Research on Estimation of Equipment Sizing for Network Deployment

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Abstract — **In this paper, we propose the objective criteria, detailed procedure and method for adequate estimation of equipment sizing in network deployment. Our purpose is to provide managers of government and public institutes with the guideline for adequate network equipment sizing when they plan to construct a new network infrastructure. We define the correction factor which is the keyword imperatively necessary for estimating of network equipment sizing in a variety of network services. And then we calculate a series of performance indicators determining the sizing of each equipment from correction factor. Together we describe the scope of target equipment. Also we present the newly proposed procedure and estimation parameters & equations for adequate estimation of network equipment sizing.**

Keywords —**correction factor, estimation of network equipment sizing, scalability, stability, link duplexing, swtiching capacity, throughput, TCP throughput, concurrent session.**

I. INTRODUCTION

Government and public institutions are performing the projects for constructing network infrastructure in the fields of national defense, administration, health care, education, and etc. However, there is no guideline for an adequate guidelines of equipment purchase for network deployment in Korea. Therefore concerns have been raised about the over-estimation of equipment sizing when compared with the actual demand. The over-estimated specification incurs an unnecessary spending of the government budget. In particular, according to The Board of Audit and Inspection of Korea's report in July 2016, average traffic utilization rate of 512 network devices deployed in 18 public institutions was as low as 2.53 %. This report came from the inspection on the Current Contract Situation for Major Information Projects performed from February to April in 2016. This report brought forth the necessity of establishing the guidelines for properly estimating network equipment sizing. At this point, our aim is to reduce the unnecessary cost of national budget caused by absence of standard for network equipment sizing. To address this concern, we propose the new scheme with a set of objective criteria that aim for adequate estimation of equipment sizing in network deployment.

In fact, it is not easy to estimate an adequate network equipment sizing because many kinds of conditions should be considered for desired network services. Those conditions include current traffic patterns, characteristics and performance indicators like throughput and switching capacity for a given network structure. In addition, the rate of traffic increase in the near future should be considered for scalability, stability and reliability reasons. In this paper, we propose a systematic approach to estimate the network equipment sizing, even though there are a variety of traffic types in network equipment. The key idea is to introduce the 'correction factor', concept which is be imperatively necessary for estimation of network equipment sizing.

In the next section, we explain about the meaning of correction factor for estimation of network equipment sizing and its use in more detail. In Section Ⅲ, we describe the scope of target network equipment and performance indicators for estimation of network equipment sizing. In Section Ⅳ and Ⅴ, we present the newly proposed procedure and estimation parameters & equations for adequate network equipment sizing. In Section Ⅵ, we conclude this proposal followed by future works.

II. CORRECTION FACTOR

In reality, network equipment deals with variety of data traffic according to network services. Therefore we need the representative value which defines each traffic's characteristics. Here we present the 'correction factor' as the representative value for exact estimation of network equipment sizing

The correction factor can be presented as

Correction factor = required bandwidth ÷ interface capacity

with Required bandwidth = data size ÷ desired response time

where, desired response time is the response period after service request, data size is the maximum value of traffic data in network service(e.g. IP telephone service, Mailing service, WEB service etc.), interface capacity is 100 Mbps(for FE)/1 Gbps(for GbE).

Next we can derive the required uplink bandwidth of connection type switch using the correction factor

Uplink bandwidth = total number of downlink port × downlink bandwidth × correction factor

For example, let's assume a switch that has 24 down link ports with 100 Mbps interface for mailing service. From the correction factor of 0.8 for mailing service at FE(100 Mbps), we can derive the required bandwidth of uplink like this:

Uplink bandwidth = 24 ports × 100 Mbps × 0.8 = 1.92 Gbps

Correction factor can be decided from actual measurement value(data size and desired response time) in network service.

We presented required bandwidth and correction factor for typical network services mainly used in government and public institutions by analyzing network traffic of some institutions for a certain period of time. We expect Table 1 provide a useful guideline for estimating of equipment sizing in network deployment.

Table 1. Required bandwidth and correction factor for network services

Network Service	Data Size	Desired Time	Required Bandwidth	Correction Factor	
				FE	GbE
WEB, Internet	10 MB	3 sec	27 Mbps	0.3	0.03
Document transmission, Mailing	100 MB	10 sec	80 Mbps	0.8	0.08
IP Telephone	100 Kbps	Real time	100 Kbps	0.001	0.0001
Security update	10 MB	3 sec	27 Mbps	0.3	0.003
Full HD(HEVC/H.265-MPEG4/H.264) Teleconference/CCTV	10 Mbps	Real time	10 Mbps	0.1	0.01
Searching 3D Map	60 MB	10 sec	48 Mbps	0.5	0.05
Wireless LAN(Wi-Fi) for AP connection	802.11n [15~150 Mbps] 802.11ac [88~867 Mbps]	Real time	150 Mbps 867 Mbps	- -	0.15 0.87

III. Scope and Performance Indicators

The project for a new network deployment generally has three processes as follows:

- Planning for network construction

  A business to devise the network construction plan for new services considering construction budget and service needs

- Design of network structure

  A business to determine network deployment, detailed structure and needs for construction according to the construction planning

- Estimation of network equipment sizing

  A business to draw performance requirements of network equipment from designed network structure and needs for construction

We should clearly distinguish the difference of the above three businesses for an accurate estimation of network equipment sizing. In this paper, we focus on estimation process of network equipment sizing after finishing planning for network construction and designing of network structure. In other words, we propose the objective criteria, procedure and method for adequate estimation of equipment sizing in public network deployment projects.

In this paper, we defined the a few devices which are used the most and essential in network deployment projects as the targets for estimation of network equipment sizing. Those are switches and optical transmission devices which are fundamental devices in a real network infrastructure. Table 2 shows each target device and its performance indicators for estimation of network equipment sizing. Each network equipment sizing can be objectively estimated by calculating its performance indicators.

Table 2. Performance indicators for estimation of network equipment sizing

Network Equipment		Performance Indicators
Switch	Connection type L2/L3 switch	▪ # of port at uplink ▪ # of port at downlink ▪ Throughput ▪ Switching capacity
	Distributed/Backbone type L3 switch	▪ Throughput ▪ Switching capacity
	L4/L7 switch (Including security device)	▪ CS(Concurrent Session) ▪ TCP Throughput
Optical Transmission Device	WDM	▪ Transmission capacity
	ROADM	▪ Transmission capacity
	MSPP	▪ Transmission capacity
	Carrier Ethernet	▪ Transmission capacity

IV. Procedure

Fig 1. shows the procedure for estimation of network equipment sizing.

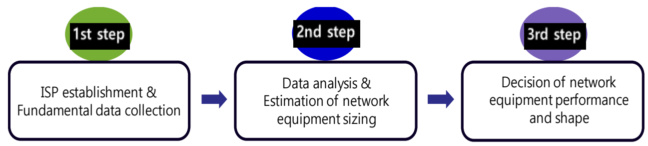

Fig 1. Procedure for estimation of network equipment sizing

Table 3. Fundamental data for estimating of network equipment sizing

Switch	Performance Indicator	Fundamental Data
Connection type L2/L3 switch	Switching capacity	▪ Max. capacity and # of interface port ▪ Bi-directional constant(2)
	Port utilization	▪ Utilization of downlink/uplink port
	Throughput	▪ Capacity by interface type ▪ Constant for system scalability(1.2) ▪ Traffic rate of increase for the past 3 years
Distributed/ Backbone type L3 switch	Switching capacity	▪ Max. capacity and # of interface port ▪ Bi-directional constant(2) ▪ Constant for system scalability(1.2) ▪ Traffic rate of increase for the past 3 years
	Throughput	▪ Capacity by interface type ▪ Constant for system scalability(1.2) ▪ Traffic rate of increase for the past 3 years
L4/L7 Switch (Including security device)	Target CS	▪ Max. CS in the first year ▪ Traffic rate of increase for the past 3 years
	TCP Throughput	▪ Average data size by session ▪ Average holding time by session ▪ Constant for system scalability(1.2)
WDM/ ROADM	Transmission capacity	▪ Max. interface capacity ▪ # of I/O interface port at WDM ▪ Traffic rate of increase for the past 3 years ▪ Constant for system scalability(1.2)
MSPP/ Carrier Ethernet	Transmission capacity	▪ Max. interface capacity ▪ # of I/O interface port at NNI, UNI ▪ Traffic rate of increase for the past 3 years ▪ Constant for system scalability(1.2)

At the first step, we should collect the fundamental data for estimation of network equipment sizing. Of course, From the ISP (Information Strategy Planning) establishment and requirement analysis for a new network deployment, we can collect the fundamental data. Together we can get basic data from the statistical measurement data of network system. Table 3 shows the fundamental data for estimation of network equipment sizing.

At the second step, we calculate performance indicators like throughput or the required traffic capacity using the fundamental data collected in the first step.

At the third step, we can finally derive the minimum sizing to satisfy required performance indicators and then decide the adequate shape and quantity of adopted network equipment

V. ESIMATION PARAMETERS & EQUATIONS

We should calculate the adequate estimation of equipment sizing by considering the requirements for a new network deployment. In this chapter, we presented requirements needed for each network equipment and detailed estimation parameters and equations for adequate equipment sizing. We can estimate adequate network equipment' sizing using all these values.

A. Requirements

Network equipment	Description
Connection type L2/L3 switch, Distributed/Backbone type L3 switch	▪ # & capacity of downlink port ▪ Downlink scalability / stability ▪ Uplink duplexing
L4/L7 Switch	▪ System scalability / stability
WDM/ROADM	▪ # & capacity of interface port ▪ # of wavelength ▪ Link duplexing ▪ System scalability
MSPP/Carrier Ethernet	▪ # & capacity of interface port ▪ Link duplexing ▪ System scalability

B. Estimation parameters & equations

1) Connection type L2/L3 switch

Parameter	Input range	General value
Downlink scalability factor	100 % ~ 200 %	120 %
Downlink stability factor	100 % ~ 150 %	120 %
Correction factor	0 ~ 1	-
Uplink duplexing	100 % ~ 200 %	200 %
Packet throughput constant	-	1,488,095(1 GbE)
Bi-directional constant	-	2

- Total # of downlink port = # of downlink port × downlink scalability factor × downlink stability factor
- Capacity of uplink port = capacity of downlink port × total # of downlink port × correction factor
- Switching fabric = {∑(total capacity of downlink & uplink port)} × Bi-directional constant
- Throughput = {∑(total capacity of downlink & uplink port) × Packet throughput constant

2) Distributed/Backbone type L3 switch

Parameter	Input range	General value
System scalability factor	100 % ~ 200 %	120 %
System stability factor	100 % ~ 150 %	120 %
Uplink duplexing	100 % ~ 200 %	200 %
Packet throughput constant	-	1,488,095(1 GbE)
Bi-directional constant	-	2

- Switching fabric = {∑(total capacity of downlink & uplink port)} × Bi-directional constant
- Throughput = {∑(total capacity of downlink & uplink port) × Packet throughput constant

※ System scalability factor can be substituted with the rate of increase for the past 3 years

3) L4/L7 switch

Parameter	Input range	General value
Average rate of increase of CS for the past 3 years	0 ~ xxx	statistics
Average data size per session	0 ~ xxx	statistics
System scalability factor	-	120 %

- Target CS = Max. # of CS for the past 1 year × Average rate of increase of CS for the past 3 years
- TCP Throughput = Target CS × Average data size per session/Average holding time per session × System scalability factor

4) WDM/ROADM, MSPP/Carrier Ethernet

Parameter	Input range	General value
Average rate of increase of traffic for the past 3 years	0 ~ xxx	statistics
System scalability factor	-	120 %

- Transmission capacity = {∑(I/O interface port at WDM)} × Average rate of increase of traffic for the past 3 years × System scalability factor
- Transmission capacity = {∑(I/O interface port at NNI & UNI)} × Average rate of increase of traffic for the past 3 years × System scalability factor

VI. CONCLUSION AND FUTURE WORKS

We hope our proposal will help managers of government and public institutes to adopt optimum sizing of network equipment. Consequentially we confident that this proposal can significantly reduce the unnecessary cost of national budget caused by over-estimated specification of network equipment in newly designed network deployment projects.

We are currently in the process of estimating network equipment sizing of certain public institution. Our plan is to apply our models to other public institution's network projects.

In the near future, we has plan to draw effectiveness analysis reports after carrying out some practical estimations of network equipment sizing.

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