<Appendix 1>

SURVEY ON OSS HRD IN JAPAN AND PROPOSAL FOR MODEL CURRICULUM

Report Summary

Survey 1. Survey on the OSS skills of the engineers using OSS required by the user companies

Survey 2. Survey on the OSS skills of the engineers using OSS required by the companies such as SI businesses

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August 2007

INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN

Survey 1

Survey on the OSS skills of the engineers using OSS required by the user companies

Report

【Summary】

August 2007

INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN

【Points of the result of this survey】

- 70% of the companies who answered the questionnaire use OSS for information systems for the company (such as personnel affaires・salary, financial accounting) in any of the usage classifications.
- As for the situation by system type, although OSS is not used for about 70% of the systems, the companies use OSS more and more in e-mail, public relations web, electronic conference・bulletin board・schedule management, which are concerned with the information sharing or transmission inside and outside the company.
- Saving of the development investment or maintenance and update cost and expectance for standard software which does not depend on particular IT vender are highly placed in the purposes of the OSS use for information systems for the company. Priority issues for future diffusion of OSS are improving the function and the speed of bug fixes and increasing a sense of reassurance for ensuring of security.
- In all the OSS skills, the actual level does not reach the expected level. The OSS-related skills highly required (the gap is wide and the required skill level is high) are described below. Also the OSS-related skills which have almost reached the expected skill level (the required skill level is high but the gap is small) with current school education or employee trainings despite the gap are mentioned as below.

Occupation etc.		OSS skills highly required by the companies	OSS skills satisfying needs to some extent
Entry-level		"RDB system management" (RDB field), "Light Weight Language" (programming field), "System programming" (system field), "Network management" (network field), "Network security" (security field) etc.	"Java" (programming field), "Network server management" (system field), "Basic of RDB" (RDB field) etc.
In the 5th year	IT service management	"Outline of OSS", "Basic of legal affaires" (basic field), "Encryption" "Network security" (security field), "Development framework" (development system field), "System programming" (system field) etc.	"Kernel of Linux", "Linux system management", "Network server management" (system field), "Network management", "Network architecture" (network field), "OS security" (security field), "Computer system, architecture" (basic field) etc.
	Application specialist	"System programming" (system field), "C,C++", "Light Weight Language" (programming field), "Development tool" (development system field), "Encryption", "OS security" (security field), "RDB system management" (RDB field) etc.	"Kernel of Linux", "Concept of Linux, basic operation", "Network server management" (system field) etc.
	IT specialist	"System programming" (system field), "Development tool" (development system field), "Encryption" "OS security" (security field), "RDB system management" (RDB field) etc.	"Network server management", "Linux system management", "Concept of Linux, basic operation" (system field), "Network architecture", "Network management" (network field), "Light Weight Language" (programming field), "Basic of RDB" (RDB field) etc.

- Although the gap between the expected level and the actual level is tend to diminish with trainings such as employee training after the entrance, the percentage of sufficient or a certain level of training implementation is less than or comparable to 20% even in the 5th year. As for the method of employee trainings, OJT and self-education are mainly adopted and external

programs such as external trainings and e-learning are not frequently used. Because of this, the training programs which are easy to use for the companies need to be developed and provided mainly in OSS-related skills.

I. Outline of the survey

We conducted a questionnaire survey on the following items at the IT division of OSS user companies.

①Situation of business using OSS

②Recognition of the OSS use and future policies

③Composition of the IT engineers and the engineers using OSS

④Skill level expected for the engineers using OSS and actual skill level

⑤Method of training for the acquisition of OSS skills

The details such as the implementation method or the state of collection are as follows.

(1) Implementation term

April 2nd—April 18, 2007

(2) Companies surveyed

1,500 companies

①Advanced companies using OSS for their IT systems 82 companies

－Obtained by OSS iPedia, information of NRI, web search etc.

②Domestic listed companies of all business (except SI businesses and software development companies) 1,418 companies

－The companies are selected from 3,939 domestic listed companies in order of proceeds by category of business. As for the holdings, we targeted the main operating companies but when there wasn't appropriate one, we sent the questionnaire to the holdings.

－Broadcast, publication, cinema, and animation in information communication business are included.

(3) Survey method

・Survey slips (see exhibit) are sent by mail. Postal cards are sent twice in the period to ask for the submission.

・In the 2nd card, a brief questionnaire is added.

(4) State of collection

	User companies	SI, software development companies
Valid responses of the main survey slip	**90**	153
Valid responses of the card survey slip	**124**	176
Total of valid responses	**214**	329
Total number	**1,500**	1,350
Total of valid responses/Total number	**14.3%**	24.4%
Valid responses of the main survey slip/Total number	**6.0%**	11.3%
Invalid (refusal)	**1**	2

II. Result of the survey

1. Situation of business using OSS

We grasped here the situation of OSS use for information systems for the company. It was found that about 70% of all the companies who answered work on information systems for the company using OSS and that they use mostly public relations web, electronic conference･bulletin board･schedule management and e-mail as main function of systems using OSS.

(1) Situation of installation of information systems for the company (Q1)

The situation of installation of information systems for the company on personnel affairs･salary, document management, financial accounting, client management, public relations web, electronic conference･bulletin board･schedule management, e-mail, ordering (EDI, SCM etc.), purchase･stock management, manufacturing management, and distribution in the companies who answered (90 companies) is as follows: “e-mail” 90.0%, “personnel affairs･salary” 84.4%, “financial accounting” 82.2%, and “electronic conference･bulletin board･schedule management” 78.9%.

(2) Situation of the OSS use for information systems for the company (Q1)

There is not OSS use for about 70% of information systems for the company. Meanwhile, the functions more frequently used are as follows: “e-mail” 51.9%, “public relations web” 31.7%, and “electronic conference･bulletin board･schedule management” 21.1%. The situation of the OSS use by usage classification represents relatively large use of OSS in “server” and “OS”.

Figure 1-Situation of OSS use for information systems for the company

(%)

						Detail of the OSS use								
			Unknown about OSS usage	Do not use OSS	Use OSS	OS	Server	DBMS	Web application architecture (J2EE etc.)	Application	Development tool	Operational management	No answer	Total
Percentage	Personnel affairs･Salary	N=76	5.3	80.3	**9.2**	6.6	6.6	3.9	1.3	1.3	2.6	1.3	5.3	—
	Document management	N=50	2.0	74.0	**18.0**	16.0	14.0	8.0	6.0	4.0	8.0	2.0	6.0	—
	Financial accounting	N=74	5.4	77.0	**9.5**	5.4	5.4	4.1	6.8	1.4	5.4	1.4	8.1	—
	Client management	N=45	4.4	75.6	**13.3**	11.1	11.1	6.7	4.4	2.2	4.4	0.0	6.7	—
	Public relations web	N=63	6.3	55.6	**31.7**	20.6	28.6	7.9	3.2	1.6	7.9	6.3	6.3	—
	Electronic conference, Bulletin board, Schedule	N=71	1.4	69.0	**21.1**	16.9	16.9	11.3	5.6	5.6	7.0	5.6	8.5	—
	E-mail	N=81	3.7	38.3	**51.9**	34.6	44.4	6.2	2.5	2.5	3.7	4.9	6.2	—
	Ordering (EDI, SCM etc.)	N=56	7.1	67.9	**17.9**	10.7	12.5	7.1	7.1	0.0	7.1	0.0	7.1	—
	Purchase･Stock management	N=62	3.2	74.2	**12.9**	8.1	8.1	4.8	8.1	1.6	9.7	0.0	9.7	—
	Manufacturing management	N=45	6.7	75.6	**13.3**	11.1	11.1	6.7	11.1	2.2	13.3	2.2	4.4	—
	Distribution	N=43	7.0	79.1	**7.0**	4.7	2.3	2.3	2.3	0.0	2.3	0.0	7.0	—

(3) Situation of the OSS use for other information systems for the company (Q1)

36 companies have used OSS for information systems for the company with functions other than personnel affairs･salary, document management, financial accounting, client management, public relations web, electronic conference･bulletin board･schedule management, e-mail, ordering (EDI, SCM etc.), purchase･stock management, manufacturing management, and distribution and the

number of total items is 70. By OSS usage classification: “OS” 70.0%, “server” 62.9%, “development tool” 32.9%, and “DBMS” 28.6%.

(4) Number of the servers used for the operation of information systems for the company and adoption of Linux etc. (Q2)

The number of the servers used for the operation of information systems for the company is as follows: “1-50 units” 46.7%, “51-100 units” 18.9%, and “101-300 units” 15.6%. Compared with this, the percentage of the servers adopting Linux etc. for OS is: “Less than 10%” 37.8%, “10%-less than 30%” 13.3%, and “Nothing adopted” 30.0%.

2. Recognition of the OSS use and future policies

We grasped here the reasons of OSS use for information systems for the company, the expected effect and the achieved effect of the introduction, and the usage policies for the future. It was found that the OSS use was decided following equally the consideration in the company or the proposals from IT venders, that the companies emphasize saving of the development investment or the maintenance and update cost, the availability of standard or de facto standard softwares, and the expected elimination of dependence on particular IT vender and that just fewer than 40% of the companies who have decided usage policies for the future (20% of all) intend to expand the usage.

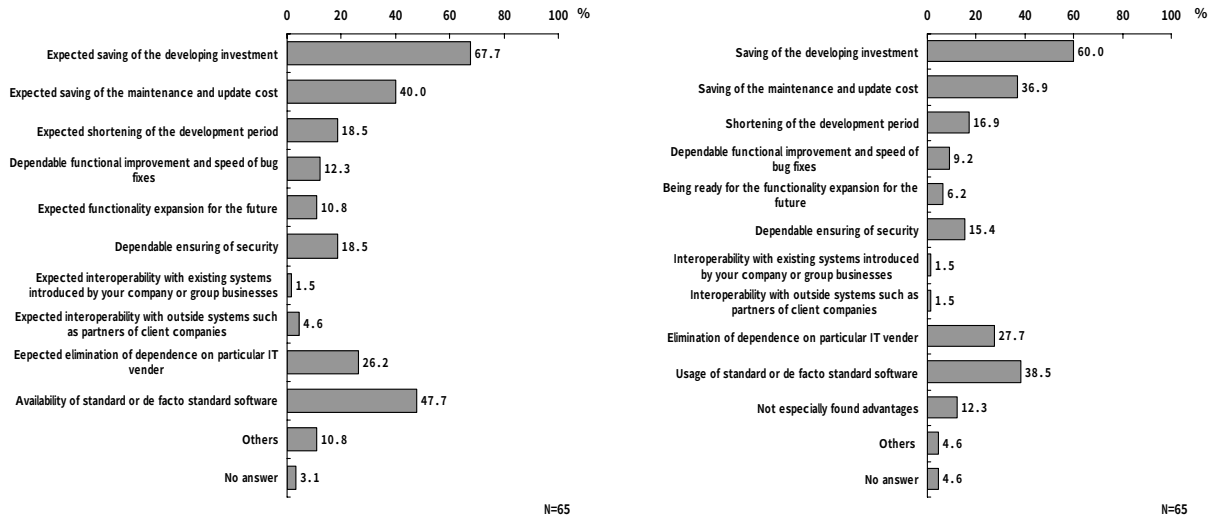
(1) Reasons of OSS use for information systems for the company, expected effect and achieved effect of the introduction (Q3, 4)

The reasons of OSS use for information systems for the company are as follows: “Following the consideration in information system division” 43.3%, “In response to proposals from IT venders” 35.6%.

As for the expectation of the OSS use for information systems for the company, “Expected saving of the developing investment” is 67.7%, “Availability of standard or de facto standard software” 47.7%, “Expected saving of the maintenance and update cost” 40.0%, and “Expected elimination of dependence on particular IT vender” 26.2%. Meanwhile, the actual effect after the introduction has similar tendency.

Figure 2-Expectation and effect of the OSS use for information systems for the company

(Left: Expectation before the introduction Right: Effect after the introduction) (multiple answers)



(2) OSS future policies in information systems for the company

20.0% of the companies have decided the OSS usage policies for the future and 38.9% of them “intend to expand the usage”. In contrast, 80% of the companies have not yet decided the OSS usage policies for the future.

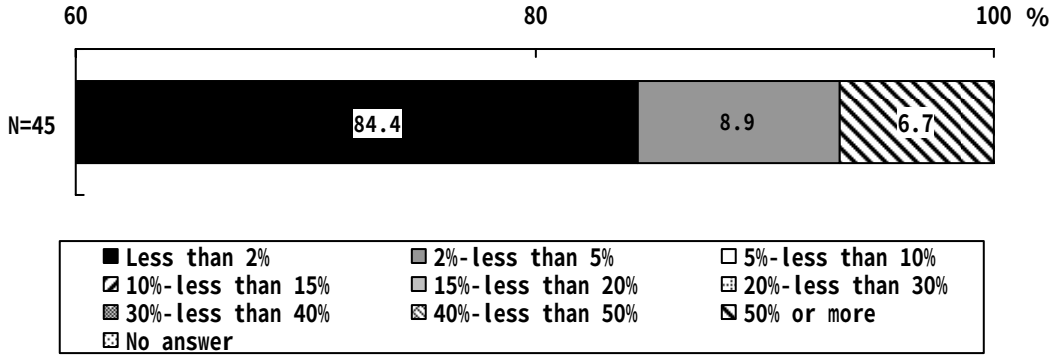
3. Composition of the IT engineers and the engineers using OSS

We grasped here the situation such as the percentage of the engineers using OSS in IT engineers. It was found that while just over 30% of the companies have less than 5% of the engineers using OSS in IT engineers; about half of the companies have more than 20% of the engineers using OSS.

(1) Number of the IT engineers and percentage of the engineers using OSS in all the employees (Q6)

While about 40% of the companies have less than 10 IT engineers, 1/3 have more than 20 IT engineers. As for the percentage of the IT engineers in all the employees, more than 80% of the companies have less than 2%.

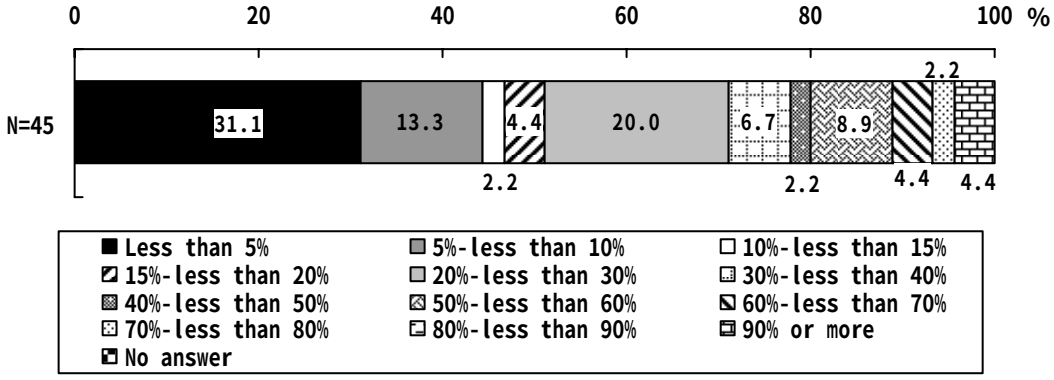
Figure 3-Percentage of the IT engineers in all the employees (at the end of March 2007)



(2) Number of the IT engineers and percentage of the IT engineers in all the employees (Q6)

While just over 30% of the companies have less than 5% of the engineers using OSS in IT engineers, about half of the companies have more than 20% of the engineers using OSS. In addition, the percentage of the IT engineers who have got involved in “introduction・operation・management” or “development” of systems using OSS is slightly lower than that and the number of the engineers who have got involved in “development” is less than the others.

Figure 4-Percentage of the engineers using OSS in the IT engineers (at the end of March 2007)



4. OSS skill level expected for the engineers using OSS and actual OSS skill level

We analyzed here the gap between the OSS skill level expected for the engineers using OSS and the actual OSS skill level based on the result of the questionnaire.

The gap is analyzed from the difference between the expected skill level and the actual skill level and its calculation process is roughly divided into two phases: “I. Calculation of skill level” and “II. Calculation of the difference between the expected level and the actual level”.

In these two phases, there is the following variation and the method is adopted this time as below.

Figure 5-Analysis method of the gap between the expected OSS skill level and the actual level

Calculation process	Variation		Advantages	Disadvantages
I. Calculation of skill level	A. Treatment of skill level 9	①Include	■ Possible to include the answer "The skill is necessary but it is not acquired" especially in "actual" part	■ Even the answer “The skill is not necessary because it is not concerned with the operation" is included in samples (Problems especially in embedded SW)
		②Exclude	■ Possible to exclude the answer "The skill is not necessary and it is not acquired "	■ Impossible to include the answer "The skill is necessary but it is not acquired" in samples especially in "actual" part
	B. Numeric evaluation of skill level	①Number of responses	■ Possible to know the volume of expected and acquired skills by level in absolute numeric value	■ Impossible to show the level of each skill in a numeric value (value by level)
		②Percentage	■ Possible to know the volume of expected and acquired skills by level in percentage (In A②, almost the same meaning as B①)	■ Impossible to show the level of each skill in a numeric value (value by level)
		③Score	■ Possible to show the level of each skill in a numeric value	■ Impossible to know the volume of expected and acquired skills by level
II. Calculation of the difference between the expected level and the actual level	C. Numeric evaluation of the gap (calculation of the difference of expected and actual values of B)	①Subtraction	■ Possible to know the volume of the gap in absolute numeric value (Especially in B①, it is usable)	■ Influenced by the value of B (for example, if the value of B is small, this value become small)
		②Division	■ Possible to compare the gap in parallel by skill regardless of the value of B	■ When the value of B is small, the value can change substantially

A Treatment of skill level 9: “②Exclude” is adopted, but only certain samples are eliminated.

- Based on two reasons: “Possible to compare each skill in parallel including embedded SW” and “Possible to prevent the case the value become extremely smaller by excluding skill level 9 when <B③Score> is adopted”
- Only certain samples are excluded, not all the samples based on the following concept.
  - The samples who answered skill level 9 for “expected OSS skill level” are excluded because “they should regard the skill as unnecessary because it is not concerned with the operation etc.” (Also excluded are the samples who didn’t answer either of the expected level or the actual level.)
  - On the contrary, the samples who answered skill level 1-3 for “expected OSS skill level” and answered skill level 9 for “actual OSS skill level “ are counted because they should be in the situation: “The skill have not been acquired.”

B Numeric evaluation of skill level: adoption of “③Score”

- Based on the reason: “Possible to give the gap and the level of each skill as a numeric value.”
- The level of each skill is changed to a score based on the following table.

Skill level	Outline of skill level	Score
1	Point where they have knowledge of the skill and are able to teach the skill itself or the operation requiring the skill to others	3
2	Point where they have acquired the skill and are able to complete all the operation requiring the skill by themselves	2
3	Point where they have partially acquired the skill and are able to complete the operation requiring the skill on some level or under the guidance	1
9	Not acquired the skill or not need to acquire the skill (considering the skill unrelated to their operation etc.)	0

C Numeric evaluation of the gap: adoption of "②Division"

・ Based on the reason: "Impossible to compare the skills with small and big value of level in parallel by "①Subtraction".

Example: Skill A: "expected" 50, "actual" 48

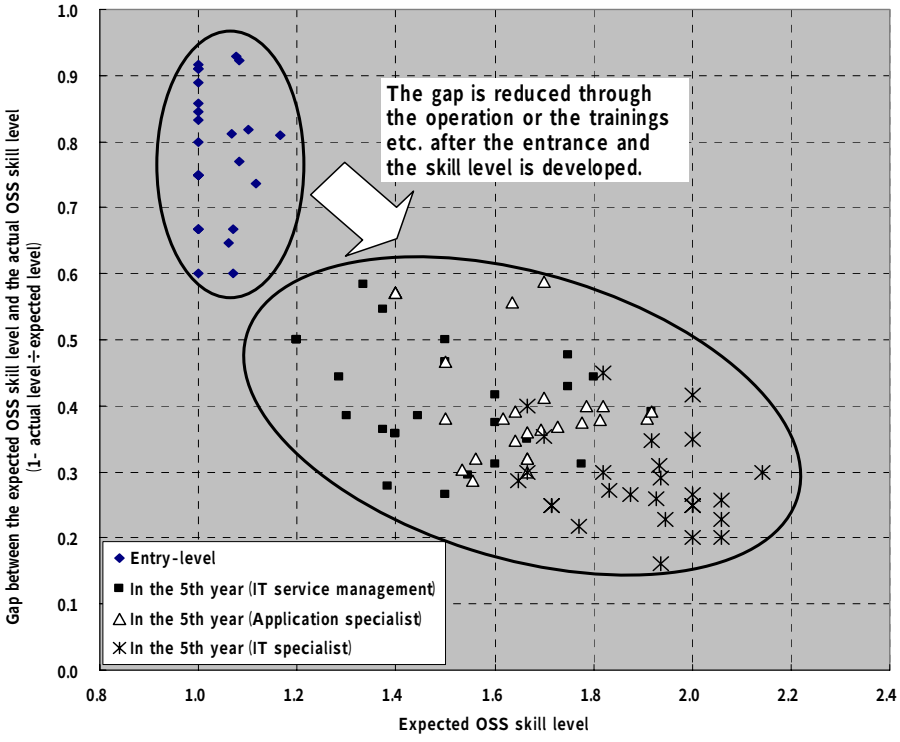
Skill B: "expected" 4, "actual" 2 (right table)

	①Subtraction	②Division
Skill A	2	0.96
Skill B	2	0.5

(1) OSS skill level expected for the engineers using OSS and actual OSS skill level (Q8)

The expected OSS skill level exceeds the actual OSS skill level in each OSS skill both at entry-level and in the 5th years; the actual skill level doesn't reach the expected level. However, the gap between two levels at entry-level is wider than that in the 5th years and the gap is reduced with the acquisition of OSS skills through the operation or the trainings after the entrance. The skill level is also developed at the same time.

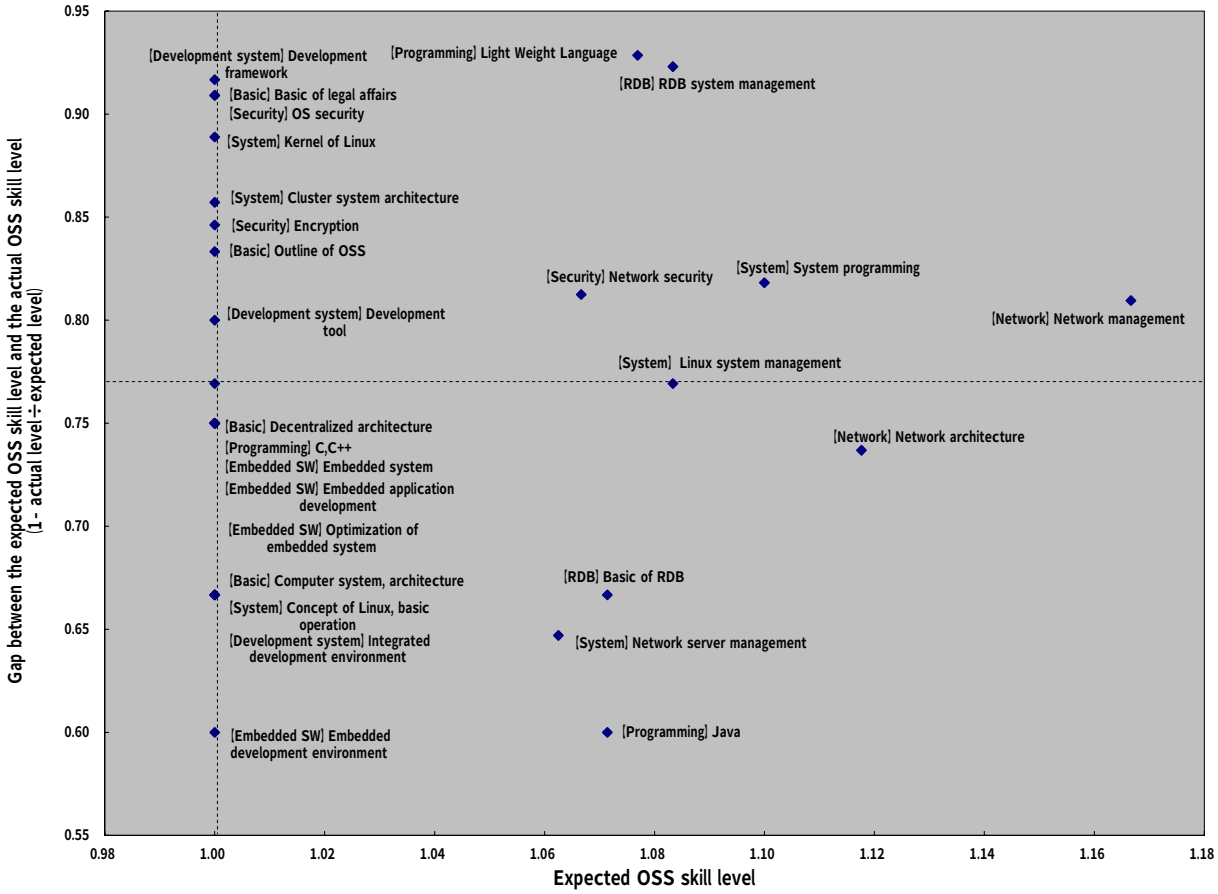
Figure 6-Secular variation of the expected OSS skill level and the gap



As for the OSS skills required by occupation, it is determined that the OSS skills more required at entry-level are “RDB system management” (RDB field), “Light Weight Language” (programming field), “System programming” (system programming), “Network management” (network field), and “Network security” (security field) because the expected skill level is high and the gap is wide. Meanwhile, as for the skills such as “Java” (programming field), “Network server management” (system field), and “Basic of RDB” (RDB field), the expected skill level at entry-level is considered to have reached the sufficient level to some extent with the school education because the expected skill level is high but the gap is small.

Figure 7-OSS skill level expected in each OSS skill and the gap (entry-level)

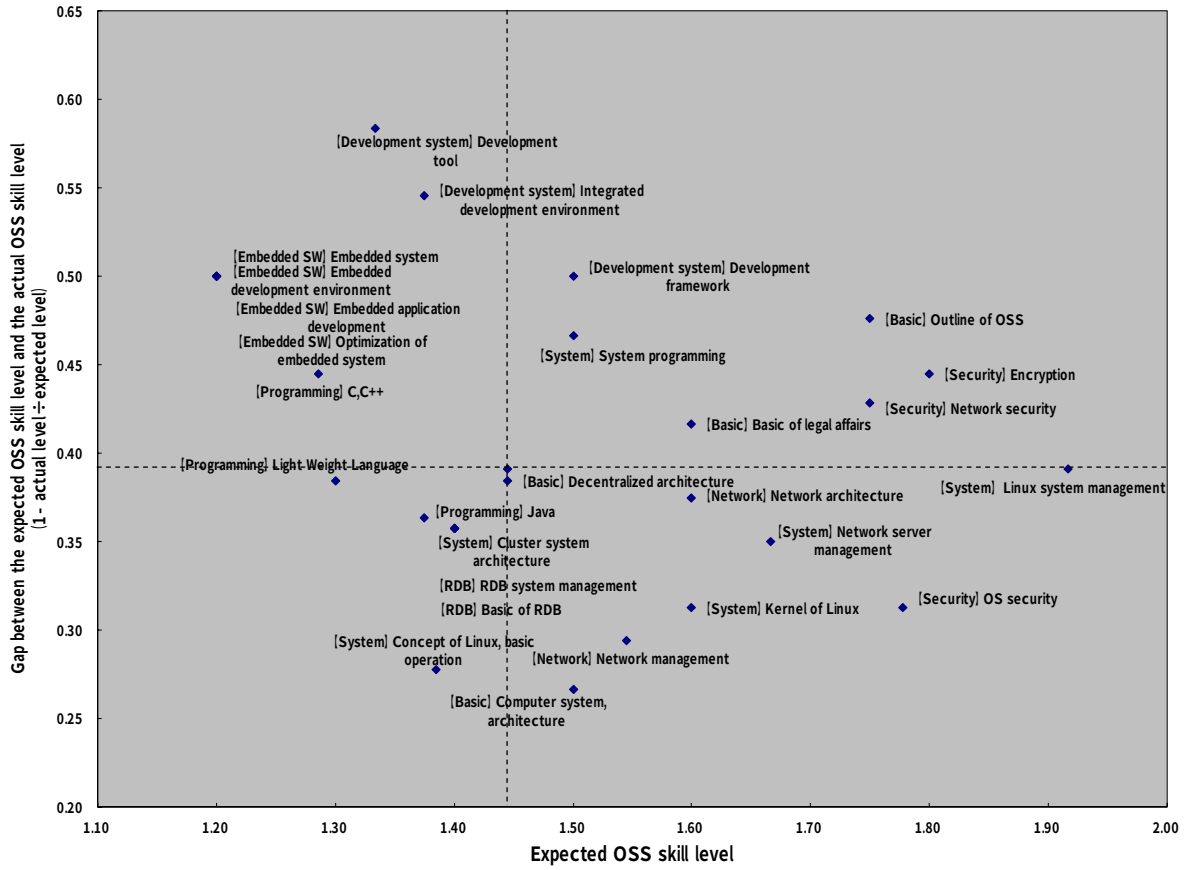
	Expected OSS skill level		Gap between the expected OSS skill level and the actual OSS skill level	
1	【Network】 Network management	1.17	【Programming】 Light Weight Language	0.93
2	【Network】 Network architecture	1.12	【RDB】 RDB system management	0.92
3	【System】 System programming	1.10	【Development system】 Development framework	0.92
4	【System】 Linux system management	1.08	【Basic】 Basic of legal affairs	0.91
5	【RDB】 RDB system management	1.08	【Security】 OS security	0.91
6	【Programming】 Light Weight Language	1.08	【System】 Kernel of Linux	0.89
7	【Programming】 Java	1.07	【System】 Cluster system architecture	0.86
8	【RDB】 Basic of RDB	1.07	【Security】 Encryption	0.85
9	【Security】 Network security	1.07	【Basic】 Outline of OSS	0.83
10	【System】 Network server management	1.06	【System】 System programming	0.82
11	【Basic】 Outline of OSS	1.00	【Security】 Network security	0.81
12	【Basic】 Basic of legal affairs	1.00	【Network】 Network management	0.81
13	【Basic】 Computer system, architecture	1.00	【Development system】 Development tool	0.80
14	【Basic】 Decentralized architecture	1.00	【System】 Linux system management	0.77
15	【System】 Concept of Linux, basic operation	1.00	【Basic】 Decentralized architecture	0.75
16	【System】 Kernel of Linux	1.00	【Programming】 C,C++	0.75
17	【System】 Cluster system architecture	1.00	【Embedded SW】 Embedded system	0.75
18	【Programming】 C,C++	1.00	【Embedded SW】 Embedded application development	0.75
19	【Development system】 Development framework	1.00	【Embedded SW】 Optimization of embedded system	0.75
20	【Development system】 Development tool	1.00	【Network】 Network architecture	0.74
21	【Development system】 Integrated development environment	1.00	【Basic】 Computer system, architecture	0.67
22	【Security】 Encryption	1.00	【System】 Concept of Linux, basic operation	0.67
23	【Security】 OS security	1.00	【Development system】 Integrated development environment	0.67
24	【Embedded SW】 Embedded system	1.00	【RDB】 Basic of RDB	0.67
25	【Embedded SW】 Embedded development environment	1.00	【System】 Network server management	0.65
26	【Embedded SW】 Embedded application development	1.00	【Programming】 Java	0.60
27	【Embedded SW】 Optimization of embedded system	1.00	【Embedded SW】 Embedded development environment	0.60



Meanwhile, it is determined that the OSS skills more required in the 5th years for IT service management are “Outline of OSS”, “Basic of legal affaires” (basic field), “Encryption”, “Network security” (security field), “Development framework” (development system field), and “System programming” (system field) because the expected skill level is high and the gap is wide. Meanwhile, as for the skills such as “Kernel of Linux”, “Linux system management”, “Network server management” (system field), “Network management”, “Network architecture” (network field), “OS security”, and “Computer system, architecture”, the expected skill level is considered to have reached the sufficient level to some extent with trainings such as employee training after the entrance because the expected skill level is high but the gap is small.

Figure 8-OSS skill level expected in each OSS skill and the gap (in the 5th year, IT service management)

	Expected OSS skill level		Gap between the expected OSS skill level and the actual OSS skill level	
1	【System】 Linux system management	1.92	【Development system】Development tool	0.58
2	【Security】Encryption	1.80	【Development system】Integrated development environment	0.55
3	【Security】OS security	1.78	【Development system】Development framework	0.50
4	【Basic】Outline of OSS	1.75	【Embedded SW】Embedded system	0.50
5	【Security】Network security	1.75	【Embedded SW】Embedded development environment	0.50
6	【System】Network server management	1.67	【Embedded SW】Embedded application development	0.50
7	【Basic】Basic of legal affairs	1.60	【Embedded SW】Optimization of embedded system	0.50
8	【System】Kernel of Linux	1.60	【Basic】Outline of OSS	0.48
9	【Network】Network architecture	1.60	【System】System programming	0.47
10	【Network】Network management	1.55	【Programming】C,C++	0.44
11	【Basic】Computer system, architecture	1.50	【Security】Encryption	0.44
12	【System】System programming	1.50	【Security】Network security	0.43
13	【Development system】Development framework	1.50	【Basic】Basic of legal affairs	0.42
14	【Basic】Decentralized architecture	1.44	【System】 Linux system management	0.39
15	【System】Cluster system architecture	1.40	【Basic】Decentralized architecture	0.38
16	【RDB】Basic of RDB	1.40	【Programming】Light Weight Language	0.38
17	【RDB】RDB system management	1.40	【Network】Network architecture	0.38
18	【System】Concept of Linux, basic operation	1.38	【Programming】Java	0.36
19	【Programming】Java	1.38	【System】Cluster system architecture	0.36
20	【Development system】Integrated development environment	1.38	【RDB】Basic of RDB	0.36
21	【Development system】Development tool	1.33	【RDB】RDB system management	0.36
22	【Programming】Light Weight Language	1.30	【System】Network server management	0.35
23	【Programming】C,C++	1.29	【System】Kernel of Linux	0.31
24	【Embedded SW】Embedded system	1.20	【Security】OS security	0.31
25	【Embedded SW】Embedded development environment	1.20	【Network】Network management	0.29
26	【Embedded SW】Embedded application development	1.20	【System】Concept of Linux, basic operation	0.28
27	【Embedded SW】Optimization of embedded system	1.20	【Basic】Computer system, architecture	0.27

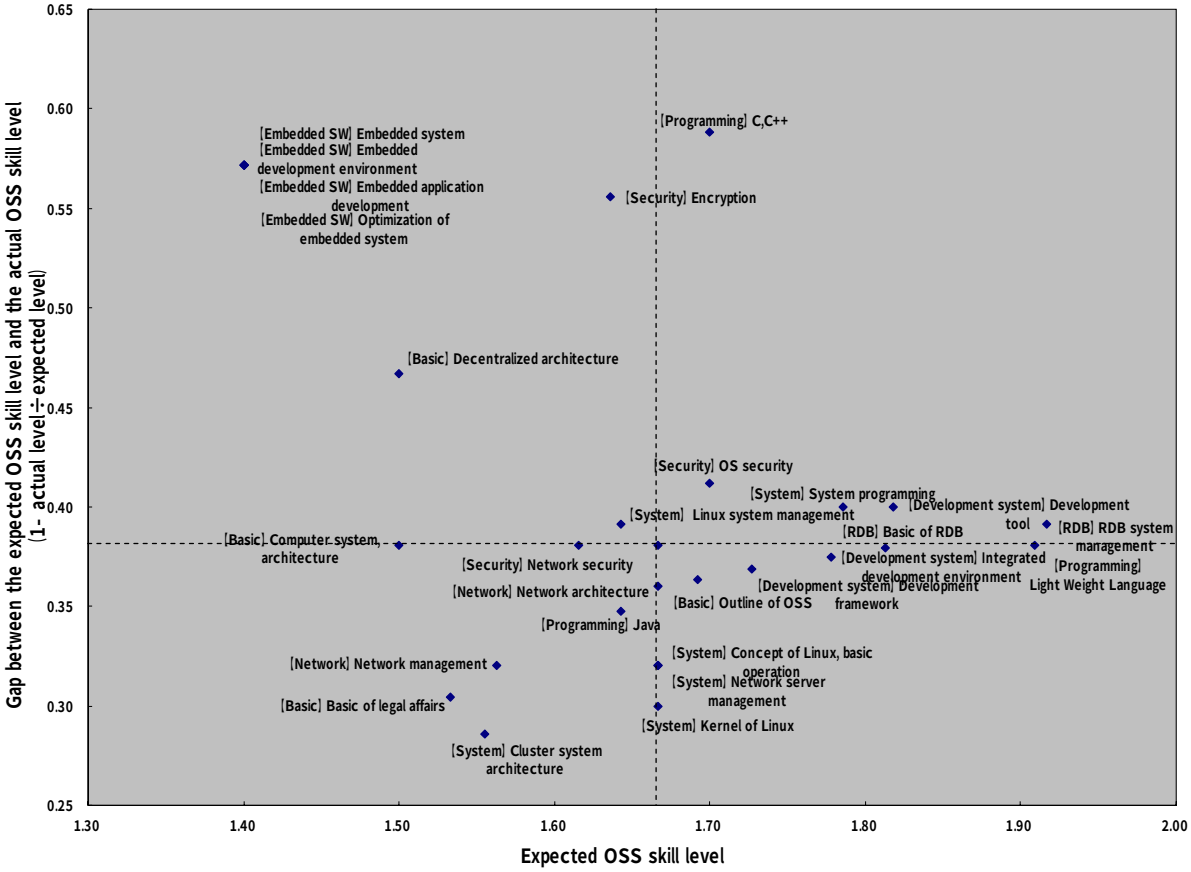


It is determined that the OSS skills more required in the 5th year for application specialist are “C, C++”, “Light Weight Language” (programming field), “Encryption”, “OS security” (security field), “Development tool” (development system field), “System programming” (system field), and “RDB system management” (RDB field) because the expected skill level is high and the gap is wide. Meanwhile, as for the skills such as “Kernel of Linux”, and “Concept of Linux, basic operation”, “Network server management” (system field), the expected skill level is considered to have reached

the sufficient level to some extent with trainings such as employee training after the entrance because the expected skill level is high but the gap is small.

Figure 9-OSS skill level expected in each OSS skill and the gap (in the 5th year, application specialist)

	Expected OSS skill level		Gap between the expected OSS skill level and the actual OSS skill level	
1	【RDB】RDB system management	1.92	【Programming】C,C++	0.59
2	【Programming】Light Weight Language	1.91	【Embedded SW】Embedded system	0.57
3	【Development system】Development tool	1.82	【Embedded SW】Embedded development environment	0.57
4	【RDB】Basic of RDB	1.81	【Embedded SW】Embedded application development	0.57
5	【System】System programming	1.79	【Embedded SW】Optimization of embedded system	0.57
6	【Development system】Integrated development environment	1.78	【Security】Encryption	0.56
7	【Development system】Development framework	1.73	【Basic】Decentralized architecture	0.47
8	【Programming】C,C++	1.70	【Security】OS security	0.41
9	【Security】OS security	1.70	【System】System programming	0.40
10	【Basic】Outline of OSS	1.69	【Development system】Development tool	0.40
11	【System】Concept of Linux, basic operation	1.67	【System】 Linux system management	0.39
12	【System】Kernel of Linux	1.67	【RDB】RDB system management	0.39
13	【System】Network server management	1.67	【Basic】Computer system, architecture	0.38
14	【Network】Network architecture	1.67	【Programming】Light Weight Language	0.38
15	【System】 Linux system management	1.64	【Security】Network security	0.38
16	【Programming】Java	1.64	【RDB】Basic of RDB	0.38
17	【Security】Encryption	1.64	【Development system】Integrated development environment	0.38
18	【Security】Network security	1.62	【Development system】Development framework	0.37
19	【Network】Network management	1.56	【Basic】Outline of OSS	0.36
20	【System】Cluster system architecture	1.56	【Network】Network architecture	0.36
21	【Basic】Basic of legal affairs	1.53	【Programming】Java	0.35
22	【Basic】Computer system, architecture	1.50	【System】Concept of Linux, basic operation	0.32
23	【Basic】Decentralized architecture	1.50	【System】Network server management	0.32
24	【Embedded SW】Embedded system	1.40	【Network】Network management	0.32
25	【Embedded SW】Embedded development environment	1.40	【Basic】Basic of legal affairs	0.30
26	【Embedded SW】Embedded application development	1.40	【System】Kernel of Linux	0.30
27	【Embedded SW】Optimization of embedded system	1.40	【System】Cluster system architecture	0.29

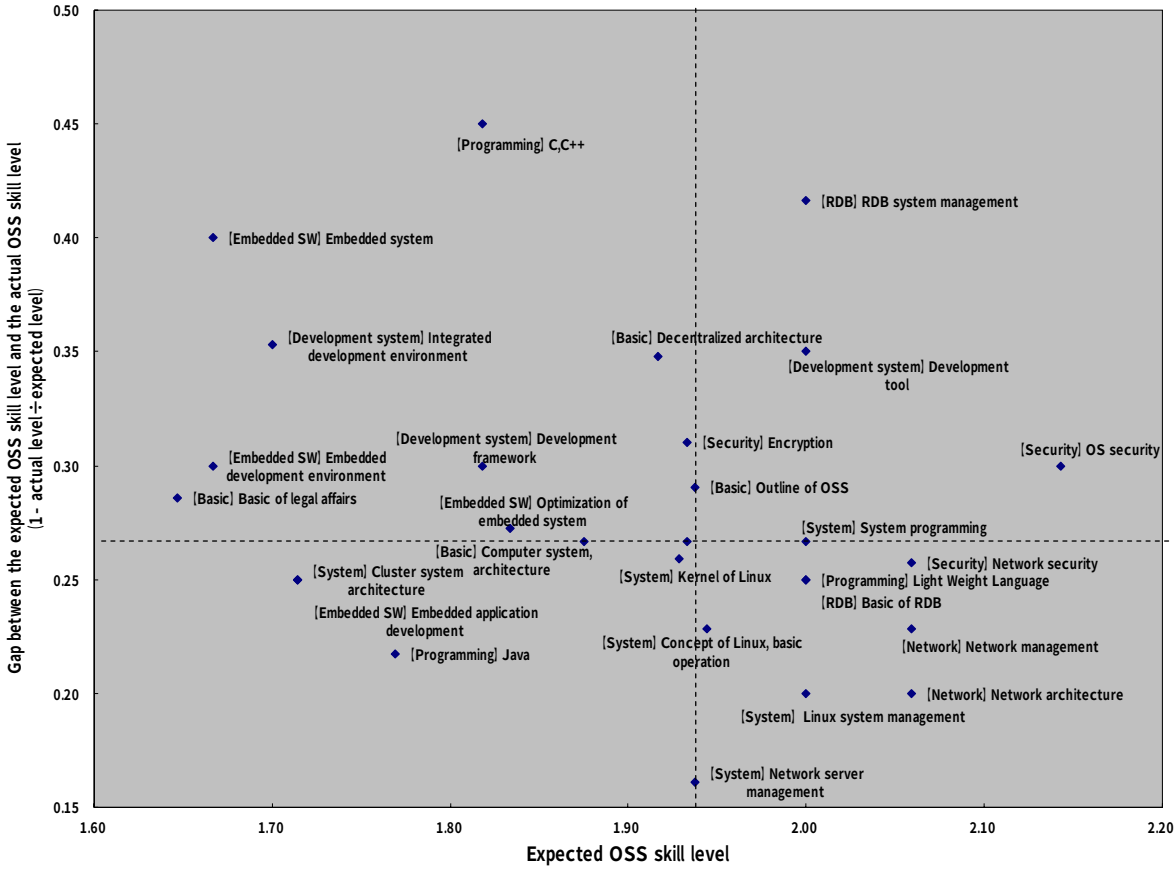


It is determined that the OSS skills more required in the 5th year for IT specialist are “RDB system management” (RDB field), “Development tool” (development system field), “Encryption”, “OS security” (security field), and “System programming” (system field) because the expected skill level is

high and the gap is wide. Meanwhile, as for the skills such as “Network server management”, “Linux system management”, “Concept of Linux, basic operation” (system field), “Network architecture”, “Network management” (network field), “Light Weight Language”, and “Basic of RDB”, the expected skill level is considered to have reached the sufficient level to some extent with trainings such as employee training after the entrance because the expected level is high but the gap is small.

Figure 10-OSS skill level expected in each OSS skill and the gap (in the 5th year, IT specialist)

	Expected OSS skill level		Gap between the expected OSS skill level and the actual OSS skill level	
1	【Security】 OS security	2.14	【Programming】 C,C++	0.45
2	【Network】 Network architecture	2.06	【RDB】 RDB system management	0.42
3	【Network】 Network management	2.06	【Embedded SW】 Embedded system	0.40
4	【Security】 Network security	2.06	【Development system】 Integrated development environment	0.35
5	【System】 Linux system management	2.00	【Development system】 Development tool	0.35
6	【System】 System programming	2.00	【Basic】 Decentralized architecture	0.35
7	【Programming】 Light Weight Language	2.00	【Security】 Encryption	0.31
8	【Development system】 Development tool	2.00	【Development system】 Development framework	0.30
9	【RDB】 Basic of RDB	2.00	【Security】 OS security	0.30
10	【RDB】 RDB system management	2.00	【Embedded SW】 Embedded development environment	0.30
11	【System】 Concept of Linux, basic operation	1.94	【Basic】 Outline of OSS	0.29
12	【Basic】 Outline of OSS	1.94	【Basic】 Basic of legal affairs	0.29
13	【System】 Network server management	1.94	【Embedded SW】 Optimization of embedded system	0.27
14	【Security】 Encryption	1.93	【Basic】 Computer system, architecture	0.27
15	【System】 Kernel of Linux	1.93	【System】 System programming	0.27
16	【Basic】 Decentralized architecture	1.92	【System】 Kernel of Linux	0.26
17	【Basic】 Computer system, architecture	1.88	【Security】 Network security	0.26
18	【Embedded SW】 Optimization of embedded system	1.83	【System】 Cluster system architecture	0.25
19	【Programming】 C,C++	1.82	【Programming】 Light Weight Language	0.25
20	【Development system】 Development framework	1.82	【RDB】 Basic of RDB	0.25
21	【Programming】 Java	1.77	【Embedded SW】 Embedded application development	0.25
22	【System】 Cluster system architecture	1.71	【System】 Concept of Linux, basic operation	0.23
23	【Embedded SW】 Embedded application development	1.71	【Network】 Network management	0.23
24	【Development system】 Integrated development environment	1.70	【Programming】 Java	0.22
25	【Embedded SW】 Embedded system	1.67	【System】 Linux system management	0.20
26	【Embedded SW】 Embedded development environment	1.67	【Network】 Network architecture	0.20
27	【Basic】 Basic of legal affairs	1.65	【System】 Network server management	0.16



5. Method of training for the acquisition of OSS skills

We grasped here the sufficiency level of the in-house education/training for the acquisition of OSS skills and the concrete ways. It was found that the sufficiency level of the in-house education/training is still low, while OJT and self-education are mainly adopted and trainings such as external trainings are not sufficiently used.

(1) Sufficiency level of the in-house education/training on OSS skills (Q9)

At entry-level, the percentage of the companies who provide sufficient or a certain level of in-house education/training on each OSS skill is very low. In addition, more than half of the companies don't feel the need for in-house education/training on each OSS skill.

In contrast, in the 5th year, just over 20% of the companies provide sufficient or a certain level of in-house education/training on network-related skills and the percentage of the provision of the trainings on network server management and network security is relatively high. However, overall, about 30% of the companies feel insufficient provision of the in-house education/training and about half of the companies don't feel the need for in-house education/training except network, security, and RDB.

Figure 11-Sufficiency level of the in-house education/training on OSS skills (entry-level)

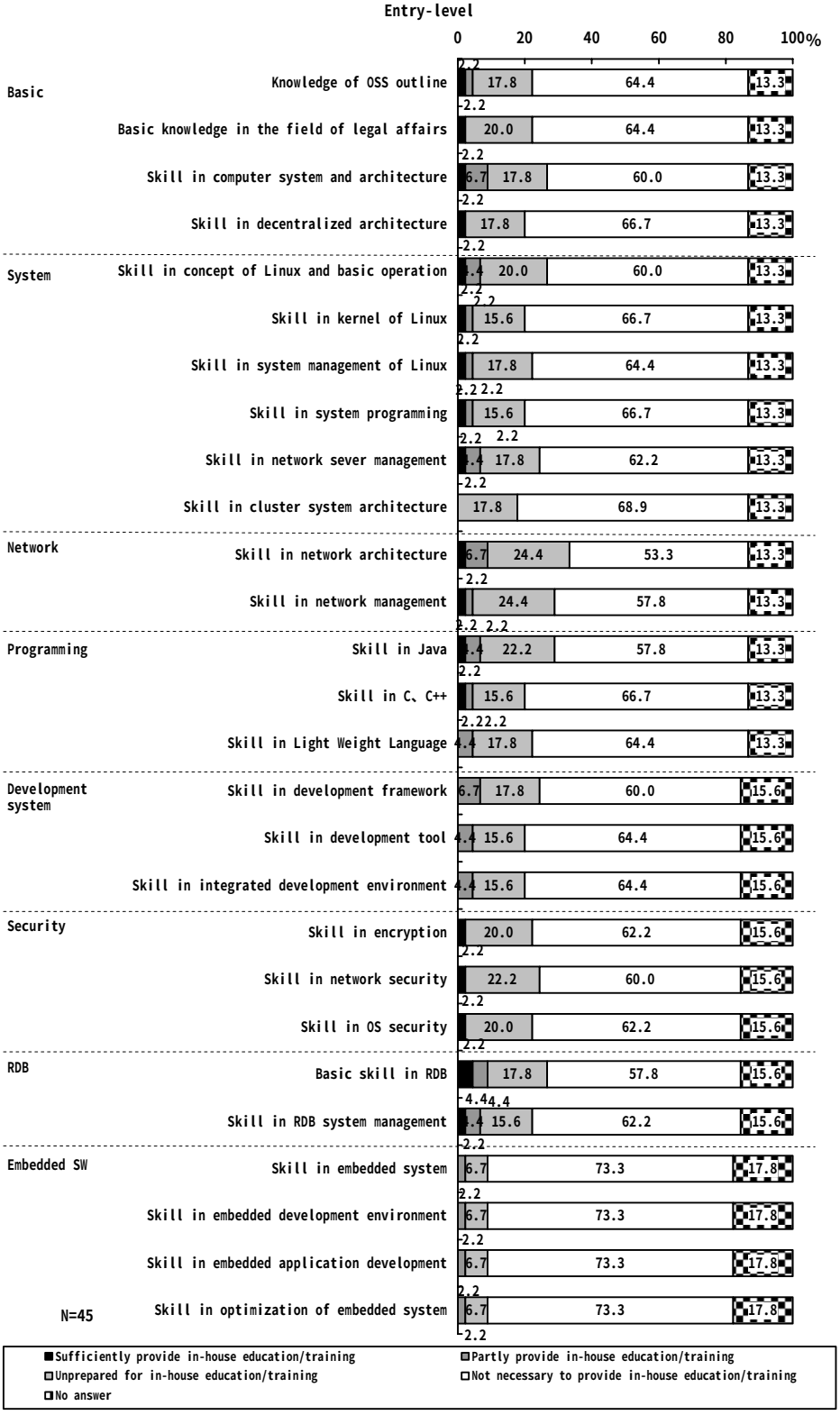
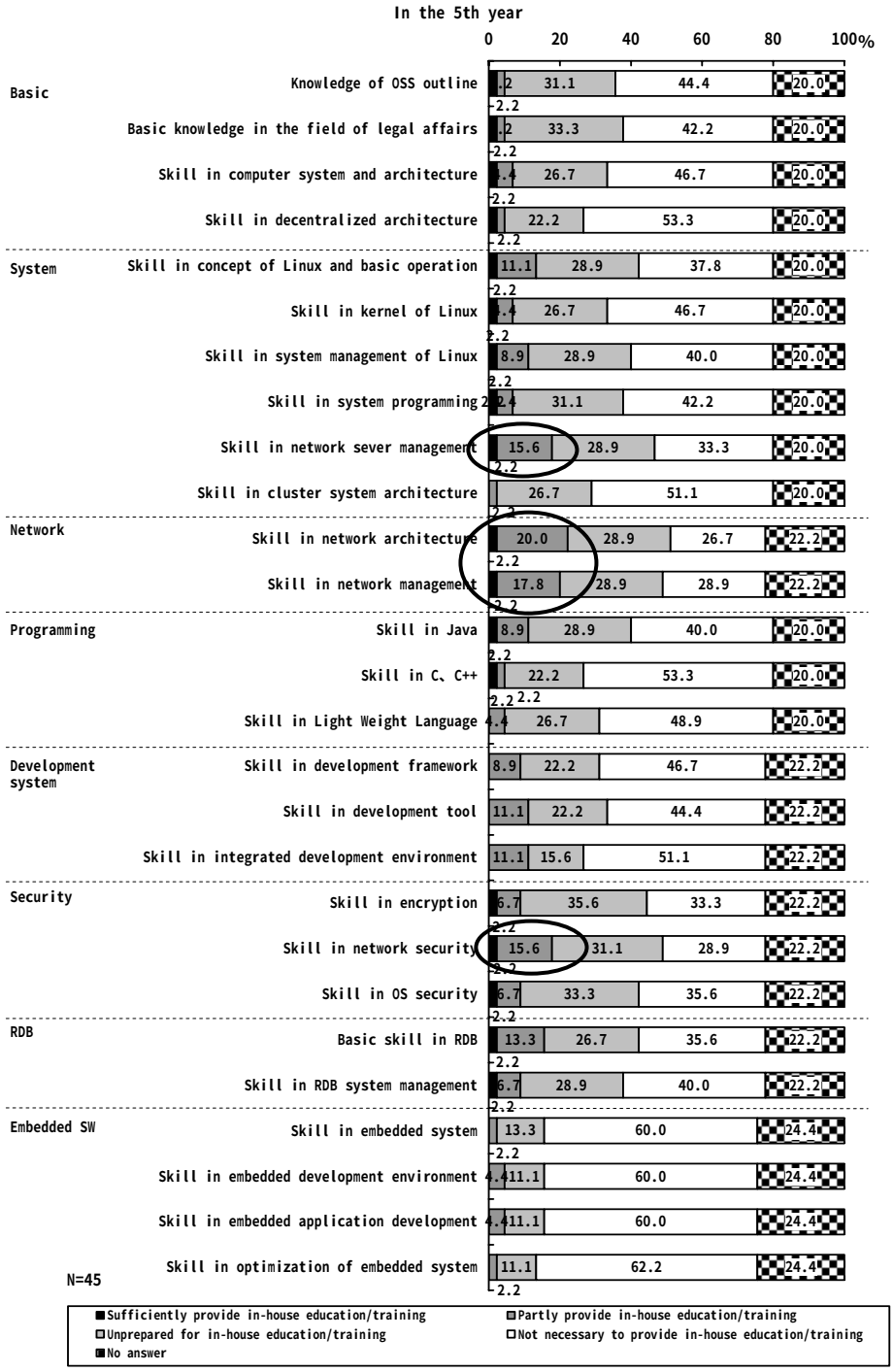


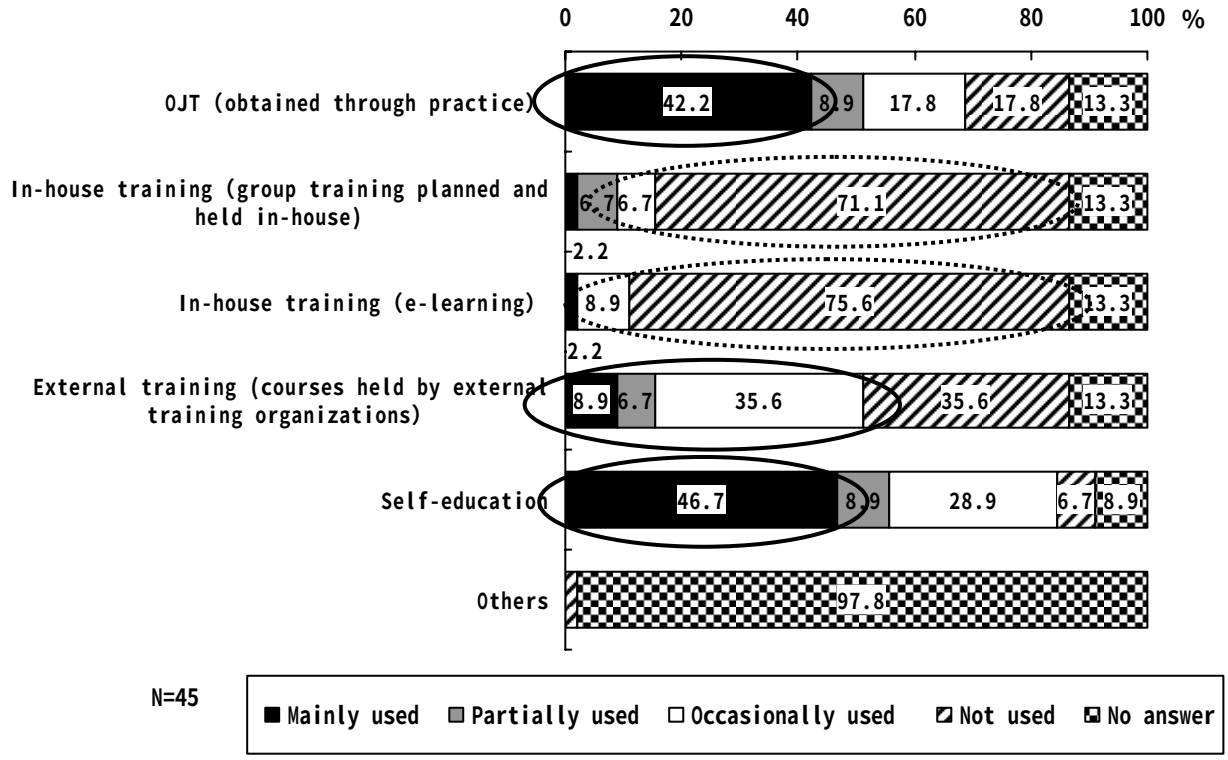
Figure 12-Sufficiency level of the in-house education/training on OSS skills (in the 5th year)



(2) Method for the acquisition of OSS skills after the entrance (Q10)

Just fewer than half of the companies mainly use self-education, followed by OJT. The employees acquire OSS skills mostly by themselves. More than half of the companies have used external trainings. However, the percentage of the companies who have used in-house trainings or e-learning stays at about 10-20%.

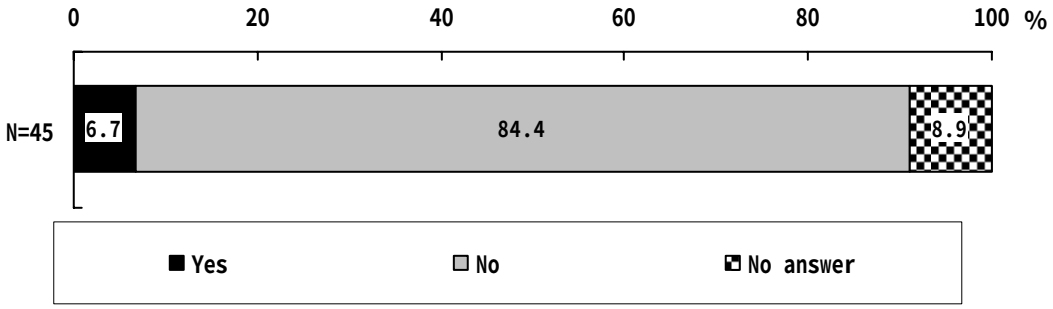
Figure 13-Method for the acquisition of OSS skills after the entrance



(3) OSS skill-related qualifications recommended acquiring (Q11)

The percentage of the companies who have the OSS skill-related qualifications recommended acquiring remains at 6.7%.

Figure 14-OSS skill-related qualification recommended acquiring



6. Profile of the companies surveyed

The following figures represent data on the category of business and the size of 90 companies, the respondents of the survey.

Figure 15-Category of business

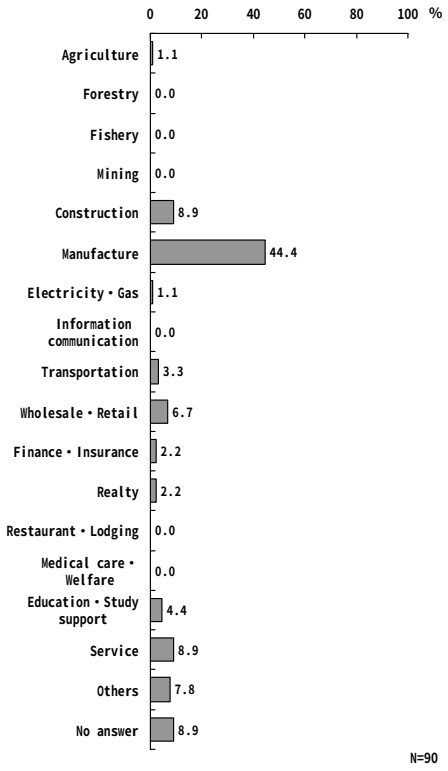


Figure16-Capital

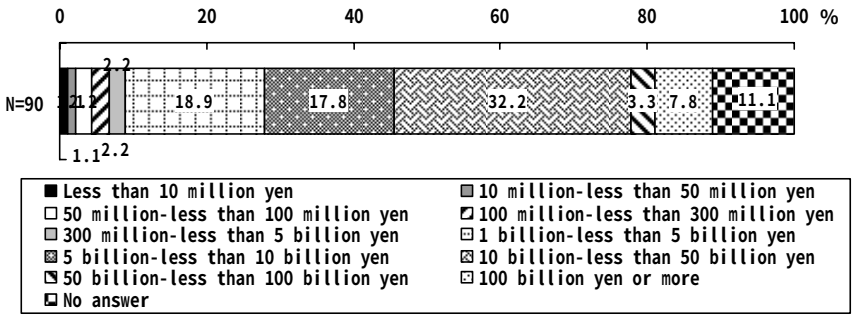
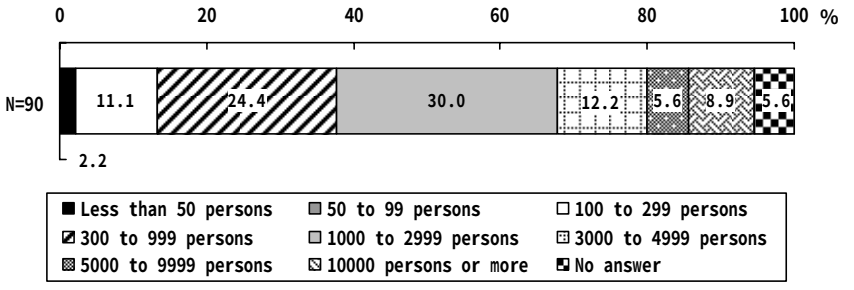


Figure 17-Number of the employees



Survey 1
Survey on the OSS skills of the engineers using OSS required by the user companies
Report【Summary】

INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN

Survey 2

Survey on the OSS skills of the engineers using OSS required by the companies such as SI businesses

Report

【Summary】

August 2007

INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN

[Points of the result of this survey]

- 70% of the companies who answered the questionnaire use OSS for information systems for clients.
- The situation of the OSS use was found that about 70% use OSS in any of the following usage classifications: OS, server, DBMS, Web application architecture (J2EE etc.), application, development tool, operational management. However, more than 50% of the companies who didn't answer the questionnaire state that they don't have information systems for clients using OSS. The situation of the OSS use varies depending on the category of business, the size of the company and the location.
- As for the information systems for clients using OSS by type, currently, the companies use OSS more in client management which attract interest as a strategic tool in the company and e-mail, public relations web, electronic conference・bulletin board・schedule management, which are concerned with the information sharing or transmission inside and outside the company. Meanwhile, the companies are slow to use OSS in the conventional main systems such as personnel affaires・salary, document management, financial accounting, manufacturing management, and distribution.
- The companies emphasize saving of the development investment or maintenance and update cost and usage of standard software for the purpose of the OSS use for information systems for clients. Priority issues for future diffusion of OSS are improving the function and the speed of bug fixes and increasing a sense of reassurance for ensuring of security.
- In all the OSS skills, the actual level does not reach the expected level. The OSS-related skills highly required (the gap is wide and the required skill level is high) are described below. Also the OSS-related skills which have almost reached the expected skill level (the required skill level is high but the gap is small) with current school education or employee trainings despite the gap, are mentioned as below.

Occupation etc.		OSS skills highly required by the companies	OSS skills satisfying needs to some extent
Entry-level		"Decentralized architecture" (basic field), "Linux system management", "Network server management" (system field), "Network security", "OS security" (security field) etc.	"C,C++", "Light Weight Language", "Java" (programming field), "Concept of Linux, basic operation", (system field), "Computer system, architecture" (basic field)
In the 5th year	IT service management	"Basic of legal affaires", "Outline of OSS" (basic field), "Encryption" "Network security" (security field), "RDB system management" (RDB field) etc.	"Basic of RDB" (RDB field), "Network architecture", "Network management" (network field), "Concept of Linux, basic operation", "Linux system management", "Network server management" (system field) etc.
	Application specialist	"Linux system management", "Network server management" (system field), "Development framework" (development system field) etc.	"Basic of RDB" (RDB field), "Java", "Light Weight Language", "C,C++" (programming field), "Concept of Linux, basic operation", "System programming" (system field), "Integrated development environment" (development system field) etc.
	IT specialist	"Outline of OSS" (basic field), "Kernel of Linux" (system field), "Network security", "OS security" (security field), "RDB system management" (RDB field) etc.	"Basic of RDB" (RDB field), "Network architecture", "Network management" (network field), "Concept of Linux, basic operation", "Network server management" (system field), "Java" (programming field) etc.

- Although the gap between the expected level and the actual level is tend to diminish with trainings such as employee training after the entrance, employee trainings especially in security field and basic field are not sufficiently provided. As for the method of employee trainings, OJT and self-education are mainly adopted and external programs such as external trainings and e-learning are not frequently used. In addition, there is not big difference in the situation of the employee trainings depending on the size of the company.
- Because of this, the establishment of the training programs which are easy to use for the companies is required in OSS-related skills mainly in security and basic field.

I. Outline of the survey

We conducted a questionnaire survey on the following items at SI businesses and the corporate planning division and the human resources development division of software development companies.

①Situation of business using OSS

②Recognition of the OSS use and future policies

③Number of the IT engineers and percentage of the engineers using OSS

④Skill level expected for the engineers using OSS and actual skill level

⑤Method of training for the acquisition of OSS skills

The details such as the implementation method or the state of collection are as follows.

(1) Implementation term

April 2nd—April 18th, 2007

(2) Companies surveyed

1,350 companies

①Advanced companies of business using OSS (including Web2.0-related companies as companies with possibility of OSS use) 205 companies

－Obtained by OSS iPedia, information of NRI, web search etc.

②Overall SI businesses and software development companies 1,145 companies

－1,081 companies with the proceeds known in most recent Tokyo Shoko Research DB out of the companies included in METI information service companies file (2005) and whose business is mainly information service

－Top 64 major companies except broadcast, publication, cinema, and animation out of the domestic listed companies of information communication (securities code)

(3) Survey method

・Survey slips (see exhibit) are sent by mail. Postal cards are sent twice in the period to ask for the submission.

・In the 2nd card, a brief questionnaire is added.

(4) State of collection

	User companies	**SI, software development companies**
Valid responses of the main survey slip	90	**153**
Valid responses of the card survey slip	124	**176**
Total of valid responses	214	**329**
Total number	1,500	**1,350**
Total of valid responses/Total number	14.3%	**24.4%**
Valid responses of the main survey slip/Total number	6.0%	**11.3%**
Invalid (refusal)	1	**2**

II. Result of the survey

1. Situation of business using OSS

We grasped here the situation of OSS use, the state of installation of divisions specialized in OSS, and the concrete functions of information systems for clients using OSS. It was found that just fewer than 70% of all the companies who answered work on the information systems for clients using OSS and that they use mostly client management, public relations web, electronic conference･bulletin board･schedule management, ordering (EDI, SCM etc.), and e-mail as main function of system using OSS.

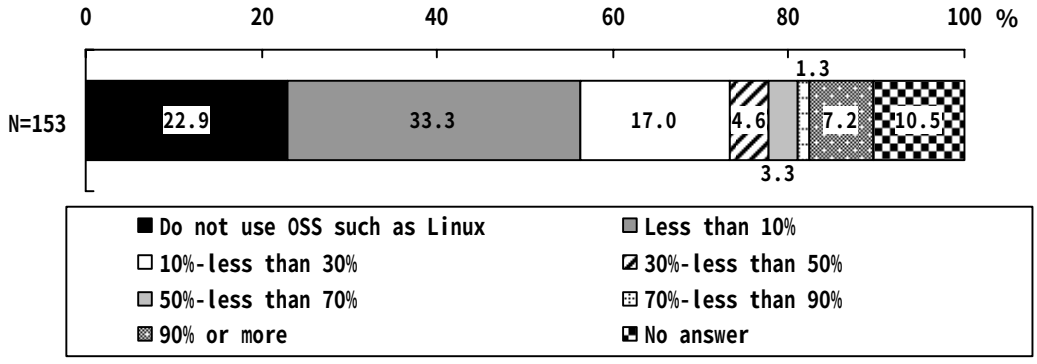
(1) Situation of the OSS use for information systems for clients (Q1)

66.7% of the companies have worked on information systems for clients using OSS such as Linux for OS in the last two years. Meanwhile, 22.9% of the companies don't use OSS. Popular OS products are "Red Hat Linux" 52.9%, "Turbolinux" 15.0%, and "Fedora Core" 13.7%.

69.2% of the companies have worked on information systems for clients using OSS for development tools (language, script language, integrated development environment, performance evaluation･test, development support, project management). Meanwhile, 19.6% of the companies don't use OSS at all.

Furthermore, 68.6% have used OSS similarly for other usage classifications (server, DBMS, web application architecture (J2EE etc.), application, operational management) except OS and development use. In contrast, 21.6% of the companies don't use any OSS.

Figure 1-Situation of the OSS use such as Linux for information systems for clients



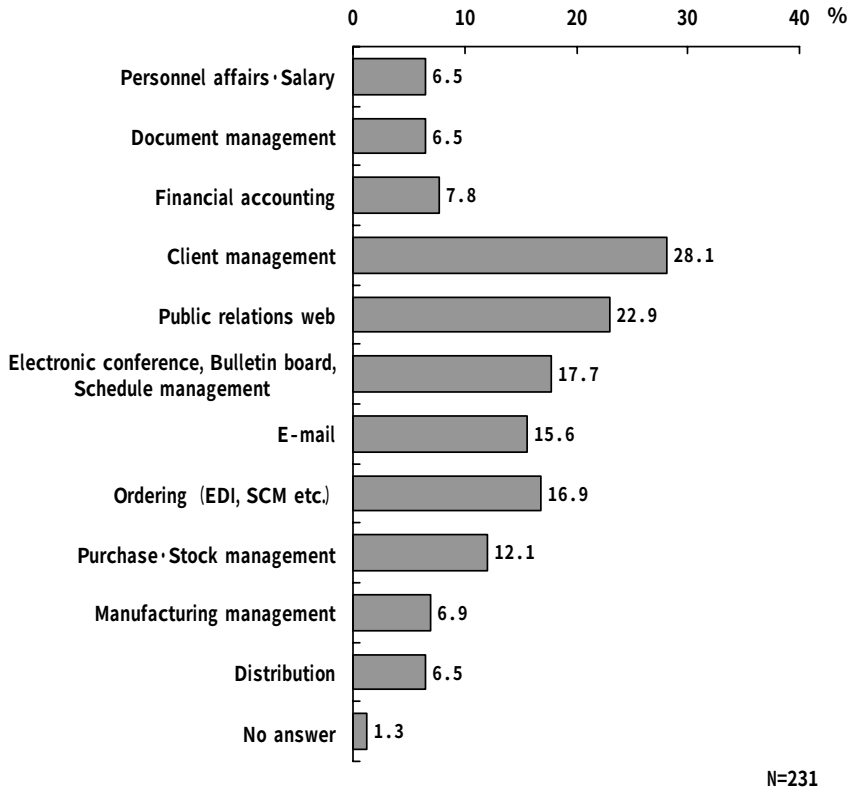
(2) Installation of divisions specializing in study of OSS itself or development using OSS (Q1)

When asked whether there is a division specialized in study of OSS itself or development using OSS, 24.8% of the companies answered "Yes", 6.5% answered "intend to install one in the future", and 60.1% answered "No".

(3) Function of information systems for clients using OSS (Q2)

In the last two years, 82 companies (53% of the respondents) have used OSS (for usage classifications as follows: server, DBMS, web application architecture (J2EE etc.), application, and operational management) in information systems with main function of personnel affairs・salary, document management, financial accounting, client management, public relations web, ordering (EDI, SCM etc.), purchase・stock management, manufacturing management, and distribution.
In 231 cases of 82 companies, client management represents 28.1%, public relations web 22.9%, followed by electronic conference・bulletin board・schedule management, ordering (EDI, SCM etc.), and e-mail. Meanwhile, the OSS use for the function of personnel affairs・salary, document management, financial accounting, manufacturing management, and distribution is relatively low.
In OSS usage classifications, “server” represents 74.5%, “web application architecture (J2EE etc.)” 57.6% and “DBMS” 47.6%.

Figure 2-Function of information systems for clients using OSS (multiple answers in each of 231cases)



2. Recognition of the OSS use and future policies

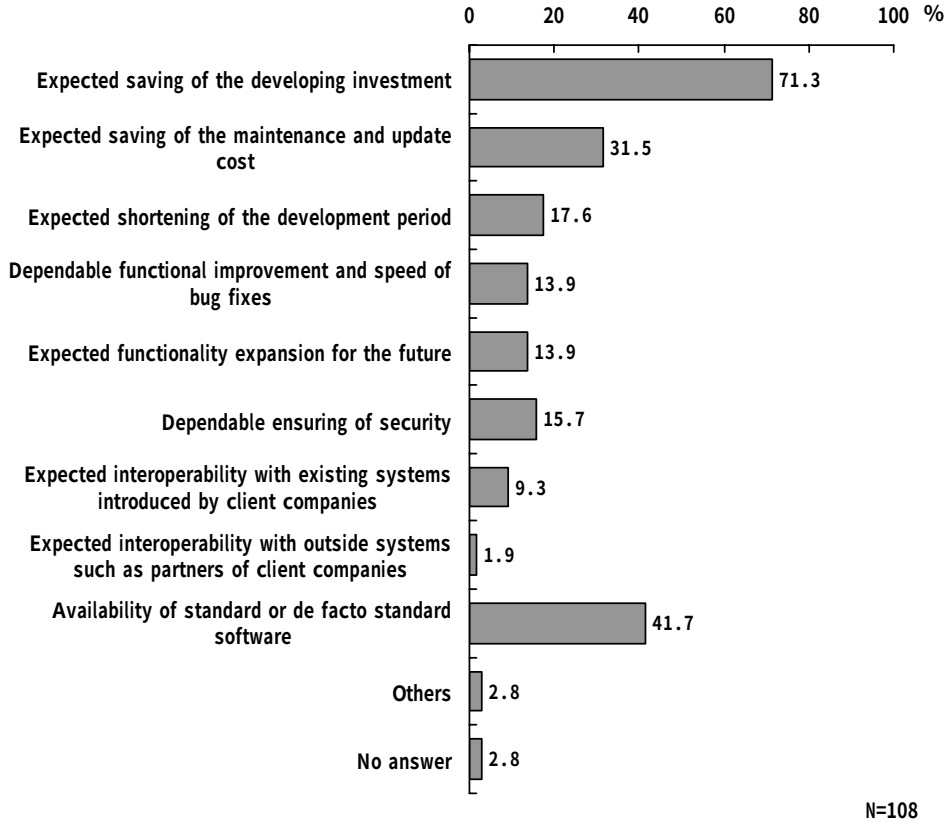
We grasped here the factors which led to OSS use for information systems for clients, the appeal points for clients, usage policies for the future. It was found that the OSS use was decided following equally the consideration in SI businesses and software development companies or clients’ demand, that the companies emphasize saving of the development or the maintenance and update cost, and that about 70% of the companies who have decided usage policies for the future (30% of all) intend

to expand the usage.

(1) Reasons of OSS use for information systems for clients (Q3)
42.5% of the companies decided OSS use for information systems for clients following “the consideration in the company” and 36.6% introduced it following “the demand from client companies”.

(2) Points emphasized when the companies recommend the OSS use for clients (Q4)
As for the points emphasized when the companies recommend the OSS use for clients, 71.3% of them answered “Expected saving of the developing investment”, 41.7% answered “Availability of standard or de facto standard software” and 31.5% answered “Expected saving of the maintenance and update cost”.

Figure 3-Points emphasized when the companies recommend the OSS use for clients (multiple answers)



(3) Future policies of the OSS use for information systems for clients (Q5)
28.1% of the companies have decided the OSS usage policies for the future and 72.1% of them “intend to expand the usage”. Meanwhile, 58.8% of the companies have not decided the OSS usage policies.

3. Number of the IT engineers and percentage of the engineers using OSS
We grasped here the situation such as the percentage of the engineers using OSS in IT engineers. It

was found that while more than half of the companies have less than 30% of the engineers using OSS in IT engineers, just over 20% have more than half of the engineers using OSS.

(1) Number of the IT engineers and percentage of the engineers using OSS (Q6)
While 44.5% of the companies have less than 50 IT engineers, 15.7% have more than 300 IT engineers. As for the percentage of the engineers using OSS of IT engineers, 51.0% have less than 30% and 21.6% have more than 50%.

Figure 4-Number of the IT engineers (at the end of March 2007)

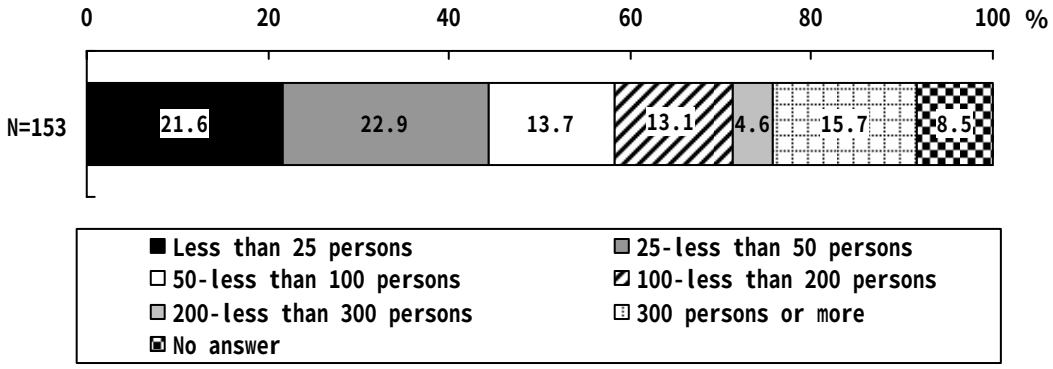
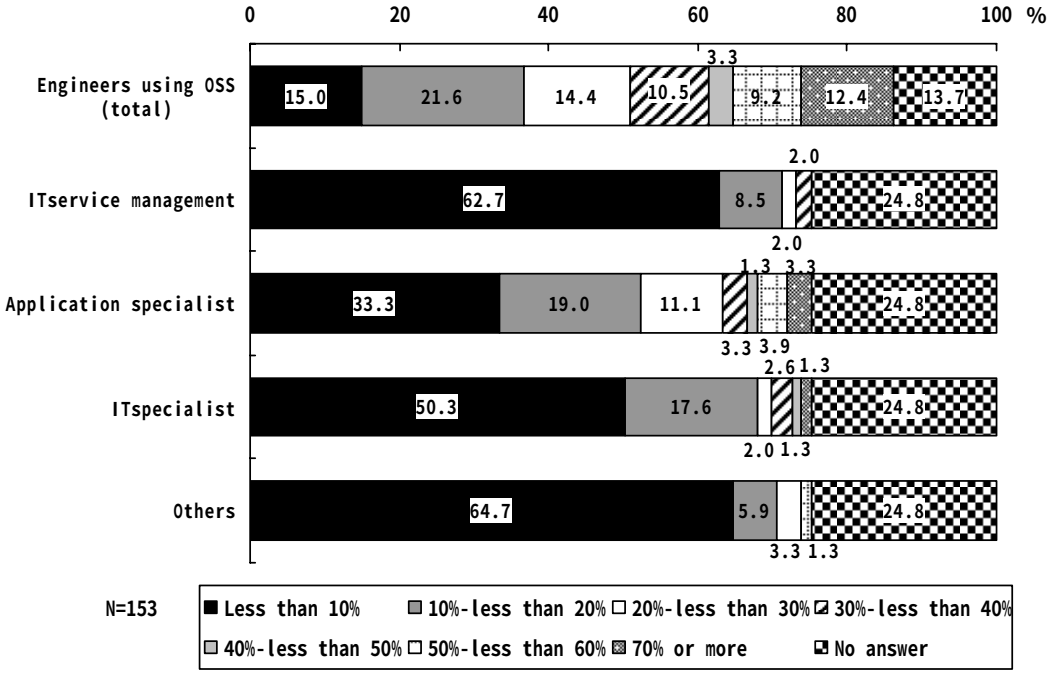


Figure 5-Percentage of the engineers using OSS in the IT engineers (at the end of March 2007)



4. OSS skill level expected for the engineers using OSS and actual OSS skill level
We analyzed here the gap between the OSS skill level expected for the engineers using OSS and

the actual OSS skill level based on the result of the questionnaire.

The gap is analyzed from the difference between the expected skill level and the actual skill level and its calculation process is roughly divided into two phases: “I. Calculation of skill level” and “II. Calculation of the difference between the expected level and the actual level”.

In these two phases, there is the following variation and the method is adopted this time as below.

Figure 6-Analysis method of the gap between the expected OSS skill level and the actual level

Calculation process	Variation		Advantages	Disadvantages
I. Calculation of skill level	A. Treatment of skill level 9	①Include	■ Possible to include the answer "The skill is necessary but it is not acquired" especially in "actual" part	■ Even the answer “The skill is not necessary because it is not concerned with the operation" is included in samples (Problems especially in embedded SW)
		②Exclude	■ Possible to exclude the answer "The skill is not necessary and it is not acquired "	■ Impossible to include the answer "The skill is necessary but it is not acquired" in samples especially in "actual" part
	B. Numeric evaluation of skill level	①Number of responses	■ Possible to know the volume of expected and acquired skills by level in absolute numeric value	■ Impossible to show the level of each skill in a numeric value (value by level)
		②Percentage	■ Possible to know the volume of expected and acquired skills by level in percentage (In A②, almost the same meaning as B①)	■ Impossible to show the level of each skill in a numeric value (value by level)
		③Score	■ Possible to show the level of each skill in a numeric value	■ Impossible to know the volume of expected and acquired skills by level
II. Calculation of the difference between the expected level and the actual level	C. Numeric evaluation of the gap (calculation of the difference of expected and actual values of B)	①Subtraction	■ Possible to know the volume of the gap in absolute numeric value (Especially in B①, it is usable)	■ Influenced by the value of B (for example, if the value of B is small, this value become small)
		②Division	■ Possible to compare the gap in parallel by skill regardless of the value of B	■ When the value of B is small, the value can change substantially

A Treatment of skill level 9: “②Exclude” is adopted, but only certain samples are eliminated.

- Based on two reasons: “Possible to compare each skill in parallel including embedded SW” and “Possible to prevent the case the value become extremely smaller by excluding skill level 9 when <B③Score> is adopted”
- Only certain samples are excluded, not all the samples based on the following concept.
  - The samples who answered skill level 9 for “expected OSS skill level” are excluded because “they should regard the skill as unnecessary because it is not concerned with the operation etc.” (Also excluded are the samples who didn’t answer either of the expected level or the actual level.)
  - On the contrary, the samples who answered skill level 1-3 for “expected OSS skill level” and answered skill level 9 for “actual OSS skill level “ are counted because they should be in the situation: “The skill have not been acquired.”

B Numeric evaluation of skill level: adoption of “③Score”

- Based on the reason: “Possible to give the gap and the level of each skill as a numeric value.”
- The level of each skill is changed to a score based on the following table.

Skill level	Outline of skill level	Score
1	Point where they have knowledge of the skill and are able to teach the skill itself or the operation requiring the skill to others	3

2	Point where they have acquired the skill and are able to complete all the operation requiring the skill by themselves	2
3	Point where they have partially acquired the skill and are able to complete the operation requiring the skill on some level or under the guidance	1
9	Not acquired the skill or not need to acquire the skill (considering the skill unrelated to their operation etc.)	0

C Numeric evaluation of the gap: adoption of "②Division"

・ Based on the reason: "Impossible to compare the skills with small and big value of level in parallel by "①Subtraction".

Example: Skill A: "expected" 50, "actual" 48

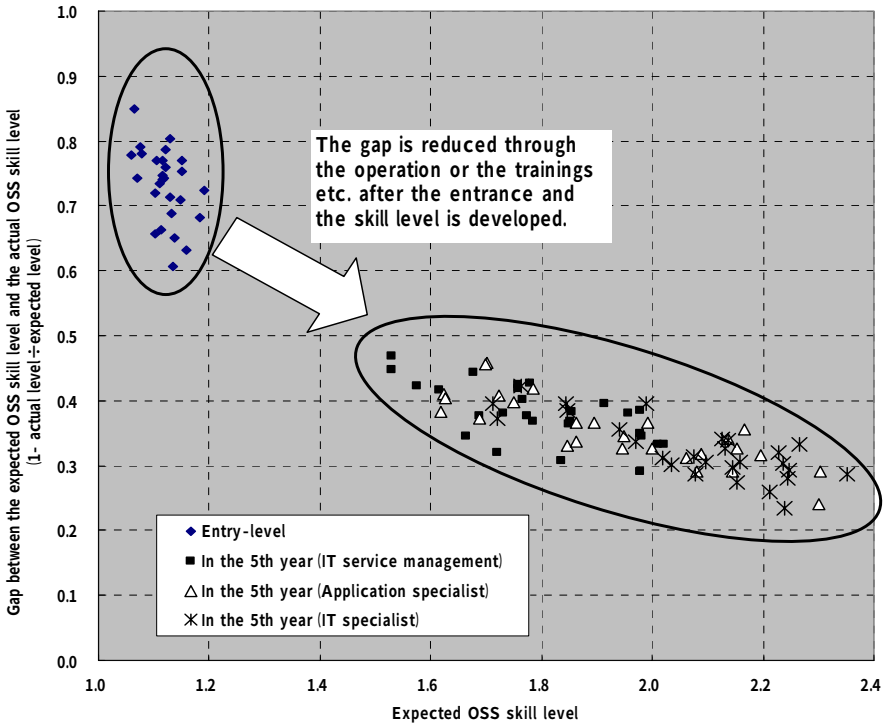
Skill B: "expected" 4, "actual" 2 (right table)

	①Subtraction	②Division
Skill A	2	0.96
Skill B	2	0.5

(1) OSS skill level expected for the engineers using OSS and actual OSS skill level (Q7)

The expected OSS skill level exceeds the actual OSS skill level in each OSS skill both at entry-level and in the 5th years; the actual skill level doesn't reach the expected level. However, the gap between two levels at entry-level is wider than that in the 5th years and the gap is reduced with the acquisition of OSS skills through the operation or the trainings after the entrance. The skill level is also developed at the same time.

Figure 7-Secular variation of the expected OSS skill level and the gap

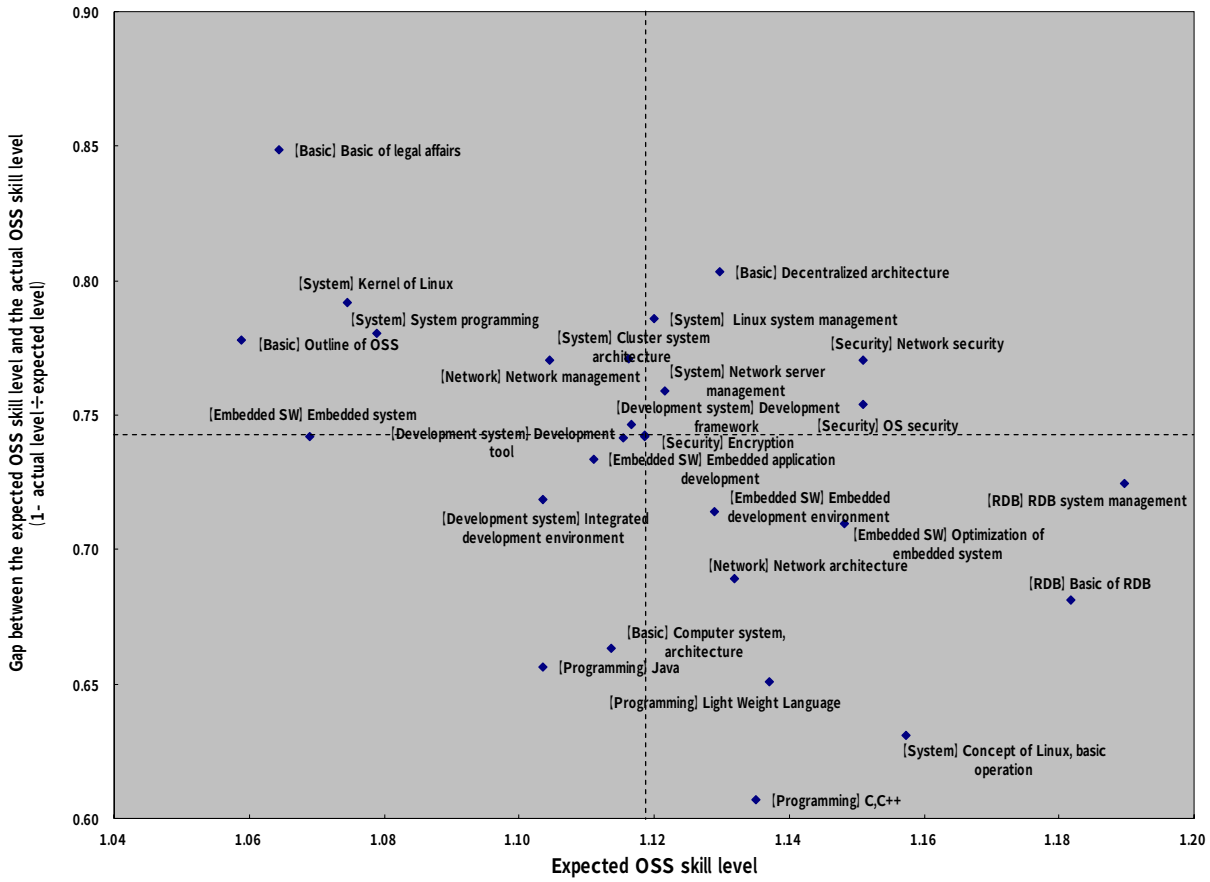


As for the OSS skills required by occupation, it is determined that the OSS skills more required at entry-level are "Decentralized architecture" (basic field), "Linux system management" "Network server

management” (system field), and “Network security”, “OS security” (security field) because the expected skill level is high and the gap is wide. Meanwhile, as for the skills such as “C, C++”, “Light Weight Language”, “Java” (programming field), “Concept of Linux, basic operation”, and “Computer system, architecture”, the expected skill level at entry-level is considered to have reached the sufficient level to some extent with the school education because the expected skill level is high but the gap is small.

Figure 8-OSS skill level expected in each OSS skill and the gap (entry-level)

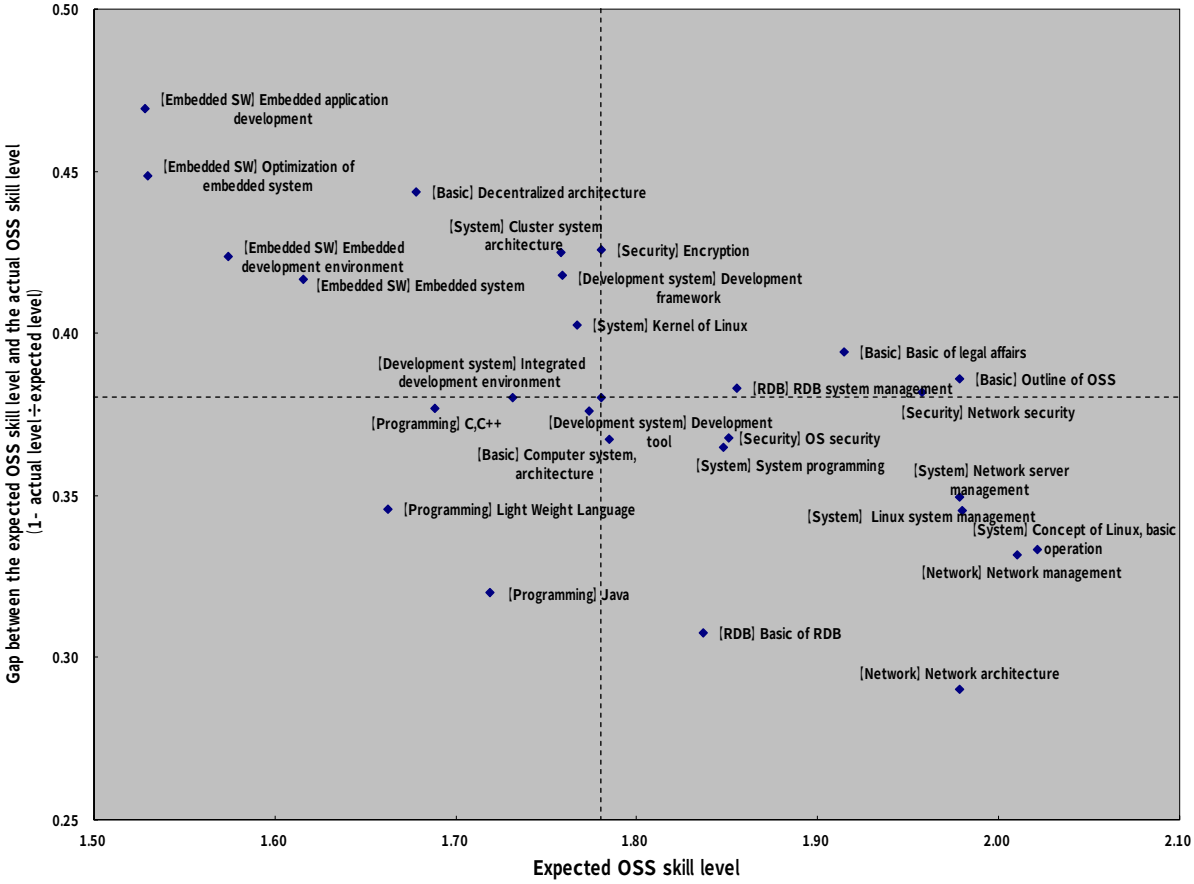
	Expected OSS skill level		Gap between the expected OSS skill level and the actual OSS skill level	
1	【RDB】RDB system management	1.19	【Basic】Basic of legal affairs	0.85
2	【RDB】Basic of RDB	1.18	【Basic】Decentralized architecture	0.80
3	【System】Concept of Linux, basic operation	1.16	【System】Kernel of Linux	0.79
4	【Security】Network security	1.15	【System】 Linux System management	0.79
5	【Security】OS security	1.15	【System】System programming	0.78
6	【Embedded SW】Optimization of embedded system	1.15	【Basic】Outline of OSS	0.78
7	【Programming】Light Weight Language	1.14	【System】Cluster system architecture	0.77
8	【Programming】C,C++	1.14	【Security】Network security	0.77
9	【Network】Network architecture	1.13	【Network】Network management	0.77
10	【Basic】Decentralized architecture	1.13	【System】 Linux system management	0.76
11	【Embedded SW】Embedded development environment	1.13	【Security】OS security	0.75
12	【System】Network server management	1.12	【Development system】Development framework	0.75
13	【System】 Linux system management	1.12	【Development system】Development tool	0.74
14	【Development system】Development tool	1.12	【Embedded SW】Embedded system	0.74
15	【Development system】Development framework	1.12	【Security】Encryption	0.74
16	【System】Cluster system architecture	1.12	【Embedded SW】Embedded application development	0.73
17	【Security】Encryption	1.12	【RDB】RDB system management	0.72
18	【Basic】Computer system, architecture	1.11	【Development system】Integrated development environment	0.72
19	【Embedded SW】Embedded application development	1.11	【Embedded SW】Embedded development environment	0.71
20	【Network】Network management	1.10	【Embedded SW】Optimization of embedded system	0.71
21	【Programming】Java	1.10	【Network】Network architecture	0.69
22	【Development system】Integrated development environment	1.10	【RDB】Basic of RDB	0.68
23	【System】System programming	1.08	【System】Cluster system architecture	0.66
24	【System】Kernel of Linux	1.07	【Programming】Java	0.66
25	【Embedded SW】Embedded system	1.07	【Programming】Light Weight Language	0.65
26	【Basic】Basic of legal affairs	1.06	【System】Concept of Linux, basic operation	0.63
27	【Basic】Outline of OSS	1.06	【Programming】C,C++	0.61



Meanwhile, it is determined that the OSS skills more required in the 5th years for IT service management are “Basic of legal affairs”, “Outline of OSS” (basic field), “Encryption”, “Network security” (security field), and “RDB system management” (RDB field) because the expected skill level is high and the gap is wide. As for the skills such as “Network architecture”, “Network management” (network field), “Concept of Linux, basic operation”, “Linux system management”, “Network server management” (system field), and “Basic of RDB” (RDB field), the expected skill level is considered to have reached the sufficient level to some extent with trainings such as employee training after the entrance because the expected skill level is high but the gap is small.

Figure 9-OSS skill level expected in each OSS skill and the gap (in the 5th year, IT service management)

	Expected OSS skill level		Gap between the expected OSS skill level and the actual OSS skill level	
1	【System】Concept of Linux, basic operation	2.02	【Embedded SW】Embedded application development	0.47
2	【Network】Network management	2.01	【Embedded SW】Optimization of embedded system	0.45
3	【System】Network server management	1.98	【Basic】Decentralized architecture	0.44
4	【System】 Linux system management	1.98	【Security】Encryption	0.43
5	【Network】Network architecture	1.98	【System】Cluster system architecture	0.43
6	【Basic】Outline of OSS	1.98	【Embedded SW】Embedded development environment	0.42
7	【Security】Network security	1.96	【Development system】Development framework	0.42
8	【Basic】Basic of legal affairs	1.91	【Embedded SW】Embedded system	0.42
9	【RDB】RDB system management	1.86	【System】Kernel of Linux	0.40
10	【System】System programming	1.85	【Basic】Basic of legal affairs	0.39
11	【Security】OS security	1.85	【Basic】Outline of OSS	0.39
12	【RDB】Basic of RDB	1.84	【RDB】RDB system management	0.38
13	【Basic】Computer system, architecture	1.78	【Security】Network security	0.38
14	【Security】Encryption	1.78	【Development system】Integrated development environment	0.38
15	【Development system】Development tool	1.77	【Programming】C,C++	0.38
16	【System】Kernel of Linux	1.77	【Development system】Development tool	0.38
17	【Development system】Development framework	1.76	【System】System programming	0.37
18	【System】Cluster system architecture	1.76	【Basic】Computer system, architecture	0.37
19	【Development system】Integrated development environment	1.73	【Security】OS security	0.36
20	【Programming】Java	1.72	【System】 Linux system management	0.35
21	【Programming】C,C++	1.69	【Programming】Light Weight Language	0.35
22	【Basic】Decentralized architecture	1.68	【System】Network server management	0.35
23	【Programming】Light Weight Language	1.66	【System】Concept of Linux, basic operation	0.33
24	【Embedded SW】Embedded system	1.62	【Network】Network management	0.33
25	【Embedded SW】Embedded development environment	1.57	【Programming】Java	0.32
26	【Embedded SW】Optimization of embedded system	1.53	【RDB】Basic of RDB	0.31
27	【Embedded SW】Embedded application development	1.53	【Network】Network architecture	0.29

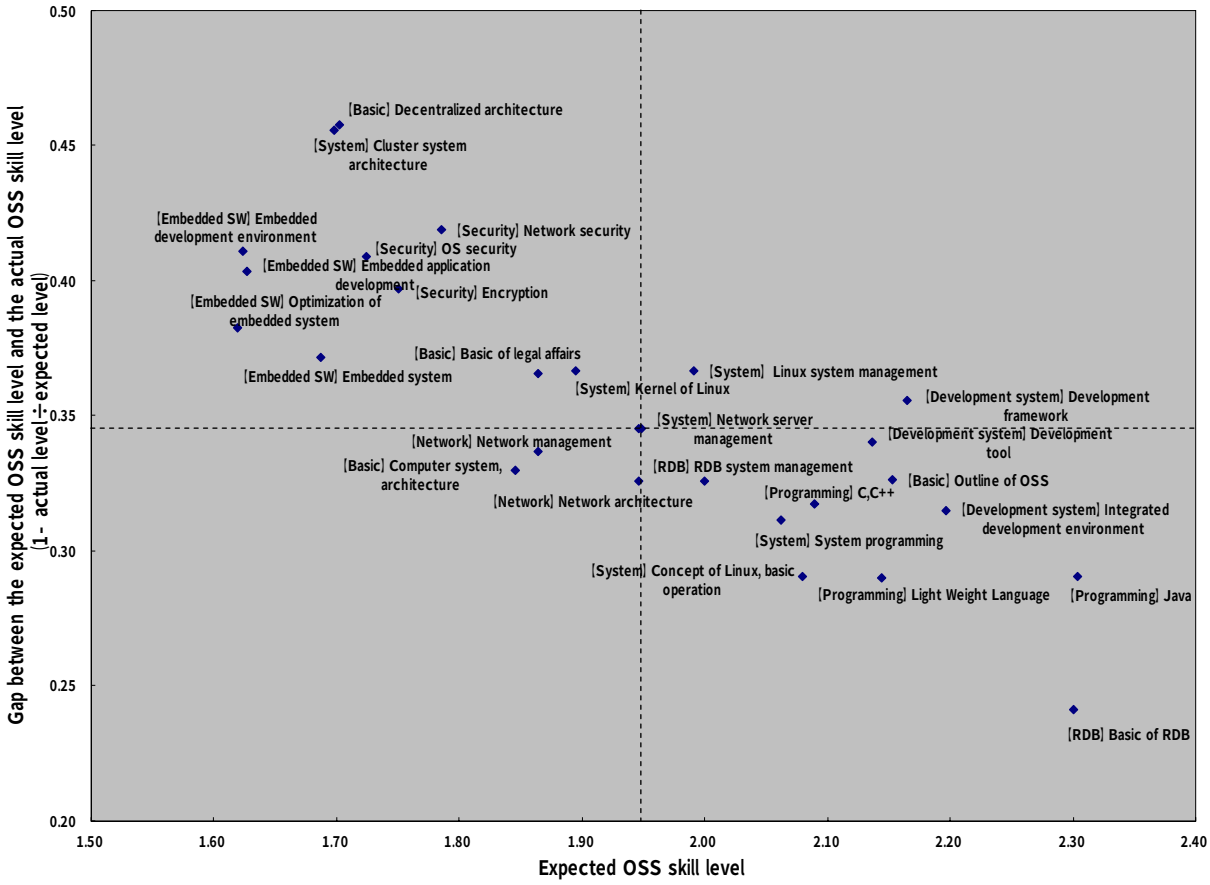


It is determined that the OSS skills more required in the 5th year for application specialist are “Linux system management”, “Network server management” (system field), and “Development framework” (development system) because the expected skill level is high and the gap is wide. Meanwhile, as for the skills such as “Java”, “Light Weight Language”, “C, C++” (programming field), “Concept of Linux, basic operation”, “System programming” (system field), “Basic of RDB”, and “Integrated development environment”, the expected skill level is considered to have reached the sufficient level to some

extent with trainings such as employee training after the entrance because the expected skill level is high but the gap is small.

Figure 10-OSS skill level expected in each OSS skill and the gap (in the 5th year, application specialist)

	Expected OSS skill level		Gap between the expected OSS skill level and the actual OSS skill level	
1	【Programming】Java	2.30	【Basic】Decentralized architecture	0.46
2	【RDB】Basic of RDB	2.30	【System】Cluster system architecture	0.46
3	【Development system】Integrated development environment	2.20	【Security】Network security	0.42
4	【Development system】Development framework	2.17	【Embedded SW】Embedded development environment	0.41
5	【Basic】Outline of OSS	2.15	【Security】OS security	0.41
6	【System】Concept of Linux, basic operation	2.14	【Embedded SW】Embedded application development	0.40
7	【Development system】Development tool	2.14	【Security】Encryption	0.40
8	【Programming】C,C++	2.09	【Embedded SW】Optimization of embedded system	0.38
9	【Programming】Light Weight Language	2.08	【Embedded SW】Embedded system	0.37
10	【System】System programming	2.06	【System】Kernel of Linux	0.37
11	【RDB】RDB system management	2.00	【System】 Linux system management	0.37
12	【System】 Linux system management	1.99	【Basic】Basic of legal affairs	0.37
13	【System】Network server management	1.95	【Development system】Development framework	0.36
14	【Network】Network architecture	1.95	【System】Network server management	0.35
15	【System】Kernel of Linux	1.90	【Development system】Development tool	0.34
16	【Basic】Basic of legal affairs	1.86	【Network】Network management	0.34
17	【Network】Network management	1.86	【Basic】Computer system, architecture	0.33
18	【Basic】Computer system, architecture	1.85	【Basic】Outline of OSS	0.33
19	【Security】Network security	1.79	【RDB】RDB system management	0.33
20	【Security】Encryption	1.75	【Network】Network architecture	0.33
21	【Security】OS security	1.72	【Programming】C,C++	0.32
22	【Basic】Decentralized architecture	1.70	【Development system】Integrated development environment	0.31
23	【System】Cluster system architecture	1.70	【System】System programming	0.31
24	【Embedded SW】Embedded system	1.69	【Programming】Java	0.29
25	【Embedded SW】Embedded application development	1.63	【Programming】Light Weight Language	0.29
26	【Embedded SW】Embedded development environment	1.62	【System】Concept of Linux, basic operation	0.29
27	【Embedded SW】Optimization of embedded system	1.62	【RDB】Basic of RDB	0.24

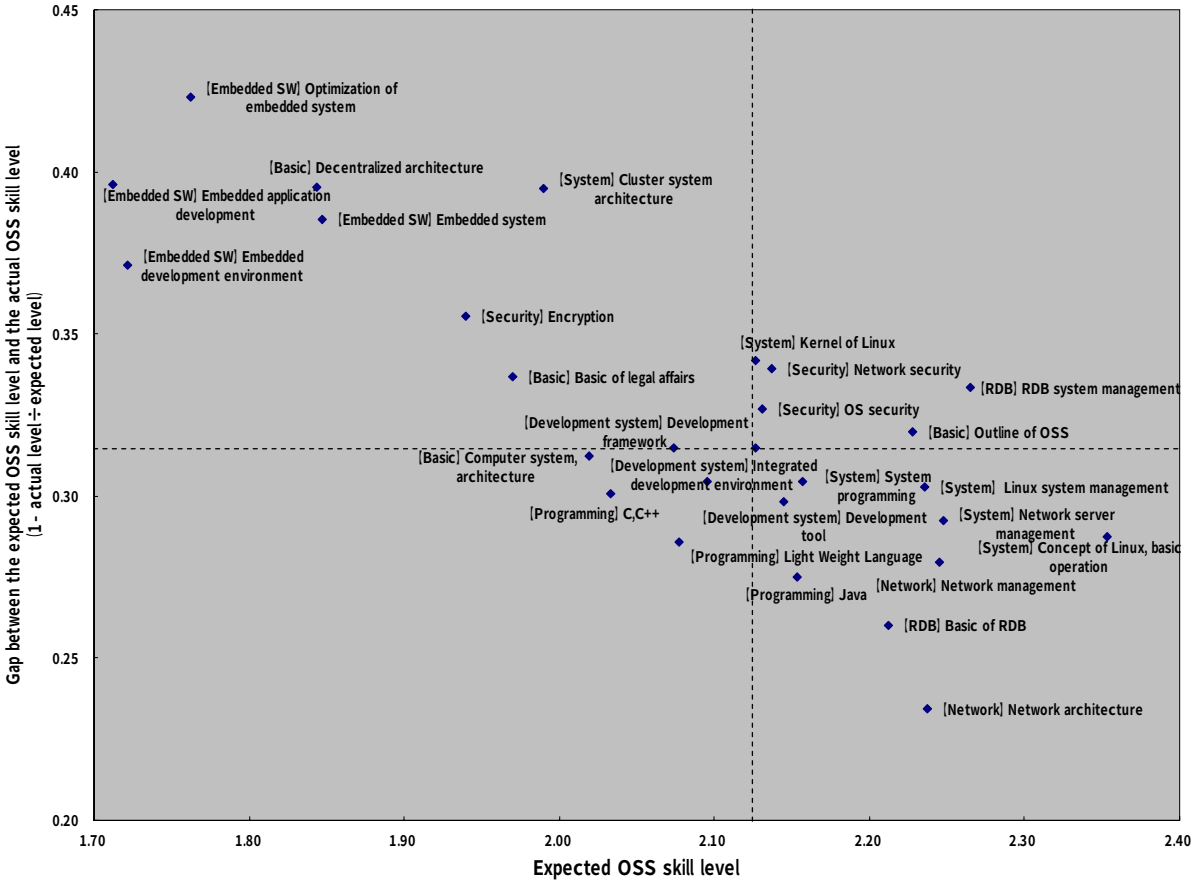


It is determined that the OSS skills more required in the 5th year for IT specialist are “Kernel of Linux” (system field), “Network security”, “OS security” (security field), “RDB system management” (RDB

field), and “Outline of OSS” (basic field) because the expected skill level is high and the gap is wide. Meanwhile, as for the skills such as “Network architecture”, “Network management” (network field), “Concept of Linux, basic operation”, “Network server management” (system field), “Basic of RDB”, and “Java”, the expected skill level is considered to have reached the sufficient level to some extent with trainings such as employee training after the entrance because the expected level is high but the gap is small.

Figure 11-OSS skill level expected in each OSS skill and the gap (in the 5th year, IT specialist)

	Expected OSS skill level		Gap between the expected OSS skill level and the actual OSS skill level	
1	【System】Concept of Linux, basic operation	2.35	【Embedded SW】Optimization of embedded system	0.42
2	【RDB】RDB system management	2.27	【Embedded SW】Embedded application development	0.40
3	【System】Network server management	2.25	【Basic】Decentralized architecture	0.40
4	【Network】Network management	2.25	【System】Cluster system architecture	0.39
5	【Network】Network architecture	2.24	【Embedded SW】Embedded system	0.39
6	【System】 Linux system management	2.24	【Embedded SW】Embedded development environment	0.37
7	【Basic】Outline of OSS	2.23	【Security】Encryption	0.36
8	【RDB】Basic of RDB	2.21	【System】Kernel of Linux	0.34
9	【System】System programming	2.16	【Security】Network security	0.34
10	【Programming】Java	2.15	【Basic】Basic of legal affairs	0.34
11	【Development system】Development tool	2.14	【RDB】RDB system management	0.33
12	【Security】Network security	2.14	【Security】OS security	0.33
13	【Security】OS security	2.13	【Basic】Outline of OSS	0.32
14	【System】Kernel of Linux	2.13	【Development system】Development framework	0.31
15	【Development system】Integrated development environment	2.10	【Basic】Computer system, architecture	0.31
16	【Programming】Light Weight Language	2.08	【Development system】Integrated development environment	0.30
17	【Development system】Development framework	2.07	【System】System programming	0.30
18	【Programming】C,C++	2.03	【System】 Linux system management	0.30
19	【Basic】Computer system, architecture	2.02	【Programming】C,C++	0.30
20	【System】Cluster system architecture	1.99	【Development system】Development tool	0.30
21	【Basic】Basic of legal affairs	1.97	【System】Network server management	0.29
22	【Security】Encryption	1.94	【System】Concept of Linux, basic operation	0.29
23	【Embedded SW】Embedded system	1.85	【Programming】Light Weight Language	0.29
24	【Basic】Decentralized architecture	1.84	【Network】Network management	0.28
25	【Embedded SW】Optimization of embedded system	1.76	【Programming】Java	0.27
26	【Embedded SW】Embedded development environment	1.72	【RDB】Basic of RDB	0.26
27	【Embedded SW】Embedded application development	1.71	【Network】Network architecture	0.23



5. Method of training for the acquisition of OSS skills

We grasped here the sufficiency level of the in-house education/training for the acquisition of OSS skills and the concrete ways. It was found that the sufficiency level of the in-house education/training is still low, while OJT and self-education are mainly adopted and trainings such as external trainings are not sufficiently used.

(1) Sufficiency level of the in-house education/training on OSS skills (Q8)

At entry-level, about 30% of the companies provide sufficient or a certain level of in-house education/training on network-related, Java, and RDB basic skill; however, the in-house education/training particularly on security is not available. About 30% of the companies don't feel the need for in-house education/training on OSS skills and just over 60% don't feel the need especially for embedded SW (or consider the skill unrelated to their operation).

Figure 12-Sufficiency level of the in-house education/training on OSS skills (entry-level)

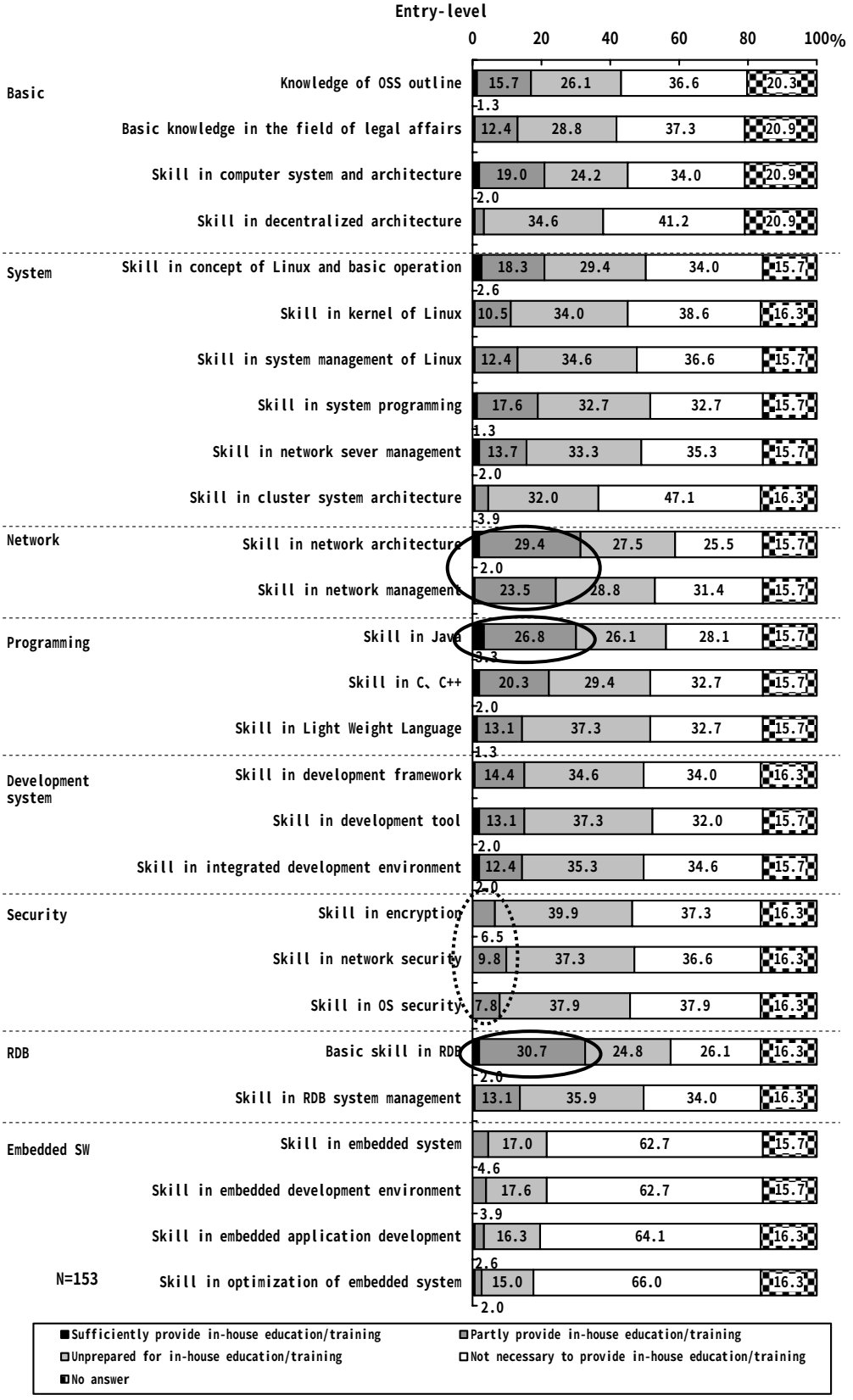
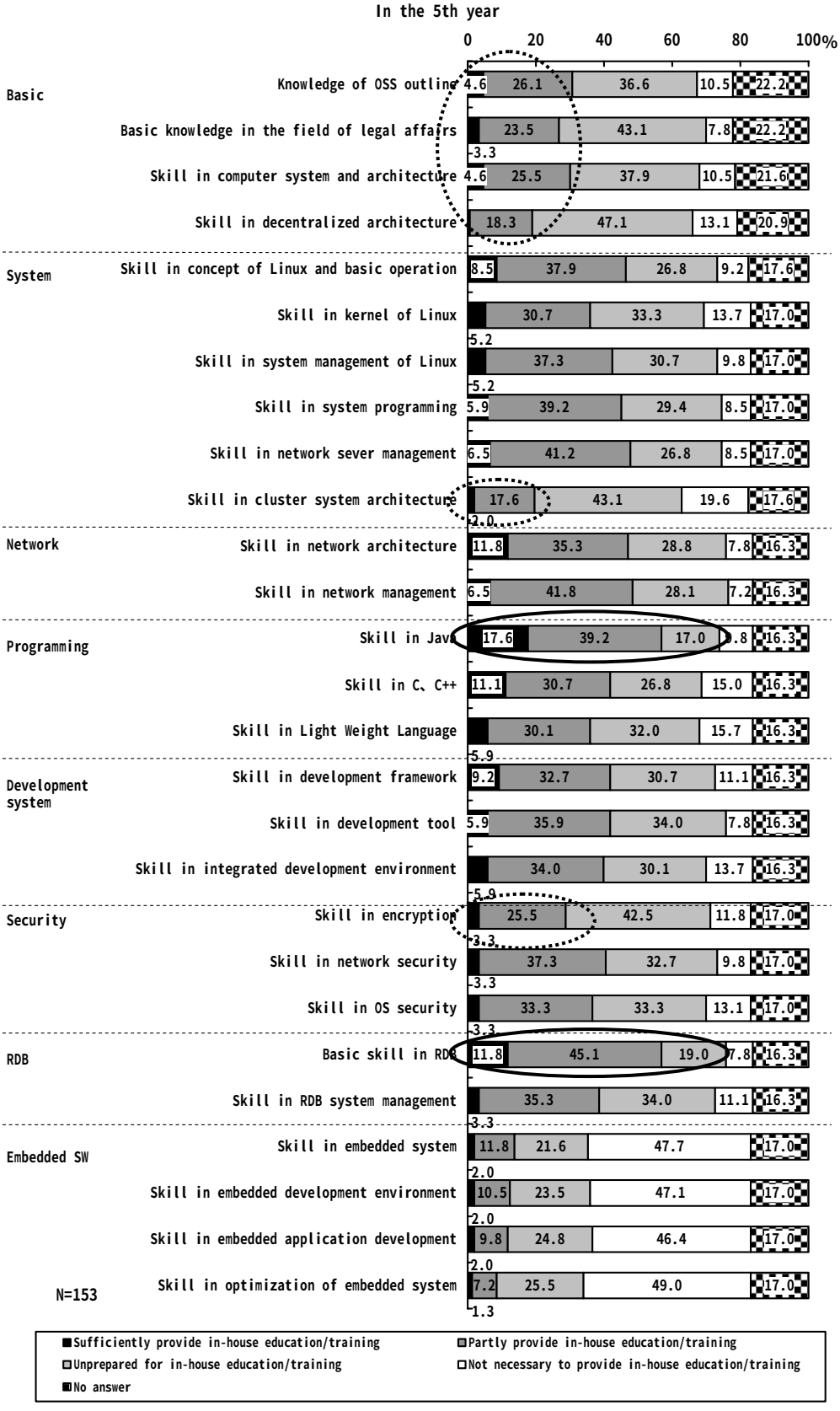


Figure 13-Sufficiency level of the in-house education/training on OSS skills (in the 5th year)

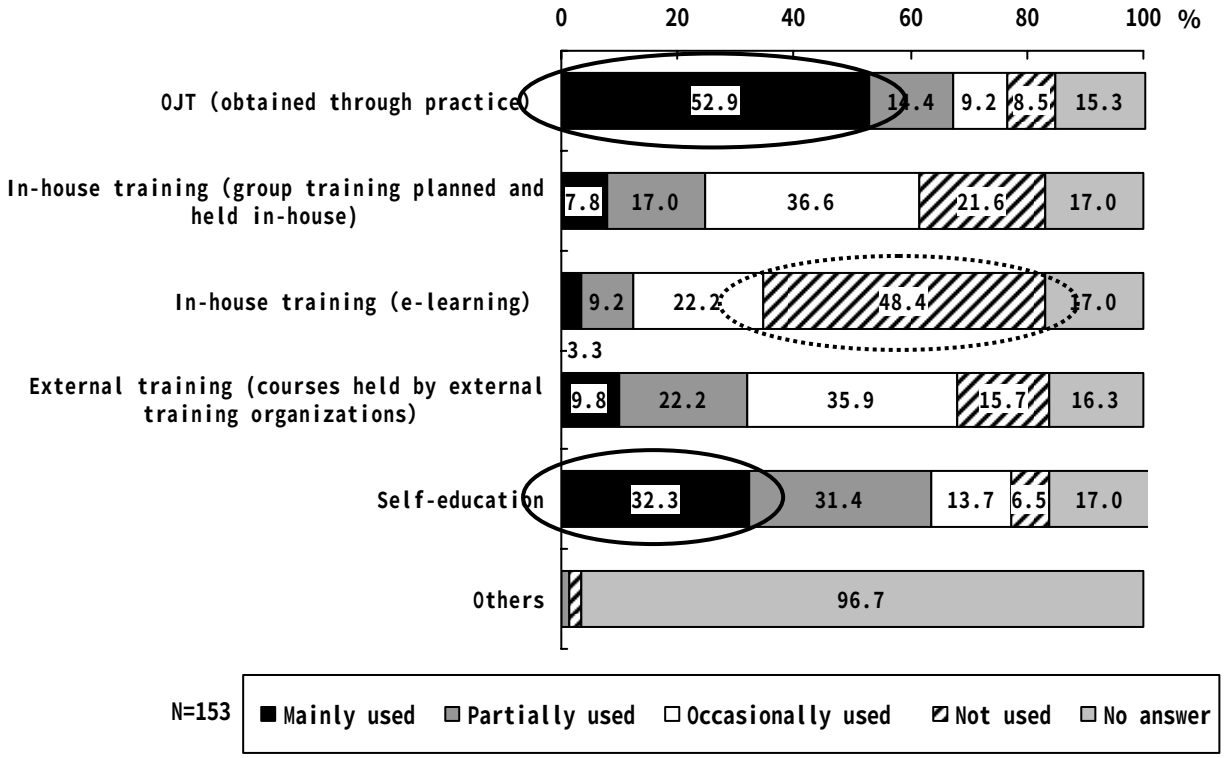


(2) Method for the acquisition of OSS skills after the entrance (Q9)

More than half of the companies mainly use OJT, followed by self-education. The employees acquire OSS skills mostly by themselves. Approximately 60% of companies have used external trainings or in-house training. However the companies who have used e-learning stay at about 30%.

There is not big difference in method for the acquisition depending on the size of the company except that the use of e-learning in medium and small companies is less than that in major companies.

Figure 14-Method for the acquisition of OSS skills after the entrance

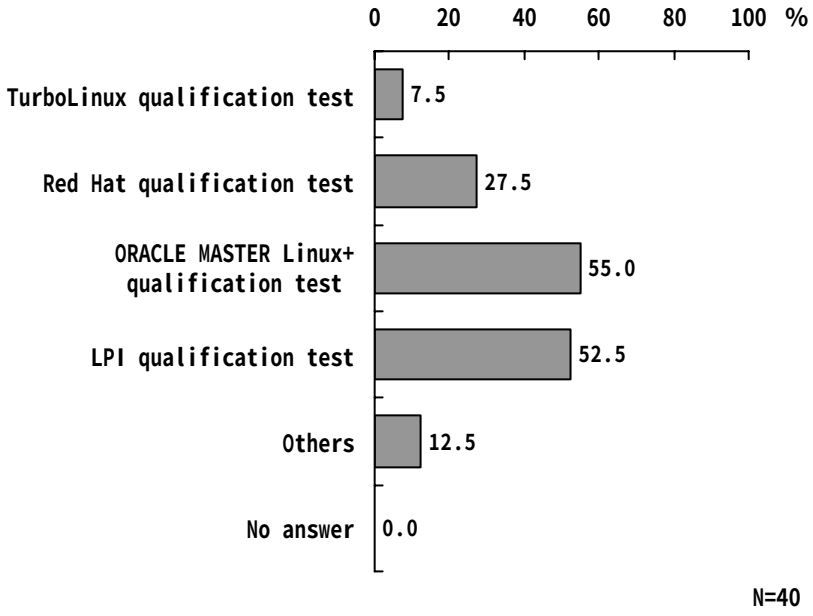


(3) OSS skill-related qualifications recommended acquiring (Q10)

Just fewer than 30% of the companies have the OSS skill-related qualifications recommended acquiring. The most required qualifications for OSS skill-related qualifications are “ORACLE MASTER Linux+ qualification” and “LPI qualification”; more than half of the companies who have the OSS skill-related qualifications recommended acquiring recommend these qualifications. Just fewer than 30% recommend “Red Hat qualification”.

There are other answers for the qualifications: “PostgreSQL CE (2 companies)”, “Sun Java qualification (2)”, “Zend PHP Certification (1)”, and “IT coordinator, official information processing qualifications (1)”.

Figure 15-OSS skill-related qualification recommended acquiring



6. Profile of the companies surveyed

The following figures represent data on the category of business and the size of the companies, the respondents of the survey.

Figure 16-Category of business

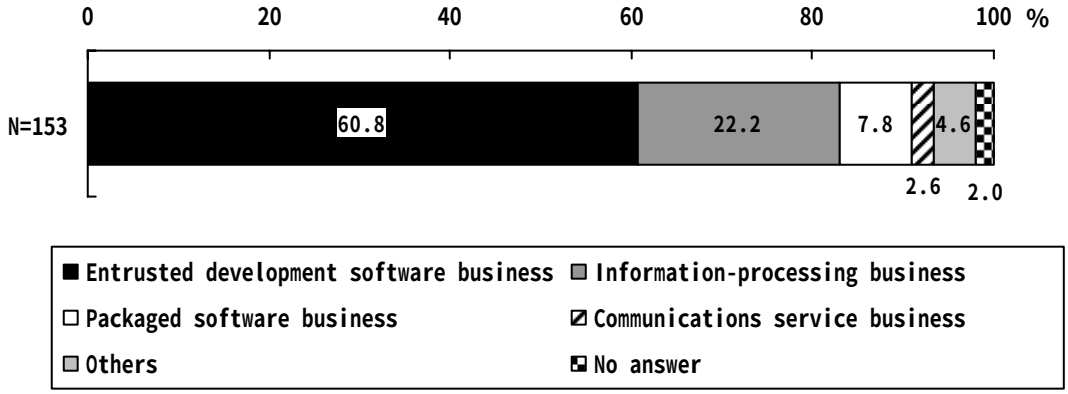


Figure 17-Capital

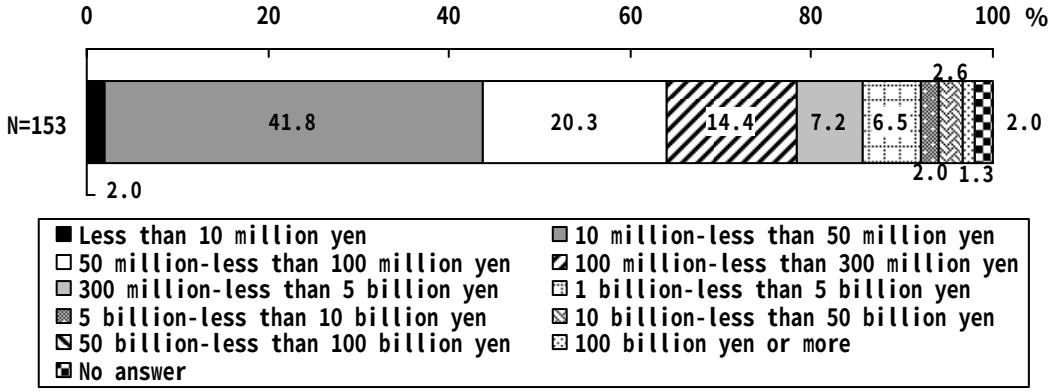
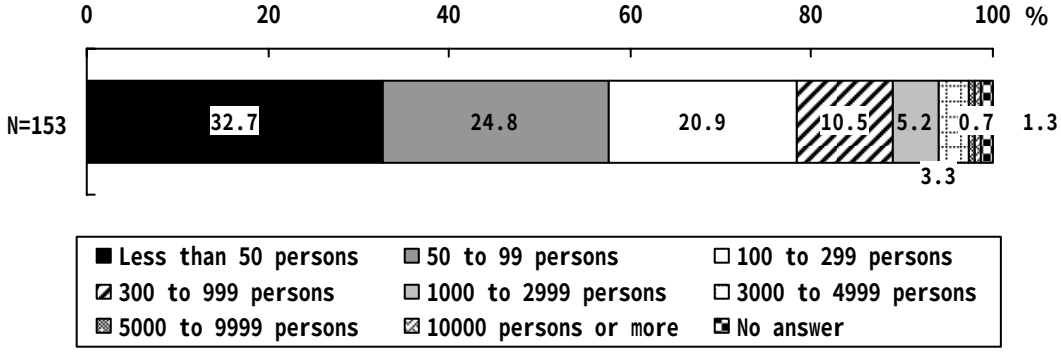


Figure 18-Number of the employees



Survey 2

Survey on the OSS skills of the engineers using OSS required by the companies such as SI businesses

Report【Summary】

INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN

Survey 3

Actual situation and gap analysis of OSS technical education provided by educational/training organizations in Japan

Report

【Summary】

August 2007

INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN

【Points of the result of this survey】

Contents and level of OSS technical education in universities and vocational schools

- Six universities and vocational schools considered to be eager for OSS technical education (Wakkanai Hokusei Gakuen University, Tohoku Gakuin University, Tokyo University of Technology, Japan Electronics College, Kobe Institute Of Computing, Aso Business Computer College) provide lectures to intensively acquire basic skills of network, programming and RDB in addition to the basic technology and theory of OSS such as outline of OSS, computer system and architecture, concept of Linux and basic operation, and kernel.
- The education level of these courses is equivalent to 1-2 level of IT Skill Standard (ITSS).

Contents and level of OSS technical education in training centers

- Leading training centers (NEC Learning, Hitachi Information Academy, Fujitsu Learning Media) and training centers focusing on OSS technical education (Open Source Research Institute, Linux Academy) provide lectures to acquire OSS-related skills except knowledge of legal affaires.
- The level of the lectures differs from 1 to 3 for various OSS engineers.

Characteristic and problems of OSS technical education

- According to the interview to Wakkanai Hokusei Gakuen University, Fujitsu Learning Media, Open Source Research Institute, OSS has the following characteristic: suitable to understand whole point of IT and easy to build up lectures based on up-to-date information.
- Meanwhile, there are problems of teachers' side such as difficulty of teaching all because of numerous and variable combinations between OSS products and of dealing with matters of rights when distributing course materials made using OSS.

Situation of OSS use in enterprises and cultivation of OSS engineers

- Four enterprises of five user companies interviewed have introduced OSS in a part of information system for the company on a trial basis and three of five SI businesses have used OSS in a part of information system for clients. They consider future expansion of OSS use due to its effect.
- Three of five user companies and two of SI businesses use OJT and self-education for cultivation of OSS engineers and it is necessary to consider both expansion of OSS use and cultivation of OSS engineers.
-

Gap between supply and demand of technical education for IT human resources at entry-level

- Six universities and vocational schools surveyed are pioneers that provide OSS technical education due to the growing demand of OSS engineers. However, they are still minority in overall information-related universities and vocational schools in Japan.
- Although in Survey 1 and 2, the skill level required by companies at entry-level is1, it is necessary to expand the lectures equivalent to ITSS level 2 in information-related universities and vocational schools because about half of IT human resources are from non-information-related departments.
- "Knowledge of legal affaires", "Decentralized architecture" and "Cluster system architecture" are not sufficiently taught even in six universities and vocational schools and there is a significant gap between the level required for IT human resources at entry-level and the actual level for these skills. Curriculums are needed to be sufficiently provided to acquire these skills.

Gap between supply and demand of technical education for mid-career IT human resources

- Training centers are providing various courses following the growing demand of OSS engineers from enterprises.
- Meanwhile, curriculums on "Knowledge of legal affairs", "Kernel of Linux", "Encryption" and "Optimization of embedded system" are expected to be sufficiently provided in the future.

(Note) The levels defined by IT Skill Standard (ITSS) are used as basis for level evaluation of OSS technical education in Japanese educational/training organizations in Survey 3, for level evaluation of OSS technical education in Chinese and Korean universities in Survey 4, and for level setting of model curriculum in Survey 5.

Utilization of the level evaluation in IT Skill Standard

(1) IT Skill Standard

In Survey 3-5, a definition of the level was adopted from a viewpoint of "achievement of a requested job" among multiple interpretations of the level in IT Skill Standard represented in the following table. IT Skill Standard is originally to evaluate the level of IT human resources by “achievement measure” based on experience and performance but here for convenience from a view point of the acquaintance level human resources in a certain level are premised of reaching. For example, in the level evaluation of OSS technical education, the courses that provide the knowledge required for human resources at level X are evaluated level X.

Figure 1 Level evaluation in IT Skill Standard

<table>
<tr><td>Level</td><td colspan="2">Entry Level</td><td colspan="2">Middle Level</td><td colspan="3">High Level</td></tr>
<tr><td></td><td>Level 1</td><td>Level 2</td><td>Level 3</td><td>Level 4</td><td>Level 5</td><td>Level 6</td><td>Level 7</td></tr>
<tr><td rowspan="5">Contribution to value creation</td><td colspan="4">Capable of finding and solving problems in operation (Utilization)</td><td colspan="3">Leading business, technology and methodology (Creation)</td></tr>
<tr><td colspan="2">Operating under the guidance</td><td colspan="2">Leading in operation(project)</td><td>Contributing to the firm</td><td>Contributing to the industry</td><td>Leading the industry</td></tr>
<tr><td colspan="6"></td><td>Affecting the market</td></tr>
<tr><td colspan="5"></td><td colspan="2">Acknowledged in the market</td></tr>
<tr><td colspan="4"></td><td colspan="3">Acknowledged in the firm</td></tr>
<tr><td rowspan="4">Achievement of required operation</td><td colspan="3"></td><td colspan="4">Capable of teaching</td></tr>
<tr><td colspan="2"></td><td colspan="5">Capable of performing all the required tasks by themselves</td></tr>
<tr><td></td><td>Capable of performing a part of required tasks by themselves</td><td colspan="5"></td></tr>
<tr><td>Capable of performing required tasks under the guidance</td><td colspan="6"></td></tr>
<tr><td rowspan="3">Scope of evaluation / Target</td><td colspan="5"></td><td colspan="2">Result as member of the industry</td></tr>
<tr><td colspan="3"></td><td colspan="4">Result as member of the organization</td></tr>
<tr><td colspan="7">Result as individual</td></tr>
</table>

Source） IT Skill Standard V2 2006 (IPA IT Skill Standard Center, Ministry of Economy, Trade and Industry)

◆Level 1-2 (Entry Level in ITSSv.2.0)

Difficult to being specialized in certain skill as professional but capable of finding and solving job-related problems under the higher-level guidance in certain profession. Responsible for performing a task in charge.

Level 1：Capable of performing required tasks under the guidance

Level 2：Capable of performing a part of required tasks by themselves

◆Level 3-4 (Middle Level in ITSSv.2.0)

Specialized in certain skill as professional and capable of finding and solving job-related problems by themselves using their skills. Responsible for the quality of products in charge to clients and team.

Level 3：Capable of performing all the required tasks by themselves

Level 4: Capable of accumulating of required professional experience as knowledge and its application(backing cultivation)

(2) Skill level of human resources in the survey 1 and 2

In Survey 1 and 2, the skill level required by enterprises have been represented as numeric value by four occupations (entry-level, IT service management , application specialist, IT specialist) in user companies and SI businesses and 27 OSS-related skills from the response of the questionnaire. The analysis has carried out based on the relation between the average and IT Skill Standard as follows.

Figure 2 Relation between average value in Survey 1 and 2 (result of the questionnaire) and IT Skill Standard

IT Skill Standard	Level 1 Capable of performing tasks under the guidance	Level 2 Capable of performing a part of tasks by themselves	Level 3 Capable of performing all tasks by themselves	Level 4 Capable of teaching others
Average value in Survey 1 and 2	1～1.5	1.5～2	2～2.5	2.5～3

(Notice) Value in Survey 1 and 2

Capable of performing under the guidance or a part of tasks by themselves	1point
Capable of performing all tasks by themselves	2points
Capable of teaching others	3points

Ⅰ. Research on actual situation of OSS technical education of domestic organizations

1. Outline of the survey

We carried out an Internet survey for eight organizations and an interview study for three to know the curriculum of OSS technical education provided by domestic educational institutions and training centers. The surveyed organizations are represented in the following table: six universities and vocational schools which focus on OSS education and five training centers which provide widely IT human resources development service and feature OSS education.

Figure 3　Surveyed organizations on OSS technical education

Universities /Special schools	Wakkanai Hokusei Gakuen University (☆), Tohoku Gakuin University, Tokyo University of Technology, Japan Electronics College, Kobe Institute Of Computing, Aso Business Computer College
Training centers	NEC Learning, Hitachi Information Academy, Fujitsu Learning Media (☆), Open Source Research Institute (☆), Linux Academy

(Notice) Organizations with ☆ are both surveyed on the Internet and interviewed and the others are only surveyed on the Internet.

2. OSS technical education in universities and vocational schools

The information on OSS technical education in the surveyed organizations is gathered. 27 courses concerning the acquisition of OSS-related skills are selected based on available information about the syllabus of each school on the Internet. The result is represented below.

Explanation about the table

"○" means that the course is provided.

"Number of the implementation of six organizations" represents the number of schools where the course concerning each skill is supplied.

"Level of the course" is the result of transposing the level of the course to ITSS level. For example, "1" means that all the courses are evaluated at level 1 and "1-2" indicates that there are the courses of level 1 and 2.

It must be noted that the information obtained by the syllabus etc. are used for the availability of the courses and the interpretation of the levels by OSS skill. Therefore, it doesn't represent the result of considering the contents and means of each course in detail.

The table shows the following features.

①OSS-related skills taught in many organizations

The five organizations of six provide the courses on "Outline of OSS" and "Computer system

and architecture” in the basic field; “Concept of Linux and basic operation”, “Kernel of Linux” and “Network server management” in the system field; “Network architecture” and “Network management” in the network field; “Java”, “C, C++”, and “Light Weight Language” in the programming field; “Network security” in the security field; and “Basic of RDB” in the RDB field.

They focus on the basic skills of network, programming, RDB in addition to the basic skills/ theory such as outline of OSS, computer system and architecture, concept of Linux and basic operation, kernel of Linux.

②OSS-related skills rarely focused on

Meanwhile, the skills provided by only two or fewer organizations of six are: “Knowledge of legal affairs” and “Decentralized architecture” in the basic field; “Cluster system architecture” in the system field; “Development tool” in the development system field; “Encryption” in the security field; and “Embedded development environment”, “Embedded application development” and “Optimization of embedded system” in the embedded software field.

It seems to be important to provide a course on the basic knowledge of legal affairs in universities and vocational schools to help students acquire skills for using OSS in companies. The skills in the embedded software field needed to be acquired in view of the growing demand for embedded software in mobile phones, home information appliances or automotive parts.

③Level of the courses

OSS education level in the surveyed organizations, which is advanced in OSS technical education, is equivalent to ITSS level 1-2.

Figure 4 Situation of OSS technical education in the universities and vocational schools

Category		Name of skill	Outline	University/ Special school						Number of the implementation of six organizations	Level of the courses of six organizations (ITSS)
				Wakkanai Hokusei Gakuen University Faculty of Information Media	Tohoku Gakuin University Department of Information Science	TOKYO UNIVERSITY OF TECHNOLOGY School of Computer Scienc	Japan Electronics College	Kobe Institute Of Computing Faculty of Information Technology	Aso Business Computer College		
Basics	1	Knowledge of the OSS outline	The history and idea of OSS, typical OSS, trends for standardization, areas in which OSS is used and market trends, OSS project growth and operation, joining the OSS communities and major communities	○		○	○	○	○	5	1
	2	Basic knowledge on the field of legal affairs	Basic knowledge from a legal perspective including OSS-related licenses	○			○			2	1
	3	Skills in computer systems and architecture	Including CPUs, buses, DMA, I/O, POSIX and threads	○	○	○	○		○	5	1
	4	Skills in distributed architecture	Including statistical probability theory, traffic theory, RIP/OSPF and CORBA			○				1	2
System	5	Skills in the concept of Linux and its basic operation	Concept organization and basic operation	○		○	○	○	○	5	1 2
	6	Skills in the kernel of Linux	Including kernel structure, processes, threads and schedulers	○	○	○	○	○		5	1 2
	7	Skills in Linux system management	Including installation, kernel configuration, boot configuration, network configuration, packaging management, user management, file management, service management, device management, log management	○	○	○			○	4	1 2
	8	Skills in Linux system programming	Including shell programming, threads, file input/output programming, network programming, shared memory, semaphores, queues and problem identification	○		○	○		○	4	1 2
	9	Skills in network sever management	Including WEB application servers, network infrastructure, file servers and troubleshooting	○	○	○	○	○	○	6	1 2
	10	Skills in cluster system architecture	Including failsafe HPC and Enterprise Systems							0	—
Network	11	Skills in network architecture	A general introduction to TCP/IP	○	○	○	○	○	○	6	1 2
	12	Skills in network management	Computer network creation and operation	○	○	○	○	○	○	6	1 2
Programming	13	Skills in Java	Including Applet, Servlet, JSP and EJB	○	○	○	○		○	5	1 2
	14	Skills in C and C++	Including POSIX termio, curses, gtk++ and Qt	○	○	○	○	○	○	6	1 2
	15	Skills in LightWeight Language	Including PHP, Perl, Python and Ruby	○	○		○	○	○	5	1 2
Development System	16	Skills in development frameworks	Including Struts and UML	○		○	○			3	1 2
	17	Skills in development tools	Including version management systems, debuggers, bug-tracking-down systems, system profilers and kernel debuggers	○					○	2	1 2
	18	Skills in integrated development environments	Including Eclipse, Net Beans and WideStudio	○		○	○			3	2
Security	19	Skills in encryption	Public key infrastructure, digital signatures, authentication and hash functions			○		○		2	2
	20	Skills in network security	Firewall design/building, network intrusion analysis, log analysis, defense design against security attacks and unauthorized access techniques by exploiting TCP/IP	○	○	○	○	○	○	6	1 2
	21	Skills in OS security	Linux system security and security-enhanced OSes	○			○		○	3	1 2
RDB	22	Basic skills in RDBs	Including ER models and SQL programming	○	○	○	○	○	○	6	1 2
	23	Skills in RDB system management	Installation, configuration and tuning of MySQL, FireBird, PostgreSQL etc.	○	○	○	○			4	1 2
Embedded SW	24	Skills in embedded systems	System structure, development methodologies, RTOSs, sensor programming, embedded processors and architecture (including ARM9, XScale, MIPS, SH, VR, MP and 68k)				○	○	○	3	1
	25	Skills in embedded development environments	Cross compile tools, toolchains (make, adb.minicom, Jflash, boothroad, tftp and tinybox) and GUI programming (GTK+, QT, Qtopia)				○			1	2
	26	Skills in embedded application development	Including VM, J2ME, UPnP, SMS and WAP protocols				○	○		2	1
	27	Skills in embedded system optimization	Low-powerization, device programming and parallelization				○			1	1

(Notice) This table is produced based on the information of the syllabus obtained by the Internet or from each organization. ○ means that there is a course for the acquisition of one of 27 OSS skills decided in this survey.

3. OSS technical education in training centers

The information on OSS technical education in the surveyed organizations is gathered. 27 courses concerning the acquisition of OSS-related skills are selected based on available information about the syllabus of each center on the Internet. The result is represented below.

The table is represented in the same way as that of universities and vocational schools.

It must be noted that the information obtained by the syllabus etc. are used for the availability of the courses and the interpretation of the levels by OSS skill. Therefore, it doesn't represent the result of considering the contents and means of each course in detail. The table shows the following features.

①OSS-related skills taught in many organizations

The four organizations of five provide the courses on "Outline of OSS" and "Computer system and architecture" in the basic field; "Concept of Linux and basic operation", "Linux system management" , "System programming" and "Network server management" in the system field; "Network architecture" and "Network management" in the network field; "Java", "C, C++", and "Light Weight Language" in the programming field; "Development framework", "Development tool" and "Integrated development environment" in the development system field; "Encryption", "Network security" and "OS security" in the security field; and "Basic of RDB" and "RDB system management" in the RDB field.

A wider range of skills are taught in training centers. In particular, they provide sufficiently courses of the skills in the system field such as "Linux system management" and "System programming", the development system field, and the security field compared with universities and vocational schools.

②OSS-related skills rarely focused on

Meanwhile, the skill provided by only one or no organization of five is "Knowledge of legal affairs". It needs to be provided in order that OSS engineers correctly understand the difference between commercial software and OSS and use OSS in companies.

While several courses on the skills in the embedded software field are available in the leading training centers which deal in wide services of IT human resources development, such courses are not provided in the training organizations which feature OSS technical education.

③Level of the courses

OSS education level in the basic field such as "Outline of OSS", "Knowledge of legal affairs" and "Computer system and architecture" is almost equivalent to ITSS level 1 and there are a wide of levels such as 1-2 or 1-3 in all the courses supplied by the organizations to meet various

needs of people aiming at being OSS engineers.

Figure 5 Situation of OSS technical education in training centers

Category		Name of skill	Outline	Training center					Number of the implementation of five organizations	Level of the courses of five organizations (ITSS)
				NEC Learning	Hitachi Information Academy	Fujitsu Learning Media	Open Source Research Institute	Linux Academy		
Basics	1	Knowledge of the OSS outline	The history and idea of OSS, typical OSS, trends for standardization, areas in which OSS is used and market trends, OSS project growth and operation, joining the OSS communities and major communities	○	○	○	○	○	5	1
	2	Basic knowledge on the field of legal affairs	Basic knowledge from a legal perspective including OSS-related licenses			○			1	1
	3	Skills in computer systems and architecture	Including CPUs, buses, DMA, I/O, POSIX and threads	○	○	○		○	4	1
	4	Skills in distributed architecture	Including statistical probability theory, traffic theory, RIP/OSPF and CORBA	○		○			2	2
System	5	Skills in the concept of Linux and its basic operation	Concept organization and basic operation	○	○	○	○	○	5	1～2
	6	Skills in the kernel of Linux	Including kernel structure, processes, threads and schedulers	○		○		○	3	2
	7	Skills in Linux system management	Including installation, kernel configuration, boot configuration, network configuration, packaging management, user management, file management, service management, device management, log management and backup	○	○	○	○	○	5	1～3
	8	Skills in Linux system programming	Including shell programming, threads, file input/output programming, network programming, shared memory, semaphores, queues and problem identification	○	○	○		○	4	1～2
	9	Skills in network sever management	Including WEB application servers, network infrastructure, file servers and troubleshooting	○	○	○	○	○	5	1～3
	10	Skills in cluster system architecture	Including failsafe HPC and Enterprise Systems	○		○			2	1～2
Network	11	Skills in network architecture	A general introduction to TCP/IP	○	○	○	○	○	5	1～3
	12	Skills in network management	Computer network creation and operation	○	○	○		○	4	1～3
Programming	13	Skills in Java	Including Applet, Servlet, JSP and EJB	○	○	○		○	4	1～2
	14	Skills in C and C++	Including POSIX termio, curses, gtk++ and Qt	○	○	○		○	4	1～2
	15	Skills in LightWeight Language	Including PHP, Perl, Python and Ruby	○	○	○	○	○	5	1～2
Development System	16	Skills in development frameworks	Including Struts and UML	○	○	○		○	4	1～2
	17	Skills in development tools	Including version management systems, debuggers, bug-tracking-down systems, system profilers and kernel debuggers	○	○	○		○	4	2
	18	Skills in integrated development environments	Including Eclipse, Net Beans and WideStudio	○	○	○		○	4	1～2
Security	19	Skills in encryption	Public key infrastructure, digital signatures, authentication and hash functions	○	○	○		○	4	1
	20	Skills in network security	Firewall design/building, network intrusion analysis, log analysis, defense design against security attacks and unauthorized access techniques by exploiting TCP/IP	○	○	○		○	4	1～3
	21	Skills in OS security	Linux system security and security-enhanced OSes	○	○	○		○	4	1～3
RDB	22	Basic skills in RDBs	Including ER models and SQL programming	○	○	○	○	○	5	1～3
	23	Skills in RDB system management	Installation, configuration and tuning of MySQL, FireBird, PostgreSQL etc.	○	○	○	○	○	5	1～3
Embedded SW	24	Skills in embedded systems	System structure, development methodologies, RTOSs, sensor programming, embedded processors and architecture (including ARM9, XScale, MIPS, SH, VR, MP and 68k)	○	○	○			3	1～2
	25	Skills in embedded development environments	Cross compile tools, toolchains (make, adb.minicom, Jflash, boothroad, tftp and tinybox) and GUI programming (GTK+, QT, Qtopia)	○	○	○			3	1～2
	26	Skills in embedded application development	Including VM, J2ME, UPnP, SMS and WAP protocols	○		○			2	1～2
	27	Skills in embedded system optimization	Low-powerization, device programming and parallelization	○		○			2	1

(Notice) This table is produced based on the information of the syllabus obtained by the Internet or from each organization. ○ means that there is a course for the acquisition of one of 27 OSS skills decided in this survey.

4. Result of the interview survey

(1) Outline of the interview survey

The interview survey was carried out in the following three organizations of the six universities and vocational schools and the five training centers.

Wakkanai Hokusei Gakuen University

Fujitsu Learning Media

Open Source Research Institute

(2) Result of the survey

①Features of OSS technical education

The characteristics of OSS technical education are as follows.

OSS is recognized as a suitable object to understand the basic of IT from the nature.

The contents of the courses are designed based on up-to-date information.

OSS education is developing following the growing demand for OSS skills.

②Problems of OSS technical education

There are problems of the education using OSS features.

It is difficult to teach all the combinations between OSS products.

It is hard to cultivate the OSS engineers who try to gather information and solve problems actively.

It is no clear whether there is a right-related problem when distributing course materials made using OSS.

It is necessary to assess whether human resources flow offshore or remain in the country although demand for embedded software may grow. It is difficult to choose the standard to teach OSS skills.

③Interest in OSS model curriculum

There are the following opinions to the model curriculum that will be unveiled by IPA.

It is expected to be useful information for approaches in the company because it may be a systematized model as OSS-related skills.

It is expected to be unveiled in relation to ITSS in order that the companies can select courses easily referring to ITSS.

Ⅱ. Post interview survey

1. Post interview survey to user companies

(1) Outline of the survey

We conducted an interview survey to verify the result of the questionnaire to the user companies of Survey 1 and to know the needs for the curriculum of OSS engineer cultivation in each firm.

Figure 6　Companies surveyed in the post interview

User companies	Daiho Corporation, Nakabayashi, SEIKO EPSON, Linux Academy, Sumitomo Electric Industries

(2) Result of the survey

①Situation of OSS use in information systems for the company

The five companies are selected due to their introduction of OSS in information systems for the company. One of them have introduced OSS in most of information systems for the company and adapts their IT human resources to OSS use. The other four firms have introduced OSS in a part of systems on a trial basis and intend to expand OSS use following its effect.

②Situation of OSS engineer cultivation in the company

While the two companies of five complement OSS engineer cultivation with educational courses and e-learning of themselves, the other three firms use only OJT and self-education. For the future, the four companies that have introduced OSS in a part of systems on a trial basis consider that further human resources development is necessary to expand the range of OSS use and to use it at high levels. They also require understanding of the system principle and the acquisition of practical skills for the personnel.

③Interest in OSS model curriculum toward improvement of OSS skill level

Although the five companies have various expectations for the model curriculum according to situations of OSS use and OSS engineer development, they appreciate the systematization of 27 OSS-related skills.

2. Interview survey to SI businesses

(1) Outline of the survey

We conducted an interview survey to verify the result of the questionnaire to the SI businesses of Survey 2 and to know the needs for the curriculum of OSS engineer cultivation in each firm.

Figure 7 Companies surveyed in the post interview

SI businesses	OKWave, Argo 21, Yamagata Nichijyo Systems, GTEC, Yamagata Nichijyo Systems

(2) Result of the survey

①Situation of OSS use in information systems for clients

The companies are selected due to their introduction of OSS in information systems for the company. Two of them have introduced OSS in information systems for clients and three firms have introduced OSS in a part of products and intend to expand OSS use.

②Situation of OSS engineer cultivation in the company

While the three companies of five adopt external programs, the other two firms use only OJT. The former companies have introduced OSS in a part of products and the demand for OSS engineer development may increase following the market trend on OSS use and changes in clients' demand. The latter firms use mainly OSS and the need for engineer cultivation may grow following future expansion of business and efforts for new recruits training.

③Interest in OSS model curriculum toward improvement of OSS skill level

Although the five companies have various expectations for the model curriculum according to situations of OSS use and OSS engineer development, they appreciate the systematization of 27 OSS-related skills.

III. Gap analysis

1. Method of gap analysis

In Survey 1 and 2, we analyzed OSS skill level expected for OSS engineers and actual skill level in user companies and SI businesses. The skills with a high expected level and a wide gap between the "expected" level and the "actual" level may have a higher demand for OSS technical education. The problem consciousness for OSS engineer development represented in Ⅱ. Post interview survey is added as opinions for demand side of OSS technical education.

Meanwhile, we grasped contents and level of the courses for each of the 27 OSS-related skills in six universities and vocational schools which focus on OSS education and five training centers which provide widely IT human resources development service and feature OSS education as supply side of OSS technical education in Survey 3 "Ⅰ. Research on actual situation of OSS technical education of domestic organizations".

Here, the gap between supply and demand for OSS technical education becomes obvious and two are compared as follows. ITSS is used for the comparison of levels.

- The level of IT human resources who have just joined the user companies and SI businesses after graduation (IT human resources at entry-level) is compared with technical education provided by universities and vocational schools.
- The level of human resources in the 5th year (IT service management, application specialist, IT specialist) (mid-carrier IT human resources) is compared with technical education provided by training centers.

2. Gap of technical education on IT human resources at entry-level

①Expectation for the expansion of OSS technical education in universities and vocational schools

The questionnaire study of Survey 1 shows that 20.0% of the user companies decide usage policies for the future and 38.9% of them "intend to expand OSS use". Survey 2 represents that 72.1% of 28.1% of the SI businesses with future usage policies "intend to expand the usage". In addition Survey 3 "Ⅱ. Post interview survey" shows the intention to expand OSS use. In this way, the demand for OSS engineers may be higher following the expansion of OSS use.

Meanwhile, the six schools surveyed to know the situation of OSS technical education focus on OSS technical education and are advanced in the belief of educators, perspective for OSS diffusion and differentiation from others. However, their efforts are partial trend in whole of information-related universities and vocational schools. In fact, in the University of Tokyo and Osaka University, OSS technical education is not sufficiently provided as mentioned in Survey 4.

Therefore, it is necessary to extend OSS technical education in information-related

educational organizations to respond to the growing demand for OSS engineers required in user companies and SI businesses.

②Expectation to the level improvement of OSS technical education

In Survey 1 and 2, OSS skill level required for new recruits is level 1. Meanwhile, as described in Survey 4, about half of IT human resources are graduates of information-related universities and vocational schools and level 2 can be required for IT human resources at entry-level because the average level required for whole of human resources including non-information-related graduates is level 1.

Meanwhile, the courses on the 27 OSS-related skills in the six surveyed organizations partially reach level 2 but there are several courses which have remained at level 1. It is therefore necessary to further improve the level as well as to extend OSS technical education.

③Expectation to enrichment of the contents of OSS technical education curriculum

The result of Survey 1 and 2 shows top ten skills with a wider gap between the level expected for in-house OSS engineers and the actual level: “Knowledge of legal affairs”, “Decentralized architecture” and “Outline of OSS” in the basic field; “Kernel of Linux”, “Linux system management”, “System programming”, “Cluster system architecture” and “Network server management” in the system field; “Network management” in the network field; “Network security” in the security field. Various contents of OSS education curriculum in universities and vocational schools and higher-level courses are important to fill the gap.

In fact, in these ten skills, only two or fewer of six organizations which focus on OSS technical education provide the courses on the skills such as “Knowledge of legal affairs” and “Decentralized architecture” in the basic field and “Cluster system architecture” in the system field. It is necessary to provide various curriculums for the acquisition of there skills as well as to extend OSS technical education.

3. Gap of technical education on mid-carrier IT human resources

①Provision of OSS technical education by training centers according to demand for OSS engineers

As mentioned above, demand for OSS engineers may further increase with future expansion of OSS use in user companies and SI businesses.

There are various courses prepared by five surveyed organizations including leading training centers and training centers which feature OSS technical education following high demand for OSS engineers. The training centers provide courses from level 1 to 3 because they need to set the levels widely from level 1 (Capable of performing required tasks under the

guidance) to level 3 (Capable of performing all the required tasks by themselves) to respond to various years of experience, occupations and career passes.

②Expectation to further enrichment of the curriculums

The result of Survey 1 and 2 shows that the required skill level for mid-carrier IT human resources differs in 27 OSS-related skills according to their occupations (IT service management, application specialist, IT specialist). In particular, IT specialists need to acquire higher skill level with a wider coverage. The following gap analysis uses the result of the questionnaire survey for IT specialists.

The result of the questionnaire survey for SI businesses etc. shows top ten skills with a wider gap between the level expected for in-house IT specialists and the actual level: “Decentralized architecture “and “Knowledge of legal affairs” in the basic field; “Cluster system architecture” and “Kernel of Linux” in the system field; “Encryption” and “Network security” in the security field; “Optimization of embedded system”, “Embedded application development”, “Embedded system” and “Embedded development environment” in the embedded software field.

Meanwhile, in these ten skills, the courses on “Knowledge of legal affairs” are provided by only one or fewer of five surveyed organizations and enrichment of the curriculums is expected. In addition, “Knowledge of legal affairs” has a wider gap between the expected skill level and the actual level also in IT service management and application specialist.

In these ten skills, “Knowledge of legal affairs”, “Kernel of Linux”, “Encryption” and “Optimization of embedded system” have not reached the expected level and enrichment of curriculums is expected in the future.

Figure 8　Comparison between the skill level required for med-carrier IT human resources and the level provided by training centers

Category of skill		Name of skill	Level required for mid- carrier IT human resources (ITSS)			
			IT service management	Application specialist	IT specialist	Level of the courses of five organizations (ITSS)
Basics	1	Knowledge of the OSS outline	2	2～3	2～3	1
	2	Basic knowledge on the field of legal affairs	2	2	2	1
	3	Skills in computer systems and architecture	2	2	2～3	1
	4	Skills in distributed architecture	1～2	2	2	2
System	5	Skills in the concept of Linux and its basic operation	1～3	2～3	2～3	1～2
	6	Skills in the kernel of Linux	2	2	2～3	2
	7	Skills in Linux system management	2	2	3	1～3
	8	Skills in Linux system programming	2	2～3	3	1～2
	9	Skills in network sever management	2	2	2～3	1～3
	10	Skills in cluster system architecture	1～2	2	2	1～2
Network	11	Skills in network architecture	2	2	3	1～3
	12	Skills in network management	2～3	2	3	1～3
Programming	13	Skills in Java	1～2	2～3	2～3	1～2
	14	Skills in C and C++	1～2	2～3	2～3	1～2
	15	Skills in LightWeight Language	1～2	2～3	3	1～2
Development System	16	Skills in development frameworks	2	2～3	2～3	1～2
	17	Skills in development tools	1～2	2～3	3	2
	18	Skills in integrated development environments	1～2	2～3	2～3	1～2
Security	19	Skills in encryption	2	2	2	1
	20	Skills in network security	2	2	3	1～3
	21	Skills in OS security	2	2	3	1～3
RDB	22	Basic skills in RDBs	1～2	2～3	3	1～3
	23	Skills in RDB system management	1～2	2～3	3	1～3
Embedded SW	24	Skills in embedded systems	1～2	1～2	2	1～2
	25	Skills in embedded development environments	1～2	1～2	2	1～2
	26	Skills in embedded application development	1～2	1～2	2	1～2
	27	Skills in embedded system optimization	1～2	1～2	2	1

(Notice) Skills in yellow are the skills that doesn't reach the expected level of the skills with a wide gap between the level expected by SI businesses for in-house IT specialists and the actual level.

Survey 3
Actual situation and gap analysis of OSS technical education provided by educational/training organizations in Japan
Report【Summary】

INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN

Survey 4

Case research of advanced OSS technical education in foreign countries

Report

【Summary】

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INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN

【Points of the result of this survey】

Actual condition of OSS technical education in China

- There are about 2,000 educational institutions such as universities and vocational schools in China and almost half of them have a computer/software-related department. Since 2003, the supply of software human resources has considerably increased and its number reached approximately 470,000 in 2005. 80% of them are graduates specializing in computer/software and related studies. In this way, most of software human resources are graduates specializing in computer/software and related studies of universities and vocational schools.
- The Chinese government promotes and supports OSS diffusion actively. In fact, Ministry of Information Industry cites OSS promotion and diffusion as the priority subjects in 2007. Human resource development is also supported by both measures and budget. The universities and vocational schools focus on OSS technical education considering OSS skill acquisition as an advantage for students to get employment.

Actual condition of OSS technical education in Korea

- In Korea, OSS skill is mainly acquired in universities and about 170 OSS-related lectures are given in universities. The number of graduates of IT-related faculty is almost 120,000 in 2006 (70,000 of them have majored in engineering). About 30% of them have taken OSS-related lectures. However, IT-related and OSS-related human resources tend to decrease since 2003. That may be explained by excessive supply of IT-related human resources and especially the influence of ABEEK (Accreditation Board for Engineering Education of Korea) .
- There is the system ABEEK certificates coerces in universities since 1999 to efficiently provide education concerning skills required by enterprises in universities etc. However, OSS is not certificated by ABEEK at present. This situation seems to make it difficult to start OSS-related courses especially for small and middle sized universities.
- In Korea, OSS-related education for human resources is provided in governmental institutions other than universities, vocational schools and other private educational institutions.

Comparative analysis of OSS technical education in Japan, China, Korea, Europe and US

- Based on the result of this survey in China and Korea and the survey 3 in Japan, there is no important difference in skill level of OSS technical education in the surveyed educational institutions of three countries. However, differences are seen in the coverage of education curriculum and the number of OSS engineers.
- There is a difference in the coverage of education curriculum: OSS technical education in embedded SW is more focused on in Chinese and Korean institutions than in Japanese institutions.
- There is no important difference in skill level because combination of lecture and practice is mainly adopted in three countries. There are several examples of project-based practical education: students are engaged in the project undertaken by a professor. However, it is provided absolutely as the professor's discretion not as academic curriculum.
- The number of OSS engineers produced in telecommunications engineering-related faculties of Japanese universities and vocational schools (categorized in special schools in Japan) is estimated to 41,000 a year. Meanwhile, there are 470,000 of IT-related graduates in China and 73,000 in Korea. In Japan, the number can not be simply compared because there are IT-related faculties in other fields such as social science and there are no comprehensive official statistics. However, it is speculated that the number of IT-related human resources is less than that of China and Korea from the population and the university advancement rate. In addition, most of IT-related human resources are from IT-related faculties in universities and vocational schools in China while more than half of Japanese human resources are from faculties including humanities other than IT-related faculties. OSS engineers seem to be in similar situation.
- There is no important difference among Japan, China. Korea, Europe and US except that education in embedded SW is more focused on in China and Korea than in Japan, Europe and US.

- It is necessary for Japan to focus on OSS skill education in universities and vocational schools for main source of OSS engineers not to lag behind China and Korea in the volume of human resources being core for diffusion and development of OSS. Japan is also required to consider educating embedded SW of which Japan has the advantage.
- In addition, it is important to consider introducing mechanism such as Korean ABEEK to feed back human resources and skill needs from enterprises to educational institutions including utilization of JABEE.

Ⅰ. Survey in China

1. Overall situation

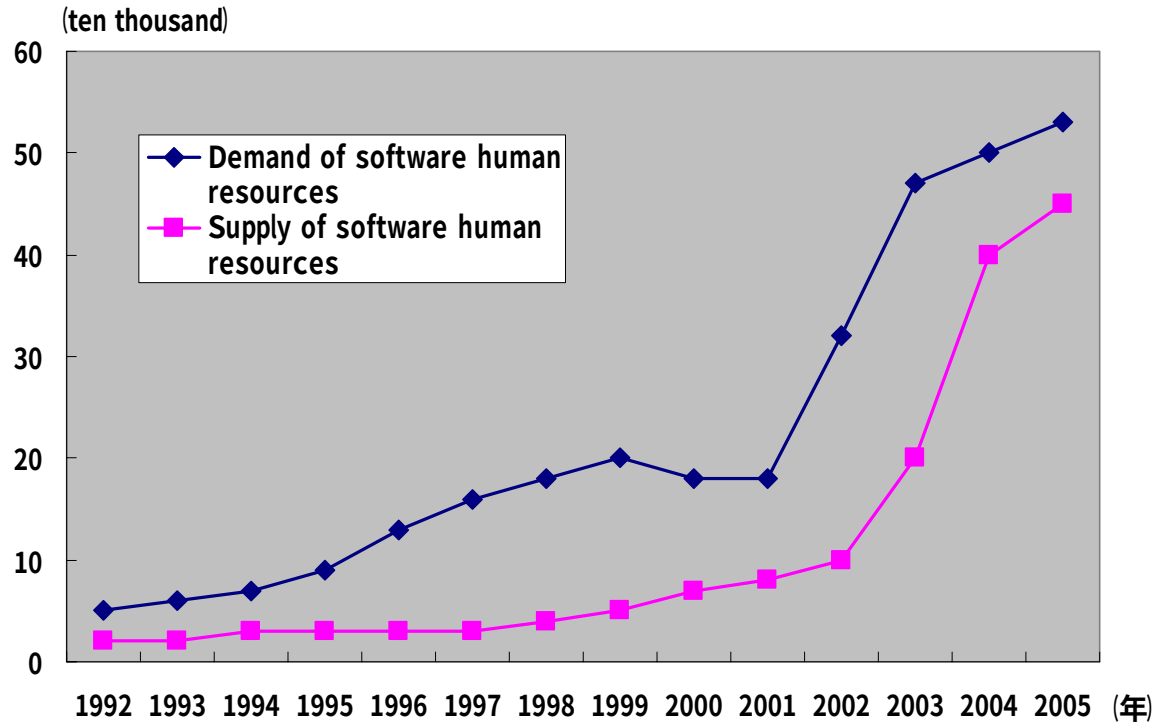
The Chinese government promotes and supports OSS diffusion actively and also focuses on development of OSS-related human resource. An overview of the situation at large in China is as follows.

（1） Software and OSS-related human resources produced in universities and vocational schools

According to the recent statistics of Chinese Ministry of Education, the number of universities and vocational schools in China is 1,824 as of 2006 and 107 of them are Key Universities, 612 are General universities and 1,105 are vocational schools. （Key Universities are the universities targeted in national “Project 211” i.e. the important universities which may receive educational investment since 1995.） The number of graduated tends to increase: it is 4.16 million in 2006, an increase of 750,000 from the previous year.

1,000 of them are universities or vocational schools with departments of computer science and technologies, computer software, or software engineering etc. The supply of software human resources has rapidly increased since 2003 and reached 470,000 in 2005.

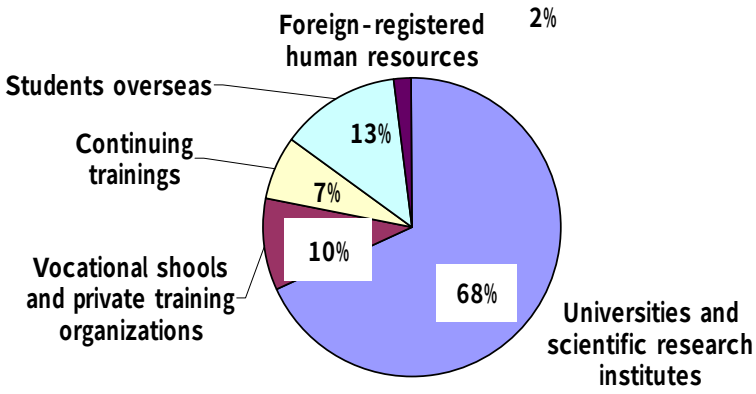
Figure 3 Supply and demand of software human resources in China



Source) ”Annual Report of China Software Industry2006” Ministry of Information Industry of the People’s Republic of China、China Software Industry Association

It is clear that software human resources are mainly provided from computer/software-related departments of universities and vocational schools because almost 80% of them are graduates specializing in computer/software-related. The increase of software resources since 2003 is explained by the increase of students specializing in computer-related studies and vocational schools (they are called “professional development schools” or “training schools” in China).

Figure 4 Source of software human resources in China



Source) "Annual Report of China Software Industry2006" Ministry of Information Industry of the People's Republic of China, China Software Industry Assosiation

Five universities and vocational schools surveyed cover a wide range of OSS skill field and produce many OSS-related human resources.

（2） Introduction of OSS technical education in Chinese universities and vocational schools

The survey of LUPA (Leadership Of Open Source University Promotion Alliance), which target Chinese 200 universities, shows that OSS technical education is not diffused all over the country and that there is a wide perception gap among the universities. That is because Windows is actually used in computer/software education and Linux is not well known.

OSS technical education is introduced more in small-sized general universities and vocational schools than big universities. There are two reasons for that: one is that the introduction of OSS education in general universities and vocational schools is relatively more easy for their structure than big key universities with a complex educational structure; the other is that OSS-related skill may to be an advantage for students in the situation where it is more difficult for the students of general universities and vocational schools to find employment than for the students of key universities.

The universities active in OSS technical education are situated in three developed economic

zone: East, South, and Bohai Rim. The earliest introduction of OSS education was seen in the universities of the coast cities in the East. However, recently, the local universities and vocational schools having a delay in economic development tend to actively work on OSS technical education to make the students more competitive.

(3) Contents of OSS lectures installed in Chinese universities and vocational schools

The universities in the East China have lectures mainly on program design language such as C language, JAVA and C++, operation system principle, and computer network. These lectures are mostly compulsory subjects or assigned elective subjects for the students specializing in computer/software and elective courses for the other students. There is a slight difference of contents and emphasis among the students. Lectures mainly on programming and embedded system development based on UNIX or Linux are available for graduate students.

Meanwhile, universities in the west have lectures mainly on operation system of UNIX and Linux and Linux network administrator. Lectures for graduate students are also for beginners. The universities in the west are behind in installation of OSS education in view of the introduction of environment equipment such as Linux.

(4) Problems of OSS education in Chinese universities and vocational schools

As mentioned above, there are differences among regions, between universities and vocational schools, graduates and undergraduate students, computer-specialized courses and other courses. The reasons are the following:

- The needs for human resources vary by region because of a gap in economic situation and development level among the regions. There are differences of visibility and emphasis on OSS and that is a factor of regional differences in OSS education.
- The attitude and the contents focused in each university for OSS education are different because of the gap of major points on development of human resources between universities and vocational schools. While universities attach importance to development of research-type+ application-type human resources, vocational schools put emphasis on development of application-type human resources and try to lead education to employment of students.
- Diffusion of OSS education is also concerned with condition of environment equipment in universities. Most of computer lectures are given in Windows environment. Also Chinese national computer examination (first and second class). Diffusion of OSS education is influenced by availability of Linux environment.

(5) Prospect for OSS education in Chinese universities and vocational schools

The Chinese government promotes and supports OSS diffusion actively. In fact, Ministry of Information Industry cites OSS promotion and diffusion as the priority subjects in 2007. The reasons are that China wants to nurture domestic enterprises which deal in original OS and application development based on OSS such as Linux having no cost for license, and that the country is concerned about security problems including the dependence on foreign commercial software such as Microsoft.

Original OS and application development based on OSS is substantially invested by the government, In fact, Institute of Software of Chinese Academy of Sciences and Founder, software leading company developed RedFlag Linux. In addition, the promulgation of the Government Procurement Law and determination of procurement principal of local government support original OS and application development based on OSS.

Figure 5 Basic principles on government procurement in China

Basic principle of the Government Procurement Law	Compulsory to purchase domestic products, projects and services in IT procurement by the government.
Basic principle of IT procurement of Beijing city	Purchasing by priority domestic software as principal of governmental procurement of software products of Beijing city if meeting demand of procurement

Source) "Annual Report of China Software Industry2006" Ministry of Information Industry of the People's Republic of China、China Software Industry Association

Beijing also focuses on cultivation of OSS-related human resources. In fiscal 2006, the government spent research fund of several thousands of Yuan. In this way, OSS education and research activities in universities and research institutes are largely supported. In addition, OSS was chosen as main theme of the 11th five-year plan in national software industry conference held in Hangzhou early in 2007.

Meanwhile, many enterprises work on OSS diffusion and promotion in finance, electronics and communication sectors etc. and market needs for OSS human resources tend to increase.

OSS technical education in universities and vocational schools may further expand.

2. Case examples

In this survey, five universities and vocational schools in China were selected and a case study on actual situation of OSS technical education in each institution was carried out. The five universities are chosen in view of type of educational institutions such as universities and vocational schools and regions as well as the ranking of graduate schools with department of software application in 2006, accession to LUPA, software park and the state of implementation of OSS education to make answers more various.

The result of the cases is described in "**III**. Comparative analysis of OSS technical education in Japan, China, Korea, Europe and US".

Figure 6 Selection chart of universities and vocational schools surveyed

Category	Name	Selection reasons and criteria				Result
		Ranking of graduate schools with department of software application in 2006	Accession to LUPA	Software park	State of implementation of OSS education etc.	
Key universities	Beijing University	5th	Member	○	OSS education is implemented.	●
	BeiHang University	20th	Member	○	OSS education is implemented.	—
	Shanghai Jiao Tong University	17th	—	○	OSS education is implemented.	—
	South China University of Technology	4th	—	○	Introduction of OSS courses is earlier and employment rate of graduates with OSS education is relatively high.	●
General universities	Hangzhou Dianzi University	—	Member	○	Introduction of OSS courses is earlier and improvement of hard equipment is relatively advanced.	●
	Zhejiang Education Institute	—	Member	—	Introduction of OSS courses is the earliest Zhejiang and course system is relatively established.	—
	Xian Institute of Post & Telecommunications	—	—	—	There are relatively many OSS developers and the institute participle in a lot of OSS-related projects.	—
Vocational schools	Zhejian Technology Institute of Economy	—	Member		Its scale is relatively large at the level of vocational schools and diffusion rate of OSS courses and employment rate are higher.	●
	Shenzhen Polytechnic	—	—	—	It leads Chinese vocational schools focusing on the introduction of OSS courses and promoting the implementation of OSS courses.	—
	Anhui Vocational college of Electronics & Information Technology	—	—	○	The scale of computer department and relatively large and the students earn credits by the acquisition of qualifications not by examinations.	—

	Changzhou Institute of Engineering Technology	—	—	—	It focuses on the implementation of OSS courses "LUPAOSS community" is started. General Secretary Hu Jintao visited "LUPA laboratory" in the Institute in June 2006 and appreciated the status of efforts for OSS. 2	●
	Dalian Vocational Technical College	—	—	—	Introduction of OSS courses is earlier. High-level OSS human resources are cultivated and employment rate of graduates with OSS education is higher.	—
	Nanning College for Vocational Technology	—	—	—	It is a model vocational school in China and the introduction of OSS courses is relatively earlier.	—

Ⅱ. Survey in Korea

1. Overall situation

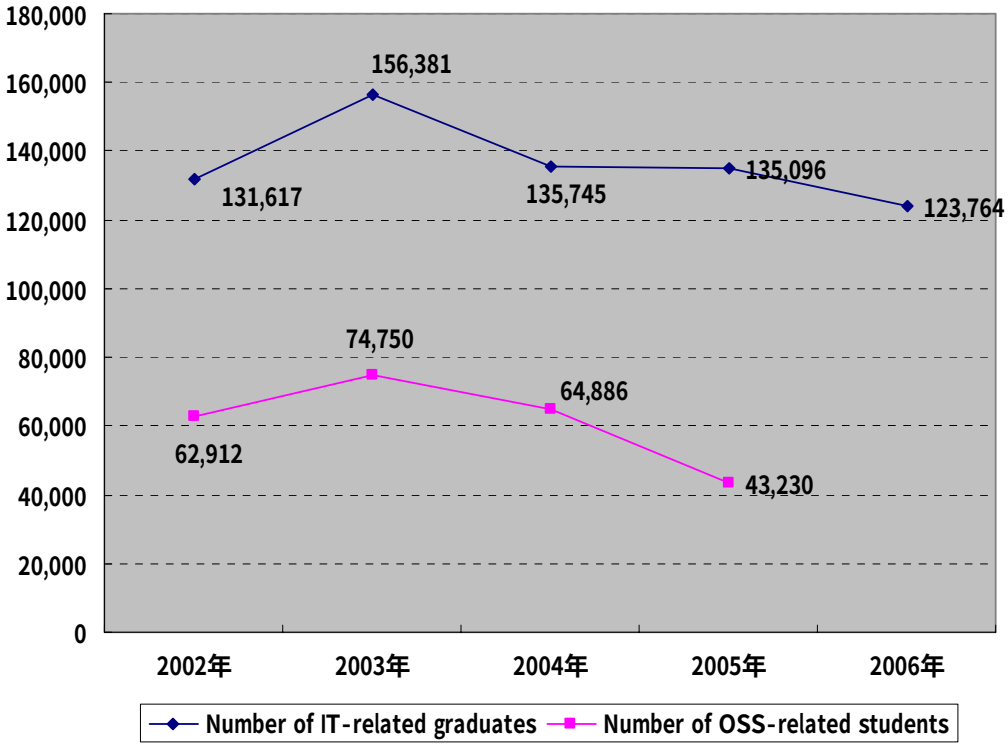
In Korea, OSS technical education is provided by universities, professional education institutions and governmental institutions. An overview of the situation at large in Korea is as follows.

（1）Outline of OSS technical education in Korea

OSS-related human resources are mainly cultivated in universities in Korea and OSS-related education is provided also in professional education institutions such as private educational institutions and governmental institutions.

There are 170 OSS-related courses provided in Korean universities and about 32% of graduates specializing in IT-related study have taken OSS-related lectures. The number of graduates from IT-related faculties and students having OSS-related lectures tends to slightly decrease after peaking in 2003. That is because the supply of human resources has decreased due to upset of supply-demand balance although the number of graduates had considerably increased because of shortage of IT human resources in the late 1990s. However, influence of ABEEK, which is mentioned later, explains also this modest increase of students having OSS-related lectures.

Figure 7 Changes in supply of IT and OSS human resources in Korean universities



＜Detail of the number of graduates of IT and IT-related department in 2006＞

Number of graduates of IT and IT-related department in 2-year colleges in 2006

Category		Number of graduates		
		Male	Female	Total
IT department	Engineering	28,645	7,782	36,427
IT-related department	Social science	5,222	4,025	9,247
	Engineering	1,904	237	2,141
	Arts/physical	6,877	10,420	17,297
	Total	14,003	14,682	28,685

Number of graduates of IT and IT-related department in four-year universities in 2006

Category		Number of graduates		
		Male	Female	Total
IT department	Engineering	28,678	7,866	36,544
IT-related department	Social science	2,482	1,612	4,094
	Engineering	3,732	617	4,349
	Natural science	2,198	2,799	4,997
	Arts/physical	2,493	6,175	8,668
	Total	10,905	11,203	22,108

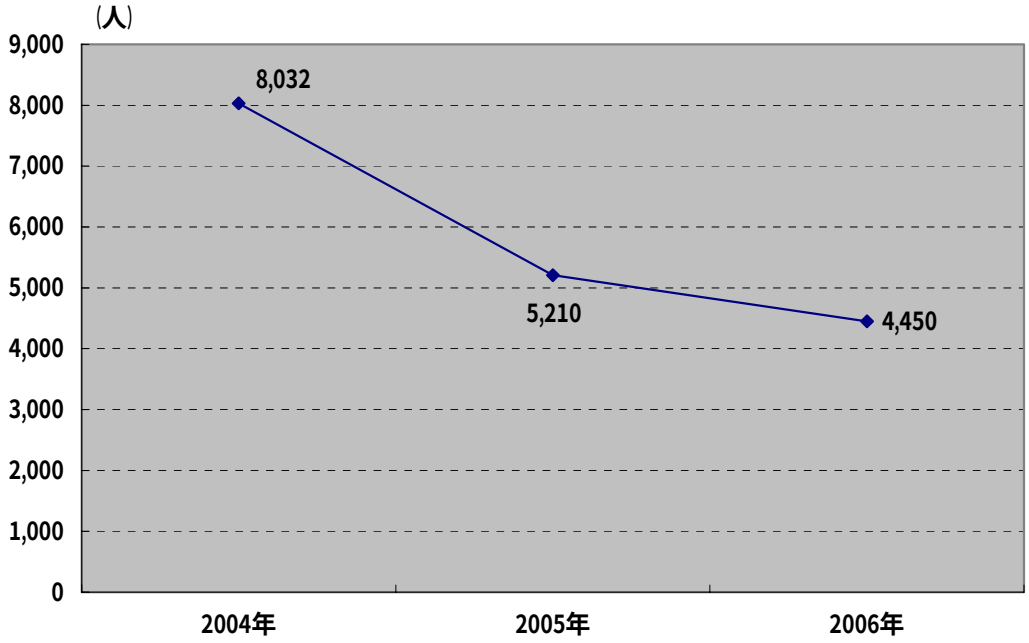
Total of IT department	72,971
Total of IT-related department	123,764

Note) KIPA defines the graduates of the faculties other than engineering-related faculties as graduates of IT-related faculties if they were the students of IT-related faculties as seen in the table above.

Source) "Research on actual condition of the supply and demand of of Open Software human resources in 2006" KIPA (Korea IT Industry Promotion Agency)

In professional education institutions, 219 OSS-related lectures are opened and students in these lectures are about 4,450. The institutions are recently on a downward trend as well as universities. They provide education curriculums based on both classroom lectures and practices.

Figure 8 Changes in supply OSS human resources in Korean professional education institutions



Source) "Research on actual condition of the supply and demand of of Open Software human resources in 2006" KIPA (Korea IT Industry Promotion Agency)

Meanwhile, in governmental institutions Ministry of Government Administration and Home Affairs voluntarily provide educational programs. KIPA and Ministry of Labor provide educational programs supported by Information & Telecommunication Human Resources Development Center of Korea.

(2) Actual situation of OSS-related courses in Korean four-year universities

In Korea, there is no formal curriculum specific to OSS and Linux is utilized in the lectures such as OS or middleware.

① Overall condition of OSS education in Korean universities

At present, there is no curriculum specific to OSS in Korea and Linux is utilized in the lectures such as OS or middleware.

OSS-related lectures are difficult to set up only with intent of universities except special cases and adjusting the level of lectures between graduate schools and undergraduate schools is also difficult. Each university has adapted educational curriculum to certification program after the enforcement of ABEK in engineering-related faculty and it makes difficult to start OSS-related lectures by themselves.

OSS is utilized mainly in Linux basis practices of OS courses of computer engineering faculties including programming courses such as SW, C, C++ etc. and system courses.

② Opportunities where students use Linux

University students use Linux through practices of Linux in OS courses, Linux-related group activities, participation in embedded SW contest etc.

- Example of circles (Konkuk University)
  - ✓ One in computer engineering faculty, the other in internet media faculty
  - ✓ The number of the circle is about 20 in computer engineering faculty and about 15 in internet media faculty
- Embedded SW contest
  - ✓ It is the embedded SW contest held by KIPA and use of Windows and C language is forbidden to use by rule.
  - ✓ Held by every two year, actually 2007 6th contest is held.
  - ✓ 78 teams participated in 2006 contest.

There is ULUG (University-unified Linux User Group), union of Linux-related circles having 11 universities.

Figure 9 Universities of ULUG

University	Circle	Homepage
Konkuk University		http://halfpants.wo.to
Kyunghee University	KHLUG	http://khlug.khu.ac.kr
Korea University	KULS	http://kuls.korea.ac.kr
Dankook University	DLUG	http://www.dlug.Org
Dongguk University	DNA	http://dna.dongguk.ac.kr
Sugang University	SLUG	http://slug.sogang.ac.kr
Seoul Womens University	SWLUG	http://swlug.swu.ac.kr
Sookmyung Womens University	SOLUX	http://solux.sookmyung.ac.kr
Soongsil University	SPLUG	http://open.ssu.ac.kr
Hankuk University of Foreign Studies	GNUVILL	http://www.gnuvill.net
Hanyang University	HLUG	http://hlug.hanyang.ac.kr

Generally, graduate students receive education from use of Linux to Linux kernel through Linux-related projects.

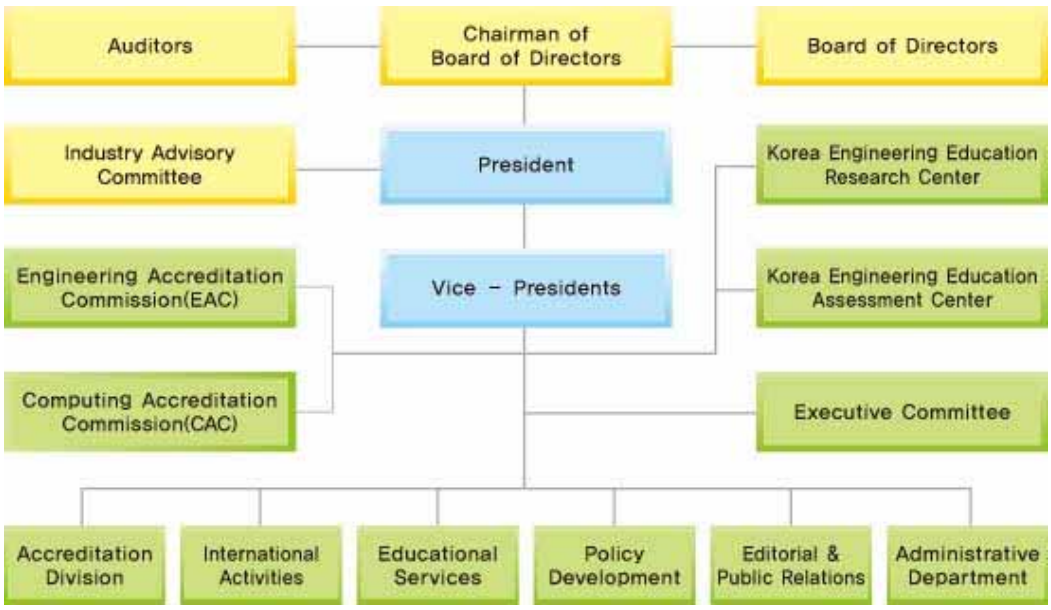
(3) ABEEK programs

In Korea, educational courses in universities are normalized by the introduction of engineering certification implemented by ABEEK (Accreditation Board for Engineering Education of Korea)

① Outline of ABEEK

ABEEK is the accreditation organization for engineering education founded on August 30, 1990 and chairman is Jong-young Yun (Vice Chairman of Samsung Electronics CO., Ltd). The organization implements accreditation and consultation in engineering education courses providing standard for engineering academic courses in universities.

Figure 10 Structure of ABEEK



Chairman: Vice Chairman of Samsung Electronics Yun, Jong-Yong
President: President of POSTECH Park, Chan-mo
Chief Vice President: Professor of Kwangwoon University Hong, Ui-Seok

ABEEK became a signatory of WA (Washington Accord) in June 2005 and aims to be a full member by 2009. WA was founded in 1989 to mutually accredit professional engineers with the participation of Ireland, Australia, Canada, New Zealand, UK, and US. As one of requirements, the signatories conclude the agreement for the mutual accreditation of the engineering degree. That means the signatories recognize the equivalence of the degree. Ten countries including Republic of South Africa (1993), HongKong (1995), Japan(2005), Singapore(2006) are signatories and Germany(2003)、 Malaysia(2003), Taiwan(2005), Korea(2005) participate in it as provisional members.

Since ABEEK was sanctioned as a non-profit organization by Ministry of Education and Human Resources Development in June 2000, it has been under the control of Ministry of Education and Human Resources Development and the budget was contributed by Ministry of Information and

Communication/Ministry of Commerce, Industry and Energy. In addition, Ministry of Science and Technology provide administrative supports, which contributed to the accession to WA.

It is an organization both government and private enterprises participate in because Board of Directors consists of Samsung Electronics, LG Electronics, LG-Nortel, Hyundai Eng. & Construction, SK Telecom, POSCO, LG Chem, KT, S-Oil.

② Actual situation of ABEEK accreditation

As an advantage of receiving the accreditation of ABEEK programs for universities, although normally the education programs need to be regularly examined by the government, it is exempted if acquiring ABEEK accreditation. As of March 2007, 182 programs of 25 universities have been accredited since a certification was implemented in 2000. 319 programs of 33 universities will be accredited this year.

The following are universities received ABEEK in their computer engineering-related program (academic courses).

Note) "Program" includes not only curriculums such as departments and courrses but also overall educational processes and environment from entrance to graduation with evaluation and determination of qualification to complete the program, and it is a general term of departments and courses.

Figure 11 Computer engineering-related courses accredited by ABEEK

Year	Accredited programs
2002	Pukyong National University / Computer Multimedia Engineering Program University of Ulsan / Computer, Information & Communication Engineering Program Inha University / Computer Engineering Program
2003	Changwon National University / Computer Engineering Program Korea Maritime University / Computer, Information Engineering Program
2004	Kwangwoon University / Computer Engineering Program Computer Software Program Kangnung National University / Computer Engineering Program Dongguk University / Computer Engineering Program Yonsei University / Computer Engineering Program
2005	Hongik University (Jochiwon Campus) / Computer, Information & Communication Engineering Program
2006	University of Ulsan / Advanced Computer, Information & Communication Program Kwangwoon University / Computer Engineering Program Computer Software Engineering Specialized Program Hanyang University / Advanced Computer Program

③ Influence of ABEEK program to OSS technical education in universities

At this time OSS-related courses are not accredited by ABEEK. Preference for the ABEEK programs prevents the universities from having OSS-related courses. The universities can not

attract the students and contribute to the employment if they provide non-ABEEK courses because ABEEK programs taken by a student influence the employment.

Such a situation is seen in the middle and small sized universities which are greatly affected by ABEEK programs. On the contrary, prestigious universities are nearly unaffected because their established reputation can be an advantage to obtain employment.

④ Difference between JABEE and ABEEK

JABEE (Japan Accreditation Board for Engineering Education founded on November 19 in 1999) is a signatory of Washington Accord as Korean ABEEK. JABEE consists mainly of Japanese academic societies with the regular members of 85 academic societies. The organization is well known in educational institutions such as universities.

However, the government doesn't especially support JABEE and accredit any academic program although it accredited this organization. While the organization demands supports from enterprises such as patronage members, it is not sufficiently supported.

One of advantages to acquire a JABEE-accredited program is the exemption of the first-stage examination of Professional Engineer. However, programs in information processing-related field are not focused because Professional Engineer itself is not sufficiently diffused.

Meanwhile, ABEEK is supported by the government and has strong links with IT-related departments and agencies on the fiscal and policy front as mentioned above. In addition, it has strong ties with IT-related enterprises. In fact, IT-related companies such as Samsung Electronics, LG Electronics or SK Telecom hold important positions. Samsung Electronics gives an additional point to the students with an ABEEK-accredited curriculum at their adoption process. It encouraged the introduction of ABEEK programs and the application to ABEEK programs increased sharply.

The difference between JABEE and ABEEK is therefore summarized as follows.

- JABEE consists of academic societies while ABEEK consists of the government and enterprises (less commitment of academic societies).
- In Korea, the application to the accreditation increased because Samsung Electronics started to give an additional point to the students with an ABEEK-accredited program at employment exam while such a situation is not seen in Japan.

ABEEK is more efficiently functioned concerning the objective of feeding back the needs from enterprises to education. That is one of the main objectives of JABEE and it is necessary to promote to feed back the needs to education utilizing JABEE.

The following is the comparison of JABEE and ABEEK-accredited programs.

Figure 10 Information Systems/software-related programs accredited by JABEE and ABEEK

Japan (Program accredited by JABEE)			Korea (Program accredited by ABEEK)	
Name of higher education facility		Name of program [year]	Name of higher education	Name of program [year]
Iwate Prefectural University	Faculty of Software and Information Science Department of Software and Information Science Studies	Computer Science Program [2003]	Pukyong National University	Computer Multimedia Engineering Program[2002]
Iwate Prefectural University	Faculty of Software and Information Science Department of Software and Information Science Studies	Information System Program [2003]	University of Ulsan	Computer/Information & Communication Engineering Program[2002]
EHIME UNIVERSITY	Faculty of Engineering	Information Engineering Special Course [2004]		Advanced Computer, Information & Communication Program[2006]
OITA UNIVERSITY	Faculty of Engineering Department of Computer Science & Intelligent Systems Engineering	Intelligent Information Course [2005]	Inha University	Computer Engineering Program[2002]
Osaka Institute of Technology	Faculty of Information Science and Technology	Computer Science Course[2005]	Changwon National University	Computer Engineering Program[2003]
Kagawa University	Faculty of Engineering Reliability-based Information Engineering	Reliability Information System Engineering Special Course[2006]	Korea Maritime University	Computer, Information Engineering Program[2003]
Kyushu Institute of Technology	Faculty of Computer Science and Systems Engineering Department of Regulating System Engineering	System Creation Information Engineering Education Program [2005]	Kwangwoon University	Computer Engineering Program Computer Software Program[2004]
Kyushu Institute of Technology	Faculty of Computer Science and Systems Engineering Department of Artificial	Intelligent Information Engineering Education Program[2005]		Computer Engineering Special Program/Computer Software Engineering Special Program[2006]
Kyushu Sangyo University	Faculty of Information Science Department of Social Information Systems, Department of Intelligent Informatics	Information Schience Synthesis Course[2006]	Kangnung National University	Computer Engineering Program[2004]
KINKI UNIVERSITY	School of Science and Engineering Department of Information	Information System Course [2006]	Dongguk University	Computer Engineering Program[2004]
Saga University	Faculty of Science and Engineering Department of Information Science	Intelligent Information System Special Program [2003]	Yonsei University	Computer Engineering Program[2004]
Shizuoka University	Faculty of Informatics Department of Information Science	Calculator Science Course [2002] (Calculator Science Program from April 2004)	Hongik University (Jochiwon	Computer, Information & Communication Engineering[2005]
Shimane University	Interdisciplinary Faculty of Science and Engineering Department of Mathematics and Computer Science	Computer Science Special Program[2004]	Hanyang University	Advanced Computer Program[2006]
TOTTORI UNIVERSITY	Faculty of Engineering	Department of Intelligent Information Engineering[2005]		
Toyota National College of	Department of Information Science	Information Science[2005]		
TOYOHASHI UNIVERSITY of TECHNOLOGY	Faculty of Engineering	Information Engineering Course [2005]		
TOYOHASHI UNIVERSITY of TECHNOLOGY	Faculty of Engineering	Knowledge Information Enginnering Course[2006]		
NAGASAKI UNIVERSITY	Faculty of Engineering	Department of Information Systme Engineering[2006]		
NIHON UNIVERSITY	College of Industrial Technology Department of Mathematical Information Engineering	Information Engineering Course [2006]		
HACHINOHE INSTITUTE OF TECHNOLOGY	Faculty of Engineering System & Information Engineering	System Information Course [2006]		
UNIVERSITY OF MIYAZAKI	Faculty of Engineering Computer Science and Systems Engineering	Information System Special Course[2005]		
Musashi Institute of Technology	Faculty of Engineering Department of Computer/Media Engineering	Computing and Media Engineering Program[2006]		
YAMAGATA UNIVERSITY	Faculty of Engineering	Daytime Course in Department of Information Science [2003]		
YAMAGUCHI UNIVERSITY	Faculty of Engineering	Daytime Course in Department of Intelligent Information System Engineering[2004]		
University of Yamanashi	Faculty of Engineering Department of Computer Science and Media Engineering	Coumputer Science Course [2005]		
University of Yamanashi	Faculty of Engineering Department of Computer Science and Media Engineering	Information Media Course[2006]		
UNIVERSITY of the RYUKYUS	Faculty of Engineering Department of Information Engineering	Computing Engineering Course [2005]		
Wakayama University	Faculty of Systems Engineering Department of Computer and Communication Sciences	Information & Communication Science Course[2006]		

Note) JABEE and ABEEK have the same definition for programs (as two paricipe in Washington Accord mutually accrediting programs)

2. Case examples

In Korea, the following five universities were selected based on a Linux-related circle and OSS-related official activities as well as OSS-related courses.

The result of the cases is described in "**III**. Comparative analysis of OSS technical education in Japan, China, Korea, Europe and US".

Figure 11 Selected five universities

University	Selection reasons and criteria			
	Korean university ranking in 2006	BK21 Selection in the Information Technology and Information Communication field	OSS-related department	Activities in ULUG
KAIST	**1st**	○		
Seoul National University	**2nd**	○	○	
POSTECH	**2nd**	○		
Korea University	**4th**	○	○	○
Yonsei University	**5th**		○	
Ajou University	**14th**	○		
Kyungpook National University	**16th**	○		
Soongsil University	**22nd**		○	○
Konkuk University	**—**		○	○
Kyunghee University	**—**		○	○
GIST	**—**	○		○
ICU	**—**	○		○

III. Comparative analysis of OSS technical education in Japan, China, Korea, Europe and US

1. Comparison of OSS technical education in Japan, China and Korea

The following is a comparison of the actual situation of OSS technical education.

(1) Coverage of OSS technical education curriculum

The coverage of technical education curriculums in educational institutions in three countries is represented in the table of the next page. The table shows that the coverage itself doesn't greatly differ except embedded SW.

In the basic field, there is no significant difference in three countries. There are one institution in Japan and one in Korea teaching the skill on decentralized architecture (China is excluded from the survey) , which is selected as academic program less often than other skills.

In the system field, while Chinese institutions provide programs sufficiently, Korean efforts seem to be slightly behind Japan and China. In fact, Korean institutions don't teach Linux system management and network server management. The skill on cluster system architecture is not taught in any institution of three countries.

In the network field, there is no important difference in three countries and the skills are taught in almost all institutions.

In the programming field, the skill on Java and C, C++ is taught in many institutions. However, while the program on Light Weight Language is prepared in many institutions of Japan and China, it is not available in any institution in Korea.

In the development system field, a slight difference is seen. The skill on development framework is taught in several institutions but the skill on development tool and integrated development environment is not taught in Japanese institutions while available in China and Korea. Japanese efforts in education of system development system and tool seem to be slightly behind two countries.

In the security field, China is a little ahead, but there is no significant difference. Meanwhile, in RDB field, Korea is advanced, but no wide gap is seen in three countries.

As for the embedded SW, there is an important difference between China/Korea and Japan. While many universities and vocational schools focus on this field in China and Korea, there are fewer institutions which focus on it in Japan. Thus, Japan is behind two countries in the field.

Figure12 Coverage of OSS-related skills in universities and vocational schools of Japan, China and Korea

Category of skill	Name of skill	Japan						China					Korea				
		Wakkanai Hokusei Gakuen University Faculty of Information Media	Tohoku Gakuin University Deparment of Information Science	TOKYO UNIVERSITY OF TECHNOLOGY School of Computer Science	Japan Electronics College	Kobe Institute Of Computing Faculty of Information Technology	Aso Business Computer College	Beijing University	South China University of Technology	Hangzhou Dianzi University	Zhejian Technology Institute of Economy	Changzhou Institute of Engineering Technology	Seoul National University	Konkuk University	Yonsei University	Korea University	Kyunghee University
Basics	Knowledge of the OSS outline			●	●	●	●	●	●	●	●	●	●	●			
	Basic knowledge on the field of legal affairs	●			●				●	●		●	●				
	Skills in computer systems and	●	●	●	●		●	–	–	–	–	–	●	●	●		
	Skills in distributed architecture			●				–	–	–	–	–		●			
System	Skills in the concept of Linux and its basic operation	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Skills in the kernel of Linux	●	●			●		●	●	●	●	●	●	●	●	●	●
	Skills in Linux system management	●	●		●		●	●	●	●	●	●					
	Skills in Linux system programming	●			●		●	●	●	●	●	●	●	●	●	●	●
	Skills in network sever management		●	●	●	●	●	●	●		●	●					
	Skills in cluster system architecture							–	–	–	–	–					
Network	Skills in network architecture	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Skills in network management	●	●	●	●	●	●	●	●	●	–	●				●	●
Programming	Skills in Java	●	●	●	●		●		●			●	●	●	●	●	●
	Skills in C and C++	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●
	Skills in LightWeight Language	●	●		●	●	●	●	●	●		●					
Development System	Skills in development frameworks	●			●				●			●	●	●	●	●	
	Skills in development tools						●	●	●			●		●	●		
	Skills in integrated development							●	●			●					
Security	Skills in encryption					●		●	●		●	●	●	●	●	●	
	Skills in network security		●		●	●	●	●	●		●	●	●			●	
	Skills in OS security	●			●		●		●		●	●		●	●		
RDB	Basic skills in RDBs	●	●		●	●	●		●		●	●	●	●	●	●	●
	Skills in RDB system management		●		●				●		●	●	●	●	●	●	●
Embedded SW	Skills in embedded systems				●	●	●	●	●	●	●	●	●	●		●	●
	Skills in embedded development							●	●	●	●	●	●	●		●	●
	Skills in embedded application development					●			●		●	●	●	●		●	
	Skills in embedded system optimization							–	–	–	–	–	●	●			

Notice) ● for China and Korea means that there is a course covering a skill. Therefore, there is not necessarily course specializing in a concerned skill.
Notice2) This table is on the educational organizations that focus on OSS technical education and it doesn't represent the tendency as a whole in each country.

Peking University and Seoul National University, which represent each country, are included in the universities surveyed and both universities focus on OSS technical education. Meanwhile, OSS education is not sufficiently provided in the Japanese universities such as the University of Tokyo and Osaka University. Students have an opportunity to learn “Computer system and architecture”, “Network architecture” or “C, C++” in IT-related courses and also OSS-related skills such as “Concept of Linux and basic operation”, “Kernel of Linux” and “Java”. However, the courses are much less than that of Peking University and Seoul National University. Especially in undergraduate schools, the universities aim at providing a broad knowledge and perspective by reorganization and aggregation of departments and it makes difficult to have OSS-specialized courses. The graduate schools provide courses on software engineering etc. but do not specially focus on courses to acquire basic knowledge and skill such as Linux or Java.

However, in these university laboratories with UNIX or Linux-based system environment, graduate students are able to acquire practical knowledge and skill on OSS-related system development by education like OJT in the laboratories because they are mainly engaged in the system development and management.

In education curriculums implemented by “Leading IT Specialist Training Promotion Program” supported by the budget of Ministry of Education, Culture, Sports, Science and Technology, more practical education is provided including OSS. However, these education curriculums are basically provisional, with three years running and it is necessary to solve problems in particular of human resources such as dispatch of teachers from enterprises to incorporate the curriculums to courses in graduate schools as persistent curriculums.

In Japanese prestigious universities, the courses for the acquisition of OSS-related skills are less than that of Peking University and Seoul National University. However, it is important to pay attention to the situation such as the education for graduate students in laboratories and the implementation of trials of the advanced education curriculum.

(2) Situation of the skill level of OSS technical education

The situation of OSS technical education in Chinese and Korean universities and vocational schools shows that most of courses in undergraduate schools consist of the combination of classroom lectures and practices. In Korea, all courses have practices and the condition of credit earning is to take required practices in the semester and present the result (ex. constracting actual systems in system-related courses). OSS technical education at almost skill level 2 seems to be provided.

Chinese institutions also adopt the combination of classroom lectures and practices and OSS technical education at almost skill level 2 seems to be provided such as in Korea. In graduate schools, there are many cases to deal with system architecture the enterprise managed by a professor entrusted but it is provided absolutely as the professor’s discretion not as academic

curriculum. In China and Korea, OSS technical education is often provided for the acquisition of not only knowledge also working-level skill through the practices.

There is no significant difference of skill level of OSS technical education among Japan, China and Korea because the surveyed six institutions in Japan provide practically the courses at skill level 2.

(3) Situation of OSS-related human resources

The number of OSS human resources produced in universities and vocational schools differs among three countries.

In Japan, the universities produce approximately 20,000 graduates specializing in telecommunications a year and there are slightly more than 40,000 graduates in total including the special schools (vocational schools). Only less than 3/4 of them find employment in information processing business.

Figure 13 Number of graduates and jobfinders of IT-related department in Japanese universities and vocational schools (fiscal 2005)

	Number of graduates		Number of jobfinders		
	Total	Telecommunications Notice1)	Total	Information Processing Field Notice2)	
				Total	Engineering-specialized Notice3)
University Notice4)	558,184	15,973	355,820	22,101	10,592
Graduate school (Master) Notice	96,675	3,679	50,782	6,076	4,373
Graduate school (Doctor) Notice	32,175	792	9,167	167	105
Special schools Notice4)	344,538	20,559	238,369	14,132	14,132
Total	1,031,572	41,003	654,138	42,476	29,202

Notice1) The number in special school is the sum of Electric Computer and Information Processing
Notice2) The number in university and graduate school is number of jobfinders as information processing engineers
The number in special school is number of jobfinders in the field of Electric Computer and Information Processing
Notice3) It it impossible to obtain the number of jobfinders in Telecommunications as there is no detail on Engineering, but jobfinders in Information Processing field is assumed to be mainly from Telecommunications in Engineering
Notice4) The numbers in university and graduate school are as of March 2006 and special schools as of fiscal 2005.

Source) Ministry of Education, Culture, Sports, Science and Technology

Meanwhile, there are 470,000 graduates specializing in IT a year in China and 73,000 in Korea. The number of Japanese graduates specializing in telecommunications is 41,000, much less than that of China and Korea. In Japan, the number can not be simply compared because there are IT-related faculties in other fields such as social science and there are not comprehensive official statistics. However, it is speculated that the number of IT-related human resources is less than that of China and Korea from the population and the university advancement rate.

Figure14 Number of IT-related graduates in universities and vocational schools of three countries

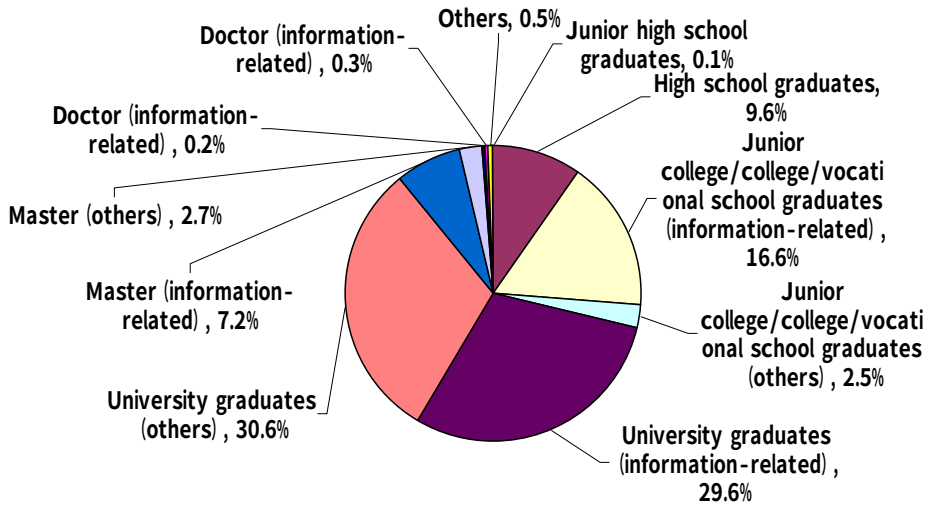
	China	Korea	Japan (Telecommunication-related graduates)
Number of annual IT-related graduates	470,000	73,000	41,000

Note) China: number in 2005, Korea: number in 2006, Japan: number in fiscal 2005

Source) Statistics of each country (See Figure1,6,17)

In addition, while most of IT-related human resources are from IT-related departments of universities and vocational schools in China, only about half of IT-related human recourses are graduates specializing in IT and the graduates specializing in humanities account for an important fraction in Japan.

Figure15 Academic background of Japanese IT-related human resources



Source) 「The survey on IT human resources (March 2006)」Nikkei BP (The survey entrusted by METI in fiscal 2005)

While a lot of IT and OSS-related human resources supporting IT industry are produced in universities and vocational schools in China and Korea, the number of such human resources is insufficient in Japan.

2. Comparison of OSS technical education in Japan, China, Korea, Europe and US

The actual situation of OSS technical education in Europe and US is arranged based on the result of case examples of OSS education in foreign countries of “The report on development program of cultivation infrastructure of Asian open source software human resources （March 2005, Mitsubishi Research Institute, Inc.）」.

The research carried out case studies of OSS education courses in the following institutions (only the result of Europe and US is shown).

【Courses on OSS technology】

Country	Name of University
Germany	Open Source Training and Consulting (OSTC) GmbH
	University of Kaiserslautern Faculty of Computer Science
Italy	Universita` degli studi di Roma Faculty of Engineering
	Università di Bologna Faculty of Information Communication Technology
	Università di Pisa Faculty of Information
	Free University of Bozen - Bolzano
Greece	Athens University of Economics and Business Faculty of Management Science Technology
Hungary	University of Szeged Faculty of Software Engineering
France	Ecole Nationale Supérieure de Techniques Avancées （ENSTA）
	University of Marne la Valee Department of Information
UK	GBdirect
	Open University
	University of Keele business and vocational education
Spain	Technical University of Madrid
	Universidad Oberta de Catalunya
	Universidad Islas Baleares
Canada	Capilano College
US	The University of Texas at Austin
	Portland State University Faculty of Computer Science
	Stanford University Faculty of Computer Science

【Courses on the outline and business model of OSS】

Country	Name of University
Germany	Universität Hamburg Faculty of Information
Sweden	Göteborg University Faculty of Management and Commercial Science Department of Information
Canada	University of Regina Faculty of Computer Science
US	Northeastern University Department of Management

The result shows that education is sufficiently provided except embedded software. In particular, there are courses in the basic field such as “Outline of OSS” and “Legal field”; the system field such as “Concept of Linux and basic operation”, “Kernel of Linux”, “Linux system management”, and “System programming”; the programming field such as “C,C++” and “Light Weight Language”; the development system field such as “Development framework” and “Development tool”; and the RDB field such as “RDB” and “RDB system management”. However, there is no

course on embedded software in the educational courses surveyed.

The level of these courses is quite advanced providing sufficient contents such as system development by group work not only classroom lectures.

As a whole, an important difference is pointed out on embedded software: while Chinese and Korean educational institutions focus on embedded software, Japanese, European and American institutions hardly provide OSS technical education on embedded software. However, there are no significant differences in the coverage of other OSS skills and the level of education of the surveyed institutions.

Survey 4
Case research of advanced OSS technical education in foreign countries
Report【Summary】

INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN

Survey 5

Proposal for the model curriculum

Report

【Summary】

August 2007

INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN

【Points of the result of this survey】

Problem consciousness for the proposal

- The cultivation of OSS engineers in Japan is requiring, not only in their greater numbers but also their higher level skill. To attain the purpose, the provision of systematic and higher level OSS technical education for universities, colleges and special schools, where the students acquire basic scholastic ability, is necessary. OSS technical education is suitable for the cultivation of high-level IT human resources required by industries because it is not only to acquire OSS-related skills but also to learn the basic technology and theory and to obtain an active attitude and skills toward innovations with applied skills.
- Based on the backgrounds mentioned above, this proposal presents following two aspects as a basic policy and propose envisioned human resources, model curriculum and courseware for OSS engineer cultivation.
  (ア) The curriculum is designed to rapidly cultivate entry-level IT human resources as OSS engineers and aims to achieve level 2 of ITSS.
  (イ) It aims to attain the expected skill level required by companies for mid-carrier IT human resources in four occupations (IT service management, application specialist (enterprise), application specialist (embedded), IT specialist).

OSS model curriculum included universities, colleges, special schools

- IT service management human resources, application development human resources (enterprise), application development human resources (embedded) and IT specialist human resources are set as envisioned human resources
- The model curriculum consists of 53 subjects according to the acquisition of 27 OSS-related skills: “basic subjects” common for all human resources, “applied subjects” compulsory by each human resource, and “elective subjects” not compulsory but preferable to be acquired by each human resource.

OSS model curriculum included training-related divisions in enterprises and IT training centers

- IT service management human resources, application development human resources (enterprise, embedded) and IT specialist human resources, which are represented in ITSS, are set as envisioned human resources.
- In 27 OSS-related skills, the model curriculum providing necessary courses to reach the skill level required for each occupation of mid-carrier IT human resources is created.

Proposal for courseware

- The courseware suitable for the acquisition of 27 OSS-related skills was proposed correlating with the model curriculum for envisioned human resources and the achievement.
- Attention should be paid since the proposed courseware is classified by skills, hence it is not meet to the actual operation case that requires combination of more than two skills.
- In this respect, it is advisable to consider the PBL (Project Based Learning) and curriculum that utilize the advanced internship schemes for the OSS model curriculum envisioned for Universities, colleges and special schools as well.
- On the other hand, in the OSS model curriculum envisioned for education related department of corporations or IT training organizations, the opportunities should be prepared to learn cross-sectional and systematic way how to integrate separately learned skill and utilize it in the actual project implementation through OJT (On the Job Training).
- Based on the aspects mentioned above, it is expected that positive and effective application of proposed model curriculum and courseware in the Universities, colleges and special schools.

Ⅰ. Problem consciousness for the proposal

In Survey 1 and 2, there is a gap between OSS skill level expected for in-house OSS engineers and the actual level by the user companies and SI businesses. In particular, the need for improving “skill with higher required level and a wide gap” was recognized.

Survey 3 shows that there are universities and vocational schools which give advanced OSS technical education and start providing various OSS-related skills at an appropriate level. OSS technical education in universities and vocational schools needs to be extended following high demand for OSS engineers due to the future expansion of OSS use in enterprises and public offices.

In Survey 4, the situations in China and Korea are compared. The survey object educational organizations in Japan, China and Korea are working positively on the OSS technical education, however, the difference can be seen in the number of OSS graduates. Examining the whole number of IT related graduates, since there is no statistical figure only for OSS engineers, those engineers graduated from telecommunications engineering-related faculties of Japanese universities and special schools (categorized in special schools in Japan) is estimated to 41,000 a year. Meanwhile, there are 470,000 of IT-related graduates in China and 73,000 in Korea. In Japan, the number can not be simply compared because there are IT-related faculties in other fields such as social science and there are no comprehensive official statistics. However, it is speculated that the number of IT-related human resources is less than that of China and Korea from the population and the university advancement rate. It is impossible to identify that the difference in the number of IT related graduates to the difference in the number of the OSS engineers. However, it can be presumed that there is similar tendency for the numbers of OSS engineers to that of IT related human resource.

Therefore, it can be emphasized that the cultivation for the higher level OSS engineers is required and it is not mean merely producing greater number of OSS engineers in Japan. In this respect, supplying the OSS technical education for the students of universities, colleges and vocational schools, where students acquire basic academic abilities, needs to be improved more systematized and higher-level. In addition, the effect of OSS technical education is not merely to provide OSS-related skills. OSS is itself a basic technology with consensus as well as practical software and it makes possible not only to acquire the basic technology and theory but also to obtain an active attitude and skills toward innovations with applied skills due to the education for understanding it from source code. Based on these reasons, it is thought that the OSS technical education is a suitable way for the cultivation of high-level IT human resources required by industries.[1]

[1] Makoto Oya：IPSJ Magazine Vol.47,No.11,pp.1250-1251 (Nov.2006)

Based on the awareness of the problems mentioned above, this proposal presents following two aspects as a basic policy and propose for envisioned human resources, model curriculum and courseware for OSS engineer cultivation.

The curriculum is designed to rapidly cultivate entry-level IT human resources as OSS engineers. Specifically, it aims to achieve level 2 of ITSS in universities, colleges and vocational schools.

It aims to attain the expected skill level required by companies for mid-carrier IT human resources in four occupations (IT service management, application specialist (enterprise), application specialist (embedded), IT specialist).

Ⅱ. Proposal for envisioned human resources and model curriculum

1. OSS model curriculum included universities, colleges and special schools

(1) Envisioned human resources

The following four types are envisioned as human resources who can work as OSS engineers from the entrance with their OSS skills acquired in universities, colleges and special schools.

IT service management (Previous: operation) human resources

They are at the department of information, engineering or electronics of university, college or special school and intend to work using OSS in the future.

They study legal affairs, encryption, and network management systematically as well as outline of OSS and basic operation of Linux and have the basic knowledge for the future.

After graduation, they aim to deal with hardware and software introduction, customization, repair and maintenance, and remote maintenance suited for clients' facilities as engineers with full knowledge of OSS, capable of providing supports such as system monitoring or building monitoring that requires real-time operation using their expertise of hardware, software, facilities, lesion analysis.

Application development human resources (enterprise)

They are at the department of information, engineering or electronics of university, college or special school and intend to work using OSS in the future.

They study the programming knowledge such as Java, Light Weight Language and other knowledge such as Basic of RDB, RDB system management, and Linux system management systematically as well as outline of OSS and basic operation of Linux and have the basic knowledge for the future.

After graduation, they aim to deal with design, development, architecture, introduction, test and maintenance of business application that is concerned with business solution as engineers capable of handling OSS and constructing system with their expertise of application development of core-business tasks using OSS.

Application development human resources (embedded)

They are at the department of information, engineering or electronics of university, college or special school and intend to work using OSS in the future.

They study embedded system, embedded development environment, embedded application development and optimization of embedded system systematically as well as outline of OSS and basic operation of Linux and have the basic knowledge for the future.

After graduation, they aim to deal with the specification determination, design and development of embedded software that can be accepted in a market as application developers of in-vehicle products, mobile devices and digital electric appliances and so on with their expertise of embedded software development using OSS.

IT specialist human resources

They are at the department of information, engineering or electronics of university, college or special school and intend to work using OSS in the future.

They acquire a wide range of knowledge such as kernel of Linux, Linux system management, network server management, network architecture, network management, RDB system management, decentralized architecture and cluster system architecture as well as outline of OSS and basic operation of Linux and have the basic knowledge for the future.

After graduation, they aim to perform as a designer, architect and introducer of system infrastructure suited for clients' environment or serve as engineers, so-called adaptable fighting potential, capable of building higher and more complex applied system by integrating multiple OSS using their expertise of hardware and software.

(2) OSS model curriculum

The model curriculum that is expected to be introduced in universities, colleges and special schools is proposed for the accelerated development of these four OSS engineers.

It is designed based on the following measures taking account of the result of Survey 1 and 2 (in particular Survey 2: questionnaire survey to SI businesses). The detail is described from the next page.

① "Basic subjects" are selected because they need to be provided to all students for the acquisition of OSS basic skills.

② "Applied subjects" are selected as compulsory subjects for "IT service management human resources", "application development human resources (enterprise)", "application development human resources (embedded)" and "IT specialist human resources". "Elective subjects" are chosen as subjects that are not compulsory but preferable to be acquired.

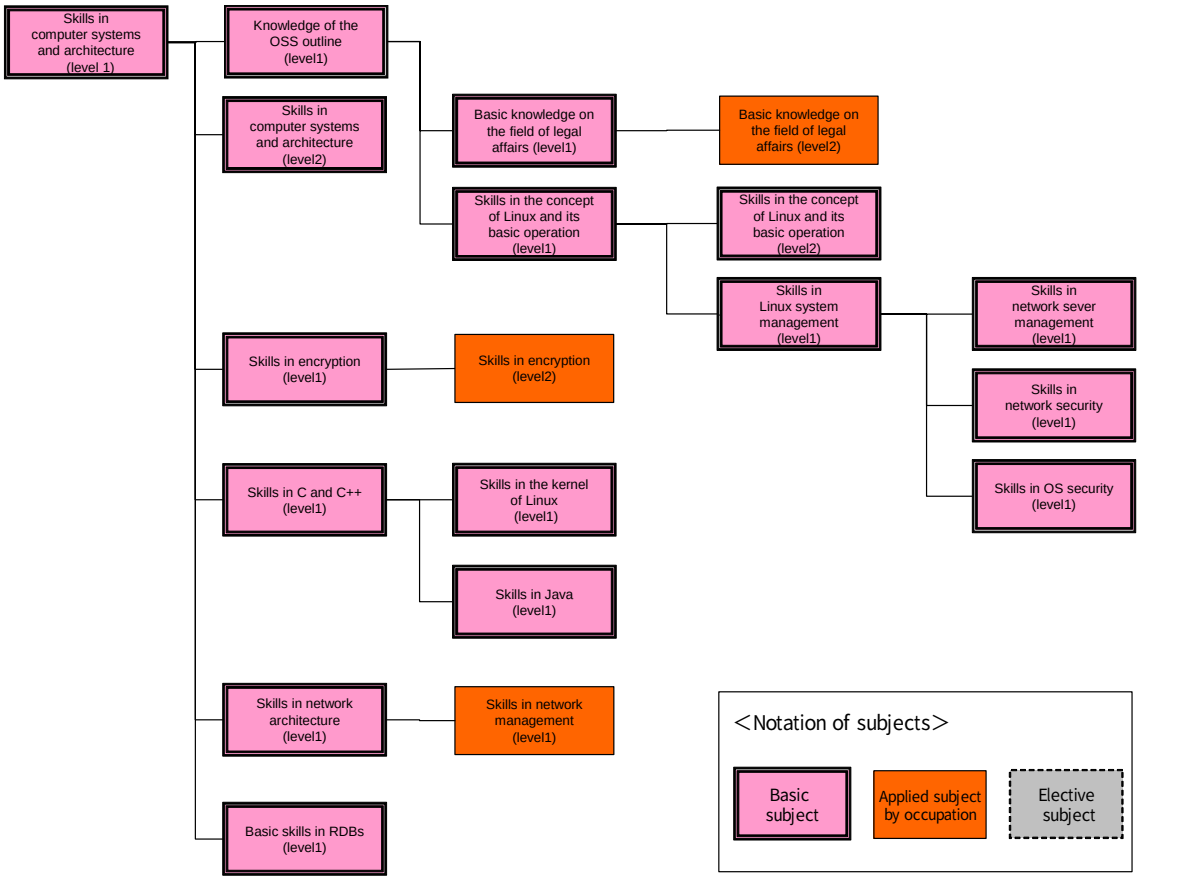
Figure 12 OSS model curriculum envisioned in universities, colleges and special schools (overall)

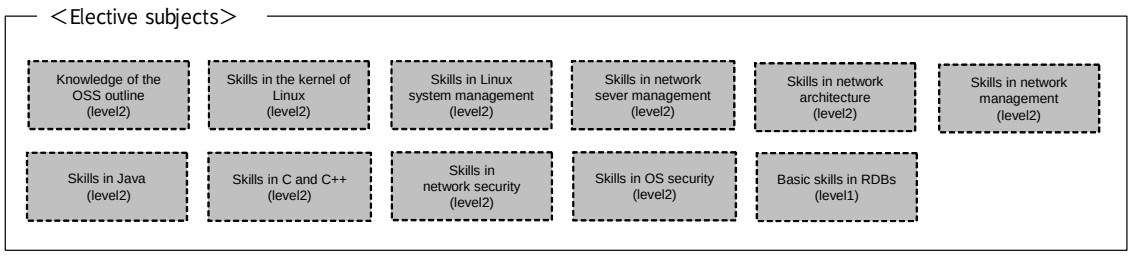
Categoy of skill	Name of skill	Skill level	
		Level 1	Level 2
Basics	Knowledge of the OSS outline		
	Basic knowledge on the field of legal affairs		
	Skills in computer systems and architecture		
	Skills in distributed architecture		
System	Skills in the concept of Linux and its basic operation		
	Skills in the kernel of Linux		
	Skills in Linux system management		
	Skills in Linux system programming		
	Skills in network sever management		
	Skills in cluster system architecture		
Network	Skills in network architecture		
	Skills in network management		
Programming	Skills in Java		
	Skills in C and C++		
	Skills in LightWeight Language		
Development system	Skills in development frameworks		
	Skills in development tools		
	Skills in integrated development environments		
Security	Skills in encryption		
	Skills in network security		
	Skills in OS security		
RDB	Basic skills in RDBs		
	Skills in RDB system management		
Embedded SW	Skills in embedded systems		
	Skills in embedded development environments		
	Skills in embedded application development		
	Skills in embedded system optimization		

	Basic subject	16 subjects
	Applied subject for IT service management	3 subjects
	Applied subject for application development (enterprise)	10 subjects
	Applied subject for application development (embedded)	11 subjects
	Applied subject for IT specialist	15 subjects
	Elective subject	11～18 subjects

Figure 2 OSS model curriculum envisioned in universities, colleges and special schools

(IT service management human resources)



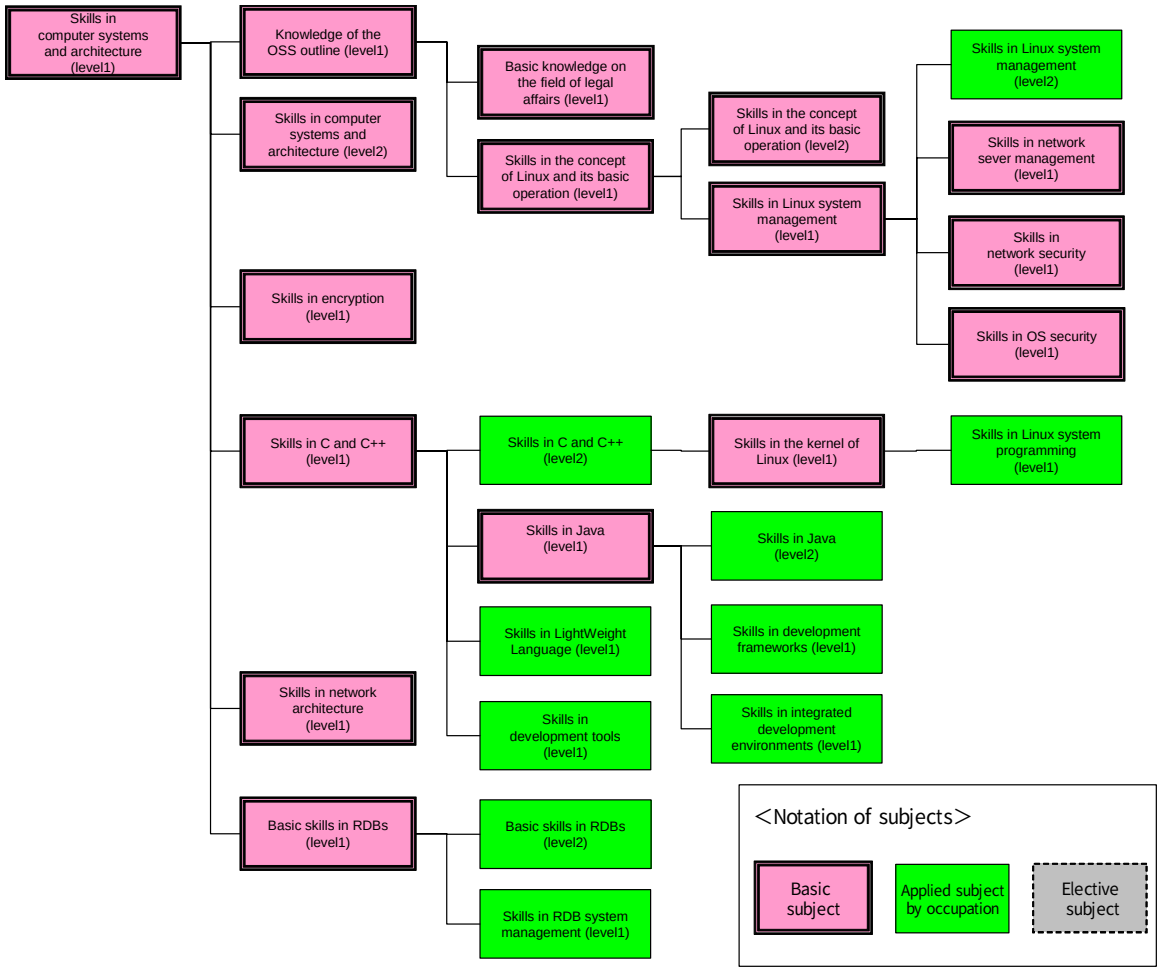


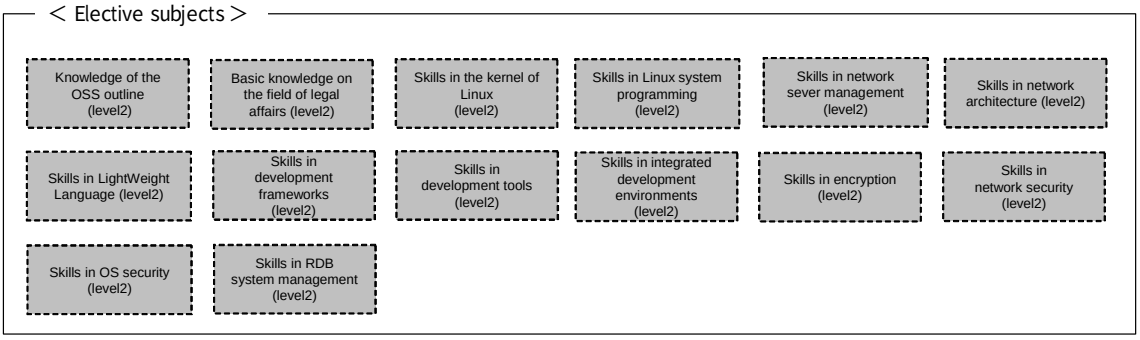
<Number of subjects>

Basic subject	16
Applied subject for IT service management	3
Elective subject	11

Figure 3　OSS model curriculum envisioned in universities, colleges and special schools

(Application development human resources (enterprise))

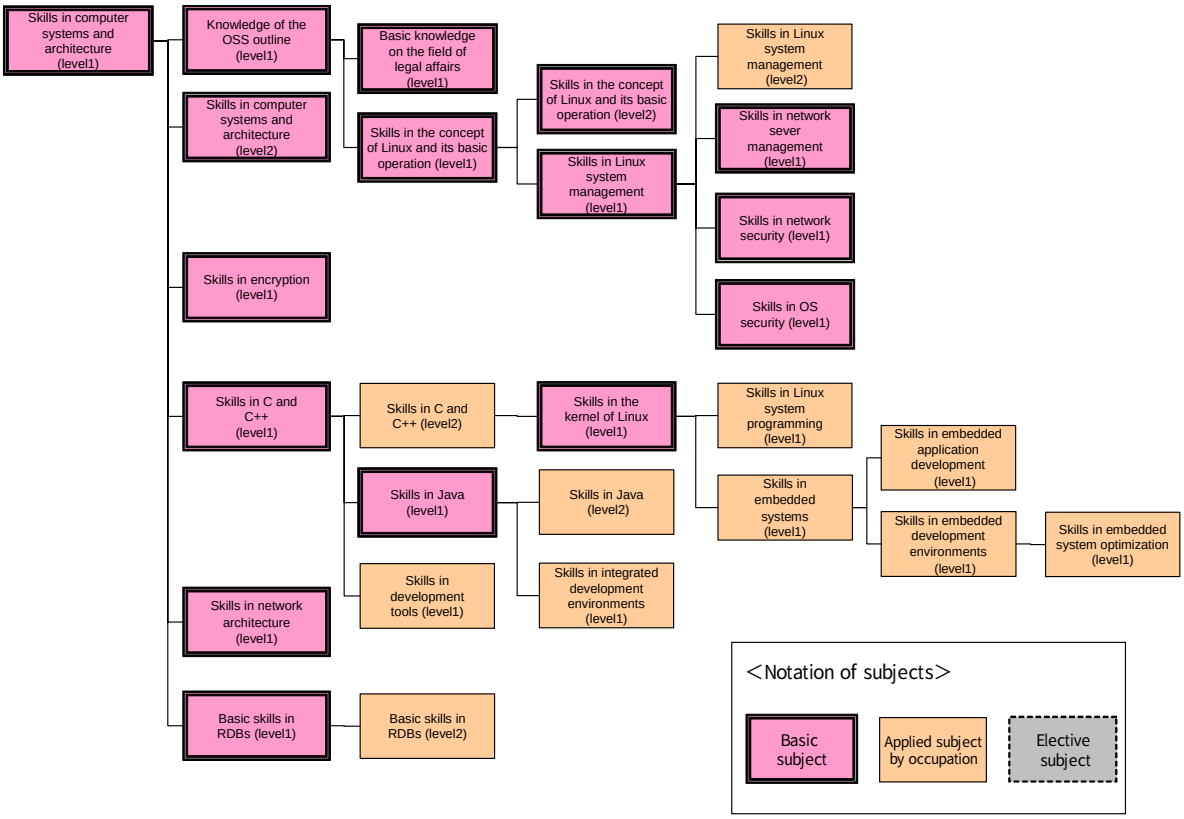


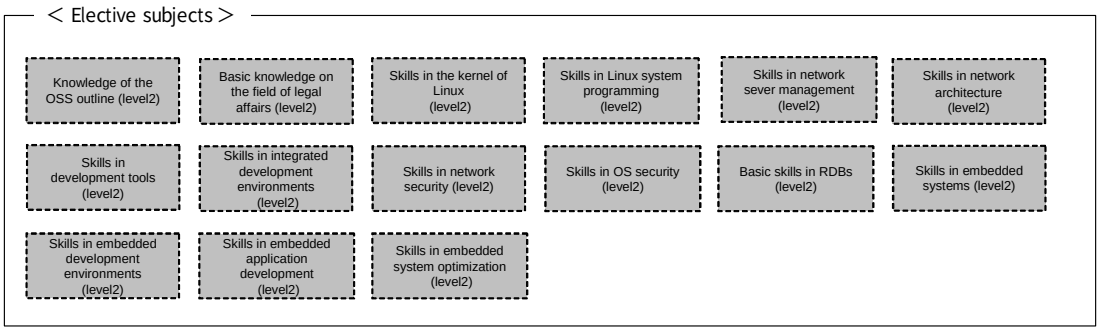


< Number of subjects>

Basic subject	16
Applied subject for application development (enterprise)	10
Elective subject	14

Figure 4　OSS model curriculum envisioned in universities, colleges and special schools (Application development human resources (embedded))

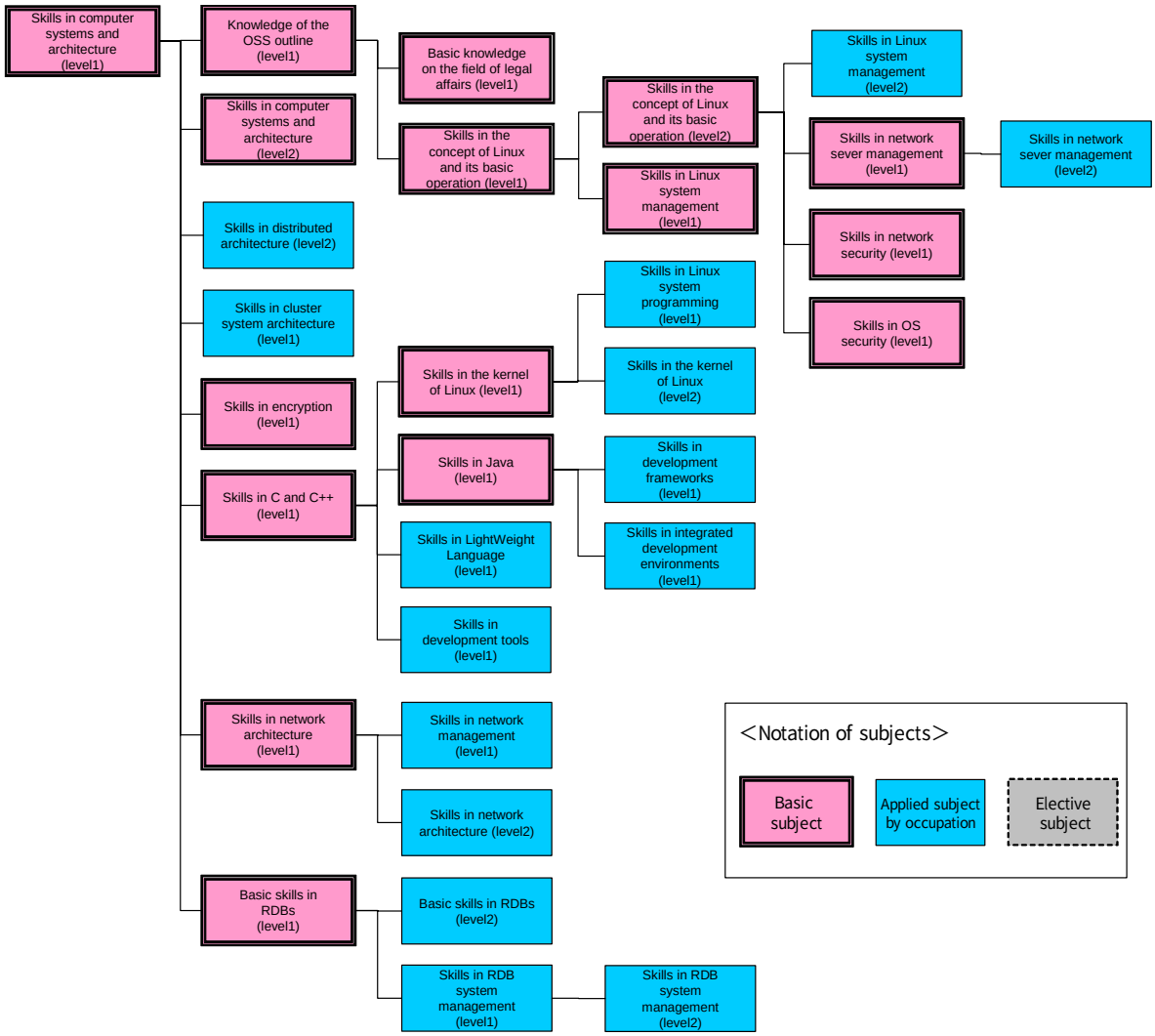


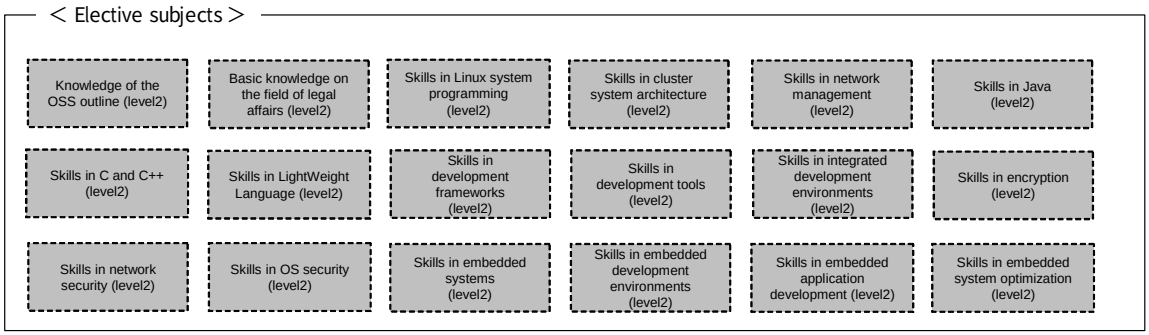


＜ Number of subjects＞

Basic subject	16
Applied subject for application development (embedded)	11
Elective subject	15

Figure 5　OSS model curriculum envisioned in universities, colleges and special schools (IT specialist human resources)





< Number of subjects>

Basic subject	16
Applied subject for IT specialist	15
Elective subject	18

2. OSS model curriculum envisioned training-related divisions in enterprises and IT training centers

(1) Envisioned human resources

The following four types are envisioned as mid-carrier human resources who work using acquired OSS skills in user companies and SI businesses.

IT service management

In IT investment activity using OSS, they deal with review of system operation ability, examination of production migration planning and planning, implementation, monitoring and failure response management of system operation in the area from development to operation/maintenance.

They have more than 1-2 years (equivalent to complexity and size of level 3 or higher) of experience and achievement of specialized operation following the specified management system and manual as members of a project team.

Application specialist (enterprise、embedded)

In IT investment activity using OSS, they deal with design, development, operation support and maintenance support of application component and establish application development plan collaborating with other occupations in the area from development to operation/maintenance.

They have more than once (equivalent to complexity and size of level 3 or higher) of experience of participation in a project being responsible for deliverables following existing operation standard and guidance as member of a development team.

IT specialist

In IT investment activity using OSS, they deal with analysis, design, introduction architecture, operation support and maintenance operation of system component and establish system architecture plan collaborating with other occupations in the area from development to operation/maintenance.

They have more than once (equivalent to complexity and size of level 3 or higher) of experience and achievement with successful attainment of requirements from clients (performance, restoration, availability) as members of a technical team in the specialized field.

(2) OSS model curriculum

The model curriculum that is expected to be introduced in training-related divisions in enterprises and IT training centers is proposed for the development of these four OSS engineers.

It is designed based on the following measures taking account of the result of Survey 1 and 2 (in particular Survey 2: questionnaire survey to SI businesses). The detail is described from the next page.

- The desirable subjects to learn preferentially are selected for “IT service management human resources”, “application development human resources (enterprise)”, “application development human resources (embedded)” and “IT specialist human resources” to produce mid-carrier IT human resources.
- The skills requiring higher level than that of OSS model curriculum (level 3) in universities, colleges and special schools are selected from Survey 1 and 2. The subjects that both “have a wider gap” and “require higher level” are chosen as subjects highly required.

Figure 6　OSS model curriculum envisioned in envisioned training-related divisions in enterprises and IT training centers (IT service management)

Category of skill	Name of Skill	Skill Level		
		Level 1	Level 2	Level 3
Basics	**Knowledge of the OSS outline ***			
	Basic knowledge on the field of legal affairs *			
	Skills in computer systems and architecture			
	Skills in distributed architecture			
System	Skills in the concept of Linux and its basic operation			
	Skills in the kernel of Linux			
	Skills in Linux system management			
	Skills in Linux system programming			
	Skills in network sever management			
	Skills in cluster system architecture			
Network	Skills in network architecture			
	Skills in network management			
Programming	Skills in Java			
	Skills in C and C++			
	Skills in LightWeight Language			
Development System	Skills in development frameworks			
	Skills in development tools			
	Skills in integrated development environments			
Security	**Skills in encryption ***			
	Skills in network security *			
	Skills in OS security			
RDB	Basic skills in RDBs			
	Skills in RDB system management			
Embedded SW	Skills in embedded systems			
	Skills in embedded development environments			
	Skills in embedded application development			
	Skills in embedded system optimization			

: "Basic subjects"in OSS curriculum envisioned in universities, colleges and special schools

: "Applied subjects"in OSS curriculum envisioned in universities, colleges and special schools

: "Elective subjects"in OSS curriculum envisioned in universities, colleges and special schools

: Higher level skills which are required to mid-carrier human resources by SI businesses resulted from Survey 2

Notice) Skills indicated by boldface with asterisk (*) represent the skills highly required in the questionnaire for SI businesses

Figure 7　OSS model curriculum envisioned in envisioned training-related divisions in enterprises and IT training centers (Application specialist (enterprise))

Category of skill	Name of skill	Skill level		
		Level 1	Level 2	Level 3
Basics	Knowledge of the OSS outline			
	Basic knowledge on the field of legal affairs			
	Skills in computer systems and architecture			
	Skills in distributed architecture			
System	Skills in the concept of Linux and its basic operation			
	Skills in the kernel of Linux			
	Skills in Linux system management *			
	Skills in Linux system programming			
	Skills in network sever management			
	Skills in cluster system architecture			
Network	Skills in network architecture			
	Skills in network management			
Programming	Skills in Java			
	Skills in C and C++			
	Skills in LightWeight Language			
Development System	**Skills in development frameworks ***			
	Skills in development tools			
	Skills in integrated development environments			
Security	Skills in encryption			
	Skills in network security			
	Skills in OS security			
RDB	Basic skills in RDBs			
	Skills in RDB system management			
Embedded SW	Skills in embedded systems			
	Skills in embedded development environments			
	Skills in embedded application development			
	Skills in embedded system optimization			

: "Basic subjects"in OSS curriculum envisioned in universities, colleges and special schools

: "Applied subjects"in OSS curriculum envisioned in universities, colleges and special schools

: "Elective subjects"in OSS curriculum envisioned in universities, colleges and special schools

: Higher level skills which are required to mid-carrier human resources by SI businesses resulted from Survey 2

Notice) Skills indicated by boldface with asterisk (*) represent the skills highly required in the questionnaire for SI businesses

Figure 8　OSS model curriculum envisioned in envisioned training-related divisions in enterprises and IT training centers (Application specialist (embedded))

Category of skill	Name of skill	Skill level		
		Level 1	Level 2	Level 3
Basics	Knowledge of the OSS outline			
	Basic knowledge on the field of legal affairs			
	Skills in computer systems and architecture			
	Skills in distributed architecture			
System	Skills in the concept of Linux and its basic operation			
	Skills in the kernel of Linux			
	Skills in Linux system management *			
	Skills in Linux system programming			
	Skills in network sever management			
	Skills in cluster system architecture			
Network	Skills in network architecture			
	Skills in network management			
Programming	Skills in Java			
	Skills in C and C++			
	Skills in LightWeight Language			
Development System	Skills in development frameworks			
	Skills in development tools			
	Skills in integrated development environments			
Security	Skills in encryption			
	Skills in network security			
	Skills in OS security			
RDB	Basic skills in RDBs			
	Skills in RDB system management			
Embedded SW	Skills in embedded systems			
	Skills in embedded development environments			
	Skills in embedded application development			
	Skills in embedded system optimization			

: "Basic subjects"in OSS curriculum envisioned in universities, colleges and special schools
: "Applied subjects"in OSS curriculum envisioned in universities, colleges and special schools
: "Elective subjects"in OSS curriculum envisioned in universities, colleges and special schools
: Higher level skills which are required to mid-carrier human resources by SI businesses resulted from Survey 2

Notice) Skills indicated by boldface with asterisk (*) represent the skills highly required in the questionnaire for SI businesses

Figure 9 OSS model curriculum envisioned in envisioned training-related divisions in enterprises and IT training centers (IT specialist)

Category of skill	Name of skill	Skill level		
		Level 1	Level 2	Level 3
Basics	**Knowledge of the OSS outline ***			
	Basic knowledge on the field of legal affairs			
	Skills in computer systems and architecture			
	Skills in distributed architecture			
System	Skills in the concept of Linux and its basic operation			
	Skills in the kernel of Linux *			
	Skills in Linux system management			
	Skills in Linux system programming			
	Skills in network sever management			
	Skills in cluster system architecture			
Network	Skills in network architecture			
	Skills in network management			
Programming	Skills in Java			
	Skills in C and C++			
	Skills in LightWeight Language			
Development System	Skills in development frameworks			
	Skills in development tools			
	Skills in integrated development environments			
Security	Skills in encryption			
	Skills in network security *			
	Skills in OS security *			
RDB	**Basic skills in RDBs ***			
	Skills in RDB system management			
Embedded SW	Skills in embedded systems			
	Skills in embedded development environments			
	Skills in embedded application development			
	Skills in embedded system optimization			

: "Basic subjects"in OSS curriculum envisioned in universities, colleges and special schools

: "Applied subjects"in OSS curriculum envisioned in universities, colleges and special schools

: "Elective subjects"in OSS curriculum envisioned in universities, colleges and special schools

: Higher level skills which are required to mid-carrier human resources by SI businesses resulted from Survey 2

Notice) Skills indicated by boldface with asterisk (*) represent the skills highly required in the questionnaire for SI businesses

III. Proposal for courseware

The courseware in 53 subjects suitable for the acquisition of 27 OSS-related skills is proposed. The following tables show the outline of 53 proposed subjects (26 subjects of level 1, 27 of level 2). (Yellow=level 1, light blue=level 2)

The proposal for courseware includes level 1 and 2. Level 3 is not included because the skills concerned are basically improved being used in actual operation and trainings may be provided mainly as workshops with problem solution and operational promotion using the skills acquired in level 1 and 2 envisioning concrete operations. In short, attention should be paid since the proposed courseware is classified by skills, hence it is not meet to the actual operation case that requires combination of more than two skills.

In this respect, it is advisable to consider the PBL (Project Based Learning)[2] and curriculum that utilize the advanced internship[3] schemes for the OSS model curriculum envisioned for Universities, colleges and special schools as well. More specially, due to the difficulty for students to experience the actual operation in actual project, it is important to provide them for courses based on the virtual project, which students can learn in the simulated experience by integrating multiple OSS skills they have learned respectively and utilize them. At the occasion of implementation of these curriculums, the support from industrial arena is also expected such as provided in the cultivation initiatives for leading IT specialist.

On the other hand, in the OSS model curriculum envisioned for education related department of corporations or IT training organizations, the opportunities should be prepared to learn cross-sectional and systematic way how to integrate separately learned skills and utilize them in the actual project implementation through OJT (On the Job Training).

Based on the aspects mentioned above, as a conclusion of this survey, it is expected that positive and effective application of proposed model curriculum and courseware in the Universities, colleges and special schools.

[2] This is an educational method to learn the way how to solve the problems or improve its ability through learners experiencing virtual developing project or discussing the examples of success or failure of actual project in the past by playing role of the each parties by them, and so on.

[3] This infers internship scheme implemented by the engaging in the actual operation for a month and not include the short term internship for one or two weeks.

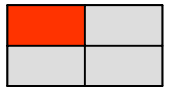


Figure 10 Outline of courseware of 53 subjects according to the acquisition of 27 OSS -related skills (1/4)

		Name of Skill	Syllabus	Course targeted at: Entrance requirements for the course	1	2	3	4	5
Basics	1	Knowledge of the OSS outline	The history and idea of OSS, typical OSS, trends for standardization, areas in which OSS is used and market trends, OSS project growth and operation, joining the OSS communities and major communities	As this curriculum is for beginners, entrance requirements are not specifically prescribed. Persons taking this course should have knowledge at the level of having mastered and experienced basic computer science (ITSS-Level-1 level).	The idea of open source	The history of open source OSes	Typical open source	Typical open source development languages	Typical open source applications
	2	Basic knowledge on the field of legal affairs	Basic knowledge from a legal perspective including OSS-related licenses	Persons taking this course should have taken the course for "Knowledge of the OSS outline" on this curriculum, or have equal knowledge.	The outline of open source licenses	Explanation of typical open source licenses [GPL type]	Explanation of typical open source licenses [MPL type]	Explanation of typical open source licenses [BSD type]	The outline of intellectual property (1)
	3	Skills in computer systems and architecture	Including CPUs, buses, DMA, I/O, POSIX and threads	As this curriculum is for beginners, entrance requirements are not specifically prescribed. Persons taking this course should have knowledge at the level of having mastered and experienced basic computer science (ITSS-Level-1 level).	The basics of computer architecture	The basics of computer hardware	The basics of CPU architecture	The basics of disks and peripheral equipment	The basics of interface technology
	4	Skills in distributed architecture	Including statistical probability theory, traffic theory, RIP/OSPF and CORBA	[Level 1] ・Persons taking this course should have experience in using basic Internet applications such as Web browsers and e-mail. ・They should understand OS fundamental concepts including files, directories and processes. ・They should have a rudimentary knowledge about probability. [Level 2] ・Persons taking this course should have experience in using more than one programming language.	What is distributed architecture?	Name management	Duplicate management	Fault tolerance	Secure channels
System	5	Skills in the concept of Linux and its basic operation	Concept organization and basic operation	It is desirable that persons taking this course should have taken courses for skills in computer systems and architecture, and a basic knowledge of the OSS outline. They also should have knowledge at the level of having mastered and experienced basic computer science and the basics of security engineering (ITSS-Level-1 level).	The outline of Linux	File operation		Users' authority and its management	
	6	Skills in the kernel of Linux	Including kernel structure, processes, threads and schedulers	Persons taking this course should have knowledge at the level of having mastered and experienced basic computer science and the basics of security engineering (ITSS-Level-1 level).	A general introduction to the kernel of Linux	Scheduling	Interrupts and delay	System calls	Process management
	7	Skills in Linux system management	Including installation, kernel configuration, boot configuration, network configuration, packaging management, user management, file management, service management, device management, log management and backup	Persons taking this course should have taken the course for "the concept of Linux and its basic operation" on this curriculum, or have equal knowledge.	The outline of Linux system management work	Linux system and server management	Linux system and file/disk management	Linux system and user management	Linux system management, and backup and log operation management
	8	Skills in Linux system programming	Including shell programming, threads, file input/output programming, network programming, shared memory, semaphores, queues and problem identification	Persons taking this course should have taken the course for "Linux system management" on this curriculum, or have equal knowledge.	Log-in and compilation procedures	Shell programming	File input/output programming	File systems	UNIX environments
	9	Skills in network sever management	Including WEB application servers, network infrastructure, file servers and troubleshooting	Persons taking this course should have taken the course for "the concept of Linux and its basic operation" on this curriculum, or have equal knowledge.	Functions and features of network servers	Server system installation	Name server installation	Web server installation	Details of mail server installation and its work procedures
	10	Skills in cluster system architecture	Including failsafe HPC and Enterprise Systems	Persons taking this course should be SEs who construct and design HA clusters and HPC clusters. They should be persons with experience in programming in C and Fortran, who can install Linux and set up its configuration.	A general introduction to cluster systems and HA clusters - 1	HA clusters - 2	HA clusters - 3	Computer simulation	A general introduction to parallel programming
Network	11	Skills in network architecture	A general introduction to TCP/IP	Persons taking this course should have knowledge at the level of having mastered and experienced basic computer science and the basics of security engineering (ITSS-Level-1 level).	The concept and mechanism of open networks	Communications forms and protocols	The mechanism of Internet communications	The mechanism of LAN networks	Types of wireless networks and the mechanism of communications
	12	Skills in network management	Computer network creation and operation	Persons taking this course should have been involved in network operation as a person in charge, or can understand design requirements for the systems of which they are in charge.	The outline of network system operation	Individual items and details of network management	Individual items and details of network capacity management	Individual items and details of network performance management	TCP/IP management

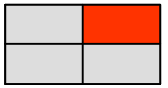


Figure 11 Outline of courseware of 53 subjects according to the acquisition of 27 OSS -related skills (2/4)

	6	7	8	9	10	11	12	13	14	15
1	Market trends in open source	Examples of systems using open source software	Open source software communities	Open source software businesses	Open source technical information acquisition methods	Open source OS installation and operation check	Open source server product installation and operation check	Open source desktop application installation and operation check	Open source server side application installation and operation check	Open source virtualization tool installation and operation check
2	The outline of intellectual property (2)	Points to be considered from the perspective of intellectual property at the time of using OSS	Points to be considered from a legal perspective other than intellectual property at the time of using OSS	Legal risk management by corporations/organizations etc.	Businesses prepared for legal risks	Legal risk reduction measures to be considered by OSS development communities	Legal risk reduction measures to be considered by OSS-business-related corporations	Examples of lawsuits/troubles in connection with OSS intellectual property issues	Controversy over patents for software	Guidelines for patent applications associated with intellectual property
3	Software architecture	OS architecture	Types and features of middleware	Computer system configuration	Examples of system architecture utilization	Web system architecture	Infrastructure design casework by using OSS	Open source system architecture creation	Hardware as an OSS operating environment	Future trends in open source architecture
4	An Introduction to CORBA - 1	An Introduction to CORBA - 2	An Introduction to Web services - 1	An Introduction to Web services - 2	An Introduction to MashUp	Distributed transactions	Peer-to-peer architecture	Mobility	Consistency	Examples of large-scale distributed systems
5	System management			File systems		Data saving and backup		Shell scripts and development environments		The basics of networks
6	Memory management (1)	Memory management (2)	Memory management (3)	File management (1):virtual file systems	File management (2):file operation	File management (3):special files	Networks (1): socket interfaces	Networks (2): IP and UDP	Networks (3): UDP and TCP	Networks (4): TCP flow control and congestion control
7	Linux system and resource management	Linux system and kernel management	Linux system and network management	Linux system and routing management	Linux system management, and DHCP construction and operation	Linux system management, and FTP construction and operation	Linux system management, and NFS construction and operation	Linux system management, and Samba building and operation	Linux system management and basic operation work troubleshooting	Linux system management and network troubleshooting
8	The use of libraries and their construction procedures	Data management	Software development environments	Debugging	Processes and threads	Signals	Communications between processes and pipes	Input/output to/from terminal equipment	Semaphores, shared memory and message queues	Network programming
9	Superserver installation	Proxy server installation	Details of other network server installation work and its work procedures	Routing processing and filtering processing implementation by network servers	Internet connection via network servers	Server operation management tasks	Log management details and procedures	Linux server security	Linux service security	Functions and implementation of secure OSes
10	Parallel programming - Practice 1 - multi-thread programming		Parallel programming - Practice 2 - HPF (High Performance Fortran) and OpenMP	Parallel programming - Practice 3 - MPI (Message Passing Interface)			Beowulf PC cluster construction	SCore clusters	PC cluster-related technology	Grid computing
11	Open network communications specifications	The mechanism of IP networks	The mechanism of routing	Routing protocol specifications	The mechanism of TCP	Communications protocol operation check	The mechanism of TCP applications - Web	The mechanism of TCP applications - FTP	The mechanism of TCP applications - TELNET	New network architecture
12	Network server operation management practice	Network hardware operation management	The outline of network management protocols	Exercising network management by the use of MRTGs	Network operation design	Network operation design	Operation management practical procedures and its system	WAN operation management	Network fault management	Network troubleshooting

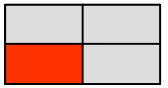


Figure 12 Outline of courseware of 53 subjects according to the acquisition of 27 OSS -related skills (3/4)

		Name of Skill	Syllabus	Course targeted at: Entrance requirements for the course	1	2	3	4	5
Programming	13	Skills in Java	Including Applet, Servlet, JSP and EJB	Although entrance requirements are not specifically prescribed, as this curriculum is for beginners, the following requirements should be met. ・Persons taking this course should have experience in programming.	The basics of Java	Fundamental structure of Java language	Advantages of object-oriented programming	Procedures for application development in Java	Network programming in Java
	14	Skills in C and C++	Including POSIX termio, curses, gtk++ and Qt	Although entrance requirements are not specifically prescribed, as this curriculum is for beginners, the following requirements should be met. ・Persons taking this course should have experience in programming.	The basics of C	Fundamental structure of C	Character string operation	Functions	Pointers
	15	Skills in LightWeight Language	Including PHP, Perl, Python and Ruby	Although entrance requirements are not specifically prescribed, as this curriculum is for beginners, the following requirements should be met. ・Persons taking this course should have experience in programming.	The basics of LightWeight Language	Fundamental structure of Perl	Fundamental structure of PHP	Fundamental structure of Python	Fundamental structure of Ruby
Development System	16	Skills in development frameworks	Including Struts and UML	Persons taking this course should have taken the course for "Skills in Java" on this curriculum, or have equal knowledge. They should have experience in system development and programming.	What are development frameworks?	Types and features of development frameworks	Web application frameworks by the use of open source	The outline of free Web containers/J2EE containers	Open source development tools
	17	Skills in development tools	Including version management systems, debuggers, bug-tracking-down systems, system profilers and kernel debuggers	As this curriculum is for beginners, entrance requirements are not specifically prescribed. Persons taking this course should have knowledge at the level of having mastered and experienced basic computer science (ITSS-Level-1 level).	Development flow and tools	The outline of software development environments	The outline of software application development in the Linux development environments	Version management tool utilization	Program debugging environments by the use of debuggers
	18	Skills in integrated development environments	Including Eclipse, Net Beans and WideStudio	Persons taking this course should understand basic terms employed in software development and programming.	Software development in integrated development environments	A variety of integrated development environments	What is Eclipse?	What is NetBeans IDE?	What is WideStudio?
Security	19	Skills in encryption	Public key infrastructure, digital signatures, authentication and hash functions	Persons taking this course should have knowledge at the level of having mastered and experienced basic computer science and the basics of security engineering (ITSS-Level-1 level).	Security functions and encryption positioning	Encryption systems/common key cipher systems	Encryption systems/public key cipher systems	Encryption application systems in information systems	The mechanism of digital certificates
	20	Skills in network security	Firewall design/building, network intrusion analysis, log analysis, defense design against security attacks and unauthorized access techniques by exploiting TCP/IP	Persons taking this course should have knowledge at the level of having mastered and experienced basic computer science and the basics of security engineering (ITSS-Level-1 level).	The outline of network security	Virus characteristics and antivirus measures	Simplified classification of network attack methods	Unauthorized access techniques by exploiting TCP	Attacks on the Web
	21	Skills in OS security	Linux system security and security-enhanced OSes	Persons taking this course should have knowledge at the level of having mastered and experienced basic computer science and the basics of security engineering (ITSS-Level-1 level).	OS security functions	Linux server local security measures	Linux network security measures	Linux firewall building	Linux server security configuration
RDB	22	Basic skills in RDBs	Including ER models and SQL programming	Although entrance requirements are not specifically prescribed, as this curriculum is for beginners, the following requirements should be met. Persons taking this course should have knowledge at the level of having mastered and experienced basic databases and the basics of computer systems on this curriculum (ITSS-Level-1 level).	Basic database theory	Fundamental knowledge of RDBMSs	Fundamental concepts of transactions	Database components	The outline of DOA
	23	Skills in RDB system management	Installation, configuration and tuning of MySQL, FireBird, PostgreSQL etc.	Persons taking this course should have taken the course for "Basic skills in RDBs" on this curriculum, or have equal knowledge. They should have experience in system development and programming.	Purposes and items of database operation management	Database operation work and recovery from faults	Database operation design	Database security	Database recovery design
Embedded SW	24	Skills in embedded systems	System structure, development methodologies, RTOSs, sensor programming, embedded processors and architecture (including ARM9, XScale, MIPS, SH, VR, MP and 68k)	Persons taking this course should have knowledge at the level of having mastered and experienced the basics of embedded computer science which form the foundation of this curriculum, and the basics of software and hardware (ITSS-Level-1 level).	What are embedded computer systems?	Embedded computer architecture	Basic embedded system configuration	The basics of embedded computer hardware	The basics of CPU architecture
	25	Skills in embedded development environments	Cross compile tools, toolchains (make, adb.minicom, Jflash, boothroad, tftp and tinybox) and GUI programming (GTK+, QT, Qtopia)	Persons taking this course should have knowledge at the level of having mastered and experienced the basics of embedded computer science which form the foundation of this curriculum, and the basics of software and hardware (ITSS-Level-1 level).	Embedded development flow and environments	The outline of embedded development environments	Development procedures in embedded development environments	Program debugging environments	Debugging environments by the use of debugger software
	26	Skills in embedded application development	Including VM, J2ME, UPnP, SMS and WAP protocols	Persons taking this course should have knowledge at the level of having mastered and experienced the basics of embedded computer science which form the foundation of this curriculum, and the basics of software and hardware (ITSS-Level-1 level).	Tasks and contexts	Asynchronization and synchronization design specifications	Task priority and its control specifications	Technology of resource allocation among embedded applications	Technology of resource sharing among embedded applications
	27	Skills in embedded system optimization	Low-powerization, device programming and parallelization	Persons taking this course should have taken the course for "Skills in embedded systems" under this curriculum system, or have knowledge at the same skill level.	Multiprocessor systems	Optimization by hardware	Real-time system design	Requirements for real-time software and optimization	Evaluation items in performance optimization

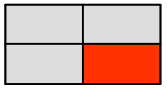


Figure 13 Outline of courseware of 53 subjects according to the acquisition of 27 OSS -related skills (4/4)

	6	7	8	9	10	11	12	13	14	15
13	The outline of Web application development according to Servlet/JSP/JDBC	Database access according to JDBC	MVC models	Application development according to EJB	Features of and design methods for Server processing implementation in Java	Web application design/implementation in Java	Server Side Java/Web application implementation in Java	Object-oriented system analysis/design/implementation practice technology	Development procedures according to design patterns	Java performance tuning
14	Structures	Console input/output	File management	Data structure	The basics of C++	Fundamental structure of C++	Object-oriented programming	STL (Standard Template Library)	GUI application development	Use of development libraries
15	Object-oriented programming	Embedded classes [data structure]	Embedded classes [data operation]	Embedded classes [file management]	GUI application development	Ruby on Rails	Database application development	Web application development	Plug-in installation and development	Open source system customization
16	Development process procedures by the use of development frameworks	Application development by the use of Ruby on Rails	What is Struts?	What are MyFace (JSF)development models?	Database connection/access frameworks	The outline of DIxAOP containers	Spring frameworks	Seasar2	Tapestry	Application development by the use of Struts
17	Debugging by the use of kernel debuggers	Debugging by the use of bug-tracking-down systems	Types and functions of open source development tools	Development procedures in integrated development environments	Types and features of open source integrated development environments	Workshops on software development in Linux development environments	The outline of software development support tools in Linux development environments	Software development tool evaluation	Workshops on software development by the use of Eclipse	Workshops on software development by the use of Eclipse
18	An Introduction to Eclipse - setup	An Introduction to Eclipse - basic operation	An Introduction to NetBeans - setup	An Introduction to NetBeans - basic operation	An Introduction to WideStudio - setup	An Introduction to WideStudio - basic operation	Java programming by the use of Eclipse	Web application development by the use of Eclipse	Web application development by the use of NetBeans	Application development by the use of WideStudio
19	OSS utilization scenes and encryption	Wireless LAN encryption	Authentication and encryption	Encrypted communications by the use of IPsec	Tunneling by the use of SSH	The mechanism of SSL protocols	VPN communications establishment	The mechanism of PKI (public key encryption infrastructure)	Authentication infrastructure building hands-on training	Encryption - future utilization scenes and issues
20	Unauthorized access techniques by exploiting IP	TCP/IP network security design methods	The mechanism of access control, and firewall functions	Linux network security measures	Network vulnerability investigation	Secure network creation	Intrusion detection system specifications and installation	Intrusion detection under IDS	Network security creation	Mobile computing and remote access security
21	Secure remote access	Server VPNs and CA according to SSL	Domain name service security measures	E-mail security measures	Web security measures - 1	Web security measures - 2	File service security measures	System log management	Linux intrusion detection methods	Server security audits and configuration automation
22	Basic database design theory	ER models	Normalization procedures and methods	Database indexes	The database physical structure	Database access in SQL	Workshops on SQL hands-on exercises	Typical open source RDBMS products	Database design/creation practice	Database creation
23	Database optimization	Database troubles	Database tuning	Database creation	Performance improvement by the use of database indexes	MySQL installation and operation	Database troubleshooting	Database operation environment creation	Database operation	Database tuning
24	The outline of embedded software	The outline of kernel processing	Configuration and the mechanism of real-time systems	Embedded system development methods	Embedded system analysis and modeling through object-oriented analysis	Embedded computer system development management	Embedded system architecture	Embedded system network functions	Embedded system design	Future trends in embedded systems
25	Debugging environments by the use of ICEs	Debugging by the use of toolchains	Embedded application debugging procedures	Examples of embedded applications and development environments	Embedded cross development environment creation	Characteristics of GNU development environments	Embedded application development in GNU development environments	The latest debugging environments for embedded Linux development	Embedded development environment evaluation	Debugging pattern exercises in embedded development environments
26	Effective resource utilization architecture	Technology of effective program resource utilization	Effective utilization of resources in input-output queues	Input/output resource management	J2ME specifications	The outline of VMs and their utilization	High-reliability implementation	Case studies of embedded application implementation	Design casework by utilizing critical microcomputer applications	Embedded application software implementation
27	Software optimization	MPU performance optimization design	System performance requirements and evaluation items	System performance evaluation methods	Performance evaluation method classification	Expandability evaluation	System resource tradeoffs	Tradeoffs between basic software and application software	Embedded system optimization system design	Items to be considered for optimization

Survey 5

Proposal for the model curriculum

Report【Summary】

INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN