THE WAY TO BE

CISCO WARRIOR

TEORY & PRACTICE

ID-Networkers

MUHAMMAD TAUFIK

PREFACE

Assalammu'alaykum wr wb

Alhamdulillah buku ini dapat terselesaikan. Buku ini adalah buku penunjang untuk belajar ilmu jaringan khususnya CISCO. InshaAllah buku ini juga akan digunakan untuk pertama kalinya dalam training "Pesantren Networkers Mengajar".

CISCO merupakan salahsatu vendor perangkat terbesar dalam dunia jaringan. Selain CISCO, ada juga Mikrotik dan Juniper. Kesemuanya mempunyai sertifikasinya masing-masing. Misalkan di CISCO ada CCNA (Cirsco Certified Network Academy), CCNP (Cirsco Certified Network Professional) dan CCIE (Cisco Certified Internetwork Expert).

Dalam buku ini dituliskan teori dan praktek step by step sehingga mudah diikuti. Walaupun buku ini lebih focus pada CISCO, namun secara teori, sama dengan yang lain semisal Mikrotik dan Juniper. Yang berbeda hanyalah pada commandnya. Dan dalam CISCO, materinya bisa dibilang adalah yang paling lengkap.

Pada akhirnya penulis berharap buku ini bermanfaat dan tidak lupa mengucapkan rasa terimakasih kepada pihak yang telah banyak membantu terselesaikannya buku ini: Pak Dedi, Alam, Ikhwan, Mas Aries, Mas Ali, Mas Bram, Pak Anshori, Mas Rofiq, Mas Okky, teman-teman Pesantren Networkers, SMK IDN dan keluarga ID-Networkers dan teman-teman Ponpes Madinatul Quran.

Wassalammu alaykum wr wb

Jakarta, 29 April 2015

Muhammad Taufik

CONTENT

NETWORK FUNDAMENTALS

CHAPTER 1 SWITCHING

CHAPTER 2 ROUTING

CHAPTER 3 IPv6

CHAPTER 4 EIGRP

CHAPTER 5 OSPF

CHAPTER 6 BGP

NETWORK FUNDAMENTALS

Pengertian Jaringan
Jaringan berdasarkan Area
OSI Layer
Perangkat Jaringan dan Simbol
IP Address
Ethernet Cable
Subnetting So Easy
Contoh Soal Subnetting
Subnetting Challenge
Broadcast Domain dan Collision Domain
Perbedaan Hub, Bridge, Switch dan Router

Network Fundamentals

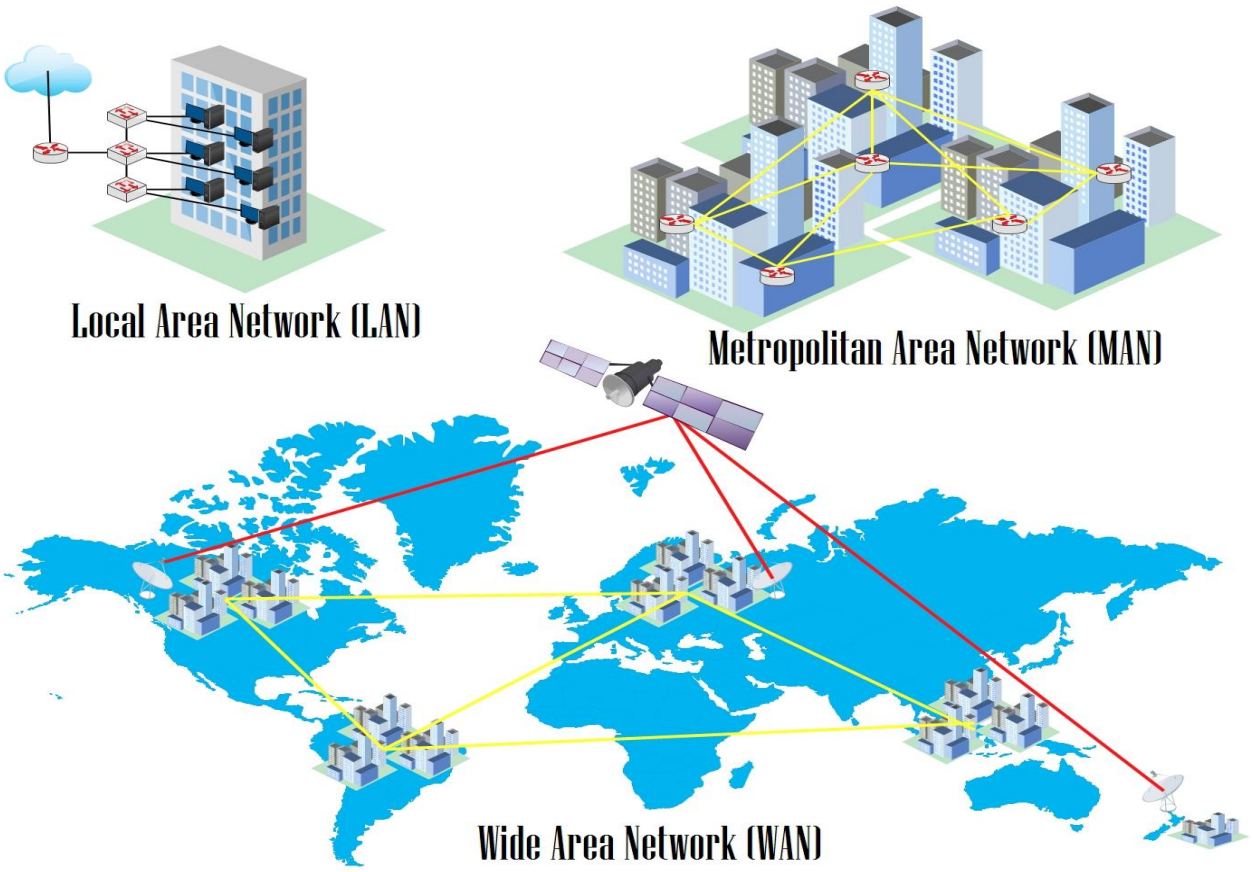
Pengertian Jaringan

Jaringan atau network adalah kumpulan perangkat jaringan (network devices) dan perangkat endhost (end devices) yang terhubung satu sama lain dan dapat melakukan sharing informasi serta resources.

Komponen pembentuk jaringan:

- Network devices: hub, bridge, switch dan router.
- End devices: PC, laptop, mobile, dll.
- Interconnection: NIC, konektor, media (cooper, fiber optic, wireless, dll).

Jaringan berdasarkan Area

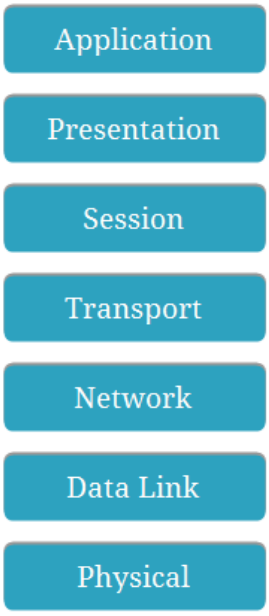


Gambar Jaringan berdasarkan area

- Local Area Network (LAN) merupakan jaringan sederhana dalam satu gedung, kantor, rumah atau sekolah. Biasanya menggunakan kabel UTP.
- Metropolitan Area Network (MAN) adalah gabungan dari banyak LAN dalam suatu wilayah.
- Wide Area Network (WAN) adalah jaringan yang menghubungkan banyak MAN antar pulau, negara atau benua. Medianya dapat berupa fiber optic dan satelit.

OSI Layer

Adalah standar dalam perangkat jaringan yang membuat berbagai perangkat kompatibel satu sama lain. Ada 7 layer dalam OSI layer, dari bawah layer 1 physical sampai atas layer 7 application.



Gambar OSI Layer

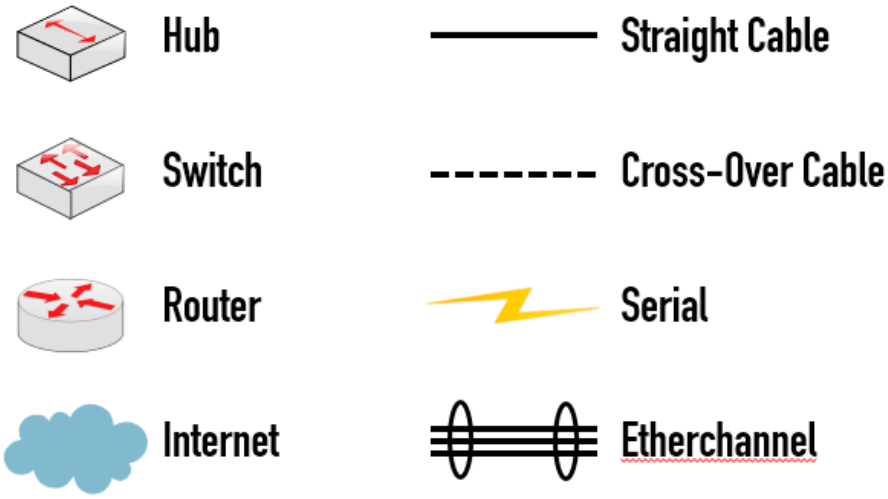
Seorang engineer wajib memahami layer 1 sampai 4 untuk memahami fungsi dan cara kerja perangkat jaringan.

	Layer	Perangkat	Data Unit	Pengalamatan
1	Physical	Hub	Bit	Binnary (1 or 0)
2	Data Link	Bridge dan Switch	Frame	MAC Address
3	Network	Router	Packet	IP Address

	Layer	Perangkat	Konektivitas	Memory
1	Physical	Hub	Broadcast ke semua port	-
2	Data Link	Bridge dan Switch	Broadcast berdasarkan MAC Address	MAC Address Tabel
3	Network	Router	Berdasarkan IP Address tujuan	Routing Tabel

Perangkat Jaringan dan Simbol

Seorang network engineer harus mengetahui berbagai jenis perangkat jaringan dan simbolnya agar dapat membaca topologi jaringan.



IP Address

IP address dipakai untuk pengalamatan dalam jaringan.

- IP Network sebagai identitas network/jaringan. Jika ada IP 192.168.1.0/24 berarti mewakili suatu kelompok IP (network) dari 192.168.1.1 – 192.168.1.254
- IP broadcast merupakan IP terakhir dalam network yang dipakai untuk membroadcast packet broadcast. Misal 192.168.1.255/24.
- Host adalah ip yang disediakan untuk host. Misal: 192.168.1.111/24.

Ada beberapa jenis IP:

- IP public digunakan untuk mengakses internet.
- IP private digunakan untuk jaringan local.

Ethernet Cable

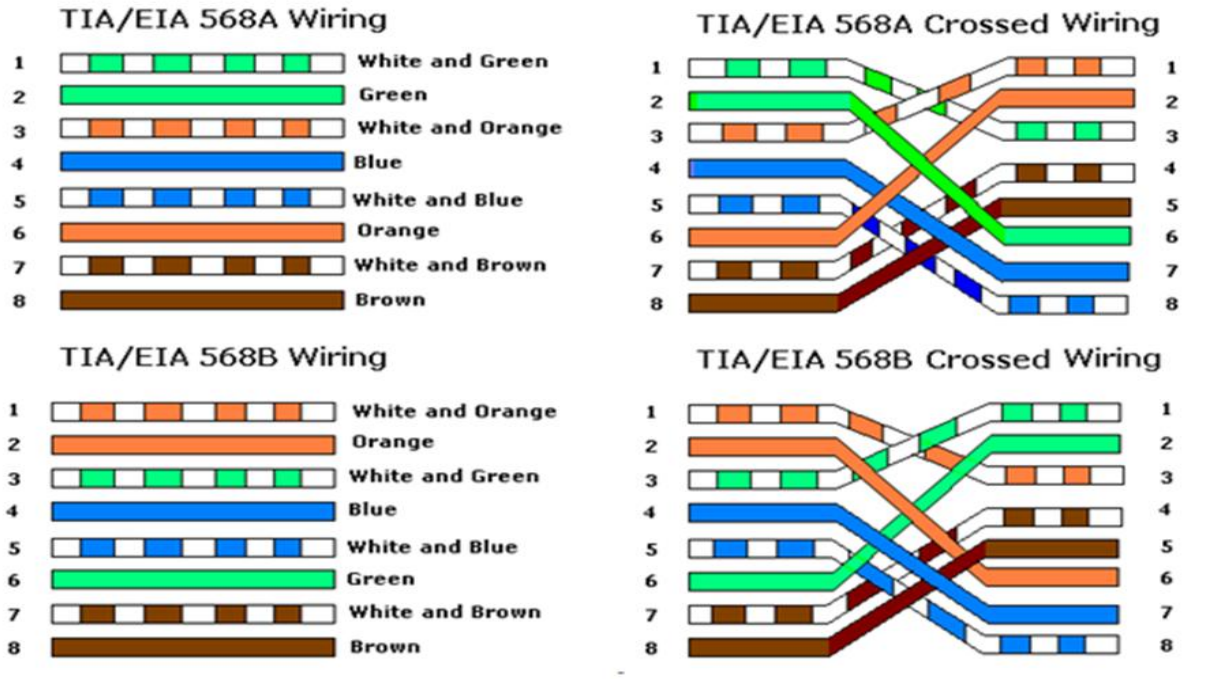


Figure A

Shows the Pin Out of Straight through Cables

Figure B

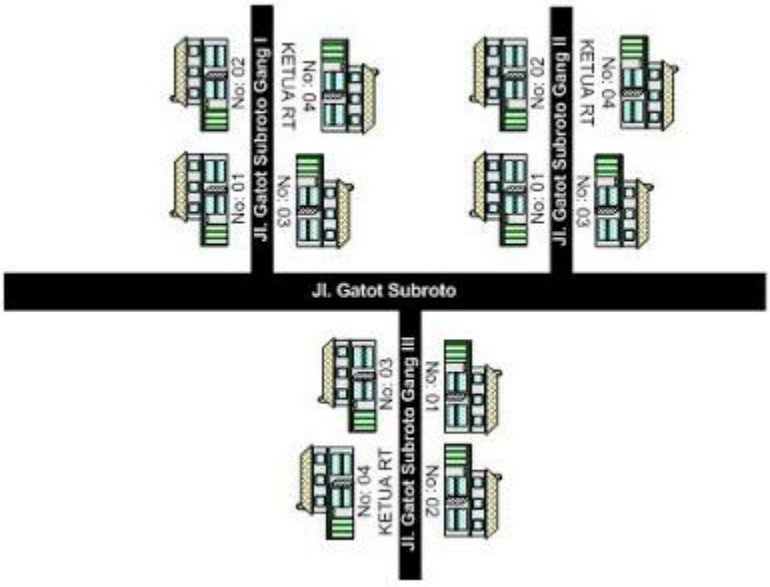
Shows the Pin Out of Crossover Cables

Subnetting so Easy

Subneting adalah membagi menjadi suatu netwok menjadi subnetwork yang lebih kecil. Inilah yang disebut subnet. Salah satu aspek dalam suatu design jaringan yang baik adalah pengoptimalan alamat ip. Subneting meminimalisir alamat ip yang tidak terpakai atau terbuang.

Subneting juga mempermudah dalam pengelolaan dan kinerja jaringan. Jika subneting dianalogikan dalam kehidupan nyata, maka akan seperti gambar dibawah. Dengan pengaturan subneting, maka akan terbentuk seperti gang-gang kecil ke komplek masing-masing sehingga mudah dalam membedakan jaringan dan pengiriman data ke tujuan.

Tanpa Subnet



Dengan Subnet

Subneting ini adalah hal yang wajib dikuasai oleh seorang network engineer. Klo dulu waktu ulangan subnet masih iseng-iseng pake subnet calculator online.

Hehehe… Sekarang harus bener-bener paham. Untuk memahami subneting ini, terlebih dahulu mengerti tentang bilangan decimal dan biner (nol atau satu).

Dalam subneting, ada beberapa hal yang paling sering dicari.

Subnetmask

Misal ada ip 192.168.2.172/26 maka subnetmask atau netmask nya adalah /26 = 11111111.11111111.11111111.11000000. Prefix /26 mengindikasikan biner 1 (Net ID) berjumlah 26 dan sisanya yaitu Host ID berjumlah 6.

Dari 11111111.11111111.11111111.11000000 ini ketika didesimalkan maka didapat subnet mask dari adalah 255.255.255.192.

Total IP

Total IP ini dihitung dari Host ID. Dari contoh soal, didapat Host ID ada 6bit. Karena IPv4 32bit jadi 32-26 sisa 6. Sehingga maksimal IP didapat 2^6=64.

Rumus menghitung maksimal IP: 2^Host ID

Jumlah Subnet

Jumlah subnet dihitung dari Net ID. Karena Net ID subnet /26 adalah 26 maka Subnet ID nya 2. Loh kok bisa? Karena Net ID 26 dikurangi 24 karena kelas C jadi 2. Intinya klo kelas C dikurangi 24, kelas B dikurangi 16, kelas A dikurangi 8. InshaAlloh akan lebih paham dalam pembahasan soal selanjutnya sob. Didapat banyak subnetnya adalah 2^2=4 subnet.

Rumus menghitung banyak subnet dengan rumus: 2^subnet ID

Menentukan IP Network dan Broadcast

Karena soalnya IP 192.168.2.172, maka gak mungkin termasuk subnet/network pertama karena 72>64. Jadi IP tersebut masuk ke subnet ke berapa ya? Kita hitung aja kelipatan 64. IP Network pasti paling awal dan broadcast paling akhir. Gampangnya ip network setelahnya dikurang 1 itulah broadcast.

	IP Network	Broadcast
1	192.168.2.**0**	192.168.2.**63**
2	192.168.2.**64**	192.168.2.**127**

3	192.168.2.**128**	192.168.2.**191**
4	192.168.2.**192**	192.168.2.**255**

Jadi IP 192.168.2.172 masuk dalam subnet ke 3 dengan ip network 192.168.2.128 dan broadcastnya 192.168.2.191.

IP Client

Dan ini adalah yang paling gampang, yaitu menghitung maksimal ip yang dapat dipakai host. Rumusnya adalah total ip dikurangi 2 karena dipakai untuk network id dan broadcast. Jadi IP Client tiap subnet adalah 64-2=62.

Untuk menghafal subnet lebih cepat, kita dapat memanfaatkan tabel subnet dibawah ini.

				Subnets			Hosts		
		/	Netmask	Block Size	Class A	Class B	Class C	Class A	Class B	Class C
Class A Network		8	255.0.0.0	256	1			16777214		
		9	255.**128**.0.0	128	2			8388606		
		10	255.**192**.0.0	64	4			4194302		
		11	255.**224**.0.0	32	8			2097150		
		12	255.**240**.0.0	16	16			1048574		
		13	255.**248**.0.0	8	32			524286		
		14	255.**252**.0.0	4	64			262142		
		15	255.**254**.0.0	2	128			131070		
	Class B Network	16	255.255.0.0	256	256	1		65534	65534	
		17	255.255.**128**.0	128	512	2		32766	32766	
		18	255.255.**192**.0	64	1024	4		16382	16382	
		19	255.255.**224**.0	32	2048	8		8190	8190	
		20	255.255.**240**.0	16	4096	16		4094	4094	
		21	255.255.**248**.0	8	8192	32		2046	2046	
		22	255.255.**252**.0	4	16384	64		1022	1022	
		23	255.255.**254**.0	2	32768	128		510	510	
Class C Network		24	255.255.255.0	256	65536	256	1	254	254	254
		25	255.255.255.**128**	128	131072	512	2	126	126	126
		26	255.255.255.**192**	64	262144	1024	4	62	62	62
		27	255.255.255.**224**	32	524288	2048	8	30	30	30
		28	255.255.255.**240**	16	1048576	4096	16	14	14	14
		29	255.255.255.**248**	8	2097152	8192	32	6	6	6
		30	255.255.255.**252**	4	4194304	16384	64	2	2	2

Tabel Subneting

Contoh Soal Subnetting

Dalam pembahasan ini, kita akan belajar untuk mengerjakan berbagai variasi soal subneting. Soal subnetingnya sebagai berikut guys.

Carilah total ip, netmask, ip network, broadcast dan host untuk masing-masing ip dibawah:

- 192.168.10.10/25
- 10.10.10.10/13
- 20.20.20.20/23
- 11.12.13.14/20
- 50.50.50.50./15

Ok langsung aja kita bahas bareng dari soal pertama ya…

IP 192.168.10.10/25 merupakan kelas C

a. Total IP : 128

   Didapat dari 2^7 = 128, 7 merupakan Host ID dari subnet /25

b. Netmask : 255.255.255.128

   Didapat dari 256 – Total IP = 256 – 128 = 128 menjadi 255.255.255.128

c. IP Network : 192.168.10.0

   Jumlah subnet adalah 2^1, 1 adalah Subnet ID. IP 192.168.2.10 masuk dalam subnet ke-1 karena berada dalam range 0-127 sehingga IP Networknya 192.168.10.0

d. Broadcast : 192.168.10.127

   IP Network setelahnya dikurangi 1 => 192.168.10.128 – 1 = 192.168.10.127

e Host : 192.168.10.1 – 192.168.10.126

   Jumlah ip yg dapat dipakai adalah 126 didapat dari 128 – 2 karena dipakai untuk IP Network dan broadcast.

10.10.10.10./13 merupakan kelas A

a. Total IP : 524288

Subnet 13 merupakan subnet kelas A sehiggga ntuk memudahkan diubah dulu menjadi subnet kelas C dengan ditambah 8 dua kali menjadi 29. Total host subnet 29 adalah 8. Lalu 8 x 256 x 256 menjadi 524288. Dikali 256 dua kali karena sebelumnya ditambah 8 dua kali untuk menjadi subnet kelas C.

b. Netmask : 255.248.0.0

Seperti biasa 248 didapat dari 256 – total ip. Karena kelas A ditambah 8 dua kali jadi kelas C maka subnet dimajukan 2 kali dari 255.255.255.248 menjadi 255.248.0.0.

c. IP Network : 10.8.0.0

Setelah disamakan menjadi kelas C(13+8+8=29), maka didapat jumlah subnet /29 adalah 2^5, 5 adalah Subnet ID. Total IP dari subnet /29 adalah 8, maka IP 10.10.10.10 masuk dalam IP Networknya 10.8.0.0.

d. Broadcast : 10.15.255.255

IP Network setelahnya dikurangi 1 => 10.16.0.0 – 1 = 10.15.255.255

e Host : 10.8.0.1 – 10.15.255.254

Jumlah ip yg dapat dipakai adalah 524286 didapat dari 524288 – 2 karena dipakai untuk IP Network dan broadcast.

11.12.13.14/20 merupakan kelas B

a. Total IP : 4096

Subnet 20 merupakan subnet kelas B sehiggga agar lebih mudah diubah dulu menjadi subnet kelas C dengan ditambah 8 menjadi 28. Total host subnet 28 adalah 16. Lalu 16 x 256 = 4096. Dikali 256 karena sebelumnya ditambah 8 kali untuk menjadi subnet kelas C.

b. Netmask : 255.255.252.0

252 didapat dari 256 – total ip. Karena kelas B ditambah 8 jadi kelas C maka subnet dimajukan 1 kali dari 255.255.255.252 menjadi 255.255.252.0.

c. IP Network : 11.12.0.0

Setelah disamakan menjadi kelas C(20+8=28), maka didapat jumlah subnet /28 adalah 2^4, 4 adalah Subnet ID. Total IP dari subnet /28 adalah 16, maka IP 11.12.13.14 masuk dalam IP Networknya 11.12.0.0 karena masih dalam rentang 11.12.0.0 – 11.15.255.255.

d. Broadcast : 11.12.15.255

IP Network setelahnya dikurangi 1 => 11.16.0.0 – 1 = 11.15.255.255

e Host : 11.12.0.1 – 11.12.255.254

Jumlah ip yg dapat dipakai adalah 4096 didapat dari 4096 – 2 karena dipakai untuk IP Network dan broadcast.

Subnetting Challenge ^_^

Carilah total ip, netmask, ip network, broadcast dan host untuk masing-masing ip dibawah:

- 172.16.10.111/27
- 99.99.99.99/28
- 100.100.100.100/20
- 111.222.33.44/14
- 8.8.8.8/32

IPv4 Subnetting

packetlife.net

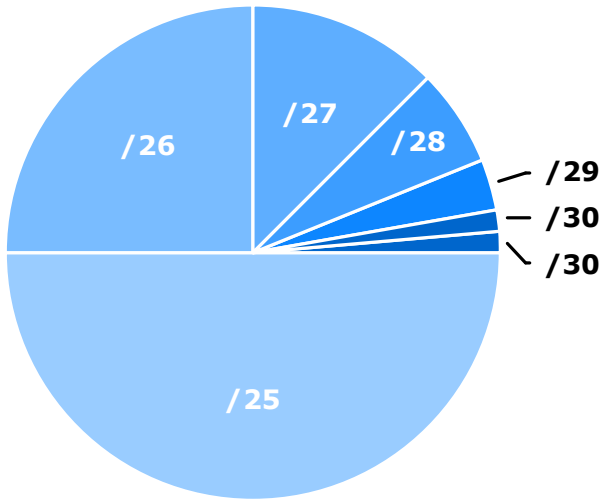
Subnets

CIDR	Subnet Mask	Addresses	Wildcard
/32	255.255.255.255	1	0.0.0.0
/31	255.255.255.254	2	0.0.0.1
/30	255.255.255.252	4	0.0.0.3
/29	255.255.255.248	8	0.0.0.7
/28	255.255.255.240	16	0.0.0.15
/27	255.255.255.224	32	0.0.0.31
/26	255.255.255.192	64	0.0.0.63
/25	255.255.255.128	128	0.0.0.127
/24	255.255.255.0	256	0.0.0.255
/23	255.255.254.0	512	0.0.1.255
/22	255.255.252.0	1,024	0.0.3.255
/21	255.255.248.0	2,048	0.0.7.255
/20	255.255.240.0	4,096	0.0.15.255
/19	255.255.224.0	8,192	0.0.31.255
/18	255.255.192.0	16,384	0.0.63.255
/17	255.255.128.0	32,768	0.0.127.255
/16	255.255.0.0	65,536	0.0.255.255
/15	255.254.0.0	131,072	0.1.255.255
/14	255.252.0.0	262,144	0.3.255.255
/13	255.248.0.0	524,288	0.7.255.255
/12	255.240.0.0	1,048,576	0.15.255.255
/11	255.224.0.0	2,097,152	0.31.255.255
/10	255.192.0.0	4,194,304	0.63.255.255
/9	255.128.0.0	8,388,608	0.127.255.255
/8	255.0.0.0	16,777,216	0.255.255.255
/7	254.0.0.0	33,554,432	1.255.255.255
/6	252.0.0.0	67,108,864	3.255.255.255
/5	248.0.0.0	134,217,728	7.255.255.255
/4	240.0.0.0	268,435,456	15.255.255.255
/3	224.0.0.0	536,870,912	31.255.255.255
/2	192.0.0.0	1,073,741,824	63.255.255.255
/1	128.0.0.0	2,147,483,648	127.255.255.255
/0	0.0.0.0	4,294,967,296	255.255.255.255

Decimal to Binary

Subnet Mask		Wildcard	
255	1111 1111	0	0000 0000
254	1111 1110	1	0000 0001
252	1111 1100	3	0000 0011
248	1111 1000	7	0000 0111
240	1111 0000	15	0000 1111
224	1110 0000	31	0001 1111
192	1100 0000	63	0011 1111
128	1000 0000	127	0111 1111
0	0000 0000	255	1111 1111

Subnet Proportion



Classful Ranges

A	0.0.0.0 – 127.255.255.255
B	128.0.0.0 - 191.255.255.255
C	192.0.0.0 - 223.255.255.255
D	224.0.0.0 - 239.255.255.255
E	240.0.0.0 - 255.255.255.255

Reserved Ranges

RFC 1918	10.0.0.0 - 10.255.255.255
Localhost	127.0.0.0 - 127.255.255.255
RFC 1918	172.16.0.0 - 172.31.255.255
RFC 1918	192.168.0.0 - 192.168.255.255

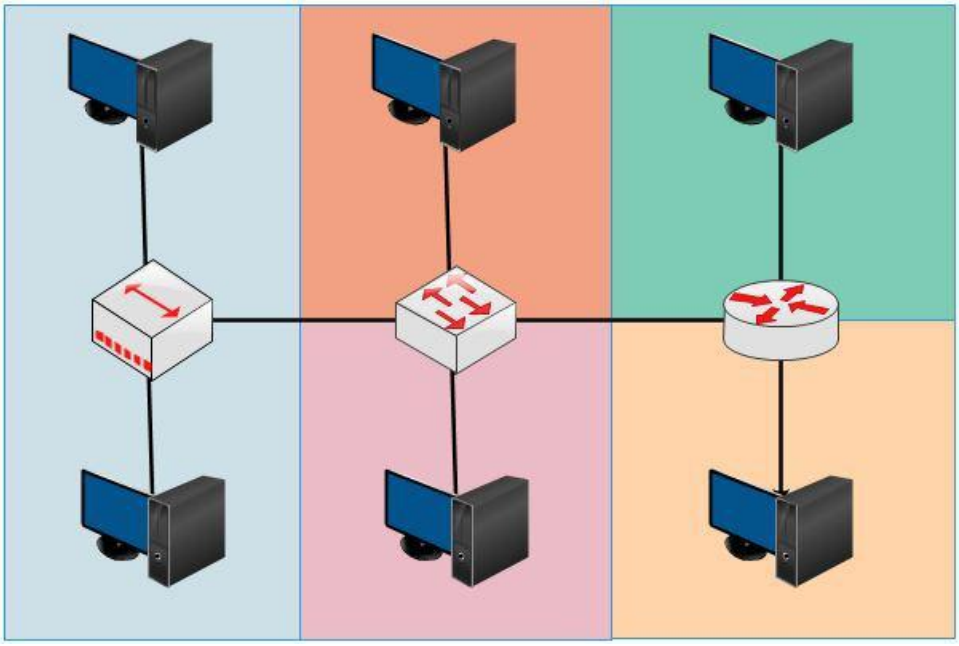
Terminology

CIDR
Classless interdomain routing was developed to provide more granularity than legacy classful addressing; CIDR notation is expressed as /XX

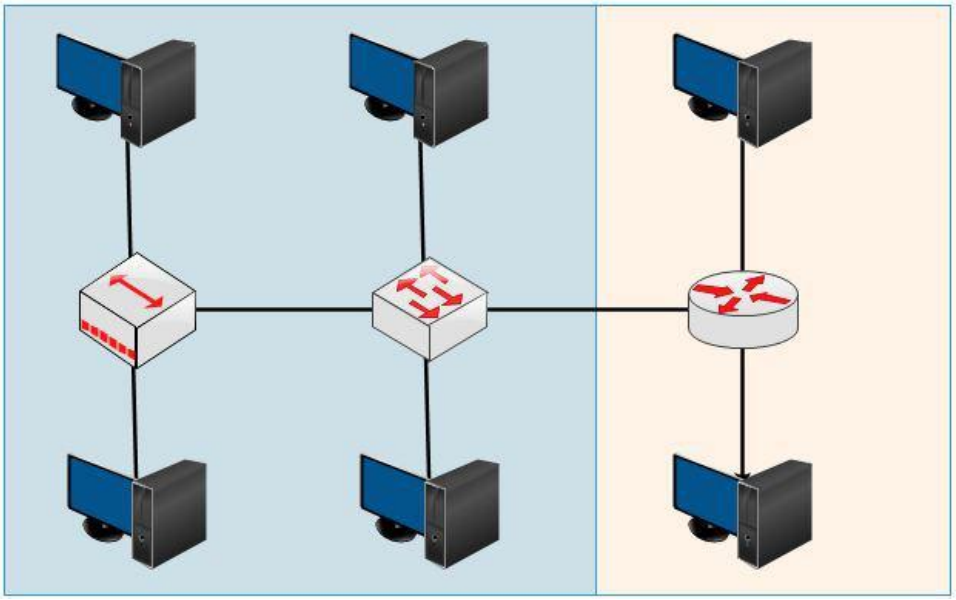
VLSM
Variable-length subnet masks are an arbitrary length between 0 and 32 bits; CIDR relies on VLSMs to define routes

Broadcast Domain dan Collision Domain

Collision domain adalah area dalam suatu jaringan dimana packet data dapat mengalami tabrakan (collision) dikarenakan device mengirimnya pada waktu yang bersamaan. Pada Hub, collision domainnya menjadi 1 (besar) dan pada Switch dan Router, collision domain hanya terjadi pada masing-masing interface.



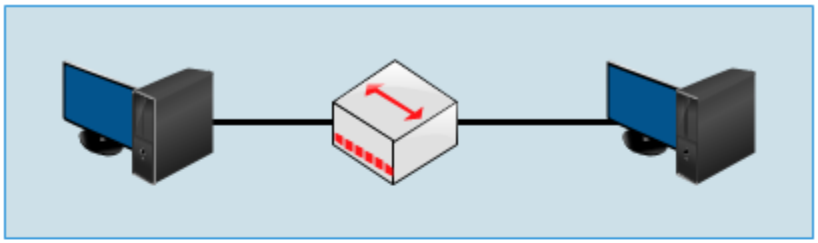
Broadcast domain adalah area dalam suatu jaringan dimana broadcast diforward pada pertama kali. Hub dan Switch mempunyai broadcast domain yang sama karena sama-sama melewatkan broadcast, sedang Router tidak melewatkan broadcast.

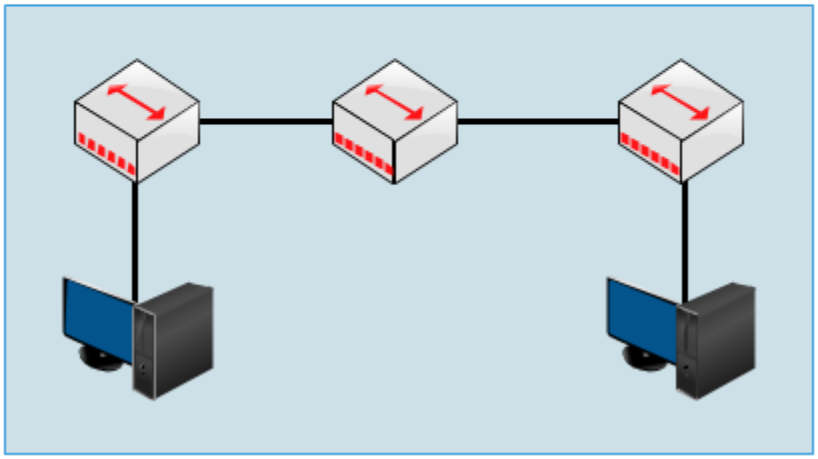


Perbedaan Hub, Bridge, Switch dan Router

Hub gak lebih dari physical repeater yang bekerja pada layer 1 dan gak punya intelijensi. Cara kerja hub adalah dengan menerima sinyal electric dari satu interface dan mengirimkannya ke semua interface kecuali ke source interface, butuh atau gak butuh.

Karena bekerja pada layer physical dengan half-duplex (satu mengirim, yang lain menunggu), maka dapat terjadi tabrakan (collision) ketika ada packet yang dikirimkan dalam waktu yang bersamaan. Area dimana dapat terjadi collision disebut dengan collision domain.





Kedua topologi diatas merupakan single collision domain. Semakin besar jaringan seperti diatas, collision juga semakin besar, dan menurunkan kinerja jaringan (down).

Terus apa solusinya?

Mengganti dengan perangkat yang bekerja pada layer 2 (data link) dan mempunyai intelijensi yaitu bridge. Karakteristik bridge:

– Memutuskan kemana Ethernet frame dikirim dengan melihat MAC Address.

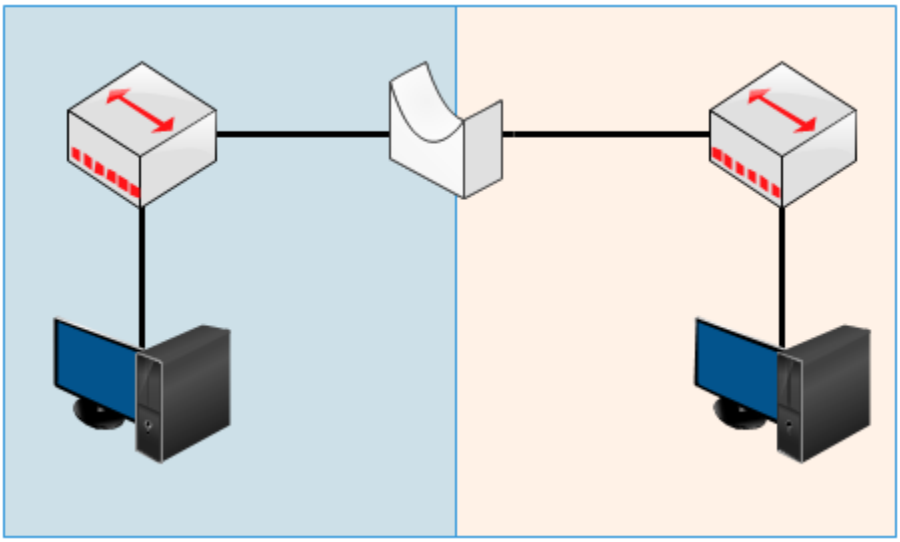
– Forward Ethernet frame hanya ke port yang membutuhkan.

– Filter Ethernet frames (discard them).

– Flood Ethernet frames (send them everywhere).

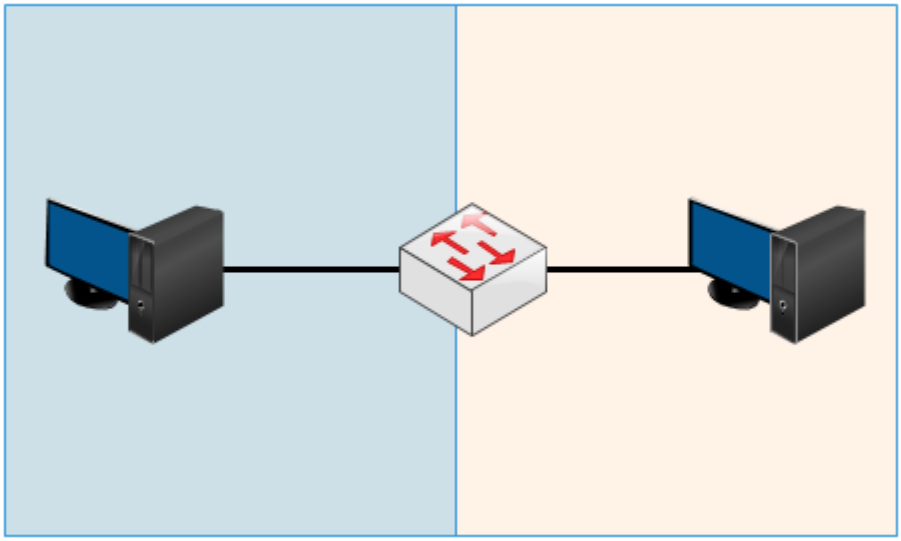
– Hanya punya beberapa port.

– Slow.



Dengan begitu collision domain terbagi menjadi 2 pada topologi diatas. Tapi sekarang kita gak pake hub atau bridge karena udah ada switch.

Bridge kembar sama switch… tapi gak sama…



Switch adalah bridge dengan beberapa kelebihan.

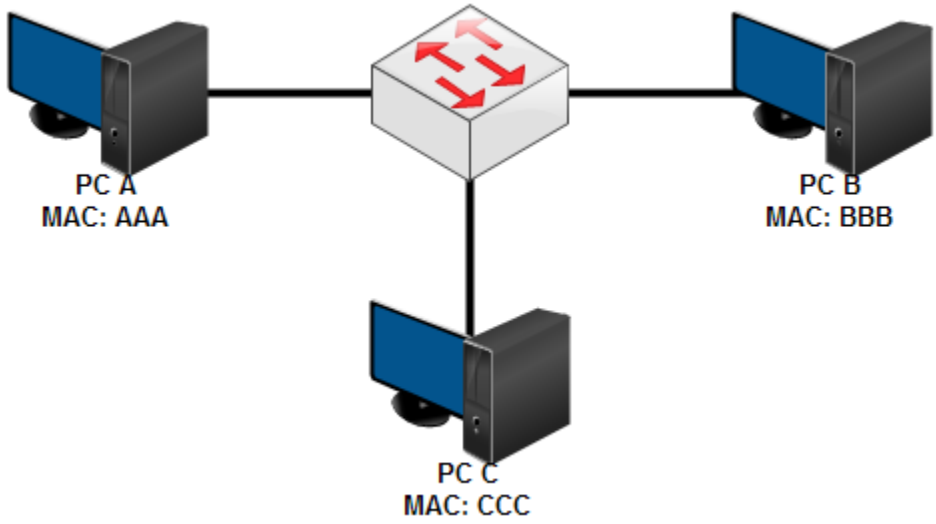
– Mempunyai banyak port.

– Mempunyai macam-macam port seperti FastEthernet dan Gigabit.

– Fast internet switching.

– Large buffers.

Cara kerja switch



Switch mempunyai tabel MAC Address yang menyimpan MAC Address dari PC yang tersambung ke port-port pada switch. Misal ketika pertama kali ketika PC disambungkan ke switch, PC A ingin mengirimkan data ke C.

–Maka PC A membuat Ethernet frame berisi IP address, MAC address dan tujuannya dan mengirimkannya ke switch.

– switch lalu membroadcastnya ke semua port kecuali source. Sampai sini, switch telah menyimpan MAC address A.

– Setelah dibroadcast, PC C akan mengirim reply berisi MAC addressnya dan ketika lewat switch, switch akan menyimpan MAC address C.

Broadcast dikirim ketika ada packet data yang destination MAC addressnya gak ada pada tabel MAC address switch.

Okey… to the point…

Hub kerja pada layer 1 – Physical

Bridge sama switch kerja di layer 2 – Data Link

Klo router? beda lagi,,, kerjanya dilayer 3 – Network

Hub, Bridge sm Switch melewatkan broadcast… Klo router enggak…

Physical Terminations

Optical Terminations

ST (Straight Tip)

SC (Subscriber Connector)

LC (Local Connector)

MT-RJ

Wireless Antennas

RP-TNC

RP-SMA

Copper Terminations

RJ-45

RJ-11

RJ-21 (25-pair)

DE-9 (Female)

DB-25 (Male)

DB-60 (Male)

GBICs

1000Base-SX/LX

1000Base-T

Cisco GigaStack

1000Base-SX/LX SFP

1000Base-T SFP

X2 (10Gig)

Common Ports

packetlife.net

TCP/UDP Port Numbers

7	Echo	**554**	RTSP	**2745**	Bagle.H	**6891-6901**	Windows Live
19	Chargen	**546-547**	DHCPv6	**2967**	Symantec AV	**6970**	Quicktime
20-21	FTP	**560**	rmonitor	**3050**	Interbase DB	**7212**	GhostSurf
22	SSH/SCP	**563**	NNTP over SSL	**3074**	XBOX Live	**7648-7649**	CU-SeeMe
23	Telnet	**587**	SMTP	**3124**	HTTP Proxy	**8000**	Internet Radio
25	SMTP	**591**	FileMaker	**3127**	MyDoom	**8080**	HTTP Proxy
42	WINS Replication	**593**	Microsoft DCOM	**3128**	HTTP Proxy	**8086-8087**	Kaspersky AV
43	WHOIS	**631**	Internet Printing	**3222**	GLBP	**8118**	Privoxy
49	TACACS	**636**	LDAP over SSL	**3260**	iSCSI Target	**8200**	VMware Server
53	DNS	**639**	MSDP (PIM)	**3306**	MySQL	**8500**	Adobe ColdFusion
67-68	DHCP/BOOTP	**646**	LDP (MPLS)	**3389**	Terminal Server	**8767**	TeamSpeak
69	TFTP	**691**	MS Exchange	**3689**	iTunes	**8866**	Bagle.B
70	Gopher	**860**	iSCSI	**3690**	Subversion	**9100**	HP JetDirect
79	Finger	**873**	rsync	**3724**	World of Warcraft	**9101-9103**	Bacula
80	HTTP	**902**	VMware Server	**3784-3785**	Ventrilo	**9119**	MXit
88	Kerberos	**989-990**	FTP over SSL	**4333**	mSQL	**9800**	WebDAV
102	MS Exchange	**993**	IMAP4 over SSL	**4444**	Blaster	**9898**	Dabber
110	POP3	**995**	POP3 over SSL	**4664**	Google Desktop	**9988**	Rbot/Spybot
113	Ident	**1025**	Microsoft RPC	**4672**	eMule	**9999**	Urchin
119	NNTP (Usenet)	**1026-1029**	Windows Messenger	**4899**	Radmin	**10000**	Webmin
123	NTP	**1080**	SOCKS Proxy	**5000**	UPnP	**10000**	BackupExec
135	Microsoft RPC	**1080**	MyDoom	**5001**	Slingbox	**10113-10116**	NetIQ
137-139	NetBIOS	**1194**	OpenVPN	**5001**	iperf	**11371**	OpenPGP
143	IMAP4	**1214**	Kazaa	**5004-5005**	RTP	**12035-12036**	Second Life
161-162	SNMP	**1241**	Nessus	**5050**	Yahoo! Messenger	**12345**	NetBus
177	XDMCP	**1311**	Dell OpenManage	**5060**	SIP	**13720-13721**	NetBackup
179	BGP	**1337**	WASTE	**5190**	AIM/ICQ	**14567**	Battlefield
201	AppleTalk	**1433-1434**	Microsoft SQL	**5222-5223**	XMPP/Jabber	**15118**	Dipnet/Oddbob
264	BGMP	**1512**	WINS	**5432**	PostgreSQL	**19226**	AdminSecure
318	TSP	**1589**	Cisco VQP	**5500**	VNC Server	**19638**	Ensim
381-383	HP Openview	**1701**	L2TP	**5554**	Sasser	**20000**	Usermin
389	LDAP	**1723**	MS PPTP	**5631-5632**	pcAnywhere	**24800**	Synergy
411-412	Direct Connect	**1725**	Steam	**5800**	VNC over HTTP	**25999**	Xfire
443	HTTP over SSL	**1741**	CiscoWorks 2000	**5900+**	VNC Server	**27015**	Half-Life
445	Microsoft DS	**1755**	MS Media Server	**6000-6001**	X11	**27374**	Sub7
464	Kerberos	**1812-1813**	RADIUS	**6112**	Battle.net	**28960**	Call of Duty
465	SMTP over SSL	**1863**	MSN	**6129**	DameWare	**31337**	Back Orifice
497	Retrospect	**1985**	Cisco HSRP	**6257**	WinMX	**33434+**	traceroute
500	ISAKMP	**2000**	Cisco SCCP	**6346-6347**	Gnutella		
512	rexec	**2002**	Cisco ACS	**6500**	GameSpy Arcade		
513	rlogin	**2049**	NFS	**6566**	SANE		
514	syslog	**2082-2083**	cPanel	**6588**	AnalogX		
515	LPD/LPR	**2100**	Oracle XDB	**6665-6669**	IRC		
520	RIP	**2222**	DirectAdmin	**6679/6697**	IRC over SSL		
521	RIPng (IPv6)	**2302**	Halo	**6699**	Napster		
540	UUCP	**2483-2484**	Oracle DB	**6881-6999**	BitTorrent		

Legend

- Chat
- Encrypted
- Gaming
- Malicious
- Peer to Peer
- Streaming

IANA port assignments published at **http://www.iana.org/assignments/port-numbers**

SWITCHING

Perintah Dasar Switch & Router Cisco
Konfigurasi Password pada Cisco
Virtual LAN (VLAN)
Trunking VLAN
Inter-VLAN - Router on a Stick
Inter-VLAN – Switch Layer 3
DHCP menggunakan Switch
Port Security
Spanning Tree Protocol (STP)
STP Portfast
Etherchannel
VLAN Trunking Protocol (VTP)

Cisco Devices Overview

Switch pada cisco biasa disebut catalyst. Perbedaan switch dan router yang paling menonjol adalah switch mempunyai banyak port.

Catalyst 1900 Series

Cisco Catalyst 2690 Series

Cisco Router 2900 series

Perintah Dasar Switch & Router Cisco

Ada beberapa perintah dasar cisco yang wajib diketahui.

```
Router>
Router>enable
Router#
Router#configure terminal
Router(config)#
```

Ada beberapa hak akses ketika masuk dalam Cisco IOS:

- *User mode* ditandai dengan tanda “>”
- *Previlige mode* ditandai dengan tanda “#”. Untuk masuk dari user mode ke previlige mode ketikkan perintah *enable.*
- *Global configuration mode* digunakan untuk mengkonfigurasi perangkat.

Mengganti Hostname

```
Router(config)#hostname Semarang
Semarang (config)#
```

Meyimpan Konfigurasi

Konfigurasi agar ketika device direboot konfigurasi tidak hilang.

```
Router(config)#write
```

atau

```
Router(config)#copy run start
```

Mereset Perangkat Cisco

Untuk mengembalikan konfigurasi ke default.

```
Router(config)#write erase
```

Perintah show ip interface brief digunakan untuk melihat informasi interface.

```
R1#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol

FastEthernet0/0        10.10.10.1      YES manual up                    up

FastEthernet0/1        12.12.12.1      YES manual up                    up

Loopback0              1.1.1.1         YES manual up                    up

Vlan1                  unassigned      YES unset  administratively down down
R1#
```

Perintah *show running-config* digunakan untuk melihat konfigurasi yang sedang berjalan.

```
R1#show running-config
Building configuration...

Current configuration : 687 bytes
!
version 12.4
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
hostname R1
!
spanning-tree mode pvst
!
interface Loopback0
```

```
 ip address 1.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.10.10.1 255.255.255.0
 ip nat inside
 duplex auto
 speed auto
!
interface FastEthernet0/1
 ip address 12.12.12.1 255.255.255.0
 ip nat outside
 duplex auto
 speed auto
!
interface Vlan1
 no ip address
 shutdown
!
ip nat inside source static 10.10.10.2 12.12.12.12
ip classless
ip route 0.0.0.0 0.0.0.0 12.12.12.2
!
line con 0
!
line aux 0
!
line vty 0 4
 login
!
+
end
```

Konfigurasi Password pada Cisco

Keamanan adalah hal yang penting dalam suatu jaringan. Pemberian authentikasi berupa username dan password dalam device dilakukan agar tidak sembarang orang dapat masuk ke device.

Mengeset Password Line Console maka ketika melakukan config melalui port console akan diminta login.

```
Router>enable
Router#configure terminal
Router(config)#line console 0
Router(config-line)#password 123
Router(config-line)#login
```

Ketika masuk ke device akan muncul tampilan berikut.

```
User Access Verification

Password:
```

Konfigurasi VTY (Virtual Terminal) agar device dapat ditelnet dengan menggunakan username dan password yang spesifik.

```
Router(config)#username admin
Router(config)#enable password coba1
Router(config)#enable secret coba2
```

Ketika di *show run*.

```
Router#sh run
Building configuration...

Current configuration : 598 bytes
!
version 12.4
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
hostname Router
!
enable secret 5 $1$mERr$9SLtlDbYs.aoemVq5cCcc.
enable password coba1
!
username admin
```

enable secret = password diencripsi.

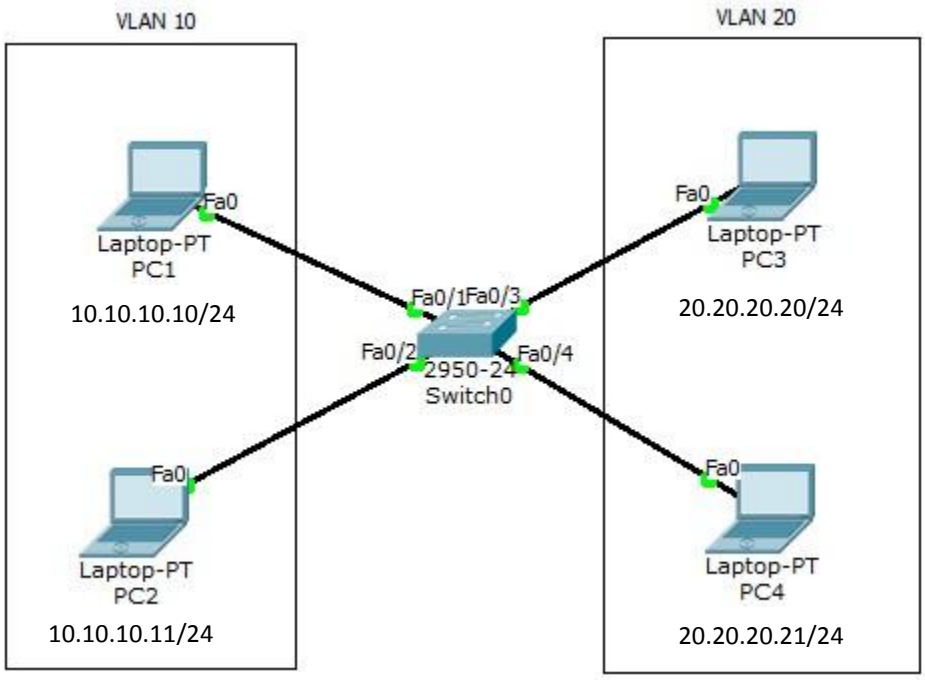
enable password = password tidak dienciprsi dan dapat dilihat dengan show run.

Jika kita mengeset enable secret dan enable password, maka yang dipakai adalah enable secret.

Virtual LAN (VLAN)

Virtual LAN (VLAN) membagi satu broadcast domain menjadi beberapa broadcast domain, sehingga dalam satu switch bisa saja terdiri dari beberapa network. Host yang berbeda VLAN tidak akan tersambung sehingga meningkatkan security jaringan.

VLAN adalah fasilitas yang dimiliki oleh switch manageable, contohnya cisco. Pada switch unmanageable, port-port nya hanya dapat digunakan untuk koneksi ke network yang sama (satu network) sehingga tidak mendukung fasilitas VLAN.



Buatlah topologi seperti pada gambar diatas pada packet tracer. Konfigurasi VLAN pada switch dengan VLAN10 berikan nama Marketing dan VLAN20 dengan nama Sales.

```
Switch>enable
Switch#conf t
Switch(config)#vlan 10
Switch(config-vlan)#name Marketing
Switch(config-vlan)#vlan 20
Switch(config-vlan)#name Sales
Switch(config-vlan)#int f0/1
Switch(config-if)#switchport access vlan 10
Switch(config-if)#int f0/2
Switch(config-if)#switchport access vlan 10
Switch(config-if)#int f0/3
Switch(config-if)#switchport access vlan 20
Switch(config-if)#int f0/4
Switch(config-if)#switchport access vlan 20
```

Untuk pengecekan,ping dari satu PC ke PC lain dan ketikkan perintah show vlan pada switch. PC tidak bisa ping ke beda VLAN.

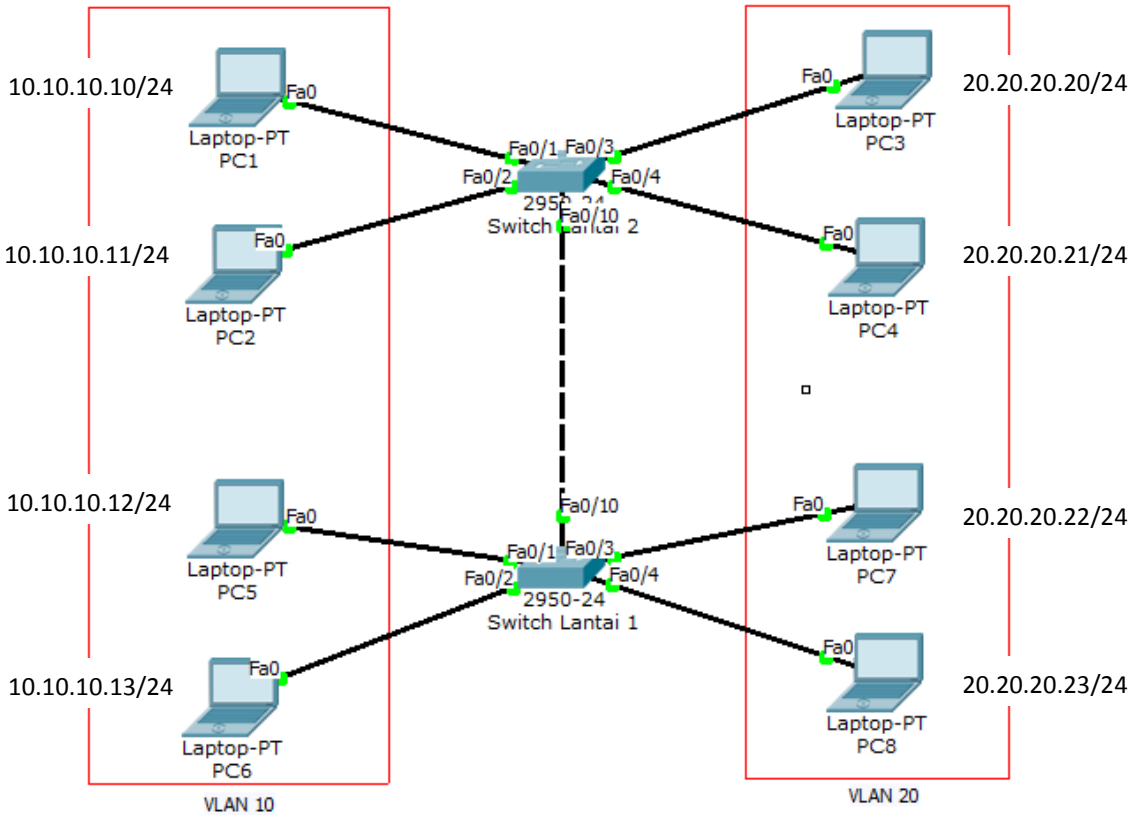
```
PC>ping 10.10.10.11

Pinging 10.10.10.11 with 32 bytes of data:

Reply from 10.10.10.11: bytes=32 time=0ms TTL=128
Reply from 10.10.10.11: bytes=32 time=0ms TTL=128
Reply from 10.10.10.11: bytes=32 time=0ms TTL=128
Reply from 10.10.10.11: bytes=32 time=0ms TTL=128

Ping statistics for 10.10.10.11:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

PC>ping 20.20.20.21

Pinging 20.20.20.21 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 20.20.20.21:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

PC>
```

```
Switch#show vlan
VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
---
1    default                           active    Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                 Fa0/9,    Fa0/10,    Fa0/11,
Fa0/12
                                                 Fa0/13,    Fa0/14,    Fa0/15,
Fa0/16
                                                 Fa0/17,    Fa0/18,    Fa0/19,
Fa0/20
                                                 Fa0/21,    Fa0/22,    Fa0/23,
Fa0/24
10   VLAN0010                          active    Fa0/1, Fa0/2
20   VLAN0020                          active    Fa0/3, Fa0/4
1002 fddi-default                      act/unsup
1003 token-ring-default                act/unsup
1004 fddinet-default                   act/unsup
1005 trnet-default                     act/unsup

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ----
--
1    enet  100001     1500  -      -      -        -    -        0      0
```

```
10   enet  100010     1500  -      -      -        -    -         0      0
20   enet  100020     1500  -      -      -        -    -         0      0
1002 fddi  101002     1500  -      -      -        -    -         0      0
1003 tr    101003     1500  -      -      -        -    -         0      0
1004 fdnet 101004     1500  -      -      -        ieee -         0      0
1005 trnet 101005     1500  -      -      -        ibm  -         0      0

Remote SPAN VLANs
------------------------------------------------------------------------------
--


Primary Secondary Type              Ports
------- --------- ----------------- ------------------------------------------
--
```

Trunking VLAN

Trunking berfungsi melewatkan traffic VLAN dari switch yang berbeda. Antara switch lantai 1 dan lantai 2 terhubung. PC1, PC2, PC5 dan PC6 masuk dalam VLAN 10 sedang PC3, PC4, PC5 dan PC6 masuk dalam VLAN 20.



Konfigurasi VLAN pada seperti dibawah. Membuat vlan 10 dan vlan 20.

```
switch1(config)#vlan 10
switch1(config-vlan)#vlan 20
switch1(config-vlan)#int f0/1
switch1(config-if)#sw access vlan 10
switch1(config-if)#int f0/2
switch1(config-if)#sw access vlan 10
switch1(config-vlan)#int f0/3
switch1(config-if)#sw access vlan 10
switch1(config-vlan)#int f0/4
switch1(config-if)#sw access vlan 10

Switch0(config)#vlan 10
Switch0(config-vlan)#vlan 20
Switch0(config-vlan)#int f0/1
Switch0(config-if)#sw access vlan 10
Switch0(config-if)#int f0/2
Switch0(config-if)#sw access vlan 10
Switch0(config-vlan)#int f0/3
Switch0(config-if)#sw access vlan 10
Switch0(config-vlan)#int f0/4
Switch0(config-if)#sw access vlan 10
```

Konfigurasi interface yang saling terhubung antar switch dengan mode trunk. Lakukan pada kedua switch.

```
Switch0(config)#int f0/10
Switch0(config-if)#switchport mode trunk

Switch1(config)#int f0/10
Switch1(config-if)#switchport mode trunk
```

Ping dari satu PC ke PC lain dan ketikkan perintah show vlan.

```
PC>ping 10.10.10.11

Pinging 10.10.10.11 with 32 bytes of data:

Reply from 10.10.10.11: bytes=32 time=17ms TTL=128
Reply from 10.10.10.11: bytes=32 time=0ms TTL=128
Reply from 10.10.10.11: bytes=32 time=0ms TTL=128
Reply from 10.10.10.11: bytes=32 time=0ms TTL=128

Ping statistics for 10.10.10.11:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 17ms, Average = 4ms

PC>ping 10.10.10.13

Pinging 10.10.10.13 with 32 bytes of data:

Reply from 10.10.10.13: bytes=32 time=11ms TTL=128
Reply from 10.10.10.13: bytes=32 time=0ms TTL=128
Reply from 10.10.10.13: bytes=32 time=0ms TTL=128
Reply from 10.10.10.13: bytes=32 time=1ms TTL=128

Ping statistics for 10.10.10.13:
```

```
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 11ms, Average = 3ms

PC>ping 20.20.20.20

Pinging 20.20.20.20 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 20.20.20.20:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

PC>
```

PC dapat melakukan ping ke sesame VLAN beda switch namun tidak bisa ke beda VLAN.

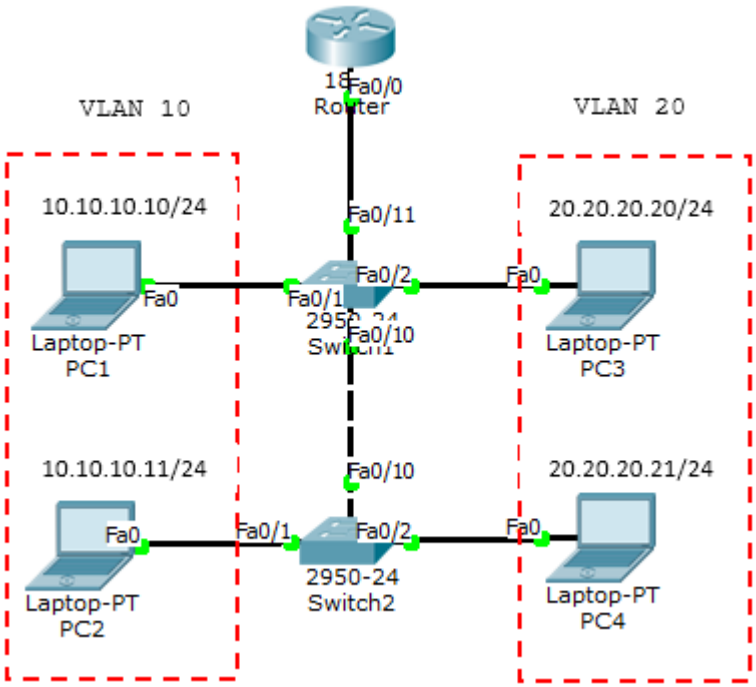
```
Switch1#sh int trunk
Port        Mode         Encapsulation  Status        Native vlan
Fa0/10      on           802.1q         trunking      1

Port        Vlans allowed on trunk
Fa0/10      1-1005

Port        Vlans allowed and active in management domain
Fa0/10      1,10,20

Port        Vlans in spanning tree forwarding state and not pruned
Fa0/10      1,10,20
```

Inter-VLAN - Router on a Stick

Untuk menghubungkan VLAN yang berbeda, dibutuhkan perangkat layer 3 baik itu router atau switch layer 3. Cara pertama adalah dengan menggunakan satu router melalui satu interface. Teknik ini disebut router on a stick. Kekurangan dari teknik ini adalah akan terjadi collision domain karena hanya menggunakan satu interface.

Ada 2 trunking protocol yang biasa digunakan:

- ISL = cisco proprietary, bekerja pada ethernet, token ring dan FDDI, menambahi tag sebesar 30byte pada frame dan semua traffic VLAN ditag.
- IEEE 802.11Q (dot1q) = open standard, hanya bekerja pada ethernet, menambahi tag sebesar 4byte pada frame.



Buat topologi seperti diatas dan konfigurasi VLAN10 dan VLAN20 seperti lab sebelumnya. Tambahkan 1 router. Karena hanya menggunakan 1 interface, maka harus dibuat sub-interface untuk dijadikan gateway VLAN. Port SW1 yang terhubung ke router harus diset mode trunk.

```
Router(config)#interface FastEthernet0/0.10
Router(config-subif)#encapsulation dot1Q 10
Router(config-subif)#ip address 10.10.10.1 255.255.255.0
Router(config-subif)#interface FastEthernet0/0.20
Router(config-subif)#encapsulation dot1Q 20
Router(config-subif)#ip address 20.20.20.1 255.255.255.0
```

Cek interface dengan perintah *show ip int brief.*

```
Router#sh ip int br
Interface              IP-Address      OK? Method Status
Protocol

FastEthernet0/0        unassigned      YES unset  up                    up

FastEthernet0/0.10     10.10.10.1      YES manual up                    up

FastEthernet0/0.20     20.20.20.1      YES manual up                    up

FastEthernet0/0.30     30.30.30.30     YES manual up                    up

FastEthernet0/1        unassigned      YES unset  administratively down down

Vlan1                  unassigned      YES unset  administratively down down
Router#
```

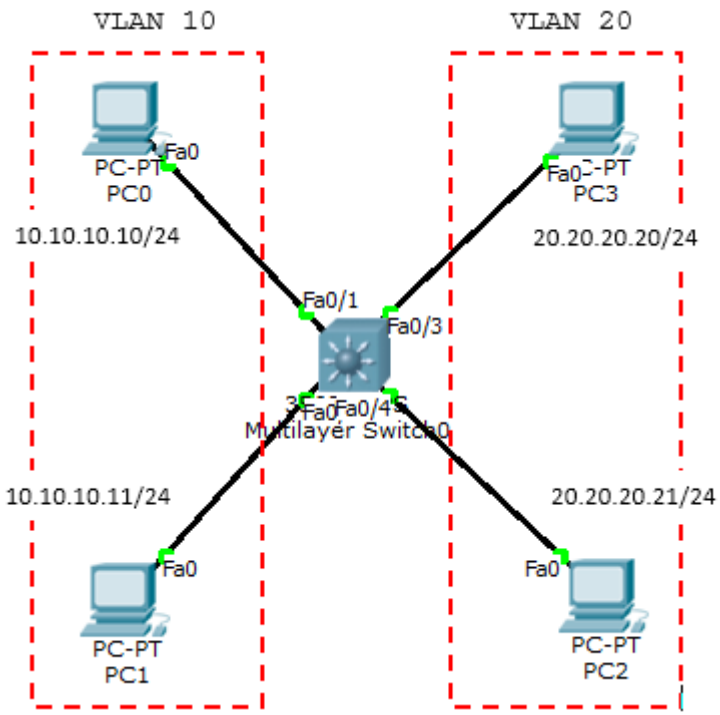
Sekarang ping antar VLAN yang berbeda.

```
PC>ping 20.20.20.21

Pinging 20.20.20.21 with 32 bytes of data:

Request timed out.
Reply from 20.20.20.21: bytes=32 time=1ms TTL=127
Reply from 20.20.20.21: bytes=32 time=0ms TTL=127
Reply from 20.20.20.21: bytes=32 time=0ms TTL=127

Ping statistics for 20.20.20.21:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

PC>tracert 20.20.20.21

Tracing route to 20.20.20.21 over a maximum of 30 hops:

  1   30 ms     0 ms      0 ms      10.10.10.1
  2   0 ms      0 ms      0 ms      20.20.20.21

Trace complete.
```

```
Router#sh ip arp
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  10.10.10.10             4   0000.0C1B.0D20  ARPA
FastEthernet0/0.10
Internet  20.20.20.21             3   0060.7092.05A9  ARPA
FastEthernet0/0.20
Internet  30.30.30.1              1   0001.C7AE.3D52  ARPA
FastEthernet0/0.30
Router#
```

Inter-VLAN – Switch Layer 3

Untuk menghubungkan antar VLAN dibutuhkan suatu perangkat layer 3 baik itu router atau switch layer 3. Kalau sebelum menggunakan router on a stick, kali ini kita akan menggunakan switch L3 (layer 3). Inilah kerennya cisco, kalo switch yang lain bekerja pada layer 2, switch cisco dapat bekerja pada layer 3 dan menjalankan routing. Namun, meski untuk routing yang lebih luas lebih dianjurkan menggunakan router sesuai fungsinya.



Konfigurasi port ke VLANnya masing-masing.

```
Switch(config)#interface FastEthernet0/1
Switch(config-if)#switchport access vlan 10
Switch(config-if)#switchport mode access
Switch(config-if)#
Switch(config-if)#interface FastEthernet0/2
Switch(config-if)#switchport access vlan 10
Switch(config-if)#switchport mode access
Switch(config-if)#
Switch(config-if)#interface FastEthernet0/3
Switch(config-if)#switchport access vlan 20
Switch(config-if)#switchport mode access
Switch(config-if)#interface FastEthernet0/4
Switch(config-if)#switchport access vlan 20
Switch(config-if)#switchport mode access
```

Buat interface VLAN dan beri ip address.

```
Switch(config)#int vlan 10
Switch(config-if)#ip add 10.10.10.1 255.255.255.0
Switch(config-if)#int vlan 20
Switch(config-if)#ip add 20.20.20.1 255.255.255.0
```

Ketiikkan perintah ip routing untuk merouting VLAN.

```
Switch(config)#ip routing
```

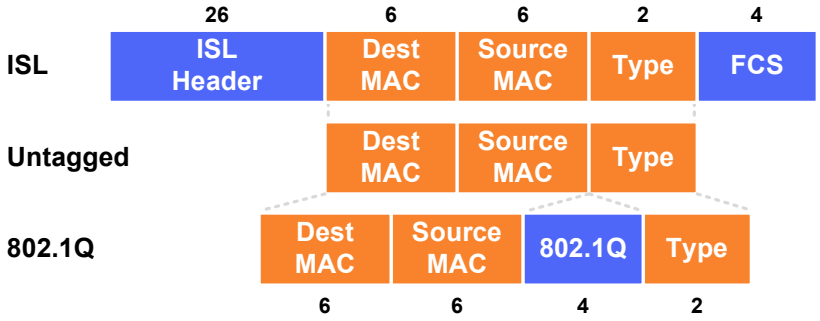
Sekarang tes ping.

```
PC>ping 20.20.20.21

Pinging 20.20.20.21 with 32 bytes of data:
```

```
Request timed out.
Reply from 20.20.20.21: bytes=32 time=0ms TTL=127
Reply from 20.20.20.21: bytes=32 time=0ms TTL=127
Reply from 20.20.20.21: bytes=32 time=0ms TTL=127

Ping statistics for 20.20.20.21:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

PC>
```

VLANs

Trunk Encapsulation



VLAN Creation

```
Switch(config)# vlan 100
Switch(config-vlan)# name Engineering
```

Access Port Configuration

```
Switch(config-if)# switchport mode access
Switch(config-if)# switchport nonegotiate
Switch(config-if)# switchport access vlan 100
Switch(config-if)# switchport voice vlan 150
```

Trunk Port Configuration

```
Switch(config-if)# switchport mode trunk
Switch(config-if)# switchport trunk encapsulation dot1q
Switch(config-if)# switchport trunk allowed vlan 10,20-30
Switch(config-if)# switchport trunk native vlan 10
```

SVI Configuration

```
Switch(config)# interface vlan100
Switch(config-if)# ip address 192.168.100.1 255.255.255.0
```

VLAN Trunking Protocol (VTP)

Domain
Common to all switches participating in VTP

Server Mode
Generates and propagates VTP advertisements to clients; default mode on unconfigured switches

Client Mode
Receives and forwards advertisements from servers; VLANs cannot be manually configured on switches in client mode

Transparent Mode
Forwards advertisements but does not participate in VTP; VLANs must be configured manually

Pruning
VLANs not having any access ports on an end switch are removed from the trunk to reduce flooded traffic

VTP Configuration

```
Switch(config)# vtp mode {server | client | transparent}
Switch(config)# vtp domain <name>
Switch(config)# vtp password <passsword>
Switch(config)# vtp version {1 | 2}
Switch(config)# vtp pruning
```

Trunk Types

	802.1Q	ISL
Header Size	4 bytes	26 bytes
Trailer Size	N/A	4 bytes
Standard	IEEE	Cisco
Maximum VLANs	4094	1000

VLAN Numbers

0	Reserved	**1004**	fdnet
1	default	**1005**	trnet
1002	fddi-default	**1006-4094**	Extended
1003	tr	**4095**	Reserved

Terminology

Trunking
Carrying multiple VLANs over the same physical connection

Native VLAN
By default, frames in this VLAN are untagged when sent across a trunk

Access VLAN
The VLAN to which an access port is assigned

Voice VLAN
If configured, enables minimal trunking to support voice traffic in addition to data traffic on an access port

Dynamic Trunking Protocol (DTP)
Can be used to automatically establish trunks between capable ports (insecure)

Switched Virtual Interface (SVI)
A virtual interface which provides a routed gateway into and out of a VLAN

Switch Port Modes

`trunk`
Forms an unconditional trunk

`dynamic desirable`
Attempts to negotiate a trunk with the far end

`dynamic auto`
Forms a trunk only if requested by the far end

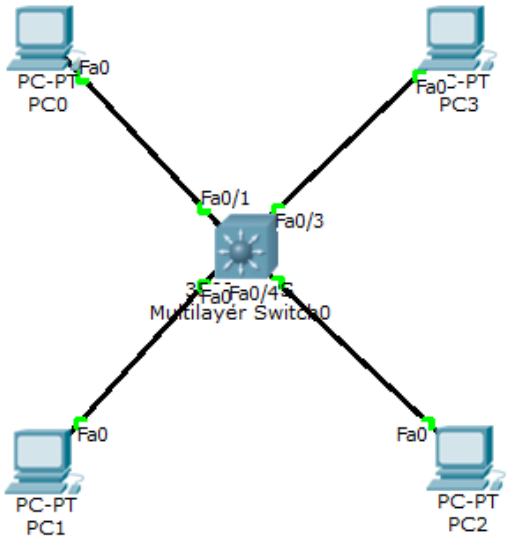
`access`
Will never form a trunk

Troubleshooting

```
show vlan
show interface [status | switchport]
show interface trunk
show vtp status
show vtp password
```

DHCP menggunakan Switch

Fungsi DHCP adalah memberikan alamat IP secara otomatis kepada host.



Konfigurasi DHCP.

```
Switch(config)#ip dhcp pool vlan10
Switch(dhcp-config)#network 10.10.10.0 255.255.255.0
Switch(dhcp-config)#default-router 10.10.10.1
Switch(dhcp-config)#dns-server 8.8.8.8
Switch(dhcp-config)#ip dhcp pool vlan20
Switch(dhcp-config)#network 20.20.20.0 255.255.255.0
Switch(dhcp-config)#default-router 20.20.20.1
Switch(dhcp-config)#dns-server 8.8.8.8
```

jika ada ip yg tidak ingin digunakan dalam DHCP masukkan perintah ip dhcp excluded-address.

```
ip dhcp excluded-address 10.10.10.2 10.10.10.10
```

Perintah show ip dhcp binding menampilkan client yang mendapat ip dhcp.

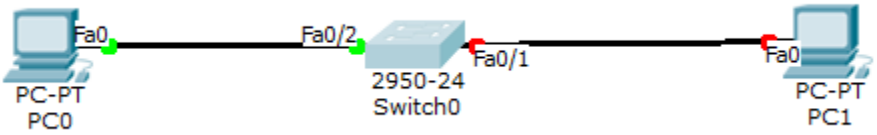
```
Switch#sh ip dhcp binding
IP address       Client-ID/              Lease expiration        Type
                 Hardware address
10.10.10.12      0003.E4A2.9D08           --                     Automatic
10.10.10.11      0001.64C9.674C           --                     Automatic
20.20.20.11      0001.4266.50B0           --                     Automatic
20.20.20.12      0002.1638.8C69           --                     Automatic
Switch#
```

DHCP juga dapat diset manual untuk client dengan MAC Address tertentu.

```
ip dhcp pool PC_MANAGER
host 20.20.20.100
default router 20.20.20.1
client-id 0102.c7f8.0004.22
client-name Komputer_IDN
```

Port Security

Port Security ini digunakan agar port interface perangkat cisco tidak dapat digunakan kecuali untuk PC dengan MAC Address tertentu.




```
int fa0/1
switchport mode access
switchport port-security
switchport port-security mac-address sticky
switchport port-security violation shutdown

int fa0/2
switchport mode access
switchport port-security
switchport port-security mac-address sticky
switchport port-security violation restrict
```

Ada 3 violation:

- protect = data yg dikirim melalui port tsb dibiarkan tdk terkirim
- restrict = seperti protect namun mengirimkan notifikasi dgn snmp
- shutdown = port akan dishutdown secara otomatis, utk mengembalikannya maka harus di no shut dengan console switch atau telnet.

Sticky artinya bahwa MAC address yang pertama kali lewat switch maka itulah yang digunakan. Jika bukan MAC address tsb yang tersambung ke port yang diset port-security maka akan diproses tergantung violation yang diset.

```
show port-security
Switch#show port-security
Secure Port MaxSecureAddr CurrentAddr SecurityViolation Security Action
               (Count)       (Count)        (Count)
---------------------------------------------------------------------
        Fa0/1        1          1                1         Shutdown
        Fa0/2        1          1                1         Restrict
---------------------------------------------------------------------
Switch#
```

Spanning Tree Protocol (STP)

Spanning Tree Protocol (STP) merupakan protocol yang berfungsi mencegah loop pada switch ketika switch menggunakan lebih dari 1 link dengan maksud redundancy. STP secara defaultnya diset aktif pada Cisco Catalyst. STP merupakan open standard (IEEE 802.1D). STP dapat mencegah:

- Broadcast Storm
- Multiple Frame Copies
- Database Instability

Ada beberapa jenis STP:

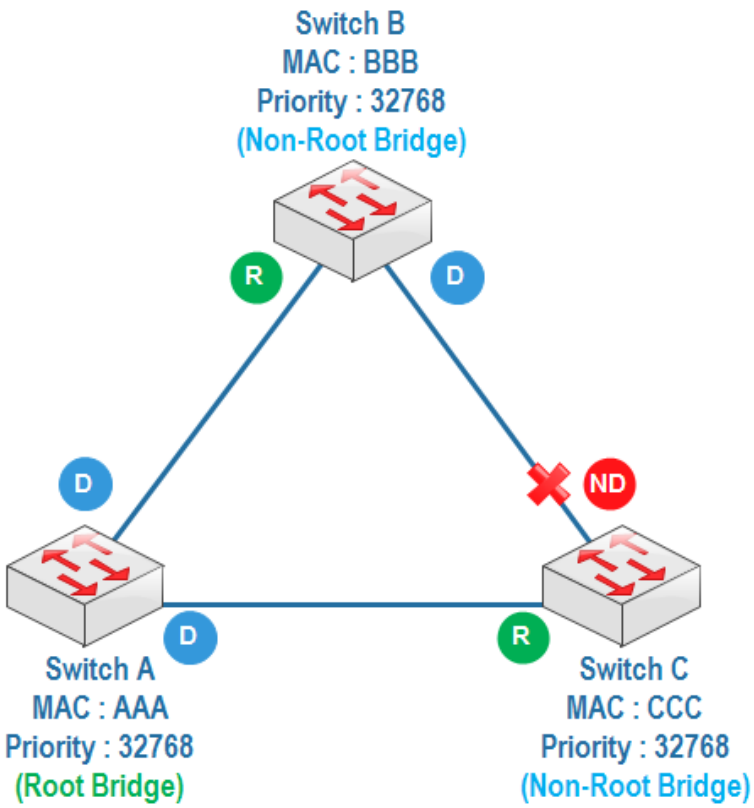
- Open Standard : STP (802.1D), Rapid STP (802.1W), Multiple Spanning Tree MST (802.1S)
- Cisco Proprietary : PVST (Per Vlan Spanning Tree), PVST+, Rapid PVST.

Ketika Switch0 mengirim packet data dengan destination yang tidak terdapat pada MAC address tabelnya, maka Switch0 akan membroadcast ke semua port sampai ke Switch1. Jika pada tabel MAC address Switch1 juga tidak terdapat destination tadi maka Switch1 akan kembali membroadcast ke Switch0 dan akan seperti itu sehingga network down.

Ada beberapa cara mengatasi hal tersebut:

- Hanya menggunakan 1 link (no redundancy)
- Shutdown salah satu interface, melakukan shutdown manual pada salah satu interface atau secara otomatis menggunakan STP.

STP akan membuat blocking atau shutdown pada salahsatu port untuk mencegah terjadinya loop. Ketika link utama down maka port yang sebelumnya blocking akan menjadi forward. Port blocking ditunjukkan dengan warna merah.



Cara kerja STP :

1. Ketika STP aktif, masing-masing switch akan mengirimkan frame khusus satu sama lain yang disebut **Bridge Protocol Data Unit (BPDU)**.
2. Menentukan Root Bridge

   Switch dengan bridge id terendah akan menjadi root bridge. Bridge id = priority + MAC address. Dalam satu LAN hanya ada satu switch sebagai root bridge, switch lain menjadi non-root bridge. Default priority adalah 32768 dan bisa diubah.
3. Menentukan Root Port

   Yang menjadi root port adalah path yang paling dekat dengan root bridge. Untuk setiap non-root bridge hanya punya 1 root port.
4. Menentukan designated port dan non-designated port

   Designated port adalah port yang forward dan non designated port adalah port yang blocking. Untuk root bridge semua portnya adalah designated port.

   Switch dengan priority terendah, salah satu portnya akan menjadi non-designated port atau port blocking. Jika priority sama maka akan dilihat MAC address terendah.

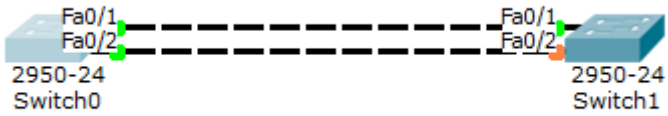
STP akan membuat blocking atau shutdown pada salahsatu port untuk mencegah terjadinya loop. Ketika link utama down maka port yang sebelumnya blocking akan menjadi forward. Port blocking ditunjukkan dengan warna merah.

STP menggunakan link cost calculation untuk menentukan root port pada non-root switch.

- 10 Gbps = Cost 2
- 1 Gbps = Cost 4
- 100 Mbps = Cost 19
- 10 Mbps = Cost 100

Spanning Tree Protocol (STP)

Buatlah topologi seperti dibawah.



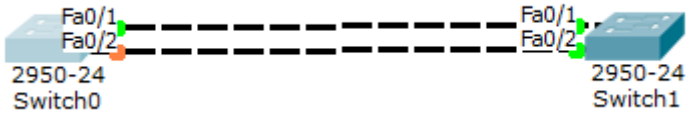

```
Switch0#show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    32769
             Address     000B.BE80.D273
             Cost        19
             Port        1(FastEthernet0/1)
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32769  (priority 32768 sys-id-ext 1)
             Address     00D0.FFDA.ECBC
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time  20

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
-
Fa0/2            Altn BLK 19        128.2    P2p
Fa0/1            Root FWD 19        128.1    P2p

Switch0#
```

```
Switch1#sh spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    32769
```

```
              Address     000B.BE80.D273
              This bridge is the root
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     000B.BE80.D273
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  20

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
-
Fa0/1            Desg FWD 19        128.1    P2p
Fa0/2            Desg FWD 19        128.2    P2p

Switch1#
```

Secara otomatis, Switch0 menjadi root bridge dilihat dari semua portnya yang fordward (berwarna hijau), agar Switch1 yang menjadi root bridge, ubah priority pada Switch1.

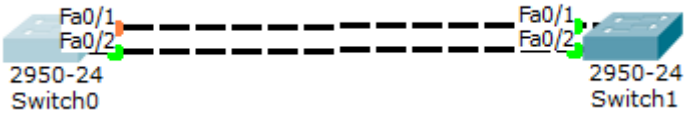
```
Switch1(config)#spanning-tree vlan 1 priority 0
```



Sekarang Switch1 yang menjadi root bridge. Untuk memindahkan blocking port dari fa0/2 menjadi fa0/1 pada Switch1 jalankan perintah berikut.

```
Switch1(config)#int f0/1
Switch1(config-if)#speed 10
```

Cek Hasilnya. Port blocking pindah ke fa0/1.




```
Switch1(config-if)#do show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    1
              Address     00D0.FFDA.ECBC
              Cost        19
              Port        2(FastEthernet0/2)
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     000B.BE80.D273
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  20

Interface        Role Sts Cost      Prio.Nbr Type
```

```
---------------- ---- --- --------- -------- --------------------------------
-
Fa0/1            Altn BLK 100       128.1    P2p
Fa0/2            Root FWD 19        128.2    P2p
```

STP Portfast

Portfast adalah salahsatu fitur STP. Ketika pertama kali mencolokkan kabel ke switch, perlu waktu agak lama dari proses blocking yang ditandai warna oranye pada lampu indicator untuk menjadi forwarding yang ditandai dengan warna kuning.

STP Port States:

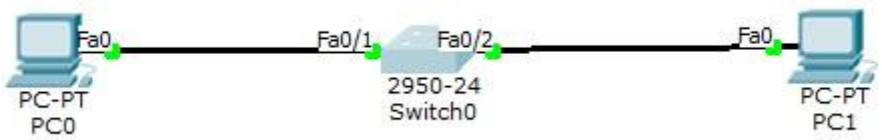
Blocking 20 second/no limits

Listening 15 second

Learning 15 second

Forwarding no limits

Disable no limits



Hal ini disebabkan switch melakukan step listening dan learning terlebih dahulu sebelum forward. Dari proses blocking, listening dan learning kira-kira dibutuhkan waktu 30 detik. Untuk langsung ke forward tanpa melalui listening dan learning maka digunakan portfast. Portfast cocok digunakan untuk port yang mengarah ke end host. Untuk port yang mengarah ke switch, maka tidak direkomendasikan karena akan mematikan fungsi STP dalam mencegah looping.

Misalkan port 1 sampai 4 yang mau dikonfigurasi stp portfast maka ketikkan perintah berikut.

```
int range fa0/1 - 4
spanning-tree portfast
```

Maka ketika mencolokkan kabel ke switch akan langsung kuning.

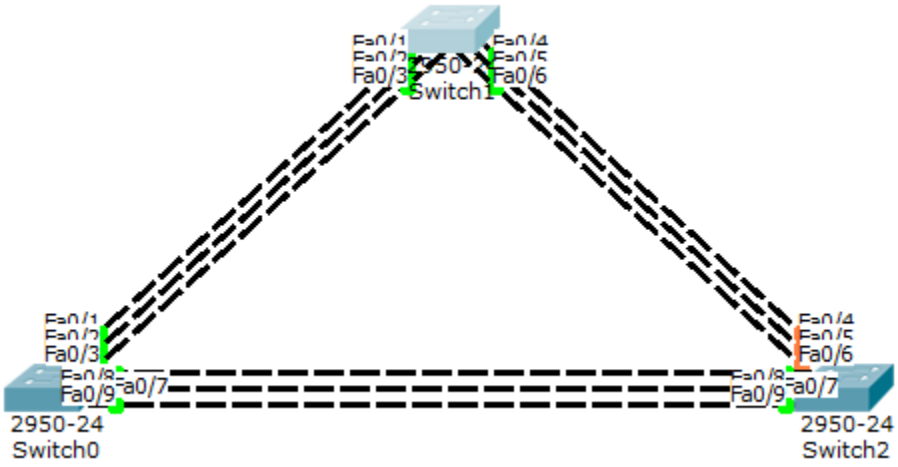
Etherchannel

Karena adanya fitur STP, akan ada port yang blocking untuk mencegah loop. Etherchannel digunakan untuk membundle beberapa link seolah-olah menjadi satu link secara logical, sehingga STP harus dimatikan dan tidak ada port blocking.

Dengan etherchannel maka transfer data lebih cepat dan tidak tergantung hanya pada 1 link. Etherchannel dapat dikonfigurasi dengan beberapa mekanisme:

- Static Persistence, tanpa menggunakan negotiation protocol.
- Dengan menggunakan negotiation protocol:
    - LACP (Link Aggregation Control Protocol) – open standard IEEE 802.1AD.
    - PAgP (Port Aggregation Protocol) – cisco proprietary.

Buat topologi seperti dibawah.



Konfigurasi LaCP pada switch kiri dan tengah.

```
Switch(config)#int range fa0/1-3
Switch(config-if-range)#channel-group 1 mode ?
  active     Enable LACP unconditionally
  auto       Enable PAgP only if a PAgP device is detected
  desirable  Enable PAgP unconditionally
  on         Enable Etherchannel only
  passive    Enable LACP only if a LACP device is detected
Switch(config-if-range)#channel-group 1 mode active
Switch(config-if-range)#int port-channel 1
```

```
Switch(config-if)#switchport mode trunk
```

Mode yang digunakan dalam LaCP boleh active-active atau active-passive namun tidak boleh passive-passive.

```
Switch#sh etherchannel summary
Flags:  D - down        P - in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port


Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------
---

1      Po1(SU)           LACP   Fa0/1(P) Fa0/2(P) Fa0/3(P)
Switch#
```

Konfigurasi PAgP pada switch tengah dan kanan.

```
Switch(config)#int range fa0/4-6
Switch(config-if-range)#channel-group 2 mode desirable
Switch(config-if-range)#int port-channel 2
Switch(config-if)#switchport mode trunk
```

Pada PAgP dapat menggunakan mode desirable-desirable atau desirable-auto. Sekarang cek di switch yang tengah.

```
Switch#sh etherchannel summary
Flags:  D - down        P - in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port


Number of channel-groups in use: 2
Number of aggregators:           2

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------
---

1      Po1(SU)           LACP   Fa0/1(P) Fa0/2(P) Fa0/3(P)
2      Po2(SU)           PAgP   Fa0/4(P) Fa0/5(P) Fa0/6(P)
Switch#
```

Konfigurasi etherchannel manual, tanpa LACP atau PAgP pada switch kiri dan kanan.

```
Switch(config)#int range fa0/7-9
Switch(config-if-range)#channel-group 3 mode on
Switch(config-if-range)#int port-channel 3
Switch(config-if)#switchport mode trunk
```

```
Switch#sh etherchannel summary
Flags:  D - down        P - in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port


Number of channel-groups in use: 2
Number of aggregators:           2

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------
---

1      Po1(SU)           LACP   Fa0/1(P) Fa0/2(P) Fa0/3(P)
3      Po3(SU)           -      Fa0/7(P) Fa0/8(P) Fa0/9(P)
Switch#
```

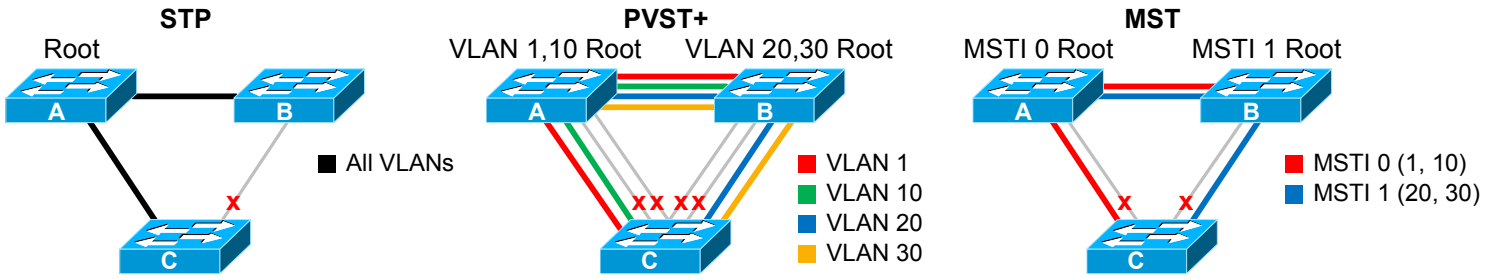
Spanning Tree · Part 1

packetlife.net

Spanning Tree Protocols

	Legacy STP	PVST	PVST+	RSTP	RPVST+	MST
Algorithm	Legacy ST	Legacy ST	Legacy ST	Rapid ST	Rapid ST	Rapid ST
Defined By	802.1D-1998	Cisco	Cisco	802.1w, 802.1D-2004	Cisco	802.1s, 802.1Q-2003
Instances	1	Per VLAN	Per VLAN	1	Per VLAN	Configurable
Trunking	N/A	ISL	802.1Q, ISL	N/A	802.1Q, ISL	802.1Q, ISL

Spanning Tree Instance Comparison



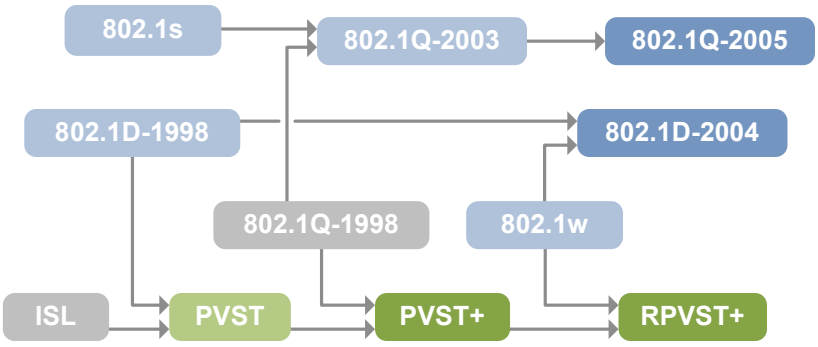
BPDU Format

Field	Bits
Protocol ID	16
Version	8
BPDU Type	8
Flags	8
Root ID	64
Root Path Cost	32
Bridge ID	64
Port ID	16
Message Age	16
Max Age	16
Hello Time	16
Forward Delay	16

Default Timers

Hello	2s
Forward Delay	15s
Max Age	20s

Spanning Tree Specifications



IEEE

- **IEEE 802.1D-1998** · Deprecated legacy STP standard
- **IEEE 802.1w** · Introduced RSTP
- **IEEE 802.1D-2004** · Replaced legacy STP with RSTP
- **IEEE 802.1s** · Introduced MST
- **IEEE 802.1Q-2003** · Added MST to 802.1Q
- **IEEE 802.1Q-2005** · Most recent 802.1Q revision

Cisco

- **PVST** · Per-VLAN implementation of legacy STP
- **PVST+** · Added 802.1Q trunking to PVST
- **RPVST+** · Per-VLAN implementation of RSTP

Spanning Tree Operation

1. **Determine root bridge**
   The bridge advertising the lowest bridge ID becomes the root bridge
2. **Select root port**
   Each bridge selects its primary port facing the root
3. **Select designated ports**
   One designated port is selected per segment
4. **Block ports with loops**
   All non-root and non-desginated ports are blocked

Link Costs

Bandwidth	Cost
4 Mbps	250
10 Mbps	100
16 Mbps	62
45 Mbps	39
100 Mbps	19
155 Mbps	14
622 Mbps	6
1 Gbps	4
10 Gbps	2
20+ Gbps	1

Port States

Legacy ST	Rapid ST
Disabled	Discarding
Blocking	
Listening	
Learning	Learning
Forwarding	Forwarding

Port Roles

Legacy ST	Rapid ST
Root	Root
Designated	Designated
Blocking	Alternate
	Backup

Spanning Tree · Part 2

PVST+ and RPVST+ Configuration

```
spanning-tree mode {pvst | rapid-pvst}

! Bridge priority
spanning-tree vlan 1-4094 priority 32768

! Timers, in seconds
spanning-tree vlan 1-4094 hello-time 2
spanning-tree vlan 1-4094 forward-time 15
spanning-tree vlan 1-4094 max-age 20

! PVST+ Enhancements
spanning-tree backbonefast
spanning-tree uplinkfast

! Interface attributes
interface FastEthernet0/1
 spanning-tree [vlan 1-4094] port-priority 128
 spanning-tree [vlan 1-4094] cost 19

 ! Manual link type specification
 spanning-tree link-type {point-to-point | shared}

 ! Enables PortFast if running PVST+, or
 ! designates an edge port under RPVST+
 spanning-tree portfast

 ! Spanning tree protection
 spanning-tree guard {loop | root | none}

 ! Per-interface toggling
 spanning-tree bpduguard enable
 spanning-tree bpdufilter enable
```

MST Configuration

```
spanning-tree mode mst

! MST Configuration
spanning-tree mst configuration
 name MyTree
 revision 1

 ! Map VLANs to instances
 instance 1 vlan 20, 30
 instance 2 vlan 40, 50

! Bridge priority (per instance)
spanning-tree mst 1 priority 32768

! Timers, in seconds
spanning-tree mst hello-time 2
spanning-tree mst forward-time 15
spanning-tree mst max-age 20

! Maximum hops for BPDUs
spanning-tree mst max-hops 20

! Interface attributes
interface FastEthernet0/1
 spanning-tree mst 1 port-priority 128
 spanning-tree mst 1 cost 19
```

Bridge ID Format

Priority
4-bit bridge priority (configurable from 0 to 61440 in increments of 4096)

System ID Extension
12-bit value taken from VLAN number (IEEE 802.1t)

MAC Address
48-bit unique identifier

Path Selection

1. Bridge with lowest root ID becomes the root
2. Prefer the neighbor with the lowest cost to root
3. Prefer the neighbor with the lowest bridge ID
4. Prefer the lowest sender port ID

Optional PVST+ Ehancements

PortFast
Enables immediate transition into the forwarding state (designates edge ports under MST)

UplinkFast
Enables switches to maintain backup paths to root

BackboneFast
Enables immediate expiration of the Max Age timer in the event of an indirect link failure

Spanning Tree Protection

Root Guard
Prevents a port from becoming the root port

BPDU Guard
Error-disables a port if a BPDU is received

Loop Guard
Prevents a blocked port from transitioning to listening after the Max Age timer has expired

BPDU Filter
Blocks BPDUs on an interface (disables STP)

RSTP Link Types

Point-to-Point
Connects to exactly one other bridge (full duplex)

Shared
Potentially connects to multiple bridges (half duplex)

Edge
Connects to a single host; designated by PortFast

Troubleshooting

```
show spanning-tree [summary | detail | root]
show spanning-tree [interface | vlan]
show spanning-tree mst […]
```

VLAN Trunking Protocol (VTP)

VLAN Trunking Protocol (VTP) adalah protocol yang mengatur VLAN pada beberapa switch sekaligus dalam VTP domain yang sama. VTP dapat menambah, mendelete dan merename VLAN sekaligus dalam beberapa switch. VTP meringankan kerja administrator sehingga tidak perlu mengkonfigurasi VLAN pada switch satu per satu.

VTP merupakan protocol cisco proprietary. Konfigurasi VLAN disimpan dalam file database vlan.dat di flash memory.

Ada 3 VTP mode:

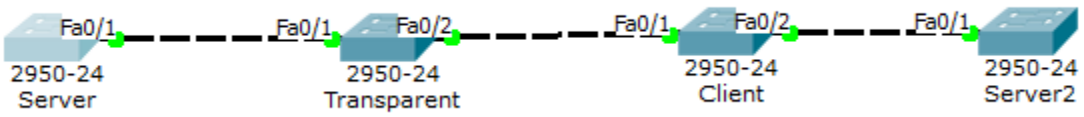
- Server (dafault)
- Client
- Transparent

	VTP Server	VTP Client	VTP Transparent
Create/Modify/Delete VLAN	Yes	No	Only local
Syncronizes itself	Yes	Yes	No
Forwards advertisements	Yes	Yes	Yes

Dalam VTP ada namanya revision number. Revision number adalah banyaknya update VTP yang telah diterima suatu switch.

Hal yang penting mengenai revision number adalah ketika switch mode server atau client dengan VTP domain yang sama dan mempunyai revision number yang lebih tinggi, ketika diletakkan dalam sebuah jaringan, maka otomatis mengirim update VLAN databasenya dan mereplace database switch sebelumnya sehingga membuat network down. Switch mode server akan tetap tereplace datatbasenya karena mode server pada dasarnya merupakan mode client juga.

Solusinya dengan direset terlebih dahulu.



Konfigurasikan command dibawah pada semua switch.

```
Switch(config)#interface range fa0/1-2
Switch(config-if-range)#switchport mode trunk
```

Server

```
Switch(config)#int vlan 1
Switch(config-if)#ip add 10.10.10.1 255.255.255.0
Switch(config-if)#no shut
Switch(config-if)#vtp mode server
Switch(config)#vtp domain belajar
Switch(config)#vtp password rahasia
```

Transparent

```
Switch(config)#int vlan 1
Switch(config-if)#ip add 10.10.10.2 255.255.255.0
Switch(config-if)#no shut
Switch(config-if)#vtp mode transparent
Switch(config)#vtp domain belajar
Switch(config)#vtp password rahasia
```

Client

```
Switch(config)#int vlan 1
Switch(config-if)#ip add 10.10.10.3 255.255.255.0
Switch(config-if)#no shut
Switch(config-if)#vtp mode client
Switch(config)#vtp domain belajar
Switch(config)#vtp password rahasia
```

Server2

```
Switch(config)#int vlan 1
Switch(config-if)#ip add 10.10.10.4 255.255.255.0
Switch(config-if)#no shut
Switch(config-if)#vtp mode server
Switch(config)#vtp domain belajar
Switch(config)#vtp password rahasia
```

Buat VLAN pada masing-masing switch.

- Server : VLAN10, VLAN20
- Transparent : VLAN30, VLAN40
- Client : VLAN50, VLAN60
- Server2 : VLAN70, VLAN80

Hasilnya Server ada 4 VLAN.

```
Switch#show vlan

VLAN Name                             Status    Ports
10   VLAN0010                         active
20   VLAN0020                         active
70   VLAN0070                         active
80   VLAN0080                         active
```

Transparent ada 2 VLAN.

```
Switch#sh vlan

VLAN Name                             Status    Ports
```

```
30   VLAN0030                         active
40   VLAN0040                         active
```

Client ada 4 VLAN

```
Switch#SH VLAN

VLAN Name                             Status    Ports
10   VLAN0010                         active
20   VLAN0020                         active
70   VLAN0070                         active
80   VLAN0080                         active
```

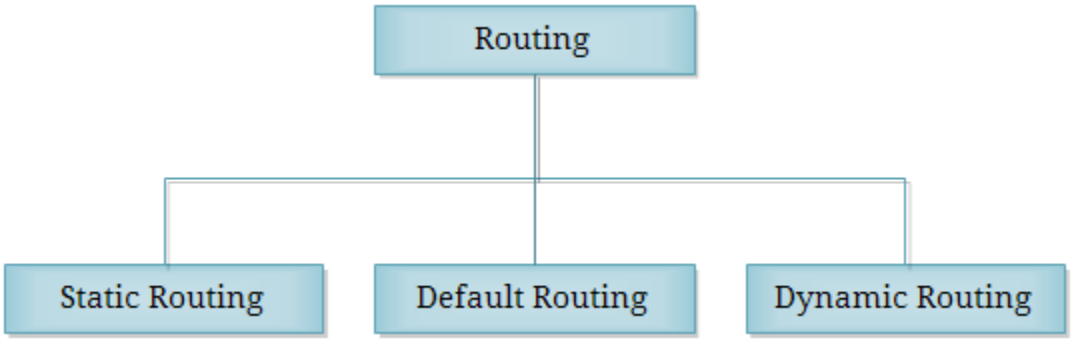
Server2 ada 4 VLAN.

```
Switch#SH VLAN

VLAN Name                             Status    Ports
10   VLAN0010                         active
20   VLAN0020                         active
70   VLAN0070                         active
80   VLAN0080                         active
```

ROUTING

Static Routing
Default Routing
Enhanced Interior Gateway Protocol (EIGRP)
Open Shortest Path First (OSPF)
Standard Access List
Extended Access List
Static NAT
Overloading/Port Address Translation (PAT)
HSRP

Routing Overview



Routing adalah mengirimkan packet data dari satu network ke network lain. Perangkat yang digunakan dalam routing adalah router. Router digunakan untuk best path selection dan packets forwarding.

Untuk menuju ke destination, router dapat dikonfigurasi dengan 2 cara:

- Manually, memasukkan route ke tabel routing secara manual (static routing).
- Dynamically, menggunakan protocol routing (dynamic routing).

Dynamic Routing vs Static Routing

	Dynamic Routing	Static Routing
Configuration Complexity	Generally independent of the network size	Increases with the network size
Topology Changes	Automatically adapts to topology changes	Administrator intervention required
Scaling	Suitable for simple and complex topologies	Suitable for simple topologies
Security	Less secure	More secure
Resource Usage	Uses CPU, memory, link bandwidth	No extra resources needed
Predictability	Route depends on the current topology	Route to destination is always the same

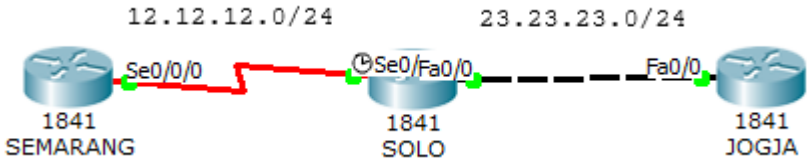
Static Routing

Dalam static routing, network administrator memasukkan route ke tabel routing secara manual untuk menuju ke spesific network. Konfigurasi harus diupdate secara manual setiap terjadi perubahan topologi.

- Static Routing mempunyai Administrative Distance (AD) 1 sehingga akan lebih dipilih daripada dynamic routing.
- Better security, static routes tidak diadvertise dalam network.
- Use less bandwidth daripada dynamic routing protocol, karena tidak melakukan pertukaran route.
- No CPU cycles are used to calculate and communicate routes.
- The path a static route uses to send data is known.
- Konfigurasi dan maintenance yang memakan waktu
- Tidak cocok untuk network skala besar.
- Untuk jaringan kecil yang tidak akan terjadi perubahan topologi secara significant
- Routing ke/dari stub network. Stub network adalah jaringan yang diakses hanya mempunyai 1 exit path (karena hanya mempunyai satu neighbor).
- Untuk unknown network menggunakan default route.

ip route (spaci) destination network (spaci) subnetmask (spaci) ip/interface next-hop

Buatlah topologi dibawah dan konfigurasi interfacenya.




```
Router(config)#hostname SEMARANG
SEMARANG(config)#interface s0/0/0
SEMARANG(config-if)#ip address 12.12.12.1 255.255.255.0
SEMARANG(config-if)#no shutdown
```

```
Router(config)#hostname SOLO
SOLO(config)#interface s0/0/0
SOLO(config-if)#ip address 12.12.12.2 255.255.255.0
SOLO(config-if)#no shutdown
SOLO(config-if)#interface f0/0
```

```
SOLO(config-if)#ip address 23.23.23.2 255.255.255.0
SOLO(config-if)#no shutdown
```

```
Router(config)#hostname JOGJA
JOGJA(config)#interface f0/0
JOGJA(config-if)#ip address 23.23.23.3 255.255.255.0
JOGJA(config-if)#no shutdown
```

Konfigurasikan routing static pada router Semarang dan Jogja. Router Solo tidak perlu dikonfigurasi static routing karena sudah direct connected dengan router Semarang dan Jogja.

```
SEMARANG(config-if)#ip route 23.23.23.0 255.255.255.0 12.12.12.2
JOGJA(config-if)#ip route 12.12.12.0 255.255.255.0 23.23.23.2
```

Sekarang cek ping dan lihat tabel routing.

```
JOGJA#ping 12.12.12.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.12.12.1, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 3/6/17 ms

JOGJA#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter
area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     12.0.0.0/24 is subnetted, 1 subnets
S       12.12.12.0 [1/0] via 23.23.23.2
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/0
JOGJA#
```

```
SEMARANG#ping 23.23.23.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 23.23.23.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/4/14 ms

SEMARANG#sh ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
```

```
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter
area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0/0
     23.0.0.0/24 is subnetted, 1 subnets
S       23.23.23.0 [1/0] via 12.12.12.2
SEMARANG#
```

Static routing ditandai dengan tanda S. Ketika ditraceroute, maka melewati 12.12.12.1 sebagai next-hop menuju network 23.23.23.0/24.

```
SEMARANG#traceroute 23.23.23.3
Type escape sequence to abort.
Tracing the route to 23.23.23.3

  1   12.12.12.2      0 msec    0 msec    0 msec
  2   23.23.23.3      1 msec    1 msec    4 msec
SEMARANG#
```

Default Routing

Default routing sebenarnya masuk dalam static routing. Biasa digunakan untuk routing ke internet. Pada tabel routing, default routing selalu berada paling bawah dan selalu menjadi last preferred (pilihan terakhir).

ip route (spaci) 0.0.0.0 (spaci) 0.0.0.0 (spaci) ip/interface next- hop

Lanjutan lab sebelumnya. Hapus dulu static route yang sebelumnya dibuat.

```
SEMARANG(config)#no ip route 23.23.23.0 255.255.255.0 12.12.12.2
JOGJA(config)#no ip route 12.12.12.0 255.255.255.0 23.23.23.2
```

Sekarang masukkan default routingnya.

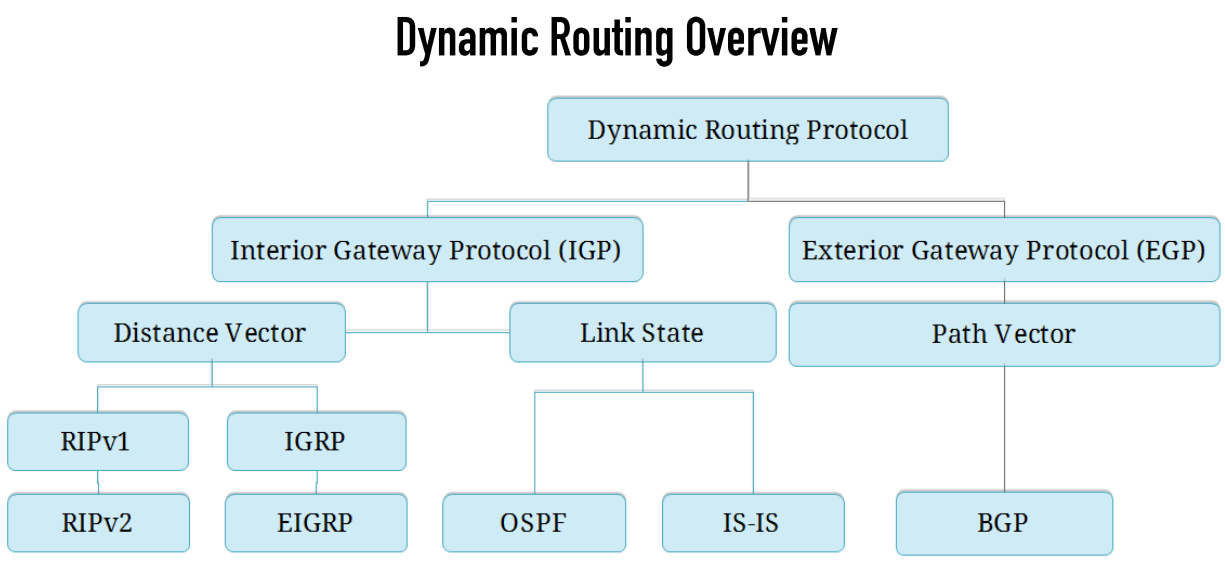
```
SEMARANG(config)#ip route 0.0.0.0 0.0.0.0 12.12.12.2
JOGJA(config)#ip route 0.0.0.0 0.0.0.0  23.23.23.2
```

Sekarang tes ping dan cek tabel routing.

```
SEMARANG#ping 23.23.23.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 23.23.23.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

```
SEMARANG#sh ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter
area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 12.12.12.2 to network 0.0.0.0

     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0/0
S*   0.0.0.0/0 [1/0] via 12.12.12.2
SEMARANG#
```

Default routing ditandai dengan tanda S* dan destination 0.0.0.0/0 yang artinya ke semua ip.



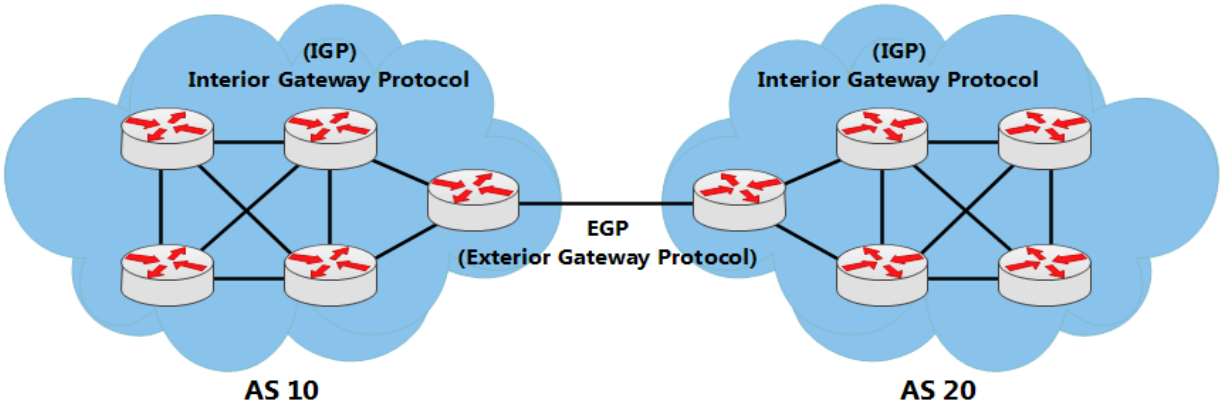
Dynamic routing menggunakan protocol routing dalam pembentukan tabel routing. Ketika topologi berubah, tabel routing akan ikut berubah secara otomatis.

- Use more bandwidth daripada static routing, karena route exchanging.
- CPU cycles are used to calculate and communicate routes.
- Cocok untuk network skala besar.

PERBANDINGAN PROTOCOL ROUTING

	RIP v1	RIP v2	IGRP	EIGRP	OSPF	IS-IS	BGP
Interior/Exterior?	Interior	Interior	Interior	Interior	Interior	Interior	Exterior
Type	Distance Vector	Distance Vector	Distance Vector	Hybrid	Link-state	Link-state	Path Vector
Default Metric	Hopcount	Hopcount	Bandwidth/Delay	Bandwidth/Delay	Cost	Cost	Multiple Attributes
Administrative Distance	120	120	100	90 (internal) 170 (external)	110	115	20 (external) 200 (internal)
Hopcount Limit	15	15	255 (100 default)	224 (100 default)	None	None	EBGP Neighbors: 1 (default) IBGP Neighbors: None
Convergence	Slow	Slow	Slow	Very Fast	Fast	Fast	Average
Update timers	30 seconds	30 seconds	90 seconds	Only when change occurs	Only when changes occur; (LSA table is refreshed every 30 minutes, however)	Only when changes occur	Only when changes occur
Updates	Full table	Full table	Full table	Only Changes	Only Changes	Only changes	Only changes
Classless	No	Yes	No	Yes	Yes	Yes	Yes
Supports VLSM	No	Yes	No	Yes	Yes	Yes	Yes
Algorithm	Bellman-Ford	Bellman-Ford	Bellman-Ford	DUAL	Dijkstra	Dijkstra	Best Path Algorithm
Update Address	Broadcast	224.0.0.9	224.0.0.10	224.0.0.10	224.0.0.5 (All SPF Routers) 224.0.0.6 (DR's and BDR's)		Unicast
Protocol and Port	UDP port 520		IP Protocol 9	IP Protocol 88	IP Protocol 89		TCP port 179

IGP dan EGP



Internet tersusun atas banyak AS. Bayangkan internet itu seperti puzzle, maka AS-AS adalah potongan puzzlenya. Dan di internet ada ribuan AS. AS atau Autonomous System sendiri adalah kumpulan router didalam suatu authority yang sama.

Interior Gateway Protocol (IGP) digunakan untuk routing dalam sebuah AS (Intra-AS). IGP digunakan untuk jaringan internal dalam sebuah perusahaan, organisasi atau service provider. IGP juga dibagi menjadi 2 jenis:

- Distance Vector

Sesuai namanya, ada 2 karakteristik utama dalam penentuan routenya.

Distance = jauhnya source network menuju destination berdasarkan metric. Metric dihitung dari hop count, cost, bandwidth, delay, dll.

Vector = direction atau arah dari next hop router untuk menuju ke destination.

Protocol jenis Distance Vector hanya mengetahui route dan metric untuk menuju destination tertentu. Protocol tersebut tidak mempunyai informasi tentang map jaringan atau topologi secara keseluruhan.

Yang termasuk protocol routing distance vector: RIPv1, RIPv2, IGRP dan EIGRP.

- Link-State

Protocol jenis link-state mengetahui topologi jaringan secara keseluruhan dengan mengumpulkan informasi dari setiap router. Untuk jaringan dengan skala yang luas (large network), link-state didesign secara hierarchical atau dibagi menjadi area-area. Area yang harus ada pada link-state adalah area 0 atau backbone. Pembagian menjadi area-area ini bertujuan mengurangi resource router dengan setiap area mempunyai table routing yang berbeda dengan area yang lain.

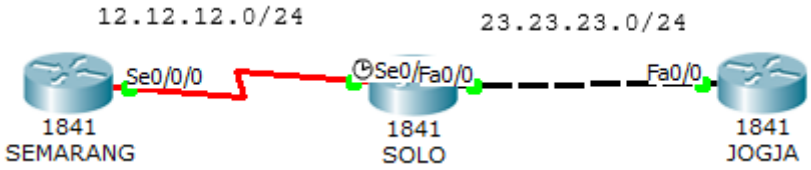
Yang termasuk protocol routing link-state: OSPF dan IS-IS.

Exterior Gateway Protocol (EGP) digunakan untuk routing antar AS (Inter AS). Satu-satunya protocol EGP adalah BGP. BGP merupakan protocol berjenis path-

vector. Route yang dihasilkan dari BGP memuat attribute as-path. AS Path adalah urutan AS Number yang dilewati suatu route untuk sampai ke destination.

Enhanced Interior Gateway Protocol (EIGRP)

- Cisco proprietary
- Advanced distance vector/hybrid routing protocol
- Using DUAL Algorithm.
- Multicast or unicast for exchange information use port 88
- Administrative distance 90
- Classless routing protocol support VLSM/CIDR.
- Support IPv6
- Rich metric (bandwidth, delay, load and reliability)
- Very fast convergence
- Equal and Unequal Load balancing
- 100% loop-free



Konfigurasi interface seperti pada lab static routing dan tambahkan interface loopback pada ketiga router. Interface loopback dapat dipakai sebagai identitas dan sebagai ip logical.

```
SEMARANG(config)#int lo0
SEMARANG(config-if)#ip address 1.1.1.1 255.255.255.255

SOLO(config)#int lo0
SOLO(config-if)#ip add 2.2.2.2 255.255.255.255

JOGJA(config)#int lo0
JOGJA(config-if)#ip add 3.3.3.3 255.255.255.255
```

Konfigurasi EIGRP pada router. AS Number dalam semua router EIGRP harus sama.

```
SEMARANG(config)#router eigrp ?
  <1-65535>  Autonomous system number
```

```
SEMARANG(config)#router eigrp 10
SEMARANG(config-router)#network 12.12.12.0 ?
  A.B.C.D  EIGRP wild card bits
  <cr>
SEMARANG(config-router)#network 12.12.12.0 0.0.0.255
SEMARANG(config-router)#network 1.1.1.1 0.0.0.0
SEMARANG(config-router)#no auto-summary
SEMARANG(config-router)#ex
```

```
SOLO(config)#router eigrp 10
SOLO(config-router)#network 12.12.12.0 0.0.0.255
SOLO(config-router)#network 23.23.23.0 0.0.0.255
SOLO(config-router)#network 2.2.2.2 0.0.0.0
SOLO(config-router)#no auto-summary
```

```
JOGJA(config)#router eigrp 10
JOGJA(config-router)#network 23.23.23.0 0.0.0.255
JOGJA(config-router)#network 3.3.3.3 0.0.0.0
JOGJA(config-router)#no auto-summary
```

No-auto summary bertujuan untuk menyertakan subnetmask dalam routing EIGRP. Sekarang lakukan tes ping dan traceroute ke router jogja.

```
SEMARANG#ping 2.2.2.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/12 ms

SEMARANG#ping 3.3.3.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/11 ms

SEMARANG#traceroute 3.3.3.3
Type escape sequence to abort.
Tracing the route to 3.3.3.3

  1   12.12.12.2      0 msec    2 msec    2 msec
  2   23.23.23.3      1 msec    0 msec    1 msec
SEMARANG#
```

Pengecekan tabel routing.

```
SEMARANG#sh ip route

Gateway of last resort is not set

     1.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D       1.0.0.0/8 [90/2809856] via 12.12.12.2, 00:07:37, Serial0/0/0
C       1.1.1.1/32 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
```

```
D       2.2.2.2 [90/2297856] via 12.12.12.2, 00:07:37, Serial0/0/0
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3 [90/2300416] via 12.12.12.2, 00:02:48, Serial0/0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0/0
     23.0.0.0/24 is subnetted, 1 subnets
D       23.23.23.0 [90/2172416] via 12.12.12.2, 00:02:49, Serial0/0/0
SEMARANG#
```

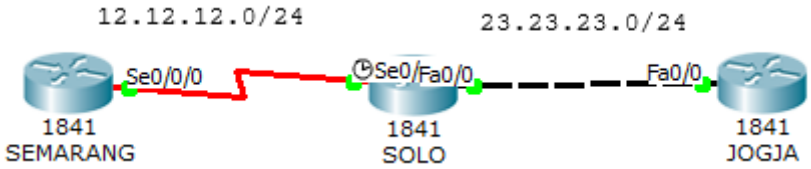
```
SOLO#sh ip route

Gateway of last resort is not set

     1.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D       1.0.0.0/8 is a summary, 00:08:13, Null0
D       1.1.1.1/32 [90/2297856] via 12.12.12.1, 00:08:07, Serial0/0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3 [90/156160] via 23.23.23.3, 00:03:19, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0/0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/0
SOLO#
```

```
JOGJA#sh ip route

Gateway of last resort is not set

     1.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D       1.0.0.0/8 [90/2300416] via 23.23.23.2, 00:03:39, FastEthernet0/0
D       1.1.1.1/32 [90/2300416] via 23.23.23.2, 00:03:39, FastEthernet0/0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/156160] via 23.23.23.2, 00:03:39, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     12.0.0.0/24 is subnetted, 1 subnets
D       12.12.12.0 [90/2172416] via 23.23.23.2, 00:03:39, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/0
JOGJA#
```

Tanda D menunjukkan bahwa route dihasilkan melalui protocol EIGRP. AD pada EIGRP adalah 90 ditandai dengan warna kuning dan metic ditandai dengan warna biru. Perhitungan metric menggunakan rumus tersendiri.

Open Shortest Path First (OSPF)

- Open Standard.
- Link-State routing protocol.
- Using SPF/Dijkstra Algorithm.
- Multicast for exchange information use port 89.
- Administrative distance 110.
- Classless routing protocol support VLSM/CIDR.
- Support IPv6.
- Metric using cost.
- Fast convergence.
- Equal load balancing only.
- Using areas (backbone area and non-backbone areas).



Hapus konfigurasi EIGRP sebelumnya.

```
SEMARANG(config)# no router eigrp 10
SOLO(config)# no router eigrp 10
JOGJA(config-if)# no router eigrp 10
```

Konfigurasi OSPF pada router. OSPF menggunakan process ID. Process ID pada setiap router tidak harus sama, yang terpenting adalah areanya. Untuk terhubung antara area yang satu dengan yang lain harus melewari area 0 atau area backbone.

```
SEMARANG(config)#router ospf ?
  <1-65535>  Process ID
SEMARANG(config)#router ospf 1
SEMARANG(config-router)#net
SEMARANG(config-router)#network 12.12.12.0 ?
  A.B.C.D  OSPF wild card bits
SEMARANG(config-router)#network 12.12.12.0 0.0.0.255 area 0
SEMARANG(config-router)#network 1.1.1.1 0.0.0.0 area 0
```

```
SOLO(config)#router ospf 2
SOLO(config-router)#network 12.12.12.0 0.0.0.255 area 0
SOLO(config-router)#network 23.23.23.0 0.0.0.255 area 1
SOLO(config-router)#network 2.2.2.2 0.0.0.0 area 0
```

```
JOGJA(config)#router ospf 3
JOGJA(config-router)#network 23.23.23.0 0.0.0.255 area 1
JOGJA(config-router)#network 3.3.3.3 0.0.0.0 area 1
```

Sekarang lakukan tes ping.

```
SEMARANG#ping 2.2.2.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms

SEMARANG#ping 3.3.3.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/7 ms

SEMARANG#
```

Cek tabel routing.

```
SEMARANG#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/65] via 12.12.12.2, 00:02:45, Serial0/0/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/66] via 12.12.12.2, 00:01:21, Serial0/0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0/0
     23.0.0.0/24 is subnetted, 1 subnets
O IA    23.23.23.0 [110/65] via 12.12.12.2, 00:03:13, Serial0/0/0
```

```
SOLO#sh ip ro

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/65] via 12.12.12.1, 00:05:40, Serial0/0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/2] via 23.23.23.3, 00:02:35, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0/0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/0
SOLO#
```

```
JOGJA#sh ip route
```

```
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/66] via 23.23.23.2, 00:02:03, FastEthernet0/0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/2] via 23.23.23.2, 00:02:03, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     12.0.0.0/24 is subnetted, 1 subnets
O IA    12.12.12.0 [110/65] via 23.23.23.2, 00:02:03, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/0
JOGJA#
```

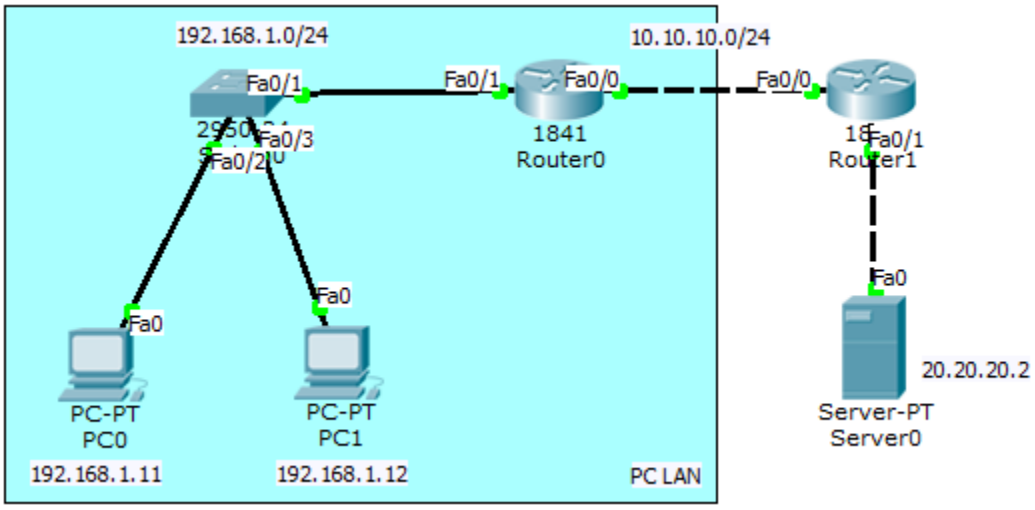
Tanda O menunjukkan bahwa route dihasilkan melalui protocol OSPF. Tanda IA menunjukkan bahwa destination route berada pada area yang berbeda. AD pada OSPF adalah 110.

Accesst List (ACL)

Access List (ACL) biasa digunakan untuk filtering. Ada 2 macam access list yaitu standard dan extented.

Standard ACL	Extended ACL
ACL Number range 1-99	ACL Number range 100-199
Can block a network, host and subnet	Can allow or deny a network, host, subnet and service
All service are blocked	Select service can be blocked
Implemented closest to the destination	Implemented closest to the destination
Filtering based on source IP address only	Filtering based on source IP address, destination IP, protocol and port number

Standard Access List



Lakukan konfigurasi supaya PC LAN dapat ping ke server.

Konfigurasi interface dan routing pada Router0.

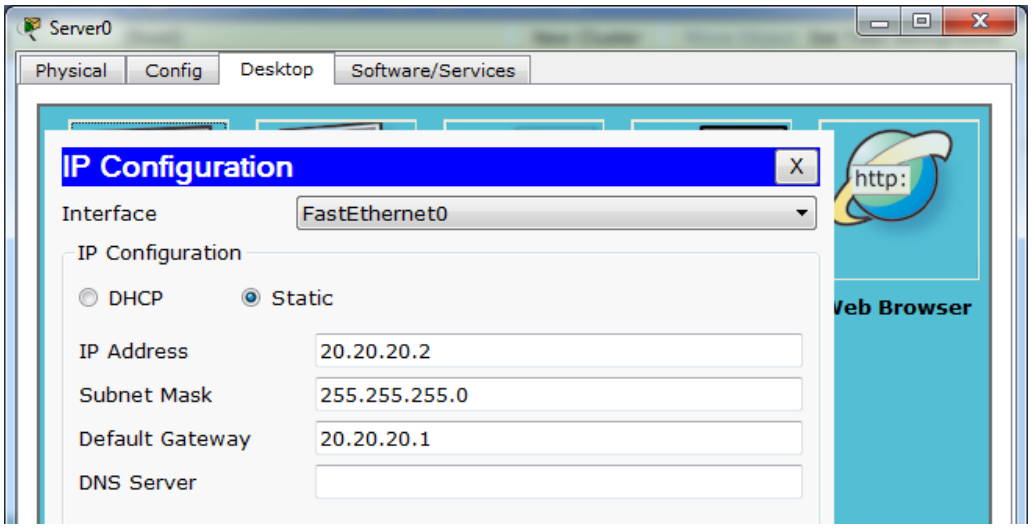
```
Router(config)#int fa0/1
Router(config-if)#ip add 192.168.1.1 255.255.255.0
```

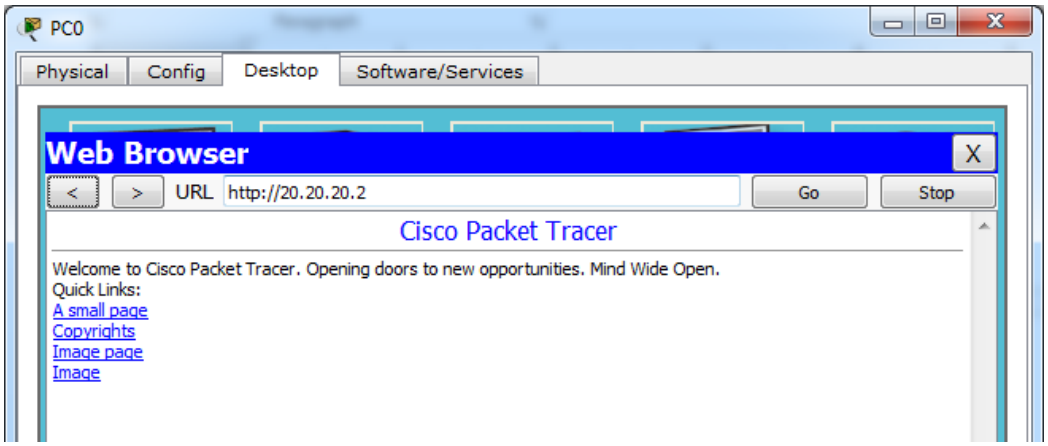
```
Router(config-if)#no sh
Router(config-if)#int fa0/0
Router(config-if)#ip add 10.10.10.1 255.255.255.0
Router(config-if)#no sh
Router(config-if)#ip route 20.20.20.0 255.255.255.0 10.10.10.2
```

Konfigurasi interface dan routing pada Router1.

```
Router(config)#int fa0/0
Router(config-if)#ip add 10.10.10.2 255.255.255.0
Router(config-if)#no sh
Router(config-if)#int fa0/1
Router(config-if)#ip add 20.20.20.1 255.255.255.0
Router(config-if)#no sh
Router(config-if)#ip route 192.168.1.0 255.255.255.0 10.10.10.1
```

Berikan IP pada server dan coba cek web server melalui browser pada PC LAN.





Cek ping dari PC LAN ke web server.

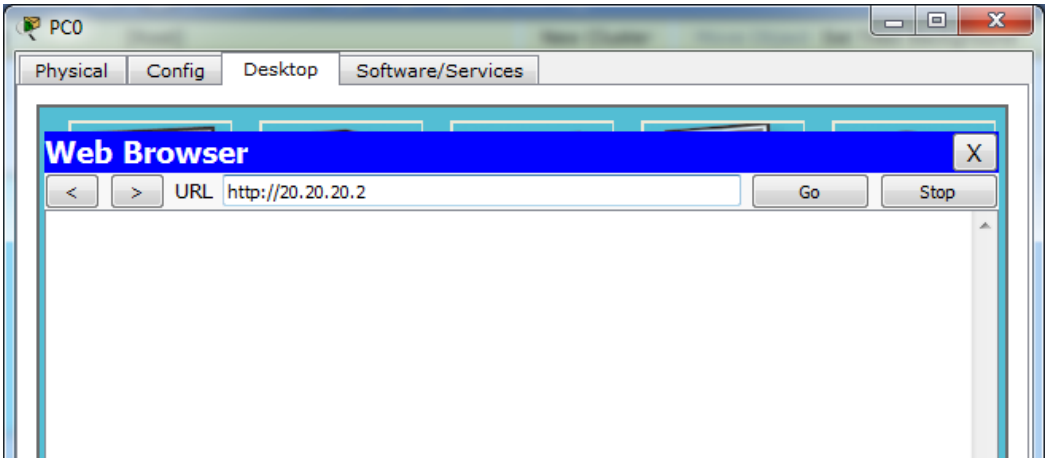
```
PC>ping 20.20.20.2

Pinging 20.20.20.2 with 32 bytes of data:

Reply from 20.20.20.2: bytes=32 time=0ms TTL=126
Reply from 20.20.20.2: bytes=32 time=0ms TTL=126
Reply from 20.20.20.2: bytes=32 time=0ms TTL=126
Reply from 20.20.20.2: bytes=32 time=0ms TTL=126

Ping statistics for 20.20.20.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

PC>
```

Sekarang konfigurasikan standard access list agar PC LAN tidak dapat mengakses web server. Set access list pada router dan interface yang paling dekat dengan destination.

```
Router(config)#access-list 10 deny 192.168.10.0 ?
  A.B.C.D  Wildcard bits
  <cr>
Router(config)#access-list 10 deny 192.168.1.0 0.0.0.255
Router(config)#access-list 10 permit any
Router(config)#int fa0/1
Router(config-if)#ip access-group 1 out
```

Cek ping dan akses browser dari PC LAN ke web server.

```
PC>ping 20.20.20.2

Pinging 20.20.20.2 with 32 bytes of data:

Reply from 10.10.10.2: Destination host unreachable.
Reply from 10.10.10.2: Destination host unreachable.
Reply from 10.10.10.2: Destination host unreachable.
Reply from 10.10.10.2: Destination host unreachable.

Ping statistics for 20.20.20.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

PC>
```



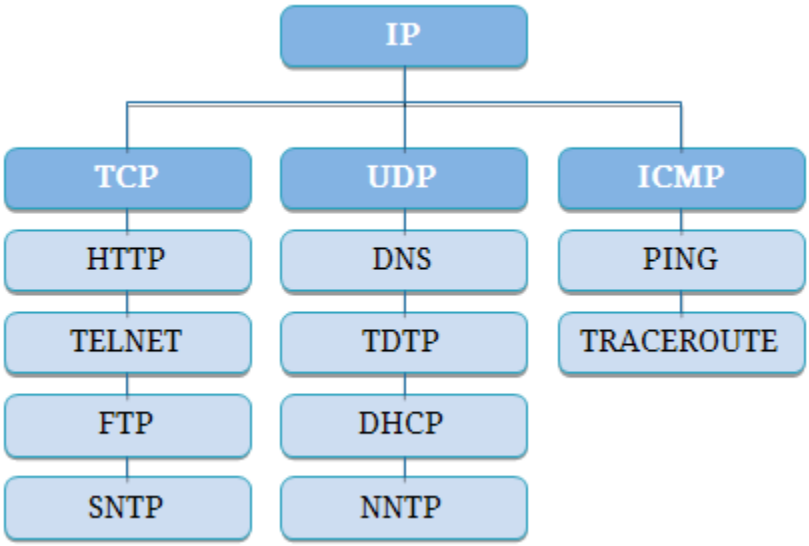
Cek access list pada Router1.

```
Router#show access-lists
Standard IP access list 10
    deny 192.168.1.0 0.0.0.255 (64 match(es))
    permit any (5 match(es))
Router#
```

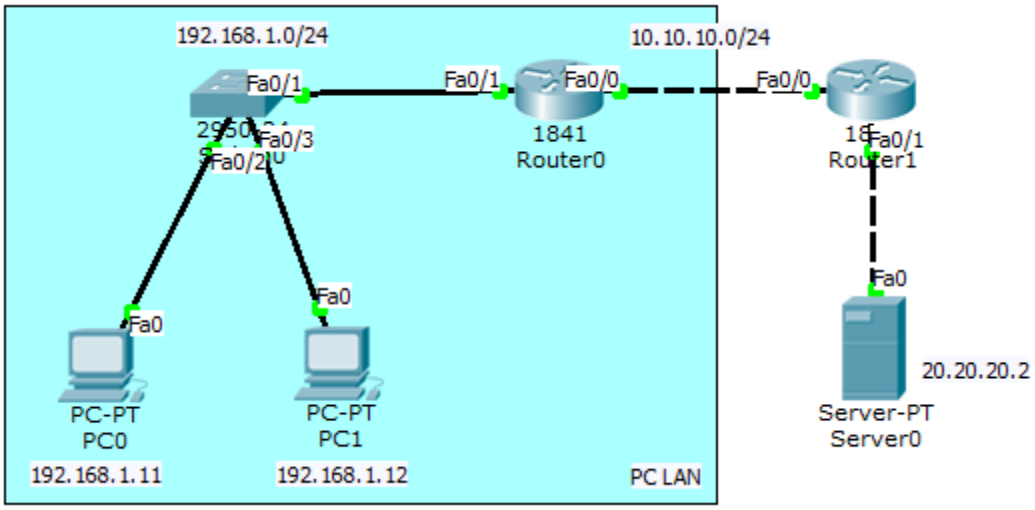
Pada standard access list, semua service akan diblok, baik UDP untuk akses browser atau ICMP untuk ping. Untuk memilih hanya service tertentu saja, gunakan extended access list.

Extended Access List

Extented access list mengizinkan hanya service tertentu saja yang diblok. Gambar dibawah adalah jenis-jenis service beserta aplikasinya.



Masih memakai topologi dari lab sebelumnya. Hapus dulu standard access list yang telah dibuat pada Router1.

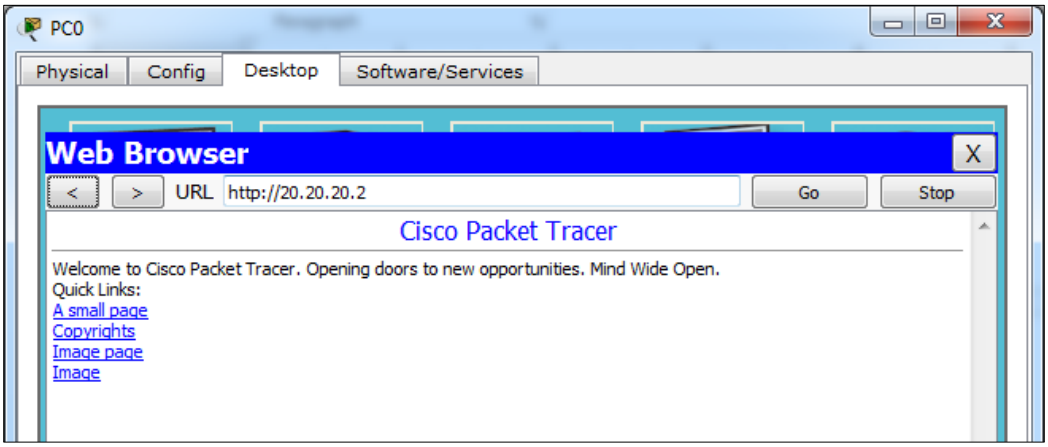



```
Router(config)#no access-list 10
```

Konfigurasi extended access list pada Router1 agar PC LAN dapat mengakses web server namun tidak bisa melakukan ping.

```
Router(config)#access-list 100 deny icmp 192.168.1.0 0.0.0.255 host
20.20.20.2 echo
Router(config)#access-list 100 permit ip any any
Router(config)#int fa0/1
Router(config-if)#ip access-group 100 out
```

Coba cek browser dan tes ping.




```
PC>ping 20.20.20.2

Pinging 20.20.20.2 with 32 bytes of data:

Reply from 10.10.10.2: Destination host unreachable.
Reply from 10.10.10.2: Destination host unreachable.
```

```
Reply from 10.10.10.2: Destination host unreachable.
Reply from 10.10.10.2: Destination host unreachable.

Ping statistics for 20.20.20.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

PC>
```

Cek access list.

```
Router#show access-lists
Standard IP access list 10
    deny 192.168.1.0 0.0.0.255 (64 match(es))
    permit any (5 match(es))
Router#
```

IOS IPv4 Access Lists

packetlife.net

Standard ACL Syntax

```
! Legacy syntax
access-list <number> {permit | deny} <source> [log]

! Modern syntax
ip access-list standard {<number> | <name>}
 [<sequence>] {permit | deny} <source> [log]
```

Actions

permit	Allow matched packets
deny	Deny matched packets
remark	Record a configuration comment
evaluate	Evaluate a reflexive ACL

Extended ACL Syntax

```
! Legacy syntax
access-list <number> {permit | deny} <protocol> <source> [<ports>] <destination> [<ports>] [<options>]

! Modern syntax
ip access-list extended {<number> | <name>}
 [<sequence>] {permit | deny} <protocol> <source> [<ports>] <destination> [<ports>] [<options>]
```

ACL Numbers

1-99 **1300-1999**	IP standard
100-199 **2000-2699**	IP extended
200-299	Protocol
300-399	DECnet
400-499	XNS
500-599	Extended XNS
600-699	Appletalk
700-799	Ethernet MAC
800-899	IPX standard
900-999	IPX extended
1000-1099	IPX SAP
1100-1199	MAC extended
1200-1299	IPX summary

TCP Options

ack	Match ACK flag
fin	Match FIN flag
psh	Match PSH flag
rst	Match RST flag
syn	Match SYN flag
urg	Match URG flag
established	Match packets in an established session

Logging Options

log	Log ACL entry matches
log-input	Log matches including ingress interface and source MAC address

Source/Destination Definitions

any	Any address
host <address>	A single address
<network> <mask>	Any address matched by the wildcard mask

IP Options

dscp <DSCP>	Match the specified IP DSCP
fragments	Check non-initial fragments
option <option>	Match the specified IP option
precedence {0-7}	Match the specified IP precedence
ttl <count>	Match the specified IP time to live (TTL)

TCP/UDP Port Definitions

eq <port>	Equal to	**neq <port>**	Not equal to
lt <port>	Less than	**gt <port>**	Greater than
range <port> <port>	Matches a range of port numbers		

Miscellaneous Options

reflect <name>	Create a reflexive ACL entry
time-range <name>	Enable rule only during the given time range

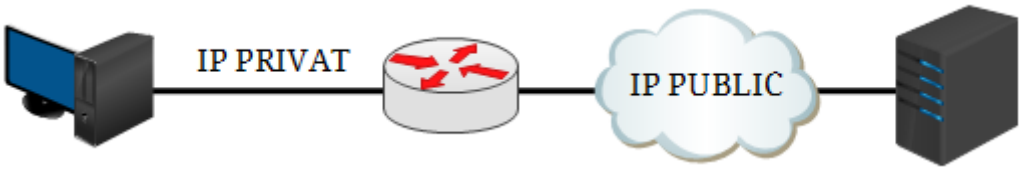
Applying ACLs to Restrict Traffic

```
interface FastEthernet0/0
 ip access-group {<number> | <name>} {in | out}
```

Troubleshooting

```
show access-lists [<number> | <name>]
show ip access-lists [<number> | <name>]
show ip access-lists interface <interface>
show ip access-lists dynamic
show ip interface [<interface>]
show time-range [<name>]
```

Network Address Translation (NAT)



Network Aceess Translation (NAT) digunakan untuk mentranslasikan ip privat ke ip public atau sebaliknya. Misalkan ada server pada suatu perusahaan, selain bisa diakses secara local, perusahaan ingin server tersebut bisa diakses lewat internet. Maka server tersebut diberi ip public dan dikonfigurasi static NAT.

Dalam konfigurasi NAT, interface diset menjadi 2 kategori: inside dan outside.

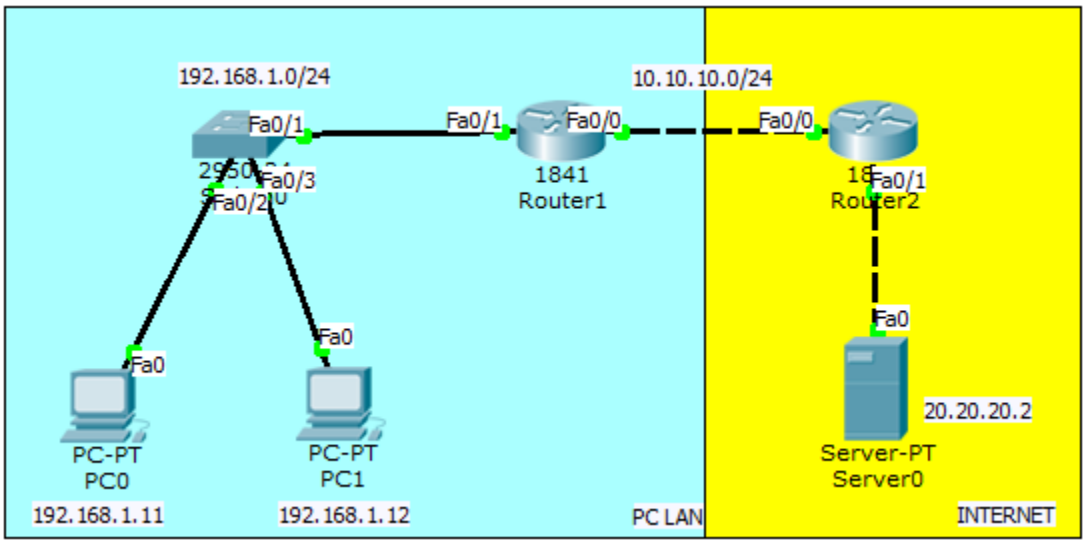
- Inside = traffic yang masuk ke interface router dari local network.
- Outside = traffic yang keluar melalui interface router menuju destination/internet.

Ada beberapa tipe NAT.

- Static NAT, satu ip privat ditranslasikan ke satu ip public (one to one mapping)
- Dynamic NAT, Jumlah ip public yang disediakan harus sejumlah ip privat yang ditranslasikan NAT jenis ini jarang digunakan.
- Overloading/Port Address Translation (PAT), akses internet menggunakan 1 ip public. Ini yang banyak digunakan sekarang.

Static NAT

Dalam static NAT, hanya 1 ip privat ditranslasikan ke 1 ip public. Artinya hanya 1 PC LAN yang dapat mengakses internet.



Konfigurasinya hampir sama dengan lab access list, namun tidak perlu dirouting karena nantinya akan menggunakan NAT.

Konfigurasi interface dan routing pada Router1.

```
Router(config)#int fa0/1
Router(config-if)#ip add 192.168.1.1 255.255.255.0
Router(config-if)#no sh
Router(config-if)#int fa0/0
Router(config-if)#ip add 10.10.10.1 255.255.255.0
Router(config-if)#no sh
```

Konfigurasi interface dan routing pada Router2.

```
Router(config)#int fa0/0
Router(config-if)#ip add 10.10.10.2 255.255.255.0
Router(config-if)#no sh
Router(config-if)#int fa0/1
Router(config-if)#ip add 20.20.20.1 255.255.255.0
Router(config-if)#no sh
```

Konfigurasi static NAT dan default route pada R1. PC LAN 192.168.1.11 akan ditranslasikan ke ip public 10.10.10.10.

```
Router(config)#ip nat inside source ?
  list    Specify access list describing local addresses
  static  Specify static local->global mapping
Router(config)#ip nat inside source static 192.168.1.11 10.10.10.10
Router(config)#int fa0/1
Router(config-if)#ip nat inside
Router(config-if)#int fa0/0
Router(config-if)#ip nat outside
Router(config)#ip route 0.0.0.0 0.0.0.0 fa0/0
```

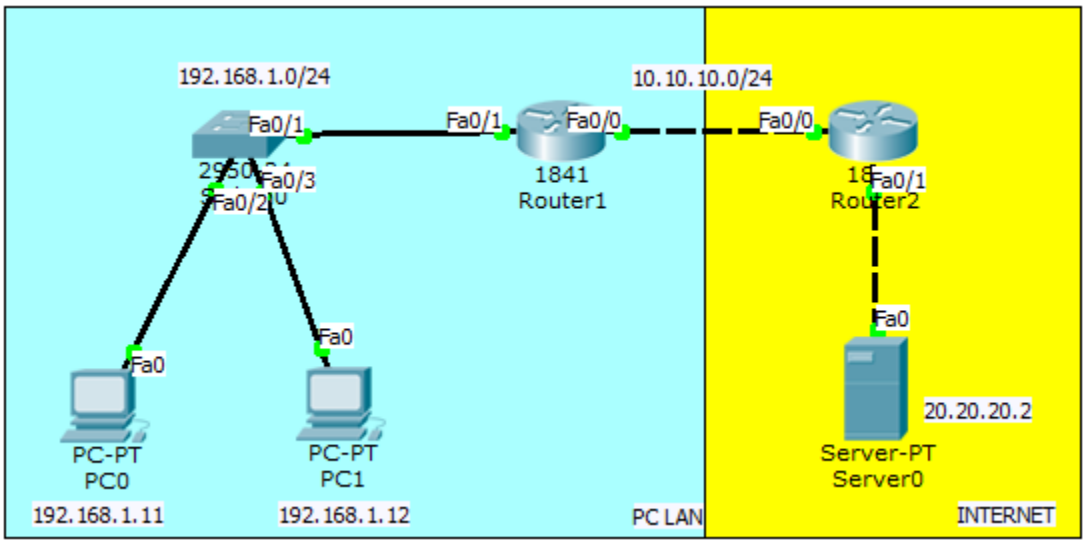
Ping static NAT melalui server dan sebaliknya. Alamat PC LAN tidak akan pernah dapat diping dari internet.

```
SERVER>ping 10.10.10.10

Pinging 10.10.10.10 with 32 bytes of data:

Reply from 10.10.10.10: bytes=32 time=11ms TTL=126
Reply from 10.10.10.10: bytes=32 time=0ms TTL=126
Reply from 10.10.10.10: bytes=32 time=0ms TTL=126
Reply from 10.10.10.10: bytes=32 time=11ms TTL=126

Ping statistics for 10.10.10.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 11ms, Average = 5ms

SERVER>ping 192.168.1.11

Pinging 192.168.1.11 with 32 bytes of data:

Reply from 20.20.20.1: Destination host unreachable.
Reply from 20.20.20.1: Destination host unreachable.
Request timed out.
Reply from 20.20.20.1: Destination host unreachable.

Ping statistics for 192.168.1.11:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

SERVER>
```

```
PC>ping 20.20.20.2

Pinging 20.20.20.2 with 32 bytes of data:

Reply from 20.20.20.2: bytes=32 time=12ms TTL=126
Reply from 20.20.20.2: bytes=32 time=0ms TTL=126
Reply from 20.20.20.2: bytes=32 time=0ms TTL=126
Reply from 20.20.20.2: bytes=32 time=0ms TTL=126

Ping statistics for 20.20.20.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 12ms, Average = 3ms

PC>
```

Overloading/Port Address Translation (PAT)

PAT digunakan agar banyak PC local dapat mengakses internet secara bersama-sama hanya dengan menggunakan 1 ip public.



Lanjutan lab sebelumnya. Hapus dahulu konfigurasi static NAT yang telah dibuat.

```
Router(config)#no ip nat inside source static 192.168.1.11 10.10.10.10
```

Buat access list untuk mendefinisikan network yang akan ditranslasikan dan konfigurasi dynamic nat overload pada R1.

```
Router(config)#access-list 1 permit 192.168.1.0 0.0.0.255
Router(config)#ip nat inside source list ?
  <1-199>  Access list number for local addresses
  WORD     Access list name for local addresses
Router(config)#ip nat inside source list 1 interface fa0/0 overload
```

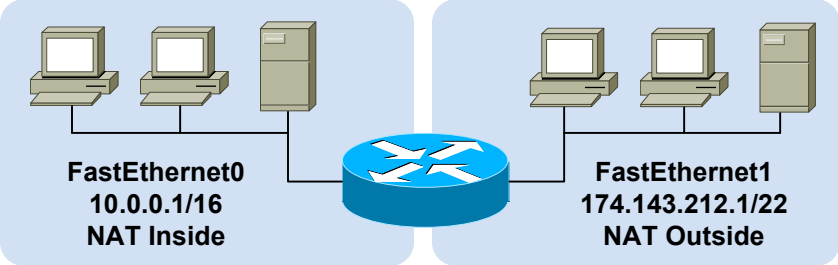
Sekarang ping web server melalui PC0 dan PC1 pastikan reply.

```
PC>ping 20.20.20.2

Pinging 20.20.20.2 with 32 bytes of data:

Reply from 20.20.20.2: bytes=32 time=12ms TTL=126
Reply from 20.20.20.2: bytes=32 time=0ms TTL=126
Reply from 20.20.20.2: bytes=32 time=0ms TTL=126
Reply from 20.20.20.2: bytes=32 time=0ms TTL=126

Ping statistics for 20.20.20.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 12ms, Average = 3ms

PC>
```

Network Address Translation

packetlife.net

Example Topology



Address Classification

Inside Local	An actual address assigned to an inside host
Inside Global	An inside address seen from the outside
Outside Global	An actual address assigned to an outside host
Outside Local	An outside address seen from the inside

NAT Boundary Configuration

```
interface FastEthernet0
 ip address 10.0.0.1 255.255.0.0
 ip nat inside
!
interface FastEthernet1
 ip address 174.143.212.1 255.255.252.0
 ip nat outside
```

		Perspective	
		Local	Global
Location	Inside	Inside Local	Inside Global
	Outside	Outside Local	Outside Global

Static Source Translation

```
! One line per static translation
ip nat inside source static 10.0.0.19 192.0.2.1
ip nat inside source static 10.0.1.47 192.0.2.2
ip nat outside source static 174.143.212.133 10.0.0.47
ip nat outside source static 174.143.213.240 10.0.2.181
```

Dynamic Source Translation

```
! Create an access list to match inside local addresses
access-list 10 permit 10.0.0.0 0.0.255.255
!
! Create NAT pool of inside global addresses
ip nat pool MyPool 192.0.2.1 192.0.2.254 prefix-length 24
!
! Combine them with a translation rule
ip nat inside source list 10 pool MyPool
!
! Dynamic translations can be combined with static entries
ip nat inside source static 10.0.0.42 192.0.2.42
```

Port Address Translation (PAT)

```
! Static layer four port translations
ip nat inside source static tcp 10.0.0.3 8080 192.0.2.1 80
ip nat inside source static udp 10.0.0.14 53 192.0.2.2 53
ip nat outside source static tcp 174.143.212.4 23 10.0.0.8 23
!
! Dynamic port translation with a pool
ip nat inside source list 11 pool MyPool overload
!
! Dynamic translation with interface overloading
ip nat inside source list 11 interface FastEthernet1 overload
```

Terminology

NAT Pool
A pool of IP addresses to be used as inside global or outside local addresses in translations

Port Address Translation (PAT)
An extension to NAT that translates information at layer four and above, such as TCP and UDP port numbers; dynamic PAT configurations include the **overload** keyword

Extendable Translation
The **extendable** keyword must be appended when multiple overlapping static translations are configured

Special NAT Pool Types

Rotary	Used for load balancing
Match-Host	Preserves the host portion of the address after translation

Troubleshooting

```
show ip nat translations [verbose]
show ip nat statistics
clear ip nat translations
```

NAT Translations Tuning

```
ip nat translation tcp-timeout <seconds>
ip nat translation udp-timeout <seconds>
ip nat translation max-entries <number>
```

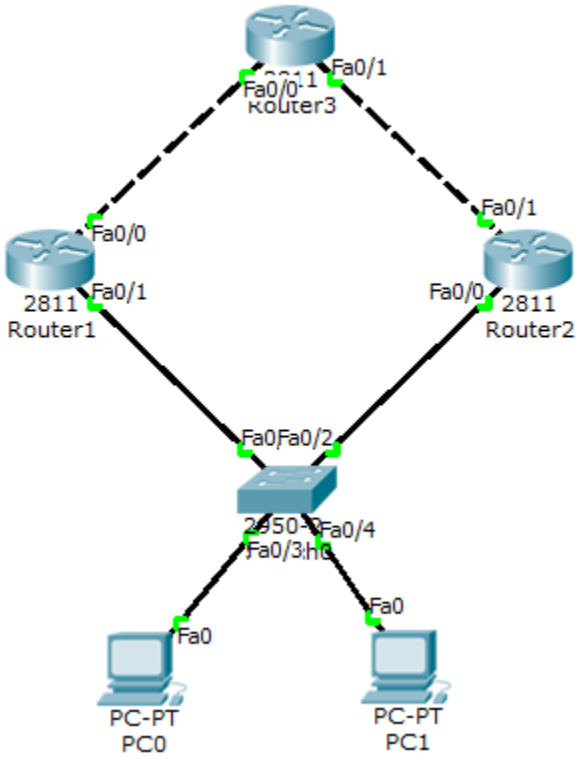
Inside Destination Translation

```
! Create a rotary NAT pool
ip nat pool LoadBalServers 10.0.99.200 10.0.99.203 prefix-length 24 type rotary
!
! Enable load balancing across inside hosts for incoming traffic
ip nat inside destination list 12 pool LoadBalServers
```

High Availibility

High Availibility digunakan dengan maksud redundancy yaitu sebagai menggunakan beberapa router, yang satu menjadi link utama dan yang lain sebagai backup. Satu virtual gateway akan dipasang di PC local sehingga ketika pindah router tidak perlu mengeset gateway lagi.

HSRP



Konfigurasi routing seperti biasa pada ketika

```
Router(config)#hostname Router1
Router1(config)#int fa0/0
Router1(config-if)#ip add 13.13.13.1 255.255.255.0
Router1(config-if)#no sh

Router1(config-if)#int fa0/1
Router1(config-if)#ip add 12.12.12.1 255.255.255.0
Router1(config-if)#no sh

Router1(config-if)#router eigrp 10
Router1(config-router)#network 13.13.13.1 0.0.0.255
Router1(config-router)#network 12.12.12.1 0.0.0.255
Router1(config-router)#passive-interface fa0/1
Router1(config-router)#no auto-summary
```

```
Router(config)#hostname Router2
Router2(config)#int fa0/1
Router2(config-if)#ip add 23.23.23.2 255.255.255.0
Router2(config-if)#no sh

Router2(config-if)#int fa0/0
Router2(config-if)#ip add 12.12.12.2 255.255.255.0
Router2(config-if)#no sh

Router2(config-if)#router eigrp 10
Router2(config-router)#network 23.23.23.2 0.0.0.255
Router2(config-router)#network 12.12.12.2 0.0.0.255
Router2(config-router)#passive-interface fa0/0
Router2(config-router)#no auto-summary
```

```
Router(config)#hostname Router3
Router3(config)#int lo0

Router3(config-if)#ip add 3.3.3.3 255.255.255.255
Router3(config-if)#int fa0/1
Router3(config-if)#ip add 23.23.23.3 255.255.255.0
Router3(config-if)#no sh

Router3(config-if)#int fa0/0
Router3(config-if)#ip add 13.13.13.3 255.255.255.0
Router3(config-if)#no sh

Router3(config-if)#router eigrp 10
Router3(config-router)#network 23.23.23.3 0.0.0.255
Router3(config-router)#network 13.13.13.3 0.0.0.255
Router3(config-router)#network 3.3.3.3 0.0.0.0
Router3(config-router)#no auto-summary
```

Pastikan Router1 dan Router2 dapat melakukan ping ke 3.3.3.3 baru lakukan konfigurasi HSRP.

```
Router1(config)#int fa0/1
Router1(config-if)#standby ?
  <0-4095>  group number
  ip        Enable HSRP and set the virtual IP address
  ipv6      Enable HSRP IPv6
  preempt   Overthrow lower priority Active routers
  priority  Priority level
  track     Priority Tracking
Router1(config-if)#standby 1 ip 12.12.12.12
Router1(config-if)#standby 1 preempt
%HSRP-6-STATECHANGE: FastEthernet0/1 Grp 1 state Speak -> Standby

%HSRP-6-STATECHANGE: FastEthernet0/1 Grp 1 state Standby -> Active
Router1(config-if)#standby 1 priority 105
Router1(config-if)#standby 1 track fa0/0
```

```
Router2(config)#int fa0/0
Router2(config-if)#standby 1 ip 12.12.12.12
Router2(config-if)#standby preempt
```

```
%HSRP-6-STATECHANGE: FastEthernet0/0 Grp 1 state Speak -> Standby
```

Konfigurasi di PC.

```
PC0 IP:12.12.12.100/24 GATEWAY:12.12.12.12
PC1 IP:12.12.12.101/24 GATEWAY:12.12.12.12
```

Ping dan trace dari PC ke 3.3.3.3.

```
PC>ping 3.3.3.3

Pinging 3.3.3.3 with 32 bytes of data:

Reply from 3.3.3.3: bytes=32 time=1ms TTL=254
Reply from 3.3.3.3: bytes=32 time=1ms TTL=254
Reply from 3.3.3.3: bytes=32 time=1ms TTL=254
Reply from 3.3.3.3: bytes=32 time=0ms TTL=254

Ping statistics for 3.3.3.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

PC>tracert 3.3.3.3

Tracing route to 3.3.3.3 over a maximum of 30 hops:

  1   1 ms      1 ms      0 ms      12.12.12.1
  2   1 ms      1 ms      0 ms      3.3.3.3

Trace complete.

PC>
```

Cek standby pada Router1 dan Router2.

```
Router1#show standby br
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State    Active          Standby         Virtual IP
Fa0/1       1    105 P Active   local           12.12.12.2      12.12.12.12
Router1#

Router2#show standby br
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State    Active          Standby         Virtual IP
Fa0/0       1    100   Standby  12.12.12.1      local           12.12.12.12
Router2#
```

```
Router2(config)#int fa0/0
Router2(config-if)#standby 1 ip 12.12.12.12
Router2(config-if)#standby preempt
%HSRP-6-STATECHANGE: FastEthernet0/0 Grp 1 state Speak -> Standby
```

First Hop Redundancy

packetlife.net

Protocols

Hot Standby Router Protocol (HSRP)
Provides default gateway redundancy using one active and one standby router; standardized but licensed by Cisco Systems

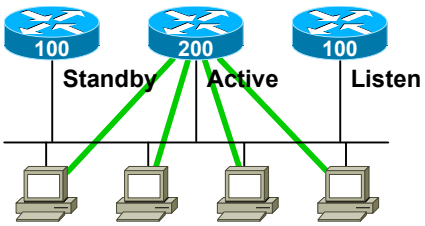
Virtual Router Redundancy Protocol (VRRP)
An open-standard alternative to Cisco's HSRP, providing the same functionality

Gateway Load Balancing Protocol (GLBP)
Supports arbitrary load balancing in addition to redundancy across gateways; Cisco proprietary

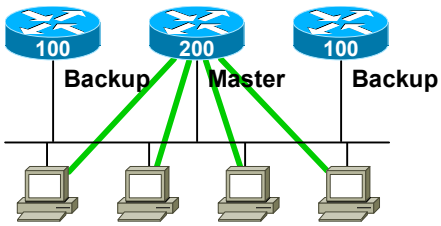
Attributes

	HSRP	VRRP	GLBP
Standard	RFC 2281	RFC 3768	Cisco
Load Balancing	No	No	Yes
IPv6 Support	Yes	No	Yes
Transport	UDP/1985	IP/112	UDP/3222
Default Priority	100	100	100
Default Hello	3 sec	1 sec	3 sec
Multicast Group	224.0.0.2	224.0.0.18	224.0.0.102

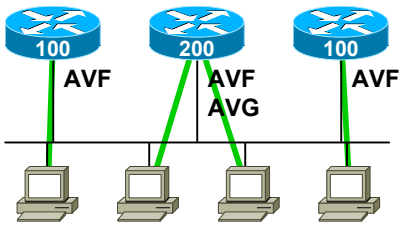
HSRP



VRRP



GLBP



HSRP Configuration

```
interface FastEthernet0/0
 ip address 10.0.1.2 255.255.255.0
 standby version {1 | 2}
 standby 1 ip 10.0.1.1
 standby 1 timers <hello> <dead>
 standby 1 priority <priority>
 standby 1 preempt
 standby 1 authentication md5 key-string <password>
 standby 1 track <interface> <value>
 standby 1 track <object> decrement <value>
```

VRRP Configuration

```
interface FastEthernet0/0
 ip address 10.0.1.2 255.255.255.0
 vrrp 1 ip 10.0.1.1
 vrrp 1 timers {advertise <hello> | learn}
 vrrp 1 priority <priority>
 vrrp 1 preempt
 vrrp 1 authentication md5 key-string <password>
 vrrp 1 track <object> decrement <value>
```

GLBP Configuration

```
interface FastEthernet0/0
 ip address 10.0.1.2 255.255.255.0
 glbp 1 ip 10.0.1.1
 glbp 1 timers <hello> <dead>
 glbp 1 timers redirect <redirect> <time-out>
 glbp 1 priority <priority>
 glbp 1 preempt
 glbp 1 forwarder preempt
 glbp 1 authentication md5 key-string <password>
 glbp 1 load-balancing <method>
 glbp 1 weighting <weight> lower <lower> upper <upper>
 glbp 1 weighting track <object> decrement <value>
```

HSRP/GLBP Interface States

Speak · Gateway election in progress

Active · Active router/VG

Standby · Backup router/VG

Listen · Not the active router/VG

VRRP Interface States

Master · Acting as the virtual router

Backup · All non-master routers

GLBP Roles

Active Virtual Gateway (AVG)
Answers for the virtual router and assigns virtual MAC addresses to group members

Active Virtual Forwarder (AVF)
All routers which forward traffic for the group

GLBP Load Balancing

Round-Robin (default)
The AVG answers host ARP requests for the virtual router with the next router in the cycle

Host-Dependent
Round-robin cycling is used while a consistent AVF is maintained for each host

Weighted
Determines the proportionate share of hosts handled by each AVF

Troubleshooting

```
show standby [brief]   show vrrp [brief]
show glbp [brief]      show track [brief]
```

IPV6

IPv6 Basic Link-Local
IPv6 Basic Global Unicast
IPv6 Basic EUI-64
IPv6 Static Routing
IPv6 RIPnG
IPv6 EIGRP
IPv6 OSPFv3
IPv6 IPv6IP Tunneling
IPv6 GRE IP Tunneling
IPv6 Tunnel 6to4
IPv6 Tunnel ISATAP
IPv6 Tunnel Auto-Tunnel

IPv6 Overview

Pengguna internet berkembang sangat pesat sehingga space IPv4 yang tersedia juga semakin sedikit. Apalagi dengan banyaknya perangkat seperti telepon dan tablet yang butuh koneksi internet juga turut mengurangi space IPv4. Solusinya adalah dengan IPv6 yang mempunyai space ip yang jauh lebih banyak.

Masalahnya adalah IPv4 berbeda dengan IPv6 sehingga banyak protocol yang tidak compatible satu sama lain. Migrasi dari IPv4 ke IPv6 sudah banyak dilakukan.

Berikut perbandingan jumlah IPv4 dan IPv6.

IPv4 32bit = 2^3 = 4.294.967.296

IPv6 128bit = 2^128 = 340.282.366.920.938.463.463.374.607.431.768.211.456

- Dengan banyaknya space yang disediakan IPv6 maka tidak perlu lagi menggunakan Network Address Translation (NAT) dan Port Address Translation (PAT).
- Dari segi size header, IPv6 mempunyai header yang lebih kecil dibanding IPv4.
- IPv6 terdiri dari 16bit hexadecimal dan case-insensitive yang terbagi menjadi 8 field, tidak seperti IPv4 yang terdiri dari 12bit dan terbagi menjadi 4 oktet.
- Jika dalam IPv4 ada namanya oktet, di IPv6 ada namanya field. Pada IPv6 prefixnya sampai 128. Contohnya*:* 0000:360B:0000:0000:0020:875B:131B/64.

Meringkas IPv6

Aslinya : 2541:0000:360B:0000:0000:0020:875B:131B/64

Jika ada 0000 baik berjejer atau tidak, dapat diwakili tanda colon 2 (::). Syaratnya semua harus 0, tidak boleh ada angka selain 0.

Diringkas : 2541:0000:360B::0020:875B:131B/64

Klo sudah ada :: maka jika ada 0000 tidak bisa diwakili :: lagi karena hanya ada satu :: dalam satu IPv6. 0000 bisa diwakili hanya dengan 0 saja.

Selain itu jika ada field yang depannya (sisi kirinya) adalah 0, maka 0 bisa dihilangkan.

Diringkas lagi : 2541:0:360B::20:875B:131B/64

Dalam IPv6 tidak ada broadcast. Adanya unicast, multicast dan anycast.

Unicast, unicast dalam IPv6 sama dengan IPv4. Kelebihannya, IPv6 dapat memberikan lebih dari 1 alamat pada 1 interface. Keren kan?

Multicast, pada IPv6, broadcast digantikan oleh multicast karena memang tidak ada broadcast dalam IPv6.

Anycast, dalam IPv6 beberapa host dan router dapat diberi ip yang sama. Misalkan kita punya beberapa web server dengan ip anycast yang sama. Dengan cara tersebut, kita bisa mengarahkan host yang mengakses web server tadi untuk di route ke web server terdekat.

Jenis-Jenis IP IPv6

Unique Local, sama dengan IP private pada IPv4. IP private digunakan untuk network local dan bukan untuk internet. IP network yang digunakan adalah FD00::/8.

Link Local, digunakan untuk mengirim dan menerima packet IPv6 dalam sebuah single subnet. Tiap perangkat yang memakai IPv6 akan mempunyai alamat link local secara otomatis pada interfacenya dan mempunyai link local scope atau jangkauan link local, artinya packet tidak akan meninggalkan link local. Packet yang dikirim ke destination tertentu akan tetap berada dalam link local dan tidak diforward ke subnet lain oleh router. Link Local menggunakan IP network FE80::/10.

Link Local digunakan sebagai RS (Router Solicitation) and RA (Router Advertisement), untuk network discovery (sama seperti ARP) dan digunakan sebagai next-hop untuk ip route.

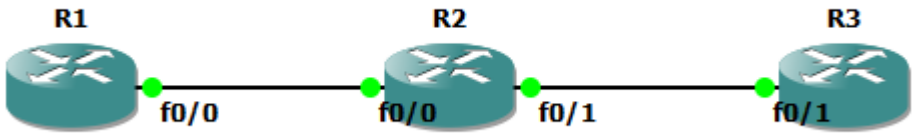
Global Unicast, sama seperti ip publik untuk internet. IP network yang digunakan adalah 2000::/3.

Unspecified, alamat ini digunakan ketika host tidak bisa menggunakan IPv6, menggunakan ::/128

Loopback yang digunakan untuk software testing seperti 127.0.0.1. Loopback menggunakan ip ::1/128.

Site Local. Site local dulunya digunakan sebagai ip private, sekarang sudah tidak digunakan. IP site local adalah FECO::/10.

IPv6 Basic Link-Local



Secara default IPv6 tidak aktif, untuk mengaktifkan ketikkan perintah unicast-routing.

```
R1(config)#ipv6 unicast-routing
```

Setiap kali mengkonfigurasi IPv6 pada interface, link-local akan otomatis terbuat.

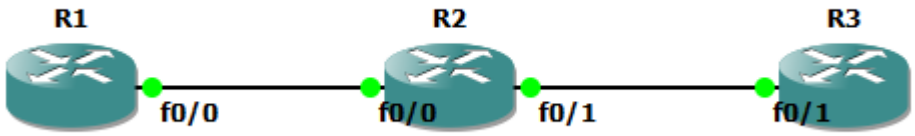
```
R1(config-if)#do sh ipv6 int fa0/0
FastEthernet0/0 is administratively down, line protocol is down
  IPv6 is enabled, link-local address is FE80::C201:9FF:FED0:0 [TEN]
  No Virtual link-local address(es):
  No global unicast address is configured
  Joined group address(es):
    FF02::1
    FF02::2
  MTU is 1500 bytes
  ICMP error messages limited to one every 100 milliseconds
  ICMP redirects are enabled
  ICMP unreachables are sent
  ND DAD is enabled, number of DAD attempts: 1
  ND reachable time is 30000 milliseconds
  ND advertised reachable time is 0 milliseconds
  ND advertised retransmit interval is 0 milliseconds
  ND router advertisements are sent every 200 seconds
  ND router advertisements live for 1800 seconds
  ND advertised default router preference is Medium
  Hosts use stateless autoconfig for addresses.
R1(config-if)#
```

Bisa juga dengan perintah berikut.

```
R2(config)#int fa0/0
R2(config-if)#ipv6 address autoconfig

R2(config)#do show ipv6 int fa0/0
FastEthernet0/0 is administratively down, line protocol is down
  IPv6 is enabled, link-local address is FE80::C202:CFF:FED8:0 [TEN]
  No Virtual link-local address(es):
  No global unicast address is configured
  Joined group address(es):
    FF02::1
    FF02::2
  MTU is 1500 bytes
  ICMP error messages limited to one every 100 milliseconds
  ICMP redirects are enabled
  ICMP unreachables are sent
  ND DAD is enabled, number of DAD attempts: 1
  ND reachable time is 30000 milliseconds
```

```
  ND advertised reachable time is 0 milliseconds
  ND advertised retransmit interval is 0 milliseconds
  ND router advertisements are sent every 200 seconds
  ND router advertisements live for 1800 seconds
  ND advertised default router preference is Medium
  Hosts use stateless autoconfig for addresses.
R2(config)#
```

IPv6 Basic Global Unicast



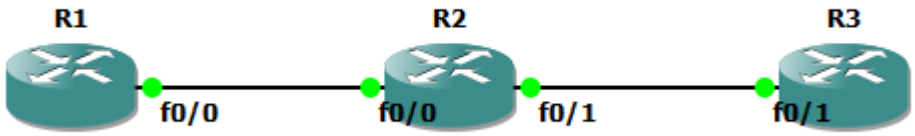

```
R1(config)#int fa0/0
R1(config-if)#ipv6 address 12::1/126
RR1(config-if)#no sh
*Mar  1 00:22:30.687: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed
state to up
*Mar  1 00:22:31.687: %LINEPROTO-5-UPDOWN: Line protocol on Interface
FastEthernet0/0, changed state to up
```

```
R2(config)#int fa0/0
R2(config-if)#ipv6 add 12::2/126
R2(config-if)#no sh
*Mar  1 00:21:23.063: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed
state to up
*Mar  1 00:21:24.063: %LINEPROTO-5-UPDOWN: Line protocol on Interface
FastEthernet0/0, changed state to up
```

Cek ping.

```
R2(config-if)#do ping 12::1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/54/104 ms
R2(config-if)#
```

IPv6 Basic EUI-64



Untuk konfigurasi otomatis.

```
R2(config-if)#int fa0/1
R2(config-if)#ipv6 address 23::/64 eui-64
R2(config-if)#no sh
*Mar  1 00:25:46.951: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed
state to up
*Mar  1 00:25:47.951: %LINEPROTO-5-UPDOWN: Line protocol on Interface
FastEthernet0/1, changed state to up
```

```
R3(config)#int fa0/1
R3(config-if)#ipv6 address 23::/64 eui-64
R3(config-if)#no sh
*Mar  1 00:24:13.739: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed
state to up
*Mar  1 00:24:14.739: %LINEPROTO-5-UPDOWN: Line protocol on Interface
FastEthernet0/1, changed state to up
```

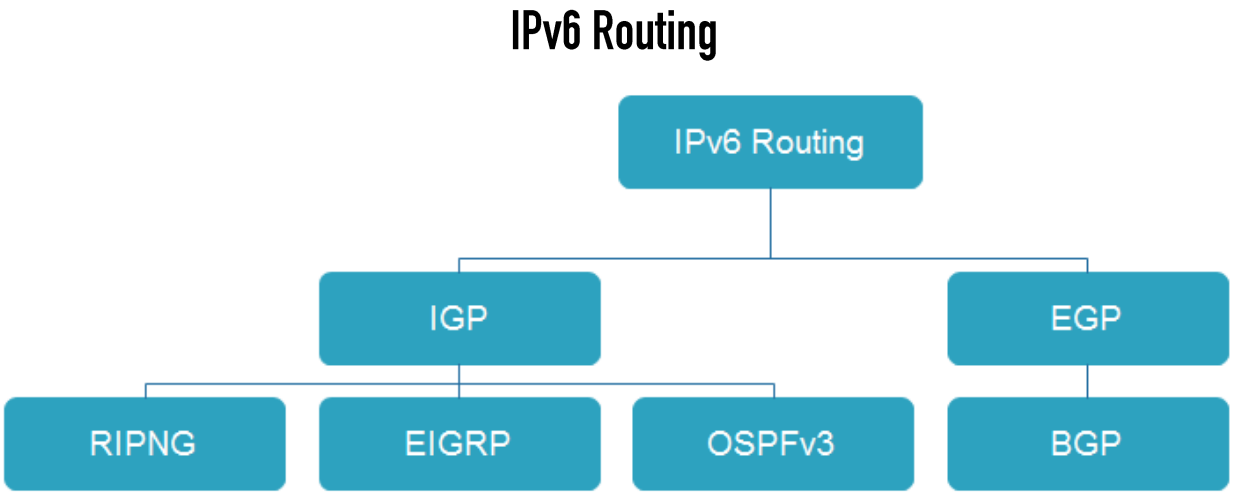
Cek interface R2 dan R3.

```
R2(config-if)#do sh ipv6 int br
FastEthernet0/0            [up/up]
    FE80::C202:CFF:FED8:0
    12::2
FastEthernet0/1            [up/up]
    FE80::C202:CFF:FED8:1
    23::C202:CFF:FED8:1
Serial1/0                  [administratively down/down]
Serial1/1                  [administratively down/down]
Serial1/2                  [administratively down/down]
Serial1/3                  [administratively down/down]
R2(config-if)#
```

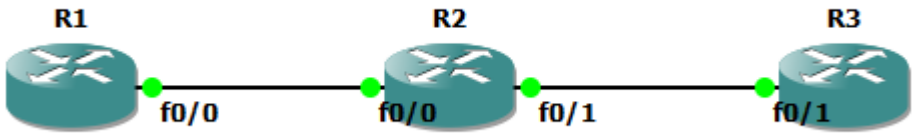
```
R3(config-if)#do sh ipv6 int br
FastEthernet0/0            [administratively down/down]
FastEthernet0/1            [up/up]
    FE80::C203:3FF:FEA8:1
    23::C203:3FF:FEA8:1
Serial1/0                  [administratively down/down]
Serial1/1                  [administratively down/down]
Serial1/2                  [administratively down/down]
Serial1/3                  [administratively down/down]
R3(config-if)#
```

Cek ping ke R2.

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 23::C202:CFF:FED8:1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/56/104 ms
R3(config-if)#
```



IPv6 Static Routing



Pakai topologi sebelumnya. Cek interface router untuk menentukan destination dan next-hop.

```
R1#sh ipv6 int br
FastEthernet0/0            [up/up]
    FE80::C201:9FF:FED0:0
    12::1
FastEthernet0/1            [administratively down/down]
Serial1/0                  [administratively down/down]
Serial1/1                  [administratively down/down]
Serial1/2                  [administratively down/down]
Serial1/3                  [administratively down/down]
R1#
```

```
R2#sh ipv6 int br
FastEthernet0/0            [up/up]
    FE80::C202:CFF:FED8:0
    12::2
FastEthernet0/1            [up/up]
    FE80::C202:CFF:FED8:1
    23::C202:CFF:FED8:1
Serial1/0                  [administratively down/down]
Serial1/1                  [administratively down/down]
Serial1/2                  [administratively down/down]
Serial1/3                  [administratively down/down]
R2#
```

```
R3#sh ipv6 int br
FastEthernet0/0            [administratively down/down]
FastEthernet0/1            [up/up]
    FE80::C203:3FF:FEA8:1
    23::C203:3FF:FEA8:1
Serial1/0                  [administratively down/down]
Serial1/1                  [administratively down/down]
Serial1/2                  [administratively down/down]
Serial1/3                  [administratively down/down]
R3#
```

Konfigurasi static routing pada IPv6 hampir sama dengan IPv4.

```
R1(config)# ipv6 route 23::/64 12::2
R3(config)#ipv6 route 12::/126 23::C202:CFF:FED8:1
```

Cek tabel routing dan tes ping.

```
R1#sh ipv6 route
IPv6 Routing Table - 4 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route, M - MIPv6
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       D - EIGRP, EX - EIGRP external
C   12::/126 [0/0]
     via ::, FastEthernet0/0
L   12::1/128 [0/0]
     via ::, FastEthernet0/0
S   23::/64 [1/0]
     via 12::2
L   FF00::/8 [0/0]
     via ::, Null0
R1#ping 23::C203:3FF:FEA8:1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 23::C203:3FF:FEA8:1, timeout is 2 seconds:
!!!!!
Succes
```

```
R3(config)#do sho ipv6 route
IPv6 Routing Table - 4 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route, M - MIPv6
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       D - EIGRP, EX - EIGRP external
S   12::/126 [1/0]
     via 23::C202:CFF:FED8:1
C   23::/64 [0/0]
     via ::, FastEthernet0/1
L   23::C203:3FF:FEA8:1/128 [0/0]
     via ::, FastEthernet0/1
L   FF00::/8 [0/0]
     via ::, Null0
R3(config)#do ping 12::1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/74/84 ms
R3(config)#
```

Selain menggunakan ip next-hop, konfigurasi static routing juga dapat menggunakan interface next-hop. Khusus IPv6, harus disertakan link localnya.

Hapus dulu static routing sebelumnya.

```
R1(config)#no ipv6 route 23::/64 12::2
R3(config)#no ipv6 route 12::/126 23::C202:CFF:FED8:1
```

```
R1(config)#ipv6 route 23::/64 FastEthernet 0/0
R1(config)#do ping 23::C203:3FF:FEA8:1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 23::C203:3FF:FEA8:1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
R1(config)#
```

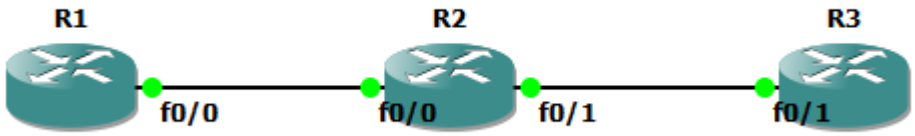
Ping gagal karena belum disertakan link local.

```
R1(config)#no ipv6 route 23::/64 FastEthernet 0/0
R1(config)#ipv6 route 23::/64 FastEthernet 0/0 FE80::C202:CFF:FED8:0
R1(config)#do ping 23::C203:3FF:FEA8:1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 23::C203:3FF:FEA8:1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 72/85/108 ms
R1(config)#
```

Sekarang konfigurasi routing static pada R3.

```
R3(config)#ipv6 route 12::/126 FastEthernet 0/1 FE80::C202:CFF:FED8:1
R3(config)#do ping 12::1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/68/92 ms
R3(config)#
```

IPv6 RIPnG



Masih memakai topologi sebelumnya, hapus dulu ipv6 route. Masukkan konfigurasi RIPnG.

```
R1(config)#ipv6 unicast-routing
R1(config)#int fa0/0
R1(config-if)#ipv6 rip ?
  WORD  User selected string identifying this RIP process

R1(config-if)#ipv6 rip 17 ?
  default-information  Configure handling of default route
  enable               Enable/disable RIP routing
```

```
  metric-offset        Adjust default metric increment
  summary-address      Configure address summarization

R1(config-if)#ipv6 rip 17 enable
```

```
R2(config)#ipv6 unicast-routing
R2(config)#int fa0/0
R2(config-if)#ipv6 rip 17 enable
R2(config-if)#int fa0/1
R2(config-if)#ipv6 rip 17 enable
```

```
R3(config)#ipv6 unicast-routing
R3(config)#int fa0/1
R3(config-if)#ipv6 rip 17 enable
```

Cek tabel routing dan tes ping.

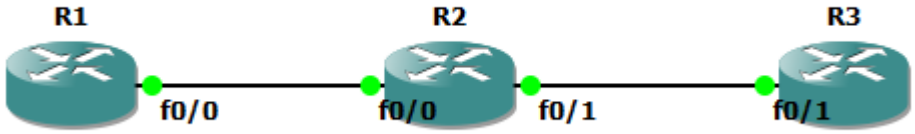
```
R3#sh ipv6 route
IPv6 Routing Table - 4 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route, M - MIPv6
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       D - EIGRP, EX - EIGRP external
R   12::/126 [120/2]
     via FE80::C202:CFF:FED8:1, FastEthernet0/1
C   23::/64 [0/0]
     via ::, FastEthernet0/1
L   23::C203:3FF:FEA8:1/128 [0/0]
     via ::, FastEthernet0/1
L   FF00::/8 [0/0]
     via ::, Null0
R3#ping 12::1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/92/160 ms
R3#
```

Cek protocol yang sedang bekerja.

```
R1#sh ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "static"
IPv6 Routing Protocol is "rip 17"
  Interfaces:
    FastEthernet0/0
  Redistribution:
    None
R1#sh ipv6 rip 17
RIP process "17", port 521, multicast-group FF02::9, pid 238
     Administrative distance is 120. Maximum paths is 16
     Updates every 30 seconds, expire after 180
     Holddown lasts 0 seconds, garbage collect after 120
```

```
    Split horizon is on; poison reverse is off
    Default routes are not generated
    Periodic updates 34, trigger updates 0
  Interfaces:
    FastEthernet0/0
  Redistribution:
    None
R1#
```

IPv6 EIGRP



Hapus dulu RIPnG nya.

```
R1(config)#no ipv6 router rip 17
R2(config)#no ipv6 router rip 17
R3(config)#no ipv6 router rip 17
```

Tambahkan interface loopback sebagai identitas dan agar lebih mudah diping.

```
R1(config-rtr)#int lo0
R1(config-if)#ipv6 address 1::1/128
R2(config-rtr)#int lo0
R2(config-if)#ipv6 address 2::2/128
R3(config-rtr)#int lo0
R3(config-if)#ipv6 address 3::3/128
```

Konfigurasi EIGRP pada ketiga router.

```
R1(config)#ipv6 router eigrp 13
R1(config-rtr)#router-id 1.1.1.1
R1(config-rtr)#no shut
*Mar  1 00:34:24.023: %DUAL-5-NBRCHANGE: IPv6-EIGRP(0) 13: Neighbor
FE80::C202:CFF:FED8:0 (FastEthernet0/0) is up: new adjacency
R2(config-rtr)#int lo0
R2(config-if)#ipv6 eigrp 13
R1(config-rtr)#int fa0/0
R1(config-if)#ipv6 eigrp 13
```

```
R2(config)#ipv6 router eigrp 13
R2(config-rtr)#router-id 2.2.2.2
R2(config-rtr)#no shut
*Mar  1 00:33:55.991: %DUAL-5-NBRCHANGE: IPv6-EIGRP(0) 13: Neighbor
FE80::C203:3FF:FEA8:1 (FastEthernet0/1) is up: new adjacency
*Mar  1 00:34:25.179: %DUAL-5-NBRCHANGE: IPv6-EIGRP(0) 13: Neighbor
FE80::C201:9FF:FED0:0 (FastEthernet0/0) is up: new adjacency
R2(config-rtr)#int lo0
```

```
R2(config-if)#ipv6 eigrp 13
R2(config-rtr)#int fa0/0
R2(config-if)#ipv6 eigrp 13
R2(config-rtr)#int fa0/1
R2(config-if)#ipv6 eigrp 13
```

```
R3(config)#ipv6 router eigrp 13
R3(config-rtr)#router-id 3.3.3.3
R3(config-rtr)#no shut
*Mar  1 00:33:56.287: %DUAL-5-NBRCHANGE: IPv6-EIGRP(0) 13: Neighbor
FE80::C202:CFF:FED8:1 (FastEthernet0/1) is up: new adjacency
R2(config-rtr)#int lo0
R2(config-if)#ipv6 eigrp 13
R3(config-rtr)#int fa0/1
R3(config-if)#ipv6 eigrp 13
```

Cek tabel routing dan tes ping.

```
R1#sh ipv6 route
IPv6 Routing Table - 7 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route, M - MIPv6
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       D - EIGRP, EX - EIGRP external
LC  1::1/128 [0/0]
     via ::, Loopback0
D   2::2/128 [90/409600]
     via FE80::C202:CFF:FED8:0, FastEthernet0/0
D   3::3/128 [90/435200]
     via FE80::C202:CFF:FED8:0, FastEthernet0/0
C   12::/126 [0/0]
     via ::, FastEthernet0/0
L   12::1/128 [0/0]
     via ::, FastEthernet0/0
D   23::/64 [90/307200]
     via FE80::C202:CFF:FED8:0, FastEthernet0/0
L   FF00::/8 [0/0]
     via ::, Null0
R1#ping 2::2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2::2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/44/92 ms
R1#ping 3::3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3::3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/57/92 ms
R1#
```

IPv6 OSPFv3

Hapus dulu EIGRP sebelumnya.

```
R1(config)##no ipv6 router eigrp 13
R2(config)##no ipv6 router eigrp 13
R3(config)##no ipv6 router eigrp 13
```

Sekarang konfigurasi OSPFv3 nya.

```
R1(config)#ipv6 router ospf 1
*Mar  1 00:21:43.595: %OSPFv3-4-NORTRID: OSPFv3 process 2 could not pick a
router-id,
R1(config-rtr)#router-id 1.1.1.1
R1(config-rtr)#int lo0
R1(config-if)#ipv6 ospf 1 area 0
R1(config-if)#int fa0/0
R1(config-if)#ipv6 ospf 1 area 0
```

```
R2(config)#ipv6 router ospf 2
*Mar  1 00:21:43.595: %OSPFv3-4-NORTRID: OSPFv3 process 2 could not pick a
router-id,
please configure manually
R2(config-rtr)#router-id 2.2.2.2
R2(config-rtr)#int lo0
R2(config-if)#ipv6 ospf 2 area 0
R2(config-if)#int fa0/0
R2(config-if)#ipv6 ospf 2 area 0
*Mar  1 00:22:34.395: %OSPFv3-5-ADJCHG: Process 2, Nbr 1.1.1.1 on
FastEthernet0/0 from LOADING to FULL, Loading Done
R2(config-if)#int fa0/1
R2(config-if)#ipv6 ospf 2 area 0
```

```
R3(config)#ipv6 router ospf 3
*Mar  1 00:25:00.603: %OSPFv3-4-NORTRID: OSPFv3 process 3 could not pick a
router-id,
please configure manually
R3(config-rtr)#router-id 3.3.3.3
R3(config-rtr)#int fa0/1
R3(config-if)#ipv6 ospf 3 area 0
*Mar  1 00:25:23.427: %OSPFv3-5-ADJCHG: Process 3, Nbr 2.2.2.2 on
FastEthernet0/1 from LOADING to FULL, Loading Done
R3(config-if)#int lo0
R3(config-if)#ipv6 ospf 3 area 0
```

Cek neighbor.

```
R2#sh ipv6 ospf neighbor

Neighbor ID     Pri   State           Dead Time   Interface ID    Interface
3.3.3.3           1   FULL/BDR        00:00:35    5
FastEthernet0/1
1.1.1.1           1   FULL/DR         00:00:27    4
FastEthernet0/0
R2#
```

Cek tabel routing dan tes ping.

```
R1#sh ipv6 route
IPv6 Routing Table - 7 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route, M - MIPv6
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       D - EIGRP, EX - EIGRP external
LC  1::1/128 [0/0]
     via ::, Loopback0
O   2::2/128 [110/10]
     via FE80::C202:CFF:FED8:0, FastEthernet0/0
O   3::3/128 [110/20]
     via FE80::C202:CFF:FED8:0, FastEthernet0/0
C   12::/126 [0/0]
     via ::, FastEthernet0/0
L   12::1/128 [0/0]
     via ::, FastEthernet0/0
O   23::/64 [110/20]
     via FE80::C202:CFF:FED8:0, FastEthernet0/0
L   FF00::/8 [0/0]
     via ::, Null0
R1#ping 2::2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2::2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/48/80 ms
R1#ping 3::3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3::3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/70/144 ms
R1#
```

IPv6 Tunneling

Tunneling adalah mengencapsulasi suatu packet data ke dalam packet data yang lain. Disini, packet IPv6 di encapsulasi ke dalam packet IPv4.

Static Point-to-Point Tunnel, digunakan untuk tunneling point-to-point dan support IGP pada IPv6. Static Point-to-Point Tunnel dibagi menjadi 2 yaitu:

- Manual Tunnel
- GRE (Generic Routing Encapsulation) Tunnel

Persamaan:

Sama-sama memforward multicast traffic.

Perbedaan:

- Untuk manual tunnel, seperti namanya, membutuhkan konfigurasi secara manual. GRE Tunnel sudah aktif secara default sehingga tidak perlu dikonfigurasi.
- GRE Tunnel mempunyai MTU yang lebih besar dibanding manual tunnel.
- Link-local GRE Tunnel dibuat secara otomatis dengan EUI-64 dan diambil dari MAC Address Interface yang paling rendah. Sedang link-local manual tunnel adalah FE80::/96 + 32 bit tunnel source IPv4.

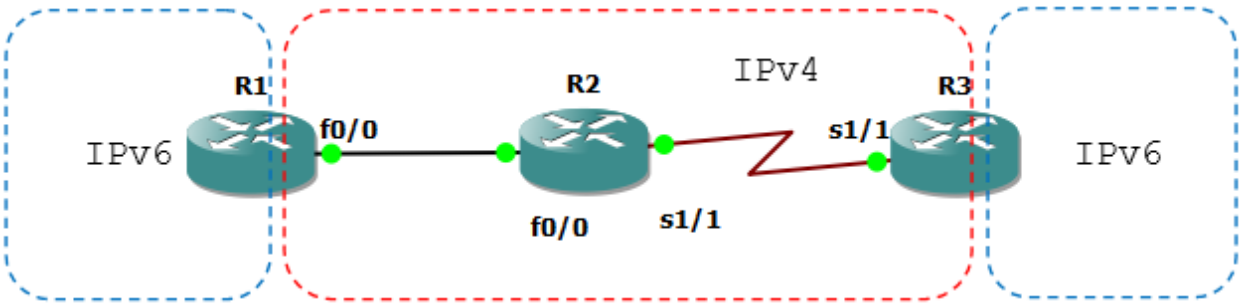
Dynamic Multipoint IPv6 Tunnel, dinamakan dynamic karena tidak perlu dispesifikasikan end-point IPv4 secara manual, atau bisa dikatakan tidak perlu mengeset tunnel destination, digunakan untuk tunneling point to multipoint. Dynamic Multipoint IPv6 Tunnel ini tidak support IGP dan hanya support static routing atau BGP. Dynamic Multipoint IPv6 Tunnel ini dibagi menjadi 3:

- Automatic 6to4
- ISATAP (Intra-site Automatic Tunneling Addressing Protocol)

Automatic 6to4, menggunakan network 2002::/16. Network 2002::/16 memang disediakan khusus untuk tunneling dan bukan untuk global unicast.

ISATAP, hampir sama dengan 6to4, namun tidak menggunakan network 2002::/16 untuk tunneling namun menggunakan global unicast. ISATAP secara otomatis membuat tunnel ID menggunakan EUI-64.

IPv6 IPv6IP Tunneling




```
R1(config)#ipv6 unicast-routing
R1(config)#int lo0
R1(config-if)#ipv6 address 1::1/128
R1(config-if)#int fa0/0
R1(config-if)#ip address 12.12.12.1 255.255.255.0
R1(config-if)#no sh
```

```
R2(config-if)#int fa0/0
R2(config-if)#ip add 12.12.12.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#int s1/1
R2(config-if)#ip add 23.23.23.2 255.255.255.0
R2(config-if)#no sh
```

```
R3(config)#ipv6 unicast-routing
R3(config)#int lo0
R3(config-if)#ipv6 add 3::3/128
R3(config-if)#int se1/1
R3(config-if)#ip add 23.23.23.3 255.255.255.0
R3(config-if)#no sh
```

Sekarang konfigurasi routing IPv4 nya, boleh pake static, EIGRP ato OSPF.

```
R1(config-if)#router ospf 1
R1(config-router)#net 12.12.12.0 0.0.0.255 area 0

R2(config-if)#router ospf 2
R2(config-router)#net 12.12.12.0 0.0.0.255 area 0
R2(config-router)#net 23.23.23.0 0.0.0.255 area 0

R3(config-if)#router ospf 3
R3(config-router)#net 23.23.23.0 0.0.0.255 area 0
```

Cek ping dulu.

```
R1#ping 23.23.23.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 23.23.23.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 84/99/116 ms
R1#sh ip route
```

```
Gateway of last resort is not set

     23.0.0.0/24 is subnetted, 1 subnets
O       23.23.23.0 [110/74] via 12.12.12.2, 00:02:39, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R1#
```

Konfigurasi tunnel IPv6IP.

```
R1(config)#int tun13
*Mar  1 00:21:38.631: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Tunnel13, changed state to down
R1(config-if)#ipv6 address 13::1/64
R1(config-if)#tunnel source 12.12.12.1
R1(config-if)#tunnel destination 23.23.23.3
*Mar  1 00:22:26.331: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Tunnel13, changed state to up
R1(config-if)#tunnel mode ?
  aurp    AURP TunnelTalk AppleTalk encapsulation
  cayman  Cayman TunnelTalk AppleTalk encapsulation
  dvmrp   DVMRP multicast tunnel
  eon     EON compatible CLNS tunnel
  gre     generic route encapsulation protocol
  ipip    IP over IP encapsulation
  ipsec   IPSec tunnel encapsulation
  iptalk  Apple IPTalk encapsulation
  ipv6    Generic packet tunneling in IPv6
  ipv6ip  IPv6 over IP encapsulation
  mpls    MPLS encapsulations
  nos     IP over IP encapsulation (KA9Q/NOS compatible)
  rbscp   RBSCP in IP tunnel

R1(config-if)#tunnel mode ipv6ip
```

```
R3(config)#int tun31
R3(config-if)#ipv6 add 13::3/64
R3(config-if)#tunnel source 23.23.23.3
R3(config-if)#tunnel destination 12.12.12.1
R3(config-if)#tunnel mode ipv6ip
```

```
R1#sh ipv6 int br
FastEthernet0/0            [up/up]
FastEthernet0/1            [administratively down/down]
Serial1/0                  [administratively down/down]
Serial1/1                  [administratively down/down]
Serial1/2                  [administratively down/down]
Serial1/3                  [administratively down/down]
Loopback0                  [up/up]
    FE80::C201:11FF:FE04:0
    1::1
Tunnel13                   [up/up]
    FE80::C0C:C01
```

```
    13::1
R1#sh ipv6 int tun13
Tunnel13 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::C0C:C01
  No Virtual link-local address(es):
  Global unicast address(es):
    13::1, subnet is 13::/64
  Joined group address(es):
    FF02::1
    FF02::2
    FF02::1:FF00:1
    FF02::1:FF0C:C01
  MTU is 1480 bytes
  ICMP error messages limited to one every 100 milliseconds
  ICMP redirects are enabled
  ICMP unreachables are sent
  ND DAD is enabled, number of DAD attempts: 1
  ND reachable time is 30000 milliseconds
  Hosts use stateless autoconfig for addresses.
R1#sh int tun13
Tunnel13 is up, line protocol is up
  Hardware is Tunnel
  MTU 1514 bytes, BW 9 Kbit, DLY 500000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation TUNNEL, loopback not set
  Keepalive not set
  Tunnel source 12.12.12.1, destination 23.23.23.3
  Tunnel protocol/transport IPv6/IP
  Tunnel TTL 255
  Fast tunneling enabled
  Tunnel transmit bandwidth 8000 (kbps)
  Tunnel receive bandwidth 8000 (kbps)
  Last input 00:02:22, output 00:07:11, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/0 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     9 packets input, 1008 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     23 packets output, 2152 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
R1#
```

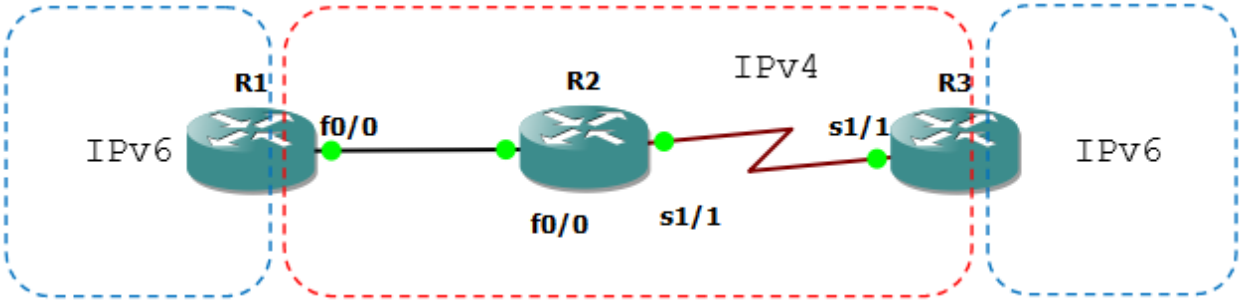
Sekarang tes ping.

```
R1#ping 3::3
```

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3::3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 92/157/240 ms
R1#sh ipv6 ro
R1#sh ipv6 route
IPv6 Routing Table - 5 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route, M - MIPv6
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       D - EIGRP, EX - EIGRP external
LC  1::1/128 [0/0]
     via ::, Loopback0
S   3::3/128 [1/0]
     via 13::3
C   13::/64 [0/0]
     via ::, Tunnel13
L   13::1/128 [0/0]
     via ::, Tunnel13
L   FF00::/8 [0/0]
     via ::, Null0
R1#
```

IPv6 GRE IP Tunneling

Dari lab sebelumnya tinggal merubah tunnel mode atau cukup menghapus tunnel mode sebelumnya karena GRE IP Tunneling secara default aktif.



Lakukan konfigurasi berikut.

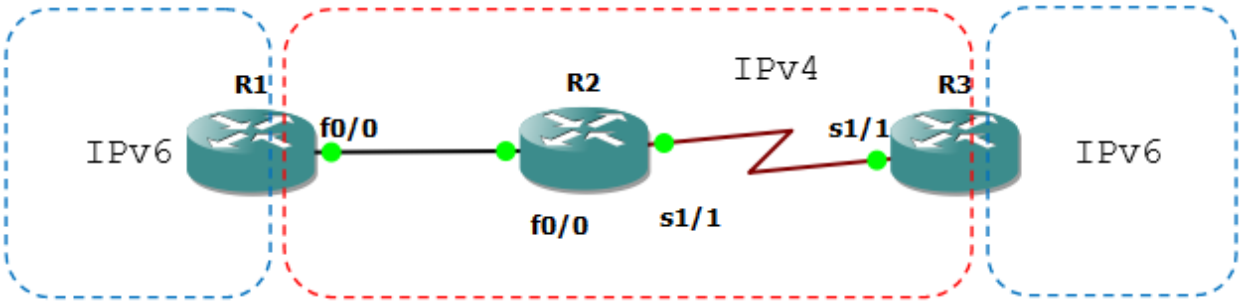
```
R1(config)#int tunnel 13
R1(config-if)#tunnel mode ipv6i
R1(config-if)#no tunnel mode ipv6ip

R3(config)#int tunnel 31
R3(config-if)#tunnel mode gre ip
```

Cek interfacenya.

```
R3#show int tunnel31
Tunnel31 is up, line protocol is up
```

```
  Hardware is Tunnel
  MTU 1514 bytes, BW 9 Kbit, DLY 500000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation TUNNEL, loopback not set
  Keepalive not set
  Tunnel source 23.23.23.3, destination 12.12.12.1
  Tunnel protocol/transport GRE/IP
    Key disabled, sequencing disabled
    Checksumming of packets disabled
  Tunnel TTL 255
  Fast tunneling enabled
  Tunnel transmit bandwidth 8000 (kbps)
  Tunnel receive bandwidth 8000 (kbps)
  Last input 00:03:54, output 00:03:54, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/0 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     29 packets input, 3296 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     38 packets output, 3988 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
R3#

Tes ping.
R3#ping 1::1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 76/116/152 ms
R3#
```

IPv6 Tunnel 6to4



Masih menggunakan topologi sebelumnya. Hapus dulu interface tunnel dan ipv6 routenya.

```
R1(config)#no int tun13
R1(config)#do sh run | s i ipv6 route
ipv6 route 3::3/128 13::3
R1(config)#no ipv6 route 3::3/128 13::3

R3(config)#no int tun31
R3(config)#do sh run | s i ipv6 route
ipv6 route 1::1/128 13::1
R3(config)#no ipv6 route 1::1/128 13::1
```

Konfigurasi 6to4 tunnel.

```
R1(config)#int tunnel 103
R1(config-if)#ipv6 address 2002:0C0C:0C01::1/64
R1(config-if)#tunnel source 12.12.12.1
R1(config-if)#tunnel mode ipv6ip ?
  6to4         IPv6 automatic tunnelling using 6to4
  auto-tunnel  IPv6 automatic tunnelling using IPv4 compatible addresses
  isatap       IPv6 automatic tunnelling using ISATAP
  <cr>

R1(config-if)#tunnel mode ipv6ip 6to4

R3(config)#int tunnel 301
 Tunnel301, changed state to down
R3(config-if)#tunnel source 23.23.23.3
R3(config-if)#ipv6 address 2002:1717:1703::3/64
R3(config-if)#tunnel mode ipv6ip 6to4
```

Pengecekan.

```
R3(config-if)#do ping 2002:0C0C:0C01::1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:C0C:C01::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 120/147/196 ms
R3(config-if)#

R1(config-if)#do ping 2002:1717:1703::3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:1717:1703::3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 124/139/168 ms
R1(config-if)#

R1#sh int tun 103
Tunnel103 is up, line protocol is up
  Hardware is Tunnel
  MTU 1514 bytes, BW 9 Kbit, DLY 500000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation TUNNEL, loopback not set
  Keepalive not set
  Tunnel source 12.12.12.1, destination UNKNOWN
  Tunnel protocol/transport IPv6 6to4
  Tunnel TTL 255
  Fast tunneling enabled
```

```
  Tunnel transmit bandwidth 8000 (kbps)
  Tunnel receive bandwidth 8000 (kbps)
  Last input never, output 00:01:41, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/0 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     6 packets output, 576 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

Hitungan IP tunnelnya sebagai berikut:

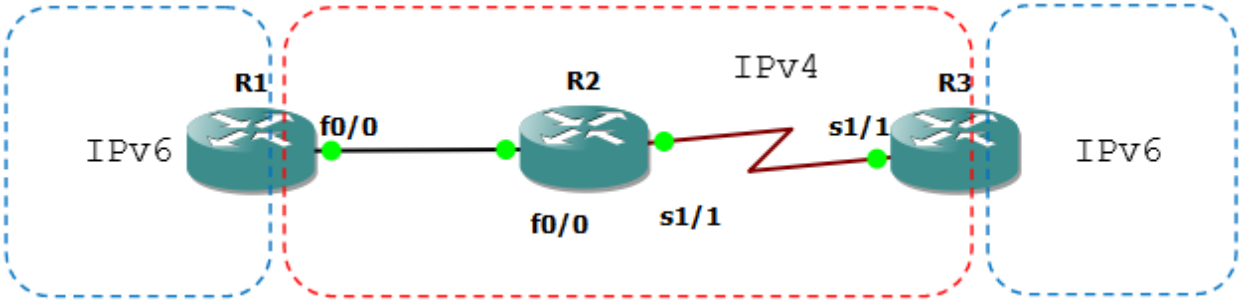
12.12.12.1 -> 01100.01100.01100.0001 -> **0C0C:0C01** -> 2002:**0C0C:0C01**::1

23.23.23.3 -> 10111.10111.10111.0011 -> **1717:1703** -> 2002:**1717:1703**::3

IP tunnel 6to4 menggunakan network 2002:/64. Untuk lebih mudahnya, perhitungan diatas dapat menggunakan calculator pada os windows dengan mode programmer.

IPv6 Tunnel ISATAP

Masih memakai topologi sebelumnya. Hapus dulu interface tunnel dan ipv6 routenya.




```
R1(config)#no int tun103
R3(config)#no int tun301
```

Konfigurasi tunnel ISATAP.

```
R1(config)#int tun 1003
R1(config-if)#ipv6 address 13::/64 eui-64
*Mar  1 00:52:50.127: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Tunnel1003, changed state to down
R1(config-if)#tunnel source 12.12.12.1
R1(config-if)#tunnel mode ipv6ip isatap
```

```
R3(config)#int tun 3001
*Mar  1 00:54:17.359: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Tunnel3001, changed state to down
R3(config-if)#tunnel source 23.23.23.3
R3(config-if)#ipv6 add 13::/64 eui-64
R3(config-if)#tunnel mode ipv6ip isatap
```

Tes ping.

```
R1(config-if)#do sh ipv6 int br
FastEthernet0/0            [up/up]
FastEthernet0/1            [administratively down/down]
Serial1/0                  [administratively down/down]
Serial1/1                  [administratively down/down]
Serial1/2                  [administratively down/down]
Serial1/3                  [administratively down/down]
Loopback0                  [up/up]
    FE80::C201:11FF:FE04:0
    1::1
Tunnel1003                 [up/up]
    FE80::5EFE:C0C:C01
    13::5EFE:C0C:C01
R1(config-if)#

R3(config-if)#do ping

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 13::5EFE:C0C:C01, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 92/124/152 ms
R3(config-if)#
```

Masukkan routing static.

```
R1(config)#ipv6 route 3::3/128 13::5EFE:1717:1703
R3(config)#ipv6 route 1::1/128 13::5EFE:C0C:C01
```

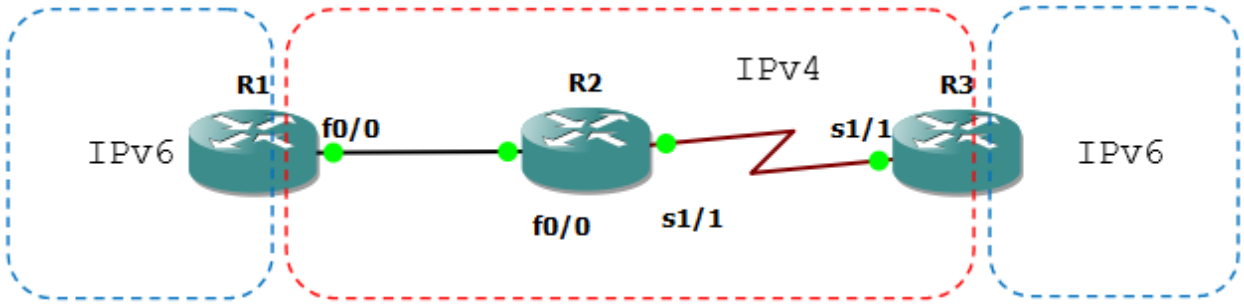
Pengecekan.

```
R1(config)#do ping 3::3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3::3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 96/117/136 ms
R1(config)#

R3(config)#do ping 1::1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 92/132/168 ms
R3(config)#

R1(config)#do sh int tun1003
Tunnel1003 is up, line protocol is up
  Hardware is Tunnel
  MTU 1514 bytes, BW 9 Kbit, DLY 500000 usec,
```

```
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation TUNNEL, loopback not set
  Keepalive not set
  Tunnel source 12.12.12.1, destination UNKNOWN
  Tunnel protocol/transport IPv6 ISATAP
  Tunnel TTL 255
  Fast tunneling enabled
  Tunnel transmit bandwidth 8000 (kbps)
  Tunnel receive bandwidth 8000 (kbps)
  Last input 00:00:53, output 00:00:53, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/0 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     15 packets input, 2100 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     19 packets output, 2184 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

IPv6 Tunnel Auto-Tunnel

Masih memakai topologi sebelumnya. Hapus dulu interface tunnel dan ipv6 routenya.




```
R1(config)#no int tun1003
R3(config)#no int tun3001
```

Konfigurasi tunnel autotunnel.

```
R1(config)#int tun10003
*Mar  1 00:03:09.163: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Tunnel10003, changed state to down
R1(config-if)#tunnel source 12.12.12.1
R1(config-if)#tunnel mode ipv6ip auto-tunnel

R3(config)#int tun30001
```

```
*Mar  1 00:04:15.243: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Tunnel30001, changed state to down
R3(config-if)#tunnel source 23.23.23.3
R3(config-if)#tunnel mode ipv6ip au
R3(config-if)#tunnel mode ipv6ip auto-tunnel
```

Ping tunnelnya.

```
R3(config-if)#do ping ::12.12.12.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to ::12.12.12.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 104/136/184 ms
R3(config-if)#do sh int tun30001
Tunnel30001 is up, line protocol is up
  Hardware is Tunnel
  MTU 1514 bytes, BW 9 Kbit, DLY 500000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation TUNNEL, loopback not set
  Keepalive not set
  Tunnel source 23.23.23.3, destination UNKNOWN
  Tunnel protocol/transport IPv6 auto-tunnel
  Tunnel TTL 255
  Fast tunneling enabled
  Tunnel transmit bandwidth 8000 (kbps)
  Tunnel receive bandwidth 8000 (kbps)
  Last input 00:00:47, output 00:00:47, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/0 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     5 packets input, 700 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     9 packets output, 984 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
R3(config-if)#
```

Konfigurasi static routing.

```
R1(config)#ipv6 route 3::3/128 ::23.23.23.3
R3(config)#ipv6 route 1::1/128 ::12.12.12.1
```

Pengecekan.

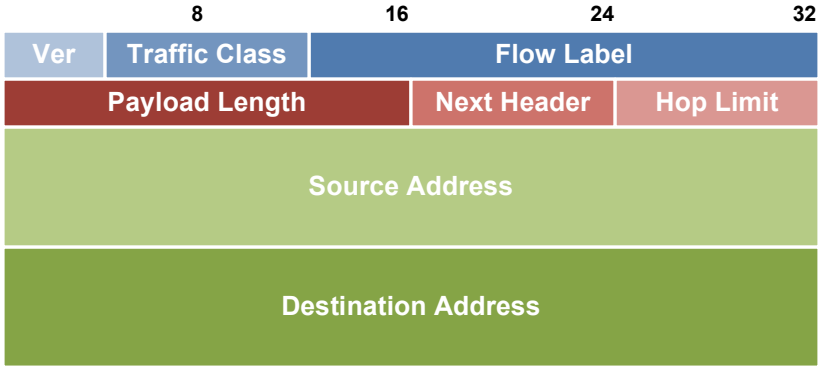
```
R1(config)#do ping 3::3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3::3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 120/136/168 ms
R1(config)#

R3(config)#do ping 1::1
```

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 84/131/156 ms
R3(config)#
```

IPv6

packetlife.net

Protocol Header



Version (4 bits) · Always set to 6

Traffic Class (8 bits) · A DSCP value for QoS

Flow Label (20 bits) · Identifies unique flows (optional)

Payload Length (16 bits) · Length of the payload in bytes

Next Header (8 bits) · Header or protocol which follows

Hop Limit (8 bits) · Similar to IPv4's time to live field

Source Address (128 bits) · Source IP address

Destination Address (128 bits) · Destination IP address

Address Types

Unicast · One-to-one communication

Multicast · One-to-many communication

Anycast · An address configured in multiple locations

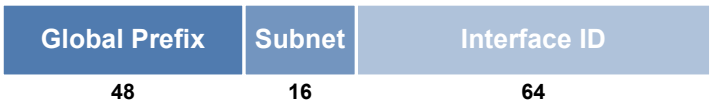
Address Notation

· Eliminate leading zeros from all two-byte sets

· Replace up to one string of consecutive zeros with a double-colon (::)

Address Formats

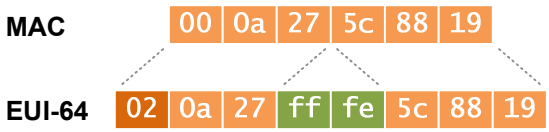
Global unicast



Link-local unicast

Multicast

EUI-64 Formation



· Insert 0xfffe between the two halves of the MAC

· Flip the seventh bit (universal/local flag) to 1

Multicast Scopes

1 Interface-local	**5** Site-local
2 Link-local	**8** Org-local
4 Admin-local	**E** Global

Special-Use Ranges

::/0	Default route
::/128	Unspecified
::1/128	Loopback
::/96	IPv4-compatible*
::FFFF:0:0/96	IPv4-mapped
2001::/32	Teredo
2001:DB8::/32	Documentation
2002::/16	6to4
FC00::/7	Unique local
FE80::/10	Link-local unicast
FEC0::/10	Site-local unicast*
FF00::/8	Multicast

* Deprecated

Extension Headers

Hop-by-hop Options (0)
Carries additional information which must be examined by every router in the path

Routing (43)
Provides source routing functionality

Fragment (44)
Included when a packet has been fragmented by its source

Encapsulating Security Payload (50)
Provides payload encryption (IPsec)

Authentication Header (51)
Provides packet authentication (IPsec)

Destination Options (60)
Carries additional information which pertains only to the recipient

Transition Mechanisms

Dual Stack
Transporting IPv4 and IPv6 across an infrastructure simultaneously

Tunneling
IPv6 traffic is encapsulated into IPv4 using IPv6-in-IP, UDP (Teredo), or Intra-Site Automatic Tunnel Addressing Protocol (ISATAP)

Translation
Stateless IP/ICMP Translation (SIIT) translates IP header fields, NAT Protocol Translation (NAT-PT) maps between IPv6 and IPv4 addresses

EIGRP

EIGRP Basic Configuration
EIGRP Filtering - Distribute List
EIGRP Filtering - Prefix List
EIGRP Filtering - Access List
EIGRP Filtering - Administrative Distance
EIGRP Authentication
EIGRP Summarization
EIGRP Unicast Update
EIGRP Default Route – Summary Address
EIGRP Redistribution - RIP
EIGRP Redistribution - OSPF
EIGRP Path Selection - Delay
EIGRP Path Selection - Bandwidth
EIGRP Equal Load Balancing
EIGRP Unequal Load Balancing
EIGRP Stub – Connected + Summary
EIGRP Stub – Connected
EIGRP Stub – Summary
EIGRP Stub – Static
EIGRP Stub – Redistributed
EIGRP Stub – Receive Only

(EIGRP)
Enhanced Interiot Gateway Protocol

EIGRP merupakan distance vector protocol dan cisco proprietary. Menggunakan algoritma DUAL (Diffusing Update Algorithm).

- Advanced distance vector/hybrid routing protocol
- Multicast or unicast for exchange information use port 88
- Administrative distance 90
- Classless routing protocol support VLSM/CIDR.
- Support IPv6
- Rich metric (bandwidth, delay, load and reliability)
- Very fast convergence
- Equal and Unequal Load balancing
- 100% loop-free

Dinamakan advanced distance vector atau hybrid routing protocol karena EIGRP tidak seperti RIP yang:

- No neighbor discovery
- Periodic updates
- Vulnerable to loops
- Simple metric (hop count)

Cisco menambahkan fitur-fitur dari link state pada EIGRP sehingga dapat mengatasi masalah-masalah RIP. Pada router yang menjalankan EIGRP akan mempunyai 3 database(tabel):

EIGRP neighbor table

- List semua directly connected neighbor
- Next-hop router
- Interface

EIGRP topology table

- List semua route yang dipelajari dari semua EIGRP neighbor
- Destination
- Metric

Routing table

- Best route dari EIGRP topology table

Successor and Feasible Successor

- Successor = best path to destination
- Feasible Successor = backup link to destination

EIGRP Packets

Hello Packet

- Untuk discover dan recovery neighbor serta membentuk adjency.
- Jika penerima membalas dengan hello packet maka terjadi adjency. Jika penerima tidak mengirim hello packet dalam X waktu (hold time), maka adjency akan didrop.
- Setelah adjency terbentuk, akan melakukan exchange routing information yang akan disimpan di topology table. Best path dari topology table akan disave di routing table.
- Reliable

Update Packet

- Berisi informasi routing
- Dapat dikirim secara unicast atau multicast
- Reliable

Query Packet

- Dikirim jika suatu router EIGRP kehilangan informasi tentang suatu network, maka query akan dikirim ke neighbor untuk mendapat informasi tentang neighbor yang hilang tadi.

Reply Packet

- Response dari query packet

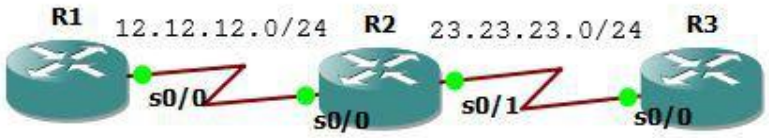
ACK Packet

- Dikirim sebagai pemberitahuan bahwa telah menerima update packet.
- Dikirim secara unicast.

No Auto-Summary

Digunakan untuk menyertakan subnetmask dalam advertise network.

EIGRP Basic Configuration



Ketikkan konfigurasi interface berikut. Pastikan dapat ping antar interface yang directly connect.

```
R1
 interface Loopback0
 ip address 1.1.1.1 255.255.255.255
!
 interface Serial0/0
 ip address 12.12.12.1 255.255.255.0
!

R2
 interface Loopback0
 ip address 2.2.2.2 255.255.255.255
!
 interface Serial0/0
 ip address 12.12.12.2 255.255.255.0
!
 interface Serial0/1
 ip address 23.23.23.2 255.255.255.0
!

R3
 interface Loopback0
 ip address 3.3.3.3 255.255.255.255
!
 interface Serial0/0
 ip address 23.23.23.3 255.255.255.0
!
```

Konfigurasi EIGRP. Advertise network ke dalam routing EIGRP. Autonomous Number (AS Number) harus sama pada setiap router.

```
R1
 router eigrp 10
 network 1.1.1.1 0.0.0.0
 network 12.12.12.1 0.0.0.0
 no auto-summary

R2
 router eigrp 10
 network 2.2.2.2 0.0.0.0
 network 12.12.12.2 0.0.0.0
 network 23.23.23.2 0.0.0.0
 no auto-summary

R3
 router eigrp 10
```

```
 network 3.3.3.3 0.0.0.0
 network 23.23.23.3 0.0.0.0
 no auto-summary
```

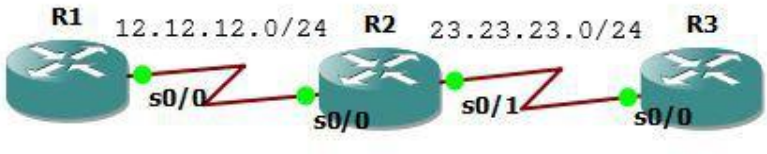
Cek routing tabel dan tes ping.

```
R1#show ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/2297856] via 12.12.12.2, 00:06:56, Serial0/0
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3 [90/2809856] via 12.12.12.2, 00:06:56, Serial0/0
     23.0.0.0/24 is subnetted, 1 subnets
D       23.23.23.0 [90/2681856] via 12.12.12.2, 00:06:56, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
R1#ping 2.2.2.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/75/128 ms
R1#ping 3.3.3.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/88/116 ms
```

EIGRP Filtering – Distribute List

Diguanakn untuk memfilter network berdasarkan route network yang masuk dan keluar interface. Pada topologi dibawah, tujuannya agar ip loopback 2.2.2.2 tidak ada dalam routing tabel R1.

Cara pertama: filter network menggunakan access list pada R1 dengan distribute IN.



Masih menggunakan lab sebelumnya.

```
access-list 10 deny 2.2.2.2
access-list 10 permit any
router eigrp 10
```

```
distribute-list 10 in Serial0/0
```

Cek ip route.

```
R1#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3 [90/2809856] via 12.12.12.2, 00:00:39, Serial0/0
     23.0.0.0/24 is subnetted, 1 subnets
D       23.23.23.0 [90/2681856] via 12.12.12.2, 00:00:39, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
R1#
```

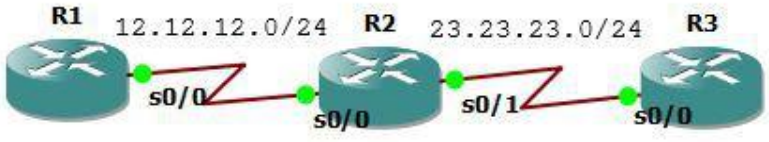
Cara kedua: filter network menggunakan access list pada R2 dengan distribute OUT. Pastikan ip loopback 2.2.2.2 ada lagi dalam tabel routing R1 lalu pada R2 ketik perintah dibawah.

```
router eigrp 10
access-list 10 deny   2.2.2.2
access-list 10 permit any
distribute-list 10 out Serial0/0
```

Cek routing tabel pastikan ip loopback 2.2.2.2 tidak ada.

EIGRP Filtering - Prefix List

Memfilter network berdasarkan prefix. Ketika dimasukkan prefix list IN pada R2, maka network R3 yang dideny oleh R2 tidak akan diadvertise ke R1.



Masih menggunakan lab sebelumnya. Tujuannya agar network pada R3 dengan prefix 24 sampai 28 diblok, selain itu ditampilkan.

```
R1
interface Loopback0
 ip address 1.1.1.1 255.255.255.255
!
interface Serial0/0
 ip address 12.12.12.1 255.255.255.0
!
router eigrp 10
 network 0.0.0.0
 no auto-summary
```

```
!

R2
interface Loopback0
 ip address 2.2.2.2 255.255.255.255
!
interface Serial0/0
 ip address 12.12.12.2 255.255.255.0
!
interface Serial0/1
 ip address 23.23.23.2 255.255.255.0
!
router eigrp 10
 network 0.0.0.0
 no auto-summary
!

R3
interface Loopback0
 ip address 3.3.3.3 255.255.255.255
!
interface Serial0/0
 ip address 23.23.23.3 255.255.255.0
!
router eigrp 10
 network 0.0.0.0
 no auto-summary
!
```

Pada R1, buat ip loopback yang bervariatif untuk difilter.

```
interface Loopback1
 ip address 3.3.3.17 255.255.255.240
!
interface Loopback2
 ip address 3.3.3.33 255.255.255.248
!
interface Loopback3
 ip address 3.3.3.150 255.255.255.252
!
interface Loopback4
 ip address 3.3.3.200 255.255.255.240
!
interface Loopback5
 ip address 3.3.3.100 255.255.255.224
!
```

Cek tabel routing R1.

```
R1#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/2297856] via 12.12.12.2, 00:04:45, Serial0/0
     3.0.0.0/8 is variably subnetted, 6 subnets, 5 masks
```

```
D       3.3.3.3/32 [90/2809856] via 12.12.12.2, 00:04:44, Serial0/0
D       3.3.3.16/28 [90/2809856] via 12.12.12.2, 00:00:02, Serial0/0
D       3.3.3.32/29 [90/2809856] via 12.12.12.2, 00:04:44, Serial0/0
D       3.3.3.96/27 [90/2809856] via 12.12.12.2, 00:00:05, Serial0/0
D       3.3.3.148/30 [90/2809856] via 12.12.12.2, 00:04:46, Serial0/0
D       3.3.3.192/28 [90/2809856] via 12.12.12.2, 00:00:05, Serial0/0
     23.0.0.0/24 is subnetted, 1 subnets
D       23.23.23.0 [90/2681856] via 12.12.12.2, 00:04:47, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
R1#
```

Konfigurasi prefix list filtering pada R2 dan cek tabel routing. Route dengan prefix antara 24 sampai 28 sudah tidak ada.

```
R2(config-router)#ip prefix-list EIGRP_IN seq 5 deny 3.3.3.0/24 le 28
R2(config)#ip prefix-list EIGRP_IN seq 10 permit 0.0.0.0/0 le 32
R2(config)#router eigrp 10
R2(config-router)#distribute-list prefix EIGRP_IN in
R2(config-router)#
*Mar  1 00:07:32.647: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 10: Neighbor 12.12.12.1
(Serial0/0) is resync: route configuration changed
*Mar  1 00:07:32.647: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 10: Neighbor 23.23.23.3
(Serial0/1) is resync: route configuration changed

R2#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D       1.1.1.1 [90/2297856] via 12.12.12.1, 00:10:55, Serial0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     3.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
D       3.3.3.3/32 [90/2297856] via 23.23.23.3, 00:02:51, Serial0/1
D       3.3.3.32/29 [90/2297856] via 23.23.23.3, 00:02:51, Serial0/1
D       3.3.3.148/30 [90/2297856] via 23.23.23.3, 00:02:51, Serial0/1
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial0/1
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
R2#
```

Begitu juga pada R1.

```
R1#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/2297856] via 12.12.12.2, 00:11:45, Serial0/0
     3.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
D       3.3.3.3/32 [90/2809856] via 12.12.12.2, 00:03:22, Serial0/0
D       3.3.3.32/29 [90/2809856] via 12.12.12.2, 00:03:22, Serial0/0
D       3.3.3.148/30 [90/2809856] via 12.12.12.2, 00:03:22, Serial0/0
     23.0.0.0/24 is subnetted, 1 subnets
```

```
D       23.23.23.0 [90/2681856] via 12.12.12.2, 00:11:47, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
R1#
```

Masih menggunakan lab sebelumnya. Tujuannya agar network pada R3 dengan prefix 24 sampai 28 diblok, selain itu ditampilkan.

Jika sebelumnya memakai prefix IN, sekarang menggunakan OUT. Tujuannya agar network pada R3 dengan prefix 28 sampai 30 diblok, selain itu ditampilkan. Hapus konfigurasi prefix list IN sebelumnya.

```
R2(config)#router eigrp 10
R2(config-router)#no distribute-list prefix EIGRP_IN in
```

Pastikan semua network muncul pada tabel routing.

```
R1#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/2297856] via 12.12.12.2, 00:04:45, Serial0/0
     3.0.0.0/8 is variably subnetted, 6 subnets, 5 masks
D       3.3.3.3/32 [90/2809856] via 12.12.12.2, 00:04:44, Serial0/0
D       3.3.3.16/28 [90/2809856] via 12.12.12.2, 00:00:02, Serial0/0
D       3.3.3.32/29 [90/2809856] via 12.12.12.2, 00:04:44, Serial0/0
D       3.3.3.96/27 [90/2809856] via 12.12.12.2, 00:00:05, Serial0/0
D       3.3.3.148/30 [90/2809856] via 12.12.12.2, 00:04:46, Serial0/0
D       3.3.3.192/28 [90/2809856] via 12.12.12.2, 00:00:05, Serial0/0
     23.0.0.0/24 is subnetted, 1 subnets
D       23.23.23.0 [90/2681856] via 12.12.12.2, 00:04:47, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
R1#
```

Konfigurasi prefix list filtering OUT pada R2.

```
R2(config-router)# ip prefix-list EIGRP_OUT seq 5 deny 3.3.3.0/24 ge 28 le
30
R2(config)# ip prefix-list EIGRP_OUT seq 10 permit 0.0.0.0/0 ge 24
R2(config)#router eigrp 10
R2(config-router)#distribute-list prefix EIGRP_OUT out
```

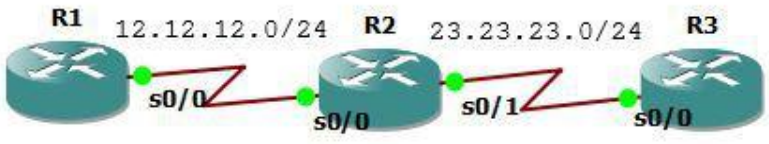
Cek tabel routing pada R1 dan R2.

```
R2#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D       1.1.1.1 [90/2297856] via 12.12.12.1, 00:10:55, Serial0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
```

```
     3.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
D       3.3.3.3/32 [90/2297856] via 23.23.23.3, 00:02:51, Serial0/1
D       3.3.3.32/29 [90/2297856] via 23.23.23.3, 00:02:51, Serial0/1
D       3.3.3.148/30 [90/2297856] via 23.23.23.3, 00:02:51, Serial0/1
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial0/1
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
R2#

R1#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/2297856] via 12.12.12.2, 00:03:29, Serial0/0
     3.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D       3.3.3.3/32 [90/2809856] via 12.12.12.2, 00:03:28, Serial0/0
D       3.3.3.96/27 [90/2809856] via 12.12.12.2, 00:03:28, Serial0/0
     23.0.0.0/24 is subnetted, 1 subnets
D       23.23.23.0 [90/2681856] via 12.12.12.2, 00:03:29, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
R1#


R2#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D       1.1.1.1 [90/2297856] via 12.12.12.1, 00:03:15, Serial0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     3.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D       3.3.3.3/32 [90/2297856] via 23.23.23.3, 00:03:15, Serial0/1
D       3.3.3.96/27 [90/2297856] via 23.23.23.3, 00:03:15, Serial0/1
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial0/1
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
R2#
```

EIGRP Filtering – Access List

Access list juga dapat digunakan untuk filtering. Tujuan lab kali ini adalah memfilter route yang genap dan ganjil pada tabel routing.



Buat ip loopback ganjil dan genap lalu advertise ke EIGRP.

```
R1(config)#interface Loopback1
R1(config-if)# ip address 11.11.11.1 255.255.255.255
R1(config-if)#!
R1(config-if)#interface Loopback2
R1(config-if)# ip address 11.11.11.2 255.255.255.255
R1(config-if)#!
R1(config-if)#interface Loopback3
R1(config-if)# ip address 11.11.11.3 255.255.255.255
R1(config-if)#!
R1(config-if)#interface Loopback4
R1(config-if)# ip address 11.11.11.4 255.255.255.255
R1(config-if)#!
R1(config-if)#interface Loopback5
R1(config-if)# ip address 11.11.11.5 255.255.255.255
R1(config-if)#!
R1(config-if)#interface Loopback6
R1(config-if)# ip address 11.11.11.6 255.255.255.255
R1(config-if)#!
R1(config-if)#interface Loopback7
R1(config-if)# ip address 11.11.11.7 255.255.255.255
R1(config-if)#!
R1(config-if)#interface Loopback8
R1(config-if)# ip address 11.11.11.8 255.255.255.255
R1(config-if)#!

***Advertise ke EIGRP***
R1(config)#router eigrp 10
R1(config-router)# network 11.11.11.1 0.0.0.0
R1(config-router)# network 11.11.11.2 0.0.0.0
R1(config-router)# network 11.11.11.3 0.0.0.0
R1(config-router)# network 11.11.11.4 0.0.0.0
R1(config-router)# network 11.11.11.5 0.0.0.0
R1(config-router)# network 11.11.11.6 0.0.0.0
R1(config-router)# network 11.11.11.7 0.0.0.0
R1(config-router)# network 11.11.11.8 0.0.0.0

***Cek tabel routing***
R3(config)#do sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D       1.1.1.1 [90/2809856] via 23.23.23.2, 00:05:40, Serial0/0
```

```
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/2297856] via 23.23.23.2, 00:00:03, Serial0/0
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial0/0
     11.0.0.0/32 is subnetted, 8 subnets
D       11.11.11.8 [90/2809856] via 23.23.23.2, 00:00:03, Serial0/0
D       11.11.11.3 [90/2809856] via 23.23.23.2, 00:03:29, Serial0/0
D       11.11.11.2 [90/2809856] via 23.23.23.2, 00:00:04, Serial0/0
D       11.11.11.1 [90/2809856] via 23.23.23.2, 00:03:29, Serial0/0
D       11.11.11.7 [90/2809856] via 23.23.23.2, 00:03:29, Serial0/0
D       11.11.11.6 [90/2809856] via 23.23.23.2, 00:00:06, Serial0/0
D       11.11.11.5 [90/2809856] via 23.23.23.2, 00:03:30, Serial0/0
D       11.11.11.4 [90/2809856] via 23.23.23.2, 00:00:06, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
D       12.12.12.0 [90/2681856] via 23.23.23.2, 00:00:06, Serial0/0
R3(config)#
```

Filter route yang ganjil aja.

```
R3(config)#access-list 10 permit 0.0.0.1 255.255.255.254
R3(config)#router  eigrp 10
R3(config-router)#distribute-list 10 in s0/0

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D       1.1.1.1 [90/2809856] via 23.23.23.2, 00:07:25, Serial0/0
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial0/0
     11.0.0.0/32 is subnetted, 4 subnets
D       11.11.11.3 [90/2809856] via 23.23.23.2, 00:05:12, Serial0/0
D       11.11.11.1 [90/2809856] via 23.23.23.2, 00:05:13, Serial0/0
D       11.11.11.7 [90/2809856] via 23.23.23.2, 00:05:14, Serial0/0
D       11.11.11.5 [90/2809856] via 23.23.23.2, 00:05:14, Serial0/0
R3(config)#
```

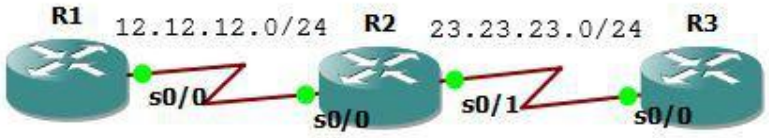
Filter route yang genap aja.

```
R3(config)#access-list 10 permit 0.0.0.0 255.255.255.254
R3(config)#router  eigrp 10
R3(config-router)#distribute-list 10 in s0/0
R3(config)#
*Mar  1 00:14:41.751: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 10: Neighbor 23.23.23.2
(Serial0/0) is resync: route configuration changed

R3(config)#do sh ip route

Gateway of last resort is not set

     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/2297856] via 23.23.23.2, 00:02:26, Serial0/0
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
```

```
C       23.23.23.0 is directly connected, Serial0/0
     11.0.0.0/32 is subnetted, 4 subnets
D       11.11.11.8 [90/2809856] via 23.23.23.2, 00:02:26, Serial0/0
D       11.11.11.2 [90/2809856] via 23.23.23.2, 00:02:26, Serial0/0
D       11.11.11.6 [90/2809856] via 23.23.23.2, 00:02:28, Serial0/0
D       11.11.11.4 [90/2809856] via 23.23.23.2, 00:02:28, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
D       12.12.12.0 [90/2681856] via 23.23.23.2, 00:02:28, Serial0/0
R3(config)#
```

EIGRP Filtering – Administrative Distance

Untuk memfilter route dengan mengeset Administrative Distance (AD) menjadi 255. Maka route tidak akan masuk tabel routing.



Buat interface loopback dan advertise ke nertwork.

```
R3(config)#int lo1
R3(config-if)#ip add 33.33.33.33 255.255.255.255

R3(config-if)#router eigrp 10
R3(config-router)#network 33.33.33.33 0.0.0.0
```

Pastikan sudah ter-advertise.

```
R2#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D       1.1.1.1 [90/2297856] via 12.12.12.1, 00:04:36, Serial0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     33.0.0.0/32 is subnetted, 1 subnets
D       33.33.33.33 [90/2297856] via 23.23.23.3, 00:00:12, Serial0/1
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3 [90/2297856] via 23.23.23.3, 00:00:12, Serial0/1
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial0/1
```

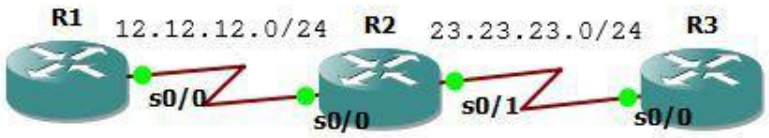
```
     11.0.0.0/32 is subnetted, 8 subnets
D       11.11.11.8 [90/2297856] via 12.12.12.1, 00:02:56, Serial0/0
D       11.11.11.3 [90/2297856] via 12.12.12.1, 00:02:56, Serial0/0
D       11.11.11.2 [90/2297856] via 12.12.12.1, 00:02:58, Serial0/0
D       11.11.11.1 [90/2297856] via 12.12.12.1, 00:02:58, Serial0/0
D       11.11.11.7 [90/2297856] via 12.12.12.1, 00:02:57, Serial0/0
D       11.11.11.6 [90/2297856] via 12.12.12.1, 00:02:58, Serial0/0
D       11.11.11.5 [90/2297856] via 12.12.12.1, 00:02:58, Serial0/0
D       11.11.11.4 [90/2297856] via 12.12.12.1, 00:02:58, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
R2#ping 3.3.3.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/82/96 ms
R2#
```

Dengan mengeset distance 255 pada network 33.33.33.33 di R2, maka network 33.33.33.33 tidak akan muncul pada tabel routing R2. Ketika dicek, network 33.33.33.33 sudah tidak ada.

```
R2(config)#access-list 33 permit 33.33.33.33
R2(config)#router eigrp 10
R2(config-router)#distance 255 0.0.0.0 255.255.255.255 33

R2(config-router)#do sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D       1.1.1.1 [90/2297856] via 12.12.12.1, 00:00:13, Serial0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3 [90/2297856] via 23.23.23.3, 00:00:13, Serial0/1
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial0/1
     11.0.0.0/32 is subnetted, 8 subnets
D       11.11.11.8 [90/2297856] via 12.12.12.1, 00:00:13, Serial0/0
D       11.11.11.3 [90/2297856] via 12.12.12.1, 00:00:15, Serial0/0
D       11.11.11.2 [90/2297856] via 12.12.12.1, 00:00:15, Serial0/0
D       11.11.11.1 [90/2297856] via 12.12.12.1, 00:00:15, Serial0/0
D       11.11.11.7 [90/2297856] via 12.12.12.1, 00:00:18, Serial0/0
D       11.11.11.6 [90/2297856] via 12.12.12.1, 00:00:18, Serial0/0
D       11.11.11.5 [90/2297856] via 12.12.12.1, 00:00:18, Serial0/0
D       11.11.11.4 [90/2297856] via 12.12.12.1, 00:00:18, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
R2(config-router)#do ping 33.33.33.33

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 33.33.33.33, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
R2(config-router)#
```

EIGRP Authentication

Untuk memberikan authentikasi pada EIGRP dengan mengeset password, Authentication akan mencegah router untuk menerima update packet dari sembarang router EIGRP.



Set authentication pada R1 dan R2.

```
R1(config)#key chain EIGRP
R1(config-keychain)#key 1
R1(config-keychain-key)#key-string CISCO
R1(config-keychain-key)#int s0/0
R1(config-if)#ip authentication mode eigrp 10 md5
R1(config-if)#ip authentication key-chain eigrp 10 EIGRP
*Mar  1 00:00:31.507: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 10: Neighbor 12.12.12.2
(Serial0/0) is down: authentication mode changed
```

```
R2(config)#key chain EIGRP
R2(config-keychain)#key 1
R2(config-keychain-key)#key-string CISCO
R2(config-keychain-key)#int s0/0
R2(config-if)#ip authentication mode eigrp 10 md5
R2(config-if)#ip authentication key-chain eigrp 10 EIGRP
R2(config-if)#
*Mar  1 00:00:31.911: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 10: Neighbor 12.12.12.1
(Serial0/0) is down: authentication mode changed
```

Lakukan debug untuk pengecekan.

```
R1#debug eigrp packets
EIGRP Packets debugging is on
    (UPDATE, REQUEST, QUERY, REPLY, HELLO, IPXSAP, PROBE, ACK, STUB,
SIAQUERY, SIAREPLY)
R1#
*Mar  1 00:01:15.211: EIGRP: received packet with MD5 authentication, key id
= 1
*Mar  1 00:01:15.215: EIGRP: Received HELLO on Serial0/0 nbr 12.12.12.2
*Mar  1 00:01:15.215:   AS 10, Flags 0x0, Seq 0/0 idbQ 0/0 iidbQ un/rely 0/0
peerQ un/rely 0/0
R1#
*Mar  1 00:01:18.395: EIGRP: Sending HELLO on Serial0/0
*Mar  1 00:01:18.395:   AS 10, Flags 0x0, Seq 0/0 idbQ 0/0 iidbQ un/rely 0/0
*Mar  1 00:01:18.419: EIGRP: Sending HELLO on Loopback0
*Mar  1 00:01:18.419:   AS 10, Flags 0x0, Seq 0/0 idbQ 0/0 iidbQ un/rely 0/0
*Mar  1 00:01:18.423: EIGRP: Received HELLO on Loopback0 nbr 1.1.1.1
*Mar  1 00:01:18.423:   AS 10, Flags 0x0, Seq 0/0 idbQ 0/0
*Mar  1 00:01:18.427: EIGRP: Packet from ourselves ignored
R1#
*Mar  1 00:01:27.315: EIGRP: Sending HELLO on Serial0/0
```

```
*Mar  1 00:01:27.315:   AS 10, Flags 0x0, Seq 0/0 idbQ 0/0 iidbQ un/rely 0/0
*Mar  1 00:01:27.655: EIGRP: Sending HELLO on Loopback0
*Mar  1 00:01:27.655:   AS 10, Flags 0x0, Seq 0/0 idbQ 0/0 iidbQ un/rely 0/0
*Mar  1 00:01:27.659: EIGRP: Received HELLO on Loopback0 nbr 1.1.1.1
*Mar  1 00:01:27.663:   AS 10, Flags 0x0, Seq 0/0 idbQ 0/0
```

Matikan debug EIGRP.

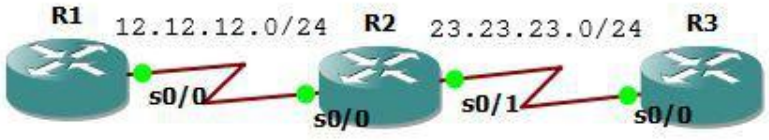
```
R1#undebug eigrp packets
EIGRP Packets debugging is off
```

Cek adjency EIGRP.

```
R1#sh ip eigrp neighbors
IP-EIGRP neighbors for process 10
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
0   12.12.12.2              Se0/0             11 00:02:43   27   200  0  8
R1#
```

EIGRP Summarization

Summarization digunakan untuk meringkas beberapa route menjadi satu route. Fungsinya untuk mengurangi size dari routing table dan mengurangi update routing.



Buat interface loopback pada R2 untuk diadvertise ke EIGRP.

```
R2(config)#interface Loopback1
R2(config-if)# ip address 22.22.22.1 255.255.255.255
R2(config-if)#!
R2(config-if)#interface Loopback2
R2(config-if)# ip address 22.22.22.2 255.255.255.255
R2(config-if)#!
R2(config-if)#interface Loopback3
R2(config-if)# ip address 22.22.22.3 255.255.255.255
R2(config-if)#!
R2(config-if)#interface Loopback4
R2(config-if)# ip address 22.22.22.4 255.255.255.255
R2(config-if)#!
R2(config-if)#interface Loopback5
R2(config-if)# ip address 22.22.22.5 255.255.255.255
R2(config-if)#!
R2(config-if)#interface Loopback6
R2(config-if)# ip address 22.22.22.6 255.255.255.255
R2(config-if)#!
R2(config-if)#interface Loopback7
R2(config-if)# ip address 22.22.22.7 255.255.255.255
```

```
R2(config-if)#!
R2(config-if)#interface Loopback8
R2(config-if)# ip address 22.22.22.8 255.255.255.255
R2(config-if)#!

R2(config-if)#router eigrp 10
R2(config-router)# network 22.22.22.1 0.0.0.0
R2(config-router)# network 22.22.22.2 0.0.0.0
R2(config-router)# network 22.22.22.3 0.0.0.0
R2(config-router)# network 22.22.22.4 0.0.0.0
R2(config-router)# network 22.22.22.5 0.0.0.0
R2(config-router)# network 22.22.22.6 0.0.0.0
R2(config-router)# network 22.22.22.7 0.0.0.0
R2(config-router)# network 22.22.22.8 0.0.0.0
```

Cek di R1 dan R3.

```
R3#show ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D       1.1.1.1 [90/2809856] via 23.23.23.2, 00:07:53, Serial0/0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/2297856] via 23.23.23.2, 00:07:53, Serial0/0
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial0/0
     22.0.0.0/32 is subnetted, 8 subnets
D       22.22.22.6 [90/2297856] via 23.23.23.2, 00:00:28, Serial0/0
D       22.22.22.7 [90/2297856] via 23.23.23.2, 00:00:31, Serial0/0
D       22.22.22.4 [90/2297856] via 23.23.23.2, 00:00:31, Serial0/0
D       22.22.22.5 [90/2297856] via 23.23.23.2, 00:00:31, Serial0/0
D       22.22.22.2 [90/2297856] via 23.23.23.2, 00:00:32, Serial0/0
D       22.22.22.3 [90/2297856] via 23.23.23.2, 00:00:32, Serial0/0
D       22.22.22.1 [90/2297856] via 23.23.23.2, 00:00:32, Serial0/0
D       22.22.22.8 [90/2297856] via 23.23.23.2, 00:00:31, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
D       12.12.12.0 [90/2681856] via 23.23.23.2, 00:07:57, Serial0/0
R3#
```

Konfigurasi summarization di interface s0/1 pada R2.

```
R2(config-router)# int s0/1
R2(config-if)#ip summary-address eigrp 10 22.22.22.0 255.255.255.248
R2(config-if)#
*Mar  1 00:13:09.727: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 10: Neighbor 23.23.23.3
(Serial0/1) is resync: summary configured
```

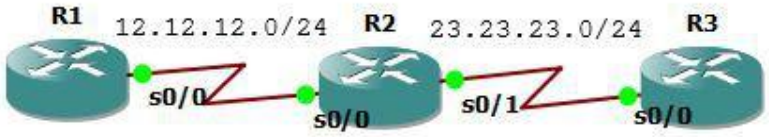
Cek di R3.

```
R3#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D       1.1.1.1 [90/2809856] via 23.23.23.2, 00:13:36, Serial0/0
     2.0.0.0/32 is subnetted, 1 subnets
```

```
D       2.2.2.2 [90/2297856] via 23.23.23.2, 00:13:36, Serial0/0
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial0/0
     22.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D       22.22.22.0/29 [90/2297856] via 23.23.23.2, 00:00:38, Serial0/0
D       22.22.22.8/32 [90/2297856] via 23.23.23.2, 00:06:13, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
D       12.12.12.0 [90/2681856] via 23.23.23.2, 00:13:39, Serial0/0
R3#ping 22.22.22.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 22.22.22.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/96/152 ms
R3#ping 22.22.22.8

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 22.22.22.8, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/52/92 ms
R3#
```

EIGRP Unicast Update

Secara default EIGRP melakukan update melalui ip multicast 224.0.0.10, unicast update mengganti update dari multicast ke unicast neighbornya.



Cek bahwa EIGRP mengirim update secara multicast. IP multicast adalah 244.0.0.10

```
R1#debug ip packet detail
IP packet debugging is on (detailed)
R1#
*Mar  1 00:00:57.331: IP: s=12.12.12.2 (Serial0/0), d=224.0.0.10, len 60,
rcvd 2, proto=88
*Mar  1 00:00:58.079: IP: s=1.1.1.1 (local), d=224.0.0.10 (Loopback0), len
60, sending broad/multicast, proto=88
*Mar  1 00:00:58.083: IP: s=1.1.1.1 (Loopback0), d=224.0.0.10, len 60, rcvd
2, proto=88
R1#
*Mar  1 00:01:00.271: IP: s=12.12.12.1 (local), d=224.0.0.10 (Serial0/0),
len 60, sending broad/multicast, proto=88
R1#
```

```
*Mar  1 00:01:03.019: IP: s=1.1.1.1 (local), d=224.0.0.10 (Loopback0), len
60, sending broad/multicast, proto=88
*Mar  1 00:01:03.023: IP: s=1.1.1.1 (Loopback0), d=224.0.0.10, len 60, rcvd
2, proto=88
R1#undebug ip packet detail
IP packet debugging is off (detailed)
```

Konfigurasi link R1 ke R2 menjadi unicast.

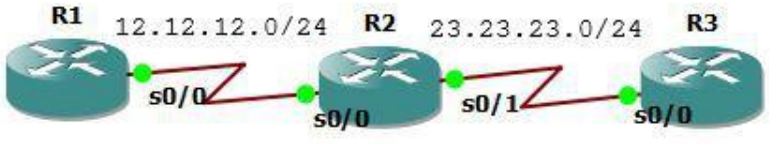
```
R1(config)#router eigrp 10
R1(config-router)#neighbor 12.12.12.2 s0/0
R1(config-router)#
*Mar  1 00:09:36.483: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 10: Neighbor 12.12.12.2
(Serial0/0) is down: Static peer configured
R1(config-router)#

R2(config)#router eigrp 10
R2(config-router)#neighbor 12.12.12.1 s0/0
```

Cek debug lagi harusnya sudah ganti unicast.

```
R1#debug ip packet detail
IP packet debugging is on (detailed)
R1#
*Mar  1 00:15:51.467: IP: tableid=0, s=12.12.12.2 (Serial0/0), d=12.12.12.1
(Serial0/0), routed via RIB
*Mar  1 00:15:51.471: IP: s=12.12.12.2 (Serial0/0), d=12.12.12.1
(Serial0/0), len 60, rcvd 3, proto=88
R1#
R1#undebug ip packet detail
IP packet debugging is off (detailed)
R1#
```

EIGRP Default Route – Summary Address

Agar setiap router tidak perlu membuat konfigurasi default route satu persatu secara manual.




```
R1(config)#int s0/0
R1(config-if)#ip sum
R1(config-if)#ip summary-address eig
R1(config-if)#ip summary-address eigrp 10 0.0.0.0 0.0.0.0
R1(config-if)#
*Mar  1 00:01:20.419: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 10: Neighbor 12.12.12.2
(Serial0/0) is resync: summary configured
```

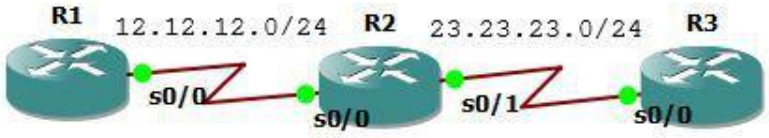
Cek di R1.

```
R1(config-if)#do sh ip route

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/2297856] via 12.12.12.2, 00:01:15, Serial0/0
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3 [90/2809856] via 12.12.12.2, 00:01:14, Serial0/0
     23.0.0.0/24 is subnetted, 1 subnets
D       23.23.23.0 [90/2681856] via 12.12.12.2, 00:01:15, Serial0/0
     22.0.0.0/32 is subnetted, 8 subnets
D       22.22.22.6 [90/2297856] via 12.12.12.2, 00:01:17, Serial0/0
D       22.22.22.7 [90/2297856] via 12.12.12.2, 00:01:17, Serial0/0
D       22.22.22.4 [90/2297856] via 12.12.12.2, 00:01:17, Serial0/0
D       22.22.22.5 [90/2297856] via 12.12.12.2, 00:01:17, Serial0/0
D       22.22.22.2 [90/2297856] via 12.12.12.2, 00:01:18, Serial0/0
D       22.22.22.3 [90/2297856] via 12.12.12.2, 00:01:18, Serial0/0
D       22.22.22.1 [90/2297856] via 12.12.12.2, 00:01:18, Serial0/0
D       22.22.22.8 [90/2297856] via 12.12.12.2, 00:01:18, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
D*    0.0.0.0/0 is a summary, 00:00:17, Null0
```

Pada default route aka nada Null0. Null0 berfungsi mendrop packet yang tidak ditemukan tujuannya karena default route.

EIGRP Redistribution – RIP

Untuk meredistribute RIP ke dalam EIGRP.



Buat interface loopback di R1 dan advertise ke dalam RIP.

```
R1(config-if)#int lo1
R1(config-if)#ip add 111.111.111.111 255.255.255.255

R1(config-if)#router rip
R1(config-router)#version 2
R1(config-router)#network 111.111.111.0
R1(config-router)#no auto-summary
```

Redistribute RIP ke EIGRP.

```
R2(config)#ipv6 unicast-routing
R2(config)#int fa0/0
R2(config-if)#ipv6 rip 17 enable
```

```
R2(config-if)#int fa0/1
R2(config-if)#ipv6 rip 17 enable
```

Redistribute RIP ke EIGRP.

```
R1(config)#router eigrp 10
R1(config-router)#redistribute rip metric 1 1 1 1 1
```

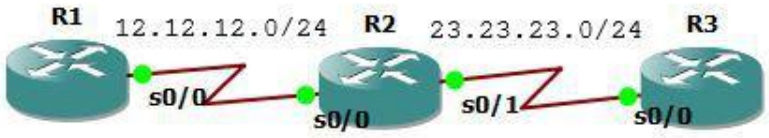
Cek tabel routing dan tes ping.

```
R1#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/2297856] via 12.12.12.2, 00:25:20, Serial0/0
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3 [90/2809856] via 12.12.12.2, 00:25:20, Serial0/0
     23.0.0.0/24 is subnetted, 1 subnets
D       23.23.23.0 [90/2681856] via 12.12.12.2, 00:25:20, Serial0/0
     111.0.0.0/32 is subnetted, 1 subnets
C       111.111.111.111 is directly connected, Loopback1
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
R1#

R3#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D       1.1.1.1 [90/2809856] via 23.23.23.2, 00:13:37, Serial0/0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/2297856] via 23.23.23.2, 00:13:38, Serial0/0
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial0/0
     111.0.0.0/32 is subnetted, 1 subnets
D EX    111.111.111.111 [170/2561024256] via 23.23.23.2, 00:00:06, Serial0/0
     12.0.0.0/24 is subnetted, 1 subnets
D       12.12.12.0 [90/2681856] via 23.23.23.2, 00:13:40, Serial0/0
R3#ping 111.111.111.111

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 111.111.111.111, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/98/248 ms
R3#
```

Tanda EX menunjukkan bahwa route dihasilkan dengan proses redistribute.

EIGRP Redistribution – OSPF

Untuk meredistribute OSPF ke dalam EIGRP.



Buat interface loopback di R2 dan advertise ke dalam OSPF.

```
R2(config)#int lo1
R2(config-if)#ip add 22
R2(config-if)#ip add 222.222.222.222 255.255.255.255

R2(config-if)#router ospf 11
R2(config-router)#net 222.222.222.222 0.0.0.0 area 0
```

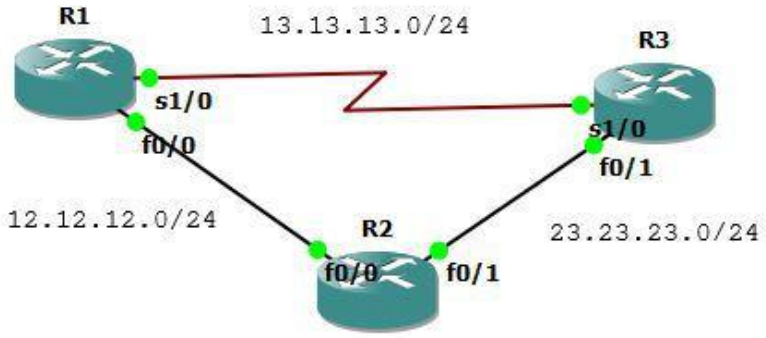
Redistribute OSPF ke EIGRP.

```
R2(config)#router eigrp 10
R2(config-router)#redistribute ospf 11 metric 1 1 1 1 1
```

Cek tabel routing dan tes ping.

```
R1#sh ip route

Gateway of last resort is not set

     222.222.222.0/32 is subnetted, 1 subnets
D EX    222.222.222.222 [170/2560512256] via 12.12.12.2, 00:00:52, Serial0/0
     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/2297856] via 12.12.12.2, 00:05:14, Serial0/0
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3 [90/2809856] via 12.12.12.2, 00:05:14, Serial0/0
     23.0.0.0/24 is subnetted, 1 subnets
D       23.23.23.0 [90/2681856] via 12.12.12.2, 00:05:17, Serial0/0
     111.0.0.0/32 is subnetted, 1 subnets
C       111.111.111.111 is directly connected, Loopback1
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, Serial0/0
R1#ping 222.222.222.222

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 222.222.222.222, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/64/92 ms
R1#
```

EIGRP Path Selection – Delay



Buatlah toplogi seperti diatas dan lakukan konfigurasi interface dan EIGRP.

```
R1(config)#int lo0
R1(config-if)#ip add 1.1.1.1 255.255.255.255
R1(config-if)#int s1/0
R1(config-if)#ip add 13.13.13.1 255.255.255.0
R1(config-if)#no sh
R1(config-if)#int f0/0
R1(config-if)#ip add 12.12.12.1 255.255.255.0
R1(config-if)#no sh
R1(config-if)#router eigrp 13
R1(config-router)#net 1.1.1.1 0.0.0.0
R1(config-router)#net 13.13.13.1 0.0.0.0
R1(config-router)#net 12.12.12.1 0.0.0.0
R1(config-router)#no au

R2(config)#int lo0
R2(config-if)#ip add 2.2.2.2 255.255.255.255
R2(config-if)#int f0/0
R2(config-if)#ip add 12.12.12.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#int fa0/1
R2(config-if)#ip add 23.23.23.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#router eigrp 13
R2(config-router)#net 2.2.2.2 0.0.0.0
R2(config-router)#net 12.12.12.2 0.0.0.0
R2(config-router)#net 23.23.23.2 0.0.0.0
R2(config-router)#no au

R3(config)#int lo0
R3(config-if)#ip add 3.3.3.3 255.255.255.255
R3(config-if)#int s1/0
R3(config-if)#ip add 13.13.13.3 255.255.255.0
R3(config-if)#no sh
R3(config-if)#int f0/1
R3(config-if)#ip add 23.23.23.3 255.255.255.0
R3(config-if)#router eigrp 13
R3(config-router)#net 3.3.3.3 0.0.0.0
R3(config-router)#net 13.13.13.3 0.0.0.0
R3(config-router)#net 23.23.23.3 0.0.0.0
```

```
R3(config-router)#no au
```

```
R2(config)#ipv6 router eigrp 13
R2(config-rtr)#router-id 2.2.2.2
R2(config-rtr)#no shut
*Mar  1 00:33:55.991: %DUAL-5-NBRCHANGE: IPv6-EIGRP(0) 13: Neighbor
FE80::C203:3FF:FEA8:1 (FastEthernet0/1) is up: new adjacency
*Mar  1 00:34:25.179: %DUAL-5-NBRCHANGE: IPv6-EIGRP(0) 13: Neighbor
FE80::C201:9FF:FED0:0 (FastEthernet0/0) is up: new adjacency
R2(config-rtr)#int lo0
R2(config-if)#ipv6 eigrp 13
R2(config-rtr)#int fa0/0
R2(config-if)#ipv6 eigrp 13
R2(config-rtr)#int fa0/1
R2(config-if)#ipv6 eigrp 13
```

Mengetahui route yang digunakan ke 3.3.3.3.

```
R1#sh ip route 3.3.3.3
Routing entry for 3.3.3.3/32
  Known via "eigrp 13", distance 90, metric 435200, type internal
  Redistributing via eigrp 13
  Last update from 12.12.12.2 on FastEthernet0/0, 00:04:36 ago
  Routing Descriptor Blocks:
  * 12.12.12.2, from 12.12.12.2, 00:04:36 ago, via FastEthernet0/0
      Route metric is 435200, traffic share count is 1
      Total delay is 7000 microseconds, minimum bandwidth is 10000 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 2
```

Mengetahui semua route yang digunakan ke 3.3.3.3 dengan EIGRP.

```
R1#sh ip eigrp top 3.3.3.3 255.255.255.255
IP-EIGRP (AS 13): Topology entry for 3.3.3.3/32
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is 435200
  Routing Descriptor Blocks:
  12.12.12.2 (FastEthernet0/0), from 12.12.12.2, Send flag is 0x0
      Composite metric is (435200/409600), Route is Internal
      Vector metric:
        Minimum bandwidth is 10000 Kbit
        Total delay is 7000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
  13.13.13.3 (Serial1/0), from 13.13.13.3, Send flag is 0x0
      Composite metric is (2297856/128256), Route is Internal
      Vector metric:
        Minimum bandwidth is 1544 Kbit
        Total delay is 25000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
```

Ternyata EIGRP lebih memilih FastEthernet daripada Serial. Hal ini dikarenakan bandwidth FastEthernet lebih besar. Untuk menjadikan Serial menjadi link utama dapat dilakukan dengan mengubah delay.

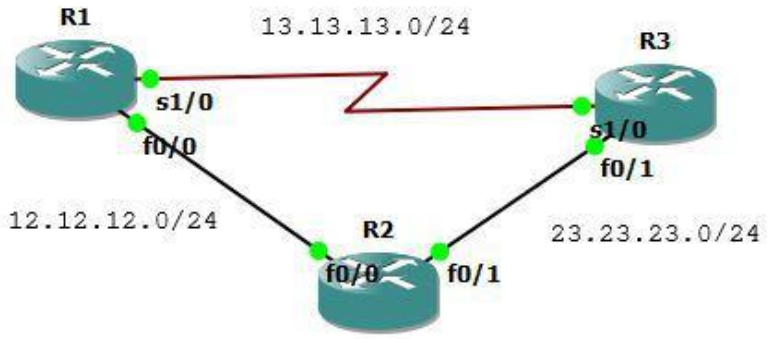
```
R1(config)#int fa0/0
R1(config-if)#delay 100000
R1(config-if)#do clear ip eigrp neighbor

*Mar  1 00:22:45.311: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 13: Neighbor 13.13.13.3
(Serial1/0) is down: manually cleared
*Mar  1 00:22:45.327: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 13: Neighbor 12.12.12.2
(FastEthernet0/0) is down: manually cleared
*Mar  1 00:22:45.863: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 13: Neighbor 12.12.12.2
(FastEthernet0/0) is up: new adjacency
*Mar  1 00:22:46.551: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 13: Neighbor 13.13.13.3
(Serial1/0) is up: new adjacency
*Mar  1 00:23:01.507: %SYS-5-CONFIG_I: Configured from console by console
```

Sekarang cek lagi dan jalur sudah berpindah melalui Serial1/0.

```
R1#sh ip eigrp top 3.3.3.3 255.255.255.255
IP-EIGRP (AS 13): Topology entry for 3.3.3.3/32
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is 2297856
  Routing Descriptor Blocks:
  13.13.13.3 (Serial1/0), from 13.13.13.3, Send flag is 0x0
      Composite metric is (2297856/128256), Route is Internal
      Vector metric:
        Minimum bandwidth is 1544 Kbit
        Total delay is 25000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
  12.12.12.2 (FastEthernet0/0), from 12.12.12.2, Send flag is 0x0
      Composite metric is (26009600/409600), Route is Internal
      Vector metric:
        Minimum bandwidth is 10000 Kbit
        Total delay is 1006000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
R1#sh ip route 3.3.3.3
Routing entry for 3.3.3.3/32
  Known via "eigrp 13", distance 90, metric 2297856, type internal
  Redistributing via eigrp 13
  Last update from 13.13.13.3 on Serial1/0, 00:00:43 ago
  Routing Descriptor Blocks:
  * 13.13.13.3, from 13.13.13.3, 00:00:43 ago, via Serial1/0
      Route metric is 2297856, traffic share count is 1
      Total delay is 25000 microseconds, minimum bandwidth is 1544 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 1

R1#traceroute 3.3.3.3

Type escape sequence to abort.
```

```
Tracing the route to 3.3.3.3

  1 13.13.13.3 140 msec 4 msec 68 msec
R1#traceroute 2.2.2.2

Type escape sequence to abort.
Tracing the route to 2.2.2.2

  1 13.13.13.3 172 msec 72 msec 72 msec
  2 23.23.23.2 140 msec 144 msec 72 msec
R1#
```

EIGRP Path Selection – Bandwidth



Selain menggunakan delay, dapat juga menggunakan bandwidth.

Hapus dulu konfigurasi delay sebelumnya sehingga route berubah seperti semula.

```
R1(config)#int f0/0
R1(config-if)#no delay 100000
R1(config-if)#do sh ip eigrp top 3.3.3.3 255.255.255.255
IP-EIGRP (AS 13): Topology entry for 3.3.3.3/32
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is 435200
  Routing Descriptor Blocks:
  12.12.12.2 (FastEthernet0/0), from 12.12.12.2, Send flag is 0x0
      Composite metric is (435200/409600), Route is Internal
      Vector metric:
        Minimum bandwidth is 10000 Kbit
        Total delay is 7000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
  13.13.13.3 (Serial1/0), from 13.13.13.3, Send flag is 0x0
      Composite metric is (2297856/128256), Route is Internal
      Vector metric:
        Minimum bandwidth is 1544 Kbit
        Total delay is 25000 microseconds
        Reliability is 255/255
        Load is 1/255
```

```
        Minimum MTU is 1500
        Hop count is 1
```

Ubah bandwidth.

```
R1(config-if)#bandwidth 1000
R1(config-if)#do clear ip eigrp neighbor
```

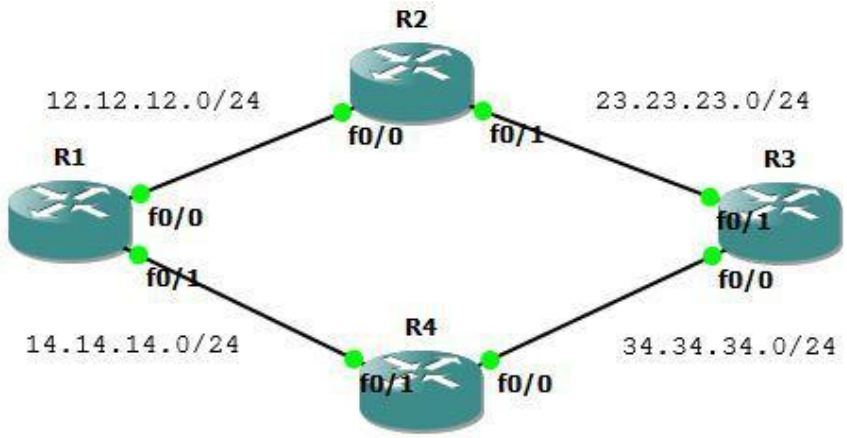
Sekarang cek lagi.

```
R1(config-if)#do sh ip eigrp top 3.3.3.3 255.255.255.255
IP-EIGRP (AS 13): Topology entry for 3.3.3.3/32
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is 2297856
  Routing Descriptor Blocks:
  13.13.13.3 (Serial1/0), from 13.13.13.3, Send flag is 0x0
      Composite metric is (2297856/128256), Route is Internal
      Vector metric:
        Minimum bandwidth is 1544 Kbit
        Total delay is 25000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
  12.12.12.2 (FastEthernet0/0), from 12.12.12.2, Send flag is 0x0
      Composite metric is (2739200/409600), Route is Internal
      Vector metric:
        Minimum bandwidth is 1000 Kbit
        Total delay is 7000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
R1(config-if)#

R1#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/2323456] via 13.13.13.3, 00:00:27, Serial1/0
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3 [90/2297856] via 13.13.13.3, 00:00:27, Serial1/0
     23.0.0.0/24 is subnetted, 1 subnets
D       23.23.23.0 [90/2195456] via 13.13.13.3, 00:00:27, Serial1/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
     13.0.0.0/24 is subnetted, 1 subnets
C       13.13.13.0 is directly connected, Serial1/0
R1#traceroute 3.3.3.3

Type escape sequence to abort.
Tracing the route to 3.3.3.3

  1 13.13.13.3 152 msec 140 msec 72 msec
R1#traceroute 2.2.2.2
```

```
Type escape sequence to abort.
Tracing the route to 2.2.2.2

  1 13.13.13.3 184 msec 44 msec 16 msec
  2 23.23.23.2 140 msec 96 msec 36 msec
```

EIGRP Equal Load Balancing

Secara default EIGRP akan menerapkan load balancing pada link yang equal. Pada topologi dibawah dari R1 menuju R3 dapat menggunakan 2 jalur dan semuanya FastEthernet.



Buat topologi diatas dan lakukan konfigurasi berikut.

```
R1(config)#int lo0
R1(config-if)#ip add 1.1.1.1 255.255.255.255
R1(config-if)#int f0/0
R1(config-if)#ip add 12.12.12.1 255.255.255.0
R1(config-if)#no sh
R1(config-if)#int fa0/1
R1(config-if)#ip add 14.14.14.1 255.255.255.0
R1(config-if)#no sh
R1(config-if)#router eigrp 16
R1(config-router)#net 0.0.0.0
R1(config-router)#no au

R2(config)#int lo0
R2(config-if)#ip add 2.2.2.2 255.255.255.255
R2(config-if)#int fa0/0
R2(config-if)#ip add 12.12.12.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#int f0/1
R2(config-if)#ip add 23.23.23.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#router eigrp 16
R2(config-router)#net 0.0.0.0
R2(config-router)#no au
```

```
R3(config)#int lo0
R3(config-if)#ip add 3.3.3.3 255.255.255.255
R3(config-if)#int f0/1
R3(config-if)#ip add 23.23.23.3 255.255.255.0
R3(config-if)#no sh
R3(config-if)#int fa0/0
R3(config-if)#ip add 34.34.34.3 255.255.255.0
R3(config-if)#no sh
R3(config-if)#router eigrp 16
R3(config-router)#net 0.0.0.0
R3(config-router)#no au


R4(config)#int lo0
R4(config-if)#ip add 4.4.4.4 255.255.255.255
R4(config-if)#int f0/1
R4(config-if)#ip add 14.14.14.4 255.255.255.0
R4(config-if)#no sh
R4(config-if)#int fa0/0
R4(config-if)#ip add 34.34.34.4 255.255.255.0
R4(config-if)#no sh
R4(config-if)#router eigrp 16
R4(config-router)#net 0.0.0.0
R4(config-router)#no au
```

Cek routing tabel dan route menuju 3.3.3.3 dari R1.

```
R1#sh ip route

Gateway of last resort is not set

     34.0.0.0/24 is subnetted, 1 subnets
D       34.34.34.0 [90/307200] via 14.14.14.4, 00:01:13, FastEthernet0/1
     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/409600] via 12.12.12.2, 00:01:17, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3 [90/435200] via 14.14.14.4, 00:01:16, FastEthernet0/1
                [90/435200] via 12.12.12.2, 00:01:16, FastEthernet0/0
     4.0.0.0/32 is subnetted, 1 subnets
D       4.4.4.4 [90/409600] via 14.14.14.4, 00:01:15, FastEthernet0/1
     23.0.0.0/24 is subnetted, 1 subnets
D       23.23.23.0 [90/307200] via 12.12.12.2, 00:01:18, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
     14.0.0.0/24 is subnetted, 1 subnets
C       14.14.14.0 is directly connected, FastEthernet0/1
R1#sh ip route 3.3.3.3
Routing entry for 3.3.3.3/32
  Known via "eigrp 16", distance 90, metric 435200, type internal
  Redistributing via eigrp 16
  Last update from 12.12.12.2 on FastEthernet0/0, 00:01:42 ago
  Routing Descriptor Blocks:
  * 14.14.14.4, from 14.14.14.4, 00:01:42 ago, via FastEthernet0/1
      Route metric is 435200, traffic share count is 1
      Total delay is 7000 microseconds, minimum bandwidth is 10000 Kbit
```

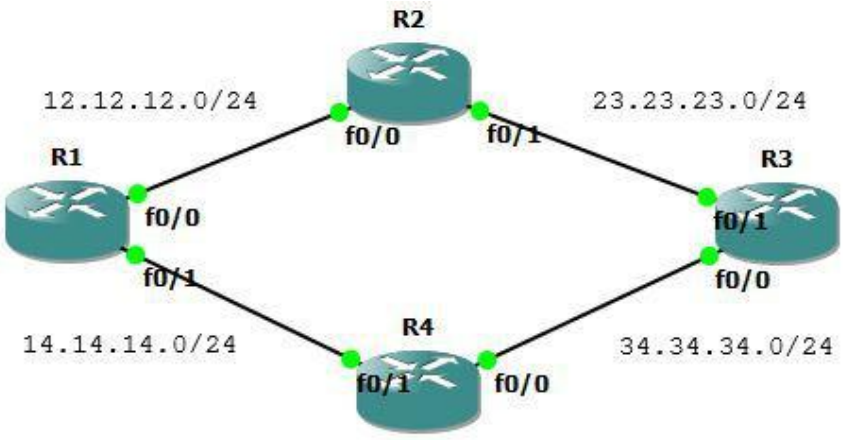
```
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 2
    12.12.12.2, from 12.12.12.2, 00:01:42 ago, via FastEthernet0/0
      Route metric is 435200, traffic share count is 1
      Total delay is 7000 microseconds, minimum bandwidth is 10000 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 2
```

Didapat bahwa 2 jalur digunakan secara bersamaan (load balancing) menuju ke 3.3.3.3. Sekarang lakukan traceroute ke 3.3.3.3.

```
R1#traceroute 3.3.3.3

Type escape sequence to abort.
Tracing the route to 3.3.3.3

  1 14.14.14.4 160 msec
    12.12.12.2 172 msec
    14.14.14.4 188 msec
  2 23.23.23.3 312 msec
    34.34.34.3 216 msec
    23.23.23.3 188 msec
R1#
```

EIGRP Unequal Load Balancing

Pada link yang unequal, maka load balancing tidak aktif dan hanya akan menggunakan satu link.



Masih memakai topologi sebelumnya. Sebelumnya ubah bandwidth interface fa0/0 menjadi 1000Kbit agar tidak equal dengan fa0/1.

```
R1(config)#int fa0/0
R1(config-if)#bandwidth 1000
```

Sekarang cek route ke 3.3.3.3 dan hanya melalui satu link.

```
R1(config-if) R1(config-if)#do clear ip route *
R1(config-if)#do sh ip route 3.3.3.3
```

```
Routing entry for 3.3.3.3/32
  Known via "eigrp 16", distance 90, metric 435200, type internal
  Redistributing via eigrp 16
  Last update from 14.14.14.4 on FastEthernet0/1, 00:00:22 ago
  Routing Descriptor Blocks:
  * 14.14.14.4, from 14.14.14.4, 00:00:22 ago, via FastEthernet0/1
      Route metric is 435200, traffic share count is 1
      Total delay is 7000 microseconds, minimum bandwidth is 10000 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 2

R1(config-if)#do sh ip eigrp top 3.3.3.3/32
IP-EIGRP (AS 16): Topology entry for 3.3.3.3/32
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is 435200
  Routing Descriptor Blocks:
  14.14.14.4 (FastEthernet0/1), from 14.14.14.4, Send flag is 0x0
      Composite metric is (435200/409600), Route is Internal
      Vector metric:
        Minimum bandwidth is 10000 Kbit
        Total delay is 7000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
  12.12.12.2 (FastEthernet0/0), from 12.12.12.2, Send flag is 0x0
      Composite metric is (2739200/409600), Route is Internal
      Vector metric:
        Minimum bandwidth is 1000 Kbit
        Total delay is 7000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
R1(config-if)# #do clear ip route
```

Untuk mengaktifkan load balancing, harus dicari nilai variencenya. Varience adalah 2739200 : 435200 = 6.29412, berapapun komanya bulatkan kebawah sehingga menjadi 7.

Dengan nilai varience 7, artinya setiap 7 packet dikirimkan melalui link pertama dan 1 packet melalui link kedua.

Sekarang set nilai variencenya.

```
R1(config-if)#router eigrp 16
R1(config-router)#variance 7
```

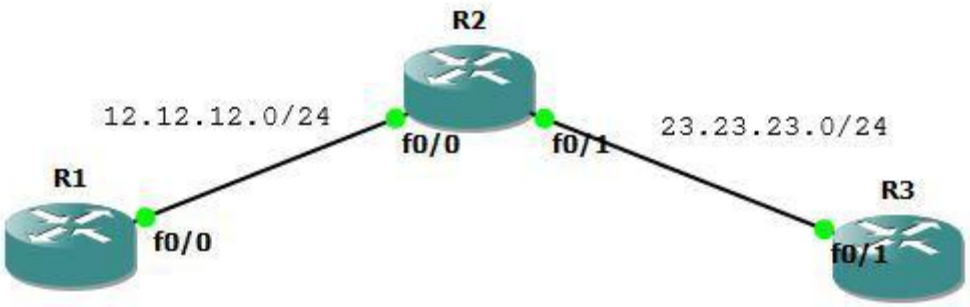
Cek apakah sudah load balancing.

```
R1(config-router)#do sh ip route

Gateway of last resort is not set

     34.0.0.0/24 is subnetted, 1 subnets
D       34.34.34.0 [90/307200] via 14.14.14.4, 00:00:17, FastEthernet0/1
     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
```

```
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/460800] via 14.14.14.4, 00:00:17, FastEthernet0/1
                [90/2713600] via 12.12.12.2, 00:00:17, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3 [90/435200] via 14.14.14.4, 00:00:17, FastEthernet0/1
                [90/2739200] via 12.12.12.2, 00:00:19, FastEthernet0/0
     4.0.0.0/32 is subnetted, 1 subnets
D       4.4.4.4 [90/409600] via 14.14.14.4, 00:00:19, FastEthernet0/1
     23.0.0.0/24 is subnetted, 1 subnets
D       23.23.23.0 [90/332800] via 14.14.14.4, 00:00:20, FastEthernet0/1
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
     14.0.0.0/24 is subnetted, 1 subnets
C       14.14.14.0 is directly connected, FastEthernet0/1
R1(config-router)#do sh ip route 3.3.3.3
Routing entry for 3.3.3.3/32
  Known via "eigrp 16", distance 90, metric 435200, type internal
  Redistributing via eigrp 16
  Last update from 12.12.12.2 on FastEthernet0/0, 00:00:42 ago
  Routing Descriptor Blocks:
  * 14.14.14.4, from 14.14.14.4, 00:00:42 ago, via FastEthernet0/1
      Route metric is 435200, traffic share count is 120
      Total delay is 7000 microseconds, minimum bandwidth is 10000 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 2
    12.12.12.2, from 12.12.12.2, 00:00:42 ago, via FastEthernet0/0
      Route metric is 2739200, traffic share count is 19
      Total delay is 7000 microseconds, minimum bandwidth is 1000 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 2

R1(config-router)#
```

EIGRP Stub – Connected + Summary

Router stub akan mengadvertise directly connected dan summary route.



Lakukan konfigurasi berikut.

```
R1
interface Loopback0
 ip address 1.1.1.1 255.255.255.255
```

```
!
interface FastEthernet0/0
 ip address 12.12.12.1 255.255.255.0
!
router eigrp 10
 redistribute static
 network 12.12.12.1 0.0.0.0
 no auto-summary
!

R2
interface Loopback0
 ip address 2.2.2.2 255.255.255.255
!
interface Loopback1
 ip address 22.22.21.1 255.255.255.0
!
interface Loopback2
 ip address 22.22.22.1 255.255.255.0
!
interface Loopback3
 ip address 22.22.23.1 255.255.255.0
!
interface Loopback4
 ip address 22.22.24.1 255.255.255.0
!
interface Loopback5
 ip address 22.22.25.1 255.255.255.0
!
interface FastEthernet0/0
 ip address 12.12.12.2 255.255.255.0
!
interface FastEthernet0/1
 ip address 23.23.23.2 255.255.255.0
 ip summary-address eigrp 10 22.22.0.0 255.255.0.0 5
!
router eigrp 10
 redistribute static
 redistribute rip metric 1 1 1 1 1
 network 2.2.2.2 0.0.0.0
 network 12.12.12.2 0.0.0.0
 network 22.22.0.0 0.0.0.0
 network 23.23.23.2 0.0.0.0
 no auto-summary
!
router rip
 network 22.0.0.0
!
ip route 1.1.1.1 255.255.255.255 FastEthernet0/0

R3
interface Loopback0
 ip address 3.3.3.3 255.255.255.255
!
interface FastEthernet0/1
 ip address 23.23.23.3 255.255.255.0
!
```

```
router eigrp 10
 network 3.3.3.3 0.0.0.0
 network 23.23.23.3 0.0.0.0
 no auto-summary
!
```

Cek tabel routing di R3.

```
R3#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D EX    1.1.1.1 [170/307200] via 23.23.23.2, 00:00:01, FastEthernet0/1
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/409600] via 23.23.23.2, 00:00:01, FastEthernet0/1
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/1
     22.0.0.0/16 is subnetted, 1 subnets
D       22.22.0.0 [90/2560025856] via 23.23.23.2, 00:00:04, FastEthernet0/1
     12.0.0.0/24 is subnetted, 1 subnets
D       12.12.12.0 [90/307200] via 23.23.23.2, 00:00:04, FastEthernet0/1
R3#
```

Sekarang tes masukkan perintah eigrp stub.

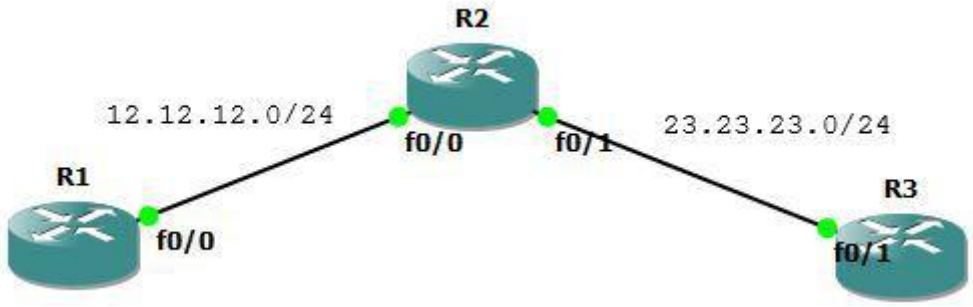
```
R2(config-router)#eigrp stub
```

Cek ip route dan bandingkan dengan sebelumnya. Hanya ada route connected dan summary sedang redistribute sudah terhapus.

```
R3#sh ip route

Gateway of last resort is not set

     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/409600] via 23.23.23.2, 00:00:06, FastEthernet0/1
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/1
     22.0.0.0/16 is subnetted, 1 subnets
D       22.22.0.0 [90/2560025856] via 23.23.23.2, 00:00:06, FastEthernet0/1
     12.0.0.0/24 is subnetted, 1 subnets
D       12.12.12.0 [90/307200] via 23.23.23.2, 00:00:09, FastEthernet0/1
R3#
```

EIGRP Stub – Connected

Router stub hanya akan mengadvertise directly connected route.



Lanjutan lab sebelumnya. Hapus dulu perintah eigrp stub sebelumnya.

```
R2(config)#router eigrp 10
R2(config-router)#no eigrp stub
```

Cek ip route dan tabel routing sudah kembali seperti semua. Masukkan eigrp stub connected.

```
R3#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D EX    1.1.1.1 [170/307200] via 23.23.23.2, 00:00:46, FastEthernet0/1
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/409600] via 23.23.23.2, 00:00:46, FastEthernet0/1
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/1
     22.0.0.0/16 is subnetted, 1 subnets
D       22.22.0.0 [90/2560025856] via 23.23.23.2, 00:00:46, FastEthernet0/1
     12.0.0.0/24 is subnetted, 1 subnets
D       12.12.12.0 [90/307200] via 23.23.23.2, 00:00:48, FastEthernet0/1
R3#

R2(config-router)# eigrp stub connected
*Mar  1 00:06:02.587: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 10: Neighbor 12.12.12.1
(FastEthernet0/0) is down: peer info changed
*Mar  1 00:06:02.599: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 10: Neighbor 23.23.23.3
(FastEthernet0/1) is down: peer info changed
```

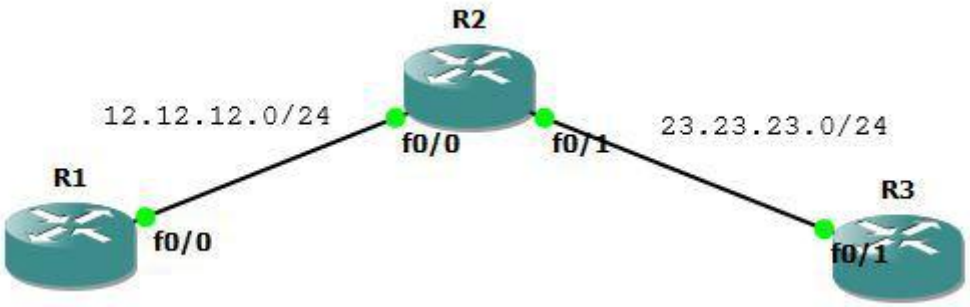
Cek lagi ip route.

```
R3#sh ip route

Gateway of last resort is not set

     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/409600] via 23.23.23.2, 00:00:12, FastEthernet0/1
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
```

```
C       23.23.23.0 is directly connected, FastEthernet0/1
     12.0.0.0/24 is subnetted, 1 subnets
D       12.12.12.0 [90/307200] via 23.23.23.2, 00:00:12, FastEthernet0/1
R3#
```

EIGRP Stub – Summary

Router stub hanya akan mengadvertise summary route.

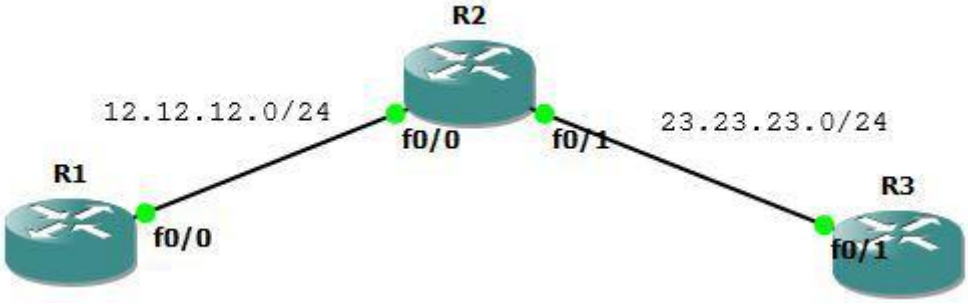



```
R2(config)#router eigrp 10
R2(config-router)#no eigrp stub
R2(config-router)# eigrp stub summary
```

```
R3#sh ip route

Gateway of last resort is not set

     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/1
     22.0.0.0/16 is subnetted, 1 subnets
D       22.22.0.0 [90/2560025856] via 23.23.23.2, 00:00:27, FastEthernet0/1
R3#
```

EIGRP Stub – Static

Router stub akan mengadvertise static route.

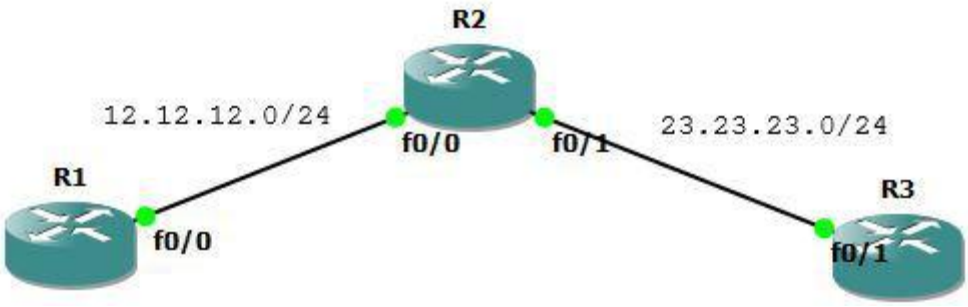



```
R2(config)#router eigrp 10
R2(config-router)#no eigrp stub
R2(config-router)#eigrp stub static
```

```
R3#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D EX    1.1.1.1 [170/307200] via 23.23.23.2, 00:00:28, FastEthernet0/1
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/1
R3#
```

EIGRP Stub – Redistributed

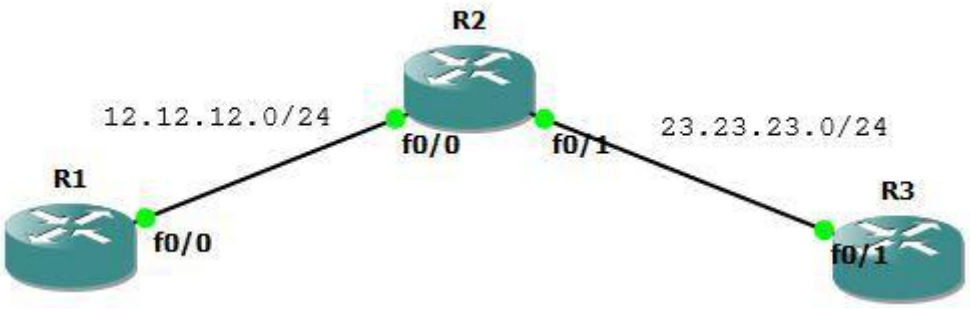
Router stub akan mengadvertise redistributed route.




```
R2(config)#router eigrp 10
R2(config-router)#no eigrp stub
R2(config-router)#eigrp stub redistributed
```

```
R3#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D EX    1.1.1.1 [170/307200] via 23.23.23.2, 00:00:02, FastEthernet0/1
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2 [90/409600] via 23.23.23.2, 00:00:02, FastEthernet0/1
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/1
     22.0.0.0/16 is subnetted, 1 subnets
D       22.22.0.0 [90/2560025856] via 23.23.23.2, 00:00:02, FastEthernet0/1
     12.0.0.0/24 is subnetted, 1 subnets
D       12.12.12.0 [90/307200] via 23.23.23.2, 00:00:05, FastEthernet0/1
R3#
```

EIGRP Stub – Receive Only



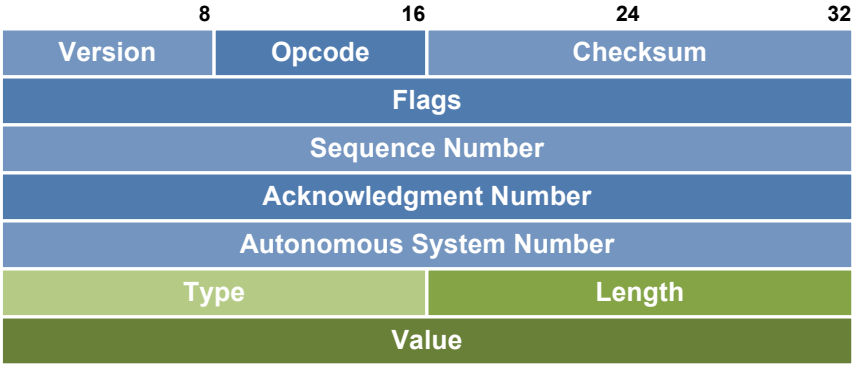
Lanjutan lab sebelumnya. Hapus dulu perintah eigrp stub sebelumnya.

```
R2(config)#router eigrp 10
R2(config-router)#no eigrp stub
R2(config-router)#eigrp stub receive-only
```

```
Gateway of last resort is not set

     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/1
R3#
R1#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
```

EIGRP

Protocol Header



Metric Formula

$$256 * (K_1 * \text{bw} + \frac{K_2 * \text{bw}}{256 - \text{load}} + K_3 * \text{delay}) * \frac{K_5}{\text{rel} + K_4}$$

· **bw** = 10^7 / minimum path bandwidth in kbps
· **delay** = interface delay in µsecs / 10

EIGRP Configuration

Protocol Configuration

```
! Enable EIGRP
router eigrp <ASN>

 ! Add networks to advertise
 network <IP address> <wildcard mask>

 ! Configure K values to manipulate metric formula
 metric weights 0 <k1> <k2> <k3> <k4> <k5>

 ! Disable automatic route summarization
 no auto-summary

 ! Designate passive interfaces
 passive-interface (<interface> | default)

 ! Enable stub routing
 eigrp stub [receive-only | connected | static | summary]

 ! Statically identify neighoring routers
 neighbor <IP address> <interface>
```

Interface Configuration

```
! Set maximum bandwidth EIGRP can consume
ip bandwidth-percent eigrp <AS> <percentage>

! Configure manual summarization of outbound routes
ip summary-address eigrp <AS> <IP address> <mask> [<AD>]

! Enable MD5 authentication
ip authentication mode eigrp <AS> md5
ip authentication key-chain eigrp <AS> <key-chain>

! Configure hello and hold timers
ip hello-interval eigrp <AS> <seconds>
ip hold-time eigrp <AS> <seconds>

! Disable split horizon for EIGRP
no ip split-horizon eigrp <AS>
```

Attributes

Type	Distance Vector
Algorithm	DUAL
Internal AD	90
External AD	170
Summary AD	5
Standard	Cisco proprietary
Protocols	IP, IPX, Appletalk
Transport	IP/88
Authentication	MD5
Multicast IP	224.0.0.10
Hello Timers	5/60
Hold Timers	15/180

K Defaults	
K_1	1
K_2	0
K_3	1
K_4	0
K_5	0

Packet Types	
1	Update
3	Query
4	Reply
5	Hello
8	Acknowledge

Terminology

Reported Distance
The metric for a route advertised by a neighbor

Feasible Distance
The distance advertised by a neighbor plus the cost to get to that neighbor

Stuck In Active (SIA)
The condition when a route becomes unreachable and not all queries for it are answered; adjacencies with unresponsive neighbors are reset

Passive Interface
An interface which does not participate in EIGRP but whose network is advertised

Stub Router
A router which advertises only a subset of routes, and is omitted from the route query process

Troubleshooting

```
show ip eigrp interfaces
show ip eigrp neighbors
show ip eigrp topology
show ip eigrp traffic
clear ip eigrp neighbors
debug ip eigrp [packet | neighbors]
```

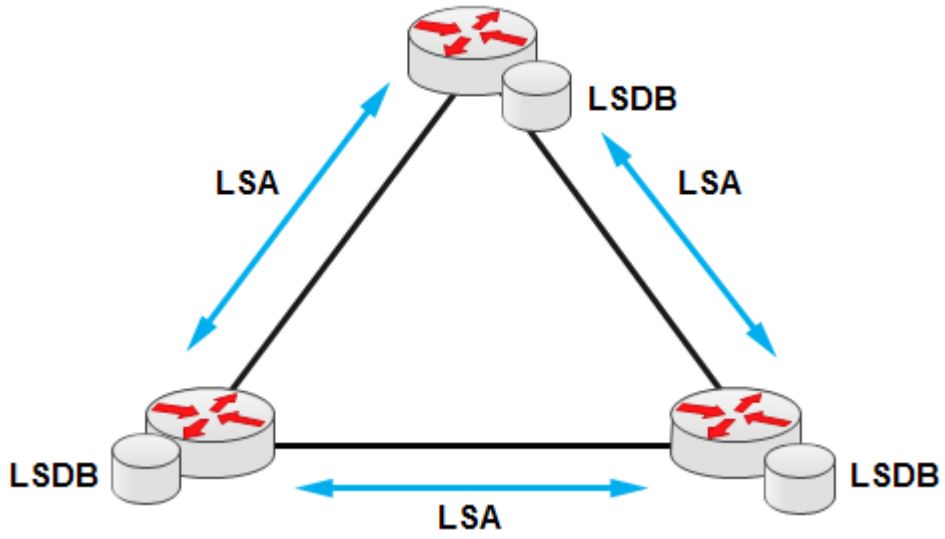
OSPF

OSPF Basic Configuration
OSPF Virtual Link
OSPF GRE Tunnel
OSPF Standar Area
OSPF Stub Area
OSPF Totally Stub Area
OSPF Not So Stubby Area (NSSA)
OSPF External Route Type 1
OSPF Summarization – Area Range
OSPF Summarization – Summary Address
OSPF Path Selection

OSPF
(Open Shortest Path First)

- Open Standard.
- Link-State routing protocol.
- Using SPF/Dijkstra Algorithm.
- Multicast for exchange information use port 89.
- Administrative distance 110.
- Classless routing protocol support VLSM/CIDR.
- Support IPv6.
- Metric using cost.
- Fast convergence.
- Equal load balancing only.
- Using areas (backbone area and non-backbone areas).

Link-state mengetahui peta keseluruhan (topology) dalam jaringan untuk menentukan shortest path.



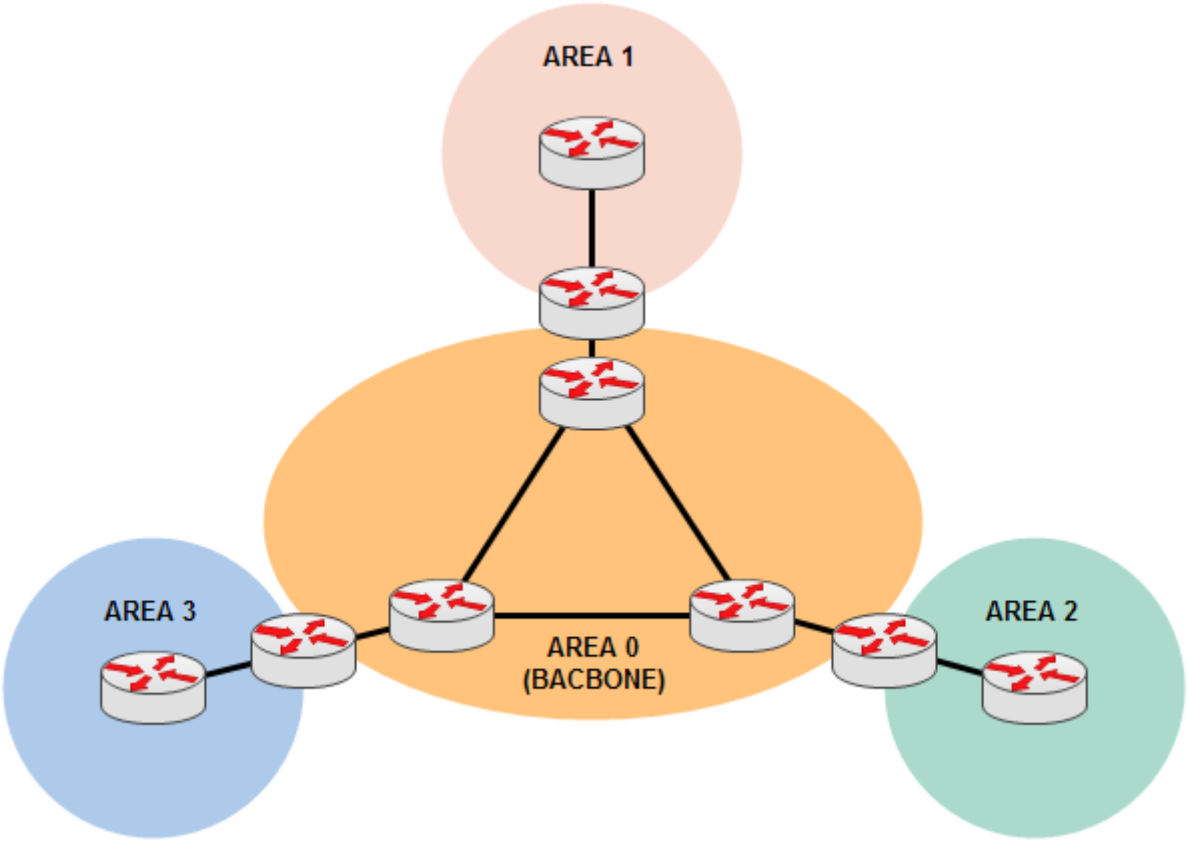
Link = interface dari router.

State = ke router neighbor mana interface tadi terhubung.

Link state router bekerja dengan mengirim link-state advertisement (LSA) ke router link-state lain dan disimpan di link-state database (LSDB). LSA seperti puzzle yang membentuk LSDB. LSDB adalah gambaran keseluruhan jaringan yang

kita sebut topology. Ketika LSDB sudah lengkap, maka OSPF akan menghitung shortest path.

OSPF bekerja dengan konsep area. Area yang harus ada pada OSPF adalah area 0 atau backbone area. Area-area lain (non-backbone area) yang ingin terhubung, harus melalui backbone area.



Pembagian area ini bertujuan untuk memanajemen traffic dan mengurangi resources yang dipakai oleh router. Ada beberapa jenis router dalam OSPF.

Backbone router = router dalam backbone area.

Area Border Router (ABR) = router dalam 2 area.

Autonomous System Border Router (ASBR) = router yang terhubung ke network lain yang menjalankan routing yang berbeda.

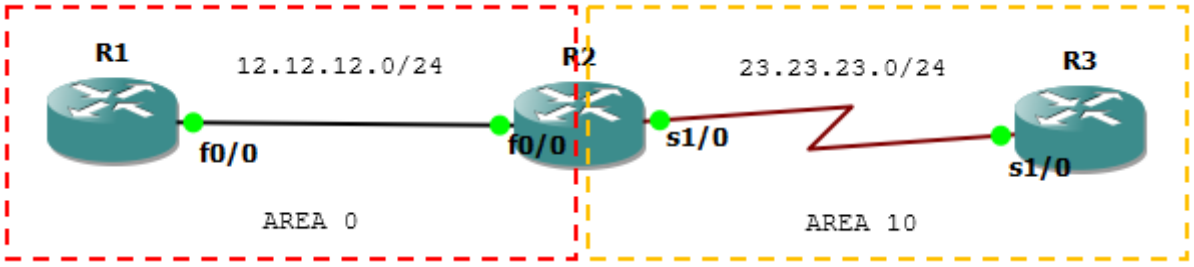
OSPF menggunakan metric yang disebut cost. Cost dihitung berdasarkan bandwidth suatu interface.

Cost = reference bandwidth / interface bandwidth

Default reference bandwidth adalah 100Mbit, tapi ini bisa diubah karena saat ini sudah ada interface yang sampai giga.

Setiap LSA mempunyai aging timer yaitu batas waktu berlaku. Defaultnya LSA valid selama 30 menit. Setelah itu akan expire dan dikirim lagi LSA baru dengan sequence number yang lebih tinggi.

OSPF Basic Configuration



Ketikkan konfigurasi interface berikut.

```
R1
interface Loopback0
 ip address 1.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 ip address 12.12.12.1 255.255.255.0
!
router ospf 13
 router-id 1.1.1.1
 network 1.1.1.1 0.0.0.0 area 0
 network 12.12.12.0 0.0.0.255 area 0
!

R2
interface Loopback0
 ip address 2.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 12.12.12.2 255.255.255.0
!
interface Serial1/0
 ip address 23.23.23.2 255.255.255.0
!
router ospf 13
 router-id 2.2.2.2
 network 2.2.2.2 0.0.0.0 area 10
 network 12.12.12.0 0.0.0.255 area 0
 network 23.23.23.0 0.0.0.255 area 10
!

R3
interface Loopback0
 ip address 3.3.3.3 255.255.255.255
!
interface Serial1/0
 ip address 23.23.23.3 255.255.255.0
!
router ospf 14
 router-id 3.3.3.3
 network 3.3.3.3 0.0.0.0 area 10
 network 23.23.23.0 0.0.0.255 area 10
!
```

Cek tabel routing.

```
R1#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/11] via 12.12.12.2, 00:07:41, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/75] via 12.12.12.2, 00:07:41, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O IA    23.23.23.0 [110/74] via 12.12.12.2, 00:07:41, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R1#

R2#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/11] via 12.12.12.1, 00:08:04, FastEthernet0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/65] via 23.23.23.3, 00:08:39, Serial1/0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R2#

R3#sh ip route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/75] via 23.23.23.2, 00:08:17, Serial1/0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/65] via 23.23.23.2, 00:08:52, Serial1/0
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
     12.0.0.0/24 is subnetted, 1 subnets
O IA    12.12.12.0 [110/74] via 23.23.23.2, 00:08:52, Serial1/0
R3#
```

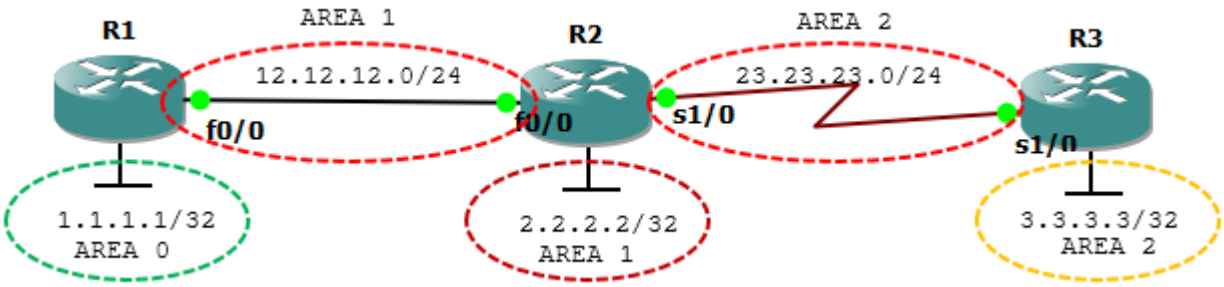
Tes ping.

```
R1#ping 2.2.2.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/75/144 ms
```

```
R1#ping 3.3.3.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 12/128/288 ms
R1#
```

```
R2#sh ip ospf database

            OSPF Router with ID (2.2.2.2) (Process ID 13)

            Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         616         0x80000002 0x0015AB 2
2.2.2.2         2.2.2.2         615         0x80000002 0x00F9D1 1

            Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
12.12.12.2      2.2.2.2         615         0x80000001 0x0014EB

            Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
2.2.2.2         2.2.2.2         656         0x80000001 0x00FA31
3.3.3.3         2.2.2.2         646         0x80000001 0x004F98
23.23.23.0      2.2.2.2         656         0x80000001 0x00901F

            Router Link States (Area 10)

Link ID         ADV Router      Age         Seq#       Checksum Link count
2.2.2.2         2.2.2.2         655         0x80000002 0x009C44 3
3.3.3.3         3.3.3.3         658         0x80000002 0x00BB1D 3

            Summary Net Link States (Area 10)

Link ID         ADV Router      Age         Seq#       Checksum
1.1.1.1         2.2.2.2         613         0x80000001 0x008D98
12.12.12.0      2.2.2.2         658         0x80000001 0x00FF07
R2#
```

OSPF Virtual Link




```
R1
interface Loopback0
 ip address 1.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 ip address 12.12.12.1 255.255.255.0
!
router ospf 13
 router-id 1.1.1.1
 network 1.1.1.1 0.0.0.0 area 0
 network 12.12.12.0 0.0.0.255 area 1
!

R2
interface Loopback0
 ip address 2.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 12.12.12.2 255.255.255.0
!
interface Serial1/0
 ip address 23.23.23.2 255.255.255.0
!
router ospf 13
 router-id 2.2.2.2
 network 2.2.2.2 0.0.0.0 area 1
 network 12.12.12.0 0.0.0.255 area 1
 network 23.23.23.0 0.0.0.255 area 2
!

R3
interface Loopback0
 ip address 3.3.3.3 255.255.255.255
!
interface Serial1/0
 ip address 23.23.23.3 255.255.255.0
!
router ospf 14
 router-id 3.3.3.3
 network 3.3.3.3 0.0.0.0 area 2
 network 23.23.23.0 0.0.0.255 area 2
!
```

Cek tabel routing.

```
R1(config-router)#do sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/11] via 12.12.12.2, 00:00:21, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R1(config-router)#

R2(config-router)#do sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/11] via 12.12.12.1, 00:01:33, FastEthernet0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/65] via 23.23.23.3, 00:01:43, Serial1/0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R2(config-router)#

R3(config-router)#do sh ip route
Gateway of last resort is not set

     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
R3(config-router)#
```

Cek database OSPF.

```
R1#sh ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 13)

            Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         261         0x80000001 0x00D351 1

            Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
2.2.2.2         1.1.1.1         189         0x80000001 0x007DA8
12.12.12.0      1.1.1.1         257         0x80000001 0x001EEC

            Router Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         193         0x80000002 0x00389C 1
```

```
2.2.2.2         2.2.2.2         195         0x80000002 0x00298A 2

            Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
12.12.12.2      2.2.2.2         195         0x80000001 0x0014EB

            Summary Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
1.1.1.1         1.1.1.1         297         0x80000001 0x0047EC
R1#

R3#sh ip ospf database

            OSPF Router with ID (3.3.3.3) (Process ID 14)

            Router Link States (Area 2)

Link ID         ADV Router      Age         Seq#       Checksum Link count
2.2.2.2         2.2.2.2         293         0x80000002 0x00D624 2
3.3.3.3         3.3.3.3         287         0x80000002 0x00BB1D 3
R3#
```

Konfigurasi virtual link: area area-id virtual-link router-id

```
R1(config)#router ospf 13
R1(config-router)#area 1 virtual-link ?
  A.B.C.D  ID (IP addr) associated with virtual link neighbor

R1(config-router)#area 1 virtual-link 2.2.2.2

R2(config-router)#area 1 virtual-link 1.1.1.1
*Mar  1 00:09:45.563: %OSPF-5-ADJCHG: Process 13, Nbr 1.1.1.1 on OSPF_VL0
from LOADING to FULL, Loading Done

R1#sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/11] via 12.12.12.2, 00:08:38, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/75] via 12.12.12.2, 00:00:48, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O IA    23.23.23.0 [110/74] via 12.12.12.2, 00:00:48, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R1#
```

Network 3.3.3.3 belum ada pada tabel routing.

```
R2(config-router)#area 2 virtual-link 3.3.3.3

R3(config-router)#area 2 virtual-link 2.2.2.2
*Mar  1 00:12:26.355: %OSPF-5-ADJCHG: Process 14, Nbr 2.2.2.2 on OSPF_VL0
from LOADING to FULL, Loading Done
```

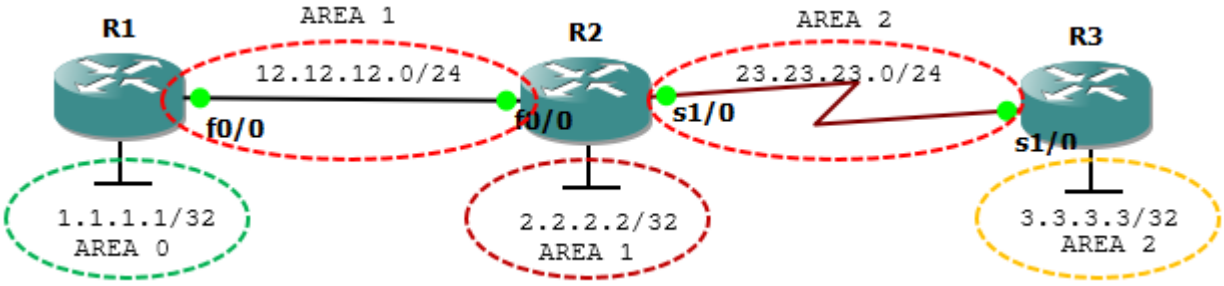
```
Cek lagi

R1#sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/11] via 12.12.12.2, 00:12:02, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/75] via 12.12.12.2, 00:01:34, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O IA    23.23.23.0 [110/74] via 12.12.12.2, 00:04:11, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R1#ping 2.2.2.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/100/204 ms
R1#ping 3.3.3.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/148/204 ms
R1#
```

Cek virtual link.

```
R1#sh ip ospf virtual-links
Virtual Link OSPF_VL0 to router 2.2.2.2 is up
  Run as demand circuit
  DoNotAge LSA allowed.
  Transit area 1, via interface FastEthernet0/0, Cost of using 10
  Transmit Delay is 1 sec, State POINT_TO_POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:09
    Adjacency State FULL (Hello suppressed)
    Index 1/2, retransmission queue length 0, number of retransmission 0
    First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
    Last retransmission scan length is 0, maximum is 0
    Last retransmission scan time is 0 msec, maximum is 0 msec
R1#

2#sh ip ospf virtual-links
Virtual Link OSPF_VL1 to router 3.3.3.3 is up
  Run as demand circuit
  DoNotAge LSA allowed.
  Transit area 2, via interface Serial1/0, Cost of using 64
  Transmit Delay is 1 sec, State POINT_TO_POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:07
    Adjacency State FULL (Hello suppressed)
    Index 2/4, retransmission queue length 0, number of retransmission 0
```

```
    First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
    Last retransmission scan length is 0, maximum is 0
    Last retransmission scan time is 0 msec, maximum is 0 msec
Virtual Link OSPF_VL0 to router 1.1.1.1 is up
  Run as demand circuit
  DoNotAge LSA allowed.
  Transit area 1, via interface FastEthernet0/0, Cost of using 10
  Transmit Delay is 1 sec, State POINT_TO_POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:02
    Adjacency State FULL (Hello suppressed)
    Index 1/3, retransmission queue length 0, number of retransmission 1
    First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
    Last retransmission scan length is 1, maximum is 1
    Last retransmission scan time is 0 msec, maximum is 0 msec
R2#

R3#sh ip ospf virtual-links
Virtual Link OSPF_VL0 to router 2.2.2.2 is up
  Run as demand circuit
  DoNotAge LSA allowed.
  Transit area 2, via interface Serial1/0, Cost of using 64
  Transmit Delay is 1 sec, State POINT_TO_POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:01
    Adjacency State FULL (Hello suppressed)
    Index 1/2, retransmission queue length 0, number of retransmission 0
    First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
    Last retransmission scan length is 0, maximum is 0
    Last retransmission scan time is 0 msec, maximum is 0 msec
R3#
```

OSPF GRE Tunnel



Hapus virtual link terlebih dahulu.

```
R1(config)#router ospf 13
R1(config-router)#no area 1 virtual-link 2.2.2.2

R2(config)#router ospf 13
R2(config-router)#no area 1 virtual-link 1.1.1.1
R2(config-router)#no area 2 virtual-link 3.3.3.3
```

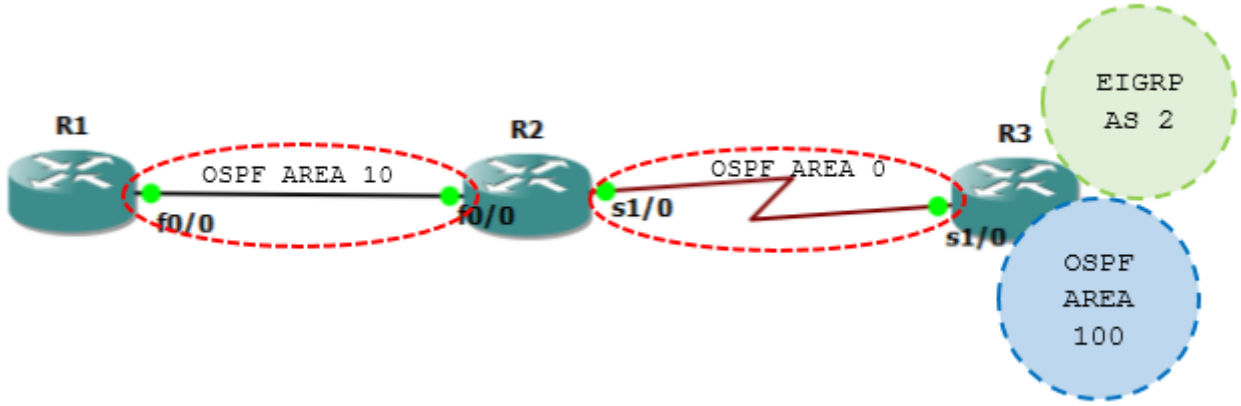
```
R3(config)#router ospf 14
R3(config-router)#no area 2 virtual-link 2.2.2.2
```

Konfigurasi GRE tunnel.

```
R1(config)#int tun1
R1(config-if)#ip add 102.102.102.1 255.255.255.0
R1(config-if)#tunnel source 12.12.12.1
R1(config-if)#tunnel destination 12.12.12.2
R1(config-if)#router ospf 13
R1(config-router)#net 102.102.102.1 0.0.0.0 area 0

R2(config)#int tun1
R2(config-if)#ip add 102.102.102.2 255.255.255.0
R2(config-if)#tunnel destination 12.12.12.1
R2(config-if)#tunnel source 12.12.12.2
R2(config-if)#router ospf 13
R2(config-router)#net 102.102.102.2 0.0.0.0 area 0

R1#sh ip route
Gateway of last resort is not set

     102.0.0.0/24 is subnetted, 1 subnets
C       102.102.102.0 is directly connected, Tunnel1
     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/11] via 12.12.12.2, 00:11:26, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/11176] via 102.102.102.2, 00:03:52, Tunnel1
     23.0.0.0/24 is subnetted, 1 subnets
O IA    23.23.23.0 [110/11175] via 102.102.102.2, 00:03:52, Tunnel1
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R1#ping 2.2.2.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/96/284 ms
R1#ping 3.3.3.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 92/200/312 ms
R1#

R1#sh ip int br
Interface                  IP-Address      OK? Method Status
Protocol
FastEthernet0/0            12.12.12.1      YES NVRAM  up
up
FastEthernet0/1            unassigned      YES NVRAM  administratively down
down
```

```
Serial1/0                  unassigned      YES NVRAM  administratively down
down
Serial1/1                  unassigned      YES NVRAM  administratively down
down
Serial1/2                  unassigned      YES NVRAM  administratively down
down
Serial1/3                  unassigned      YES NVRAM  administratively down
down
Loopback0                  1.1.1.1         YES NVRAM  up
up
Tunnel1                    102.102.102.1   YES manual up
up
R1#
```

OSPF Standar Area




```
R1
interface Loopback0
 ip address 1.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 ip address 12.12.12.1 255.255.255.0
!
router ospf 13
 router-id 1.1.1.1
 network 1.1.1.1 0.0.0.0 area 10
 network 12.12.12.0 0.0.0.255 area 10
!

R2
interface Loopback0
 ip address 2.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 12.12.12.2 255.255.255.0
!
interface Serial1/0
 ip address 23.23.23.2 255.255.255.0
!
```

```
router ospf 13
 router-id 2.2.2.2
 network 2.2.2.2 0.0.0.0 area 0
 network 12.12.12.0 0.0.0.255 area 10
 network 23.23.23.0 0.0.0.255 area 0
!

R3
interface Loopback0
 ip address 3.3.3.3 255.255.255.255
!
interface Serial1/0
 ip address 23.23.23.3 255.255.255.0
!
router ospf 14
 router-id 3.3.3.3
 network 3.3.3.3 0.0.0.0 area 0
 network 23.23.23.0 0.0.0.255 area 0
!
```

Buat interface loopback di R3 dan masukkan beberapa interfacenya ke EIGRP.

```
interface Loopback1
 ip address 33.33.33.1 255.255.255.255
!
interface Loopback2
 ip address 33.33.33.2 255.255.255.255
!
interface Loopback3
 ip address 33.33.33.3 255.255.255.255
!
interface Loopback4
 ip address 33.33.33.4 255.255.255.255
!
interface Loopback5
 ip address 33.33.33.5 255.255.255.255
!
interface Loopback6
 ip address 33.33.33.6 255.255.255.255
!
interface Loopback7
 ip address 33.33.33.7 255.255.255.255
!
interface Loopback8
 ip address 33.33.33.8 255.255.255.255
!

router eigrp 2
net 33.33.33.1 0.0.0.0
net 33.33.33.2 0.0.0.0
net 33.33.33.3 0.0.0.0
net 33.33.33.4 0.0.0.0
no auto-summary
```

Masukkan interface yang lain ke OSPF dengan area 100 dan redistribute EIGRP ke OSPF lalu cek tabel routing R1.

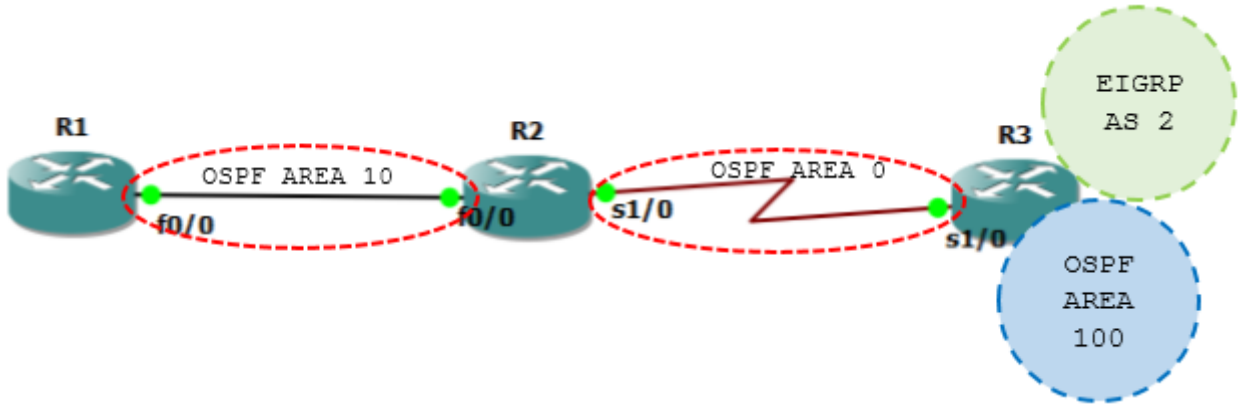
```
router ospf 14
```

```
net 33.33.33.5 0.0.0.0 area 100
net 33.33.33.6 0.0.0.0 area 100
net 33.33.33.7 0.0.0.0 area 100
net 33.33.33.8 0.0.0.0 area 100
redistribute eigrp 2 subnets

Cek R1.
R1(config-router)#do sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/11] via 12.12.12.2, 00:00:28, FastEthernet0/0
     33.0.0.0/32 is subnetted, 8 subnets
O E2    33.33.33.1 [110/20] via 12.12.12.2, 00:00:03, FastEthernet0/0
O E2    33.33.33.3 [110/20] via 12.12.12.2, 00:00:03, FastEthernet0/0
O E2    33.33.33.2 [110/20] via 12.12.12.2, 00:00:03, FastEthernet0/0
O IA    33.33.33.5 [110/75] via 12.12.12.2, 00:00:08, FastEthernet0/0
O E2    33.33.33.4 [110/20] via 12.12.12.2, 00:00:04, FastEthernet0/0
O IA    33.33.33.7 [110/75] via 12.12.12.2, 00:00:09, FastEthernet0/0
O IA    33.33.33.6 [110/75] via 12.12.12.2, 00:00:09, FastEthernet0/0
O IA    33.33.33.8 [110/75] via 12.12.12.2, 00:00:09, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/75] via 12.12.12.2, 00:00:11, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O IA    23.23.23.0 [110/74] via 12.12.12.2, 00:00:31, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R1(config-router)#
```

```
R1(config-router)#do sh ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 13)

            Router Link States (Area 10)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         127         0x80000002 0x0015AB 2
2.2.2.2         2.2.2.2         127         0x80000002 0x00F9D1 1

            Net Link States (Area 10)

Link ID         ADV Router      Age         Seq#       Checksum
12.12.12.2      2.2.2.2         127         0x80000001 0x0014EB

            Summary Net Link States (Area 10)

Link ID         ADV Router      Age         Seq#       Checksum
2.2.2.2         2.2.2.2         193         0x80000001 0x00FA31
3.3.3.3         2.2.2.2         103         0x80000001 0x004F98
23.23.23.0      2.2.2.2         193         0x80000001 0x00901F
33.33.33.5      2.2.2.2         103         0x80000001 0x00FE8C
33.33.33.6      2.2.2.2         103         0x80000001 0x00F495
33.33.33.7      2.2.2.2         103         0x80000001 0x00EA9E
```

```
33.33.33.8      2.2.2.2         103         0x80000001 0x00E0A7

            Summary ASB Link States (Area 10)

Link ID         ADV Router      Age         Seq#       Checksum
3.3.3.3         2.2.2.2         105         0x80000001 0x0037B0

            Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
33.33.33.1      3.3.3.3         433         0x80000001 0x00DA55 0
33.33.33.2      3.3.3.3         433         0x80000001 0x00D05E 0
33.33.33.3      3.3.3.3         433         0x80000001 0x00C667 0
33.33.33.4      3.3.3.3         433         0x80000001 0x00BC70 0
R1(config-router)#
```

OSPF Stub Area



Cek tabel routing R1.

```
R1#sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/11] via 12.12.12.2, 00:00:04, FastEthernet0/0
     33.0.0.0/32 is subnetted, 8 subnets
O E2    33.33.33.1 [110/20] via 12.12.12.2, 00:00:04, FastEthernet0/0
O E2    33.33.33.3 [110/20] via 12.12.12.2, 00:00:04, FastEthernet0/0
O E2    33.33.33.2 [110/20] via 12.12.12.2, 00:00:04, FastEthernet0/0
O IA    33.33.33.5 [110/75] via 12.12.12.2, 00:00:04, FastEthernet0/0
O E2    33.33.33.4 [110/20] via 12.12.12.2, 00:00:05, FastEthernet0/0
O IA    33.33.33.7 [110/75] via 12.12.12.2, 00:00:05, FastEthernet0/0
O IA    33.33.33.6 [110/75] via 12.12.12.2, 00:00:05, FastEthernet0/0
O IA    33.33.33.8 [110/75] via 12.12.12.2, 00:00:05, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/75] via 12.12.12.2, 00:00:07, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
```

```
O IA    23.23.23.0 [110/74] via 12.12.12.2, 00:00:07, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
```

Konfigurasi stub.

```
R1(config-router)#area 10 stub
R2(config-router)#area 10 stub
```

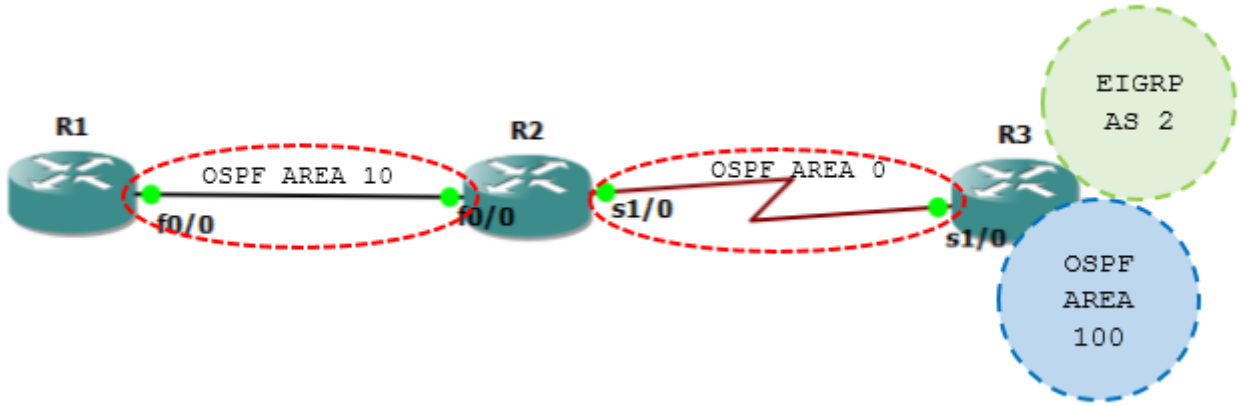
Sekarang cek tabel routing lagi.

```
R1(config-router)#do sh ip route
Gateway of last resort is 12.12.12.2 to network 0.0.0.0

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/11] via 12.12.12.2, 00:02:06, FastEthernet0/0
     33.0.0.0/32 is subnetted, 4 subnets
O IA    33.33.33.5 [110/75] via 12.12.12.2, 00:02:06, FastEthernet0/0
O IA    33.33.33.7 [110/75] via 12.12.12.2, 00:02:06, FastEthernet0/0
O IA    33.33.33.6 [110/75] via 12.12.12.2, 00:02:06, FastEthernet0/0
O IA    33.33.33.8 [110/75] via 12.12.12.2, 00:02:07, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/75] via 12.12.12.2, 00:02:07, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O IA    23.23.23.0 [110/74] via 12.12.12.2, 00:02:08, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
O*IA 0.0.0.0/0 [110/11] via 12.12.12.2, 00:02:09, FastEthernet0/0
```

E2 hilang diganti dengan 0*. Cek database OSPF.

```
R1#sh ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 13)

            Router Link States (Area 10)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         339         0x80000005 0x00687D 2
2.2.2.2         2.2.2.2         499         0x80000005 0x0012B8 1

            Net Link States (Area 10)

Link ID         ADV Router      Age         Seq#       Checksum
12.12.12.2      2.2.2.2         495         0x80000003 0x002ED1

            Summary Net Link States (Area 10)

Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         2.2.2.2         501         0x80000001 0x0075C0
2.2.2.2         2.2.2.2         501         0x80000002 0x001716
3.3.3.3         2.2.2.2         501         0x80000002 0x006B7D
23.23.23.0      2.2.2.2         501         0x80000002 0x00AC04
33.33.33.5      2.2.2.2         501         0x80000002 0x001B71
33.33.33.6      2.2.2.2         501         0x80000002 0x00117A
33.33.33.7      2.2.2.2         501         0x80000002 0x000783
33.33.33.8      2.2.2.2         503         0x80000002 0x00FC8C
```

OSPF Totally Stub Area



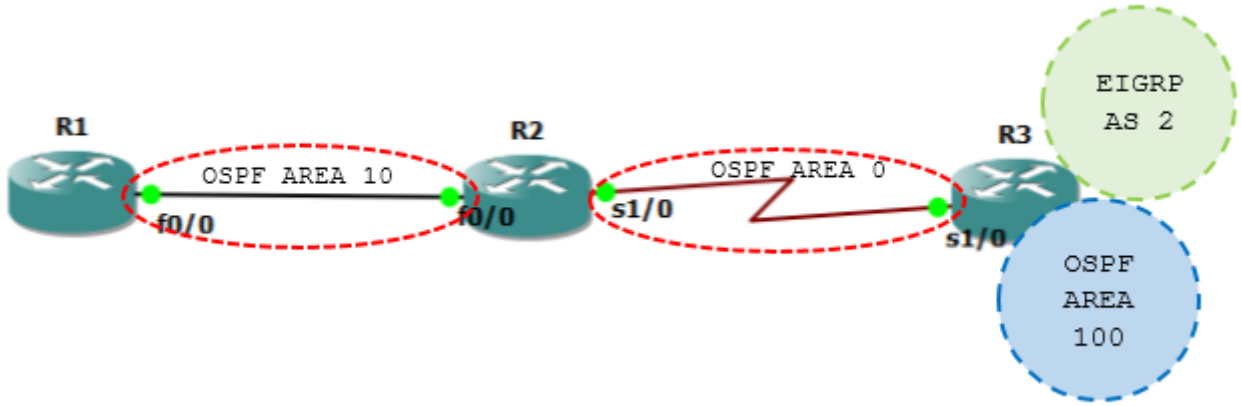
Konfigurasi totally stub.

```
R2(config-router)#no area 10 stub
R2(config-router)#area 10 stub no-summary
```

Cek tabel routing dan OSPF database.

```
R1#sh ip route
Gateway of last resort is 12.12.12.2 to network 0.0.0.0

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
O*IA 0.0.0.0/0 [110/11] via 12.12.12.2, 00:00:47, FastEthernet0/0

R1#sh ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 13)

            Router Link States (Area 10)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         251         0x80000004 0x002F91 2
2.2.2.2         2.2.2.2         257         0x80000004 0x0014B7 1

            Net Link States (Area 10)

Link ID         ADV Router      Age         Seq#       Checksum
12.12.12.2      2.2.2.2         252         0x80000003 0x002ED1

            Summary Net Link States (Area 10)

Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         2.2.2.2         625         0x80000001 0x0075C0
R1#
```

OSPF Not So Stubby Area (NSSA)



Tambahkan interface loopback di R1 dengan konfigurasi RIP.

```
R1(config-if)#interface Loopback1
R1(config-if)# ip address 11.11.11.1 255.255.255.255
R1(config-if)#interface Loopback2
R1(config-if)# ip address 11.11.11.2 255.255.255.255
R1(config-if)#interface Loopback3
R1(config-if)# ip address 11.11.11.3 255.255.255.255

R1(config-if)#router rip
R1(config-router)#ver 2
R1(config-router)#no auto-summary
R1(config-router)#net 11.0.0.0
R1(config)#router ospf 13
R1(config-router)#redistribute rip subnets
```

Hapus OSPF stub sebelumnya dan ganti dengan nssa.

```
R2(config-router)#no area 10 stub
R2(config-router)#area 10 nssa
*Mar  1 00:10:39.295: %OSPF-5-ADJCHG: Process 13, Nbr 2.2.2.2 on
FastEthernet0/0 from DOWN to DOWN, Neighbor Down: Adjacency forced to reset
```

Cek tabel routing R1. Internal area dari ospf area 100 muncul di stub router R1.

```
R1(config-router)#do sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/11] via 12.12.12.2, 00:01:48, FastEthernet0/0
     33.0.0.0/32 is subnetted, 4 subnets
O IA    33.33.33.5 [110/75] via 12.12.12.2, 00:01:48, FastEthernet0/0
O IA    33.33.33.7 [110/75] via 12.12.12.2, 00:01:48, FastEthernet0/0
O IA    33.33.33.6 [110/75] via 12.12.12.2, 00:01:48, FastEthernet0/0
O IA    33.33.33.8 [110/75] via 12.12.12.2, 00:01:48, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/75] via 12.12.12.2, 00:01:49, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O IA    23.23.23.0 [110/74] via 12.12.12.2, 00:01:49, FastEthernet0/0
```

```
     11.0.0.0/32 is subnetted, 3 subnets
C       11.11.11.3 is directly connected, Loopback3
C       11.11.11.2 is directly connected, Loopback2
C       11.11.11.1 is directly connected, Loopback1
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R1(config-router)#
```

Cek tabel routing R3. External route dari RIP dan EIGRP sudah muncul di R1.

```
R3#sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/75] via 23.23.23.2, 00:19:55, Serial1/0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/65] via 23.23.23.2, 00:27:47, Serial1/0
     33.0.0.0/32 is subnetted, 8 subnets
C       33.33.33.1 is directly connected, Loopback1
C       33.33.33.3 is directly connected, Loopback3
C       33.33.33.2 is directly connected, Loopback2
C       33.33.33.5 is directly connected, Loopback5
C       33.33.33.4 is directly connected, Loopback4
C       33.33.33.7 is directly connected, Loopback7
C       33.33.33.6 is directly connected, Loopback6
C       33.33.33.8 is directly connected, Loopback8
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
     11.0.0.0/32 is subnetted, 3 subnets
O E2    11.11.11.3 [110/20] via 23.23.23.2, 00:19:11, Serial1/0
O E2    11.11.11.2 [110/20] via 23.23.23.2, 00:19:11, Serial1/0
O E2    11.11.11.1 [110/20] via 23.23.23.2, 00:19:11, Serial1/0
     12.0.0.0/24 is subnetted, 1 subnets
O IA    12.12.12.0 [110/74] via 23.23.23.2, 00:27:49, Serial1/0
R3#
```

Pada R1 belum ada default route sehingga belum bisa ping ke 33.33.33.1 - 33.33.33.4 pada network EIGRP pada R3 yang diredistribute ke OSPF.

```
R1#ping 33.33.33.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 33.33.33.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
R1#
```

Caranya adalah dengan menambahkan konfigurasi pada ABR routernya yaitu R2.

```
R2(config-router)#area 10 nssa default-information-originate

R1#sh ip route
Gateway of last resort is 12.12.12.2 to network 0.0.0.0

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
```

```
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/11] via 12.12.12.2, 00:27:01, FastEthernet0/0
     33.0.0.0/32 is subnetted, 4 subnets
O IA    33.33.33.5 [110/75] via 12.12.12.2, 00:27:01, FastEthernet0/0
O IA    33.33.33.7 [110/75] via 12.12.12.2, 00:27:01, FastEthernet0/0
O IA    33.33.33.6 [110/75] via 12.12.12.2, 00:27:01, FastEthernet0/0
O IA    33.33.33.8 [110/75] via 12.12.12.2, 00:27:02, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/75] via 12.12.12.2, 00:27:02, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O IA    23.23.23.0 [110/74] via 12.12.12.2, 00:27:03, FastEthernet0/0
     11.0.0.0/32 is subnetted, 3 subnets
C       11.11.11.3 is directly connected, Loopback3
C       11.11.11.2 is directly connected, Loopback2
C       11.11.11.1 is directly connected, Loopback1
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
O*N2 0.0.0.0/0 [110/1] via 12.12.12.2, 00:00:18, FastEthernet0/0
R1#ping 33.33.33.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 33.33.33.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/64/124 ms
R1#
```

Jika diinginkan internal route OSPF area lain tidak ditampilkan dalam database namun masih bisa mengirimkan External Route RIP nya, maka tambahkan no-summary pada ABR R2.

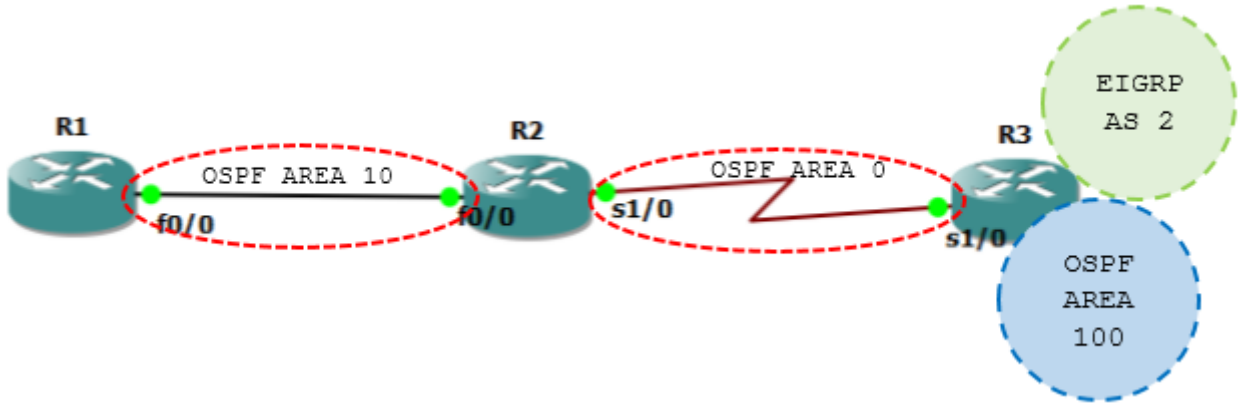
```
R2(config-router)#area 10 nssa no-summary

Cek tabel route R1.
R1#sh ip route
Gateway of last resort is 12.12.12.2 to network 0.0.0.0

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     11.0.0.0/32 is subnetted, 3 subnets
C       11.11.11.3 is directly connected, Loopback3
C       11.11.11.2 is directly connected, Loopback2
C       11.11.11.1 is directly connected, Loopback1
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
O*IA 0.0.0.0/0 [110/11] via 12.12.12.2, 00:00:17, FastEthernet0/0
R1#ping 33.33.33.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 33.33.33.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/80/144 ms
```

Pastikan external route RIP dari R1 masih bisa diterima R3.

```
R3#sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
```

```
O IA    1.1.1.1 [110/75] via 23.23.23.2, 00:32:10, Serial1/0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/65] via 23.23.23.2, 00:40:02, Serial1/0
     33.0.0.0/32 is subnetted, 8 subnets
C       33.33.33.1 is directly connected, Loopback1
C       33.33.33.3 is directly connected, Loopback3
C       33.33.33.2 is directly connected, Loopback2
C       33.33.33.5 is directly connected, Loopback5
C       33.33.33.4 is directly connected, Loopback4
C       33.33.33.7 is directly connected, Loopback7
C       33.33.33.6 is directly connected, Loopback6
C       33.33.33.8 is directly connected, Loopback8
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
     11.0.0.0/32 is subnetted, 3 subnets
O E2    11.11.11.3 [110/20] via 23.23.23.2, 00:31:28, Serial1/0
O E2    11.11.11.2 [110/20] via 23.23.23.2, 00:31:28, Serial1/0
O E2    11.11.11.1 [110/20] via 23.23.23.2, 00:31:28, Serial1/0
     12.0.0.0/24 is subnetted, 1 subnets
O IA    12.12.12.0 [110/74] via 23.23.23.2, 00:40:06, Serial1/0
R3#ping 11.11.11.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 11.11.11.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/65/104 ms
R3#
```

OSPF External Route Type 1




```
R2#sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/11] via 12.12.12.1, 00:02:05, FastEthernet0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
```

```
     33.0.0.0/32 is subnetted, 8 subnets
O E2    33.33.33.1 [110/20] via 23.23.23.3, 00:02:41, Serial1/0
O E2    33.33.33.3 [110/20] via 23.23.23.3, 00:02:41, Serial1/0
O E2    33.33.33.2 [110/20] via 23.23.23.3, 00:02:41, Serial1/0
O IA    33.33.33.5 [110/65] via 23.23.23.3, 00:02:41, Serial1/0
O E2    33.33.33.4 [110/20] via 23.23.23.3, 00:02:42, Serial1/0
O IA    33.33.33.7 [110/65] via 23.23.23.3, 00:02:42, Serial1/0
O IA    33.33.33.6 [110/65] via 23.23.23.3, 00:02:42, Serial1/0
O IA    33.33.33.8 [110/65] via 23.23.23.3, 00:02:42, Serial1/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/65] via 23.23.23.3, 00:02:43, Serial1/0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
     11.0.0.0/32 is subnetted, 3 subnets
O N2    11.11.11.3 [110/20] via 12.12.12.1, 00:02:08, FastEthernet0/0
O N2    11.11.11.2 [110/20] via 12.12.12.1, 00:02:08, FastEthernet0/0
O N2    11.11.11.1 [110/20] via 12.12.12.1, 00:02:08, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R2#

R3#sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/75] via 23.23.23.2, 00:01:14, Serial1/0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/65] via 23.23.23.2, 00:01:47, Serial1/0
     33.0.0.0/32 is subnetted, 8 subnets
C       33.33.33.1 is directly connected, Loopback1
C       33.33.33.3 is directly connected, Loopback3
C       33.33.33.2 is directly connected, Loopback2
C       33.33.33.5 is directly connected, Loopback5
C       33.33.33.4 is directly connected, Loopback4
C       33.33.33.7 is directly connected, Loopback7
C       33.33.33.6 is directly connected, Loopback6
C       33.33.33.8 is directly connected, Loopback8
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
     11.0.0.0/32 is subnetted, 3 subnets
O E2    11.11.11.3 [110/20] via 23.23.23.2, 00:01:11, Serial1/0
O E2    11.11.11.2 [110/20] via 23.23.23.2, 00:01:11, Serial1/0
O E2    11.11.11.1 [110/20] via 23.23.23.2, 00:01:11, Serial1/0
     12.0.0.0/24 is subnetted, 1 subnets
O IA    12.12.12.0 [110/74] via 23.23.23.2, 00:01:49, Serial1/0

R3#sh ip route 11.11.11.1
Routing entry for 11.11.11.1/32
  Known via "ospf 14", distance 110, metric 20, type extern 2, forward
metric 75
  Last update from 23.23.23.2 on Serial1/0, 00:02:39 ago
  Routing Descriptor Blocks:
  * 23.23.23.2, from 2.2.2.2, 00:02:39 ago, via Serial1/0
      Route metric is 20, traffic share count is 1
```

Konfigurasi external route 1.

```
R1(config)#route-map TIPE_SATU
R1(config-route-map)#set metric-type type-1
R1(config-route-map)#router ospf 13
R1(config-router)#redistribute rip subnets route-map TIPE_SATU
```

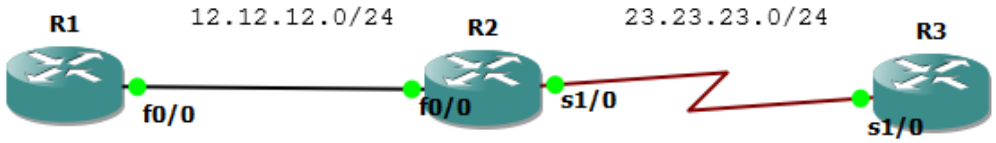
Cek di R3.

```
R3#sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/75] via 23.23.23.2, 00:01:01, Serial1/0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/65] via 23.23.23.2, 00:01:01, Serial1/0
     33.0.0.0/32 is subnetted, 8 subnets
C       33.33.33.1 is directly connected, Loopback1
C       33.33.33.3 is directly connected, Loopback3
C       33.33.33.2 is directly connected, Loopback2
C       33.33.33.5 is directly connected, Loopback5
C       33.33.33.4 is directly connected, Loopback4
C       33.33.33.7 is directly connected, Loopback7
C       33.33.33.6 is directly connected, Loopback6
C       33.33.33.8 is directly connected, Loopback8
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
     11.0.0.0/32 is subnetted, 3 subnets
O E1    11.11.11.3 [110/95] via 23.23.23.2, 00:00:53, Serial1/0
O E1    11.11.11.2 [110/95] via 23.23.23.2, 00:00:53, Serial1/0
O E1    11.11.11.1 [110/95] via 23.23.23.2, 00:00:53, Serial1/0
     12.0.0.0/24 is subnetted, 1 subnets
O IA    12.12.12.0 [110/74] via 23.23.23.2, 00:01:03, Serial1/0
R3#

R2#sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/11] via 12.12.12.1, 00:02:42, FastEthernet0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     33.0.0.0/32 is subnetted, 8 subnets
O E2    33.33.33.1 [110/20] via 23.23.23.3, 00:02:42, Serial1/0
O E2    33.33.33.3 [110/20] via 23.23.23.3, 00:02:42, Serial1/0
O E2    33.33.33.2 [110/20] via 23.23.23.3, 00:02:42, Serial1/0
O IA    33.33.33.5 [110/65] via 23.23.23.3, 00:02:42, Serial1/0
O E2    33.33.33.4 [110/20] via 23.23.23.3, 00:02:44, Serial1/0
O IA    33.33.33.7 [110/65] via 23.23.23.3, 00:02:44, Serial1/0
O IA    33.33.33.6 [110/65] via 23.23.23.3, 00:02:44, Serial1/0
O IA    33.33.33.8 [110/65] via 23.23.23.3, 00:02:44, Serial1/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/65] via 23.23.23.3, 00:02:46, Serial1/0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
     11.0.0.0/32 is subnetted, 3 subnets
```

```
O N1     11.11.11.3 [110/31] via 12.12.12.1, 00:02:46, FastEthernet0/0
O N1     11.11.11.2 [110/31] via 12.12.12.1, 00:02:46, FastEthernet0/0
O N1     11.11.11.1 [110/31] via 12.12.12.1, 00:02:46, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R2#
```

Jika sebelumnya metric sama-sama 20 pada tabel routing R2 dan R3, sekarang sudah berbeda.

OSPF Filtering Using Distribute List




```
R1
interface Loopback0
 ip address 1.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 ip address 12.12.12.1 255.255.255.0
!
router ospf 1
 router-id 1.1.1.1
 network 0.0.0.0 255.255.255.255 area 0
!

R2
interface Loopback0
 ip address 2.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 12.12.12.2 255.255.255.0
!
interface Serial1/0
 ip address 23.23.23.2 255.255.255.0
!
router ospf 2
 router-id 2.2.2.2
 network 0.0.0.0 255.255.255.255 area 0
!

R3
interface Loopback0
 ip address 3.3.3.3 255.255.255.255
!
interface Serial1/0
 ip address 23.23.23.3 255.255.255.0
!
```

```
router ospf 3
 router-id 3.3.3.3
 network 0.0.0.0 255.255.255.255 area 0
!

Buat ip loopback yang bervariatif.
R1(config)#int lo1
R1(config-if)#ip add 11.11.11.1 255.255.255.255
R1(config-if)#int lo2
R1(config-if)#ip add 11.11.11.2 255.255.255.255
R1(config-if)#int lo3
R1(config-if)#ip add 11.11.11.3 255.255.255.255
R1(config-if)#int lo4
R1(config-if)#ip add 11.11.11.4 255.255.255.255
R1(config-if)#int lo5
R1(config-if)#ip add 11.11.11.5 255.255.255.255
R1(config-if)#int lo6
R1(config-if)#ip add 11.11.11.6 255.255.255.255
```

Cek routing table.

```
R2#sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/11] via 12.12.12.1, 00:05:05, FastEthernet0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/65] via 23.23.23.3, 00:04:12, Serial1/0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
     11.0.0.0/32 is subnetted, 6 subnets
O       11.11.11.3 [110/11] via 12.12.12.1, 00:00:47, FastEthernet0/0
O       11.11.11.2 [110/11] via 12.12.12.1, 00:00:49, FastEthernet0/0
O       11.11.11.1 [110/11] via 12.12.12.1, 00:00:49, FastEthernet0/0
O       11.11.11.6 [110/11] via 12.12.12.1, 00:00:49, FastEthernet0/0
O       11.11.11.5 [110/11] via 12.12.12.1, 00:00:49, FastEthernet0/0
O       11.11.11.4 [110/11] via 12.12.12.1, 00:00:49, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R2#
```

Filter yang ganjil saja menggunakan access-list dan konfigurasi distribute-list.

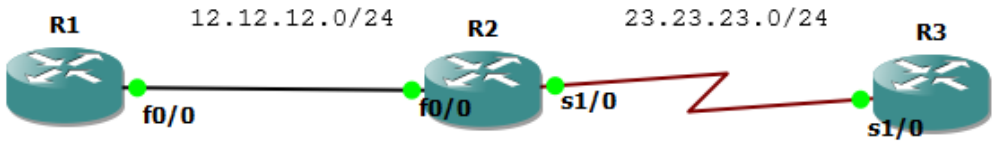
```
R2(config)#access-list 10 permit 0.0.0.1 255.255.255.254
R2(config)#router ospf 2
R2(config-router)#distribute-list 10 in
```

Cek tabel routing dan lihat hasilnya.

```
R2(config-router)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
```

```
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/11] via 12.12.12.1, 00:00:15, FastEthernet0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/65] via 23.23.23.3, 00:00:15, Serial1/0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
     11.0.0.0/32 is subnetted, 3 subnets
O       11.11.11.3 [110/11] via 12.12.12.1, 00:00:15, FastEthernet0/0
O       11.11.11.1 [110/11] via 12.12.12.1, 00:00:16, FastEthernet0/0
O       11.11.11.5 [110/11] via 12.12.12.1, 00:00:16, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R2(config-router)#

Walau didalalam ip route tidak muncul, namun di ospf database masih muncul
karena router dalam area yang sama memiliki database yang sama.

R2#sh ip ospf database

            OSPF Router with ID (2.2.2.2) (Process ID 2)

            Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         401         0x80000007 0x003446 8
2.2.2.2         2.2.2.2         617         0x80000002 0x000875 4
3.3.3.3         3.3.3.3         613         0x80000002 0x007365 3

            Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
12.12.12.1      1.1.1.1         662         0x80000001 0x004CB8
R2#

R1#sh ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 1)

            Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         430         0x80000007 0x003446 8
2.2.2.2         2.2.2.2         648         0x80000002 0x000875 4
3.3.3.3         3.3.3.3         643         0x80000002 0x007365 3

            Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
12.12.12.1      1.1.1.1         690         0x80000001 0x004CB8
R1#
```

OSPF Summarization – Area Range




```
R1
interface Loopback0
 ip address 1.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 ip address 12.12.12.1 255.255.255.0
!
router ospf 1
 router-id 1.1.1.1
 network 0.0.0.0 255.255.255.255 area 0
!

R2
interface Loopback0
 ip address 2.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 12.12.12.2 255.255.255.0
!
interface Serial1/0
 ip address 23.23.23.2 255.255.255.0
!
router ospf 2
 router-id 2.2.2.2
 network 0.0.0.0 255.255.255.255 area 0
!

R3
interface Loopback0
 ip address 3.3.3.3 255.255.255.255
!
interface Serial1/0
 ip address 23.23.23.3 255.255.255.0
!
router ospf 3
 router-id 3.3.3.3
 network 0.0.0.0 255.255.255.255 area 0
!
```

Buat ip loopback untuk nantinya disummary.

```
R3(config)#int lo1
R3(config-if)#ip add 33.33.33.1 255.255.255.255
R3(config-if)#int lo2
R3(config-if)#ip add 33.33.33.2 255.255.255.255
R3(config-if)#int lo3
R3(config-if)#ip add 33.33.33.3 255.255.255.255
R3(config-if)#int lo4
```

```
R3(config-if)#ip add 33.33.33.4 255.255.255.255
R3(config-if)#int lo5
R3(config-if)#ip add 33.33.33.5 255.255.255.255
R3(config-if)#int lo6
R3(config-if)#ip add 33.33.33.6 255.255.255.255

R3(config)#router ospf 3
R3(config-router)#net 33.33.33.1 0.0.0.0 area 10
R3(config-router)#net 33.33.33.2 0.0.0.0 area 10
R3(config-router)#net 33.33.33.3 0.0.0.0 area 10
R3(config-router)#net 33.33.33.4 0.0.0.0 area 10
R3(config-router)#net 33.33.33.5 0.0.0.0 area 10
R3(config-router)#net 33.33.33.6 0.0.0.0 area 10

R1(config-router)#do sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/11] via 12.12.12.2, 00:04:12, FastEthernet0/0
     33.0.0.0/32 is subnetted, 6 subnets
O IA    33.33.33.1 [110/75] via 12.12.12.2, 00:00:20, FastEthernet0/0
O IA    33.33.33.3 [110/75] via 12.12.12.2, 00:00:20, FastEthernet0/0
O IA    33.33.33.2 [110/75] via 12.12.12.2, 00:00:20, FastEthernet0/0
O IA    33.33.33.5 [110/75] via 12.12.12.2, 00:00:20, FastEthernet0/0
O IA    33.33.33.4 [110/75] via 12.12.12.2, 00:00:21, FastEthernet0/0
O IA    33.33.33.6 [110/75] via 12.12.12.2, 00:00:12, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/75] via 12.12.12.2, 00:02:51, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O       23.23.23.0 [110/74] via 12.12.12.2, 00:04:15, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R1(config-router)#
```

Konfigurasi summary di R3.

```
R3(config-router)#area 10 range 33.33.33.0 255.255.255.248
Cek tabel routing dan sudah tersummary.
R1(config-router)#do sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/11] via 12.12.12.2, 00:05:34, FastEthernet0/0
     33.0.0.0/29 is subnetted, 1 subnets
```

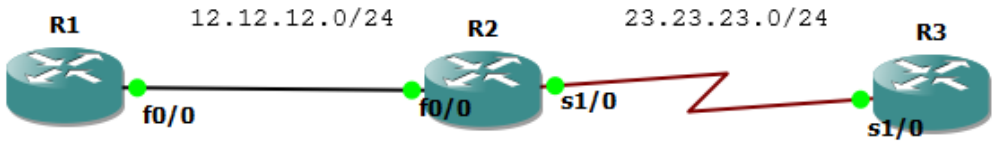
```
O IA    33.33.33.0 [110/75] via 12.12.12.2, 00:00:06, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/75] via 12.12.12.2, 00:04:12, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O       23.23.23.0 [110/74] via 12.12.12.2, 00:05:36, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R1(config-router)#
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/75] via 23.23.23.2, 00:02:04, Serial1/0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/65] via 23.23.23.2, 00:02:04, Serial1/0
     33.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
C       33.33.33.1/32 is directly connected, Loopback1
O       33.33.33.0/29 is a summary, 00:02:04, Null0
C       33.33.33.3/32 is directly connected, Loopback3
C       33.33.33.2/32 is directly connected, Loopback2
C       33.33.33.5/32 is directly connected, Loopback5
C       33.33.33.4/32 is directly connected, Loopback4
C       33.33.33.6/32 is directly connected, Loopback6
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
     12.0.0.0/24 is subnetted, 1 subnets
O       12.12.12.0 [110/74] via 23.23.23.2, 00:02:06, Serial1/0
R3#
```

Jika ingin menghapus Null0 gunakan perintah dibawah.

```
R3(config-router)#no discard-route internal
R3(config-router)#do sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/75] via 23.23.23.2, 00:00:09, Serial1/0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/65] via 23.23.23.2, 00:00:09, Serial1/0
     33.0.0.0/32 is subnetted, 6 subnets
C       33.33.33.1 is directly connected, Loopback1
C       33.33.33.3 is directly connected, Loopback3
C       33.33.33.2 is directly connected, Loopback2
C       33.33.33.5 is directly connected, Loopback5
C       33.33.33.4 is directly connected, Loopback4
C       33.33.33.6 is directly connected, Loopback6
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, Serial1/0
     12.0.0.0/24 is subnetted, 1 subnets
O       12.12.12.0 [110/74] via 23.23.23.2, 00:00:11, Serial1/0
R3(config-router)#
```

Dan Null0 sudah tiada.

OSPF Summarization – Summary Address



Masih menggunakan lab sebelumnya.

```
R3(config)#router eigrp 3
R3(config-router)#net 33.33.33.1 0.0.0.0
R3(config-router)#net 33.33.33.2 0.0.0.0
R3(config-router)#net 33.33.33.3 0.0.0.0
R3(config-router)#net 33.33.33.4 0.0.0.0
R3(config-router)#net 33.33.33.5 0.0.0.0
R3(config-router)#net 33.33.33.6 0.0.0.0
R3(config-router)#no auto-summary

R3(config)#no router ospf 3
*Mar  1 00:01:06.811: %OSPF-5-ADJCHG: Process 3, Nbr 2.2.2.2 on Serial1/0
from FULL to DOWN, Neighbor Down: Interface down or detached
R3(config)#router ospf 3
R3(config-router)#router-id 3.3.3.3
R3(config-router)#network 3.3.3.3 0.0.0.0 area 0
R3(config-router)#network 23.23.23.3 0.0.0.0 area 0 e
R3(config-router)#redistribute eigrp 3 subnets

R1#sh ip route
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/11] via 12.12.12.2, 00:04:26, FastEthernet0/0
     33.0.0.0/32 is subnetted, 6 subnets
O E2    33.33.33.1 [110/20] via 12.12.12.2, 00:01:08, FastEthernet0/0
O E2    33.33.33.3 [110/20] via 12.12.12.2, 00:01:08, FastEthernet0/0
O E2    33.33.33.2 [110/20] via 12.12.12.2, 00:01:08, FastEthernet0/0
O E2    33.33.33.5 [110/20] via 12.12.12.2, 00:01:08, FastEthernet0/0
O E2    33.33.33.4 [110/20] via 12.12.12.2, 00:01:09, FastEthernet0/0
O E2    33.33.33.6 [110/20] via 12.12.12.2, 00:01:09, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/75] via 12.12.12.2, 00:03:15, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O       23.23.23.0 [110/74] via 12.12.12.2, 00:04:36, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R1#
```

Konfigurasi external route summary di R3.

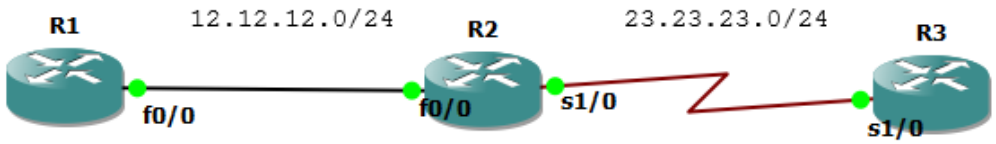
```
R3(config-router)#summary-address 33.33.33.0 255.255.255.248
```

Cek lagi tabel routing R1.

```
R1#sh ip route
```

```
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/11] via 12.12.12.2, 00:06:38, FastEthernet0/0
     33.0.0.0/29 is subnetted, 1 subnets
O E2    33.33.33.0 [110/20] via 12.12.12.2, 00:00:30, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/75] via 12.12.12.2, 00:05:25, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O       23.23.23.0 [110/74] via 12.12.12.2, 00:06:39, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R1#
```

OSPF Default Route



Masih menggunakan lab sebelumnya. Buat 1 ip loopback di R3 dan tidak usah diadvertise.

```
R3(config)#int lo11
R3(config-if)#ip add 113.113.113.113 255.255.255.255
```

Untuk mengakses loopback 113.113.113.113 yang tidak diadvertise, maka gunakan default route.

```
R3(config)#router ospf 3
R3(config-router)#default-information originate always
```

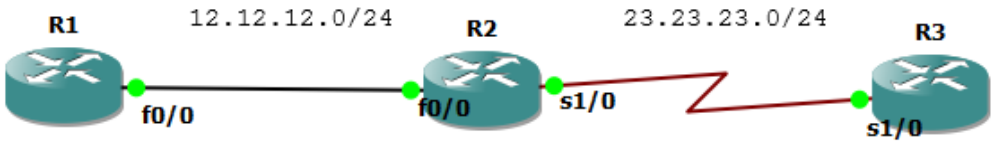
Cek tabel routing R1.

```
R1#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is 12.12.12.2 to network 0.0.0.0
```

```
     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/11] via 12.12.12.2, 00:02:49, FastEthernet0/0
     33.0.0.0/29 is subnetted, 1 subnets
O E2    33.33.33.0 [110/20] via 12.12.12.2, 00:02:49, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/75] via 12.12.12.2, 00:02:49, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O       23.23.23.0 [110/74] via 12.12.12.2, 00:02:51, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
O*E2 0.0.0.0/0 [110/1] via 12.12.12.2, 00:00:09, FastEthernet0/0
R1#ping 113.113.113.113

R1#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is 12.12.12.2 to network 0.0.0.0

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/11] via 12.12.12.2, 00:02:49, FastEthernet0/0
     33.0.0.0/29 is subnetted, 1 subnets
O E2    33.33.33.0 [110/20] via 12.12.12.2, 00:02:49, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/75] via 12.12.12.2, 00:02:49, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O       23.23.23.0 [110/74] via 12.12.12.2, 00:02:51, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
O*E2 0.0.0.0/0 [110/1] via 12.12.12.2, 00:00:09, FastEthernet0/0
R1#ping 113.113.113.113

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 113.113.113.113, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/164/280 ms
R1#


Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 113.113.113.113, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/164/280 ms
R1#
```

Default route sudah muncul.

OSPF Authentication



Ada 2 authentication dalam ospf.

1. Clear Text Authentication
2. MD5 Authentication

Konfigurasi Clear Text Authentication antara R1 dan R2.

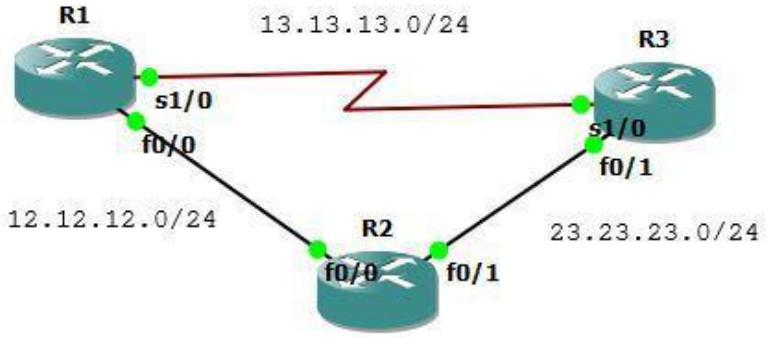
```
R1(config)#int f0/0
R1(config-if)#ip ospf authentication
R1(config-if)#ip ospf authentication-key CISCO123

R2(config)#int f0/0
R2(config-if)#ip ospf authentication
R2(config-if)#ip ospf authentication-key CISCO123

R1(config-if)#do sh ip ospf int f0/0
FastEthernet0/0 is up, line protocol is up
  Internet Address 12.12.12.1/24, Area 0
  Process ID 1, Router ID 1.1.1.1, Network Type BROADCAST, Cost: 10
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 2.2.2.2, Interface address 12.12.12.2
  Backup Designated router (ID) 1.1.1.1, Interface address 12.12.12.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:00
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 2.2.2.2  (Designated Router)
  Suppress hello for 0 neighbor(s)
  Simple password authentication enabled
R1(config-if)#
```

Konfigurasi MD5 Authentication antara R2 dan R3.

```
R2(config-if)#int s1/0
R2(config-if)#ip ospf authentication message-digest
R2(config-if)#ip ospf message-digest-key 13 md5 CISCO123

R3(config)#int s1/0
R3(config-if)#ip ospf authentication message-digest
R3(config-if)#ip ospf message-digest-key 13 md5 CISCO123
```

```
R3(config-if)#do sh ip ospf int s1/0
Serial1/0 is up, line protocol is up
  Internet Address 23.23.23.3/24, Area 0
  Process ID 3, Router ID 3.3.3.3, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:06
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 2.2.2.2
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 13
R3(config-if)#
```

OSPF Path Selection




```
R1(config)#interface Loopback0
R1(config-if)#ip address 1.1.1.1 255.255.255.255
R1(config-if)#interface FastEthernet0/0
R1(config-if)#ip address 12.12.12.1 255.255.255.0
R1(config-if)#no sh
R1(config-if)#interface Serial1/0
R1(config-if)#ip address 13.13.13.1 255.255.255.0
R1(config-if)#no sh
R1(config-if)#router ospf 1
R1(config-router)#router-id 1.1.1.1
R1(config-router)#network 0.0.0.0 255.255.255.255 area 0

R2(config)#interface Loopback0
R2(config-if)#ip address 2.2.2.2 255.255.255.255
R2(config-if)#interface FastEthernet0/0
```

```
R2(config-if)#ip address 12.12.12.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#interface FastEthernet0/1
R2(config-if)#ip address 23.23.23.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#router ospf 2
R2(config-router)#router-id 2.2.2.2
R2(config-router)#network 0.0.0.0 255.255.255.255 area 0

R3(config)#interface Loopback0
R3(config-if)#ip address 3.3.3.3 255.255.255.255
R3(config-if)#interface FastEthernet0/1
R3(config-if)#ip address 23.23.23.3 255.255.255.0
R3(config-if)#no sh
R3(config-if)#interface Serial1/0
R3(config-if)#ip address 13.13.13.3 255.255.255.0
R3(config-if)#no sh
R3(config-if)#router ospf 3
R3(config-router)#router-id 3.3.3.3
R3(config-router)#network 0.0.0.0 255.255.255.255 area 0
```

Cek jalurnya ternyata melalui R2.

```
R1#traceroute 3.3.3.3

Type escape sequence to abort.
Tracing the route to 3.3.3.3

  1 12.12.12.2 208 msec 4 msec 8 msec
  2 23.23.23.3 276 msec 80 msec 216 msec
R1#sh ip route 3.3.3.3
Routing entry for 3.3.3.3/32
  Known via "ospf 1", distance 110, metric 21, type intra area
  Last update from 12.12.12.2 on FastEthernet0/0, 00:02:07 ago
  Routing Descriptor Blocks:
  * 12.12.12.2, from 3.3.3.3, 00:02:07 ago, via FastEthernet0/0
      Route metric is 21, traffic share count is 1

R1#
```

Karena ospf menggunakan bandwidth maka jalur yang lebih dipilih adalah yang melalui FastEthernet. FastEthernet mempunyai metric 10 didapat dari 100.000.000:10.000.000(bandwidth terendah 10Mbps).

Tertulis metric nya 21 didapat dari metric FastEthernet R1-R2 dan R2-R3 masing-masing 10 dan loopback R3 1 sehingga totalnya 21.

Coba shutdown FastEthernet pada R2.

```
R2(config)#interface FastEthernet0/0
R2(config-if)#shutdown

R1#sh ip route 3.3.3.3
Routing entry for 3.3.3.3/32
  Known via "ospf 1", distance 110, metric 65, type intra area
  Last update from 13.13.13.3 on Serial1/0, 00:00:18 ago
  Routing Descriptor Blocks:
  * 13.13.13.3, from 3.3.3.3, 00:00:18 ago, via Serial1/0
```

```
      Route metric is 65, traffic share count is 1

R1#
```

Maka jalurnya berpindah ke serial. Serial mempunyai metric 64 didapat dari 100.000.000:1.544.000(pembulatan bandwidth serial).

Metric 65 didapat dari link serial R1-R3 yaitu 64 dan loopback R3 1 totalnya 65.

Hidupkan lagi FastEthernet dan pastikan jalur kembali seperti semula.

```
R2(config)#interface FastEthernet0/0
R2(config-if)#no shutdown

R1#sh ip route 3.3.3.3
Routing entry for 3.3.3.3/32
  Known via "ospf 1", distance 110, metric 21, type intra area
  Last update from 12.12.12.2 on FastEthernet0/0, 00:00:55 ago
  Routing Descriptor Blocks:
  * 12.12.12.2, from 3.3.3.3, 00:00:55 ago, via FastEthernet0/0
      Route metric is 21, traffic share count is 1

R1#
```

Untuk memindahkan jalur ke Serial, ubah parameter bandwidth FastEthernet.

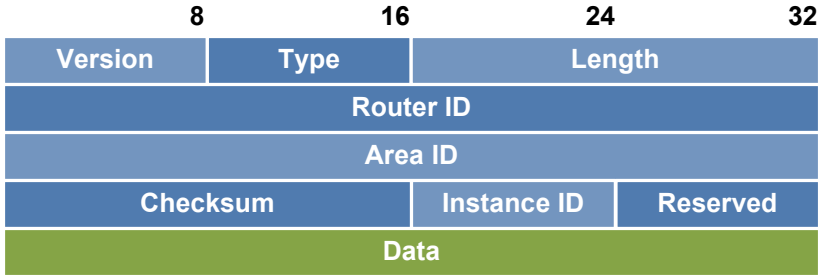
```
R1(config)#int fastEthernet0/0
R1(config-if)#bandwidth 100
R1#sh ip route 3.3.3.3
Routing entry for 3.3.3.3/32
  Known via "ospf 1", distance 110, metric 65, type intra area
  Last update from 13.13.13.3 on Serial1/0, 00:00:12 ago
  Routing Descriptor Blocks:
  * 13.13.13.3, from 3.3.3.3, 00:00:12 ago, via Serial1/0
      Route metric is 65, traffic share count is 1

R1#
```

Maka jalur berpindah ke Serial.

OSPF · Part 1

packetlife.net

Protocol Header



Link State Advertisements

Router Link (Type 1)
Lists neighboring routers and the cost to each; flooded within an area

Network Link (Type 2)
Generated by a DR; lists all routers on an adjacent segment; flooded within an area

Network Summary (Type 3)
Generated by an ABR and advertised among areas

ASBR Summary (Type 4)
Injected by an ABR into the backbone to advertise the presence of an ASBR within an area

External Link (Type 5)
Generated by an ASBR and flooded throughout the AS to advertise a route external to OSPF

NSSA External Link (Type 7)
Generated by an ASBR in a not-so-stubby area; converted into a type 5 LSA by the ABR when leaving the area

Router Types

Internal Router
All interfaces reside within the same area

Backbone Router
A router with an interface in area 0 (the backbone)

Area Border Router (ABR)
Connects two or more areas

AS Boundary Router (ASBR)
Connects to additional routing domains; typically located in the backbone

Area Types

Standard Area
Default OSPF area type

Stub Area
External link (type 5) LSAs are replaced with a default route

Totally Stubby Area
Type 3, 4, and 5 LSAs are replaced with a default route

Not So Stubby Area (NSSA)
A stub area containing an ASBR; type 5 LSAs are converted to type 7 within the area

External Route Types

E1 · Cost to the advertising ASBR plus the external cost of the route

E2 (Default) · Cost of the route as seen by the ASBR

Troubleshooting

`show ip [route | protocols]`	`show ip ospf border-routers`
`show ip ospf interface`	`show ip ospf virtual-links`
`show ip ospf neighbor`	`debug ip ospf […]`

Attributes

Type	Link-State
Algorithm	Dijkstra
Metric	Cost (Bandwidth)
AD	110
Standard	RFC 2328, 2740
Protocols	IP
Transport	IP/89
Authentication	Plaintext, MD5
AllSPF Address	224.0.0.5
AllDR Address	224.0.0.6

Metric Formula

$$\text{cost} = \frac{100{,}000\ \text{Kbps}^*}{\textbf{link speed}}$$

* modifiable with
`ospf auto-cost reference-bandwidth`

Adjacency States

1	Down	**5**	Exstart
2	Attempt	**6**	Exchange
3	Init	**7**	Loading
4	2-Way	**8**	Full

DR/BDR Election

· The DR serves as a common point for all adjacencies on a multiaccess segment

· The BDR also maintains adjacencies with all routers in case the DR fails

· Election does not occur on point-to-point or multipoint links

· Default priority (0-255) is 1; highest priority wins; 0 cannot be elected

· DR preemption will not occur unless the current DR is reset

Virtual Links

· Tunnel formed to join two areas across an intermediate

· Both end routers must share a common area

· At least one end must reside in area 0

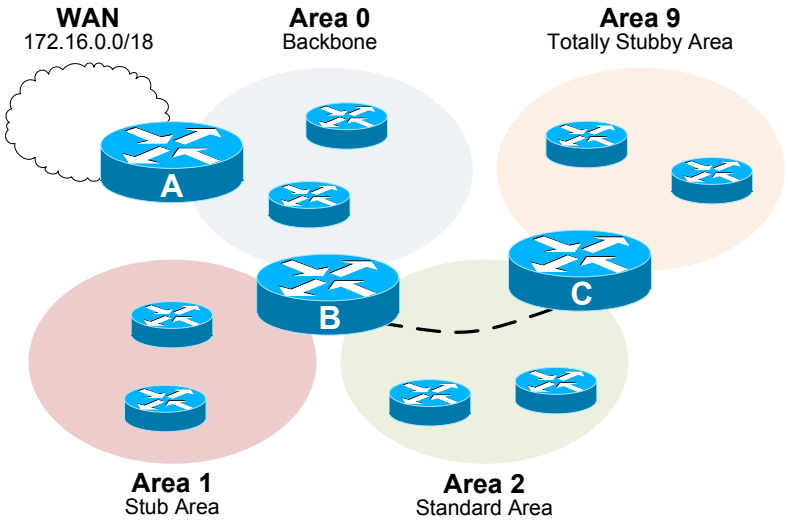
· Cannot traverse stub areas

OSPF · Part 2

Network Types

	Nonbroadcast (NBMA)	Multipoint Broadcast	Multipoint Nonbroadcast	Broadcast	Point-to-Point
DR/BDR Elected	Yes	No	No	Yes	No
Neighbor Discovery	No	Yes	No	Yes	Yes
Hello/Dead Timers	30/120	30/120	30/120	10/40	10/40
Defined By	RFC 2328	RFC 2328	Cisco	Cisco	Cisco
Supported Topology	Full Mesh	Any	Any	Full Mesh	Point-to-Point

Configuration Example



Router A

```
interface Serial0/0
 description WAN Link
 ip address 172.16.34.2 255.255.255.252
!
interface FastEthernet0/0
 description Area 0
 ip address 192.168.0.1 255.255.255.0
!
interface Loopback0
! Used as router ID
 ip address 10.0.34.1 255.255.255.0
!
router ospf 100
 ! Advertising the WAN cloud to OSPF
 redistribute static subnets
 network 192.168.0.0 0.0.0.255 area 0
!
! Static route to the WAN cloud
ip route 172.16.0.0 255.255.192.0 172.16.34.1
```

Router B

```
interface Ethernet0/0
 description Area 0
 ip address 192.168.0.2 255.255.255.0
 ip ospf 100 area 0
!
interface Ethernet0/1
 description Area 2
 ip address 192.168.2.1 255.255.255.0
 ip ospf 100 area 2
 ! Optional MD5 authentication configured
 ip ospf authentication message-digest
 ip ospf message-digest-key 1 md5 FooBar
 ! Give B priority in DR election
 ip ospf priority 100
!
interface Ethernet0/2
 description Area 1
 ip address 192.168.1.1 255.255.255.0
 ip ospf 100 area 1
!
interface Loopback0
 ip address 10.0.34.2 255.255.255.0
!
router ospf 100
 ! Define area 1 as a stub area
 area 1 stub
 ! Virtual link from area 0 to area 9
 area 2 virtual-link 10.0.34.3
```

Router C

```
interface Ethernet0/0
 description Area 9
 ip address 192.168.9.1 255.255.255.0
 ip ospf 100 area 9
!
interface Ethernet0/1
 description Area 2
 ip address 192.168.2.2 255.255.255.0
 ip ospf 100 area 2
 ! Optional MD5 authentication configured
 ip ospf authentication message-digest
 ip ospf message-digest-key 1 md5 FooBar
 ! Give C second priority (BDR) in election
 ip ospf priority 50
!
!
!
!
!
!
interface Loopback0
 ip address 10.0.34.3 255.255.255.0
!
router ospf 100
 ! Define area 9 as a totally stubby area
 area 9 stub no-summary
 ! Virtual link from area 9 to area 0
 area 2 virtual-link 10.0.34.2
```

BGP

BGP - iBGP Configuration
BGP - iBGP Update via Loopback
BGP – eBGP Configuration
BGP – eBGP Configuration 2
BGP – eBGP Configuration 3
BGP – Next Hop Self
BGP – Authentication
BGP Route Reflector
BGP Attribute - Origin
BGP Attribute - Community
BGP Attribute - Community Local-AS and Configuring Confederation
BGP Aggregator
BGP Attribute - Weight
BGP Dualhoming – Load Balance
BGP Dualhoming – Set Weight
BGP Dualhoming – Set MED
BGP Dualhoming – Set AS Path
BGP Multihoming – Equal Load Balance
BGP Multihoming – Unequal Load Balance

BGP
(Border Gateway Protocol)

Border Router Gateway (BGP) adalah protocol yang membentuk jaringan internet. BGP termasuk Exterior Gateway Protocol (EGP) atau bisa dikatakan satu-satunya protocol EGP. EGP menghubungkan Autonomous System (AS) yang satu dengan yang lain. Autonomous System sendiri adalah kumpulan router yang berada dibawah satu administrative domain.

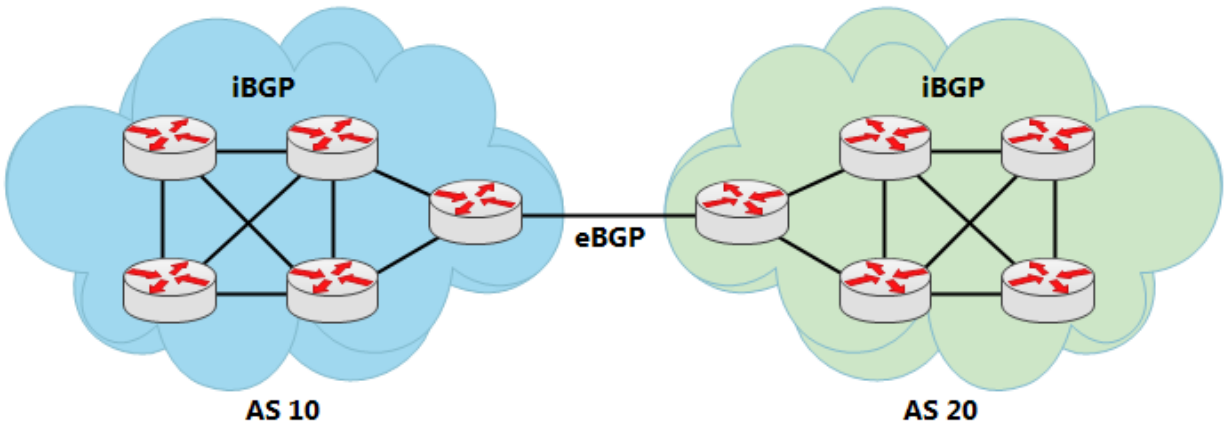
BGP menggunakan TCP port 179 untuk transport protocol. Agar 2 router BGP saling peer atau saling menjadi neighbor, harus dibangun TCP connection terlebih dahulu, setelah itu baru dapat dilakukan pertukaran informasi routing BGP antara 2 router.

BGP menentukan route berdasarkan kebijakan AS yang dilewati (Policy Based). Berbeda dengan protocol IGP yang menentukan route berdasarkan shortest path.

Setiap router BGP mempunyai Router ID, IP loopback tertinggi akan menjadi router ID, jika tidak ada loopback maka akan dipilih IP interface tertinggi.

eBGP dan iBGP

Ketika BGP berjalan didalam router-router dalam 1 AS, disebut iBGP. BGP yang berjalan antar AS disebut eBGP. eBGP harus direct connected antara 2 router, namun iBGP tidak harus direct connected selama ada IGP baik itu EIGRP, OSPF, atau static routing yang berjalan dan menjadikan 2 router BGP tadi reachable satu sama lain.



iBGP juga digunakan ketika suatu AS menjadi transit AS menuju AS lain. Pertanyaannya, Kenapa tidak menggunakan IGP saja? RIP, EIGRP atau OSPF lalu diredistribute? Hal ini karena iBGP lebih efisien dan fleksibel untuk pertukaran routing information dalam suatu AS.

iBGP memberikan kebebasan untuk menentukan pintu keluar atau exit point suatu route dengan kesediaan attribute yang banyak. Alasan lainnya, banyak prefix akan memenuhi tabel routing jika dilakukan redistribute IGB dan BGP. Bayangkan saja, ada berapa ribu prefix di internet?

iBGP harus full mesh atau route reflector.

Source Update via Loopback

Ketika interface yang dijadikan source update down, maka adjency BGP juga ajan down. Karena physical interface bisa down kapan saja, maka digunakan source update via loopback karena interface loopback tidak akan down. Umumnya digunakan dalam iBGP.

Route Map

Dalam BGP, route map digunakan untuk mengontrol dan memodifikasi informasi routing untuk incoming routes dan outcoming routes.

Attribute BGP

Attribute dalam BGP juga sering disebut path attribute. Ada beberapa jenis attribute dalam BGP:

WELL KNOWN = ada pada setiap BGP

- Mandatory = ter-include pada setiap route BGP, jika attribute ini tidak ada akan muncul error message. Harus disertakan dalam setiap update.
  - AS Path
  - Origin
  - Next Hop
- Discreationay = setiap BGP … namun tidak tampil pada setiap route entry.
  - local preference
  - Atomic Aggregate

OPTIONAL

- Transitive
  - Community
  - Aggregator
- Non-Transitive

- Multi Exit Discriminator (MED)

AS Path

Ketika packet update route dikirim melewati suatu AS, maka AS Number tersebut akan ditambahkan ke dalam packet update. Jadi AS Path adalah urutan AS Number yang dilewati suatu route untuk sampai ke destination. Karena hal ini juga, BGP disebut juga path-vector protocol.

AS Path digunakan untuk loop detection.

Origin

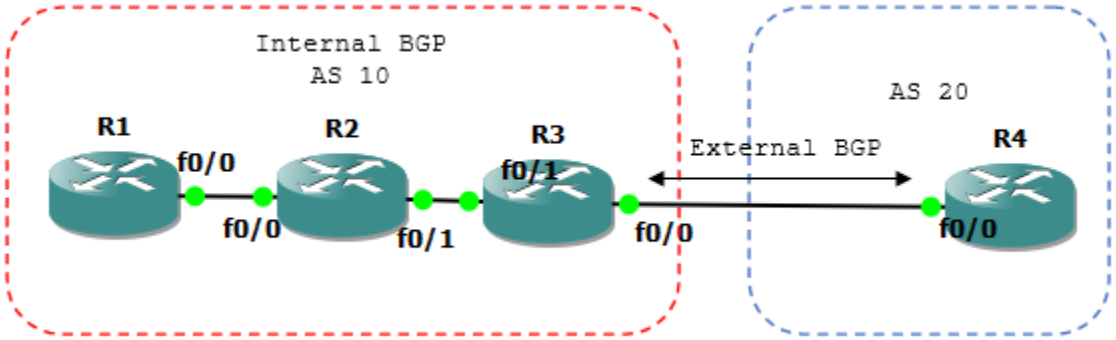
Origin mendefinisikan asal dari suatu path information. Ada 3 value dari origin attribute.

- IGP (i) = berasal dari BGP baik iBGP atau eBGP dengan perintah network x.x.x.x mask x.x.x.x
- EGP (e) = berasal dari protocol EGP, saat ini sudah tidak ada.
- INCOMPLETE (?) = berasal dari protocol lain(RIP, EIGRP, OSPF, Static) yang diredistribute ke BGP.

BGP Route Selection Process

- Step 1: Prefer highest weight (local to router)
- Step 2: Prefer highest local preference (global within AS)
- Step 3: Prefer route originated by the local router
- Step 4: Prefer shortest AS path
- Step 5: Prefer lowest origin code (IGP < EGP < incomplete)
- Step 6: Prefer lowest MED (from other AS)
- Step 7: Prefer EBGP path over IBGP path
- Step 8: Prefer the path through the closest IGP neighbor
- Step 9: Prefer oldest route for EBGP paths
- Step 10: Prefer the path with the lowest neighbor BGP router ID

BGP – iBGP Configuration



Ketikkan konfigurasi interface berikut.

```
R1(config)#int fa0/0
R1(config-if)#ip add 12.12.12.1 255.255.255.0
R1(config-if)#no sh
R1(config-if)#router ospf 1
R1(config-router)#net 0.0.0.0 255.255.255.255 area 0

R2(config)#int fa0/0
R2(config-if)#ip add 12.12.12.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#int f0/1
R2(config-if)#ip add 23.23.23.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#router ospf 1
R2(config-router)#net 0.0.0.0 255.255.255.255 area 0

R3(config)#int fa0/1
R3(config-if)#ip add 23.23.23.3 255.255.255.0
R3(config-if)#no sh
R3(config-if)#int fa0/0
R3(config-if)#ip add 34.34.34.3 255.255.255.0
R3(config-if)#no sh
R3(config-if)#router ospf 1
R3(config-router)#net 0.0.0.0 255.255.255.255 area 0
R3(config-router)#passive-interface fa0/0

R4(config)#int fa0/0
R4(config-if)#ip add 34.34.34.4 255.255.255.0
R4(config-if)#no sh
```

Oke pastikan R1 dapat mengeping R3.

```
R1(config-router)#do ping 23.23.23.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 23.23.23.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/63/120 ms
R1(config-router)#
```

Konfigurasi iBGP antara R1 dengan R3 terlebih dahulu.

```
R1(config)#router bgp 10
```

```
R1(config-router)#neighbor 23.23.23.3 remote-as 10

R3(config)#router bgp 10
R3(config-router)#neighbor 12.12.12.1 remote-as 10

Cek show ip bgp summary pastikan sudah neighbornya sudah ada.

R1(config-router)#do sh ip bgp sum
BGP router identifier 12.12.12.1, local AS number 10
BGP table version is 1, main routing table version 1

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
23.23.23.3      4    10       6       6        1    0    0 00:03:24        0
R1(config-router)#

R3(config-router)#do sh ip bgp sum
BGP router identifier 34.34.34.3, local AS number 10
BGP table version is 1, main routing table version 1

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
12.12.12.1      4    10       6       6        1    0    0 00:03:43        0
R3(config-router)#
```

Oke sekarang buat interface loopback yang akan di advertise ke iBGP.

```
R1(config-router)#int lo11
R1(config-if)#ip add 11.11.11.11 255.255.255.255

R1(config-if)#router bgp 10
R1(config-router)#network 11.11.11.11 mask 255.255.255.255
```

Sekarang cek di R3, pastikan State/PfxRcd sudah tidak 0 lagi.

```
R3(config-router)#do sh ip bgp sum
BGP router identifier 34.34.34.3, local AS number 10
BGP table version is 3, main routing table version 3
1 network entries using 120 bytes of memory
1 path entries using 52 bytes of memory
2/1 BGP path/bestpath attribute entries using 248 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 420 total bytes of memory
BGP activity 1/0 prefixes, 1/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down State/PfxRcd
12.12.12.1      4    10      10       9        3    0    0 00:06:07        1
```

Cek network yang diadvertise.

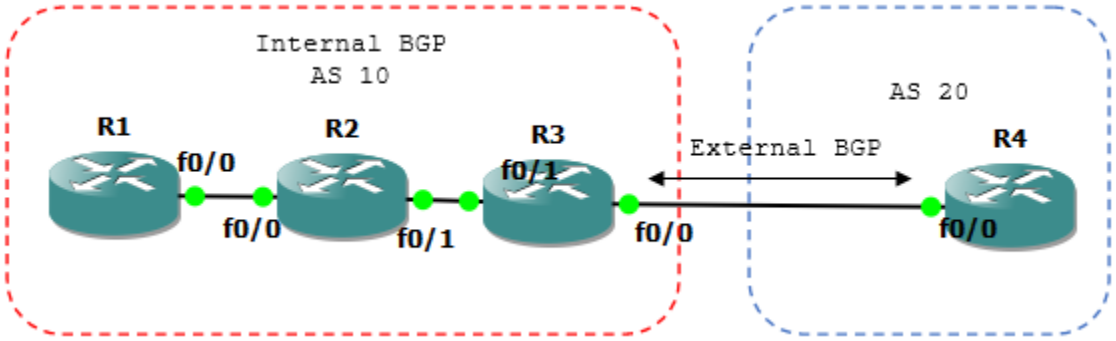
```
R3(config-router)#do sh ip bgp
BGP table version is 3, local router ID is 34.34.34.3
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
```

```
   Network          Next Hop            Metric LocPrf Weight Path
r>i11.11.11.11/32   12.12.12.1               0    100      0 i
```

Cek ping dan sukses.

```
R3(config-router)#do ping 11.11.11.11

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 11.11.11.11, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/72/96 ms
R3(config-router)#
```

BGP – iBGP Update via Loopback



Interface fisik bisa down sewaktu-waktu sehingga adjency BGP juga bisa drop. Karena itu adjency BGP dilakukan melalui loopback.

Buat dulu interface loopback nya.

```
R1(config)#int lo0
R1(config-if)#ip add 1.1.1.1 255.255.255.255

R3(config)#int lo0
R3(config-if)#ip add 3.3.3.3 255.255.255.255

Sekarang konfigurasikan loopback sebagai neighbor.

R1(config-if)#router bgp 10
R1(config-router)#neighbor 3.3.3.3 remote-as 10

R3(config-if)#router bgp 10
R3(config-router)#neighbor 1.1.1.1 remote-as 10
```

Oke sekarang cek neighbor BGP nya.

```
R3(config-router)#do sh ip bgp sum
BGP router identifier 34.34.34.3, local AS number 10
BGP table version is 3, main routing table version 3
1 network entries using 120 bytes of memory
1 path entries using 52 bytes of memory
2/1 BGP path/bestpath attribute entries using 248 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
```

```
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 420 total bytes of memory
BGP activity 1/0 prefixes, 1/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
1.1.1.1         4    10       0       0        0    0    0 never    Active
12.12.12.1      4    10       8       7        3    0    0 00:04:20        1
```

Ups... ternyata adjency melalui loopback belum berhasil, walau state sudah active tapi PfxRcd masih belum ada. Tambahkan perintah berikut.

```
R3(config-router)#neighbor 1.1.1.1 update-source loopback0
*Mar  1 00:06:33.639: %BGP-5-ADJCHANGE: neighbor 1.1.1.1 Up

R1(config-router)#neighbor 3.3.3.3 update-source loopback0
*Mar  1 00:06:20.067: %BGP-5-ADJCHANGE: neighbor 3.3.3.3 Up
```

Oke cek lagi.

```
R3(config-router)#do sh ip bgp sum
BGP router identifier 34.34.34.3, local AS number 10
BGP table version is 3, main routing table version 3
1 network entries using 120 bytes of memory
2 path entries using 104 bytes of memory
2/1 BGP path/bestpath attribute entries using 248 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 472 total bytes of memory
BGP activity 1/0 prefixes, 2/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
1.1.1.1         4    10      11      10        3    0    0 00:06:02        1
12.12.12.1      4    10      15      14        3    0    0 00:11:08        1
R3(config-router)#
```

Sip... sudah berubah. Hapus dulu adjency 12.12.12.1 dan 23.23.23.3.

```
R3(config-router)#no neighbor 12.12.12.1
*Mar  1 00:14:47.347: %BGP-5-ADJCHANGE: neighbor 12.12.12.1 Down Neighbor
deleted

R1(config-router)#
*Mar  1 00:14:33.951: %BGP-5-ADJCHANGE: neighbor 23.23.23.3 Down Peer closed
the session
R1(config-router)#no neighbor 23.23.23.3
```

Oke cek lagi dan neighbor nya hanya ada 1.

```
R3(config-router)#do sh ip bgp sum
BGP router identifier 34.34.34.3, local AS number 10
BGP table version is 4, main routing table version 4
1 network entries using 120 bytes of memory
1 path entries using 52 bytes of memory
2/1 BGP path/bestpath attribute entries using 248 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 420 total bytes of memory
BGP activity 1/0 prefixes, 2/1 paths, scan interval 60 secs
```

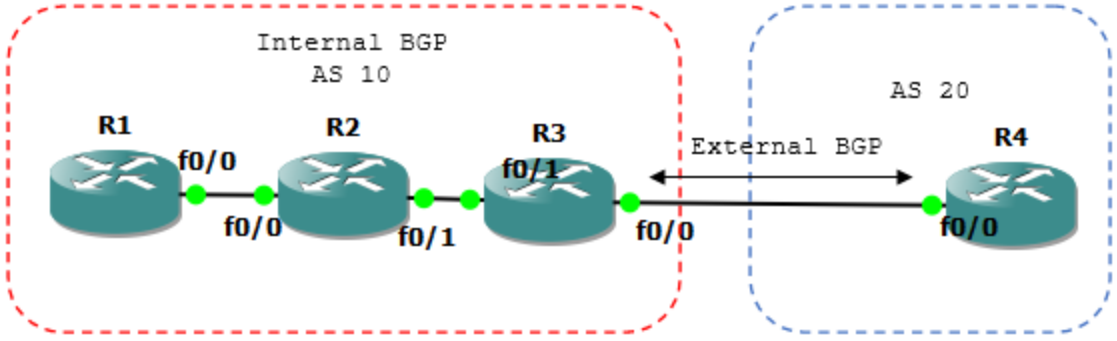
```
Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
1.1.1.1         4    10      14      13        4    0    0 00:09:13        1
R3(config-router)#
```

Dan yang terakhir, tes ping.

```
R3(config-router)#do ping 11.11.11.11

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 11.11.11.11, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/87/140 ms
R3(config-router)#
```

Siipp... berhasil.

BGP – eBGP Configuration



Konfigurasi eBGP pada R3 dan R4.

```
R3(config)#router bgp 10
R3(config-router)#neighbor 34.34.34.4 remote-as 20
*Mar  1 00:03:03.087: %BGP-5-ADJCHANGE: neighbor 34.34.34.4 Up

R4(config)#router bgp 20
R4(config-router)#neighbor 34.34.34.3 remote-as 10
*Mar  1 00:02:03.487: %BGP-5-ADJCHANGE: neighbor 34.34.34.3 Up
```

Cek neighbor.

```
R4(config-router)#do sh ip bgp sum
Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
34.34.34.3      4    10       5       4        2    0    0 00:00:02        1
R4(config-router)#

R3(config-router)#do sh ip bgp sum
Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
1.1.1.1         4    10       7       6        3    0    0 00:03:49        1
34.34.34.4      4    20       6       7        3    0    0 00:02:06        0
```

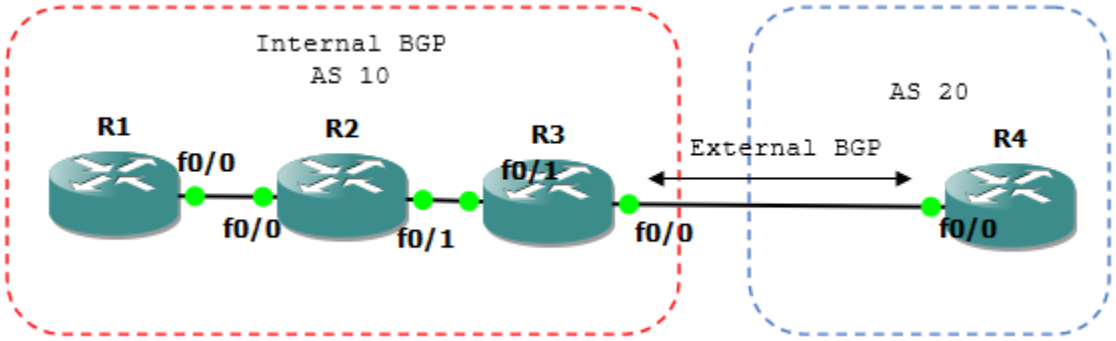
Oke sekarang cek tabek bgp dan tes ping.

```
R4#sh ip bgp
BGP table version is 2, local router ID is 34.34.34.4
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 11.11.11.11/32   34.34.34.3                           0 10 i
R4(config-router)#do ping 11.11.11.11

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 11.11.11.11, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 68/94/148 ms
R4(config-router)#
```

Berhasil. Path menunjukkan bahwa network 11.11.11.11 diadvertise ke dalam iBGP (ditandai dengan i) dari AS 10.

Oke fix.

BGP – eBGP Configuration 2



Oke lanjutan lab sebelumnya. Buatlah interface loopback di R4 dan advertise ke BGP 20.

```
R4(config)#int lo44
*Mar  1 00:18:42.419: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Loopback44, changed state to up
R4(config-if)#ip add 44.44.44.44 255.255.255.255
R4(config-if)#router bgp 20
R4(config-router)#network 44.44.44.44 mask 255.255.255.255
R4(config-router)#do sh ip bgp
BGP table version is 3, local router ID is 34.34.34.4
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
```

```
   Network          Next Hop            Metric LocPrf Weight Path
*> 11.11.11.11/32   34.34.34.3                             0 10 i
*> 44.44.44.44/32   0.0.0.0                  0         32768 i
R4(config-router)#
```

Sekarang coba ping dari R3.

```
R3#ping 44.44.44.44

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 44.44.44.44, timeout is 2 seconds:
!!!!!
Succes
```

Klo dari R1?

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 44.44.44.44, timeout is 2 seconds:
UUUUU
Success rate is 0 percent (0/5)

R1#sh ip route
Gateway of last resort is not set

     34.0.0.0/24 is subnetted, 1 subnets
O       34.34.34.0 [110/30] via 12.12.12.2, 00:23:17, FastEthernet0/0
     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/21] via 12.12.12.2, 00:23:17, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
O       23.23.23.0 [110/20] via 12.12.12.2, 00:23:17, FastEthernet0/0
     11.0.0.0/32 is subnetted, 1 subnets
C       11.11.11.11 is directly connected, Loopback11
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
     44.0.0.0/32 is subnetted, 1 subnets
B       44.44.44.44 [200/0] via 34.34.34.4, 00:04:24
R1#
```

Upsss... unreachable. Padahal network 44.44.44.44 sudah ada di tabel routing. Coba di traceroute dulu ah.

```
R1#traceroute 44.44.44.44

Type escape sequence to abort.
Tracing the route to 44.44.44.44

  1 12.12.12.2 76 msec 80 msec 44 msec
  2 12.12.12.2 !H  !H  !H
R1#
```

Ternyata berhenti di R2. Lalu bagaimana solusinya? Cek tabel routing pada R4.

```
R4#sh ip ro
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
```

```
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     34.0.0.0/24 is subnetted, 1 subnets
C       34.34.34.0 is directly connected, FastEthernet0/0
     23.0.0.0/24 is subnetted, 1 subnets
B       23.23.23.0 [20/0] via 34.34.34.3, 00:01:22
     11.0.0.0/32 is subnetted, 1 subnets
B       11.11.11.11 [20/0] via 34.34.34.3, 00:02:38
     44.0.0.0/32 is subnetted, 1 subnets
C       44.44.44.44 is directly connected, Loopback44
R4#
```

Ternyata hanya ada IP 11.11.11.11 yang dikenali. Gunakan IP tersebut sebagai source.

```
R1#ping
Protocol [ip]:
Target IP address: 44.44.44.44
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 11.11.11.11
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 44.44.44.44, timeout is 2 seconds:
Packet sent with a source address of 11.11.11.11
UUUUU
Success rate is 0 percent (0/5)
R1#
```

Upss... ternyata masih belum bisa. Disitu kadang saya merasa sedih...

Caranya... angkat R2 menjadi iBGP juga. Syarat iBGP adalah full mesh atau bisa juga route reflector. Klo full mesh berarti setiap router harus punya satu link ke setiap router lain.

```
R2(config)#int lo0
R2(config-if)#ip add 2.2.2.2 255.255.255.255
R2(config-if)#router bgp 10
R2(config-router)#neighbor 1.1.1.1 remote-as 10
R2(config-router)#neighbor 1.1.1.1 up lo0
R2(config-router)#neighbor 3.3.3.3 remote-as 10
R2(config-router)#neighbor 3.3.3.3 up lo0

R1(config)#router bgp 10
```

```
R1(config-router)#neighbor 2.2.2.2 remote-as 10
R1(config-router)#neighbor 2.2.2.2 up lo0

R3(config)#router bgp 10
R3(config-router)#neighbor 2.2.2.2 remot 10
R3(config-router)#neighbor 2.2.2.2 up lo0
```

Oke cek lagi.

```
R1#ping
Protocol [ip]:
Target IP address: 44.44.44.44
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 11.11.11.11
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 44.44.44.44, timeout is 2 seconds:
Packet sent with a source address of 11.11.11.11
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 144/196/264 ms
R1#
```

Hal ini dikarenakan secara default source yang dipakai untuk ping adalah interface phisicalnya. Jadi tinggal advertise network interfacenya ke dalam BGP.

```
R1(config)#router bgp 10
R1(config-router)#network 12.12.12.0 mask 255.255.255.0
R1(config-router)#do ping 44.44.44.44

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 44.44.44.44, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/150/204 ms
R1(config-router)#
```

Oke sekarang coba ping 44.44.44.44 dari R2.

```
R2#ping 44.44.44.44

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 44.44.44.44, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
R2#tra
R2#traceroute 44.44.44.44

Type escape sequence to abort.
Tracing the route to 44.44.44.44

  1 23.23.23.3 72 msec 72 msec 68 msec
```

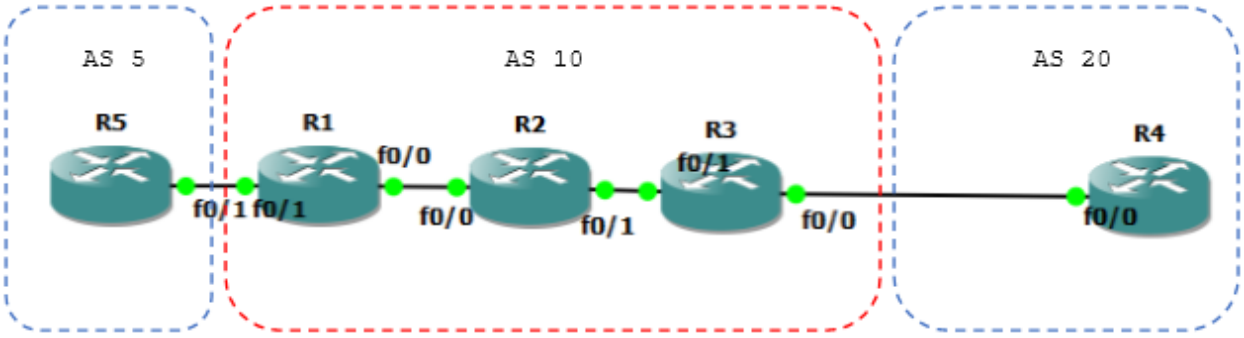
```
  2   *   *   *
  3
R2#
```

Gagal ya? Trace nya berakhir di R3. Klo begitu advertise network 23.23.23.0 pada R3 ke BGP.

```
R3(config)#router bgp 10
R3(config-router)#net 23.23.23.0 mask 255.255.255.0

R2#ping 44.44.44.44

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 44.44.44.44, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 68/102/144 ms
R2#
```

Good Job...

BGP – eBGP Configuration 3



Masih pake topologi sebelumnya cuma tambahin R5 disebelah kiri.

```
R1(config)#int fa0/1
R1(config-if)#ip add 15.15.15.1 255.255.255.0
R1(config-if)#no sh
R1(config-if)#router bgp 10
R1(config-router)#nei 15.15.15.5 remot 5

R5(config)#int fa0/1
R5(config-if)#ip add 15.15.15.5 255.255.255.0
R5(config-if)#no sh
R5(config-if)#router bgp 5
R5(config-router)#neighbor 15.15.15.1 remot 10

R5(config-router)#do sh ip bgp
BGP table version is 4, local router ID is 15.15.15.5
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
```

```
   Network          Next Hop            Metric LocPrf Weight Path
*> 11.11.11.11/32   15.15.15.1               0             0 10 i
*> 12.12.12.0/24    15.15.15.1               0             0 10 i
*> 44.44.44.44/32   15.15.15.1                             0 10 20 i
R5(config-router)#
```

Sekarang ping dan trace ke R4 pada AS 20.

```
R5#ping 44.44.44.44

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 44.44.44.44, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
R5#trac 44.44.44.44

Type escape sequence to abort.
Tracing the route to 44.44.44.44

  1 15.15.15.1 92 msec 76 msec 92 msec
  2 12.12.12.2 [AS 10] 96 msec 60 msec 60 msec
  3 23.23.23.3 152 msec 156 msec 88 msec
  4
R5#
```

Ups gagal... solusinya R5 harus mengadvertise source network nya.

```
R5(config)#router bgp 5
R5(config-router)#network 15.15.15.0 mask 255.255.255.0
R5#ping 44.44.44.44

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 44.44.44.44, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 188/251/304 ms
R5#
```

Sekarang kita lakukan sedikit percobaan. Hapus bgp 10 pada R2. Sebelumnya copy dulu konfigurasi BGP nya ke notepad.

```
R2#sh run | s r b
router bgp 10
 no synchronization
 bgp log-neighbor-changes
 neighbor 1.1.1.1 remote-as 10
 neighbor 1.1.1.1 update-source Loopback0
 neighbor 3.3.3.3 remote-as 10
 neighbor 3.3.3.3 update-source Loopback0
 no auto-summary

R2(config)#no router bgp 10
*Mar  1 00:10:49.335: %BGP-5-ADJCHANGE: neighbor 1.1.1.1 Down BGP protocol
initialization
*Mar  1 00:10:49.335: %BGP-5-ADJCHANGE: neighbor 3.3.3.3 Down BGP protocol
initialization
```

Cek ping R5 ke R4.

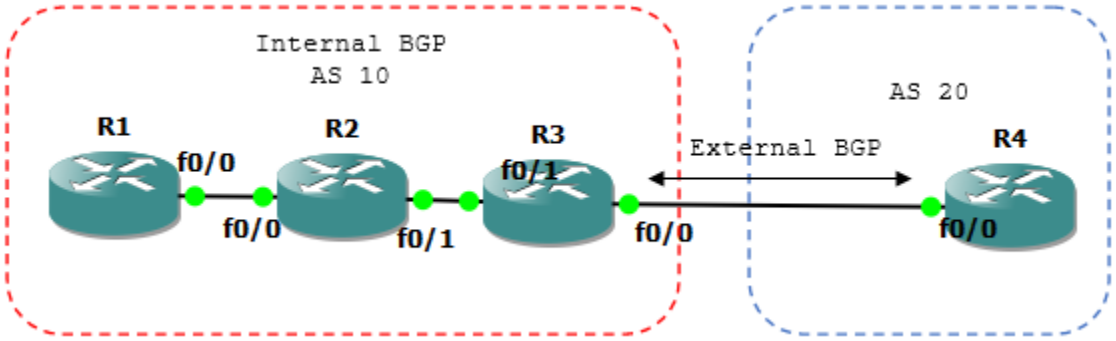
```
R5#ping 44.44.44.44

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 44.44.44.44, timeout is 2 seconds:
UUUUU
Success rate is 0 percent (0/5)
R5#
```

Sekarang balikin lagi konfigurasi BGP 10 ke R2 dan cek lagi.

```
R5#ping 44.44.44.44

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 44.44.44.44, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 156/218/276 ms
R5#
```

Oke sip. Kesimpulannya? ... Tulis sendiri ya.

BGP – Next Hop Self



Lanjutin lab 4 yang lebih simpel dan enteng.

```
R2#sh ip route
Gateway of last resort is not set

     34.0.0.0/24 is subnetted, 1 subnets
O       34.34.34.0 [110/20] via 23.23.23.3, 00:01:53, FastEthernet0/1
     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/11] via 12.12.12.1, 00:01:53, FastEthernet0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/11] via 23.23.23.3, 00:01:53, FastEthernet0/1
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/1
     11.0.0.0/32 is subnetted, 1 subnets
O       11.11.11.11 [110/11] via 12.12.12.1, 00:01:54, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
     44.0.0.0/32 is subnetted, 1 subnets
```

```
B       44.44.44.44 [200/0] via 34.34.34.4, 00:01:06
R2#sh ip bgp
BGP table version is 8, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
r>i11.11.11.11/32   1.1.1.1                  0    100      0 i
r>i12.12.12.0/24    1.1.1.1                  0    100      0 i
r>i23.23.23.0/24    3.3.3.3                  0    100      0 i
*>i44.44.44.44/32   34.34.34.4               0    100      0 20 i
R2#
```

Ketika default network ospf R3 dihapus, maka route nya hilang.

```
R3(config)#router ospf 1
R3(config-router)#no network 0.0.0.0 255.255.255.255 area 0
Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/11] via 12.12.12.1, 00:05:18, FastEthernet0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/1
     11.0.0.0/32 is subnetted, 1 subnets
O       11.11.11.11 [110/11] via 12.12.12.1, 00:05:18, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
R2#sh ip bgp
BGP table version is 10, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
r>i11.11.11.11/32   1.1.1.1                  0    100      0 i
r>i12.12.12.0/24    1.1.1.1                  0    100      0 i
* i23.23.23.0/24    3.3.3.3                  0    100      0 i
* i44.44.44.44/32   34.34.34.4               0    100      0 20 i
R2#
```

iBGP tidak memilih next-hop nya sendiri, dalam hal ini dia numpang sama OSPF. Karena OSPF dihapus, maka route BGP tidak muncul dalam tabel routing. Namun, kita bisa mengkonfigurasi next-hop secara manual pada iBGP.

```
R2(config-router)#router bgp 10
R2(config-router)#neighbor 23.23.23.3 remot 10

R3(config-router)#router bgp 10
R3(config-router)#neighbor 23.23.23.2 remot 10
R3(config-router)#neighbor 23.23.23.2 next-hop-self
```

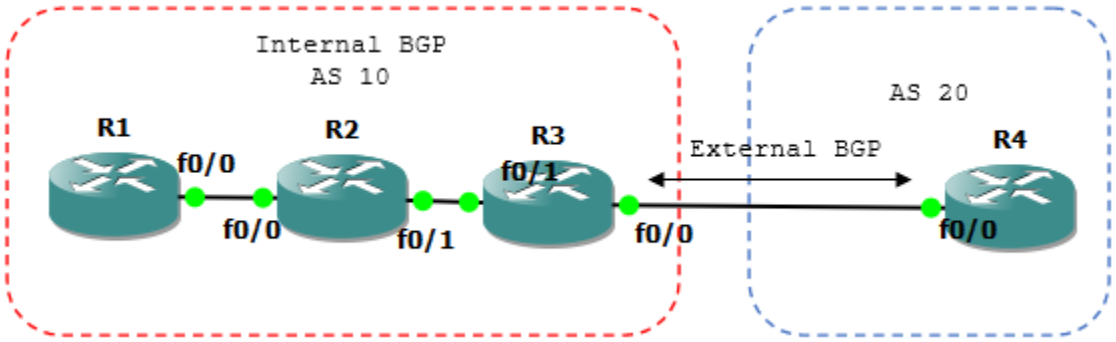
Sekarang cek lagi.

```
R2#sh ip bgp sum
BGP router identifier 2.2.2.2, local AS number 10
BGP table version is 13, main routing table version 13
4 network entries using 480 bytes of memory
4 path entries using 208 bytes of memory
3/2 BGP path/bestpath attribute entries using 372 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1084 total bytes of memory
BGP activity 6/2 prefixes, 6/2 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
1.1.1.1         4    10      18      16       13    0    0 00:13:04        2
3.3.3.3         4    10      10      12        0    0    0 00:06:10 Active
23.23.23.3      4    10       8       6       13    0    0 00:02:33        2
R2#sh ip bgp
BGP table version is 13, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
r>i11.11.11.11/32   1.1.1.1                  0    100      0 i
r>i12.12.12.0/24    1.1.1.1                  0    100      0 i
r>i23.23.23.0/24    23.23.23.3               0    100      0 i
*>i44.44.44.44/32   23.23.23.3               0    100      0 20 i
R2#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/11] via 12.12.12.1, 00:13:39, FastEthernet0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     23.0.0.0/24 is subnetted, 1 subnets
C       23.23.23.0 is directly connected, FastEthernet0/1
     11.0.0.0/32 is subnetted, 1 subnets
O       11.11.11.11 [110/11] via 12.12.12.1, 00:13:39, FastEthernet0/0
     12.0.0.0/24 is subnetted, 1 subnets
C       12.12.12.0 is directly connected, FastEthernet0/0
     44.0.0.0/32 is subnetted, 1 subnets
B       44.44.44.44 [200/0] via 23.23.23.3, 00:02:49
R2#ping 44.44.44.44

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 44.44.44.44, timeout is 2 seconds:
```

```
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 48/78/112 ms
R2#
```

Sip dah.

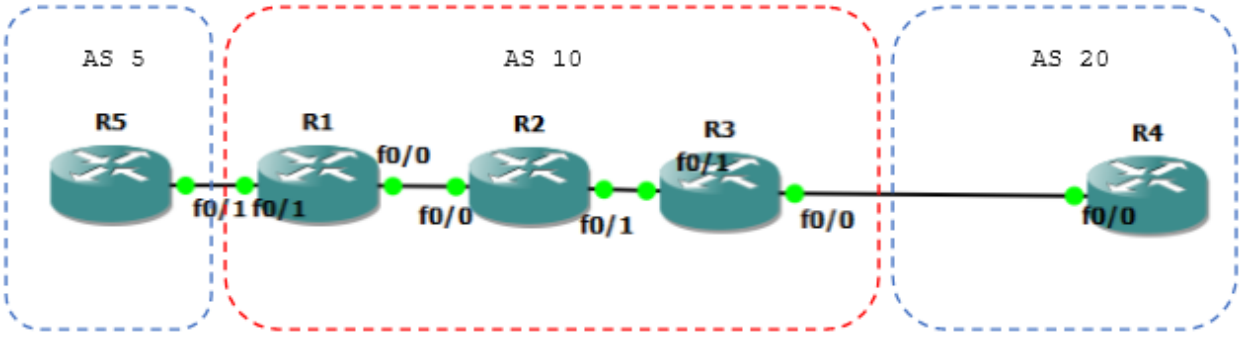
BGP – Authentication




```
R2(config)#router bgp 10
R2(config-router)#neighbor 1.1.1.1 password ?
  <0-7>  Encryption type (0 to disable encryption, 7 for proprietary)

R2(config-router)#neighbor 1.1.1.1 password 0 HAHAHA

R1(config)#router bgp 10
R1(config-router)#neighbor 2.2.2.2 password 0 HAHAHA
*Mar  1 00:05:09.383: %BGP-3-NOTIFICATION: received from neighbor 2.2.2.2
4/0 (hold time expired) 0 bytes
R1(config)#
*Mar  1 00:05:09.383: %BGP-5-ADJCHANGE: neighbor 2.2.2.2 Down BGP
Notification received
*Mar  1 00:05:36.667: %BGP-5-ADJCHANGE: neighbor 2.2.2.2 Up
```

Oke selesai. Gampangkan.

BGP Route Reflector



Balik lagi ke topologi lab 5. Pada iBGP, peers nya harus full mesh. Masalah terjadi ketika ada router baru yang tersambung. Artinya harus dikonfigurasi peer yang baru satu per satu.

Solusinya adalah menjadikan salah saru router menjadi Route Reflector(RR) sehingga hanya RR yang full mesh ke semua router sedang router lain hanya perlu peer ke RR.

Yang mau kita konfigurasi adalah iBGP AS 10. R1 akan kita jadikan RR.

```
R1#sh run | s r b
router bgp 10
 no synchronization
 bgp log-neighbor-changes
 network 11.11.11.11 mask 255.255.255.255
 network 12.12.12.0 mask 255.255.255.0
 neighbor 2.2.2.2 remote-as 10
 neighbor 2.2.2.2 update-source Loopback0
 neighbor 3.3.3.3 remote-as 10
 neighbor 3.3.3.3 update-source Loopback0
 neighbor 15.15.15.5 remote-as 5
 no auto-summary
R1#
```

Karena sudah dikonfigurasi sebelumnya, tinggal mengeset route-reflector-client aja.

```
R1(config)#router bgp 10
R1(config-router)#neighbor 2.2.2.2 route-reflector-client
R1(config-router)#neighbor 3.3.3.3 route-reflector-client
*Mar  1 00:11:20.291: %BGP-5-ADJCHANGE: neighbor 2.2.2.2 Down RR client
config change
R1(config-router)#neighbor 2.2.2.2 route-reflector-client
*Mar  1 00:11:22.543: %BGP-5-ADJCHANGE: neighbor 2.2.2.2 Up
*Mar  1 00:11:30.891: %BGP-5-ADJCHANGE: neighbor 3.3.3.3 Down RR client
config change
*Mar  1 00:11:33.275: %BGP-5-ADJCHANGE: neighbor 3.3.3.3 Up
```

Sekarang hapus peer pada R2 dan R3 yang tidak mengarah ke R1.

```
R2(config-router)#no neighbor 3.3.3.3 remot 10
R3(config-router)#no neighbor 2.2.2.2 remot 10
```

Untuk pengecekan, buat interface loopback dan advertise ke iBGP.

```
R2(config)#int lo22
R2(config-if)#ip add 22.22.22.22 255.255.255.255
R2(config-if)#router bgp 10
R2(config-router)#net 22.22.22.22 mask 255.255.255.255
```

Pastikan R1 dan R3 bisa ping.

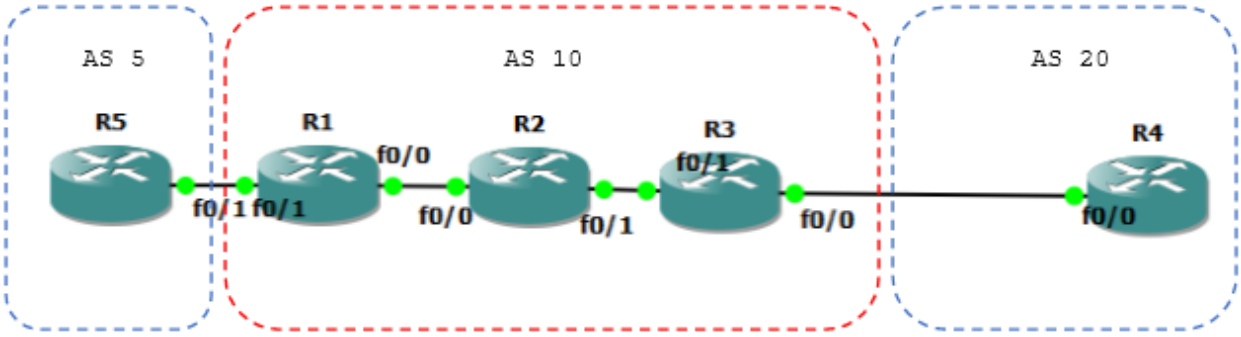
```
R1#ping 22.22.22.22

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 22.22.22.22, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/52/80 ms
R1#
R3#ping 22.22.22.22

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 22.22.22.22, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/53/88 ms
R3#
```

Dan ketika dicek, peer atau networknya hanya ada satu.

```
R2#sh ip bgp sum
BGP router identifier 2.2.2.2, local AS number 10
BGP table version is 19, main routing table version 19
5 network entries using 600 bytes of memory
5 path entries using 260 bytes of memory
5/4 BGP path/bestpath attribute entries using 620 bytes of memory
1 BGP rrinfo entries using 24 bytes of memory
2 BGP AS-PATH entries using 48 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
Bitfield cache entries: current 1 (at peak 1) using 32 bytes of memory
BGP using 1584 total bytes of memory
BGP activity 5/0 prefixes, 10/5 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
1.1.1.1         4    10      35      28       19    0    0 00:10:28        4
R2#
```

Oke fix.

BGP Attribute – Origin



Buat interface loopback untuk diredistribute ke BGP.

```
R2(config)#int lo222
R2(config-if)#ip add 222.222.222.222 255.255.255.255
R2(config-if)#router rip
R2(config-router)#net 222.222.222.0
R2(config-router)#router bgp 10
R2(config-router)#redistribute rip

R5#sh ip bgp
BGP table version is 8, local router ID is 15.15.15.5
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network            Next Hop            Metric LocPrf Weight Path
*> 11.11.11.11/32     15.15.15.1               0             0 10 i
*> 12.12.12.0/24      15.15.15.1               0             0 10 i
*> 15.15.15.0/24      0.0.0.0                  0         32768 i
*> 22.22.22.22/32     15.15.15.1                             0 10 i
*> 23.23.23.0/24      15.15.15.1                             0 10 i
*> 44.44.44.44/32     15.15.15.1                             0 10 20 i
*> 222.222.222.222/32 15.15.15.1                             0 10 ?
R5#ping 222.222.222.222

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 222.222.222.222, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/80/108 ms
R5#
```

Pada path ada beberapa keterangan origin code:

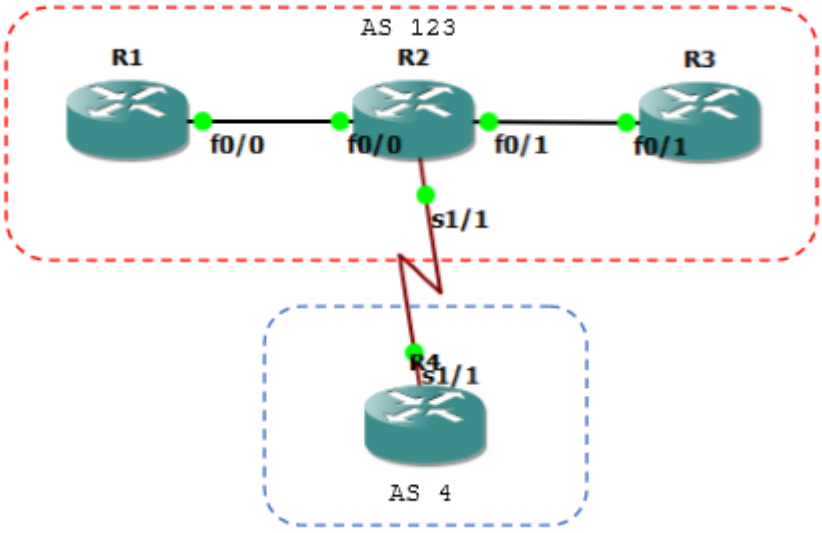
i = berasal dari BGP baik iBGP atau eBGP dengan perintah network x.x.x.x mask x.x.x.x

e = berasal dari protocol EGP, saat ini sudah tidak ada.

? = berasal dari protocol lain(RIP, EIGRP, OSPF, Static) yang diredistribute ke BGP.

R5 menuju 222.222.222.222/32 melalui 15.15.15.1 dengan path 10 ?. Artinya Next AS Path nya adalah 200 dengan origin code adalah ? artinya terjadi melalui redistribute protocol lain ke BGP.

BGP Attribute – Community




```
R1(config)#int lo0
R1(config-if)#ip add 1.1.1.1 255.255.255.255
R1(config-if)#int lo11
R1(config-if)#ip add 11.11.11.11 255.255.255.255
R1(config-if)#int fa0/0
R1(config-if)#ip add 12.12.12.1 255.255.255.0
R1(config-if)#router ospf 1
R1(config-router)#net 1.1.1.1 0.0.0.0 area 0
R1(config-router)#net 12.12.12.0 0.0.0.255 area 0

R2(config)#int lo0
R2(config-if)#ip add 2.2.2.2 255.255.255.255
R2(config-if)#int lo22
R2(config-if)#ip add 22.22.22.22 255.255.255.255
R2(config-if)#int fa0/0
R2(config-if)#no sh
R2(config-if)#ip add 12.12.12.2 255.255.255.0
R2(config-if)#int fa0/1
R2(config-if)#ip add 23.23.23.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#int s1/1
R2(config-if)#ip add 24.24.24.2 255.255.255.0
R2(config-if)#no sh
R2(config)#router ospf 1
R2(config-router)#net 2.2.2.2 0.0.0.0 area 0
R2(config-router)#net 12.12.12.0 0.0.0.255 area 0
R2(config-router)#net 24.24.24.0 0.0.0.255 area 0
```

```
R2(config-router)#net 23.23.23.0 0.0.0.255 area 0

R3(config)#int lo0
R3(config-if)#ip add 3.3.3.3 255.255.255.255
R3(config-if)#int lo33
R3(config-if)#ip add 33.33.33.33 255.255.255.255
R3(config-if)#int fa0/1
R3(config-if)#no sh
R3(config-if)#ip add 23.23.23.
R3(config-if)#ip add 23.23.23.3 255.255.255.0
R3(config-if)#router ospf 1
R3(config-router)#net 3.3.3.3 0.0.0.0 area 0
R3(config-router)#net 23.23.23.0 0.0.0.255 area 0

R4(config-if)#int lo0
R4(config-if)#ip add 4.4.4.4 255.255.255.255
R4(config-if)#int s1/1
R4(config-if)#ip add 24.24.24.24 255.255.255.0
R4(config-if)#no sh
```

Konfigurasi BGP. R1 sebagai RR.

```
R1(config-router)#router bgp 123
R1(config-router)#neighbor 2.2.2.2 remote-as 123
R1(config-router)#neighbor 2.2.2.2 update-source loopback0
R1(config-router)#network 11.11.11.11 mask 255.255.255.255

R2(config-router)#router bgp 123
R2(config-router)#neighbor 1.1.1.1 remote-as 123
R2(config-router)#neighbor 3.3.3.3 remote-as 123
R2(config-router)#neighbor 24.24.24.4 remote-as 4
R2(config-router)#neighbor 1.1.1.1 update-source loopback 0
R2(config-router)#neighbor 3.3.3.3 update-source loopback 0
R2(config-router)#neighbor 1.1.1.1 route-reflector-client
R2(config-router)#neighbor 3.3.3.3 route-reflector-client
R2(config-router)#network 22.22.22.22 mask 255.255.255.255

R3(config)#router bgp 123
R3(config-router)#neighbor 2.2.2.2 remote-as 123
R3(config-router)#neighbor 2.2.2.2 up lo0
R3(config-router)#network 33.33.33.33 mask 255.255.255.255

R4(config-if)#router bgp 4
R4(config-router)#neighbor 24.24.24.2 remot 123
R4(config-router)#network 4.4.4.4 mask 255.255.255.255
```

Sekarang cek bgp route di R1 dan R4.

```
R1#sh ip bgp
BGP table version is 4, local router ID is 11.11.11.11
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
* i4.4.4.4/32       24.24.24.4               0    100      0 4 i
*> 11.11.11.11/32   0.0.0.0                  0         32768 i
```

```
*>i22.22.22.22/32   2.2.2.2                  0    100      0 i
*>i33.33.33.33/32   3.3.3.3                  0    100      0 i
R1#

R4#sh ip bgp
BGP table version is 5, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 4.4.4.4/32       0.0.0.0                  0         32768 i
*> 11.11.11.11/32   24.24.24.2                             0 123 i
*> 22.22.22.22/32   24.24.24.2               0             0 123 i
*> 33.33.33.33/32   24.24.24.2                             0 123 i
R4#
```

Ada beberapa set-community dalam BGP:

no-export = network tidak diadvertise ke eBGP.

no-advertise = network tidak diadvertise ke iBGP/eBGP.

local-as = network hanya diadvertise ke iBGP Confederation(ada AS didalam AS).

Set comunity no-export di R1.

```
R1(config)#access-list 10 permit host 11.11.11.11
R1(config)#route-map NO-EXPORT
R1(config-route-map)#match ip address ?
  <1-199>      IP access-list number
  <1300-2699>  IP access-list number (expanded range)
  WORD         IP access-list name
  prefix-list  Match entries of prefix-lists
  <cr>

R1(config-route-map)#match ip address 10
R1(config-route-map)#set community ?
  <1-4294967295>  community number
  aa:nn           community number in aa:nn format
  additive        Add to the existing community
  internet        Internet (well-known community)
  local-AS        Do not send outside local AS (well-known community)
  no-advertise    Do not advertise to any peer (well-known community)
  no-export       Do not export to next AS (well-known community)
  none            No community attribute
  <cr>

R1(config-route-map)#set community no-export
R1(config-route-map)#router bgp 123
R1(config-router)#neighbor 2.2.2.2 route-map NO-EXPORT out
R1(config-router)#neighbor 2.2.2.2 send-community
```

Cek bgp di R4 pastikan network 11.11.11.11 tidak ada.

```
R4#sh ip bgp
```

```
BGP table version is 6, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 4.4.4.4/32       0.0.0.0                  0         32768 i
*> 22.22.22.22/32   24.24.24.2               0             0 123 i
*> 33.33.33.33/32   24.24.24.2                             0 123 i
R4#

R2#sh ip bgp 11.11.11.11
BGP routing table entry for 11.11.11.11/32, version 3
Paths: (1 available, best #1, table Default-IP-Routing-Table, not advertised
to EBGP peer)
Flag: 0x820
  Advertised to update-groups:
        2
  Local, (Received from a RR-client)
    1.1.1.1 (metric 11) from 1.1.1.1 (11.11.11.11)
      Origin IGP, metric 0, localpref 100, valid, internal, best
      Community: no-export
R2#
```

Set community no-advertise di R3.

```
R3(config)#access-list 10 permit host 33.33.33.33
R3(config)#route-map NO-ADVERTISE
R3(config-route-map)#match ip address 10
R3(config-route-map)#set community no-advertise
R3(config-route-map)#router bgp 123
R3(config-router)#neighbor 2.2.2.2 route-map NO-ADVERTISE out
R3(config-router)#neighbor 2.2.2.2 send-community
```

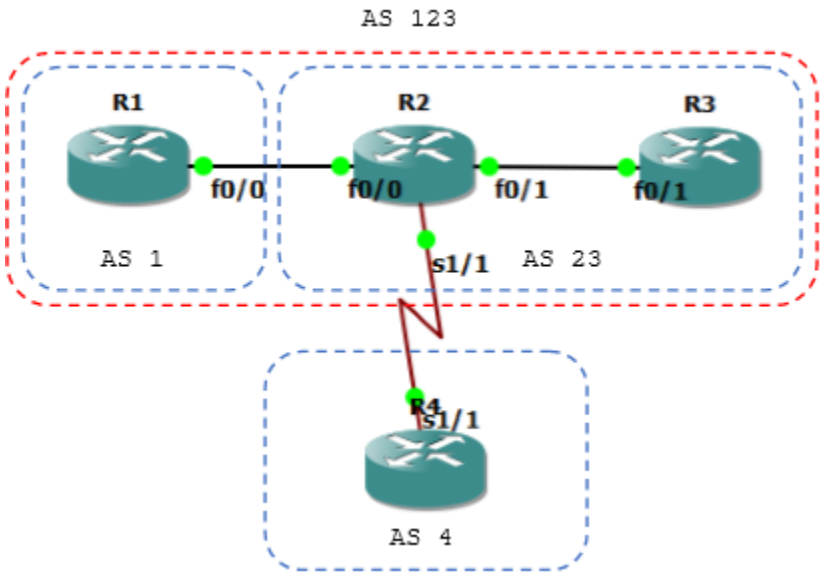
Cek di R1 dan R4 pastikan network 33.33.33.33 sudah tidak ada.

```
R1#sh ip bgp
BGP table version is 5, local router ID is 11.11.11.11
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
* i4.4.4.4/32       24.24.24.4               0    100      0 4 i
*> 11.11.11.11/32   0.0.0.0                  0         32768 i
*>i22.22.22.22/32   2.2.2.2                  0    100      0 i
R1#

R4#sh ip bgp
BGP table version is 7, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
```

```
*> 4.4.4.4/32       0.0.0.0                  0         32768 i
*> 22.22.22.22/32   24.24.24.2               0             0 123 i
R4#

R2#sh ip bgp 33.33.33.33
BGP routing table entry for 33.33.33.33/32, version 5
Paths: (1 available, best #1, table Default-IP-Routing-Table, not advertised
to any peer)
Flag: 0x820
  Not advertised to any peer
  Local, (Received from a RR-client)
    3.3.3.3 (metric 11) from 3.3.3.3 (33.33.33.33)
      Origin IGP, metric 0, localpref 100, valid, internal, best
      Community: no-advertise
R2#
```

Oke sip.

BGP Attribute - Community Local-AS and Configuring Confederation



Oke konfigurasi BGP Confederation, sebelumnya hapus dulu BGP 123.

```
R1(config)#no router bgp 123
R1(config)#router bgp 1
R1(config-router)# bgp confederation identifier 123
R1(config-router)# bgp confederation peers 23
R1(config-router)# network 11.11.11.11 mask 255.255.255.255
R1(config-router)# neighbor 12.12.12.2 remote-as 23

R2(config)#no router bgp 123
R2(config)#router bgp 23
R2(config-router)# bgp confederation identifier 123
R2(config-router)# bgp confederation peers 1
```

```
R2(config-router)# network 22.22.22.22 mask 255.255.255.255
R2(config-router)# neighbor 12.12.12.1 remote-as 1
R2(config-router)# neighbor 12.12.12.1 next-hop-self
R2(config-router)# neighbor 23.23.23.3 remote-as 23
R2(config-router)# neighbor 23.23.23.3 next-hop-self
R2(config-router)# neighbor 24.24.24.4 remote-as 4

R3(config)#no router bgp 123
R3(config)#router bgp 23
R3(config-router)# bgp confederation identifier 123
R3(config-router)# network 33.33.33.33 mask 255.255.255.255
R3(config-router)# neighbor 23.23.23.2 remote-as 23
```

Oke cek dulu.

```
R2(config-router)#do sh ip bgp sum
BGP router identifier 22.22.22.22, local AS number 23
BGP table version is 5, main routing table version 5
4 network entries using 480 bytes of memory
4 path entries using 208 bytes of memory
5/4 BGP path/bestpath attribute entries using 620 bytes of memory
2 BGP AS-PATH entries using 48 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
Bitfield cache entries: current 4 (at peak 4) using 128 bytes of memory
BGP using 1484 total bytes of memory
BGP activity 4/0 prefixes, 4/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
12.12.12.1      4     1       6       8        5    0    0 00:02:13        1
23.23.23.3      4    23       6       8        5    0    0 00:02:03        1
24.24.24.4      4     4       7       9        5    0    0 00:02:08        1
R2(config-router)#do sh ip bgp
BGP table version is 5, local router ID is 22.22.22.22
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 4.4.4.4/32       24.24.24.4               0             0 4 i
*> 11.11.11.11/32   12.12.12.1               0    100      0 (1) i
*> 22.22.22.22/32   0.0.0.0                  0         32768 i
*>i33.33.33.33/32   23.23.23.3               0    100      0 i
R2(config-router)#

R1(config-router)#do sh ip bgp
BGP table version is 5, local router ID is 11.11.11.11
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 4.4.4.4/32       12.12.12.2               0    100      0 (23) 4 i
*> 11.11.11.11/32   0.0.0.0                  0         32768 i
```

```
*> 22.22.22.22/32   12.12.12.2               0    100      0 (23) i
*> 33.33.33.33/32   12.12.12.2               0    100      0 (23) i
R1(config-router)#
```

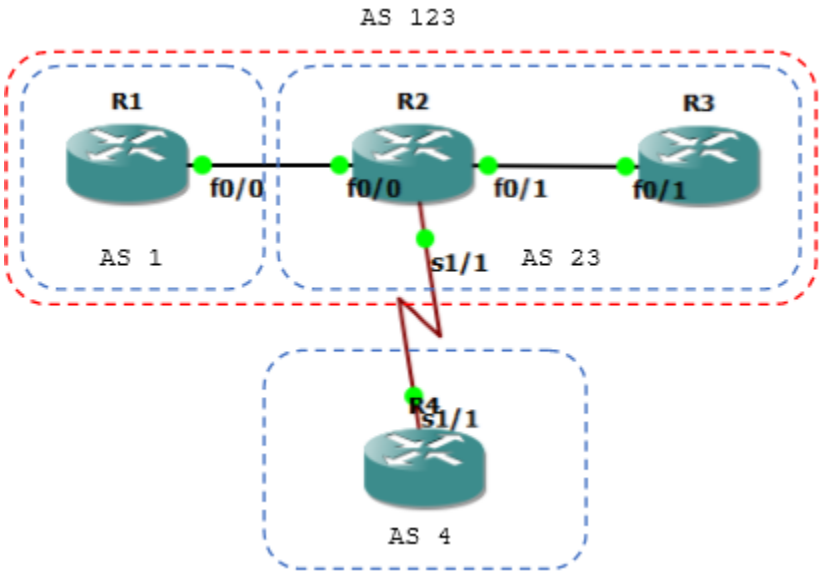
Sekarang set community local-as pada R3.

```
R3(config)#access-list 20 permit host 33.33.33.33
R3(config)#route-map LOCAL-AS
R3(config-route-map)#match ip address 20
R3(config-route-map)#set community local-AS
R3(config-route-map)#router bgp 23
R3(config-router)#neighbor 23.23.23.2 route-map LOCAL-AS out
R3(config-router)#neighbor 23.23.23.2 send-community
```

Cek di R1 dan R2. Harusnya network 33.33.33.33 hanya diadvertise ke Confederation iBGP(R2) saja.

```
R1#sh ip bgp
BGP table version is 4, local router ID is 11.11.11.11
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 4.4.4.4/32       12.12.12.2               0    100      0 (23) 4 i
*> 11.11.11.11/32   0.0.0.0                  0         32768 i
*> 22.22.22.22/32   12.12.12.2               0    100      0 (23) i
R1#

R2#sh ip bgp
BGP table version is 5, local router ID is 22.22.22.22
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 4.4.4.4/32       24.24.24.4               0             0 4 i
*> 11.11.11.11/32   12.12.12.1               0    100      0 (1) i
*> 22.22.22.22/32   0.0.0.0                  0         32768 i
*>i33.33.33.33/32   23.23.23.3               0    100      0 i
R2#sh ip bgp 33.33.33.33
BGP routing table entry for 33.33.33.33/32, version 4
Paths: (1 available, best #1, table Default-IP-Routing-Table, not advertised
outside local AS)
  Not advertised to any peer
  Local
    23.23.23.3 from 23.23.23.3 (33.33.33.33)
      Origin IGP, metric 0, localpref 100, valid, confed-internal, best
      Community: local-AS
R2#
```

BGP Aggregator



Aggregator ini sama dengan summary.

```
R4(config)#int lo1
R4(config-if)#ip add 44.1.1.1 255.255.255.255
R4(config-if)#int lo2
R4(config-if)#ip add 44.2.1.1 255.255.255.255
R4(config-if)#int lo3
R4(config-if)#ip add 44.3.1.1 255.255.255.255
R4(config-if)#int lo4
R4(config-if)#ip add 44.4.1.1 255.255.255.255
R4(config-if)#int lo5
R4(config-if)#ip add 44.5.1.1 255.255.255.255
R4(config-if)#int lo6
R4(config-if)#ip add 44.6.1.1 255.255.255.255
```

Advertise ke BGP.

```
R4(config-if)#router bgp 4
R4(config-router)#network 44.1.1.1 mask 255.255.255.255
R4(config-router)#network 44.2.1.1 mask 255.255.255.255
R4(config-router)#network 44.3.1.1 mask 255.255.255.255
R4(config-router)#network 44.4.1.1 mask 255.255.255.255
R4(config-router)#network 44.5.1.1 mask 255.255.255.255
R4(config-router)#network 44.6.1.1 mask 255.255.255.255
```

Cek di R1.

```
R1#sh ip bgp
BGP table version is 10, local router ID is 11.11.11.11
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 4.4.4.4/32       12.12.12.2               0    100      0 (23) 4 i
```

```
*> 11.11.11.11/32   0.0.0.0                  0         32768 i
*> 22.22.22.22/32   12.12.12.2               0    100      0 (23) i
*> 44.1.1.1/32      12.12.12.2               0    100      0 (23) 4 i
*> 44.2.1.1/32      12.12.12.2               0    100      0 (23) 4 i
*> 44.3.1.1/32      12.12.12.2               0    100      0 (23) 4 i
*> 44.4.1.1/32      12.12.12.2               0    100      0 (23) 4 i
*> 44.5.1.1/32      12.12.12.2               0    100      0 (23) 4 i
*> 44.6.1.1/32      12.12.12.2               0    100      0 (23) 4 i
R1#
```

Lakukan aggregate di R4 lalu cek kembali di R1.

```
R4(config-router)#aggregate-address 44.0.0.0 255.248.0.0

R1#sh ip bgp
BGP table version is 11, local router ID is 11.11.11.11
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 4.4.4.4/32       12.12.12.2               0    100      0 (23) 4 i
*> 11.11.11.11/32   0.0.0.0                  0         32768 i
*> 22.22.22.22/32   12.12.12.2               0    100      0 (23) i
*> 44.0.0.0/13      12.12.12.2               0    100      0 (23) 4 i
*> 44.1.1.1/32      12.12.12.2               0    100      0 (23) 4 i
*> 44.2.1.1/32      12.12.12.2               0    100      0 (23) 4 i
*> 44.3.1.1/32      12.12.12.2               0    100      0 (23) 4 i
*> 44.4.1.1/32      12.12.12.2               0    100      0 (23) 4 i
*> 44.5.1.1/32      12.12.12.2               0    100      0 (23) 4 i
*> 44.6.1.1/32      12.12.12.2               0    100      0 (23) 4 i
R1#sh ip bgp 44.0.0.0
BGP routing table entry for 44.0.0.0/13, version 11
Paths: (1 available, best #1, table Default-IP-Routing-Table)
Flag: 0x820
  Not advertised to any peer
  (23) 4, (aggregated by 4 4.4.4.4)
    12.12.12.2 from 12.12.12.2 (22.22.22.22)
      Origin IGP, metric 0, localpref 100, valid, confed-external, atomic-
aggregate, best
R1#
```

Aggregate single route.

```
R4(config-router)#aggregate-address 44.0.0.0 255.248.0.0 summary-only

R1#sh ip bgp
BGP table version is 17, local router ID is 11.11.11.11
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 4.4.4.4/32       12.12.12.2               0    100      0 (23) 4 i
*> 11.11.11.11/32   0.0.0.0                  0         32768 i
```

```
*> 22.22.22.22/32   12.12.12.2               0    100      0 (23) i
*> 44.0.0.0/13      12.12.12.2               0    100      0 (23) 4 i
R1#
```

Aggregate suppress map.

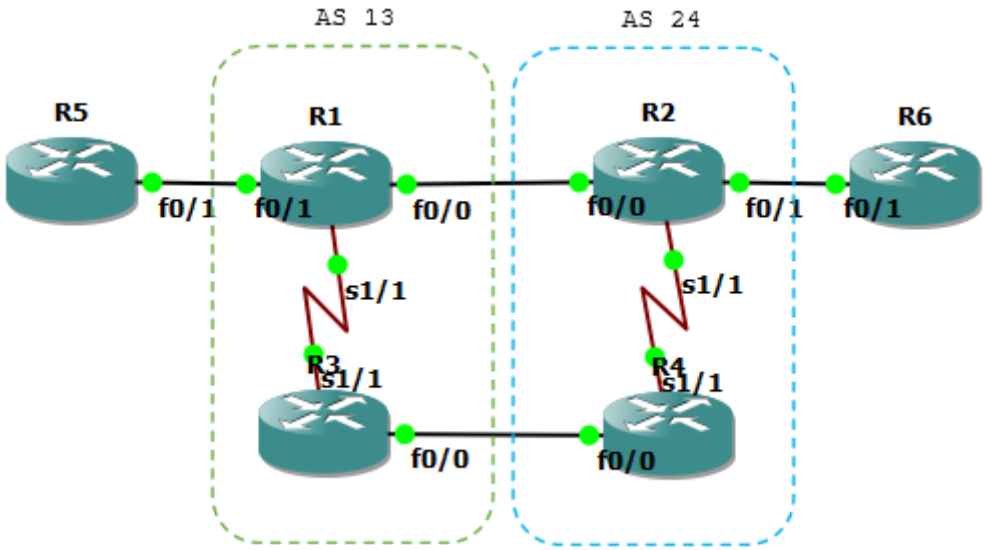
```
R4(config)#access-list 1 permit host 44.1.1.1
R4(config)#access-list 1 permit host 44.2.1.1
R4(config)#access-list 1 permit host 44.3.1.1
R4(config)#access-list 1 deny any
R4(config)#route-map BLOK
R4(config-route-map)#match ip address 1
R4(config-route-map)#router bgp 4
R4(config-router)#aggregate-address 44.0.0.0 255.248.0.0 suppress-map BLOK
R4(config-router)#do sh bgp
BGP table version is 26, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 4.4.4.4/32       0.0.0.0                  0         32768 i
*> 11.11.11.11/32   24.24.24.2                           0 123 i
*> 22.22.22.22/32   24.24.24.2               0           0 123 i
*> 44.0.0.0/13      0.0.0.0                            32768 i
s> 44.1.1.1/32      0.0.0.0                  0         32768 i
s> 44.2.1.1/32      0.0.0.0                  0         32768 i
s> 44.3.1.1/32      0.0.0.0                  0         32768 i
*> 44.4.1.1/32      0.0.0.0                  0         32768 i
*> 44.5.1.1/32      0.0.0.0                  0         32768 i
*> 44.6.1.1/32      0.0.0.0                  0         32768 i
R4(config-router)#
```

Cek di R1.

```
R1#sh ip bgp
BGP table version is 26, local router ID is 11.11.11.11
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 4.4.4.4/32       12.12.12.2               0    100      0 (23) 4 i
*> 11.11.11.11/32   0.0.0.0                  0         32768 i
*> 22.22.22.22/32   12.12.12.2               0    100      0 (23) i
*> 44.0.0.0/13      12.12.12.2               0    100      0 (23) 4 i
*> 44.4.1.1/32      12.12.12.2               0    100      0 (23) 4 i
*> 44.5.1.1/32      12.12.12.2               0    100      0 (23) 4 i
*> 44.6.1.1/32      12.12.12.2               0    100      0 (23) 4 i
R1#
```

Oke sip.

BGP Attribute – Weight




```
R1(config)#int fa0/0
R1(config-if)#ip add 12.12.12.1 255.255.255.0
R1(config-if)#no sh
R1(config-if)#int fa0/1
R1(config-if)#ip add 15.15.15.1 255.255.255.0
R1(config-if)#no sh
R1(config-if)#int s1/1
R1(config-if)#ip add 13.13.13.1 255.255.255.0
R1(config-if)#no sh

R2(config)#int fa0/0
R2(config-if)#ip add 12.12.12.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#int s1/1
R2(config-if)#ip add 24.24.24.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#int fa0/1
R2(config-if)#ip add 26.26.26.2 255.255.255.0
R2(config-if)#no sh

R3(config)#int fa0/0
R3(config-if)#ip add 34.34.34.3 255.255.255.0
R3(config-if)#no sh
R3(config-if)#int s1/1
R3(config-if)#ip add 13.13.13.3 255.255.255.0
R3(config-if)#no sh

R4(config)#int fa0/0
R4(config-if)#ip add 34.34.34.4 255.255.255.0
R4(config-if)#no sh
R4(config-if)#int s1/1
R4(config-if)#ip add 24.24.24.4 255.255.255.0
R4(config-if)#no sh

R5(config)#int fa0/1
```

```
R5(config-if)#ip add 15.15.15.5 255.255.255.0
R5(config-if)#no sh

R6(config)#int fa0/1
R6(config-if)#ip add 26.26.26.6 255.255.255.0
R6(config-if)#no sh
```

Konfigurasi BGP.

```
R1(config)#router bgp 13
R1(config-router)# neighbor 12.12.12.2 remote-as 24
R1(config-router)# neighbor 12.12.12.2 next-hop-self
R1(config-router)# neighbor 13.13.13.3 remote-as 13
R1(config-router)# neighbor 13.13.13.3 next-hop-self

R3(config-router)#router bgp 13
R3(config-router)# neighbor 13.13.13.1 remote-as 13
R3(config-router)# neighbor 13.13.13.1 next-hop-self
R3(config-router)# neighbor 34.34.34.4 remote-as 24
R3(config-router)# neighbor 34.34.34.4 next-hop-self

R2(config)#router bgp 24
R2(config-router)# neighbor 12.12.12.1 remote-as 13
R2(config-router)# neighbor 12.12.12.1 next-hop-self
R2(config-router)# neighbor 24.24.24.4 remote-as 24
R2(config-router)# neighbor 24.24.24.4 next-hop-self

R4(config-if)#router bgp 24
R4(config-router)# network 45.45.45.0 mask 255.255.255.0
R4(config-router)# neighbor 24.24.24.2 remote-as 24
R4(config-router)# neighbor 34.34.34.3 remote-as 13
R4(config-router)# neighbor 24.24.24.2 next-hop-self
R4(config-router)# neighbor 34.34.34.3 next-hop-self
```

Default route pada R5 dan R6. Advertise dulu network R2 ke BGP.

```
R1(config-router)#network 15.15.15.0 mask 255.255.255.0
R2(config-router)# network 26.26.26.0 mask 255.255.255.0

R1(config-router)#do sh ip bgp
BGP table version is 8, local router ID is 15.15.15.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 15.15.15.0/24    0.0.0.0                  0         32768 i
* i26.26.26.0/24    13.13.13.3               0    100      0 24 i
*>                  12.12.12.2               0           100 24 i
R1(config-router)#do sh ip bgp 26.26.26.0
BGP routing table entry for 26.26.26.0/24, version 2
Paths: (2 available, best #2, table Default-IP-Routing-Table)
  Advertised to update-groups:
        2
  24
    12.12.12.2 from 12.12.12.2 (26.26.26.2)
      Origin IGP, metric 0, localpref 100, valid, external
```

```
  24
    13.13.13.3 from 13.13.13.3 (34.34.34.3)
      Origin IGP, metric 0, localpref 100, valid, internal, best
R1(config-router)#
```

Ternyata ada 2 jalur menuju network 26.26.26.0, namun yang digunakan sekarang adalah melalui 12.12.12.2. Sekarang masukkan default routing ke R5 dan R6.

```
R5(config-if)#ip route 0.0.0.0 0.0.0.0 15.15.15.1
R6(config-if)#ip route 0.0.0.0 0.0.0.0 26.26.26.2
```

Trace dari R5 ke R6.

```
R5#trace 26.26.26.6

Type escape sequence to abort.
Tracing the route to 26.26.26.6

  1 15.15.15.1 68 msec 96 msec 68 msec
  2 12.12.12.2 88 msec 76 msec 80 msec
  3 26.26.26.6 200 msec 148 msec 56 msec
R5#
```

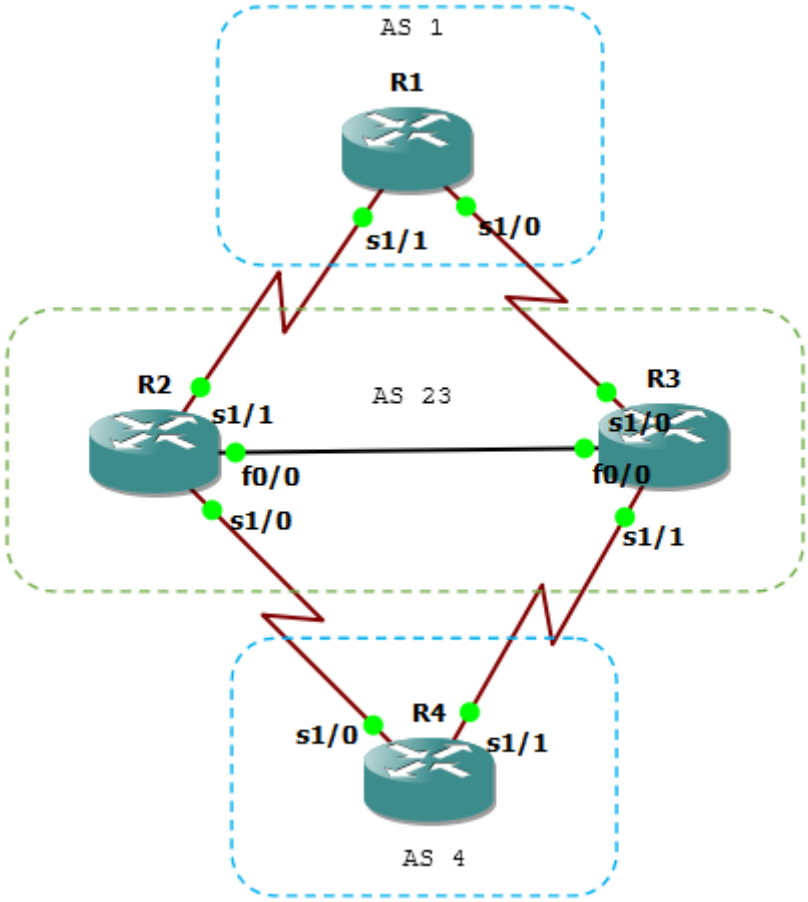
Sekarang kita belokkan jalurnya agar melalui 13.13.13.3 dengan konfigurasi weight attribute.

```
R1(config)#route-map WEIGHT permit 10
R1(config-route-map)#set weight 100
R1(config-route-map)#router bgp 13
R1(config-router)#neighbor 13.13.13.3 route-map WEIGHT in
R1(config-router)#do clear ip bgp *
```

Sekarang kita cek lagi.

```
R1(config-router)#do sh ip bgp 26.26.26.0
BGP routing table entry for 26.26.26.0/24, version 2
Paths: (2 available, best #2, table Default-IP-Routing-Table)
  Advertised to update-groups:
        2
  24
    12.12.12.2 from 12.12.12.2 (26.26.26.2)
      Origin IGP, metric 0, localpref 100, valid, external
  24
    13.13.13.3 from 13.13.13.3 (34.34.34.3)
      Origin IGP, metric 0, localpref 100, weight 100, valid, internal, best
R1(config-router)#

R5#trace 26.26.26.6

Type escape sequence to abort.
Tracing the route to 26.26.26.6

  1 15.15.15.1 112 msec 72 msec 60 msec
  2 13.13.13.3 140 msec 112 msec 88 msec
  3 34.34.34.4 232 msec 172 msec 88 msec
  4 24.24.24.2 112 msec 140 msec 156 msec
  5 26.26.26.6 220 msec 240 msec 152 msec
R5#
```

BGP Dualhoming – Load Balance



Konfigurasi interface.

```
R1(config)#int s1/1
R1(config-if)#ip add 12.12.12.1 255.255.255.0
R1(config-if)#no sh
R1(config-if)#int s1/0
R1(config-if)#ip add 13.13.13.1 255.255.255.0
R1(config-if)#no sh

R2(config)#int s1/1
R2(config-if)#ip add 12.12.12.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#int s1/0
R2(config-if)#ip add 24.24.24.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#int fa0/0
R2(config-if)#ip add 23.23.23.2 255.255.255.0
R2(config-if)#no sh

R3(config)#int s1/1
R3(config-if)#ip add 34.34.34.3 255.255.255.0
R3(config-if)#no sh
R3(config-if)#int s1/0
R3(config-if)#ip add 13.13.13.3 255.255.255.0
```

```
R3(config-if)#no sh
R3(config-if)#int fa0/0
R3(config-if)#ip add 23.23.23.3 255.255.255.0
R3(config-if)#no sh

R4(config)#int s1/1
R4(config-if)#ip add 34.34.34.4 255.255.255.0
R4(config-if)#no sh
R4(config-if)#int s1/0
R4(config-if)#ip add 24.24.24.4 255.255.255.0
R4(config-if)#no sh
```

Konfigurasi BGP.

```
R1(config)#router bgp 1
R1(config-router)#neighbor 12.12.12.2 remote-as 23
R1(config-router)#neighbor 13.13.13.3 remote-as 23


R2(config)#router bgp 23
R2(config-router)#neighbor 12.12.12.1 remote-as 1
R2(config-router)#neighbor 24.24.24.4 remote-as 4
R2(config-router)#neighbor 23.23.23.3 remote-as 23
R2(config-router)#neighbor 23.23.23.3 next-hop-self

R3(config)#router bgp 23
R3(config-router)#neighbor 34.34.34.4 remote-as 4
R3(config-router)#neighbor 13.13.13.1 remote-as 1
R3(config-router)#neighbor 23.23.23.2 remote-as 23
R2(config-router)#neighbor 23.23.23.2 next-hop-self

R4(config)#router bgp 4
R4(config-router)#neighbor 24.24.24.2 remote-as 23
R4(config-router)#neighbor 34.34.34.3 remote-as 23
```

Buat loopback di R1 dan R4 lalu advertise ke BGP..

```
R1(config)#int lo0
R1(config-if)#ip add 1.1.1.1 255.255.255.255
R1(config-if)#router bgp 1
R1(config-router)#network 1.1.1.1 mask 255.255.255.255

R4(config)#int lo0
R4(config-if)#ip add 4.4.4.4  255.255.255.255
R4(config-if)#router bgp 4
R4(config-router)#net 4.4.4.4 mask 255.255.255.255

R1(config-router)#do sh ip bgp
BGP table version is 15, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 1.1.1.1/32       0.0.0.0                  0         32768 i
*> 4.4.4.4/32       12.12.12.2                             100 23 4 i
*                   13.13.13.3                               0 23 4 i
```

Walau ada 2 link, yang dipakai hanya 1, dilihat dari tanda “>” nya hanya satu. Informasi diatas menunjukkan yang dipakai sebagai next hop ke 4.4.4.4 adalah 12.12.12.2.

Coba ping dari R1 ke R4.

```
R1(config-router)#do ping 4.4.4.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
R1(config-router)#do trace 4.4.4.4

Type escape sequence to abort.
Tracing the route to 4.4.4.4

  1 12.12.12.2 84 msec 60 msec 64 msec
  2  *  *  *
  3  *
R1(config)#
```

Ternyata gagal. Hal ini dikarenakan network belum diadvertise ke BGP.

```
R1(config-router)#network 12.12.12.0 mask 255.255.255.0
R1(config-router)#network 13.13.13.0 mask 255.255.255.0

R4(config-router)#network 24.24.24.0 mask 255.255.255.0
R4(config-router)#network 34.34.34.0 mask 255.255.255.0
```

Oke cek lagi.

```
R1(config-router)#do ping 4.4.4.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/88/152 ms
R1(config-router)#do trace 4.4.4.4

Type escape sequence to abort.
Tracing the route to 4.4.4.4

  1 12.12.12.2 52 msec 44 msec 32 msec
  2 24.24.24.4 [AS 4] 96 msec 108 msec 64 msec
R1(config-router)#
```

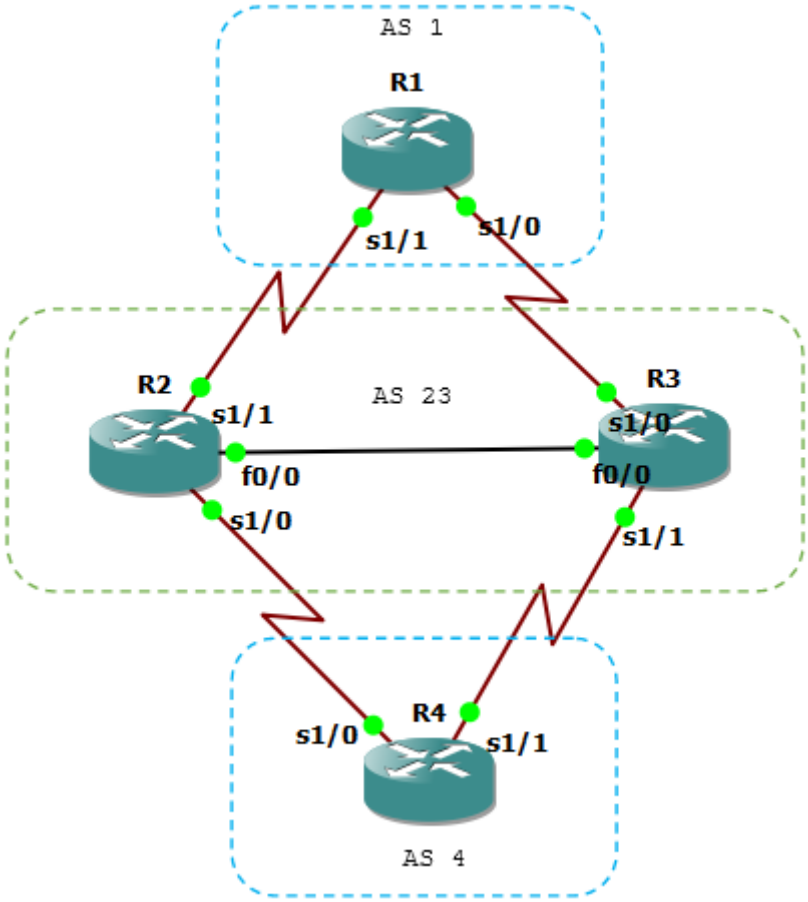
Sekarang konfigurasikan agar load-balance.

```
R1(config-router)#maximum-paths 2

R1(config-router)#do sh ip bgp
BGP table version is 21, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
```

```
*> 1.1.1.1/32       0.0.0.0                  0         32768 i
*> 4.4.4.4/32       12.12.12.2                           100 23 4 i
*                   13.13.13.3                             0 23 4 i
*> 12.12.12.0/24    0.0.0.0                  0         32768 i
*> 13.13.13.0/24    0.0.0.0                  0         32768 i
*> 24.24.24.0/24    12.12.12.2                           100 23 4 i
*                   13.13.13.3                             0 23 4 i
*> 34.34.34.0/24    12.12.12.2                           100 23 4 i
*                   13.13.13.3                             0 23 4 i
R1(config-router)#do trace 4.4.4.4

Type escape sequence to abort.
Tracing the route to 4.4.4.4

  1 13.13.13.3 80 msec
    12.12.12.2 64 msec
    13.13.13.3 60 msec
  2 24.24.24.4 [AS 4] 188 msec
    34.34.34.4 [AS 4] 152 msec
    24.24.24.4 [AS 4] 168 msec
R1(config-router)#
```

Walau pada show ip bgp tanda “>” hanya 1, tapi ketika dicek sudah load balance. Oke sip.

BGP Dualhoming – Set Weight



Oke hapus dulu konfigurasi load balancenya.

```
R1(config)#router bgp 1
R1(config-router)#no maximum-paths 2
```

Sekarang coba ping ke 4.4.4.4.

```
R1#sh ip bgp
BGP table version is 8, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 1.1.1.1/32       0.0.0.0                  0         32768 i
*>  4.4.4.4/32      12.12.12.2                             0 23 4 i
*                   13.13.13.3                             0 23 4 i
*> 12.12.12.0/24    0.0.0.0                  0         32768 i
*> 13.13.13.0/24    0.0.0.0                  0         32768 i
*  23.23.23.0/24    12.12.12.2               0             0 23 i
*>                  13.13.13.3               0             0 23 i
*  24.24.24.0/24    12.12.12.2                             0 23 4 i
*>                  13.13.13.3                             0 23 4 i
*  34.34.34.0/24    12.12.12.2                             0 23 4 i
```

```
*>                  13.13.13.3                               0 23 4 i
R1#trace 4.4.4.4

Type escape sequence to abort.
Tracing the route to 4.4.4.4

  1 12.12.12.2 40 msec 108 msec 60 msec
  2 24.24.24.4 [AS 4] 88 msec 100 msec 96 msec
R1#
```

Untuk menuju 4.4.4.4, melewati 12.12.12.2. Sekarang coba matikan interface 12.12.12.1.

```
R1(config-if)#int s1/1
R1(config-if)#shutdown
*Mar  1 00:07:37.387: %BGP-5-ADJCHANGE: neighbor 12.12.12.2 Down Interface
flap

R1(config-if)#do sh ip bgp
BGP table version is 23, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 1.1.1.1/32       0.0.0.0                  0         32768 i
*> 4.4.4.4/32       13.13.13.3                             0 23 4 i
*> 13.13.13.0/24    0.0.0.0                  0         32768 i
*> 23.23.23.0/24    13.13.13.3               0             0 23 i
*> 24.24.24.0/24    13.13.13.3                             0 23 4 i
*> 34.34.34.0/24    13.13.13.3                             0 23 4 i
R1(config-if)#
```

Maka sekarang akan untuk menuju 4.4.4.4 akan melewati 13.13.13.3. Coba hidupkan interface nya lagi. Ternyata walau sudah dihidupkan, main link nya tidak kembali ke 12.12.12.2 tapi tetap menggunakan 13.13.13.3.

```
R1(config-if)#int s1/1
R1(config-if)#no sh
R1(config-if)#do sh ip bgp
BGP table version is 24, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 1.1.1.1/32       0.0.0.0                  0         32768 i
*  4.4.4.4/32       12.12.12.2                             0 23 4 i
*>                  13.13.13.3                             0 23 4 i
*> 12.12.12.0/24    0.0.0.0                  0         32768 i
*> 13.13.13.0/24    0.0.0.0                  0         32768 i
*  23.23.23.0/24    12.12.12.2               0             0 23 i
*>                  13.13.13.3               0             0 23 i
*  24.24.24.0/24    12.12.12.2                             0 23 4 i
*>                  13.13.13.3                             0 23 4 i
```

```
*  34.34.34.0/24    12.12.12.2                               0 23 4 i
*>                  13.13.13.3                               0 23 4 i
R1(config-if)#
```

Untuk mengatasinya, konfigurasikan attribute weight.

```
R1(config)#route-map WEIGHT
R1(config-route-map)#set ?
  as-path            Prepend string for a BGP AS-path attribute
  automatic-tag      Automatically compute TAG value
  clns               OSI summary address
  comm-list          set BGP community list (for deletion)
  community          BGP community attribute
  dampening          Set BGP route flap dampening parameters
  default            Set default information
  extcommunity       BGP extended community attribute
  interface          Output interface
  ip                 IP specific information
  ipv6               IPv6 specific information
  level              Where to import route
  local-preference   BGP local preference path attribute
  metric             Metric value for destination routing protocol
  metric-type        Type of metric for destination routing protocol
  mpls-label         Set MPLS label for prefix
  origin             BGP origin code
  tag                Tag value for destination routing protocol
  traffic-index      BGP traffic classification number for accounting
  vrf                Define VRF name
  weight             BGP weight for routing table

R1(config-route-map)#set weight 100
R1(config-route-map)#router bgp 1
R1(config-router)#nei
R1(config-router)#neighbor 12.12.12.2 route-map WEIGHT in
R1(config-router)#do clear ip bgp *

R1(config-router)#do sh ip bgp
BGP table version is 5, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*  4.4.4.4/32       13.13.13.3                             0 23 4 i
*>                  12.12.12.2                           100 23 4 i
*  23.23.23.0/24    13.13.13.3               0             0 23 i
*>                  12.12.12.2               0           100 23 i
*  24.24.24.0/24    13.13.13.3                             0 23 4 i
*>                  12.12.12.2                           100 23 4 i
*  34.34.34.0/24    13.13.13.3                             0 23 4 i
*>                  12.12.12.2                           100 23 4 i
R1(config-router)#
```

Sip dah. Klo gak percaya kita tes lagi.

```
R1(config-router)#int s1/1
```

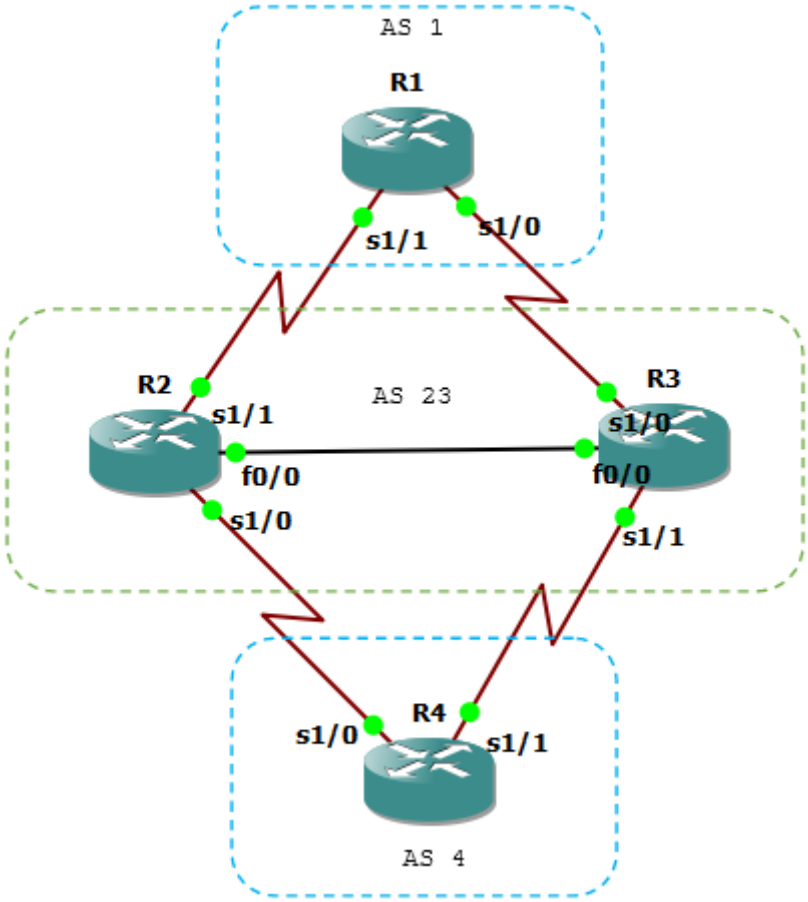
```
R1(config-if)#sh
*Mar  1 00:15:25.867: %BGP-5-ADJCHANGE: neighbor 12.12.12.2 Down Interface
flap
R1(config-if)#
*Mar  1 00:15:27.827: %LINK-5-CHANGED: Interface Serial1/1, changed state to
administratively down
*Mar  1 00:15:28.827: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial1/1, changed state to down
R1(config-if)#do sh ip bgp
BGP table version is 13, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 1.1.1.1/32       0.0.0.0                  0         32768 i
*> 4.4.4.4/32       13.13.13.3                             0 23 4 i
*> 13.13.13.0/24    0.0.0.0                  0         32768 i
*> 23.23.23.0/24    13.13.13.3               0             0 23 i
*> 24.24.24.0/24    13.13.13.3                             0 23 4 i
*> 34.34.34.0/24    13.13.13.3                             0 23 4 i
R1(config-if)#
```

Sekarang hidupin lagi. Tunggu agak lama baru cek show ip bgp.

```
R1(config-if)#no sh
R1(config-if)#
*Mar  1 00:15:52.047: %LINK-3-UPDOWN: Interface Serial1/1, changed state to
up
R1(config-if)#
*Mar  1 00:15:53.051: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial1/1, changed state to up
*Mar  1 00:16:19.355: %BGP-5-ADJCHANGE: neighbor 12.12.12.2 Up
R1(config-if)#do sh ip bgp
BGP table version is 18, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 1.1.1.1/32       0.0.0.0                  0         32768 i
*> 4.4.4.4/32       12.12.12.2                             100 23 4 i
*                   13.13.13.3                               0 23 4 i
*> 12.12.12.0/24    0.0.0.0                  0         32768 i
*> 13.13.13.0/24    0.0.0.0                  0         32768 i
*> 23.23.23.0/24    12.12.12.2               0           100 23 i
*                   13.13.13.3               0             0 23 i
*> 24.24.24.0/24    12.12.12.2                           100 23 4 i
*                   13.13.13.3                             0 23 4 i
*> 34.34.34.0/24    12.12.12.2                           100 23 4 i
*                   13.13.13.3                             0 23 4 i
R1(config-if)#
```

Oke sip.

BGP Dualhoming – Set MED



Selain mengatur traffic yang keluar dari R1, juga bisa mengatur traffic yang menuju R1 salah satunya dengan MED atau metric.

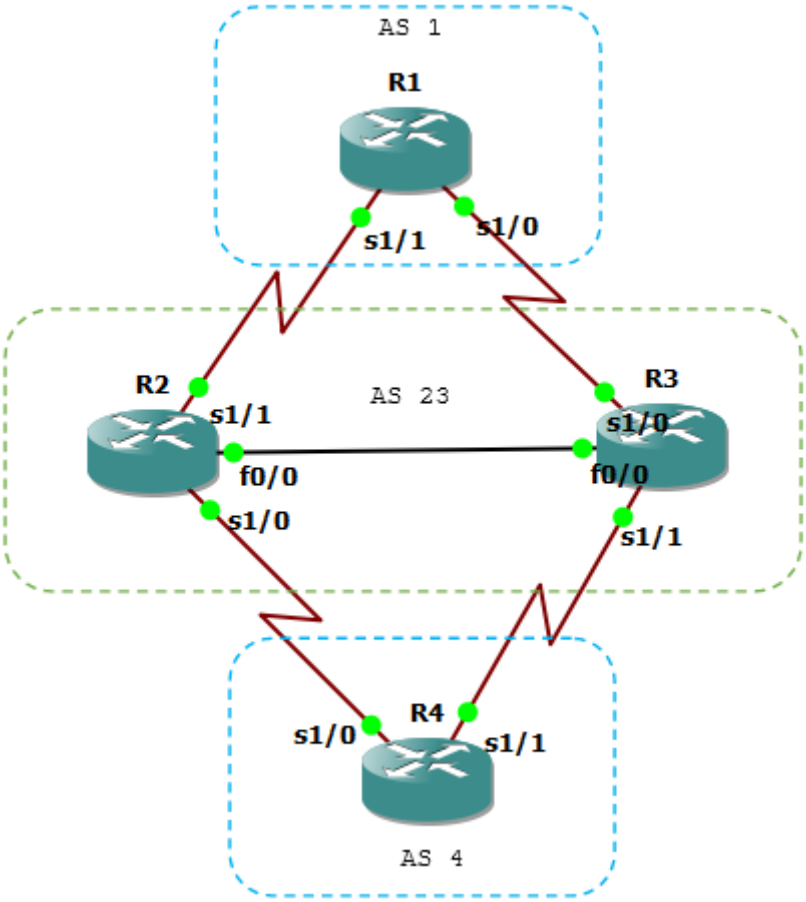
```
R1(config)#ip access-list standard LAN
R1(config-std-nacl)#permit 1.1.1.1
R1(config-std-nacl)#route-map R2MED permit 10
R1(config-route-map)#match ip address LAN
R1(config-route-map)#set metric 110
R1(config-route-map)#route-map R3MED permit 10
R1(config-route-map)#match ip address LAN
R1(config-route-map)#set metric 100
R1(config-route-map)#
R1(config-route-map)#router bgp 1
R1(config-router)#neighbor 12.12.12.2 route-map R2MED out
R1(config-router)#neighbor 13.13.13.3 route-map R3MED out
R1(config-router)#do clear ip bgp *
```

Cek di R2. Sekarang untuk menuju ke 1.1.1.1, akan dilewatkan 23.23.23.3 lalu ke 13.13.13.1 terlebih dahulu.

```
R2(config-router)#do sh ip bgp
BGP table version is 23, local router ID is 24.24.24.2
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
```

```
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*>i1.1.1.1/32       23.23.23.3             100    100      0 1 i
*                   12.12.12.1             110             0 1 i
* i4.4.4.4/32       23.23.23.3               0    100      0 4 i
*>                  24.24.24.4               0             0 4 i
*> 23.23.23.0/24    0.0.0.0                  0          32768 i
* i                  23.23.23.3               0    100      0 i
r i24.24.24.0/24    23.23.23.3               0    100      0 4 i
r>                  24.24.24.4               0             0 4 i
* i34.34.34.0/24    23.23.23.3               0    100      0 4 i
*>                  24.24.24.4               0             0 4 i
R2(config-router)#do trace 1.1.1.1

Type escape sequence to abort.
Tracing the route to 1.1.1.1

  1 23.23.23.3 56 msec 100 msec 64 msec
  2 13.13.13.1 112 msec 84 msec 72 msec
R2(config-router)#
```

BGP Dualhoming – Set AS Path



Mengatur traffic yang menuju R1 selain menggunakan metric juga bisa menggunakan AS Path. Hapus dulu MED nya.

```
R1(config-router)#no neighbor 12.12.12.2 route-map R2MED out
R1(config-router)#no neighbor 13.13.13.3 route-map R3MED out
```

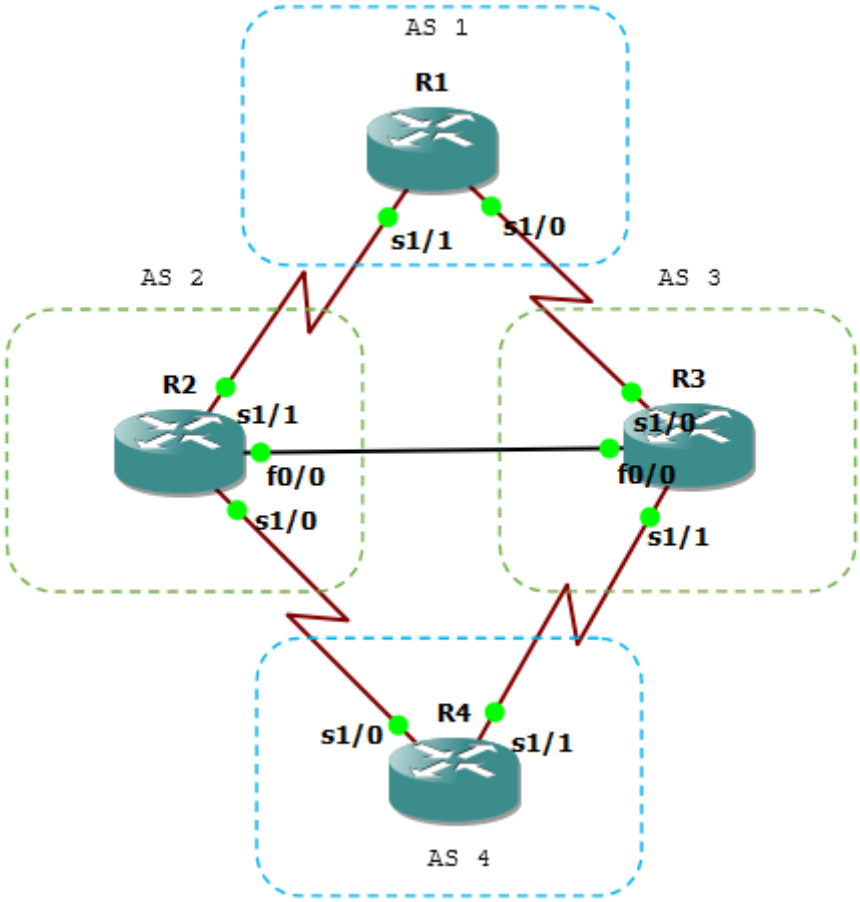
Sekarang set as-path pada route-map.

```
R1(config)#route-map AS-PREPEND
R1(config-route-map)#set as-path prepend 1 1 1
R1(config-route-map)#router bgp 1
R1(config-router)#neighbor 12.12.12.2 route-map AS-PREPEND out
R1(config-router)#do clear ip bgp *
```

Cek.

```
R2#traceroute 1.1.1.1

Type escape sequence to abort.
Tracing the route to 1.1.1.1

  1 23.23.23.3 60 msec 96 msec 44 msec
  2 13.13.13.1 [AS 1] 80 msec 92 msec 80 msec
R2#
```

BGP Multihoming – Equal Load Balance



Tujuannya agar dapat load balance melalui 2 AS atau 2 ISP.

Hapus AS 23 dan ubah menjadi masing-masing AS 2 dan AS 3. Hapus juga route-map sebelumnya.

```
R1(config)#router bgp 1
R1(config-router)#no neighbor 12.12.12.2 remote-as 23
R1(config-router)#neighbor 12.12.12.2 remote-as 2
R1(config-router)#no neighbor 12.12.12.2 route-map AS-PREPEND out
R1(config-router)#no neighbor 13.13.13.3 remote-as 23
R1(config-router)#neighbor 13.13.13.3 remote-as 3

R2(config)#no router bgp 23
R2(config)#router bgp 2
R2(config-router)#neighbor 12.12.12.1 remote-as 1
R2(config-router)#neighbor 24.24.24.4 remote-as 4
R2(config-router)#neighbor 23.23.23.3 remote-as 3

R3(config)#no router bgp 23
R3(config)#router bgp 3
R3(config-router)#neighbor 34.34.34.4 remote-as 4
R3(config-router)#neighbor 13.13.13.1 remote-as 1
R3(config-router)#neighbor 23.23.23.2 remote-as 2
R4(config)#router bgp 4
```

```
R4(config-router)#no neighbor 24.24.24.2 remote-as 23
R4(config-router)#neighbor 24.24.24.2 remote-as 2
R4(config-router)#no neighbor 34.34.34.3 remote-as 23
R4(config-router)#neighbor 34.34.34.3 remote-as 3
```

Konfigurasikan load balance pada R1.

```
R1(config)#router bgp 1
R1(config-router)#maximum-paths 2
R1#trace 4.4.4.4

Type escape sequence to abort.
Tracing the route to 4.4.4.4

  1 12.12.12.2 104 msec 72 msec 48 msec
  2 24.24.24.4 [AS 4] 140 msec 92 msec 64 msec
R1#
```

Ternyata walau sudah dikonfigurasi maximum-path, tetap saja belum load-balance. Tambahkan konfigurasi dibawah.

```
R1(config)#router bgp 1
R1(config-router)#bgp bestpath as-path multipath-relax
R1(config-router)#do clear ip bgp *
```

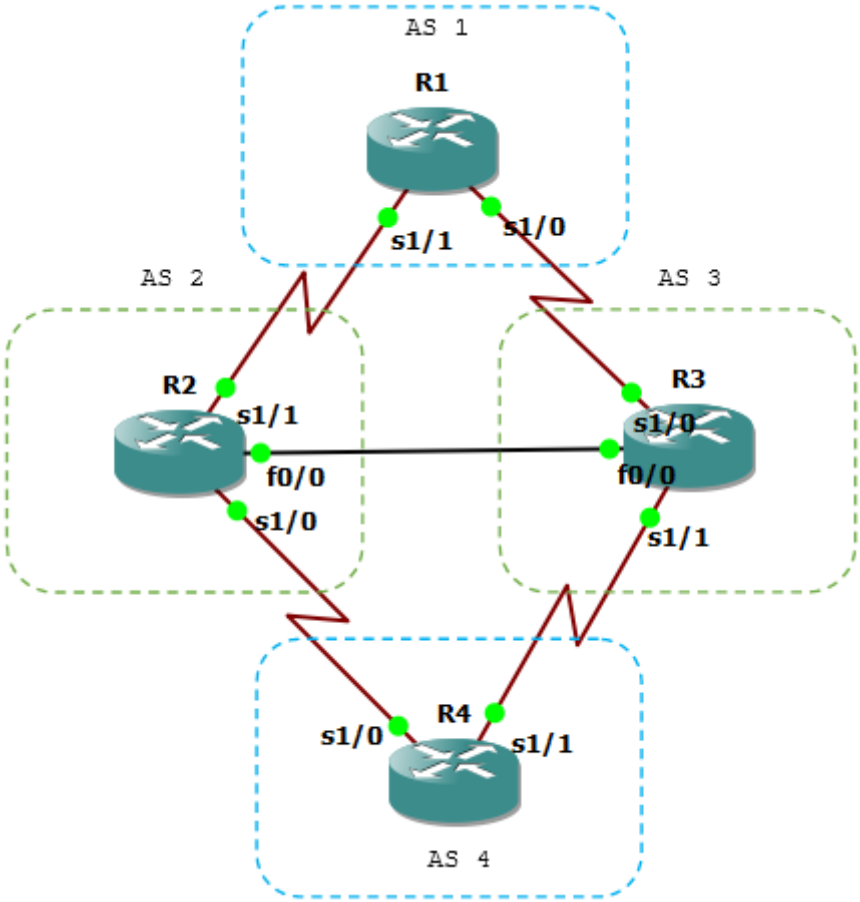
Oke tunggu bentar dan sekarang cek lagi.

```
R1(config-router)#do trace 4.4.4.4

Type escape sequence to abort.
Tracing the route to 4.4.4.4

  1 13.13.13.3 116 msec
    12.12.12.2 108 msec
    13.13.13.3 88 msec
  2 24.24.24.4 [AS 4] 204 msec
    34.34.34.4 [AS 4] 44 msec
    24.24.24.4 [AS 4] 92 msec
R1(config-router)#
```

Sip sudah load-balance.

```
R1(config)#router bgp 1
R1(config-router)#maximum-paths 2
R1#trace 4.4.4.4

Type escape sequence to abort.
Tracing the route to 4.4.4.4

  1 12.12.12.2 104 msec 72 msec 48 msec
  2 24.24.24.4 [AS 4] 140 msec 92 msec 64 msec
R1#
```

BGP Multihoming – Unequal Load Balance



Permasalahan terjadi ketika link ke AS 4 melalui AS 2 dan AS 3 berbeda bandwidth.

```
R1(config)#int s1/0
R1(config-if)#bandwidth 100
R1(config-if)#int s1/1
R1(config-if)#bandwidth 200
R1(config-if)#do clear ip bgp *

R1(config-if)#do sh ip bgp
BGP table version is 7, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 1.1.1.1/32       0.0.0.0                  0         32768 i
*  4.4.4.4/32       13.13.13.3                             0 3 4 i
*>                  12.12.12.2                             0 2 4 i
*> 12.12.12.0/24    0.0.0.0                  0         32768 i
```

```
*> 13.13.13.0/24    0.0.0.0                  0         32768 i
*  24.24.24.0/24    13.13.13.3                             0 3 4 i
*>                  12.12.12.2                             0 2 4 i
*  34.34.34.0/24    13.13.13.3                             0 3 4 i
*>                  12.12.12.2                             0 2 4 i

R1(config-if)#do sh ip route 4.4.4.4
Routing entry for 4.4.4.4/32
  Known via "bgp 1", distance 20, metric 0
  Tag 2, type external
  Last update from 12.12.12.2 00:00:16 ago
  Routing Descriptor Blocks:
  * 13.13.13.3, from 13.13.13.3, 00:00:16 ago
      Route metric is 0, traffic share count is 1
      AS Hops 2
      Route tag 2
    12.12.12.2, from 12.12.12.2, 00:00:16 ago
      Route metric is 0, traffic share count is 1
      AS Hops 2
      Route tag 2

R1(config-if)#
```

Maka akan didapati perbandingan bandwidthnya masih 1:1. Bagaimana jika perbedaan bandwidthnya jauh?

```
R1(config-if)#router bgp 1
R1(config-router)#bgp dmzlink-bw
R1(config-router)#neighbor 12.12.12.2 dmzlink-bw
R1(config-router)#neighbor 13.13.13.3 dmzlink-bw
R1(config-router)#do clear ip bgp *
```

Oke cek lagi.

```
R1(config-router)#do sh ip route 4.4.4.4
Routing entry for 4.4.4.4/32
  Known via "bgp 1", distance 20, metric 0
  Tag 2, type external
  Last update from 13.13.13.3 00:00:15 ago
  Routing Descriptor Blocks:
    13.13.13.3, from 13.13.13.3, 00:00:15 ago
      Route metric is 0, traffic share count is 23
      AS Hops 2
      Route tag 2
  * 12.12.12.2, from 12.12.12.2, 00:00:15 ago
      Route metric is 0, traffic share count is 48
      AS Hops 2
      Route tag 2

R1(config-router)#
```

Oke sudah berhasil.

BGP · PART 1

packetlife.net

Attributes

	Name	Description
Well-known Mandatory · Must be supported and propagated		
1	**Origin**	Origin type (IGP, EGP, or unknown)
2	**AS Path**	List of autonomous systems which the advertisement has traversed
3	**Next Hop**	External peer in neighboring AS
Well-known Discretionary · Must be supported; propagation optional		
5	**Local Preference**	Metric for internal neighbors to reach external destinations (default 100)
6	**Atomic Aggregate**	Includes ASes which have been dropped due to route aggregation
Optional Transitive · Marked as partial if unsupported by neighbor		
7	**Aggregator**	ID and AS of summarizing router
8	**Community**	Route tag
Optional Nontransitive · Deleted if unsupported by neighbor		
4	**Multiple Exit Discriminator (MED)**	Metric for external neighbors to reach the local AS (default 0)
9	**Originator ID**	The originator of a reflected route
10	**Cluster List**	List of cluster IDs
13	**Cluster ID**	Originating cluster
--	**Weight**	Cisco proprietary, not communicated to peers (default 0)

About BGP

Type	Path Vector
eBGP AD	20
iBGP AD	200
Standard	RFC 4271
Protocols	IP
Transport	TCP/179
Authentication	MD5

Terminology

Autonomous System (AS)
A logical domain under the control of a single entity

External BGP (eBGP)
BGP adjacencies which span autonomous system boundaries

Internal BGP (iBGP)
BGP adjacencies formed within a single AS

Synchronization Requirement
A route must be known by an IGP before it may be advertised to BGP peers

Packet Types

Open	**Update**
Keepalive	**Notification**

Path Selection

	Attribute	Description	Preference
1	**Weight**	Administrative preference	Highest
2	**Local Preference**	Communicated between peers within an AS	Highest
3	**Self-originated**	Prefer paths originated locally	True
4	**AS Path**	Minimize AS hops	Shortest
5	**Origin**	Prefer IGP-learned routes over EGP, and EGP over unknown	IGP
6	**MED**	Used externally to enter an AS	Lowest
7	**External**	Prefer eBGP routes over iBGP	eBGP
8	**IGP Cost**	Consider IGP metric	Lowest
9	**eBGP Peering**	Favor more stable routes	Oldest
10	**Router ID**	Tie breaker	Lowest

Neighbor States

Idle · Neighbor is not responding

Active · Attempting to connect

Connect · TCP session established

Open Sent · Open message sent

Open Confirm · Response received

Established · Adjacency established

Troubleshooting

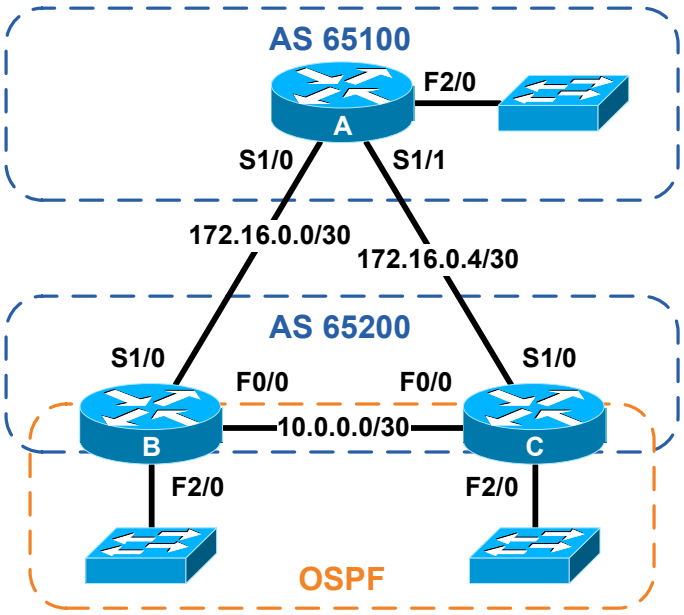
```
show ip bgp [summary]
show ip bgp neighbors
show ip route [bgp]
clear ip bgp * [soft]
debug ip bgp […]
```

Influencing Path Selection

Weight	`neighbor 172.16.0.1 weight 200`	**Local Preference**	`bgp default local-preference 100`
MED	`default-metric 400`	**Route Map**	`neighbor 172.16.0.1 route-map Foo`
Ignore AS Path	`bgp bestpath as-path ignore`	**Ignore Cost Communities**	`bgp bestpath cost-community ignore`

BGP · PART 2

Configuration Example



Router A

```
interface Serial1/0
 description Backbone to B
 ip address 172.16.0.1 255.255.255.252
!
interface Serial1/1
 description Backbone to C
 ip address 172.16.0.5 255.255.255.252
!
interface FastEthernet2/0
 description LAN
 ip address 192.168.1.1 255.255.255.0
!
router bgp 65100
 no synchronization
 network 172.16.0.0 mask 255.255.255.252
 network 172.16.0.4 mask 255.255.255.252
 network 192.168.1.0
 neighbor South peer-group
 neighbor South remote-as 65200
 neighbor 172.16.0.2 peer-group South
 neighbor 172.16.0.6 peer-group South
 no auto-summary
```

Router B

```
interface FastEthernet0/0
 description Backbone to C
 ip address 10.0.0.1 255.255.255.252
!
interface Serial1/0
 description Backbone to A
 ip address 172.16.0.2 255.255.255.252
!
interface FastEthernet2/0
 description LAN
 ip address 192.168.2.1 255.255.255.0
!
router ospf 100
 network 10.0.0.1 0.0.0.0 area 0
 network 192.168.2.1 0.0.0.0 area 1
!
router bgp 65200
 no synchronization
 redistribute ospf 100 route-map LAN_Subnets
 neighbor 10.0.0.2 remote-as 65200
 neighbor 172.16.0.1 remote-as 65100
 no auto-summary
!
access-list 10 permit 192.168.0.0 0.0.255.255
!
route-map LAN_Subnets permit 10
 match ip address 10
 set metric 100
```

Router C

```
interface FastEthernet0/0
 description Backbone to B
 ip address 10.0.0.2 255.255.255.252
!
interface Serial1/0
 description Backbone to A
 ip address 172.16.0.6 255.255.255.252
!
interface FastEthernet2/0
 description LAN
 ip address 192.168.3.1 255.255.255.0
!
router ospf 100
 network 10.0.0.2 0.0.0.0 area 0
 network 192.168.3.1 0.0.0.0 area 2
!
router bgp 65200
 no synchronization
 redistribute ospf 100 route-map LAN_Subnets
 neighbor 10.0.0.1 remote-as 65200
 neighbor 172.16.0.5 remote-as 65100
 no auto-summary
!
access-list 10 permit 192.168.0.0 0.0.255.255
!
route-map LAN_Subnets permit 10
 match ip address 10
 set metric 100
```

Router A Routing Table

```
     172.16.0.0/30 is subnetted, 2 subnets
C       172.16.0.4 is directly connected, S1/1
C       172.16.0.0 is directly connected, S1/0
C    192.168.1.0/24 is directly connected, F2/0
B    192.168.2.0/24 [20/100] via 172.16.0.2
B    192.168.3.0/24 [20/100] via 172.16.0.2
```

Router B Routing Table

```
     172.16.0.0/30 is subnetted, 2 subnets
B       172.16.0.4 [20/0] via 172.16.0.1
C       172.16.0.0 is directly connected, S1/0
     10.0.0.0/30 is subnetted, 1 subnets
C       10.0.0.0 is directly connected, F0/0
B    192.168.1.0/24 [20/0] via 172.16.0.1
C    192.168.2.0/24 is directly connected, F2/0
O IA 192.168.3.0/24 [110/2] via 10.0.0.2, F0/0
```

ABOUT AUTHOR

Name	:	Muhammad Taufik
Website	:	http://muhammadtaufik7.wordpress.com
Email	:	muhammadtaufik951@gmail.com
Facebook	:	facebook.com/MuhammadTaufiq72

NOTES

NOTES

NOTES

THE WAY TO BE CISCO WARRIOR TEORY AND PRACTICE