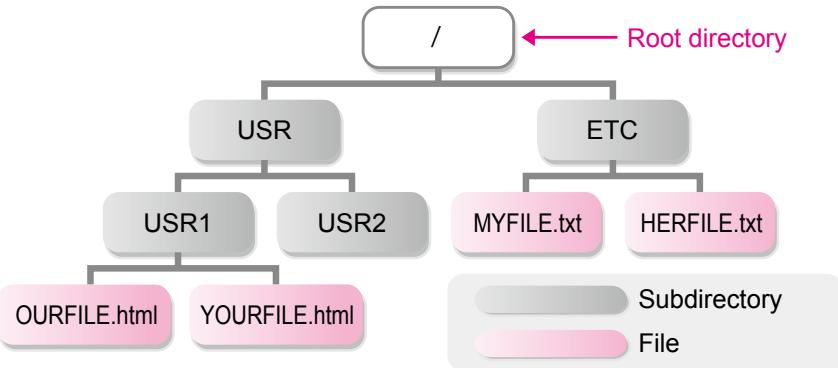
#### Role of a file system

A "file system" is a mechanism that manages files on storage media such as a hard disk. The method for creating files and directories on storage media and the maximum capacity of a volume of storage media depends on the file system.

# 1 Directory (folder) management

“Directory management” refers to the management of files in a hierarchical structure in order to make file search easy. In a hierarchy, the directory at the top is called the “**root directory**,” directories below this are called “**subdirectory**,” and the directory on which an operation will start is called “**current directory**.”

Directories have the tree structure as follows:



The location of a file within a computer is represented with a “**path**” that is like an address. Paths are specified by using either an “**absolute path**” or a “**relative path**.”

## ● If “USR” is considered to be the current directory

Specification method	Description	Specify MYFILE.txt
Specification of relative path	It is a method that specifies the location of a target file from the current directory (current directory).	../ETC/MYFILE.txt
Specification of absolute path	It is a method that specifies all directory names and filenames from the root directory to the target file in hierarchical order.	/ETC/MYFILE.txt

### Reference

#### “.” symbol

In a relative path specification, this indicates the current directory.

### Reference

#### “..” symbol

In a relative path specification, this indicates the directory one level above the starting directory.

### Reference

#### Notation method for directories

The notation method for directories differs depending on the OS. / or \ (backslash) is used in some cases.

### Reference

#### Filename

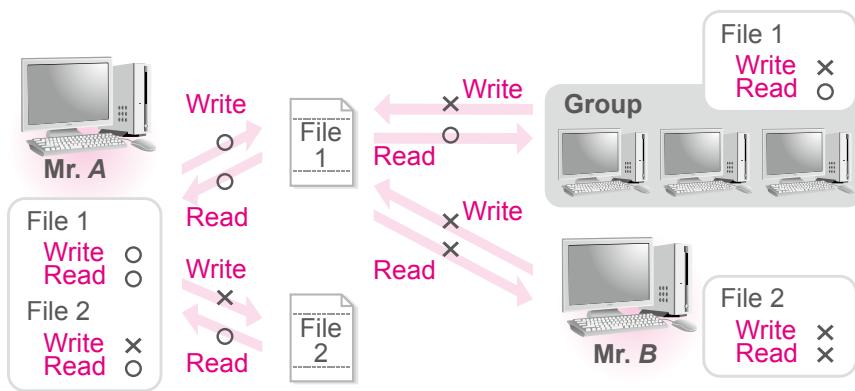
A filename is composed of a part that shows the name of the file and a “file extension” that shows format of the file. File extension refers to the alphanumeric characters after the “.(period)” at the end of the filename, and is also simply called the “extension.”

For example, in the case of “MYFILE.txt,” “MYFILE” is the filename and “.txt” is the extension that indicates the file is a text file.

## 2 File sharing

If a network is constructed, computer files can be shared between multiple users on the network. For example, an organization such as a company saves files such as negotiation case studies and customer information on a computer with a large capacity hard disk and can share information with employees by sharing these files.

In cases where directories and files are shared on a network, “**access rights**” are set to restrict reading and writing for each user.



## 3 Backup

“**Backup**” refers to the copying of files to an auxiliary storage device in preparation for damage to data or programs because of failures in the computer or the storage units. By implementing a backup, data can be recovered from this file if anything goes wrong.

The followings are the points for attention when a backup is implemented.

- Backup should be performed periodically, such as daily, weekly, or monthly.
- Scheduling should be performed to ensure that it causes no problems for daily work, such as after the close of business processes.
- Backup media should be chosen in consideration of the time required for backup and the cost, and it should be able to store all the data for backup.
- In order to avoid the loss of backup files, the original backup and a copy of the original backup should normally be stored in different locations.
- Care should be taken against loss and theft, and backups should be stored in a secure location.

## (1) Files for backup

If a backup is to be implemented for all files and registries on the computer, the storage media with a large capacity is required, and it is time-consuming.

Since the OS and the application software can be restored to their initial status by reinstalling them, they should normally not be backed up.

Important files that users create, files that store environment settings, and other such files should be backed up. However, if the impact of a failure is large, the whole hard disk should be backed up.

## (2) Types of backup

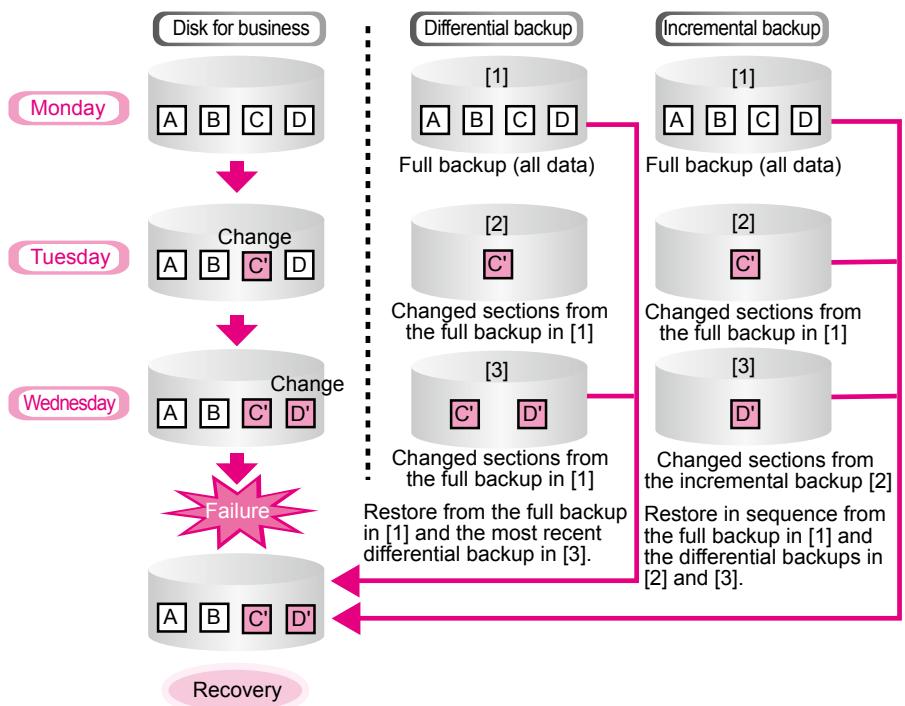
The followings are the types of backup that depend on conditions such as the recovery time and the backup workload.

### Reference

#### Restore

"Restore" means to return the contents of a backup to a hard disk, etc.

Type	Data for backup	Recovery method	Backup time	Recovery time
Full backup	All data on the disk.	Restore from a full backup.	Longer	Shorter
Differential backup	Data that has changed since the last full backup.	Restore from a full backup and the most recent differential backup.		
Incremental backup	Data that has changed since the last backup.	Restore from a full backup and the incremental backups since the full backup in sequence.		Longer



### (3) Backup methods

Important files are backed up on a separate drive or storage media for backup.

Method	Description
Copying files and folders	A backup is taken by simply dragging and dropping individual files and folders, or by copying and pasting them.
Use of a backup tool	A backup is taken by using specialized application software.

### (4) Storage media for backup

Storage media is selected depending on the size and use of files to be backed up.

The backup uses recording media such as a hard disk, CD-R, CD-RW, or DVD-R.

Reference

#### Archive

“Archive” means to move the data with a low frequency of use and the old data that is currently not used but must be stored to the storage media that is suitable for long-term storage.

Reference

#### Generation management

“Generation management” is the storage of several generations of previous backup data. Backup data is required when data is recovered, but if data is accidentally rewritten then sometimes old data is required. Therefore, generation management is useful.

Reference

#### Backup using DAT

“DAT” is a type of magnetic tape, and it is suitable for taking a backup of a whole hard disk. Backups are taken in units of disks rather than files.

Reference

#### Plugin

A “plugin” is a program that adds a function to application software. It expands the functions of the original application software, and a plugin itself can be upgraded and uninstalled.

Reference

#### Clipboard

A “clipboard” is an area where data is temporarily stored during copy and transfer operations.

Once the data is transferred or copied, it can be pasted an unlimited amount of times.

Reference

#### CSV format

“CSV format” is a text format that stores table data by separating it with a “, (commas).” It is often used for the exchange of data between different types of software.

## 8-3-3 Development Tools

Software that is used for business and other purposes includes software packages such as office tools. If the characteristics and basic operating methods of software are understood, the software can be used efficiently for work.

### ① Software package

Software that is used for a specific purpose or business, etc. is called “application software.”

There are many types of application software, and many are sold as a software package. In comparison with software that is developed from scratch to meet the requirements of a specific company or user, a software package has a relatively low development cost and is sold to many and unspecified companies and users.

The followings are some types of software packages for application software that are used on PCs.

Type	Characteristics
Word processing software	It enables the creation, editing, and printing of documentation. Has many functions for the creation of attractive documentation, such as the creation of tables and the embedding of diagrams.
Spreadsheet software	It enables the creation of tables and graphs, and the tabulation and searching of data, etc. It can use functions, and has many calculation functions.
Database software	It enables the storage of a large volume of data and the processing of data. It can use more advanced tabulation and searches than spreadsheet software.
Presentation software	It enables the creation of presentation materials that include diagrams, graphs, and images, etc. It also has functions for implementing a presentation.

## 2 WWW browser (Web browser)

“WWW” is a service for the viewing and searching “web page” information on the Internet. It is also called the “web.” A web page is a collection of information that is published on the Internet. In order to get information from the Internet, the web page that a user wishes to view is accessed. In order to view a web page, a software application called a “WWW browser” is used.

The main functions of a WWW browser are as follows:

### (1) Web page viewing

In order to view a web page, a “URL” is specified from the WWW browser. URL is the rule for the description of a web page address, and is also simply called an “address.”

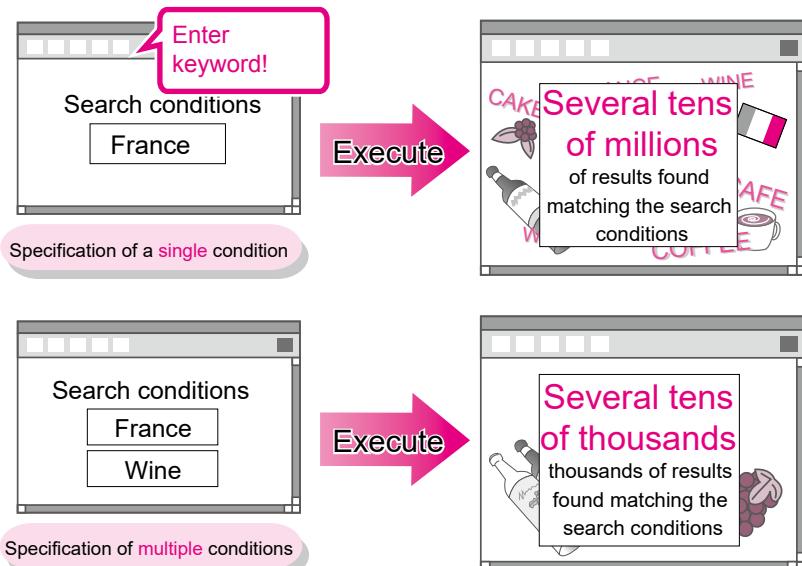
### (2) Web page search

If a user does not know the address for the web page they wish to view, a “search site” or a “search engine” can be used to search for and collect information by simply entering key words and making selections. If the number of web pages related to a keyword is large, extra keywords can be added to refine the search.

#### Reference

##### Crawler

A “crawler” is a program that acquires information such as URLs and keywords by automatically visiting all websites around the world in order to build a search database for a search site.



[Symbols when multiple keywords are specified]

Symbol	Meaning	Example
AND	A search including both France and wine	France AND wine
OR	A search including France or wine	France OR wine
NOT	A search including France but not wine	France NOT wine

## 8-3-4 OSS (Open Source Software)

OSS is freely modified and distributed by many people and is used around the world.

### 1 The characteristics of OSS

“OSS” is software whose source code is published free of charge on the Internet by its creator, and can be freely modified and redistributed if the copyright is not violated. Normally, in the case of a company, distribution is charged to prevent creation of similar products that copy the technology used in the software. However, the aim of OSS is to develop the software through redistribution free of charge with no guarantee as a general rule. The characteristics of OSS are as follows:

- It permits free redistribution.
- It permits distribution of source code.
- It permits distribution of derivative software.
- It protects the integrity of the original source code is protected.
- It does not discriminate against individuals or groups.
- It does not discriminate against fields of use.
- It does not require additional license for redistribution.
- It does not depend on specific software.
- It does not restrict other software that is distributed on the same media.
- It does not depend on a specific technology nor interface.

### 2 The types of OSS

The main types of OSS are as follows:

Category	OSS example
OS	Linux
Office tool	Open Office.org
WWW browser	Firefox
WWW server	Apache
E-mail	Thunderbird
Database management system	MySQL, PostgreSQL

#### Reference

##### Source code

“Source code” is the documentation that is the source of the software created in a programming language. In order to run software, a program must be created in source code.

#### Reference

##### OSI (Open Source Initiative)

“OSI” is an organization that aims to promote OSS. The OSI defines and compiles the requirements for programs that are distributed as OSS.

## 8-4-1 Hardware

“Hardware” refers to the actual devices of a PC. A computer is composed of many types of hardware. By understanding the types and characteristics of hardware, it can be used for business.

### ① Computer

Computers are categorized depending on their performance, purpose, shape, and size.

#### (1) Types of computer

Computers are used for a range of purposes in places such as homes and schools as well as companies and research institutes.

Computers are categorized by performance and purpose as follows:

Type	Description
Super computer	They are the fastest, highest performance computers that are used for high-speed processing such as calculations for science and technology. They are used for weather forecasts, air traffic control, space development, etc.
General-purpose computer	They are computers that are designed to be used for both business processing and science and technology calculation. They are also called “mainframes.” They are used for train seat reservations, online systems for savings at banks, etc.
Office computer	They are computers that are specialized for business processing. They are also called “business servers.” They are used for inventory control, sales management, etc.
Workstation	They are high performance computers that are used for specialized work. They are categorized into an “EWS (Engineering Workstation)” that is used for things such as CAD/CAM and science and technology calculations, and an “office workstation” that is used for things such as administrative processing and information management. They are used for software development, CAD/CAM, servers, etc.
Personal computer	They are computers for personal use. They are also used in companies. They are also called “PC.”
Mobile computer	They are compact computers that can be carried. They include notebook computers and mobile devices.

#### Reference

##### Grid computing

“Grid computing” is a mechanism in which multiple computers are connected to a network such as the Internet, and then used as if they are a single computer system.

## (2) Types of PC

There are different types of PCs depending on the shape and size of the main unit, and they are categorized as below.

Type	Description
Desktop	<p>They are PCs that are set up in a fixed location such as on a desk. Types of desktop PC are as follows:</p> <ul style="list-style-type: none"><li>• <b>Tower</b></li><li>The main unit of the PC is vertical, and it is relatively large.</li><li>• <b>Space saving</b></li><li>The main unit of the PC is thin and does not require much space.</li><li>• <b>Integrated</b></li><li>The main unit of the PC and the display are integrated.</li></ul>
Notebook	The liquid crystal display, keyboard, and main unit of the PC are integrated, and the ability to be folded up and carried like an actual notebook is prioritized. They are available in sizes including A4 and B5.
Tablet computer	They are touch panel-type mobile devices that can be operated by touching with fingers. Internet connection functions are usually included as standard. Application software called apps that have a wide range of functions are available on the Internet, and they can be used to simply achieve multifunctionality. A smartphone is a type of tablet computer.
Wearable device	They are information devices that can be worn on the body. They include wristwatch types and eyeglass types. They are also called “wearable computers.”

### Reference

#### Rack-mounted server

A “rack-mounted server” is a flat server that is placed in a stack in a shelf called a rack, and is suitable for organizing and storing multiple servers. A power supply and cables must be provided for each individual server.

### Reference

#### Blade server

A “blade server” is a server that has a special housing (chassis) is packed with multiple thin servers, and so excels at processing large amounts of data. Multiple servers can be placed in a very thin configuration and can share the power supply and the cables. Therefore, more space and electricity can be saved than rack-mounted servers.

**Pointing device**

A “pointing device” is the general name for input devices that specify the input position on a screen.

## 2 Input devices

An “input device” is a device that provides instructions and data to a computer.

Types of input device are as follows:

Type	Description
Keyboard	It is a standard device for entering data such as characters, numbers, and symbols by pressing keys on the keyboard. 
Mouse	It is a device that moves a pointer on the screen by sliding the device on a desk. Types of mouse include optical and cordless. Furthermore, the display on the screen can be moved with the “scroll button” that is between the left and right buttons on the mouse. 
Trackpad (touchpad)	It is a device that moves the mouse pointer by tracing over a flat plastic surface with a finger. It detects changes in capacitance when a finger traces over it, and accurately calculates the position of the mouse pointer. It differs from a mouse because it does not use any moving parts, and it is therefore very durable. It is mostly used in notebook computers. 
Tablet	It is a device that enters an illustration or a diagram by tracing over a flat plastic surface with a pen. The pen that is used for input is called a “stylus.” 
Touch panel	It is a device that enters data when an icon or a button that is shown on a display is touched with a finger, etc. Touch panels are used for bank ATMs or guidance displays in places such as a library. 
Image scanner	It is a device that imports photographs, pictures, printed material, or handwriting characters as digital data. Types of scanner include “flatbed,” “sheet fed,” and “handheld.” 
Barcode reader	It is a device that optically reads bar codes that are attached to things such as products. It is used as an input device for POS terminals. Types of barcode reader include “stationary” and “handheld.” 
OCR (Optical Character Reader)	It is a device that optically reads handwritten or printed characters and converts them to a character code. In OCR for a PC, an image is read with an image scanner and the characters are recognized with OCR software. 
Web camera	It is a compact video camera that is connected to a PC, etc. It is used to distribute recoded movies over the Internet, and for showing one's own face or a venue in a video conference or a video chat. 

**OMR (Optical Mark Reader)**

An “OMR” is a device that optically reads whether a mark made with a pencil, etc. is present on a mark sheet.

### ③ Output devices

An “output device” is a device that retrieves information from within a PC to a human in an easy to understand way. Types of output device for a PC are as follows:

#### (1) Display

The types of display are as follows:

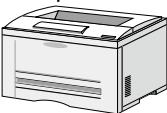
Type	Description
Liquid crystal display	It is a display device that uses liquid crystals. The size is from 10 to 60 inches, and the display uses the property of liquid crystals whereby their light transparency changes when a voltage is applied.
OLED (Organic Light Emitting Diode) display	“Organic EL” is a low-voltage-driven, low-power consumption device that emits light when a voltage is applied. Since the luminescent material uses organic materials such as diamine or anthracene, it is called an organic EL. In addition to being low-voltage driving and low-power consumption, the display can be made thin. Therefore, it is used in the same way as a liquid crystal display.

#### (2) Printer

Printers are categorized into a “page printer” and a “serial printer” depending on the units in which they print information such as characters onto paper.

A page printer stores a printing pattern for one page in the printer’s memory and prints the whole page. A serial printer prints one character at a time.

Types of page printer and serial printer are as follows:

Type	Description
Page printer	<p>Laser printer</p>  <p>It is a device that prints by using a laser beam and electrostatics to affix toner to paper. The speed and quality of printing is high, and this is the main type of printer that is used in offices.</p>
	<p>Inkjet printer</p>  <p>It is a device that sprays ink in mist form from a nozzle onto paper to print. It is cheap and provides attractive color printing, and so is the main type of printer for personal use.</p>
Serial printer	<p>Dot impact printer</p>  <p>It is a device that creates a character shape from a group of pins, and prints with an ink ribbon between the paper and the pins. It is used for carbon copy printing.</p>
	<p>Thermal printer</p>  <p>It is a device that prints by making a print head (the part that prints) produce heat and then putting it in contact with heat-sensitive paper that produces a color when heat is applied. It is used for printing receipts, etc.</p>

#### Reference

##### Pixel

“Pixel” is a point on a display and is the smallest unit of an image. It is also called a “dot.”

#### Reference

##### Projector

“Projector” is a device that projects an enlarged image from a computer or a television onto a screen.

#### Reference

##### Spool

“Spool” is also called “spooling,” and when input/output or other such processing that takes time occurs, all data is temporarily written to a hard disk and then processed incrementally.

Processing such as processing output to a printer take time, so spooling can increases the overall efficiency of the system by avoiding concentrated CPU utilization.

#### Reference

##### Printer performance

##### indexes

The followings are units that are used to evaluate printer performance.

Unit	Description
dpi (dot per inch)	It indicates the number of dots per inch (approximately 2.5 cm). It is used as a unit to indicate the quality of a printer or an image scanner, etc. The higher the number, the greater the detail.
ppm (page per minute)	It is the number of pages that can be printed per minute. It is used as a unit to indicate the printing speed of a page printer.
cps (characters per second)	It is the number of characters that can be printed per second. It is used as a unit to indicate the printing speed of a serial printer.

#### Reference

##### 3D printer

A “3D printer” is a device that uses three dimensional data created by using a 3D CAD or a 3D scanner, etc. to create a three dimensional object.

Mainly for manufacturing industry, it is used in a wide range of fields including construction, healthcare, and education.

# 8-5

# Chapter Quiz

[Note] Answers can be found on page 23 of the appendix “Answers and Explanations for the Chapter Quiz” at the end of this book.

## Q 8-1

A system is composed of a single CPU and a single output device and has five (5) jobs to process. The CPU and the output device are independent and can perform processing separately, but output processing can only be performed after processing by the CPU is complete. If the five (5) jobs are processed in ascending order of the number, in the time taken until output processing of the final job is complete, what is the total number of seconds that the output device does not perform processing?

	Time taken for CPU processing	Time taken for output processing
Job 3	15 seconds	15 seconds
Job 1	25 seconds	10 seconds
Job 4	10 seconds	30 seconds
Job 2	40 seconds	20 seconds
Job 5	15 seconds	15 seconds

- a) 25 seconds      b) 35 seconds      c) 45 seconds      d) 55 seconds

## Q 8-2

Among the types of RAID, which of the following is the level called “striping with parity” that distributes data and parity information over all hard disks?

- a) RAID0      b) RAID1      c) RAID3      d) RAID5

## Q 8-3

Which of the following is the appropriate order of storage units in terms of access speed, starting with the fastest?

- a) Hard disk → Cache memory → Main memory  
b) Main memory → Hard disk → Cache memory  
c) Cache memory → Main memory → Hard disk  
d) Main memory → Cache memory → Hard disk

## Q 8-4

Which of the following is an appropriate explanation of a plug and play?

- a) It increases the speed between CPU and main memory.  
b) It is an interface that uses infrared rays and wireless transmission technology to transmit data.  
c) The CPU executes multiple tasks simultaneously.  
d) It is a function that, when a peripheral device is newly connected to a computer, the OS automatically configures the optimum settings.

**Q 8-5****Which of the following is an appropriate explanation of a blade server?**

- a) It is a server that has a DBMS (Database Management System), and it has the role of performing processing such as searching, aggregating, and sorting of a large volume of data as per a request from a client.
- b) By stacking servers in a dedicated rack, multiple servers can be organized and stored, but the power supply and cables cannot be shared.
- c) It is a server that manages and controls a printer, and it has the role of temporarily storing the printing data from clients and printing it in order.
- d) By stacking servers in a dedicated chassis, multiple servers can be stored with sharing the same power supply and cables.

**Q 8-6****Which of the following is an appropriate explanation of a cluster?**

- a) It is a system configuration in which two (2) systems with the same configuration perform the same process simultaneously, and if a failure occurs in one of the systems, it is isolated and processing is continued by the other system.
- b) It is a system configuration where resources such as application software and files are managed on the server side, and the client side only has the minimum necessary functions.
- c) It is a system configuration in which multiple computers are connected by a network and operated as if they are a single system, and can continuously provide services even if a problem occurs on one of the connected computers by having another computer perform the activity.
- d) It is a system configuration in which a primary system and a secondary system are prepared as two (2) systems, and if a failure occurs in the primary system, processing is continued by the secondary system.

**Q 8-7****Blu-ray Discs are spreading as a next generation optical disc to replace DVDs. Which of the following is an appropriate characteristic of a Blu-ray Disc?**

- a) There is no maximum number of times a disc can be written to.
- b) A cartridge is required for playback.
- c) It has a storage capacity that is several times greater than a DVD.
- d) It can be played back in a DVD drive.

**Q 8-8****There is a system that is composed of the two (2) processors A and B. If both of the processors are not operating normally, then the system does not operate. If the availability of each processor is 0.8 and 0.9 respectively, what is the availability of the system? However, no factors other than the processors are considered.**

- a) 0.98
- b) 0.89
- c) 0.72
- d) 0.83

**Q 8-9**

There are three (3) files A, B, and C that store HR information for a company's planning department. These files are saved on a network, and the three (3) access rights of reference, update, and delete are configured for the staff of the planning department. If the file access rights of the department staff are as shown in the table, which is the staff member being able to update all three (3) files? The criteria for the access rights are as follows:

[Criteria]

- (1) Access rights are indicated with 0 and 1. 0 means prohibited and 1 means permitted.
- (2) Access rights are displayed in the order of reference, update, delete.
- (3) Access rights for individuals are prioritized over access rights for groups.
- (4) The structure of the staff members that belong to the groups is as below.  
Group 1 ... Staff member 1, 2      Group 2 ... Staff member 3, 4, 5

	Group 1	Group 2	Staff member 2	Staff member 4	Staff member 5
File A	111	000	100	110	110
File B	110	110	100	100	111
File C	110	110	000	111	100

- a) All staff members that belong to Group 1
- b) Staff member 1
- c) Staff member 3
- d) All staff members that belong to Group 2 except Staff member 4

**Q 8-10**

Which of the following is an appropriate explanation of MTBF and MTTR that show the reliability of a system?

- a) MTBF is the mean time between failures in a system, and the greater the MTBF value the more stable the system is.
- b) MTBF is the mean time between failures in a system, and the smaller the MTBF value the more stable the system is.
- c) MTTR is the mean time between failures in a system, and the greater the MTTR value the more stable the system is.
- d) MTTR is the mean time between failures in a system, and the smaller the MTTR value the more stable the system is.

**Q 8-11**

Which of the following is an appropriate explanation of fail-safe that is an approach to the construction of the high reliability system?

- a) Even if the usage differs from the original specifications, no fault occurs.
- b) When a fault occurs, the system is fixed in a stable status to limit the impact.
- c) Even if a fault occurs, all original functions are maintained and processing continues through duplexing of the system, etc.
- d) When a fault occurs, the system does not completely stop and it maintains the minimum level of functions.

# Chapter 9

# Technology Element

This chapter explains the characteristics of human interfaces, characteristics of multimedia technology, basic knowledge of database design and networks, security measures.

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### 9-1-1 Human Interface Technology

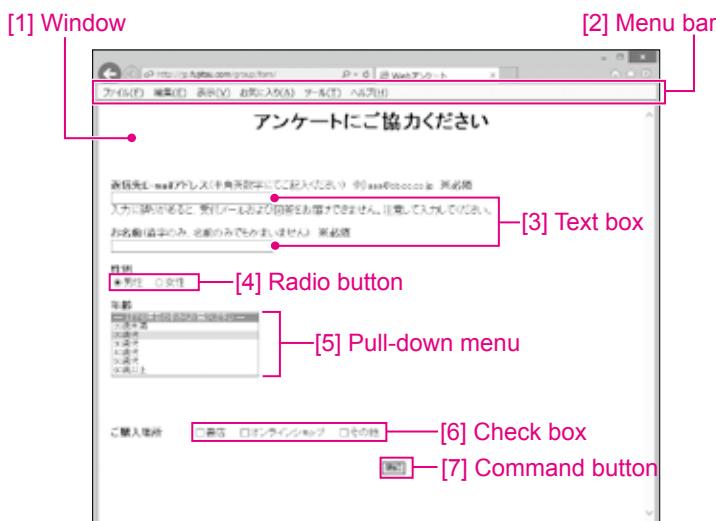
"Human interface" refers to the portion that serves as a contact point between humans and computers. To be concrete, it indicates the layout of screens and ledger sheets, and operation method of computers.

In the process of system architecture design of system development, it is important to develop a human interface that is easy to use from the standpoint of users, and it is necessary to acquire knowledge and learn the process of designing this.

#### 1 GUI (Graphical User Interface)

"GUI" refers to a human interface that extensively uses graphics and visually expresses information so that basic operations can be performed using mouse or other device.

GUI is made of the following elements.



#### Reference

##### Help function

"Help function" refers to the operation guide (help) where users can view the operation method of system etc. on the screen.

Element	Description
[1] Window	This is a work area for performing independent activity. This appears on the operation screen for each activity.
[2] Menu bar	Clicking this will show a list of commands. A command is selected from the list and instructions are given to the computer.
[3] Text box	A character or number is entered inside the box.
[4] Radio button	Only one applicable item is selected from multiple options.
[5] Pull-down menu	Clicking the down arrow ▼ will show the list. Only one applicable item is selected from the list.
[6] Check box	The applicable items are selected from multiple options. Multiple items can be selected.
[7] Command button	Clicking the button will execute the process set in the button.
List box	The applicable items are selected from the list. Multiple items can be selected.
Icon	File or directory (folder) is shown as a drawing pattern. This is used when selecting and loading a file.
Pop-up menu	Right clicking will show the list of commands according to the situation of current operation. This is called "Shortcut menu." A command is selected from the list and instructions are given to the computer.

**Reference****Thumbnail**

"Thumbnail" refers to a scaled down image that is used for displaying multiple images as a list. By displaying a list of thumbnails, it becomes easier to search the required images from many images. It is called a thumbnail because it is a small image like the nail of a thumb.

## 9-1-2 Interface Design

Interface design can be divided into "screen design" and "form design."

Screen design	Used for designing items and layout of the screen used when data is entered, and operation method of keyboard and mouse.
Form design	Used for designing the layout of input paper and input source document, contents exported to the printer, and the like.

Points to keep in mind in interface design are as follows:

- Clearly identify the purpose and items of data to be exported. Next, clearly define the input data required for exporting the above data.
- Prepare the format after specifying whether the user of the input screen and recipient of the form is an internal person or a customer.
- Select the appropriate human interface according to the familiarity level of the user.
- Select the device according to input/output contents.
- Shorten the response time and turnaround time, and ensure that the waiting time of a process does not become long.
- Clearly define the method of dealing with operation errors and system failure.
- Take measures so that the input data is not leaked externally.

**Reference****Source document**

"Source document" refers to the form where data to be fed to the computer is written beforehand. Required item names, frame, and the like are printed such that users can write easily.

## 1 Screen design

Input screen is one of the interfaces of the system that are most extensively used by the users.

An input screen that is easy to use from the user's standpoint should be designed.

Steps involved in designing the input screen are as follows:

### Reference

#### Default value

"Default value" refers to the value set in the item in advance. By entering data, the default value can be replaced with the entered value.

#### Standardization of screens

Standardize common items for screens, such as position of the screen title and allocation of keys.

#### Systematization of screens

Design hierarchical relation or flow between related screens. When screens are systematized, show it in the figures such as the "screen hierarchy figure" and "screen transition figure."

#### Definition of screen items and layout design

For the respective screen, decide position and default value of each item, input method, etc.

#### Example: Screen design of meeting room reservation system

##### Screen hierarchy figure

##### Main menu

##### Reserve for use

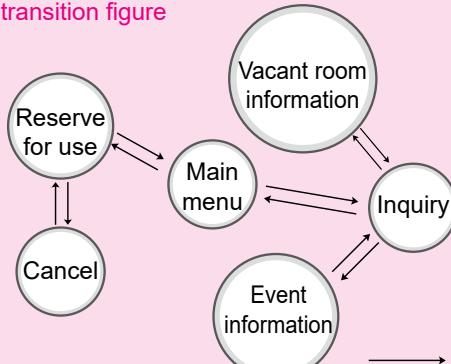
##### Cancel

##### Inquiry

##### Event information

##### Vacant room information

##### Screen transition figure



→ Shows that ... screen can transition

### ● Key points in screen design

Some of the key points in screen design are as follows:

- In order to ensure natural flow of input data, data is arranged so that it moves from left to right and from top to bottom.
- When the number of options is high, options are divided in groups for the ease of selection.
- Rules are defined for using colors.
- The operation guide (help) is displayed for users not familiar with operations.
- Input devices other than keyboard (for example, bar code, touch panel, and scanner) can also be used according to the purpose of use.

## 2 Form design

Forms used in day-to-day work should be designed such that they are easy to use for anyone.

Steps involved in designing forms are as follows:

Standardization of forms

Standardize common items for forms, such as position of the title and the number of lines in one page.



Layout design

Design the layout of each item.



Deciding printer and slip paper

When printing, decide printer and slip paper according to the purpose of use.

Some of the key points in form design are as follows:

- Place the items that are common across all forms at the same place.
- Remove any extra information and include only minimum required information.
- In numerical data, place comma after every three digits so that users can read it easily.
- Properly use tables, graphs, drawings, etc. in the layout according to the purpose.
- Keep in mind special output such as bar code according to the purpose.

### **Usability**

"Usability" refers to the ease of use felt by the users. It serves as an index of website design that is easy to use for users in terms of ease of operation and readability of the website.

## **3 Web design**

Companies are increasingly building their own websites for disseminating information over the Internet. These websites are viewed by many people and it would not be an exaggeration to say that the quality of web design affects the image of the company. Moreover, websites are also used for searching information about the company and receiving inquiries from the users.

In designing a website, it is important to keep web design in mind and build a website that anyone can easily understand.

Some of the key points of web design are as follows:

- Use a style sheet for unifying color tone and design.
- Minimize the use of images to ensure stress-free operability for the users.
- Do not include functions that can be only displayed with specific web browsers. Build such that it can be displayed with any web browser.

### **Accessibility**

"Accessibility" refers to the index for design to ensure that as many people as possible including elderly people and people with disability are able to access information and they are able to obtain information or services they require.

### **Information barrier free**

"Information barrier free" refers to remove barriers that would come in the way of operating and using information devices so that they can be used without any hurdles. Basically, it is believed that devices that are easy to use or screens that are easy to view for some of people having disabilities or characteristics are easy to use and easy to view for everyone.

## **4 Universal design**

"Universal design" is the concept of designing products, devices, facilities, and life space that everyone can use irrespective of their country, culture, gender, age, or any disability. For example, vending machines where the slot for fetching the product is in the center and elevators where you can exit from the door that is opposite to the entry door. It can be said that these designs offer ease of use to all people and not only the users of wheelchairs and people having big luggage.

Universal design in web design is called "**web accessibility**." It refers to all people being able to obtain equal information from the website irrespective of differences in their individual capabilities. In specific terms, font size can be increased, keeping elderly people in mind, and information is appropriately arranged in the sequence of reading by voice software, keeping blind people in mind.

# 9-2

# Multimedia

## 9-2-1 Multimedia Technology

“Multimedia” includes not only characters and numbers, but also various types of data such as still images, videos, and audio. This information is used in “web content,” “hypermedia,” “streaming,” and the like.

### 1 File formats for multimedia

Multimedia includes still images, videos, audio, and the like.

#### (1) Still image

Types and characteristics of still images are as follows:

File format	Extension	Characteristics
JPEG (Joint Photographic Experts Group)	.jpg .jpeg	It is a file format where still images are compressed and saved. It can handle 24-bit full color (16,770,000 colors) images. It is suitable for images having multiple types of colors such as photographs and it is used as the image format of digital cameras. Image quality declines because of lossy compression technology. Compression rate can be changed.
GIF (Graphics Interchange Format)	.gif	It is a file format where still images are compressed and saved. It can handle 8-bit color (256 colors) images. It is suitable for images with fewer types of colors such as graphics. Image quality does not decline because of lossless compression technology. Compression rate cannot be changed.
BMP (Bit Map)	.bmp	It is a file format where still images are stored as a collection of dots. File size becomes large in proportion to the size of image and the number of colors in it because the file is not compressed.
TIFF (Tagged Image File Format)	.tif .tiff	It is a file format for saving still images. It is developed by Microsoft and Aldus (Adobe Systems at present) and its key characteristic is that it can save image data of different formats. In the head part of image data, there is record type attribute information called tag. Images are displayed on the basis of this information. Therefore, images can be recorded irrespective of format such as resolution and number of colors. Moreover, you can also specify whether to compress the images or not. Image quality does not decline because of lossless compression technology.
PNG (Portable Network Graphics)	.png	It is a file format where still images are compressed and saved. It can handle 48-bit colors. Image quality does not decline because of lossless compression technology.

#### Reference

#### Web content

“Web content” refers to the collective term used for information and data such as still images, videos, audio, and characters appearing in a web browser.

#### Reference

#### Hypermedia

“Hypermedia” refers to the concept created by expanding hypertext intended for characters, and it is a form that allows diverse access after making a relation between objects such as characters, images, and audio.

#### Reference

#### Streaming

“Streaming” refers to the technology of efficiently distributing and playing web contents such as audio and video. It plays the contents while downloading data. Therefore, users need not wait until downloading is complete. Watching movies and listening songs from the Internet becomes easier.

#### Reference

#### PDF (Portable Document Format)

“PDF” refers to a file format that accurately shows the contents as created in the original application software irrespective of type and environment of the computer. Files can be displayed even if the application software used for creating the content is not available. Therefore, it is used for distributing contents.

## (2) Videos

Types and characteristics of videos are as follows:

File format	Extension	Characteristics
MPEG (Moving Picture Experts Group)	.mpg	<p>It is a file format where videos are compressed and saved. International standard of data format for color videos and audio. There are following three formats of MPEG.</p> <ul style="list-style-type: none"><li>• <b>MPEG-1</b></li><li>It is used for media such as CD (Video-CD) and hard disk where data transfer rate is about 1.5Mbps. Compression and decompression is done using software.</li><li>• <b>MPEG-2</b></li><li>It is used for DVD (DVD-Video) and digital satellite broadcast where data transfer rate is few Mbps to 10s of Mbps. Compression and expansion is done by using hardware. Image quality is like high-definition quality.</li><li>• <b>MPEG-4</b></li><li>It is used for portable communication (mobile phones etc.) and video conferencing system where data transfer rate is about few kbps to 10s of kbps.</li></ul>
AVI	.avi	<p>It is a composite file format of audio and video used as a standard in Windows. For playing AVI files, software programs such as "CODEC" are required according to the compression format of video and audio respectively.</p>

## (3) Audio

Types and characteristics of audio are as follows:

File format	Extension	Characteristics
MP3 (MPEG Audio Layer-3)	.mp3	<p>It is a file format in which audio data is compressed and saved by using the portion that suppresses audio of MPEG-1 used for compressing video. Data can be stored in about 1/10th of audio CD space (compression rate can be specified). Therefore, it is used in portable audio players and distributing songs over the Internet.</p>
MIDI (Musical Instrument Digital Interface)	.mid	<p>It is a file format used for saving musical score data of songs such as pitch of music, volume of music, and tone. It is used for rendition of data created with electronic musical instruments (synthesizer and audio source unit) on computers and for Karaoke on demand.</p>

## 2 Compression and decompression of information

“**Compression**” refers to the technology of reducing the amount of data in a file, while “**decompression**” is referred to reverting the compressed file to its original state. Data compression software is used when compressing and decompressing a file.

Data compression software can also “**archive**” apart from reducing the file size. Archive is the process of consolidating multiple files into one, and it helps in compressing large size files for increasing empty space and distributing multiple files after consolidating them into one.

Archiving the files simplifies the task of attaching them to an e-mail or publishing them on a website, thereby reducing the load on the network.

Data compression formats are as follows:

### ●Compression technology

Technology	Description
Lossless compression technology	It is a data compression technology where data can be fully recovered to the original form by extending the file after compression.
Lossy compression technology	It is a data compression technology where data cannot be fully recovered to the original form by extending the file after compression.

Formats of compressed files are as follows:

### ●Compressed file format

File format	Extension	Characteristics
LZH	.lzh	It is a file format compressed with compression software like "LHA." Data can be fully recovered because it is a lossless compression technology.
ZIP	.zip	It is a file format compressed with compression software like "WinZip." Data can be fully recovered because it is a lossless compression technology.

### Reference

#### Compression rate

“Compression rate” refers to the ratio to which data can be compressed. The higher the compression rate is, the smaller the file size will be.

## 9-2-2 Multimedia Application

Applications of multimedia technology and graphics processing are used in various fields.

### 1 Graphics processing

“Graphics processing” refers to displaying, processing, and saving the loaded images. For handling graphics processing, it is necessary to understand image quality, color, and the like.

#### (1) Representation of colors

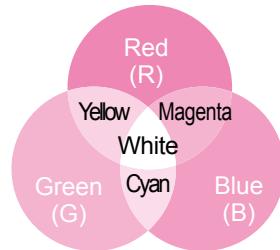
For showing colors on a display and for taking color printouts from a printer, color models such as “RGB” and “CMYK” are used.

##### ● Three primary colors of light (RGB)

For achieving color display, one dot is made of three shining points of R (Red), G (Green), and B (Blue).

Each color is represented with strength of each light of RGB. When making all lights of RGB shine, it will become white, and when none of lights of RGB are shining, it will become black.

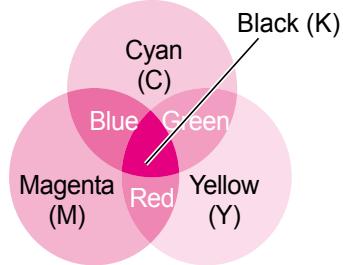
Three primary colors of light (RGB)



##### ● Three primary colors (CMYK)

When taking color printout with a printer, color is creating by mixing C (Cyan), M (Magenta), and Y (Yellow). When CMY are mixed, it will become black. For making bright black, CMYK ink is used where K (Black) is added.

Three primary colors (CMYK)



### ● Three elements of color

Color has three elements, namely “**hue**,” “**brightness**,” and “**saturation**.” By adjusting these three elements, you can come up with various ideas such as creating a sense of oneness of colors and using prominent colors as accents.

Element	Description
Hue	It refers to shades of color. It refers to tones such as red, yellow, and blue.
Brightness	It refers to brightness of colors. Color becomes closer to white as brightness increases, and it becomes closer to black as brightness decreases.
Saturation	It refers to vividness of colors. The higher the saturation is, the more it will become a vivid color closer to elementary color. The lower the saturation is, the more tranquil and somber will be the shades of color.

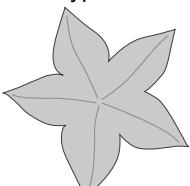
### (2) Image quality

Image quality is determined by the following elements.

Element	Description
Image (Pixel)	It refers to points that make up an image and it is the smallest unit of an image. The higher the pixel count, the greater the amount of information will be.
Resolution	It refers to a value that shows density of pixels, and it serves as a scale that shows fineness and slickness of images. Number of pixels per one inch is represented in the unit of "ppi (pixel per inch)." The higher the resolution is, the more natural and clearer the image will be. If the resolution is low, crinkles will appear on the image.
Tone (Contrast)	It refers to changes in contrasting density of color, or gradation in other words, and it serves as a scale that shows the fineness of images. The greater the contrast is, the smoother the image will be. The lower the contrast is, the clearer the definition of colors in the image will be.

### (3) Graphics software

Graphics software programs that handle images can be either “**paint type**” or “**draw type**.”

Type	Description
Paint type 	It is suitable for creating and processing “luster images.” Luster images refer to images that are formed by collection of small points. It is suitable for representing images (photographs, etc.) that have fine tone. In the case of luster images, image quality is deteriorated by enlarging and contracting the images. Therefore, crinkles may become prominent. Microsoft’s “Paint”, Adobe’ System’s “Photoshop”, etc.
Draw type 	It is suitable for creating and processing “vector images.” Vector images refer to the images made of multiple coordinates and lines connecting them, where images are formed by computing from the equations. They are suitable for showing images (illustrations, drawings, etc.) having lines and planes with clear contours. Sharpness of contour lines is maintained even if the vector images are enlarged or contracted. Therefore, image quality does not deteriorate. Adobe System’s “Illustrator”, etc.

## 2 Applications of multimedia technology

Graphics processing is one of the application technologies for representing multimedia. In graphics processing, you can use computers to create still images or videos and give an artificial sense of reality by adding audio effects and the like. It is used for entertainment purpose such as games and various forms of occupational training.

The main technologies are as follows:

Reference	Technology	Description
<b>3D (3 Dimension)</b> "3D" refers to three-dimensional computer expression.	CG (Computer Graphics)	<p>It is a technology for processing and creating still images and videos by using computers.</p> <p>Computer graphics have two-dimensional expression and three-dimensional expression.</p> <p>Two-dimensional expression is used in tablet-based painting or image processing after importing photographs.</p> <p>Three-dimensional expression is applied in expressing virtual worlds in games, etc., simulating future urban landscapes, and CAD-based industrial design.</p>
	VR (Virtual Reality)	<p>It is a technology of creating an artificial sense of reality (virtual reality) by combining computer graphics and sound effects.</p> <p>Imaginary reality can be created such as a far-off world, or past or future space, and actually experience it while remaining in the present time space.</p>
	AR (Augmented Reality)	<p>It is a technology of adding information created with computer graphics to the actual world.</p> <p>The actual world can be augmented in terms of superimposing and displaying maps processed using computers onto the actual landscape.</p>
	Computer simulation	<p>It refers to simulate a phenomenon using computers. By creating various artificial situations, outcomes can be produced that cannot be obtained with actual theory or experiments.</p> <p>For example, it is used in simulating disaster conditions before a fire breaks out in a building and weather forecasts based on the impact of global warming.</p> <p>The hardware and software used for computer simulation is called a "simulator."</p>
	Authoring	<p>It refers to create contents by integrating characters, still images, videos, audio, etc. Software used for authoring is called a "multimedia authoring tool."</p> <p>By using the authoring technology, you can create your own unique audio CD combining your favorite songs, and develop original videos by combining still images, audio, and the like.</p>
	CAD	<p>It is a system used in designing machines, architectural structures, electronic circuits, and the like.</p> <p>In addition to layout diagram and design diagram of architectural structures, design diagram of mechanical products such as automobiles and televisions, CAD is also used for creating the basic data of CG used in television commercials and video games.</p>

# 9-3 Database

## 9-3-1 Database Architecture

In database, different data (information) is summarized in the units having a certain purpose, and this data is stored in one place in a consolidated manner. For example, data is summarized in units such as product information and customer information, and it is stored in the database in a consolidated manner.

By using a database, business operations can be streamlined and represented from the standpoint of information.

### 1 Characteristics of database

“Database” is a set of data collected for a certain purpose.

Earlier, data used in business operations was saved in files for each program (process). In this approach, when creating a program according to the format of data, one problem was that programs could not flexibly handle the changes in data format. The concept of a database was developed in order to solve this problem.

A comparison between files used in the past and databases is as follows:

Comparison parameters	File	Database
Impact on program because of change in data format	Large	Small
Duplication of data	Data may be duplicated by each operation	No duplication
Consistency between related data	Difficult to maintain	Maintained
Sharing of data between operations	Difficult to share	Easy to share
Data backup	Complicated	Simple and easy

### 2 Database models

There are various models of database according to the form of managing data.

The typical models are as follows:

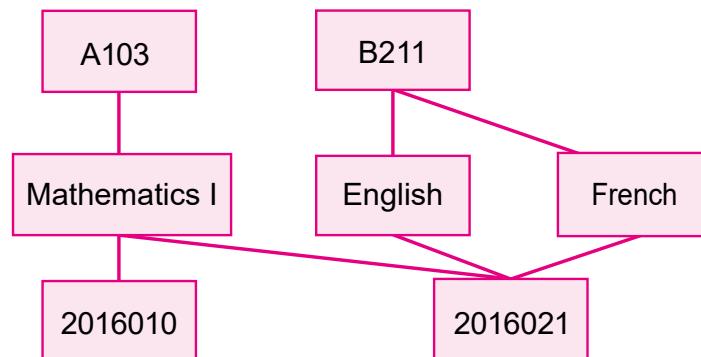
### ● Relational database

Data is managed in a table form. Multiple tables are formed in such a way that they are associated with the value of data items. Managing data in table form helps to create a database that is easy to understand for users and from which the required data is easy to fetch. A relational database is used as the basic form of E-R diagram.

Student_ID	Course_name	Course_name	Classroom
2016010	Mathematics I	Mathematics I	A103
2016021	English	English	B211
2016021	Mathematics I	French	B211
2016021	French		

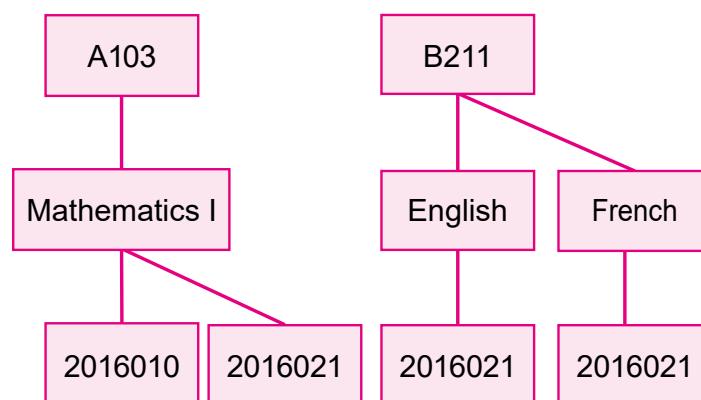
### ● Network database

Data is managed in such a way that data items are in a connected status like the mesh of a net. In a network database, there is many-to-many parentage relationship between data items.



### ● Tree (hierarchical) database

Data is managed in a hierarchical structure. In a tree database, there is one-to-many parentage relationship between data items.

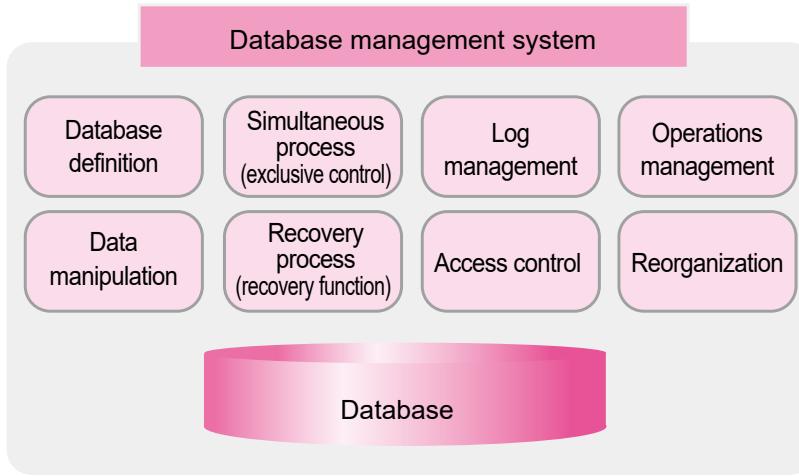


### ③ DBMS ( DataBase Management System)

For database management and utilization, a database product (software) called a “**database management system**” is used.

The role of the database management system is to structurally accumulate data and maintain consistency so that users can correctly use the database anytime.

The main functions of a database management system are as follows:



Function	Description
Database definition	This refers to defining database structure in terms of table, items, and index.
Data manipulation	This refers to unifying data manipulation (search, insert, update, delete) with respect to the database.
Simultaneous process (exclusive control)	This refers to maintaining data consistency of data so that contradiction in data does not occur even if multiple users simultaneously manipulate the database.
Recovery process (recovery function)	This refers to a process when a failure has occurred in hardware or software, data is recovered to the status just prior to the occurrence of failure.
Log management	This refers to saving and operating the log files required for the recovery process.
Access control	This refers to setting the authority to use the database for users so that users not having access rights cannot access data.
Operations management	This has various functions related to operations, such as database backup and restoration, database storage conditions, and status of use of buffer.
Reorganization	This refers to removing database fragmentation (fragmentation of the area used on the disk) that occurs due to repeated addition and deletion of data. Database reorganization (reallocation to successive areas) improves the speed of data manipulation.

#### Reference

##### Setting access rights

When setting access rights for the database, you can specify “which user” will be able to access “which data” under “what authority.” For example, setting access rights so that “Employee A” can have “Read only” access to “HR data.”

#### Reference

##### Buffer

“Buffer” refers to memory space for temporarily saving data.

## 9-3-2 Database Design

When designing a database, it is necessary to consider “**data analysis**,” “**data design**,” “**data normalization**,” and the like.

### ① Data analysis

Before creating a database, it is important to clearly define what kind of operations will be captured in the database and for what purpose it will be used. Print results matching with a purpose and the input items required to obtain the results should be decided, and the tables should be designed accordingly.

Clarifying purpose

Analyze the flow of operations, and clearly define the purpose of the database, such as sales management and inventory control. Clearly define the method of using the database and who will use this database.



Deciding the printing results and the input items

Decide the image of the required printing results in the end, and input items according to these results.



Designing tables

Design the tables on the basis of the input items you decided. Associate the tables with common items and reference the data as required. By dividing the tables after categorizing each input item, you can avoid duplicate data input and you can build a database that will efficiently use the disk space and where input errors are not likely to occur. For designing tables, perform data normalization.

The key points of table design are as follows:

- Erasing iterative data
- Ensuring that information can be registered only once
- Not saving the information obtained with calculation in a table

## ② Data design

Database uses “**tables**” to manage the data. The configuration of the database tables is as follows:

Customer_table				Column (Field)	Item name (Field name)
Customer_code	Customer_name	Telephone_number	Address		
A-1	South North Electric	03-3592-123X	Tokyo		
B-1	Japan Corp	06-6967-123X	Osaka		
A-20	Alpha Electronics	078-927-123X	Hyogo		

**Primary key**: Item for identifying a row from the table  
For example, when customer\_code is specified, the corresponding customer\_name can be specified

The “**relationships**” should be thought when managing multiple tables. Relationship means two tables are associated with a “**primary key**” and a “**foreign key**.”

Foreign key refers to the item used when searching data from a different table.

For example, in the case of the following two tables (order\_table, customer\_table), there is no customer\_name in order\_table. However, by associating these two tables with customer\_code, it is possible to reference the applicable customer\_name from customer\_table on the basis of the value of customer\_code in order\_table.

Here, customer\_code in customer\_table is called the primary key, and customer\_code in order\_table is called the foreign key.

When setting a foreign key, a “**referential constraint**” is used so that inconsistency does not occur while referencing. For example, in the column where a foreign key is set, you can only enter the values that are present in the column to be referenced (table of primary key).

Order_table	“Primary key” of Order_table	“Foreign key” with respect to Customer_table		
Order_number	Order_date	Customer_code	Product_name	Quantity
0001	10/2/2016	A-1	W type radio	30
0002	10/2/2016	B-1	X type monitor	20
0003	10/2/2016	B-1	Y type recorder	100
0004	10/3/2016	A-20	Z type recorder	5

Customer_table			
Customer_code	Customer_name	Telephone_number	Address
A-1	South North Electric	03-3592-123X	Tokyo
B-1	Japan Corp	06-6967-123X	Osaka
A-20	Alpha Electronics	078-927-123X	Hyogo

On the basis of Customer\_code, items from Customer\_table can be referenced.

“Primary key” of Customer\_table

When referential constraints are set with regard to Customer\_code (for example, B-1) in the Order\_table, you can delete the corresponding row in the Customer\_table or rewrite the Customer\_code itself. Moreover, a row having a Customer\_code that is not there in Customer\_table cannot be added to Order\_table.

### Reference

#### Database elements

A database has the following elements.

Name	Description
Primary key	It is an item set for distinguishing a particular row in the table from another row.
Foreign key	It is an item other than the primary key in a particular table is the primary key of another table.
Referential constraint	It is a constraint set for maintaining consistency between tables such that a value present in the foreign key is always present in the primary key that is referenced.
Index	It is a data index created for high-speed search of data. Creating the index makes the database search faster.

### Example

What is the problem that would occur if you were to set a primary key in the following customer table, and what is the solution to this problem?

**Customer\_table**

Customer_code	Company name	Dept	Staff_name	Telephone_number	Address
A-1	South North Electric	Sales Department 3	Tanaka	03-3592-123X	Tokyo
A-1	South North Electric	Sales Department 1	Sasaki	03-3592-123X	Tokyo
B-1	Japan Corp	Corporate Sales Department	Higashida	06-6967-123X	Osaka
B-2	East West Electric	Sales Department 1	Sasaki	06-6967-123X	Osaka
A-20	Alpha Electronics	Planning department	Mori	078-927-123X	Hyogo

The primary key is used to distinguish data in the table, and it is necessary to set it so that there is no duplication within the same field. In this customer\_table, there is data that is duplicated in each field. For example, concerning “South North Electric,” while data items are different with sales department 3 and sales department 1, only one customer\_code “A-1” is set. The primary key cannot be independently set in the fields where duplicate data exists. Therefore, use the following method to set the primary key in this table.

- [1] Set the primary key as a combination of two fields.
- [2] Set customer\_code once again such that there is no duplication.

In the case of [1], you may set the primary key as the following combination.

“Customer\_code” and “Department”, or “Company\_name” and “Department.” If “Staff\_name” is combined instead of “Department,” when there are staff members having the same name, data items will not be unique, so it is not appropriate.

In the case of [2], set “Customer\_code” once again after considering two fields of “Company\_name” and “Department” such that there is no duplication. In other words, if Department is different even if the company is same, customer\_code should be differentiated

### ③ Code design

Like Customer\_code, “Code” is generally used to associate multiple tables. It is necessary to design the code according to the purpose of use and the field of application, such that users can easily understand.

The methods of designing code are as follows:

Name	Description
Sequence code	This is a method of assigning consecutive numbers from the beginning.
Section code	This is a method of assigning numbers for each group after dividing into groups.
Digit code	This is a method of assigning some kind of meaning to digits of the code. For example, make a total 7-digit code where the first four digits from the beginning are years after joining the company and the next three digits are the employee number.
Mnemonic code	This is a method of assigning some kind of meaning by using character strings as code.
Synthetic code	This is a method of combining the above code design methods.

## 4 Data normalization

“Data normalization” refers to appropriately partitioning the tables so that data doesn’t duplicate.

Tables that are normalized are called “**normal form**”, and tables that are not normalized are called “**unnormalized form**.”

In the tables of unnormalized form, there is duplication of data. Therefore, contradiction or inconsistency of data can easily occur and it will become difficult to manage them correctly. In contrast, in the tables in normal form, there is no contradiction or duplication of data. Therefore, it is easy to manage them. As a result, the risk of occurrence of data inconsistency will reduce.

Following are the objectives of doing data normalization.

- Overlap or contradiction of data stored in the table is removed.
- Data is not overlapping. Therefore, the table can be used for various purposes.

### (1) Normal form and unnormalized form of tables

The following table has repetitive items. Therefore, it is in unnormalized form.

Course\_table

Student_ID	Name	Faculty_code	Faculty_name	Course_name	Classroom	Performance
2016010	Masashi Iuchi	S	Faculty of science	Mathematics I	A103	A
				English	B211	C
				Biology	B305	B
				English	B211	B
2016021	Yuki Nakahara	E	Faculty of economics	German	B105	B

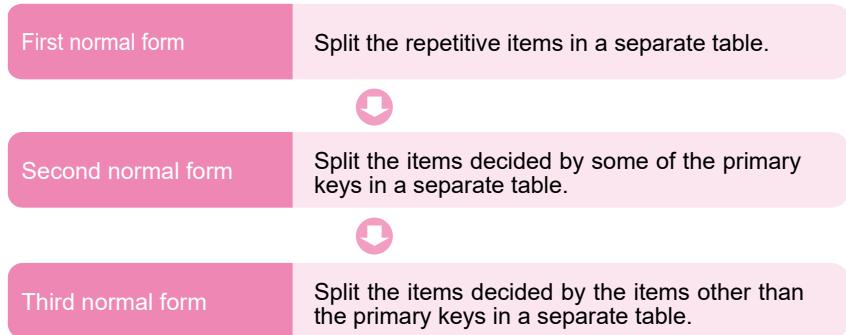
There are repetitive items.

Items “Name”, “Classroom”, and “Performance” in the Course\_table have multiple data items in one data item. Therefore, these items are called “**repetitive items**.” Tables having repetitive items are called tables in unnormalized form.

### (2) Procedure of normalization

Tables that are in unnormalized form and that contain repetitive items, normalization is performed in the sequence of “**first normal form**,” “**second normal form**,” “**third normal form**.” By performing normalization up to third normal form, you can create a table where there is no duplication of data.

The sequence of performance of normalization is as follows:



### Example

What will happen if the following table is normalized according to the steps given below?

Order_slip_table										
Order_number	Order_date	Customer_code	Customer_name	Address	Product_number	Product_name	Unit_price	Quantity	Order_subtotal	Order_total
0001	1/10/2016	A-1	South North Electric	Tokyo...	1-001	Television (LCD)	200,000	2	400,000	640,000
					2-004	DVD recorder	80,000	3	240,000	
0002	1/10/2016	B-1	Japan Corp	Osaka...	5-012	Radio	3,000	6	18,000	168,000
					1-002	TV	15,000	10	150,000	
0003	1/11/2016	A-20	Alpha Electronics	Hyogo...	1-001	Television (LCD)	200,000	3	600,000	600,000
0004	1/13/2016	B-1	Japan Corp	Osaka...	5-012	Radio	3,000	1	3,000	3,000

### Reference

#### Derived items

"Derived items" refers to the items derived by calculation from other items.

### ●First normal form

Delete the derived items "Order\_subtotal" and "Order\_total" from Order\_slip table, and partition the repetitive items "Product\_number", "Product\_name", "Unit\_price", and "Quantity" in a separate table.

Order\_slip\_table

Order_number	Order_date	Customer_code	Customer_name	Address	Product_number	Product_name	Unit_price	Quantity	Order_subtotal	Order_total
0001	1/10/2016	A-1	South North Electric	Tokyo...	1-001	Television (LCD)	200,000	2	400,000	640,000
					2-004	DVD recorder	80,000	3	240,000	
0002	1/10/2016	B-1	Japan Corp	Osaka...	5-012	Radio	3,000	6	18,000	168,000
					1-002	TV	15,000	10	150,000	
0003	1/11/2016	A-20	Alpha Electronics	Hyogo...	1-001	Television (LCD)	200,000	3	600,000	600,000
0004	1/13/2016	B-1	Japan Corp	Osaka...	5-012	Radio	3,000	1	3,000	3,000

Repetitive items

Derived items deleted

Order\_table

Order_number	Order_date	Customer_code	Customer_name	Address
0001	1/10/2016	A-1	South North Electric	Tokyo...
0002	1/10/2016	B-1	Japan Corp	Osaka...
0003	1/11/2016	A-20	Alpha Electronics	Hyogo...
0004	1/13/2016	B-1	Japan Corp	Osaka...

Associated by Order\_number

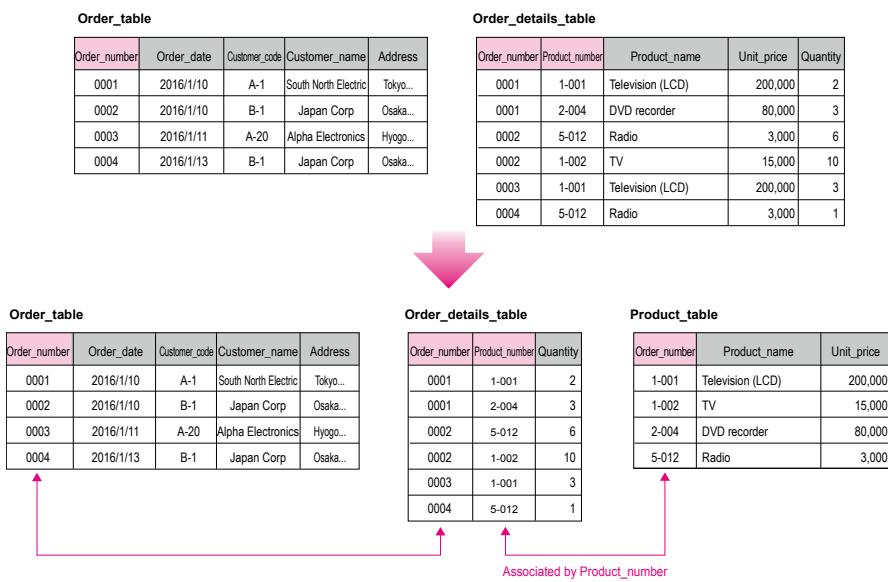
Order\_details\_table

Order_number	Product_number	Product_name	Unit price	Quantity
0001	1-001	Television (LCD)	200,000	2
0001	2-004	DVD recorder	80,000	3
0002	5-012	Radio	3,000	6
	1-002	TV	15,000	10
0003	1-001	Television (LCD)	200,000	3
0004	5-012	Radio	3,000	1

Associate Order\_table and Order\_details\_table with "Order\_number." "Order\_number" and "Product\_number" of Order\_details\_table become the primary keys.

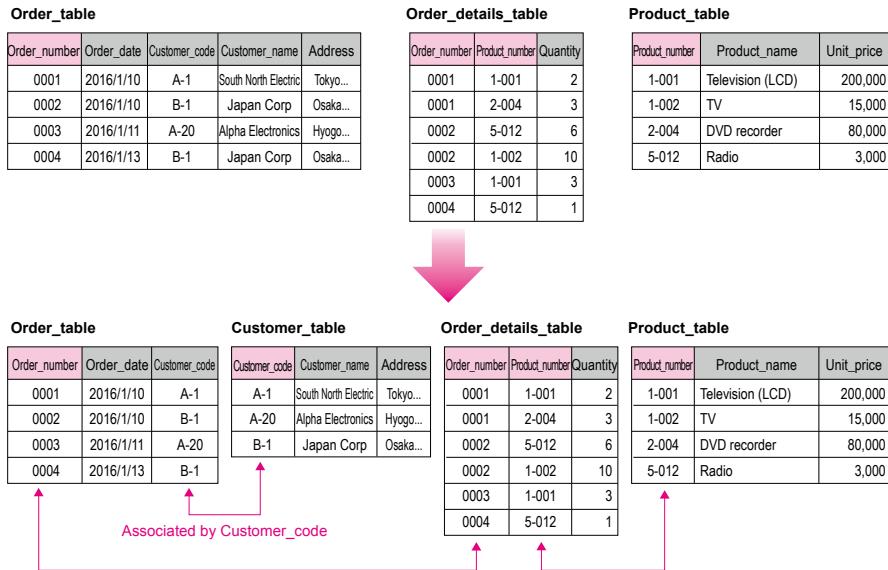
## ●Second normal form

“Product\_name” and “Unit\_price” are decided by primary key “Product\_number” of Order\_details\_table. Therefore, partition them in a separate table.



## ●Third normal form

“Customer\_name” and “Address” are determined by the item “Customer\_code” that is not a primary key in Order\_table. Therefore, partition them in a separate table.



### Example

Create sales slip as shown in the figure.

Sales slip					
Slip number:	Sale entry date:	Customer number:	Customer name:		
Product_number	Product_name	Category	Unit_price	Quantity	Amount
				Discount_rate	
				Total_amount	

When creating a sales slip from the following three tables, "Product\_number" shown in this sales slip would be the item of which table?

•**Product\_master\_table**

Product_number	Product_name	Category	Unit_price

•**Customer\_master\_table**

Customer_number	Customer_name	Discount_rate

•**Sales\_table**

Slip_number	Sale_entry_date	Customer_number	Product_number	Quantity

"**Product\_number**" is present in Product\_master table and Sales\_table. Therefore, these two tables are associated with "**Product\_number**." Association is performed through "**Primary key**" and "**Foreign key**." However, in this case, "**Product\_number**" in Product\_master table is the primary key, and "**Product\_number**" in Sales\_table is a foreign key with respect to Product\_master table. By using the foreign key, it will be possible to search data from the associated tables. Therefore, it is clear that "**Product\_number**" in this sales slip is "**Product\_number**" of Sales\_table.

## ■ 9-3-3 Data Manipulation

In a database management system, "**SQL**," which is a unified method of data manipulation, is used for defining tables and manipulating data in terms of data search, insertion, update, and deletion. A command called an SQL statement is used for dialogical search of data. SQL is standardized by ISO (International Organization for Standardization) and JIS (Japanese Industrial Standards). Therefore, it can handle data irrespective of the type of database management system.

Fetching the required data from a database is called an “**operation**.” Types of operations include “**relational operations**” and “**set operations**.”

## 1 Relational operation

“**Relational operation**” refers to the operations of fetching the target data from the table.

The following three types of relational operations are available.

Type	Description
Projection	This fetches the specified item from the table.
Selection	This fetches the specified row from the table.
Join	For two or more tables, this fetches the data after joining the tables where the value of a particular item is the same.

### Example of relational operation

**Select**

Customer_code	Customer_name	Staff_code
2051	Ono	A12
4293	Tanaka	B30
5018	Harada	A11

Customer_code	Customer_name	Staff_code
4293	Tanaka	B30

Fetch on Customer\_code “4293” row only

**Projection**

Customer_code
2051
4293
5018

Fetch on Customer\_code “Item” only

Customer_code	Customer_name	Staff_code
2051	Ono	A12
4293	Tanaka	B30
5018	Harada	A11

Staff_code	Staff_name
A12	Suzuki
A11	Yamada
B30	Saito
B60	Yoshida

**Join**

Join data having the same “Staff\_code” in the row direction  
In this case, “Staff\_code” is referred to as “Join key”

## 2 Set operation

“**Set operation**” refers to the operations of fetching data from two tables using the concept of setting.

The main set operations are as follows:

Type	Description
Sum	This fetches all data from two tables.
Product	This fetches common data from two tables.
Difference	This fetches data that is present in only one of two tables.

### Reference

#### Data manipulation

Types of data manipulation other than the three relational operations are as follows:

Type	Description
Insert	This inserts the specified record in the table.
Delete	This deletes the specified record from the table.
Update	This updates the specified record of the table.

### Reference

#### Wild card

By specifying conditions using a wild card, you can search a string that is partially the same. The following types of wild cards are available.

Type	Description
%	Any character string having zero or more characters
_	One random character

## Example of set operation

Purchase_table_A		
Customer_code	Customer_name	Staff_code
1311	Inoue	C01
2051	Ono	A12
4293	Tanaka	B30
1806	Mori	A11
7745	Yagi	D04

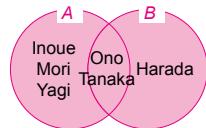
Purchase_table_B		
Customer_code	Customer_name	Staff_code
2051	Ono	A12
4293	Tanaka	B30
5018	Harada	A11

### Sum

Data that is there in either Purchase\_table\_A or Purchase\_table\_B

Customer_code	Customer_name	Staff_code
1311	Inoue	C01
2051	Ono	A12
4293	Tanaka	B30
1806	Mori	A11
7745	Yagi	D04
5018	Harada	A11

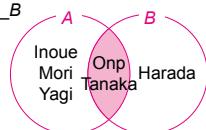
Row common in two tables can be consolidated into one row



### Product

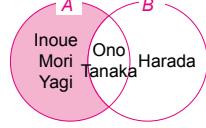
Data that is there in both Purchase\_table\_A and Purchase\_table\_B

Customer_code	Customer_name	Staff_code
2051	Ono	A12
4293	Tanaka	B30



### Difference

Data after subtracting data of Purchase\_table\_B from Purchase\_table\_A (Data that is there only in Purchase\_table\_A)



## 9-3-4 Transaction Processing

In database manipulation, in order to handle data referencing and updating by multiple users, it is necessary to maintain the consistency of a database through exclusive control and recovery functions.

### ① Exclusive control

“Exclusive control” is the function of temporarily restricting the writing of data for one of the users when multiple users want to update the same data at the same time. This is done in order to prevent any discrepancy in the database. The database is “locked” in order to restrict access. Consistency of data can be maintained by restricting access.

## (1) Lock

“Lock” is a mechanism where data updated and referenced by one user cannot be used by other users. Lock includes “**exclusive lock**” that locks both updating and referencing of data, and “**shared lock**” that locks only the updating of data.

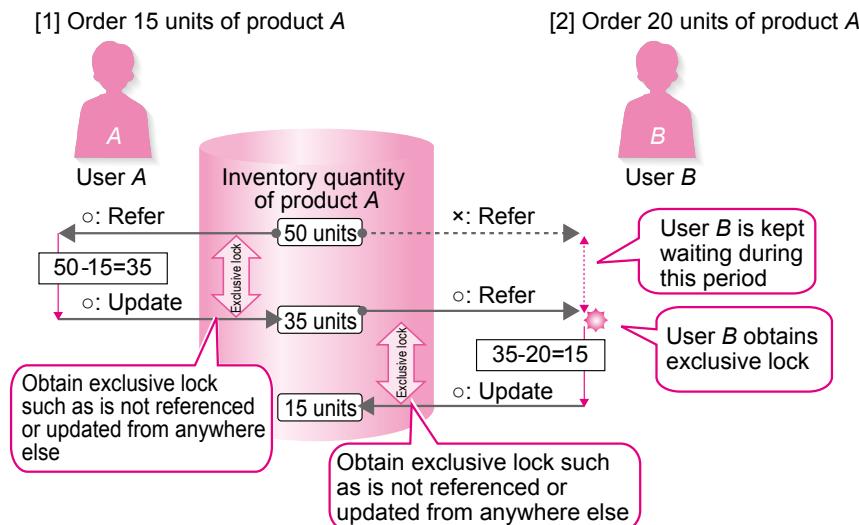
In general, when the update (including add/delete) process is run, the database management system automatically applies the exclusive lock. Moreover, when running the reference process, you can also specify whether or not to apply the shared lock in the program.

### Use of data from outside and lock status

	Exclusive lock	Shared lock
Update	×	×
Refer	×	○
Delete	×	×
Exclusive lock by other program	×	×
Shared lock by other program	×	○

#### Example

When there are 50 units of item A in inventory in a particular store, example of reducing the inventory quantity by two persons simultaneously ordering item A



## Online transaction processing

"Online transaction processing" refers to the process where a client connected to the network requests the server to run the process, and the server runs the process on the basis of this request and returns the processing results to the client. Normally, update (including add or delete) process of the database is frequently used. However, reliability is required for such process because consistency of the data cannot be ensured if the process is interrupted partway through.

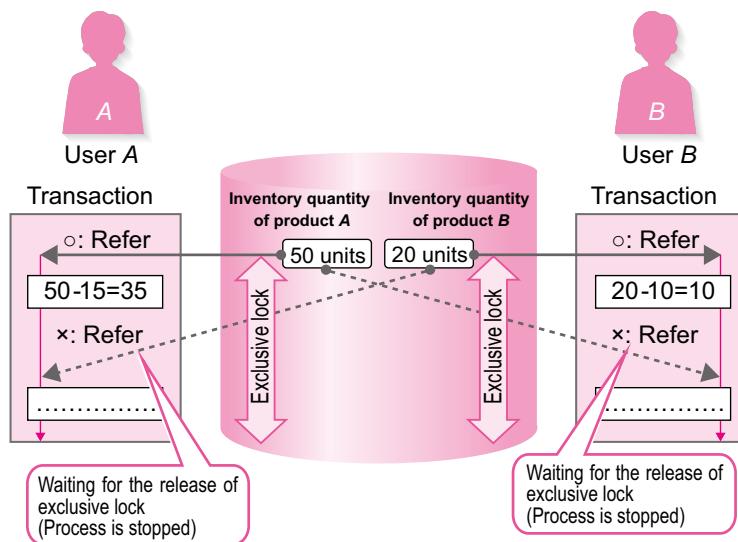
## (2) Transaction

"Transaction" refers to one complete and self-contained process unit. For example, the process of "**Ordering 15 units of product A**" would become a transaction.

The transaction will either be correctly and completely processed, or it will result in an error and it will not be processed at all. When the transaction has completed normally, the update will be reflected in the database. However, if the transaction has ended abnormally partway through, the update will not be reflected in the database. Consistency of database will be maintained through this mechanism.

## (3) Deadlock

"Deadlock" refers to the status where two transactions mutually get the data locked and the process stops while waiting for the release of both locks.

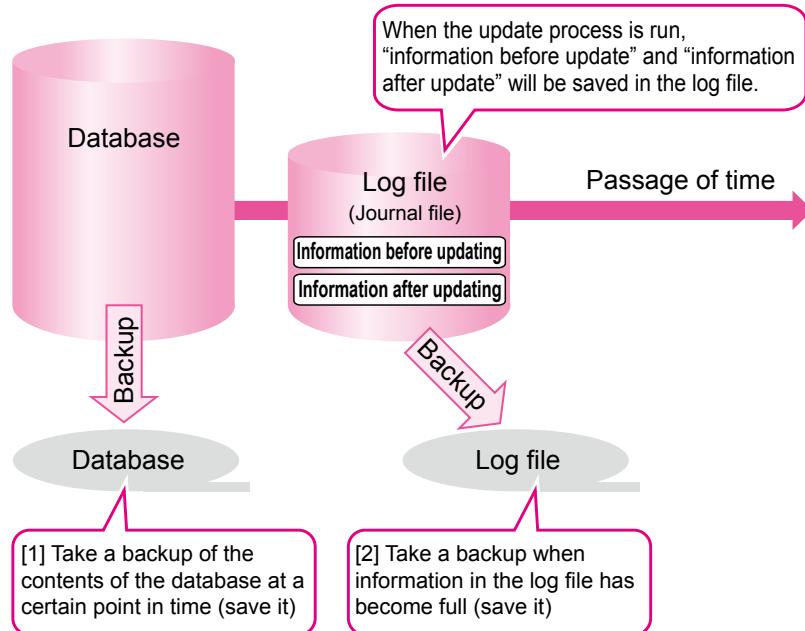


It is not possible to completely stop the occurrence of deadlock. However, it is possible to reduce the instances of its occurrence by limiting the scope of locking and by determining the sequence of data access.

## ② Backup in preparation for occurrence of failure

After running the update process on the database, the database management system will automatically write the updated information in the “**log file**.”

Periodic backup of database and log file is taken in preparation for hardware faults. By taking a backup, even if a hardware fault has occurred, it is possible to exchange the hardware media and recover the database up to the time of the backup log file.



## ③ Recovery process

“Recovery process” refers to the process of recovering the database up to the backup time point or the status just prior to the occurrence of failure in the event of occurrence of any hardware or software failure.

There are two types of recovery process.

Process	Description
Rollforward	When a hardware fault or the like has occurred, process remaining in the log file is regenerated using the backup database and the database is restored up to the status at the time of taking backup of the log file.
Rollback	When a transaction processing error has occurred, data is rolled back up to the time prior to the transaction process and the process is restarted.

### Reference

#### Log file

“Log file” refers to a file where the status of use on the computer is recorded. By loading the log file, it is possible to know who did what and when on the data residing in the server.

### 9-4-1 Network Architecture

“Network” is the form of using multiple computers after they have been connected with cables.

Compared with the stand-alone architecture where only one computer or laptop was used, a network can achieve the following things.

#### ● Sharing of resources

Software resources such as programs and data, and hardware resources such as storage units and printers can be shared. Moreover, sharing of data improves the efficiency of work and sharing of hardware helps in reducing costs.

#### ● Exchange of information

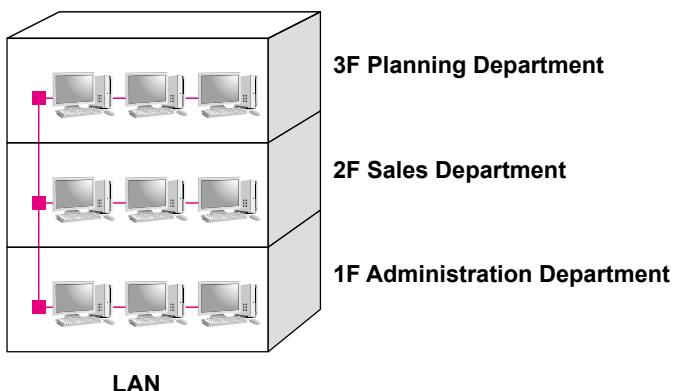
In addition to data, text and audio messages, multimedia information such as still images and videos can be exchanged. Even in remote locations, it can be used as a means of communication using various expressions.

### ① Forms of network

The following forms of network are available.

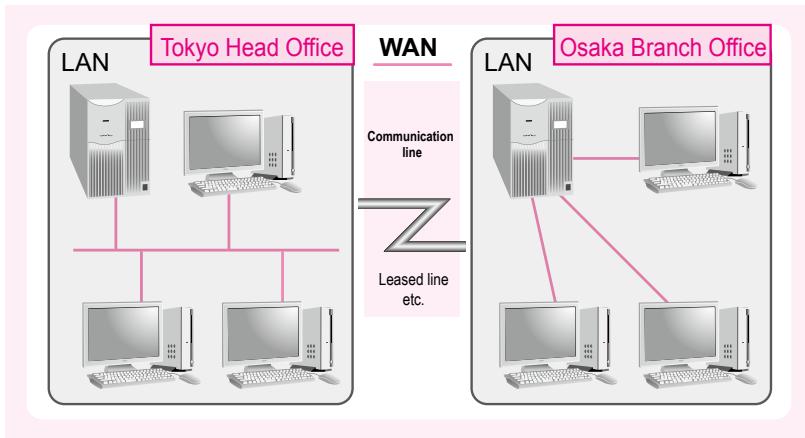
#### ● LAN (Local Area Network)

“LAN” refers to the network for exchanging information within a comparatively limited area such as within the same building or premises, within a factory, or within a school.



## ●WAN (Wide Area Network)

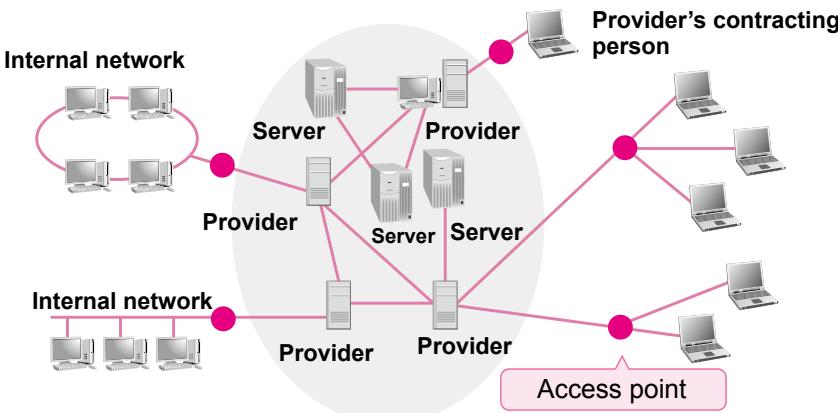
“WAN” refers to the network that connects LANs or computers in remote locations by using the communication services (network services) offered by telecommunications companies.



## ●Internet

“Internet” refers to the network where LANs and WANs within companies, stand-alone computers within each household, and the like are interconnected on a worldwide scale.

By using the Internet, users can freely view websites and exchange e-mails. Moreover, by creating their own website and publishing it, users can disseminate information all over the world.



### Reference

#### Access point

“Access point” refers to the connection point prepared by the provider for Internet users. Users and access points connect through a leased line, optical line, or ADSL line.

## 2 Constituent elements of network

For building a network, it is necessary to understand the constituent devices, standards, and the like of a network.

### (1) Constituent devices of a network

Types of LAN include "wired LAN" and "wireless LAN," and the hardware required for each of them is different.

#### ●Wired LAN

"Wired LAN" is the method of connecting computers and networks by using LAN cables.

Hardware required for building a wired LAN includes the following items.

Type	Description
LAN board	It is an extension board equipped with a "LAN port" for inserting LAN cable in order to connect a computer with LAN. It is also called a "LAN adapter" or "NIC (Network Interface Card)." It is necessary to have a LAN board that matches the standards of both LAN and computer. LAN boards are mostly built-in to the computer.
LAN cable	It is a cable used for connecting a computer with a network.
Hub	It is a concentrator that bundles into one the LAN cables coming out from individual computers. A hub has multiple ports, and only computers equal to the number of ports can be connected.

Reference

#### Segment

"Segment" refers to the unit constituting LAN. Usually, it refers to the range constituted with one cable.

Reference

#### PLC (Power Line Communications) adapter

"PLC adapter" refers to a device that can construct a LAN by using the electric cables within the room. It can be used by inserting into the power socket, and it superimposes or separates electric power and communication signals.

Reference

#### PoE (Power over Ethernet)

"PoE" refers to the technology for transmitting electric power through a LAN cable. Electric power can be supplied even when electric power supply from the power socket is difficult.

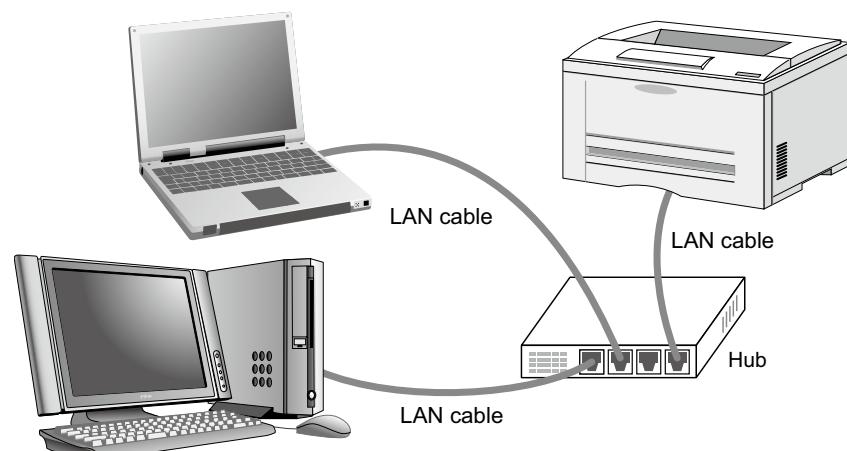
Reference

#### Modular jack

"Modular jack" refers to the connector used in telephone lines and twisted pair cables.

The types of LAN cable are as follows:

Type	Description
Twisted pair cable	It is a cable where two thin copper cables are twisted around each other and several sets of them are bundled. It is easy to handle because it is soft and thin. It is also called a "twisted pair cable." One type of twisted pair cable is the "cross cable" where input and output signal wires are crossed within the cable.
Optical fiber cable	It is a thin and light cable made of quartz glass and plastic, etc. Signals can be transmitted with hardly any degradation or attenuation of data, and it is not affected by electromagnetic waves. Instead of electric signals, it uses light for transmitting data. It supports a wide range of transmission speeds from 10 Mbps to 1,000 Mbps.

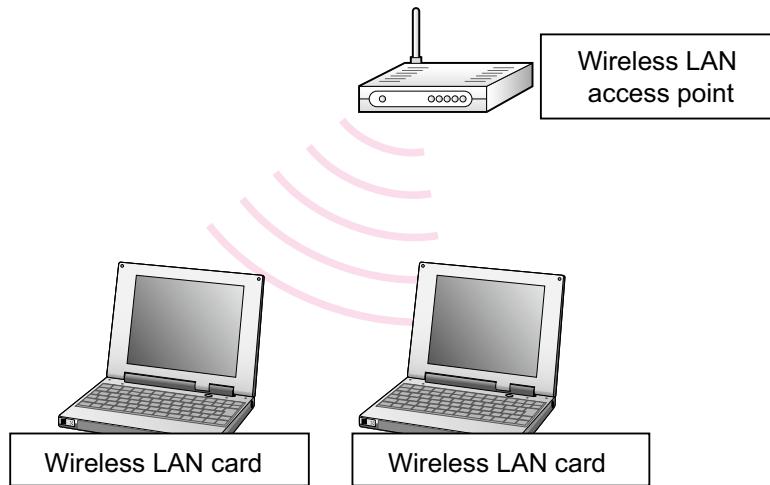


## ●Wireless LAN

“Wireless LAN” is the method of connecting computers and networks by using electromagnetic waves or infrared rays. It does not use LAN cables. Therefore, it is used in places where the office layout is frequently changed, where wiring is difficult to install, and where aesthetics are given importance.

Hardware required for building a wireless LAN includes the following items.

Type	Description
Wireless LAN card	It is an expansion card equipped with a communication function, and used for connecting to the network through a wireless LAN access point. There are products that directly communicate between wireless LAN cards without going through wireless LAN access points.
Wireless LAN Access point	It is a device that serves as a mediator in the exchange of data between wireless LAN cards. Obstacles can be ignored to some extent if within the communication area. Therefore, computers can be freely moved within the area.



## (2) Standards of LAN

There are various standards available for LAN, and these standards determine the cable, communication method, etc. used in the network.

“Ethernet” and “IEEE802.11” are the typical standards of LAN.

### Reference

#### Wireless channel

“Wireless channel” is the width of the frequency required for sending and receiving data. When there is another access point (connection point) nearby, if the same wireless channel is used, it may result in a decline in transmission speed because of radio-frequency interference. In this case, changing the wireless channel may improve the performance.

Reference

## Wide Area Ethernet

"Wide Area Ethernet" refers to a large-scale network. By using WAN, multiple LANs that are detached can be directly and mutually connected without using a router.

Reference

## Ethernet standards

The initial number shows transmission speed and the last alphabetic character shows the type of cable.

10BASE-T  
10Mbps Twisted pair cable

Reference

## Transmission speed

"Transmission speed" refers to the amount of data that can be transmitted within a certain time. It is also called "communication speed." The unit called "bps (bits per second)" to show the amount of data that can be sent in one second.

1bps → 1kbps → 1Mbps → 1Gbps  
x1000      x1000      x1000

Reference

## Transmission path

"Transmission path" refers to the path used for data communication. Amount of information that can be exchanged will differ depending on the width of transmission path.

Reference

## Wi-Fi

"Wi-Fi" refers to a wireless LAN standard. Wi-Fi spots are installed at various places, and computers and smartphones can connect to the Internet through these spots. Wi-Fi for household use has also become very popular.

Reference

## ESSID (Extended Service Set Identifier)

"ESSID" refers to the network identifier used in IEEE802.11 wireless LAN, and up to 32 alphanumeric characters can be specified. ESSID can also be used in networks where multiple access points are set. By using ESSID, network congestion can be avoided because communication takes place only with the computers having matching ESSID.

Reference

## Standards for mobile communication

Current popular communication standards for mobile phones and smartphones include "3rd generation mobile communication system (3G)", and "LTE" and "4th generation mobile communication system (4G)," which offer higher speeds than 3G.

## ●Ethernet

"Ethernet" is the most popular international standard of networks.

The following types of Ethernet are available.

Type	Description
Ethernet	Its transmission speed is 10Mbps, and it is mainly used for connecting computers within a company or a house. There are methods such as 10BASE-T, which uses twisted pair cables.
Fast Ethernet	It is a high-speed Ethernet standard having a high transmission speed of 100Mbps. There are methods such as 100BASE-TX, which uses twisted pair cables, and 100BASE-FX, which uses optical fiber cables.
Gigabit Ethernet	This is a high-speed Ethernet standard having a high transmission speed of 1Gbps (1,000Mbps). There are methods such as 1000BASE-T, which uses twisted pair cables, and 1000BASE-LX, which uses optical fiber cables.

## ●IEEE802.11

"IEEE802.11" is the international standard for constructing wireless LANs. There are several standards depending on the frequency used and the transmission speed. The main standards are as follows:

Standard	Frequency band used	Transmission speed	Characteristics
IEEE802.11a	5.2GHz	54Mbps	Transmission speed is fast. It uses high frequency, and therefore it may be affected by obstacles and the like. However, it is resilient against noise because this frequency is hardly used in other electronic devices.
IEEE802.11g	2.4GHz	54Mbps	Transmission speed is fast. It is compatible with 11b standard. It uses a low frequency, and therefore it is not easily affected by obstacles. However, this frequency is extensively used in electronic devices, and therefore the quality of communication is inferior to 11a.
IEEE802.11b		11Mbps	It can be obtained at a lower price than high-speed standards. It uses low frequency, and therefore it is not easily affected by obstacles. However, this frequency is extensively used in electronic devices, and therefore the quality of communication is inferior to 11a.

### (3) Relay devices

Various relay devices are used for expanding the network by connecting LANs or devices within a LAN, or by connecting a LAN and a WAN.

#### ● Relay devices used within a LAN

Following are the main relay devices used when you connect devices within a LAN.

Type	Description
Repeater	It is a device for amplifying electrical signals flowing in a cable in order to extend the transmission distance. The simplest hub is referred to as a "repeater hub."
Switching hub	It is a hub having the function of sending packets to only those LAN ports whose MAC addresses exist. Unlike repeater hubs, there are no restrictions on the number of intermediate hubs.

#### ● Relay devices between LANs, and between LAN and WAN

The main relay devices used for connecting LANs, and LAN and WAN, are as follows:

Type	Description
Bridge	It is a device that connects multiple LANs. It stores MAC addresses of LAN cards present in each computer, and it does not transmit unnecessary data to LANs that have nothing to do with communication. Therefore, it can help in reducing traffic (data flowing in the network).
Router	It is a device that connects multiple LANs or WANs. It has a function that decides the optimum route for data transmission (routing) and a function that transmits data only to specific computers (filtering).
Gateway	It is a device that connects LANs or WANs of different protocols after performing protocol conversion.

#### Reference

#### MAC address

"MAC address" refers to a 48-bit number assigned to a LAN port at the production stage. It is assigned for identifying each computer within the LAN.

#### Reference

#### Packet

"Packet" refers to the unit of data transfer where data is partitioned below a certain length. When sending data over the Internet, it is divided into multiple packets, and these packets are sent after attaching a header that specifies the recipient and the order of partitioning.

#### Reference

#### Multicast

"Multicast" refers to transmitting data after specifying multiple recipients within the network. In multicast, when data is transmitted after specifying multiple recipients, network devices such as routers automatically duplicate the packets.

#### Reference

#### Default gateway

"Default gateway" refers to devices such as computers and routers used for accessing computers located outside the network. It serves as an entrance/exit for allowing communication.

#### Reference

### MVNO (Mobile Virtual Network Operator)

“MVNO” refers to a communication services provider that leases wireless communication lines and networks such as mobile phones that are already installed, and offers services at low prices under its own brand.

#### Reference

### Tethering

“Tethering” refers to a function that uses mobile devices such as mobile phones and smartphones as access points for connecting computers, gaming machines, and the like to the Internet.

#### Reference

### SIM card

“SIM card” refers to the IC chip card installed in mobile devices such as smartphones and mobile phones. Telephone numbers can be identified with SIM cards. Therefore, installed SIM cards in mobile devices allow voice communication and data communication.

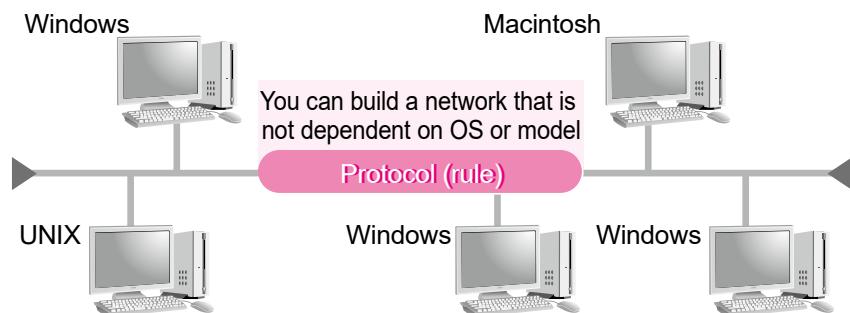
### Digital service unit

Some of the devices used for data communication by using communication services are as follows:

Types of line	Required devices	Description
FTTH	Media converter	It converts optical signals and electric signals.
ADSL	ADSL modem	It converts the analog signals and the digital signals of ADSL. Connection ports available for the computer include Ethernet and USB interfaces.
	Splitter	Splits the audio signals and the data signals in frequency bands.
CATV	Cable modem	It converts the band not used by cable television lines such that it can be used for data communication.
ISDN	DSU (Network Channel Terminating Equipment)	It converts digital signal format of the computer and digital signal format on the network. It connects to the terminal of the digital link.
	TA (Terminal Adapter)	It converts the digital signal and the analog signal of ISDN. Most of the terminal adapters have built-in DSU.
	Dial-up router	It is a router equipped with the functions of TA, DSU, and hub. It generally plays the role of simultaneously connecting multiple computers from the LAN to the Internet through the ISDN line.
Analog line	Modem	It converts digital signals and analog signals.

## 9-4-2 Communication Protocols

“Protocol” is a rule for performing data communication between computers on a network. When you exchange data between computers, it is necessary to mutually decide protocols beforehand.



## 1 Protocols that can be used on the Internet

The protocols that can be used on the Internet are as follows:

Protocol	Description
TCP/IP (Transmission Control Protocol/Internet Protocol)	It is a protocol for performing data communication on the Internet.
HTTP (HyperText Transfer Protocol)	It is a protocol for web browsers to exchange data on the Internet.
HTTPS (HTTP Security)	It is a protocol where SSL-based data encryption function is added to HTTP.
SSL (Secure Sockets Layer)	It is a protocol for protecting data by encrypting information on the Internet.
FTP (File Transfer Protocol)	It is a protocol for transferring files on the Internet.
NTP (Network Time Protocol)	It is a protocol for synchronization of time on a network.
DHCP (Dynamic Host Configuration Protocol)	It is a protocol that automatically assigns an IP address to a computer that temporarily connects to the Internet.
WPA2 (Wi-Fi Protected Access 2)	It is a protocol that encrypts the electromagnetic waves on a wireless LAN and also uses authentication function for protecting data.

### (1) TCP (Transmission Control Protocol)

“TCP” ensures reliable end-to-end communication. It has the following functions for playing this role.

- Data is split into packets, and then these packets are assembled.
- Packets are assigned a number (sequence number) that shows the order of splitting.
- Packets have a number (port number) for identifying the application software to which the data belongs.

#### Reference

##### End-to-end

“End-to-end” refers to computers that ultimately communicate.

The main port numbers are as follows:

Port number	Protocol
20, 21	FTP
25	SMTP
80	HTTP

**Octet**

“Octet” refers to a unit that shows 8 bits with a binary number.

**IPv4 (Internet Protocol version4)**

“IPv4” refers to a 32-bit Internet protocol that is used at present.

**IPv6 (Internet Protocol version6)**

“IPv6” refers to the Internet protocol developed by expanding the functionalities of IPv4.

In IPv6, the address space that can be managed is expanded from 32 bits to 128 bits. This solves the problem of shortfall of IP addresses that occurs because of the rapid growth of the Internet. In addition, it has other characteristics such as high speed routing, plug and play function, security function, multimedia support, and expandability and flexibility of functions.

**(2) IP (Internet Protocol)**

The main functions of the “IP” are “Addressing” and “Routing.”

**●Addressing**

A number called the “IP address” is used for distinguishing the computers connected to the network. The IP address is represented with a 32-bit binary number, and it consists of a “network address” that distinguishes multiple networks and a “host address” that distinguishes each computer within the network. However, because binary numbers are difficult to read, it is separated with a “.(dot)” after every 8 bit and each octet is represented with a decimal number.

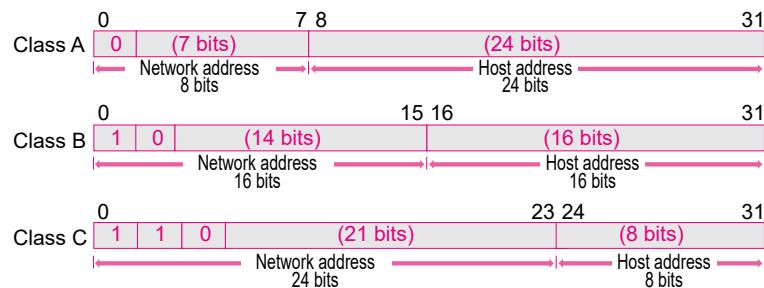
1st octet	2nd octet	3rd octet	4th octet
-----------	-----------	-----------	-----------

Binary notation	11000000 .	10101000 .	00000001 .	00011001
-----------------	------------	------------	------------	----------

Decimal notation	192 .	168 .	1 .	25
------------------	-------	-------	-----	----

**●Classes of IP address**

An IP address can be of class A, class B, or class C according to the scale of the network. Classes A through C have the following composition.



Address numbers that can be represented with network address and host numbers are as follows:

Class	Network scale	Number of network addresses	Number of host addresses
A	Large scale	$2^7 - 2 = 126$	$2^{24} - 2 = \text{About } 16,770,000$
B	Medium scale	$2^{14} - 2 = \text{About } 16,000$	$2^{16} - 2 = \text{About } 65,000$
C	Small scale	$2^{21} - 2 = \text{About } 2,090,000$	$2^8 - 2 = 254$

[Note] All “0s” and all “1s” in the host address are used for special purposes. Therefore, the number of addresses is  $2^n - 2$  (n is the number of bits). Concerning the network address, in RFC950-compliant networks, all “0s” and all “1s” are used for special purposes. Therefore, the number of addresses is  $2^n - 2$  (n is the number of bits). In RFC1812 compliant networks, all “0s” and all “1s” can be used as effective subnets. Therefore, it is not necessary to deduct 2.

## ●Global IP address and private IP address

“Global IP address” is an IP address that can be used on the Internet. IP addresses used on the Internet must be unique. Therefore, one cannot set IP addresses in an arbitrary manner. In Japan, IP addresses are managed by “JPNIC,” and allocation of IP addresses to Internet users is carried out by the vendors (providers, etc.) designated by JPNIC.

“Private IP address” refers to an IP address that can be freely set within a particular range of IP addresses even if a global IP address is not obtained. It is used in local networks such as networks within a company.

## ●Routing

“Router” is a device that connects multiple LANs and WANs, and transmits data between computers through the optimum transmission path.

“Routing” is one of the main functions of a router. Routing refers to transmitting data through the optimum transmission path so that the data reaches the recipient’s computer. Each router installed between computers determines the next router to be used for sending the data, and it relays the data. The next router is determined by searching the recipient’s IP address in the IP packet from the routing table available in the router.

Routing is also called “route control” or “route selection.”

### Reference

## NAT (Network Address Translation)

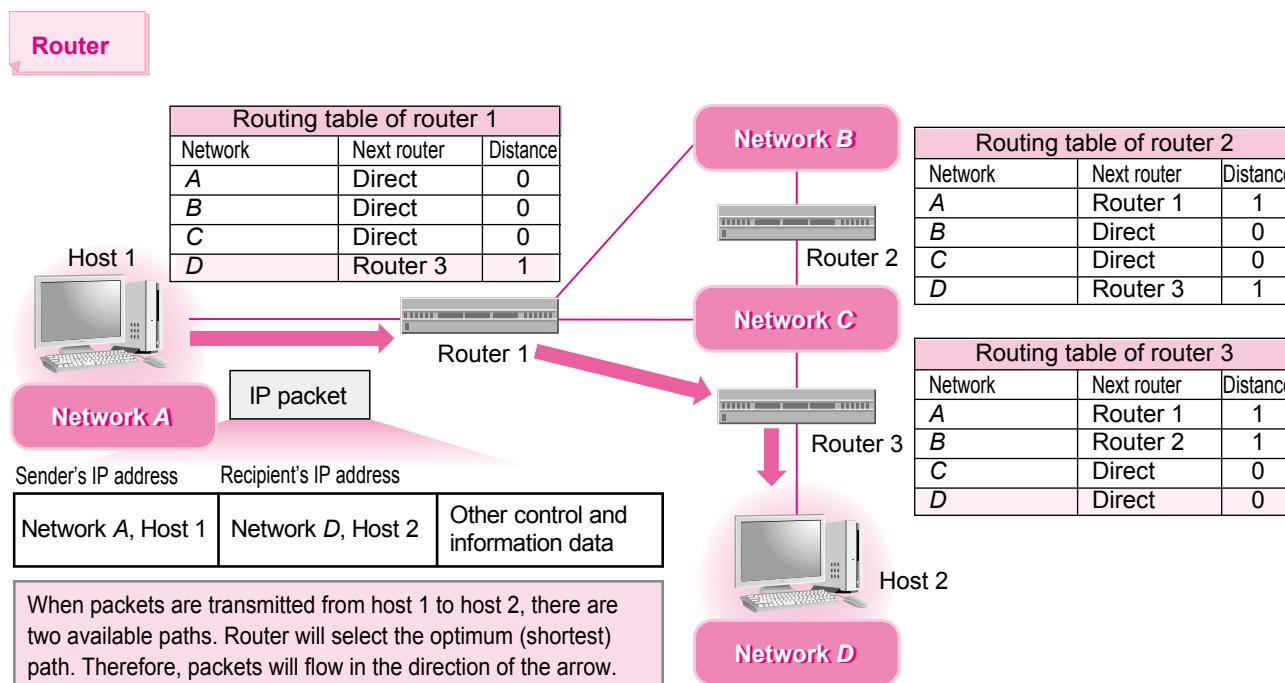
“NAT” refers to a technology that mutually converts between private IP addresses and global IP addresses.

### Reference

## Routing table

“Routing table” refers to the route information where recipients of the packets managed by the router are shown in the form of a list. In specific terms, it has a route table that links recipients of the packets received, and IP addresses of networks and routers passed through on the way, while it sends the packets to the recipient.

As for the method of creating and managing route tables, there is “static routing” where the router administrator manually sets a 1:1 correspondence table, and there is “dynamic routing” where routers interact and automatically set the correspondence.



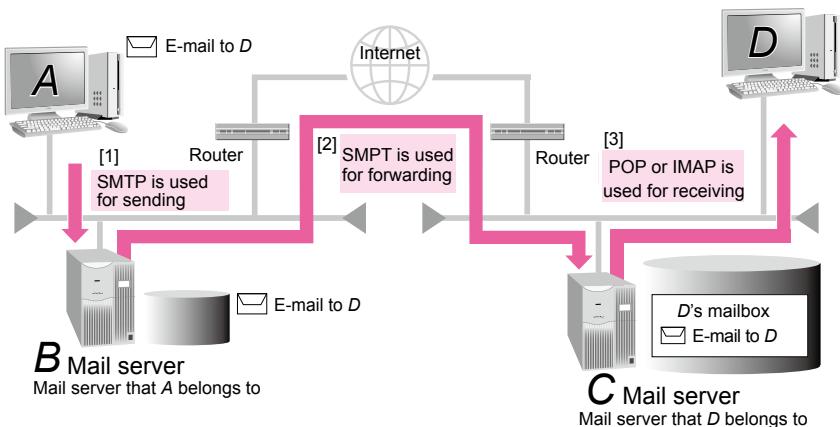
## 2 Protocols used in e-mails

The protocols used in e-mails are as follows:

Protocol	Description
SMTP (Simple Mail Transfer Protocol)	It is a protocol used for sending e-mails. It is used for sending e-mails between mail servers, or for sending e-mails from the mail client to the mail server.
POP (Post Office Protocol)	It is a protocol used for receiving e-mails. It receives all newly arrived e-mails for the user in one batch, where these e-mails are stored on the mail server.
IMAP (Internet Message Access Protocol)	It is a protocol used for receiving e-mails. E-mails can be stored on the mail server, and the status of e-mails, such as unread/read, can also be managed on the mail server.

### Example

Example of protocols used when you send an e-mail from A to D



### ● Other protocols used for e-mails

In addition, the following protocols are available for expanding data formats and adding security functions.

Protocol	Description
MIME (Multipurpose Internet Mail Extensions)	It is a protocol that expands data formats that can be sent and received on e-mails. Originally, only text format was available. However, now multimedia such as still images, videos, and audio data can also be sent and received as attachment files.
S/MIME (Secure/MIME)	It is a protocol developed by adding a security function (encryption function) to MIME. It can help in preventing tapping, spoofing, and falsification of e-mails.
APOP (Authenticated Post Office Protocol)	It is a protocol used for encrypting passwords. When you receive e-mails, the password sent to the provider can be encrypted.

## 9-4-3 Network Application

There are various services that are used on the Internet. In using these services, it is necessary to understand the mechanism of the Internet.

### ① The mechanism of the Internet

On the Internet, it is possible to mutually connect all computers in the world according to the protocols, and exchange information between the computers.

#### (1) DNS

“DNS” is the mechanism of the service that manages IP addresses and domain names after associating them in 1:1 relation. When computers communicate, an IP address is used to find the computer of the other party. However, the IP address is an enumeration of numbers and is not easy for humans to understand. Therefore, a domain name is used as a separate name.

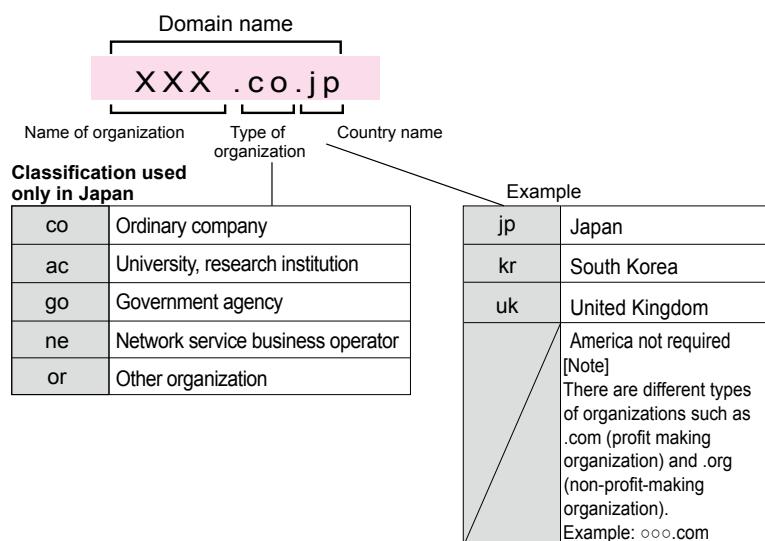
#### (2) Domain name

“Domain name” shows an IP address as a combination of characters that is easy for people to understand. Domain names are generally used for accessing servers on the Internet.

Starting from the right side, the domain name is divided into “**top level domain (TLD)**” and “**2nd level domain**” parts that are divided with a “.(period)”.

The further it is on the right side, the wider the indicated range.

Top level domain shows the country with two characters. The 2nd level domain is also called the “**organization domain**,” and it shows the type of association represented by this organization. In Japan, it is common to use the organization domain. However, the way of using the 3rd level domain and below differs according to the country. The left side of this is called the “**sub domain**.” When the WWW or organization used in the URL is large, characters that separate the group etc. are attached.



### Example

E-mail address

xx @ OOO.co.jp

User name Domain name

Shows Mr. XX who belongs to ooo.co.jp.

Moreover, new operating rules of JP domain where the tail of the domain name is ending with "jp" is called a "**general purpose JP domain**." In the earlier JP domain rule, a 2nd level domain ("co," "ne," etc.) showing the type of organization was the organization type defined by JPNIC. However, in the general purpose JP domain, the 2nd level domain was released for general users, which allowed for registration of association names and the like. In addition, each organization could register only one domain name. Characteristics of the new rule include obtaining as many domain names as one wants, using Japanese names in domain names, and transferring domain names.

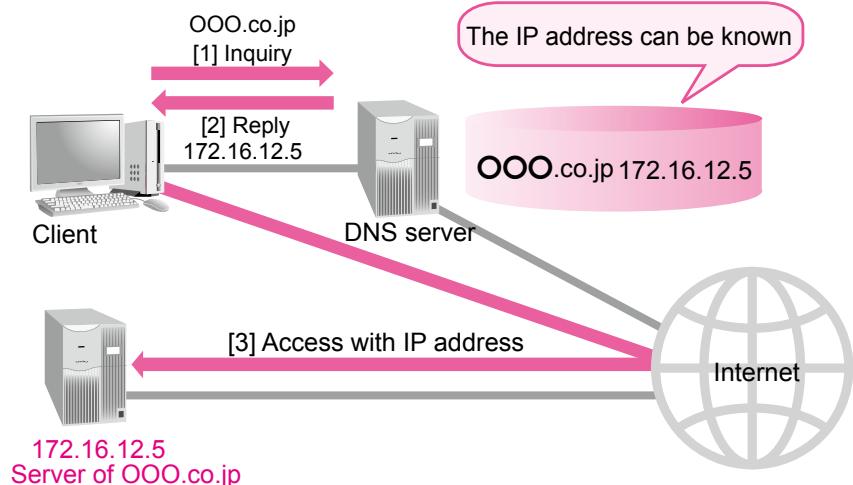
### (3) DNS server

"**DNS server**" refers to a server having DNS functions. DNS server offers the service that converts a domain name inquiry from the client into an IP address.

By using DNS server, users can view websites and send e-mails with the domain name without using the IP address.

### Example

Example when you access OOO.co.jp



## 2 Internet services

Various services are offered on the Internet.

The main services offered on the Internet are as follows:

### (1) WWW

“WWW” is the service for searching and viewing the “hypertext” information on the Internet. Hypertext is a file written in markup languages like HTML and XML.

In addition to text information (characters), still images, video, and audio can also be published and viewed. “HTTP” is the protocol used for communication in the WWW.

### (2) E-mail

“E-mail” is a service for exchanging messages. Users can instantly send and receive e-mails any time irrespective of where and how far away the other party is.

Moreover, the following services are also available in the e-mail service.

#### ●Broadcast mail

“Broadcast mail” refers to sending the same e-mail to multiple mail addresses. When you send a broadcast mail, the types of recipients are separately used as follows:

Recipient	Description
TO	The e-mail address of a regular recipient is specified here. You may also specify multiple e-mail addresses.
CC	Apart from regular recipients, you can specify e-mail addresses of recipients who you want to read the e-mail for their reference.
BCC	The e-mail address specified in BCC is not disclosed to any other person except the recipient. This is used when you do not want the recipients to know that you have sent the e-mail to other persons, or when multiple recipients of the e-mail do not know each other.

#### ●Mailing list

“Mailing list” refers to the mechanism that allows communication with multiple people using e-mail. By just sending e-mail to the pre-determined e-mail address, you can send e-mail to all persons registered in the list.

#### ●Mailbox

“Mailbox” is the virtual area where the e-mails you have received are temporarily stored. E-mails addressed to you will be delivered to your exclusive mailbox kept with the provider that you are using. As soon as you use the receive operation, e-mails will be downloaded from the mailbox on to your computer.

### (3) File transfer

This is a service for transferring files by downloading or uploading the files. “FTP” is the protocol used for transferring files.

#### Reference

#### anonymous FTP

“anonymous FTP” refers to the service of forwarding files to an unspecified large number of people. Usually, it is not necessary to register the required account when using FTP, and anyone can freely upload or download the files.

**Carrier**

"Carrier" refers to a vendor that offers lines for connecting to the Internet.

**Leased line service**

"Leased line service" refers to the communication service where there is always-on connection with the contracted and the designated connection point.

**VoIP (Voice over Internet Protocol)**

"VoIP" refers to a technology for sending and receiving audio on a network like the Internet. Audio data is split into units called packets, and such packets can be sent and received in real time.

**Broadband**

"Broadband" refers to the communication services such as ADSL and FTH that allow high-speed and large capacity communication. On the other hand, low-speed communication services offered by using analog lines (telephone lines) are called "Narrowband."

**Carrier aggregation**

"Carrier aggregation" is the technology that allows high-speed communication by simultaneously using multiple different frequencies for communication.

## ③ Communication services

Communication services of the Internet are offered by "**Internet Service Providers (ISP)**." These are also called "**Providers**." The Provider collects connection fees from the users and offers various Internet services in return.

### (1) Types of data communication services

The main data communication services are as follows:

#### ●FTTH

"**FTTH**" is a service where very high speed data communication is offered by using optical fiber from the telephone station to the user's residence. Data is exchanged by using fiber instead of electric signals. It is also called "**optical communication**."

#### ●ADSL

"**ADSL**" uses the bandwidth that is not used by telephone lines (analog lines) and is an asymmetric service that provides high speed data communication. It is also called an "**Asymmetric Digital Subscriber Line**." Asymmetric means communication speed is different for uploading (from computer to network) and downloading (from network to computer). Uploading speed is between 640 kbps to 1 Mbps, and downloading speed is 1.5 Mbps to 10 Mbps and above. This service is suitable when there is a greater downloading requirement, especially accessing websites on the Internet and downloading files from the Internet and other cases.

#### ●CATV

"**CATV**" is a high-speed data communication service offered by using the bandwidth that is not used by cable television lines for transmitting videos.

#### ●Mobile communication

"**Mobile communication**" is a service that uses a data communication card for exchanging data from mobile terminals such as laptop computers and mobile phones.

Because of wireless communication, data can be exchanged anywhere as long as it is within the area where electromagnetic waves can be sent and received.

#### ●IP telephone

"**IP telephone**" is a service where audio converted into digital data is exchanged by using the Internet. Equipment cost is less than that of conventional telephone lines. Therefore, usage fees are comparatively lower than conventional telephones. Moreover, there is no difference in charges depending on communication distance. Therefore, the cost of making long distance calls can be kept very low.

## (2) Billing method

“Billing” refers to applying charges for using the service. Depending on the method of billing, there are fixed amount systems, metered rate systems, and partial metered rate systems.

Billing method	Fee structure
Fixed amount system	This system charges a fixed usage fee irrespective of the number of hours for which the service is used. For example, “10 dollars per month.”
Metered rate system	This system charges according to the number of hours of use. For example, “0.1 dollars per 3 minutes.”
Partial metered rate system	This system includes usage fee in the basic fee for certain hours. For excess usage, an additional fee is charged as per the metered rate system for the excess part.
Cap system	This system decides the upper limit of the fee. For example, “0.1 dollars per 3 minutes up to 1 hour. After that, monthly 10 dollars irrespective of usage.”

### ●Calculating transmission time and communication fee

“Transmission time” is the time required for transmitting data. A calculation expression such as the one given below is used for determining transmission time and transmission time communication fee.

#### Expression for determining transmission time

$$\text{Data to be transmitted} \div (\text{Transmission speed of the line} \times \text{Transmission efficiency})$$

#### Example

Approximately how many seconds would be required for sending data under the following conditions?

Transmission data : 2,000 dots × 1,500 dots, 16,770,000 colors,  
JPEG image data compressed to the ratio of 10:1

Line speed : 100Mbps optical line  
Transmission efficiency : 60%

#### [Calculating transmission data volume]

16,770,000 colors are 24-bit colors. Therefore, transmission data volume will be as follows:

$$2,000 \text{ dots} \times 1,500 \text{ dots} \times 24 \text{ bits} \times \frac{1}{10} = 7,200,000 \text{ bits}$$

#### [Calculating transmission time]

100Mbps=100,000,000bps. Therefore, transmission time will become as follows:

$$7,200,000 \text{ bits} \div (100,000,000 \text{ bits/second} \times 0.6) = 0.12 \text{ seconds}$$

#### Reference

### Packet communication

Method of communication where data to be sent and received is split into smaller chunks of constant size. By splitting data into smaller chunks, multiple people can share one line. Therefore, communication lines can be effectively used and it also addresses the problem of line disconnection. Therefore, this method of communication is widely used. Communication volume is calculated on the basis of “packet size × number of packets actually sent and received.”

#### Reference

### Transmission efficiency

“Transmission efficiency” refers to the proportion of actual data in all transmission data. Usually it is between 60% and 80% because there are control characters.

### Example

When a cell phone is used for downloading a file from the Internet under the conditions below, how much will it cost? Here, ignore the time required for file selection, and connecting and disconnecting to the line. Also, the Internet connection service provided by the cell phone company can be used with no additional charge other than the cell phone charge.

Cell phone charge : 0.3 dollars for every 30 seconds

Transmission speed : 9,600 bits / second

Actual communication speed : 80% of communication speed

File to be downloaded : 1.2Mbytes [Note] 1 byte = 8 bits

File size

[Calculating transmission time]

1.2M bytes = 9,600,000 bits. Therefore, transmission time will become as follows:

$$9,600,000 \text{ bits} \div (9,600 \text{ bits/second} \times 0.8) = 1,250 \text{ seconds}$$

[Calculating telephone charges]

30 Yen is charged for every 30 seconds. Therefore, telephone charges will become as follows:

$$1,250 \text{ seconds} \div 30 \text{ seconds} = 41.666\cdots \rightarrow 30 \text{ seconds used for 42 times}$$

$$42 \times 0.3 \text{ dollars} = 12.6 \text{ dollars}$$

# 9-5 Security

## 9-5-1 Information Assets and Information Security

Companies handle various information such as personal information and confidential information, and such information is shared by using computers.

Such “**Information**” is a very important “**Asset**” irrespective of whether it is a company, an association, or an educational institution. It is necessary to strictly manage these information assets.

### ① Purpose of information security

With the introduction of computers and the increasing spread of the Internet, use of IT-based information is rapidly increasing.

When information such as client information, that should be only used by the company, is also used by another organization after it has been leaked, the competitiveness of the company will decline, and ultimately it may result in a crisis that threatens the existence of the company.

Moreover, it is necessary to protect personal information, such as customer information from the standpoint of privacy. Leakage of such information will certainly result in decline of the organization’s reliability.

Therefore, it is necessary to take appropriate information security measures for various threats and safely keep the information assets.

### ② Information assets

“**Information assets**” are assets that are worth protecting, such as data, software, computers, and network devices.

The main information assets are as follows:

Type	Description
Customer information	It is an information of customers (companies, individuals, etc.), with whom business is conducted. Information such as address, name, and telephone number may be used by another person. Such information is subject to protection under the Japanese Act on the Protection of Personal Information, and therefore it is necessary to appropriately manage this information.
Sales information	It is an information useful for sales activities, for example, marketing, sales revenue analysis, product development technology, and sales methods.
Intellectual property-related information	It is an information protected with copyrights and industrial property rights.
HR information	It is a personal information of employees. Information such as age, family details, salary, job designation, and performance may be used by another person.

#### Reference

##### Tangible assets

Information assets such as computers, peripheral devices, and forms that are printed.

#### Reference

##### Intangible assets

Information assets such as system and data.

### ③ Threats and vulnerabilities

These days, many companies use information systems and the Internet. While this offers the advantage that anyone can quickly and easily access the information, there are many case examples of virus infection and unauthorized access to information systems. For protecting information assets from vulnerabilities arising from these reasons and for safely using them, it is important to understand various risks surrounding the information assets and take appropriate measures.

#### (1) Types and characteristics of human threats

Human threats include loss, wrong transmission, etc. of information and “**social engineering**,” which means obtaining important information through physical and human modus operandi and then misusing such information. Caution is required because anyone can easily misuse the information by exploiting psychological weaknesses of human beings even without any technical knowledge.

The main examples of human threats are as follows:

Type	Description
Leakage	It is an act of leaking information assets to the outside. Copying information from recorded media and taking out such media, taking out information from systems, verbally communicating information, etc.
Loss	It is an act of losing information assets. Forgetting information assets on a train, completely deleting from systems, etc.
Damage	It is a threat that damaged information assets that cannot be recovered to the original state. Destroying documents in a shredder, files getting corrupted, etc.
Covert glance	It is an act of taking a covert glance at information assets. Looking at the keyboard when password is being entered, looking at the computer's display over shoulders, taking a covert glance at documents, etc.
Spoofing	It is an act of intruding by impersonating as a genuine user. Unauthorized access to the system by using other person's user ID and password, intruding into the building by using other person's ID card, etc.
One-click billing fraud	It is a fraud where the users are asked to pay charges such as membership fees or usage fees when they have only clicked an image or a character on the screen. In most cases, terms of use and explanation of charges is written in very small characters, or such explanation is provided on a different page. Such web pages are developed assuming that users would not read them.
Operational error	It is an error that put information assets at risk because of incorrect operation methods that are not normally used. Operational errors, error in data entry, error in locking, monitoring error, etc.
Targeted attack	It is an attack on specific users of a company or an organization. Making a specific user trust by pretending to be a related party, and then obtaining confidential information or sending virus infected e-mails.
Cracking	It is an act of intruding the systems in an authorized manner and committing illegal acts such as destroying or falsifying the information. Moreover, a person committing such acts is called "cracker."

#### Reference

##### Internal fraud

In recent years, incidents of information theft because of fraudulent behavior have been increasing within organizations. There are even cases where the foundation of the company is shaken in terms of paying compensation for damage or loss of credibility because of leakage of customer information or business secrets.

For companies and organizations that handle important information, it has become necessary to conduct inspection or look into the measures necessary for preventing fraud by internal people.

## (2) Types and characteristics of technical threats

Technical threats include shutting down the services by putting excess load on the servers that can be accessed from outside such as web servers and mail servers, and making attacks such as infecting with a computer virus.

The main examples of technical threats are as follows:

Type	Description
Computer virus	It is a program that secretly infiltrates into the computer without the user knowing about it, where such program would destabilize the operation and corrupt the files. "Macro virus" is a computer virus that misuses the macro function that automates the process with word processing software or spreadsheet software.
Gumblar	It is an attack that falsifies the website of an organization. System is affected with computer virus by just viewing the falsified website.
Spyware	It is a common name of software programs that send personal information to the Internet from inside the computer. In most of the cases, users do not realize that spyware is installed in their computer. Therefore, it causes serious damage.
Ransomware	It is a program that arbitrarily encrypts data and applies access restrictions so that computer can no longer be used normally. Such program would then demand money for restoring the original status.
Worm	It is a program that continuously self-propagates in the computers connected to the network.
Trojan horse	It is a program that makes the users believe that it is a useful program so that users run the program.
Phishing fraud	It is an act of sending e-mails by pretending as an actual company or an organization, and gaining unauthorized access to financial information (credit card number, user ID, password) of the individuals receiving these e-mails.
Key logger	It is a program that records the details entered from the keyboard with the objective of stealing user ID and password.
Password crack	It is an act of finding out the password with the objective of gaining unauthorized access to the computer. There is "dictionary attack" that uses the files (dictionary files) containing a large number of candidates of user names and passwords, and that conducts analysis with the combinations of user names and passwords, and there is the "brute force attack" that conducts analysis by using the combinations of characters randomly generated by the program.
Password list-based attack	It is an attack that uses the combinations of users IDs and passwords identifying from a particular system, and that attempts to log on to a different system.
Cross-site scripting	It refers to embedding a malevolent code into a website by using a security hole in the software, or it refers to a security hole that is misused for such acts. When a web site containing such malevolent code is accessed, and when information is entered on such a bulletin board or web form, personal information is stolen or files residing on the computer are destroyed.
IP spoofing	It is an attack where a packet having a false IP address is sent in order to cover up the source of attack. For example, the sender (attacker) would send a packet spoofing as an IP address of the recipient's network, and thereby intruding into the recipient's network.

### Reference

#### Malware

"Malware" refers to a collective term for malicious software programs as typified by computer viruses.

### Reference

#### BOT

"BOT" refers to a new type of computer virus created with the purpose of misusing computers. Once infected, the computer will be manipulated, and undesirable acts such as mail bomb and DOS attacks will be performed. This name was given because a third party would manipulate the infected computer like a "robot."

### Reference

#### Stealth virus

"Stealth virus" refers to a computer virus that would hide itself and make it difficult to detect the infection.

### Reference

#### Back door

"Back door" refers to a backdoor-like access path embedded by an intruder of the computer in order to intrude by using this path, which is not a regular access path. By creating this backdoor, the intruder would intrude into the computer many times such that the administrator of the computer would not realize this.

### Reference

#### File exchange software

"File exchange software" refers to a software program that would allow exchanging files between computers on a network. Sharing a file on the computer where file exchange software is installed would allow this file to be downloaded on another computer. Therefore, using it without discretion would result in a serious information leakage.

Type	Description
SQL injection	When you use a database on a website, SQL may be used in the program. "SQL injection" is an attack where an unexpected syntax is entered and SQL is run, thereby getting unauthorized access to the information by making the program malfunction. Alternatively, it refers to the vulnerability of the program because of which such attack happens.
DoS (Denial of Service) attack	It is an attack that overloads the server, and thereby stops its function. Generally, a large amount of packets is sent such that the server cannot process them. Moreover, a concurrent DoS (Denial of Service) attack on one server from multiple computers is called a "DDoS attack."
Port scan	It refers to accessing the ports of a computer in sequence in order to find a "security hole (software defect or error)."
Zero-day attack	Once a security hole of software is found, the OS manufacturer or developer would distribute a program that would repair the security hole. "Zero-day attack" is an attack made by misusing the security hole during the period from the detection of this security hole until the distribution of the reconditioning program.
Watering hole attack	It is an attack that sets a trap where a malicious program is embedded in a website that the user subject to attack frequently accesses so that the user's device is infected with a virus by just accessing this website.
Buffer overflow attack	It is an attack that sends a large amount of data that exceeds the memory capacity (buffer) reserved by the programs running on a computer so that the buffer overflows, and then runs an unauthorized process intended by the cracker.
Spam mail	It refers to sending a large amount of advertisement e-mails in an indiscriminate manner on the basis of e-mail addresses collected on the Internet.
Mail bomb	It refers to sending a large amount of e-mails to the mail server so that the mail server is overloaded and it stops functioning.

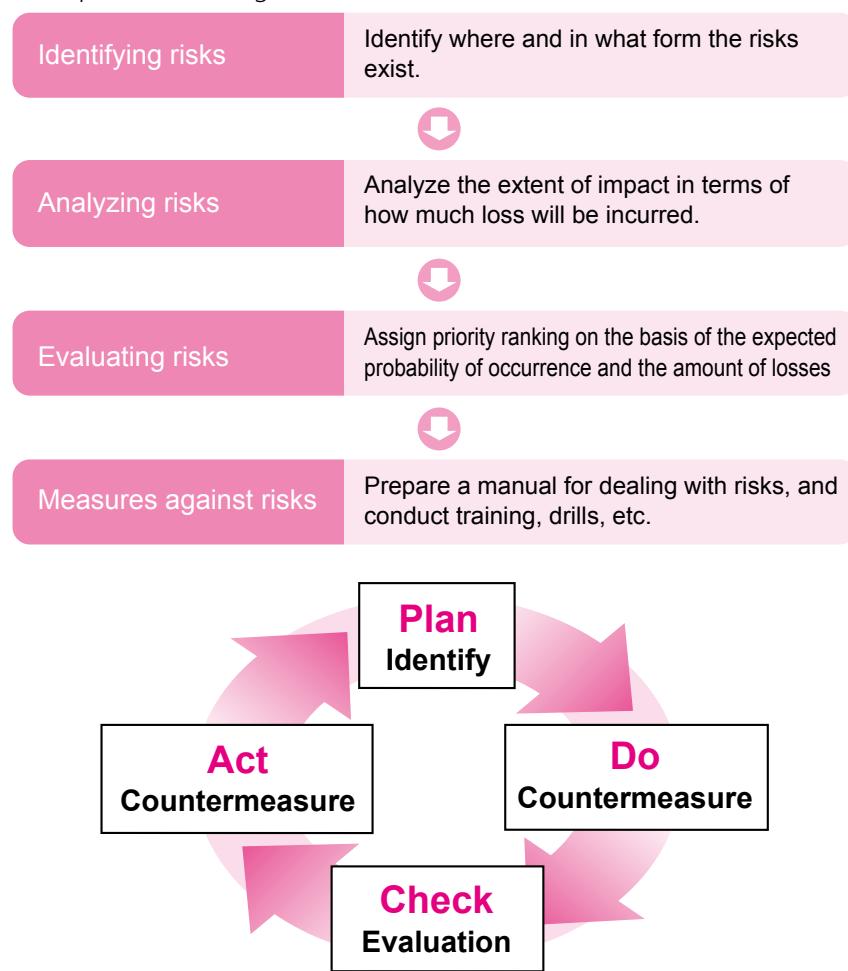
### (3) Types and characteristics of physical threats

Information may become inaccessible or information may be destroyed because of natural disasters, destruction, sabotage, etc., which may hamper the performance of operations or provision of services.

Type	Description
Disaster	It is a threat where computers and information is damaged because of natural disasters such as earthquake, fire, and flood. For threats caused by disasters, it is difficult to contain the occurrence of disasters. Therefore, it is necessary to take measures including steps to be taken after the threat has occurred.
Act of destruction	It is an act of deleting data from the computer or destroying the recording medium itself.
Sabotage	It is an act of disconnecting the communication lines and interrupting the operations.

## 9-5-2 Information Security Management

“Risk management” refers to understanding and analyzing the risks, assessing such risks from the standpoint of their frequency of occurrence and extent of impact, and then taking measures according to the risk type. Moreover, it is important to take measures that would minimize the damage caused by the risks even when such risks have actually occurred. The steps in risk management are as follows:



### ① ISMS (Information Security Management System)

As a part of risk management, there is information security management and personal information protection.

“Information security management system” refers to the mechanism of taking the required information security measures by analyzing and assessing the risks, where the entire organization works as one team for enhancing information security.

#### Reference

#### ISO/IEC 27000

“ISO/IEC 27000” refers to the international standard related to information security management systems. For maintaining and improvement the balance of confidentiality, integrity, and availability of information systems, the required security balance is decided through risk management of the organization and it is operated as per the plan.

#### Reference

#### Risk assessment

“Risk assessment” refers to identifying and analyzing the risk, and thereby assessing the risk.

#### Reference

#### Measures against risks

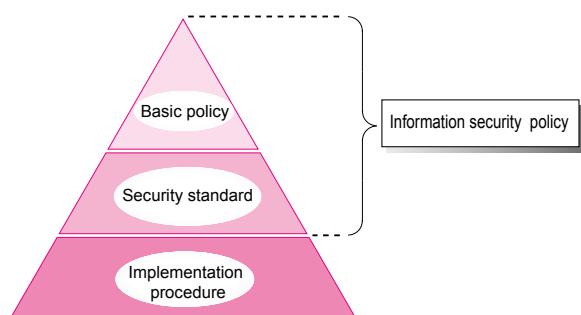
In measures against risks, on the basis of the results of risk analysis, specific measures to be taken for maintaining information assets are decided. Methods of preventing or mitigating the occurrence of losses can be classified into the following four categories.

Measures	Details
Risk avoidance	Avoiding the situation where risk may occur. For example, separating information assets from the Internet or destroying information assets.
Risk mitigation	Splitting information assets or underlying reasons that may cause losses for reducing the scale of impact. For example, dividing computers or people that manage information assets into multiple units, and then managing these multiple units.
Risk transfer	Transferring responsibility to another company through a contract, etc. For example, outsourcing the management of information assets to an external party, taking insurance, etc.
Risk acceptance	Taking responsibility and bearing losses. This option is used when the risk is not that big. Such risk is accommodated by preparing reserve or compensation money.

## 2 Information security policy

“Information security policy” clearly defines the basic security policy of the organization in terms of technical measures as well as usage and operational aspects of the system, structural aspects of the organization, etc. in order to implement consistent information security measures across the entire organization. After you identified important information assets in the organization, measures for protecting these information assets are developed.

Information security policy consists of “**Basic policy**,” “**Security standard**,” and “**Implementation procedure**.” Usually, “**Basic policy**” and “**Security standard**” are called information security policies.



Type	Description
Basic policy (Basic policy of information security)	Initiatives to be taken by the organization for information security are presented as a policy top management. Top management needs to explain to employees why such initiatives are required.
Security standard (Standards for information security measures)	On the basis of the basic policy, specific actions to or decision criteria to follow are set in terms of “which information assets should be protected to what extent and from which kind of threat.”
Implementation procedure (Information security implementation procedure)	Usually, it is not included in information security policy. It shows how the details stipulated in the “standards for measures” are implemented in each specific operation and information system.

## 3 Three major elements of information security management

“Information security management” refers to preventing various threats to the information assets and ensuring “**confidentiality**,” “**integrity**,” and “**availability**” of the information assets. It is necessary to have these three elements in a balanced manner.

Element	Description
Confidentiality	Only persons having the access rights can access the information.
Integrity	Information and processing methods are accurate and complete. Information is correct and it is not falsified.
Availability	Approved users can access information and related assets when necessary.

## ④ Protection of personal information

Amid several incidents of leakage of personal information, it has become necessary to protect personal information, which is one of the important assets of a company, and manage it very rigorously. Leakage of personal information not only poses a threat to individuals in terms of annoying telemarketing calls, large amount of direct promotion emails, or inappropriate invoice notices, but it also damages the company's credibility.

### ● Privacy mark system

Today when a large amount of personal information is stored on computers, there is higher risk of unintentionally leaking this personal information. Therefore, developed countries have taken measures such as enacting laws related to protection of personal information. Even in Japan, taking a cue from 1995 EU Directive (Directive of the European Parliament and of the Council on the protection of individuals with regard to the processing of personal data and on the free movement of such data), in April 1998, “**Privacy Mark System**” was launched with “**JIPDEC (Japan Information Processing Development Corporation)**” as the agency that would grant this mark.

The three objectives of this system are as follows:

- Enhancing awareness of individuals about protection of personal information
- Assigning to individuals the index of determining appropriateness about handling of personal information by business operators
- Giving incentives to business operators for taking measures for protection of personal information

This systems allows the use of privacy mark to the business operators found to have taken appropriate initiatives for the protection of personal information. Business operators that are allowed to use the privacy mark can show this mark on their advertisements, business cards, envelops, websites, etc. and appeal to the external parties that they have taken appropriate initiatives for personal information.



### Sample

[Note]  
The displayed number of privacy mark is a sample number and registration number issued in each case.

## Reference

### Information security countermeasure guideline

"Information security countermeasure guideline" contain a selection of specific measures that should be taken as information security measures in order to prevent virus infection, leakage of confidential information, shutdown of system, and destruction of data.

One of the examples is "Information security countermeasure guideline for Small and Medium Companies" published by IPA (Information - Technology Promotion Agency, Japan).

## Reference

### CSIRT (Computer Security Incident Response Team)

"CSIRT" refers to a collective term used for organizations that detect security problems and that take actions when a security problem is detected.

Incident management concerning security is performed in a consolidated manner.

## Reference

### Data erasing from hard disk

When you transfer or sell a computer or a hard disk, completely delete the data for preventing the leakage of confidential information. However, even after the usual formatting (logical formatting) or emptying the contents from recycle bin, data is physically remaining and it is possible that this data could be restored by using a software program for data recovery. In order to ensure that data cannot be recovered, it is necessary to overwrite the entire hard disk with meaningless data, or rewrite the entire hard disk with meaningless data by using a software program for erasing data.

## Reference

### Digital forensics

"Digital forensics" is a substantiating method or technology such as analyzing the contents of a log or hard disk when a computer crime or incident has occurred, such as information leakage or unauthorized access.

## 9-5-3 Information Security Measures and Information Security Implementation Technology

For taking appropriate and required measures with respect to various threats to information security, it is necessary to implement measures from different aspects.

In terms of information security measures, it is important to take security measures with respect to human threats, technical threats, and physical threats respectively.

### ① Types of human security measures

The following types of human security measures are available.

#### (1) Fulfillment of information security policy

Purpose of information security policy is to achieve integrated information security as the organization. There are multiple information security measures for one threat. From these measures, by showing "**these measures as a standard characteristic of the organization**," it is possible to achieve integrated information security in the organization.

#### (2) Imparting security education

It is important to periodically impart security education and increase the awareness of users with respect to security.

#### (3) Following company regulations and manuals

Company should prepare company regulations and manuals, and make sure that users follow them.

For example, when you log on to a server, different methods are available such as "IC card," "password," and "fingerprint authentication." Therefore, define the management approach in company regulations or manuals, and ensure that all users follow them.

#### (4) Access control

Any unauthorized intrusion in the company's network may result in theft or falsification of the data residing in the common folder. When you share a directory or a file on the network, decide who is to be granted what kind of permission to use and set "**access rights**." By setting access rights, you can restrict the users who can use and the extent to which they can use, and you can prevent theft and falsification of data.

Moreover, when a user is transferred, new access rights are granted and old access rights are taken back. When a user has resigned, steps are taken so that the user ID can no longer be used.

For verifying that access rights are granted as designed, it is necessary to collect the log of users and conduct periodic monitoring.

## 2 Types of technical security measures

The following types of technical security measures are available.

### (1) Measures against computer virus

The infection route of computer viruses includes removable disks such as USB (portable recording media) and networks.

The measures for protecting the systems from the threat of computer viruses are as follows:

#### ● Regular scanning by using antivirus software

“Antivirus software” is a software program that scans the computer to detect whether it is infected with a computer virus or not, and when the computer is infected with a virus, it cleans and gets rid of the computer virus. It is also referred to as “vaccine software (vaccine).”

When a file or an e-mail is downloaded from the Internet, it may be infected with a computer virus. Therefore, it is necessary to check the downloaded files and e-mails for any virus infection by using antivirus software. Moreover, virus infection may happen because of USB memory, etc. brought in from outside. Therefore, always check such devices for any virus infection before using them.

#### ● Measures for preventing intrusion of viruses from the network

For preventing intrusion of computer viruses from the network, it is necessary to appropriately install antivirus software in the infection route on the network. In specific terms, antivirus software is installed in the firewall on the only path that connects the Internet and the internal network, public servers, internal servers, and clients for minimizing the extent of infection of computer virus. Moreover, build a mechanism of automatically distributing antivirus software to these resources so that updates to the latest version and the pattern files (virus detection information) can happen without fail.

#### ● Measures for preventing the spread of damage after virus infection

Once you have detected a situation that shows that the system might be infected with a computer virus, it is important to note the following and take quick actions in order to prevent the spread of infection.

Reference

#### OS updating

At times, a bug called “security hole” is found in OS or e-mail software program. When a security hole is found, the OS manufacturer would distribute the update program for repairing the security hole on its website. By downloading this, users can repair the security hole and maintain safety. It is important to update the OS on a periodic basis.

Reference

#### Quarantine network

“Quarantine network” refers the mechanism of testing the computers attempting to connect to the internal network, and allowing only those computers to connect to the internal network where no problem is found. Check the OS update and pattern file of antivirus software, and prevent the spread of virus infection by temporarily isolating the computers that are not updated.

### **Single sign-on**

“Single sign-on” refers to an authentication system that allows accessing multiple systems with one-time authentication. By using single sign-on, after logging on to the system once, users can use multiple systems without re-entering the user ID and the password. Moreover, by carrying out member registration once, this membership information can be shared by the websites of the companies belonging to the same group. It offers the advantage of reducing the number of user IDs and passwords used by the users.

### **One-time password**

“One-time password” refers to a disposable password that can be used only once. Moreover, it refers to the mechanism that allows generating such password. A password is generated by using hardware called a “password generator.” One-time password takes a different value for every login. Therefore, it has the advantage that even if the one-time password is leaked, safety is ensured.

### **Digital watermarking**

“Digital watermarking” refers to the technology of embedding information such as date of creation and author in the data to the extent that it doesn’t affect the quality in order to prevent unauthorized copying and falsification of data. The embedded information cannot be distinguished at a glance. However, it can be checked with special digital watermarking detection software. Therefore, it is possible to detect any unauthorized copying or falsification.

### **SSL (Secure Sockets Layer)**

“SSL” refers to a protocol that ensures communication security. In specific terms, it encrypts and sends and receives information between the Internet and the web browser, thereby preventing its misuse by a third party.

- Even after you initialized the removable disk suspected of virus infection, there is no guarantee that the computer virus can be completely removed. Therefore, it is basically destroyed.
- For fixed disk suspected of virus infection, follow the instructions of the security administrator concerning subsequent measures.
- Even when you recover the system or data with backup systems, follow the instructions of the security administrator after considering the expansion of scope of infection.
- Disconnect the computer suspected of virus infection from the network, and follow the instructions of the security administrator.
- Concerning the network systems suspected of virus infection, conduct investigation about the infection route, scope of possibility of infection, and type of computer virus, and contact the concerned department and the network users.
- Until the security administrator and the network administrator restores the systems to the normal state, take measures such as restricting the use of networks.

## **(2) User ID and password management**

“User ID” refers to the user name assigned for identifying a user of the system. “Password” is for authenticating that it is a genuine user. The identity of the person is verified only when the combination of these two items matches.

### **●Setting and management of password**

In user ID and password based management, when the correct combination is entered, the user is allowed to access and use the system. Therefore, it is necessary to set a password that is difficult for other people to guess, and strictly manage the password such as periodically changing it and not writing it on a piece of paper.

### **●Steps to be taken by the security administrator**

Even the security administrator is not allowed to know the user’s password as long as there is a risk of leakage. When the user has forgotten his password, instead of security administrator setting a new password, it is necessary to initialize the old password and make it unusable, and then let the user reset the password.

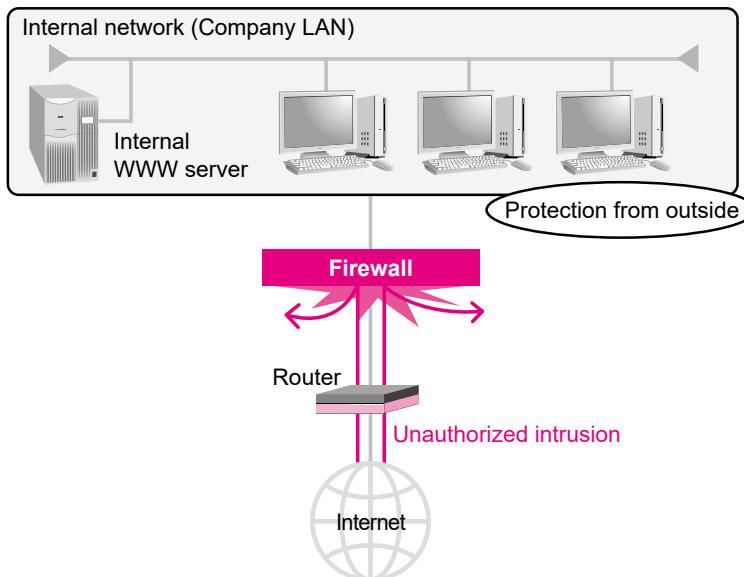
Moreover, passwords can be encrypted so that even if the password file containing the passwords is stolen, it cannot be misused and one cannot immediately know the passwords even after looking at the contents of the password file.

### (3) Firewall settings

“Firewall” is the mechanism of preventing unauthorized intrusion from the Internet. It serves as an entry and exit door between the internal network and the Internet, and monitors communication and blocks any unauthorized communication.

The most basic function of the firewall is “**packet filtering**.” Packet filtering is a function where TCP port number and IP address of the packets are checked in advance, and only those packets that are having pre-registered and pre-approved IP address and TCP port number are allowed to pass through. This prevents intrusion of packets that are not approved.

This function can also be substituted with a router. However, the basic principle of a router is to allow all packets to pass through. Packets that are not allowed to pass through are registered beforehand. Against this, the basic principle of firewall is to block the packets from passing through, and packets that are allowed to pass through are registered beforehand.



### (4) Proxy server settings

“Proxy server” is a server that relays communication when a computer in the company accesses the Internet. It is also called “**application gateway**” or “**proxy**.”

By going through the proxy server, it is possible to hide the IP address of each computer and reduce the risk of becoming a subject of attack.

### (5) Use of content filter

“Content filter” refers to the function of blocking inappropriate contents for preventing information leakage. For example, educational institutions restrict access to harmful websites for students such as pornographic websites and violence-related websites. Methods of restricting access to such harmful websites include preparing a list of URLs of harmful websites and blocking access to such websites, and blocking access to the websites that contain specific terms and phrases. Even in companies, content filters are used for blocking access to the websites not related to official work and for preventing information leakage on public boards and blogs.

#### Reference

##### VPN (Virtual Private Network)

“VPN” refers to a service that allows using public lines as if a network built within the company. VPN includes “Closed VPN” that uses a closed network owned by the provider and “Internet VPN” that uses the Internet and that can be operated at a very low cost.

#### Reference

##### Security settings of e-mail and web browsers

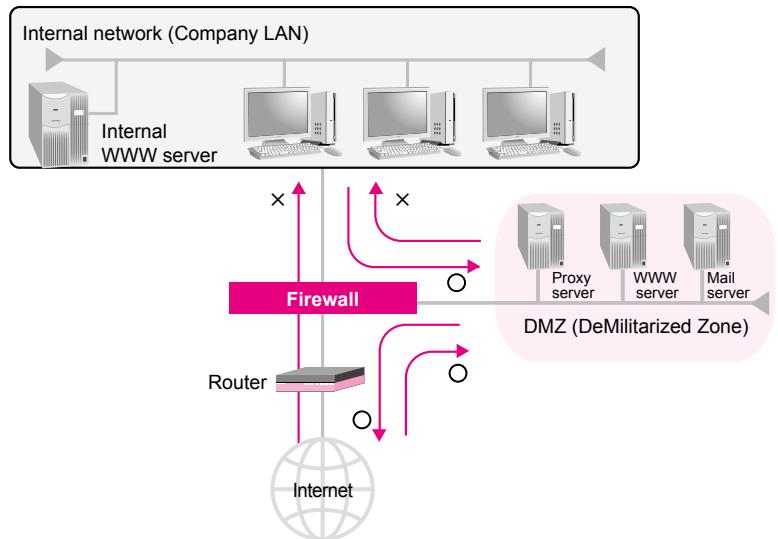
E-mail software programs and web browsers have the function of setting the security level. By setting this security level high, it is possible to prevent virus intrusion.

## (6) DMZ (DeMilitarized Zone)

"DMZ" refers to the network area set up between the internal network and the external networks such as the Internet.

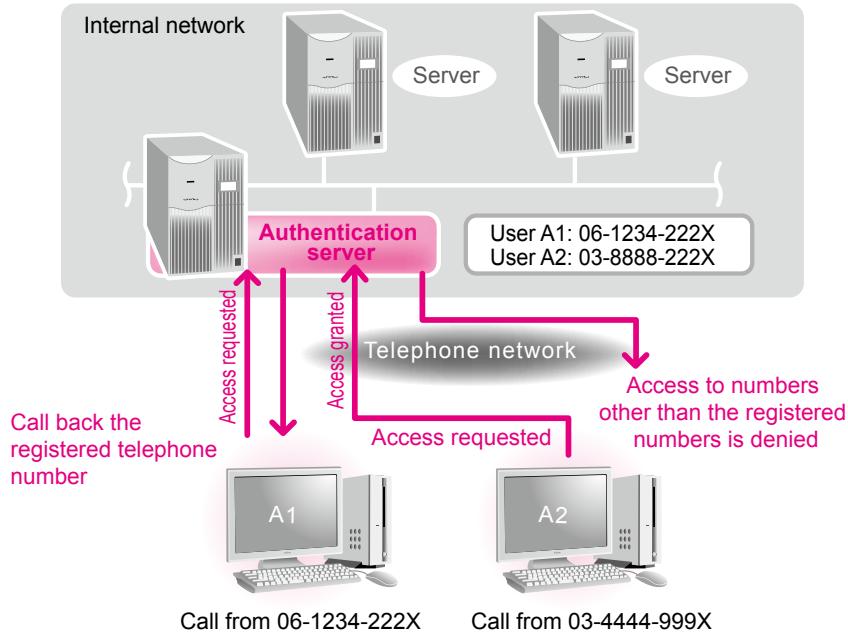
WWW server, e-mail server, proxy server, etc. made open by the company on the Internet are installed in DMZ.

Servers made open in DMZ allow access from the Internet in addition to access from the internal network. Access to the Internet through DMZ is also allowed. However, access to the internal network through DMZ is not allowed. In the unlikely event of unauthorized access to the servers made open on the Internet, if such servers are installed in DMZ, it will help in preventing the spread of the damage to the internal network.



## (7) Call back

"Call back" is a mechanism where in the event of connection to the authentication server in the company's network from an external party, the line would be disconnected and the authentication server would call once again. Access to the network from the numbers that are not pre-registered by the other party can be denied. Therefore, it can be verified whether the other party is genuine or not. Moreover, it also helps in minimizing the communication cost incurred by the user.



## (8) Wireless LAN measures

In wireless LAN, communication can take place if it is within the reach of electromagnetic waves. Therefore, more attention must be paid to security than with the cable-based LAN network.

The following types of security measures for wireless LAN are available.

### ●MAC address filtering

"**MAC address filtering**" is a function where the access point (connection point) of the LAN would allow only devices with pre-registered MAC address to connect to the LAN. This ensures that the devices whose MAC address is not registered cannot connect to a wireless LAN.

### ●ESSID stealth

"**ESSID stealth**" refers stopping the message that informs ESSID, which is a character string for identifying the wireless LAN network. This will help in making it difficult for people in the surrounding area to know about the LAN's access point.

### ●ANY connection denied

"**ANY connection**" is the method of detecting all access points with the range of electromagnetic waves and selecting the access point for connection from the list. By denying this connection, it is possible to prevent connection from other devices.

### ●WPA2-based encryption

By using WPA2, which is an encryption protocol of wireless LAN, it is possible to encrypt the electromagnetic waves and protect the device by combining with the authentication function. This will help in preventing tapping.

### ③ Types of physical security measures

The following types of physical security measures are available.

Reference

#### Biometrics

"Biometrics" refers to a term coined by combining "Biology" and "Metrics."

Reference

#### Secular change

"Secular change" refers to the change that happens after the passage of a certain number of years.

#### (1) Biometric authentication

"**Biometric authentication**" is a matching technology that identifies fingerprints or veins etc., which are unique bodily characteristics.

Individual is identified by using bodily characteristics, therefore, it offers advantages such as high safety and there is no risk of forgetting one's identification. At present, various technologies are being researched, and as soon as problems of technical aspects and cost aspects are resolved, these technologies are put into commercial use. However, there are still some problems such as dealing with people for whom biometric authentication cannot be used because of illness or injury, handling changes in bodily characteristics because of time, and managing biometric information that is recorded beforehand.

The main biometric authentication technologies that have been put into actual use are as follows:

Biometric authentication	Description
Fingerprints	In this method, devices used for authentication have become compact and less expensive. Therefore, it is also used for authentication in laptop computers and smartphones.
Voice print	In this method, matching is performed by using the frequency characteristics, etc. of the voice.
Veins	In this method, the patterns of veins are matched by using the quality that blood flowing through veins absorbs near infrared rays. Matching is performed by using the veins of fingers or hands.
Face	In this method, matching is performed after extracting parts of the face (eyes, nose, etc.) as characteristic points. In one of the methods, the user stands in front of the camera for authentication. There is another method where authentication automatically happens when the user is walking through the passage. These methods are used for check-in and entrance and exit control at airports, or for customer management.
Retina and iris	"Retina" is a thin membrane located on the inner side of eyeballs. In this method, pattern of capillary inside the retina is matched. "Iris" refers to a thin circular membrane that expands and contracts the pupil, and it matches the pattern of the iris. This is used for entrance and exit control to a confidential division in the government or a company because retina and iris in the left eye and the right eye would be different even in the same person, and they do not change over years.

#### (2) Entrance and exit control

"**Entrance and exit control**" refers to controlling the entry and exit of people (when, who, where). It can also be used for taking measures against suspicious individuals. In the buildings and rooms where important information or confidential information is handled, it is necessary to allow only authorized persons to enter and save the records of persons entering the room.

Moreover, with the method on the basis of IC tags, it is possible to maintain more precise records of persons entering and leaving the room. An IC tag is a very small chip that can perform wireless radio communication. When users who are wearing IC tag pass near the IC tag reader (reading device), entry and exit details are automatically recorded. It is possible to record the details even when multiple people pass simultaneously. Therefore, it is used for keeping entry and exit records and checking on whereabouts.

Reference

#### Installation of monitoring camera

Installing cameras and video cameras for monitoring the activities of suspicious individuals refers to also a useful method. Cameras can be installed near entrance doors or where the confidential information is kept so that theft and information leakage can be prevented.

### (3) Locking management

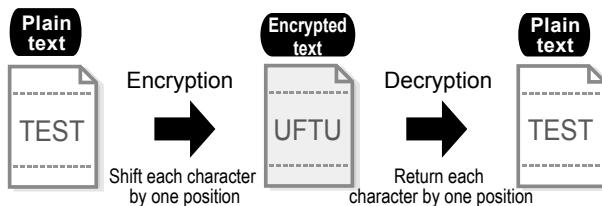
Locking the buildings, rooms, lockers, etc. where information assets are stored and managed, prevents external intrusion and use of information assets by unauthorized persons. Considering the convenience of users, locking with electronic locks is become more prevalent.

## 4 Cryptography

“Encryption” refers to converting the plain text (source text) as per the predefined rules so that a third party cannot decode the text. Reverting the encrypted text into plain text is called “decryption.” In this case, key for encryption and key for decryption would be required.

### Example

Example of encryption where “TEST” is shifted by “one character” in the order of the Japanese alphabet

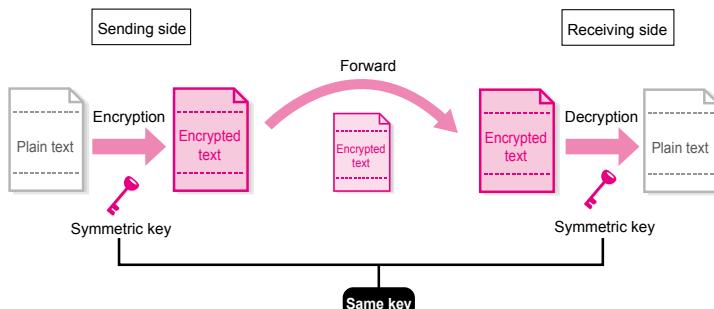


### (1) Symmetric cryptography

“Symmetric cryptography” is the method where the same key (symmetric key) is used for encryption and decryption. If the key is leaked to a third party, it will not be possible to prevent tapping and falsification. Therefore, symmetric key must be shared in a confidential fashion. Because of this, it is also called “private key cryptography.” One of the main methods is the “DES method.”

The mechanism and characteristics of symmetric cryptography-based communication are as follows:

- Speed of encryption and decryption is fast.
- When you forward the symmetric key, there is a risk of leakage of the symmetric key.
- It is necessary to prepare a separate the symmetric key for each communication partner.



- [1] Plain text (source text) is encrypted by using the symmetric key of the sender.
- [2] Encrypted text and symmetric key are forwarded by the sender to the recipient.
- [3] Recipient decrypts the encrypted text by using the symmetric key received from the sender.

### Reference

#### Encryption strength

“Encryption strength” refers to the strength that measures the extent to which a cipher text is encrypted.

Encryption strength differs depending on the type of encryption method and the contents of the key. Higher is the encryption strength, decoding the cipher text would be difficult. On the other hand, lower is the encryption strength, decoding the cipher text would be easy.

## PKI (Public Key Infrastructure)

“PKI” refers to the mechanism of ensuring security by using public key cryptography. It is also called “Public Key Infrastructure.” It includes public key cryptography technologies such as the RSA method, browsers with embedded SSL, encrypted emails that use S/MIME, and servers of certification authorities that issue digital certificates. This was designed so that electronic commercial transactions can be conducted in a safe manner.

## RSA

“RSA” refers to a public key cryptography and it was developed by focusing on the difficulty of factorizing a large number in prime numbers.

## Certificate authority

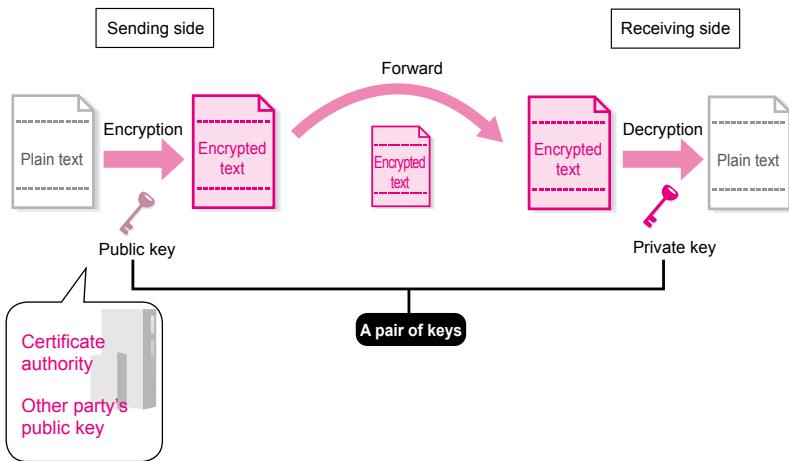
“Certificate authority” refers to an agency that issues certificates for assuring the validity of public keys used in public key cryptography and digital signature. It is also called “CA” or “CA bureau.”

## (2) Public key cryptography

“Public key cryptography” is the method where different keys (private key and public key) are used for encryption and decryption. Only the user will have the private key, and it must not be shared with a third party. Public key is widely shared with third parties. Therefore, it is shared after registration with the certificate authority. One of the main methods is the **“RSA method.”**

The mechanism and characteristics of public key cryptography-based communication are as follows:

- It uses public key, and therefore it is suitable for communicating with a large number of parties.
- Management of the key is easy.
- Speed of encryption and decryption is slow.



- [1] Recipient generates the private key and the public key, and register the public key with a certificate authority.
- [2] Sender encrypts the plain text by using the recipient's public key registered with the certificate authority.
- [3] Only encrypted text is forwarded by the sender to the recipient.
- [4] Recipient decrypts the encrypted text using the corresponding private key that is only available to the recipient.

## 5 Authentication technique

“Authentication technique” is the technique for certifying legitimacy of data. By certifying that data or information sent by the user is not falsified, it will increase the integrity of exchange of information through the network. “Digital signature” is the main authentication technique.

### (1) Digital signature

“Digital signature” is the information assigned for assuring validity of electromagnetic records (digital documents), and it has the same effect as assuring validity of documents through using a signature or seal in daily life.

Digital signature is implemented by combining public key cryptography and message digest, and it has the following characteristics.

- By encrypting using the private key of the sender, it verifies the identity of the sender.
- By comparing the message digest after sending and the message authentication code (message digest before sending), it assures that the data is not falsified.

#### Reference

##### Message digest

“Message digest” refers to short data where the original plain text is summarized. A hash function is used for summarizing the original plain text. Its salient characteristics are the original plain text cannot be reverse generated from the message digest and even if one character of the original plain text changes, the message digest would change to a completely different value. Therefore, by comparing the message digest before sending and the message digest after sending, it ensures that the data is not falsified.

[Note] Answers can be found on page 26 of the appendix "Answers and Explanations for the Chapter Quiz" at the end of this book.

**Q 9-1**

A particular department handles operations related to ordering of products, and it enters the order slips received from the customers by FAX in the order management system for each customer. This system mainly relies on keyboard operations. There is variation in the proficiency level of keyboard operations among the data entry team. Therefore, the department decided to design GUI screens that would improve operational efficiency for users who are used to keyboard operations as well as users who are not used to keyboard operations. Which of the following is the most appropriate point to keep in mind when designing GUI screens?

- a) Completely eliminate keyboard operations, and ensure that all operations can be performed using mouse.
- b) For operations that are frequently performed, ensure that such operations can be performed using both mouse and keyboard.
- c) When the input page has changed, reset and let operators perform the operations from the beginning.
- d) Make sure that the operator has to enter the company name of the customer.

**Q 9-2**

Which of the following is an appropriate explanation of streaming?

- a) There is no partial loss of data received, and it can always playback the data with high image quality.
- b) It plays data while downloading it. Therefore, users do not need to wait until the download is completed.
- c) Data is distributed after it is fully stored in the server. Therefore, it cannot handle live broadcasting.
- d) It is limited to individual's access and use, and therefore it cannot be used in companies.

**Q 9-3**

Which of the following is an appropriate explanation of exclusive control of database?

- a) Applying shared lock allows simultaneously updating the same data.
- b) Applying exclusive lock allows the user who accessed the data afterwards to update the data.
- c) Applying shared lock allows even other users to reference the data while it is updating.
- d) Applying exclusive lock allows even other users to reference the data while it is updating.

**Q 9-4**

Which of the following is an appropriate explanation of spyware, which is a threat to information security?

- a) Sending a large number of advertisement e-mails in an indiscriminate manner on the basis of e-mail addresses collected on the Internet.
- b) Sending personal information etc. residing inside the computer to the Internet.
- c) Finding open port numbers in order to intrude into the computer.
- d) Analyzing user name and password by combining the letters generated by the program in a random manner.

**Q 9-5**

Which of the following is an appropriate description concerning IP address?

- a) IP address is represented with a binary 16-bit number, and it is composed of the global IP address and the private IP address.
- b) The problem of shortfall of IP addresses can be resolved by using IPv6.
- c) Global IP address can be freely set.
- d) In class A, which is categorized by address class, it is possible to allocate more IP addresses than the population of Japan (about 127 million people) with respect to one network.

**Q 9-6**

Which of the following is an appropriate description concerning IPv6?

- a) Communication speed becomes fast because optical fiber can be used.
- b) Address space that can be managed is 32 bits, and IP address is shown after separating it with a ".(dot)" after every 8 bits.
- c) Address space that can be managed is 128 bits, and it can solve the problem of shortfall of IP addresses.
- d) IPv6 and IPv4 cannot co-exist in a single LAN.

**Q 9-7**

Which of the following is an appropriate explanation concerning cross-site scripting?

- a) Misusing user ID and password obtained from another website, spoofing as a user, and attempting unauthorized login on multiple websites
- b) Embedding a malicious code in the website by using a security hole in the software
- c) By entering an unexpected sentence structure on the website and running SQL, malfunctioning the program and obtaining information in an unauthorized manner
- d) Sending a large amount of e-mails to the mail server so that the mail server is overloaded and it stops functioning

**Q 9-8**

When using digital signature in public key cryptography for establishing the identity of the sender, keys required for encryption are the sender's public key and which one of the following keys?

- a) Recipient's public key
- b) Recipient's private key
- c) Sender's private key
- d) Sender's symmetric key

**Q 9-9**

Which of the following technologies is for processing and playing still images and videos by using computers?

- a) Computer graphics
- b) CAD
- c) Computer simulation
- d) Virtual reality

**Q 9-10**

Which of the following is an appropriate attack that involves setting a trap by embedding a malicious program in the website frequently accessed by the user to be attacked so that just accessing the website will result in virus infection?

- a) Watering hole attack
- b) Port scan
- c) Buffer overflow attack
- d) Phishing

**Q 9-11**

Out of the processes performed in a database management system, which system searches and updates data in the database according to the request from the client that is connected online to the server?

- a) Workflow system
- b) Online transaction processing system
- c) Client/server system
- d) Online system

**Q 9-12**

There is an encryption table that assigns one character from the source text at a time in the horizontal direction from top left up to bottom right in a  $3 \times 3$  table, where these characters are then read in the vertical direction from top-right to bottom-left. Which of the following is the encrypted text when "I/am/Sato" is encrypted in this system?

- a) Ima//taSo
- b) oSat//aml
- c) aSo//tlma
- d) I/as/mato

**Q 9-13**

One (1) minute has passed after starting to copy 800 MB data required for the official work from the internal file server. Company has installed the LAN that is having the transmission speed of 100 MB/second, and its transmission efficiency is 50%. What is the approximate remaining waiting time in seconds until copying of the data is completed? Here,  $1 \text{ MB} = 10^6 \text{ bytes}$ .

- a) 68
- b) 128
- c) 340
- d) 400

**Q 9-14**

Which of the following is an appropriate explanation of web accessibility when designing a website?

- a) In order to ensure that information can be quickly obtained even in low performance computers, speed of the communication line is increased and the speed of accessing the website is increased.
- b) It is a type of measures against computer viruses, where the website is designed such that a virtual keyboard is displayed on the screen so that the same characters and numbers as keyboard can be entered by using the mouse.
- c) The website is designed to multiple websites can be accessed from one website.
- d) The website is designed to elderly people and people with disorders can obtain the desired information or service from the website.

Which of the following is appropriate in terms of table of the result obtained by projecting “Customer\_management\_table” of the database?

Customer\_management\_table

Personal_ID	Customer_name	Staff_code
1150	Tanaka	A18600
2640	Matsumoto	B19700
3680	Suzuki	C20100

Staff\_code\_table

Staff_code	Staff_name
A18600	Yamamoto
B19700	Morita
C20100	Yamada

a)

Customer_name
Tanaka
Matsumoto
Suzuki

b)

Personal_ID	Customer_name	Staff_code
1150	Tanaka	A18600

c)

Personal_ID	Customer_name	Staff_code	Staff_name
1150	Tanaka	A18600	Yamamoto
2640	Matsumoto	B19700	Morita
3680	Suzuki	C20100	Yamada

d) This is a table that cannot be projected.

## Middle Question



**Note**  
Middle questions have been abolished since April 2017.

Read the following description concerning course management work at a culture school and then answer questions 9-17 through 9-20.

Company I operates a culture school, and its sales management department manages the information about the courses offered by the company using a database.

After receiving an application for a course from a participant, the reception staff would issue a course slip shown in Figure 2 by using the print function of the database management system and the database shown in Figure 1.

There are referential constraints set in the database shown in Figure 1, and even when there are applications for multiple courses from one participant, one (1) course slip is issued for one course. All information about participants who apply for a course once is recorded in the database, and when applying for the course next time, the participants are not required to once again register the information such as contact details.

Flow from applying for a course until issuing the course slip is given below.

- (1) Receiving application from participant.
- (2) Entering participant information in the database.
- (3) Issuing course slip.
- (4) Sending course slip to the participant.

Figure 1 Structure of the database related to course management work

**Course\_date\_table**

Course_date	Course_code	Classroom

**Course\_list\_table**

Course_code	Course_name	Lecturer_code	Teaching_material_code	Amount

**Lecturer\_list\_table**

Lecturer_code	Lecturer_name	Department

**Teaching\_material\_list\_table**

Teaching_material_code	Teaching_material_name	Teaching_material_image

Figure 2 Template of the course slip

[Student_code] Mr/ Ms [Student_name]	[Contact_details]	[Date_received]	[Reception_code]
<b>Course slip</b>			
Culture school 1			
Thank you very much for applying to the following course. Please carry this course slip on the day of the course, and directly come to [classroom number].			
Note			
Course Date Lecturer	[Course_date] [Lecturer_name]	Course_code [Course_code] Teaching_material [Teaching_material_name]	*Course fees Please pay [Amount] Yen in the classroom.
END			

**Q 9-16**

Image data of the teaching material used in the courses is saved, and this data is searched in the database. When recording 500 images of  $350 \times 200$  pixels, about how many mega bytes of space would be required? Here, the image data is not compressed, and each pixel is represented by 24 bits. Moreover, 1 MB is calculated as 1,024 kB.

- a) 12      b) 100      c) 840      d) 1,000

**Q 9-17**

Which of the following is appropriate in terms of showing the relation of Teaching\_material\_codes in Course\_list\_table and Teaching\_material\_list\_table in Figure 1 using primary key and foreign key?

	Course_list_table. Teaching_material_code	Teaching_material_list_table. Teaching_material_code
a)	Primary key	Primary key
b)	Foreign key	Foreign key
c)	Primary key	Foreign key
d)	Foreign key	Primary key

**Q 9-18**

Upon receiving an application for a course from the participant, the reception staff creates the course slip and sends it to the participant. For creating a course slip, it was decided to record seven items, namely, Reception\_code, Reception\_date, Participant\_code, Participant\_name, Contact\_details, Course\_code, and Course\_date. Which of the following is an appropriate composition of table when normalizing and recording these items?

- a) 

Reception_code	Reception_date	Participant_code	Participant_name	Contact_details	Course_code	Course_date
----------------	----------------	------------------	------------------	-----------------	-------------	-------------
- b) 

Participant_code	Participant_name	Contact_details	Course_code	Course_date
Reception_code	Reception_date	Course_code		
- c) 

Participant_code	Participant_name	Contact_details		
Reception_code	Reception_date	Participant_code	Course_code	Course_date
- d) 

Participant_code	Participant_name	Contact_details	
Reception_code	Reception_date	Course_code	Course_date

**Q 9-19**

When issuing the course slip shown in Figure 2, it is necessary to refer to four types of tables shown in Figure 1 and the tables created in question 9-19. When issuing one course slip with the following conditions, which of the following shows four tables of Figure 1 in the descending order of the number of times these tables are referenced?

- (Condition) (1) Operation of fetching one record with a primary key when referencing is counted as one time.
- (2) "Course\_date\_table > Teaching\_material\_list\_table" shows that the number of times of referencing Course\_date\_table is more than Teaching\_material\_list\_table.

- a) Course\_date\_table = Course\_list\_table = Lecturer\_list\_table = Teaching\_material\_list\_table
- b) Course\_date\_table  $\leq$  Course\_list\_table = Lecturer\_list\_table = Teaching\_material\_list\_table
- c) Course\_date\_table  $\leq$  Course\_list\_table  $\leq$  Lecturer\_list\_table = Teaching\_material\_list\_table
- d) Course\_date\_table  $\leq$  Course\_list\_table  $\leq$  Lecturer\_list\_table  $\leq$  Teaching\_material\_list\_table

# Chapter 10

## Spreadsheet

This chapter explains basic knowledge of spreadsheet software and calculation methods using functions.

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<b>10-2</b>	Expressions .....	321
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# 10-1

# Spreadsheet Software

## Reference

### Spreadsheet software

Spreadsheet software includes software such as Microsoft's "Excel."

## 10-1-1 Spreadsheet Software Functions

"Spreadsheet software" is integrated software that combines a variety of functions, including spreadsheets, graph creation, and data management. It can be used to enter text, numeric values, functions, and other expressions into a worksheet, and to create tables and graphs. Spreadsheet software is used for purposes such as the creation of ledgers, quotations, invoices and other forms; budgeting; and price decision models or other sales analysis. It is well suited to complex data analysis. Some functions found in typical spreadsheet software are shown below.

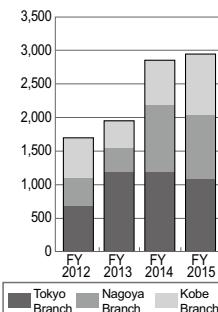
Name	Description
Editing functions	<ul style="list-style-type: none"><li>The display formatting, display position, and other properties of data entered in tables can be changed.</li><li>Columns and rows can be added to or deleted from tables, as well as copied or moved.</li></ul>
Calculation functions	<ul style="list-style-type: none"><li>Data entered in tables can be used for calculations.</li><li>When entered data is changed, recalculation occurs automatically.</li></ul>
Sorting functions	<ul style="list-style-type: none"><li>Data within a cell range can be sorted in ascending or descending order on the basis of specified key items.</li></ul>
Macro functions	<ul style="list-style-type: none"><li>Frequently performed actions can be recorded.</li></ul>
Graphing functions	<ul style="list-style-type: none"><li>Graphs (bar graphs, pie graphs, line graphs, etc.) can be easily created from tables.</li></ul>
Database functions	<ul style="list-style-type: none"><li>Needed values can be quickly searched for and identified within tables holding large numbers of values.</li></ul>
Add-in functions	<ul style="list-style-type: none"><li>Optional functions can be added.</li></ul>

Per-branch sales performance table (Unit: 1,000 dollars)

	FY 2012	FY 2013	FY 2014	FY 2015
Tokyo Branch	650	1,200	1,300	1,100
Nagoya Branch	400	320	860	960
Kobe Branch	670	450	720	890
Nationwide total	1,720	1,970	2,880	2,950

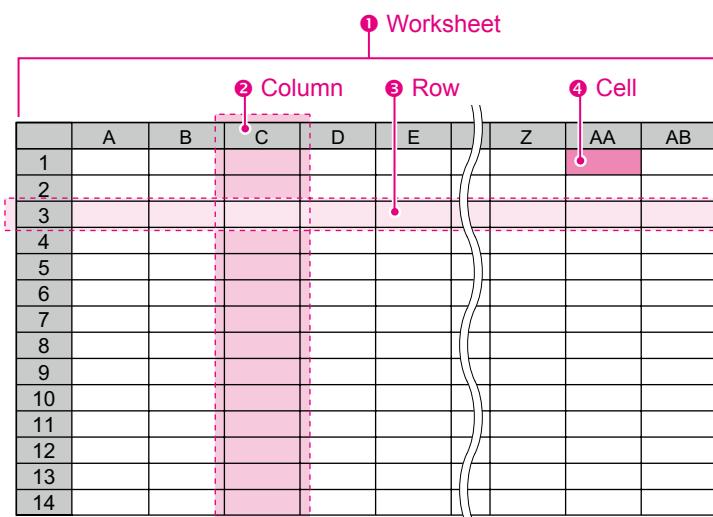
After an expression for the total is entered, the total will be automatically calculated when amounts for the detailed items are entered.

Graphs based on the table and matched to purpose can be created through simple steps.  
Item names and other data in the table can be used as is.



## 10-1-2 Basic Structure of Worksheets

The basic structure of typical spreadsheet software is as shown below.



[Note] The functions and terms used by spreadsheet software may differ with the software used.

### ① Worksheet

The workplace for creating tables and graphs.

### ② Column

A collection of cells in the vertical direction. The number for each column is indicated by using letters of the alphabet.

In the case of 256 columns, these are column A, columns B-Z, and columns AA-IV.

### ③ Row

A collection of cells in the horizontal direction. The number for each row is indicated by using a numeral.

In the case of 1,000 rows, these are row 1, row 2, and so on, through row 1000.

### ④ Cell

This refers to one cell within a worksheet that is divided into columns and rows. Data can be entered in a cell. The cell currently subject to actions is called the “active cell.”

### Reference

#### Cell address

A “cell address” is location information that identifies a specific cell. It indicates the cell’s location through a combination of a column number and a row number. As an example, the cell located at the 13th row of column AA is expressed as “AA13”.

### Reference

#### Cell range

A “cell range” is a collection of consecutive cells. As an example, the cell range from cell A1 to cell A3 is expressed as “A1:A3”.

## Reference

**Expressions**

“Expressions” are composed of constants, cell addresses, operators, parentheses, and functions. The input of expressions allows the execution of calculations, the acquisition of information, the referencing of cell data, etc.

Expressions include “arithmetic expressions” that yield numeric values, “literal expressions” that yield character strings, and “logical expressions” that yield logical values (true or false).

**10-2-1 Arithmetic Operators**

Arithmetic operators that can be used in expressions are shown below.

Arithmetic operators		Reading	Example of entry	Meaning of expression
Addition	+	plus	2+3	$2+3$
Subtraction	-	minus	2-3	$2-3$
Multiplication	*	asterisk	2*3	$2\times3$
Division	/	slash	2/3	$2\div3$
Exponentiation	^	caret or hat	2^3	$2^3$

Arithmetic operators use the same order of operations as operators in mathematics.

Priority order	Arithmetic operators
1	^
2	* /
3	+ -

Example: For  $1+2\times 3^4$ :

$$1+2*3^4$$

↑ ↑ ↑  
3 2 1

$$\begin{aligned} &= 1+2\times 3^4 \\ &= 1+2\times 81 \\ &= 1+162 \quad = 163 \end{aligned}$$

Use ( ) to change the order of operations.

$$(1+2)*3^4$$

↑ ↑ ↑  
1 2 3

$$=(3\times 3)^4 \quad = 6561$$

## 10-2-2 Cell References

Referencing cells in input is common, as in the expression “**A1\*A2**”. Cell references include “relative reference” and “absolute reference.”

### 1 Relative reference

A “**relative reference**” is one that references a cell’s relative location. When the expression is copied, the cell reference is automatically adjusted.

In the figure, the “**B2**” and “**C2**” of the “**B2\*C2**” that is entered in cell D2 are relative references. When the expression is copied, it is automatically adjusted in accordance with the direction of the copying (e.g., “**B3\*C3**” and “**B4\*C4**”).

	A	B	C	D
1	Product name	Price	Wholesale / retail price ratio	Sales price
2	Suit	\$560	80%	\$448 • B2*C2
3	Coat	\$750	60%	\$450 • B3*C3
4	Shirt	\$150	70%	\$1,050 • B4*C4

### 2 Absolute reference

An “**absolute reference**” is one that always references a cell in a specific location. Even if the expression is copied, the cell reference remains fixed and is not adjusted. A “\$” is appended to make a cell an absolute reference.

In the figure, the “**B\$1**” of the “**B4\*B\$1**” that is entered in cell C4 is an absolute reference. Even if the numeric expression is copied, “**B\$1**” remains fixed and is not adjusted (e.g., “**B5\*B\$1**” and “**B6\*B\$1**”).

	A	B	C
1	Wholesale / retail price ratio	75%	
2			
3	Product name	Price	Sales price
4	Suit	\$560	\$420 • B4*B\$1
5	Coat	\$750	\$562 • B5*B\$1
6	Shirt	\$150	\$112 • B6*B\$1

#### Reference

#### Combinations of relative reference and absolute reference

Relative reference and absolute reference can be combined.

Example: Absolute column reference, relative row reference

**\$B1**

When this is copied, the column will remain fixed and the row will be automatically adjusted (e.g., “\$B2”, “\$B3”, “\$B4”...).

Example: Relative column reference, absolute row reference

**B\$1**

When this is copied, the column will be automatically adjusted and the row will remain fixed (e.g., “C\$1”, “D\$1”, “E\$1”...).

Example: Absolute column and row reference

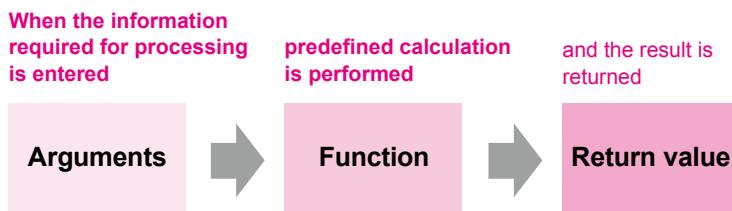
**\$B\$1**

When this is copied, both the column and the row will remain fixed as “\$B\$1”.

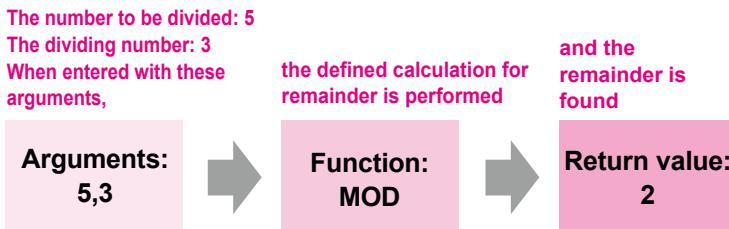
### 10-3-1 Functions

“**Functions**” are expressions that perform calculations in accordance with predefined rules. Complex expressions can be entered in an easy format by using functions.

Information required for a calculation using a function is called an “argument” and the result of the calculation is called the “return value.” A depiction of a function, expressed as a figure, is shown below.



#### Example: Calculating the remainder of division



## 1 How to use functions

A function is generally entered in the following format:

**Function name (argument 1, argument 2, ...)**

The following are points of caution to note when entering functions.

- **Arguments are enclosed in parentheses. Function name ( ) is used when there are no arguments.**
- **When there are two or more arguments, these are separated by “,” (commas).**
- **When an argument is a character string, it is enclosed in “” (single quotation marks, e.g., 'ABC').**
- **Expressions, cell ranges, cell range names, and logical expressions may be specified as arguments.**

When calculating sums or averages by using arithmetic operators such as “+” or “/”, the expression can become very long (e.g., B3+B4+B5+B6+B7+B8+B9+B10...) as the number of data items increases.

By using functions to calculate sums, averages, and so on, the objects of the calculation can be specified by using cell ranges, allowing easy input of the expression.

Functions can be used to calculate report card sums and averages, as shown below.

	A	B	C	D	E
1	Report card				
2		Mr. A	Mr. B	Mr. C	Average
3	Reading/Writing	90	70	65	AVG(B3:D3)
4	Math	60	85	92	AVG(B4:D4)
5	Social studies	80	60	70	AVG(B5:D5)
6	Total	SUM(B3:B5)	SUM(C3:C5)	SUM(D3:D5)	

When the expression is copied,  
the arguments' cell references are also automatically adjusted

Copy

## 2 Type of function

Some typical functions are shown below.

Name	Example of use	Description
Total	SUM(A1:A5)	This returns the sum of the numeric values in cell A1 to cell A5.
Average	AVG(A1:A5)	This returns the average of the numeric values in cell A1 to cell A5.
Maximum	MAX(A1:A5)	This returns the maximum value from among the numeric values in cell A1 to cell A5.
Minimum	MIN(A1:A5)	This returns the minimum value from among the numeric values in cell A1 to cell A5.
Integer part	INT(A1)	This returns the highest integer that does not exceed the numeric value in cell A1. For example, INT(2.9)=2, INT(-2.9)=-3
Remainder	MOD(A1,B1)	This returns the remainder of cell A1÷cell B1. For example, MOD(11,2)=1
Square root	SQRT(A1)	This returns the non-negative square root of the value in cell A1. The value specified as the argument must be a numeric value equal to or greater than 0.
Standard deviation	STDEV(A1:A19)	This returns the standard deviation of the numeric values from cell A1 to cell A19.
Count	COUNT(A1:A5)	This returns the count of non-blank cells within the cell range consisting of cell A1 to cell A5.
Conditional count	COUNTIF(A1:A5, >20)	This returns the count of cells containing a value equal to or greater than 20, from among cell A1 to cell A5.
Logical product (AND)	AND(logical expression 1, logical expression 2, ...)	This returns “true” if the logical expressions specified as arguments are all true. If one or more of the arguments are false, the function returns “false”.
Logical sum (OR)	OR(logical expression 1, logical expression 2, ...)	This returns “false” if the logical expressions specified as arguments are all false. If one or more of the arguments are true, the function returns “true”.
Negation	NOT(logical expression)	This returns “false” if the logical expression specified as the argument is true, and returns “true” if it is false.

### Reference

#### Sample standard deviation and population standard deviation

“Sample standard deviation” is used for the prediction of the standard deviation of a large group from a portion of the data in the group. “Population standard deviation” is used for the calculation of the standard deviation for all data in a group (i.e., the population.)

For example, when measuring the athletic ability of hundreds of thousands of children nationwide, sample standard deviation is used to perform analysis on a portion of the sample data, because of the difficulty of investigating the entire set.

Conversely, when calculating the standard deviation of height, weight, and so on in a class of 10 persons, population standard deviation is used, as all persons are the object of analysis.

Name	Example of use	Description
Round off	ROUNDOFF (A1,digit position)	This returns the value in cell A1, rounded off at the specified digit position. The digit position indicates the position when counting with the rightward direction as the positive direction, with the first decimal place set as digit position 0. For example, ROUNDOFF(-314.059,2)=-314.06, ROUNDOFF(314.059,-2)=300, ROUNDOFF(314.059,0)=314
Round up	ROUNDUP (A1,digit position)	This returns the value in cell A1, rounded up at the specified digit position. The digit position indicates the position when counting with the rightward direction as the positive direction, with the first decimal place set as digit position 0. For example, ROUNDUP(-314.059,2)=-314.06, ROUNDUP(314.059,-2)=400, ROUNDUP(314.059,0)=315
Round down	ROUNDDOWN (A1,digit position)	This returns the value in cell A1, rounded down at the specified digit position. The digit position indicates the position when counting with the rightward direction as the positive direction, with the first decimal place set as digit position 0. For example, ROUNDDOWN(-314.059,2)=-314.05, ROUNDDOWN(314.059,-2)=300, ROUNDDOWN(314.059,0)=314
Concatenate	CONCATENATE (expression 1, expression 2, ...)	This returns a value that concatenates the values of expression 1, expression 2, ..., taking these as character strings. For example, CONCATENATE('Osaka','Tokyo',123,456) =OsakaTokyo123456
Rank	RANK (A1,A1:A5,0)	This returns the rank of cell A1 within the cell range from cell A1 to cell A5. If matching values exist, these are treated as having the same rank, and the next rank is augmented by the number of values having the same rank. The third argument, "specification of order," specifies either ascending order (0) or descending order (1).
Random number	RANDOM( )	This returns a random number (a real numeric value), each with equal probability of occurring and each equal to or greater than 0 and less than 1.
Table lookup	TLOOKUP (A3:H11,2,5)	This returns the value in the cell at the position of the 2nd row and 5th column from the upper left of the cell range from cell A3 to cell H11. (Returns the value in cell E4) The positions of the row and column are each counted as 1, 2, ... from the upper left.

[Note] In the functions SUM, AVG, MAX, MIN, STDEV, and RANK, character strings or blank cells within the cell range specified in the arguments are not subject to calculation.

# 10-4

# Chapter Quiz

[Note] Answers can be found on page 33 of the appendix “Answers and Explanations for Chapter Quiz” at the end of this book.

## Q 10-1

From April to June total net sales for each store, the overall component ratio will be calculated. Which of the following is the expression that should be entered in cell F2? Here, the expression entered in cell F2 will be copied and used in cells F3:F7.

	A	B	C	D	E	F
1		April sales	May sales	June sales	Total	Component ratio
2	Store A	550	430	500	1,480	
3	Store B	450	400	450	1,300	
4	Store C	300	210	510	1,020	
5	Store D	450	200	340	990	
6	Store E	230	340	230	800	
7	Total	1,980	1,580	2,030	5,590	

- a) E2/E\$7
- b) \$E\$2/\$E7
- c) \$E\$2/E7
- d) E2/B2

## Q 10-2

Company Y has decided to proportionally allocate incentive payments for the term to its departments, on the basis of the sales of each. Given the table shown below, which of the following is the expression that should be entered in cell C3?

The expression in cell C3 will be copied and used for Department B through Department D.

	A	B	C
1	Incentive payment	5,000	
2		Sales	Dividend
3	Department A	1,200	
4	Department B	800	
5	Department C	1,500	
6	Department D	1,000	

- a) B3/SUM(B\$3:B\$6)\*B\$1
- b) B3/AVG(B\$3:B\$6)\*\$B\$1
- c) B3/SUM(\$B3:\$B6)\*\$B1
- d) B\$3/SUM(B\$3:B\$6)\*B\$1

**Q 10-3**

Responses to a questionnaire are entered in cells B2:F50. The number of responses for each question, for cells B52:F53 will be calculated. Which of the following is the expression that should be entered in cell B52, when it is copied into cells B52:F53?

	A	B	C	D	E	F
1	Name	Q1	Q2	Q3	Q4	Q5
2	Nozomi Iizuka	Yes	Yes	No	No	No
3	Tomoya Ide	No	Yes	Yes	Yes	No
4	Yuki Ouchi	No	No	Yes	Yes	Yes
5	Sosuke Kato	Yes	Yes	No	Yes	Yes
:	:	:	:	:	:	:
50	Kenta Watanabe	Yes	No	Yes	No	Yes
51	Response	Q1	Q2	Q3	Q4	Q5
52	Yes					
53	No					

- a) COUNTIF(\$B2:\$B50, =A\$52)
- b) COUNTIF(B\$2:B\$50, =\$A52)
- c) COUNTIF(\$B2:\$B50, =\$A52)
- d) SUMIF(B\$2:B\$50, =A\$52)

**Q 10-4**

In order to calculate the gross profit ratio for each product, an expression in cell G2 of the worksheet shown below will be entered, and copied into the cell range G3:G7.

Which of the following is the expression that should be entered in cell G2?

Gross profit ratio has percentage to the first decimal place set as its display format.

	A	B	C	D	E	F	G
1		Cost price	Unit price	Quantity	Sales	Gross profit	Gross profit ratio
2	Product A	1,000	2,000	2,310	4,620,000	2,310,000	31.5%
3	Product B	2,500	4,500	300	1,350,000	600,000	8.2%
4	Product C	1,700	3,000	2,500	7,500,000	3,250,000	44.4%
5	Product D	350	500	3,100	1,550,000	465,000	6.3%
6	Product E	1,000	3,000	350	1,050,000	700,000	9.6%
7	Total			8,560	16,070,000	7,325,000	100.0%

- a) F2/E2
- b) \$F7/F2
- c) F2/SUM(E\$2:E\$7)
- d) F2/F\$7

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# Index

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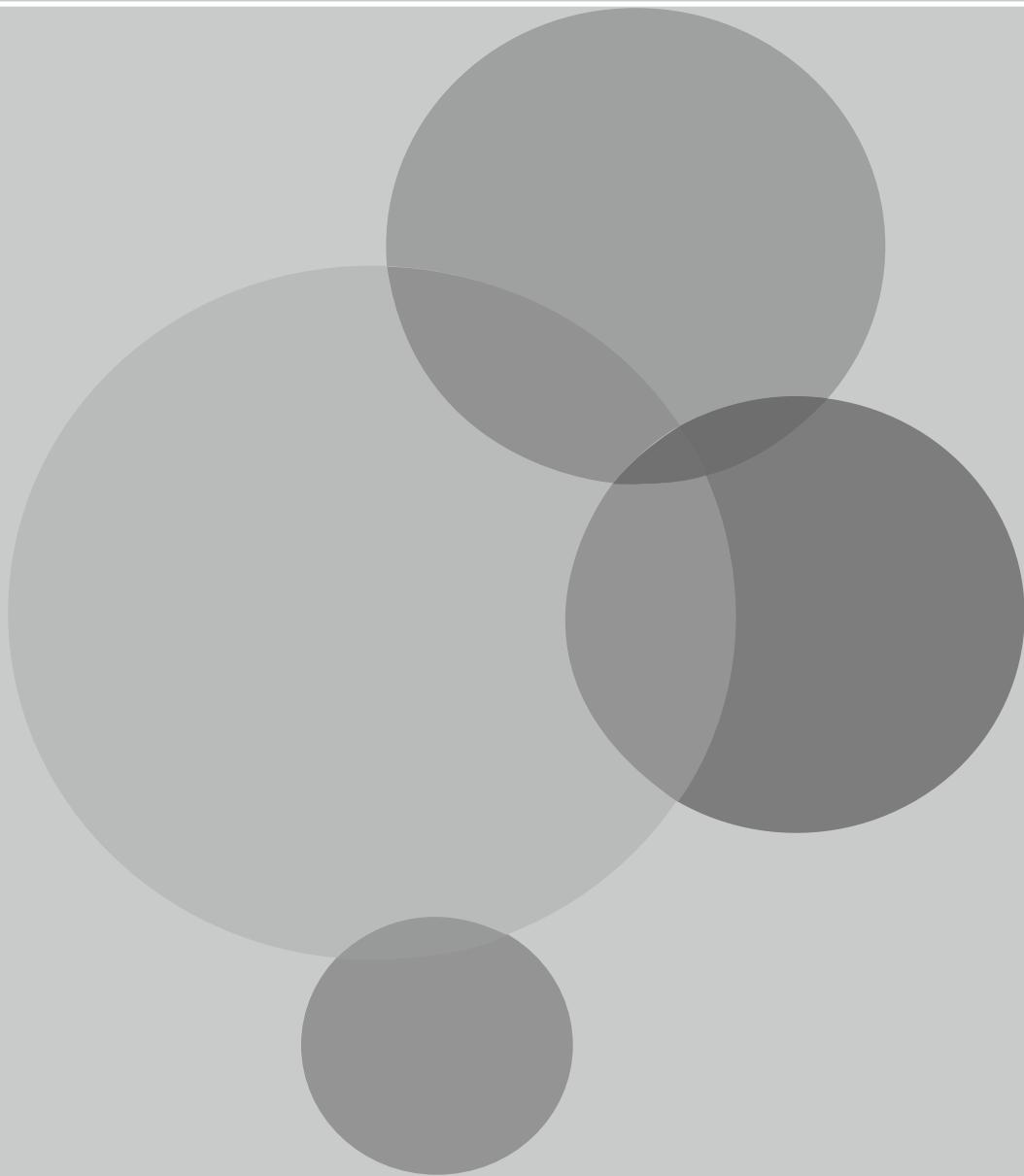
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# **New IT Passport Examination Preparation Book**

## **Chapter Quiz Answers and Explanations**

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# Chapter Quiz Answers and Explanations

## Chapter 1 Corporate and Legal Affairs

**Q 1-1 Answer C)**

(Category) 1-2 Legal Affairs

### Explanation

"Copyright" is a right to protect something represented creatively by a creator. When program is created, its copyright generally belongs to the creator. Therefore, the copyright originally belongs to Employee D; however, when a program is developed as a task, unless otherwise specified, its copyright belongs to the company (Company C).

- a) and b): They do not actually develop program; therefore, the copyright does not belong to them.
- c) It is the person who developed program; however, because it was developed at work, and no other contract was concluded concerning copyrights, the copyright does not belong to Employee D.

**Q 1-2 Answer a)**

(Category) 1-1 Corporate Activities

### Explanation

Accounts receivable is the money not collected yet at the time when sales are made, and generally, the collection deadline is clearly stated in the accounts receivable. In this table, payment delays where the payment cannot be confirmed after the collection deadline has passed are divided into four (4) categories. "Accounts receivable that passed the collection deadline" means all uncollected money that payment cannot be confirmed; therefore, the amount is 1,200 dollars. The question states "a long-term bond is defined as the account that payment delay is 91 days or more"; therefore, the long-term bond amount of Company D is 180 dollars.

The ratio of the long-term bond amount against the accounts receivable that passed the collection deadline is as follows:

$$180 \text{ dollars} \div 1,200 \text{ dollars} = 0.15 (15\%)$$

					Units: \$10
	Payment confirmed	Payment delayed (1 to 30 days)	Payment delayed (31 to 60 days)	Payment delayed (61 to 90 days)	Payment delayed (91 days or more)
1st Sales Department	880	12	5	5	3
2nd Sales Department	97	15	8	4	10
3rd Sales Department	550	10	7	3	3
4th Sales Department	390	21	10	2	2
Total: 1,200 dollars					Total: 180 dollars

**Q 1-3 Answer d)**

(Category) 1-2 Legal Affairs

**Explanation**

Some tasks have a limited duration for a staffed company to accept a temporary worker. Such acceptance duration of the temporary worker is also included even if the staffed worker is changed during the certain duration. Therefore, it is necessary for the staffed company to give notification concerning the duration limit when concluding a temporary worker dispatch contract.

- a) Complaints from the temporary worker must be handled properly by the staffed company.
- b) When the staffed company to dispatch the temporary worker to another company even if it is a group company of the staffed company, it is regarded as redispensing, which is a violation of Employment Security Law.
- c) When the staffing company (source of dispatching) reaches an agreement about working overtime and working on holidays in the Article 36 agreement, overtime work and work on holidays can be requested within the range of the agreement. "Article 36 agreement" is an agreement that labor exceeding the work hours (eight (8) hours a day, and 40 hours a week) determined by the Labor Standards Law becomes possible.

**Q 1-4 Answer a)**

(Category) 1-1 Corporate Activities

**Explanation**

"ABC analysis" is an analysis method to clarify a significant level and a priority level of an element and an item (product, etc.). In general, the group occupying the upper 70% is categorized as Group A, 70 to 90% as Group B, and the rest as Group C, and Group A is given focus and high priority management.

In the table, when the sales and the component ratio of each product are added, and they are sorted in the descending order by using the sales as a basis, it looks as follows:

Product code	Sales volume	Unit price	Sales	Component ratio
3	860	900	774,000	29.9%
5	2,200	250	550,000	21.2%
8	1,570	320	502,400	19.4%
7	905	320	289,600	11.2%
10	345	350	120,750	4.7%
9	640	150	96,000	3.7%
4	465	180	83,700	3.2%
1	480	150	72,000	2.8%
6	680	90	61,200	2.4%
2	600	65	39,000	1.5%
Total			2,588,650	100.0%

When Group A, B, and C are categorized from above, it looks as follows:

Group A: Product code 3, 5, and 8

Group B: Product code 7, 10, and 9

Group C: Product code 4, 1, 6, and 2

**Q 1-5 Answer a)**

(Category) 1-2 Legal Affairs

**Explanation**

The Act on the Prohibition of Unauthorized Computer Access is a law that prohibits unauthorized access. In Act on the Prohibition of Unauthorized Computer Access, it is prohibited to provide other's user ID and password except for its authorized user and administrators, and regarded as an action to facilitate unauthorized access. Therefore, the answer is a).

b), c), and d): Not applicable as actions to encourage unauthorized access.

**Q 1-6 Answer d)**

(Category) 1-1 Corporate Activities

**Explanation**

The initial inventory is four (4) units, the total purchase from October to February is  $2 + 4 + 3 + 5 = 14$  units, and then the end of term inventory is 10 units; therefore,  $4 + 14 - 10 = 8$  were shipped.

The first-in first-out method is a method for calculating the inventory evaluation value on the end of term inventory products being deemed as having been made from old products.

When eight (8) units were shipped from the old ones, the purchased inventory for November is two (2) units, January is three (3) units, and February is five (5) units. The inventory evaluation value can be obtained by multiplying the purchased inventory on these months that had inventory, November, January, and February, by the unit price respectively, and adding each result.

	Count	Unit price	Shipment	Inventory	Inventory evaluation value
Initial inventory	4 units	1 dollar	4 units	0 units	
Oct. purchase	2 units	1.1 dollars	2 units	0 units	
Nov. purchase	4 units	1.2 dollars	2 units	2 units	$2 \text{ units} \times 1.2 \text{ dollars} = 2.4 \text{ dollars}$
Jan. purchase	3 units	1.3 dollars		3 units	$3 \text{ units} \times 1.3 \text{ dollars} = 3.9 \text{ dollars}$
Feb. purchase	5 units	1.4 dollars		5 units	$5 \text{ units} \times 1.4 \text{ dollars} = 7 \text{ dollars}$
End of term inventory	10 units				$2.4 \text{ dollars} + 3.9 \text{ dollars} + 7 \text{ dollars} = 13.3 \text{ dollars}$

Therefore, the answer is d).

**Q 1-7 Answer b)**

(Category) 1-2 Legal Affairs

**Explanation**

The law enacted in order to control unfair competitive actions such as stealing trade secrets that a company does not disclose, creating imitation goods, and spreading disadvantageous rumors for competitors is the Unfair Competition Prevention Act. When these unfair competitive actions are allowed and neglected, the adequate competition principle is destroyed, causing market confusion and significant damage to consumers.

- a) Copyright Act is a law to protect something represented creatively (drawings, novels, program, and web pages).
- c) The Act on Specified Commercial Transactions is a law that provides a specified control for those who engage in door-to-door sales, mail order sales, and telemarketing sales, and determines rules that business owners must comply with in order to protect consumers.
- d) The Act on the Prohibition of Unauthorized Computer Access is a law to prohibit unauthorized access.

**Q 1-8 Answer c)**

(Category) 1-1 Corporate Activities

**Explanation**

Expression to obtain an ordering quantity in the periodical ordering method is as follows:

$$\text{Ordering quantity} = (\text{Ordering cycle} + \text{Delivery lead time}) \times \text{Average planned usage quantity} + \text{Safety stock} - \text{Current inventory quantity} - \text{Current order remaining}$$

Therefore, the ordering quantity for this time is as follows:

$$(1 \text{ week} + 3 \text{ weeks}) \times 70 \text{ items} + 35 \text{ items} - 210 \text{ items} = 105 \text{ items}$$

## Chapter 2 Business Strategy

**Q 2-1 Answer C)**

(Category) 2-1 Business Strategy Management

### Explanation

Cross-selling is a technique for expanding sales by convincing a customer to buy not only an individual product, but recommending other products and services, etc. related to that product and convincing the customer to buy those too together.

- a) Test marketing refers to the sales of a product, on a test basis, in a restricted region and market before the actual start of sales of the product.
- b) Pull strategy is a strategy of making customers buy the products of one's company by arousing customer willingness to purchase through media such as television and magazines.
- d) Up-selling is a technique of recommending products with a better quality and a higher price than the product that a customer wishes to buy, thus increasing the purchase amount.

---

**Q 2-2 Answer a)**

(Category) 2-1 Business Strategy Management

### Explanation

Marketing mix is a combination of marketing tools used to achieve the purpose of marketing in a market, and typically includes "Four Ps (4Ps)" taken into consideration from the viewpoint of the sales side, and "Four Cs (4Cs)" that are considered from the viewpoint of the customer side.

The "Four Ps" are "Product," "Price," "Place," and "Promotion," and the four Cs are "Customer Value," "Cost," "Convenience," and "Communication."

---

**Q 2-3 Answer b)**

(Category) 2-3 Business Industry

### Explanation

RFID (Radio Frequency IDentification) is a mechanism of embedding an IC chip in the belongings of a person as well as products to manage them. A minute radio chip is processed into a label seal or a wrist band, etc. and thus used for managing the entry and exit of persons and the distribution history of products. Since it is possible to simultaneously read information from several chips, it can be handled more quickly than reading a barcode.

- a) It is the characteristic of a POS system (Point Of Sales system).
- c) It is the characteristic of a GPS (Global Positioning System) application system.
- d) It is the characteristic of electronic money. Typical examples of services include Edy, Suica, and Osaifu-Koitai (wallet cellphone).

---

**Q 2-4 Answer b)**

(Category) 2-1 Business Strategy Management

### Explanation

The analysis technique asked in the question is called PPM (Product Portfolio Management).

- a) SWOT analysis is an analysis technique for analyzing and evaluating the internal environment of an organization, such as its strengths and weaknesses, and external factors such as opportunities and threats in the market.
- c) Marketing research refers to the collection of related information such as the market size and trend in order to ensure that a company effectively proceeds with its activities like development and sales of products, and advertising, etc.
- d) Basket analysis is a technique of analyzing that a customer who has purchased a particular product has purchased what other products at the same time.

**Q 2-5 Answer d)**

(Category) 2-1 Business Strategy Management

**Explanation**

A CIO (Chief Information Officer) not only simply performs the role of an administrator of an information system, but also bears the responsibility of creating the business strategy of the company using the information system.

- a) A CEO (Chief Executive Officer) bears the operational responsibility as a representative of a company.
- b) A CFO (Chief Financial Officer) bears the responsibility of managing financial affairs such as procurement of capital and finance, etc.
- c) A COO (Chief Operating Officer) bears the responsibility of the daily business operations centered mainly on the sales activities under a CEO having responsibility of the entire business.

**Q 2-6 Answer b)**

(Category) 2-1 Business Strategy Management

**Explanation**

A niche strategy is a strategy by which products are developed by setting the focus on a specific market (niche market) so as to secure and maintain profitability in such a market.

It is believed that in b), a specific layer of customers is aimed at by using organic vegetables and high-grade Japanese cattle as ingredients. Therefore, it can be called a niche strategy.

- a) A strategy of improving the brand image of one's company by having a prominent figure appeal for something that he/she uses regularly.
- c) Sampling sales corresponds to a push strategy by which the products of one's company are aggressively sold to consumers.
- d) The sales promotion activity through television commercials corresponds to the pull strategy.

**Q 2-7 Answer c)**

(Category) 2-1 Business Strategy Management

**Explanation**

M&A is a general term for Merger and Acquisition of companies, and while Merger refers to combining of several companies into a single company, Acquisition means buying an entire or a part of a company. Through M&A, it is possible to develop new businesses in a short period of time by acquiring technologies and know-how that one's own company does not have.

Capital participation refers to acquisition of the stocks of a counterpart company to become its stockholder in order to strengthen the cooperation with the company. Due to possession of capital of the counterpart company, this form gives rise to a cooperative relationship.

Therefore, in order to develop new businesses in a short period of time by acquiring technologies and know-how that Company A does not have, Company A is planning an M&A with Company B that is strong in the EC business, and even if the M&A is unsuccessful, Company A is examining "capital participation" in Company B in order to deepen the association with Company B.

- a) OEM refers to the manufacture of products that are sold under the brand of a partner company, and does not have any relation to the development of new businesses by Company A in a short period of time.
- b) OEM does not have any relation to the development of new businesses by Company A in a short period of time. Benchmarking refers to the analysis of the best methods of the superior companies and superior examples, and the use of the hints acquired from the analysis results for the improvement of management and business operations, and does not have any relation to deepening of cooperation with Company B.
- d) A franchise chain refers to a segment of the retail industry according to which the head office offers the business rights, trademarks, and business knowhow to stores, and collects loyalty (compensation) from member stores, and does not have any relation to deepening of cooperation with Company B.

## Chapter 3 System Strategy

**Q 3-1 Answer b)**

(Category) 3-1 System Strategy

### Explanation

Computerizing the analysis of large volumes of data makes the work of searching for and aggregating necessary data more efficient, and enables prompt and accurate decision making in business strategy and enterprise strategy.

- a) Computerization offers the benefits of business efficiency and support for decision making. It also makes increased productivity and cost reductions feasible through the automation of routine work.
- c) Information system strategy does not haphazardly direct the computerization of all work. Rather, it correctly assesses the current business tasks and business flow, and engages in computerization on the basis of the company's business strategy and enterprise strategy, with an eye toward the benefits to be gained.
- d) A computerization promotion system is centered not on the COO (Chief Operating Officer) but rather the CIO (Chief Information Officer). Under the system, total computerization planning that targets work overall is first created.

---

**Q 3-2 Answer d)**

(Category) 3-1 System Strategy

### Explanation

Offshore outsourcing is a form of outsourcing by which a company entrusts a portion of its work to service providers in overseas locations where personnel costs and other expenses are relatively low.

- a) This is a description of online storage. Online storage refers to services by which server space on the Internet is rented for the purpose of data storage. Data stored on the Internet can be accessed at any time from a location with a connection to the Internet.
- b) This is a description of housing service. A housing service is a form of outsourcing by which a company prepares its own servers, communications equipment, and other equipment, and entrusts these with a business provider that has a prepared environment with communication lines, power supply, etc. The service is convenient when an existing system is relocated as-is.
- c) This is a description of a system integrator. A system integrator is a company that undertakes comprehensive work including the design, development, testing, operation, and maintenance of information systems. By using a system integrator lets even companies without system development experience develop information systems.

---

**Q 3-3 Answer a)**

(Category) 3-1 System Strategy

### Explanation

Digital divide refers to the way in which differences in information collection capabilities result in inequalities, such as disadvantages or restricted potential for participation in society because of the inability to use computers, the Internet, and other information tools.

Solving the problem of the digital divide requires education on information technology, along with activities for its promotion, by the government, private enterprise, and other organizations.

- b) This is a description of diversity.
- c) This is a description of accessibility.
- d) This is a description of information ethics.

**Q 3-4 Answer a)**

(Category) 3-2 System Planning

**Explanation**

The necessary expenses for Company F's system are as follows:

Initial investment cost	400,000 dollars
Expenses involving system operation (annual)	5,000 dollars/month × 12 months = 60,000 dollars/year
Annual maintenance fees	400,000 dollars × 10% = 40,000 dollars/year

The effect (annual) following launch of the system is as follows:

$$25,000 \text{ dollars/month} \times 12 \text{ months} = 300,000 \text{ dollars/year}$$

A payout period is assumed to be  $n$  years.

Since the investment can be recouped if effect exceeds necessary expenses, the expression is as follows:

$$3,000n \geq 4,000 + 600n + 400n$$

$$2,000n \geq 4,000$$

$$n \geq 2$$

Therefore, the payout period is two (2) years.

**Q 3-5 Answer b)**

(Category) 3-2 System Planning

**Explanation**

"Procurement" refers to the purchasing activities for the purpose of arranging the products and services necessary for the execution of business. It is carried out in this order: "[1] Creation of an RFI (Request For Information) document to request information" → "[2] Creation of an RFP (Request For Proposals) document to request proposals for a system" → "[3] Collection of proposals" → "[4] Collection of estimates" → "[5] Selection of a supplier company" → "[6] Conclusion of a contract."

An RFI is a document that is used to request information related to computerization from system vendors or other companies that are supplier candidate companies.

An RFP is a document used to ask system vendors or other supplier candidate companies to make specific system proposals.

Therefore, "RFI" corresponds to X, and "RFP" corresponds to Y in the text.

**Q 3-6 Answer c)**

(Category) 3-1 System Strategy

**Explanation**

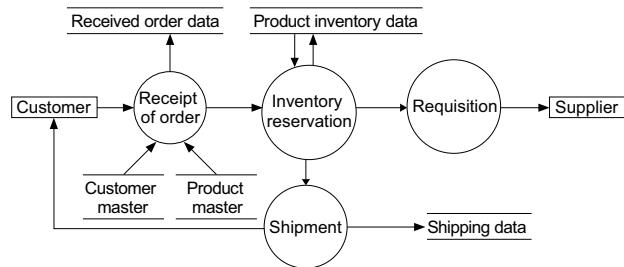
A DFD (Data Flow Diagram) is a technique for representing the business flow as a flow of data, by using the four (4) elements of data flows, processes, data stores (files), and external entities (data sources/data absorption) to model work and systems.

As the ○ in the diagram represents a process, it corresponds to either processing of order receipt, processing of requisition, processing of shipping, or processing of inventory reservation. In addition, — represents a data store.

First, upon considering what each process is, A and C are dealings with customers. Therefore, these are either processing of order receipt or processing of shipping. Since A receives data from customers, this data can be deemed to be an order. Therefore, A is processing of order receipt. Moreover, as C delivers data to customers, this data can be deemed to be delivery. Therefore, C is processing of shipping. Since D delivers data to suppliers, this data can be deemed to be requisition. Therefore, D is processing of requisition. Moreover, as B delivers data to the processing of requisition and processing of shipping, these data can be deemed to be requisition instruction and shipping instruction. Therefore, B is processing of inventory reservation.

Next, considering what each data store is, [1] writes data from processing of order receipt, and thus is received order data. [2] reads in and writes data in processing of inventory reservation, and thus can be deemed to be processing that checks the number of products in inventory and update the number if reservation is possible. Therefore, [2] is product inventory data. [3] and [4] read data in the processing of order receipt, and thus are the customer master or the product master. [5] writes data in the processing of shipping, and thus is shipping data.

Therefore, [1] is received order data, [2] is product inventory data, [3] and [4] are the customer master or the product master, and [5] is shipping data, which means that c) is the correct answer.



**Q 3-7 Answer b)**

## Category 3-1 System Strategy

## **Explanation**

SaaS (Software as a Service) is a service that uses the Internet to deliver only necessary functions of software to multiple companies, which pay usage fees for those functions. Software normally provides its functions equally to all users, who therefore must pay fees even for functions that are not necessary. By contrast, SaaS offers a benefit in that users pay fees only for necessary functions.

- a) This is a description of on-premises.
  - c) This is a description of IaaS (Infrastructure as a Service).
  - d) This is a description of PaaS (Platform as a Service).

**Q 3-8** | **Answer** **a)**

## (Category) 1-1 Corporate Activities

## **Explanation**

The break-even point is the point at which sales and costs are equal and both profit and loss are zero (0). The calculation method is as follows:

Variable cost ratio ..... 200,000 dollars  $\div$  800,000 dollars = 0.25

Contribution profit ratio .....  $1 - 0.25 = 0.75$

Net sales at break-even point ..... 120,000 dollars  $\div$  0.75 = 160,000 dollars

Therefore, 160,000 dollars is the break-even point above which makes profit and below which makes loss.

**Q 3-9 Answer a)**

(Category) 2-1 Business Strategy Management

**Explanation**

A completed table, with expressions that meet the instructions are entered in the conditions, is as follows:

	A Store name	B Sales (10 dollars)	C Daily average number of customers (persons)	D Number of seats in the store (seats)	E Average spending per customer (yen)	F Seat turnover (number of times)	G Congestion rate (%)	H Difference from average congestion rate	I Congestion status
1									
2	Store J	704	327	30	590	10.9	77.9%	14.4%	◎
3	Store K	486.4	437	150	305	2.9	20.8%	-42.7%	×
4	Store L	219.4	145	10	415	14.5	103.6%	40.1%	◎
5	Store M	394.5	198	20	546	9.9	70.7%	7.2%	○
6	Store N	976.8	500	45	535	11.1	79.4%	15.9%	◎
7	Store O	555.7	260	35	586	7.4	53.1%	-10.4%	×
8	Store P	398	600	50	182	12.0	85.7%	22.2%	◎
9	Store Q	878	405	50	594	8.1	57.9%	-5.6%	○
10	Store R	619	250	40	678	6.3	44.6%	-18.9%	×
11	Store S	1,156	350	60	905	5.8	41.7%	-21.8%	×
12		Average			533	8.9	63.5%		

Conditional evaluation here is performed under the following condition: if H2 is -0.1 or less, the result is ×; if H2 is higher than -0.1 but less than or equal to 0.1, the result is ○; and otherwise, the result is ◎. If "H2 ≤ 0.1" is subject to conditional evaluation first, values of -0.1 or less will also be included. Therefore, "H2 ≤ -0.1" must be evaluated first.

**Q 3-10 Answer a)**

(Category) 2-1 Business Strategy Management

**Explanation**

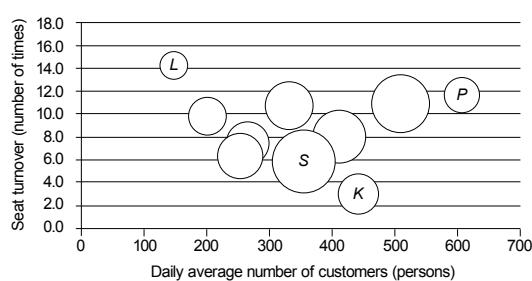
There are four (4) stores for which congestion status is ◎: Store J, Store L, Store N, and Store P. Among these, one (1) store has a daily average number of customers of 300 or less: Store L.

**Q 3-11 Answer d)**

(Category) 1-1 Corporate Activities

**Explanation**

When the charts are compared against the [Store-specific sales analysis worksheet], the bubble chart that correctly expresses the daily average number of customers and the seat turnover is d).



## Chapter 4 Development Technology

**Q 4-1 Answer d)**

(Category) 4-1 System Development Technology

### Explanation

Software to be developed is required to have a high quality. The standard for the quality characteristics is JIS X 0129 (ISO/IEC 9126). The quality characteristics of software products include "Functionality," "Reliability," "Usability," "Efficiency," "Maintainability," and "Portability."

It corresponds to the reliability whether a system can restore the immediately preceding state without losing data after unexpected operation. The reliability is associated with the measurement of the extent of whether or not a software product continues to work correctly.

- a) The portability is associated with the measurement of the extent of whether or not a software product can be easily transplanted to work under a different environment.
- b) The maintainability is associated with the measurement of the extent of whether or not revisions to a software product are easy to make (whether or not the coverage affected by a revision is small).
- c) The usability is associated with the measurement of the extent of whether or not a software product is easy to use (has good operability).

**Q 4-2 Answer b)**

(Category) 4-2 Software Development Management Techniques

### Explanation

CMMI (Capability Maturity Model Integration) came into existence through adding to CMM (Capability Maturity Model) the opinions of well-informed persons and some improvements, and through integrating various types of CMM. The CMMI is an index for evaluating and/or improving the processes of system development and maintenance, that allows an objective evaluation of the software development capability of an organization.

In CMMI, the degree of maturity is defined in the following five levels:

Level	Process maturity level	Description
1	Initial state	System development rules do not exist. Development capability is dependent on the skills of individuals.
2	Managed state	System development rules exist and managed as the rules of thumb for the organization.
3	Defined state	System development rules are defined for the organization, and systems of a certain level of quality can be steadily developed.
4	Quantitatively managed state	In addition to Level 3, development performance can be evaluated quantitatively on the basis of certain criteria.
5	Optimized state	In addition to Level 4, the organization continuously works towards the improvement of development processes.

**Q 4-3 Answer c)**

(Category) 4-1 System Development Technology

### Explanation

Software maintenance refers to monitoring of the usage and operation conditions after the start of system production operation, and to revising and changing the program to support the stable operation of the system, or to cope with the progress of information technology or changes in business strategy.

- a) Since the set of documents (such as design documents and operation manuals) concerning system development must always be maintained in the latest state, the act of recording the contents of program revisions in a document after the start of system operation corresponds to software maintenance.
- b) Since it is a program revision before the system operation, it does not correspond to software maintenance.
- d) The revision of a program performed after the start of system operation corresponds to software maintenance.

**Explanation**

A turnkey contract is also called a contract for work in that an outsourcing company requests business operation to an outsourced company, and guarantees to pay remuneration when the business operation is complete.

- a) If a remuneration needs to be paid for some kind of a process, it refers to a time and material contract.
- b) An outsourcing company cannot issue direct instructions to the employees of an outsourced company.
- c) In a contract for work, an outsourced company can perform an activity by using a subcontractor.

**Explanation**

The “White box test” is a test technique of focusing on the control and the flow of a program, and checking the internal structure and the logic of the program. It involves focusing on the internal structure of the program, and performing the test so that all operation statements and all branch conditions may be covered.

- a) The “Black box test” is a test technique of focusing on the resultant output with respect to the entered data, and checking whether the functions work in accordance with the specifications.
- c) The “Top-down test” is one of the methods of the integration test in that testing is performed in an order starting from a higher-level module.
- d) The “Bottom-up test” is one of the methods of the integration test in that testing is performed in an order starting from a lower-level module.

**Explanation**

A spiral model is a development model in that a system is divided into multiple subsystems and the degree of perfection of the system is raised by repeating the cycle of requirements definition, system design, development, and testing within each subsystem. It is also called an iterative model. In a spiral model, since the user (system user departments) verifies each subsystem and the requirements of the user can be incorporated in the next cycle, user satisfaction increases, but the management of the development process becomes complex.

- a) A prototyping model is a development model in that a prototype (trial product) is created in an early stage of system development, and the development proceeds with while obtaining the confirmation of the user (system user departments).
- b) Reverse engineering refers to the analysis of existing software and the extraction of information such as the mechanism and the specifications of the software.
- c) A waterfall model implies “falling water,” and is a development model in that a system development process is divided into subprocesses, and the development of one subprocess leads to that of another in a sequence starting from the upstream subprocess to the downstream subprocess, without return.

## Chapter 5 Project management

**Q 5-1 Answer b)**

(Category) 5-1 Project Management

### Explanation

First, find how many 25% of programs must be created in the company.

$$8,000 \times 25\% = 2,000$$

Then, find the necessary days to create 2,000 programs.

$$2,000 \div 0.2 = 10,000 \text{ days}$$

Finally, find what is the number of person-months necessary to complete the task by working for 20 days (one (1) person-month = 20 days) per month.

$$10,000 \text{ days} \div 20 \text{ days} = 500 \text{ person-months}$$

Therefore, the answer is b).

---

**Q 5-2 Answer c)**

(Category) 5-1 Project Management

### Explanation

Milestones are major points in a schedule to check for a discrepancy with the initial plan and necessity of plan changes afterwards. System acceptance is for a user to accept a developed system. Acceptance means the system goes through various tests and is determined as adequate. The system migrates from the development stage to the operation stage; therefore, it is a milestone.

- a) Calculation of cost for system installation is not appropriate as a milestone because it is still in the budget determination stage. A budget is determined after calculated cost are evaluated and approved; therefore, the budget determination stage is more appropriate as a milestone.
- b) Proposal of a test plan is in the middle of the planning stage; therefore, it is not appropriate as a milestone. A test plan is determined after being proposed, evaluated and approved; therefore, the test plan determination stage is more appropriate as a milestone.
- c) One (1) week of attendance after full operation of the system is started is not appropriate that one (1) week duration after the operation stage is started. More appropriate as milestones are the stage when operation training for users is complete after system operation is started, and the stage when migration from pilot operation (small scale operation in one (1) department) to full operation is approved.

---

**Q 5-3 Answer a)**

(Category) 5-1 Project Management

### Explanation

The whole number of work days when the number of necessary days for Task F is one (1) day is as shown below.

$$\text{Task A (2)} + \text{Task C (4)} + \text{Task E (2)} + \text{Task G (3)} = 11 \text{ days}$$

The whole number of work days when the number of necessary days for Task F becomes three (3) days, as shown below.

$$\text{Task A (2)} + \text{Task C (4)} + \text{Task F (3)} + \text{Task G (3)} = 12 \text{ days}$$

Therefore, one (1) day is extended in the number of overall necessary days.

**Q 5-4 Answer C)**

(Category) 5-1 Project Management

**Explanation**

PMBOK (Project Management Body Of Knowledge) is the systematized knowledge required for project management, also called the de facto standard and world standard of project management. It is a guideline for a project manager to perform a project comprehensively. Management targets such as scope, time, and cost are subdivided as knowledge areas.

a ), b), and d) are explanations of PMBOK.

c ) is a explanation of CMMI (Capability Maturity Model Integration).

**Q 5-5 Answer b)**

(Category) 5-1 Project Management

**Explanation**

If there are 12 program task processes, for example, Mr. A completes one (1) process in one (1) day, and therefore, it takes 12 days. Mr. B completes two (2) processes in one (1) day, and therefore, it takes six (6) days. 10% of one (1) day's work hours is used for discussion when they work together; therefore, the actual work hours are 90% of one (1) day. When the number of days for them to work together is presented by  $x$ ,  $x$  can be obtained with the following expression.

$$(1 \times 0.9)x + (2 \times 0.9)x = 12$$

$$0.9x + 1.8x = 12$$

$$x = 12 \div 2.7 = 4.444\cdots$$

Therefore, at least five (5) days are necessary.

**Q 5-6 Answer b)**

(Category) 5-1 Project Management

**Explanation**

The number of necessary days for each person in charge on each process is shown below.

**[Person in charge A]**

Design .....  $20 \div 2.5 = 8$  days

Programming .....  $40 \div 8 = 5$  days

Testing .....  $18 \div 9 = 2$  days Total 15 days

**[Person in charge B]**

Design .....  $20 \div 2.5 = 8$  days

Programming .....  $40 \div 6.25 = 6.4$  days

Testing .....  $18 \div 5 = 3.6$  days Total 18 days

**[Person in charge C]**

Design .....  $20 \div 5 = 4$  days

Programming .....  $40 \div 8 = 5$  days

Testing .....  $18 \div 6 = 3$  days Total 12 days

**[Person in charge D]**

Design .....  $20 \div 2.5 = 8$  days

Programming .....  $40 \div 12.5 = 3.2$  days

Testing .....  $18 \div 5 = 3.6$  days Total 14.8 days

Therefore, the person in charge who takes the most number of days for development is B.

**Q 5-7 Answer d)**

(Category) 5-1 Project Management

**Explanation**

WBS (Work Breakdown Structure) is a hierarchical chart where the scope of work of a project is subdivided (broken down to elements) into detailed items. Created WBS is utilized for planning and management of schedule, cost, human resources, quality, etc.

- a) A management figure is a method to show the process status with a line graph.
- b) DFD (Data Flow Diagram) is a method to represent the work flow as data flow through business and system modeling by using the following four (4) elements: data flow, process, data storage (file), and external (data source / data absorption).
- c) An arrow diagram is one of the methods to create a better work plan, and work order relationship and necessary number of days are represented through arrangement by using arrows.

**Q 5-8 Answer a)**

(Category) 5-1 Project Management

**Explanation**

50% of coding task completed means that tasks for three (3) days are done within the planned person-hours.

The remaining number of days for the tasks is as follows:

$$3 \text{ days (coding)} + 4 \text{ days (compiling)} + 5 \text{ days (testing)} = 12 \text{ days}$$

The whole number of work days is 28 days; therefore, the calculation is  $12 \div 28 = 0.428\dots$

Therefore, the answer is a).

**Q 5-9 Answer c)**

(Category) 5-1 Project Management

**Explanation**

The total budget is 4,000 dollars therefore, the budget usable in each process is 1,000 dollars.

The consumed cost when 40% of Process C is done is shown below.

$$\text{Process C} \cdots 1,000 \text{ dollars} - 480 \text{ dollars} = 520 \text{ dollars}$$

The consumed cost of Process C when the task is continued is as follows:

$$\text{Process C} \cdots 520 \text{ dollars} \div 40\% = 1,300 \text{ dollars}$$

The cost of Process D is reduced by 20% while the cost of Process C remains the same; therefore, the overall cost is shown below.

$$\text{Process D} \cdots 1,000 \text{ dollars} \times (1 - 20\%) = 800 \text{ dollars}$$

$$\begin{aligned} \text{Overall cost} &\cdots \text{Process A (1,100 dollars)} + \text{Process B (900 dollars)} + \text{Process C (1,300 dollars)} \\ &+ \text{Process D (800 dollars)} = 4,100 \text{ dollars} \end{aligned}$$

**Explanation**

IT control is internal control utilizing IT. The purpose is to monitor and control to make sure information systems and managed information are used by a company in healthy and effective ways.

IT control can be classified into operation processing control and overall control. Operation processing control refers to control activities to secure approved tasks under a business managing system to be entirely processed and recorded accurately. Overall control refers to control activities in order to arrange an environment for operation processing control to function effectively.

A consistency check with various types of masters while entering data falls under operation processing control, because it is a control activity to secure tasks to be processed and recorded accurately.

**Explanation**

Facility management is a concept to maintain computers, networks, facilities, equipment, and other things a company possesses in order to keep them in a better state. In facility management of an information system, it is important to prepare for natural disasters such as earthquakes and flood damage, and for accidents such as fire. When a large scale disaster strikes, it is considered difficult to access a data server directly; therefore, it is desirable to have a backup in a remote location.

- a) A hot aisle is a space where only warm air inside a server room is gathered in a data center or other facilities. A cold aisle is a space where only cold air to be drawn by servers is collected through air conditioning equipment. Clearly dividing a hot aisle and cold aisle, and not to mix warm air with cold air will make the air conditioning more effective inside a server room and reduce power consumption; however, it is not related with facility management during a large-scale disaster.
- c) Green IT is a concept to lead to whole society's energy-saving and environment protection by utilizing IT equipment including energy conservation and effective utilization of IT equipment. It corresponds to green IT to reduce the number of business trips through installing a teleconference system to contribute to the reduction of CO<sub>2</sub> emission in the whole of society. It is not related to facility management under a large-scale disaster.
- d) Even if a power source within a data center has a redundancy system, it is not considered to be prepared for a large-scale disaster since such a redundant power system does not function when a data center itself is damaged or power supply is discontinued because of a large-scale disaster.

**Q 6-3 Answer d)**

(Category) 6-1 Service Management

**Explanation**

Service desk is a window to respond to users' inquiries. It is also called a call center, user support, etc.

Generally, various inquiries are accepted, such as how to use a product, how to use a service, how to cope with trouble, or a repair request on failure. It also responds to claims and complaints. Inquiries are accepted through the telephone, fax, e-mail, etc.

- a) If there are multiple separate windows on service desk depending on a type of inquiry contents, users may be unable to easily find an appropriate window to contact, or may have to use time to investigate an appropriate window; therefore, it is better for the window of the service desk to be integrated.
- b) Accumulating inquiry contents in a database will help to provide a prompt response for similar inquiries. When inquiry contents are registered to a database, unnecessary personal information should not be included; however, if even inquiry contents are deleted, necessary information cannot be accumulated, and therefore, a prompt response cannot be provided.
- c) A set of commonly asked questions and their answers gathered together is called FAQ (Frequently Asked Questions), and many companies publicize these questions and answers in a web site for users to browse freely. Users can obtain answers themselves; therefore, it can save time and labor in dealing with inquiries.

Therefore, the content of c) is appropriate for content to examine when a service desk is established.

**Q 6-4 Answer b)**

(Category) 6-1 Service Management

**Explanation**

Facility management is a concept to maintain computers, networks, facilities, equipment, and other things a company possesses in order to keep them in a better state.

- a) A power outlet with built-in surge protector can prevent damage caused by abnormally high voltage generated momentarily when struck by lightning. Therefore, it is one of the implementation items of environment arrangement along the lines of facility management.
- b) To encrypt data that flows through a network is an implementation item of environment arrangement along the lines of information security management, and therefore, it is not related to facility management.
- c) If a security cable is attached to a laptop, theft of equipment can be prevented. Therefore, it is one of the implementation items of environment arrangement along the lines of facility management.
- d) Installing a UPS (Uninterruptible Power Supply) can prevent power failure caused by power service outage or momentary power supply outage. Therefore, it is one of the implementation items of environment arrangement along the lines of facility management.

**Q 6-5 Answer d)**

(Category) 6-2 System Audit

**Explanation**

System audit is performed by a system auditor who is an independent third party to verify and evaluate a system comprehensively, and to give advice and recommendations to the people concerned. It is used to help make judgment on whether or not the system is making a contribution to business management. In order to audit information systems properly, system audit standards are provided where the code of conduct required for system auditors is described.

- a) System audit should be performed in accordance with a standard, not from the subjective perspective of an auditor.
- b) Preliminary audit is performed before a main audit in order to grasp the overview of a target system.
- c) After audit is completed, the auditor creates an audit report and communicates the results to the business owner, audited departments, and related departments.

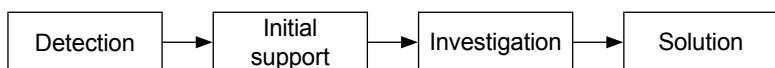
**Q 6-6 Answer b)**

(Category) 6-1 Service Management

**Explanation**

Incident management (fault management) is a series of activities from detection of an incident (failure or accident) occurred in IT service to its resolution. When an incident occurs, it is required to recover normal service operation as soon as possible, to minimize impact on business, and to maintain service quality.

In incident management, after an incident is first detected, its degree of effect is judged and initial support is provided. Then, if the incident cannot be solved with the initial support, the process flow is to perform an investigation and to solve the problem.



Therefore, A is "investigation", and the answer is b).

**Q 6-7 Answer a)**

(Category) 6-2 System Audit

**Explanation**

Internal control is to structure a framework by a company itself to allow business to be conducted properly. Policies and procedures to integrate internal control into business activities are called control activities. In order to actualize control activities, risks are clarified for illegal act and fraudulent behavior to occur in business, authorities of each personnel are clarified and work responsibility is divided into multiple personnel duties (separation of job duties). Rules for responding to the risks are set and their implementation condition is checked. Therefore, the answer is a).

- b) If an illegal act or fraudulent behavior is reported from inside a company, it proves to be an evaluation indicator to show that the internal reporting system is working properly and internal control is functioning correctly.
- c) It is called an external audit when an audit is conducted by an external and independent third party to examine if works are performed properly.
- d) An environment must be arranged to allow everybody in an organization to acquire, communicate, and share necessary information accurately.

**Q 6-8 Answer c)**

(Category) 1-1 Corporate Activities

**Explanation**

The production amount per non-skilled worker in one (1) week is calculated as follows:

$$\text{Production amount in one (1) week} \quad 20 \text{ (pieces/hour)} \times 4 \text{ (hours)} \times 5 \text{ (days)} = 400 \text{ pieces}$$

Therefore, c) is the answer.

- a) It is the cumulated production amount of one (1) skilled worker and one (1) non-skilled worker in one (1) week.
- b) It is the cumulated production amount of one (1) skilled worker in one (1) week.
- c) It is the production amount of one (1) skilled worker and one (1) non-skilled worker in one (1) day, but not cumulated.

**Q 6-9 Answer b)**

(Category) 5-1 Project Management

**Explanation**

A 50% increase from the current production amount of 2,400 pieces means 1.5 times the production amount, which makes 3,600 pieces.

These 3,600 pieces are the weekly production amount; therefore, the production amount in one (1) day is  $\frac{1}{5} 720$  pieces.

Take variable  $x$  to be the work hours in one (1) day, then the production amount of one (1) skilled worker in one (1) day is  $30x$ , and that of one (1) non-skilled worker is  $20x$ . Therefore,

$$30x \times 2 \text{ (workers)} + 20x \times 3 \text{ (workers)} = 720 \text{ pieces}$$

$$120x = 720 \text{ pieces}$$

$$x = 6$$

As a result, the work hours in one (1) day is six (6) hours that is two (2) hours more than the current hours.

**Q 6-10 Answer c)**

(Category) 5-1 Project Management

**Explanation**

The production amount of each worker in one (1) week is calculated as follows:

$$\text{Skilled worker } \cdots 30 \text{ (pieces/hour)} \times 4 \text{ (hours)} \times 5 \text{ (days)} = 600 \text{ pieces}$$

$$\text{Skilled worker } \cdots 20 \text{ (pieces/hour)} \times 4 \text{ (hours)} \times 5 \text{ (days)} = 400 \text{ pieces}$$

Take variable  $x$  to be the number of non-skilled workers, then the necessary number of workers to produce 3,600 pieces is as follows:

$$600 \text{ (pieces)} \times 2 \text{ (workers)} + 400x = 3,600 \text{ pieces}$$

$$400x = 2,400 \text{ pieces}$$

$$x = 6$$

Currently the number of non-skilled workers working is three (3), and therefore the number of non-skilled workers to add is three (3).

**Q 6-11 Answer c)**

(Category) 5-1 Project Management

**Explanation**

Since a 50% increase of the current production amount 2,400 pieces is 3,600 pieces, divide it evenly by all the workers.

$$3,600 \text{ pieces} \div (5 \text{ (workers)} \times 4 \text{ (hours)} \times 5 \text{ (days)}) = 36 \text{ pieces}$$

Therefore, if every worker has an ability to produce 36 pieces in one (1) hour, the current number of workers and work hours can remain unchanged.

## Chapter 7 Basic Theory

**Q 7-1 Answer b)**

(Category) 7-1 Basic Theory

### Explanation

When "00101110110" is converted one by one according to the replacement rules, it looks as follows:

0	0	10	11	10	11	0
C	C	A	B	A	B	C

**Q 7-2 Answer a)**

(Category) 7-2 Algorithm and Programming

### Explanation

HTML (HyperText Markup Language) is a language used to create web pages. Control characters called tags are used to designate how a page should be displayed. Major tags used in HTML are shown below.

Tag	Description
<html> - </html>	Start and end of HTML
<title> - </title>	Start and end of a title
<body> - </body>	Start and end of a text body
<p> - </p>	Start and end of a paragraph

CSS (Cascading Style Sheets) is a style sheet language for HTML. A style sheet defines the design and the layout of a web page, such as its character font, size, background, and margins.

- b) It is the explanation of XML (eXtensible Markup Language) and PDF (Portable Document Format).
- c) It is the explanation of Perl (Practical Extraction and Report Language) and W3C (World Wide Web Consortium).
- d) It is the explanation of Java and Unicode.

**Q 7-3 Answer d)**

(Category) 7-1 Basic Theory

### Explanation

A logical expression is represented by AND operation and OR operation. AND is an operation that makes true when both are true, and OR is an operation that makes true when either one is true.

By using this operation, aquariums in City A and art museums in City B are represented as follows:

Aquariums in City A: "City A" AND "aquarium"  
Art museums in City B: "City B" AND "art museum"

In order to obtain a result for either of the two to be true, they are combined with OR operation.

("City A" AND "aquarium") OR ("City B" AND "art museum")

**Explanation**

It is called binary search (half-interval search) to find the position of a target value within a sorted array through narrowing down whether it lies in the first or latter half by comparing it with the middle element of the array.

Steps to find the position of 99 in the array of ticket numbers one (1) through 100 are as follows:

- 1) Find if the issued number 99 lies in the first or latter half by comparing it with the middle value, 50.
- 2) Since the number lies in the latter half larger than 50, find if it lies in the first or latter half by comparing it with the middle value between 51 and 100, that is 75.
- 3) Since the number lies in the latter half larger than 75, find if it lies in the first or latter half by comparing it with the middle value between 76 and 100, that is 88.
- 4) Since the number lies in the latter half larger than 88, find if it lies in the first or latter half by comparing it with the middle value between 89 and 100, that is 94.
- 5) Since the number lies in the latter half larger than 94, find if it lies in the first or latter half by comparing it with the middle value between 95 and 100, that is 97.
- 6) Since the number lies in the latter half larger than 97, find if it lies in the first or latter half by comparing it with the middle value between 98 and 100, that is 99.
- 7) The number meets the middle value 99, and the search completes.

**Explanation**

The voice is sampled 10,000 times in one (1) second. When each sampled value is recorded as eight (8) bit data, the data volume that can be recorded in one (1) second is as follows:

$$10,000 \times 8 \text{ (bits)} = 80,000 \text{ (bits)}$$

When the unit is converted to byte, it becomes:

$$80,000 \div 8 \text{ (bytes)} = 10,000 \text{ (bytes)}$$

The data volume that can be recorded in one (1) minute is  $10,000 \text{ (bytes)} \times 60 \text{ (sec)} = 6 \times 10^5$ ; therefore, the time (in minutes) that can be recorded on a CD with 700 MB capacity is:

$$700 \times 10^6 \div (6 \times 10^5) = 7000 \div 6 = 1166.66 \dots \text{(minutes)}$$

Therefore, the maximum time that can be recorded on the CD is 1166 minutes, and the correct answer is c).

**Explanation**

When  $r$  items are taken out arbitrarily from individually unique  $n$  items, and the number of permutations lined up in a row is represented as  ${}_nP_r$ , it is obtained with the expression below. The number of permutations is a total number of sorting ways when an arbitrary number of items are extracted from a group of data, and sorted.

$${}_nP_r = n \times (n - 1) \times (n - 2) \times \cdots \times (n - r + 1)$$

First, Mr. A and Mr. D must be adjacent to each other. Therefore, consider Mr. A and Mr. D to be one (1) person, and find the total number of permutations when four (4) people are lined up in all the possible sequences of order.

$${}_4P_4 = 4 \times (4 - 1) \times (4 - 2) \times (4 - 3) = 4 \times 3 \times 2 \times 1 = 24 \text{ ways}$$

Next, Mr. A and Mr. D can line up in two (2) ways as "A after D" or "D after A"; therefore, 24 ways is multiplied by two (2). The answer is:  $24 \times 2 = 48$  ways.

**Explanation**

In the binary system, a digit indicates twice the next lower digit. Such a number to be carried over (10 in the decimal system or 2 in the binary system) is called radix, and every digit represents a coefficient of a power of the radix. A power of a radix is called a weight for each digit, and numbers below the radix point can be also represented with the weights.

1	0	0	1	1
:	:	:	:	:
2 <sup>1</sup> 2 <sup>0</sup> 2 <sup>-1</sup> 2 <sup>-2</sup> 2 <sup>-3</sup> ... Weight of each digit				

(10.011)<sub>2</sub> means 2<sup>1</sup> is 1, 2<sup>0</sup> is 0, 2<sup>-1</sup> is 0, 2<sup>-2</sup> is 1, and 2<sup>-3</sup> is 1. By using the weight of each digit, it is calculated as follows:

$$(10.011)_2 = (2^1 \times 1) + (2^0 \times 0) + (2^{-1} \times 0) + (2^{-2} \times 1) + (2^{-3} \times 1)$$

2<sup>1</sup> is 2, 2<sup>0</sup> is 1, 2<sup>-1</sup> is  $\frac{1}{2^1}$ , 2<sup>-2</sup> is  $\frac{1}{2^2}$ , and 2<sup>-3</sup> is  $\frac{1}{2^3}$ ; therefore, it becomes as follows:

$$(10.011)_2 = 2 + 0 + 0 + \frac{1}{4} + \frac{1}{8} = 2 + 0.25 + 0.125 = 2.375$$

**Explanation**

The expected value is the sum of products of the probability for a case to occur, multiplied by a random variable. The probability for Very lucky to appear is  $\frac{1}{6}$ , and the score 5 means a random variable.

$$\text{Very lucky } \dots \frac{1}{6} \times 5 = \frac{5}{6}$$

$$\text{Quite lucky } \dots \frac{1}{6} \times 4 = \frac{4}{6}$$

$$\text{Little lucky } \dots \frac{1}{6} \times 3 = \frac{3}{6}$$

$$\text{Lucky } \dots \dots \dots \frac{1}{6} \times 2 = \frac{2}{6}$$

$$\text{Unlucky } \dots \dots \dots \frac{1}{6} \times 1 = \frac{1}{6}$$

$$\text{Sum } = \frac{15}{6}; \text{ therefore, the expected value is 2.5.}$$

## Chapter 8 Computer System

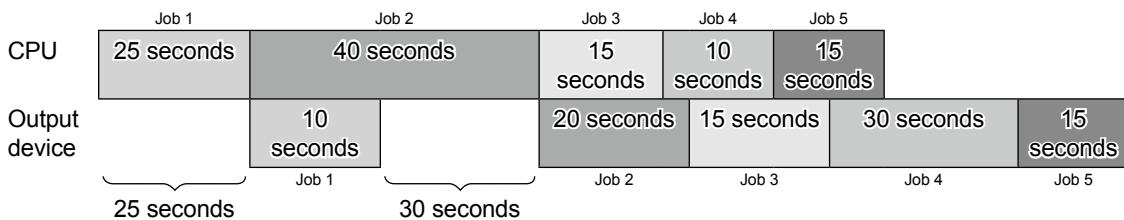
### Q 8-1 Answer d)

(Category) 8-1 Computer Component

#### Explanation

A job is a unit of work from the perspective of the user. In OS job management, the order of job execution is managed to ensure multiple jobs are processed efficiently.

The state of each process is as below because of the fact that jobs are processed in ascending order starting with the smallest number, the CPU and output device can perform processing separately, and output processing must be performed after processing by the CPU is complete.



Below is the time that the output device does not perform processing.

$$25 \text{ seconds} + 30 \text{ seconds} = 55 \text{ seconds}$$

### Q 8-2 Answer d)

(Category) 8-2 System Component

#### Explanation

RAID (Redundant Arrays of Inexpensive Disk) is a countermeasure for failure that is implemented when a system is constructed with the purpose of improving reliability and access speed. It is a technology that allows multiple hard disks to be handled as a single device. RAID5 divides data and parity information and writes them to all hard disks.

- This is also called striping and divides data and writes it to multiple hard disks, and therefore the access does not concentrate on one disk and the writing time is reduced.
- This is also called mirroring, and writes the same data to two (2) or more hard disks in preparation for a fault in one of the hard disks.
- Data is divided and written to multiple hard disks in units of bits or bytes, and parity information for the purposes of error detection and correction is written to a dedicated hard disk.

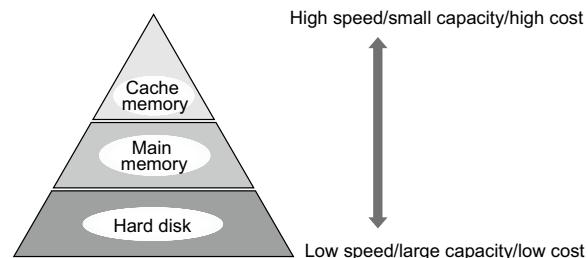
### Q 8-3 Answer C)

(Category) 8-1 Computer Component

#### Explanation

Among cache memory, main memory, and hard disks, the storage unit with the fastest access speed is cache memory. Cache memory is used to make up for the difference in processing speed between the CPU (high-speed processing) and main memory (low-speed processing).

The storage units are represented in a storage hierarchy as shown here.



**Q 8-4 Answer d)**

(Category) 8-1 Computer Component

**Explanation**

A function that, when a peripheral device is newly connected to a computer, the OS automatically configures the optimum settings. This is called plug and play. If a peripheral device supports plug and play, the required device driver is automatically installed, and the optimum settings are configured by simply connecting the device.

- a): This is an explanation of cache memory.
- b): This is an explanation of a wireless interface.
- c): This is an explanation of multitasking.

**Q 8-5 Answer d)**

(Category) 8-4 Hardware

**Explanation**

In a blade server, multiple thin servers are placed in a special housing (chassis), and they can share the power supply and cables connected to the chassis. It is suitable for systems such as those that process large volumes of data and require multiple servers.

- a) This is an explanation of a database server.
- b) This is an explanation of a rack-mounted server.
- c) This is an explanation of a print server.

**Q 8-6 Answer C)**

(Category) 8-2 System Component

**Explanation**

A cluster is a system configuration where multiple computers (including a server) are connected to a network and operated as if it were a single system.

It is a system configuration that has high reliability and is able to continue provision of services without stoppage in the event of a failure during operation.

- a) This is an explanation of a dual system.
- b) This is an explanation of a thin client.
- c) This is an explanation of a duplex system.

**Q 8-7 Answer C)**

(Category) 8-1 Computer Component

**Explanation**

A Blu-ray Disc is an optical disc that is the same shape as a CD and a DVD. It uses a short-wavelength blue-violet laser beam in order to read and write data. Its capacity is 25 gigabytes that is several times greater than a DVD, and it is often used to store high-quality video.

- a) The number of times that it can be written to is limited in the same way as a DVD. A BD-R can be written to once, and a BD-RE can be written to approximately 10,000 times.
- b) Since the protective layer of a Blu-ray Disc is thinner than that of a DVD, early Blu-ray Discs needed a cartridge, but the protective coating has been applied to the recent Blu-ray Discs, and therefore they do not need a cartridge.
- d) In order to play a Blu-ray Disc back, a Blu-ray drive is required. A general Blu-ray drive can also play back CDs and DVDs.

**Explanation**

The calculation method for availability differs for a series system and a parallel system. The question sentence states "If both of the processors are not operating normally, then the system does not operate," and therefore it can be understood that this system is a series system.

The following is the expression for calculation of the availability of a series system.

$$\text{Availability} = \text{Availability of device } A \times \text{Availability of device } B$$

The following is the result of application of the availability of device A and the availability of device B to this expression.

$$\begin{aligned}\text{Availability} &= 0.8 \times 0.9 \\ &= 0.72\end{aligned}$$

Therefore, c) is the correct answer.

**Explanation**

First, the access rights of Group 1 are considered.

The access rights of Group 1 are as below, and update is permitted (1) for every staff member of the group. However, individual access rights are set for Staff member 2 of Group 1.

	Group 1	Staff member 2
File A	111	100
File B	110	100
File C	110	000

Since access rights for individuals are prioritized over a group's access rights, update of all three (3) files is prohibited (0) for Staff member 2. Therefore, the only staff member in Group 1 who can update all three (3) files is Staff member 1.

Next, Group 2 is considered.

The access rights of Group 2 are as below, and update is prohibited (0) for File A. However, individual access rights are set for Staff members 4 and 5 of Group 2.

	Group 2	Staff member 4	Staff member 5
File A	000	110	110
File B	110	100	111
File C	110	111	100

For Staff member 4, update is permitted (1) for File A and File C, but prohibited (0) for File B. For Staff member 5, update is permitted (1) for File A and File B but prohibited (0) for File C, and therefore there are no staff members in Group 2 who can update all three (3) files. Therefore, b) is the correct answer.

**Q 8-10 Answer a)**

(Category) 8-2 System Component

**Explanation**

In an information system, MTBF (mean time between failures) is the mean continuous availability between a fault and the next fault. The greater the MTBF value the greater the stability of the system.

MTTR (Mean Time To Repair) is the mean time that is required for repair when a fault occurs in an information system. The smaller the MTTR value the greater the stability of the system.

**Q 8-11 Answer d)**

(Category) 8-2 System Component

**Explanation**

Fail-safe is an approach to the construction of highly reliable systems that ensures a system does not completely stop when a fault occurs, and maintains the minimum level of functions.

- a) This is an explanation of foolproof.
- b) This is an explanation of fail-safe.
- c) This is an explanation of fault tolerant.

## Chapter 9 Technology Elements

**Q 9-1 Answer b)**

(Category) 9-1 Human Interface

**Explanation**

For accommodating both users who are used to keyboard operations and users who are not used to keyboard operations, it is better to make available keyboard operations and other simple operations (including a mouse, in this case). Moreover, it may be better to allow the use of additional input devices (bar code, touch panel, etc.) other than mouse and keyboard according to the purpose of use.

- a) This answer is not appropriate because normally keyboard is used for entering numerical data and product code.
- c) This answer is not appropriate because even if the input page has changed, the same item may be used (operator or supplier etc.).
- d) This answer is not appropriate because input errors are normally prevented by letting the user enter or select the company code instead of the company name.

**Q 9-2 Answer b)**

(Category) 9-2 Multimedia

**Explanation**

Streaming is the technology of efficiently distributing and playing web contents such as audio and video. Instead of downloading all data of web contents together, data can be played while downloading. Therefore, users need not wait for the completion of download.

- a) In streaming, the focus is on efficient distribution and playback of data. Therefore, if the data received is partially missing, the image quality may become poor.
- c) Streaming basically disseminates data by downloading the data stored in the streaming server. However, there is another method of real-time dissemination where data of taking videos is sequentially converted into data for streaming. Therefore, live broadcasting can also be disseminated.
- d) It is not limited to an individual's access and use, and therefore it can be used in companies too.

**Q 9-3** Answer **C)**

(Category) 9-3 Database

**Explanation**

Even when multiple users simultaneously manipulate a database, it is necessary to maintain consistency of data such that conflict of data does not occur. Therefore, a database management system that manages the database is equipped with exclusive control.

When multiple users wish to simultaneously update the same data, exclusive control temporarily locks the writing of data for some of the users. The lock can be an exclusive lock that locks both data update and data reference, or it can be a shared lock that locks only data updates.

- a), d) In the exclusive control of a database management system, data cannot be simultaneously updated irrespective of the type of lock.
- b) When an exclusive lock is applied from the user who accessed the data first, data will be exclusively locked for the user who accessed the data first. Therefore, the user who accessed the data afterwards cannot refer to the data.

**Q 9-4** Answer **b)**

(Category) 9-5 Security

**Explanation**

Spyware is a common name of software programs that send personal information to the Internet from inside the computer. In most of the cases, users do not realize that spyware is installed in their computer. Therefore, it causes serious damage.

- a) This is the explanation of spam mail.
- c) This is the explanation of port scan.
- d) This is the explanation of round-robin attack (brute force attack).

**Q 9-5** Answer **b)**

(Category) 9-4 Network

**Explanation**

An IP address is a number used for identifying the computers connected to the network. It is represented with a 32-bit binary number. However, with the rapid spread of the Internet, there is a shortfall of IP addresses. Therefore, people have started using IPv6 that has been developed by expanding the functions of the Internet protocol (IPv4) being used at present.

- a) IP address is represented with a 32-bit binary number, and it is composed of a network address that distinguishes multiple networks and a host address that distinguishes each computer within the network.
- c) Global IP addresses used in the Internet must be unique.
- d) In class A of address class, although IP addresses in a large-scale network can be represented, there are about 16,770,000 IP addresses that can be allowed to one network.

**Q 9-6** Answer **C)**

(Category) 9-4 Network

**Explanation**

IPv6 (Internet Protocol version 6) is the Internet protocol developed by expanding the functionalities of IPv4. By changing from IPv4 to IPv6, the address space that can be managed is expanded from 32 bits to 128 bits. This solves the problem of shortfall of IP addresses that occurs because of the rapid growth of the Internet. IPv4 (Internet Protocol version 4) is a 32-bit Internet protocol that is used at present.

- a) Communication speed becomes fast by using optical fiber because of installing optical fiber in the communication line. It has nothing to do with IPv6.
- b) This is a description about IPv4.
- d) IPv6 and IPv4 can co-exist in a single LAN.

**Q 9-7 Answer b)**

(Category) 9-5 Security

**Explanation**

Cross-site scripting refers to embedding a malevolent code into a website by using a security hole in the software, or it refers to a security hole that is misused for such acts. When a web site containing such malevolent code is accessed, or when information is entered on such bulletin board or web form, personal information is stolen or files residing on the computer are destroyed.

- a) This is the explanation of password list-based attack.
- c) This is the explanation of SQL injection.
- d) This is the explanation of mail bomb.

**Q 9-8 Answer c)**

(Category) 9-5 Security

**Explanation**

Digital signature is the information assigned for certifying the validity of electromagnetic records (digital document), and it certifies the identity of the sender and assures that the data is not falsified. It can be implemented by combining public key cryptography and message digest (summary data).

Sender encrypts the data by using his private key, and the recipient decrypts the data by using the sender's public key. Since both private key and public key are created by the sender, it proves that the data is the sender's data only.

- a), b) Identity of the sender cannot be certified with the combination of the sender's public key and the recipient's public key, and the sender's public key and the recipient's private key.
- d) Symmetric key is a key used in symmetric cryptography.

**Q 9-9 Answer a)**

(Category) 9-2 Multimedia

**Explanation**

Technology of processing and playing back still images and videos by using computers is called computer graphics or CG.

Computer graphics have two-dimensional expression and three-dimensional expression.

Two-dimensional expression is used in tablet-based painting or image processing after importing photographs.

Three-dimensional expression is applied in expressing virtual worlds in games, etc., simulating future urban landscapes, and CAD-based industrial design.

- b) CAD refers to the system used for designing machinery, structures, and electronic circuits.
- c) Computer simulation refers to simulating (quasi-experiment) a phenomenon by using computers.
- d) Virtual reality is a technique of creating artificial sense of reality by combining computer graphics and sound effects. It is also called VR.

**Q 9-10 Answer a)**

(Category) 9-5 Security

**Explanation**

Watering hole attack involves setting a trap where a malicious program is embedded in a website that the user subject to attack frequently accesses so that the user's device is infected with a virus by just accessing this website.

In many cases, websites that users normally access as a reliable source of information are falsified. Therefore, such attacks are difficult to prevent by taking measures like not accessing dubious websites.

- b) Port scan refers to finding out the open port numbers of a computer. Attackers can attempt to intrude from this port numbers and stop the services that are using these port numbers.
- c) Buffer overflow attack involves sending a large amount of data that access the memory capacity (buffer) reserved by the programs running on a computer so that the buffer overflows, and then running an unauthorized process intended by the cracker.
- d) Phishing is an act of sending e-mails by pretending as an actual company or an organization, and gaining unauthorized access to financial information (credit card number, user ID, password) of the individuals receiving these e-mails.

**Q 9-11 Answer b)**

(Category) 9-3 Database

**Explanation**

Online transaction processing system is a mechanism where a client connected to the network sends a processing request to the server, and the server runs the process on the basis of this request, and then returns the processing results to the client. Usually, update (including add and delete) process of database is mostly used. If the process is interrupted in between, consistency of data cannot be ensured. Therefore, reliability is required.

- a) This is a mechanism that gives diagrammatic representation of the work flow, and ensures that work flows in an efficient manner on the network.
- c) This refers to a system made up by dividing responsibilities to the server that offers a service to the computer connected to the network, and the client that requests the server to provide the services.
- d) This is about system configuration that connects computers through communication lines for processing.

**Q 9-12 Answer c)**

(Category) 9-5 Security

**Explanation**

3 × 3 table can be represented as follows:

→Source text

I	/	a
m	/	s
a	t	o

↓  
Encrypted text

Reading this table from top right will give aSo//tlma.

**Q 9-13 Answer a)**

(Category) 9-4 Network

**Explanation**

Time required for forwarding is determined with the following calculation expression.

Forwarding time = Amount of data to be forwarded  $\div$  (Transmission speed of the link  $\times$  Transmission efficiency)

In the first place, it is important to align the numerical values of the units to be calculated. Here, calculation is performed after aligning the units to bits.

Transmission speed of the link is 100 Mbit / second, so it can be represented as follows:

$$100 \times 10^6 \text{ bit/second} = 10^8 \text{ bit/second}$$

Moreover, in the question, it is given that  $1\text{MB} = 10^6$  bytes. Therefore, the amount of data to be forwarded is  $8 \text{ bits} \times (8 \times 10^8) \text{ byte}$ .

Accordingly, the forwarding time can be determined as follows:

$$8 \times 8 \times 10^8 \div (10^8 \times 0.5) = 64 \div 0.5 = 12^8 \text{ seconds}$$

Here, as one (1) minute has already passed, waiting time will become as follows:

$$128 - 60 = 68 \text{ seconds}$$

**Q 9-15 Answer d)**

(Category) 9-1 Human Interface

**Explanation**

Web accessibility refers to designing a website such that everyone including elderly people and people with disorders can access the information.

Accessibility is formed by combining the two words of "Access" and "Ability." Access means "Reaching the information and trying to use the information", while Ability means "Achieving this and feasibility of achieving this." For example, it is possible that elderly people will have difficulty in reading small letters and operating small buttons. Moreover, people with visual disorders may be able to obtain information from the website by using an audio browser (software that reads out characters from the website). Web accessibility improved by designing the website keeps such environment of use in mind.

- a) This answer is not appropriate because web accessibility is not a concept that pursues high access speed.
- b) This is an explanation about a key logger, which is a spyware that obtains information about characters and numbers entered from the keyboard and sends this information to the outside in an unauthorized manner.
- c) This is explaining the mechanism of hyperlink provided on a website.

**Q 9-16 Answer a)**

(Category) 9-3 Database

**Explanation**

Operations for fetching the required data from the database include relational operation (operation that fetches the target data from the table) and set operation (operation that fetches data from multiple tables with conditions such as common data or data that is present in either of the tables). Projection is a type of relational operation, and it refers to fetching the specified column (field) from the table. Therefore, a) is the correct answer.

- b) This is selection because it is fetching the specified row (record) from the table.
- c) This is concatenation because it is fetching data after joining two tables for items that have the same value.

**Q 9-17 Answer b)**

(Category) 7-1 Basic theory

**Explanation**

24 bits = 3 bytes ( $24 \div 8$ ). Therefore, data volume will be as follows:

$$350 \text{ pixels} \times 200 \text{ pixels} \times 3 \text{ bytes} \times 500 \text{ images} = 105,000,000 \text{ bytes}$$

1MB = 1,024 KB, 1 KB = 1,024 bytes. Therefore, 1 MB = 1,048,576 bytes.

Accordingly, the area blocked will be as follows:

$$105,000,000 \text{ bytes} \div 1,048,576 \text{ bytes} = 100.135\cdots \text{MB} \rightarrow \text{Approximately } 100 \text{ MB}$$

**Q 9-18 Answer d)**

(Category) 9-3 Database

**Explanation**

Teaching\_material\_list\_table is a table that stores the data that would serve as teaching material master. Teaching\_material\_code in Teaching\_material\_list\_table would be the primary key because it is unique. Teaching\_material\_code in Course\_list\_table would be the foreign key because the same teaching material may be used in multiple courses. By linking with Teaching\_material\_code in Teaching\_material\_list\_table as the primary key and Teaching\_material\_code in Course\_list\_table as the foreign key, it would be possible to reference Teaching\_material\_name and Teaching\_material\_image from Course\_list\_table.

**Q 9-19 Answer c)**

(Category) 9-3 Database

**Explanation**

It is necessary to summarize participant information such as participant name and contact details in a separate table so that this information need not be registered again when they apply for the next course, and then associate this information with the courses application and reception date by using the participant code.

- a) Only participant information is summarized, and normalization is not performed.
- b) Course code and course date should not be included in participant information.
- c) There is no item that links the participant and the courses applied.

**Explanation**

Even when one participant has applied for multiple courses, only one (1) course slip is issued for one course. Therefore, in one course slip, information of only one course (Course\_name, Course\_date, Course\_code, Lecturer\_name, Teaching\_material\_name, Classroom\_number, Amount) is mentioned.

Moreover, because all tables are linked, the number of times of referencing the tables while one record is referenced would be the same.

Therefore, a) is the correct answer.

### Q 10-1 Answer a)

(Category) 10-2 Expressions

#### Explanation

A reference to a value in another cell within an expression, etc. is called a cell reference. Normally, when an expression containing a cell reference is copied into another cell, the cell reference is automatically adjusted. This is called a relative reference. By contrast, to prevent automatic adjustment of a cell reference when an expression containing the reference is copied into another cell, the symbol "\$" is added to the cell to be fixed. This is called an absolute reference.

An expression to calculate the component ratio for Store A should be entered in cell F2, as the total number of sales for each store is entered in cells E2:E6 and the grand total for all stores is entered in cell E7. Accordingly, the expression in cell F2 is as follows:

E2/E7

According to the question description, the expression in cell F2 will be copied into cells F3:F7. The component ratio for number of sales must use an absolute reference that contains a fixed row (7), so that the cell E7, in which the grand total is entered, does not change. Using "\$" in the expression creates an absolute reference, allowing the column or the row of the entered cell to be fixed. Accordingly, the expression in cell F2 is as follows:

E2/E\$7

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### Q 10-2 Answer a)

(Category) 10-3 Use of Functions

#### Explanation

The SUM function is defined as follows:

Form of the function	Explanation
SUM(cell range)	Returns the sum of the numeric values contained in the cell range. Example: SUM(A1:B5) returns the sum of the numeric values contained in cells A1–B5.

The dividend for each department is determined on the basis of the sales of the department compared to total sales. Total sales can be described with "SUM(B3:B6)" by using the sum function, as the sales for each department are entered in cells B3:B6. The expression in cell C3 is shown below, as the incentive payment for the period is entered in cell B1.

B3/SUM(B3:B6)\*B1

According to the question description, the expression in cell C3 is copied into cells C4:C6. When copying the expression in cell C3 into cells C4:C6 (downward in the direction of rows), it is necessary to use an absolute reference with fixed rows, so that the rows (3–6) of cells B3–B6, in which sales are entered, and the row (1) of cell B1, in which the incentive payment is entered, do not change. Using "\$" in the expression creates an absolute reference, allowing the column or the row of the entered cell to be fixed. Accordingly, the expression in cell C3 is as follows:

B3/SUM(B\$3:B\$6)\*B\$1

**Q 10-3 Answer b)**

(Category) 10-3 Use of Functions

**Explanation**

The COUNTIF function is defined as follows:

Form of the function	Explanation
COUNTIF(cell range, description of search condition)	Returns the number of cells contained in the cell range that meet the described search condition. The search condition is described as a comparison operator paired with an expression. Each cell contained in the cell range, and the value of the expression in the cell, are evaluated according to the specified comparison operator. Example 1: COUNTIF(H5:L9, >A1) returns the number of cells within the cells H5–L9 that contain a value greater than the value of cell A1. Example 2: COUNTIF(H5:L9, =A4') returns the number of cells within the cells H5–L9 that contain the character string "A4".

Cell B52 returns the number of "Yes" responses within the cells B2:B50, into which the questionnaire results for Q1 are entered. The expression in cell B52 can be described as follows by using a conditional count function, as the "Yes" entered in cell A52 is made the search condition.

COUNTIF(B2:B50, =A52)

According to the question description, the expression in cell B52 will be copied into cells B52:F53. Consider separately the case in which the expression in cell B52 is copied in cell B53 (downward in the direction of rows), and the case in which the expression in cell B52 is copied in cells C52:F52 (rightward in the direction of columns.)

When copying the expression in cell B52 into cell B53 (downward in the direction of rows), it is necessary to use an absolute reference with fixed rows, so that the rows (2–50) of cells B2:B50, in which questionnaire results are entered, do not change. Using "\$" in the expression creates an absolute reference, allowing the column or the row of the entered cell to be fixed. Accordingly, the expression in cell B52 is as follows:

COUNTIF(B\$2:B\$50, =A52)

When copying the expression in cell B52 into cells C52:F52 (rightward in the direction of columns), it is necessary to use an absolute reference with fixed columns, so that the column (A) of cell A52, in which the search condition description "Yes" is entered, does not change. Accordingly, the expression in cell B52 is as follows:

COUNTIF(B\$2:B\$50, =\$A52)

**Q 10-4 Answer d)**

(Category) 10-2 Expressions

**Explanation**

The expression to be entered into cell G2 can be calculated with the expression shown below.

Per-product gross profit ratio = per-product gross profit ÷ total gross profit

An expression to calculate the gross profit ratio of "Product A" is entered into cell G2. When cell F2, into which the gross profit of "Product A" is entered, and cell F7, into which total gross profit is entered, are applied to the expression, the result is as follows:

F2/F7

According to the question description, the expression entered in cell G2 will be copied into cells G3:G7. When copying the expression in cell G2 into cells G3:G7 (downward in the direction of rows), it is necessary to use an absolute reference with fixed rows, so that the row (7) of cell F7, in which total gross profit is entered, does not change. Using "\$" in the expression creates an absolute reference, allowing the column or the row of the entered cell to be fixed.

Accordingly, the expression to be entered in cell G2 is as follows:

F2/F\$7

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