FA Equipment for Beginners (Industrial Network)

This course is for the first time users of industrial network to understand the outline of industrial network.

An industrial network is a mean to extend a programmable controller system in order to control remote machines/equipment. This course will show you the difference between the general network 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.

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

Chapter 1 - Understanding Networks

You will learn about the basic information of networks.

Chapter 2 - Industrial Network

You will learn about the outline of industrial network.

Chapter 3 - Understanding Information Network and Control Network

You will learn about the difference between the information network and the control network.

Chapter 4 - Control Network

You will learn about the details on the control network.

Chapter 5 - Application Examples of Industrial Network

You will learn application examples of the industrial network and network products for Mitsubishi Electric programmable controllers.

Final Test

Passing grade: 60% or higher.

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	X	Exit the learning.

Safety precautions

When you learn based on using actual products, please carefully read the safety precautions in the corresponding manuals.

Chapter 1   Understanding Networks

Networking is important in our daily lives.
Networks make contacting others and transmitting information easy.

This chapter describes the details on networks.

Information ranges from private information exchanged among individuals to public information used for running companies and organizations. It is important to smoothly transmit and share the information. To do so, various transmission methods are used.

Transmission methods are roughly categorized into two as listed below.

(1) Information transmission between individuals	Example: Conversation, letter, telephone, fax, e-mail
(2) Information transmission between individuals and groups	Example: Speech, conference, bulletin board, radio, TV, website

A network is a tool used for mutually transmitting and sharing various kinds of information among individuals and groups.
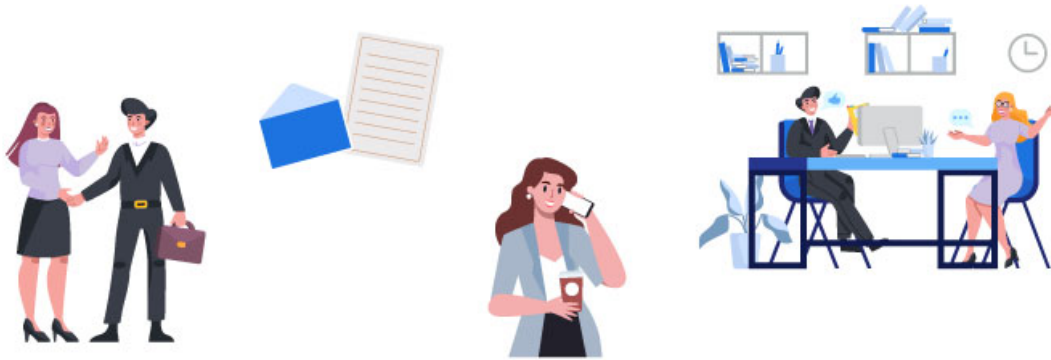
Communication networks have been developed to mutually transmit information by connecting information devices such as a computer though a communication line.

The rapid spread of networks has changed information transmission methods. We can access worldwide information using our own computer now.
The following shows how networks have changed information transmission methods.

Direct contact   **Fax**   **Paper record**   **Video call**   **E-mail**   **Server record**

Before network installation   **After network installation**

Networks have improved productivity and have enhanced the speed of information transmission at a workplace, and also have made working from home possible.
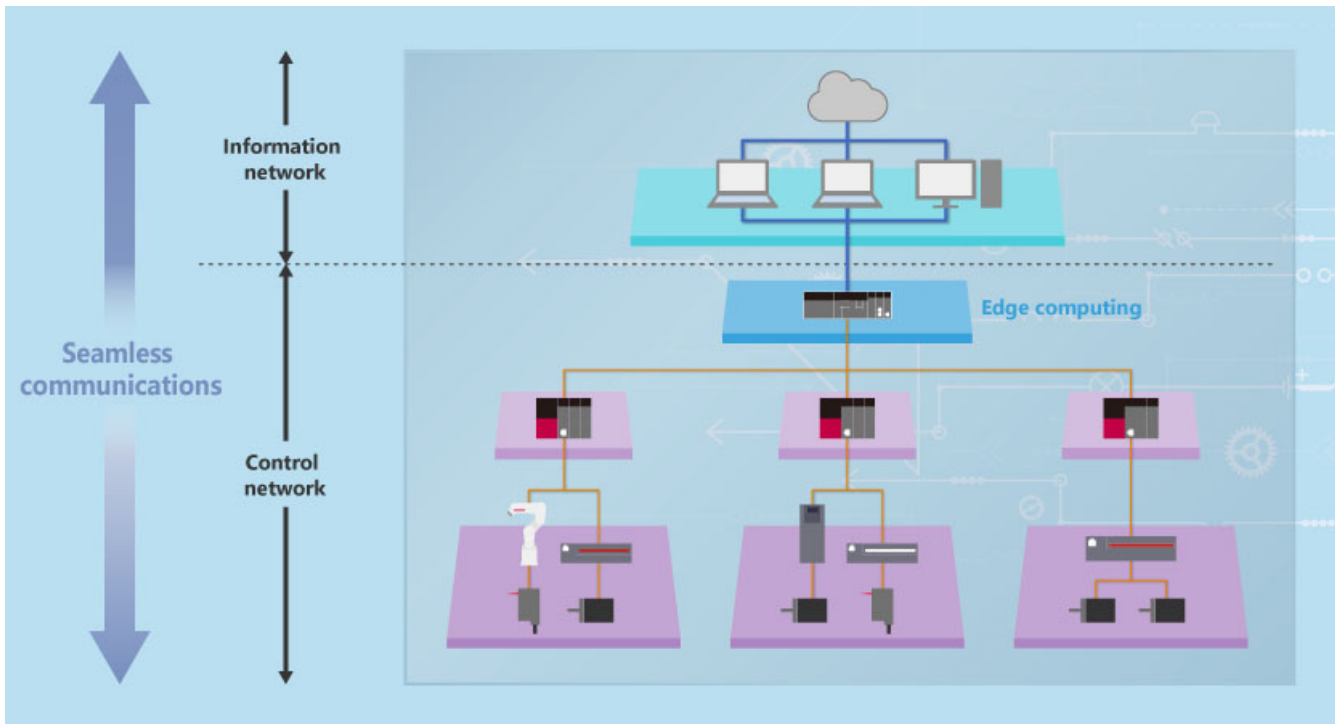
Chapter 2 Industrial Network

This chapter describes the industrial network.

An industrial network is different from a general network that can access websites from your office computer.

An industrial network consists of an information network that connects the factory to a host server, and a control network for system control that supports communication between different hardware (equipment) in the factory.

Nowadays, we can connect the information network and the industrial network seamlessly*. Devices from the host server on the information network to end devices such as a sensor at the production site can be connected.

The following shows an example of the industrial network.

The production efficiency is improved by visualizing the production quality and production status at the production site and sharing/analyzing information.

* Seamless: No joints or breaks between one part and the next exist. Each function does not separate the connection of all devices, and a host server can acquire information of end devices such as a sensor.

This section describes categories of the industrial network. Let's take a look at the figure below.

The industrial network is roughly categorized into the information network and control network.
Also, the control network is subdivided into the controller-to-controller network, which connects programmable controllers to each other, and the field network, which connects programmable controllers and devices.
Details on each network will be described in Chapter 4.
Computer communications (shown in the figure below) refer to the data communications between the computer and the server of the host station through a communication line.
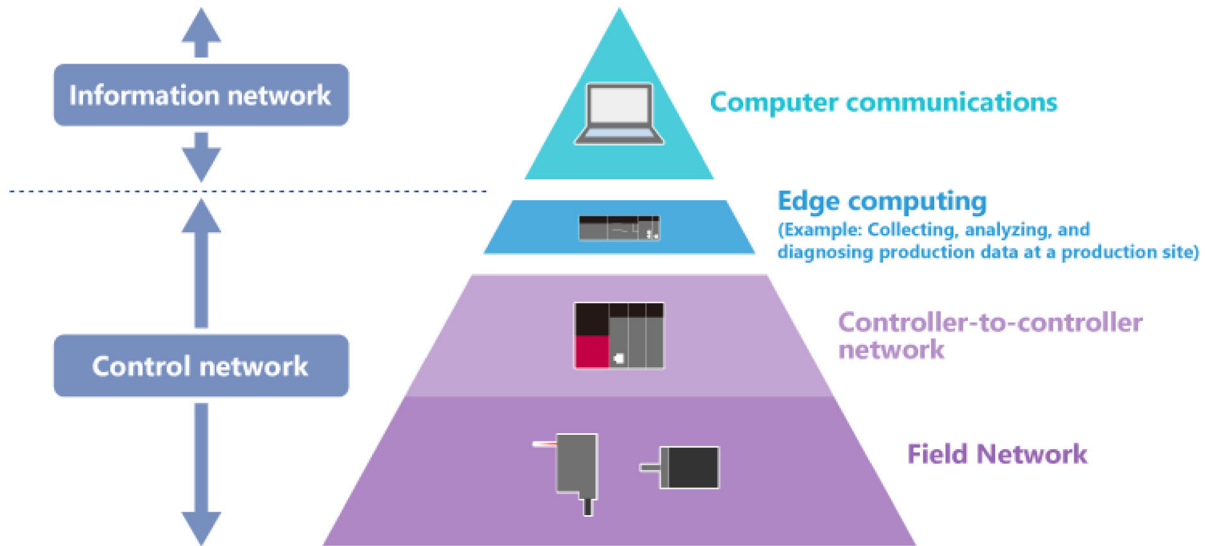
* Edge computing: Industrial computers, which collect, analyze, and diagnose data, are installed close to the production site (data source) and process data in advance before sending the data to a cloud/IT system. This improves the real time reaction and production efficiency.

Chapter 3 Understanding Information Network and Control Network

This chapter describes the information network aimed at improving productivity in the industrial network and the control network aimed at the automating production and improving efficiency of production.
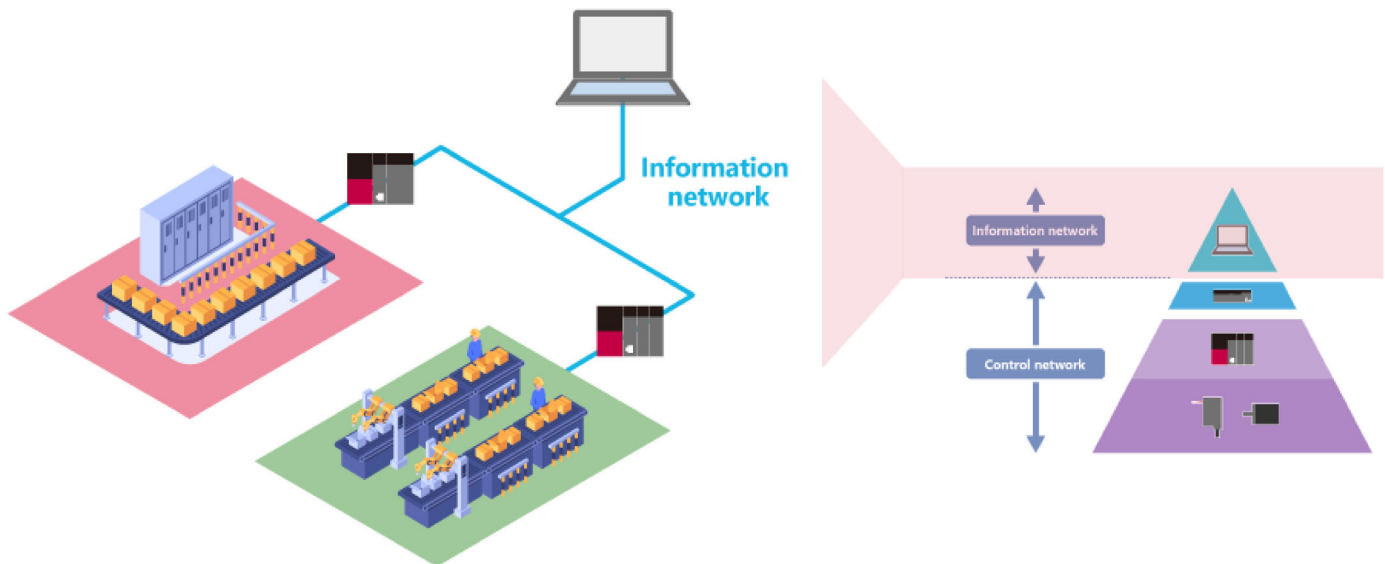
3.1 Information Network

3.2 Control Network

3.3 Comparison Between Information Network and Control Network

3.4 Network Using Information Network and Control Network Together

The information network is used to connect computers and servers of the management department (such as production plan and manufacturing management) through a communication line. In this network, the large amount of data is handled, information is managed/shared, and various devices are used in common. This contributes to improving efficiency of work at each department.

It is essential as an information infrastructure to perform the production control at a production site.

Nowadays, the information network is widely used in our daily lives so that you can browse websites on the Internet or use e-mail.
This e-learning training is also supported by the information network.

The concept of information communication on the information network is equivalent to "Information transmission between individuals" described in Chapter 1.

The data communication is performed as follows. A request source sends a data send request to a communication destination, and the communication destination returns the data to the request source. Basically, one-to-one communications between the request source and the communication destination are performed.
All devices on the network can communicate with each other at anytime.

Click the [Play] button to start the video of data communications on the information network.
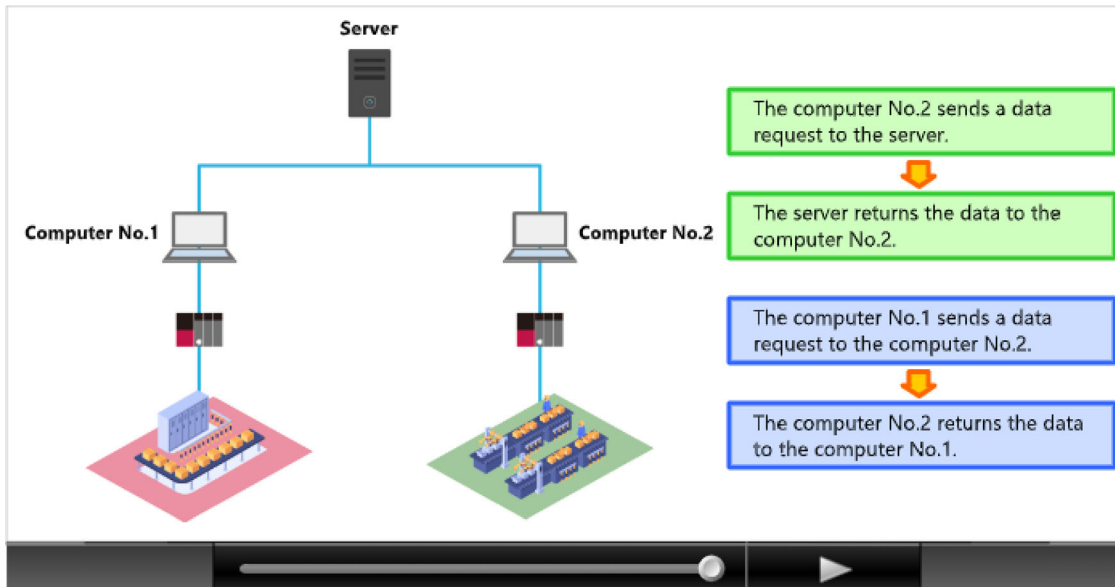
This section describes the features of information network.

Information network
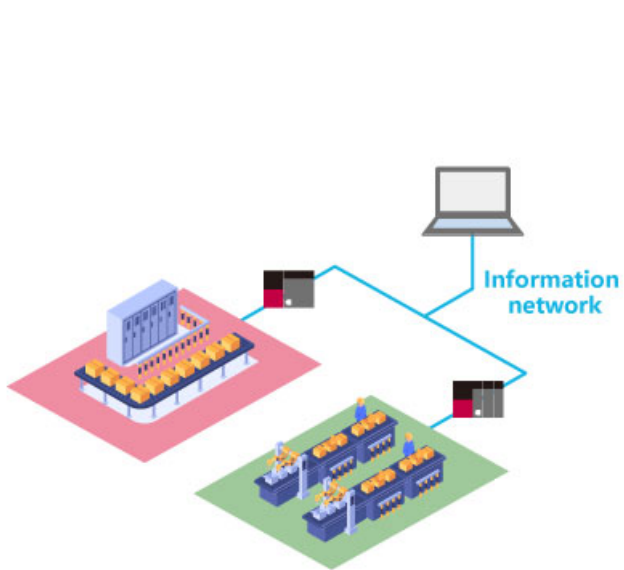
Connection

Computer-to-Computer

Network standard

Globally used Ethernet

Data capacity and real time reaction

Large amount of data. The real time reaction is less important.
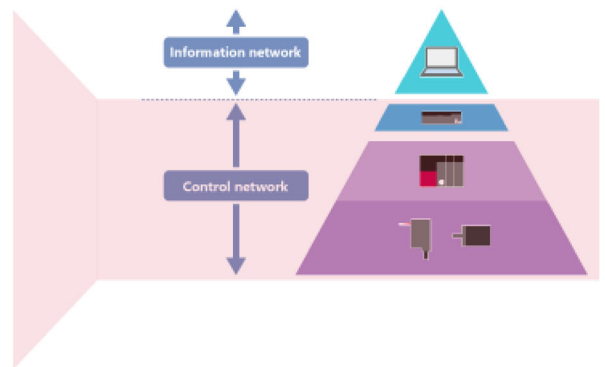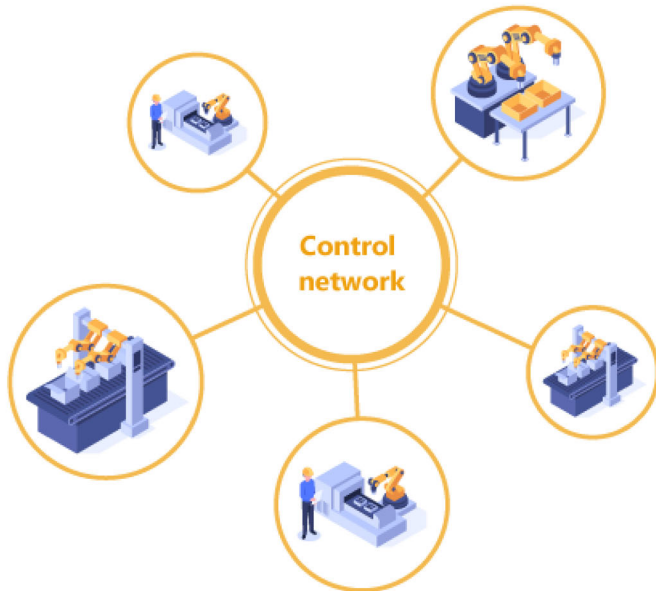
Communication timing

Data accuracy is essential, but time variation in communications is acceptable.

The control network is used to connect programmable controllers, which control machines/equipment at a production site, and various devices (such as controller, I/O, sensor, and actuator[*1]) through a communication line.

Control information of various machines/equipment, which configure a production system[*2], is communicated on this network. This achieves the automation of production and reduction of labor. Also, the production result of the entire system is summarized and the operating status and error status are monitored.

*1: Actuator: A component or unit that is responsible for operating devices such as a solenoid valve or motor directly.
*2: Production system: A group of computers and various of machines/equipment, which are used for production.

The concept of information communication on the control network is equivalent to "Information transmission between individuals and groups" described in Chapter 1.

A machine writes data to its own write area in rotation, and the other machines on the same network read the written data. Imagine this network as an Internet forum on which anyone on the network can write and browse information.

Click the [Play] button to start the video of data communications on the control network.

This section describes the features of control network.

Connection

Programmable controllers that control machines and equipment, various devices (controllers, I/Os, etc.), remote modules

Network standard

Network dedicated to device control

Data capacity and real time reaction

Smaller-capacity (compared to the information network). The real time reaction is important.

Communication timing

Data is updated because data communications are performed periodically while the system is operated.

Control network

This section describes the comparison between the information network and the control network.
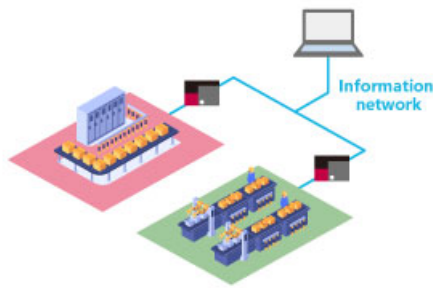

Information network	Control network
Efficient operation at a production site and reduction of labor	Automation of production system and reduction of labor
Personal computer, OA equipment	Programmable controllers, various devices (controllers, I/Os, etc.), remote modules
Ethernet	Network dedicated to device control
Large amount of data. The real time reaction is less important.	Smaller-capacity (compared to the information network). The real time reaction is important.
Data communications are performed at any timing as required.	Data communications are performed periodically.

* ⊟ ⋯ Connection   ⊘ ⋯ Network standard   ▤ ⋯ Data capacity and real time reaction   📶 ⋯ Communication timing

This section describes the current situation of networks.

Nowadays, the use of network technology that extends standard Ethernet and seamlessly integrates information and control networks and the renewal of communication protocols have progressed. Networks that collect data in real time from various devices at production sites and realize consistent communication with IT systems that create newly added values are becoming mainstream.

A highly-flexible system configuration and wiring cost reduction are possible by combining other network communications and information communications in the IT system on the same network while control communications with real-time accuracy is performed.
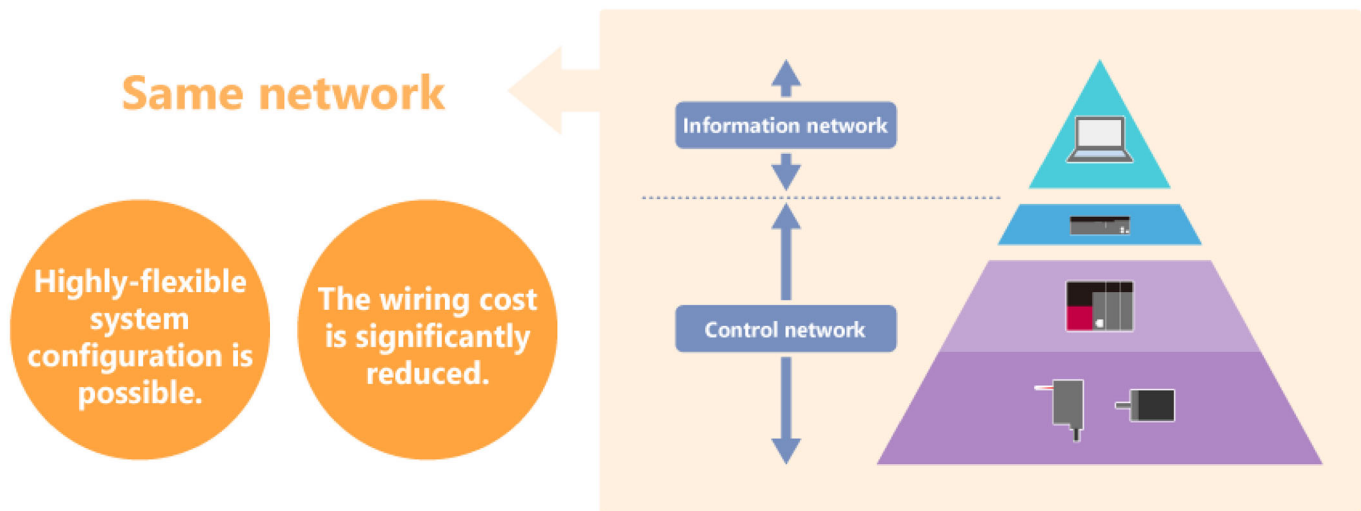
This chapter describes the details on the control network.
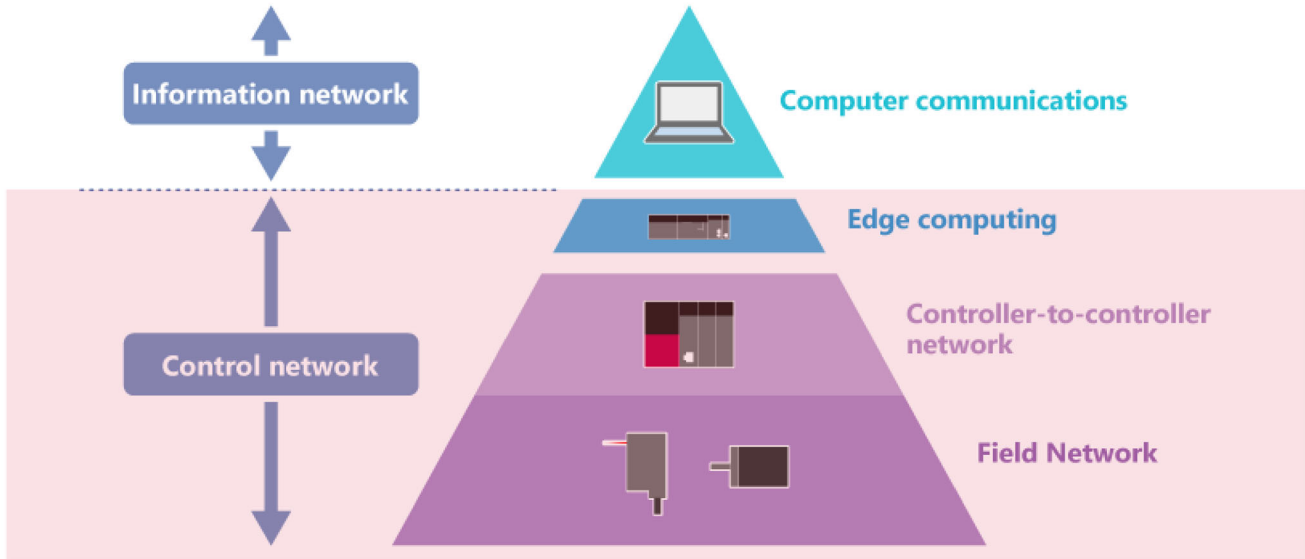
Devices, such as a programmable controller, robot, and HMI, can be connected.
This section describes data communications between programmable controllers (devices* (contact, coil, data register)) as an example.

For example, when the programmable controller connected to the network turns on the device "B0", the other programmable controllers acquire the device data immediately and check it at the same time.
The programmable controllers on the same network can share signals and data using the same device.

* Device: CPU module memory where signals and data are stored for sequence program calculation

Click the [Start] button to display the operation guide.
Follow the guide and turn on/off each switch with a mouse-click. The ladder monitor status will change.
(The switches in the ladder monitor can be operated directly (without clicking the [Start] button).)
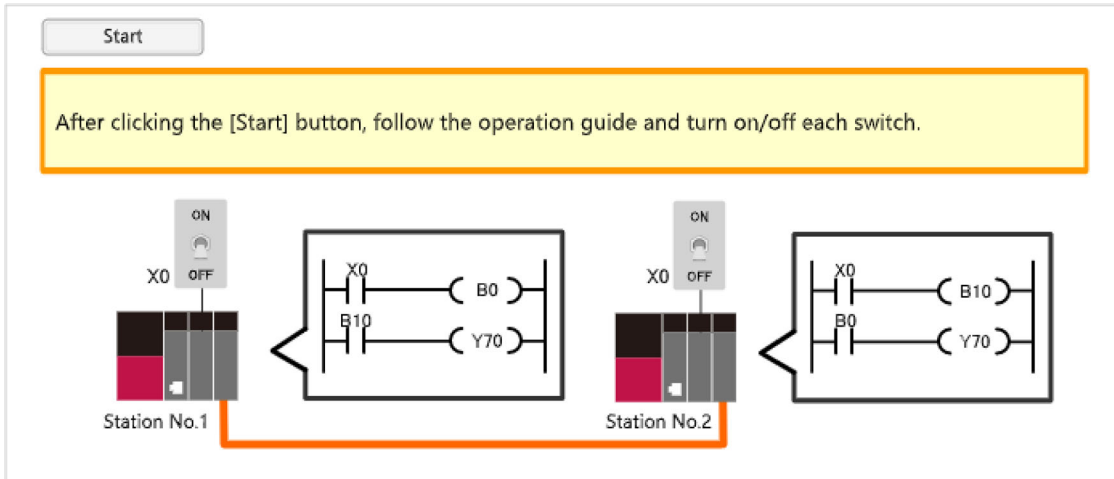
This section describes the controller-to-controller network in the control network (area shaded in red) shown in the figure below.

Programmable controllers lead the automation of machines at the production site.
To increase the productivity of the production site, the production system that automates the entire production process by collectively controlling all the machines in each production line is required.

To achieve this system, the control information and production information processed by the programmable controller of each machine need to be integrated, and the entire production system needs to be controlled. Therefore, this network is used to connect all programmable controllers.

By interfacing between programmable controllers based on instructions and control signals from the master programmable controller, the entire production system is collectively controlled.
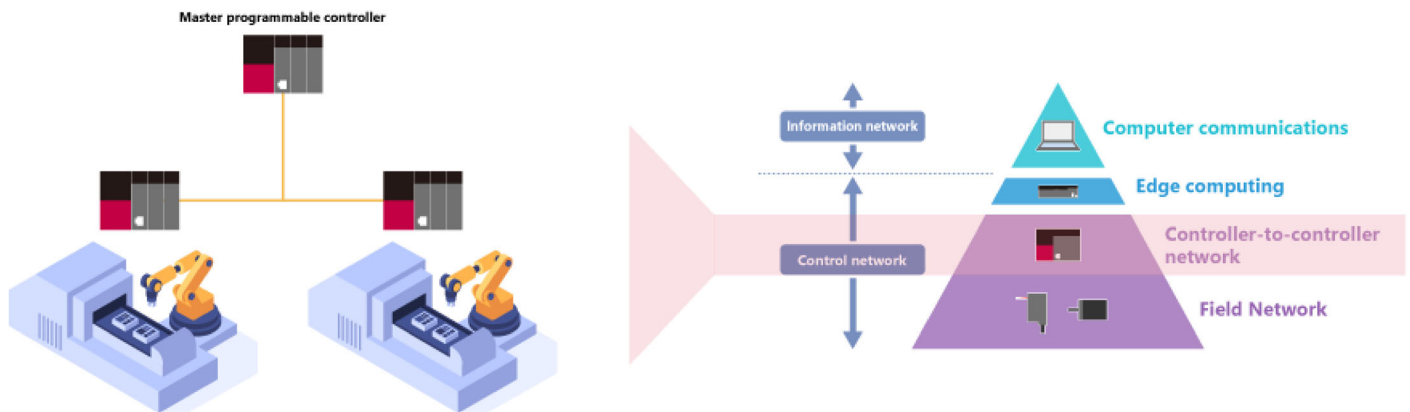
This section describes the features of the controller-to-controller network.
The following shows the simple configuration using three machines as an example. Check the operation.

- The programmable controller of each machine has its own task. Each task is processed on the same network so that the entire system can be controlled.

- Each programmable controller connected to the network must have a CPU module.

- The task is distributed among multiple programmable controllers on the same network so that the task processing load on one programmable controller can be reduced.

- Each programmable controller summarizes the production result and monitors the production status based on its own sequence program.

- This network can be used for various systems, from a small-scale system consisting of one network to a large-scale system consisting of multiple networks.
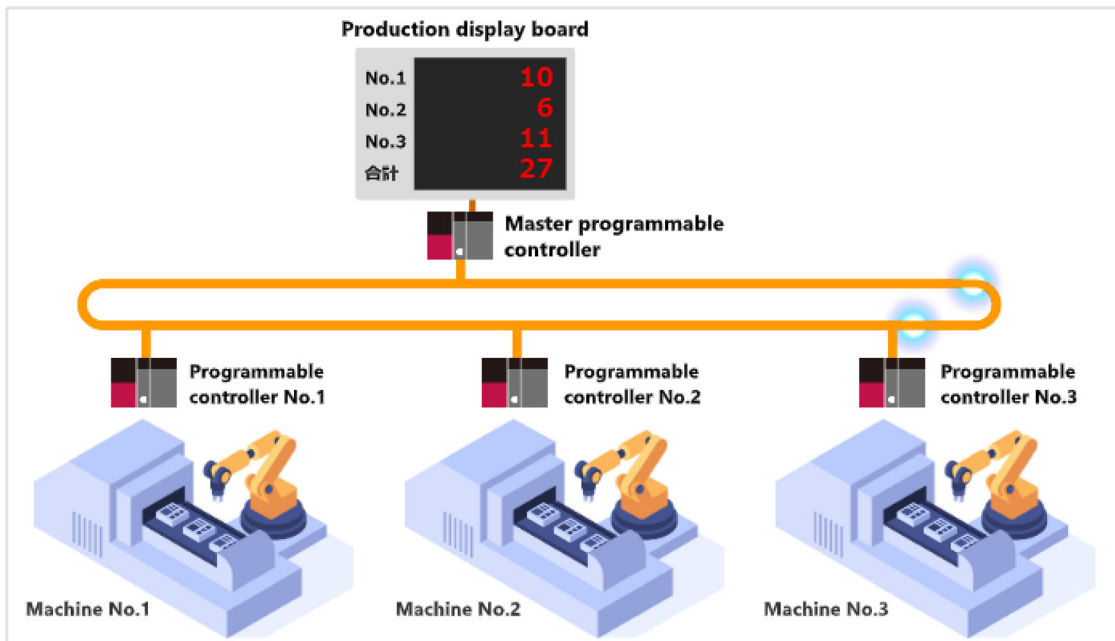
This section describes the field network in the control network (area shaded in red) shown in the figure below.
We call "field network" as the network that connects programmable controllers and devices such as a remote I/O module or motor.

As machines/equipment become larger, one programmable controller needs to process more I/O signals.
Furthermore, the large amount of signal wiring must be installed to transmit many signals to different devices/tools in the machines/equipment.
As a result, wiring installation and maintenance takes a lot of time.

One way to solve these problems is to install remote I/O modules near sensors and actuators in the machine and to connect the programmable controller and each remote I/O module using a communication cable so that I/O signals are transmitted collectively.
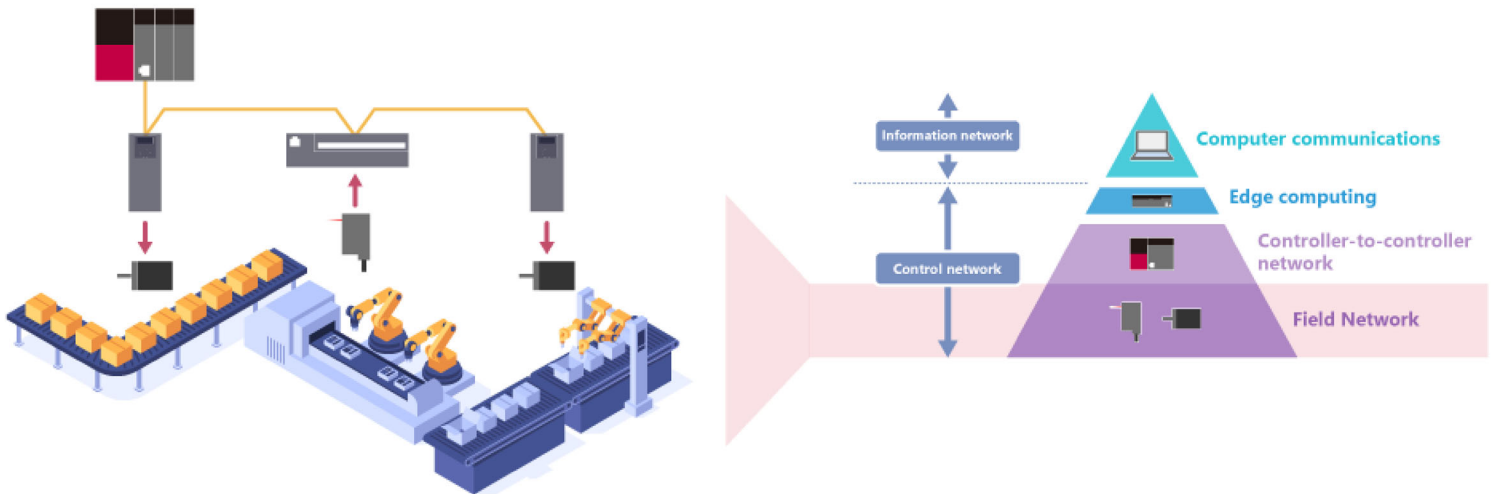
This section describes the features of the field network.
Click the [Start] button to start the video, and the [Stop] button to end it.

- Remote I/O modules can be installed flexibly in the machine.

- Connecting the master station programmable controller and multiple remote I/O modules using one communication cable can save wiring and space.

- The sequence program of the master station programmable controller transmit I/O signals between remote I/O modules and external devices.

- A field network can be implemented within in-device systems to control of small production lines.

Chapter 5 Application Examples of Industrial Network
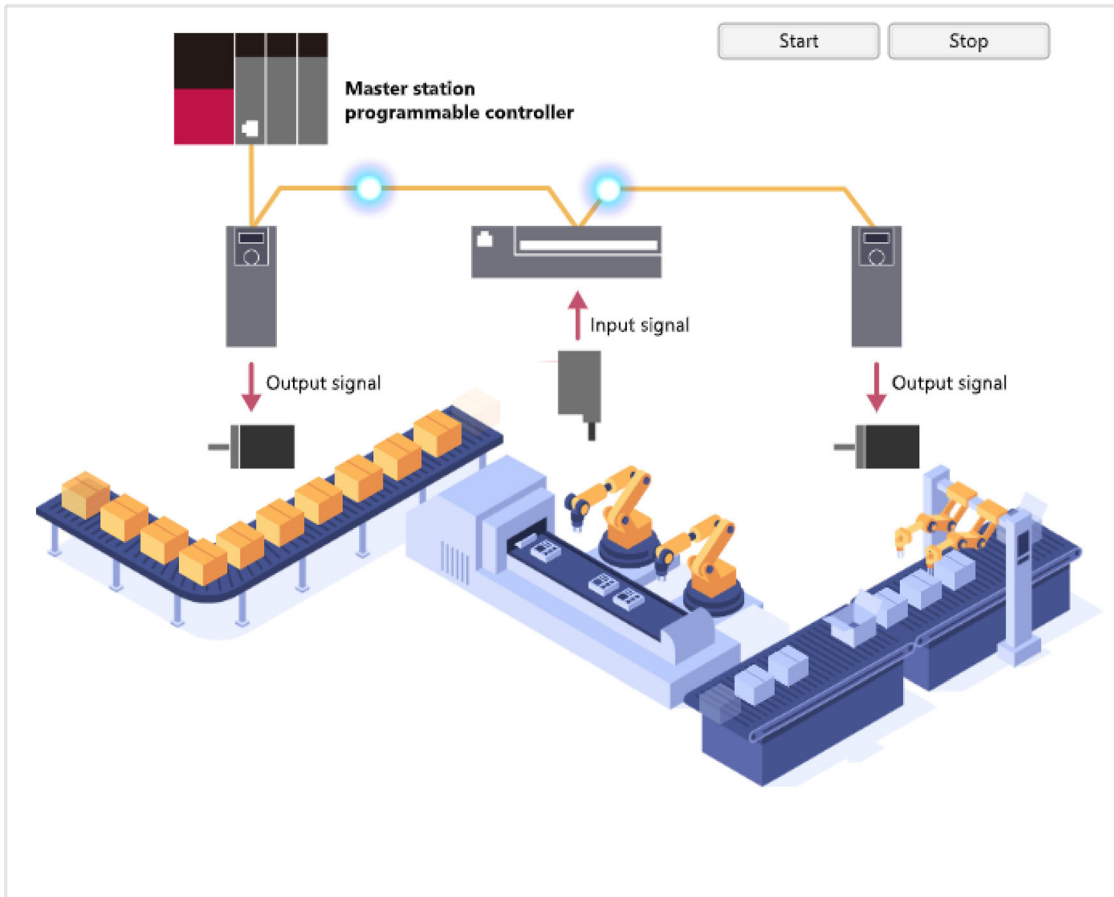
This chapter describes the application examples of the industrial network.

5.1 Application Example 1

5.2 Application Example 2

5.3 Network Products for Mitsubishi Electric Programmable Controllers

An industrial network is used at an automated warehouse, which is commonly used in the current logistics fields.

Click the red circles below to view the details.
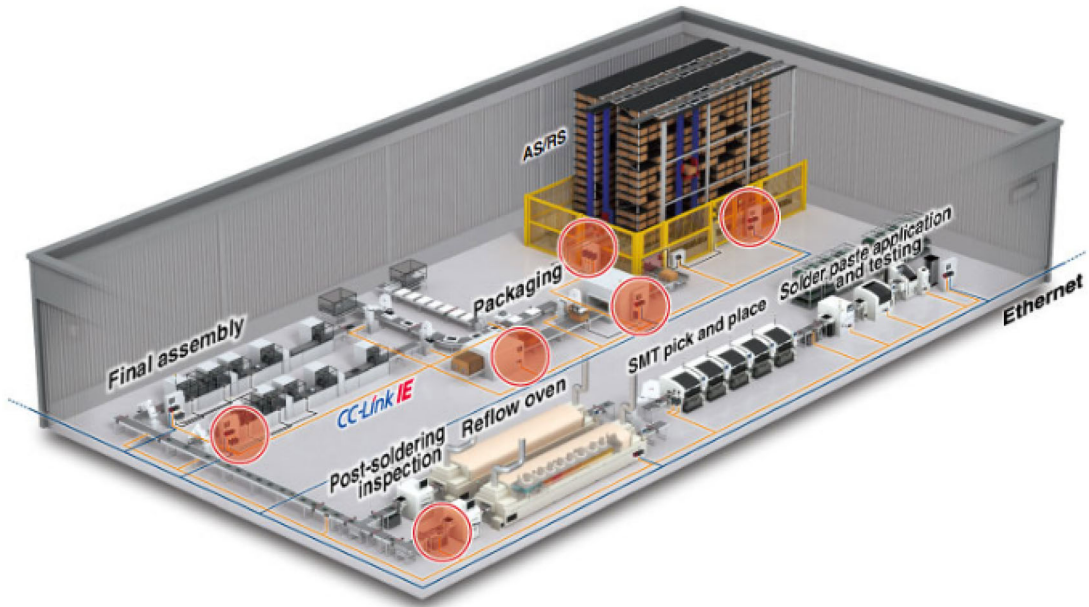
As described in previous chapters, nowadays, the following network has become dominant: a network that realizes seamless communications in the IT system creating newly added values by collecting real-time data from various devices at the production site.
The representative network is CC-Link IE TSN. CC-Link IE TSN can be used in various fields.
For details, check the following video.

Click the [Play] button.

Provided by CC-Link Partner Association

Different types of products supporting various networks are available in MELSEC series.
Representative products supported by MELSEC iQ-R series programmable controllers are shown below.
For details, refer to the catalogs for Mitsubishi Electric programmable controllers and the manuals for related products.

Control network compatible products		Information network compatible products	Internet compatible product
Controller-to-controller network	**Field Network**	**Computer communications**	**Remote maintenance**
CC-Link IE Control	*CC-Link IE Field*	**Ethernet**	**Internet**
‣ CC-Link IE Controller Network module	‣ CC-Link IE Field Network master/local module	‣ Ethernet module	‣ Web server module
	‣ Remote module		
MELSECNET/H	*CC-Link*		
‣ MELSECNET/H network module	‣ CC-Link master/local module		
	‣ Remote module		

CC-Link IE TSN	‣ CC-Link IE TSN module	
	‣ Remote module	

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 6 questions (21 items) in this Final Test.

You can take the final test as many times as you like.

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.

		1	2	3	4	5	6	7	8	9	10	
Retry	Final Test 1	✔	✔	✔	✕							Total questions: **28**
	Final Test 2	✔	✔	✔	✔							
	Final Test 3	✔										Correct answers: **23**
	Final Test 4	✔	✔									
	Final Test 5	✔	✔									Percentage: **82** %
Retry	Final Test 6	✔	✕	✕	✕							
	Final Test 7	✔	✔	✔	✔							
	Final Test 8	✔	✔	✔	✔	✔						To pass the test, **60%** of correct answers is required.
	Final Test 9	✔										
Retry	Final Test 10	✕										

Select the correct descriptions about "how the ways we handle information at work have changed after network installation". (Multiple answers allowed)

Q1

☐ **Information transmission is performed by direct contact or fax.**

☑ **Information transmission is performed by video call or e-mail.**

☐ **Common information is stored on a paper medium such as a document, ledger, and slip.**

☑ **Common information is stored on a server.**

The following describes the concept of information communication on the information network. Select the correct term from each pull-down selection to complete the sentence.

Information communication starts when a request source sends a **(Q1)** to the communication destination, and the communication destination returns the data to the **(Q2)** .

Q1   data request   ⌄

Q2   request source   ⌄

The following describes the concept of information communication on the control network. Select the correct term from each pull-down selection to complete the sentence.

A machine writes data to its own write area **(Q1)** , and the other machines on the same network read the written data. **(Q2)** devices on the network can write and browse information.

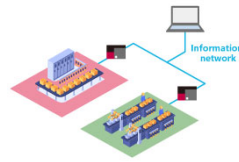**Q1** | in rotation ⌄

Q2 | Any ⌄

Select the correct description from each pull-down selection to complete the table on the right.

Q1 Automation of production system and redu... ⌄

Q2 Ethernet ⌄

Q3 Large amount of data. The real time reactio... ⌄

Q4 Data communications are performed period... ⌄

|	Information network	Control network
Appli-cation	Efficient operation at a production site and reduction of labor	Q1
	Computer, OA equipment	Programmable controllers, various devices (controllers, I/Os, etc.), remote modules
	Q2	Network dedicated to device control
	Q3	Smaller-capacity (compared to the information network). The real time reaction is important.
	Data communications are performed at any timing as required.	Q4

⚡ ··· Connection   ⊘ ··· Network standard   ▭ ··· Data capacity and real time reaction   📶 ··· Communication timing

[+]

The following describes the control network configuration diagram. Select the correct term from each pull-down selection to complete the sentence.

When the switch "X0" of the programmable controller (station No.1) turns on, the **(Q1)** "B0" turns on.
At the same time, the **(Q2)** "B0" of the programmable controller (station No.2) turns on, and the coil " **(Q3)** " turns on.
When the switch "X0" of programmable controller (station No.2) turns on, the coil " **(Q4)** " turns on.

Q1	coil ⌄
Q2	contact ⌄
Q3	Y70 ⌄
Q4	B100 ⌄
Q5	B100 ⌄

[+]
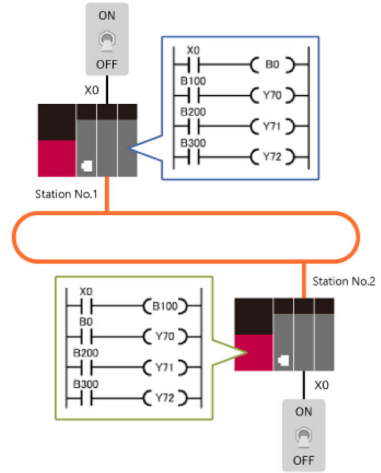
The following are the features of controller-to-controller network and field network. Select an applicable network (controller-to-controller network or field network) to each description.

(Q1) Remote I/O modules can be installed flexibly in the machine.
(Q2) The programmable controller of each machine has its own task. Each task is processed on the same network so that the entire system can be controlled.

Q1	Field network	⌄
Q2	Controller-to-controller network	⌄
Q3	Controller-to-controller network	⌄
Q4	Field network	⌄

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

		1	2	3	4	5	6	7	8	9	10
	Final Test 1	✔									
	Final Test 2	✔	✔								
	Final Test 3	✔	✔								
	Final Test 4	✔	✔	✔	✔						
	Final Test 5	✔	✔	✔	✔	✔					
	Final Test 6	✔	✔	✔	✔						

Total questions: **18**

Correct answers: **18**

Percentage: **100** %

Clear

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