



Autumn 2012

**Applied Information Technology Engineer Examination
(Afternoon)**

Questions must be answered in accordance with the following:

Question Nos.	Q1	Q2-Q7
Question Selection	Compulsory	Select 5 of 6
Examination Time	13:30 - 16:00 (150 minutes)	

Instructions:

1. Use pencils only. If you need to change an answer, erase your previous answer completely and neatly. Wipe away any eraser debris.
2. Fill in the answer sheet.
Do not write on the answer sheet outside of the prescribed places.
 - (1) **Examinee's Number**
Write your examinee number in the space provided.
 - (2) **Date of Birth**
Write your date of birth (in numbers) exactly as it is printed on your examination admission card.
 - (3) **Question selection**
For Q2 to Q7, circle the question number that you have answered. If you do not circle, your answer will not be graded. If you circled every question number, the first 5 questions will be graded.
 - (4) **Answers**
Write each answer in the space specified for that question.
Write your answers clearly and neatly. Illegible answers may lower your score.
3. After the examination, you may take this question booklet home with you.

**Do not open the question booklet unless instructed to do so.
Inquiries on questions will not be accepted.**

Company names and product names appearing in the exam questions are trademarks or registered trademarks of their respective companies. Note that the ® and ™ symbols are not used within.

Q1. Read the following description concerning the data structures and algorithms used by an application, and then answer Subquestions 1 through 4.

Figure 1 shows a screenshot of an application that lets the user place memos at desired positions on the desktop of a PC, and Figure 2 illustrates the data image of a memo.

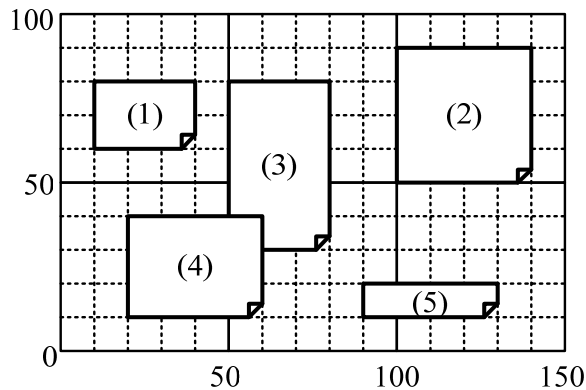


Figure 1: Image of memos on the desktop

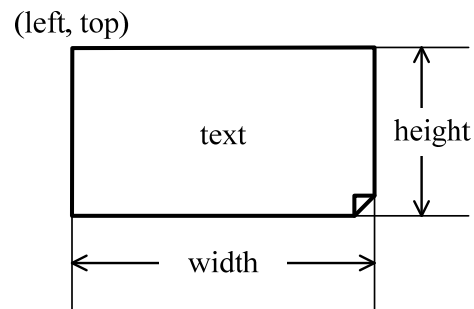


Figure 2: Data image of a memo

The array and the doubly-linked list (hereinafter the list) are evaluated to determine which is better suited for managing multiple memo data. To compare these two, an algorithm that moves a memo behind other memos, such as Memo (3) in Figure 1, to the front is implemented with the array and with the list. Table 1 shows the structures, array, constant, variables, and functions that are used. Figures 3 and 4 show how Memos (1) through (5) in Figure 1 are stored sequentially in the array and in the list, respectively.

The closer the memo data is to the end of the array or the list, the nearer to the foreground layer on the desktop it is displayed.

Table 1: Structures, array, constant, variables, and functions that are used

Name	Type	Description
Memo	Structure	Data structure for a memo. This structure manages the following values: i d: Unique ID of the memo text: Contents of the memo l e f t, t o p: Positions of the left and the top ends of the memo w i d t h, h e i g h t: Width and height of the memo
MEMO_MAX_SIZE	Constant	Maximum number of memos that can be placed on the desktop.
MemoArray	Array	Array that uses the structure Memo as an element (memo data). The array has MEMO_MAX_SIZE elements. Each element of the array is represented as MemoArray[i] (where i is the index of the array). The index of the array begins with 0.
memoArrayCount	Variable	Number of memo data stored in the array MemoArray.
moveForeArray(i d)	Function	Moves the memo data whose memo ID is i d to the end of the array MemoArray.
fi ndArrayI ndex(i d)	Function	Finds the memo data whose memo ID is i d in the array MemoArray, and returns its index.
MemoLi stNode	Structure	Data structure for a node representing memo data. These nodes constitute a list. This structure manages the following values: data: Memo data (structure Memo) prevNode, nextNode: Reference to the previous or the next node. prevNode of the head node of the list and nextNode of the tail node of the list are null.
headNode	Variable	Reference to the head node of the list. The initial value is null.
tai l Node	Variable	Reference to the tail node of the list. The initial value is null.
moveForeLi st(i d)	Function	Moves the node of the memo data whose memo ID is i d to the end of the list.
fi ndLi stNode(i d)	Function	Finds the node storing the memo data whose memo ID is i d in the list, and returns the reference to it.

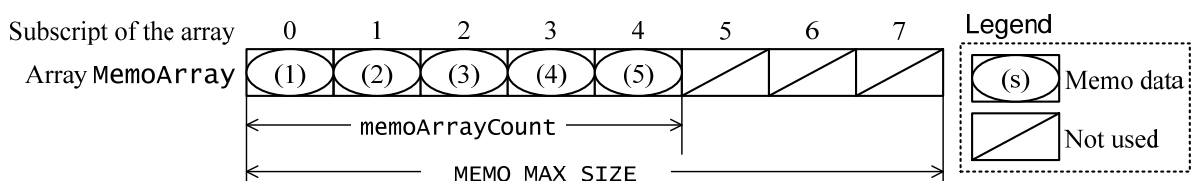


Figure 3: Example of data stored in the array

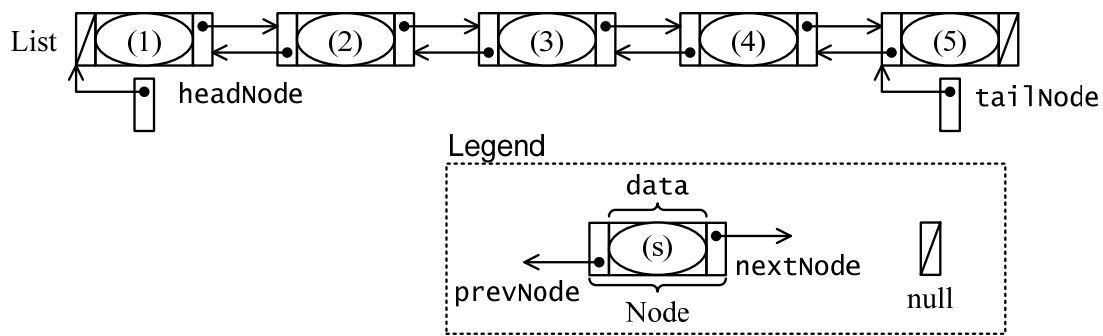


Figure 4: Example of data stored in the list

An element of the structure is referenced using the “.” notation. On the left side of “.” is the variable representing or referencing a structure. On the right side of “.” is the name of the element. In the case of the array, the contents of Memo (5) in Figure 3 may be written as MemoArray[4].text. In the case of the list, the ID of Memo (2) in Figure 4 may be written as headNode.nextNode.data.id.

[Function moveForeArray]

The processing steps of the function moveForeArray are described in (1) through (4) below. Its program is shown in Figure 5.

- (1) Find the index of the memo data in the array whose memo ID is id.
- (2) Save the memo data in the array located at the position found in (1) to a temporary variable.
- (3) Shift the memo data in the array located between the position next to the position found in (1) and the position where the last memo data is stored, by one position toward the head of the array.
- (4) Store the memo data saved in (2) to the position where the last memo data in the array was stored.

```

function moveForeArray(id)
  index ← findArrayIndex(id)
  tempMemo ← A
  for (i ← index+1 to B by 1)
    MemoArray[i-1] ← MemoArray[i]
  endfor
  MemoArray[B] ← tempMemo
endfunction

```

Figure 5: Program of the function moveForeArray

The processing steps of the function `moveForeList` are described in (1) through (4) below. The operations of steps (3) (ii) and (4) are illustrated in Figure 6. The program of the function `moveForeList` is shown in Figure 7.

- (1) From the list, find the reference to the node storing the memo data whose memo ID is i d.
- (2) If the node found in (1) (node k) is the tail node, end the processing.
- (3) If the node k is the head node, perform (i). Otherwise, perform (ii). Here, the next node of the node k is called the node $k + 1$, and the previous node is called the node $k - 1$.
 - (i) Change the reference to the head node of the list to the reference to the node $k + 1$, and change the reference to the previous node of the node $k + 1$ to null.
 - (ii) Change the reference to the next node of the node $k - 1$ to the reference to the node $k + 1$, and change the reference to the previous node of the node $k + 1$ to the reference to the node $k - 1$.
- (4) Change the reference to the next node of the tail node (node n) of the list to the reference to the node k , and change the reference to the previous node of the node k to the reference to the node n . Change the reference to the next node of the node k to null, and change the reference to the tail node of the list (`tail Node`) to the reference to the node k .

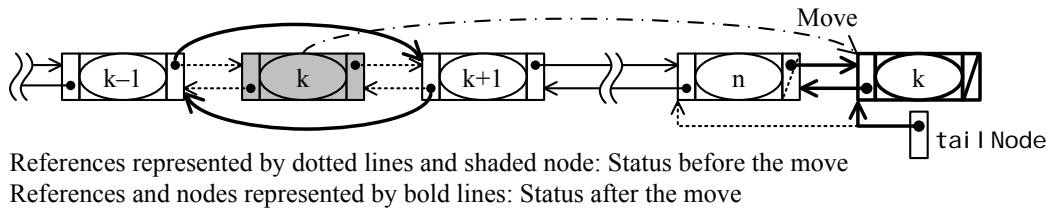


Figure 6: Operations of moving node k to the end of the list

```

function moveForeList(id)
    node ← findListNode(id)
    if (node.nextNode is equal to null)
        // In the case of the tail node
        return
    endif
    if (node.prevNode is equal to null)
        // In the case of the head node
        headNode ← node.nextNode
        node.nextNode.prevNode ← null
    else
        // In the case of a node other than the head node
        node.prevNode.nextNode ← node.nextNode
        
    endif
    tailNode.nextNode ← node
    
    node.nextNode ← null
    tailNode ← node
endfunction

```

Figure 7: Program of the function moveForeList

[Consideration regarding the two algorithms]

First, the time complexity is considered. In the case of the array, all the elements trailing behind the element to be moved to the end need to be shifted. The complexity of this processing is . In the case of the list, the relative positional relationship of data can be changed easily by changing a small number of references, regardless of the position of the memo data moved to the end. The complexity of this processing is .

Next, the size of the required area is considered. The size of the area required per memo data is smaller for the array. The list requires an extra area to store references. As for the size of the total required area, however, in the case of the array, it is necessary to . In the case of the list, only an area for the actually placed memo data needs to be secured.

Subquestion 1

Answer (1) and (2) below about the array in Figure 3 and the list in Figure 4, both of which store Memos (1) through (5) in Figure 1.

- (1) Show an appropriate expression to obtain the height 20 of Memo (1) stored in the array?
- (2) Find the value of tailNode.prevNode.data.height.

Subquestion 2

Fill in each blank and in Figure 5 with the appropriate term or phrase.

Subquestion 3

Fill in each blank and in Figure 7 with the appropriate term or phrase.

Subquestion 4

Answer (1) and (2) below about [Consideration regarding the two algorithms].

- (1) Fill in each blank and in the description, by using the O notation.

Here, the number of memo data in the array or the list is n , and the complexity of the functions `findArrayIndex` and `findListNode` is ignored.

- (2) In comparison with the list that requires securing an area for the actually placed memo data only, the situation is different for the array. Fill in the blank with an appropriate brief description.

Q2. Read the following description concerning a network of automated teller machines (ATM) for a bank, and then answer Subquestions 1 and 2.

Bank *T* is implementing a network of 60 Automated Teller Machines (ATM) across the metropolis. Each ATM connects to the bank's server through a network. Currently, Bank *T* does not offer the inter-banking connection service, and these ATMs accept only the transactions from Bank *T*'s customers.

Assuming no technical problems would arise, the time required for a transaction by a customer exhibits a normal distribution (see Figure 1) with the average of 2 min. and the standard deviation of 0.25 min. Of all transactions Bank *T* receives, 97.7% are completed within 2.5min.

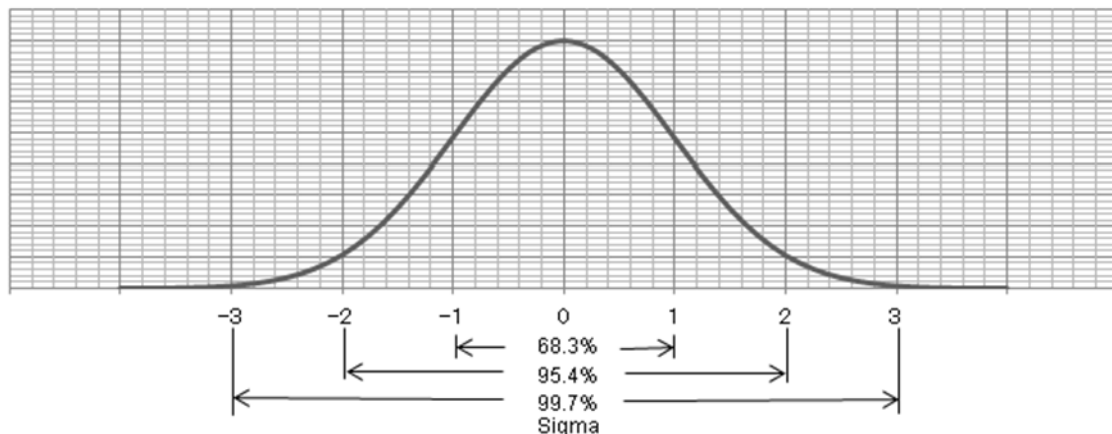


Figure 1: Normal Distribution Chart

Customers wishing to use an ATM form a queue. The queue can be represented using the M/M/1 model (see Table 1). During peak hours, the arrival rate of customers at an ATM is 20 per hour. It may be deduced that, for 97.7% of the time, one ATM can serve up to customers per hour and that there will approximately be customers waiting in the queue.

Bank *T*'s server handles transactions from the 60 ATMs. In addition, it receives transactions from 50 branches across the metropolis where each branch has 3 teller-operated terminals connected to the server. There are 20 customers arriving per hour at each of the 3 teller-operated terminals in each branch. The time required for the server to complete a transaction is fixed at 100ms. Since the time for processing a transaction is fixed, each teller machine can be modeled using the M/D/1 model (see Table 1). So the server can handle a maximum of transactions per minute. During peak hours, there will be

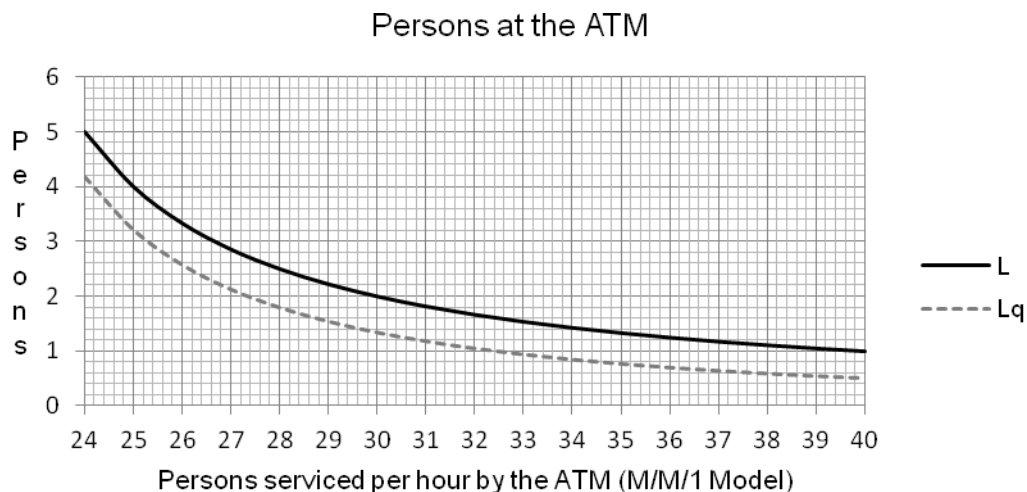
combined transactions per minute arriving from the ATMs and the teller-operated terminals, and a transaction will be waiting for its turn in the server for **E** .

Table 1: Queue Modeling Formulas

Legend	M/M/1 Model	M/D/1 Model
	Non-deterministic service time	Deterministic service time
customers in the system	$L = \frac{\lambda}{\mu - \lambda}$	$L = L_q + \frac{\lambda}{\mu}$
customers waiting in line	$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)}$	$L_q = \frac{\lambda^2}{2\mu(\mu - \lambda)}$
waiting time in the line	$W_q = \frac{\lambda}{\mu(\mu - \lambda)}$	$W_q = \frac{\lambda}{2\mu(\mu - \lambda)}$

λ = no of customers arriving at the ATM per hour

μ = no of customers serviced by the ATM per hour



Line above is L – customers in the system

Line below is L_q – customers waiting in line

Figure 2: Persons at the ATM

[Improving waiting time]

Bank T 's guideline states that the maximum time tolerated by customers waiting in a queue is 4 min. Based on this guideline, it has been determined that the length and the waiting time are unacceptable. In order to satisfy the guideline, the average time for a user to complete a transaction at an ATM must be improved to **F**, resulting in **G** persons waiting in a queue. The software installed in ATM is revised to achieve this. (Here we

assume that, after the software revision, the time spent by a customer at an ATM still exhibits a normal distribution, and that the standard deviation does not change.)

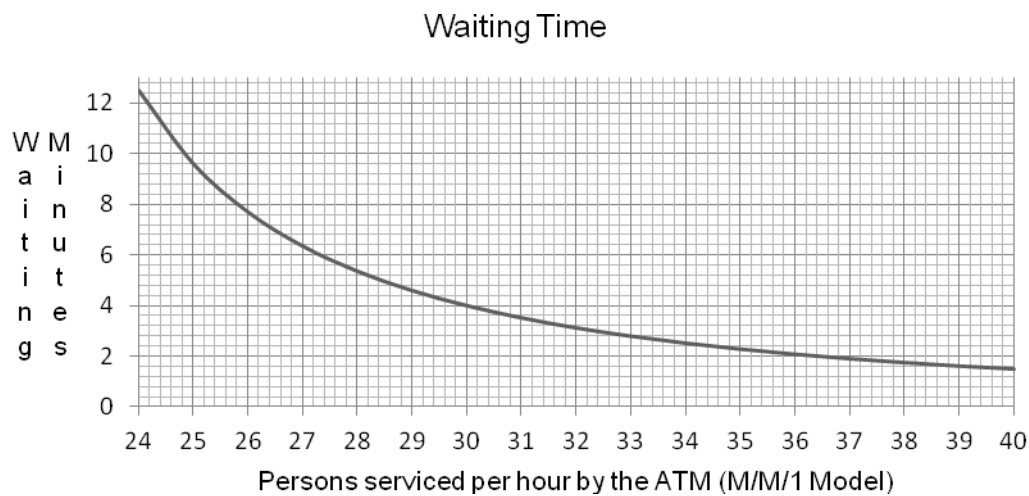


Figure 3: Waiting time in using the ATM

[Expansion program]

Bank *T* is planning on an expansion program. Its goal is to double the number of clients within a year by making itself available in more locations. Bank *T* is faced with two major options

Option 1: The bank joins the inter-banking network used by major banks within and outside of the metropolis. Bank *T*'s customers will be able to perform transactions via this network from the ATMs provided by any bank belonging to this network, as well as from Bank *T*'s ATMs. Therefore, this will bring about an immediate increase of presence in many locations. It would require only a small capital expenditure on Bank *T*, but would incur added transaction costs for the customers.

In this setup, the application server of a bank routes a transaction to the corresponding bank if it is not addressed to that bank. The corresponding bank then sends the transaction result back to the server that routed the transaction to it. The network that connects the banks is available 97% of the time.

Option 2: The bank purchases new ATM machines to double its current capacity. The customers will not be charged for the transactions.

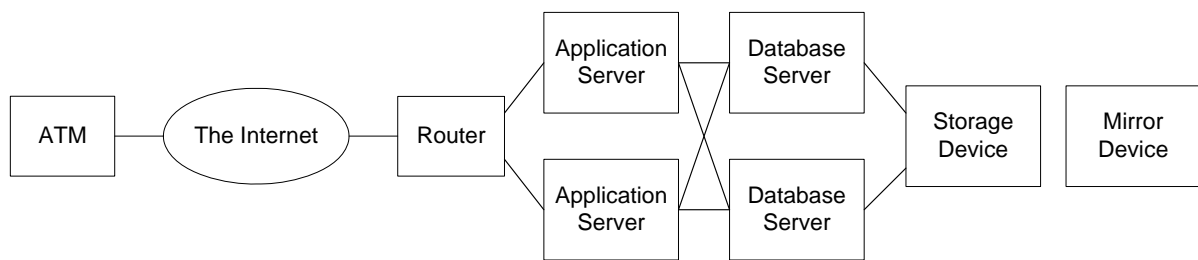


Figure 4: System Configuration for one bank (one ATM showing)

It is assumed that all banks make use of the configuration presented in Figure 4.

Subquestion 1

From the answer groups below, select the correct answer to be inserted into each blank

through in the above description.

Answer group [for A, B and G]

- | | |
|--------|--------|
| a) 1.3 | b) 2.0 |
| c) 2.5 | d) 4.1 |
| e) 22 | f) 24 |
| g) 25 | h) 27 |

Answer group [for C and D]

- | | |
|--------|---------|
| a) 60 | b) 70 |
| c) 100 | d) 120 |
| e) 600 | f) 6000 |

Answer group [for E and F]

- | | |
|------------|------------|
| a) 0.1 ms | b) 1.9 ms |
| c) 6.6 ms | d) 13.2 ms |
| e) 75 sec | f) 90 sec |
| g) 105 sec | h) 120 sec |

Subquestion 2

Assume that the bank system (the combination of application servers, database servers, storage devices, routers and connectors within the bank premises) all have an availability of less than 100%, and that it is the same for all banks. Decide whether each of the following statements regarding the expansion program a) through e) is true or false and put “TRUE” or “FALSE” in each answer field.

- a) Option 2 leads to an increase in the daily transactions received at Bank *T*'s server proportionate to the increase in its customers while keeping the length of the queues at the individual ATM machines to a minimum if the new ATMs are placed in appropriate locations.
- b) Option 1 leads to an increase in the daily transactions received at Bank *T*'s server proportionate to the increase in its customers while transactions received at the servers of the other member banks of the inter-banking network will not change.
- c) If the availability for each ATM is the same for both Option 1 and Option 2, then the only noticeable difference will be the inter-banking transaction cost.
- d) The availability of the system, that a customer can find a working ATM somewhere in the metropolis, will increase for Bank *T* in Option 1 only if there are redundant ATMs from participating banks in the inter-banking network that are well distributed geographically.
- e) When combining Option 1 and Option 2, the optimal placement of ATM should maximize reach, giving preference to places with little or no ATM service even if it has low traffic volume. This will help increase the number of customers and lower the transaction cost incurred on each customer.

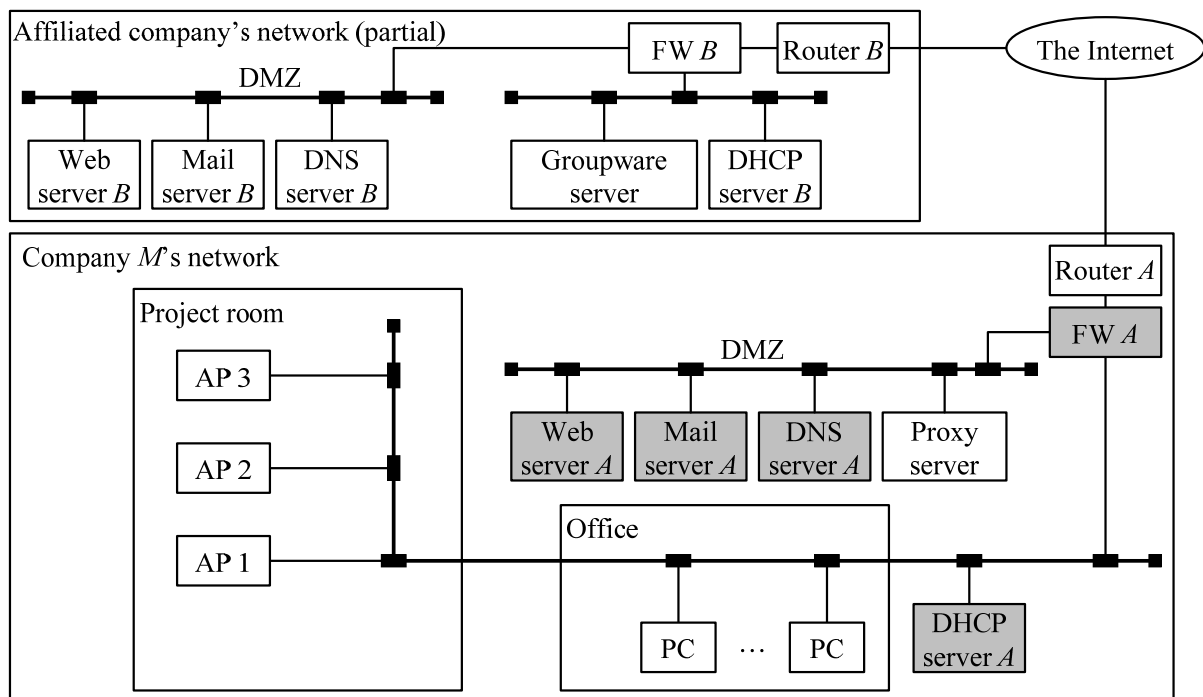
Q3. Read the following description concerning the causes of and the measures against network failures, and then answer Subquestions 1 through 3.

Company *J* decided to install a wireless LAN in its project room. The company also planned to replace the outdated devices at the same time.

In addition, the company made the groupware used from the PCs accessible from the project room via the wireless LAN. This groupware had been developed by an affiliated company of Company *J*, and used a TCP port assigned specifically to it for communication. The groupware server is installed in and operated by the affiliated company. For the communication with the groupware, the VPN function of the firewall (hereinafter the FW) is used.

[Network configuration]

Figure 1 shows the network configuration. As the client PCs used in the project room, laptop PCs featuring the wireless LAN function were introduced. As shown in Figure 1, the wireless LAN was set up by connecting the wireless LAN access points (hereinafter the APs) to the existing LAN.



Note: The shaded parts represent the replaced devices.

Figure 1: Network configuration

[Wireless LAN]

For the wireless LAN, IEEE 802.11g with the theoretical maximum transmission speed of **A** Mbps was adopted. Another standard for the same frequency band is **B**, but its transmission speed was not sufficiently fast. **C** standard also offers the same theoretical transmission speed, but IEEE 802.11g is selected because it had a successful record of operation at the affiliated company.

IEEE 802.11g employs 13 channels in the 2.4 GHz range spaced 5 MHz apart. Figure 2 shows the allocation of the frequency range used by each channel. The channel width of each channel is 22 MHz, and up to three channels can be selected as a combination of mutually non-interfering, independent frequency ranges. Possible combinations of such channels include “1, 6, and 11”, “2, 7, and 12”, and “3, 8, and 13”. Different channels were assigned to AP1 through AP3 in the project room in order to prevent radio wave interference.

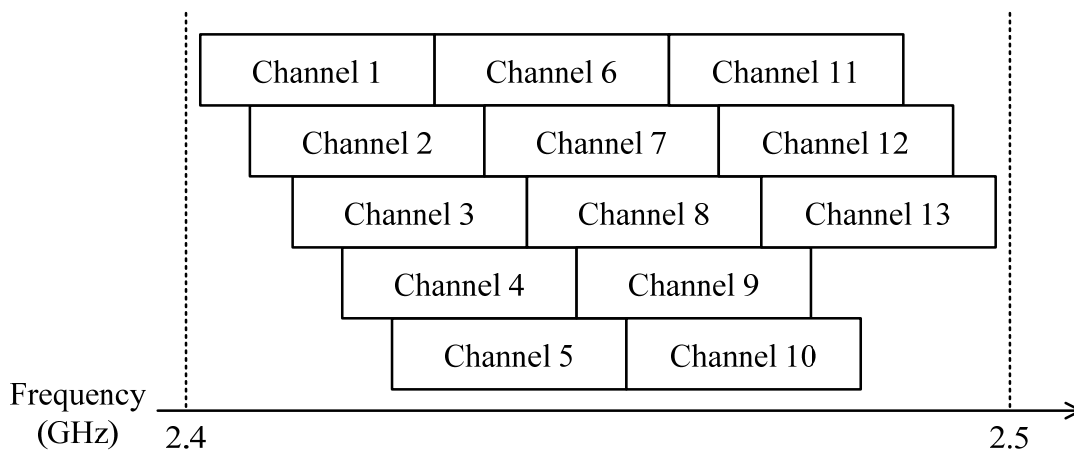


Figure 2: Frequency range used by each channel

[Connection failure of the groupware server]

Immediately after the devices replacement, the groupware server became inaccessible from the PCs in the office.

It was possible to view the Web site of the affiliated company from the PCs in the office, to view the Web site of Company *J* from the affiliated company, and to send and receive e-mails between the PCs in the office and the affiliated company. When the *ping* command was executed from a PC in the office with the host name of the groupware server specified, the result was normal. Also, the affiliated company was able to connect to and use the groupware without any problem.

The cause was found to be (1) a mistake in the setting of one of the newly introduced devices, and the mistake was corrected.

[Slowdown of the transmission speed of the wireless LAN]

When the wireless LAN was put into operation, a failure occurred where data transmission sometimes slowed down while using laptop PCs.

All laptop PCs were checked to examine the settings for AP connection and the radio field strength, but no problem was found.

Next, the project room was checked by using a device for collecting data on the APs operating in the periphery, and an AP outside Company *J* which might be causing (2) radio wave interference was detected in the window-side area.

As a result of the check, it was found that radio wave interference was occurring between this “AP outside Company *J*” and AP1.

Then, in order to identify the channels on which radio wave interference occurred, AP2 and AP3 were turned off and each of the channels 1 through 13 on AP1 was checked one by one for any radio wave interference. While radio wave interference was not detected on channels 1 through 6, channels 7 through 13 exhibited a trace of interference.

AP2 and AP3 were also checked in a similar way, and no radio wave interference was discovered on any of their channels.

The cause of interference was identified from the check results, and (3) the channel settings of the APs were changed.

After these measures were taken for the connection failure of the groupware server and the slowdown of the transmission speed of the wireless LAN, the network of Company *J* now operates normally.

Subquestion 1

From the answer groups below, select the correct answer to be inserted in each blank through in the description concerning the wireless LAN standards.

Answer group for A:

- a) 54 b) 64 c) 72 d) 92 e) 128

Answer group for B and C:

- a) IEEE 802.11a b) IEEE 802.11b c) IEEE 802.11n
d) IEEE 802.15.1 e) IEEE 802.15.3a

Subquestion 2

Answer (1) and (2) below about [Connection failure of the groupware server].

- (1) Regarding the underlined part (1) in the description, select one device out of those shaded in Figure 1, on which the setting mistake was made.
- (2) From the answer group below, select the correct description concerning the cause and the countermeasure.

Answer group:

- a) Since the conversion from an FQDN to an IP address failed, the company forcibly discarded the contents of the cache.
- b) Since the cache function was disabled for HTML and FTP data, the company enabled the cache function.
- c) Since the IP addresses to be assigned dynamically to the clients were insufficient, the company changed the assignment of IP addresses.
- d) Since the setting to enable the TCP port that the groupware used for communication was wrong, the company changed it to the correct one.
- e) Since a large number of received e-mails remained in the server, the company deleted the received e-mails from the server.

Subquestion 3

Answer (1) and (2) below about [Slowdown of the transmission speed of the wireless LAN].

- (1) Regarding the underlined part (2) in the description, what is the channel used by the “AP outside Company *J*”?
- (2) Regarding the underlined part (3) in the description, the company wants to decide on the combination of the channels to be set on AP1 through AP3 so that radio wave interference does not occur not only between the “AP outside Company *J*” and AP1, but also among AP1 through AP3. Find all channel numbers that can possibly be set on AP1.

Q4. Read the following description on the database for managing the subscriber information, and answer Subquestions 1 through 4.

Company K operates a cable TV service. Company K sells several packages of channels to its customers. A customer subscribes to one or more of those packages for a certain period. The customer may choose the length of the subscription period for each package he/she subscribes to. A package contains one or more channels, and a subscription to a package lets the customer freely watch the channels contained in it for the duration of subscription. When the subscription period terminates, the customer may renew it, or subscribe to another package.

Company K has several sales offices in major cities. Customers may come to one of these offices, and purchase or renew the subscription to a package. Company K also reminds the customers by phone whose subscription is going to expire in one week so the customers can renew their subscription in time.

Company K runs a system for managing the subscription information. The E-R diagram for this system is shown in Figure 1. Company K's system uses a relational database where tables are defined by appropriate data types, entity names are used as table names and attribute names are used as column names according to the E-R diagram.

[Entities Used in the E-R Diagram]

The brief description on each entity is provided below:

<u>Entity</u>	<u>Description</u>
Channel	Individual TV channels offered by Company K
Package	Packages to which a customer may subscribe
PkgDetail	Details of each package, i.e., which package contains which channels
Duration	Durations of subscription period
Customer	Company K's customers
SaleHis	Record of purchases made by customers
SaleDetail	Details of each sale

Note that FromDate in the SaleDetail entity is identical to Sales_Date in the SaleHis entity, and that ToDate is found by adding the Duration (days) to FromDate. A subscription expires on ToDate.

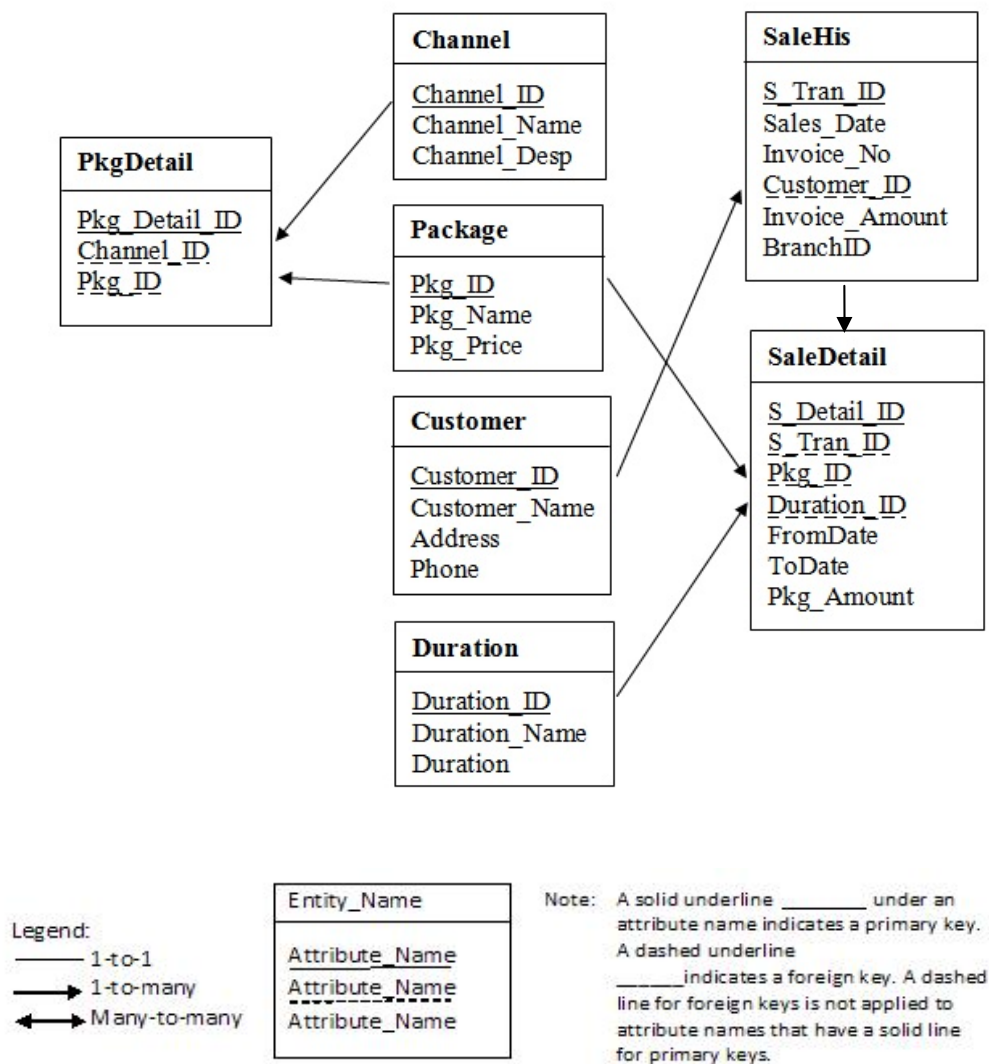


Figure 1: E-R diagram for the subscription management system

[Expiration Notice]

The sales department generates a list of customers whose subscription will end within the following month. This list is used to remind customers about the expiration of their subscription. If a customer has more than one valid subscription, the one with the earliest ToDate will be considered when compiling this list.

For example, the list thus produced for November 2012 will be as follows:

<u>Name</u>	<u>Phone</u>	<u>EndDate</u>
Aung Aung	09 5047221	2012-11-11
Myo Min	01 5542036	2012-11-15
Zaw Zaw	01 6045874	2012-11-23

The following SQL statement is used to generate this list.

```

SELECT [A] AS Name, [B] AS Phone,
       [C] ([D]) AS EndDate
FROM Customer C
      JOIN SaleHis HS ON C.Customer_ID = SH.Customer_ID
      JOIN SaleDetail SD ON SH.S_Trans_ID = SD.S_Trans_ID
WHERE SD.ToDate BETWEEN '2012-11-01' AND '2012-11-30'
GROUP BY [A], [B]

```

[Daily Summary]

At the end of each day, every sales counter generates a daily sales summary report showing number of customers who bought each channel in the following format. For example, the list summarizing the sales at a downtown sales office (BranchID is 11) on 2012-08-26 will be as follows:

<u>SalesDate</u>	<u>Channel</u>	<u>ChannelCount</u>
2012-08-26	Sports7	120
2012-08-26	5Movie	55
2012-08-26	5Serise	45

The following SQL statement is used to generate this report.

```

SELECT SH.Sales_Date, C.Channel_Name as Channel, [E] AS
Channel Count
FROM SaleHis SH
      JOIN SaleDetail SD ON SH.S_Trans_ID = SD.S_Trans_ID
      JOIN [F] P ON [G]
      JOIN Channel C ON [H]
WHERE SH.Sales_Date = '2012-08-26'
      AND SH.BranchID = 11
GROUP BY SH.Sales_Date, C.Channel_Name

```

ORDER BY Channel Count DESC;

[Promotion: Free Extra Months]

The sales and marketing department plans to launch a promotion giving free duration based on the subscription duration bought by customers. For example, customers who buy 6 months subscription of “Premium Package” may receive additional 2 months of free duration.

The length of free duration is decided on each sale. Moreover, the management needs reports on free duration, e.g., total free duration given out in a specific period for each package.

In order to account for this promotion, a new field “Free_Duration” should be added to the table.

[Free Choice Package]

To give more flexibility in choosing channels, the sales and marketing department considers the sale of customizable packages – any 3 channels, any 5 channels, etc. Customers may choose any channel he/she likes. Again, the management requests the report about which channels are popular among customers, and the channels chosen by the subscribers of customizable packages must be stored in the database.

In order to store the additional information introduced by the this change, a new table SaleAny with the following columns should be added to the database.

<u>Field Name</u>	<u>Description</u>
S_Any_ID	Primary key
<input type="text" value="J"/>	a foreign key referencing an existing table
<input type="text" value="K"/>	a foreign key referencing an existing table
<input type="text" value="L"/>	a foreign key referencing an existing table

Subquestion 1

Fill in each blank through with appropriate terms and phrases.

Subquestion 2

Fill in each blank through with appropriate terms and phrases.

Subquestion 3

Fill in the blank with the appropriate table name.

Subquestion 4

From the answer group below, select the correct answer to be inserted into each blank

through .

Answer group

- | | |
|----------------|----------------|
| a) S_Trans_ID | b) S_Detail_ID |
| c) Sales_Date | d) Invoice_No |
| e) Pkg_ID | f) Channel_ID |
| g) Duration_ID | |

Q5. Read the following description concerning object-oriented design of a dynamic form, and then answer Subquestions 1 through 4.

Forms are commonly used in GUI applications whenever a series of questions needs to be asked of the user. A typical form consists of a set of questions and blanks to be filled in by the user. Questions are displayed using labels while blanks can be one of the available GUI elements. Table 1 shows a list of the available GUI elements to build a form, along with their corresponding class names and supported data type.

Table 1: GUI elements, class names, and data types

GUI element	Class name	Data type
Combo box	CComboBox	String
Label	CLabel	String
Spin box	CSpinBox	Integer
Text box	CLineEdit	String

The GUI element is selected according to the data type of the expected answer to the question. For example, the question “What is your name?” expects a String input, so a text box would be appropriate. Figure 1 shows an example of a Form with a text box, a combo box, and a spin box.



Figure 1: Form within a Dialog

[Dynamic Forms]

Forms such as the one shown in Figure 1 can be designed and implemented in many ways. Object-oriented features of programming languages make it possible to design Dynamic Forms. Dynamic Forms allow building of these Forms at run-time.

Dynamic Forms can be implemented by keeping the questions separate from their presentation. The class diagram in Figure 2 shows the relationship between the CFormModel and the CQuestion classes. CQuestion is designed to handle different data types for input.

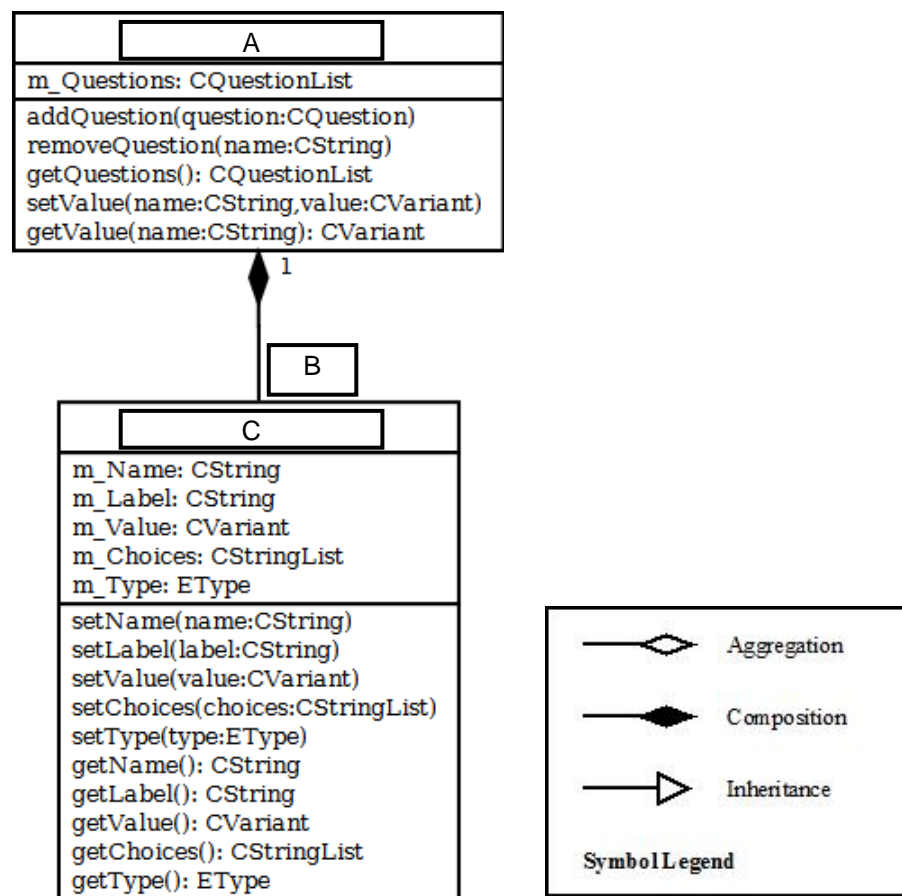


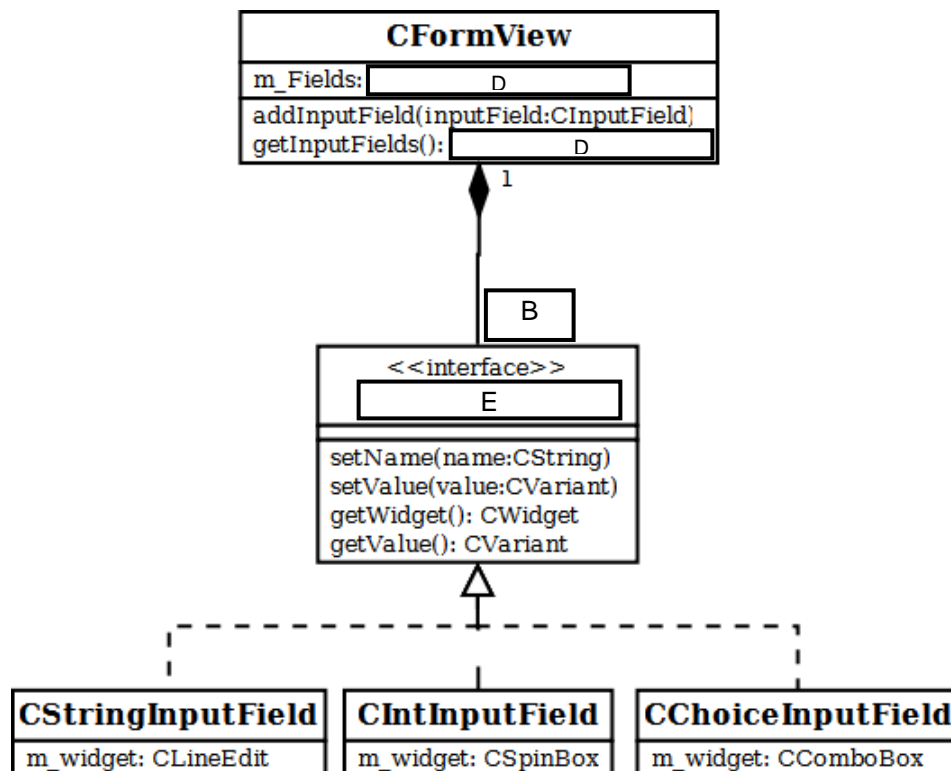
Figure 2: Model classes

A CQuestion object contains a name which is used to identify the question, a label which contains the actual question displayed on the form, and a value which stores the input of the user. Table 2 shows a list of helper classes and types used in the design.

Table 2. Helper classes and types

Class or type name	Description
CAction	Base class for GUI actions.
CInputField	Provides a unified interface for different GUI elements.
CInputFieldList	Collection of CInputField-compatible GUI elements.
CQuestionList	Collection of CQuestion objects.
CVariant	Wrapper class that can represent different data types such as integer, double, string.
CWidget	Base class for all GUI elements.
CString	String class.
CStringList	Collection of CString objects.
EType	Enumeration type which is used to identify the data type of a CVariant.
Double	Double primitive type.
Integer	Integer primitive type.

To generate a Dynamic Form, a GUI object is created for every CQuestion object and added to the CFormView object for display. The exact type of the GUI object depends on the data type of the input. Figure 3 shows the relationship of the view classes.

**Figure 3: View classes**

The model classes and the view classes are tied together by a set of controller classes (Figure 4). The CFormDialog class serves as a container for the CFormView object while the CFormFactory class implements the creation of the CFormView object. In addition, the COkAction and the CCancelAction classes provide data synchronization between the model and the view objects.

The sequence diagram in Figure 5 shows how a CFormView object is created and how GUI elements are added to it.

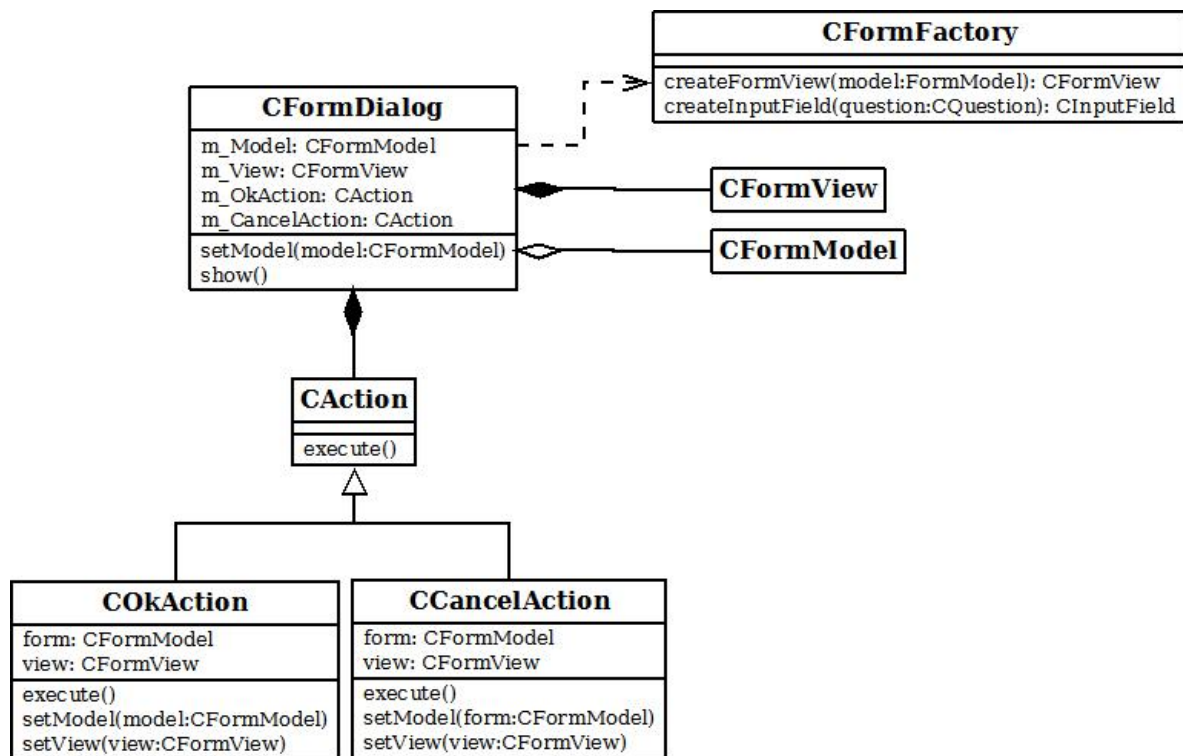


Figure 4: Controller classes

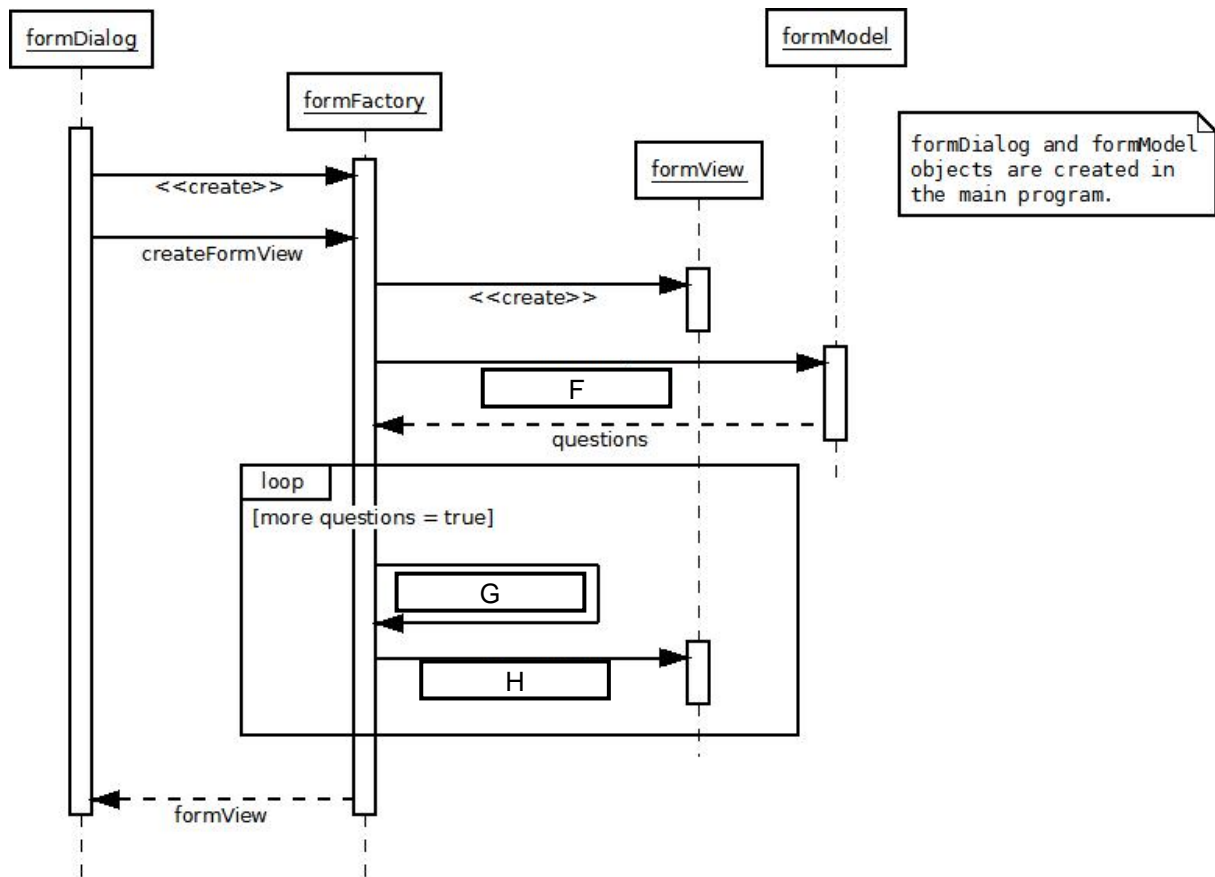


Figure 5: Dynamic form generation sequence diagram

[Additional Data Types]

It often happens that a new requirement arises after a design has been fixed. In case of a dynamic form, we may face with the addition of new input data types, such as a double and a date. With the object-oriented approach, a new requirement like this can be easily accommodated with the minimal design change.

New classes such CDoubleInputField and CDateInputField can be added to the design as long as they I the CInputField interface. In addition, the createInputField method of the CFormFactory class needs to be modified in order to support the new GUI elements.

When building a Form, the CFormView does not need to know the exact type of input, e.g., a string or an integer. By the mechanism of J, when a method is called using the CInputField interface, the appropriate method for the right data type will actually be called.

Subquestion 1

From the answer group below, select the correct answer to be inserted into each blank

, , and in Figures 2 and 3.

Answer group

- a) CFormModel
- b) CFormView
- c) CInputField
- d) CInputFieldList
- e) CQuestion
- f) CQuestionList

Subquestion 2

From the answer group below, select the correct answer to be inserted into blank

in Figures 2 and 3.

Answer group

- a) 0
- b) 1
- c) 0..1
- d) 0..*

Subquestion 3

From the answer group below, select the correct answer to be inserted into each blank

through in Figure 5.

Answer group

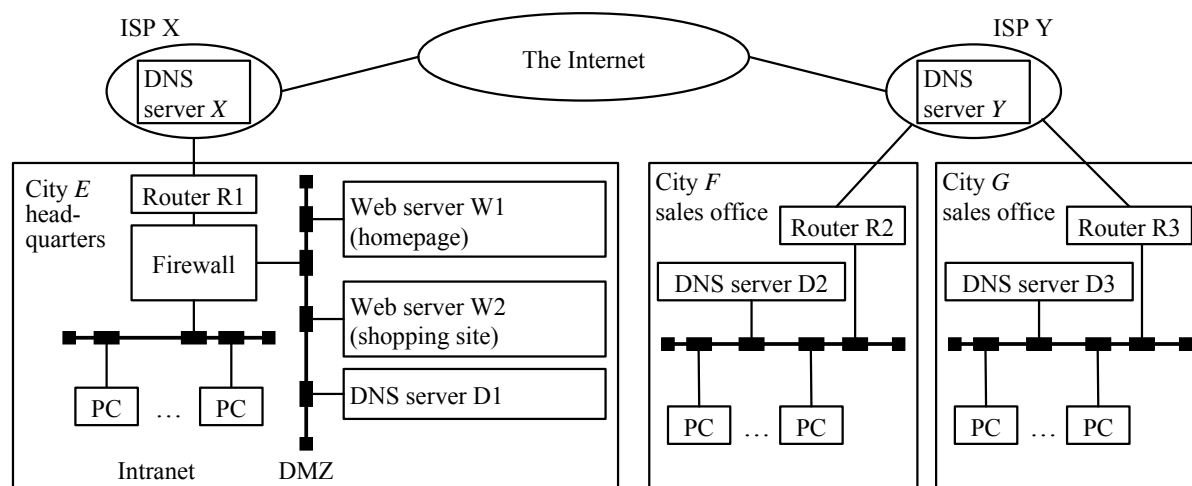
- a) addInputField
- b) addQuestion
- c) createFormView
- d) createInputField
- e) getInputFields
- f) getQuestions

Subquestion 4

Fill in each blank I J in the description with the appropriate term or phrase.

Q6. Read the following description concerning the security measures for DNS servers, and then answer Subquestions 1 through 4.

Company *M* develops and sells a certain type of products and has sales offices in City *F* and City *G* in addition to the headquarters in City *E*. The company operates its company Web site on Web server W1 and the shopping site for its products on Web server W2. The host name information of Company *M*'s Web servers W1 and W2 is managed by DNS server D1. Servers W1, W2, and D1 are located in City *E* headquarters. The network of City *E* headquarters is connected to the Internet via the Internet service provider (hereinafter ISP) *X*, and the networks of City *F* and City *G* sales offices are connected to the Internet via ISP *Y*. Figure 1 shows the network configuration of Company *M*. Table 1 shows the DNS server information stored in the PCs of Company *M*.



Note: Routers R2 and R3 are equipped with a simple firewall function.

Figure 1: Network configuration of Company *M*

Table 1: DNS server information set in the PCs of Company *M*

PC	DNS server information
PCs in City <i>E</i> headquarters	DNS server D1
PCs in City <i>F</i> sales office	DNS server D2
PCs in City <i>G</i> sales office	DNS server D3

One day, an employee of City *G* sales office, Mr. *A*, who accessed Company *M*'s shopping site to check on the listed products, informed City *E* headquarters that, (1) when he clicked the link in a web page to access the shopping site, a site different from the one that would usually appear was displayed. Mr. *B*, the network administrator of Company *M*, instructed employees of City *E* headquarters and City *F* sales office to access the shopping site from their PCs in the same way as Mr. *A* did, but the incident experienced by Mr. *A* did not occur. To find out the cause of the incident, Mr. *B* requested security company *N* to conduct an investigation and propose possible countermeasures.

After a while, Mr. *A* reported that, (2) when he attempted to access the shopping site again in the same way, the normal shopping site was displayed.

Mr. *C* of Company *C* in charge of the investigation checked Web servers W1 and W2 and DNS server D1 located in City *E* headquarters for any trace of falsification, but no evidence of malicious contents or unauthorized access was found. He also examined the virus check results on the PCs located in City *F* and City *G* sales offices and the condition of DNS servers D2 and D3, but no anomaly was found, either. In addition, he asked ISPs *X* and *Y* whether there was any incident during the period in question, but their responses were negative.

Based on the results of the investigation, Mr. *C* concluded that the cause of the incident was "DNS cache poisoning." The investigation report presented by Mr. *C* is outlined below.

[Outline of the investigation report]

- The cause of the incident that occurred in City *G* sales office is presumed to be DNS cache poisoning.
- Specifically, the incident reported by Mr. *A* occurred because false information was temporarily placed in the DNS cache of A.
- While there are several ways of poisoning DNS cache, the Kaminsky attack announced in 2008 is likely the one employed this time.
- Since the version of the DNS software of A is outdated, the latest version featuring protection against the Kaminsky attack should be installed immediately.
- A desired fundamental countermeasure against DNS cache poisoning is to install B, which uses public key cryptography to sign a response from the DNS server, but it will take some time for this countermeasure to take effect. For the present, efforts should be made to reduce the possibility of false information being placed in the DNS servers that are referenced by the PCs in City *E* headquarters and City *F* and City *G* sales offices.

The following is the conversation that took place between Mr. *B* and Mr. *C* after the investigation:

[Conversation after the investigation]

C: I suppose that the cause of the incident that occurred in City *G* sales office is DNS cache poisoning. Are you familiar with DNS cache poisoning?

B: I have heard of the name, but this is the first time that I have seen it actually happen.

C: As for the countermeasure, the first thing to do is to notify all the staff members of Company *M* about the incident that took place.

B: What should I tell them specifically?

C: First of all, you should tell them exactly what happened. Be sure to tell them two things: that C and that D. As for DNS cache poisoning, I think that you should set up a separate opportunity to inform employees about it as part of the security training.

B: I understand. I will draft a memo and arrange that the staff will see it on our internal portal site or by some other means. By the way, what should I do about the DNS server setting for the PCs in City *G* sales office? Will it be enough to change the current setting to DNS server *Y* of ISP *Y*?

C: Rather than that, I suggest that you change the DNS server setting for the PCs in City *F* and City *G* sales offices to DNS server D1 located in City *E* headquarters.

B: You mean that all the PCs in the company refer to the same DNS server, and we will have only one DNS server to manage. That will simplify the operation controls of the entire network as well.

C: It is economical to connect the intranets over the Internet connections currently used. This involves connecting City *E* headquarters, City *F* sales office, and City *G* sales office by using E.

B: Doing so combines City *E* headquarters, City *F* sales office, and City *G* sales office into a single network, so we need to check whether there is any overlap of F assigned to the PCs. We will do that right away.

C: DNS server D1 currently provides the DNS content server function (which provides information on Web servers to the Internet) and the DNS cache server function (which relays queries from internal PCs). To limit access to the DNS cache server from G, the DNS content server function should be separated from the DNS cache server function.

B: In that case, where should we place the DNS cache server in the network?

C: You can place it in the DMZ where DNS server D1 is currently located, but it is more desirable to place it in the intranet where the PCs are located. I think that it is appropriate to protect it with the firewall under the same security policy as that for the PCs in City *E* headquarters.

Subquestion 1

Answer (1) and (2) below about the incident mentioned in the underlined parts (1) and (2) in the description.

- (1) From the answer group below, select the name of the threat that, as described in (1), leads the user to a Web site different from the intended one in order to steal information such as personal data.

Answer group:

- | | |
|---------------------------|-----------------------|
| a) Falsification | b) Social engineering |
| c) Wiretapping | d) Phishing |
| e) Unauthorized intrusion | |

- (2) Briefly describe the reason why the situation mentioned in (1) changed to the one mentioned in (2).

Subquestion 2

Answer (1) and (2) below about the outline of the investigation report presented by Mr. C.

- (1) From Figure 1, select the correct answer to be inserted in the blank

 in the description.
- (2) From the answer group below, select the correct answer to be inserted in the blank

 in the description.

Answer group:

- | | | |
|-----------|----------|--------|
| a) DNSSEC | b) IPSEC | c) PKI |
| d) SSH | e) SSL | |

Subquestion 3

From the answer group below, select the correct answer to be inserted in each blank

and in the description.

Answer group:

- a) DNS server *X* had a problem
- b) DNS server *Y* had a problem
- c) the PCs at City *F* sales office had a problem
- d) none of the servers at City *E* headquarters had a problem
- e) DNS server D3 at City *G* sales office had a problem
- f) the PCs at City *G* sales office had a problem

Subquestion 4

Fill in each blank through in the description with the appropriate term or phrase.

Q7. Read the following description concerning risk management for a project, and then answer Subquestions 1 through 5.

Company *P* develops business software on commission. When Company *P* was notified in advance by Company *R* of the intention to place an order for a production management system, Company *P* planned to start software development as Project *Q*. Details such as the amount of the contract and the responsibility assignment have not yet been decided, and are now under negotiation. Company *R*, a manufacturer that mainly produces home appliances and AV equipment, is expected to continue growing. Company *P* has not conducted business with Company *R* before, and is not very familiar with details of the situation surrounding of Company *R*'s information systems department. According to the estimate submitted from Company *P* to Company *R*, a profit equivalent to 10% of the order amount is expected. The RFP from Company *R* is well prepared and enables accurate estimation, and it is not necessary to consider in advance an increase in person-hours due to specification changes. Company *R* is also interested in software development technology and, from a long-term perspective, with a view of performing maintenance by itself, has a positive attitude towards development using new software development technology (hereinafter development using new technology).

[Risk management for Project *Q*]

Company *P* is preparing to start Project *Q*, and Mr. *S* of Company *P* has been assigned as the project manager. Mr. *S* clarified the risks and the issues involved in the project together with the members planned to participate in Project *Q*. The risks and the issues included (1) through (7) below.

- (1) Company *R* is not well-prepared for the development, and the decisions on requirements are delayed.
- (2) Company *R* cannot prepare the equipment for development that it is supposed to prepare.
- (3) Person-hours to support the integration test exceeds the estimate.
- (4) Development using new technology is requested.
- (5) Tied up with the negotiation with Company *R* and the internal adjustments within the company, the project manager does not have time to prepare the project plans.
- (6) Even if the responsibility assignment concerning the integration test is agreed on with Company *R*, the test cannot be implemented as planned.
- (7) Since the initially submitted estimate is ambiguous in some points such as the responsibility assignment, Company *P* is request to resubmit the estimate in order to clarify the conditions of the estimate.

[Evaluation of the risk that development using new technology is requested]

While detailed conditions are under negotiation, the probability that development using new technology will be requested is expected to be as high as 80%, according to what Mr. S has heard from sales representatives. Even if such development is requested, an option of development using existing technology still remains. Mr. S considered factors involved in development using new technology, such as the assignment of technology development personnel, the development of technology, the verification using prototypes, the training of development personnel, and the instability of initial quality. He compared development using existing technology with development using new technology and summarized the results as shown in Table 1.

Table 1: Comparison between development using existing technology and development using new technology

	Order amount, cost, etc.	Development period ⁽¹⁾	Quality
Development using existing technology	<ul style="list-style-type: none"> - The order amount decreases by 5% from the estimated amount. - The cost is the same as the estimation. 	As specified	Stable
Development using new technology	<ul style="list-style-type: none"> - The order amount is the same as the estimated amount. - The cost increases by 10% from the estimation, because quality needs to be stabilized. 	Extended by three (3) months	Stable

Note ⁽¹⁾: Conditions that apply if the development period is extended:

- A penalty equivalent to 1% of the order amount arises per month.
- To maintain the development framework, an additional cost equivalent to 5% of the estimated cost is invested per month during the extended period.

Mr. S decided to evaluate the risks of Project Q from a profit-oriented perspective. He evaluated the countermeasures against the risks for development using existing technology and for development using new technology, and came up with the results as shown in Table 2. The profit ratio is calculated by the expression below.

Profit ratio = (Order amount – Cost) ÷ Order amount expected at the time of estimation × 100 (%)

Table 2: Results of evaluating the countermeasures against the risks that development using new technology is requested

Method	Response	Profit ratio	Development period	Quality
<i>A</i>	Development using existing technology	A %	As specified	Stable
<i>B</i>	Development using new technology	-15.5%	Extended by three (3) months	Stable

According to the information from sales representatives, if Project *Q* “succeeds,” there is a possibility that Company *P* will receive an order from Company *R* for another project worth double the order amount of Project *Q* as the second stage development. Results of examining the outcome of the contracts that Company *R* signed with other companies indicate a high probability of receiving an order for the second stage development. However, if quality is instable, the project is not regarded as successful and there is no possibility that Company *P* will receive such an order. If quality is stable, the project is regarded as successful, even when the development period is extended, as long as the consent of Company *R* is obtained in advance and the penalty is paid.

[Judgment of Project *Q*]

Mr. *S* concluded that the method *A* was better even if development using new technology was requested by Company *R*.

[Judgment of Company *P*]

To obtain the consensus within Company *P*, Mr. *S* consulted his superior and sales representatives about the countermeasures. After considering the accumulation of technology resulting from development using new technology in Project *Q* and the profit from the project for the second stage development, they concluded that Company *P* should adopt the method *B*. If development is done by using new technology in Project *Q*, the know-how gained from development using new technology can be used for the second stage development and, according to an estimate using the same criteria as for Project *Q*, a cost reduction of 10% will be possible. Figure 1 below shows the relationship of the order amount, the cost, and the profit of the second stage development estimated by using the criteria for Project *Q*.

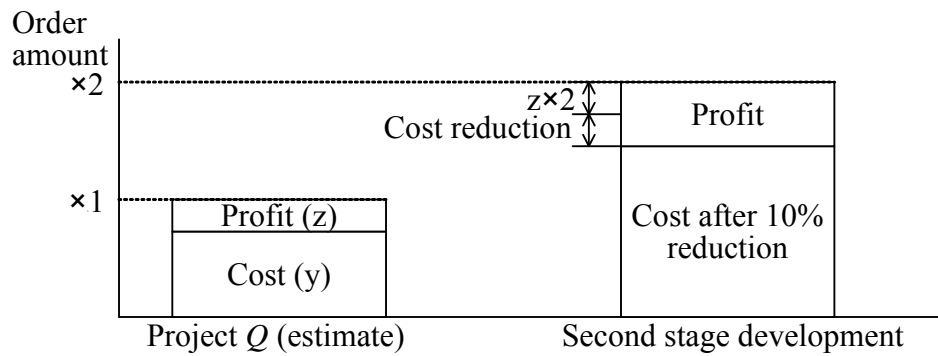


Figure 1: Relationship of the order amount, cost, and profit of secondary development estimated by using the criteria for Project Q

In this case, the combined profit from Project Q and the second stage development will be % of the total order amount.

[Risk priority in Project Q]

Among the risks that require response regarding Project Q , three are listed in Table 3.

The priority of responding to the risk that development using new technology is requested in Project Q is positioned in in Table 3.

Table 3: Priority of risks to be responded in Project *Q*

Priority	Risk	Occurrence probability ⁽²⁾	Profit ratio	Risk evaluation using the occurrence probability and profit ratio
High ↑	a)			
	Company <i>R</i> is not well-prepared, so the decisions on requirements are delayed.	High (80%)	–20%	–16%
	b)			
	Company <i>R</i> cannot prepare the equipment for development that it is supposed to prepare.	Medium (50%)	–28%	–14%
	c)			
↓ Low	Person-hours to support the integration test exceeds the estimate.	High (80%)	–14%	–11%
	d)			

Note ⁽²⁾: The occurrence probability is one of high (80%), medium (50%), and low (20%).

Subquestion 1

Classify (5) through (7) in [Risk management for Project *Q*] into risks and issues. Those that have not yet occurred are risks, and those that have already occurred are issues. In the answer field, put “R” for a risk or “I” for an issue.

Subquestion 2

Fill in the blank

A

 in Table 2 with the appropriate value. Round the value to the first decimal place.

Subquestion 3

Describe briefly the reason that Mr. *S* thought as stated in the underlined section in the description.

Subquestion 4

Fill in the blank in the description with the appropriate value. Round the value to the first decimal place.

Subquestion 5

From a) to d) in Table 3, select the appropriate position to be inserted in the blank in the description.