Topology Analysis of BGP Confederation of iBGP Indonesia Research and Education Network (IdREN)

The Effect of Topology Scheme of QoS

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***Abstract*— *IdREN* is Indonesian NREN (National Research and Education Network) was built as a platform to do data exchange on research and education between education Institution according to its main purpose at the beginning. It needs right topology scheme to optimize the network usage according to its function. There have been 5 Universities (UGM, UI, ITB, ITS and UB) in the main network as Border Gateway for other Universities by using full mesh based on their iBGP. By considering the development of IdREN, this research conduct analysis on the using of BGP Confederation as its iBGP topology scheme. The number Sub AS being main discussion to show its impact when it is applied in reality.**

Keywords -- IdREN, NREN, iBGP, iBGP Full Mesh, BGP Confederation, QoS.

I. INTRODUCTION

In the data communication through internet network, routing is the most vital thing to be managed in increasing its network performance. Routing and routing dynamic are compulsory to gain fast updating address between routing wares.

Indonesia Research and Education Network (IdREN) runs its function to connect academician from various Institution and Universities on Border Gateway Protocol (BGP) protocol in make them run normally. On its implementation, IdREN applies the standard BGP topology scheme, Internal BGP (iBGP) and External BGP (eBGP) by using *full mesh* method on its iBGP.

Internal BGP (iBGP) is wellknown in having three methods : Full Mesh, Route Reflector and BGP Confederation. All of them have their own plus and minus.

BGP Confederation was formed to break iBGP into several Sub Autonomous System (AS) to integrated work inside the system of iBGP. So far, the choosing way and grouping scheme of router into part of a Sub AS always been ignored. This condition lead this research be done to test how big *the effect* of those groupings into Sub AS BGP Confederation to the increasing of Quality of Service (QoS) in a network is.

A. IdREN

IdREN is the development of Indonesia Higher Education Network (INHERENT) which has been operated since September 2015[1]. Today, it connects 55 Higher Educations and 32 others on the queue of physical connection[2].

At the founding age of IdREN by using AS Number AS18007 as its prior one, INHERENT, but then in 2016 it changed to use AS64302 [3].and consist of 5 node border gateway on each University such as in UI, UGM, ITB, ITS and UB, also node border on Internet Provider , that is Telkom [4].

Figure 1, IdREN Gates and Nodes [5]

As part of Research and Education Network (REN) global network, IdREN is connected to global REN through *TEIN4* (AS24490) with 1 Gbps bandwidth, where national gate is in ITB IdREN [4], [6].

IdREN plan development forward will apply *multihomed system*, It will has several providers to participate in serving IdREN members[7]. By this development, the spread of bandwith and topology scheme of IdREN will be important one to discuss further.

IdREN nowadays is getting widely spread and mostly related to the research implementation on networks such as *Network test Bed* / SDN; *Weather prediction Model* / Disaster mitigation (Flood and fire); *Telemedicine* (TEMDEC); *E-learning*; *Lapak IdREN*; *e-Village*; *RIPE Atlas*; and Cloud and ID Federation [4].

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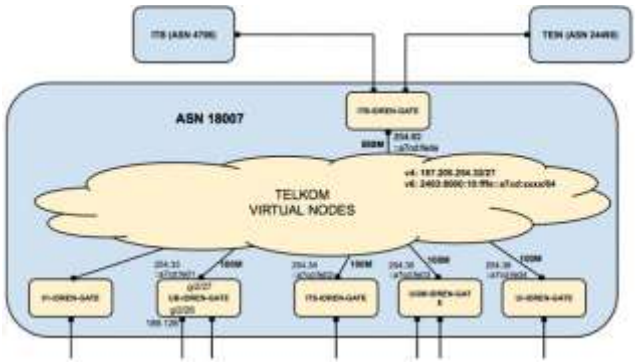

Figure 2, IdREN Link to Global REN [4]

B. BGP Confederation

By considering IdREN in the future which the long queue among Universities and geographical location in Indonesia, the form of iBGP topology and IdREN node border location take them important issues.

Research on IdREN topology is also important to decide any University joining its best suit in a such of provider.

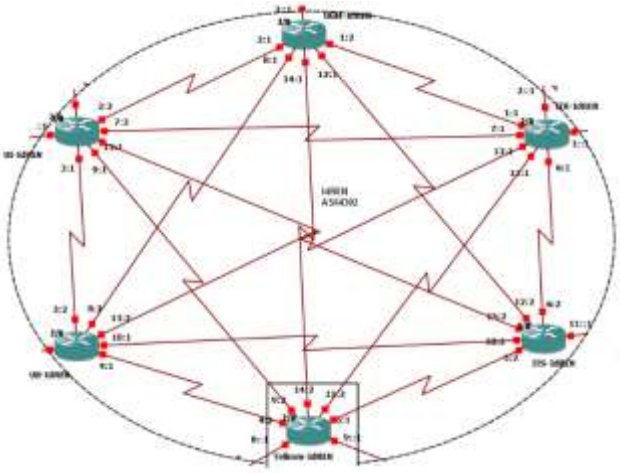

Figure 3, The Last iBGP IdREN Topology (Full Mesh)[7]

Design of *Full Mesh* Routing used in iBGP topology has lackness when it is used in a big scale where the configuration been complex and it makes difficulty for administrator to setting it on every changing made[8].

Beside Full Mesh, the other method to reduce this iBGP routing complexity are Route Reflector and BGP Confederation[9], [10].

This research focus on *BGP Confederation* method as a solution to test it by using some scnearios on knowing *the effect* of BGP Confederation topology design inside internal BGP.

C. IPv6

IdREN network in migration transition period from Internet Protocol version 4 (IPv4) to IPv6 so on its implementation there are some parts of AS, represents the Institution, still use IPv4 format while the others use IPv6 or dualstack IPv4/IPv6[3].

IdREN advertised the prefix IPv4 103.78.232.0/22 and prefix IPv6 2001:df6:5a00::/48 then shaped into peer as seen in Chart 1 and chart 2 [3].

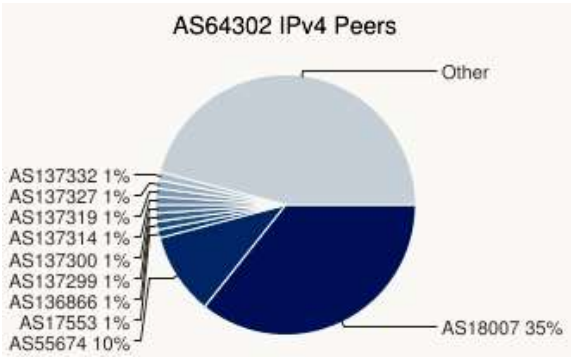

Chart 1, IPv4 Peers Composition of IdREN[3]

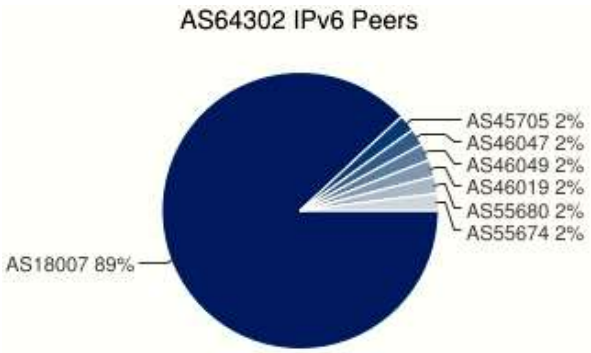

Chart 2, IPv6 Peers Composition of IdREN [3].

As part of global adaptation in the future, Institution/University in IdREN need to adjust to the previous Institution members in preparing migration process to IPv6.

II. Related Research

There are some researchs related to BGP and IdREN. M. Hafiz Ramadhan (2015) which discussed the using of Weight BGP on prior IdREN, the INHERENT[11]. There was also a research by Fikry Ardian (2016) discussed the BGP attribute engineering on IdREN topology[7].

Furthermore, the research on the effect of network model has been done by Lady Silk with Suhardi with topic on Open Shortest Path First (OSPF) protocol, tested by Ping application and File Transfer Protocol (FTP) [12]. Beside that, Nugraha also developed research to answer some questions related to simulation scenario on iBGP Confederation but they used Transmission Control Protocol (TCP) data and Mikrotic testing ware in term of IPv4 protocol [13].

III. Testing Scenario

On this paper, there are several topologies with BGP Confederation methods on iBGP IdREN.

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Testing was conducted by using *Graphical Network Simulator 3 (GNS3)* on 3 scenarios to test its topology scheme performance. The traffic was applied to tested topology by using *Iperf3* run on the *VM Ubuntu Operation System*.

All of the router whether internal or external BGP are then configured by protocol IPv6 so that the scenario will reflect the next condition of IdREN.

QoS from the-will-be-tested BGP Confederation scenario was measured based on 3 parameters i.e Delay, jitter and throughtput. Each of them will produce a compared value between each scenario.

Delay is the total time needed for a packet to travel from the origin (sender) to the destination (recipient). Delay from sender to receiver is basically composed of hardware latency, access delay, and transmission delay[14].

Jitter is a variety of package arrivals, this is caused by variations in queue length, in data processing time, and also in the time of reassembling packages at the end of the package trip[14].

Throughput is the rate of effective data transfer, measured in bps. Throughput is related to the available bandwidth on the network. Bandwidth provided is not all used by applications on the network. The amount of bandwidth used by the application is throughput[14].

Three tested scenarios were made according to real IdREN which had 6 Border Gateway iBGP. Scenario simulation was made by using Router Cisco c3640 to omit all of *BGP attributes* (optional) to gain the result mach with research aim in finding the best topology scheme.

A. *Case Scenario of 2 Sub AS*

On this scenario, iBGP of IdREN was divided into 2 Sub AS by each consisted of 3 node routers.

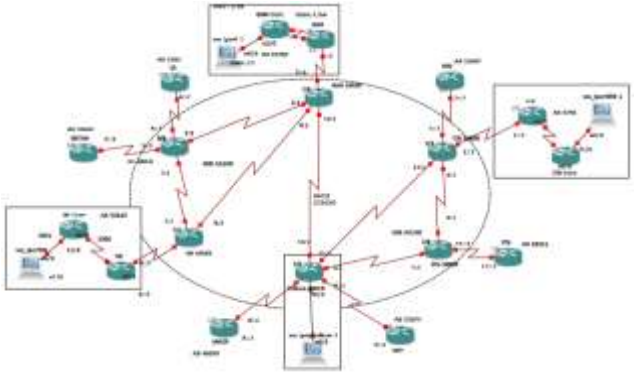

Figure 4, iBGP Topology with 2 Sub AS

Figure 4 showed iBGP of IdREN with AS64302 was divided into 2 Sub AS, Sub AS100 and Sub AS200. By 6 IdREN Border Router, the Combination was then obtained,

$$C(6,3)= 6!/(6-3)!.3! = 20. \quad (1)$$

but this paper only tested one combination (showed at Figure 4) as test representative by 2 Sub AS.

B. *Case Scenario of 3 Sub AS*

On this scenario, iBGP IdREN was divided into 3 Sub AS such as AS100, AS200 and AS300. Each of them consisted of 2 node router. Same like Scenario 2 Sub AS, this scenario produced some combinations.

$$C(6,2)= 6!/(6-2)!.2! = 15 \quad (2)$$

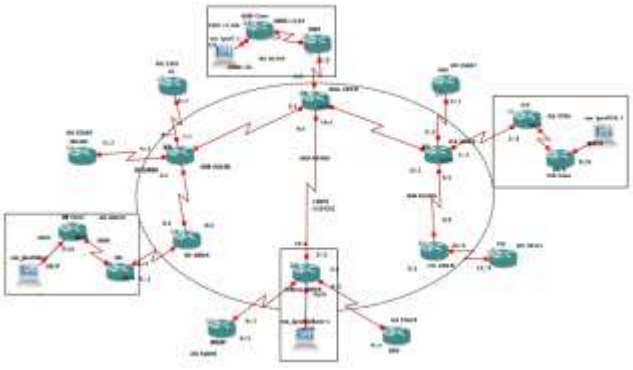

Figure 5, iBGP Topology with 3 Sub AS

C. *Case Scenario of 6 Sub AS*

On this scenario, iBGP of IdREN was divided into 6 Sub AS. Each of them had 1 node router. It looked like ring topology if we see it at glance.

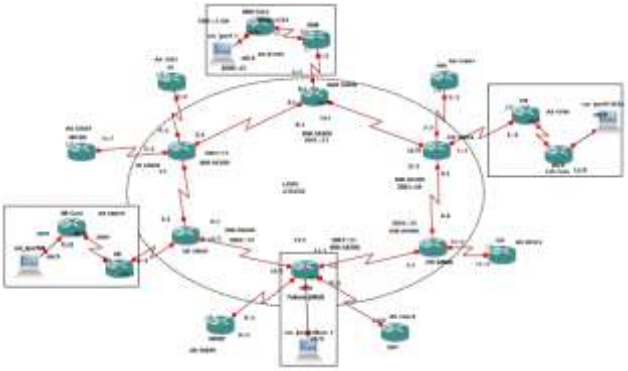

Figure 6, iBGP Topology with 6 Sub AS

After finishing the mentioned network configurations, some further tests were conducted to obtain the best QoS between scenarios. Those used load giver application, iperf3, which would produce artificial traffic from Client to Server based on input parameter.

There were some parameters used on the tests, Testing Data Size : 100 Mbytes; Bandwidth Set = 100 Mbps, Kind of Data : UDP, and Testing Route : UB (Client) - ITB (Server).

After testing, some data were then taken listed below: Throughput, Jitter,and Delay.

All of those three scenarios took two routers outside the iBGP which had function as Client and Server during the testing process. The connection of Client and Server then shaped topology of BGP External into iBGP of IdREN. The furthest

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route from its hop between Client and Server was chosen to maximize test result.

IV. Testing and Result

Every scenario had 30 times of iteration, then being tested statistically on each testing parameter.

Here is the Graphic of Delay Comparison of Every Sub AS:

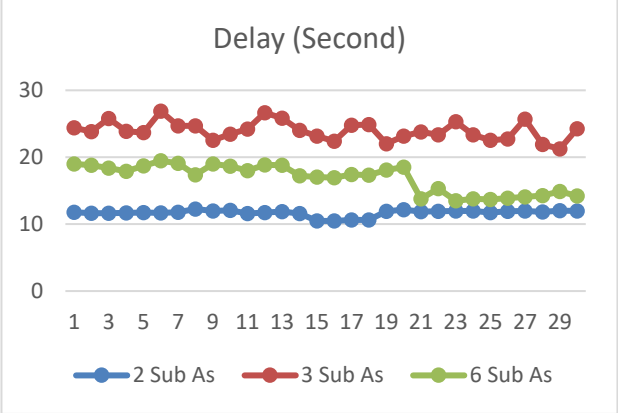

Figure 7, Graphic of Delay Comparison of Every Sub AS

Here is the Graphic of Throughput Comparison of Every Sub AS:

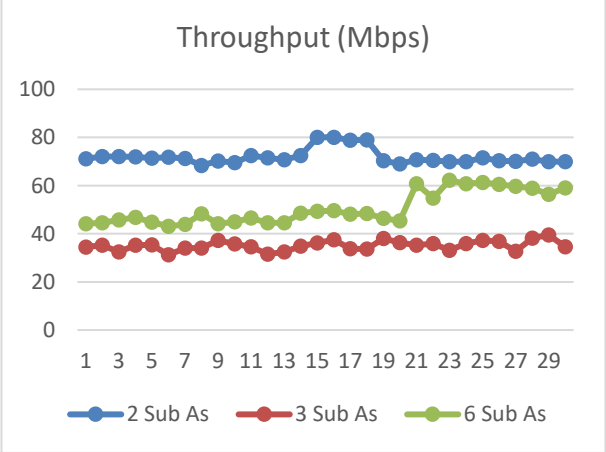

Figure 8, Graphic of Throughput of Every Sub AS

Here is the Graphic of Jitter Comparison of Every Sub AS:

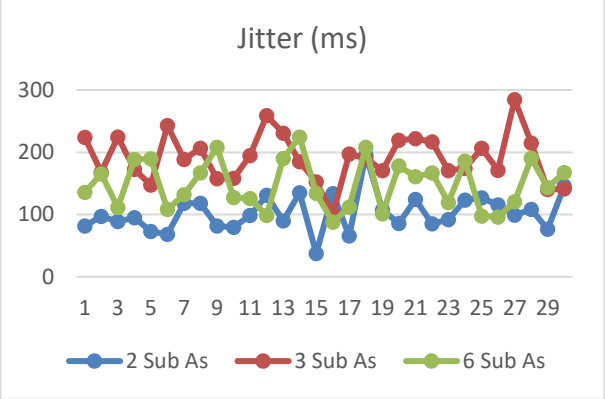

Figure 9, Graphic of Jitter of Every Sub AS

The test on data normality was conducted to see *data homogeneity* to be base of next statistical test as seen on Table I.

TABLE I. Normality Test of Each iBGP Skenario

Tests of Normality							
Testing Parameter	Group of Sub AS	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Delay	2 Sub As	.284	30	.000	.742	30	.000
	3 Sub As	.066	30	.200*	.986	30	.949
	6 Sub As	.179	30	.015	.848	30	.001
throughput	2 Sub As	.297	30	.000	.709	30	.000
	3 Sub As	.051	30	.200*	.990	30	.990
	6 Sub As	.222	30	.001	.821	30	.000
jitter	2 Sub As	.110	30	.200*	.955	30	.223
	3 Sub As	.099	30	.200*	.987	30	.971
	6 Sub As	.126	30	.200*	.945	30	.125

A. *Delay*

The result of Delay measurement can be seen on Table II.

TABLE II. The Result of Delay Measurement (Mean±SEM)

Groups of Sub AS	n	mean ±SEM (Sec)	p
2 Sub AS	30	11,68±0,08	0,001
3 sub AS	30	23.97±**0**,25	
6 Sub AS	30	16.86±0,38	

Based on data normality test by using *Shapiro-Wilk test*, it showed p>0.05 which showed the not-normal data there. By this, data transformation then be used to test again by using ln but the result of not-normal was still there so it took any statistical test of nonparametric, the *Kruskal-Wallis test*. It was followed by using *post hoc Mann-Whitney*. This showed 0.001 result meant that p value < 0.05 so it could be concluded that group of 2 Sub AS, 3 Sub AS and 6 Sub AS had significant difference statistically. On the other word, by seeing Delay measurement, iBGP Confederation topology by using 2 Sub AS scenario was the best result with 11.68±0,08 Sec of Delay value.

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B. Throughput

The result of throughput measurement can be seen on Table III.

TABLE III. THE RESULT OF THROUGHPUT MEASUREMENT (MEAN±SEM)

Groups of Sub AS	n	Mean±SEM (Mbps)	p
2 Sub AS	30	71,94±0,57	0,001
3 sub AS	30	35,11±**0**,36	
6 Sub AS	30	50,54± 1,22	

Based on *Shapiro-Wilk* data normality test, it showed p value > 0.05 so the data were identified not-normal so it took any data transformation on throughput test by using In but it was still not-normal. Further, it was necessary to take any statistical test of nonparametric, the *Kruskal-Wallis*, continued by *Mann-Whitney* statistical test. It showed 0.001 p value<0.05 meant that there was significant difference on 2 Sub AS, 3 Sub AS and 6 Sub AS at throughput test. On the other word, by seeing throughput measurement, topology of iBGP Confederation with 2 Sub AS scenario gave the best result. It had 71,94±0,57 Mbps of throughput value.

C. Jitter

The result of jitter measurement can be seen on Table IV.

TABLE IV. THE RESULT OF JITTER MEASUREMENT (MEAN±SEM)

Groups of Sub AS	n	Mean ±SEM (ms)	p
2 Sub AS	30	102,53±5,51	0,001
3 sub AS	30	191,07±**7**, **15**	
6 Sub AS	30	147,95± 7,17	

Based on *Shapiro-Wilk* data normality test, it showed p value > 0.05. The Jitter test by using one way ANOVA, continued by *post hoc multiple comparison*, showed p value < 0,05 . It could be concluded that there was significant difference on 2 Sub AS, 3 Sub AS and 6 Sub AS groups. On the other word, based on the jitter measurement, topology of iBGP Confederation with 2 Sub AS scenario gave the best result. It has 102.53±5,51 ms of Jitter value.

V. CONCLUSION AND RECOMMENDATION

According to applied test on several iBGP Confederation scenarios on IdREN network, there are some conclusions can be obtained as mentioned below:

- The result shows that topology of BGP Confederation on IdREN network has significant value on Sub AS Scenario. This can be a consideration to optimize future IdREN in increasing its service quality to its users at the same time the increasing of throughput and the decreasing of Delay are exist.
- This research paper can be an evaluation for stakeholder in deciding the node border location of iBGP by considering the necessity of additional ones and decision making of connection spots for upcoming joined institution / University.
- The test with *UDP* Test limitation on this research paper could be used as reference for other researcher to test this network in other scenarios.
- We recommend using the latest version of iperf to get maximum results in testing, or use other testing applications for testing variations.

REFERENCES

[1] A. Basuki and A. Basalamah, "Indonesia Research & Education Network (IDREN) - Past, Present & Future," 2017.

[2] "IdREN Website." [Online]. Available: https://idren.id. [Accessed: 20-Oct-2018].

[3] "AS64302 IdREN, Hurricane Electric Internet Service," 2018. [Online]. Available: https://bgp.he.net/AS64302#_asinfo. [Accessed: 22-Oct-2018].

[4] B. Suhardiman, "Inherent / IDRen status update in Indonesia by August 2018," no. August, 2018.

[5] A. Basuki, "IdREN - Background / Objective, Approach, Milestone," pp. 1–20, 2016.

[6] B. Suhardiman, "TEIN Activities and in Indonesia," 2015.

[7] F. Ardian, "Simulasi Routing Policy Pada Border Gateway Protocol Dalam Jaringan IdREN Mempergunakan GNS3," Universitas Gadjah Mada, 2017.

[8] M.-O. Buob, A. Lambert, and S. Uhlig, "iBGP2: A scalable iBGP redistribution mechanism leading to optimal routing," in IEEE INFOCOM 2016 - The 35th Annual IEEE International Conference on Computer Communications, 2016, vol. 2016–July, pp. 1–9.

[9] Y. Breitbart, M. Garofalakis, A. Gupta, A. Kumar, and R. Rastogi, "On Configuring BGP Route Reflectors," in 2007 2nd International Conference on Communication Systems Software and Middleware, 2007, pp. 1–12.

[10] R. Zhang and C. No, BGP Design and Implementation. Cisco Press, 2003.

[11] M. R. Hafiz, "Simulasi Border Gateway Protocol (BGP) pada IPv6 Dalam Proses Pemilihan Jalur Routing," p. 298231, 2015.

[12] L. S. Moonlight and S. Suhardi, "Pengaruh Model Jaringan Terhadap Optimasi Routing Open Shortest Path First (Ospf)," Teknol. J. Ilm. Sist. Inf., vol. 1, no. 2, pp. 68–80, 2012.

[13] N. S. Nugraha, J. T. Informatika, F. I. Komputer, U. D. Nuswantoro, and M. Jaringan, "Analisa Pengaruh Model Jaringan Terhadap Optimasi Dynamic Routing Border Gateway Protocol," 2009.

[14] A. I. Diwi, R. M. Rumani, and I. Wahidah, "Analisis Kualitas Layanan Video Live Streaming pada Jaringan Lokal Universitas Telkom Quality of Service Analysis for Live Streaming Video Services on Telkom University Local Network," pp. 207–216, 2014.

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