BALANCEO DE CARGA

Escenarios: tradicional y empleando BGP

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Presentación personal

- Alejandro Teixeira
  - Ingeniero de Telecomunicaciones
  - Magister en Ingeniería de Negocios
  - Magister en Finanzas
- Gerente Comercial
  - AUSTRO INTERNET S.A.
- Gerente General
  - TF CONSULTING LTDA

Presentación personal

- Consultor y Entrenador MikroTik RouterOS
- Experiencia con MikroTik desde 2007

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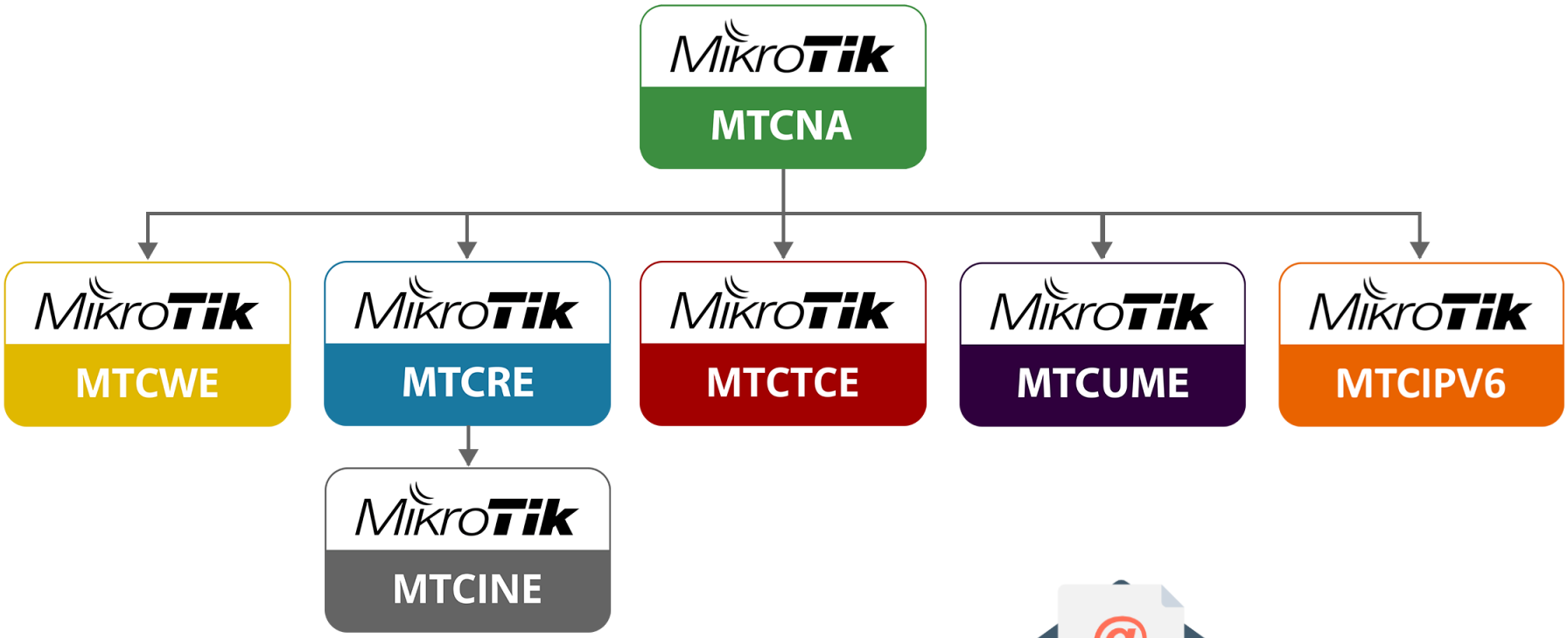
Cursos oficiales MikroTik RouterOS

- Cursos de certificación oficial MikroTik



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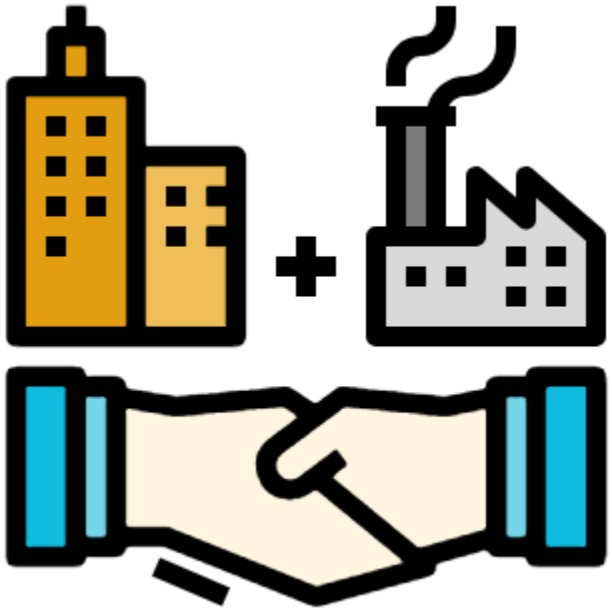
Consultoría y servicios de TI

- Asesoría en redes y telecomunicaciones
- Diseño y desarrollo de soluciones infomáticas
- Soporte mensual
  - Asesoría especializada
  - Mantenimiento preventivo
  - Monitoreo
  - Soporte prioritario
  - NOC 24/7



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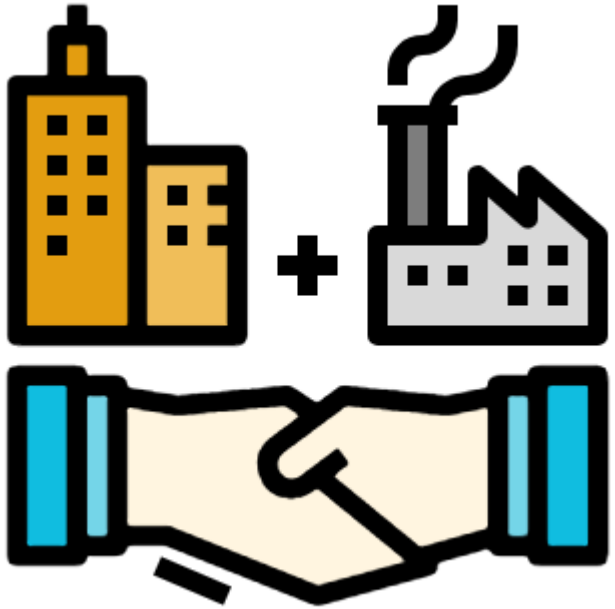
Consultoría y servicios de TI

- Soluciones BGP
- Firewall Avanzado
  - Anti-DDoS
- Balanceo de Carga
- Calidad de Servicio (QoS)
- VPN
- Soluciones inalámbricas
- Hotspot
- Trámite ante LACNIC
  - Bloque IP + ASN



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Enlaces de internet y datos

- Enlaces de acceso a internet
- Enlaces de datos
  - MPLS / VPLS
- Tránsito internacional
- Conexión con CDN de mayor consumo
  - Google, YouTube, Drive, Gmail
  - Facebook, Instagram
  - Microsoft
  - Netflix

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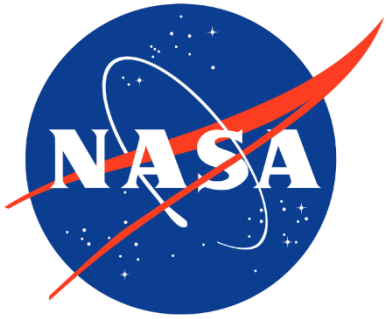
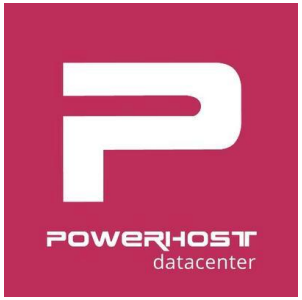
Algunos de nuestros clientes





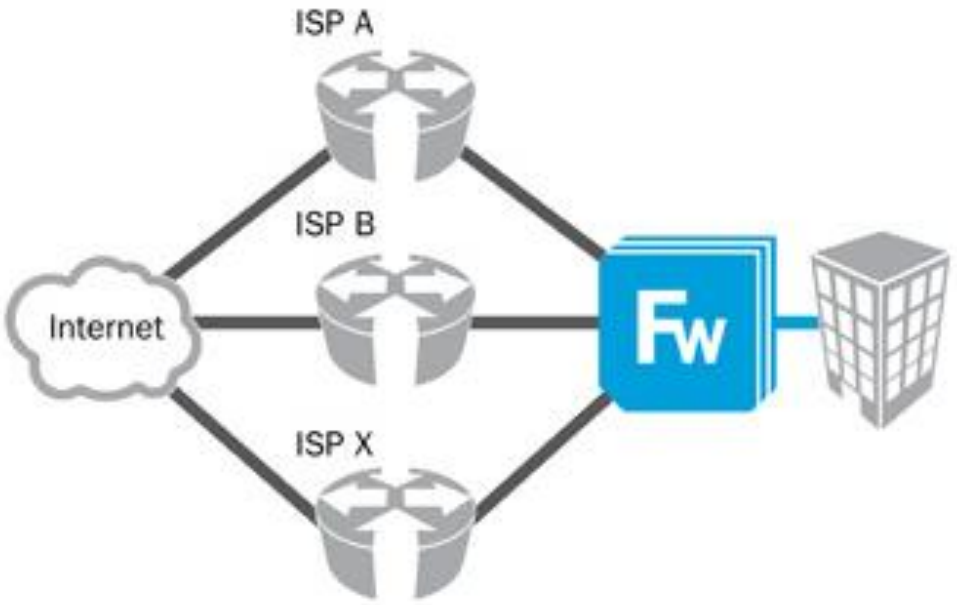
Agenda

- ¿Qué es balanceo de carga?
  - Escenario tradicional
  - En escenarios con BGP
  - Consideraciones
- Mecanismos de balanceo
  - ECMP / PCC / NTH
  - Escenarios con BGP
- Ponderación de enlaces
- Posibles problemas y soluciones
- Failover

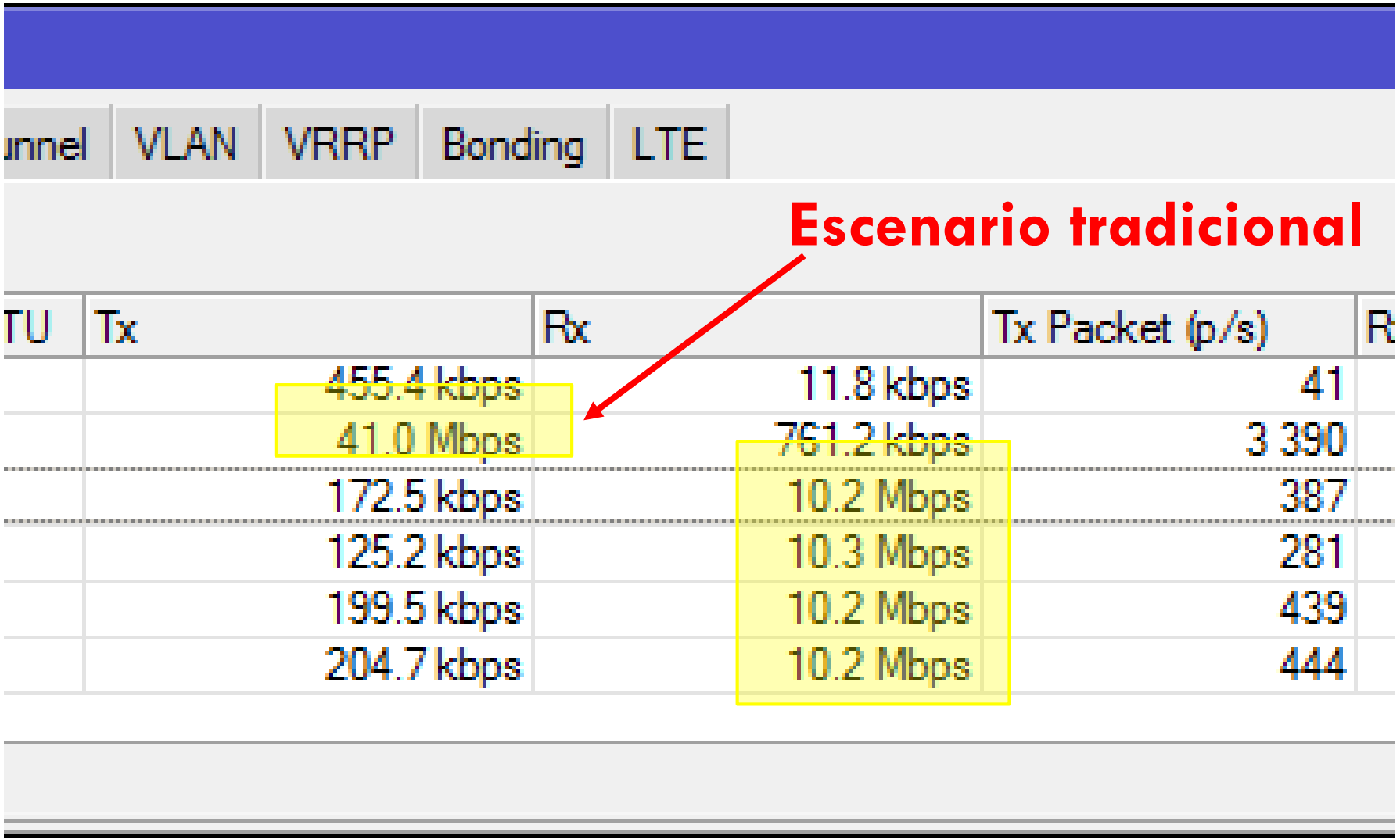
¿Qué es balanceo de carga?

¿Qué es balanceo de carga?

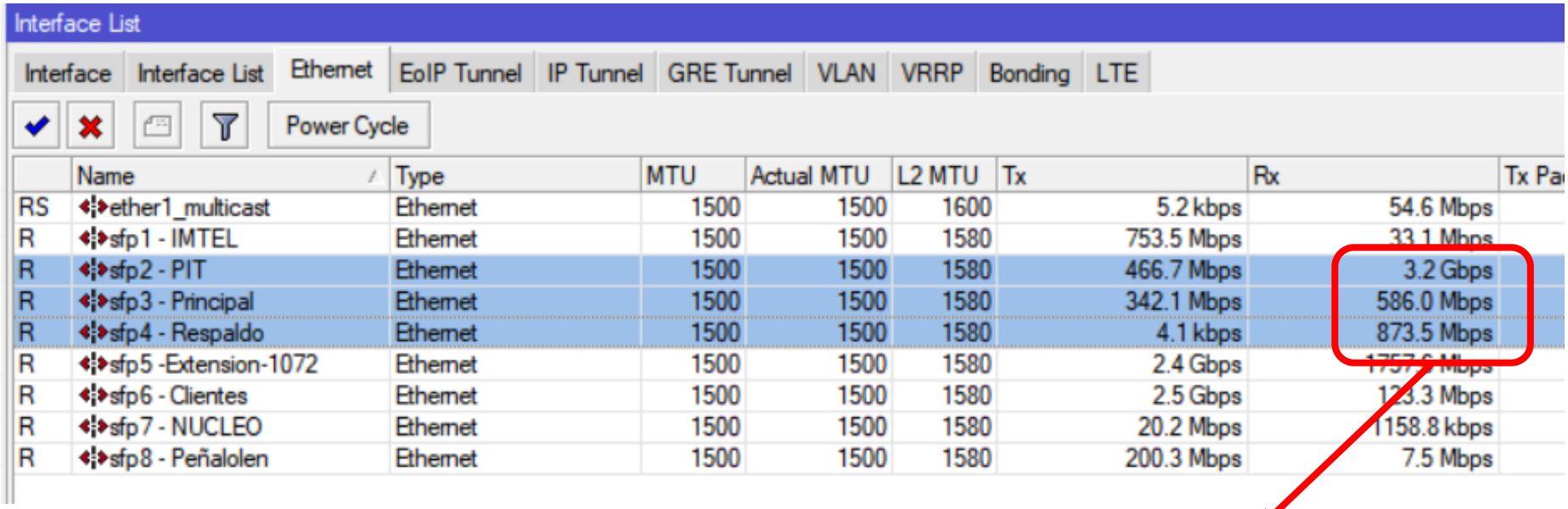
- Proceso a través del cual **el tráfico saliente es distribuido por múltiples enlaces**



Ejemplo


unnel
VLAN
VRRP
Bonding
LTE
Escenario tradicional
TU
Tx
Rx
Tx Packet (p/s)
R
455.4 kbps
11.8 kbps
41
41.0 Mbps
761.2 kbps
3 390
172.5 kbps
10.2 Mbps
387
125.2 kbps
10.3 Mbps
281
199.5 kbps
10.2 Mbps
439
204.7 kbps
10.2 Mbps
444

Ejemplo



Tráfico total: 4,85 Gbps

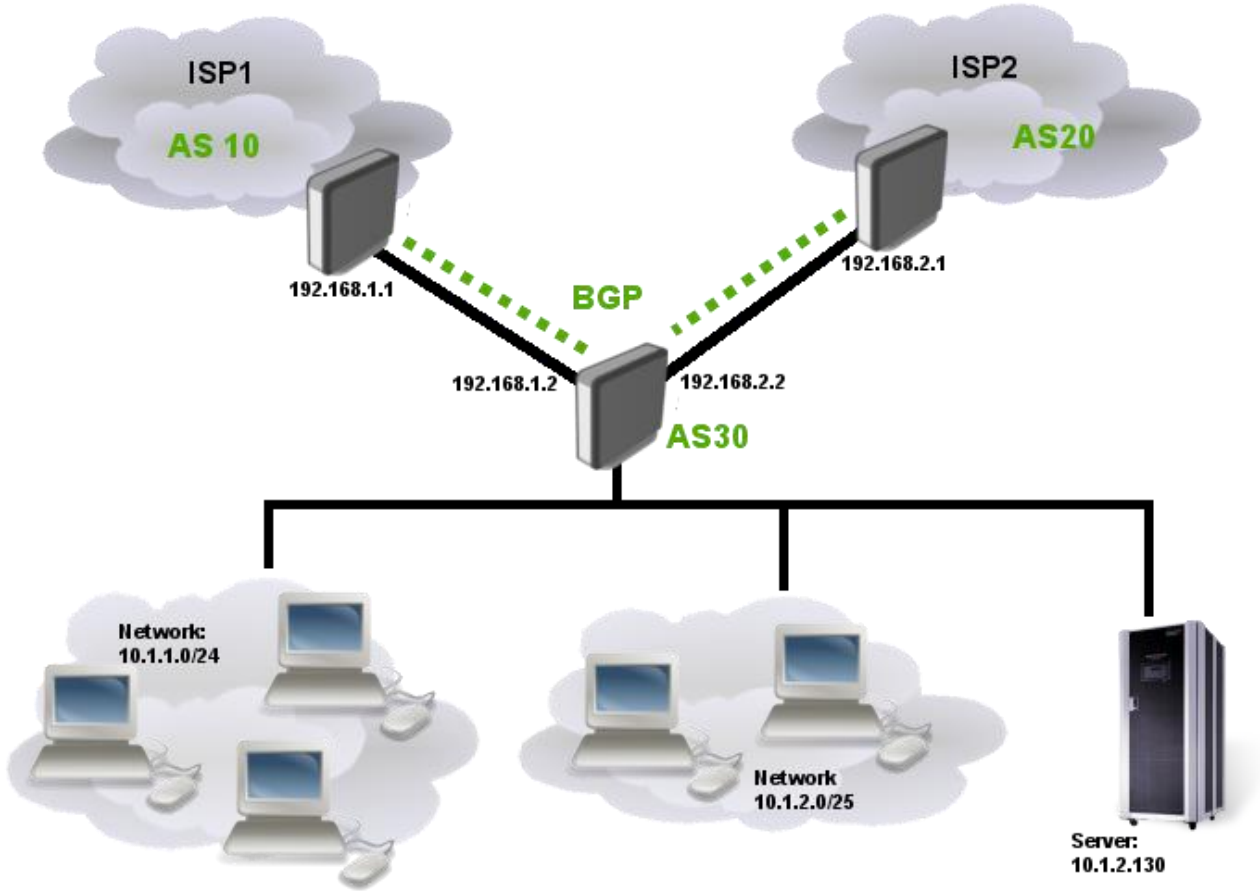
3 enlaces de internet

Escenario BGP

Escenarios

- Tradicional
  - Cada WAN tiene un pool de IP asignado
  - Los pool de IP pertenecen a cada ISP
    - ENTEL
    - MOVISTAR
    - CLARO
- BGP (multihomed)
  - Requiere recursos propios (otorgados por LACNIC)
    - IP
    - ASN
  - Pool de IP compartido en todas las WAN

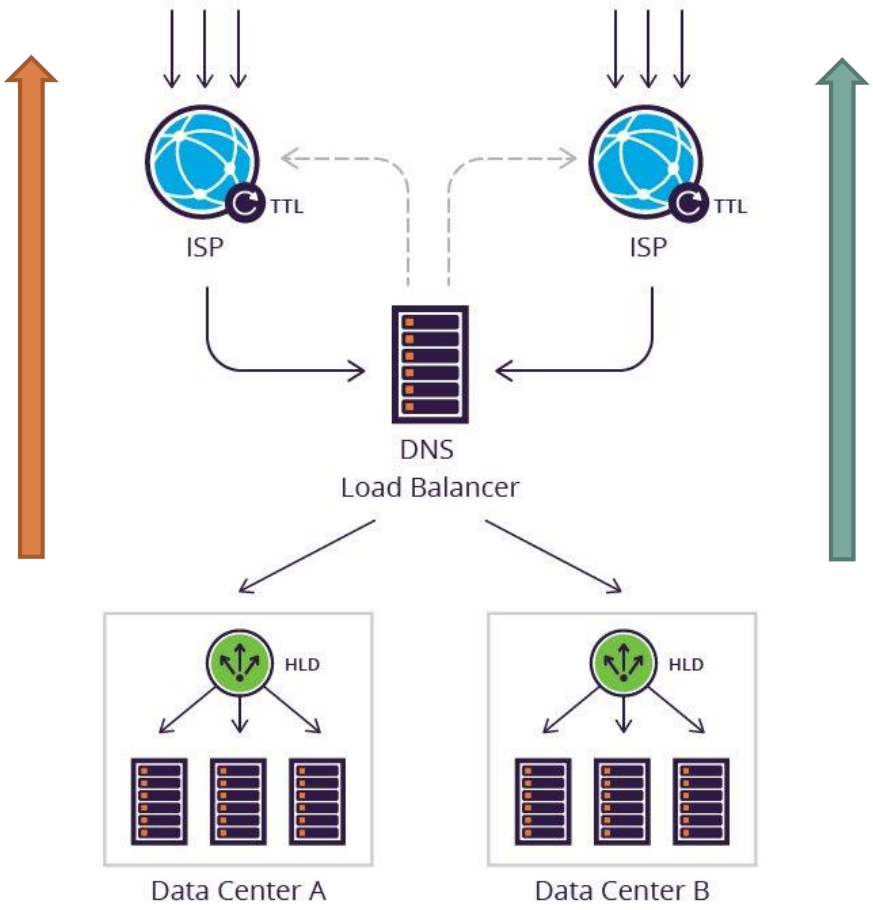
BGP: multihomed



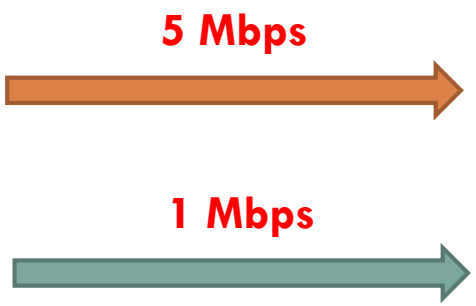
Consideraciones

- Cuando se emplea algún mecanismo de balanceo, **lo que realmente se balancea son el número total de conexiones** entre la cantidad de enlaces disponibles.
- **No se balancea el consumo de tráfico**
- **En BGP se anuncian prefijos IP** (segmentos de red) a cada ISP y se aplica prepend para definer las prioridades de subida y bajada, entre otras condiciones
  - Capacidad para recibir por cualquier WAN el mismo segmento de red

Consideraciones



- Balanceo correcto
  - 2 conexiones
  - No es equitativo



Mecanismos de balanceo

Herramientas involucradas

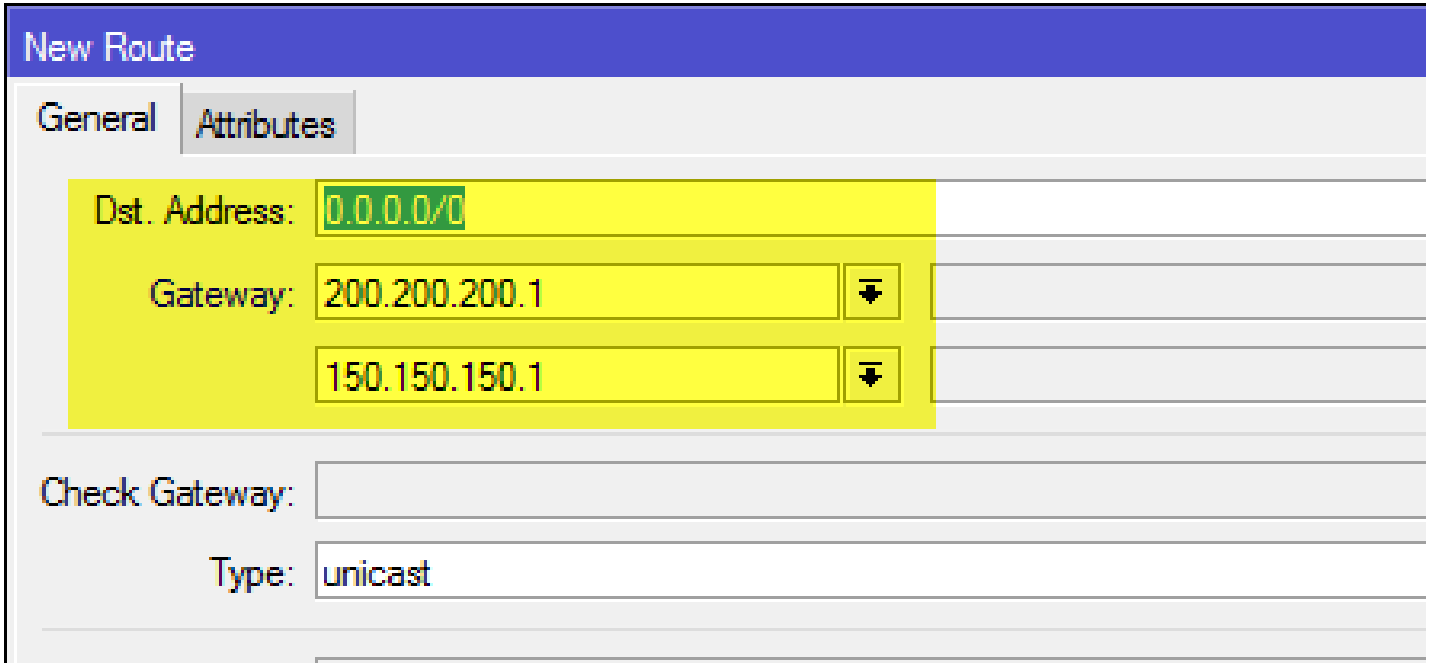
- Escenario tradicional
  - /ip firewall mangle
  - /ip route
  - /system scripts
  - /system scheduler
  - /ip firewall filter
- Escenario BGP
  - Filtros BGP
  - Tabla de rutas
  - /ip firewall mangle (opcional)

ECMP: Equal Cost Multi-Path

- Simple de implementar
- Balanceo persistente por conexión (IP SRC/DST)
- Se agregan todas las puertas de enlace
  - En la misma ruta
- No se puede controlar la forma de balanceo
- No funciona con puertas de enlace iguales
  - Mas de una por proveedor
- Failover automatico
  - No es práctico

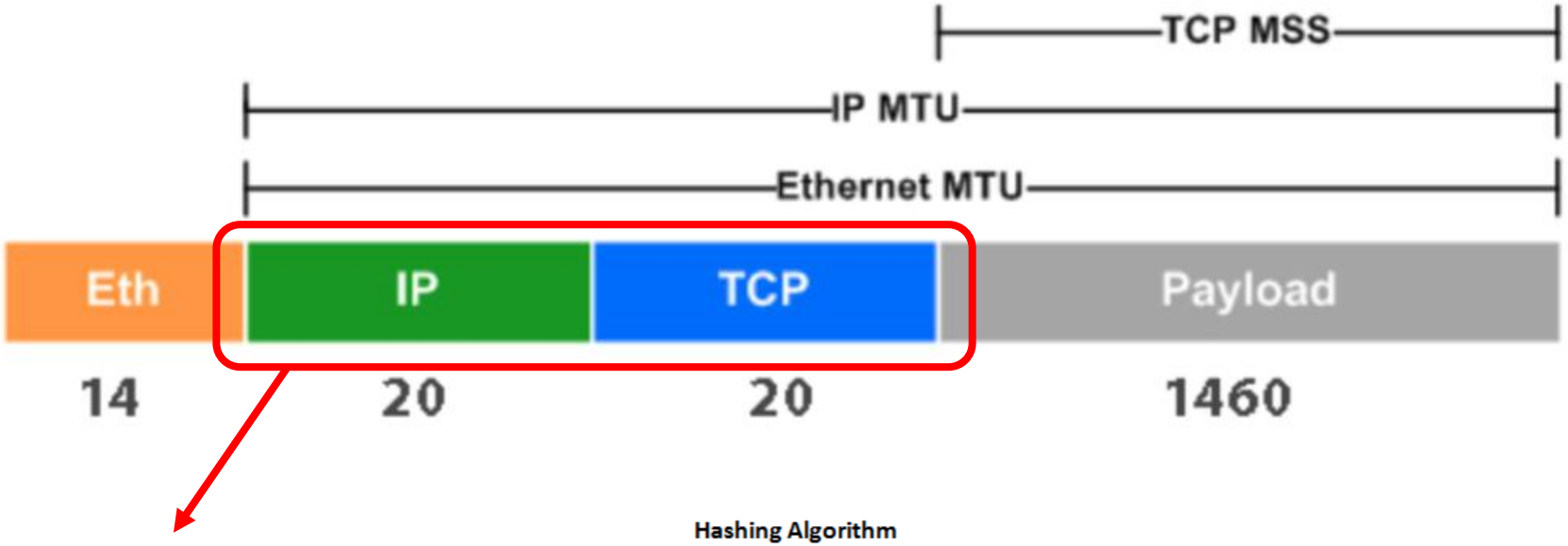
ECMP: Implementación


```
/ip route add
gateway=1.1.1.1,2.2.2.1
check-gateway=ping
```

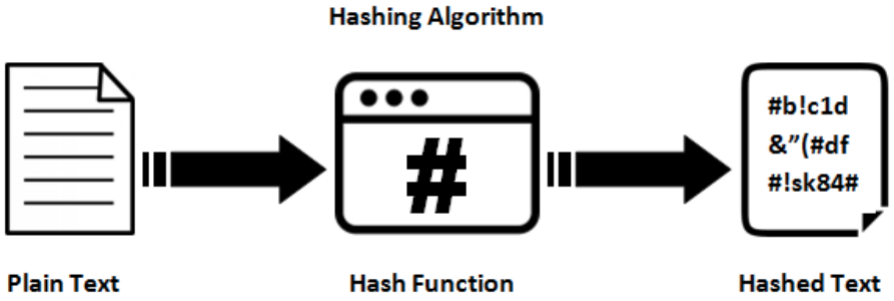


PCC: Peer Connection Classifier

- Sofisticado
- No distribuye de forma equitativa la cantidad de conexiones (aleatorio)
- PCC toma algunos campos de la cabecera IP
  - Alguna combinación
    - IP (origen/destino) y puerto (origen/destino)
- Clasificadores
  - src-address
  - dst-address
  - src-port
  - dst-port



- IP SRC
- IP DST
- PORT DST
- PORT SRC



Escenario: both addrees and ports

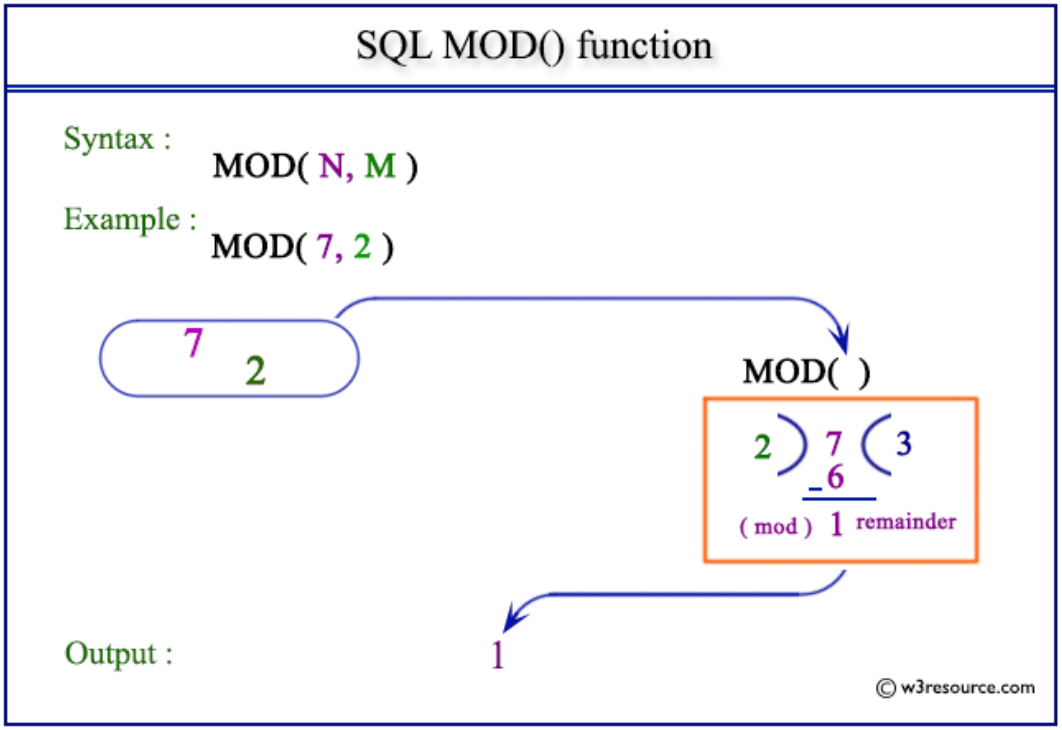
- IP SRC: 10.25.78.54
  - 00001010.00011001.01001110.00110110
  - 169.430.582
- IP DST: 8.8.8.8
  - 00001000.00001000.00001000.00001000
  - 134.744.072
- PORT SRC: 58952
- PORT DST: 53

IP SRC + IP DST + PORT SCR + PORT DST

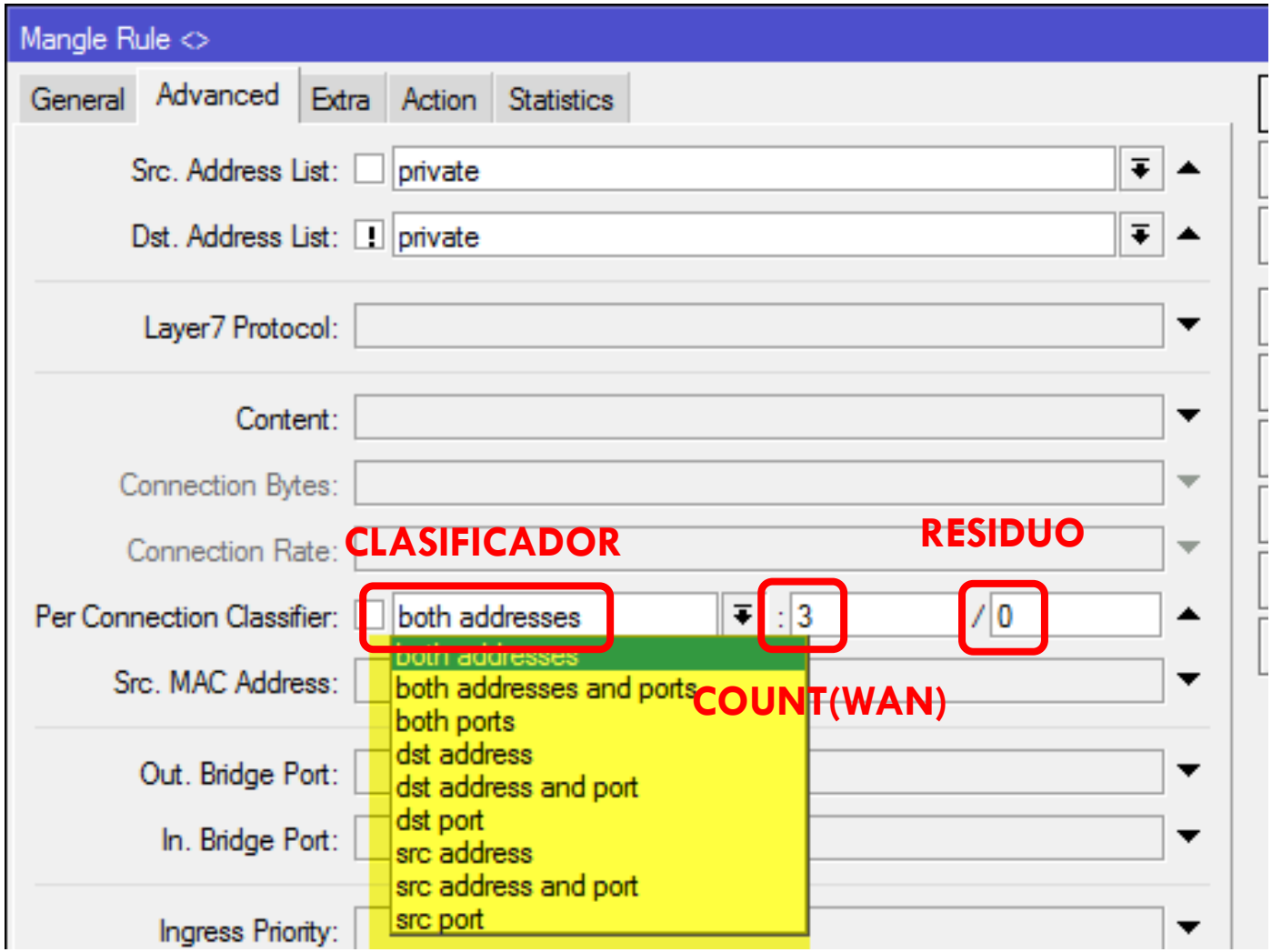
304.233.659 MOD COUNT(WAN)

MOD = RESIDUO DE LA DIVISIÓN

- 10 MOD 2 = 0
- 10 MOD 3 = 1
- 10 MOD 4 = 2
- 10 MOD 5 = 0
- 10 MOD 6 = 4
- 10 MOD 7 = 3
- 10 MOD 8 = 2
- 10 MOD 9 = 1
- 10 MOD 10 = 0



PCC: MANGLE


Mangle Rule <>
General
Advanced
Extra
Action
Statistics
Src. Address List:
private
Dst. Address List:
private
Layer7 Protocol:
Content:
Connection Bytes:
Connection Rate:
CLASIFICADOR
RESIDUO
Per Connection Classifier:
both addresses
: 3
/ 0
Src. MAC Address:
both addresses and ports
both ports
dst address
dst address and port
dst port
src address
src address and port
src port
COUNT(WAN)
Out. Bridge Port:
In. Bridge Port:
Ingress Priority:

PCC: ¿Cómo funciona?

- Número de enlaces wan: 3
- Posibles resultados: 0, 1 o 2

- Hash 1: 14.350 / 3 = 1
- Hash 2: 3480 / 3 = 0
- Hash 3: 13.468 / 3 = 1
- Hash 4: 5.390 / 3 = 2
- Hash 5: 7.894 / 3 = 1

- Link 0: 1
- Link 1: 3
- Link 2: 1

DISTRIBUCIÓN UNIFORME

ALEATORIO

to-scl-2	642.7 GiB	2895 992 045	BALANCER-SCL
to-scl-2	660.6 GiB	2930 834 269	BALANCER-SCL
to-scl-4	644.1 GiB	2895 769 277	BALANCER-SCL
to-scl-4	647.6 GiB	2886 430 152	BALANCER-SCL

TABLA DE RUTAS

	Dst. Address	Gateway	Di...	Routing Mark
AS	0.0.0.0/0	209.244.0.3 recursive via 190.82.8...	1	vlan-501
AS	0.0.0.0/0	208.67.220.222 recursive via 186....	1	vlan-401
AS	0.0.0.0/0	208.67.222.220 recursive via 186....	1	vlan-301
AS	0.0.0.0/0	208.67.222.123 recursive via 186....	1	vlan-201
AS	0.0.0.0/0	208.67.220.123 recursive via 186....	1	vlan-101
AS	0.0.0.0/0	172.23.105.1 reachable ipip_vc5	1	to-scl-5
AS	0.0.0.0/0	172.23.104.1 reachable ipip_vc4	1	to-scl-4
AS	0.0.0.0/0	172.23.103.1 reachable ipip_vc3	1	to-scl-3
AS	0.0.0.0/0	172.23.102.1 reachable ipip_vc2	1	to-scl-2
AS	0.0.0.0/0	172.23.101.1 reachable ipip_vc1	1	to-scl-1
AS	0.0.0.0/0	208.67.220.123 recursive via 186....	1	full-balancer

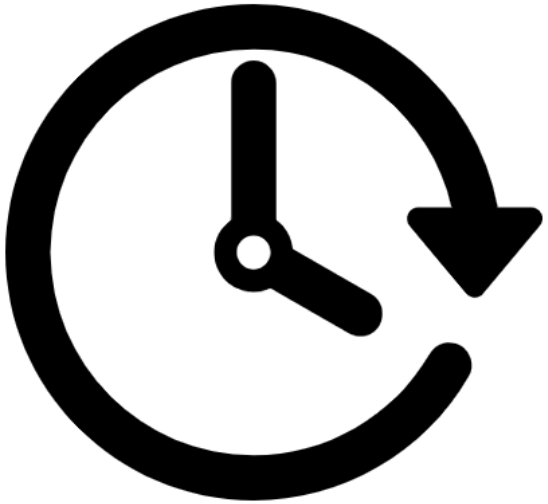
RESULTADO PCC CON 4 WAN

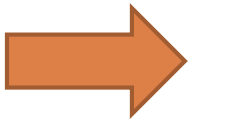
unnel | VLAN | VRRP | Bonding | LTE

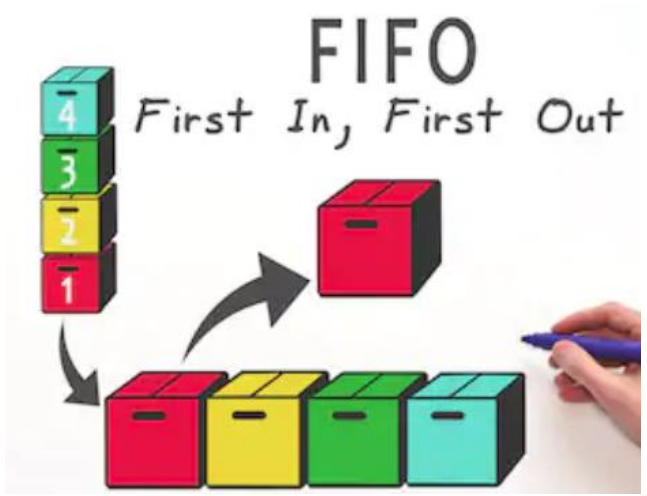
TU	Tx	Rx	Tx Packet (p/s)	R
	455.4 kbps	11.8 kbps	41	
	41.0 Mbps	761.2 kbps	3 390	
	172.5 kbps	10.2 Mbps	387	
	125.2 kbps	10.3 Mbps	281	
	199.5 kbps	10.2 Mbps	439	
	204.7 kbps	10.2 Mbps	444	

NTH

- Permite distribuir de forma **equitativa**
- Cada regla del NTH tiene su propio **contador**
- Cuando una regla **recibe un paquete** se **incrementa el contador**
- Cuando el contador llega al máximo se reinicia

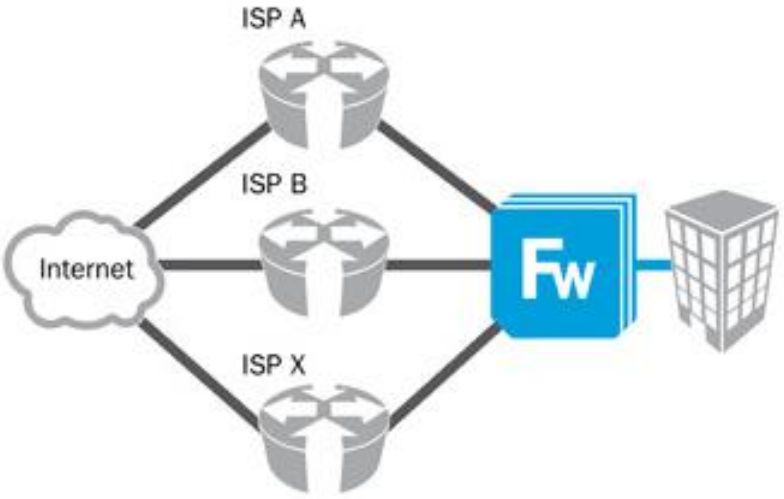






Resumen: balanceo tradicional

- ECMP / PCC / NTH
  - Conexiones persistentes
  - Subida y bajada por la misma WAN
  - Conexión depende de la IP de la interfaz WAN



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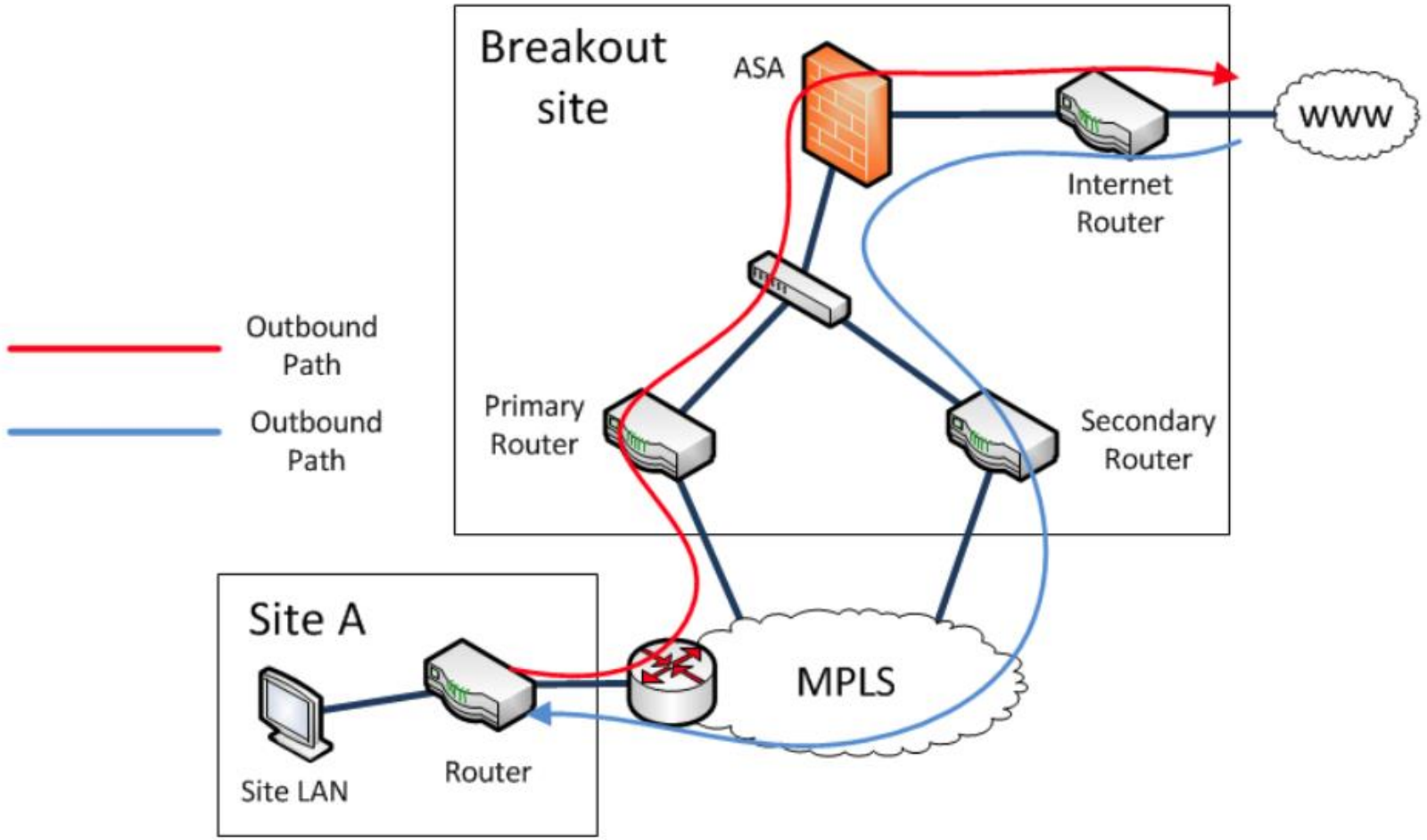
AS	0.0.0.0/0	208.67.220.222 recursive via 186....	1	vlan-401
AS	0.0.0.0/0	208.67.222.220 recursive via 186....	1	vlan-301
AS	0.0.0.0/0	208.67.222.123 recursive via 186....	1	vlan-201
AS	0.0.0.0/0	208.67.220.123 recursive via 186....	1	vlan-101
AS	0.0.0.0/0	172.23.105.1 reachable ipip_vc5	1	to-scl-5
AS	0.0.0.0/0	172.23.104.1 reachable ipip_vc4	1	to-scl-4
AS	0.0.0.0/0	172.23.103.1 reachable ipip_vc3	1	to-scl-3
AS	0.0.0.0/0	172.23.102.1 reachable ipip_vc2	1	to-scl-2
AS	0.0.0.0/0	172.23.101.1 reachable ipip_vc1	1	to-scl-1
AS	0.0.0.0/0	208.67.220.123 recursive via 186....	1	full-balancer

Balanceo BGP: multihomed

- Las conexiones NO son persistentes
  - 10.88.77.22 → 8.8.8.8
  - Sale por WAN 1 / Regresa por WAN 2
- Se puede aplicar PCC / ECMP y NTH
  - No se suele hacer
- Se debe establecer una sesión BGP con el upstream
  - Se anuncian los prefijos de red propios de la empresa o de tránsito (terceros)
  - Se aplican filtros
    - Entrantes
    - Salientes

Conexiones NO son persistentes



Balanceo BGP: multihomed

- Saliente
  - Se basa en la tabla de rutas
    - Filtros entrantes
- Entrante
  - Se basa en la información entregada a los ISP de tránsito (upstream)
  - Prefijo + máscara de subred
  - Prepend del AS = AS-PATH
  - Decisión propia de los ISP (no se puede alterar)

Sesión BGP

BGP

Instances | VRFs | Peers | Networks | Aggregates | VPN4 Routes | Advertisements

Refresh | Refresh All | Resend | Resend All

Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID	Uptime	Prefix Co...	State
ifx	default	10.60.0.201	18747	no	no	d...	10.0.120.153	3d 12:52...		established
powerhost	default	10.164.71.1	263237	no	no	d...	10.60.99.1	16d 20:4...	12	established
intercable	default	172.18.126.2	61503	no	no	d...	138.36.253.17	4d 16:51...		established
austro-pbc	default	172.19.84.2	265703	no	no	d...	172.19.84.2	17d 11:2...	5	established
natales-scl-1	natales-scl-1	172.23.101.2	101	no	no	d...	172.23.101.2	10d 23:5...	279	established
natales-scl-2	natales-scl-2	172.23.102.2	102	no	no	d...	172.23.102.2	10d 23:5...	279	established
natales-scl-3	natales-scl-3	172.23.103.2	103	no	no	d...	172.23.103.2	10d 23:5...	279	established
natales-scl-4	natales-scl-4	172.23.104.2	104	no	no	d...	172.23.104.2	10d 23:5...	279	established
natales-scl-5	natales-scl-5	172.23.105.2	105	no	no	d...	172.23.105.2	10d 23:5...	279	established
natales-scl-17	natales-scl-17	172.23.117.2	117	no	no	d...	172.23.117.2	10d 23:5...	279	established
puq-scl-1	puq-scl-1	172.23.201.2	201	no	no	d...	172.23.201.2	15:40:12	80	established
puq-scl-2	puq-scl-2	172.23.202.2	202	no	no	d...	172.23.202.2	15:39:21	80	established
puq-scl-3	puq-scl-3	172.23.203.2	203	no	no	d...	172.23.203.2	15:39:15	80	established
puq-scl-17	puq-scl-17	172.23.217.2	217	no	no	d...	172.23.217.2	15:40:12	80	established
gtd	default	192.168.213.221	14259	no	no	d...	190.196.126.81	50d 01:0...	6045	established
pitchile-1	default	200.23.206.1	61522	no	no	d...	200.23.206.1	10d 23:2...	5176	established
pitchile-2	default	200.23.206.2	61522	no	no	d...	200.23.206.2	10d 23:2...	5274	established
facebook-1	default	200.23.206.205	32934	no	no	d...	129.134.61.190	21d 16:1...	34	established
microsoft-1	default	200.23.206.210	8075	no	no	d...	207.46.32.81	21d 16:1...	212	established
microsoft-2	default	200.23.206.211	8075	no	no	d...	207.46.32.82	21d 16:1...	212	established
google	default	200.23.206.225	15169	no	no	d...	74.125.251.16	21d 16:1...	579	established

Prefijos recibidos = caminos posibles

Tabla de rutas basada en las sesiones BGP

Route List

Routes | Nexthops | Rules | VRF

BGP is yes

	Dst. Address	Gateway	Pref. Source	BGP AS Path
DAb	216.252.222.0/24	200.23.206.225 reachable vlan-25_pit	160.20.188.1	15169
Db	216.252.222.0/24	192.168.213.221 reachable ether1_gtd-internet	160.20.188.1	14259,15169
DAb	216.252.220.0/24	200.23.206.225 reachable vlan-25_pit	160.20.188.1	15169
Db	216.252.220.0/24	192.168.213.221 reachable ether1_gtd-internet	160.20.188.1	14259,15169
DAb	216.252.220.0/22	200.23.206.225 reachable vlan-25_pit	160.20.188.1	15169
Db	216.252.220.0/22	192.168.213.221 reachable ether1_gtd-internet	160.20.188.1	14259,15169
Db	216.241.29.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
DAb	216.241.29.0/24	192.168.213.221 reachable ether1_gtd-internet	160.20.188.1	14259,19228,18747
Db	216.241.29.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
Db	216.241.26.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
Db	216.241.26.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
DAb	216.241.26.0/24	192.168.213.221 reachable ether1_gtd-internet	160.20.188.1	14259,19228,18747
DAb	216.241.25.0/24	192.168.213.221 reachable ether1_gtd-internet	160.20.188.1	14259,19228,18747
Db	216.241.25.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
Db	216.241.25.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
DAb	216.241.17.0/24	192.168.213.221 reachable ether1_gtd-internet	160.20.188.1	14259,19228,18747
Db	216.241.17.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
Db	216.241.17.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
Db	216.241.14.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
Db	216.241.14.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
DAb	216.241.14.0/24	192.168.213.221 reachable ether1_gtd-internet	160.20.188.1	14259,19228,18747
Db	216.241.13.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
DAb	216.241.13.0/24	192.168.213.221 reachable ether1_gtd-internet	160.20.188.1	14259,19228,18747
Db	216.241.13.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
Db	216.241.11.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
Db	216.241.11.0/24	200.23.206.20 reachable vlan-25_pit	160.20.188.1	265703,265703,265703,265703,265703,61522,18747
DAb	216.241.11.0/24	192.168.213.221 reachable ether1_gtd-internet	160.20.188.1	14259,19228,18747

Tabla de rutas basada en las sesiones BGP

- En algunos casos toma salida por PIT CHILE
- En otros casos toma salida por LEVEL3

Route List

Routes | Nexthops | Rules | VRF

BGP | is | yes

	Dst. Address	Gateway	BGP AS Path
Db	216.252.222.0/24	216.241.14.9 reachable sfp1_IFX	18747,15169
DAb	216.252.222.0/24	200.23.206.225 reachable vlan-25_pitchile	15169
Db	216.252.220.0/24	216.241.14.9 reachable sfp1_IFX	18747,15169
DAb	216.252.220.0/24	200.23.206.225 reachable vlan-25_pitchile	15169
Db	216.252.220.0/22	216.241.14.9 reachable sfp1_IFX	18747,15169
DAb	216.252.220.0/22	200.23.206.225 reachable vlan-25_pitchile	15169
Db	216.252.220.0/22	200.41.94.229 reachable vlan-811_LEVEL3_nacional	3549,15169
DAb	216.241.29.0/24	200.41.94.229 reachable vlan-811_LEVEL3_nacional	3549,21838,61522,18747
Db	216.241.29.0/24	200.23.206.20 reachable vlan-25_pitchile	263237,263237,263237,263237,263237,263237,263237,263237,263237,263237,61522,18747
Db	216.241.29.0/24	200.23.206.20 reachable vlan-25_pitchile	263237,263237,263237,263237,263237,263237,263237,263237,263237,263237,61522,18747
DAb	216.241.26.0/24	200.41.94.229 reachable vlan-811_LEVEL3_nacional	3549,21838,61522,18747
Db	216.241.26.0/24	200.23.206.20 reachable vlan-25_pitchile	263237,263237,263237,263237,263237,263237,263237,263237,263237,263237,61522,18747
Db	216.241.26.0/24	200.23.206.20 reachable vlan-25_pitchile	263237,263237,263237,263237,263237,263237,263237,263237,263237,263237,61522,18747
DAb	216.241.25.0/24	200.41.94.229 reachable vlan-811_LEVEL3_nacional	3549,21838,61522,18747
Db	216.241.25.0/24	200.23.206.20 reachable vlan-25_pitchile	263237,263237,263237,263237,263237,263237,263237,263237,263237,263237,61522,18747
Db	216.241.25.0/24	200.23.206.20 reachable vlan-25_pitchile	263237,263237,263237,263237,263237,263237,263237,263237,263237,263237,61522,18747

Tabla de rutas: MAIN

- Múltiples caminos para alcanzar un destino
- Solo 1 ruta activa para un destino específico
- Se tomará siempre la ruta mas específica
- Se tomará la ruta que tenga el AS-PATH mas corto
  - Se puede modificar con los filtros entrantes
  - Prepend AS-PATH
- Distancia no es útil para la decisión
  - BGP Best Path Selection Algorithm
  - https://wiki.mikrotik.com/wiki/Manual:BGP_Best_Path_Selection_Algorithm

Best Path Selection Algorithm

BEST PATH ALGORITHM

1. Router is ignoring received path if the route is not **valid**. Route is valid if:
   - NEXT_HOP of the route is valid and reachable
   - AS_PATH received from external peers does not contain the local AS
   - route is not rejected by routing filters

   For more information read nexthop selection and validation.
2. The first path received is automatically considered 'best path'. Any further received paths are compared to first received to determine if the new path is better.
3. Prefer the path with the highest **WEIGHT**.

   WEIGHT parameter is local to the router on which it is configured. A route without assigned WEIGHT have a default value of 0.
4. Prefer the path with the highest **LOCAL_PREF**. It is used only within an AS.

   A path without **LOCAL_PREF** attribute have a value of 100 by default.
5. Prefer the path with the shortest **AS_PATH**. (skipped if `ignore-as-path-len` set to **yes**)

   Each **AS_SET** counts as 1, regardless of the set size. The **AS_CONFED_SEQUENCE** and **AS_CONFED_SET** are not included in the **AS_PATH** length.
6. Prefer the path that was locally originated via aggregate or BGP network
7. Prefer the path with the lowest **ORIGIN** type.

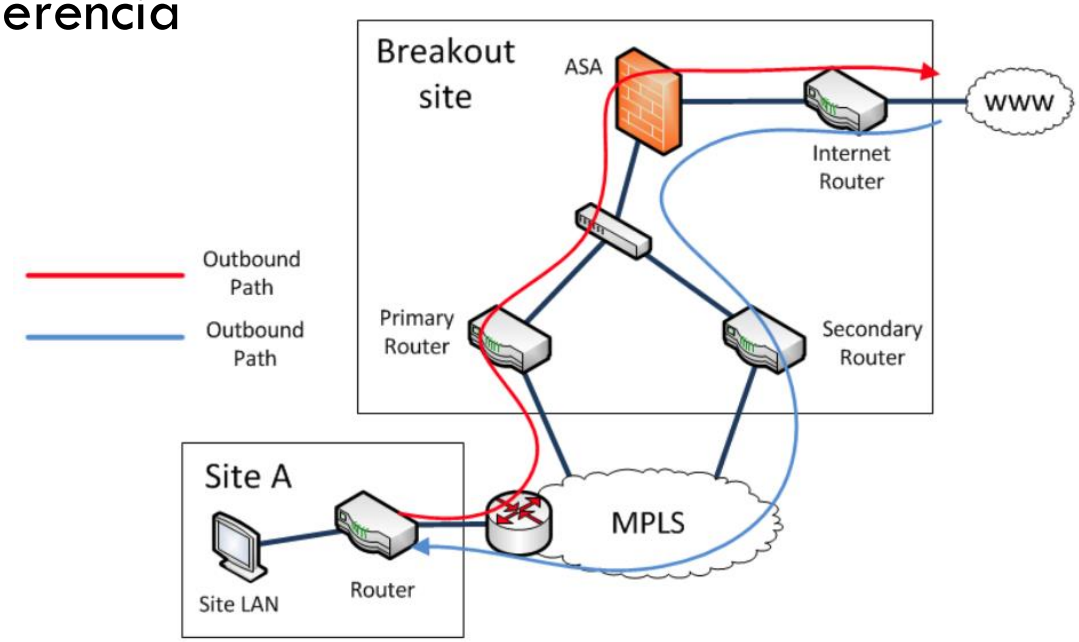
   Interior Gateway Protocol (IGP) is lower than Exterior Gateway Protocol (EGP), and EGP is lower than INCOMPLETE

   in other words **IGP < EGP < INCOMPLETE**
8. Prefer the path with the lowest **multi-exit discriminator** (MED).

   The router compare MED attribute only for paths that have the same neighboring (leftmost) AS. Paths without explicit MED value are treated as with MED of 0
9. Prefer **eBGP** over **iBGP** paths
10. Prefer the route that comes from the BGP router with the lowest **router ID**. If a route carries the **ORIGINATOR_ID** attribute, then the **ORIGINATOR_ID** is used instead of router ID.
11. Prefer the route with the shortest **route reflection cluster list**. Routes without a cluster list are considered to have a cluster list of length 0.
12. Prefer the path that comes from the lowest neighbor address

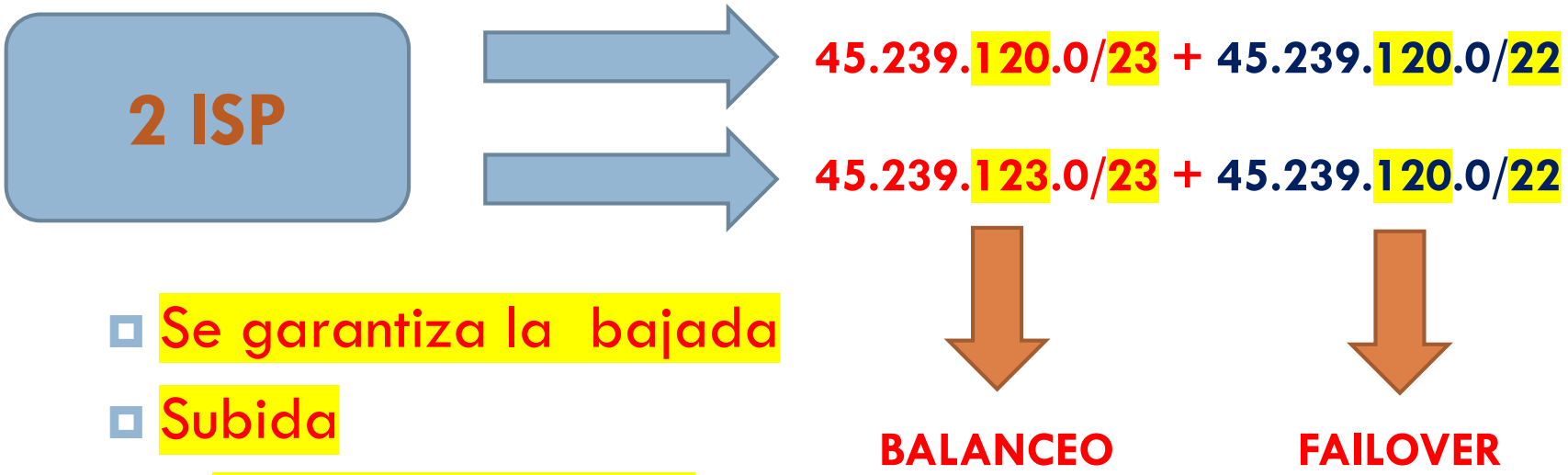
Best Path Selection Algorithm

- Ejecutado por cada router de la RED del UPSTREAM
  - No podemos controlar la interpretación del upstream
  - Podemos intentar "persuadir" a los upstream
    - Tomar alguna preferencia
    - Balanceo entrante



BGP: balanceo entrante / Escenario

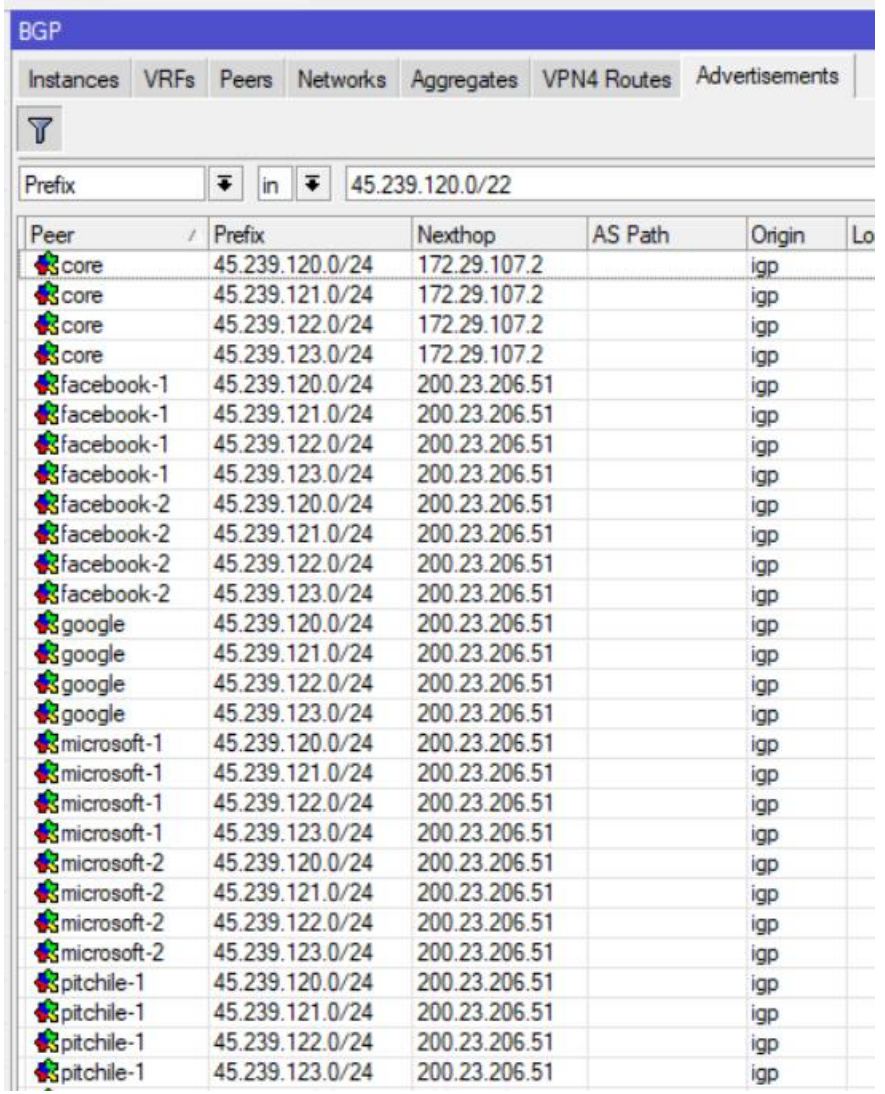
- Basado en que LACNIC otorgó 1 prefijo /22
- Usando filtros de salida
  - Modificar los anuncios (publicaciones)



- Se garantiza la bajada
- Subida
  - Depende de la MAIN
  - Se puede formar salida con mangle

Publicación por defecto: persistencia

- En este escenario NO se puede garantizar la persistencia
- Bajo este escenario se puede saturar alguno de los enlaces dado
- Es un buen escenario para failover automático
- Balanceo basado en la decisión de los upstream



Peer	Prefix	Nexthop	AS Path	Origin	Lo
core	45.239.120.0/24	172.29.107.2		igp	
core	45.239.121.0/24	172.29.107.2		igp	
core	45.239.122.0/24	172.29.107.2		igp	
core	45.239.123.0/24	172.29.107.2		igp	
facebook-1	45.239.120.0/24	200.23.206.51		igp	
facebook-1	45.239.121.0/24	200.23.206.51		igp	
facebook-1	45.239.122.0/24	200.23.206.51		igp	
facebook-1	45.239.123.0/24	200.23.206.51		igp	
facebook-2	45.239.120.0/24	200.23.206.51		igp	
facebook-2	45.239.121.0/24	200.23.206.51		igp	
facebook-2	45.239.122.0/24	200.23.206.51		igp	
facebook-2	45.239.123.0/24	200.23.206.51		igp	
google	45.239.120.0/24	200.23.206.51		igp	
google	45.239.121.0/24	200.23.206.51		igp	
google	45.239.122.0/24	200.23.206.51		igp	
google	45.239.123.0/24	200.23.206.51		igp	
microsoft-1	45.239.120.0/24	200.23.206.51		igp	
microsoft-1	45.239.121.0/24	200.23.206.51		igp	
microsoft-1	45.239.122.0/24	200.23.206.51		igp	
microsoft-1	45.239.123.0/24	200.23.206.51		igp	
microsoft-2	45.239.120.0/24	200.23.206.51		igp	
microsoft-2	45.239.121.0/24	200.23.206.51		igp	
microsoft-2	45.239.122.0/24	200.23.206.51		igp	
microsoft-2	45.239.123.0/24	200.23.206.51		igp	
pitchile-1	45.239.120.0/24	200.23.206.51		igp	
pitchile-1	45.239.121.0/24	200.23.206.51		igp	
pitchile-1	45.239.122.0/24	200.23.206.51		igp	
pitchile-1	45.239.123.0/24	200.23.206.51		igp	

Publicación por defecto: persistencia


```
forward: in:vlan-811_LEVEL3_nacional out:sfp4_1072-1, src-mac dc:38:e1:14:fc:08, proto TCP (ACK), 186.35.38.16:50915->200.73.113.191:80, len 1500
forward: in:vlan-811_LEVEL3_nacional out:sfp4_1072-1, src-mac dc:38:e1:14:fc:08, proto TCP (ACK), 186.35.38.16:50915->200.73.113.191:80, len 1500
forward: in:vlan-811_LEVEL3_nacional out:sfp4_1072-1, src-mac dc:38:e1:14:fc:08, proto TCP (ACK), 186.35.38.16:50915->200.73.113.191:80, len 1500
forward: in:vlan-811_LEVEL3_nacional out:sfp4_1072-1, src-mac dc:38:e1:14:fc:08, proto TCP (ACK), 186.35.38.16:50915->200.73.113.191:80, len 1500
forward: in:vlan-811_LEVEL3_nacional out:sfp4_1072-1, src-mac dc:38:e1:14:fc:08, proto TCP (ACK), 186.35.38.16:50915->200.73.113.191:80, len 1500
forward: in:vlan-811_LEVEL3_nacional out:sfp4_1072-1, src-mac dc:38:e1:14:fc:08, proto TCP (ACK), 186.35.38.16:50915->200.73.113.191:80, len 1500
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forward: in:sfp4_1072-1 out:sfp1_IFX, src-mac 6c:3b:6b:f0:03:1f, proto TCP (ACK), 200.73.113.191:80->186.35.38.16:50915, len 40
forward: in:sfp4_1072-1 out:sfp1_IFX, src-mac 6c:3b:6b:f0:03:1f, proto TCP (ACK), 200.73.113.191:80->186.35.38.16:50915, len 40
forward: in:sfp4_1072-1 out:sfp1_IFX, src-mac 6c:3b:6b:f0:03:1f, proto TCP (ACK), 200.73.113.191:80->186.35.38.16:50915, len 40
forward: in:sfp4_1072-1 out:sfp1_IFX, src-mac 6c:3b:6b:f0:03:1f, proto TCP (ACK), 200.73.113.191:80->186.35.38.16:50915, len 40
forward: in:vlan-811_LEVEL3_nacional out:sfp4_1072-1, src-mac dc:38:e1:14:fc:08, proto TCP (ACK), 186.35.38.16:50915->200.73.113.191:80, len 1500
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forward: in:sfp4_1072-1 out:sfp1_IFX, src-mac 6c:3b:6b:f0:03:1f, proto TCP (ACK), 200.73.113.191:80->186.35.38.16:50915, len 40
forward: in:sfp4_1072-1 out:sfp1_IFX, src-mac 6c:3b:6b:f0:03:1f, proto TCP (ACK), 200.73.113.191:80->186.35.38.16:50915, len 40
forward: in:vlan-811_LEVEL3_nacional out:sfp4_1072-1, src-mac dc:38:e1:14:fc:08, proto TCP (ACK), 186.35.38.16:50915->200.73.113.191:80, len 1500
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forward: in:sfp4_1072-1 out:sfp1_IFX, src-mac 6c:3b:6b:f0:03:1f, proto TCP (ACK), 200.73.113.191:80->186.35.38.16:50915, len 40
forward: in:sfp4_1072-1 out:sfp1_IFX, src-mac 6c:3b:6b:f0:03:1f, proto TCP (ACK), 200.73.113.191:80->186.35.38.16:50915, len 40
```
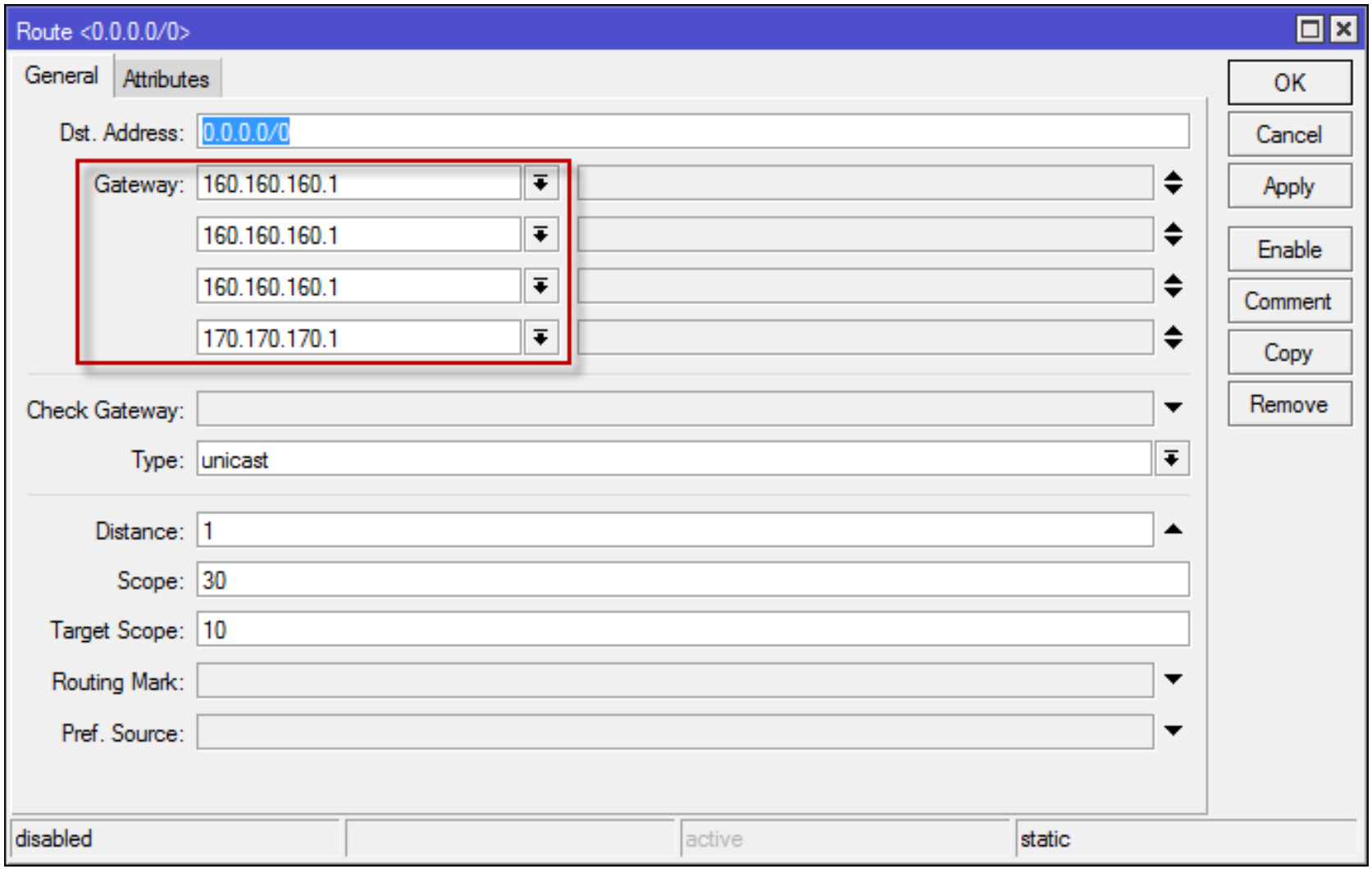

Poderación de enlaces

¿Dónde puedo aplicar ponderación?

- ECMP
  - Simple de implementar
- PCC
  - Complejo de implementar
  - Robusto y escalable
- NTH
  - No permite implementar

Ponderación: ECMP



Ponderación: PCC

- add action=mark-connection chain=prerouting comment="SIN PONDERACION - 2 WAN / PCC" **connection-mark=no-mark** in-interface=ether2_laptop new-connection-**mark=mc_to-wan1 per-connection-classifier=both-addresses-and-ports:8/x**

	both addresses and ports:8/0	mc_to-wan1	0 B	0	CON PONDERAC...
	both addresses and ports:8/1	mc_to-wan1	0 B	0	CON PONDERAC...
	both addresses and ports:8/2	mc_to-wan1	250 B	2	CON PONDERAC...
	both addresses and ports:8/3	mc_to-wan2	0 B	0	CON PONDERAC...
	both addresses and ports:8/4	mc_to-wan2	0 B	0	CON PONDERAC...
	both addresses and ports:8/5	mc_to-wan3	0 B	0	CON PONDERAC...
	both addresses and ports:8/6	mc_to-wan3	0 B	0	CON PONDERAC...
	both addresses and ports:8/7	mc_to-wan4	0 B	0	CON PONDERAC...

Posibles problemas (tradicional)

Posibles problemas balanceando

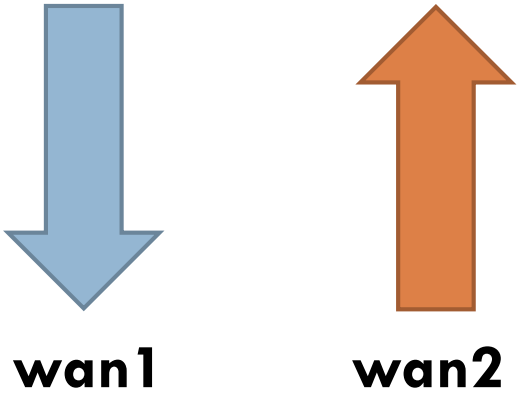
- Problemas con páginas HTTPS
- Problemas con conexiones al mismo router
- Acceso a servidores internos por una WAN específica (DST-NAT)
- Forzar un host a salir por una wan específica
- Varios links con el mismo gateway

Problema con páginas cifradas (https)

- Sitios que usan cifrado (bancos, google, youtube, facebook, etc) no permiten establecer múltiples conexiones provenientes de diferentes enlaces simultáneamente.
  - Phishing
- Solución
  - Mantener la persistencia
  - Usar ECMP o PCC con BOTH ADDRESS
    - Excluir los puertos origen y destino

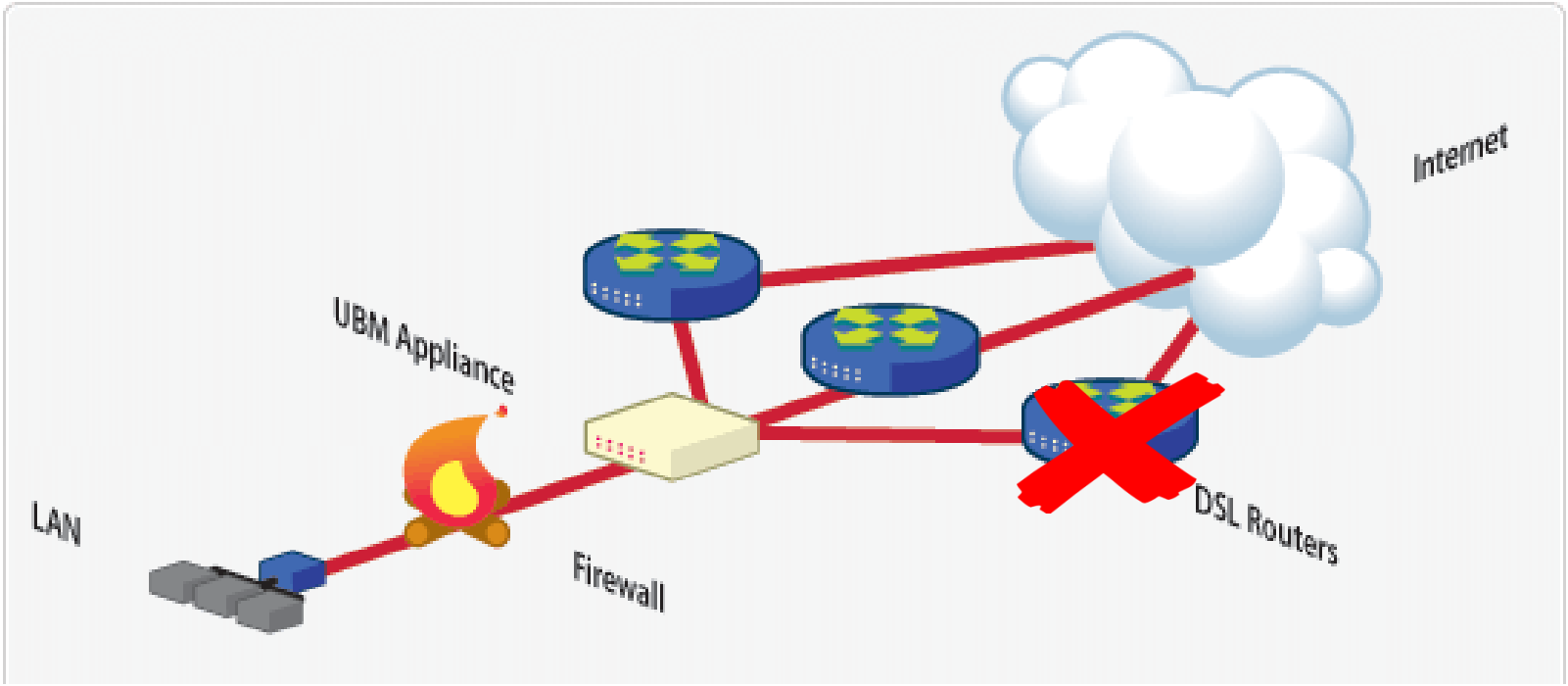
Conexiones dirigidas al router

- Paquetes salientes utilizan la misma decisión de ruteo que los paquetes que atraviesan el router.
- Las respuestas de un paquete que fue recibida por wan1 podría ser enviada de vuelta y enmascarada por wan2
- Solución
  - Marcar conexiones entrantes
  - Forzar a salir por la misma wan



Failover

Failover



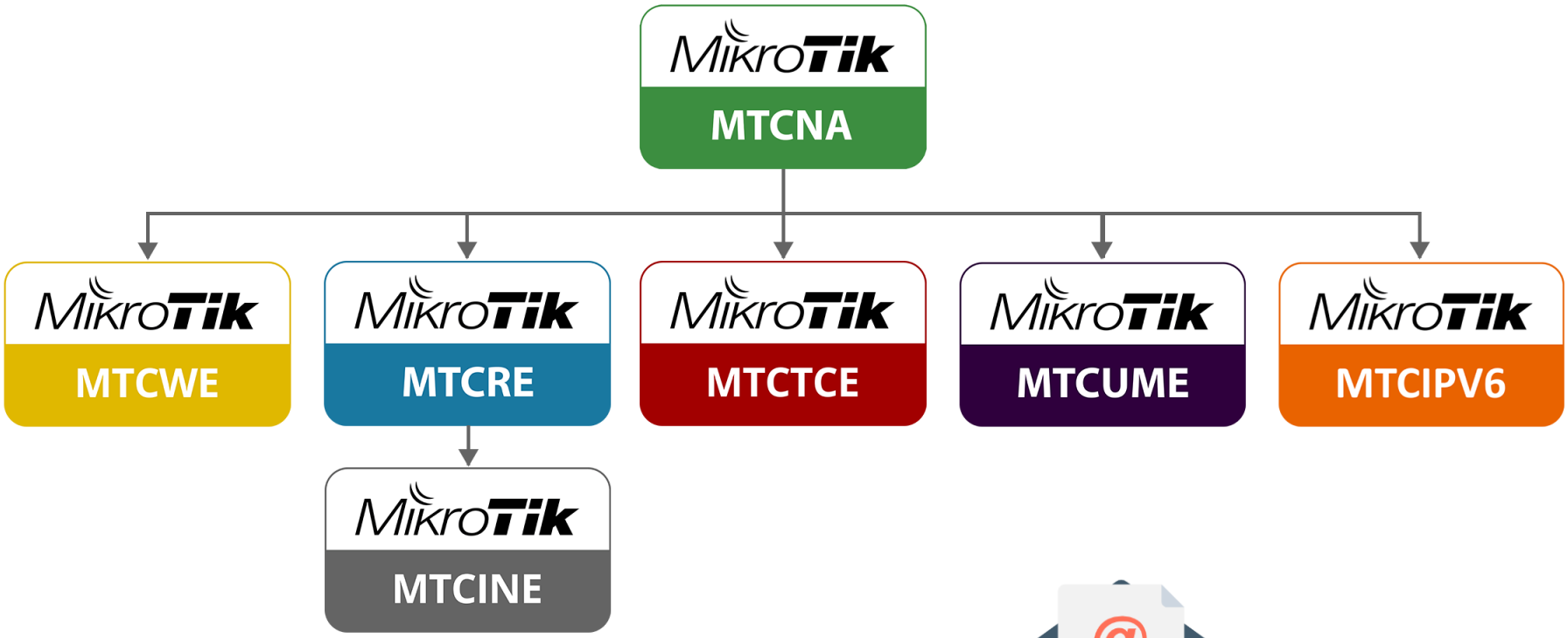
Cómo manejar Failover

- Formas comúmes
  - Scripts
    - Haciendo ping a links externos.
  - Netwatch
    - Haciendo ping a links externos.
- Sin scripts ni Netwatch
  - Routes Nexthop Lookup
    - Rutas recursivas
    - Usando scope=10
    - check-gateway=ping

RUTAS RECURSIVAS

Cursos oficiales MikroTik RouterOS

- Cursos de certificación oficial MikroTik



at@mkx.cl

¿Preguntas?

Gracias por su atención