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Characteristics of Network Congestion Control: Preliminary Observation in a Mobile-based Foreign Language Classroom

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Abstract: In this paper, we would like to suggest the use of network congestion optimizer which may have possibility to improve mobile-based foreign language classroom environment on the basis of our pilot experiments. In a foreign language teaching context, uploading and downloading a large volume of sound or video materials is very common in a wired computer classroom, or a so-called Computer-Assisted Language Learning (CALL) classroom. If we try this in wireless classroom settings with tablet or mobile computers, there is an issue of network congestion, which must be avoided by any means, because the trouble may make the students discouraged at the tasks. Since the introduction of tablet computers and one-to-one wireless classroom setting has been promoted by the Japanese government, this issue becomes more serious and real recently. This paper carried out an experiment using an English class in a Japanese university, where online training and downloading video materials were actually conducted and observed how the congestion change with the sue of the optimizer. The result was that the introduction of optimizer in addition to more reasonable standalone-mode Access Point (AP) is effective in reducing packet loss and raising communication speed.

Keywords: congestion control, wireless mobile classroom. One-to-one model, packet loss, foreign language learning

1. Introduction

Constructing one-to-one wireless networked classroom with mobile or tablet computers in schools (elementary, junior and high schools) is an urgent issue in Japan. Since 2011, when government of Japan adopted a "The Vision for ICT in Education --- Toward the Creation of a Learning System and Schools Suitable for the 21st Century" at the Cabinet meeting, several pilot studies have been carried out in public schools. Needless to say, careful consideration must be given to the problem of network congestions, because all the classroom management in the classroom stops when this kind of trouble happens. Moreover, this type of trouble discourages students in terms of motivations to work on the task, discussed in Ono, Ishihara and Yamashiro (2013), where the relationship between download time and learners' stress was investigated. However, the fact is that several problems have been occurring when all the students try to download teaching materials --- e.g., digitalized textbook materials students use instead of paper-based materials--- at the same time from the server during the class time. Unfortunately, in a certain pilot public school in Japan, students are requested to buy their own tablet computers before the school terms starts with some budget assistance from the government, and this trouble happens. Faced with the situations, we cannot but say that we need more experimental studies imitating an actual school situations as well as usual pretests like stress or loading tests.

What is more, the situations become more and more complex and difficult when we think about foreign language teaching which is conducted under the wireless conditions with tablet or mobile computers. Usually, foreign language teaching courses involve both individualized tasks and collaborative tasks. In an individualized task, students work on listening practice like dictation, listening to the sounds or watching videos. If students try to conduct this task, they need to download sound or video materials to their individual computers, along with other teaching materials. When we

try collaborative study using Learning Management System (LMS) in a classroom, all the students have to upload onto the on-line bulletin board their recorded speeches or videos recorded or taken with their tablet or mobile computers in a class time. After observing them, they usually have to make comments to the original posts, which are sometimes conducted in a posting with sound or videos. Since foreign language teaching generally has a higher degree of familiarity or affinity to use of multimedia, the above mentioned issue on network congestion becomes a particularly serious issue for foreign language classroom management.

This study starts with a review of theoretical and practical issues on network congestion and its management on the part of less familiar foreign language teachers. Then, a congestion control tool is introduced to reduce the congestion occurring in and around classroom network, followed by our experimental study using foreign language classes of the first author's university. Lastly we would like to conclude that the situations were improved in the combined use of congestion control use to the standalone use of Access Point (AP) in spite of low cost construction, on the basis of the data of packet loss and network performance.

2. Backgrounds

2.1 Congestion Control and Access Point

When one or more routers in an area become overloaded, congestion results. Factors which lead to congestion is (i) packet arrival rate and outgoing link capacity, (ii) insufficient memory for storing arrival, (iii) bursty traffic and (iv) slow processor (Smith, Woodham, and Marg, 2010). In order to avoid situations caused from these four factors, we need to raise the capacity of network and processors. Considering common cases of wireless LAN communications, bottlenecks sometimes occur in and around Access Points (AP). As was told in the previous chapter, network conditions will be tough for network, since it often happens that all the students, more than 40 users, start to access the network at the same time in downloading the materials from the LMS server. Although it is a very expensive, one idea to solve this problem is to purchase an AP with higher specifications and functions. In general, there are two modes for access point; one is a traditional "standalone AP deploy" mode and the other is a more advanced "controller-based AP deploy" mode. The latter controller can cover proper channel assignment, coverage control, and dynamic load balancing. In a case of the former, we need to manually determine every setting of AP. Since the former mode does not require wireless LAN controller, it costs all the less for it. Some schools cannot help adopting the former "standalone" mode of AP purely due to the budget reason. The reason is clear. If there are five classes per one grade in a junior high school, there must be more than 15 classrooms which require Access Points for tablet uses. If one classroom has more than 40 students, as is often the case in Japan, we suggests that there should at least two Access Points set up for one classroom. Then more than 30 Access Points are necessary in this case. If all the Access Points had to be "controller-based" ones, then institution would require more than several times more the budget for them.

One practical solution to this problem is to add a rather reasonable congestion optimizer around the standalone AP, where the congestion or packet losses frequently occur. This paper employs one such product, called "Tbridge", to reduce congestion in the network around foreign language classroom. The product was originally created by NOA System, and is sold by Chieru, Japan. Figure 1 shows the optimizer, and Figure 2 visualized expected effects to reduce the number of packet losses.

Figure 1. Congestion Optimizer (above: front side; below: back side)

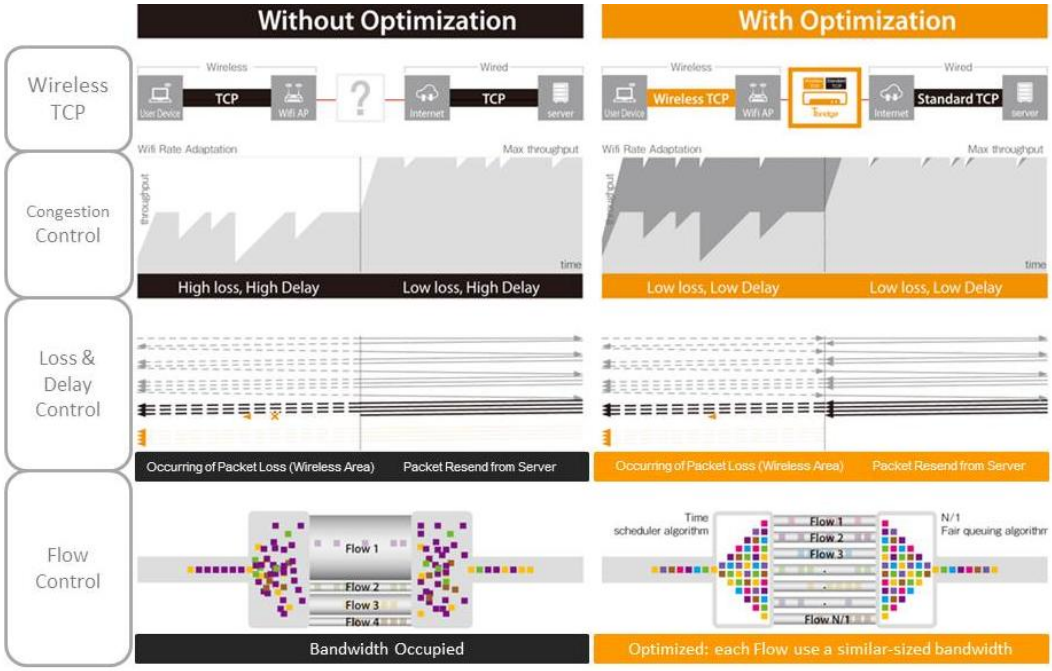


Figure 2. Effects of Congestion Optimizer *(http://www.chieru.co.jp/news/2014/lantbridge1020.html)*

2.2 Network of Our Foreign Language Center

Ono, Ishihara and Yamashiro (2014) constructed a wireless Computer-Assisted Language (CALL) Classroom, and the same classroom was used for experimental study in this paper. The network and hardware (Server, AP, Switch, and UPS) description was illustrated in Figure 3 below.

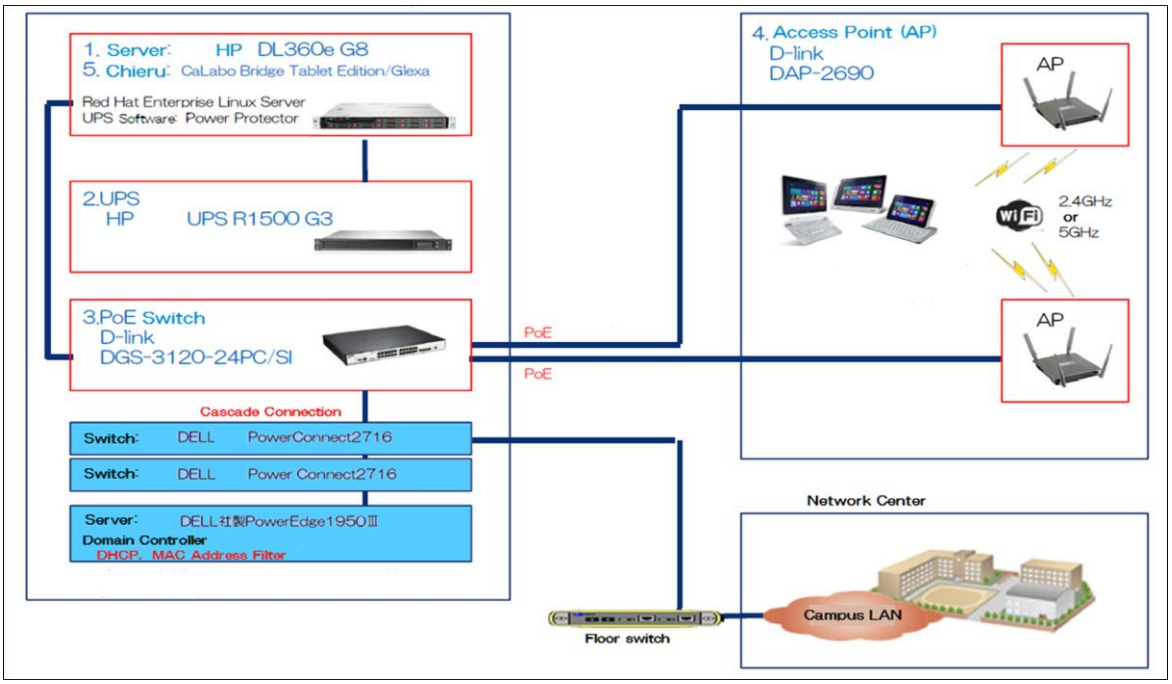


Figure 3. Network and Hardware

As to students' computers, we adopted Windows 8 tablet PC, with the picture given in Figure 3 and the specification in Table 1 below (Ono, Ishihara, and Yamashiro, 2014).

Figure 4. Students' PC

Table 1. Specifications of Students' PC

OS	Windows 8
Processor	Intel Atom, Z2760, 1.80 GHz, 2core
Memory	2GB
Storage	64GB
Display	25.7 ㎝(10.1"), HD, Resolution: 1366 x 768
Communications	Broadcom IEEE 802.11a/b/g/n
Battery	2 cells (Li-Polymer) 3540 mAh Video mode： 9 hours
Others	Height： 18.7 mm Width： 167.5 mm Depth： 258.5 mm Weight：1.26 kg

3. Experimental Study

3.1 Purpose of Experiment

We conducted an experimental study in the classroom constructed in the previous chapter. The purpose of this study is to observe if there is any effect of congestion optimizer on reduction of packet loss in the network.

3.2 Procedures

In the classroom, we carried out usual class activities involving two different types of network communication. One is a Cloud-based Online Listening Training Course ("Super-Eigo Academic Express 2"; *http://www.supereigo.com/*). The other one is movie materials. In the class, we asked the students to download the movie material (About 30 MB mpeg4 file) at the same time. The movie file to be downloaded is stored in the Learning Management System (LMS) server, called "CaLabo Bridge", indicated as 1 in Figure 3. In each task, we set up two different communication conditions; namely, Optimizer "ON/OFF". We did the same task twice to see the difference between ON and OFF conditions in packet loss. In this experiment, 46 first-year students participated.

3.3 Results

3.3.1 Online Contents and YouTube Practice

Figure 5 describes the location of the optimizer. Since it is generally said that bottle neck occurs around AP, we connected the optimizer between AP and the switch to the university network. The results of number of packet loss, packet retry and round trip time are shown in Table 2.

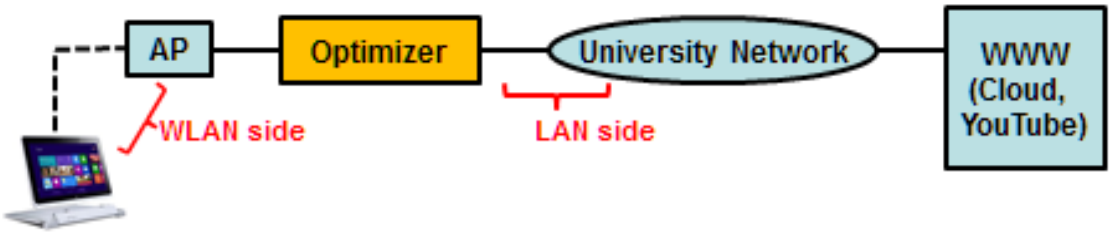


Figure 5. The location of the optimizer

Table 2. The results in a case of online course training

	Online Training			
	Optimizer **OFF**		Optimizer **ON**	
	WLAN	LAN	WLAN	LAN
LOS(Packet Loss)	197	197	9	224
RET(Packet Retry)	148	148	31	22
RTT(Round Trip Time (ms))	44.2	44.2	19.5	17.7

As is clear from the Table 2, the effect is definitely clear between the two conditions; very few packet losses in the ON condition, resulting in RTT scores, as well.

3.3.2 Video Material Download

Packet Data was collected under the same conditions of the above experiment. The result is shown in Table 3.

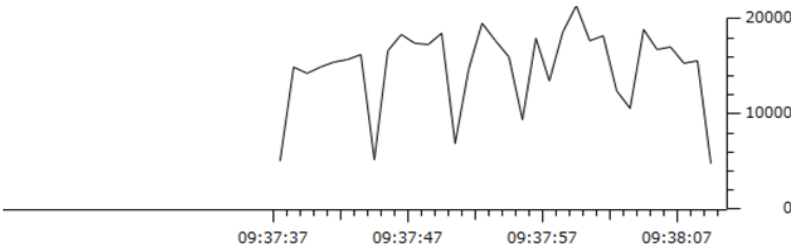
Table 3. The results in a case of video download

	Online Training			
	Optimizer **OFF**		Optimizer **ON**	
	WLAN	LAN	WLAN	LAN
LOS(Packet Loss)	278	230	130	230
RET(Packet Retry)	216	223	85	27
Max. Speed (Total)	132.3Mbps		164.9Mbps	

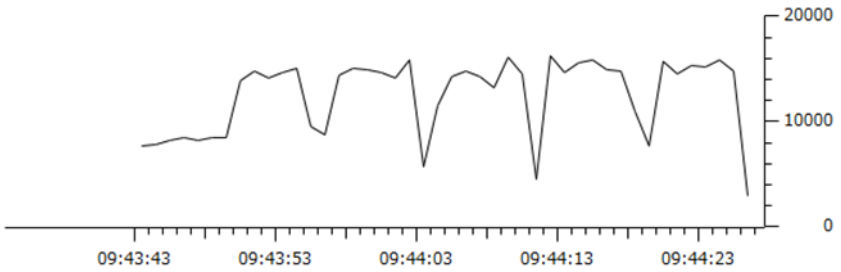
Again, the result shows that the optimizer seems to be effective if we look at the difference in Max Speed. Note that all the 46 students were successful in downloading in less than 30 seconds.

3.3.3 Congestion during the Video Material Downloading

Figure 6 below shows the graphs of network congestion when downloading the material. When the optimizer is ON, the communication starts smoothly and performs at the level of 20000 packets per tick. On the other hand, when the optimizer is OFF, the graph shows the so-called “slow start”, the system does not receive much data at the beginning, which sometimes leads to delay.



(a) Optimizer ON (Y axis: Packets per Tick)



(b) Optimizer OFF (Y axis: Packets per Tick)

Figure 6. Graph of Wireless Communications

4. Concluding Remarks

This paper dealt with the employment of the congestion optimizer, which would be a reasonable and practical choice to improve communication performance in network traffic when dealing with online learning and video data downloading. In the classroom constructed for foreign language learning using tablet or mobile computers, we carried out an experiment of measuring the difference in congestion between optimizer ON and optimizer OFF conditions. The result shows the improvement of effectiveness of the operation of the optimizer, which implies future possibility for securing network traffic in wireless classrooms using tablet or computers.

There are several limitations in this paper to be addressed. This is only one experiment presented in this paper. Moreover, the experiment was restricted in a specific time when the classroom was available in the first author's class. Other future issues to be discussed include the case of combined use of downloading (listen or watch) and uploading (voice or video) in a bulletin board in the classroom, because this activity is a very common in recent CALL teaching method and it seems to give a great amount of pressure to the network and server. But this type of exchange of large amount of data must be examined for evaluating the effectiveness of the optimizer. Moreover, It was observed in this experiment that the higher area (LAN and further WWW) of the network somehow was the place of bottleneck or heavy traffic, as we observed a much larger number of packet losses on the listening training with connecting to YouTube. This implies the necessity of the experiment with a focus on the congestion control of that area of the network. Anyway, since collaborative learning paradigm is becoming more and more popular with mobile uses, more research on the normalization of reasonable system construction for foreign language teaching is expected in a near future.

Acknowledgements

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