



# L2-коммутация в Mikrotik RB/CRS

**it•lab**  
system integrator

# Who am I?

## Алексей Чобан

- Опыт работы с сетями – 14 лет
- Опыт работы с Mikrotik – 13 лет
- Сертифицирован Mikrotik, Cisco
- Тренер Mikrotik с 2009 года



- системный интегратор

(Mikrotik, Cisco, VoIP, Billing, IPTV, Linux/FreeBSD, high load, soft. development, монтаж сетей)

- 5 специалистов Mikrotik  
MTCNA/MTCRE/MTCWE/MTCTCE/MTCUME
- 2 специалиста Cisco
- 2 VoIP-инженера
- 2 \*nix-админа
- 2 программиста

# Предлагаемое оборудование и решения

- Поставка Mikrotik, Cisco
  - Поставка антенн
  - Поставка VoIP/TDM-оборудования
  - Поставка IPTV-оборудования
  - Поставка серверов Cisco, HP
  - Поставка и программирование SFP/SFP+/XFP
- 
- Курсы Mikrotik (MTCNA, MTCRE, MTCWE, MTCUME, MTCTCE)
  - Кабельные работы
  - Монтаж и настройка LAN, WiFi
  - Корпоративные сети и сети VPN
  - Решения для операторов связи (Billing, VoIP, LNP, IPTV)
  - IP PBX, Call Centers, Asterisk
  - Виртуализация (VMware, Xen, Proxmox), кластеры
  - WEB-программирование, внедрение CRM, e-archive
  - Гибридные решения (VoIP + CRM)



# Лотерея от IT-LAB

1. Заполните анкету – получите презент (USB-флешка, блокнот) и возможность выиграть RB260GS
2. Сфотографируйтесь на фоне плаката IT-LAB  
Выложите на FB с хештегом #ITLAB\_MUM2015  
Лайкните FB-страницу IT-LAB  
Наберите наибольшее кол-во лайков и получите CRS125-24G-1S-IN



# Содержание

- L2-switching (коммутация) в Mikrotik
- Switch-chip в RouterBOARD.
- Обзор линейки CRS
- Преимущества и недостатки
- Feature requests

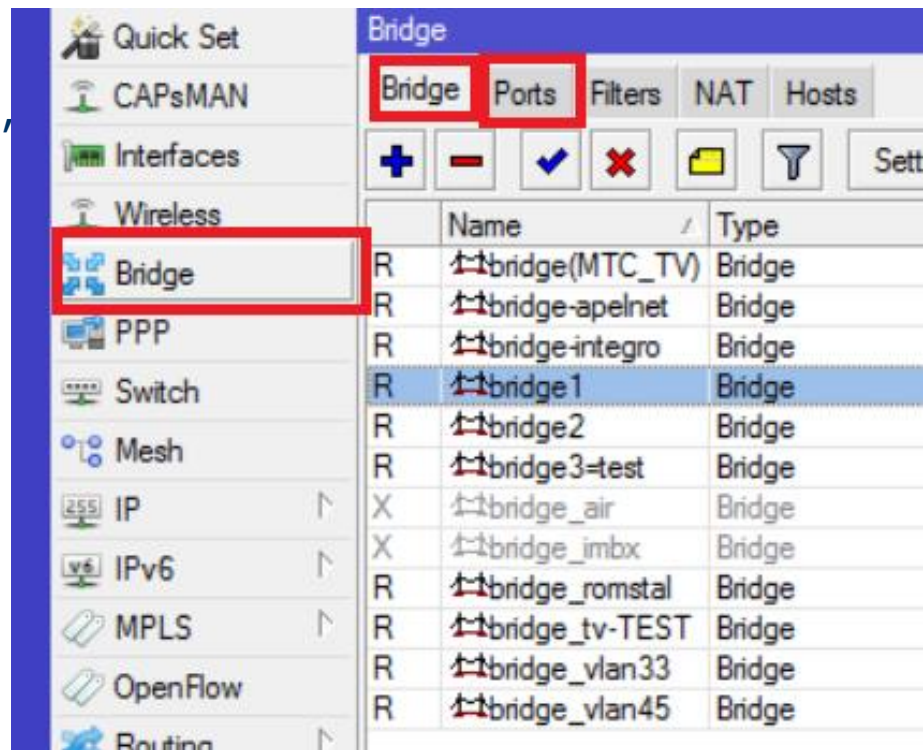
# L2-коммутация

- Осуществляется на втором уровне модели OSI – Layer 2
- Единица адресации – MAC-адрес, 48 бит,  
01-02-03-04-05-06
- Устройства – коммутаторы
- Порты – 5,8,16,24,48 и т.д.
- Управляемые (managed) и неуправляемые (unmanaged)
- Производители – Cisco, HP, D-Link, TP-Link и т.д.
- Функции – switching (forwarding), VLAN, port security, L2/L3 filtering, STP, mirroring, IGMP snooping, QoS etc.



# L2-коммутация в Mikrotik

- Software bridging
  - Реализуется средствами ОС
  - Позволяет объединять разнотипные интерфейсы (Ethernet, Wireless, Tunnel)
  - Использует CPU => ограничение в производительности
  - Богатый функционал (L2/L3 firewall, NAT, STP, fast path)



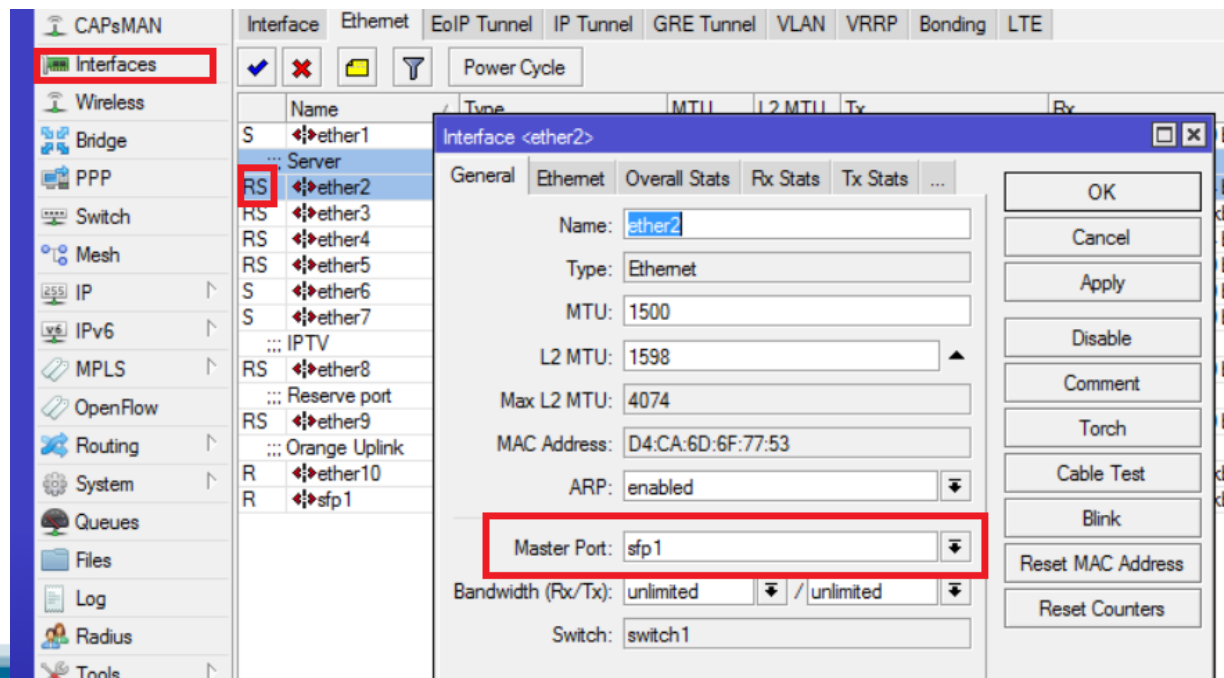
The screenshot shows the Mikrotik WinBox interface for configuring bridges. On the left sidebar, the 'Bridge' menu item is highlighted with a red box. The main window displays the 'Bridge' configuration page, with the 'Bridge' and 'Ports' tabs highlighted in red. Below the tabs is a table listing existing bridges.

	Name	Type
R	bridge(MTC_TV)	Bridge
R	bridge-apelnet	Bridge
R	bridge-integro	Bridge
R	bridge1	Bridge
R	bridge2	Bridge
R	bridge3-test	Bridge
X	bridge_air	Bridge
X	bridge_imbx	Bridge
R	bridge_romstal	Bridge
R	bridge_tv-TEST	Bridge
R	bridge_vlan33	Bridge
R	bridge_vlan45	Bridge

# L2-коммутация в Mikrotik

- Hardware bridging

- Реализуется в «железе» – с помощью спец. микросхемы – switch-chip (asic)
- Работает только на однотипных интерфейсах – Ethernet, 100Mbps, 1Gbps
- CPU не задействуется => работает быстро, wire speed
- Ограниченный функционал
- Master, slave - интерфейсы



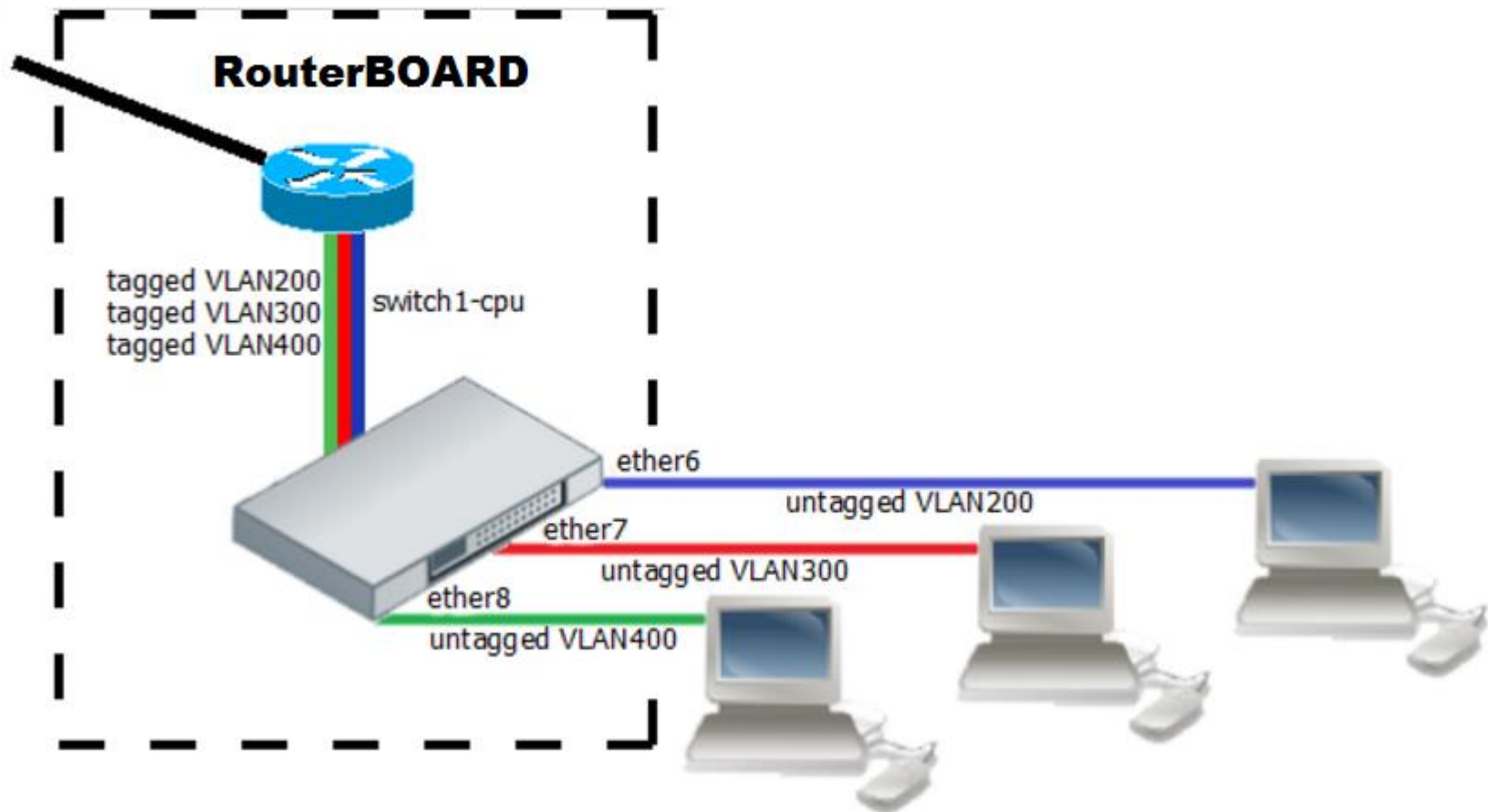


# Типы switch-chip в RouterBOARD

Feature	QCA8337	Atheros8327	Atheros8316
Port Switching	yes	yes	yes
Port Mirroring	yes	yes	yes
Host table	2048 entries	2048 entries	2048 entries
Vlan table	4096 entries	4096 entries	4096 entries
Rule table	92 rules	92 rules	32 rules

Feature	Atheros8227	Atheros7240	ICPlus175D	Other
Port Switching	yes	yes	yes	yes
Port Mirroring	yes	yes	yes	no
Host table	1024 entries	2048 entries	no	no
Vlan table	4096 entries	16 entries	no	no
Rule table	no	no	no	no

# Принцип работы switch-chip



# Модели RB с switch-chip

- RB4xx, RB7xx, RB9xx
- RB2011, RB3011
- RB850Gx2
- RB1100, RB1200
- CCR1009



- В CCR1016/1036/1072 – нет!!!

- Подробности - [http://wiki.mikrotik.com/wiki/Manual:Switch\\_Chip\\_Features](http://wiki.mikrotik.com/wiki/Manual:Switch_Chip_Features)



# Настройка switch-chip

- Выберите master-интерфейс
- Привяжите к нему slave-интерфейсы

The screenshot displays the Mikrotik WinBox interface for configuring a switch-chip. On the left, the 'Interfaces' menu is highlighted with a red box. The main window shows a list of interfaces, with 'ether5' selected and highlighted in blue. A red box highlights the 'ether5' entry in the list. The configuration window for 'Interface <ether5>' is open, showing the 'General' tab. The 'Name' field is set to 'ether5'. The 'Type' is 'Ethernet'. The 'MTU' is 1500, and the 'L2 MTU' is 1598. The 'Max L2 MTU' is 4074. The 'MAC Address' is D4:CA:6D:6F:77:56. The 'ARP' is enabled. The 'Master Port' is set to 'sfp1', which is highlighted with a red box. The 'Bandwidth (Rx/Tx)' is unlimited. The 'Switch' is set to 'switch1'. The 'OK' button is visible on the right side of the configuration window.

# Настройка switch-chip

- На одном RB можно быть несколько чипов – RB2011, RB3011, RB1100

The screenshot displays the Mikrotik WinBox interface. On the left sidebar, the 'Switch' menu item is highlighted with a red rectangle. The main window shows a table of switch configurations:

Name	Type	Mirror Source	Mirror Target
switch1	Atheros 8327		
switch2	Atheros 8227		

A configuration dialog for 'switch1' is open, showing the following fields:

- Name: switch1
- Type: Atheros 8327
- Mirror Source: (empty dropdown)
- Mirror Target: (empty dropdown)
- Switch All Ports

Buttons for OK, Cancel, and Apply are visible in the dialog. The status bar at the bottom indicates '2 items (1 selected)'.

# Настройка switch-chip

- Настройка портов (VLAN mode, VLAN header, PVID)
- Switch CPU port – для чего?

The screenshot displays a network management interface with a table of switch ports and a configuration dialog for a specific port.

Name	Switch	VLAN Mode	VLAN Header	
ether10	switch2	disabled	leave as is	
ether6	switch2	disabled	leave as is	
ether7	switch2	disabled	leave as is	
ether8	switch2	disabled	leave as is	
ether9	switch2	disabled	leave as is	
switch2 cpu	switch2	disabled	leave as is	
ether1	switch1	fallback	leave as is	30
ether2	switch1	secure	add if missing	
ether3	switch1	fallback	leave as is	20
ether4	switch1	fallback	leave as is	20
ether5	switch1	fallback	leave as is	30
sfp1	switch1	secure	add if missing	
switch1 cpu	switch1	secure	add if missing	

13 items (1 selected)

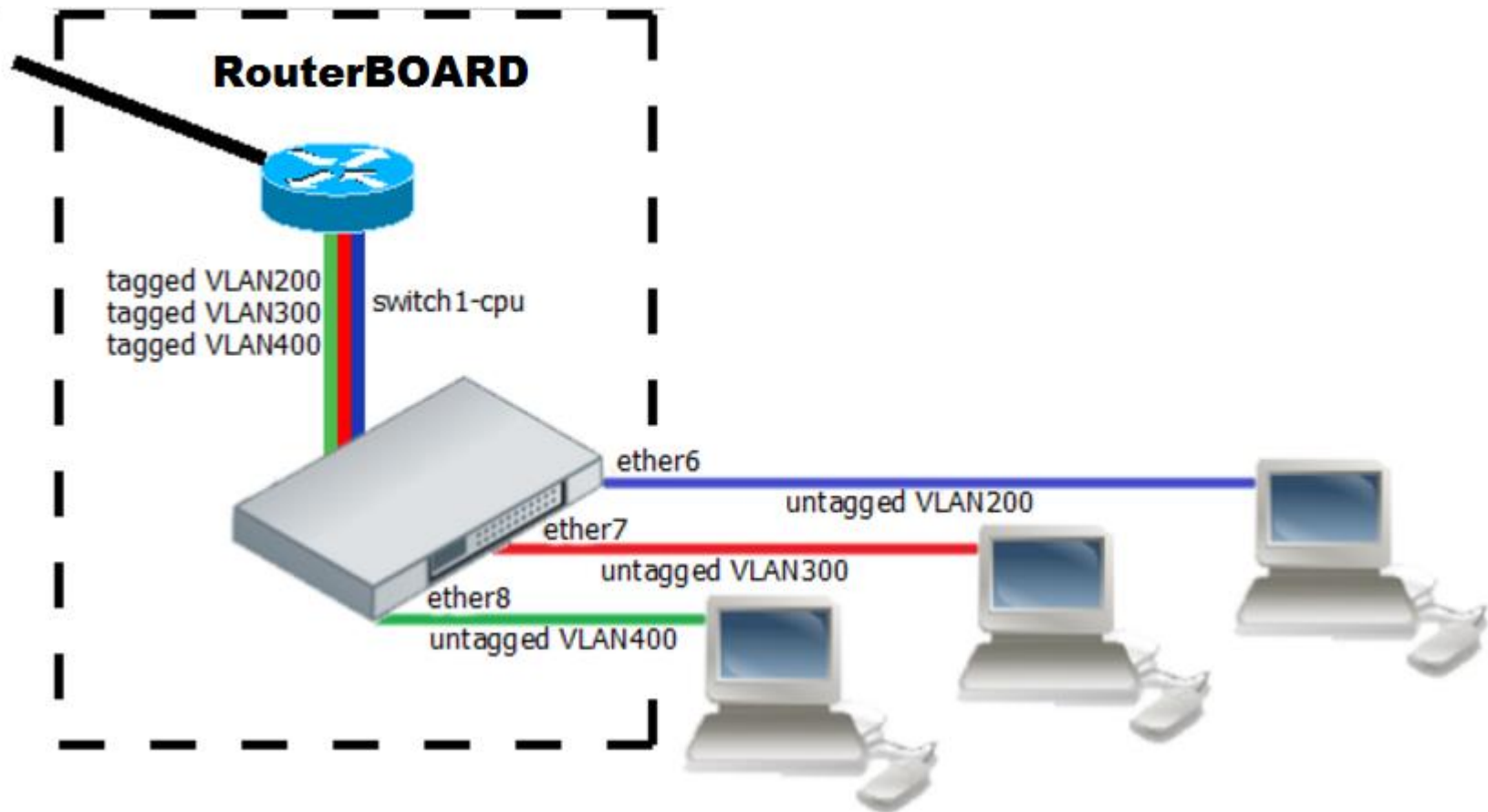
**Switch Port <ether2>**

Name: ether2  
Switch: switch1  
VLAN Mode: secure  
VLAN Header: add if missing  
Default VLAN ID: [ ]

Buttons: OK, Cancel, Apply



# Принцип работы switch-chip



# Настройка switch-chip

- Создание VLAN и привязка к портам

The screenshot shows a network management interface with a 'Switch' window. The 'VLAN' tab is active, displaying a table of VLAN configurations. A dialog box titled 'Switch VLAN <20>' is open, showing the configuration for a new VLAN.

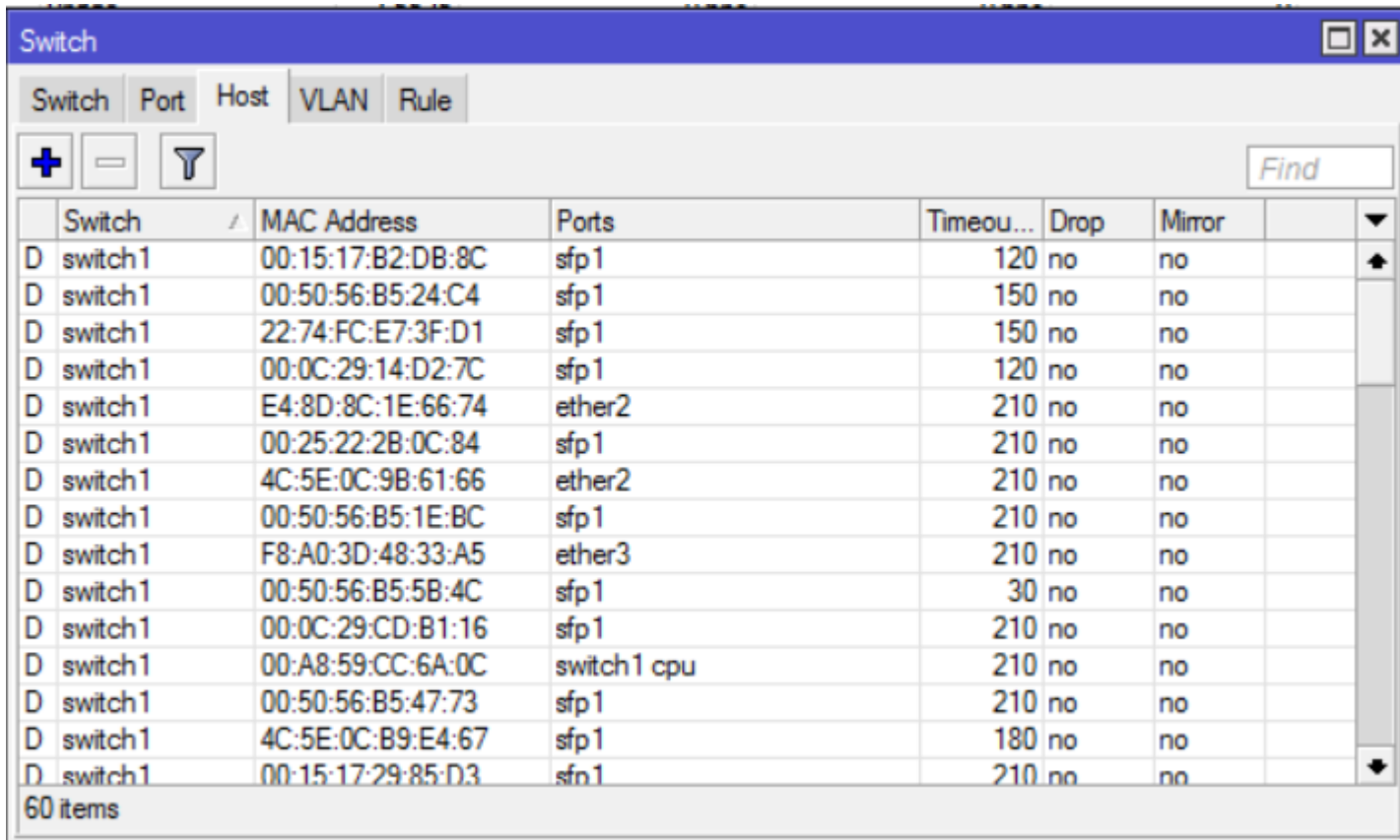
Switch	VLAN ID	Ports
switch1	20	ether2, ether4, ether3, sfp1, switch1 cpu
switch1	33	ether2, sfp1
switch1	40	ether2, sfp1
switch1	45	ether2, sfp1
switch1	30	ether2, sfp1, ether1, ether5

Switch: switch 1  
VLAN ID: 20  
Ports: ether2, ether4, ether3, sfp1, switch1 cpu  
 Independent Learning  
enabled



# Настройка switch-chip

- MAC-таблица (не путать с ARP-таблицей) – заполняется динамически
- Можно добавлять статические записи



The screenshot shows a window titled "Switch" with a tabbed interface. The "VLAN" tab is selected. Below the tabs are three icons: a plus sign, a minus sign, and a funnel (filter). To the right is a "Find" search box. The main area contains a table with the following columns: Switch, MAC Address, Ports, Timeou..., Drop, and Mirror. The table lists 15 entries for "switch1" with various MAC addresses and port names. At the bottom left of the table area, it says "60 items".

Switch	MAC Address	Ports	Timeou...	Drop	Mirror
D switch1	00:15:17:B2:DB:8C	sfp1	120	no	no
D switch1	00:50:56:B5:24:C4	sfp1	150	no	no
D switch1	22:74:FC:E7:3F:D1	sfp1	150	no	no
D switch1	00:0C:29:14:D2:7C	sfp1	120	no	no
D switch1	E4:8D:8C:1E:66:74	ether2	210	no	no
D switch1	00:25:22:2B:0C:84	sfp1	210	no	no
D switch1	4C:5E:0C:9B:61:66	ether2	210	no	no
D switch1	00:50:56:B5:1E:BC	sfp1	210	no	no
D switch1	F8:A0:3D:48:33:A5	ether3	210	no	no
D switch1	00:50:56:B5:5B:4C	sfp1	30	no	no
D switch1	00:0C:29:CD:B1:16	sfp1	210	no	no
D switch1	00:A8:59:CC:6A:0C	switch1 cpu	210	no	no
D switch1	00:50:56:B5:47:73	sfp1	210	no	no
D switch1	4C:5E:0C:B9:E4:67	sfp1	180	no	no
D switch1	00:15:17:29:85:D3	sfp1	210	no	no

# Настройка switch-chip

- L2/L3/L4 - фильтрация
- Нет функции DROP (есть в других чипах)

Switch

Switch Port Host VLAN Rule

New Switch Rule

Match Action

Switch: switch1

Ports:

Src. MAC Address:

Dst. MAC Address:

MAC Protocol:

VLAN

IP

IP 6

OK

Cancel

Apply

Disable

Copy

Remove

Switch

Switch Port Host VLAN Rule

New Switch Rule

Match Action

Copy To CPU

Redirect To CPU

Mirror

Set New Dst. Ports

New Dst. Ports:

New VLAN ID:

New VLAN Priority:

OK

Cancel

Apply

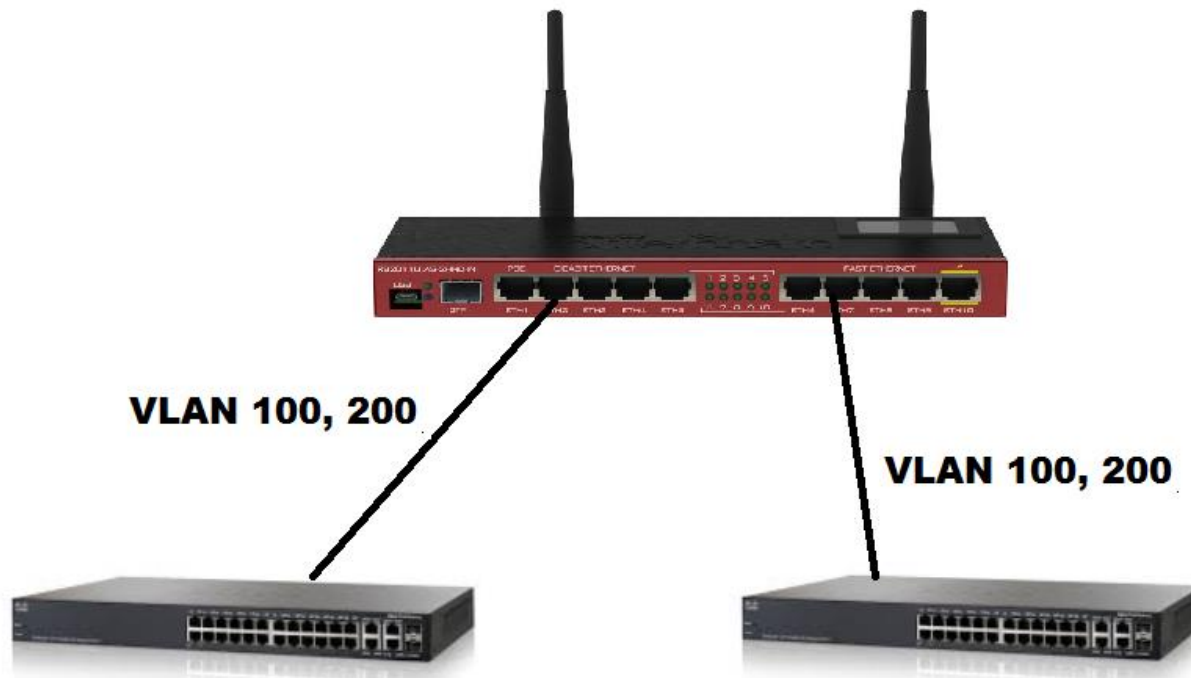
Disable

Copy

Remove

# Применение switch-chip

- Коммутация wire speed с поддержкой VLAN - быстрее, чем на software bridge (как реализуется?)
- Найдите ошибку в схеме



# Производительность switch-chip

Uptime: 1d 05:02:51 CPU: 8%  Hide Pa

## Interface List

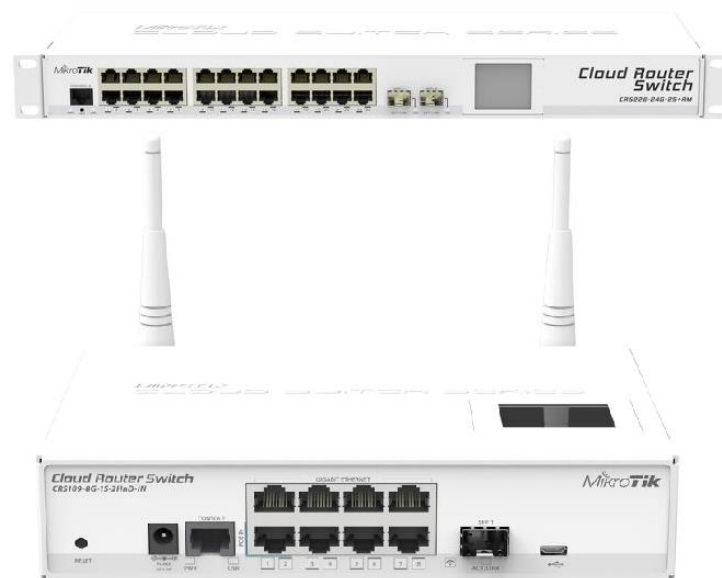
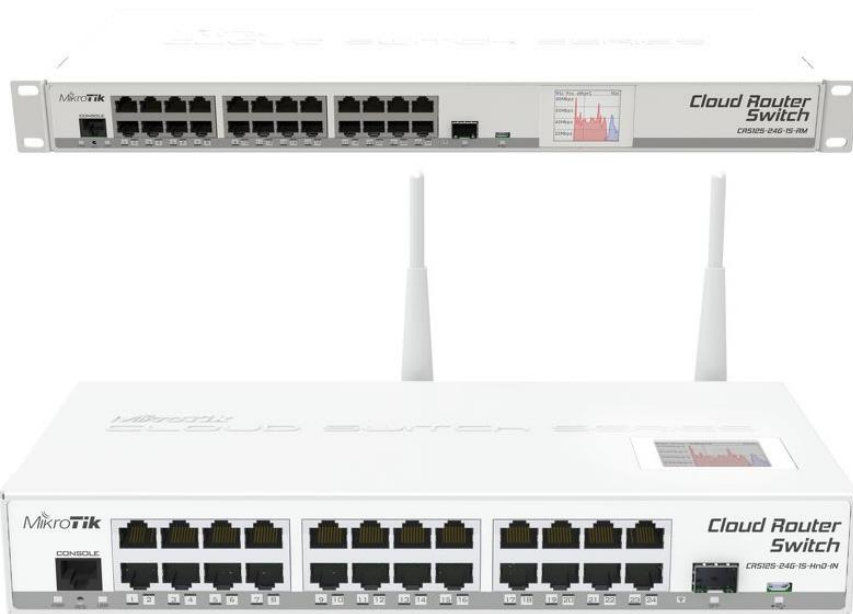
Interface Ethernet EoIP Tunnel IP Tunnel GRE Tunnel VLAN VRRP Bonding LTE



	Name	Type	L2 MTU	Tx	Rx	Tx Packet (p/s)	Rx Packet (p/s)
R	bridge-local	Bridge	1598	0 bps	0 bps	0	0
R	ether1	Ethernet	1598	960.3 Mbps	961.3 Mbps	82 333	82 418
RS	ether2	Ethernet	1598	960.4 Mbps	960.6 Mbps	82 346	82 360
RS	ether3	Ethernet	1598	958.2 Mbps	958.2 Mbps	82 383	82 378
RS	ether4	Ethernet	1598	958.1 Mbps	957.6 Mbps	82 371	82 330
R	ether5	Ethernet	1598	0 bps	0 bps	0	0
RS	ether6	Ethernet	1598	0 bps	0 bps	0	0
RS	ether7	Ethernet	1598	0 bps	0 bps	0	0
RS	ether8	Ethernet	1598	0 bps	0 bps	0	0
S	ether9	Ethernet	1598	0 bps	0 bps	0	0
S	ether10	Ethernet	1598	0 bps	0 bps	0	0
S	sfp1	Ethernet	1598	0 bps	0 bps	0	0
R	wlan1	Wireless (Atheros AR...	2290	109.5 kbps	7.9 kbps	11	13

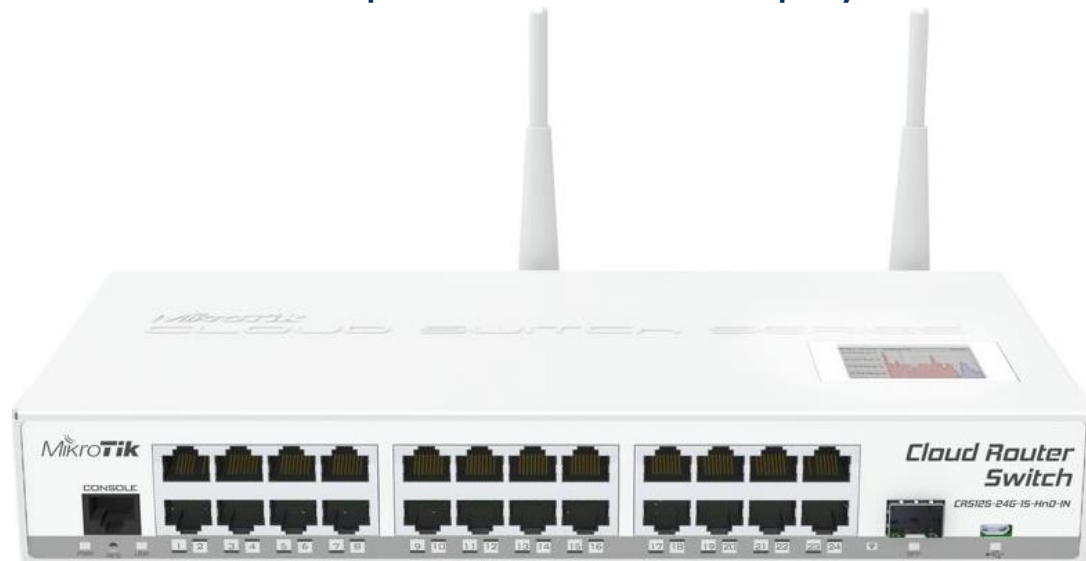
# Cloud Router Switch - CRS

- Новая линейка коммутаторов
- Многопортовый маршрутизатор с продвинутыми функциями L2-коммутатора
- Называть его L3-коммутатором неправильно, так как он не имеет hardware L3 (fast path?).



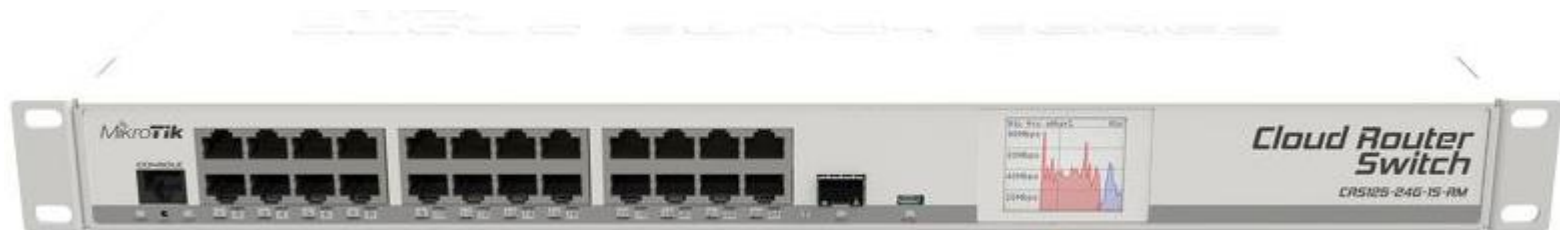
# Cloud Router Switch - CRS

- Каждый порт может работать в режиме коммутатора (switched) или маршрутизатора (routed)
- Полноценный RouterOS
- CPU – 600MHz, RAM – 128Mb => мало для wiwrespeed routing
- USB, SFP/SFP+
- Power consumption – 15W
- Router + switch + access point в одном корпусе



# Cloud Router Switch - CRS

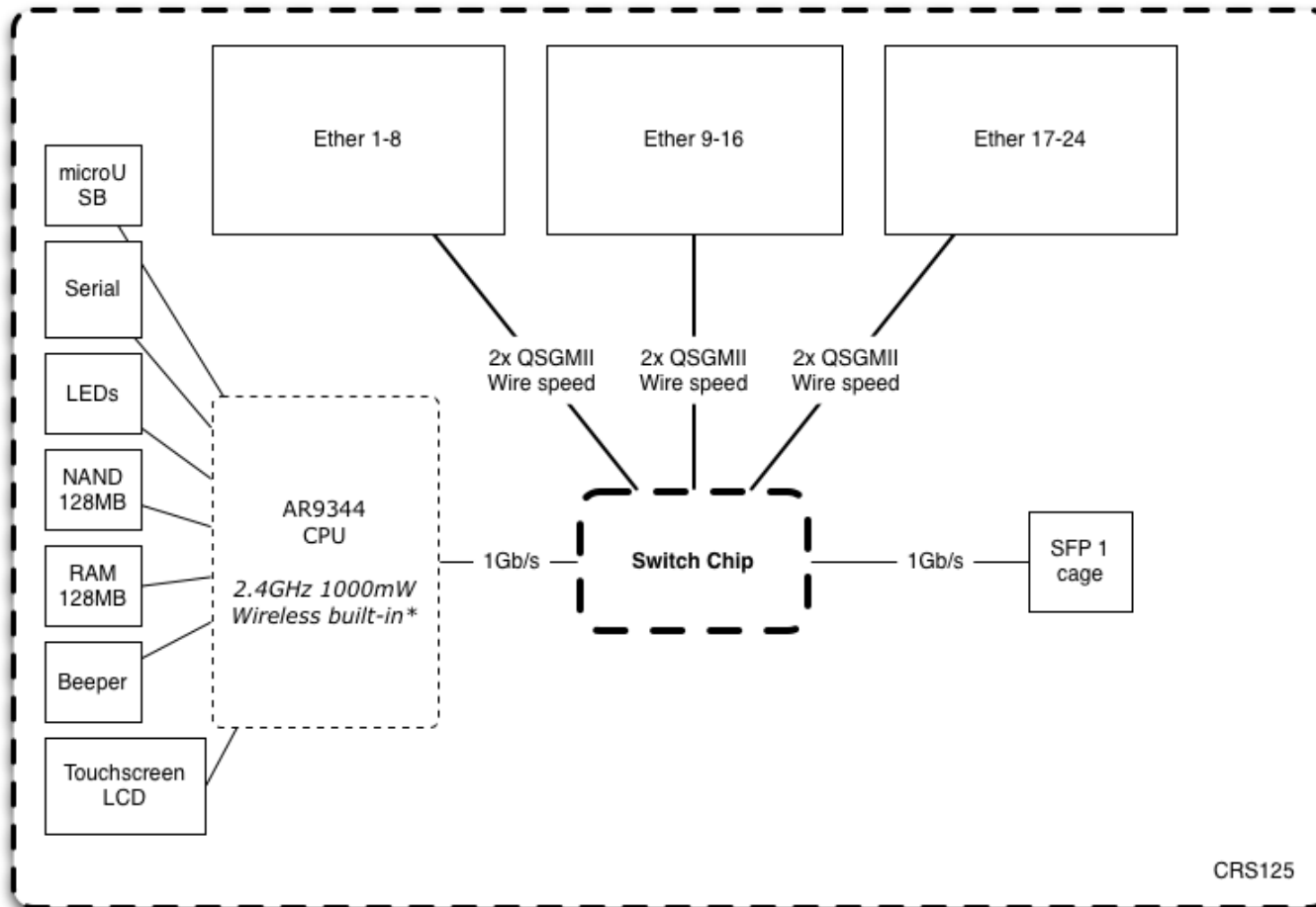
- 1Gbps ports, SFP/SFP+
- 16k MAC address table
- 4k active VLANs (!!!!!)
- Q-in-Q
- Port isolation
- Mirroring
- ACL (L2, L3)
- QoS (DSCP, VLAN, MAC, etc)
- Trunking on hardware level (static bonding)
- Shaping/scheduling
- Jumbo frames





# Cloud Router Switch - CRS

- Принципиальная схема CRS





# Настройка CRS

- Для включения коммутатора нужно выбрать master/slave-интерфейсы
- Можно создавать несколько switch-групп

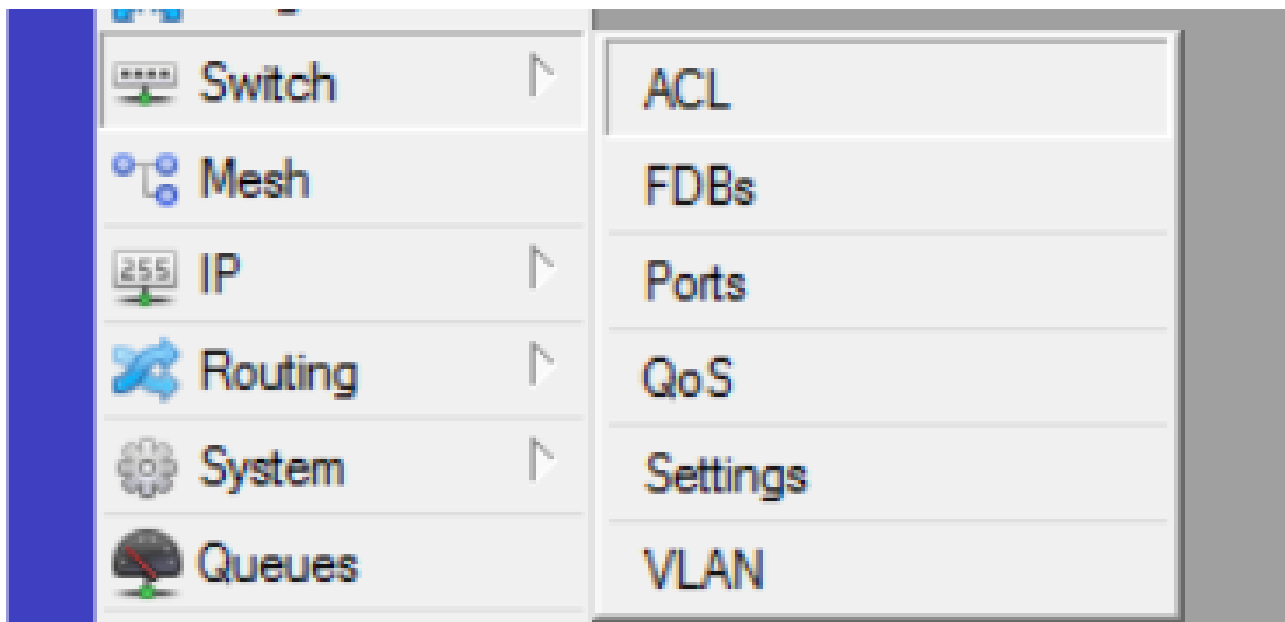
Interface List

Interface Ethernet EoIP Tunnel IP Tunnel GRE Tunnel VLAN VRRP Bonding LTE

	Name	Type	L2 MTU	Tx	Rx	Tx Packet (p/s)	Rx Packet (p/s)
R	ether1-master-local	Ethernet	1588	298.4 kbps	29.9 kbps	29	38
R	vlan20	VLAN	1584	295.8 kbps	13.1 kbps	28	22
S	ether2-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether3-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether4-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether5-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether6-slave-local	Ethernet	1588	0 bps	0 bps	0	0
RS	ether7-slave-local	Ethernet	1588	9.3 kbps	704 bps	13	1
S	ether8-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether9-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether10-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether11-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether12-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether13-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether14-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether15-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether16-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether17-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether18-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether19-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether20-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether21-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether22-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	ether23-slave-local	Ethernet	1588	0 bps	0 bps	0	0
... routed							
	ether24-slave-local	Ethernet	1588	0 bps	0 bps	0	0
S	sfp1-slave-local	Ethernet	1588	0 bps	0 bps	0	0

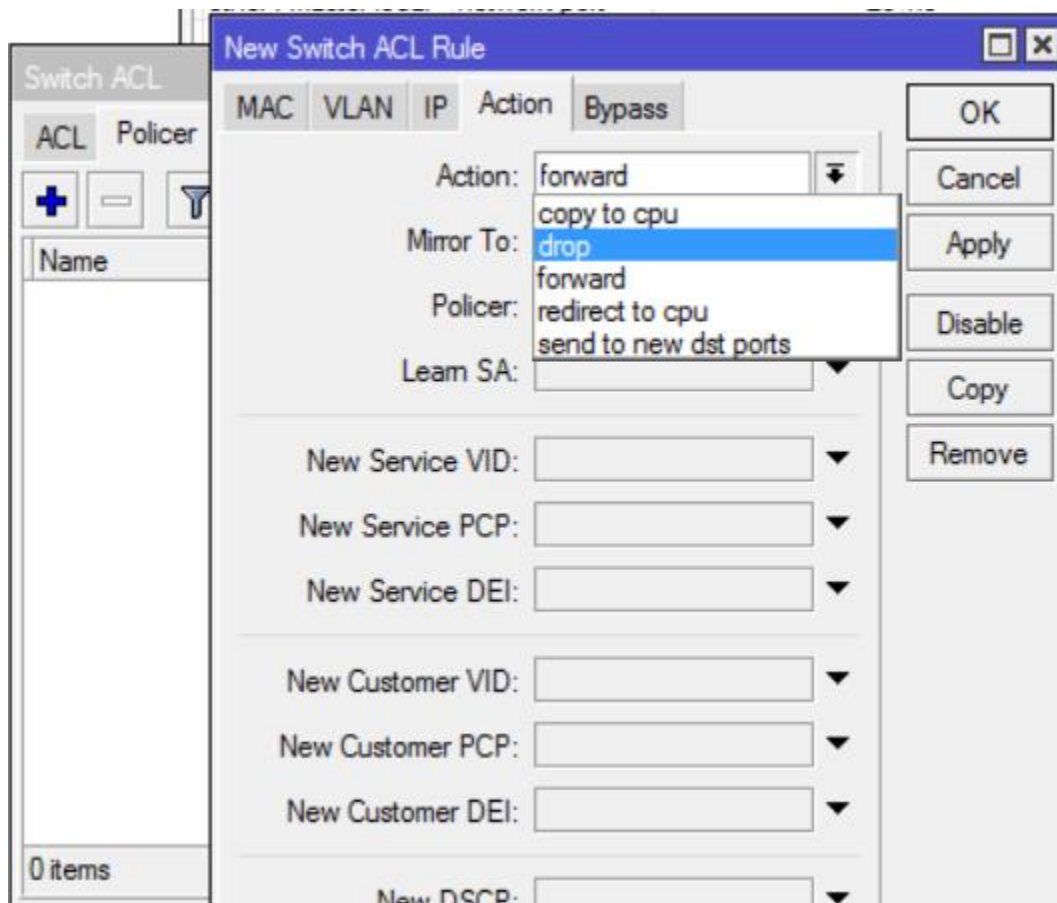
# Настройка CRS

- Меню switch – ACL, FDB, Ports, QoS, Settings, VLAN



# Настройка CRS

- Access Control Lists – MAC,IP, VLAN-based



# Настройка CRS

- Forwarding Data Base – FDB
- Unicast/Multicast/Reserved
- MAC-таблица
- Можно добавлять статические записи – forward, drop, etc

Switch FDBs

Unicast FDB Multicast FDB Reserved FDB

+ - ✓ ✗ T

	MAC Address	Port
D	00:0C:29:14:D2:7C	ether1-master-local
D	00:0C:29:2E:7C:2E	ether1-master-local
D	00:0C:29:58:B0:66	ether1-master-local
D	00:0C:29:CD:B1:16	ether1-master-local
D	00:0C:29:DE:C1:FA	ether1-master-local
D	00:0C:29:F8:0D:25	ether1-master-local
D	00:0C:42:73:A9:79	ether1-master-local
D	00:0C:42:9D:24:38	ether1-master-local
D	00:0C:42:FC:84:E9	ether1-master-local
D	00:15:17:29:85:D3	ether1-master-local
D	00:15:17:B2:DB:8C	ether1-master-local
D	00:1A:79:04:58:30	ether1-master-local
D	00:1B:77:CC:CB:B2	ether1-master-local
D	00:1C:27:07:03:8F	ether1-master-local
D	00:1C:27:07:03:9F	ether1-master-local

72 items

New Switch FDB Entry

MAC Address: 00:00:00:00:00:00

Port: ether1-master-local

VLAN ID: 0

Action: forward

Isolation Profile: ingress port policing bypass

QoS Group: src. and dst. redirect to cpu

Age: 0

enabled

OK Cancel Apply Disable Copy Remove

VL	Age
o	2
o	1
o	1
o	2
o	1
o	2
o	2
o	2
o	2
o	2
o	2
o	1
o	1
o	2
o	2

# Настройка CRS

- Port, trunk, port isolation, port leakage

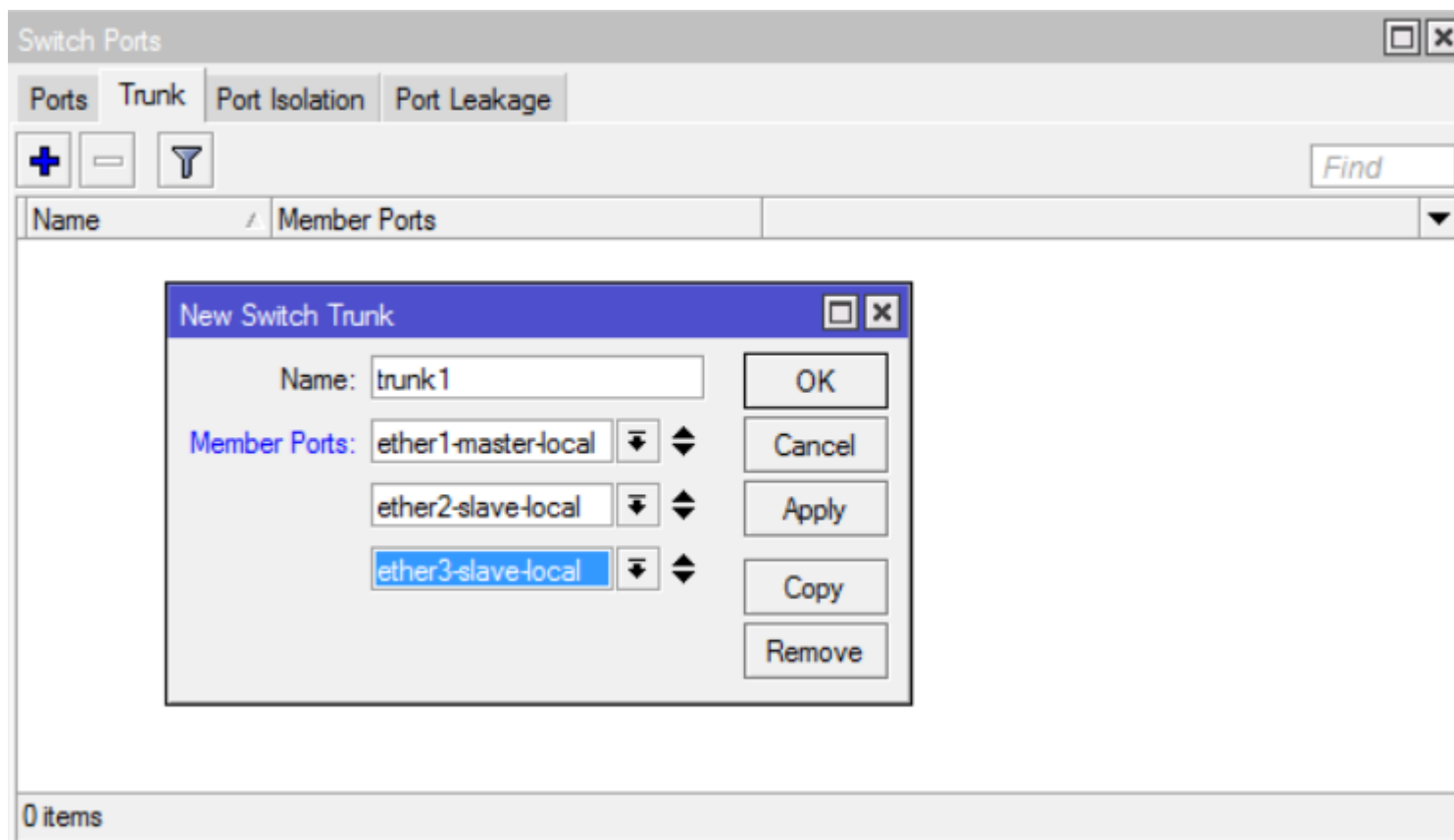
The screenshot displays the 'Switch Ports' configuration window. On the left, a list of ports is shown, with 'ether6-slave-local' selected. The main configuration area is titled 'Switch Port <ether6-slave-local>' and contains several tabs: 'Generic', 'Ingress VLAN', 'Egress VLAN', 'Mirroring', 'QoS', 'Queues', 'TPIDs', and 'Counters'. The 'Generic' tab is active, showing the following settings:

- Name: ether6-slave-local
- VLAN Type: network port
- Isolation Profile: 29
- Isolation Profile Override: (empty)
- Leaming
- Leaming Override: (empty)
- Leaming Limit: (empty)
- Allow Unicast FDB Drop
- Allow Unicast Loopback
- Allow Multicast Loopback
- Action On Static Station Move: forward
- Drop Secure Static MAC Move
- Drop Dynamic MAC Move

Buttons for 'OK', 'Cancel', and 'Apply' are located on the right side of the configuration window.

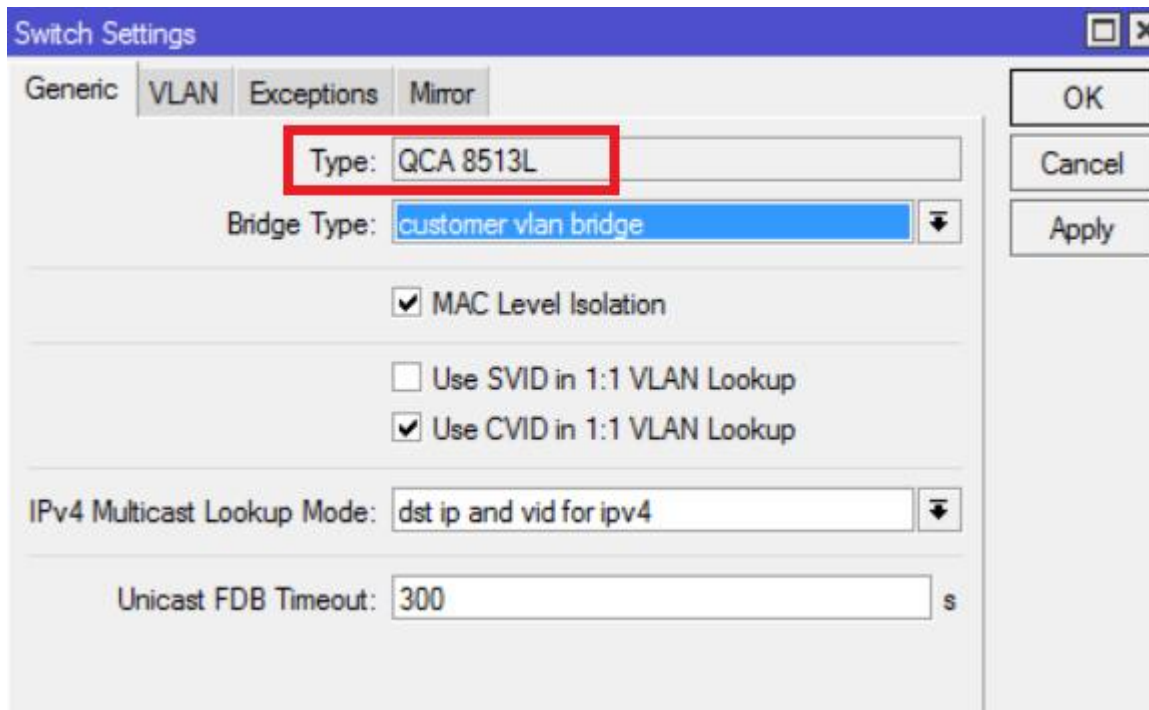
# Настройка CRS

- Настройка static trunk (bonding), LACP пока не поддерживается
- Реализуется в hardware, в отличие от /interface bonding в ROS



# Настройка CRS

- Глобальные настройки свитча
- Модель чипа – QCA 8513L



Switch Settings

Generic | VLAN | Exceptions | Mirror

Type: QCA 8513L

Bridge Type: customer vlan bridge

MAC Level Isolation

Use SVID in 1:1 VLAN Lookup

Use CVID in 1:1 VLAN Lookup

IPv4 Multicast Lookup Mode: dst ip and vid for ipv4

Unicast FDB Timeout: 300 s

OK  
Cancel  
Apply



# Настройка CRS

- Создание и привязка VLAN к портам

Switch VLAN

VLAN | VLAN Tagging | In. VLAN Tran. | Eg. VLAN Tran. | 1:1 VLAN Switching | MAC Based VLAN | Protocol Based VLAN

+ - ✓ ✗ ⏏

VLAN ID	Ports
20	ether1-master-local, ether2-slave-local, ether3-slave-local, eth...
30	ether1-master-local, ether6-slave-local, ether16-slave-local, et...
33	ether1-master-local, ether19-slave-local
40	ether1-master-local, ether22-slave-local, ether23-slave-local
45	ether1-master-local, ether20-slave-local, ether21-slave-local
D 4091	ether21-slave-local, ether22-slave-local, ether23-slave-local, ...
D 4095	ether24-slave-local, switch 1-cpu

Switch VLAN <33>

VLAN ID: 33

Ports: ether1-master-local  
ether19-slave-local

SVL  
 SA Learning  
 Flood  
 Ingress Mirror

QoS Group: none

OK  
Cancel  
Apply  
Disable  
Copy  
Remove



# Настройка CRS

- Настройка tagged VLAN

Switch VLAN

VLAN | VLAN Tagging | In. VLAN Tran. | Eg. VLAN Tran. | 1:1 VLAN Switching | MAC Based VLAN | Protocol Based VLAN

+ - ✓ ✗ ⏏

	VLAN ID /	Tagged Ports
	20	ether1-master-local, s...
	30	ether1-master-local
	33	ether1-master-local
	40	ether1-master-local
	45	ether1-master-local, et...
D	4091	
D	4095	

Switch Egress Tag VLAN <20>

VLAN ID:

Tagged Ports:  ⏏ ⏑

⏏ ⏑

OK

Cancel

Apply

Disable

Copy

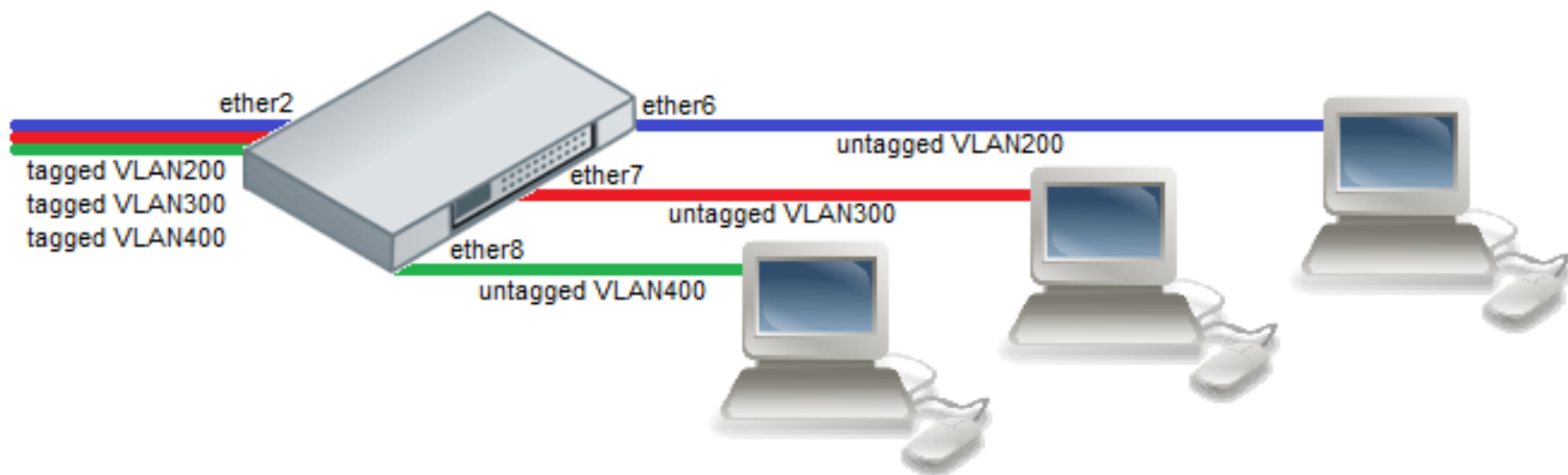
Remove

enabled



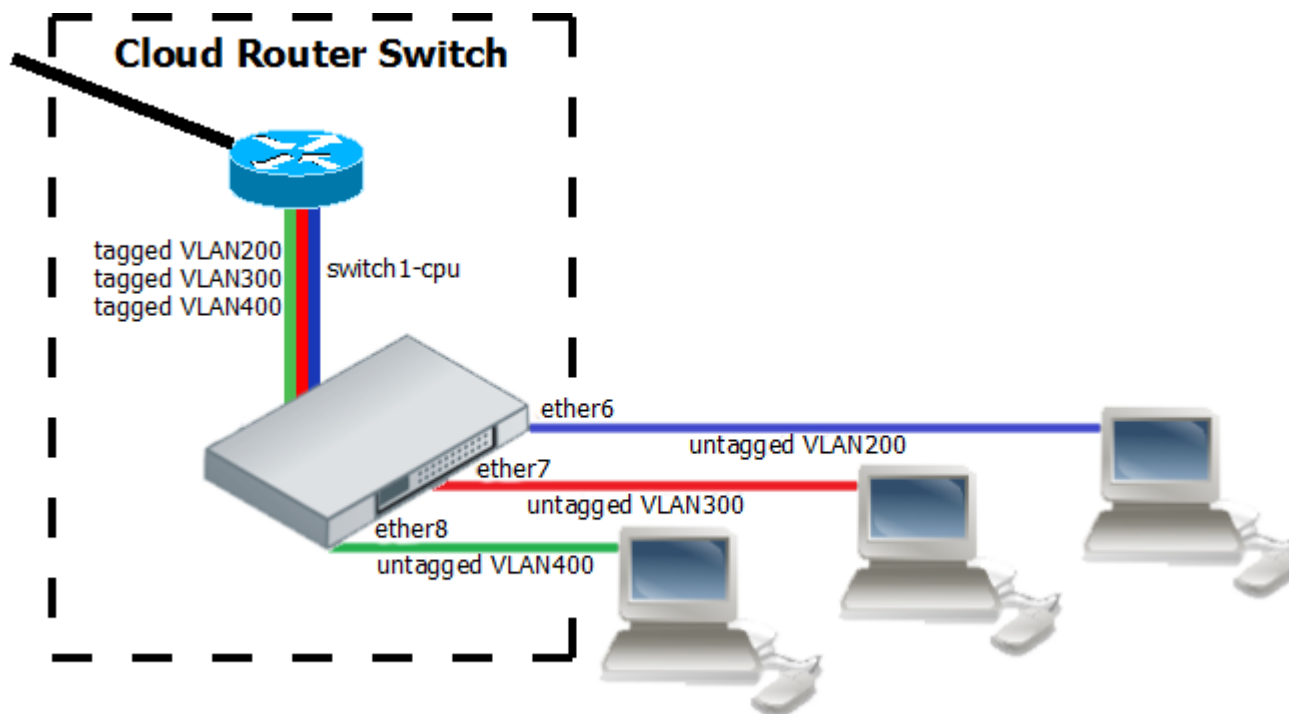
# Применение CRS

- Разделение сети на VLAN на уровне доступа (access layer)



# Применение CRS

- Inter VLAN routing на одном устройстве

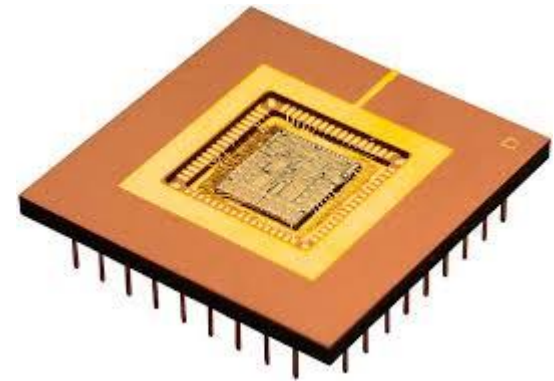


# Преимущества и недостатки

- Область применения CRS:
  - 3 устройства в одном (router, switch, AP) в небольших офисах
  - Гигабитный коммутатор уровня доступа или агрегации в небольших и средних организациях
- Крупные организации со сложной структурой и ISP – рано (нет 802.1X, RADIUS, RSTP)
- Плюсы:
  - соотношение цена/функциональность (~250\$)
  - удобство (3 в 1)
- Минусы:
  - Нет IGMP snooping (обещают в ROS 7)
  - Нет loopback detection
  - Нет PoE 48V для VoIP, камер
  - Нет RSTP в «железе»
  - Сложное меню настройки

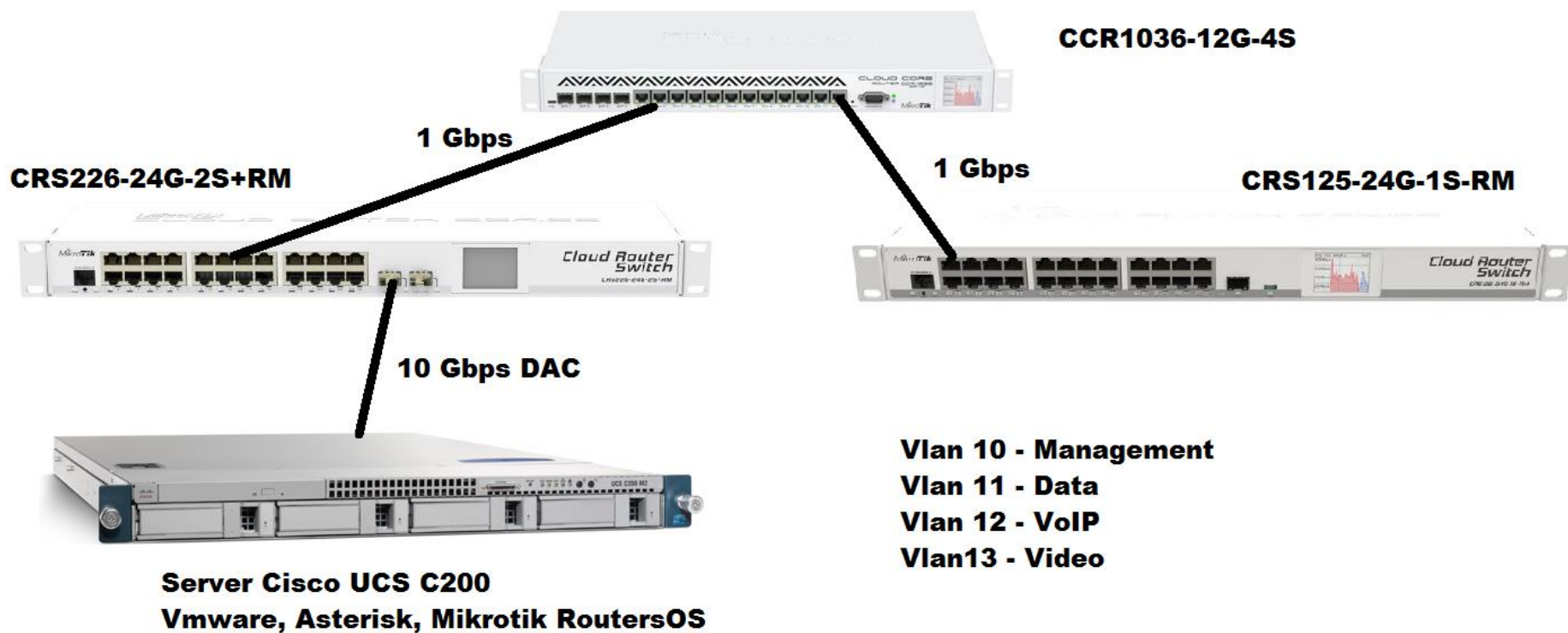
# Feature request

- STP (RSTP) in hardware
- IGMP snooping
- Loopback detection
- DHCP Option 82
- Удобное меню
- 48 портов
- Больше SFP
- L3-routing in hardware (at least static) !!!



Загадочный QCA8513L

# Демо-стенд IT-LAB



# Литература

- <http://routerboard.com/>
- [http://wiki.mikrotik.com/wiki/Manual:CRS examples](http://wiki.mikrotik.com/wiki/Manual:CRS_examples)
- [http://wiki.mikrotik.com/wiki/Manual:CRS features](http://wiki.mikrotik.com/wiki/Manual:CRS_features)
- [http://wiki.mikrotik.com/wiki/Manual:Switch Chip Features](http://wiki.mikrotik.com/wiki/Manual:Switch_Chip_Features)
- [http://wiki.mikrotik.com/wiki/Manual:Fast Path](http://wiki.mikrotik.com/wiki/Manual:Fast_Path)



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