

# PERFORMANCE IMPROVEMENT OF KSTAR NETWORKS FOR LONG DISTANCE COLLABORATIONS

Jinseop Park<sup>a</sup>, Sangil Lee<sup>a</sup>, Sangwon Yun<sup>a</sup>, Taegu Lee<sup>a</sup>, Ali Kashif Bashir<sup>a</sup>, Dosub Lee<sup>a</sup>, Buseung Cho<sup>b</sup>

<sup>a</sup>National Fusion Research Institute (NFRI), Daejeon 305-333, Korea

<sup>b</sup>Korea Institute of Science and Technology Information (KISTI), Daejeon 305-806, Korea

## Abstract

KSTAR (Korea Superconducting Tokamak Advanced Research) has completed its 6<sup>th</sup> campaign. Every year, it produces enormous amount of data that need to be forwarded to international collaborators shot by shot for run-time analysis. Analysis of one shot helps in deciding parameters for next shot. Many shots are conducted in a day, therefore, this communication need to be very efficient. Moreover, amount of KSTAR data and number of international collaborators are increasing every year. In presence of big data and various collaborators exists in all over the world, communicating at run-time will be a challenge. To meet this challenge, we need efficient ways of communications to transfer data. Therefore, in this paper, we will optimize paths among internal and external networks of KSTAR for efficient communication. We will also discuss transmission solutions for environment construction and evaluate performance for long distance collaborations.

## INTRODUCTION

The researchers participate in the experiment to analyse the experimental data and to be applied with parameters for next shot based on analysed data during the experiment. The researchers need to connect to the storage of experimental data in KSTAR or need to connect to the near storage of experimental data which were moved from KSTAR in order to analyse data from the outside. The first way requires more time to load experimental data which is in KSTAR for analysis from the researchers who are long distance. The second way require less time to load experimental data for analysis from the researchers who are long distance than first way because experimental data is nearby long distance from KSTAR. In order to be able to do the second way, bandwidth is very important to transfer experimental data from internal storage to external storage. In this paper, we conducted benchmark for bandwidth in consideration of the second way. We used solution programs of iperf and bbcp for the evaluation and analysis of networks performance. We got results after evaluation and analysis of networks performance and conducted experiment in order to share ways in order to get better performance based on this results with related managers of KREONET (Korea Research Environment Open NETWORK) [1] and GLORIAD-KR(Global Ring Network for Advanced Application Development-KoRea) [2] and NFRI (National Fusion Research Institute).

## TEST AND TRANSMISSION SOLUTION

The traceroute [3] which was a program to check path of networks was used to find the optimal path. The iperf [4] program was used to check bandwidth of TCP and UDP. The bbcp [5] program was used to check bandwidth when we transfer file data from local to remote. Because reading and writing performance is important between disk and memory, we used the dd [6] program to measure each server between local and remote areas. We used the tracepath in order to measure configuration of MTU and Jumbo Frame of networks routers.

## PERFORMANCE ANALYSIS AND EVALUATION

### Configuration

Table 1: Servers Information

Server	Type	Information
dtn01	CPU	Quad-Core 2 2.3 GHz
	MEM	24 GB
	DISK	Luster
	LAN	10 Gbps
ps	CPU	Xeon 2 GHz
	MEM	4 GB
	DISK	Read 2.5 GB/s, Write 115 MB/s
nfri-s1	LAN	10 Gbps
	CPU	Xeon 2.93 GHz
	MEM	8 GB
kstar-s1	DISK	Read 3.5 GB/s, Write 76.9 MB/s
	LAN	1 Gbps
	CPU	Quad-Core 2 2.6 GHz
kstar-s2	MEM	4 GB
	DISK	Read 2.6 GB/s, Write 68.3 MB/s
	LAN	1 Gbps
kstar-s2	CPU	Xeon 2.67GHz
	MEM	16GB
	DISK	Read 3.2 GB/s, Write 121 MB/s
kstar-s2	LAN	1 Gbps

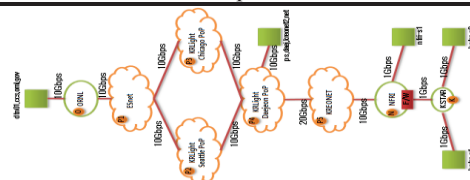


Figure 1: Configuration of networks.

We tested in this configuration of above Fig. 1 but we couldn't be able to get assigned resources of networks in order to transfer data in KREONET and GLORIAD-KR. We just use normal networks of research.

Table 2: Networks Path Information

Time	Path of networks
Before	O < P1 < P3 < P4 < P5 < N < K
After	O < P1 < P2 < P4 < P5 < N < K

Before we changed the path of the networks to transfer data, we got a result that sending path and receiving path were different. And then when we tested response time with traceroute, some sections were late. After we changed the path to transfer data, we got a result that sending path and receiving path were same. And then when we tested response time with traceroute, we got better result than before.

**Jumbo Frame information**

We could not change value of jumbo frame [7] for NFRI (IN). If we need change value of it, we have to reboot security system after we change value of it. Therefore we will try to change value of it later to get a result with a manager of NFRI networks.

Table 3: Jumbo Frame Set

	O	P1	P2	P4	P5	N (IN)	N (OUT)	K
Before	O	O	X	X	X	X	X	O
After	O	O	O	O	O	X	O	O

**MTU information**

We didn't change the value of MTU [8] for servers because bcbp could not be able to transfer data to ps and nfri-s1 even if a file was made from dtn01. If we have time, we need to solve this problem with managers of exterior networks.

Table 4: MTU Set (byte)

	dtn01	ps	nfri-s1	kstar-s1	kstar-s2
Before					
After	9000	1500	1500	1500	1500

**Experimental A (ORNL)**

Table 5: Bandwidth Test from dtn01 by iperf(mbpb)

Src.	Dst.	Type	Before	1 <sup>st</sup> After	2 <sup>nd</sup>	3 <sup>rd</sup>
dtn01	ps	TCP	X	920	560	29
		UDP	746	738	739	74
	nfri-s1	TCP	2.56	9.37	8.97	12.
		UDP	X	X	X	X
kstar-s1	TCP	2.84	88.8	70.3	50.	
	UDP	X	X	X	X	

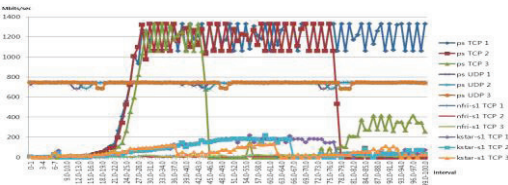


Figure 2: TCP/UDP test from dtn01 to ps and nfri-s1 and kstar-s1 after change.

Table 6: Bandwidth Test from dtn01 by iperf (mbpb)

Src.	Dst.	Session	Before	1 <sup>st</sup> After	2 <sup>nd</sup>	
dtn01	ps	1	X	196.5	179.7	
		8	X	266.8	286.9	
		16	X	217.1	220.1	
		32	X	272.1	199.8	
		64	X	343.7	315.6	
		1	14.4	22.5	22.6	
	nfri-s1	8	28.8	40.9	40	
		16	46.4	70.4	74.7	
		32	91.2	84	102.2	
		64	155.2	190.6	181.4	
		kstar-s1	1	24.8	32.3	26.2
			8	23.2	50	48.3
16	37.6		51	43.8		
32	71.2		77.6	62.4		
		64	119.2	126.8	127	

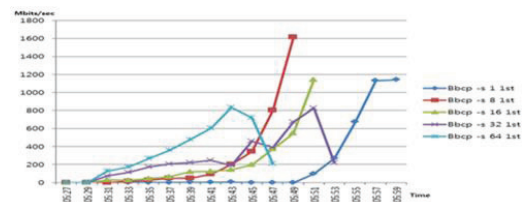


Figure 3: Bcbp test from dtn01 to ps after change.

We tested to transfer dummy file of 1GB from local to remote server. The more we used TCP sessions which were limited by 64, the data was quickly moved by bcbp.

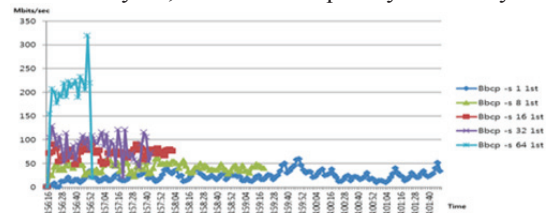


Figure 4: Bcbp test from dtn01 to nfri-s1 after change.

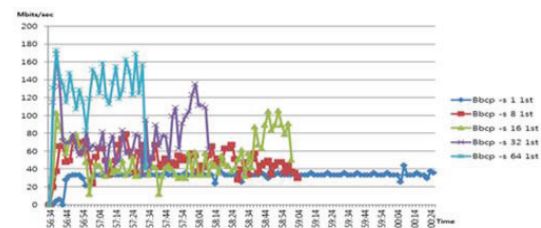


Figure 5: Bcbp test from dtn01 to kstar-s1 after change.

We were able to clearly know that bandwidth were difference depending on sessions of bcbp. TCP test was impossible from dtn01 to ps but TCP test was possible from dtn01 to nfri-s1 and kstar-s1 from the default configuration. UDP test was impossible from dtn01 to kstar-s1. When we transferred data from dtn01 to ps and nfri-s1 and kstar-s1, we used the KRLight Seattle PoP instead of KRLight Chicago PoP. After we changed path of networks, we was able to get results of TCP bandwidth from dtn01 to ps by iperf. We were not able to get results of clearly bandwidth from dtn01 to ps and nfri-s1 and kstar-s1 because bandwidth of networks was ever-changing.

Experimental B (KISTI)

Table 7: Bandwidth test from ps by iperf (mbps)

Src.	Det.	Type	Before	1 <sup>st</sup> After	2 <sup>nd</sup>
ps	nfri-s1	TCP	933	922	923
	kstar-s1	TCP	564	525	501

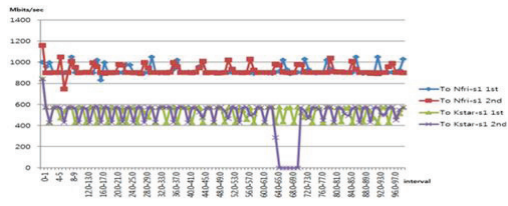


Figure 6: TCP test from ps to nfri-s1 and kstar-s1 after change.

When we tested bandwidth of TCP/UDP from ps to dtn01 with iperf, TCP/UDP test was impossible. TCP test was possible from ps to nfri-s1 and kstar-s1 but UDP test was impossible. We found cause of the security systems which blocked packet of TCP/UDP. When we were using iperf to get bandwidth of TCP from nfri-s1 to kstar-s1, we got results that bandwidth of TCP were difference. We were able to confirm that by security systems. We got the maximum value of bandwidth from ps to nfri-s1 by iperf of TCP because nfri-s1 had network interface card of 1Gbps. What was unique about Fig. 6 was bandwidth values went up to normal after bandwidth values went down to 0.

Table 8: Bandwidth Test from ps by bbcp (mbps)

Src	Dst.	Session	Before	1 <sup>st</sup> After	2 <sup>nd</sup>
.	dtn01	1	X	X	X
		1	671.2	739.8	791.5
ps	nfri-s1	8	814.4	850.8	853.4
		16	870.4	885.6	863.6
		32	883.2	885.4	769.7
		1	32.8	33.1	32.2
kstar-s1	8	91.2	91.8	136.1	
	16	135.2	140.3	109.1	
	32	138.4	156.7	143.8	

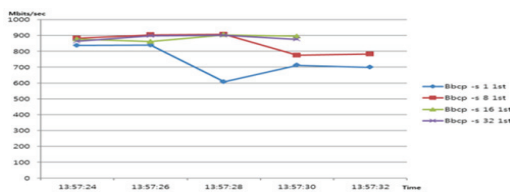


Figure 7: Bbcp test from ps to nfri-s1 after change.

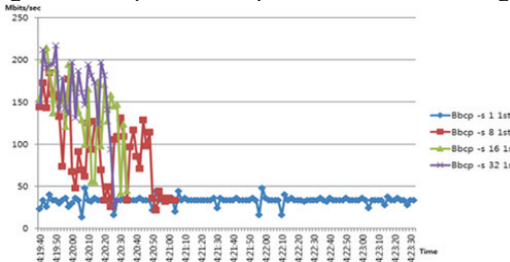


Figure 8: Bbcp test from ps to kstar-s1 after change.

As for Table 7 and Table 8 and Fig. 7 and Fig. 8 results, if we want to improve bandwidth of networks, we need to tune security systems between local to remote areas with managers of networks. The peculiar thing was that when we measured bandwidth from ps to nfri-s1 and kstar-s1 by bbcp, if we used sessions of 64, we were not able to transfer file data because bbcp program was killed by security program.

Experimental C (NFRI)

Table 9: Bandwidth Test from nfri-s1 by iperf (mbps)

Src.	Dst.	Type	Before	1 <sup>st</sup> After	2 <sup>nd</sup>
nfri-s1	dtn01	TCP	X	X	X
		UDP	X	X	X
	ps	TCP	956	949	949
		UDP	681	678	676



Figure 9: TCP/UDP test from nfri-s1 to ps after change.

Table 10: Bandwidth Test from nfri-s1 by bbcp (mbps)

Src.	Dst.	Session	Before	1 <sup>st</sup> After	2 <sup>nd</sup>
nfri-s1	dtn01	1	X	X	X
		1	741.6	724.8	885.2
	ps	8	686.4	902.2	903.4
		16	896.8	900.2	901.4
		32	851.2	899.6	896.8
		64	891.2	891.8	891.8

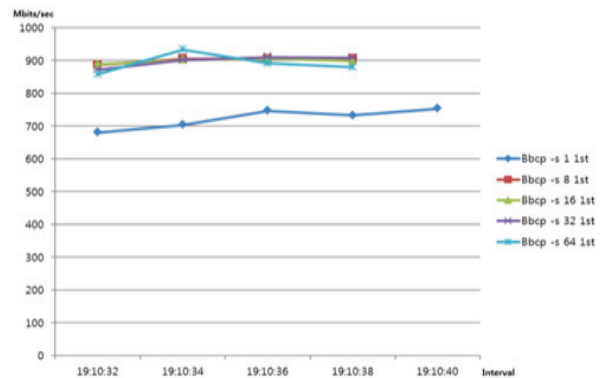


Figure 10: Bbcp test from nfri-s1 to ps after change.

We were not able to measure bandwidth of TCP/UDP from nfri-s1 to kstar-s1 by iperf. We were able to confirm that by configuration of NAT (Network Address Translation) system in NFRI. As we can see the Fig. 10, we were able to get results that this test had stable bandwidth from nfri-s1 to ps between the outside firewall by iperf and bbcp.

Experimental D (KSTAR)

Table 11: Bandwidth Test form kstar-s2 by iperf (mbps)

Src.	Dst.	Type	Before	1 <sup>st</sup> After	2 <sup>nd</sup>
kstar-s1	dtn01	TCP	X	X	X
		UTP			
	ps	TCP	528	524	557
		UDP	690	689	687
	nfri-s1	TCP	500	491	491
		UDP	678	689	687
	kstar-s2	TCP	943	990	990
		UDP	684	680	682



Figure 11: TCP/UDP test from kstar-s1 to ps and nfri-s1 and kstar-s2 after change.

As we can see the Fig. 11, we were able to get stable bandwidth from kstar-s1 to kstar-s2 without security systems.

Table 12: Bandwidth Test from kstar-s1 by bcbp (mbps)

Src.	Dst.	Session	Before	1 <sup>st</sup> After	2 <sup>nd</sup>
kstar-s1	dtn01	1	X	X	X
		8	33.6	32.8	32.8
		16	104.8	107.7	134.8
	ps	32	130.4	151.9	137.6
		64	154.4	161	153.8
		1	34.4	34.1	34.1
	nfri-s1	8	135.2	94.1	93
		16	135.2	137.8	136
		32	150.4	150.8	156.4
		64	156.8	157.4	169.4
kstar-s2	1	852	943.2	941.8	
	8	882.4	940.2	939	
	16	887.2	934.8	936.4	
	32	892	938.2	935.2	
		64	892	929	934.2

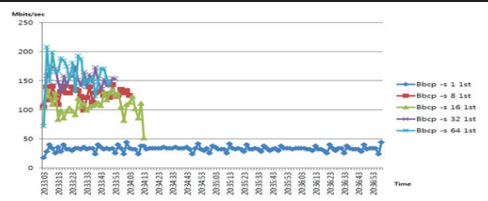


Figure 12: Bcbp test from kstar-s1 to ps after change.

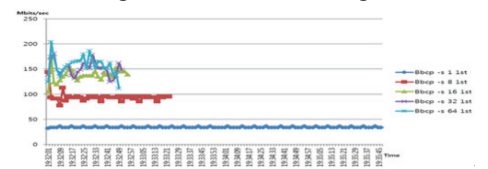


Figure 13: Bcbp test from kstar-s1 to nfri-s1 after change.

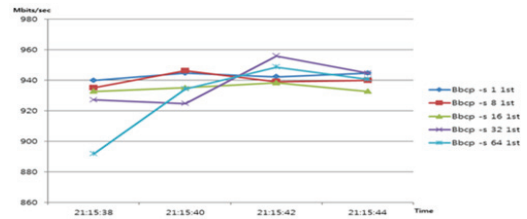


Figure 14: Bcbp test from kstar-s1 to kstar-s2 after change.

As we can see the Fig. 13 and Fig. 14, the results that bandwidth values were similar from kstar-s1 to nfri-s1 and kstar-s1 to ps. So, we were able to confirm that security systems were able to affect reducing bandwidth.

SUMMARY AND FUTURE PLAN

The difference between iperf and bcbp is whether it uses hard disk. If disk have problem which are read and write, we will get low bandwidth to transfer amount of data from local to remote areas. When we used more TCP session of bcbp for performance measurement of bandwidth, we were able to know an increase in Bandwidth. We were not reserved dedicated bandwidth to measure performance on research networks which are KREONET and GLORIAD-KR because we wanted to know general bandwidth. So, bandwidth was able to be both good and bad according to state of KREONET and GLORIAD-KR. We plan to conduct experiment to measure bandwidth from local to remote areas after we reserved the dedicated bandwidth from end to end. The utilization of the servers will be affected to measure bandwidth. If the servers are not dedicated to transfer amount data, we are able to get bad bandwidth from local to remote areas. So bandwidth depends on state of the servers. The measurement values of networks bandwidth are different depending on how to change configuration of security systems which are in each site. In this regard, we plan to cooperate with managers of security systems in internal and external to find ways to improve bandwidth.

We plan to measure transfer data after we found more diverse solution of data transfer. We plan to improve performance of KSTAR networks after we found and verified more diverse solutions for long distance collaborations.

REFERENCES

- [1] [www.gloriad.org/gloriaddrupal/?q=node/114](http://www.gloriad.org/gloriaddrupal/?q=node/114)
- [2] Kwangjong Cho, Other, "GLORIAD-KR and Its Advanced Applications", SAINT '10 Proceedings of the 2010 10th IEEE/IPSJ International Symposium on Applications and the Internet., (2010).
- [3] [en.wikipedia.org/wiki/Traceroute](http://en.wikipedia.org/wiki/Traceroute)
- [4] [en.wikipedia.org/wiki/Iperf](http://en.wikipedia.org/wiki/Iperf)
- [5] [www.slac.stanford.edu/~abh/bcbp](http://www.slac.stanford.edu/~abh/bcbp)
- [6] [en.wikipedia.org/wiki/Dd\\_\(Unix\)](http://en.wikipedia.org/wiki/Dd_(Unix))
- [7] [en.wikipedia.org/wiki/Jumbo\\_frame](http://en.wikipedia.org/wiki/Jumbo_frame)
- [8] [en.wikipedia.org/wiki/Maximum\\_transmission\\_unit](http://en.wikipedia.org/wiki/Maximum_transmission_unit)