

About Me

- Steve Discher, from College Station, Texas, USA
- MikroTik Certified Trainer since 2008 and teach RouterOS classes, LearnMikroTik.com and blog at SteveDischer.com
- Operate a wireless distribution company, ISP Supplies
- Author of RouterOS by Example



Congratulations!

28 New MTCNA Engineers



01:00

How to Properly Use the Switching Functions of the CRS Cloud Router Switches

Practice Quiz



This is a:

A. Switch

B. Router

C. All of the above

Practice Quiz



This is a:

A. Switch

B. Router

C. All of the above

CRS Features

Switching Features & Highlights

Features	Description
Forwarding	<ul style="list-style-type: none">• Configurable ports for switching or routing• Full non-blocking wirespeed switching• Up to 16k MAC entries in Unicast FDB for Layer 2 unicast forwarding• Up to 1k MAC entries in Multicast FDB for multicast forwarding• Up to 256 MAC entries in Reserved FDB for control and management purposes• All Forwarding Databases support IVL and SVL• Configurable Port based MAC learning limit (max 1024 MACs per port)• Jumbo frame support (CRS1xx: 4064 Bytes; CRS2xx: 9204 Bytes)
Mirroring	<ul style="list-style-type: none">• Various types of mirroring:<ul style="list-style-type: none">• Port based mirroring• VLAN based mirroring• MAC based mirroring• 2 independent mirroring analyzer ports

Wires speed switching and jumbo frame support

Port, VLAN and MAC based mirroring

CRS Features

Features	Description
VLAN	<ul style="list-style-type: none">• Fully compatible with IEEE802.1Q and IEEE802.1ad VLAN• 4k active VLANs• Flexible VLAN assignment:<ul style="list-style-type: none">• Port based VLAN• Protocol based VLAN• MAC based VLAN• From any to any VLAN translation and swapping• 1:1 VLAN switching - VLAN to port mapping• VLAN filtering
Port Isolation and Leakage	<ul style="list-style-type: none">• Applicable for Private VLAN implementation• 3 port profile types: Promiscuous, Isolated and Community• Up to 28 Community profiles• Leakage profiles allow bypassing egress VLAN filtering

802.1Q and Q in Q
VLANs, up to 4000
VLANs

Port isolation and
leakage

CRS Features

Features	Description
Trunking	<ul style="list-style-type: none">• Supports static link aggregation groups• Up to 8 Port Trunk groups• Up to 8 member ports per Port Trunk group• Hardware automatic failover and load balancing
Quality of Service (QoS)	<ul style="list-style-type: none">• Flexible QoS classification and assignment:<ul style="list-style-type: none">• Port based• MAC based• VLAN based• Protocol based• PCP/DEI based• DSCP based• ACL based• QoS remarking and remapping for QoS domain translation between service provider and client networks• Overriding of each QoS assignment according to the configured priority

Trunking including standards based LAG, Link Aggregation Groups

Layer 2 QoS based on port, MAC, VLAN and many other matchers

CRS Features

Traffic shaping

Features	Description
Shaping and Scheduling	<ul style="list-style-type: none">• 8 queues on each physical port• Shaping per port, per queue, per queue group
Access Control List	<ul style="list-style-type: none">• Ingress and Egress ACL tables• Up to 512 ACL rules• Classification based on ports, L2, L3, L4 protocol header fields• ACL actions include filtering, forwarding and modifying of the protocol header fields

Ingress and Egress
ACL's

CRS

- Those are the switching features
- Don't forget about RouterOS

Question

True or False: Steve knows how to use all the capabilities of the CRS?

Answer

False. Why? There are three to four features that most people need all the time, the rest are designed to address certain, less common scenarios.

Question

True or False: I can solve most if not all of the switching needs of the average WISP or integrator by learning 3 basic switching setups on the CRS.

Answer

True. We will look at three simple setups that will work for the majority of your applications.

Agenda

1. Why switch, why not just bridge?
2. Background knowledge
3. Examples of setups



Why Use Switching Instead of Bridging?

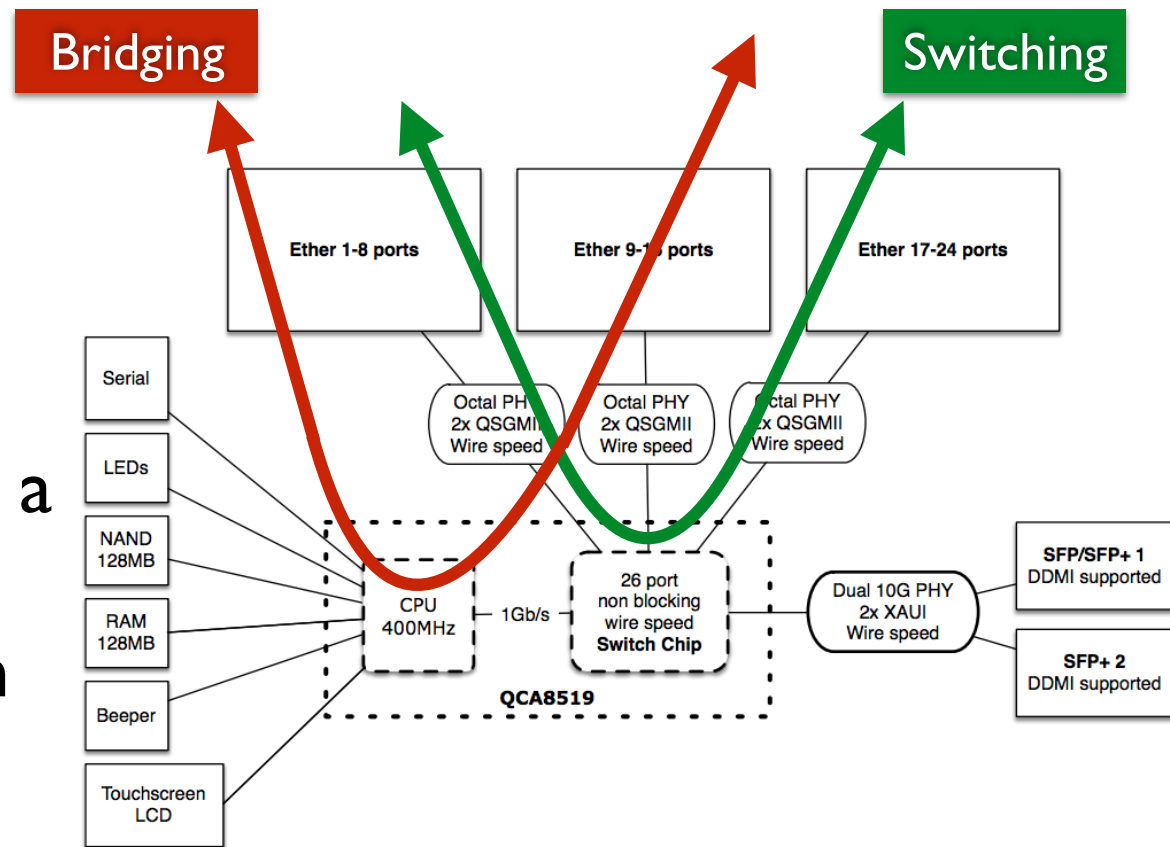
- Bridges are easy, and perfect for joining ports that can not be joined any other way
- Example: Wireless to Ethernet
- Bridges are done in software, resource hit
- Bridges could max out a CPU before the interfaces hit wire speed



How Are Switches Different Than Bridges?

How Are Switches Different Than Bridges?

- Although functionally they are the same, operationally they are very different
- Switching involves using a dedicated switch chip, separate and apart from the Router CPU and processes



Dedicated hardware, not software

CRS226

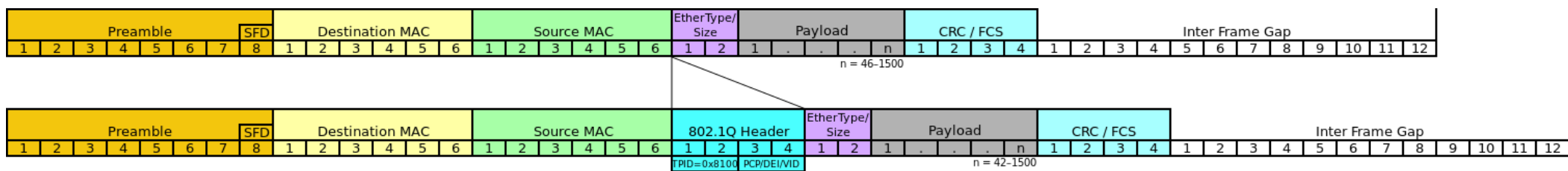


What are VLANs?

- A Virtual LAN (VLAN) is any broadcast domain that is partitioned and isolated in a computer network at the data link layer (OSI layer 2). -*Wikipedia*
- It is like a virtual switch or switches inside a physical switch

How Are VLANs Done

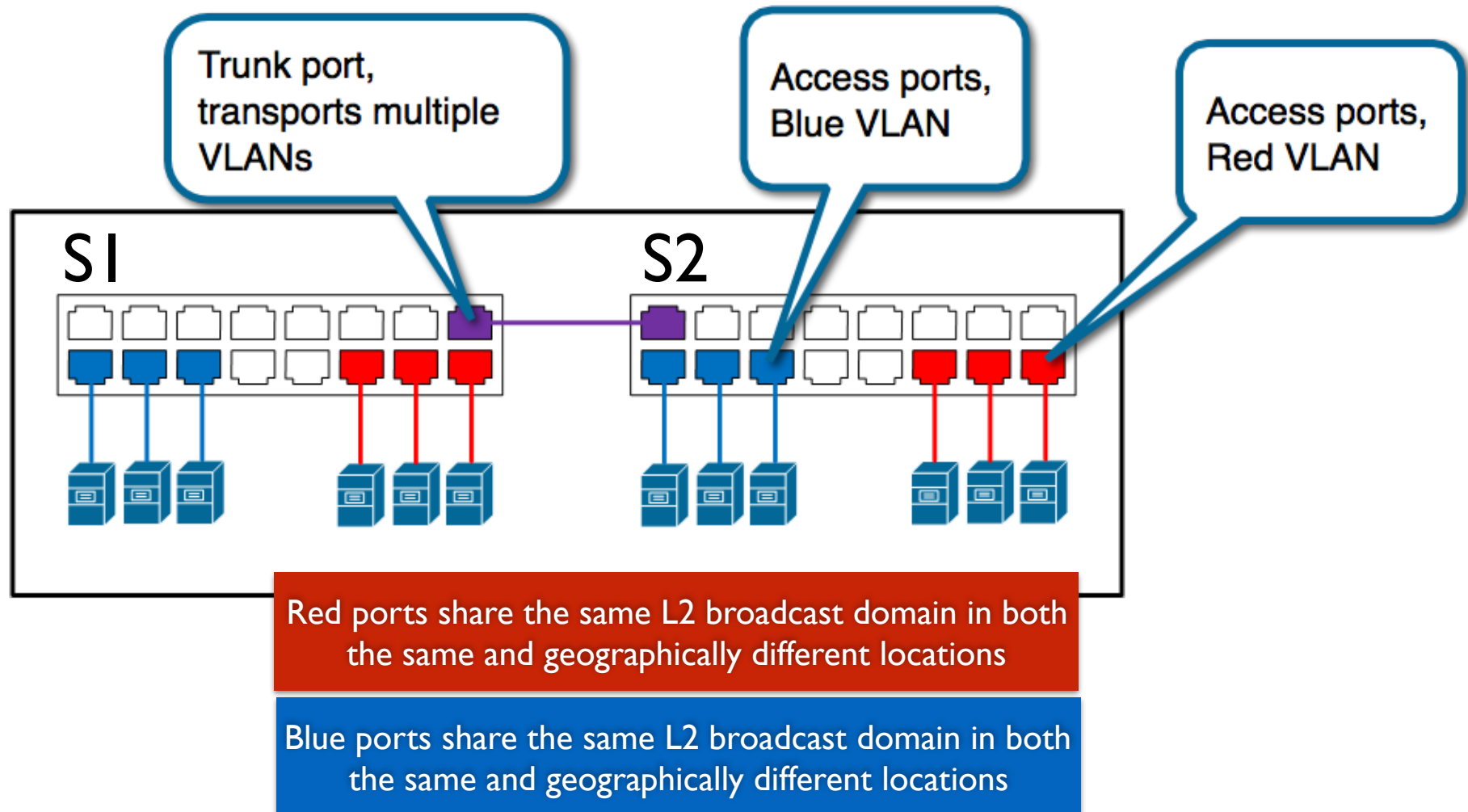
- “Encapsulation” is a misnomer
- 802.1Q does not “encapsulate” the original frame, per se, instead it adds a 32-bit field between the source MAC address and the “EtherType” field of the original frame



VLAN Terms

- **Tagging** - adding the VLAN tag to frames
- **Untagging** - Stripping the VLAN tag
- **Trunk Port** - (not an aggregation group) Allowing various, different frame tags to pass through a switch typically without change
- **Access port** - Receives only frames with a certain tag and strips them before the frames leave the port for non-VLAN aware devices
- **Hybrid port** - Passes some tags intact but strips others

VLANs in Action



School's out!





Application Examples

How can we use these features?

Example 1

- **Basic switch** - Set all or a group of ports to be switched together

Example 2

- **Inter VLAN Routing** - Trunk VLANs to a router port to be presented as VLAN sub-interfaces

Example 3

- **Port Isolation** - Prevent rogue DHCP servers on a switch

Example 1

Configure a Basic Switch

- Using default configuration, all ports are switched with ether1 as the master

The screenshot shows the Mikrotik RouterOS interface configuration. On the left, the 'Interface List' window displays a table of interfaces. On the right, the configuration window for 'ether2' is open, showing various settings.

Interface	Type	L2 MTU	Tx	Rx
R ether1-master	Ethernet	1588		0 bps
S ether2	Ethernet	1500		0 bps
S ether3	Ethernet			
S ether4	Ethernet			
S ether5	Ethernet			
S ether6	Ethernet			
S ether7	Ethernet			
S ether8	Ethernet			
S ether9	Ethernet			
S ether10	Ethernet			
S ether11	Ethernet			
S ether12	Ethernet			
S ether13	Ethernet			
S ether14	Ethernet			
S ether15	Ethernet			
S ether16	Ethernet			
S ether17	Ethernet			
S ether18	Ethernet			

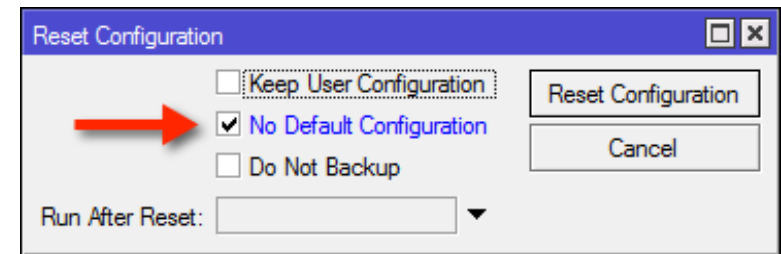
The configuration window for 'ether2' shows the following settings:

- Name: ether2
- Type: Ethernet
- MTU: 1500
- L2 MTU: 1588
- Max L2 MTU: 9204
- MAC Address: 4C:5E:0C:0C:90:A6
- ARP: enabled
- Master Port: ether1-master (indicated by a red arrow)

Interfaces

Configure a Basic Switch

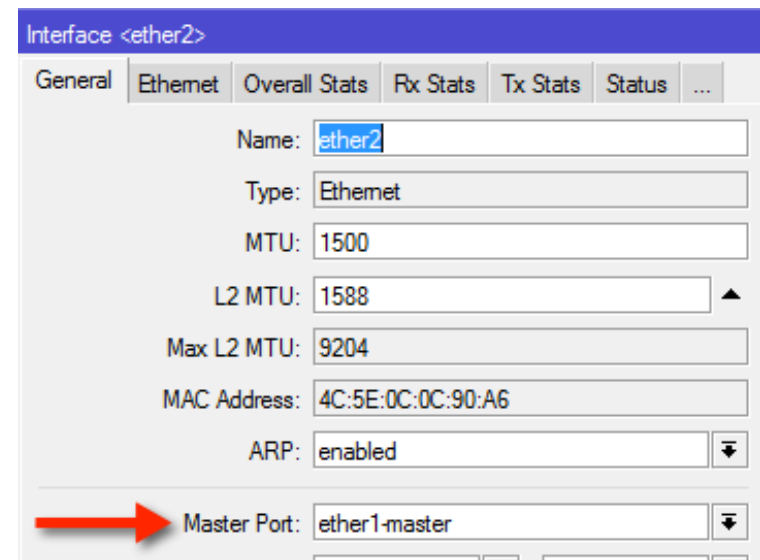
- Without default configuration, you will need to assign ports manually or by using a script
- “No Default Configuration” does just that



System → Reset Configuration

Configure a Basic Switch

- After reset, we can assign interfaces manually or using a script
- Without scripting this can take a while!



Interfaces

Configure a Basic Switch

- Two scripts to greatly simplify configuration

The screenshot displays the Mikrotik RouterOS Scripts configuration interface. At the top, there is a 'Script List' window with tabs for 'Scripts', 'Jobs', and 'Environment'. Below the tabs are icons for adding (+), deleting (-), and running a script, along with a 'Run Script' button and a search field labeled 'Find'. The main area shows a table of scripts:

Name	Owner	Last Time Started	Run Count
Clear Ports	admin	Jan/02/1970 00:59:11	2
Set Ports	admin	Jan/02/1970 00:58:00	5

Below the table, the text 'System → Scripts' is visible. Two configuration windows are open below the list:

- Script <Clear Ports>**: Name: Clear Ports, Owner: admin, Policy: ftp, read, policy, password, sensitive, reboot, write, test, sniff.
- Script <Set Ports>**: Name: Set Ports, Owner: admin, Policy: ftp, read, policy, password, sensitive, reboot, write, test, sniff.

Configure a Basic Switch

```
/system script
add name="Set Ports" owner=admin policy=ftp,reboot,read,write,policy,test,password,sniff,sensitive
source="#\r\
\n#\r\
\n# Set master port\r\
\n# Then set slave port type i.e.: ether or sfp \r\
\n# This is for interfaces not named \93ether\94 like SFP\r\
\n# Then set ports in range form using SlavePortStart and SlavePortStop.\r\
\n:global MasterPort \"ether24\"\r\
\n:global PortType \"ether\"\r\
\n:global SlavePortsStart \"1\"\r\
\n:global SlavePortsStop \"9\"\r\
\n:for i from=\$SlavePortsStart to=\$SlavePortsStop do={\r\
\n/interface ethernet set (\$PortType . \$i) master-port=\$MasterPort\r\
\n}"
add name="Clear Ports" owner=admin policy=ftp,reboot,read,write,policy,test,password,sniff,sensitive
source=\
"/interface ethernet\r\
\nset [find] master=none"
```

Download at <http://wiki.ispsupplies.com>
Search for “script”

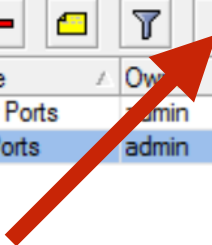
Helpful Scripts

Script List

Scripts Jobs Environment

+ - [Folder] [Filter] Run Script

Name	Owner	Last Time Started
Clear Ports	admin	Jan/02/19
Set Ports	admin	Jan/02/19



Script <Clear Ports>

Name: Clear Ports

Owner: admin

Policy: ftp reboot
 read write
 policy test
 password sniff
 sensitive

Last Time Started:

Run Count: 0

```
/interface ethernet
set [find] master=none
```

Script <Set Ports>

Name: Set Ports

Owner: admin

Policy: ftp reboot
 read write
 policy test
 password sniff
 sensitive

Last Time Started:

Run Count: 0

Source:

```
# Then set slave port type i.e.: ether or sfp
# This is for interfaces not named "ether" like SFP
# Then set ports in range form using SlavePortStart and
# SlavePortStop
:global MasterPort "ether1"
:global PortType "ether"
:global SlavePortsStart "2"
:global SlavePortsStop "6"
for [from=$SlavePortsStart to=$SlavePortsStop do={
/interface ethernet set ($PortType . $i) master-port=$MasterPort
```

Configure a Basic Switch



Result=2 x 6 port switches

That's it!

Interface List

Interface	Ethernet	EoIP Tunnel	IP Tunnel	GRE Tunnel	VLAN	VRRP	Bonding	LTE
+ - ✓ ✗ 📄 🔍	Interface <ether8>							
Name	General Ethernet Overall Stats Rx Stats Tx Stats Status ...							
ether1-group1-master								
S ether2								
S ether3								
S ether4								
S ether5								
S ether6								
ether7-group2-master								
S ether8								
S ether9								
S ether10								
S ether11								
S ether12								
ether13								
ether14								
ether15								
ether16								
ether17								
ether18								

Name: ether8

Type: Ethernet

MTU: 1500

L2 MTU: 1588

Max L2 MTU: 9204

MAC Address: 4C:5E:0C:0C:90:AC

ARP: enabled

Master Port: ether7-group2-master

Bandwidth (Rx/Tx): unlimited / unlimited

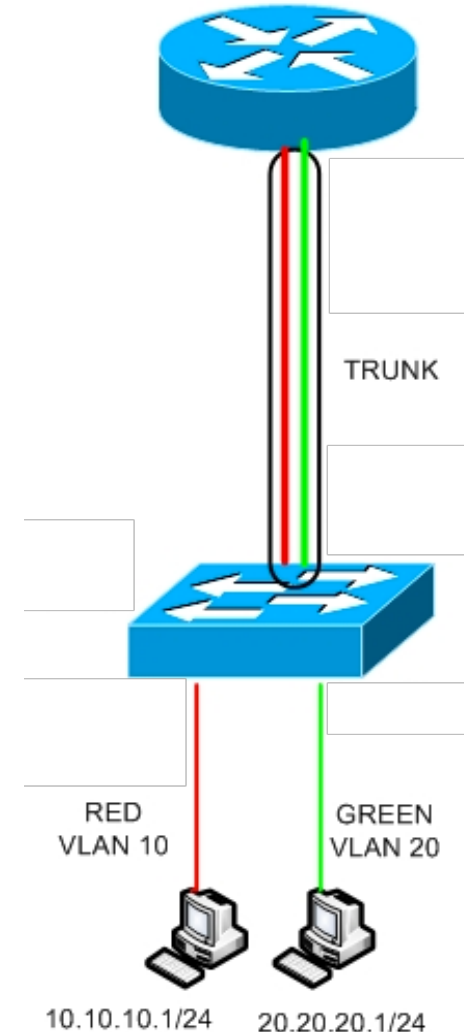
Switch: switch1

Interfaces

Example 2

Inter VLAN Routing

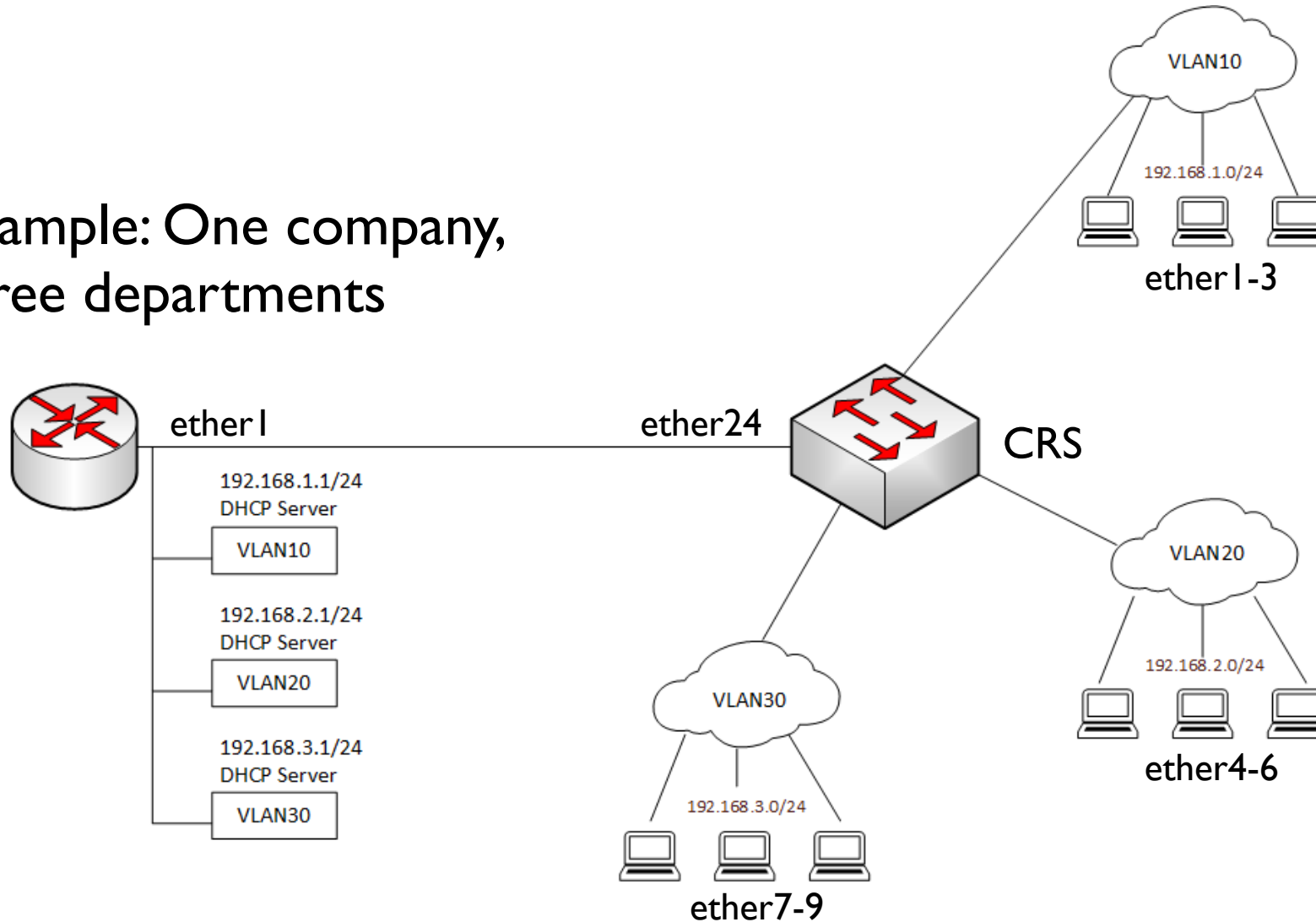
- Common configuration when a router needs many independent ports
- Each switch port appears as a separate virtual interface on the router



Example 2

Inter VLAN Routing

Example: One company, three departments



Inter VLAN Routing

Router Config

Step 1

- Separate routing device apart from CRS
- Router, create three VLAN interfaces subordinate to ether1

Interfaces → VLAN

The screenshot shows the Mikrotik RouterOS configuration interface. At the top, there is an 'Interface List' table with columns for Name, Type, MTU, L2 MTU, Tx, and Rx. Below this, three configuration panels are shown for 'Interface <vlan10>', 'Interface <vlan20>', and 'Interface <vlan30>'. Each panel has tabs for 'General', 'Status', and 'Traffic'. The 'General' tab is selected for each. The configuration for each interface is as follows:

Interface	Name	Type	MTU	L2 MTU	MAC Address	ARP	VLAN ID	Interface	Use Service Tag
vlan10	vlan10	VLAN	1500	1584	4C:5E:0C:0C:90:90	enabled	10	ether1-trunk	<input type="checkbox"/>
vlan20	vlan20	VLAN	1500	1584	4C:5E:0C:0C:90:A5	enabled	20	ether1-trunk	<input type="checkbox"/>
vlan30	vlan30	VLAN	1500	1584	4C:5E:0C:0C:90:A5	enabled	30	ether1-trunk	<input type="checkbox"/>

Red arrows in the original image point from the 'vlan20' and 'vlan30' configuration panels to the 'vlan30' panel, indicating a sequence or relationship between the configurations.

Example 2

Inter VLAN Routing

Router Config

Step 2

- Add IP Addresses to each VLAN interface

The screenshot shows the Mikrotik RouterOS configuration interface. At the top is the 'Address List' window, which contains a table with the following data:

Address	Network	Interface
192.168.1.1/24	192.168.1.0	vlan10
192.168.2.1/24	192.168.2.0	vlan20
192.168.3.1/24	192.168.3.0	vlan30

Below the table are three configuration windows for each address. Each window has fields for 'Address', 'Network', and 'Interface', along with 'OK', 'Cancel', 'Apply', 'Disable', 'Comment', 'Copy', and 'Remove' buttons. Red arrows point to the 'OK' and 'Apply' buttons in each window. The status 'enabled' is shown at the bottom of each configuration window.

IP → Addresses

Example 2

Inter VLAN Routing

Router Config

Step 3

- And add DHCP Servers to each VLAN interface using the setup button and accept the defaults

Name	Interface	Relay	Lease Time	Address Pool	Add AR...
dhcp1	vlan10		00:10:00	dhcp_pool1	no
dhcp2	vlan20		00:10:00	dhcp_pool2	no
dhcp3	vlan30		00:10:00	dhcp_pool3	no

IP → DHCP-Server

Inter VLAN Routing

Switch Config

Step 1

- Create a switch port group, ether24 is master, ether1-ether9 are slaves to port 24 using our script “Set Ports”
- 1 switch port group

Interfaces

The screenshot shows the Mikrotik WinBox interface. At the top, there is a tabbed window titled 'Interface List' with tabs for 'Interface', 'Ethernet', 'EoIP Tunnel', 'IP Tunnel', 'GRE Tunnel', 'VLAN', 'VRRP', 'Bonding', and 'LTE'. The 'Interface' tab is active, showing a table of interfaces. A red box highlights the first ten rows of the table, which are labeled 'ether1' through 'ether10'. Below this, a window titled 'Interface <ether1>' is open, showing the configuration for the 'ether1' interface. The 'General' tab is selected, and the 'Master Port' field is set to 'ether24-trunk', indicated by a red arrow.

Name	Type	L2 MTU	Tx	Rx
ether1	Ethernet	1588	0 bps	0 bps
ether2	Ethernet	1588	0 bps	0 bps
ether3	Ethernet	1588	0 bps	0 bps
ether4	Ethernet	1588	0 bps	0 bps
ether5	Ethernet	1588	0 bps	0 bps
ether6	Ethernet	1588	0 bps	0 bps
ether7	Ethernet	1588	0 bps	0 bps
ether8	Ethernet	1588	0 bps	0 bps
ether9	Ethernet	1588	0 bps	0 bps
ether10	Ethernet	1588	0 bps	0 bps

Interface <ether1> configuration:

- Name: ether1
- Type: Ethernet
- MTU: 1500
- L2 MTU: 1588
- Max L2 MTU: 9204
- MAC Address: 4C:5E:0C:0C:90:A5
- ARP: enabled
- Master Port: ether24-trunk
- Bandwidth (Rx/Tx): unlimited / unlimited
- Switch: switch1

Example 2

Inter VLAN Routing

Switch Config

Step 2

- Set access ports for each VLAN

Switch → VLAN → In-VLAN-Tran

The screenshot shows the Mikrotik RouterOS configuration interface for VLANs. At the top, there is a table with columns: VLAN, Eg. VLAN Tag, In. VLAN Tran., Eg. VLAN Tran., 1:1 VLAN Switching, MAC Based VLAN, and Protocol Based VLAN. The table lists three VLANs: 10 (ports ether1-3), 20 (ports ether4-6), and 30 (ports ether7-9). Below the table, three 'Ingress VLAN Translation' windows are open, each for a different VLAN. Each window has a 'Ports' field with a list of ports and a 'New Customer VID' field. Red boxes highlight the 'Ports' and 'New Customer VID' fields in each window. Red arrows point from the 'New Customer VID' fields to the values 10, 20, and 30. The 'New Customer VID' fields are also highlighted with red boxes.

VLAN	Eg. VLAN Tag	In. VLAN Tran.	Eg. VLAN Tran.	1:1 VLAN Switching	MAC Based VLAN	Protocol Based VLAN
10	ether1, ether2, ether3	any	any			
20	ether4, ether5, ether6	any	any			
30	ether7, ether8, ether9	any	any			

Example 2

Inter VLAN Routing

Switch Config

Step 3

- Set the trunk port, ether24

The screenshot shows the Mikrotik Switch VLAN configuration interface. At the top, there are tabs for 'VLAN', 'Eg. VLAN Tag', 'In. VLAN Tran.', 'Eg. VLAN Tran.', '1:1 VLAN Switching', 'MAC Based VLAN', and 'Protocol Based VLAN'. Below the tabs is a table with columns 'VLAN ID' and 'Tagged Ports'. The table contains three rows: VLAN 10 with 'ether24-trunk', VLAN 20 with 'ether24-trunk', and VLAN 30 with 'ether24-trunk'. Below the table, there are three dialog boxes for 'Switch Egress Tag VLAN <10>', 'Switch Egress Tag VLAN <20>', and 'Switch Egress Tag VLAN <30>'. Each dialog box has a 'VLAN ID' field and a 'Tagged Ports' dropdown menu. Red arrows point to the 'VLAN ID' fields and the 'Tagged Ports' dropdown menus in each dialog box, indicating that the configuration is being applied to the correct VLAN and port.

Switch → VLAN → Eg-VLAN-Tag

Inter VLAN Routing

Switch Config

Step 4

- Add VLAN membership definitions in the VLAN table

That's it!

The screenshot shows the Mikrotik Switch VLAN configuration interface. At the top, there is a table with columns: VLAN ID, Ports, SVL, SA Leami..., Flood, and Ingress M... The table contains the following data:

VLAN ID	Ports	SVL	SA Leami...	Flood	Ingress M...
10	ether1, ether2, ether3	no	yes	no	no
20	ether4, ether5, ether6	no	yes	no	no
30	ether7, ether8, ether9	no	yes	no	no
D	4095 switch1-cpu, ether10, ether11, ...	no	no	no	no

Below the table are three configuration windows for VLAN 10, 20, and 30. Each window has a 'Ports' field with a list of ports and a red box around it. Red arrows point from the 'Ports' column in the table to these red boxes. The windows also have 'OK', 'Cancel', 'Apply', 'Disable', 'Copy', and 'Remove' buttons. The 'SA Leaming' checkbox is checked in each window. The 'QoS Group' is set to 'none' and the status is 'enabled'.

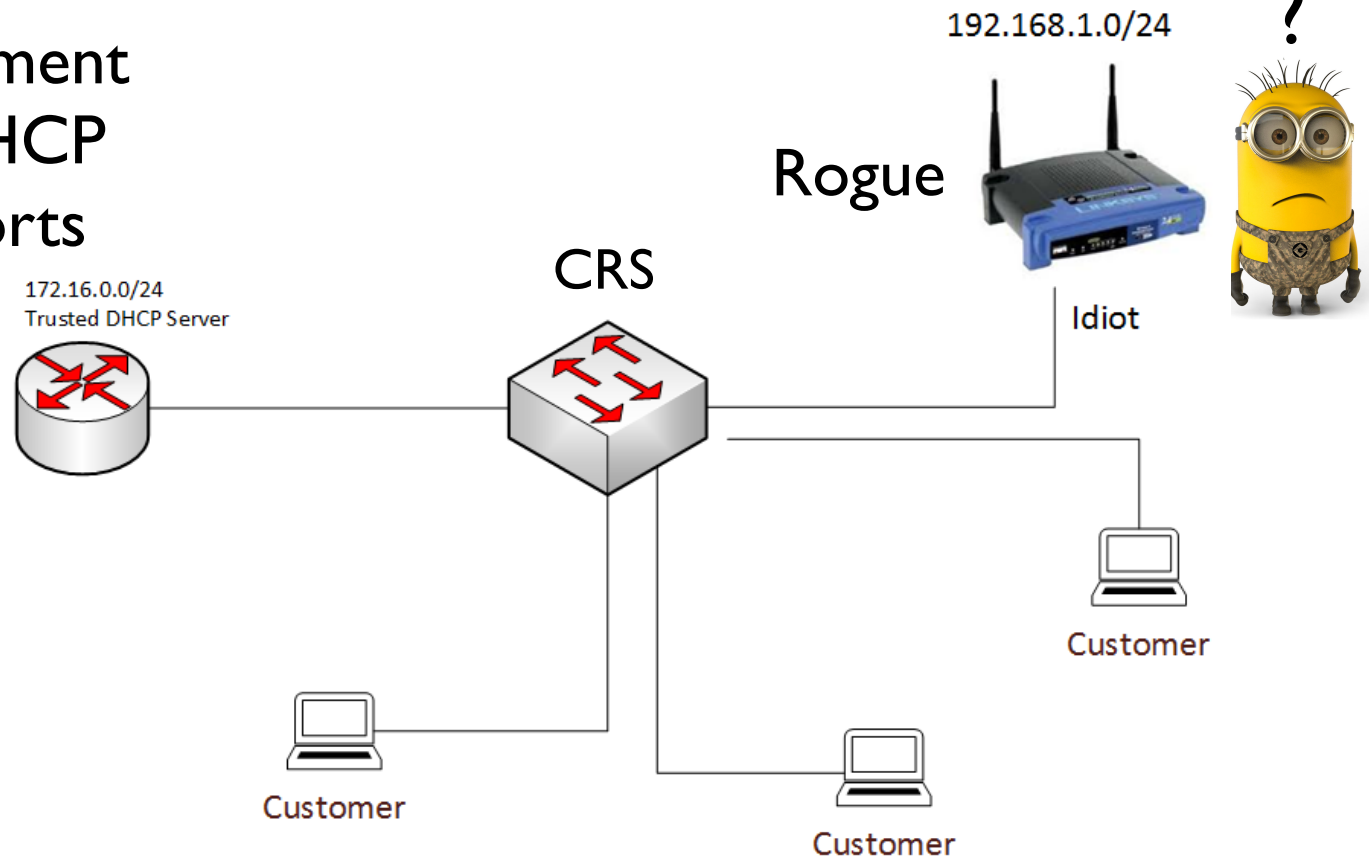
Switch → VLAN → VLAN

Example 3

Configure Rogue DHCP Prevention

(port level isolation)

Example: MDU, apartment complex, etc., one DHCP server, 9 customer ports



Configure Rogue DHCP Prevention

Step 1

- Create a switch port group, ether24 is master, ether1-ether9 are slaves to port 24 using our script “Set Ports”

The screenshot shows the Mikrotik RouterOS configuration interface. At the top, the 'Interface List' window displays a table of interfaces:

Interface	Name	Type	L2 MTU	Tx	Rx
S	ether1	Ethernet	1588	0 bps	0 bps
S	ether2	Ethernet	1588	0 bps	0 bps
S	ether3	Ethernet	1588	0 bps	0 bps
S	ether4	Ethernet	1588	0 bps	0 bps
S	ether5	Ethernet	1588	0 bps	0 bps
S	ether6	Ethernet	1588	0 bps	0 bps
S	ether7	Ethernet	1588	0 bps	0 bps
S	ether8	Ethernet	1588	0 bps	0 bps
S	ether9	Ethernet	1588	0 bps	0 bps
S	ether10	Ethernet	1588	0 bps	0 bps

A red box highlights the first ten rows of this table. Below the table, the 'Interface <ether1>' configuration window is open, showing the following settings:

- Name: ether1
- Type: Ethernet
- MTU: 1500
- L2 MTU: 1588
- Max L2 MTU: 9204
- MAC Address: 4C:5E:0C:0C:90:A5
- ARP: enabled
- Master Port: ether24-trunk (indicated by a red arrow)
- Bandwidth (Rx/Tx): unlimited / unlimited
- Switch: switch1

Interfaces

Configure Rogue DHCP Prevention

Step 2

- Set the same Community port profile for all DHCP client ports. Community port profile numbers are from 2 to 30

Switch → Ports

The screenshot shows the Mikrotik WinBox interface. The 'Switch Ports' window is open, displaying a table of ports. A red box highlights the 'Isolation Profile' column, showing values from 2 to 30 for ports ether1 through ether23. Below this, the 'Switch Port <ether1>' configuration window is open, showing the 'Generic' tab. The 'Isolation Profile' is set to 29, and the 'Isolation Profile Override' is set to 2. A red arrow points from the 'Isolation Profile Override' field in the configuration window to the 'Isolation Profile' column in the table above.

Name	VLAN Type	Isolation Profile	Isolation Profile O...	MAC...	Egress VLAN Mode
ether1	network port	9	2	o	unmodified
ether2	network port	9	2	o	unmodified
ether3	network port	9	2	o	unmodified
ether4	network port	9	2	o	unmodified
ether5	network port	9	2	o	unmodified
ether6	network port	9	2	o	unmodified
ether7	network port	9	2	o	unmodified
ether8	network port	9	2	o	unmodified
ether9	network port	9	2	o	unmodified
ether10	network port	9	2	o	unmodified
ether11	network port	30	no	no	unmodified
ether12	netw				
ether13	netw				
ether14	netw				
ether15	netw				
ether16	netw				
ether17	netw				
ether18	netw				
ether19	netw				
ether20	netw				
ether21	netw				
ether22	netw				
ether23	netw				
ether24-trunk	netw				
sfp-sfpplus1	netw				
sfpplus2	netw				
switch1-cpu	netw				

Switch Port <ether1> configuration:

- Name: ether1
- VLAN Type: network port
- Isolation Profile: 29
- Isolation Profile Override: 2
- Leaming:
- Leaming Override:
- Leaming Limit:

Configure Rogue DHCP Prevention

Step 3

- Tell the switch which port is trusted for DHCP server
- Define your profile to match DHCP protocol traffic only, straight from the wiki.

Switch → Port Isolation

The screenshot shows the Mikrotik WinBox interface for configuring a Switch Port Isolation profile. The main window is titled 'Switch Ports' and has tabs for 'Ports', 'Trunk', 'Port Isolation', and 'Port Leakage'. The 'Port Isolation' tab is active, showing a table of ports:

#	Ports	Type	Forwarding Ty...	Traffic Type	Registration S...
0	ether24-trunk	dst	bridged		
1	D switch1-cpu, ether1, ether2...	dst	routed bridged	broadcast multica...	unknown kno...
2	D switch1-cpu	dst	routed bridged	broadcast multica...	unknown kno...

A dialog box titled 'Switch Port Isolation <ether24-trunk>' is open, showing the configuration for the selected port. The 'Ports' field is set to 'ether24-trunk'. The 'Type' is set to 'dst'. The 'Forwarding Type' is set to 'routed' and 'bridged'. The 'Traffic Type' is set to 'broadcast', 'multicast', and 'unicast'. The 'Registration Status' is set to 'unknown' and 'known'. The 'Protocol Type' is set to 'DHCPv4'. The 'MAC Profile' is set to 'promiscuous', the 'Port Profile' is set to '2', and the 'VLAN Profile' is empty. Red arrows point to the 'Ports' field and the 'DHCPv4' checkbox.

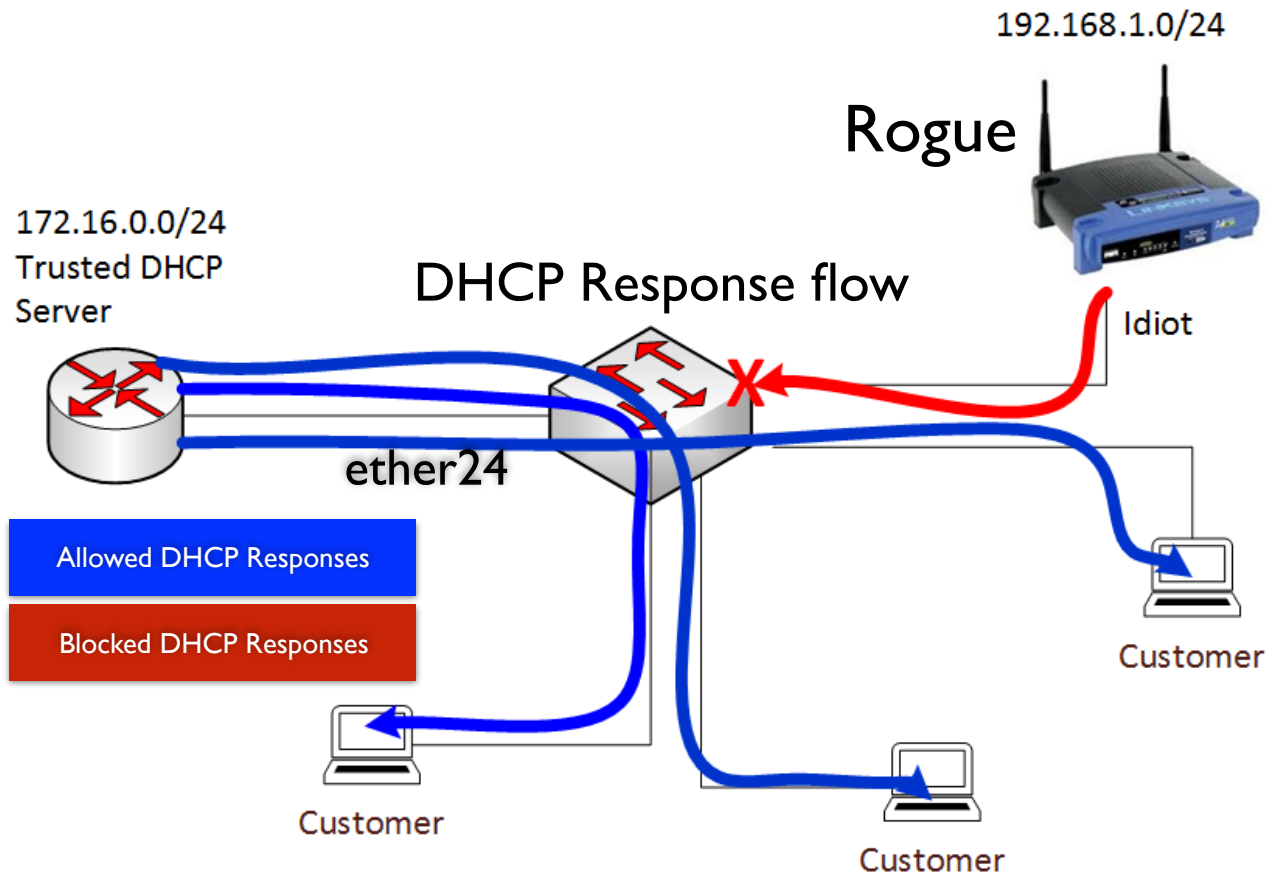
Example 3

Configure Rogue DHCP Prevention

Result: Customers will not see DHCP server responses unless they come from port 24.

All other traffic is allowed.

That's it!



Other Ideas With CRS

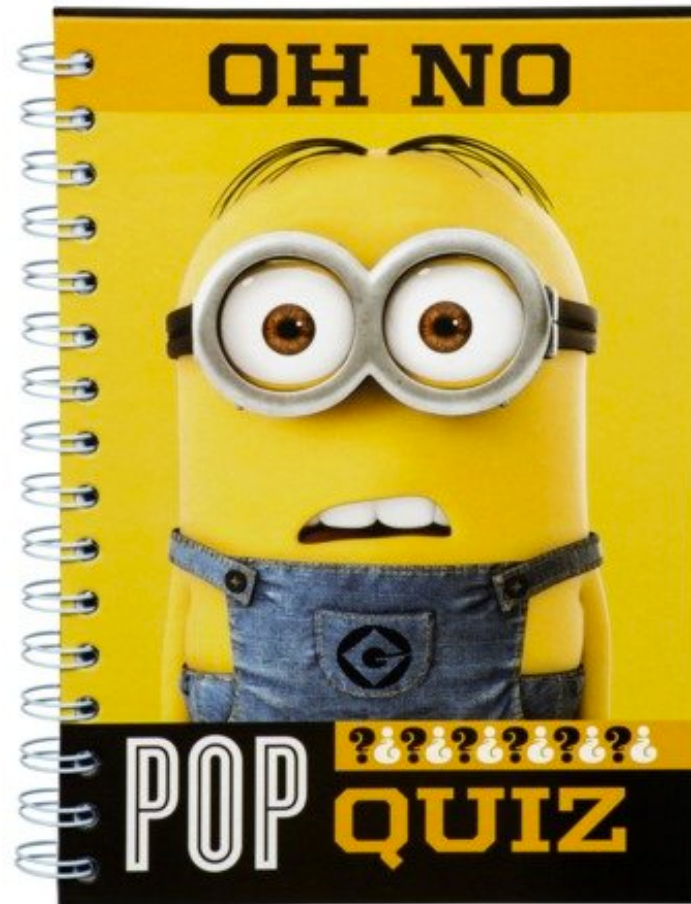
- **MAC based VLAN.** Tag packets as they enter a port based on MAC matcher

Example: All Grandstream phones tag as VLAN 100 based on MAC address pattern matcher

- **Port based bandwidth limiting.** Ensures virus infected hosts do not saturate uplinks.
- **Port based storm control.** Prevent disruptions on Layer 2 ports caused by broadcast, multicast or unicast traffic storms.
- Many other examples at http://wiki.mikrotik.com/wiki/Manual:CRS_examples

Summary

- Stop bridging when you have switching capabilities.
- Don't be overwhelmed by all the features, pick the two or three setups you actually need and learn them.
- Make your networks more efficient by utilizing VLANs and other advanced CRS features



Pop Quiz

- True or **false** - CRS supports various frame sizes up to but not including jumbo frames?
- What is the maximum number of VLANs supported by the CRS? **4000**
- Which is done in software, switching or bridging? **Bridging**
- **True** or false - To configure port level isolation for rogue DHCP server control, we use the Port Isolation feature?
- True or **false** - To configure a basic switch on the CRS using the switch chip, create a bridge interface and add ports to it.

Questions?

MikroTik Maze Winners

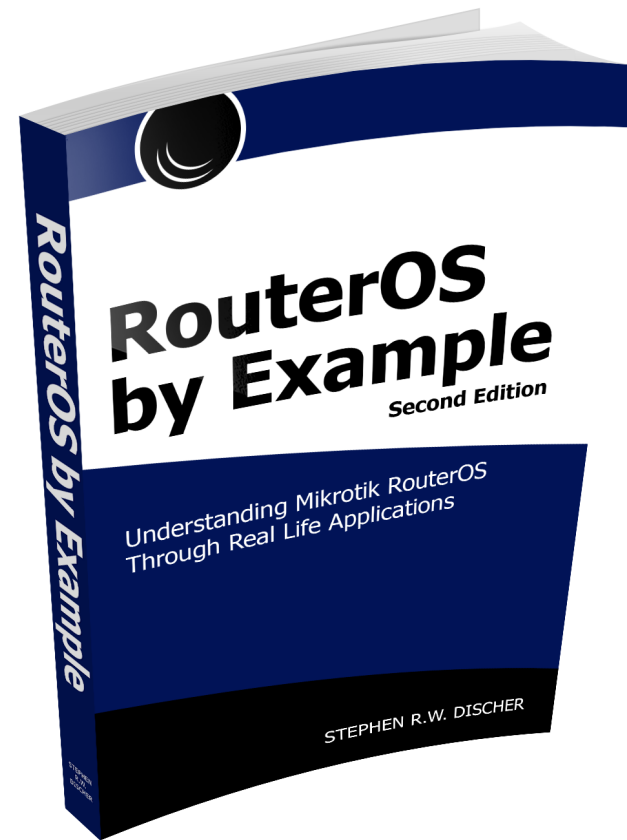
<http://learnmikrotik.com/mazerunner/game.php>

Top 5 Prizes

Come Get a Shirt!

Second Edition

- Updated everything to version 6
- Expanded the examples
- Added significant content for CRS switches
- Currently in edit, shipping beginning of summer 2016
Amazon and ISPSupplies.com



Thank you for playing!

- Try our MikroTik Maze at ISP Supplies table
- Training: MyWISPTraining.com & LearnMikroTik.com
- Store: ISPSupplies.com
- Blog: SteveDischer.com
- “RouterOS by Example” available from ISP Supplies, Amazon, 2nd Edition early summer
- Configurator: MikroTikConfig.com

