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Learning Styles for e-learning Systems over Virtual Desktop Infrastructure*

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QoS (Quality of Service)

of the VDI (Communication line)

↑

V.S

↓

QoE (Quality of Experience)

of the e-learning (Applications)

mesured by MOS (Mean Opinion Score)

Out line of this paper

I.   Introduction

II.   e-learning over the VDI

    A. Learning styles for e-learning   ・Seven basic Operations are extracted

    B. The VoD for e-learning   ・Advantages and Disadvantage over VDI

III. Preliminary

    A. Current state of quality of mobile network: to include the mobile learning

    B. Usability of mobile terminal: to show the difference of the usability between PC and tablet

IV.   Experiments by using network emulators : Main Investigations of this paper

    A. Conditions of experiments   ・Only for PC

    B. Experimental methods and their results

V.   Discussions

    A. Discussions for the experiments

    B. Remarks for the experiments

VI.   Concluding remarks

I.   Introduction

- [e-learning]
  Learning styles which achieve high learning effect by using ICT (Information and Communication Technology).

- [Learning style]
  Learning method, form, type or manner of each learner who has an individuality for given learning environment.

- We expect that we can create the innovative learning style by using ICT.

ICT

・High speed networks + cloud computing technology

・various kinds of computers (PC, tablet, smart phone, etc.)

・Video on Demand (VoD) contents for e-learning

Virtual Desktop Infrastructure (VDI)

・strengthened security, reduced management cost, etc.

・Advantage of the VDI for e-learning

: to provide the identical learning environment to the learner at
  any time and at any place.

・Disadvantage of the VDI for e-learning

: the quality of the screen images on the desktop is affected by
  the quality of service (QoS) of the network, since the screen
  images are transferred to the client from the server by a screen
  transfer protocol.

  →QoS v.s. QoE

II.   e-learning over VDI

A.   Learning styles for e-learning

Video on Demand (VoD) / Web Based Training (WBT) contents

TABLE I. BASIC OPERATIONS IN e-LEARNING STYLES

Works	Basic operations
[I] Production works such as report, presentation contents	(1)Typing characters and sentences
	(2)Editing documents using MS Word
	(3)Drawing figures using PowerPoint
[II] Learning by e-learning contents	(4)Selecting radio buttons on the Web
	(5)Listening audio on the Web
	(6)Watching video on the Web
	(7)Learning the WBT contents

B.   The VoD for e-learning

Advantages of the VDI for e-learning:

- If the learner quits out of his or her work, he or she can restart it with the same environment at all times.
- The learner can restart it at any terminals (including the OSs and their product versions).

Mobile Learning

VoD
・ Any where
・ Any time

PC at university   Internet   server

Transferring
the screen image of the desktop
to client from server

PC at home   smart phones
tablet terminal

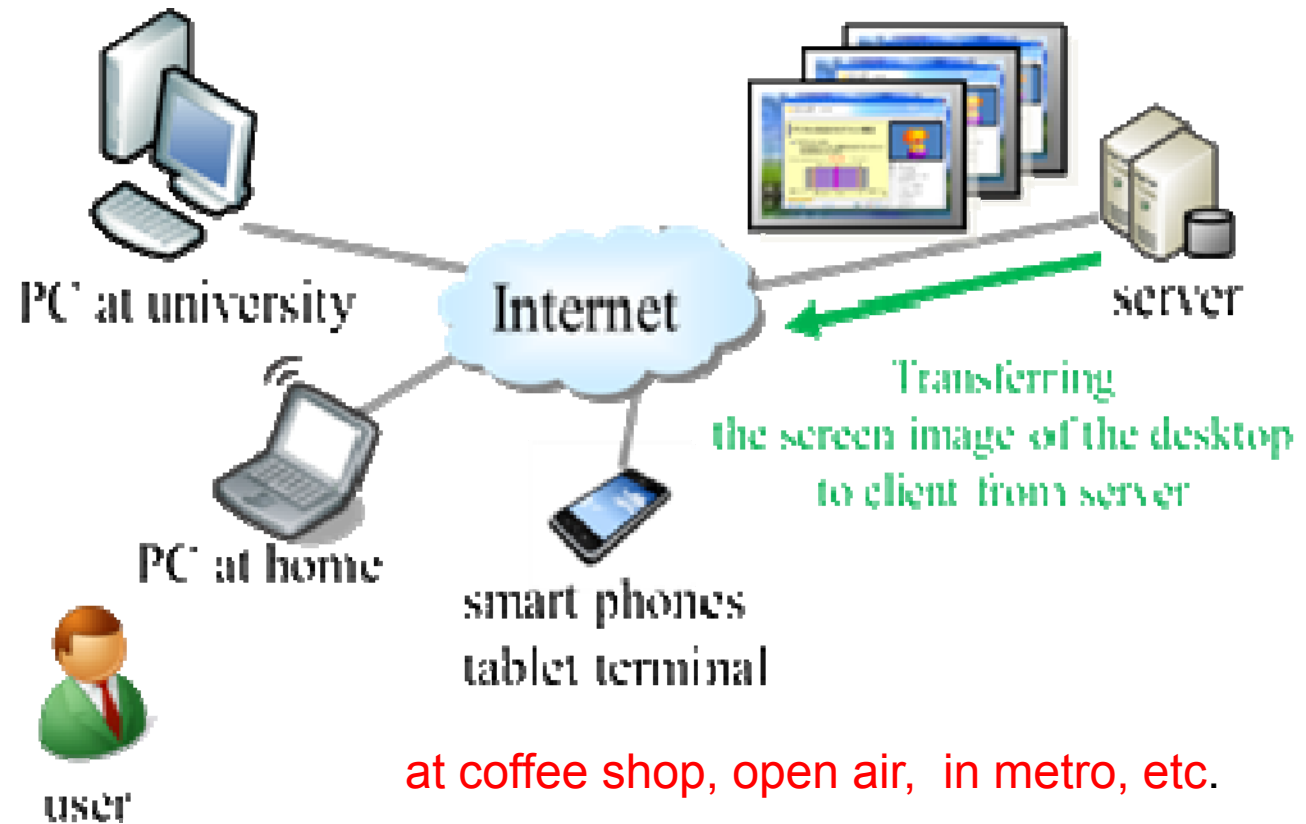user   at coffee shop, open air, in metro, etc.

Fig.1.The conceptual diagram of e-learning with the mobile terminals

III. Preliminary

A. Current State of Quality of Mobile Network
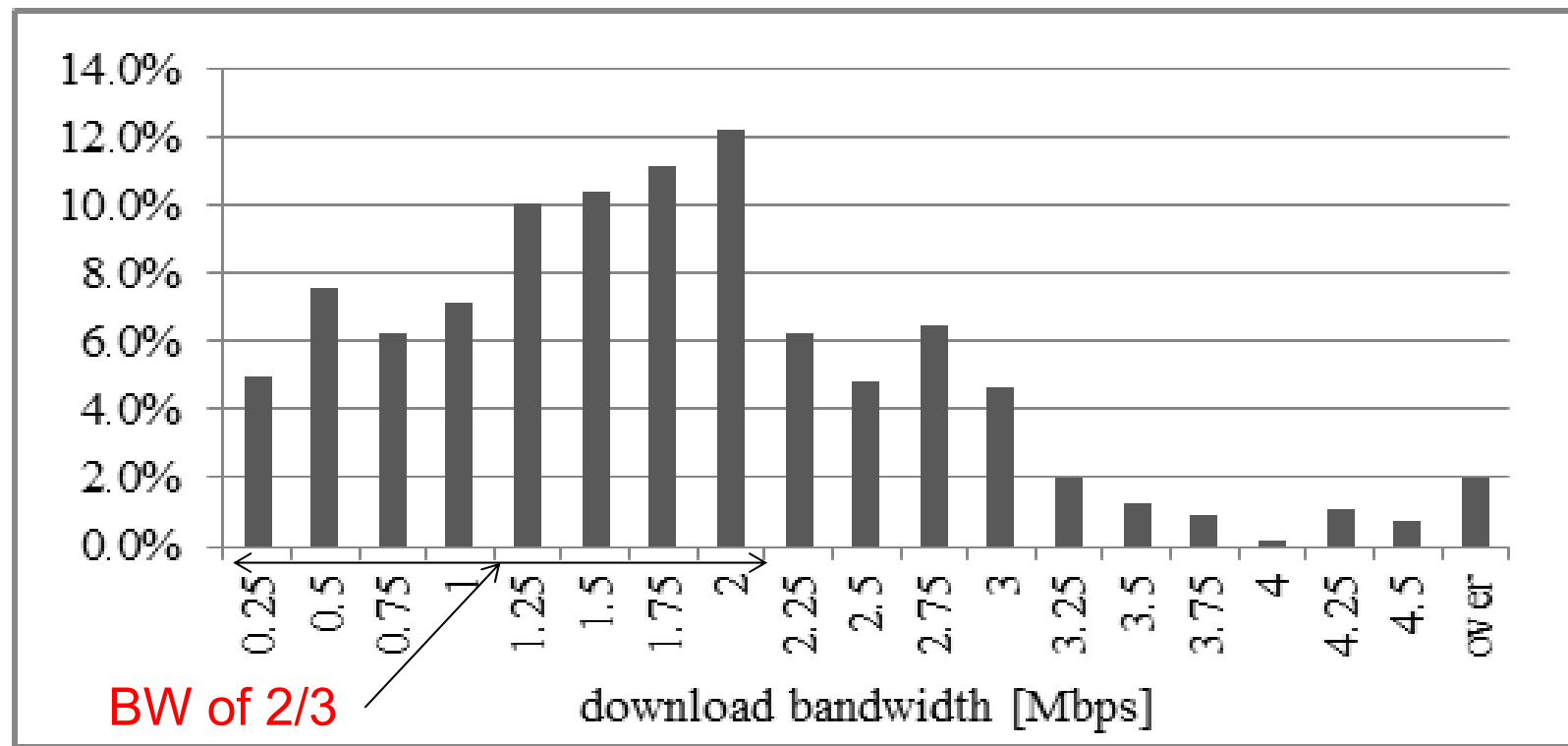
■ BW (bandwidth) for mobile network

Fig. 2. The actual distribution of the BW (bandwidth) for Japanese mobile carriers

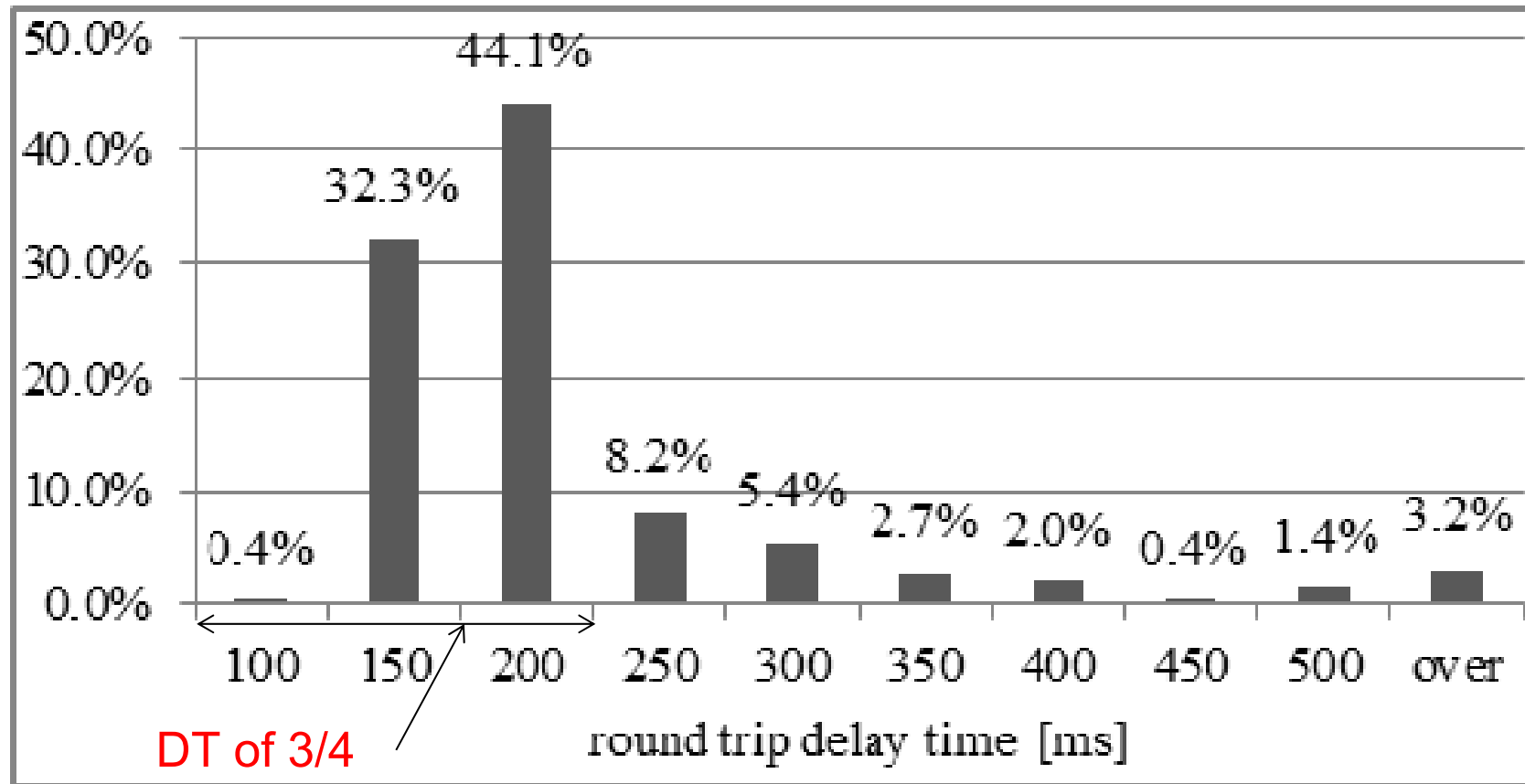■ DT (round-trip delay time) for mobile network

Fig. 3. The actual distribution of the DT (round-trip delay time)for Japanese mobile carriers
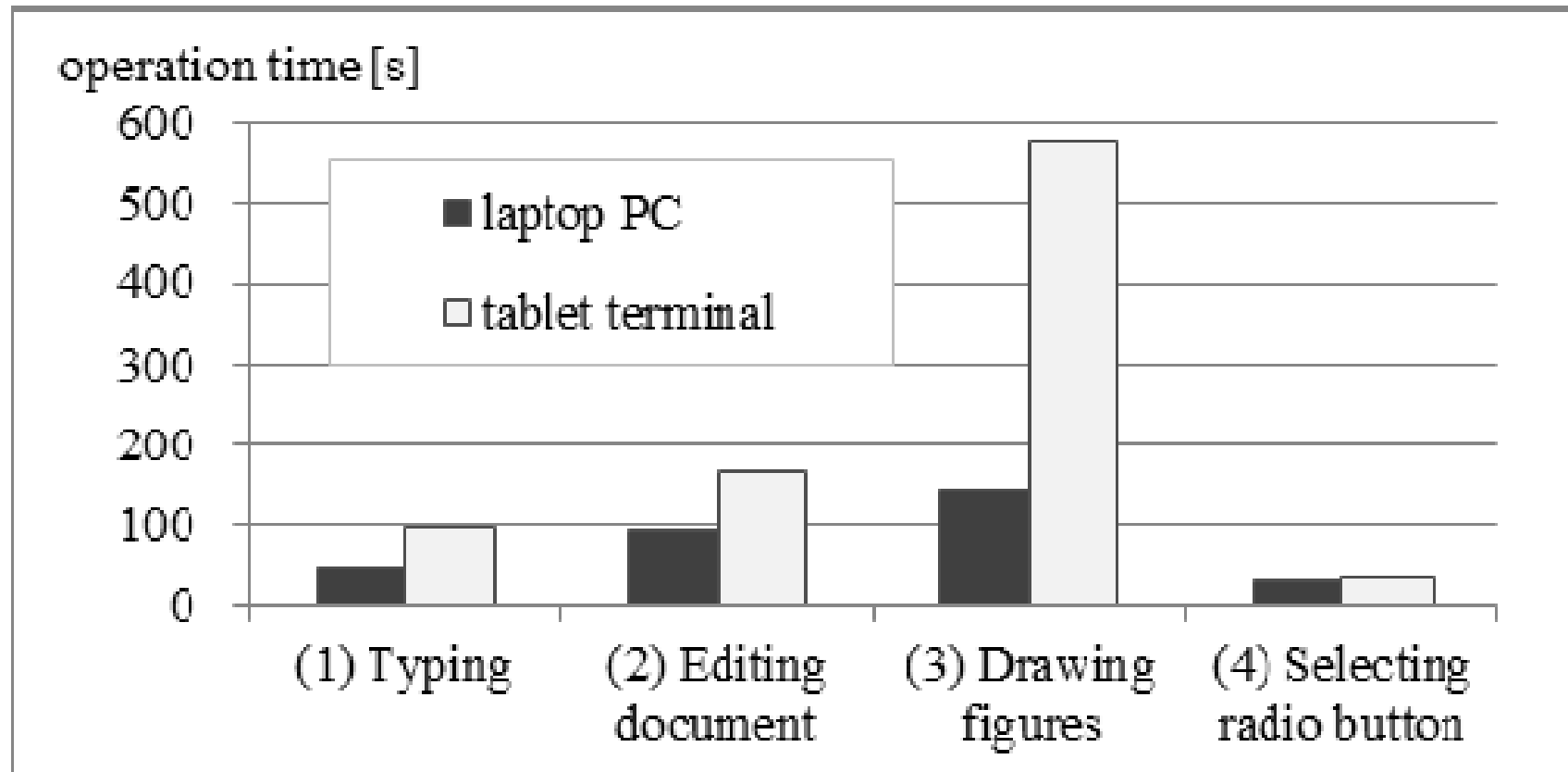
B.   Usability of Mobile Terminal

Fig. 4. Influence of usability of terminals for various operations

IV.   Experiments by using network emulators

・ the quality of the mobile network

・ the usability of the mobile terminals

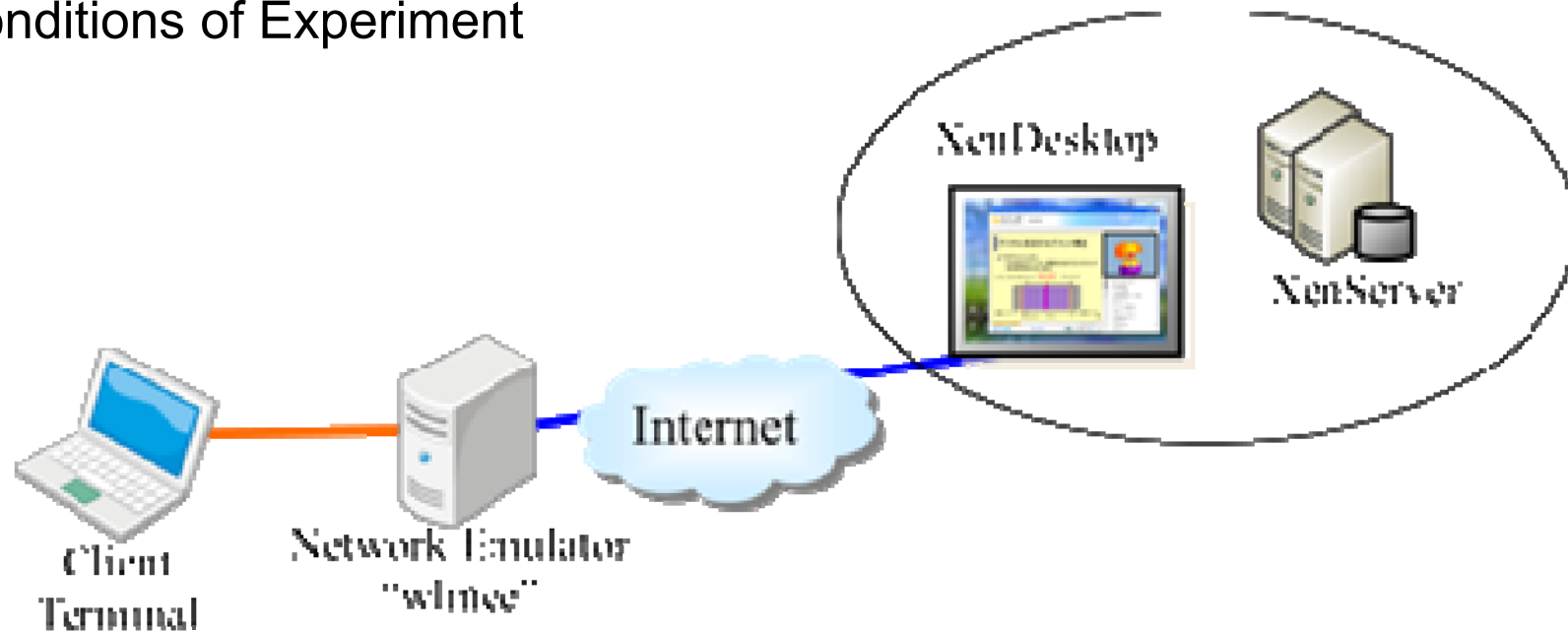→evaluate hereafter by only the case of the PC

A.Conditions of Experiment

Fig. 5: Configuration of experimental environment

Conditions of Experiment

(1)　Client Terminal: Laptop PC by Hewlet-Packerd Co.
- ・Desktop: 15-inch (resolution: 1280 × 800)
- ・Main Storage: 1 [GB]
- ・HDD: 20 [GB]

(2)　Network Emulator: wlinee

(3)　Screen Transfer Protocol: ICA by Citrix Systems Inc.

(4)　Virtualized Desktop Infrastructure (VDI) : XenDesktop
　　　 and XenServer

(5)　Subjects: Students of around 20 years old

(6)　Number of Subjects : 10

(7)　Duration of Experiment: May-July 2012

■The typical QoS of the Internet is given by

　　　Bandwidth (BW) : approximately 2.2 [Mbps]
　　　Round-trip delay time (DT) : approximately 40 [ms]

B.   Experimental Methods and their Results

Method: 7 basic operations shown in Table I by students

x-axis: BW (band width), or DT (round-trip delay time) ←QoS

y-axis: objective (operation time), or subjective (MOS: 5 levels*) ←QoE

(i) Evaluation for the effect of the BW: For the fixed DT=40 [ms]

(typical QoS of the Internet)

(ii) Evaluation for the effect of the DT: For the fixed BW>2.2M[bps]

(typical QoS of the Internet)

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* 1 to 5, i.e., the lowest point 1 to the highest point 5. Based on ITU-T P.800 , the average (MOS: Mean Opinion Score) is used [4][5].

TABLE A-I. Actual Movements for Basic Operation

Works	Basic operations	Actual Movements	Evaluations
[I]	(1)Typing characters and sentences	The Hiragana input by typing software	OE: in [# of characters/min]
	(2)Editing documents using MS Word	The Japanese text input using the MS Word	OE: in [# of characters/min] SE: the MOS
	(3)Drawing figures using PowerPoint	Drawing the 12 squares at a specified location along the grid lines by operation of the mouse.	OE: in [# of squeres/sec] SE: the MOS
[II]	(4)Selecting radio buttons on the Web	Selecting 1 among 5 items for 12 sets executed by the radio buttons on the Web.	OE: in [# of squeres/min] SE: the MOS
	(5)Listening audio on the Web	Listening the reproduced audio signal using the site of the NHK radio news	SE: the MOS
	(6)Watching video on the Web	Watching the reproduced video signal using the site of YouTube and TBS Newsi	SE: the MOS
	(7)Learning the WBT contents	Learning the WBT contents by Web learning plaza provided by JST	SE: the MOS

OE: Objective Evaluation

SE: Subjective Evaluation

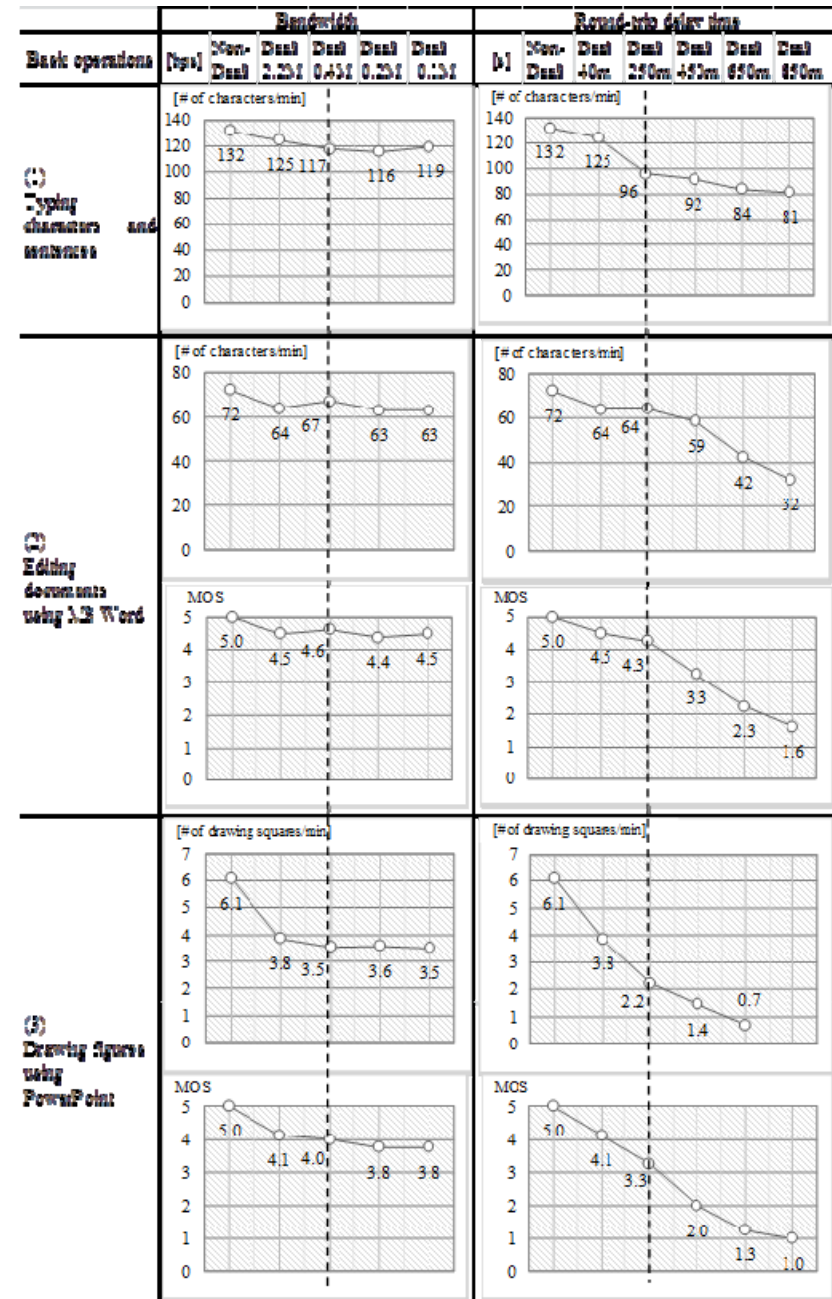MOS: Mean Opinion Score

[I] Operations related to production works such as documentation

[Notes] Dotted line shows:

BW: 0.4 M [bps]

DT: 250 m [sec]

Fig. 6 [I]: Evaluations for [I] production works such as report, presentation contents
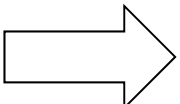
Example of (2): Japanese Document Input using MS Word Japanese:

Roman character→ Kana character→ Kanji character

wa	→	わ		
se	→	せ	⇨	早稲田
da	→	だ		

Roman-Kana conversion   Kana-Kanji conversion

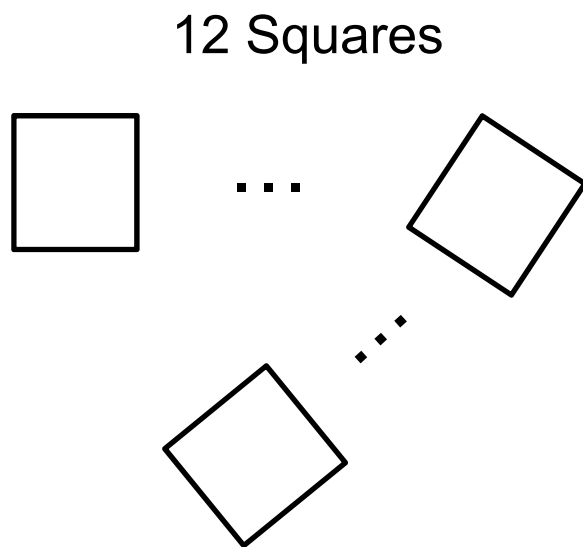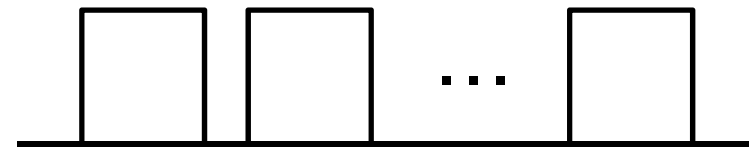## English:

Waseda

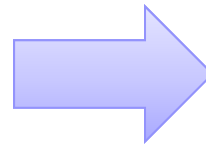# Example of (3): Drawing figures using PowerPoint

[Before]

[After]

12 Squares
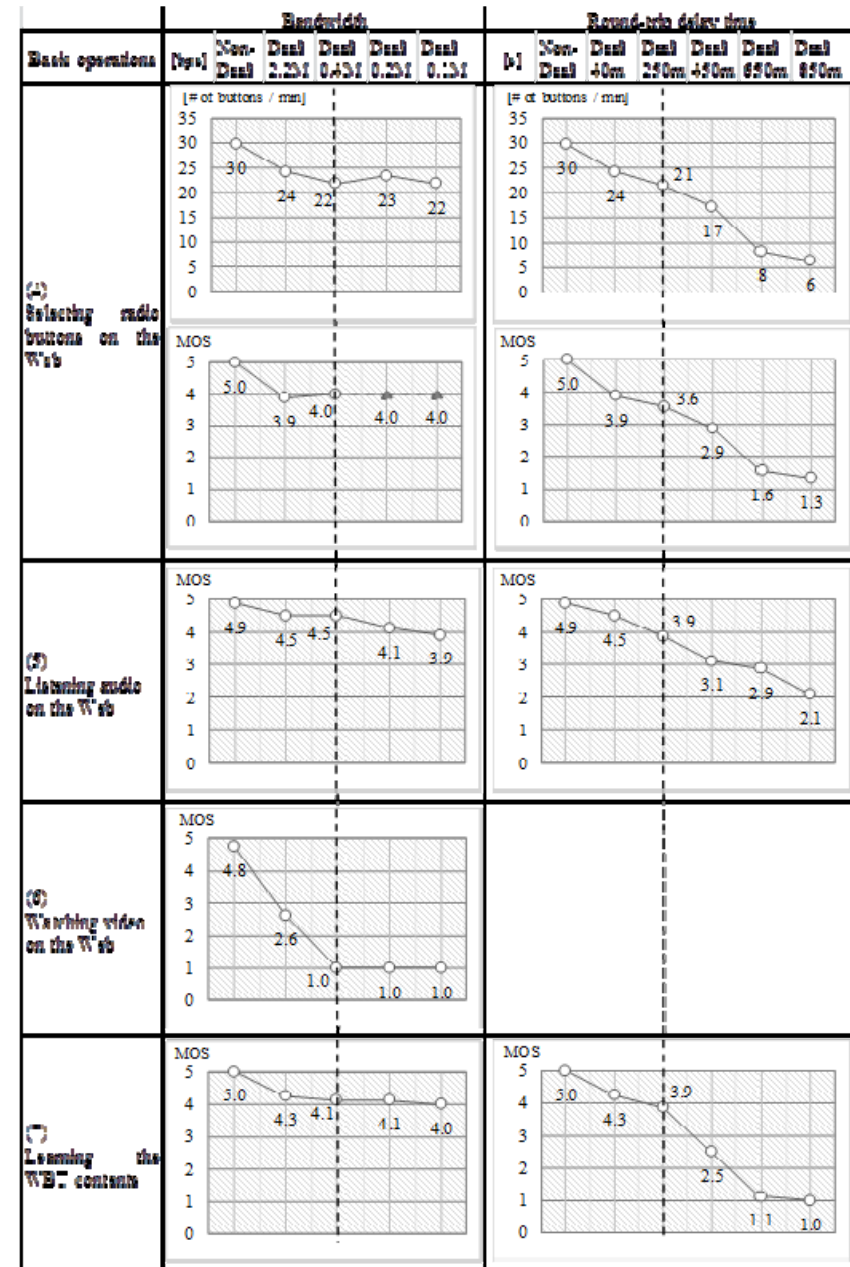
[II] Operations related learning by e-learning contents such as VoD and WBT

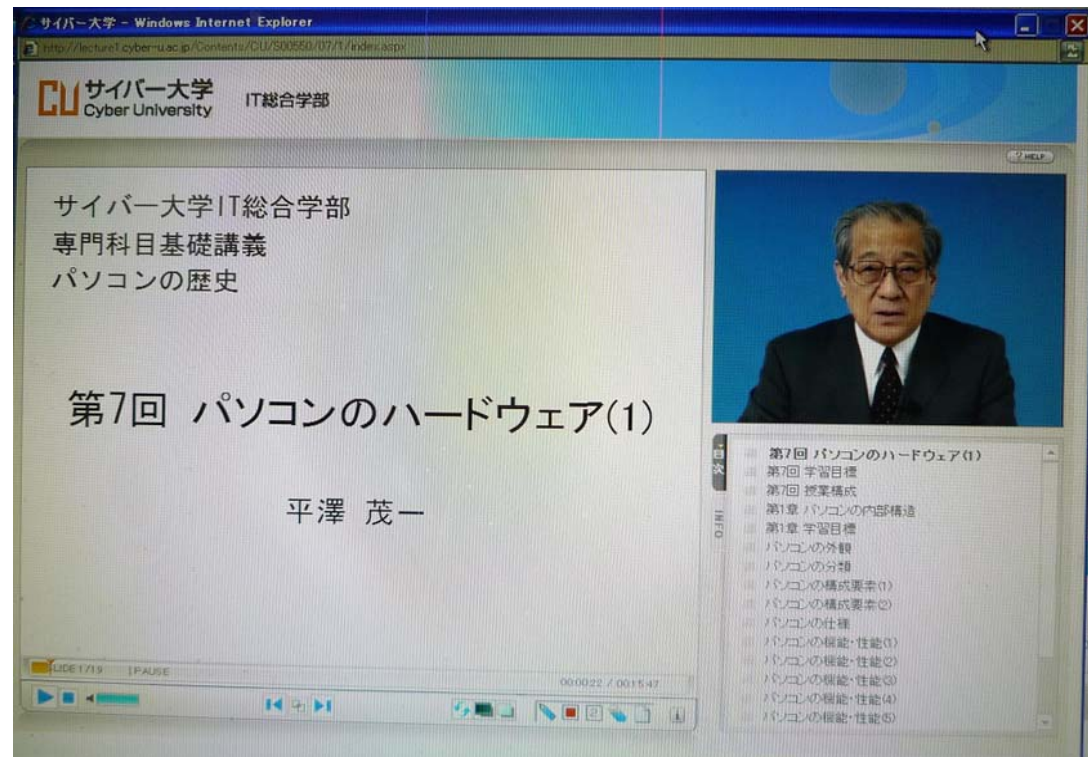[Notes] Dotted line shows:

BW: 0.4 M [bps]

DT: 250 m [sec]

Fig.6 [II]: Evaluations for [II] learning by e-learning contents such as VoD and WBT

Example of (6) : Watching the Reproduced Video signal using VoD Contents

Example of image of VoD contents

V.   Discussions

A.   Discussions for the Experiments

TABLE A-II: Experimental Results
and Discussions

Works	Basic operations	MOS		Discussions
		BW	DT	
[I]	(1)Typing characters and sentences			Increasing of the DT affects to responsibility, i.e.quick indicating the inputted cractors.
	(2)Editing documents using MS Word	4.6	4.3	The influence of the DT exceeds 650 [ms] (in case where the 3G network for mobile phones can be occured) is large: Since the the Kana-kanji conversion is necessary, the real-time interactivity is required.
	(3)Drawing figures using PowerPoint	4	3.3	This operation which requires fine cursor positioning such as drawing, the tracking of the pointer is important, hence it is more sensitive to the DT.
[II]	(4)Selecting radio buttons on the Web	4	3.6	Since the operation of the pointer requires to follow in real time even for the case of relatively simple in the mouse operation like the choice of the radio buttons. The work which requires the mouse operation is not suitable for the case of the DT exceeding 400 [ms].
	(5)Listening audio on the Web	4.5	3.9	We can permit relatively large DT, since the audio signal reproduction does not need to quick response.
	(6)Watching video on the Web	1		The video signal reproduction is dominated by the BW in contrast to other operations, i.e., watching the video contents is intolerable even the condition of the BW around 2.2 [Mbps]. If the resolution is small, for instance, in the VoD contents only a portrait of a lecturer with small size video images (e.g., 20 frames/second, and 240x400 pixels) is displayed, it may be improved.
	(7)Learning the WBT contents	4.1	3.9	Comparering to watching video, although the contents include animation, the BW assumption is small, since the animation does not require a large BW. The DT exceeding 450 [ms] brings degradation in usability of the mouse operation.
		BW=0.4 [Mbps]	DT=250 [ms]	

White: High Score   Green: Medium Score   Red: Low Score

B.   Remarks for the experiments

- Except for the case of watching video, the influence of the   BW is small. Although the audio signal reproduction has no deterioration, the video signal reproduction has, even if the case of the BW around 2.2 [Mbps]. There are still a few effects on works of drawing figures by the Power Point

- When interactive communication to servers is necessary, the influence of the DT is large. It affects to learning styles such as producing the presentation documents or reports, and learning by the WBT contents, even if the case of the DT around 300 [ms].

- There is a possibility that the objective evaluation in application layer is fairly good estimation of the subjective evaluation (MOS) as partially shown in Figure 6 [I] and [II].

Although details are omitted here, the following are obtained by additional experiments:

- It is almost possible to evaluate by assuming that the BW and the DT are mutually independent [8].

- If the packet loss rate is less than 15 [%], there is no large influence, and the influence of the jitter is still small [9].

- The video signal reproduction is affected by the BW, but it is possible to improve by letting the ratio of the bit rate of the video signal to the BW is about 1/2. The influence of a packet delay and the packet loss is small [9].

As a conclusion, it can be noted that almost all learning styles
except for watching video are acceptable assuming

the BW > 0.4 [Mbps], and

the DT < 250 [ms]

which can be applicable to the domestic network environment such
that the server is located in Japan, and the client uses the ADSL.

VI.   Concluding Remarks

We have evaluated from a viewpoint of how much must be the QoS of the network to achieve the required QoE for the e-learning styles based on seven basic operations. As a result, we have for the mobile learning:

[I]   As working for such as producing the reports;

■The editing work can be practically tolerable by using the 3G line environment.

■There are still many problems from the stand point of the usability to operate application software for the MS Windows by tablet type terminals.

[II]   As learning by the environment of the e-learning class;

■The works which require the real-time responsiveness such as the character input or the mouse operation are affected by the DT, but even the quality of the 3G lines is acceptable.

■There is no large problem on narrow BW except for the video signal reproduction.

■It should be avoided to use the streaming of the video signal for the mobile terminals under the present conditions.

As future works, we have:

■In addition to seven basic operations of e-learning which discussed in this paper , we try to perform experiments of the other operations such as for collaborative learning and active learning.

■We clarify the guideline of the contents design methods for the applications programs which can automatically choose screen images for PCs or those for mobile terminals.

■Additional experiments are necessary for the coming networks, e.g., the 4G lines, the LTE, and the Wi-Fi spot.
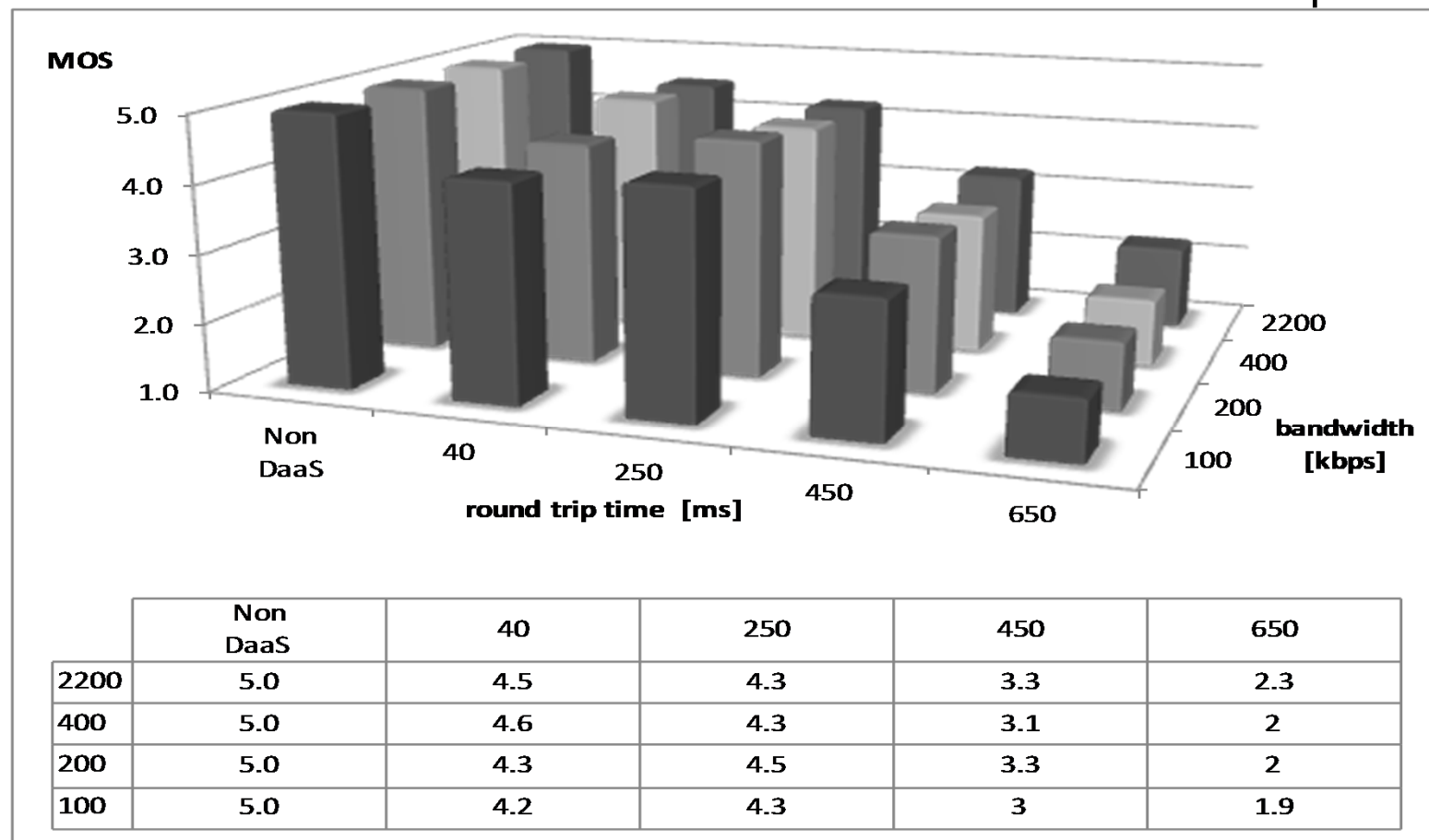
実験結果（まとめ）・・・2つのパラメータの場合（追加）

MOS: Mean Opinion Score

	Non DaaS	40	250	450	650
2200	5.0	4.5	4.3	3.3	2.3
400	5.0	4.6	4.3	3.1	2
200	5.0	4.3	4.5	3.3	2
100	5.0	4.2	4.3	3	1.9

図4.A1: 平仮名入力に対する主観評価

MOS: Mean Opinion Score

	Non DaaS	40	250	450	650
2200	5.0	4.1	3.3	2.0	1.3
400	5.0	4	3.2	1.8	1.2
200	5.0	4	3	2.1	1.1
100	5.0	3.9	3.2	1.8	1.1
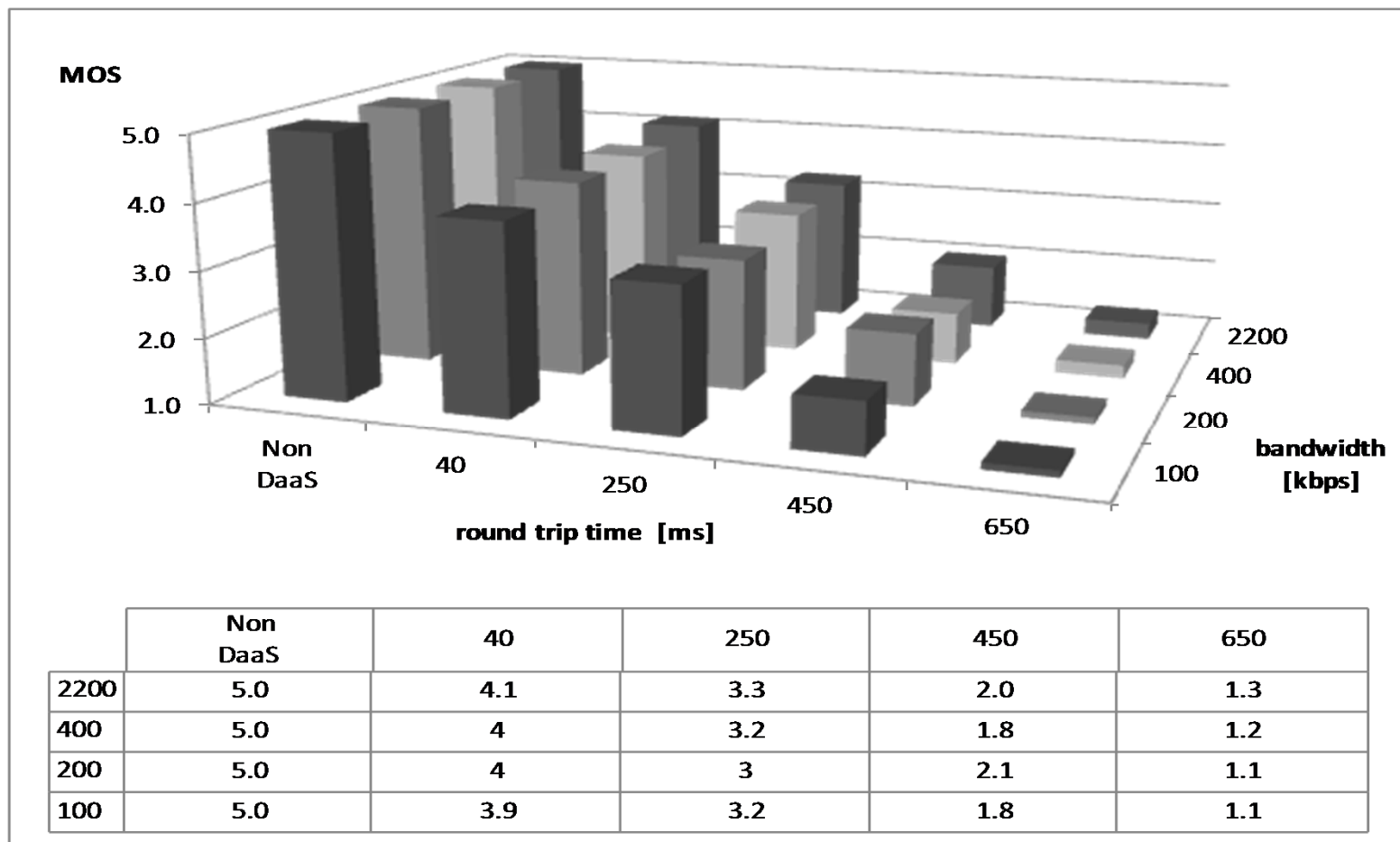
図4.A2: 作図に対する主観評価

MOS: Mean Opinion Score

	Non-DaaS	40	250	450	650	850
2200	5	4.5	3.9	3.1	2.9	2.1
400	5	4.5	4.2	3	2.5	2.2
200	5	4.1	3.9	2.8	2.1	2
100	5	3.9	3.8	2.7	2.3	2
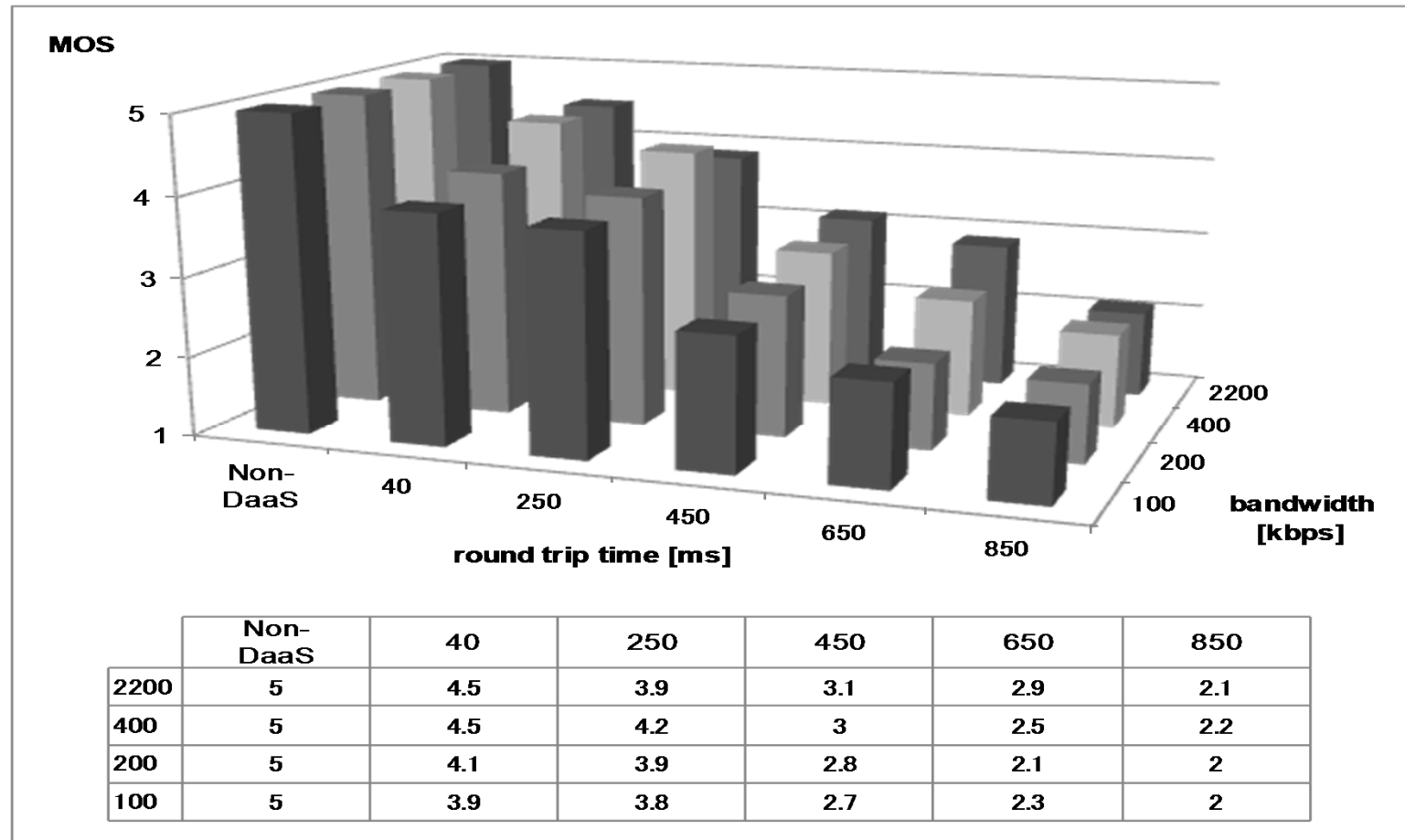
図4.A3: 音声再生に対する主観評価

MOS: Mean Opinion Score
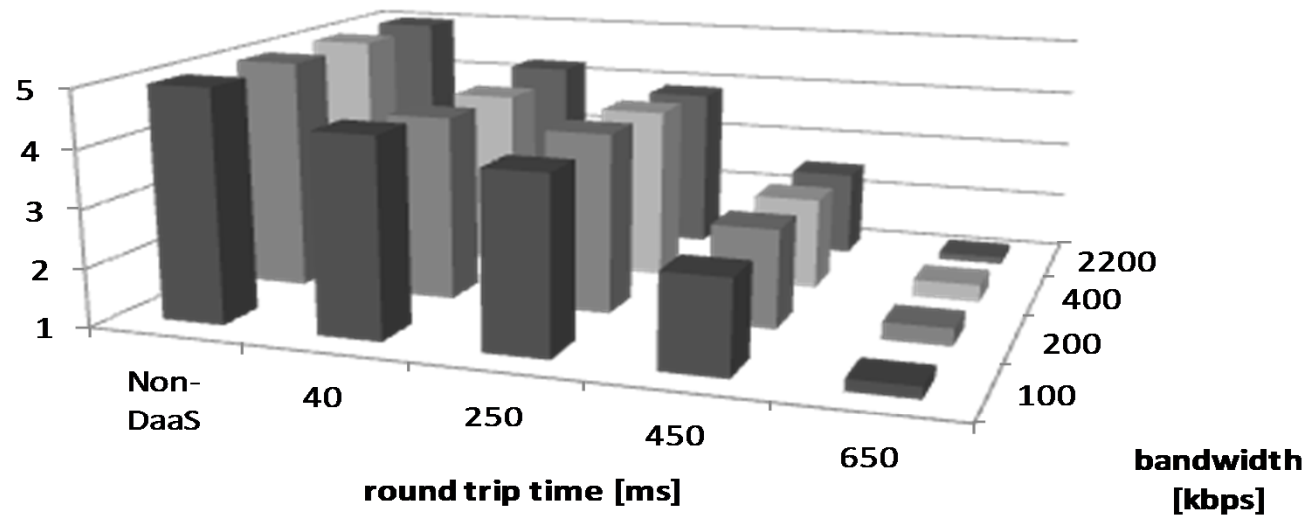
	Non-DaaS	40	250	450	650
2200	5	4.3	3.9	2.5	1.1
400	5	4.1	4.0	2.6	1.3
200	5	4.2	4.1	2.7	1.3
100	5	4.4	4.0	2.6	1.2

図4.A4: WBTのe-learningに対する主観評価