



## **CASO DE ESTUDIO:**

### **VIRTUALIZACIÓN DE ROUTEROS ORIENTADO A LA ENSEÑANZA DE REDES DE COMUNICACIÓN BASADAS EN MIKROTIK.**

Implementación en ambientes de virtualización del sistema operativo RouterOS orientado a la enseñanza de redes y comunicaciones basadas en MikroTik, permitiendo a los estudiantes simular escenarios reales de implementación y resolución de problemas.

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**Sede Esmeraldas**

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# ANTECEDENTES DEL CASO

## LABORATORIO DE REDES UNIVERSIDAD



Equipos especializados para las diferentes practicas a realizarse en el transcurso de la enseñanza.

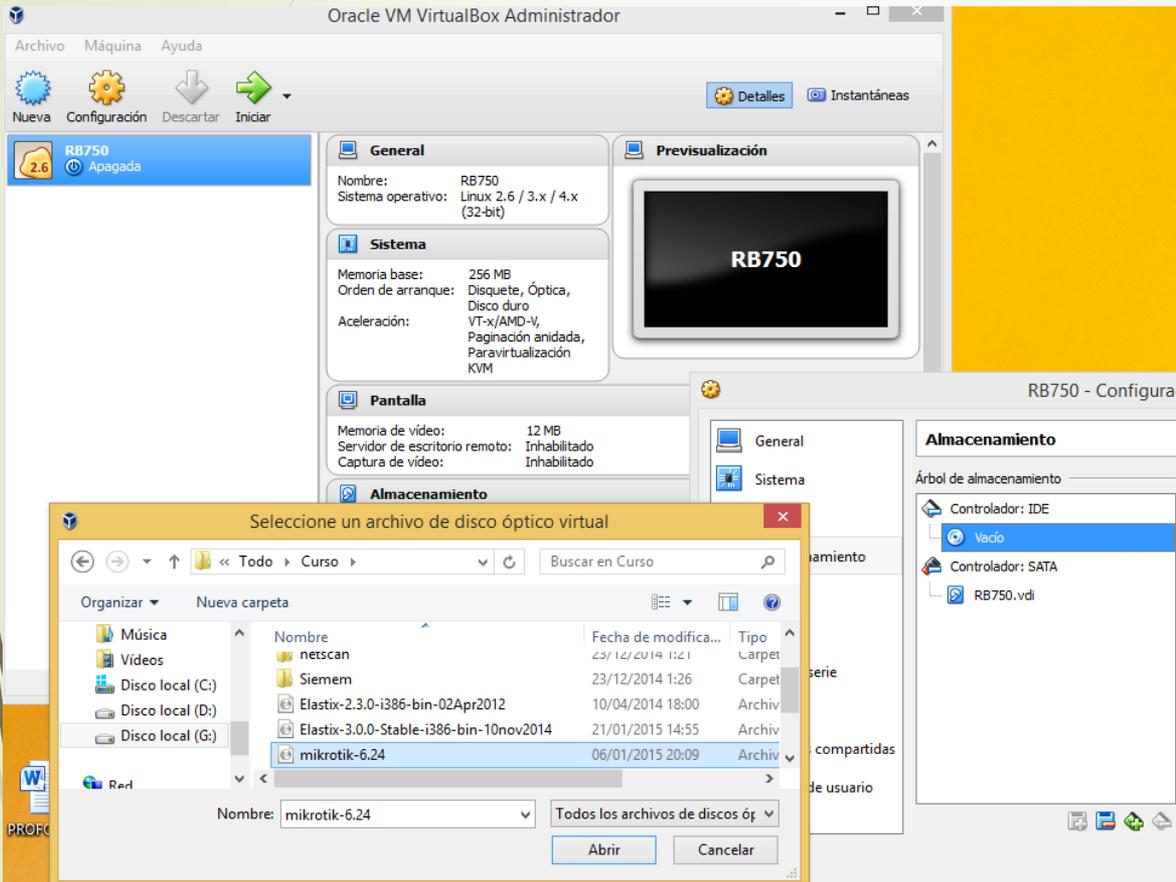
Restricción del acceso en lo diferente a horarios no académicos.

Múltiples estudiantes interactuando en la configuración de los equipos.

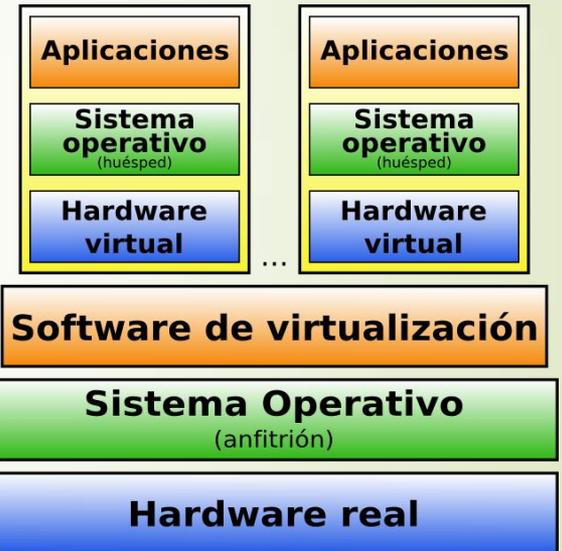
Perdida de tiempo en carga y descarga de información

Posibles daños de puertos físicos en proceso de conexión y desconexión

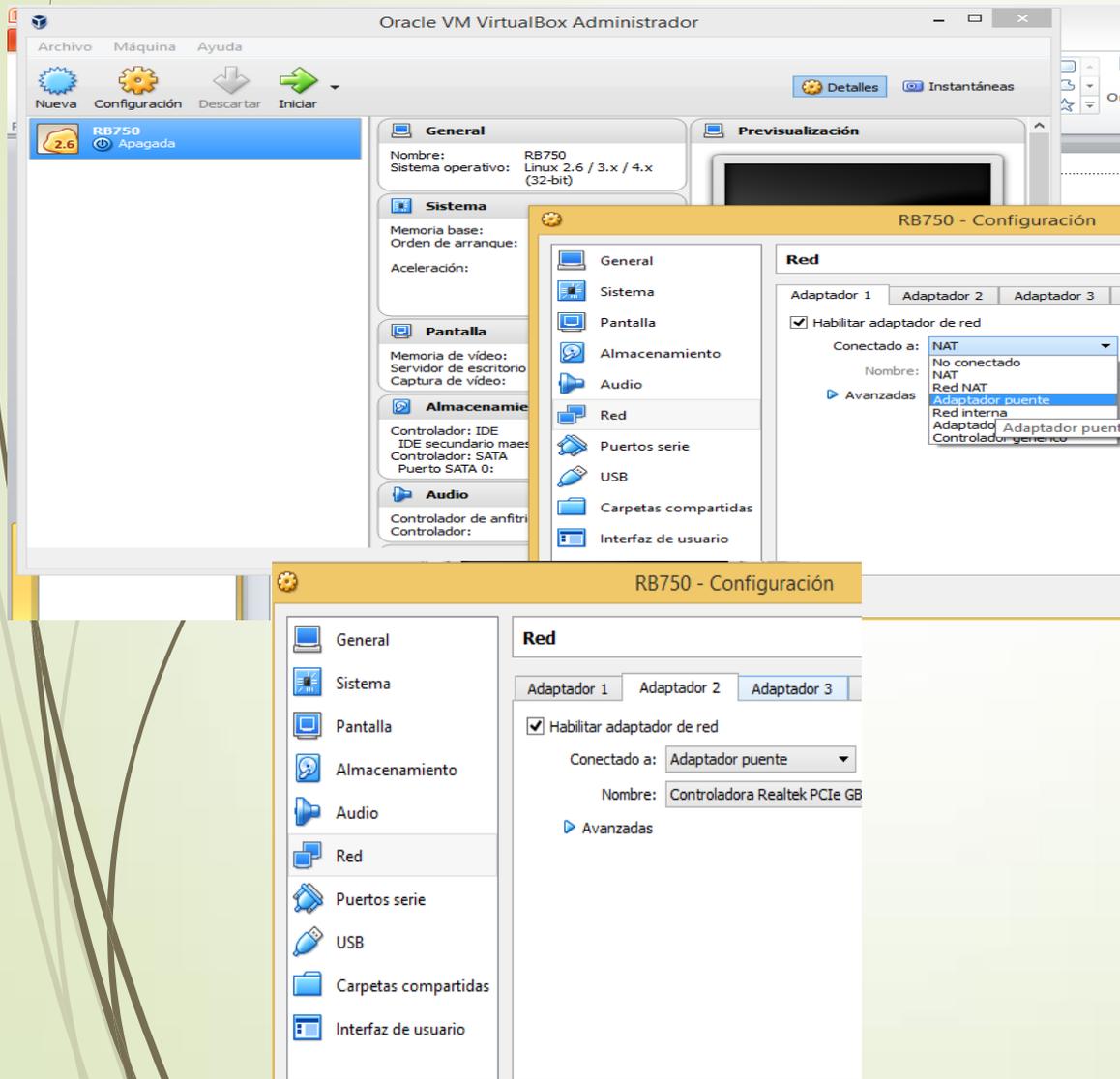
# Virtual Box selección de ISO Routeros



Plataforma virtual para instalación de RouterOS



# VIRTUALIZACIÓN DE INTERFACE DE RED



- Creación de interfaces de red virtuales con la opción puente.
- Se comparte el medio físico con interfaces virtuales
- Capacidad de un direccionamiento independiente al nativo del equipo.

# INSTALACIÓN ISO ROUTEOS

```
Welcome to MikroTik Router Software installat

Move around menu using 'p' and 'n' or arrow keys, select with
Select all with 'a', minimum with 'm'. Press 'i' to install l
cancel and reboot.

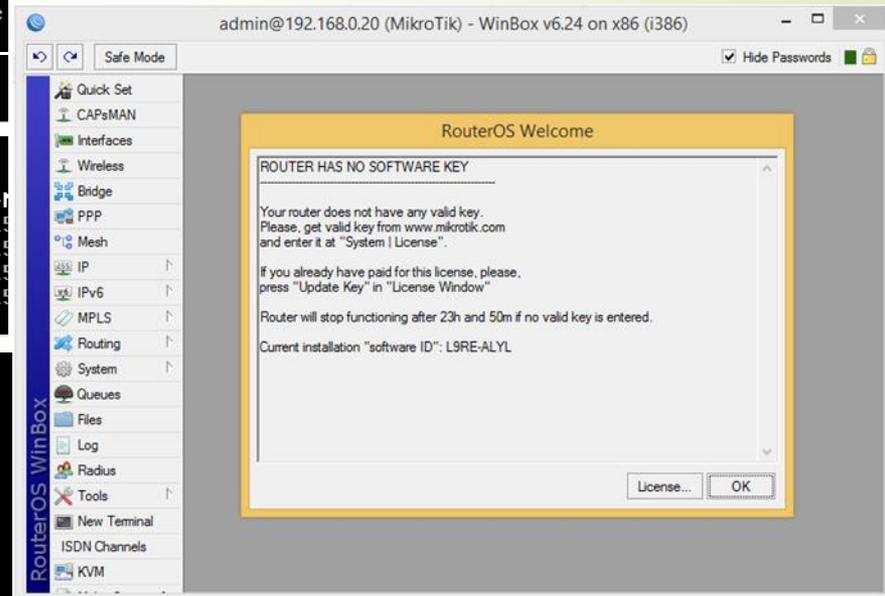
[X] system          [X] ipv6          [X] rout
[X] ppp            [X] isdn         [X] secu
[X] dhcp          [X] kvm          [X] ups
[X] advanced-tools [X] lcd          [X] user
[X] calea         [X] mpls         [X] wire
[X] gps           [X] multicast    [X] wire
[X] hotspot       [X] ntp
```

```
[admin@MikroTik] > _
```

```
[admin@MikroTik] </interface> print
Flags: D - dynamic, X - disabled, R - running, S - slave
#    NAME    TYPE    ACTUAL-
0   R ether1  ether  15
1   R ether2  ether  15
2   R ether3  ether  15
3   R ether4  ether  15
[admin@MikroTik] </interface> _
```

```
[admin@MikroTik] > ip dns print
servers:
dynamic-servers:
allow-remote-requests: no
max-udp-packet-size: 4096
query-server-timeout: 2s
query-total-timeout: 10s
cache-size: 2048KiB
cache-max-ttl: 1w
cache-used: 8KiB
```

## WINBOX



# ROUTEROS EN EJECUCIÓN

The screenshot displays three Oracle VM VirtualBox windows, each running a MikroTik router VM. The top window is RB750, the middle is RB751, and the bottom is RB752. All three are in a 'Corriendo' (Running) state. Each window shows the terminal output of the 'ip address print' command, which lists the IP addresses assigned to the interfaces ether2 and ether1.

```
[admin@MikroTik] > ip address print
Flags: X - disabled, I - invalid, D - dynamic
# ADDRESS NETWORK INTERFACE
0 192.168.10.1/24 192.168.10.0 ether2
1 D 10.0.5.22/24 10.0.5.0 ether1
[admin@MikroTik] > _
```

```
[admin@MikroTik] > ip address print
Flags: X - disabled, I - invalid, D - dynamic
# ADDRESS NETWORK INTERFACE
0 192.168.10.2/24 192.168.10.0 ether1
1 192.168.20.1/24 192.168.20.0 ether2
[admin@MikroTik] > _
```

```
[admin@MikroTik] > ip address print
Flags: X - disabled, I - invalid, D - dynamic
# ADDRESS NETWORK INTERFACE
0 192.168.20.2/24 192.168.20.0 ether1
1 192.168.30.1/24 192.168.30.0 ether2
line 2 of 2> _
```

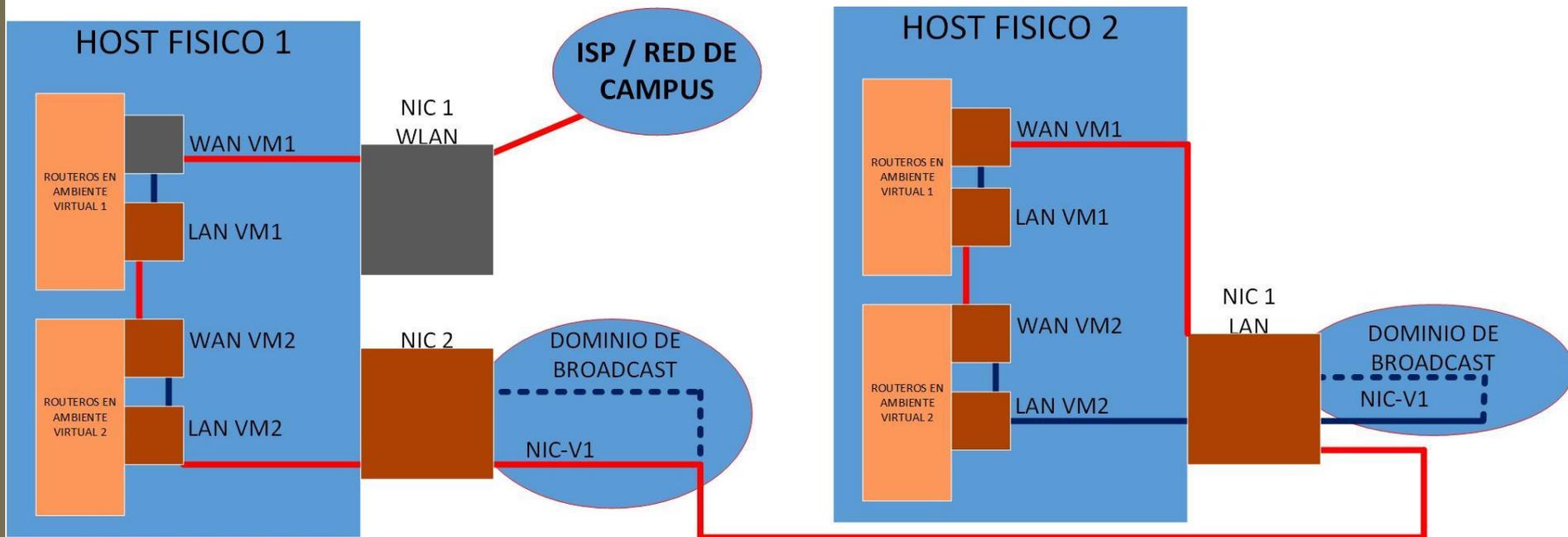
- Imagen ilustra los diferentes sistemas RouterOS habilitados.
- Ejecutándose cada uno con su interface virtual corriendo sobre la física.

The screenshot shows the WinBox v6.24 on x86 (i386) interface. The top bar indicates the user is 'admin@192.168.50.1 (MikroTik)'. A 'Route (Running)' window is open, showing a route table with columns for Host, Loss, Sent, Last, Avg., Best, Worst, Std. Dev., History, and Status. Below the route table, a ping command is being executed, showing the output of the ping command.

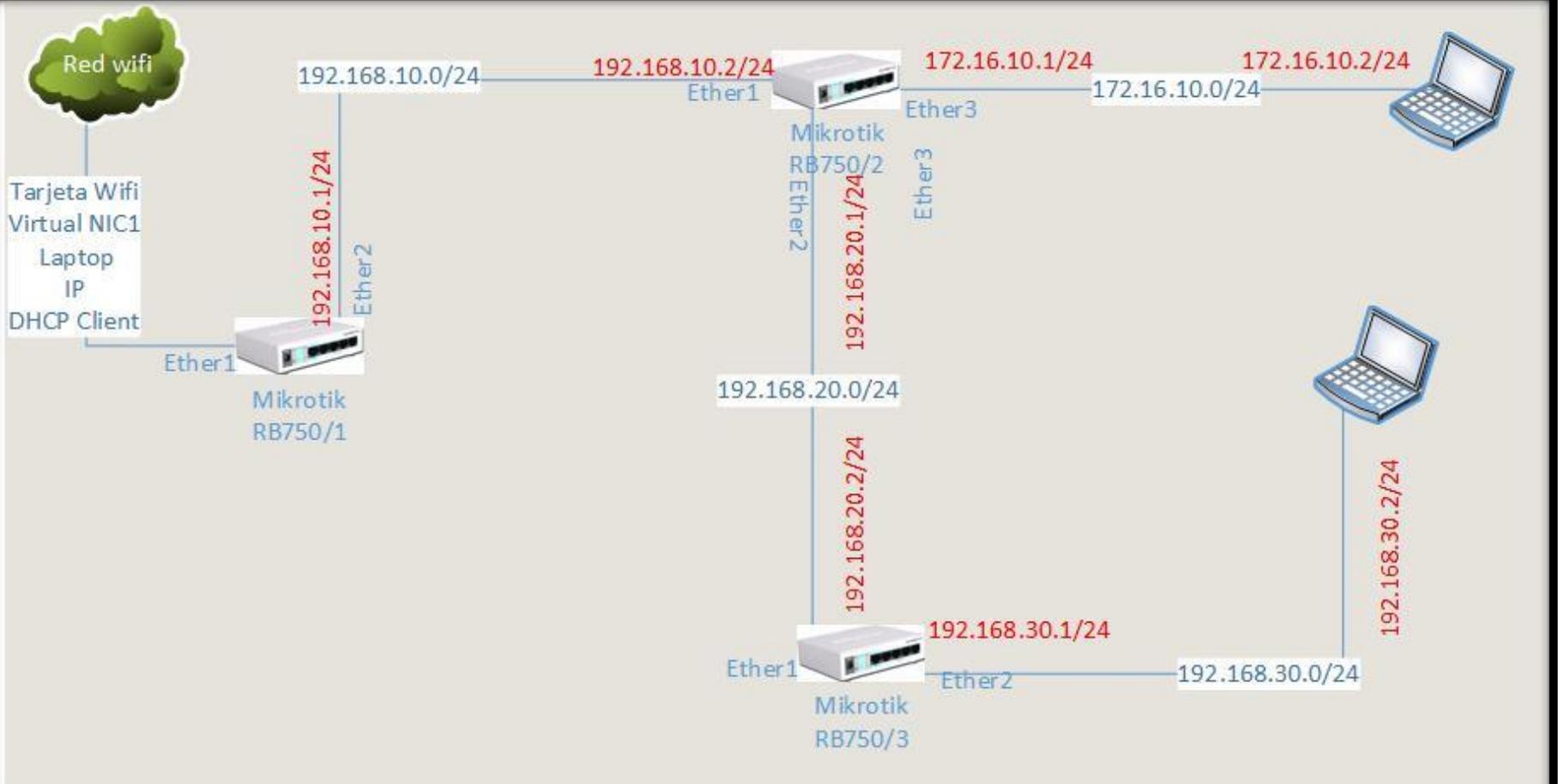
| Host                             | Loss  | Sent | Last    | Avg.  | Best | Worst | Std. Dev. | History | Status                               |
|----------------------------------|-------|------|---------|-------|------|-------|-----------|---------|--------------------------------------|
| 5 186.42.182.1, 192.168.33.178   | 22.6% | 93   | timeout | 33.4  | 2.7  | 978.1 | 159.7     |         | host unreachable from 192.168.33.178 |
| 6 10.31.0.33, 192.168.33.178     | 21.7% | 93   | timeout | 37.5  | 2.9  | 966.4 | 157.0     |         | host unreachable from 192.168.33.178 |
| 7 190.152.252.181, 192.168.3...  | 5.4%  | 92   | 978.2ms | 206.6 | 9.1  | 991.2 | 428.9     |         | host unreachable from 192.168.33.178 |
| 8 190.152.252.110, 192.168.3...  | 21.7% | 92   | timeout | 46.7  | 9.2  | 969.6 | 152.8     |         | host unreachable from 192.168.33.178 |
| 9 190.152.251.189, 192.168.3...  | 22.8% | 92   | timeout | 104.4 | 79.3 | 977.8 | 142.3     |         | host unreachable from 192.168.33.178 |
| 10 190.152.251.130, 192.168.3... | 6.5%  | 92   | 989.7ms | 278.7 | 80.7 | 990.7 | 451.1     |         | host unreachable from 192.168.33.178 |
| 11 190.152.251.82, 192.168.33... | 22.8% | 92   | timeout | 119.6 | 78.8 | 970.3 | 176.1     |         | host unreachable from 192.168.33.178 |
| 12 216.239.50.55, 192.168.33...  | 23.9% | 92   | timeout | 113.2 | 88.6 | 966.5 | 140.7     |         | host unreachable from 192.168.33.178 |
| 13 216.239.50.101, 192.168.33... | 4.3%  | 92   | 958.9ms | 286.9 | 84.9 | 990.1 | 456.4     |         | host unreachable from 192.168.33.178 |
| 14 8.8.8.8, 192.168.33.178       | 22.8% | 92   | timeout | 132.5 | 88.5 | 984.5 | 200.7     |         | host unreachable from 192.168.33.178 |

```
ns (1 selected)
1 1 ms <1 ms <1 ms 192.168.50.1
2 1 ms 3 ms 2 ms 192.168.40.1
3 2 ms 1 ms 2 ms 192.168.10.1
4 5 ms 6 ms 3 ms 192.168.33.1
5 * * 192.168.33.178 informes: Host de destino inaccesible
```

# PROCESO DE COMUNICACIÓN ENTRE MEDIOS FÍSICOS Y VIRTUALES EN LA SIMULACIÓN

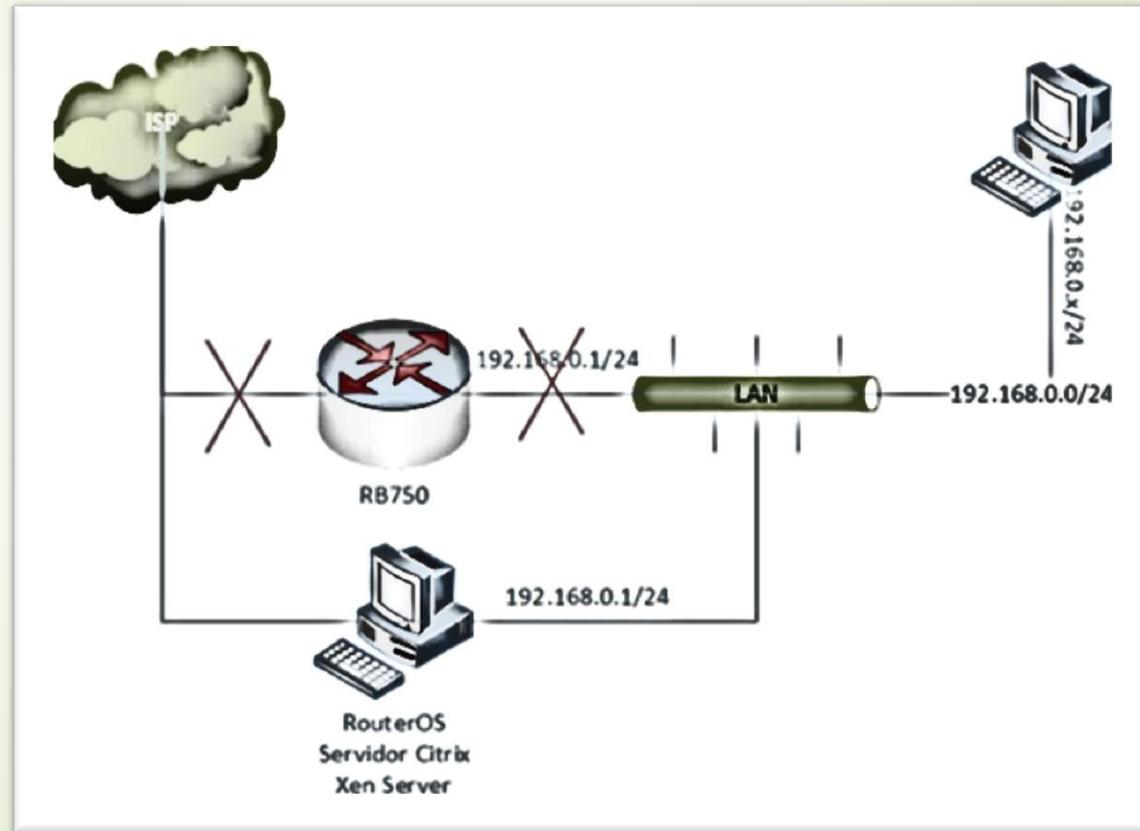


# PRACTICA EN PROCESOS EDUCATIVIVOS EJECUTADOS



**Proceso ejecutado en un pc explotando recursos VM**

# RECUPERAR LA OPERATIVIDAD DE LA RED



# ROUTEROS Y CITRIX XEN SERVER EXPORTAR SERVICIO VIRTUALIZADO

The screenshot displays the Oracle VM VirtualBox Administrator interface. The 'Archivo' menu is open, highlighting the 'Exportar servicio virtualizado...' option (Ctrl+E). The main window shows a virtual machine named 'mikrotik' in a 'Previsualización' (Preview) state. The VM is powered off and has a version of 2.6. The hardware configuration is visible on the right side of the window.

**Oracle VM VirtualBox Administrador**

Archivo Máquina Ayuda

- Preferencias... Ctrl+G
- Importar servicio virtualizado... Ctrl+I
- Exportar servicio virtualizado... Ctrl+E**
- Administrador de medios virtuales... Ctrl+D
- Administrador de operaciones de red...
- Comprobar actualizaciones...
- Reiniciar todas las advertencias
- Salir Ctrl+Q

2.6 mikrotik 2 (GN...) Apagada

2.6 mikrotik 3 (GN...) Apagada

2.6 mikrotik 4 (GN...) Apagada

64 2.6 Proxmox Apagada

64 2.6 vmware Apagada

64 2.6 citrix Apagada

Previsualización

mikrotik

Pantalla

- Memoria de vídeo: 12 MB
- Servidor de escritorio remoto: Inhabilitado
- Captura de vídeo: Inhabilitado

Almacenamiento

- Controlador: IDE
- IDE secundario maestro: [Unidad óptica] mikrotik-6.32.2.iso (**Inaccesible**)
- Controlador: SATA
- Puerto SATA 0: mikrotik.vdi (Normal, 8,00 GB)

Audio

- Controlador de anfitrión: Windows DirectSound
- Controlador: ICH AC97

Red

Exportar un servicio virtualizado («Appliance») fuera de la MV de VirtualBox

# ROUTEROS Y CITRIX XEN SERVER

## EXPORTAR DE VIRTUALBOX EN FORMATO \*.ova

Exportar servicio virtualizado

Máquinas virtuales a exportar

- citrix
- mikrotik**
- mikrotik 1
- mikrotik 2
- mikrotik 3
- mikrotik 4
- Proxmox
- RB01
- vmware

Preferencias de servicio virtualizado

| Descripción       | Configuración |
|-------------------|---------------|
| Sistema virtual 1 |               |
| Nombre            | mikrotik      |
| Producto          |               |
| URL del producto  |               |
| Vendedor          |               |
| URL del vendedor  |               |
| Versión           |               |
| Descripción       |               |
| Licencia          |               |

Preferencias de almacenamiento

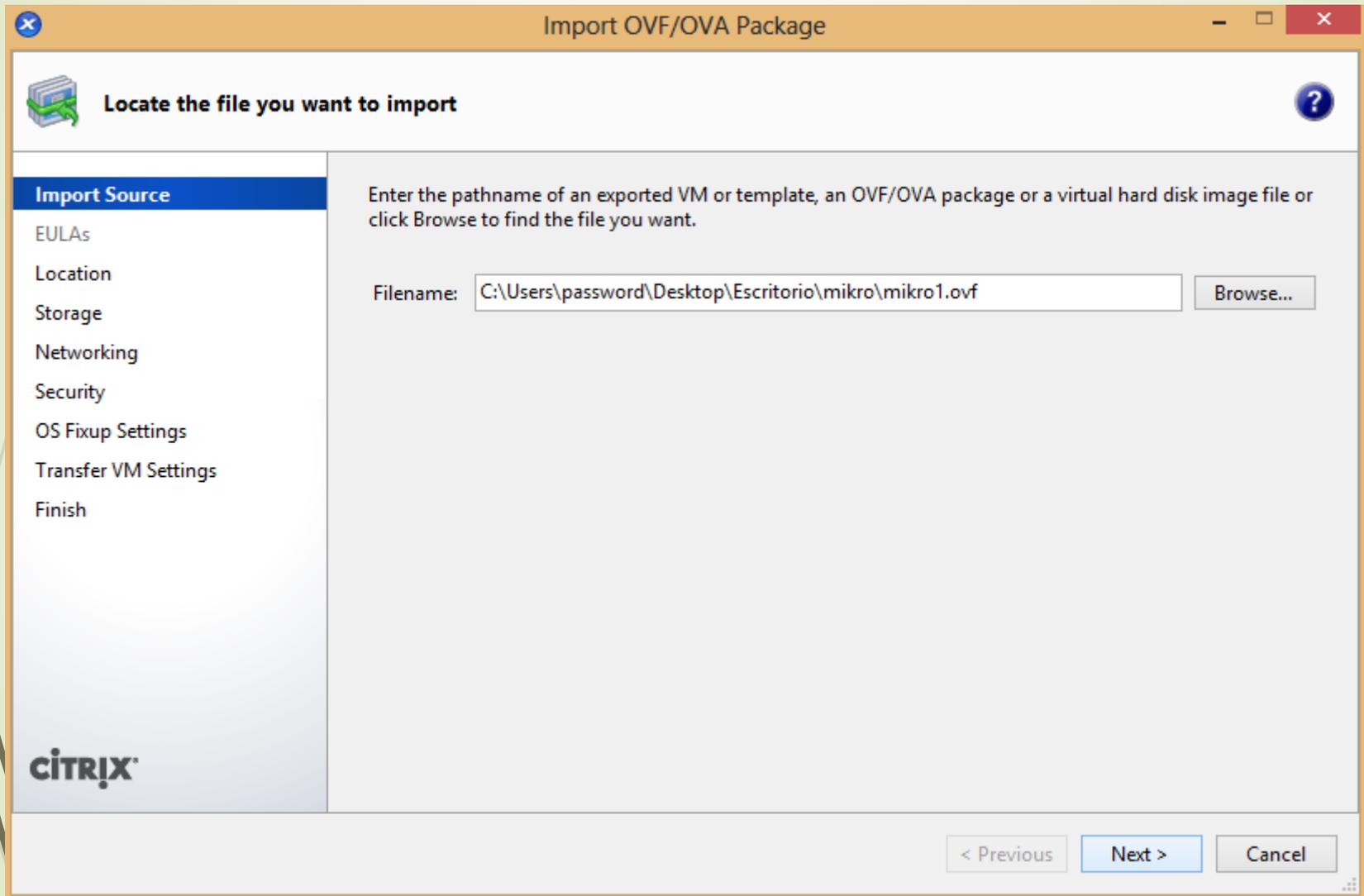
Archivo:

Formato:

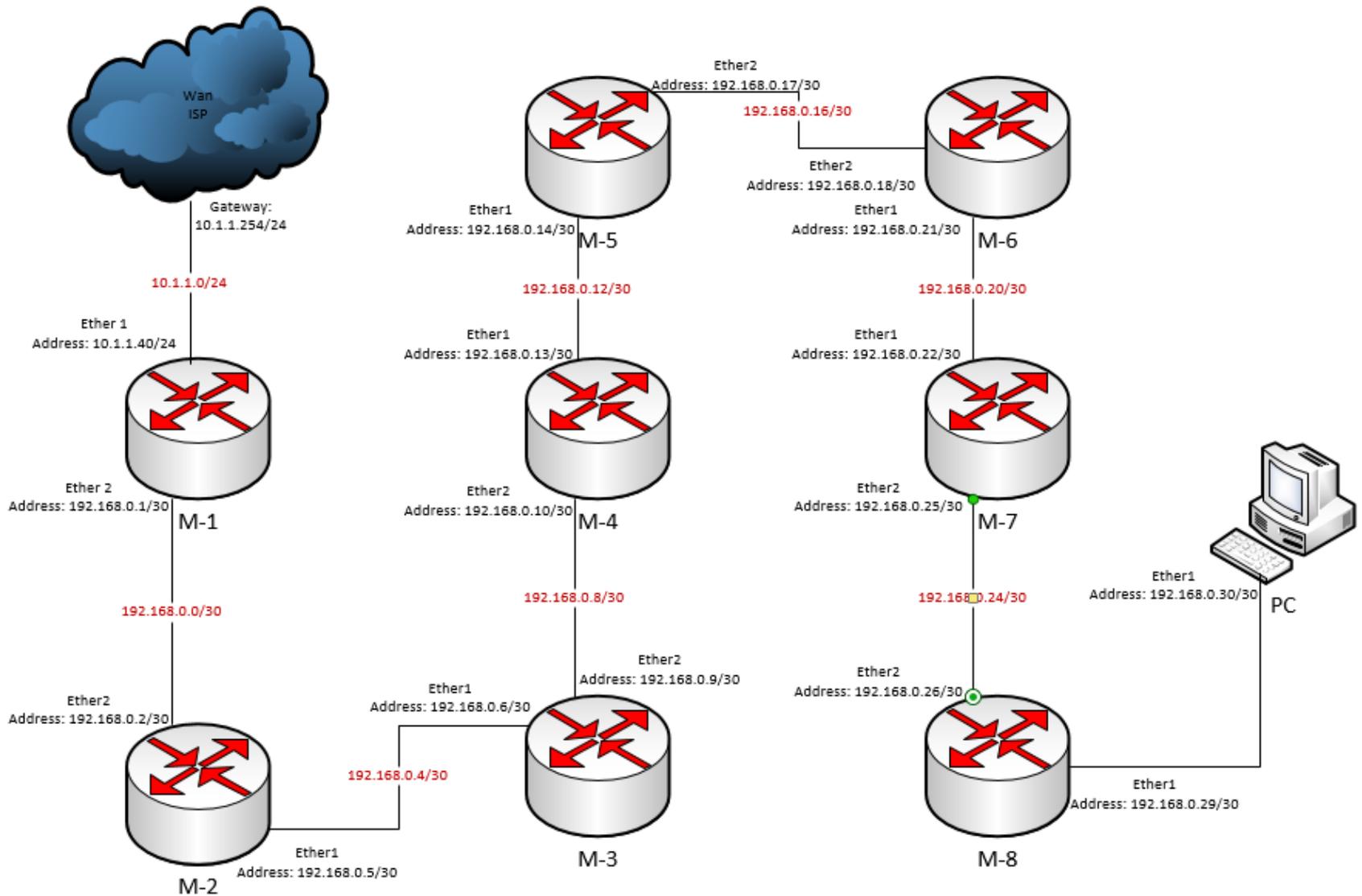
Guardar archivo Manifest

Modo guiado   Restaurar valores predeterminados   **Exportar**   Cancelar

# ROUTEROS Y CITRIX XEN SERVER IMPORTAR EN SERVIDOR CITRIX



# COPIA Y CONFIGURACIÓN DE MAQUINAS VIRTUALES



# MAQUINAS VIRTUALES EN EJECUCIÓN CON CONFIGURACIONES ESPECIFICAS

The screenshot displays the XenCenter management console. The interface includes a menu bar (File, View, Pool, Server, VM, Storage, Templates, Tools, Window, Help) and a toolbar with navigation and management actions like Back, Forward, Add New Server, New Pool, New Storage, New VM, Shut Down, Reboot, and Suspend. The left sidebar shows a tree view of the XenCenter environment, including servers (servidor3, Servidor5, Servidor6) and various virtual machines (M-1 to M-8, ubuntu, UBUNTU\_1) along with storage options. The main pane is titled 'Servidor6 Overview' and contains a table of VMs with their resource usage.

| Name                                      | CPU Usage     | Used Memory     | Disks (avg / max KB)                   |
|---|---------------|-----------------|--|
| Servidor6<br>Default install of XenServer | 46% of 2 CPUs | 3970 of 4058 MB | -                                      |
| M-1<br>Imported from an OVF/OVA pac...    | 3% of 1 CPU   |                 | <a href="#">XenServer Tools not in</a> |
| M-2<br>Imported from an OVF/OVA pac...    | 3% of 1 CPU   |                 | <a href="#">XenServer Tools not in</a> |
| M-3<br>Imported from an OVF/OVA pac...    | 3% of 1 CPU   |                 | <a href="#">XenServer Tools not in</a> |
| M-4<br>Imported from an OVF/OVA pac...    | 3% of 1 CPU   |                 | <a href="#">XenServer Tools not in</a> |
| M-5<br>Imported from an OVF/OVA pac...    | 3% of 1 CPU   |                 | <a href="#">XenServer Tools not in</a> |
| M-6<br>Imported from an OVF/OVA pac...    | 3% of 1 CPU   |                 | <a href="#">XenServer Tools not in</a> |
| M-7<br>Imported from an OVF/OVA pac...    | 3% of 1 CPU   |                 | <a href="#">XenServer Tools not in</a> |
| M-8<br>Imported from an OVF/OVA pac...    | 3% of 1 CPU   |                 | <a href="#">XenServer Tools not in</a> |

# ACCESIBILIDAD DE LOS SISTEMAS VIRTUALES DESDE WINBOX

The image displays a central WinBox v6.24 interface with a sidebar on the left containing various system management options. The main area is divided into several windows, each representing a different virtual machine (VM) accessible from the host. Each window shows a 'Dashboard' and an 'Address List' table.

**Virtual Machines and their IP addresses:**

- admin@192.168.0.1 (M-1) - WinBox v6.24
- 8.0.5 (M-2) - WinBox v6.24
- 0.9 (M-7) - WinBox v6.24
- 0.13 (M-4) - WinBox v6.24
- admin@192.168.0.29 (M-8) - WinBox v6.24
- 5 (M-7) - WinBox v6.24
- 21 (M-6) - WinBox v6.24
- 58.0.17 (M-5) - WinBox v6.24

**Address List Tables:**

**VM 1 (192.168.0.1):**

| Address        | Network     | Interf |
|----------------|-------------|--------|
| Wan            |             |        |
| 10.1.1.40/24   | 10.1.1.0    | ether1 |
| Lan 1          |             |        |
| 192.168.0.1/30 | 192.168.0.0 | ether2 |

**VM 2 (192.168.0.5):**

| Address        | Network     | Interf |
|----------------|-------------|--------|
| Wan            |             |        |
| 192.168.0.2/30 | 192.168.0.0 | ether2 |
| Lan 1          |             |        |
| 192.168.0.5/30 | 192.168.0.4 | ether1 |

**VM 3 (192.168.0.9):**

| Address        | Network     | Interf |
|----------------|-------------|--------|
| Wan            |             |        |
| 192.168.0.6/30 | 192.168.0.4 | ether1 |
| Lan 1          |             |        |
| 192.168.0.9/30 | 192.168.0.8 | ether2 |

**VM 4 (192.168.0.13):**

| Address          | Network      | Interf |
|------------------|--------------|--------|
| Wan              |              |        |
| 192.168.0.10/... | 192.168.0.8  | ether2 |
| Lan 1            |              |        |
| 192.168.0.13/... | 192.168.0.12 | ether1 |

**VM 5 (192.168.0.29):**

| Address          | Network      | Interf |
|------------------|--------------|--------|
| Wan              |              |        |
| 192.168.0.26/... | 192.168.0.24 | ether1 |
| Lan 1            |              |        |
| 192.168.0.29/... | 192.168.0.28 | ether2 |

**VM 6 (192.168.0.25):**

| Address         | Network      | Interf |
|-----------------|--------------|--------|
| Wan             |              |        |
| 192.168.0.22/30 | 192.168.0.20 | ether1 |
| Lan 1           |              |        |
| 192.168.0.25/30 | 192.168.0.24 | ether2 |

**VM 7 (192.168.0.21):**

| Address         | Network      | Interf |
|-----------------|--------------|--------|
| Wan             |              |        |
| 192.168.0.18/30 | 192.168.0.16 | ether2 |
| Lan 1           |              |        |
| 192.168.0.21/30 | 192.168.0.20 | ether1 |

**VM 8 (192.168.0.17):**

| Address          | Network      | Interf |
|------------------|--------------|--------|
| Wan              |              |        |
| 192.168.0.14/... | 192.168.0.12 | ether2 |
| Lan 1            |              |        |
| 192.168.0.17/... | 192.168.0.16 | ether1 |

# TRAFICO DESDE HOST CONECTADO A ROUTEROS EN CITRIX

Catálogo

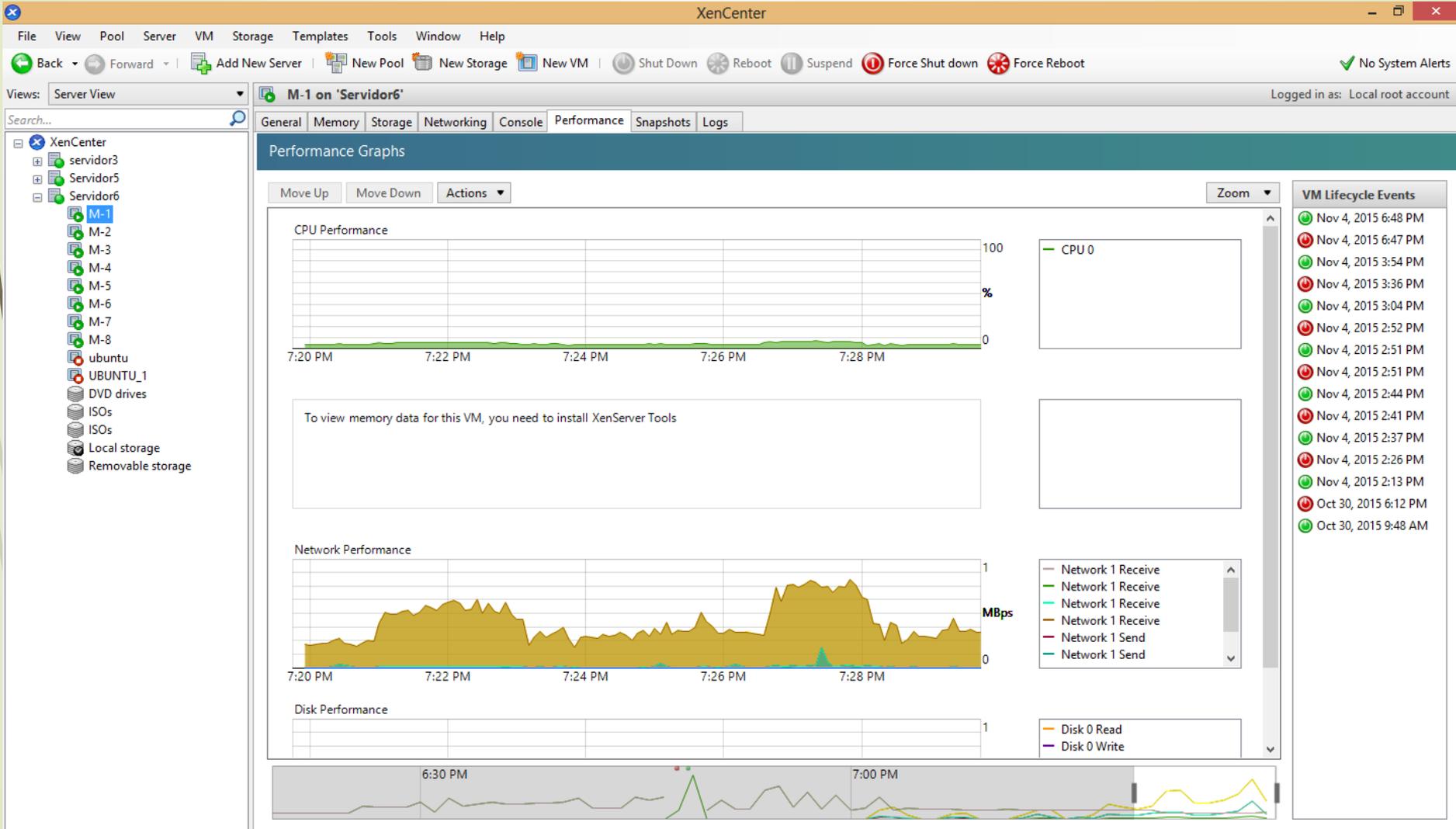
Organizar Limpiar descargas

- Historial
- Descargas
- Etiquetas
- Todos los marcadores

| File Name                           | Progress   | Remaining Time                 | Downloaded       | Speed          |
|-------------------------------------|------------|--------------------------------|------------------|----------------|
| ubuntu-14.04.3-desktop-amd64(6).iso | ██████████ | 9 horas, 48 minutos restantes  | 2,2 MB de 1,0 GB | (25,3 KB/seg.) |
| ubuntu-14.04.3-desktop-amd64(5).iso | ██████████ | 11 horas, 34 minutos restantes | 1,8 MB de 1,0 GB | (25,4 KB/seg.) |
| ubuntu-14.04.3-desktop-amd64(4).iso | ██████████ | 12 horas, 42 minutos restantes | 1,9 MB de 1,0 GB | (23,9 KB/seg.) |
| ubuntu-14.04.3-desktop-amd64(3).iso | ██████████ | 12 horas, 32 minutos restantes | 1,5 MB de 1,0 GB | (18,7 KB/seg.) |
| ubuntu-14.04.3-desktop-amd64(2).iso | ██████████ | 12 horas, 25 minutos restantes | 2,0 MB de 1,0 GB | (20,4 KB/seg.) |
| ubuntu-14.04.3-desktop-amd64(1).iso | ██████████ | 11 horas, 1 minuto restantes   | 2,1 MB de 1,0 GB | (23,9 KB/seg.) |
| ubuntu-14.04.3-desktop-amd64.iso    | ██████████ | 6 horas, 43 minutos restantes  | 4,6 MB de 1,0 GB | (40,8 KB/seg.) |



# PERFORMANCE DE ROUTEROS VIRTUAL Y EN LÍNEA.

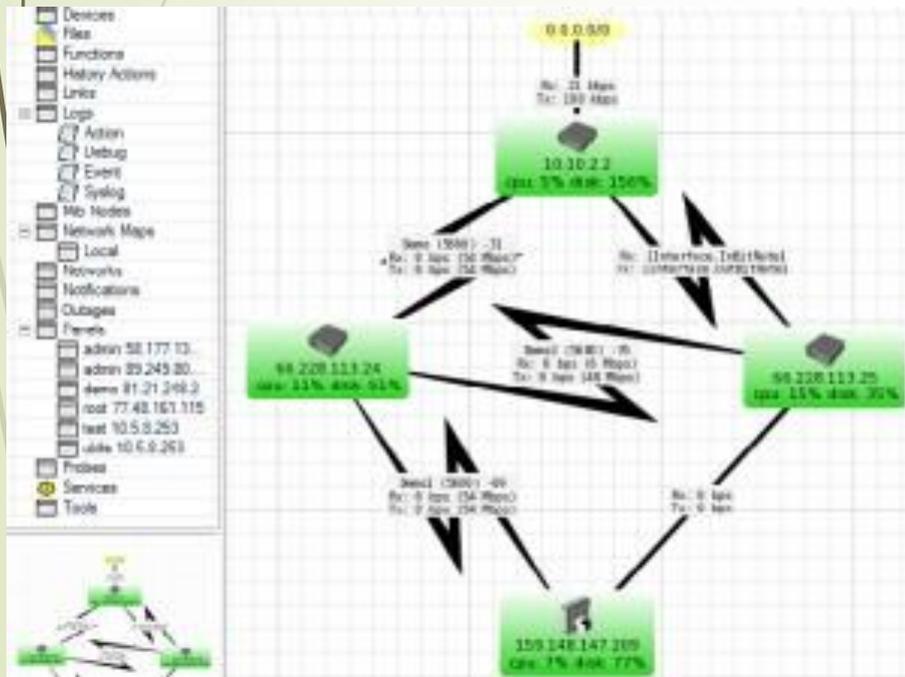


# GESTIÓN DE REDES

## MONITOREO SNMP

### THE DUDE

### LORIOT-PRO

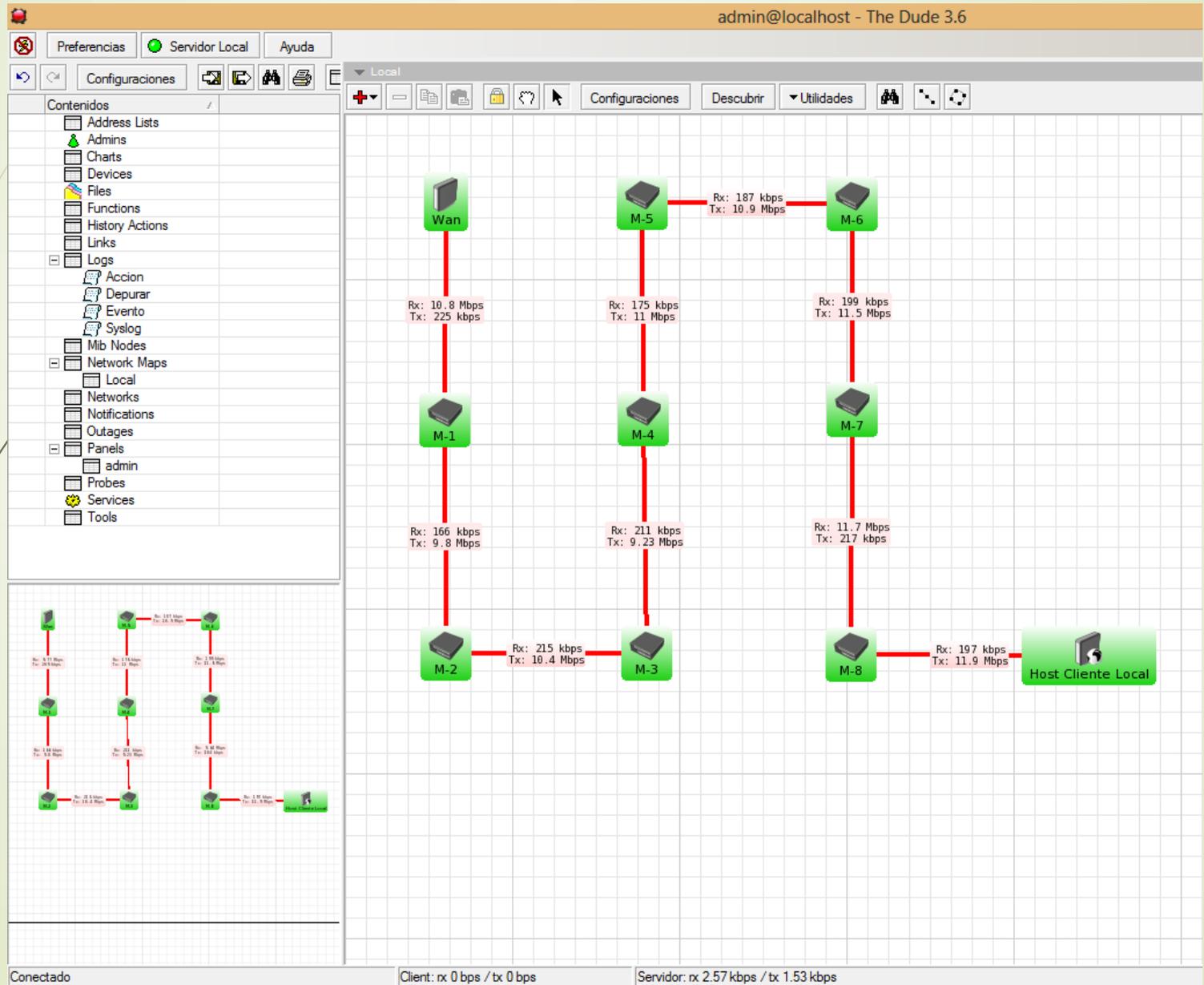


The screenshot shows the LORIOT-PRO network monitoring software interface. The top menu bar includes TOOLS, CONFIGURE, WINDOW, and HELP. Below the menu is a toolbar with icons for MIB Bar, Directory, MIB Output, Events, Mini Map, MIB Tree, Report Center, Routers, Services, and Tasks. The main window is titled 'MiniMap' and displays a network topology diagram with nodes and connections. A 'Syslogs' window is open, showing a table of log entries. The table has columns for Agent Name, IP address, and SysName. The data rows are as follows:

| Agent Name       | IP address      | SysName |
|------------------|-----------------|---------|
| MyOrganisation   |                 |         |
| >192.168.204.1   | 192.168.204.1   |         |
| >192.168.207.239 | 192.168.207.239 |         |
| >192.168.56.1    | 192.168.56.1    |         |

At the bottom of the interface, there is a status bar with indicators for 'Syslogs(Global)', 'Syslogs(1)', 'Syslogs(2)', and 'Syslogs(3)'. The status bar also shows 'ODBC: OFF', 'DISCOVER: OFF', and 'RESERVED: MAJ NUM DEF'.

# MONITOREO CON SOFTWARE THE DUDE DE PLATAFORMA VIRTUAL CON 8 ROUTEROS EN LINEA



# MONITOREO CON SOFTWARE LORIoTPRO DE PLATAFORMA VIRTUAL CON 8 ROUTEROS EN LINEA

The screenshot displays the LortioPro V7.00 software interface, which is used for monitoring a virtual platform with 8 routers online. The interface is divided into several sections:

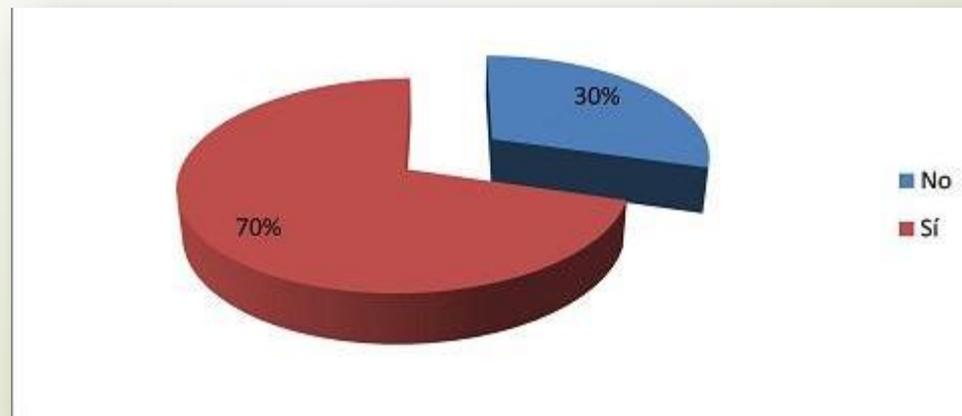
- Router Space:** A tree view on the left showing the network hierarchy. It includes a 'Root' node and several sub-nodes labeled [M-1] through [M-8], each with associated IP addresses and device types (e.g., M-1, M-2, M-3, M-4, M-5, M-6, M-7, M-8).
- MiniMap:** A small diagram in the center showing a simplified network topology.
- Agent Name Table:** A table listing the agents and their details. The table has columns for Agent Name, IP address, Sys..., SysObjectID, Mac Address, Node Service, and User 1.
- Trans Syslogs Table:** A table for system logs with columns for TimeStamp, Agent, Facility, Level, and Alert.
- LortioPro - Internetwork Map:** A detailed network map window showing the physical connections between the 8 routers. The routers are represented by icons with their IP addresses, and they are interconnected in a complex mesh topology.

| Agent Name           | IP address   | Sys... | SysObjectID         | Mac Address       | Node Service | User 1 |
|----------------------|--------------|--------|---------------------|-------------------|--------------|--------|
| Network 192.168.0.28 | 192.168.0.28 |        |                     |                   |              |        |
| M-8                  | 192.168.0.29 | M-8    | enterprises.14988.1 | 2A:AE:8B:BD:BF:3D | Router       |        |
| > 192.168.0.30       | 192.168.0.30 |        |                     | B8:97:5A:6A:8A:76 |              |        |

| TimeStamp | Agent | Facility | Level | Alert |
|-----------|-------|----------|-------|-------|
|-----------|-------|----------|-------|-------|

# NIVEL DE EFECTIVIDAD EN LO ACADÉMICO.

- ▶ Los procesos generados desde ambientes virtuales no reemplazan al 100% las practicas con equipos físicos, pero si permiten el desarrollo de un 90% mas de practicas en la especialidad, generando posibilidades de tener un laboratorio en casa.
- ▶ Se logro incrementar un 70% de practicas adicionales a las presenciales en los laboratorios especializados, así como abrir un horizonte a las tendencias de virtualización de componentes en hardware bajo software especializado.





➤ **Gracias.**  
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**MikroTik Solutions**  
**MikroTik**  
<http://www.e-learning-mikrotik.com/>