

Intelioffice S.A.  
Andrés Castro Valencia

# MULTI-ENLACES INALÁMBRICOS DE ALTA CAPACIDAD



- 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.

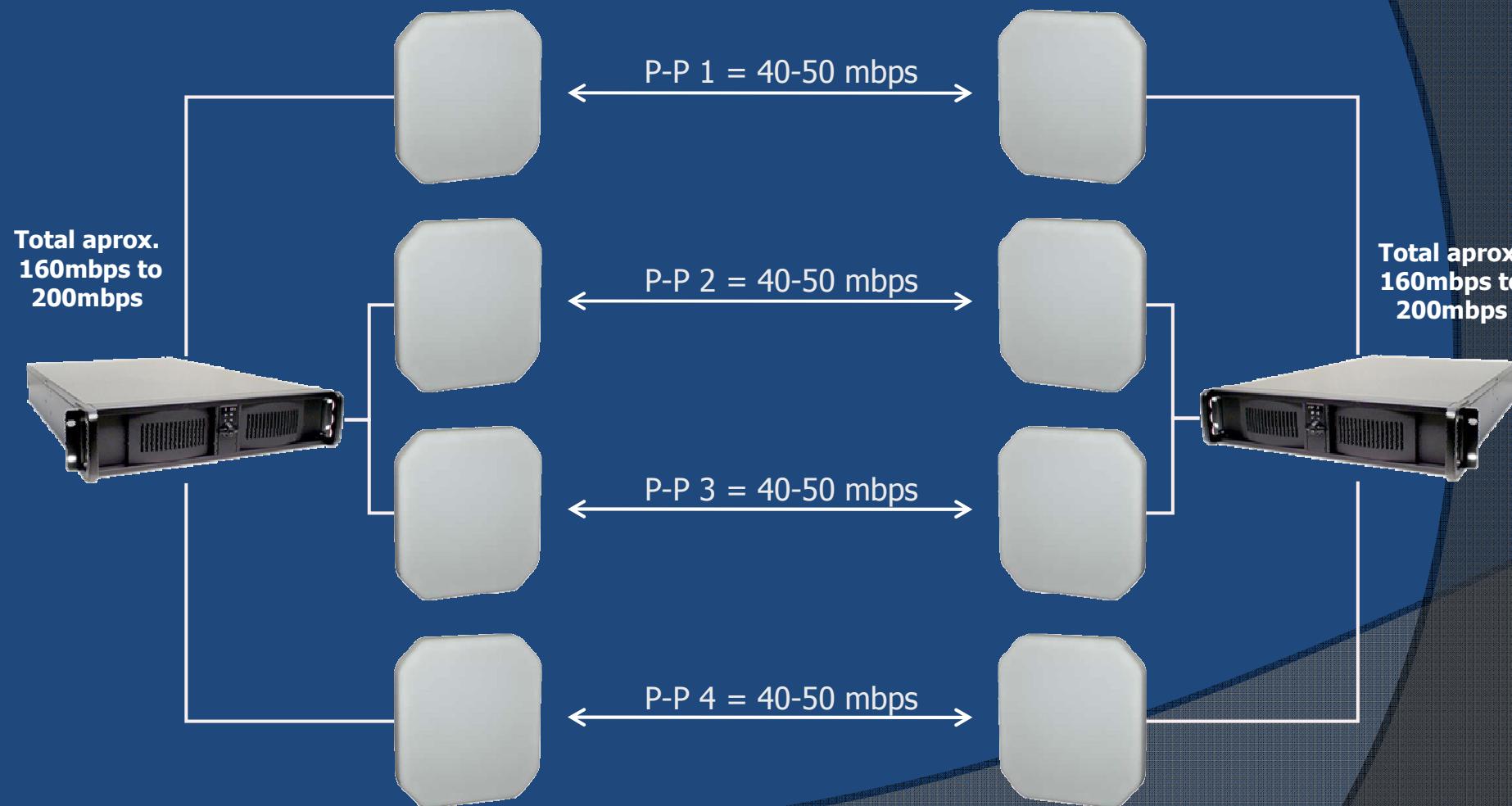
# Long Distance Wireless Multi-Links

- 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
  - Imagenes 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:**

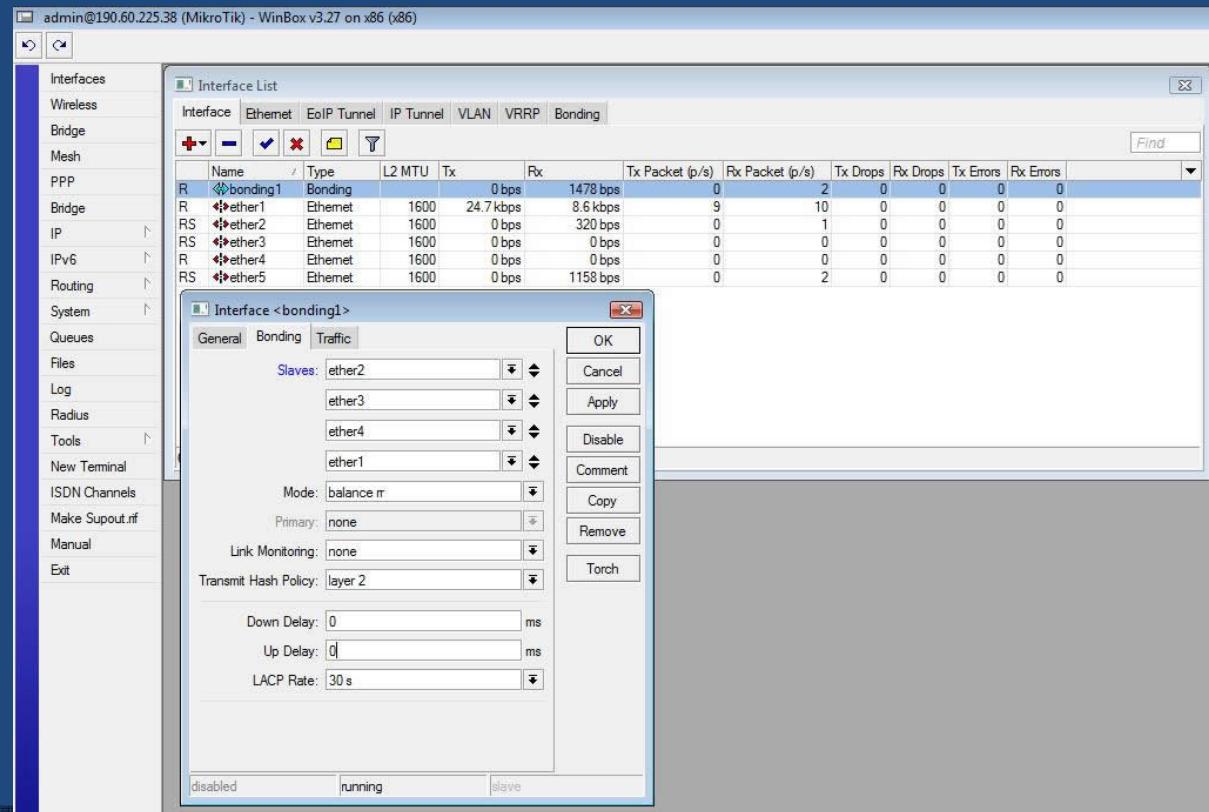
- Un (01) Router x86: CPU Intel Dual Core 2.6GHz, 1024MB RAM, 5 LAN.
- Cuatro (04) MikroTik RB433AH con Atheros CPU 680MHz y 802.11n Wireless Mini-PCI Cards.
- Cuatro (04) Swivel Antennas 5GHz 5dBi.

# 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

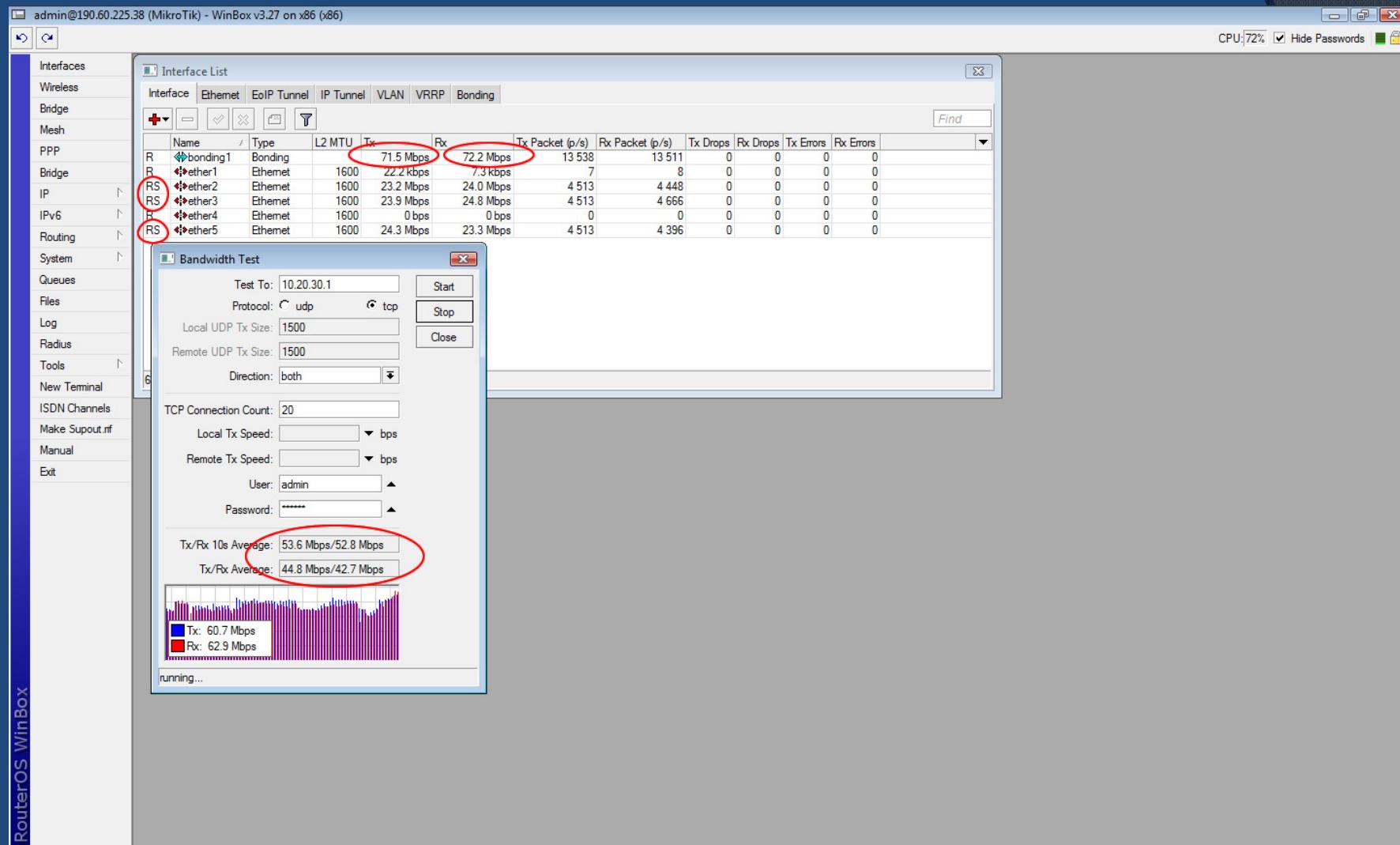


# Pasos para construir Enlaces Multi-Link

## ○ 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

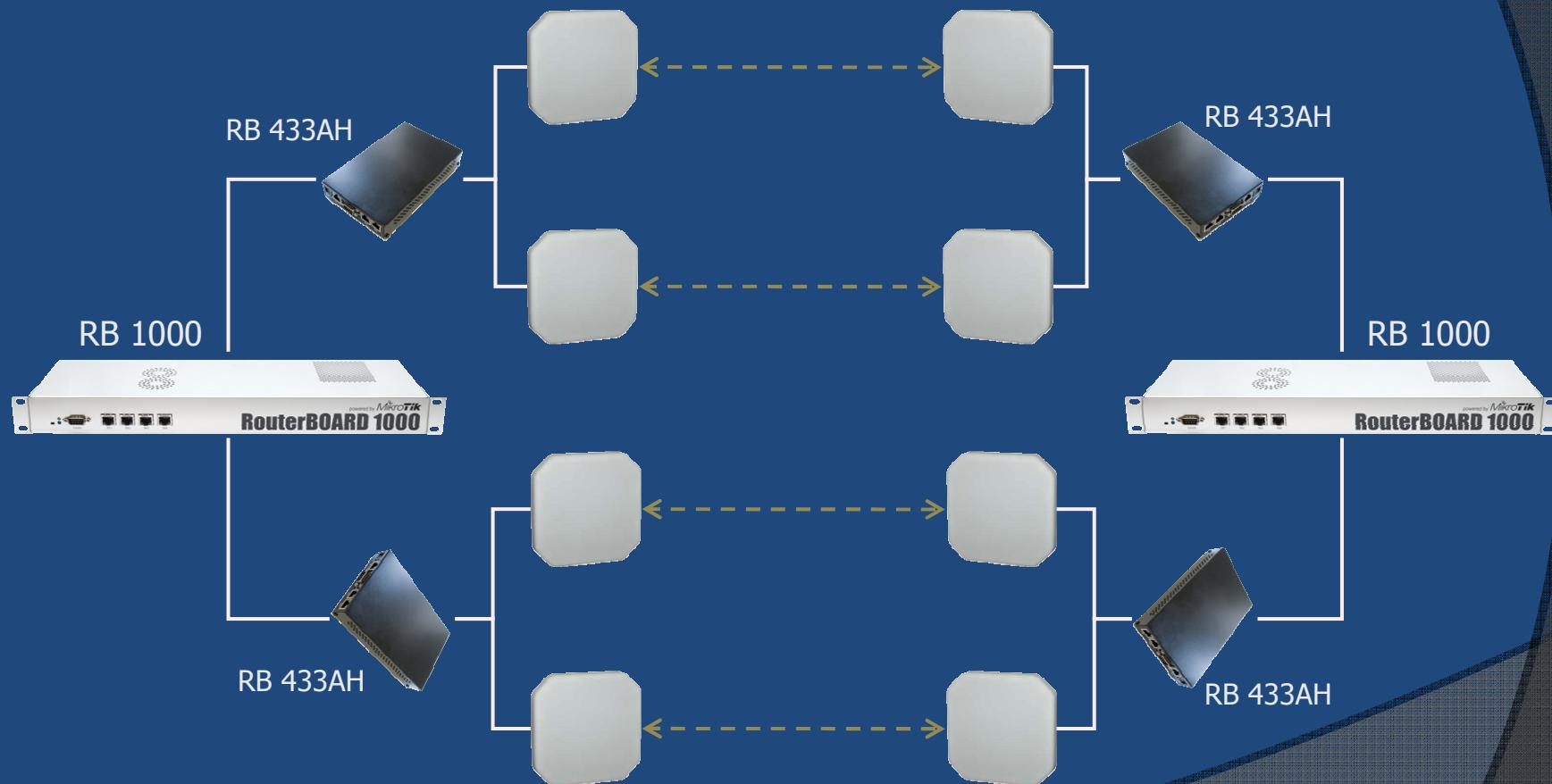


# Aplicación real con OSPF

- 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 asesoria y capacitación para el mejoramiento de la Red WISP de SOLUNET SRL de Argentina

# Gráfica de la Solución



# Requerimiento de Equipos

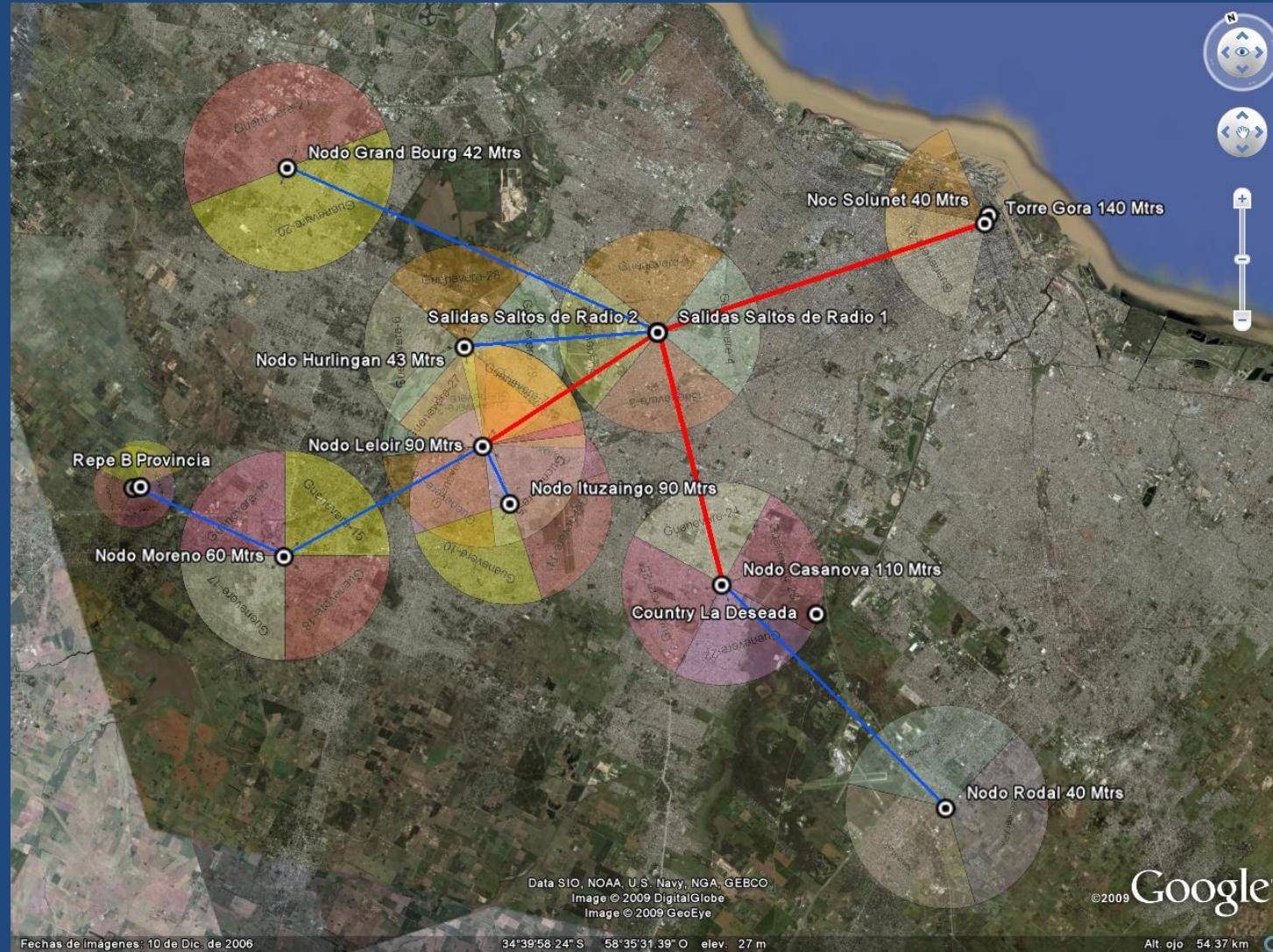
- **Torre Gora:**

- 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.

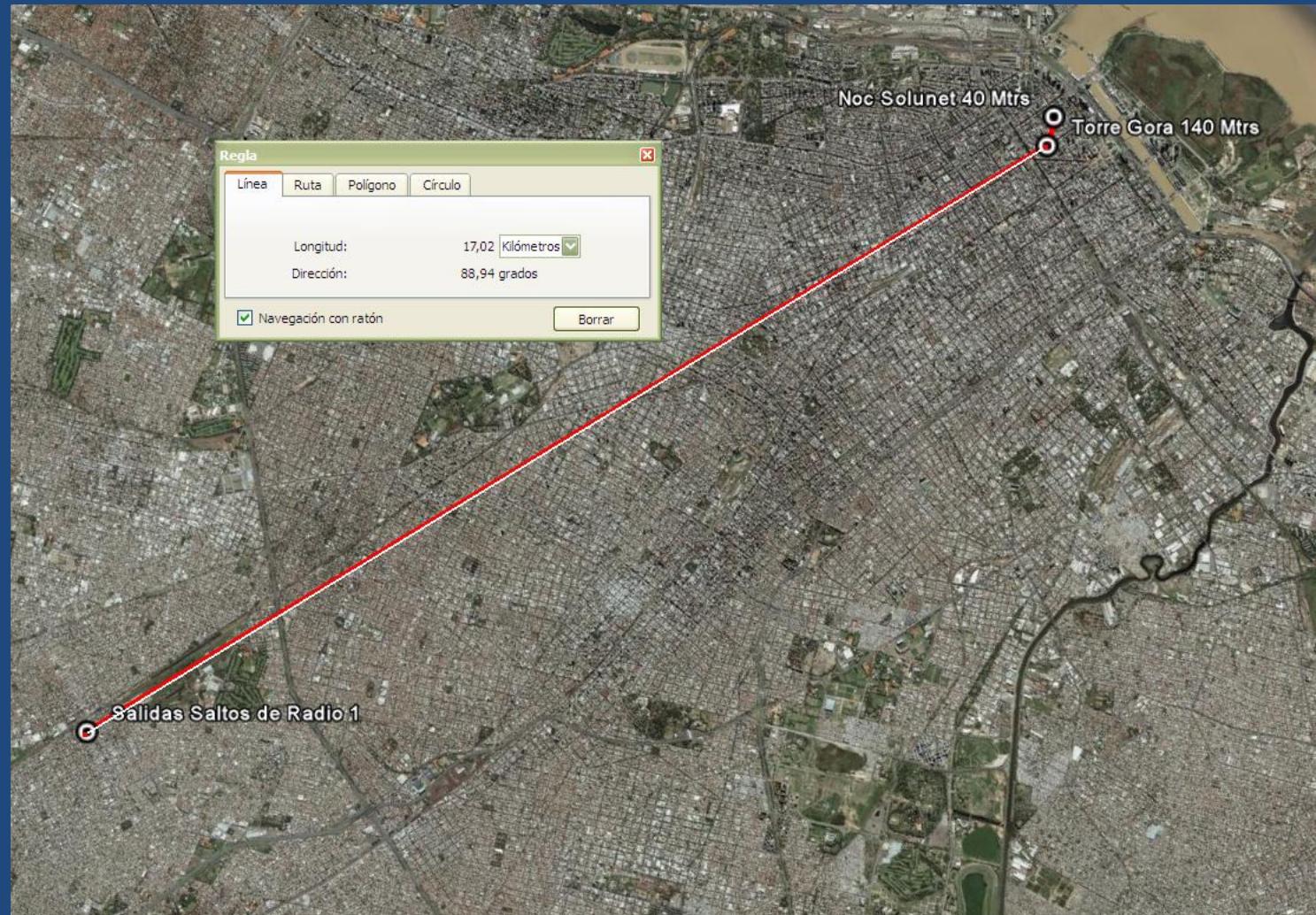
- **Salida Salto de Radio 1:**

- 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.

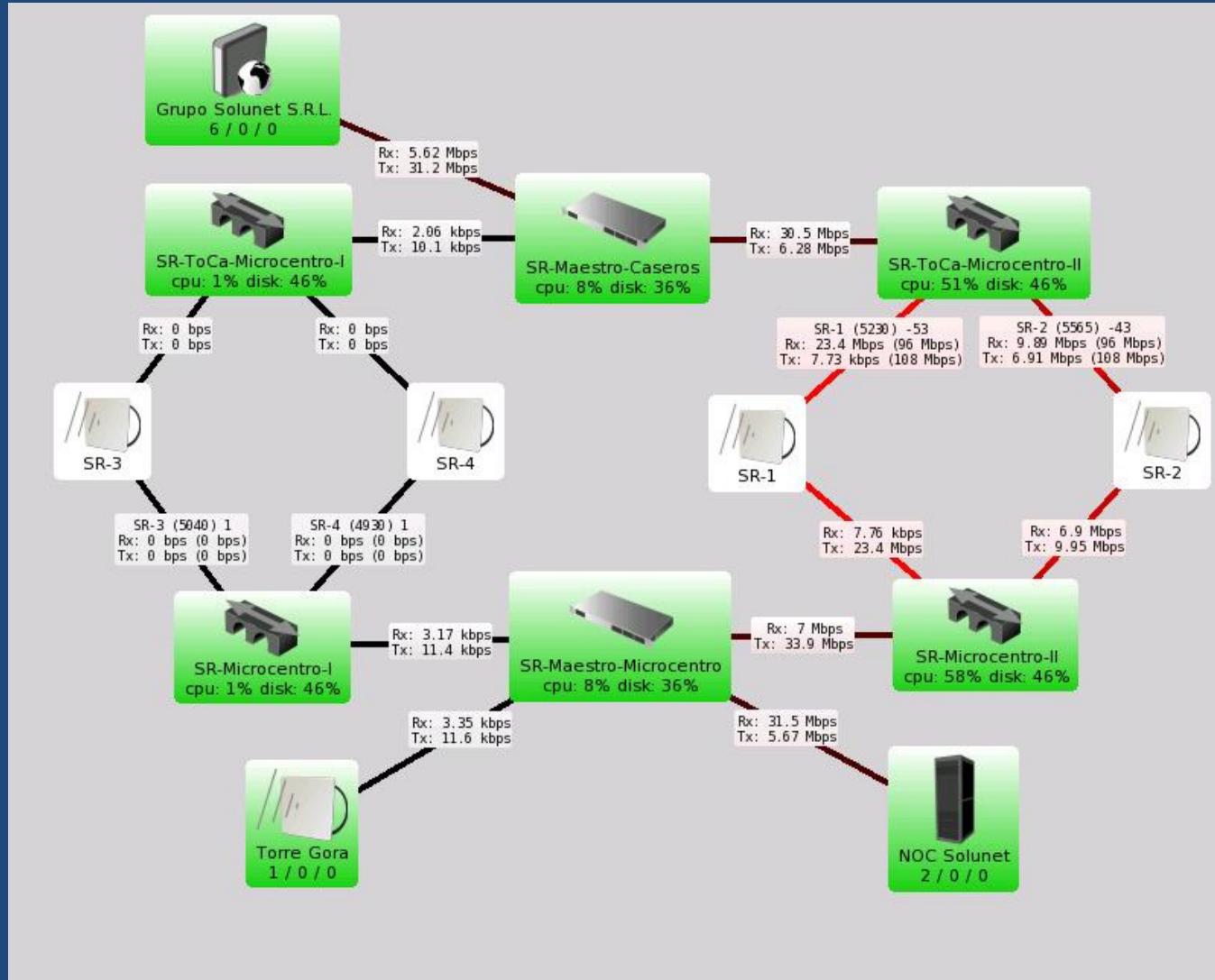
# Imágenes de la Red y Configuración



# Imágenes de la Red y Configuración



# Dude Manager Multi-Link



# Registration del Point to Point Activo

The screenshot shows the WinBox interface on a RB433 device. The main window displays a table of wireless clients, with two clients highlighted: SR-1(Ariba) and SR-2(Abajo). The interface on the left shows the navigation menu. Two detailed windows are overlaid on the main table, showing configuration for each client.

**Wireless Tables** (Main Window):

Radio Name	MAC Address	Interface	Uptime	AP	W...	Last Activit...	Signal Strengt...	Tx/Rx Rate
SR-1(Ariba)	00:15:6D:63:EE:76	SR-1(Ariba)	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

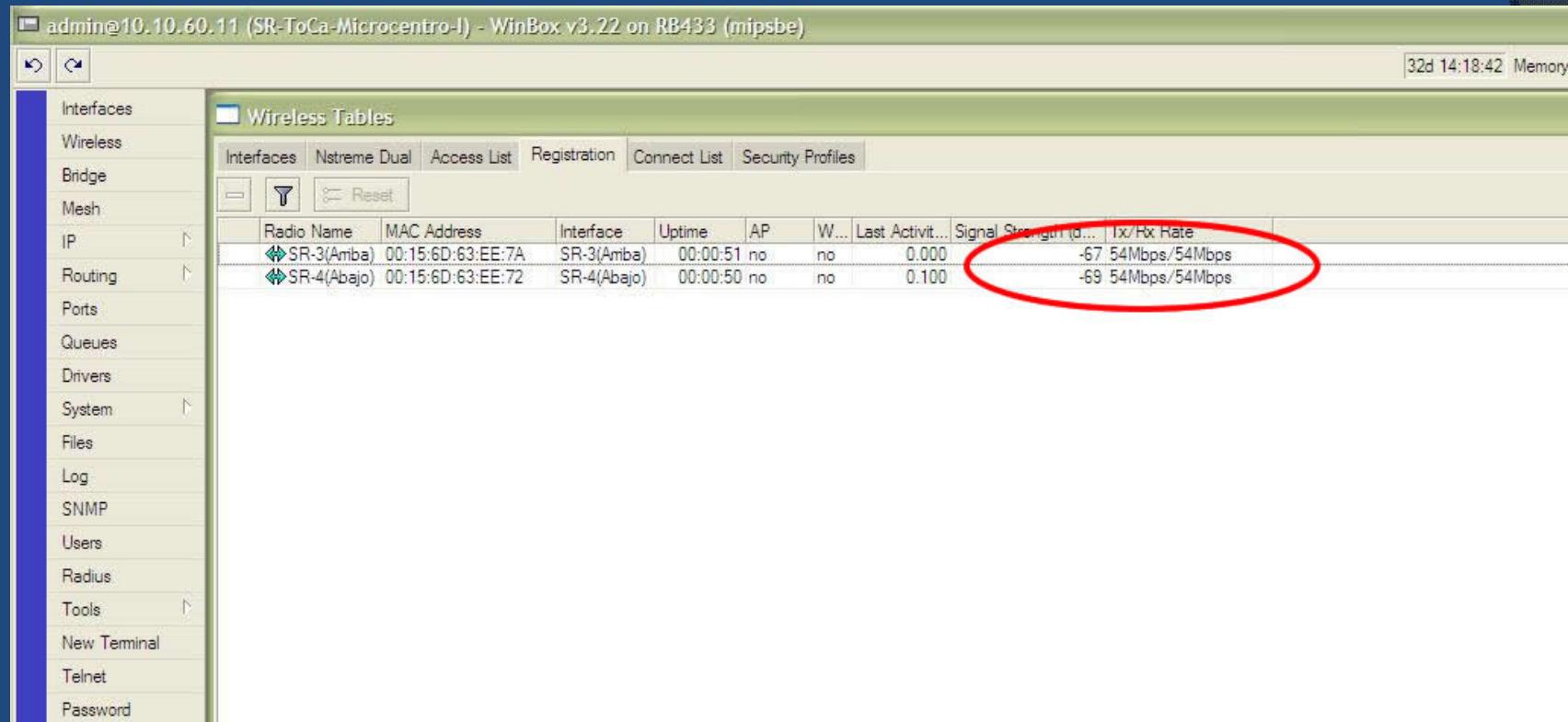
**AP Client <00:15:6D:63:EE:76>** (Left Overlay):

General	802.1x	Signal	Nstreme	Statistics
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			

**AP Client <00:15:6D:64:BE:D0>** (Right Overlay):

General	802.1x	Signal	Nstreme	Statistics
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			

# Imagen de la Interfaz Wireless



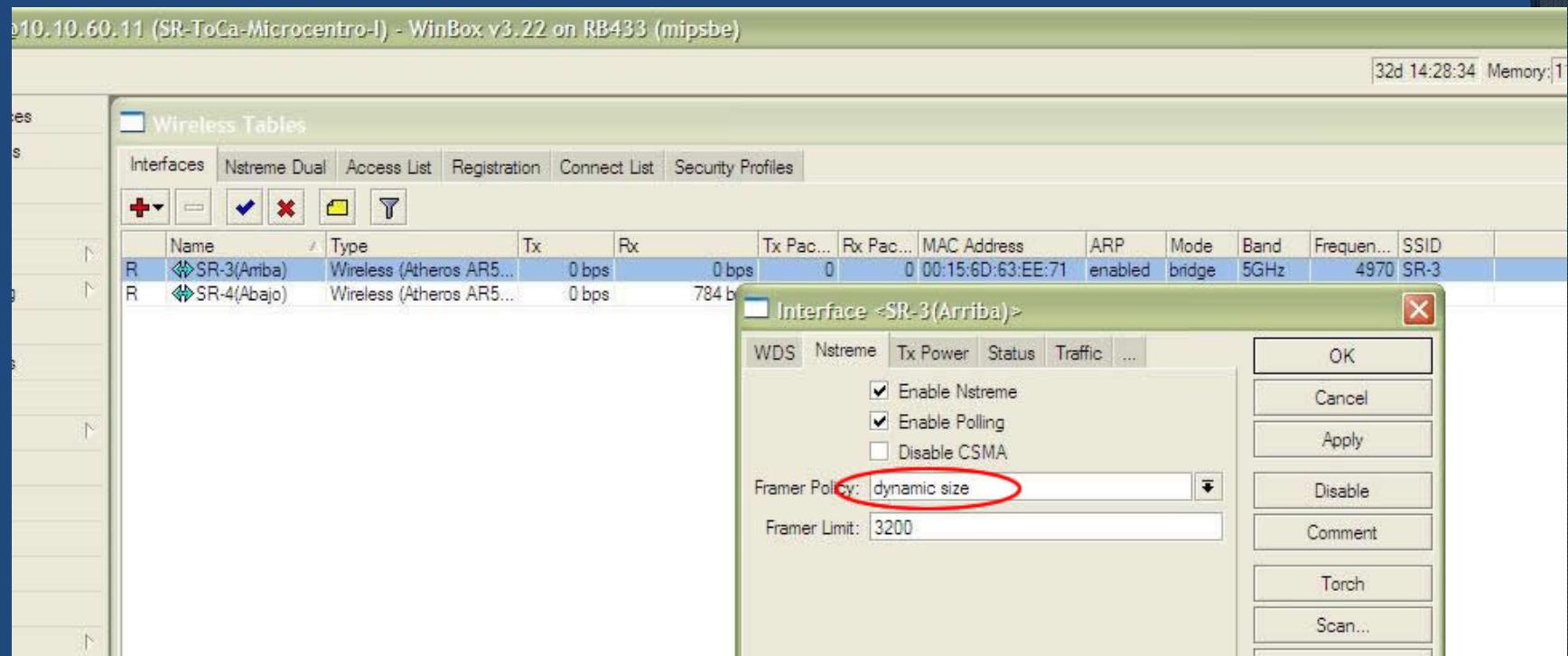
The screenshot shows the WinBox interface on a RB433 device. The left sidebar lists various system and network management options. The main window is titled 'Wireless Tables' and displays a table of wireless interfaces. The table has the following columns: Radio Name, MAC Address, Interface, Uptime, AP, W..., Last Activit..., Signal Strength (d...), and Tx/Rx Rate. Two rows are present in the table:

Radio Name	MAC Address	Interface	Uptime	AP	W...	Last Activit...	Signal Strength (d...)	Tx/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

A red oval highlights the 'Signal Strength (d...)' column for the second row, which shows a value of -69.

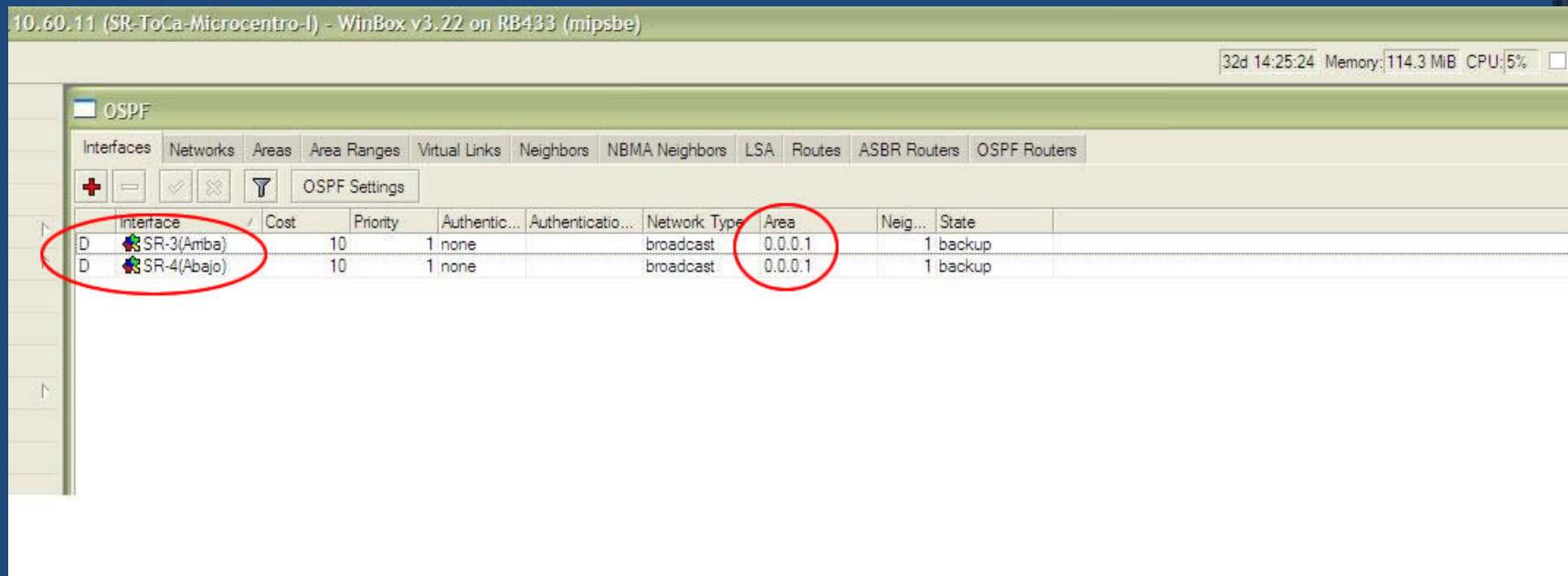
# Imagen nstreme

- 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



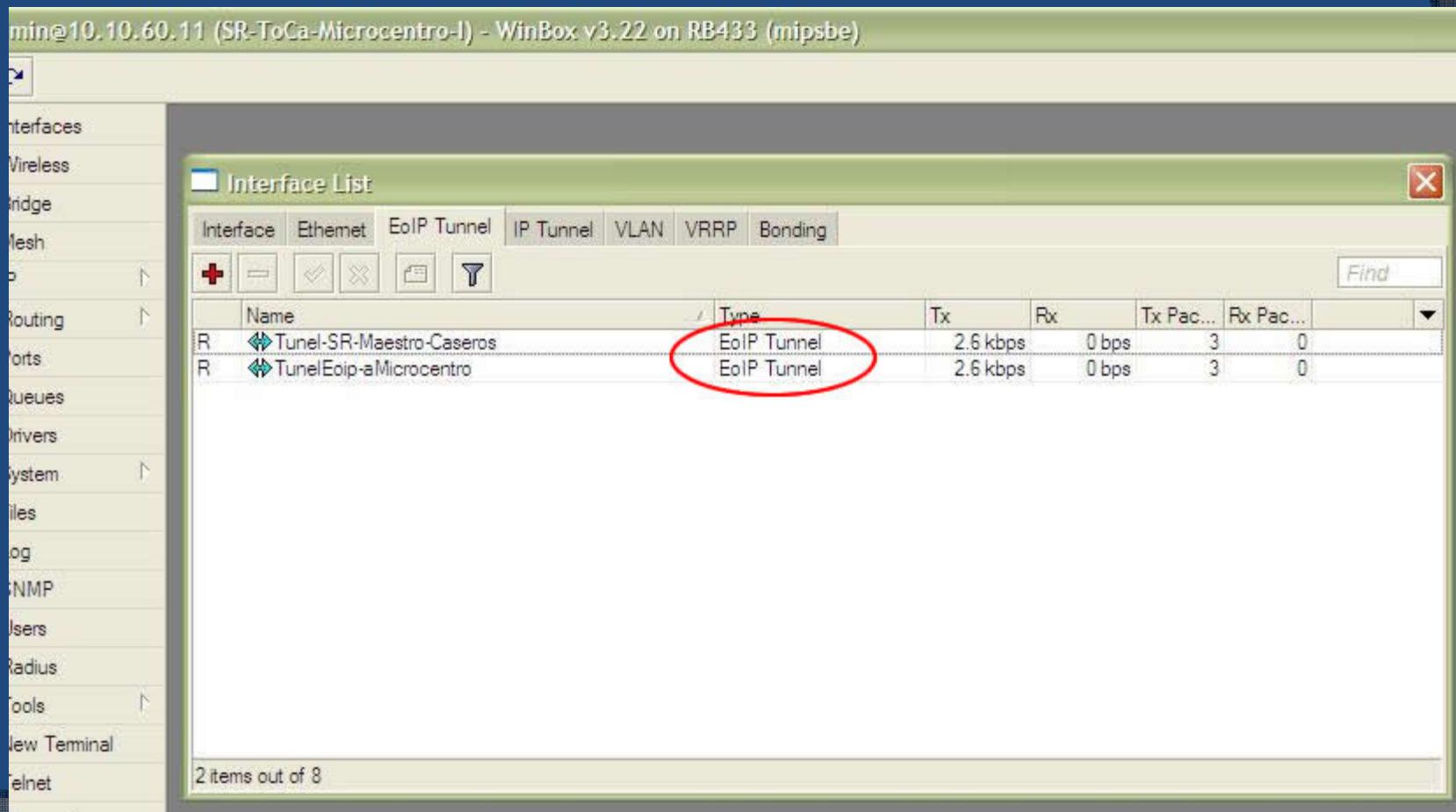
# Configuración Interfaces OSPF

- 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



# Imagen 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

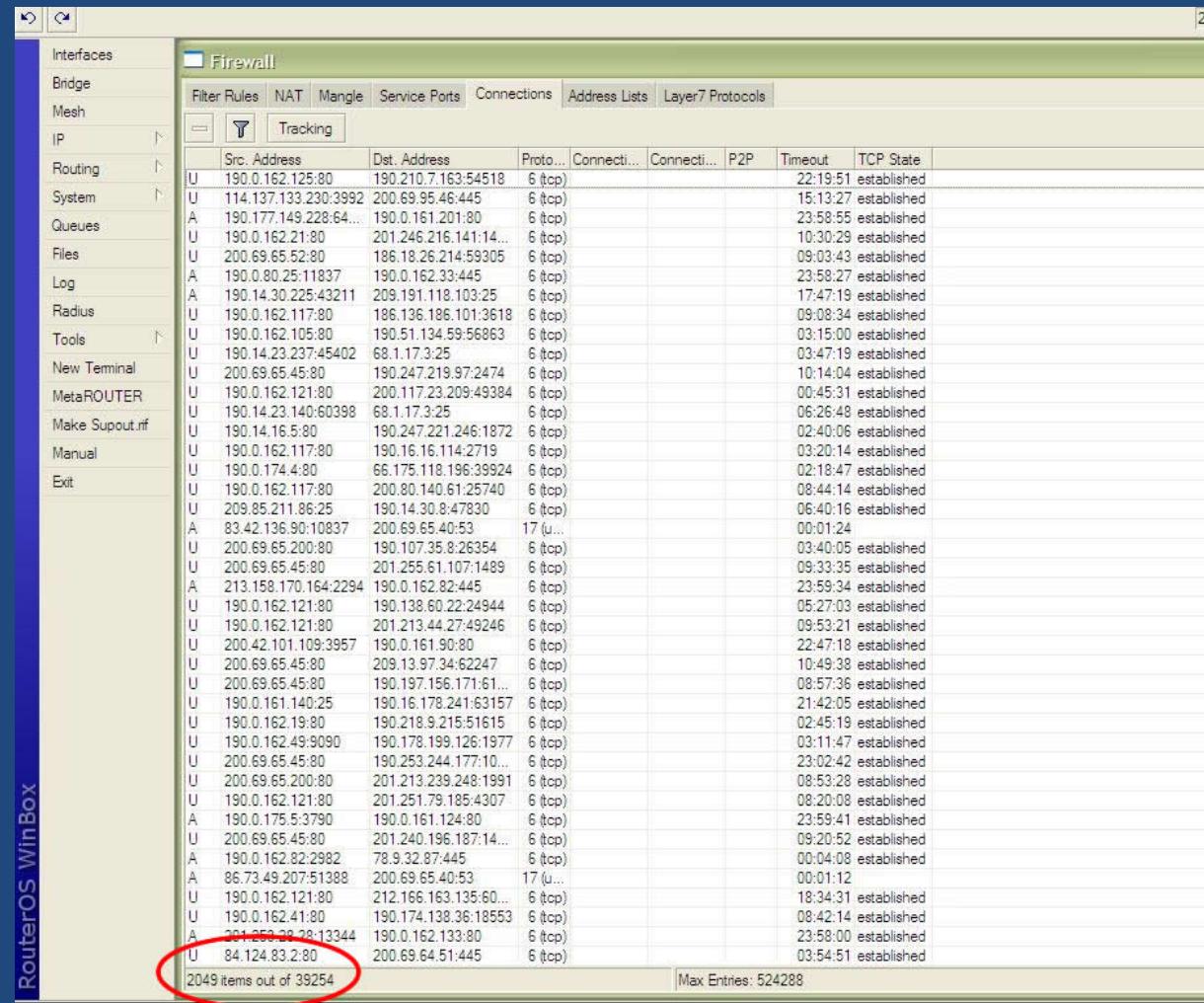


# Tracking Connection Core Router A

IP		Src. Address	Dest. Address	Proto...	Connecti...	Connection Mark	P2P	Timeout	TCP State
Routing	A	190.0.165.188:1107	64.59.73.39:80	6 (tcp)	HTTP-L7		11:59:22		established
System	A	190.0.168.222:41264	64.180.20.58:8458	17 (u...)	Resto-UDP-P2P-L7-S		00:02:11		
Queues	A	190.0.163.186.28622	64.231.133.220:54725	17 (u...)	Resto-UDP-P2P-L7-S		00:00:02		
Files	U	190.0.165.213:26847	65.32.218.138:3376	6 (tcp)	Resto-TCP-P2P-L7-S		02:21:38		
Log	A	190.0.166.4:1246	65.54.48.125:1963	6 (tcp)	MSN-L7		11:59:22		established
Radius	A	190.0.167.210:32416	65.54.49.170:1863	6 (tcp)	MSN-L7		11:58:59		established
Tools	U	190.0.168.89:1424	65.54.93.175:80	6 (tcp)	HTTP-L7		00:00:04		fin wait
New Terminal	A	190.0.166.190:50427	65.55.15.124:80	6 (tcp)	HTTP-L7		11:59:27		established
MetaROUTER	A	190.0.168.244:1310	65.55.15.244:80	6 (tcp)	HTTP-L7		11:58:58		established
Make Supout.rif	A	190.0.164.166:41335	65.27.164.131:43661	17 (u...)	Resto-UDP-P2P-L7-S		00:00:22		
Manual	A	190.0.163.48:41517	66.56.180.242:24971	17 (u...)	Resto-UDP-P2P-L7-S		00:02:58		
Exit	U	190.0.163.61:3554	66.77.197.153:80	6 (tcp)	HTTP-L7		04:49:33		established
	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	68.101.139.83:55256	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	bitor...	09:38:42		established
	A	190.0.168.248:3091	69.39.85.196:443	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
	A	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
	A	190.0.166.242:15432	71.79.102.187:1223	6 (tcp)	Resto-TCP-P2P-L7-S		11:18:42		established
	A	190.0.169.121:26465	71.130.208.168:38721	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
	A	190.0.165.251:3757	71.236.105.147:35446	17 (u...)	Resto-UDP-P2P-L7-S		00:00:03		
	A	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		02:28:38		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		
	A	190.0.166.83:56801	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
	A	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

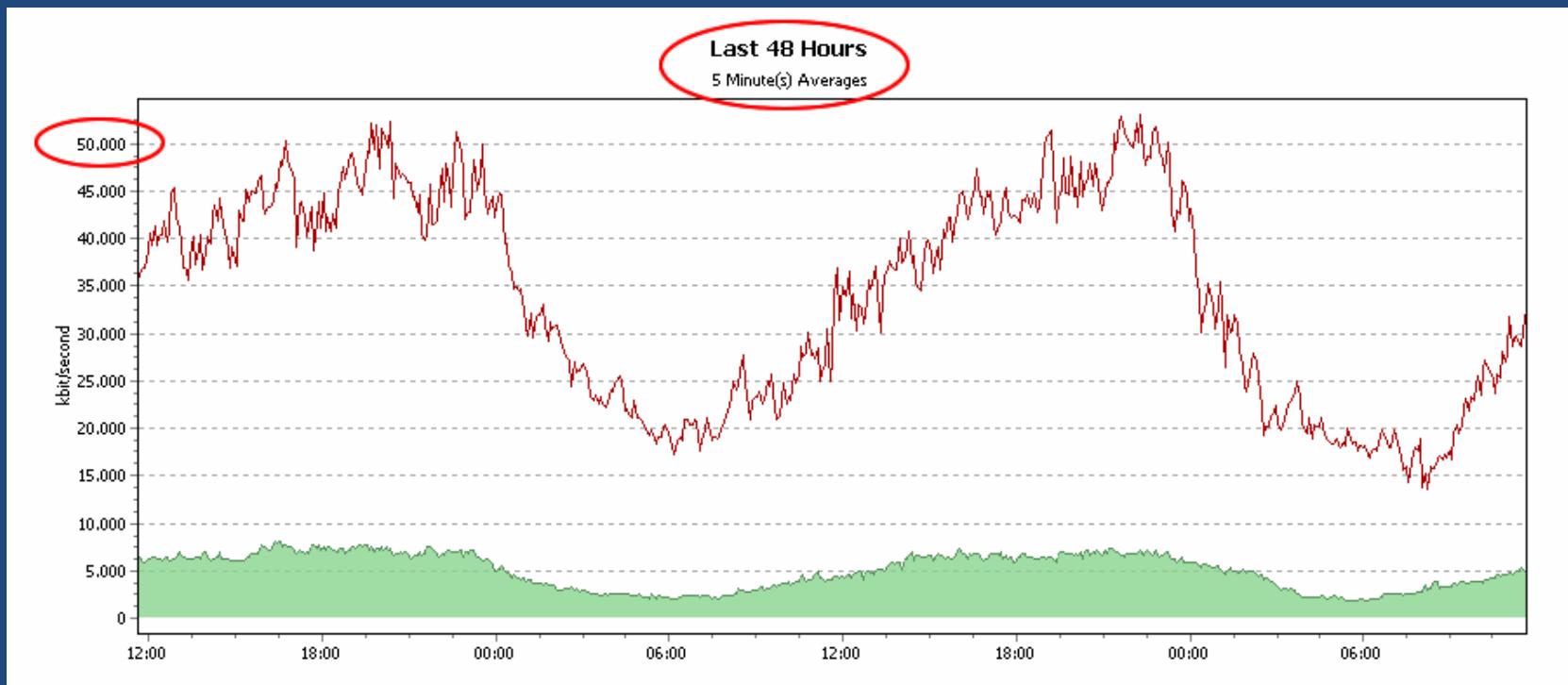


The screenshot shows the RouterOS WinBox Firewall interface. The left sidebar lists various network components: Interfaces, Bridge, Mesh, IP, Routing, System, Queues, Files, Log, Radius, Tools, New Terminal, MetaROUTER, Make Supout.rif, Manual, and Exit. The main window title is "Firewall" with tabs for Filter Rules, NAT, Mangle, Service Ports, Connections, Address Lists, and Layer7 Protocols. The "Connections" tab is selected. The table displays a list of tracked connections with columns: Src. Address, Dst. Address, Proto, Connecti..., Connecti..., P2P, Timeout, and TCP State. The TCP State column shows values like "established", "15:13:27 established", and "03:47:19 established". The status column (first column) shows mostly "U" (Untracked) except for the last row which shows "U" (Untracked). A red circle highlights the "U" in the first column of the last row. The status bar at the bottom indicates "2049 items out of 39254" and "Max Entries: 524288".

	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	201.253.32.28:13344	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

# Gráfica MRTG del Enlace Multi-Link

- El cliente trae 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 !!!**