

Intelioffice S.A.
Andrés Castro Valencia

MULTI-ENLACES INALÁMBRICOS DE ALTA CAPACIDAD



INTELIOFFICE

SU INTELIGENTE CONEXION AL FUTURO

- Andrés Castro Valencia
 - Compañía: Intelioffice S.A. (Colombia)
 - MikroTik Certified Trainer
 - MikroTik Certified Consultant
 - Trabajando en Networking desde 2002.
 - Especialidades: Enlaces inalámbricos de Larga Distancia y Alta Capacidad, Diseño de Redes, Redes Malladas, QoS (Mangle y Queue Tree), Tunnels (EoIP, L2TP, PPTP), Políticas de Ruteo, Ruteo Estático y OSPF.

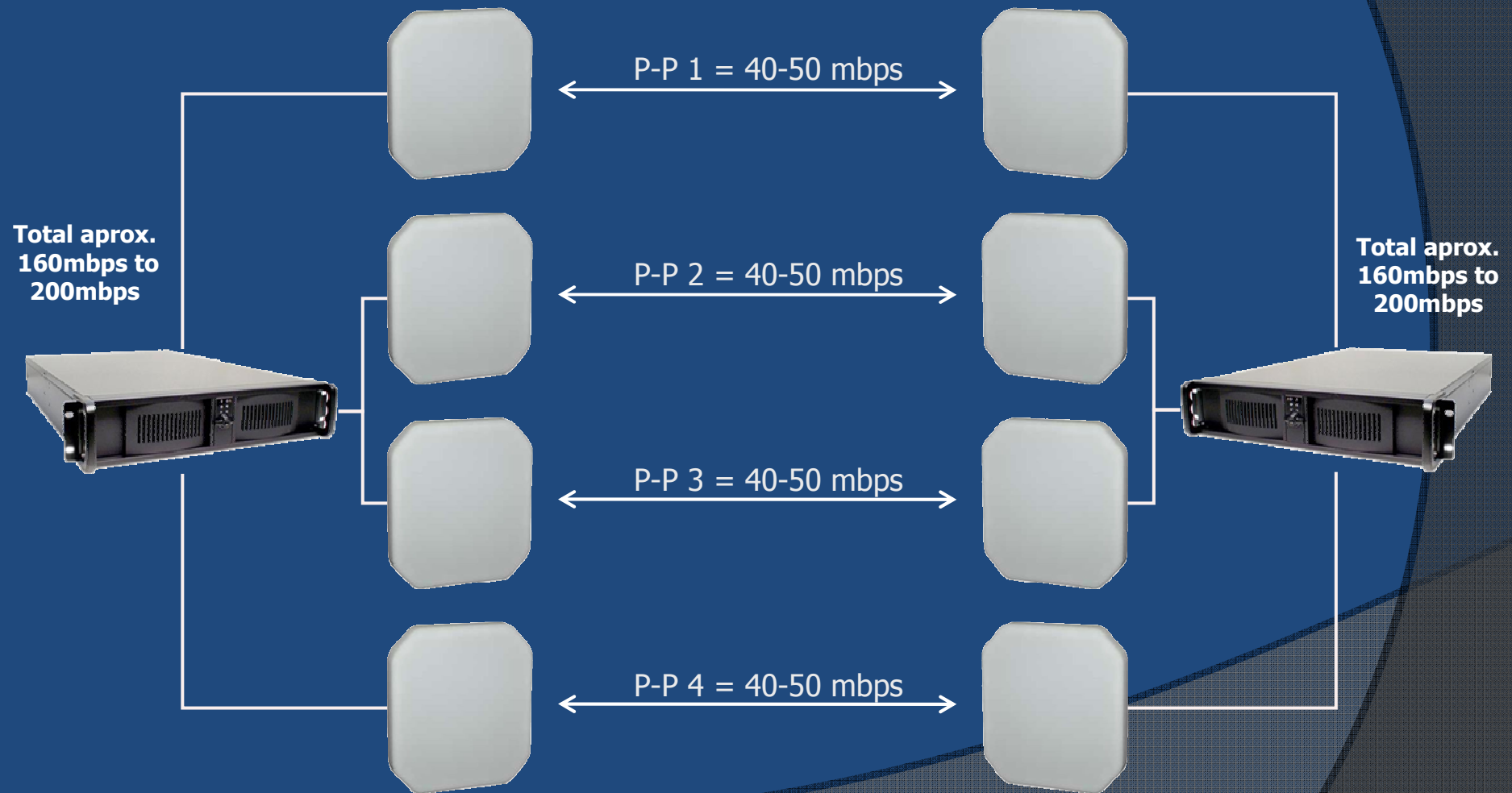
Long Distance Wireless Multi-Links

- ◉ Objetivos
- ◉ Laboratorio con Bonding
 - Gráficas de la solución
 - Requerimiento de equipos
 - Datos técnicos del caso
 - Pasos para construir Multi-Enlaces con Protocolo Bonding
- ◉ Aplicación con OSPF (Cliente en Argentina)
 - Gráficas de la solución
 - Requerimiento de equipos
 - Imágenes de la Red y Configuración

Objetivos

- Dar a conocer los diferentes alcances del RouterOS de MikroTik al implementar Enlaces Multi-Links con Protocolo Bonding.
- Breve reseña de Enlaces Multi-Links con Protocolo de Enrutamiento OSPF (Load Balancing) y cómo trabaja este con MikroTik RouterOS.
- Aprender sobre las diferentes soluciones complejas que pueden ser diseñadas con MikroTik.

Gráfica de la Solución con Bonding



Requerimiento de Equipos

Side 1:

- Un (01) Router x86: CPU Intel Dual Core 2.6GHz, 1024MB RAM, 5 LAN.
- Cuatro (04) MikroTik RB433AH con Atheros CPU 680MHz y 802.11n Wireless Mini-PCI Cards.
- Cuatro (04) Swivel Antennas 5GHz 5dBi.

Side 2:

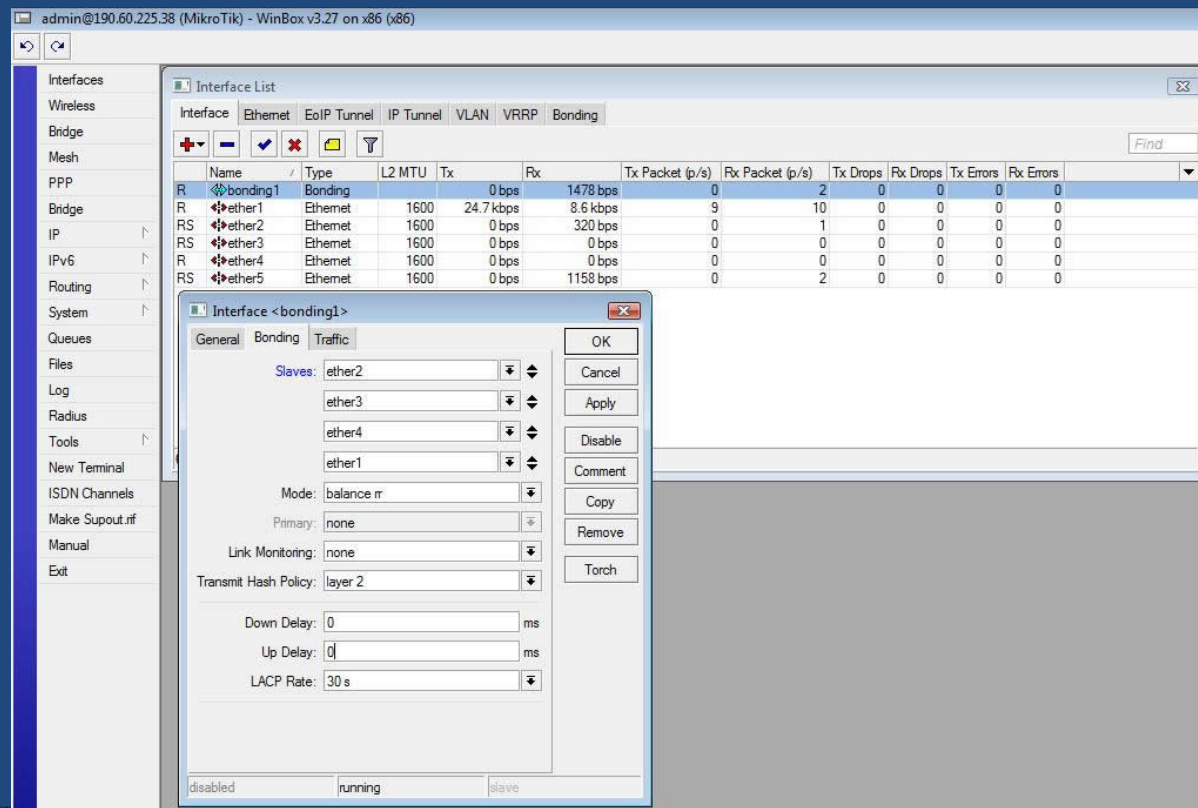
- Un (01) Router x86: CPU Intel Dual Core 2.6GHz, 1024MB RAM, 5 LAN.
- Cuatro (04) MikroTik RB433AH con Atheros CPU 680MHz y 802.11n Wireless Mini-PCI Cards.
- Cuatro (04) Swivel Antennas 5GHz 5dBi.

Datos técnicos del caso

- Ubicación
 - Laboratorio Local
- Tipo de Configuración
 - Ambos lados: Core Routers: Bonding con Link1, Link2, Link3 y Link4 como interfaces esclavas.
 - Bonding Mode: Balance-rr
 - Software Version: 3.27 (x86) Routers y 4.0 Beta 4 RB433AH
 - Band: 5GHz-Only-N
 - Frequency: 5180, 5290, 5500 y 5800 MHz
 - Nstreme: Dynamic Size
 - Tx Power: Default
 - ACK Timeout: Dynamic
 - Router AP: AP-Bridge
 - Client: Station-WDS

Pasos para construir Enlaces Multi-Link

- Instalar y configurar cuidadosamente cada Enlace Inalámbrico
- Configurar en cada Router la Interfaz Bonding
- Adicionar las Interfaces Wireless como Esclavas al Bonding



Pasos para construir Enlaces Multi-Link

⦿ IMPORTANTE !!!

- Cada enlace inalámbrico debe ser configurado de forma adecuada, estos deben estar bien sincronizados
- El protocolo bonding hace trabajar todo el Multi-Link de acuerdo al link de menor capacidad de ancho de banda
 - Por ejemplo, si tenemos en los links 1, 2 y 3 un throughput real de 40mbps en c/u, pero el enlace 4 solo tiene 20mbps, entonces, el Bonding reconoce para cada Link 20mbps en c/u sin importar que las otras interfaces tengan un BW mayor
- Para este tipo de solución es necesario obtener en lo posible, el mismo ancho de banda en cada Link inalámbrico para tener como resultado el mejor rendimiento en el total de ancho de banda
- Bonding es el único protocolo que permite realizar físicamente agregación de interfaces

Test

admin@190.60.225.38 (MikroTik) - WinBox v3.27 on x86 (x86)

CPU: 72% ☒ Hide Passwords

Interfaces

- Wireless
- Bridge
- Mesh
- PPP
- Bridge
- IP
- IPv6
- Routing
- System
- Queues
- Files
- Log
- Radius
- Tools
- New Terminal
- ISDN Channels
- Make Supout.nf
- Manual
- Exit

Interface List

Interface	Name	Type	L2 MTU	Tx	Rx	Tx Packet (p/s)	Rx Packet (p/s)	Tx Drops	Rx Drops	Tx Errors	Rx Errors
R	bonding1	Bonding		71.5 Mbps	72.2 Mbps	13 538	13 511	0	0	0	0
R	ether1	Ethernet	1600	22.2 Kbps	7.3 Kbps	7	8	0	0	0	0
RS	ether2	Ethernet	1600	23.2 Mbps	24.0 Mbps	4 513	4 448	0	0	0	0
RS	ether3	Ethernet	1600	23.9 Mbps	24.8 Mbps	4 513	4 666	0	0	0	0
R	ether4	Ethernet	1600	0 bps	0 bps	0	0	0	0	0	0
RS	ether5	Ethernet	1600	24.3 Mbps	23.3 Mbps	4 513	4 396	0	0	0	0

Bandwidth Test

Test To: 10.20.30.1

Protocol: ☐ udp ☒ tcp

Local UDP Tx Size: 1500

Remote UDP Tx Size: 1500

Direction: both

TCP Connection Count: 20

Local Tx Speed: bps

Remote Tx Speed: bps

User: admin

Password: *****

Tx/Rx 10s Average: 53.6 Mbps/52.8 Mbps

Tx/Rx Average: 44.8 Mbps/42.7 Mbps

Tx: 60.7 Mbps

Rx: 62.9 Mbps

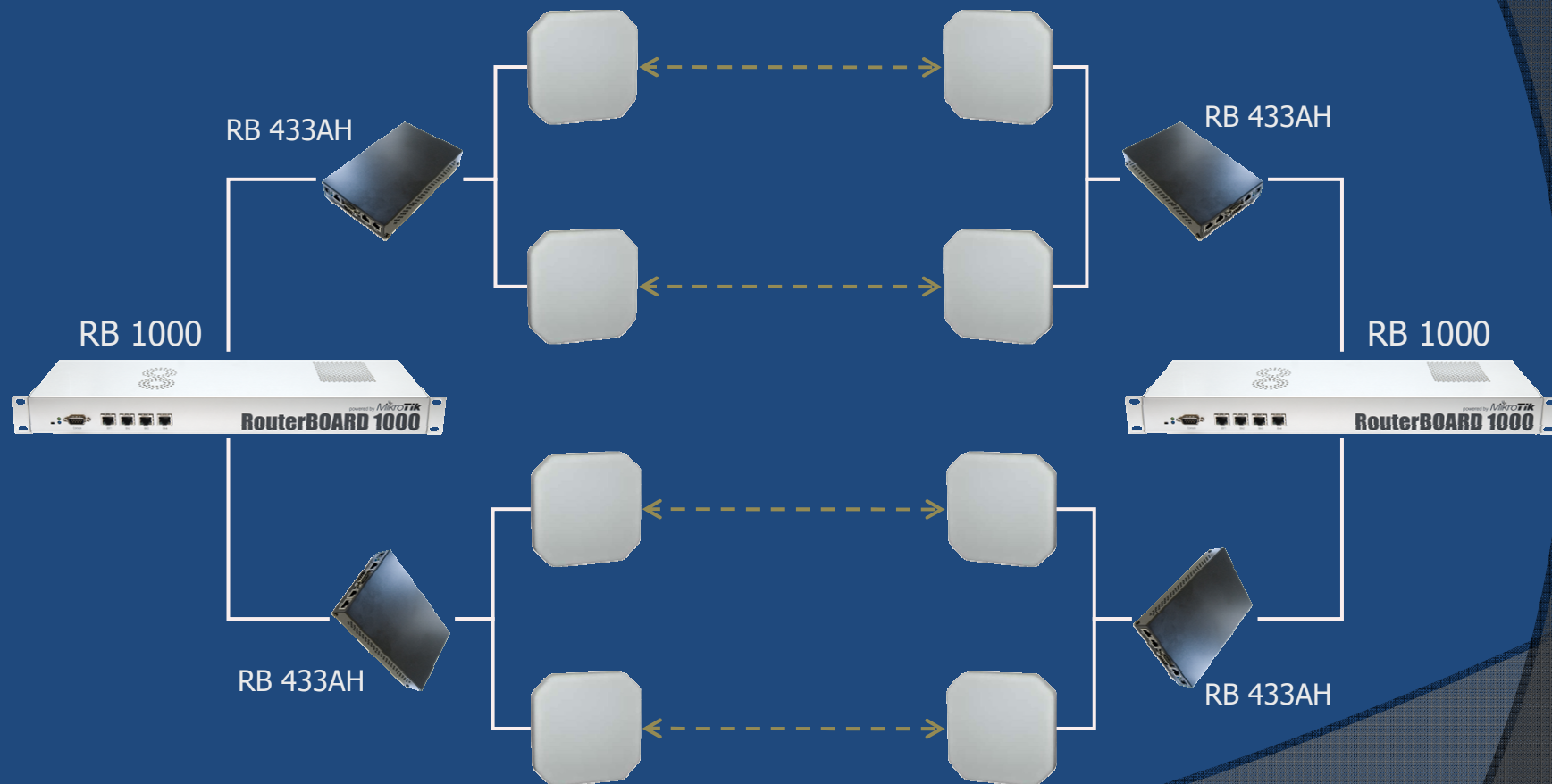
running...

Aplicación real con OSPF

- ◉ Breve presentación del Cliente:

- Compañía: SOLUNET SRL GROUP
- Ubicación: Buenos Aires, Argentina
- Actividad Comercial: **WISP**
- Tipo de Clientes: Residencial and Corporativo
- Numero de Clientes: **5.000**
- Experiencia: Mas de 10 años vendiendo soluciones de comunicaciones y conectividad en Buenos Aires
- Relación con Intelioffice S.A. (Colombia): Intelioffice de Colombia ofrece servicios de asesoría y capacitación para el mejoramiento de la Red WISP de SOLUNET SRL de Argentina

Gráfica de la Solución



Requerimiento de Equipos

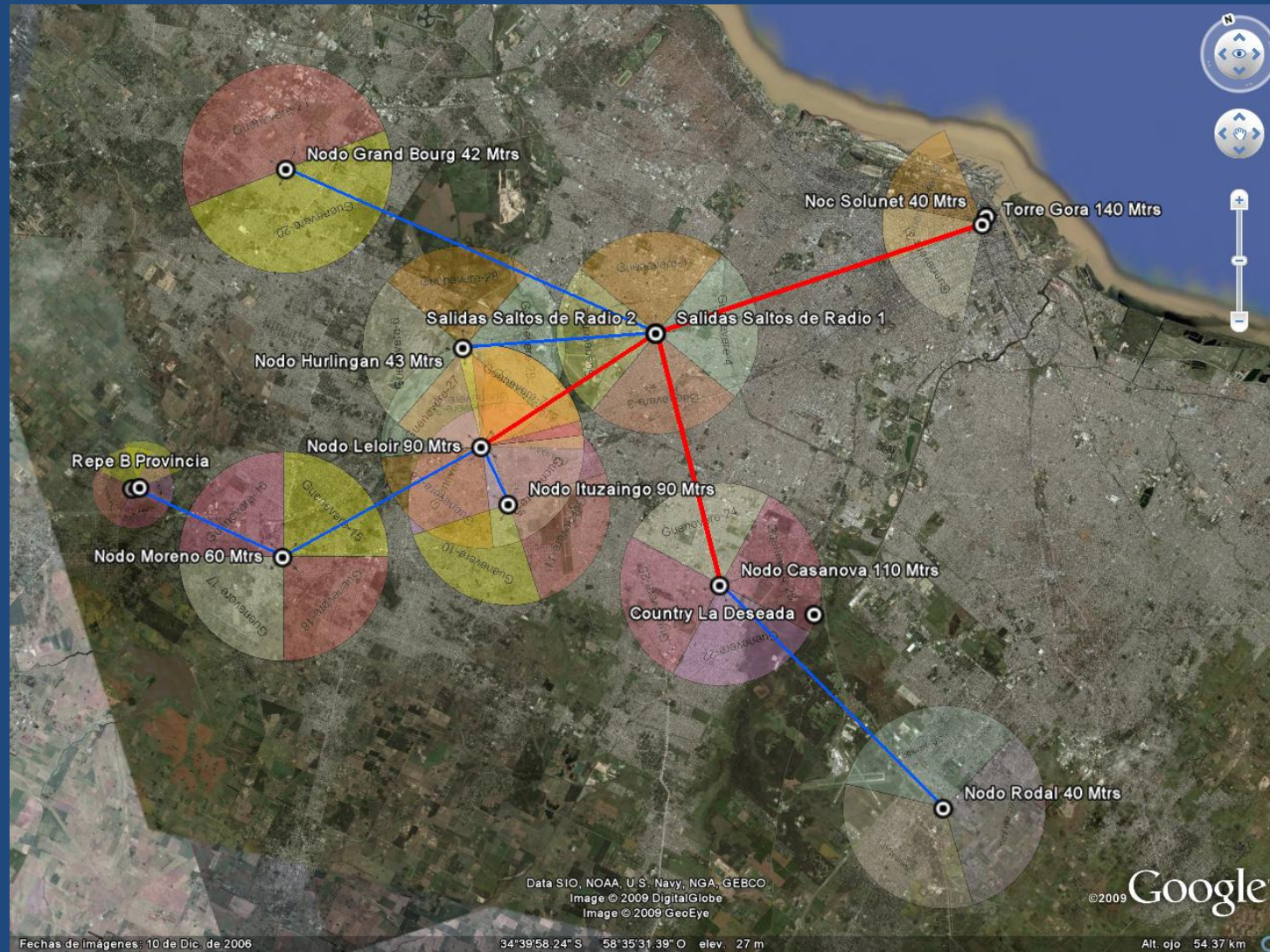
⦿ **Torre Gora:**

- Un (01) Router RB1000 4 LAN.
- Dos (02) MikroTik RB433AH con Atheros CPU 680MHz y Cuatro (04) 802.11a Wireless Mini-PCI Cards Ubiquiti XR5.
- Dos (02) Dual Polarity Antennas 5GHz 32dBi Hyperlinktech.

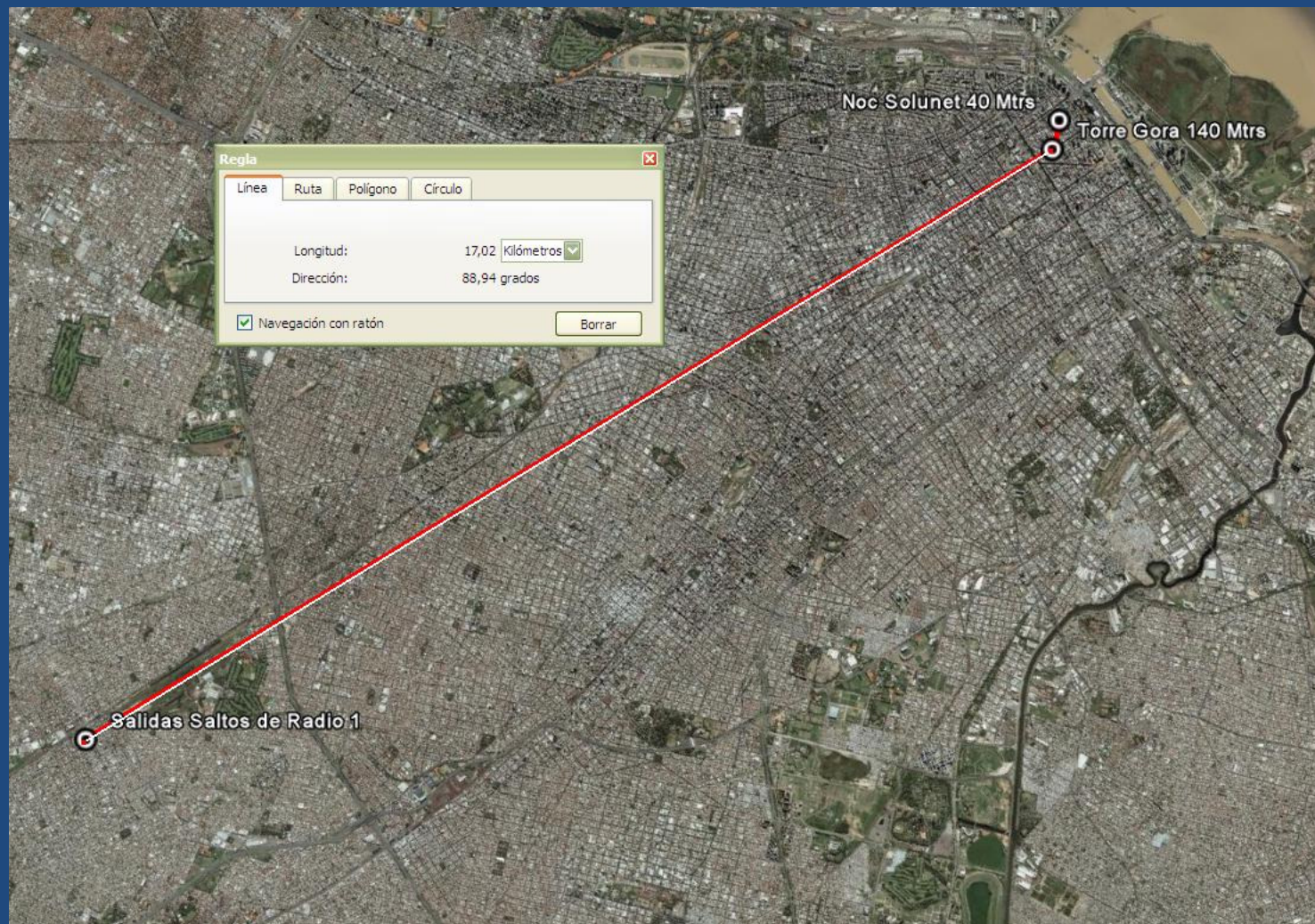
⦿ **Salida Salto de Radio 1:**

- Un (01) Router RB1000 4 LAN.
- Dos (02) MikroTik RB433AH con Atheros CPU 680MHz y Cuatro (04) 802.11a Wireless Mini-PCI Cards Ubiquiti XR5.
- Dos (02) Dual Polarity Antennas 5GHz 32dBi Hyperlinktech.

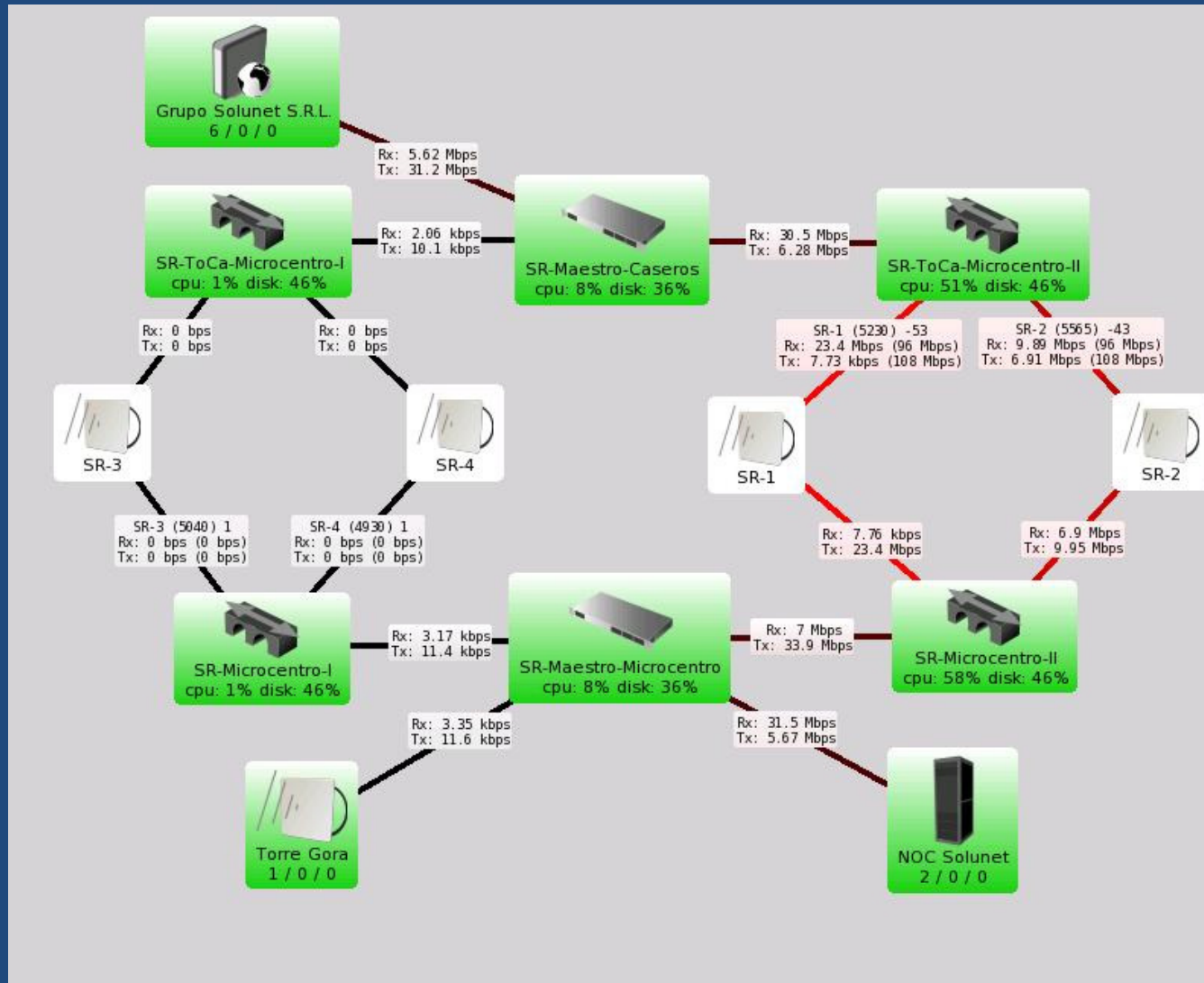
Imágenes de la Red y Configuración



Imágenes de la Red y Configuración



Dude Manager Multi-Link



Registration del Point to Point Activo

admin@10.10.60.12 (SR-ToCa-Microcentro-II) - WinBox v3.22 on RB433 (mipsbe) 134d 03:06:37 Memory: 114.5 MB

Wireless Tables

Interfaces Nstream Dual Access List Registration Connect List Security Profiles

Reset

Radio Name	MAC Address	Interface	Uptime	AP	W...	Last Activit...	Signal Strengt...	Tx/Rx Rate
SR-1(Amba)	00:15:6D:63:EE:76	SR-1(Amba)	134d 03:...	yes	no	0.000	-52	54Mbps*2/36Mbps*2
SR-2(Abajo)	00:15:6D:64:BE:D0	SR-2(Abajo)	9d 15:01:...	yes	no	0.010	-43	54Mbps*2/54Mbps*2

AP Client <00:15:6D:63:EE:76>

General 802.1x Signal Nstream Statistics OK

Last Activity: 0.000 s

Signal Strength: -52 dBm

Tx Signal Strength: -53 dBm

Signal To Noise: 39 dB

Tx/Rx CCQ: 91/78 %

P Throughput: 53772 kbps

Signal Strengths

Rate	Strength
6Mbps	-52
9Mbps	-62
12Mbps	-52
18Mbps	-52
24Mbps	-53
36Mbps	-54
48Mbps	-57
54Mbps	-59

Remove

Reset

Copy to Access List

Copy to Connect List

Ping

MAC Ping

Telnet

MAC Telnet

Torch

AP Client <00:15:6D:64:BE:D0>

General 802.1x Signal Nstream Statistics OK

Last Activity: 0.010 s

Signal Strength: -43 dBm

Tx Signal Strength: -42 dBm

Signal To Noise: 53 dB

Tx/Rx CCQ: 100/97 %

P Throughput: 55138 kbps

Signal Strengths

Rate	Strength
6Mbps	-43
9Mbps	-47
12Mbps	-45
18Mbps	-42
24Mbps	-42
36Mbps	-45
48Mbps	-47
54Mbps	-49

Remove

Reset

Copy to Access List

Copy to Connect List

Ping

MAC Ping

Telnet

MAC Telnet

Torch

Imágen de la Interfaz Wireless

admin@10.10.60.11 (SR-ToCa-Microcentro-I) - WinBox v3.22 on RB433 (mipsbe)

32d 14:18:42 Memory

Interfaces
Wireless
Bridge
Mesh
IP
Routing
Ports
Queues
Drivers
System
Files
Log
SNMP
Users
Radius
Tools
New Terminal
Telnet
Password

Wireless Tables

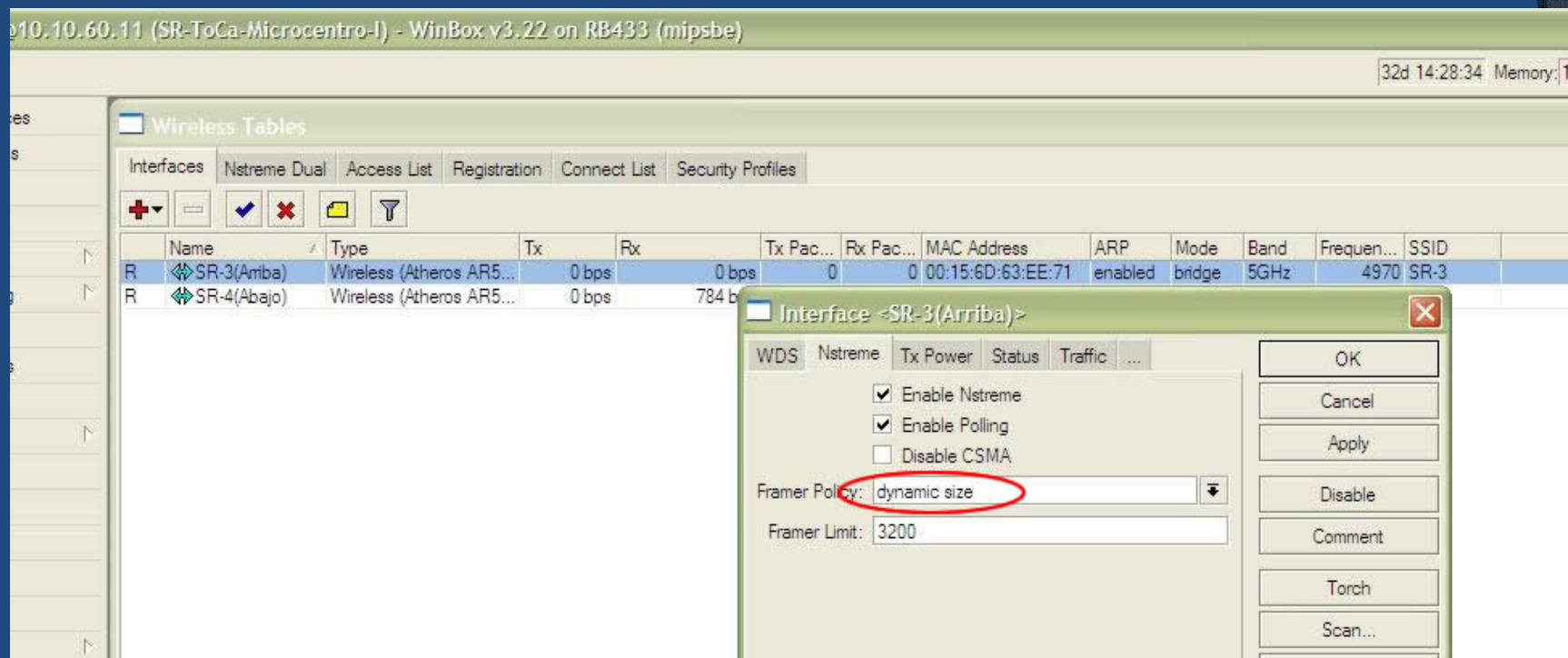
Interfaces Nstreme Dual Access List Registration Connect List Security Profiles

Reset

Radio Name	MAC Address	Interface	Uptime	AP	W...	Last Activit...	Signal Strength (d...	Ix/Rx Rate
SR-3(Amba)	00:15:6D:63:EE:7A	SR-3(Amba)	00:00:51	no	no	0.000	-67	54Mbps/54Mbps
SR-4(Abajo)	00:15:6D:63:EE:72	SR-4(Abajo)	00:00:50	no	no	0.100	-69	54Mbps/54Mbps

Imágen nstreme

- Después de varias pruebas concluimos que la mejor configuración del **nstreme** en este caso es con la política dynamic size
- El protocolo nstreme nos permite obtener un mejor desempeño en cada enlace inalámbrico



Configuración Interfaces OSPF

- Configuramos OSPF en cada RB433 para obtener Balanceo de Cargas entre las interfaces inalámbricas
- El área debe ser solo una para todas las interfaces inalámbricas
- En este esquema, el protocolo OSPF hace el balanceo de todo el tráfico adicionando el ancho de banda de todas los Enlaces Inalámbricos, de tal forma que los suma todos

10.60.11 (SR-ToCa-Microcentro-I) - WinBox v3.22 on RB433 (mipsbe)

32d 14:25:24 Memory: 114.3 MiB CPU: 5%

OSPF

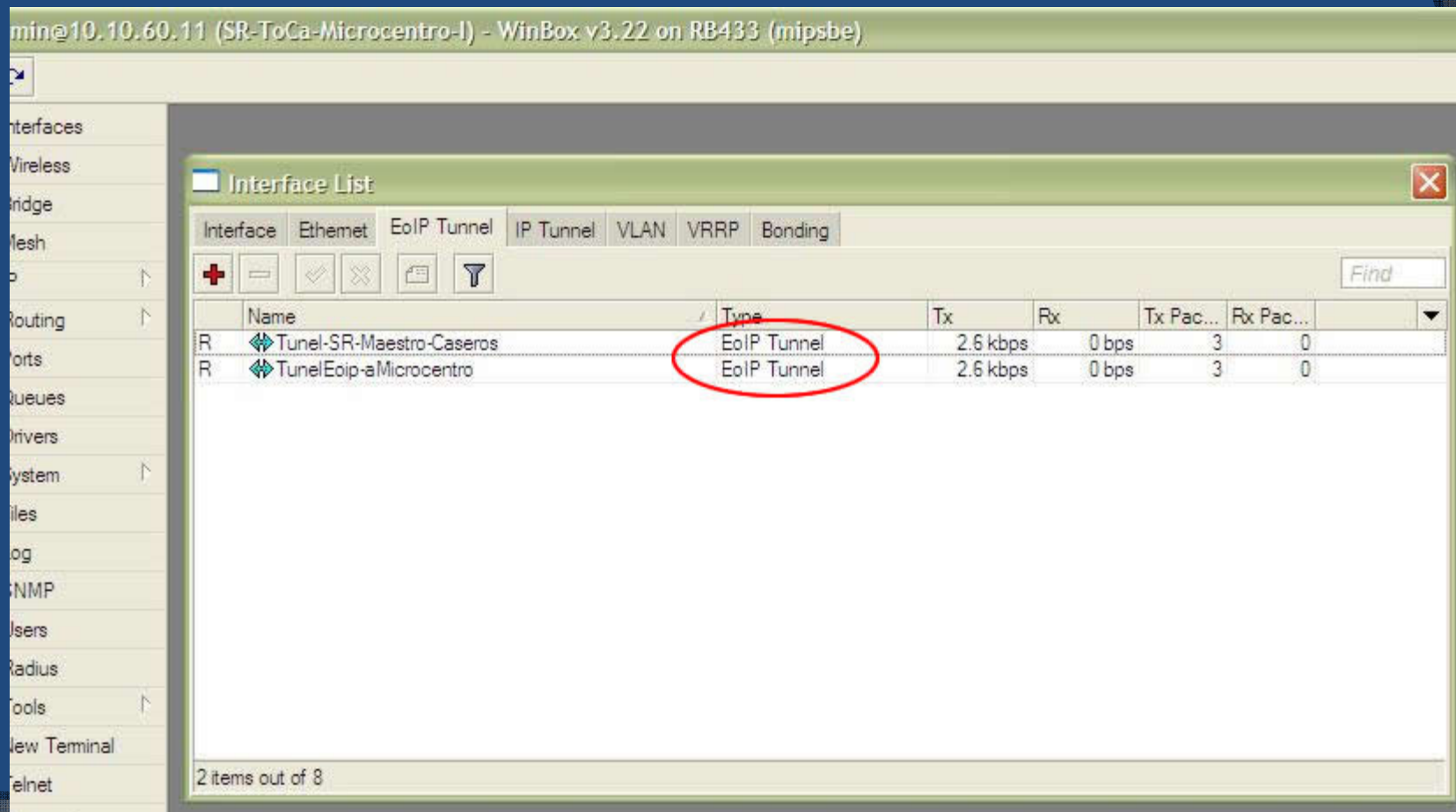
Interfaces Networks Areas Area Ranges Virtual Links Neighbors NBMA Neighbors LSA Routes ASBR Routers OSPF Routers

OSPF Settings

Interface	Cost	Priority	Authentic...	Authenticatio...	Network Type	Area	Neig...	State
D SR-3(Amba)	10	1	none		broadcast	0.0.0.1	1	backup
D SR-4(Abajo)	10	1	none		broadcast	0.0.0.1	1	backup

Imágen Interface EoIP

- En este caso tuvimos que usar un Tunnel EoIP entre cada interfaz ethernet de las RB433AH
- El cliente tiene configurada su Red en Modo BRIDGE



Tracking Connection Core Router A

		Src. Address	Dest. Address	Proto...	Connect...	Connection Mark	P2P	Timeout	TCP State
IP	A	190.0.165.188:1107	64.59.73.39:80	6 (tcp)		HTTP-L7		11:59:22	established
Routing	A	190.0.168.222:41264	64.180.20.58:8458	17 (u...		Resto-UDP-P2P-L7-S		00:02:11	
System		190.0.163.186:28622	64.231.133.220:54725	17 (u...		Resto-UDP-P2P-L7-S		00:00:02	
Queues	U	190.0.165.213:26847	65.32.218.138:3376	6 (tcp)		Resto-TCP-P2P-L7-S		02:21:38	established
Files	A	190.0.166.4:1246	65.54.48.125:1863	6 (tcp)		MSN-L7		11:59:22	established
Log	A	190.0.167.210:32416	65.54.49.170:1863	6 (tcp)		MSN-L7		11:58:59	established
Radius	U	190.0.168.89:1424	65.54.93.175:80	6 (tcp)		HTTP-L7		00:00:04	fin wait
Tools	A	190.0.166.190:50427	65.55.15.124:80	6 (tcp)		HTTP-L7		11:59:27	established
New Terminal	A	190.0.168.244:1310	65.55.15.244:80	6 (tcp)		HTTP-L7		11:58:58	established
MetaROUTER		190.0.164.166:41335	66.27.164.131:43661	17 (u...		Resto-UDP-P2P-L7-S		00:00:22	
Make Supout.tif	A	190.0.163.48:41517	66.56.180.242:24971	17 (u...		Resto-UDP-P2P-L7-S		00:02:58	
Manual	U	190.0.163.61:3554	66.77.197.153:80	6 (tcp)		HTTP-L7		00:49:33	established
Exit	U	190.0.165.198:13038	66.143.52.80:21873	17 (u...		Resto-UDP-P2P-L7-S		00:00:15	
	A	190.0.165.242:4194	66.175.123.38:80	6 (tcp)		HTTP-L7		11:59:27	established
	U	190.0.168.234:2194	67.83.52.237:21267	6 (tcp)		Resto-TCP-P2P-L7-S		08:31:29	established
	U	190.0.168.234:2345	67.83.52.237:21267	6 (tcp)		Resto-TCP-P2P-L7-S		08:35:01	established
	A	190.0.165.82:42786	67.149.139.227:10959	17 (u...		Resto-UDP-P2P-L7-S		00:02:07	
	A	190.0.165.233:20445	67.167.2.191:16759	17 (u...		Resto-UDP-P2P-L7-S		00:02:26	
	U	190.0.163.47:6862	67.182.200.6:3101	6 (tcp)		Resto-TCP-P2P-L7-S		03:06:52	established
	A	190.0.167.197:42187	67.193.238.231:22529	6 (tcp)		Resto-TCP-P2P-L7-S		01:18:20	established
	A	190.0.175.9:61407	67.195.15.12:80	6 (tcp)				00:00:01	close wait
	A	190.0.169.17:3000	67.196.156.35:80	6 (tcp)		HTTP-L7		01:33:48	established
	U	190.0.166.68:56344	68.43.237.64:2396	6 (tcp)		Resto-TCP-P2P-L7-S		08:30:04	established
	U	190.0.166.68:3926	68.49.117.69:17511	6 (tcp)		Resto-TCP-P2P-L7-S		11:38:10	established
	U	190.0.166.68:56344	68.100.149.133:50571	6 (tcp)		Resto-TCP-P2P-L7-S		07:59:15	established
	U	190.0.166.242:15432	68.101.138.83:55256	6 (tcp)		Resto-TCP-P2P-L7-S		01:28:33	established
	U	190.0.165.213:26847	68.108.77.100:56952	6 (tcp)		Resto-TCP-P2P-L7-S		00:01:40	established
	A	190.0.163.199:3039	68.142.118.195:80	6 (tcp)		HTTP-L7		00:00:01	close
	U	190.0.166.68:56344	68.194.114.163:2586	6 (tcp)		P2P-L7-S	bittor...	09:38:42	established
	A	190.0.168.248:3091	69.39.86.196:443	6 (tcp)		HTTP-L7		00:00:00	fin wait
	A	190.0.163.197:53202	69.63.176.195:80	6 (tcp)		HTTP-L7		11:59:39	established
	A	190.0.163.168:1612	69.63.184.32:80	6 (tcp)		HTTP-L7		11:57:43	established
	A	190.0.165.110:14314	69.156.93.193:4952	17 (u...		Resto-UDP-P2P-L7-S		00:00:55	
	A	190.0.166.83:53820	69.249.191.74:20766	17 (u...		Resto-UDP-P2P-L7-S		00:02:40	
	U	190.0.165.213:26847	70.69.177.137:55878	6 (tcp)		Resto-TCP-P2P-L7-S		04:11:00	established
	U	190.0.163.251:11116	70.81.164.107:4326	6 (tcp)		Resto-TCP-P2P-L7-S		05:12:38	established
	A	190.0.167.197:42187	70.104.119.95:50870	6 (tcp)		Resto-TCP-P2P-L7-S		00:02:01	established
		190.0.163.221:27304	70.122.82.135:31196	17 (u...		Resto-UDP-P2P-L7-S		00:00:04	
		190.0.167.238:48047	71.65.213.103:35530	17 (u...		Resto-UDP-P2P-L7-S		00:00:02	
	U	190.0.165.213:26847	71.72.59.255:63418	6 (tcp)		Resto-TCP-P2P-L7-S		01:20:28	established
	U	190.0.166.242:15432	71.79.102.187:1223	6 (tcp)		Resto-TCP-P2P-L7-S		11:18:42	established
	A	190.0.168.121:26465	71.130.208.169:38721	17 (u...		Resto-UDP-P2P-L7-S		00:02:05	
	A	190.0.169.9:58074	71.191.71.14:6648	6 (tcp)		Resto-TCP-P2P-L7-S		02:42:08	established
		190.0.165.251:3757	71.236.105.147:35446	17 (u...		Resto-UDP-P2P-L7-S		00:00:03	
		190.0.163.40:64731	72.18.205.210:80	6 (tcp)		HTTP-L7		00:00:19	syn recei...
	A	190.0.165.58:1484	72.30.180.76:80	6 (tcp)		HTTP-L7		00:00:06	close wait
	U	190.0.168.91:1117	72.46.254.76:80	6 (tcp)		HTTP-L7		02:28:36	established
	A	190.0.165.124:1246	72.46.254.95:80	6 (tcp)		HTTP-L7		11:59:16	established
	A	190.0.165.189:23924	72.68.118.180:50025	17 (u...		Resto-UDP-P2P-L7-S		00:01:59	
		190.0.166.83:56901	72.178.221.113:33519	17 (u...		Resto-UDP-P2P-L7-S		00:00:02	
	U	190.0.163.52:22009	72.196.246.251:1187	6 (tcp)		Resto-TCP-P2P-L7-S		11:25:08	established
	U	190.0.166.68:56344	72.201.0.113:2883	6 (tcp)		Resto-TCP-P2P-L7-S		07:04:17	established
	U	190.0.166.242:15432	74.76.20.146:1607	6 (tcp)		Resto-TCP-P2P-L7-S		08:49:44	established
		190.0.163.205:4739	74.125.242.196:80	6 (tcp)		HTTP-L7		00:00:07	syn recei...
	U	190.0.166.68:56344	74.128.208.114:62134	6 (tcp)		Resto-TCP-P2P-L7-S		05:20:40	established
	U	190.0.166.68:56344	74.192.189.200:4901	6 (tcp)		Resto-TCP-P2P-L7-S		06:59:36	established
		2049 items out of 90117				Max Entries: 524288			

Tracking Connection Core Router B

RouterOS WinBox

28d

Firewall

Filter Rules NAT Mangle Service Ports Connections Address Lists Layer7 Protocols

Tracking

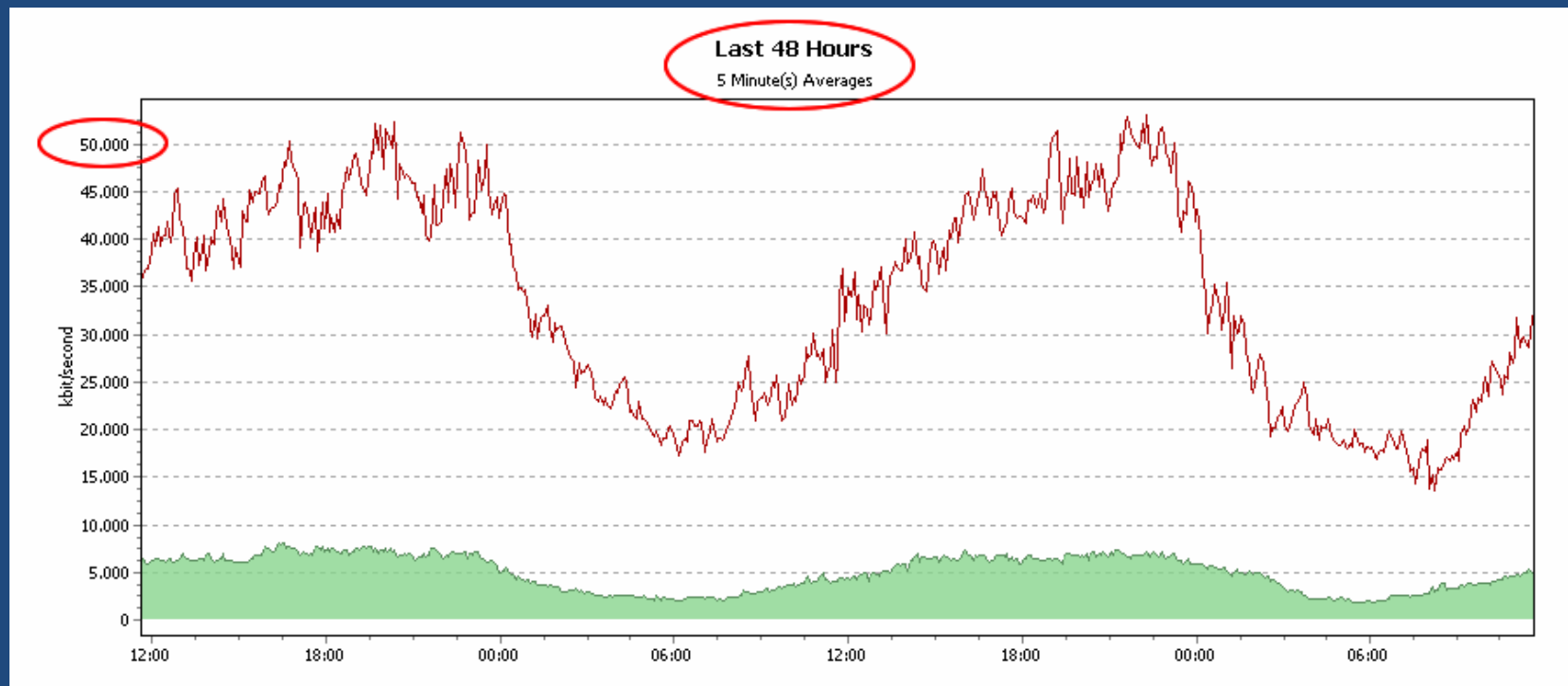
	Src. Address	Dst. Address	Proto...	Connecti...	Connecti...	P2P	Timeout	TCP State
U	190.0.162.125:80	190.210.7.163:54518	6 (tcp)				22:19:51	established
U	114.137.133.230:3992	200.69.95.46:445	6 (tcp)				15:13:27	established
A	190.177.149.228:64...	190.0.161.201:80	6 (tcp)				23:58:55	established
U	190.0.162.21:80	201.246.216.141:14...	6 (tcp)				10:30:29	established
U	200.69.65.52:80	186.18.26.214:59305	6 (tcp)				09:03:43	established
A	190.0.80.25:11837	190.0.162.33:445	6 (tcp)				23:58:27	established
A	190.14.30.225:43211	209.191.118.103:25	6 (tcp)				17:47:19	established
U	190.0.162.117:80	186.136.186.101:3618	6 (tcp)				09:08:34	established
U	190.0.162.105:80	190.51.134.59:56863	6 (tcp)				03:15:00	established
U	190.14.23.237:45402	68.1.17.3:25	6 (tcp)				03:47:19	established
U	200.69.65.45:80	190.247.219.97:2474	6 (tcp)				10:14:04	established
U	190.0.162.121:80	200.117.23.209:49384	6 (tcp)				00:45:31	established
U	190.14.23.140:60398	68.1.17.3:25	6 (tcp)				06:26:48	established
U	190.14.16.5:80	190.247.221.246:1872	6 (tcp)				02:40:06	established
U	190.0.162.117:80	190.16.16.114:2719	6 (tcp)				03:20:14	established
U	190.0.174.4:80	66.175.118.196:39924	6 (tcp)				02:18:47	established
U	190.0.162.117:80	200.80.140.61:25740	6 (tcp)				08:44:14	established
U	209.85.211.86:25	190.14.30.8:47830	6 (tcp)				06:40:16	established
A	83.42.136.90:10837	200.69.65.40:53	17 (u...				00:01:24	
U	200.69.65.200:80	190.107.35.8:26354	6 (tcp)				03:40:05	established
U	200.69.65.45:80	201.255.61.107:1489	6 (tcp)				09:33:35	established
A	213.158.170.164:2294	190.0.162.82:445	6 (tcp)				23:59:34	established
U	190.0.162.121:80	190.138.60.22:24944	6 (tcp)				05:27:03	established
U	190.0.162.121:80	201.213.44.27:49246	6 (tcp)				09:53:21	established
U	200.42.101.109:3957	190.0.161.90:80	6 (tcp)				22:47:18	established
U	200.69.65.45:80	209.13.97.34:62247	6 (tcp)				10:49:38	established
U	200.69.65.45:80	190.197.156.171:61...	6 (tcp)				08:57:36	established
U	190.0.161.140:25	190.16.178.241:63157	6 (tcp)				21:42:05	established
U	190.0.162.19:80	190.218.9.215:51615	6 (tcp)				02:45:19	established
U	190.0.162.49:9090	190.178.199.126:1977	6 (tcp)				03:11:47	established
U	200.69.65.45:80	190.253.244.177:10...	6 (tcp)				23:02:42	established
U	200.69.65.200:80	201.213.239.248:1991	6 (tcp)				08:53:28	established
U	190.0.162.121:80	201.251.79.185:4307	6 (tcp)				08:20:08	established
A	190.0.175.5:3790	190.0.161.124:80	6 (tcp)				23:59:41	established
U	200.69.65.45:80	201.240.196.187:14...	6 (tcp)				09:20:52	established
A	190.0.162.82:2982	78.9.32.87:445	6 (tcp)				00:04:08	established
A	86.73.49.207:51388	200.69.65.40:53	17 (u...				00:01:12	
U	190.0.162.121:80	212.166.163.135:60...	6 (tcp)				18:34:31	established
U	190.0.162.41:80	190.174.138.36:18553	6 (tcp)				08:42:14	established
A	201.259.39.28:13344	190.0.162.133:80	6 (tcp)				23:58:00	established
U	84.124.83.2:80	200.69.64.51:445	6 (tcp)				03:54:51	established

2049 items out of 39254

Max Entries: 524288

Gráfica MRTG del Enlace Multi-Link

- El cliente trafica datos por este Multi-Link Inalámbrico en horas congestionadas de hasta 80mbps de throughput efectivo
- Esta Gráfica MRTG nos muestra el tráfico de datos pasando por el Multi-Link cada 48 horas



GRACIAS POR SU ATENCIÓN !!!