MITSUBISHI ELECTRIC
Changes for the Better

FA Equipment for Beginners (Industrial Network)

This is a quick overview of industrial network for beginners.

L(NA)00050ENG

Introduction | **Purpose of the Course**

An industrial network is a mean to control remote machineries in a system of PLC's.
This course will show you the difference between general networks used for information processing such as the Internet and the industrial network used for industrial automation control. It will also enable you to select the industrial network suitable for the control purpose.

Introduction Course Structure

The contents of this course are as follows.
We recommend that you start from Chapter 1.

Chapter 1 - Understanding Networks

Learn the basic knowledge of networks.

Chapter 2 - Understand the Information Network and Industrial Network

Learn the difference between information networks and industrial networks.

Chapter 3 - Understanding the PLC Network

Learn about the industrial network using a programmable controller (PLC).

Chapter 4 - Future Trends in Industrial Networks

The trends of industrial networks and network-compatible Mitsubishi PLCs are introduced.

Final Test

Passing grade: 60% or higher.

Introduction　How to use this e-Learning Tool

Go to the next page	▶️	Go to the next page.
Back to the previous page	◀️	Back to the previous page.
Move to the desired page	TOC	"Table of Contents" will be displayed, enabling you to navigate to the desired page.
Exit the learning	❌	Exit the learning. Window such as "Contents" screen and the learning will be closed.

Introduction **Precautions for Use**

Safety precautions

Before using the physical hardware, please read the Safety Precautions in the corresponding manuals and follow the relevant safety information contained therein.

Chapter 1　Understanding Networks

1.1　Transmission of Information

Information ranges from familiar information exchanged between people to important information for running a company or organization. It is important to smoothly transmit and share these types of information. Various transmission methods are used to do this.

Information transmission systems are roughly classified into the following.

(1) Information transmission between individuals	Example: Conversations, letters, telephone, fax, e-mail, etc.
(2) Information transmission between individuals and groups	Example: Speeches, conferences, bulletin boards, radio, TV, Web, etc.

* Web: The information transfer system used to publish and browse Internet websites

A network is a tool used by individuals and groups for transmitting and sharing various kinds of information.
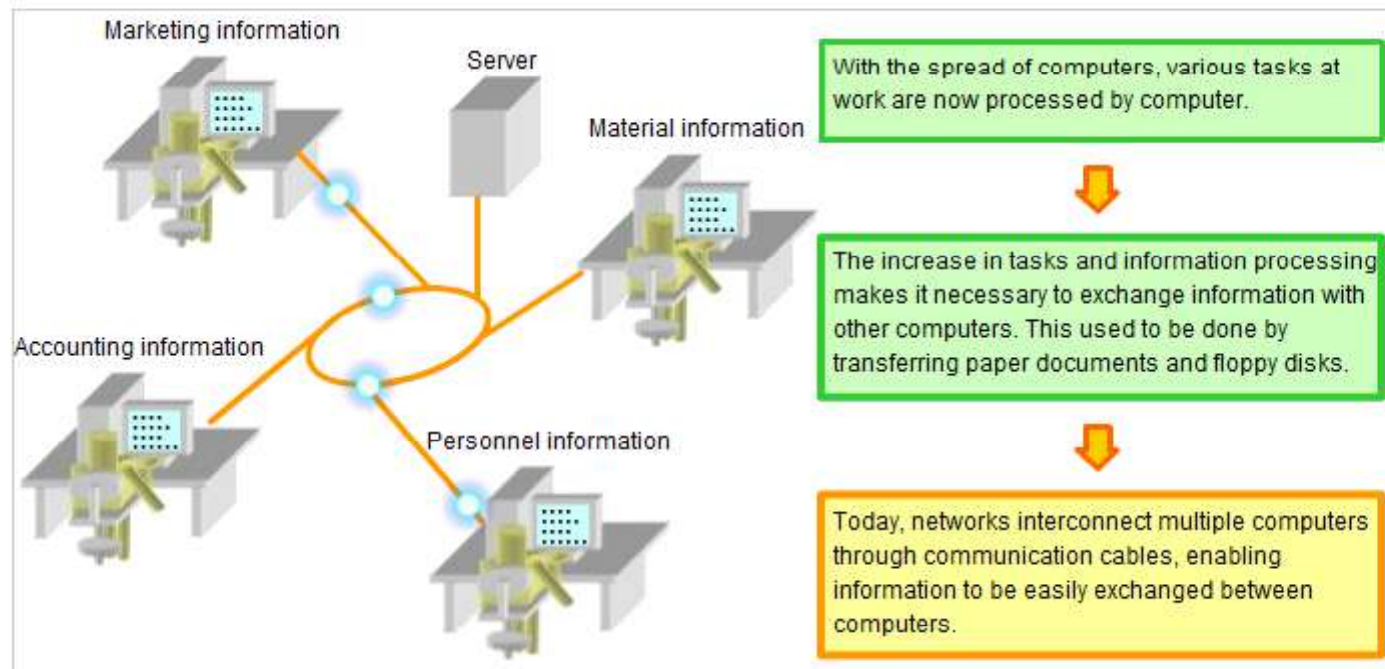
1.2 Background of Networks

Communication networks have been developed rapidly in recent years.
Information is transferred among devices such as computers through communication networks.

This has revolutionized the way we communicate with each other.
Information can be accessed from around the world using one's computer.

Here, you will learn how networks have changed our ways of doing business.

With the spread of computers, various tasks at work are now processed by computer.

The increase in tasks and information processing makes it necessary to exchange information with other computers. This used to be done by transferring paper documents and floppy disks.

Today, networks interconnect multiple computers through communication cables, enabling information to be easily exchanged between computers.

1.2 Background of Networks

[Introduction of how networks are changing the way we work]

This slide shows how networks are changing the workplace.

Without networks
- Information is shared within a workplace by oral communications or paper documents. - Information is shared outside a workplace by letter, telephone, and fax. - It takes time to search for specific information or sorting through paper documents, which also occupies space.

With networks
- E-mail is used to exchange information within the company and with external companies at any time. - Information shared within the workplace is stored on servers and can be retrieved by anyone when needed via the network. - Today, each employee in the workplace has a personal computer connected to the network, and all task processing, work instructions, and reports are transferred through the network. - This has effectively improved productivity and created the paperless workplace.

* Server: A computer that provides various services for the network is called a server computer ("server" for short). Servers include file servers for sharing files between users connected via the network, and print servers that enable printers to be shared.

# Chapter 2 — Understand the Information Network and Industrial Network

Network types include information network, which connect office PCs; and industrial network, which connects factory equipment.

2.1 — Information Network

This type of network connects PCs to administrative servers (Example: human resource, accounting, marketing, etc.) and OA equipment.
The usage of server network makes information and equipment sharing more efficient between departments.

Information network is now an essential business infrastructure.

| HR Dept. | Marketing Dept. | Accounting Dept. |

Information Network

| Materials Dept. | Server | Printer |
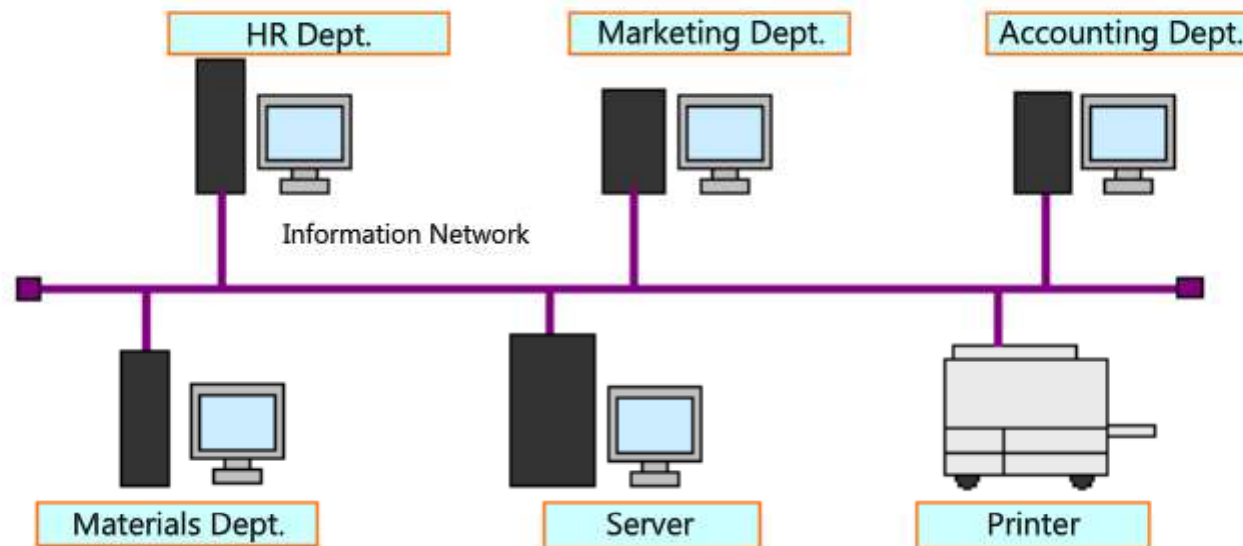
Today, information network is also widely used in internet browsing and e-mail exchange.
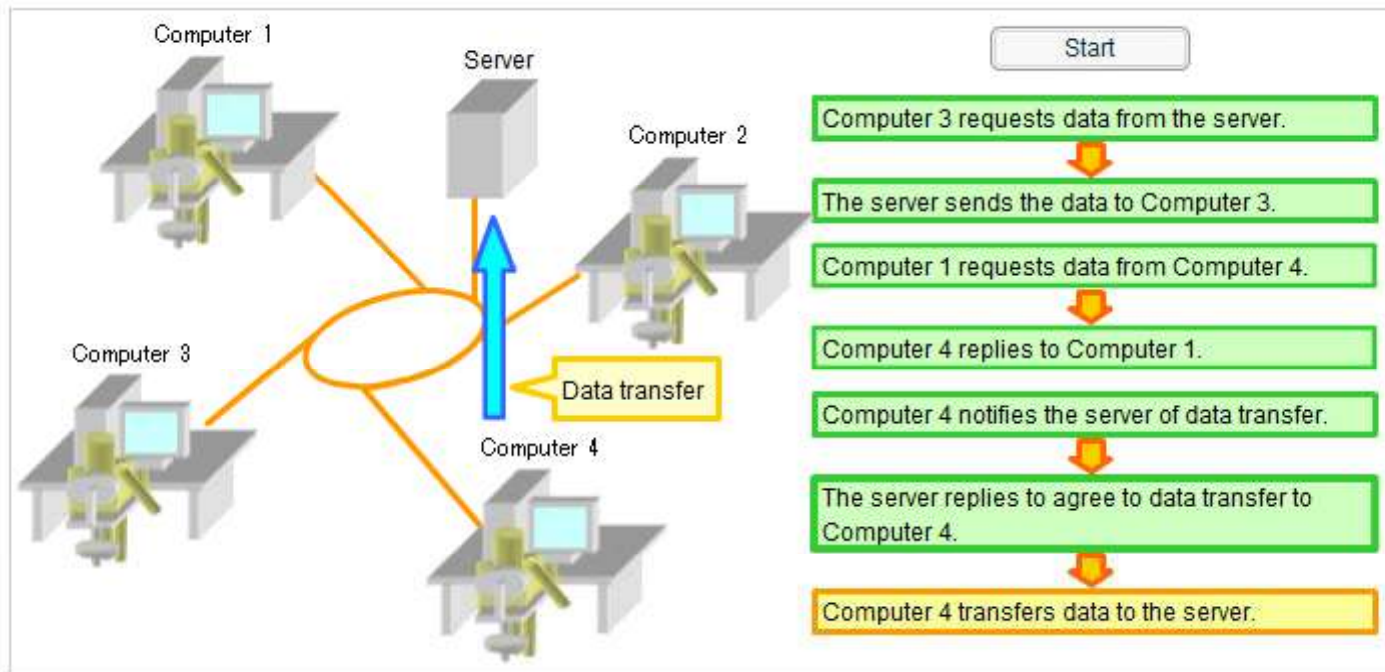
2.1.1 Information Exchange within an Information Network

The concept of information exchange is similar to that discussed in Chapter 1.

Exchange begins when data request is sent to a target, and ends when the requested data is received by the requester.
That is a one-to-one communication between the requester and the target. All network participants can communicate with each other at anytime. However, once two parties begin to communicate, no one else can interrupt them until they are done. The party who begins the communication is given priority.

Click the Start button for an explanation about data communication through an information network.

Computer 1

Server

Computer 2

Computer 3

Data transfer

Computer 4

Start

Computer 3 requests data from the server.

The server sends the data to Computer 3.

Computer 1 requests data from Computer 4.

Computer 4 replies to Computer 1.

Computer 4 notifies the server of data transfer.

The server replies to agree to data transfer to Computer 4.

Computer 4 transfers data to the server.

2.1.2   Features of Information Networks

The features of information networks are shown below.

- Network of computers as the core infrastructure.
- Globally used common Ethernet network standard.
- Large data handling capacity.
- For data communication, accuracy of data is essential, but temporary variations in communication are acceptable.

 * Ethernet: A network standard developed Xerox and DEC in the U.S., now widely used for networks around the world.

- Examples of information network configurations are shown below.
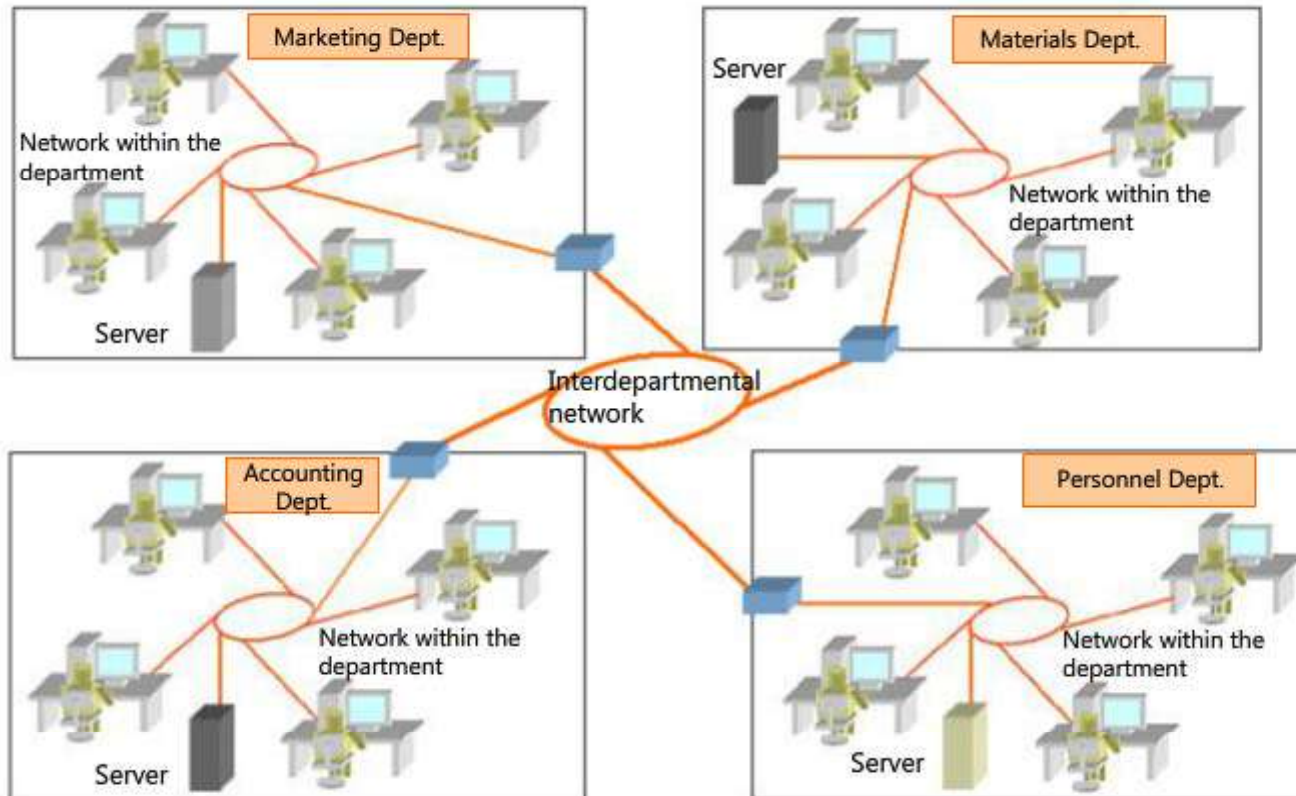
2.2   Industrial Network

The industrial network connects to PLCs, factory devices and equipment (such as NC) through communication cables. Control information and production system configuration setting transmit through the industrial network. It also allows us to aggregate production in the entire system and monitor the operating condition and faults.

* NC: Numerical Controller, which is mainly used for automatic control of machine tools
* Production system: Consists of computers and various machines and devices to produce products

Production system

Industrial Network
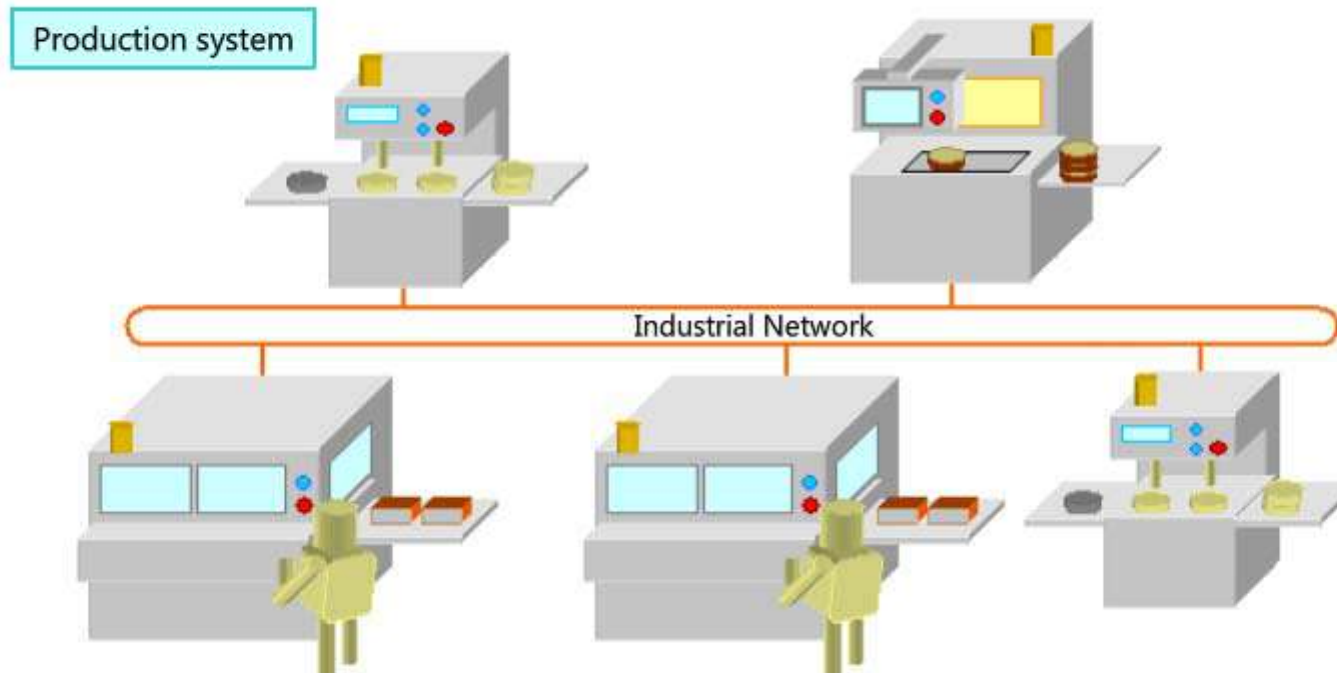
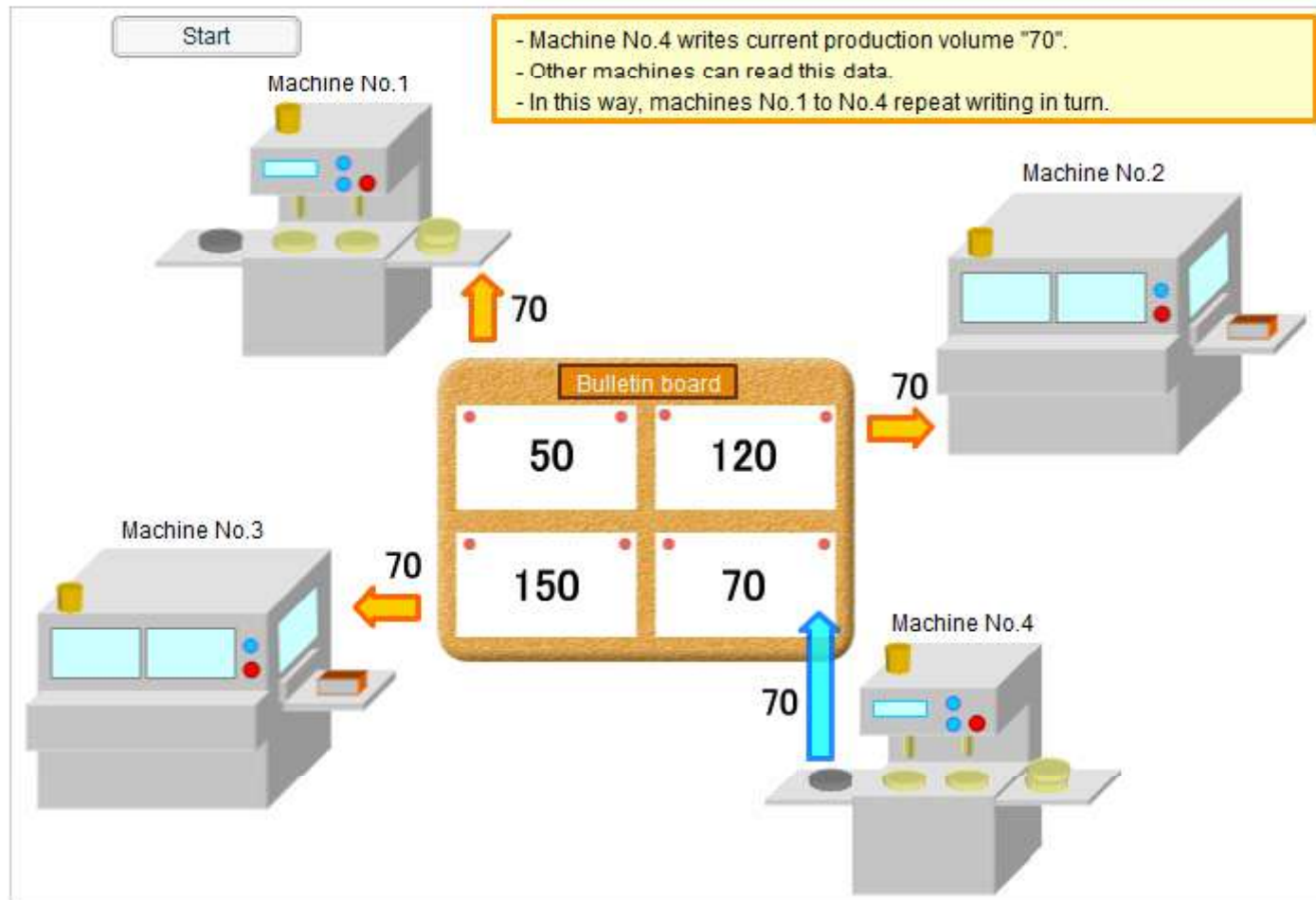## 2.2.1 Information Exchange within an Industrial Network

The concept of information exchange is similar to that discussed in Chapter 1.

Information exchange is implemented in such a way that individual machines write data in turns in their own write areas and other machines within the network read the written data.
Compared to the information network, think of an industrial network as an Internet bulletin board on which anyone in the network can write and read.

Click the Start button for an explanation about data communication through an Industrial network.

Start

Machine No.1

- Machine No.4 writes current production volume "70".
- Other machines can read this data.
- In this way, machines No.1 to No.4 repeat writing in turn.

Machine No.2

70

Bulletin board

70

| 50 | 120 |

Machine No.3

70

| 150 | 70 |

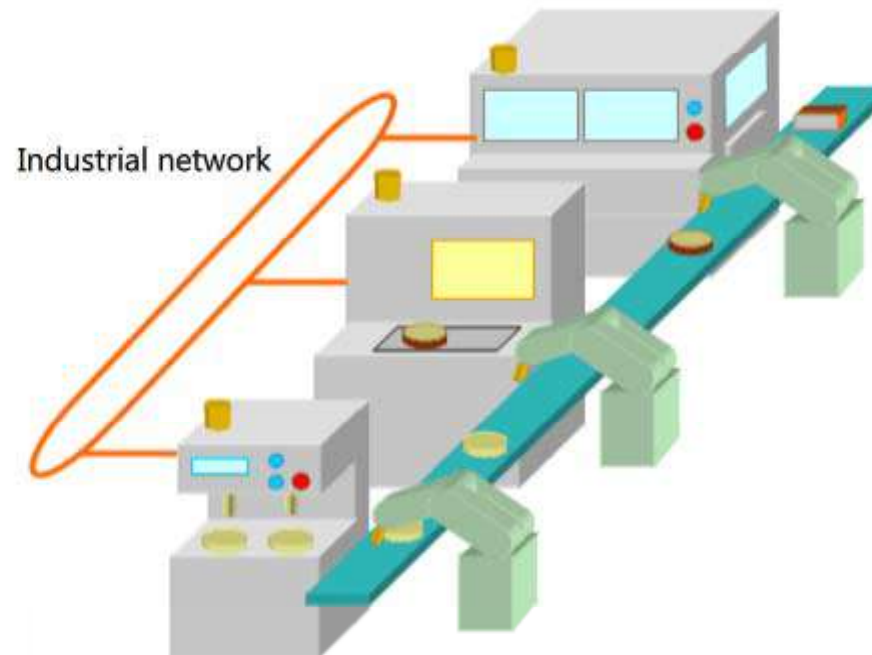Machine No.4

70

2.2.2   Features of an Industrial Network

The features of the industrial network are shown below.

- A basic industrial network consists of PLCs.
- Data is synchronized at regular intervals by cyclical data transfer.

- An example of an industrial network configuration is shown below.

Industrial network

2.2.3 Comparison between Information and Industrial Network

The information network and the industrial network are compared below.

Item	Information network	Industrial network
Purpose	Streamlining and labor-saving of office work	Automation and labor-saving of production system
Connected equipment	Computers (such as personal computers), office equipment	PLCs and various controllers (such as NC)
Communication timing	Communication when needed	Continuous communication at regular intervals
Amount of data transmitted	Large volume	Small volume
Network standard	Ethernet	Network standard of each PLC maker

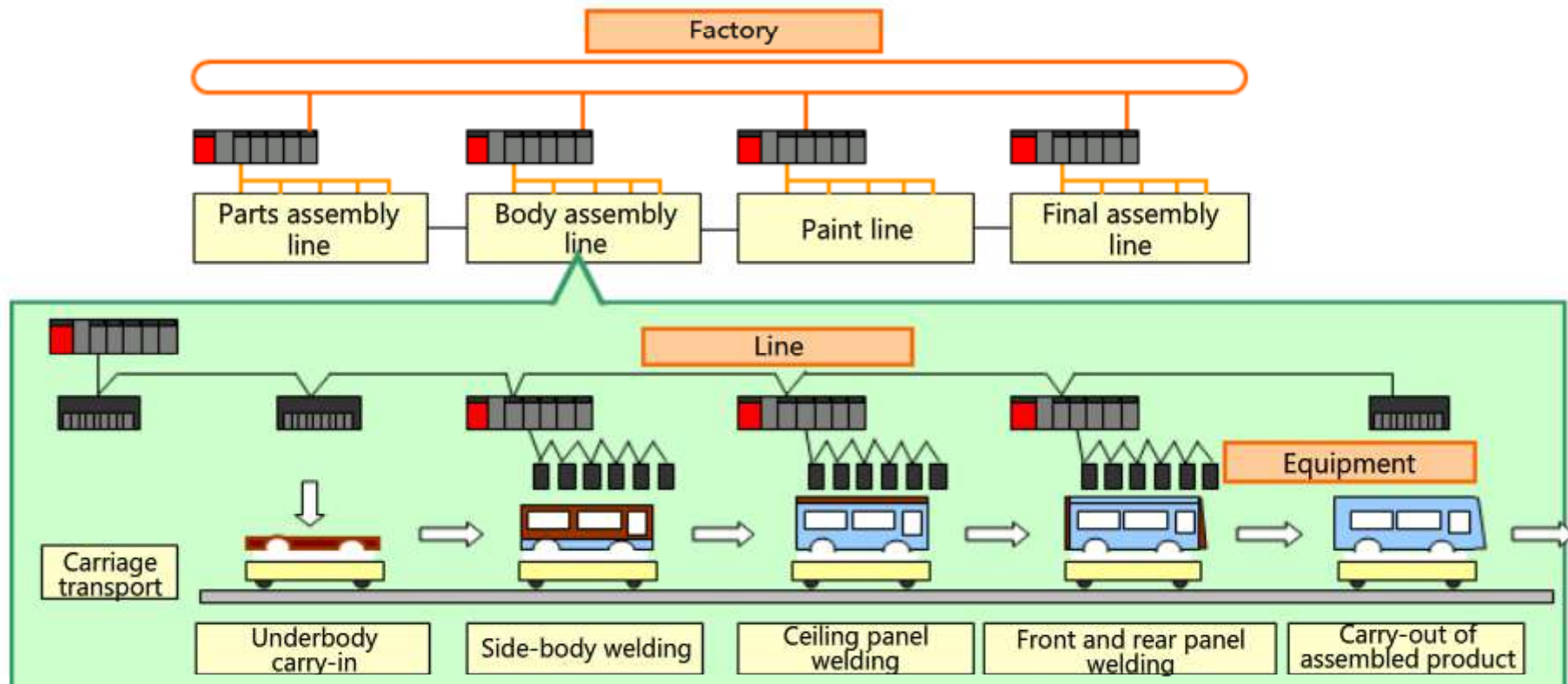## 2.3 Basics of Communication in an Industrial Network

2.3.1 PLC Network

The machines and devices in the production system are controlled by the PLC.
The industrial network is configured by PLCs that control these machines and is thus called a PLC network.

- An example of a PLC network configuration is shown below.

2.3.2   Basics of Data Communication

[Communication using contacts and coils of sequence program]
The ON/OFF signal of a PLC connected to the network is promptly transmitted to other PLCs.

> In a PLC network, data is passed using the devices (contacts, coils, and data registers) of the PLCs.
> Suppose a certain PLC turns on device "B0", then the other PLCs can also simultaneously check that "B0" is on.
> The PLCs in the network can thus share signals and data using the same devices.

Try using the simulated network for learning on the next page to see how the ON/OFF signals of a PLC in the network are passed to the other PLCs.

* Device: Memory provided in CPU modules to store signals and data used for operations by sequence programs. Devices include input relays, output relays, internal relays, link relays, and data registers.

2.3.2   Basics of Data Communication

[Confirming PLC communication performed using devices]

Click the Start button to display the operation guide. Click switches according to the operation guide. Each switch turns on or off and the status of the ladder monitor changes. (You can also operate the switches directly without using the operation guide.)

Start

The operation guide is finished. Click ▶ to proceed.
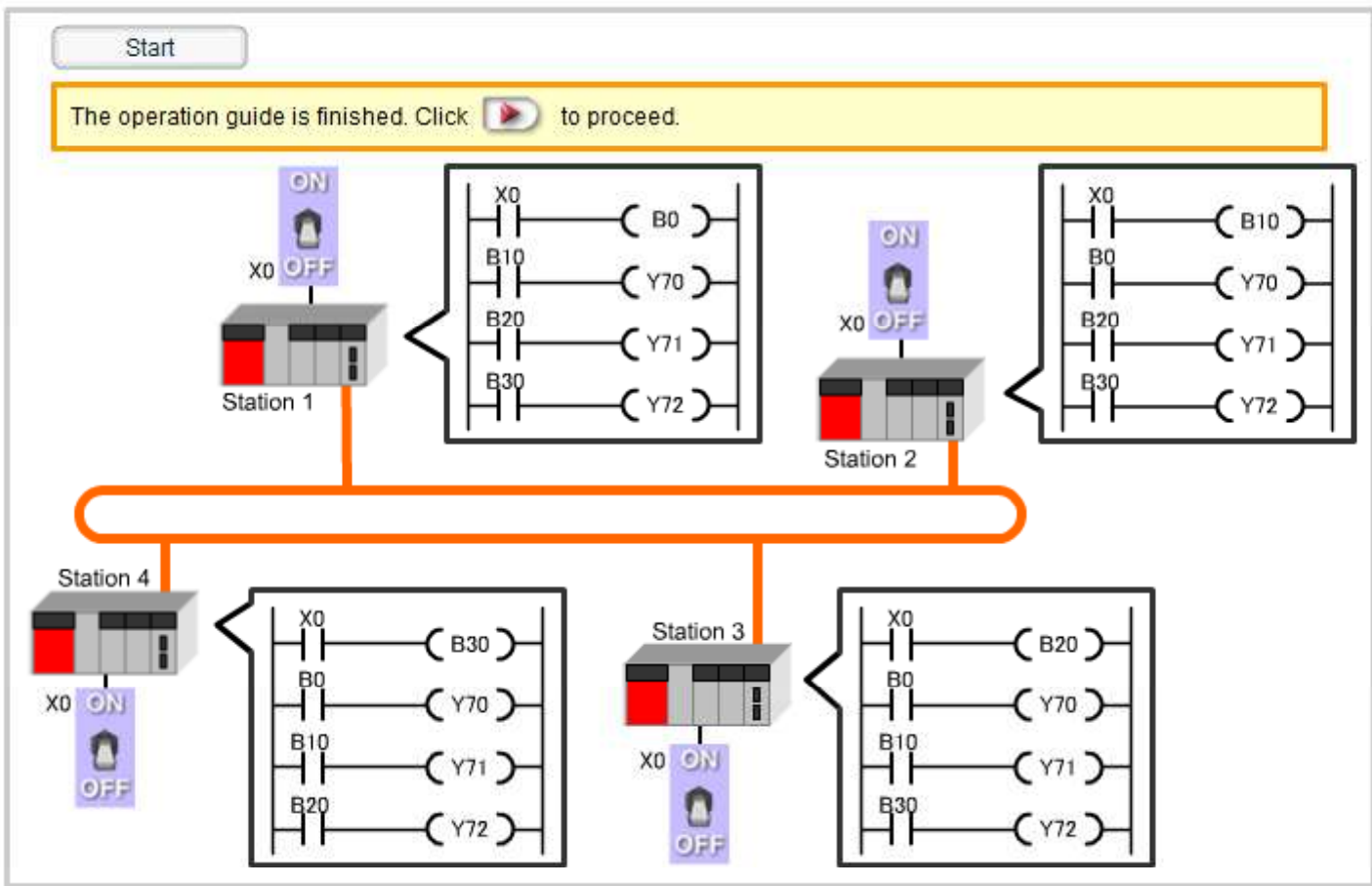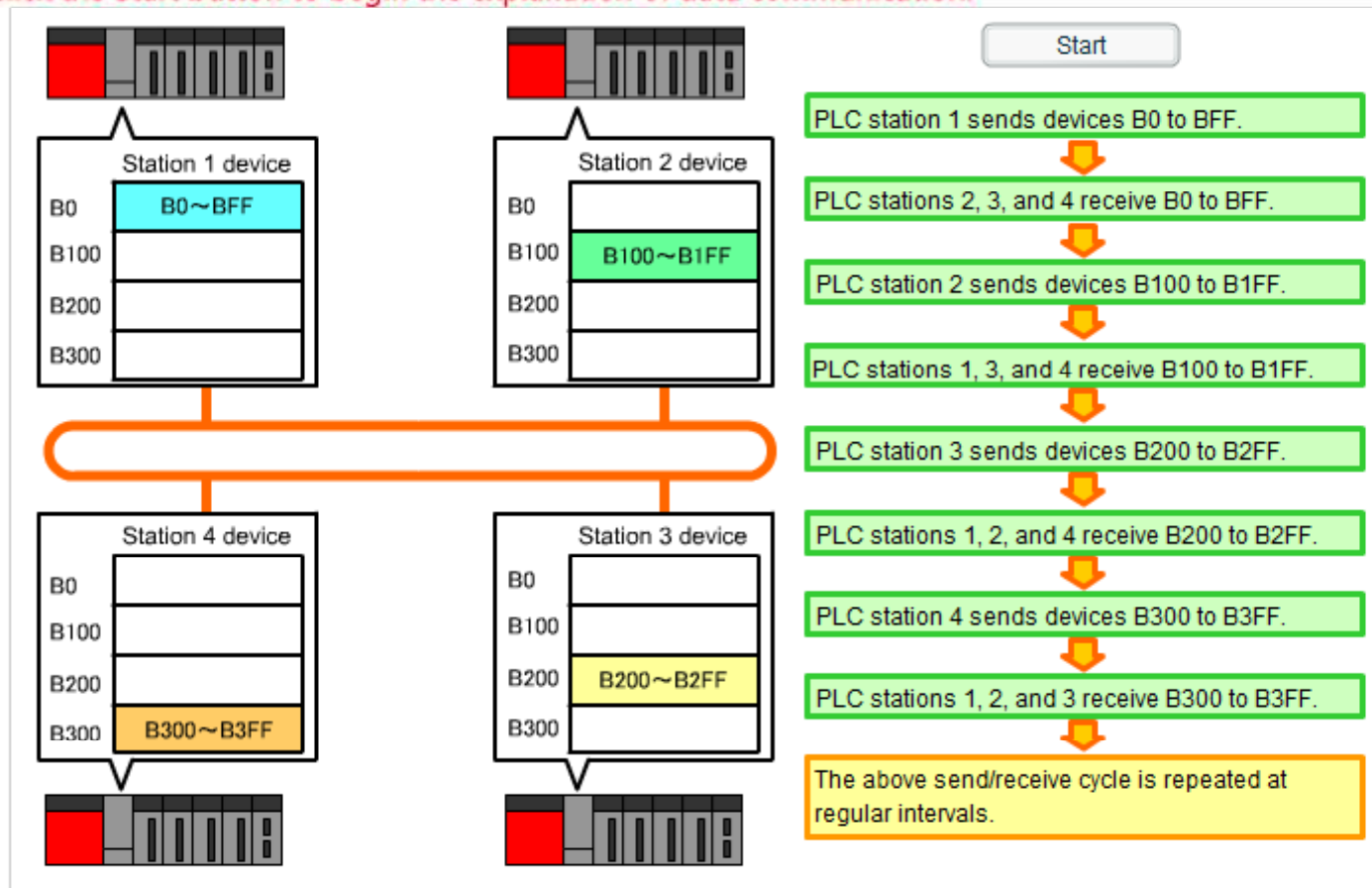
2.3.2 Basics of Data Communication

[Data communication system of PLC network]

PLC station 1 sends the device in the local send area to the network. PLC station numbers 2 to 4 receive the device simultaneously. In this way, the PLCs in the network, cyclically in order of station 1, 2, 3, 4, 1, ..., repeat transmission. Cyclic transmission at regular intervals keeps data punctuality, which is indispensable for the control network.
This communication system is called "cyclic transmission." It requires no user program for communication but is automatically performed simply by setting network parameters.
 * Network parameters: Data which must be set to control and manage the network system.

Click the Start button to begin the explanation of data communication.

	Station 1 device		Station 2 device
B0	B0~BFF	B0	
B100		B100	B100~B1FF
B200		B200	
B300		B300	

	Station 4 device		Station 3 device
B0		B0	
B100		B100	
B200		B200	B200~B2FF
B300	B300~B3FF	B300	

Start

PLC station 1 sends devices B0 to BFF.

PLC stations 2, 3, and 4 receive B0 to BFF.

PLC station 2 sends devices B100 to B1FF.

PLC stations 1, 3, and 4 receive B100 to B1FF.

PLC station 3 sends devices B200 to B2FF.

PLC stations 1, 2, and 4 receive B200 to B2FF.

PLC station 4 sends devices B300 to B3FF.

PLC stations 1, 2, and 3 receive B300 to B3FF.

The above send/receive cycle is repeated at regular intervals.

Chapter 3 Understanding the PLC Network

## 3.1 Controlling Multiple Machines together for Production

PLCs have led to the automation of factory machines.

To further improve the productivity of the whole factory, the production system should automate the entire production process by collectively controlling the machines in each production line.
To do this, the control information and production information processed by the programmable controls of individual machines need to be integrated to control the entire production system. So, a network is used to connect the PLCs of individual machines.

The network that connects multiple PLCs to each other is called a "PLC to PLC network."
* PLC: Programmable Logic Controller
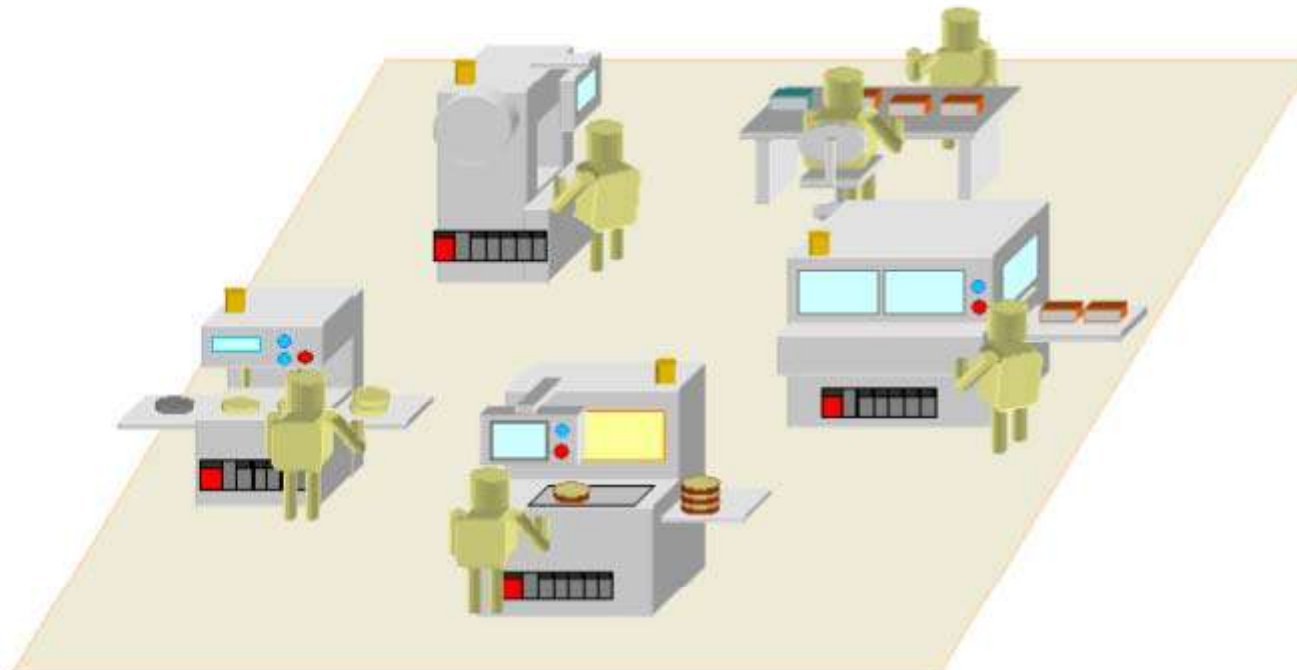
3.1.1 Network that Connects PLCs of Individual Machines

The PLC to PLC network connects the PLC that controls the system to those that control individual machines.
Based on the instructions and control signals from the system control PLC, the PLCs of individual machines work together to control the entire production system in an integrated manner. Check the operation using the following simple configuration example of a PLC to PLC network consisting of three machines.
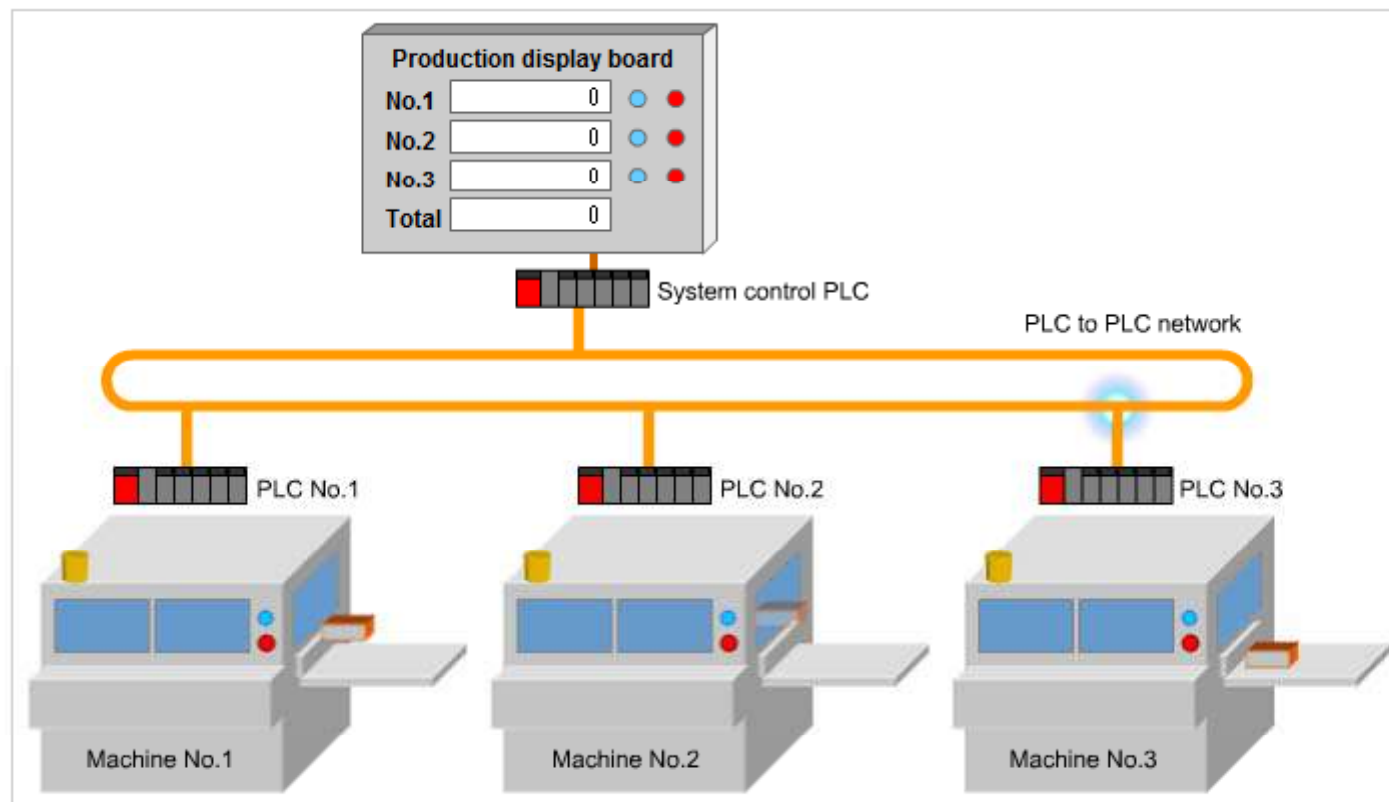
3.1.1 Network that Connects PLCs of Individual Machines

[Features of a PLC to PLC network]

- The network controls loads of multiple PLCs.
- Each PLC connected to the network must contain a CPU module.
- The load is distributed among multiple PLCs.
- Each PLC operates based on the relevant sequence program to aggregate production results and monitor the progress of production.
- This type of network can be used for various systems, from a small system consisting of one network to a large production system involving multiple networks.

- A configuration example of the multi-network system involving two networks is shown below.
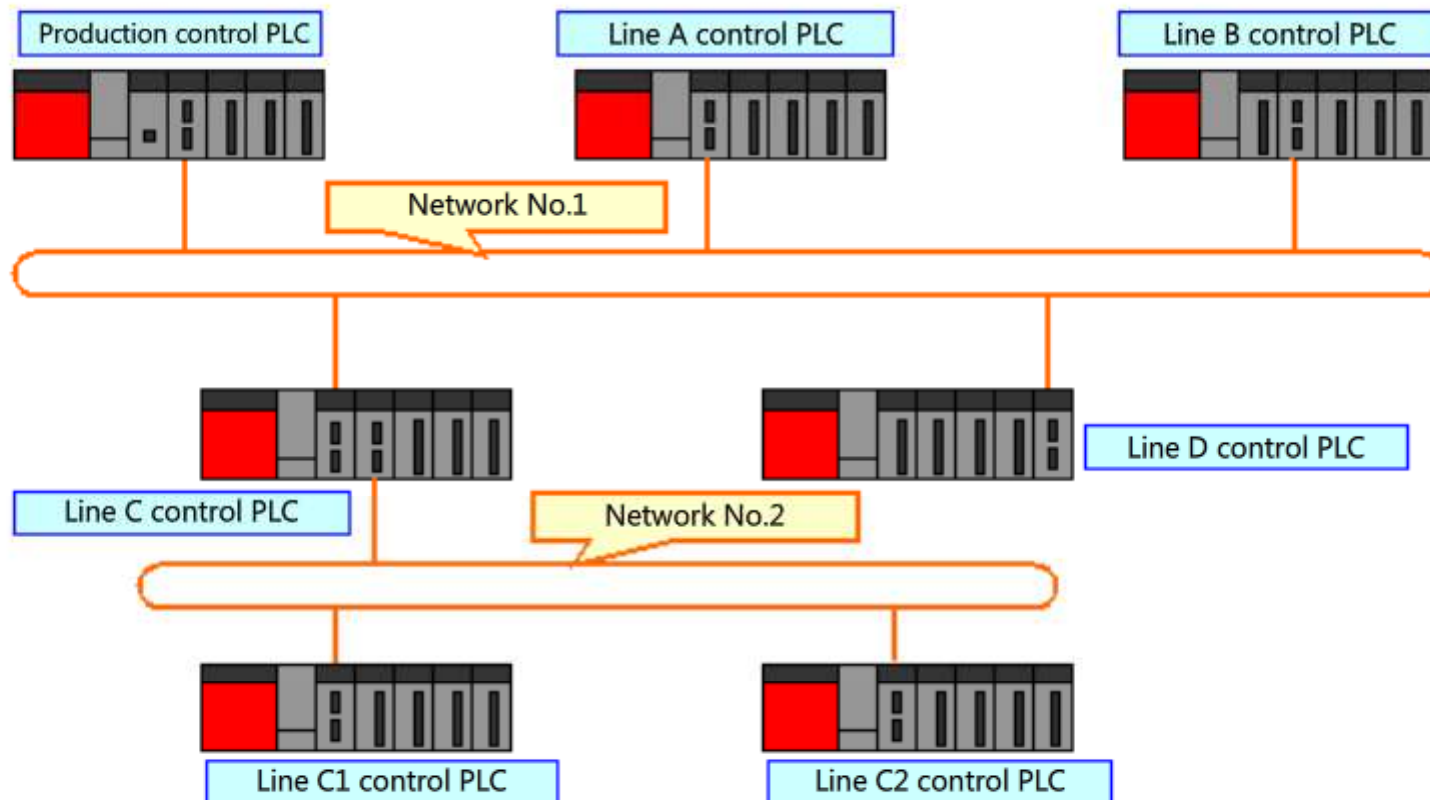
3.2 Transferring PLC I/O Signals with Distant Equipment

As machinery becomes larger, one PLC has to process an increasing number of I/O signals.
In addition, large amounts of signal wiring must be laid in the machinery to transmit many signals to everywhere in the machinery.
As a result, wiring installation and maintenance take much time.
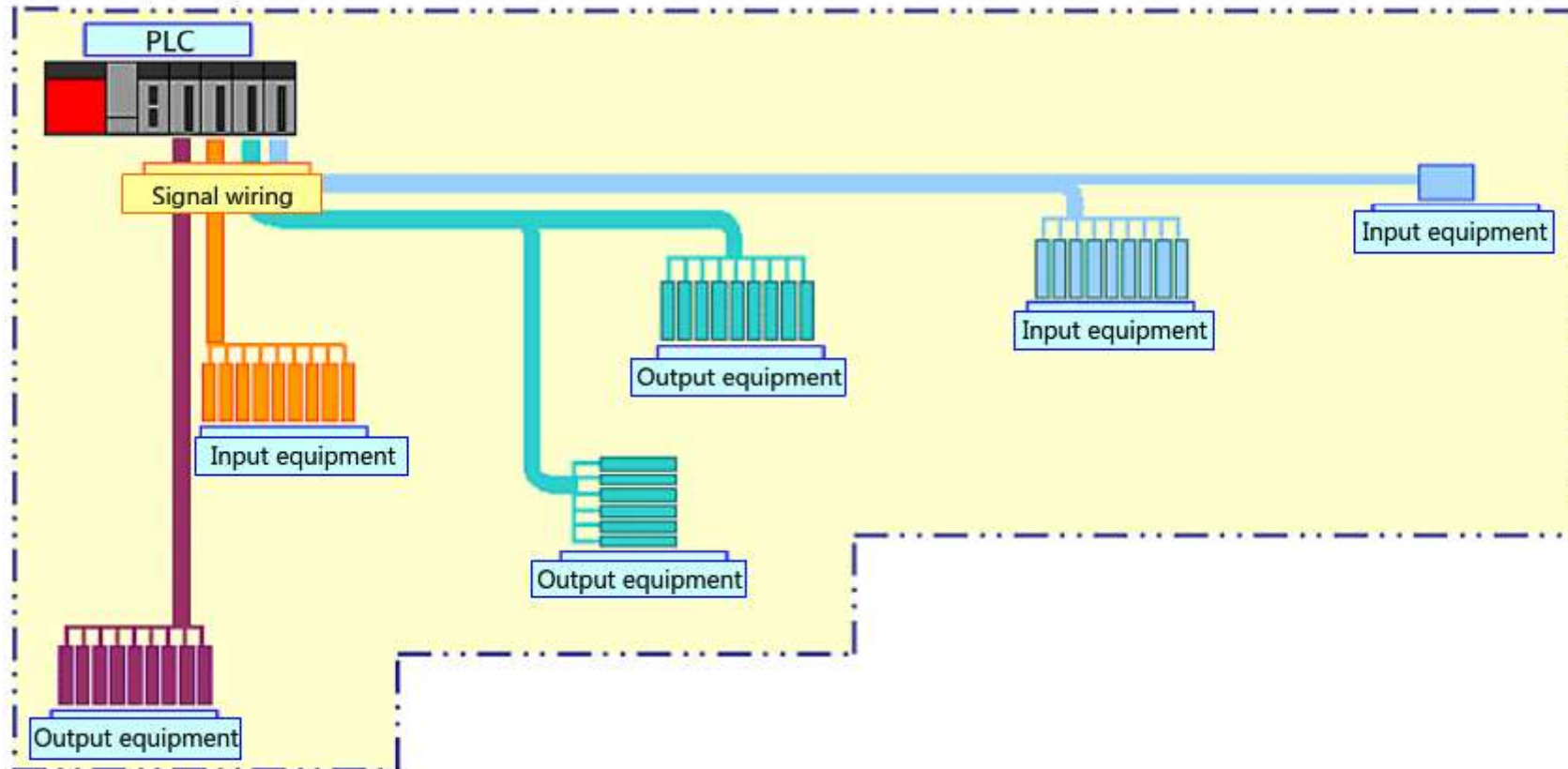
One way to solve these problems is to install I/O modules near the sensors and actuators at various positions of machines and to connect the PLC and each I/O module with a communication cable so that I/O signals are transmitted collectively. These types of products now exist in the market.

A network which connects the PLC and I/O modules as shown above is called a "remote I/O network."
An I/O module which is installed far from the PLC is called a "remote I/O module."
  * Actuator: Part or module such as a solenoid valve or motor, which directly activates a machine

3.2.1 PLC I/O Signal Network

Remote I/O modules, such as sensors and actuators installed near I/O equipment, are connected to the PLC with communication cables.
I/O signals are transferred between I/O equipment installed at various locations in the machinery and the PLC.

Click the Start button for an explanation of the remote I/O network, and the Stop button to end it.
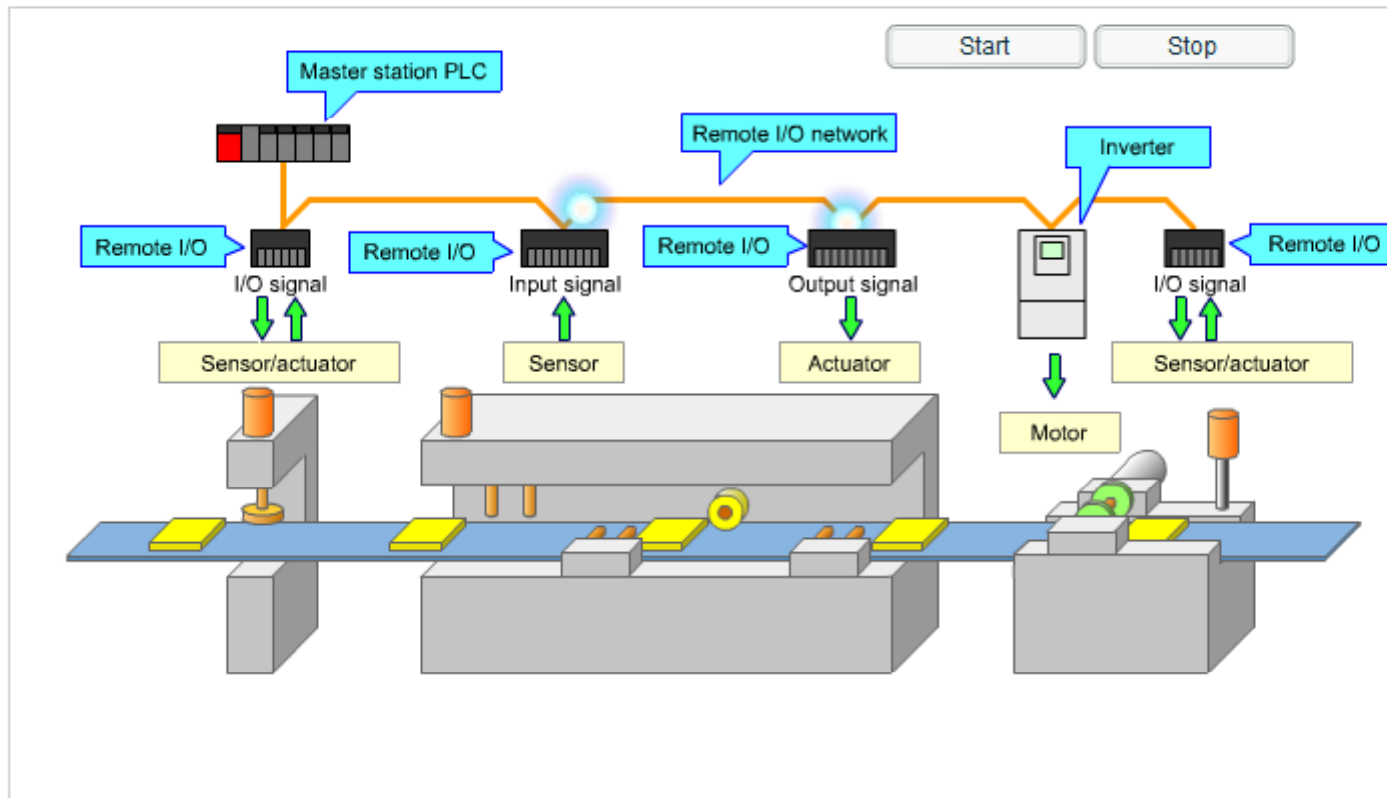
3.2.1 PLC I/O Signal Network

[Features of a remote I/O network]

- I/O modules can be distributed and installed anywhere in the machine.
- Connecting the master station PLC and multiple remote I/O modules with a single communication cable can save wiring and space.
- The sequence program in the master station PLC transfers I/O signals between remote I/O modules and external equipment.
- The remote I/O network can be used for controlling intra-equipment systems as well as small-scale production lines.

- A connection example of the line control network is shown below.
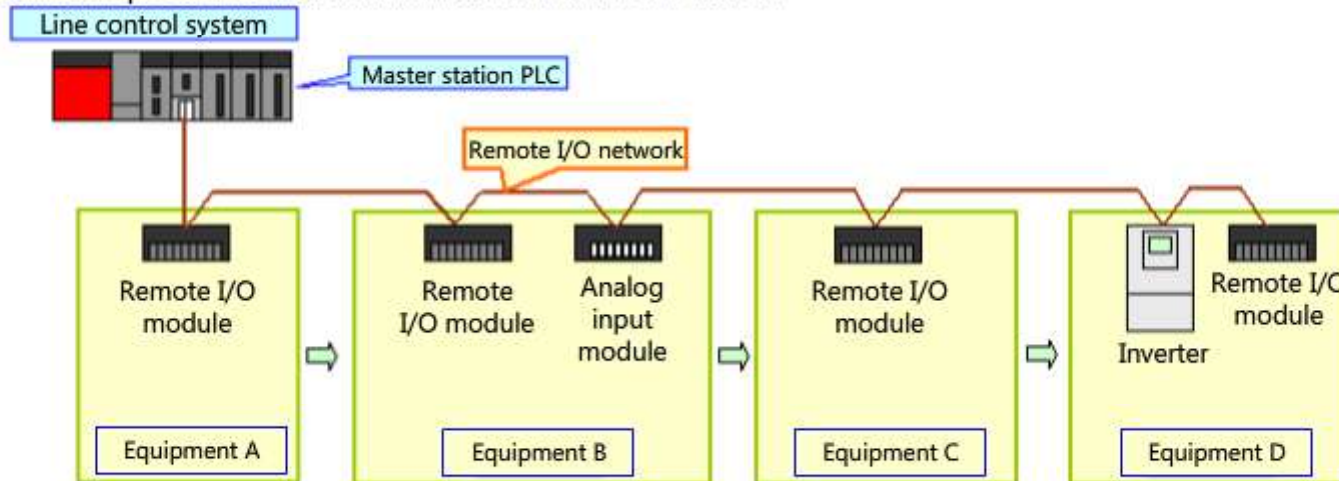
- A connection example of the intra-equipment network is shown below.
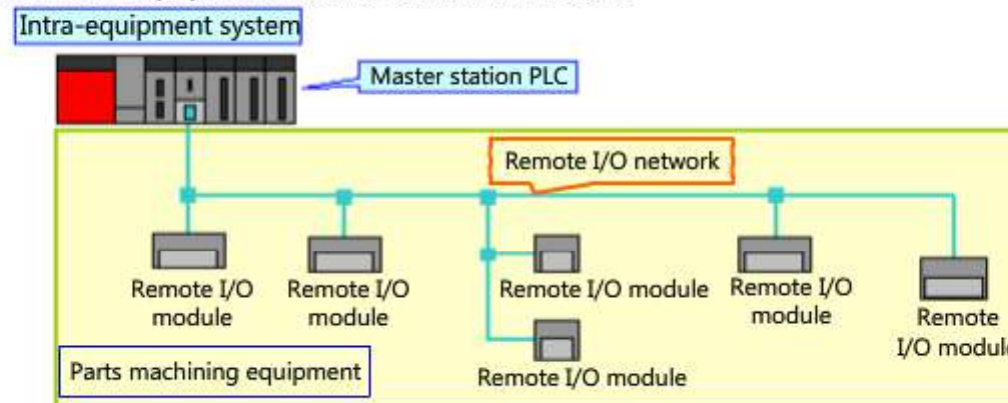
Chapter 4 Future Trends in Industrial Networks

4.1 Fusion of Industrial and Information Networks

Today, a total production system is needed that consistently manages and controls, through a network, the production activities of the entire factory from order reception to shipment.

Therefore, the computer that processes order request, product design, and production constraints needs to exchange information with the PLC that controls the production system.
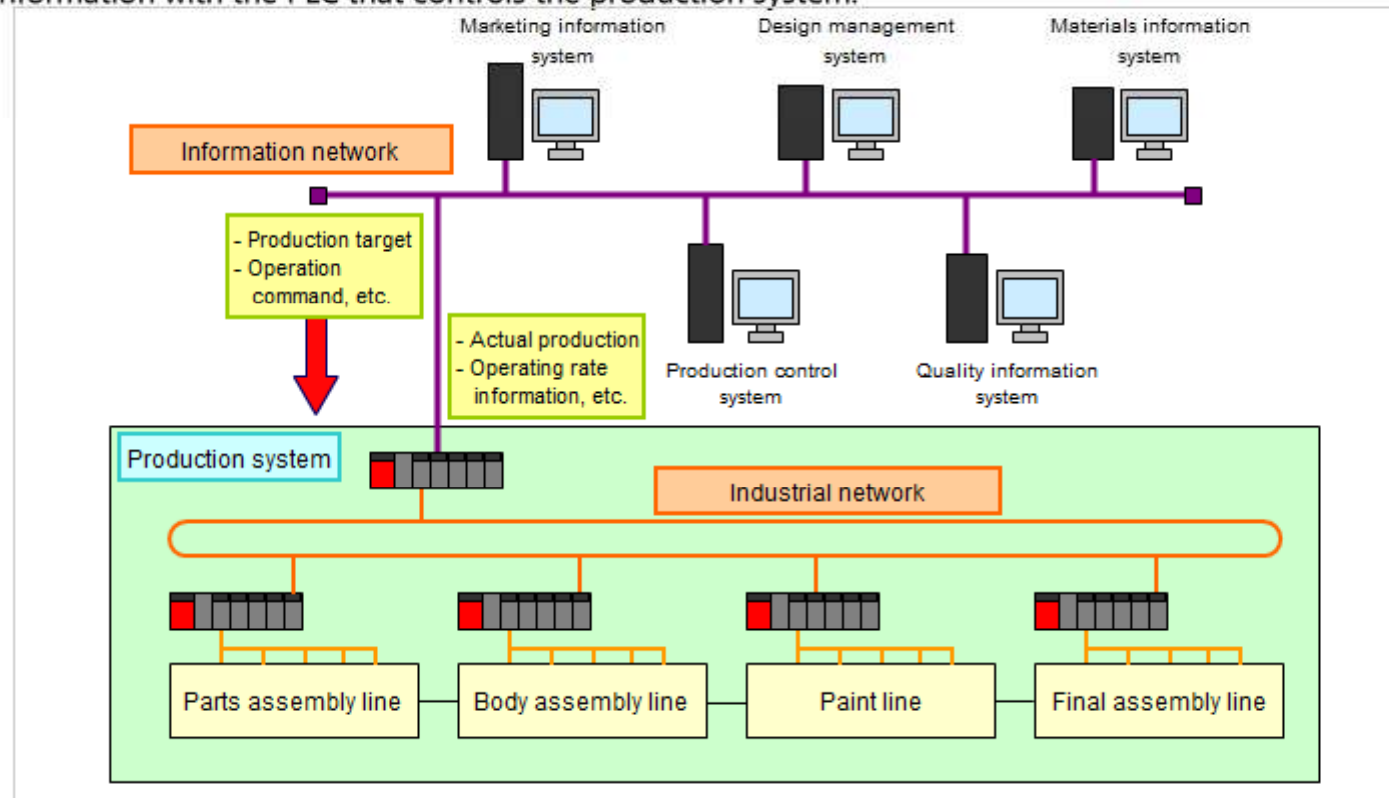
Furthermore, the information network and industrial network are starting to overlap. For example, a network system may now control the production activities of the entire company including marketing, product development, manufacturing, shipment, and distribution, by connecting business locations at home and abroad through the Internet. Another example is a remote maintenance system that remotely monitors the factory production line and machine operations.

4.2 Network Compatible Mitsubishi PLC Products

Mitsubishi PLC "MELSEC Series" products support various types of networks.
Typical MELSEC Series PLC products are introduced here. For more information, refer to the Mitsubishi PLC catalogs and manuals for the related products.

Network type		Network name	PLC module name
PLC network compatible product	Controller level network (PLC to PLC)	CC-Link IE Controller Network	- CC-Link IE Controller Network master/local network module
		CC-Link IE Field Network	- CC-Link IE Field Network master/local network module - Remote I/O head module
	Device level network (Remote I/O)	CC-Link	- CC-Link master/local module - Remote I/O module
		CC-Link/LT	- CC-Link/LT master module - Remote I/O module
Information network compatible product	Communication with computer	Ethernet	- Ethernet module
Internet compatible product	Remote maintenance	Internet	- Web server module

Test — **Final Test**

Now that you have completed all of the lessons of the FA Equipment for Beginners (Industrial Network) Course, you are ready to take the final test. If you are unclear on any of the topics covered, please take this opportunity to review those topics.
There are a total of 10 questions (32 items) in this Final Test.
You can take the final test as many times as you like.

How to score the test

After selecting the answer, make sure to click the **Answer** button. Your answer will be lost if you proceed without clicking the Answer button. (Regarded as unanswered question.)

Score results

The number of correct answers, the number of questions, the percentage of correct answers, and the pass/fail result will appear on the score page.

Correct answers : 3

Total questions : 10

Parcentage : 30%

To pass the test, you have to answer **60%** of the questions correct.

| Proceed | Review | Retry |

- Click the **Proceed** button to exit the test.
- Click the **Review** button to review the test. (Correct answer check)
- Click the **Retry** button to retake the test again.

Test   Final Test 1

In the following explanation, select the sentence that correctly explains "how work has been changed by networks." (Multiple selections allowed)

- ☐ Information transmission is performed using telephone and fax.

- ☐ Information transmission is performed via the network between computers.

- ☐ Common information is stored on paper such as documents, ledgers, and slips.

- ☐ Common information is stored on a server.

- ☐ The paperless office is promoted.

[Answer]   [Back]

Test   **Final Test 2**

The following text explains the concept of data passing in the information network.
Select the appropriate option in each box to complete the text.

Information passing starts when the data requester sends [--Select-- ▼] to the communication partner, and the

communication partner responds with data transfer to [--Select-- ▼] .

[Answer]   [Back]

Test — Final Test 3

The following text explains the concept of data passing in the industrial network.
Select the appropriate option in each box to complete the text.

Information passing is performed as follows: each machine writes data to its own write area [--Select-- ▼] , and

other machines in the network read the written data.

[--Select-- ▼] network participant can write and browse data.

[Answer] [Back]

Test | Final Test 4

Each of the following texts explains the information network or industrial network.
Select which type of network explained by each text.

| --Select-- ▼ | The basic network connects between computers (such as personal computers). |

| --Select-- ▼ | Data communication is performed cyclically at regular intervals while the system is running, so

data punctuality (synchronization) is maintained. |

| --Select-- ▼ | One-to-one communication between the data requestor and communication partner is the

basic rule of information passing. |

| --Select-- ▼ | The basic network is configured centering on the PLC that controls machinery and equipment. |

| --Select-- ▼ | "Ethernet", which is used worldwide, is used as the network standard. |

Answer   Back

Test   Final Test 5

The following table compares the information network and industrial network.
Select the appropriate option in each box to complete the table.

| Item	Information network	Industrial network
Purpose	--Select-- ▼	--Select-- ▼
Connected equipment	Computers (PC, etc.), office equipment	PLC, various types of controllers (NC, etc.)
Communication timing	--Select-- ▼	--Select-- ▼
Data volume	Large volume	Small volume
Network standard	--Select-- ▼	Network standard of PLC of each maker

[Answer]   [Back]

Test | Final Test 6

A PLC network configuration diagram is shown below, and the following text explains the diagram. Select the appropriate option in each box to complete the text.
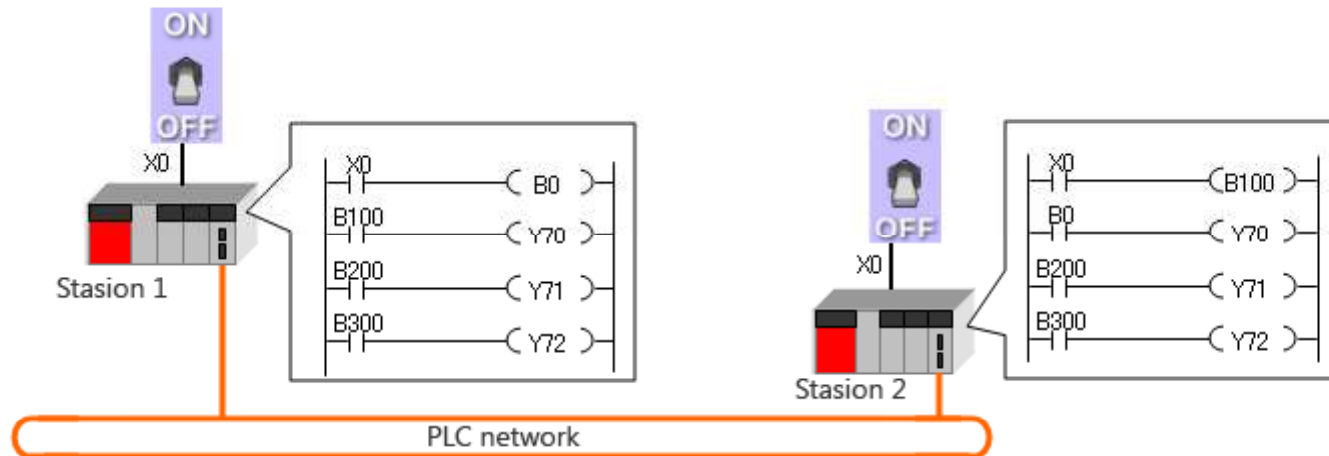
When switch "X0" on PLC station 1 is set to ON, [--Select-- ▼] "B0" turns ON.

At the same time, [--Select-- ▼] B0 on PLC station 2 turns ON and coil [▼] turns ON.

When switch "X0" on PLC station 2 is set to ON, coil [▼] turns ON.

At the same time, contact [▼] on PLC station 1 turns ON and [▼] Y70 turns ON.

[Answer] [Back]

Test — Final Test 7

Among the following sentences, select one which correctly explains the features of the PLC network.
(Multiple selections allowed)

- ☐ The PLCs in the network send the devices in their own send areas in order at regular intervals.

- ☐ Each PLC in the network sends the device in its own send area when requested by another PLC.

- ☐ A user program for communication is required in the PLC network.

- ☐ No user program for communication is required in the PLC network.

- ☐ The data communication system in the PLC network is called cyclic transmission.

[Answer]   [Back]

Test — Final Test 8

Each of the following texts explains the PLC to PLC network or remote I/O network.
Select which type of network explained by each text.

[--Select-- ▼] I/O modules can be distributed and installed anywhere in the machine.

[--Select-- ▼] Processing distributed to the PLCs of individual machines is integrated through the

network to control the entire system.

[--Select-- ▼] Each PLC connected to the network must contain a CPU module.

[--Select-- ▼] The sequence program in the master station PLC controls I/O in the entire system.

[Answer] [Back]

Test **Final Test 9**

The following text explains the PLC network. Select the appropriate option in each box to complete the text.

To automate the production process, the control information and production information processed by the

[--Select-- ▼] of individual machines need to be [--Select-- ▼] to control the entire production system. This

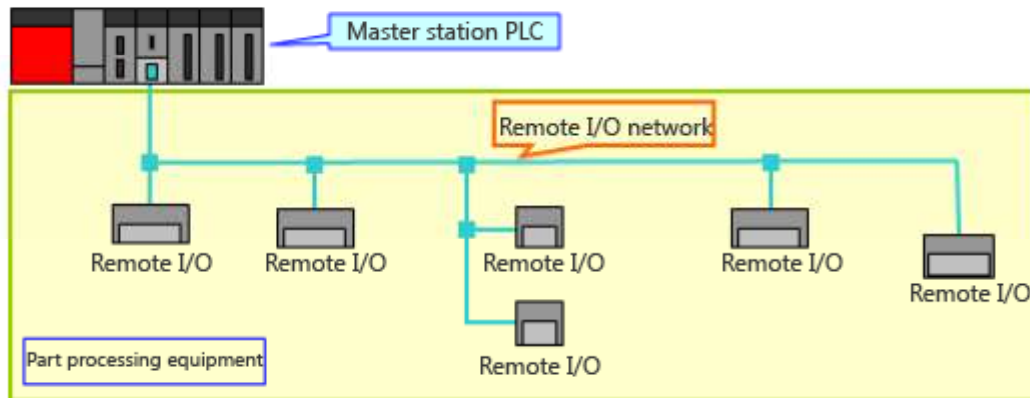has encouraged the use of a network that connects the PLCs of individual machines.

The network that thus connects multiple PLCs to each other is called a [--Select-- ▼] .

[Answer] [Back]

Test   Final Test 10

The following text explains the features of the remote I/O network.
Select the appropriate option in each box to complete the text.

Connecting the master station PLC and multiple --Select-- ▼ modules with a communication cable enables

--Select-- ▼ and space saving.

The sequence --Select-- ▼ in the master station PLC transfers I/O signals between remote I/O modules and

external equipment.

Answer   Back

Test | **Test Score**

You have completed the Final Test. You results area as follows.
To end the Final Test, proceed to the next page.

Correct answers :   0

Total questions :   10

Parcentage :   0%

[Proceed]   [Review]   [Retry]

You failed the test.

You have completed the FA Equipment for Beginners (Industrial Network) Course.

Thank you for taking this course.

We hope you enjoyed the lessons and the information you acquired in this course will be useful in the future.

You can review the course as many times as you want.

Review   Close