it·lab
system integrator

MikroTik
TRAINING CENTER

# Обзор коммутаторов

# MIKROTIK

версия 2



# Обо мне

- Чобан Алексей Иванович
- Опыт работы в IT – 18 лет
- Опыт работы с Mikrotik – 17 лет
- Тренер Mikrotik с 2009 года
- Mikrotik MTCNA, MTCRE, MTCWE, MTCTCE, MTCUME, MTCIPv6E, MTCINE, MTCSE
- Сертифицированный инженер и тренер Ubiquiti
- Сертифицированный инженер Cisco, HPE Aruba
- Сертифицированный  инженер Asterisk
- Cisco, Juniper, VoIP, *nix, Windows

# IT-LAB – www.itlab.md

- Системный интегратор, 25 человек
- Год основания - 2007
- Сетевое оборудование – Mikrotik, Ubiquiti, Cisco, HPE Aruba, Juniper, оптические трансиверы SFP/SFP+
- High-density WiFi, customized Hotspot systems
- VoIP – Asterisk, колл-центры, софтсвитчи, биллинги, IP-телефоны, ATA/GSM/3G/TDM/TDMoIP-шлюзы, гарнитуры
- Сервера – HPE, Supermicro, Cisco
- Виртуализация – Vmware, Citrix Xen, KVM
- *nix, Windows – mail, www, high-load, AD, streaming, etc
- Решения для операторов связи (оборудование, billing, VoIP, IPTV)
- Монтаж сетей
- Программирование – CRM, BPM, ERP, комплексные проекты (PHP, Android)
- Безопасность – Fortinet, DLP, Firewall, Security scanners, Antiviruses
- Сертификация ISO 9001:2015, ISO 27001:2013

# IT-LAB – www.itlab.md

MikroTik MASTER DISTRIBUTOR

MikroTik TRAINING CENTER

Hewlett Packard Enterprise

aruba a Hewlett Packard Enterprise company

cisco

UBIQUITI NETWORKS

Juniper NETWORKS

SUPERMICRO

Asterisk

Fanvil

DINSTAR

Jabra GN

Microsoft

vmware

KVM

CITRIX XenServer

FORTINET

imperva

Bitdefender

eset

# Курсы Mikrotik

- Проводим курсы с 2009 года
- Два тренера, являющихся практикующими инженерами, которые «нюхают порох» каждый день
- Мы не просто знаем теорию, можем много рассказать из своего опыта
- Цель курсов – не «грести бабло», а дать хорошие базовые знания студентам и заслужить их лояльность. При возникновении проблем или решении сложных задач они обратятся к нам
- Вся гамма курсов Mikrotik: MTCNA, MTCRE, MTCWE, MTCTCE, MTCUME, MTCIPv6, MTCINE, MTCSE
- Дополнительные темы, теоретическая подготовка перед каждой темой
- Для достижения высокой эффективности обучения курсы длятся минимум **3-4 недели**, не отвлекая от работы
- Студенты успевают впитать новую информацию, попрактиковаться дома или на работе
- Цель – не высокий средний балл, а качественные знания и навыки

MikroTik TRAINING CENTER

# Курсы Mikrotik

- Веселая атмосфера, новые знакомства

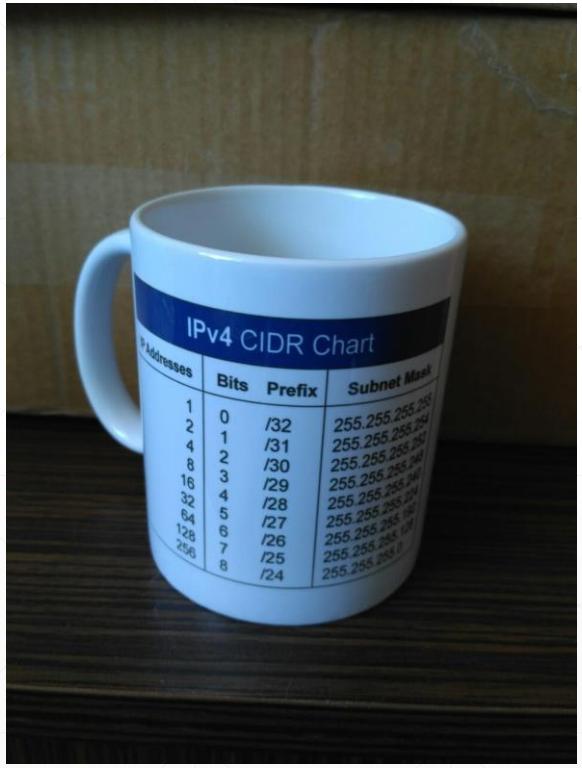


# Курсы Mikrotik

- Халява








# История коммутаторов Mikrotik



- RB250GS, ~2010, swOS, only 5 x 1Gbps ports, web-smart switch, Atheros chip, VLAN, ACL, etc.
- CRS125, ~2014, RouterOS, 24x1Gbps ports + 1x1Gbps SFP, full managed L2 switch + router + WiFi AP, QCA8513 chip, VLAN, ACL, etc



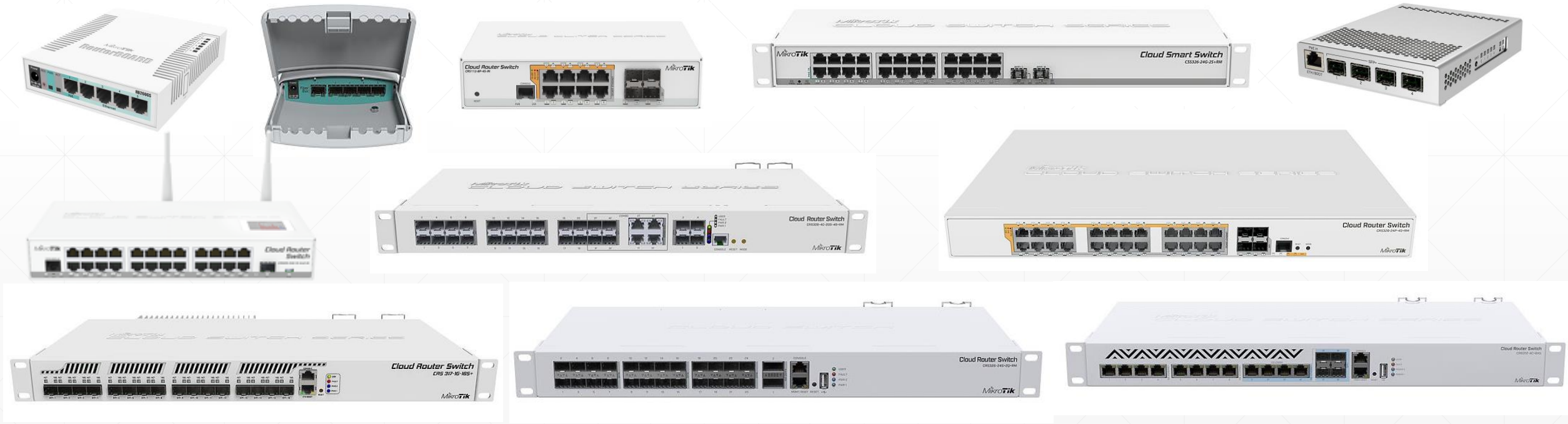

- CRS226, ~2015, RouterOS, 24x1Gbps ports + 2x10Gbps SFP+, full managed L2 switch + router, QCA8519 chip, VLAN, ACL, more features, etc




- http://mum.mikrotik.com/presentations/MD15/presentation_2985_1450257451.pdf

# Линейка коммутаторов Mikrotik сегодня

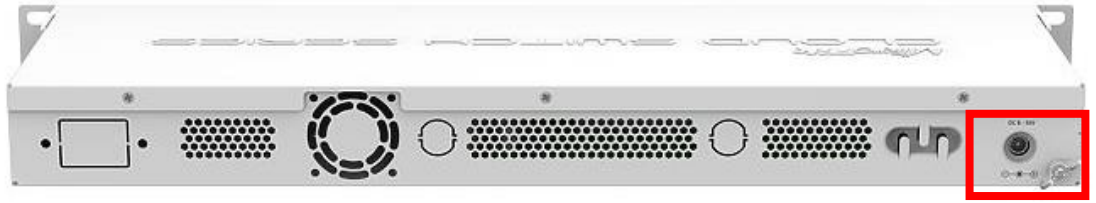
- https://mikrotik.com/products/group/switches
- 19 моделей
- Серии CSS1xx(RB260), CSS3xx, CRS1xx, CRS2xx, CRS3xx
- Indoor/outdoor, desktop/rack-mount, non-PoE/PoE(24/48V), passive/active cooling, copper/fiber, web-smart/full-managed + router, single/dual PSU, 1/10/40Gbps SFP/SFP+/QSFP+ uplinks, RS-232/USB/OOBM



# Mikrotik CSS326-24G-2S+RM

- ~ 2017
- 24 порта 10/100/1000Mbps RJ-45, 2 порта 1/10Gbps SFP+
- swOS, web smart switch, WEB mgmt only
- Passive cooling, -20°C to 70°C!!!
- External power supply ☹
- PoE in, max 19W
- Chipset Marvell 98DX3216A1
- IGMP snooping, LACP trunks, DHCP snooping & option 82, VLANs, RSTP, ACLs, etc
- ~ 170 USD !!!





# Mikrotik CSS326-24G-2S+RM

| | |
|---|---|
| Product code | CSS326-24G-2S+RM |
| Switch chip model | 98DX3216A1 |
| Storage type | Flash |
| Storage size | 2 MB |
| 10/100/1000 Ethernet ports | 24 |
| SFP+ cages | 2 |
| Operating system | SwOS |
| Supported input voltage | 10 - 30 V (jack or passive PoE) |
| Dimensions | 440 x 144 x 44 mm |
| Operating temperature | -40°C .. +70°C tested |
| Max power consumption | 19 W |

- Non-blocking Layer 2 switching capacity
- 16K host table
- IEEE 802.1Q VLAN
- Supports up to 4K VLANs
- Port isolation
- Port security
- Broadcast storm control
- Port mirroring of ingress/egress traffic
- Rapid Spanning Tree Protocol
- Access Control List
- MikroTik neighbor discovery
- SNMP v1
- Web-based GUI

# Mikrotik CSS326-24G-2S+RM

| CSS326-24G-2S+RM | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mode | Configuration | 1518 byte | | 512 byte | | 64 byte | |
| | | kpps | Mbps | kpps | Mbps | kpps | Mbps |
| Switching | Non blocking Layer 2 throughput | 3,576.1 | 43,427.8 | 10,338.3 | 42,345.9 | 65,476.2 | 33,523.8 |
| Switching | Non blocking Layer 2 capacity | 3,576.1 | 86,855.7 | 10,338.3 | 84,691.7 | 65,476.2 | 67,047.6 |
| Switching | Non blocking Layer 1 throughput | 3,576.1 | 44,000.0 | 10,338.3 | 44,000.0 | 65,476.2 | 44,000.0 |
| Switching | Non blocking Layer 1 capacity | 3,576.1 | 88,000.0 | 10,338.3 | 88,000.0 | 65,476.2 | 88,000.0 |

# Mikrotik CSS326-24G-2S+RM

MikroTik SwOS

Link | SFP | Port Isolation | LAG | Forwarding | RSTP | Stats | Errors | Hist | VLAN | VLANs | Hosts | IGMP | SNMP | ACL | System | Upgrade

| | Enabled | Name | Link Status | Auto Negotiation | Speed | Full Duplex | Flow Control |
|---|---|---|---|---|---|---|---|
| **Port1** | ☑ | Port1 | **link on** | ☑ | 1G | yes | ☑ |
| **Port2** | ☑ | Port2 | **link on** | ☑ | 100M | yes | ☑ |
| **Port3** | ☑ | Port3 | no link | ☑ | | no | ☑ |
| **Port4** | ☑ | Port4_newBill | **link on** | ☑ | 1G | yes | ☑ |
| **Port5** | ☑ | Port5_Mk160.2 | **link on** | ☑ | 1G | yes | ☑ |
| **Port6** | ☑ | Port6_Stalker | **link on** | ☑ | 1G | yes | ☑ |
| **Port7** | ☑ | Port7_vl810 | **link on** | ☑ | 1G | yes | ☑ |
| **Port8** | ☑ | Port8_vl810 | **link on** | ☑ | 1G | yes | ☑ |
| **Port9** | ☑ | Port9_vl810 | **link on** | ☑ | 1G | yes | ☑ |
| **Port10** | ☑ | Port10_Flussonic | no link | ☑ | | no | ☑ |
| **Port11** | ☑ | Port11_IPS-02 | no link | ☑ | | no | ☑ |
| **Port12** | ☑ | Port12_IPS-03 | no link | ☑ | | no | ☑ |
| **Port13** | ☑ | Port13_Astra13 | no link | ☑ | | no | ☑ |
| **Port14** | ☑ | Port14_Astra10 | no link | ☑ | | no | ☑ |
| **Port15** | ☑ | Port15_Astra3 | no link | ☑ | | no | ☑ |
| **Port16** | ☑ | Port16_vl810 | **link on** | ☑ | 1G | yes | ☑ |

# Mikrotik CSS326-24G-2S+RM

MikroTik SwOS

Link | SFP | Port Isolation | LAG | Forwarding | RSTP | Stats | Errors | Hist | **VLAN** | VLANs | Hosts | IGMP | SNMP | ACL | System | Upgrade

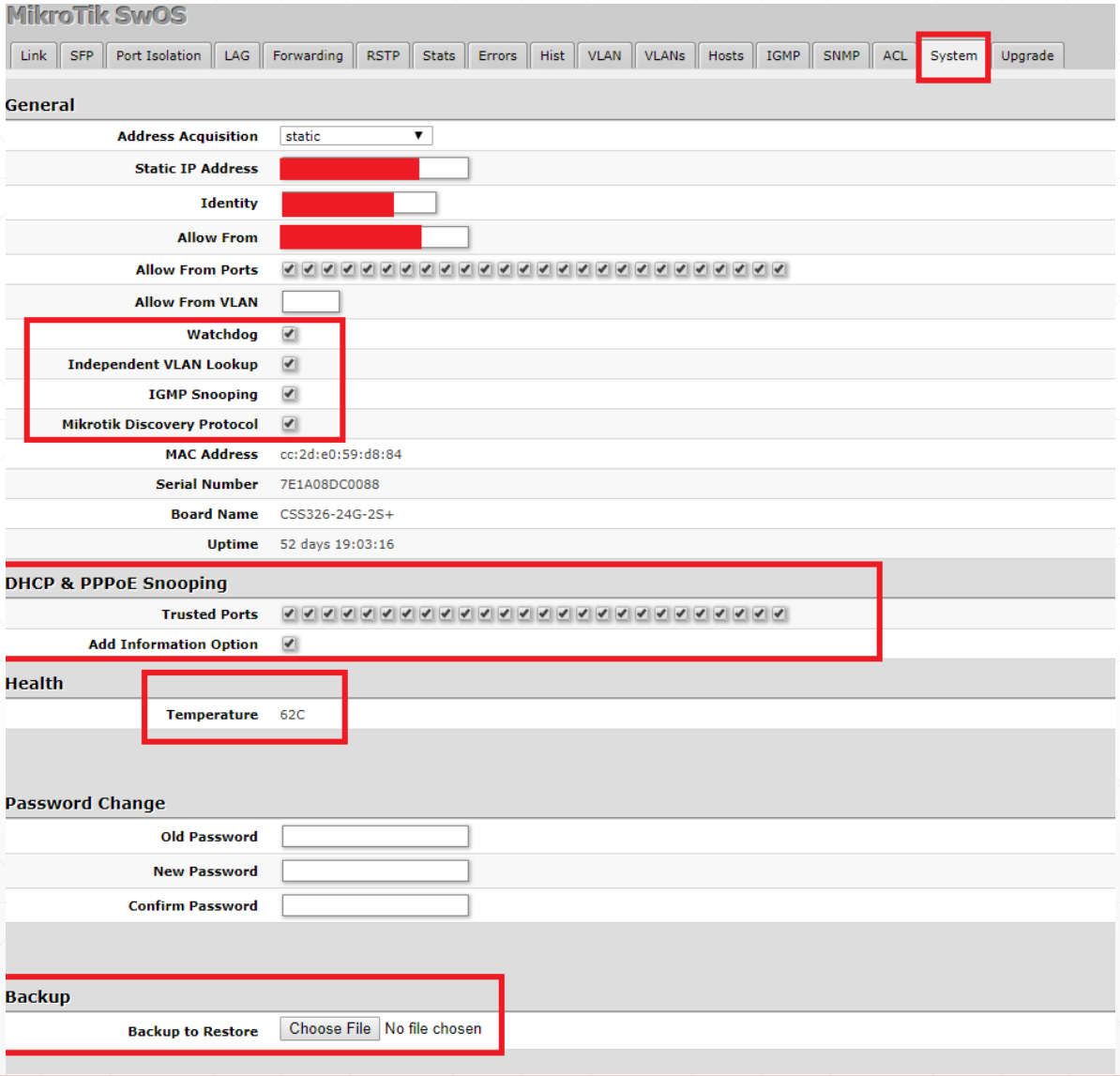
| | VLAN Mode | VLAN Receive | Default VLAN ID | Force VLAN ID |
|---|---|---|---|---|
| **Port1** | enabled | only untagged | 160 | ☐ |
| **Port2** | enabled | only untagged | 160 | ☐ |
| **Port3** | enabled | only untagged | 160 | ☐ |
| **Port4_newBill** | enabled | only untagged | 160 | ☐ |
| **Port5_Mk160.2** | enabled | only tagged | 1 | ☐ |

MikroTik SwOS — Logout

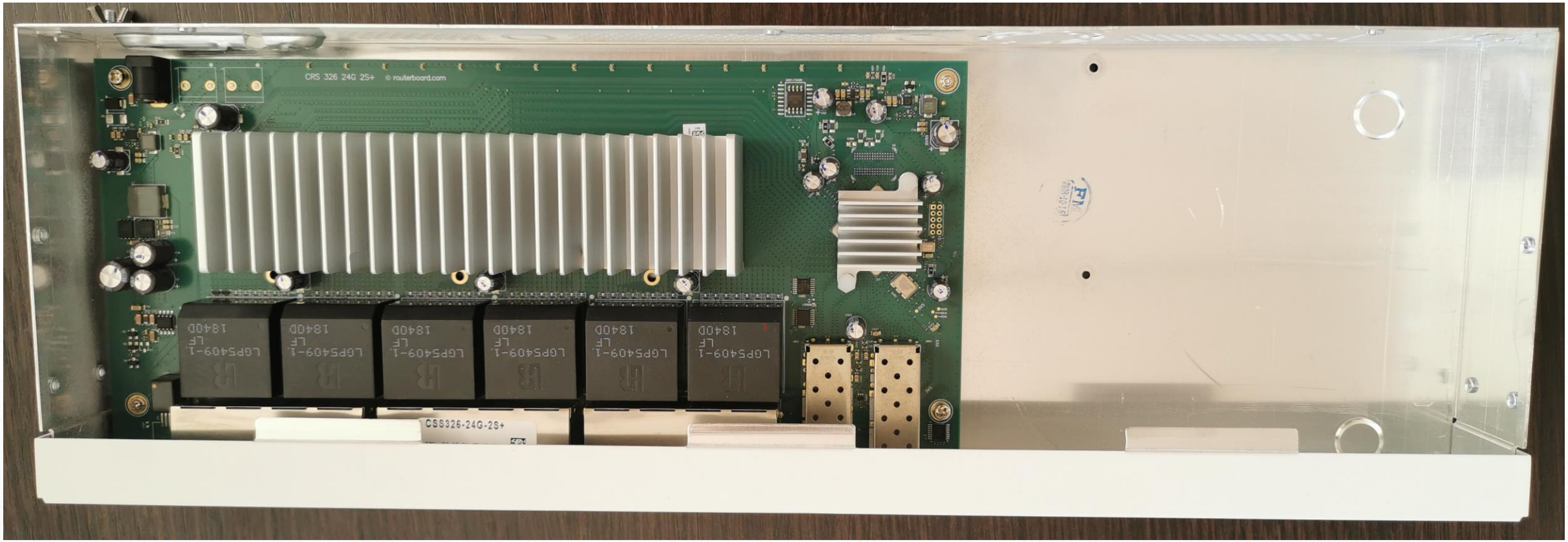
Link | SFP | Port Isolation | LAG | Forwarding | RSTP | Stats | Errors | Hist | VLAN | **VLANs** | Hosts | IGMP | SNMP | ACL | System | Upgrade

| VLAN ID | Port Isolation | Learning | Mirror | IGMP Snooping | Members | | |
|---|---|---|---|---|---|---|---|
| 160 | ☑ | ☑ | ☐ | ☐ | ☑☑☑☑☑☑☐☐☐☑☐☐☑☑☑☑☑☑☑☑☑☑☑☑☑☐ | Cut | Insert |
| 199 | ☑ | ☑ | ☐ | ☐ | ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☑☐☐☑☐ | Cut | Insert |
| 450 | ☑ | ☑ | ☐ | ☐ | ☐☐☐☐☑☑☐☐☐☑☐☐☐☐☐☐☐☐☐☑☐☐☐☐☑☑☐ | Cut | Insert |
| 453 | ☑ | ☑ | ☐ | ☐ | ☐☐☐☐☑☐☐☐☐☐☐☐☐☐☐☐☐☐☐☑☐☐☐☐☐☑☐ | Cut | Insert |

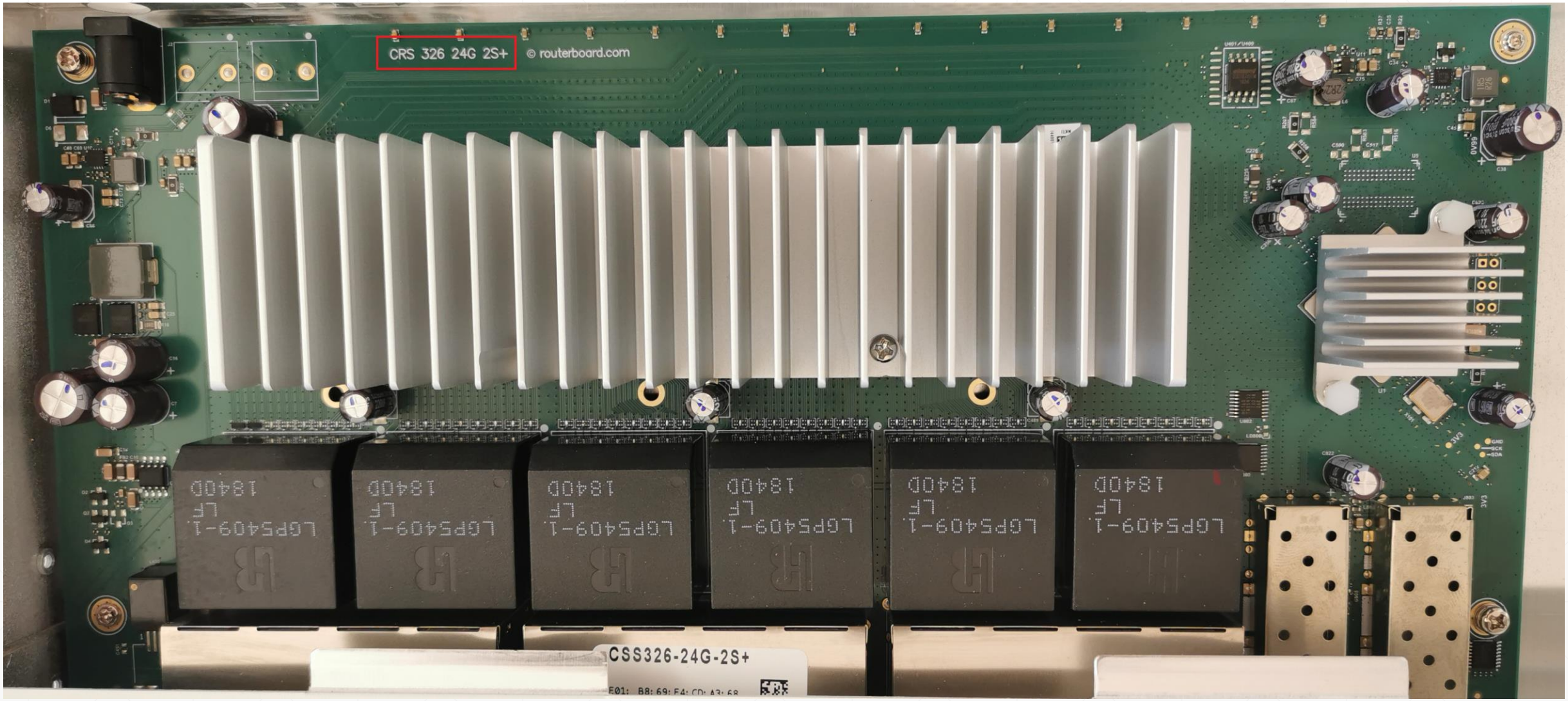
# Mikrotik CSS326-24G-2S+RM



# Mikrotik CSS326-24G-2S+RM



# Mikrotik CSS326-24G-2S+RM



# Mikrotik CSS326-24G-2S+RM

- Mikrotik CSS326-24G-2S+RM (2 x 10Gbps uplinks) - ~170 USD
- Ubiquiti EdgeSwitch 24 Lite (2 x 1Gbps uplinks) - ~ 220 USD
- D-Link DGS-1210-26 (2 x 1Gbps uplinks) - ~ 180 USD
- TP-Link T1600G-28TS (4 x 1Gbps uplinks) - ~ 190 USD
- Cisco SG250-26 (2 x 1Gbps uplinks) - ~300 USD







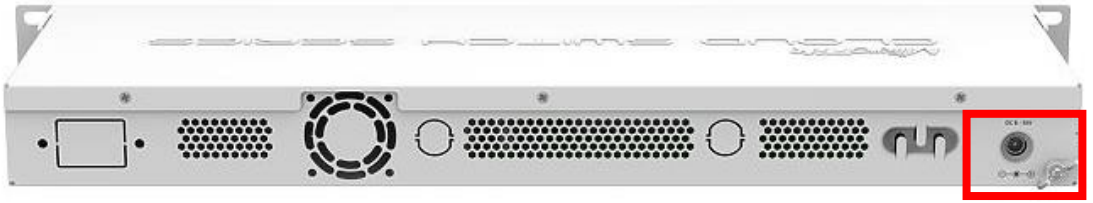





# Mikrotik CRS326-24G-2S+RM

- ~ 2016
- 24 порта 10/100/1000Mbps RJ-45, 2 порта 1/10Gbps SFP+
- RouterOS L5, Windows/SSH/Telnet/Webfig
- Dual boot RouterOS/swOS
- Full L2-managed switch + router (not L3 switch!!!)
- Passive cooling, -40°C to 60°C!!!
- External power supply ☹
- PoE in, max 24W
- Chipset Marvell 98DX3236
- IGMP snooping, LACP trunks, DHCP snooping & option 82, VLANs, RSTP, ACLs, etc
- ~ 240 USD !!!





# Mikrotik CRS326-24G-2S+RM

| | |
|---|---|
| Product code | CRS326-24G-2S+RM |
| CPU | 98DX3236A1 800 MHz |
| RAM | 512 MB |
| Storage type | Flash, 16 MB |
| Switch chip model | 98DX3236A1 |
| 10/100/1000 Ethernet ports | 24 |
| SFP+ cages | 2 |
| Operating system | SwOS /RouterOS (Dual boot) |
| Supported input voltage | 9 - 30 V (jack or passive PoE) |
| Dimensions | 440 x 144 x 44 mm |
| Operating temperature | -40°C .. +60°C tested |
| Max power consumption | 24 W |
| Serial port | RJ45 |

- Non-blocking Layer 2 switching capacity
- 16K host table
- IEEE 802.1Q VLAN
- Supports up to 4K VLANs
- Port isolation
- Port security
- Broadcast storm control
- Port mirroring of ingress/egress traffic
- Rapid Spanning Tree Protocol
- Access Control List
- MikroTik neighbor discovery
- SNMP v1
- Web-based GUI

# Mikrotik CRS326-24G-2S+RM

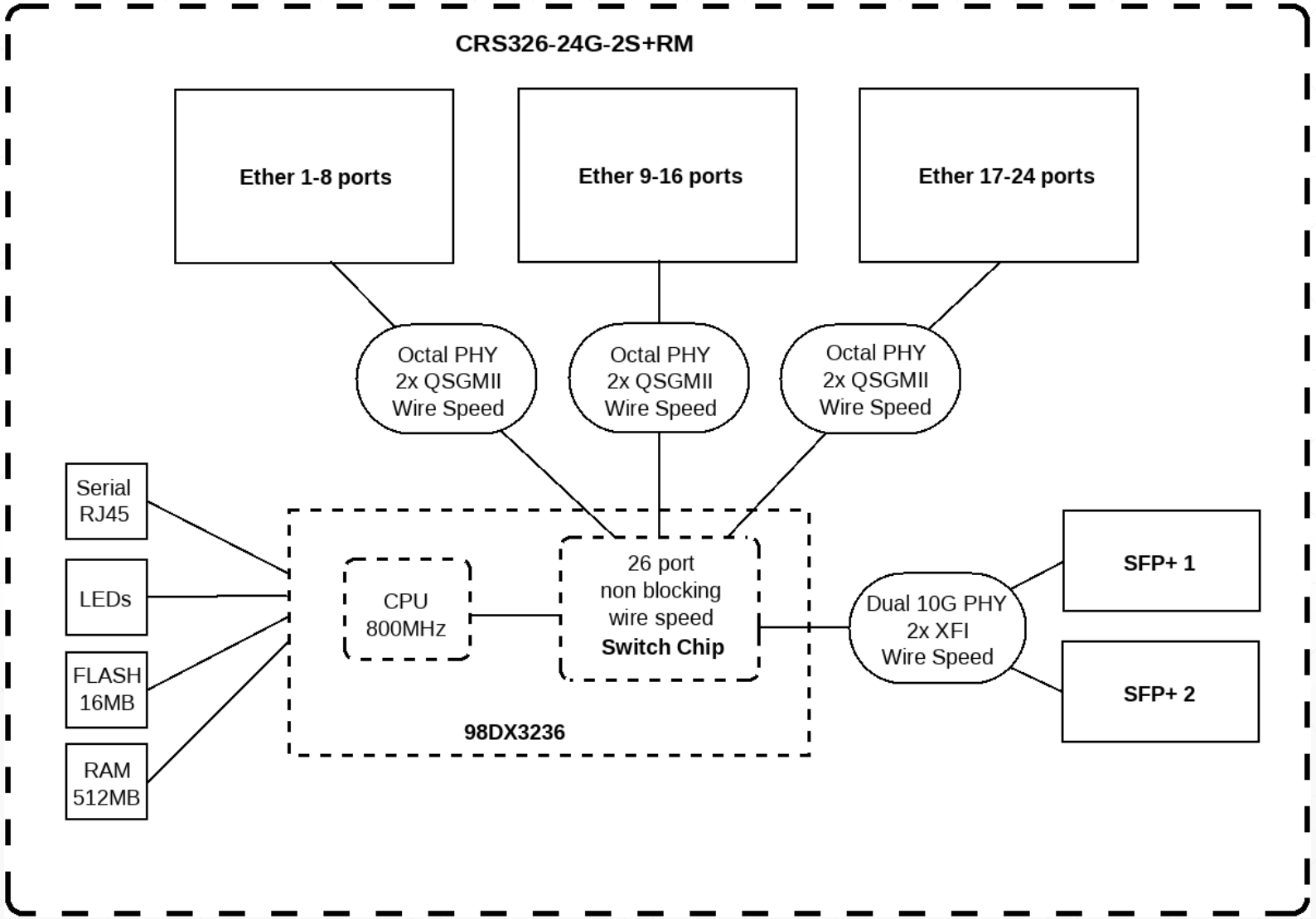
## Switching results

| CRS326-24G-2S+RM | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mode | Configuration | 1518 byte | | 512 byte | | 64 byte | |
| | | kpps | Mbps | kpps | Mbps | kpps | Mbps |
| Switching | Non blocking Layer 2 throughput | 3,576.1 | 43,427.8 | 10,338.3 | 42,345.9 | 65,476.2 | 33,523.8 |
| Switching | Non blocking Layer 2 capacity | 3,576.1 | 86,855.7 | 10,338.3 | 84,691.7 | 65,476.2 | 67,047.6 |
| Switching | Non blocking Layer 1 throughput | 3,576.1 | 44,000.0 | 10,338.3 | 44,000.0 | 65,476.2 | 44,000.0 |
| Switching | Non blocking Layer 1 capacity | 3,576.1 | 88,000.0 | 10,338.3 | 88,000.0 | 65,476.2 | 88,000.0 |

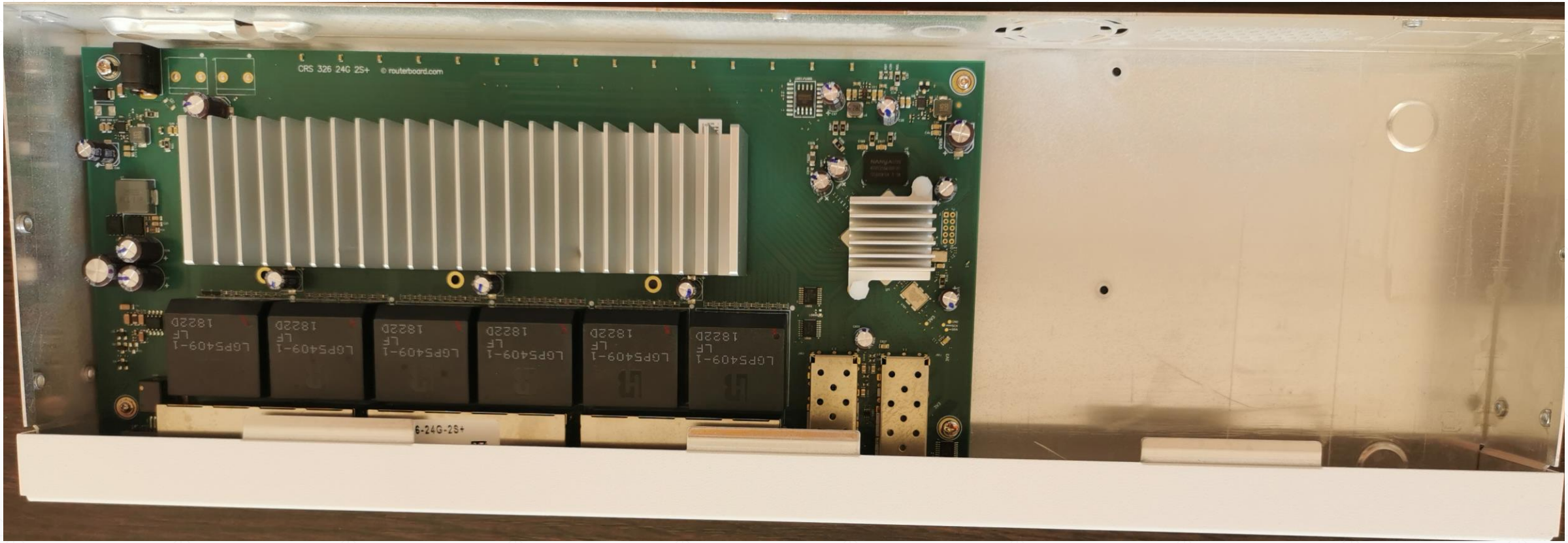
## Ethernet test results

| CRS326-24G-2S+RM | | 98DX3236 all port test | | | | | |
|---|---|---|---|---|---|---|---|
| Mode | Configuration | 1518 byte | | 512 byte | | 64 byte | |
| | | kpps | Mbps | kpps | Mbps | kpps | Mbps |
| Bridging | none (fast path) | 104,3 | 1266.6 | 273,5 | 1120.3 | 449 | 229.9 |
| Bridging | 25 bridge filter rules | 104 | 1263.0 | 104,6 | 428.4 | 104,5 | 53.5 |
| Routing | none (fast path) | 104,3 | 1266.6 | 273,9 | 1121.9 | 343,5 | 175.9 |
| Routing | 25 simple queues | 104,3 | 1266.6 | 136,9 | 560.7 | 137,4 | 70.3 |
| Routing | 25 ip filter rules | 64,8 | 786.9 | 65,9 | 269.9 | 65,8 | 33.7 |

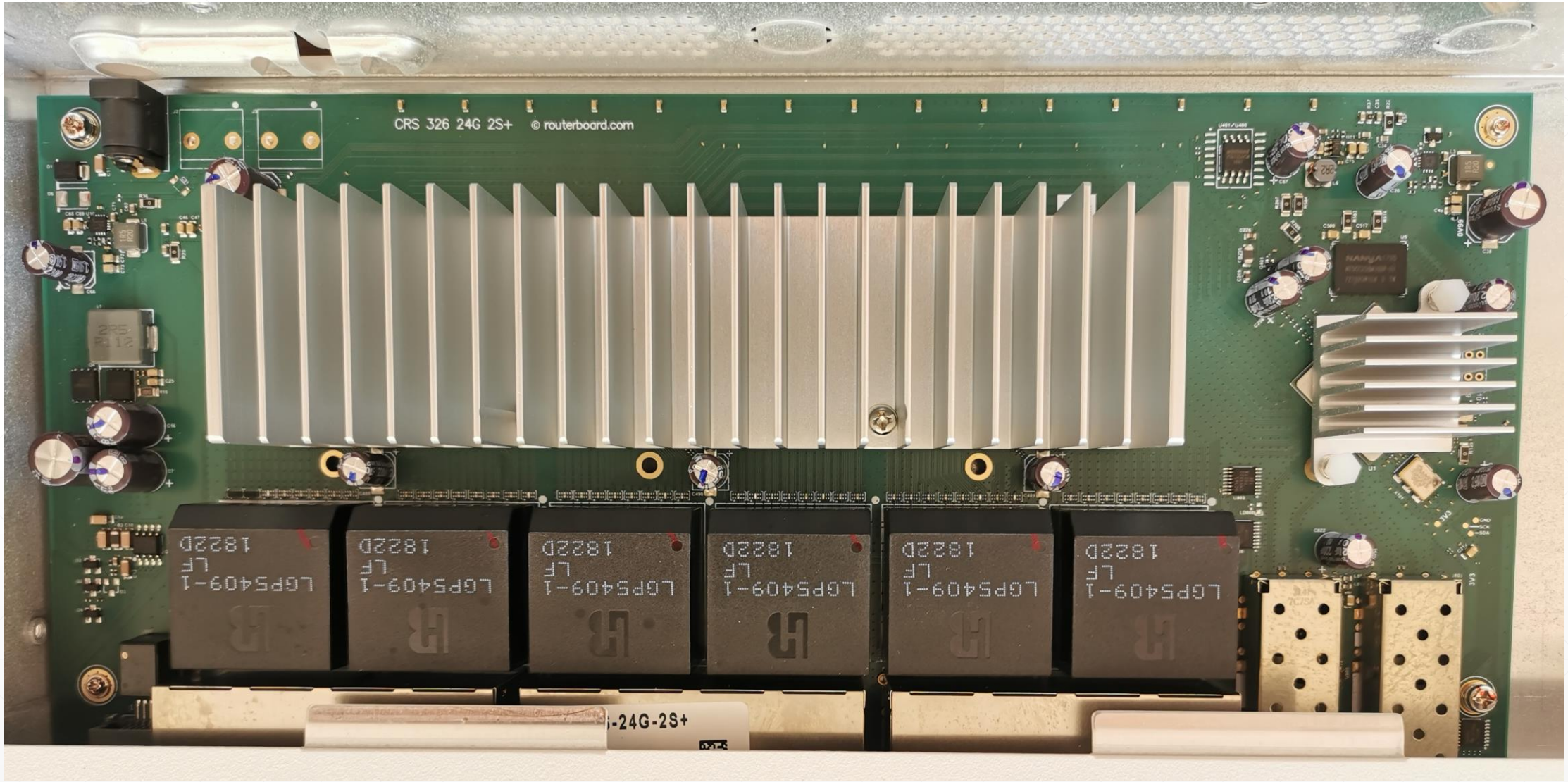
# Mikrotik CRS326-24G-2S+RM



# Mikrotik CRS326-24G-2S+RM

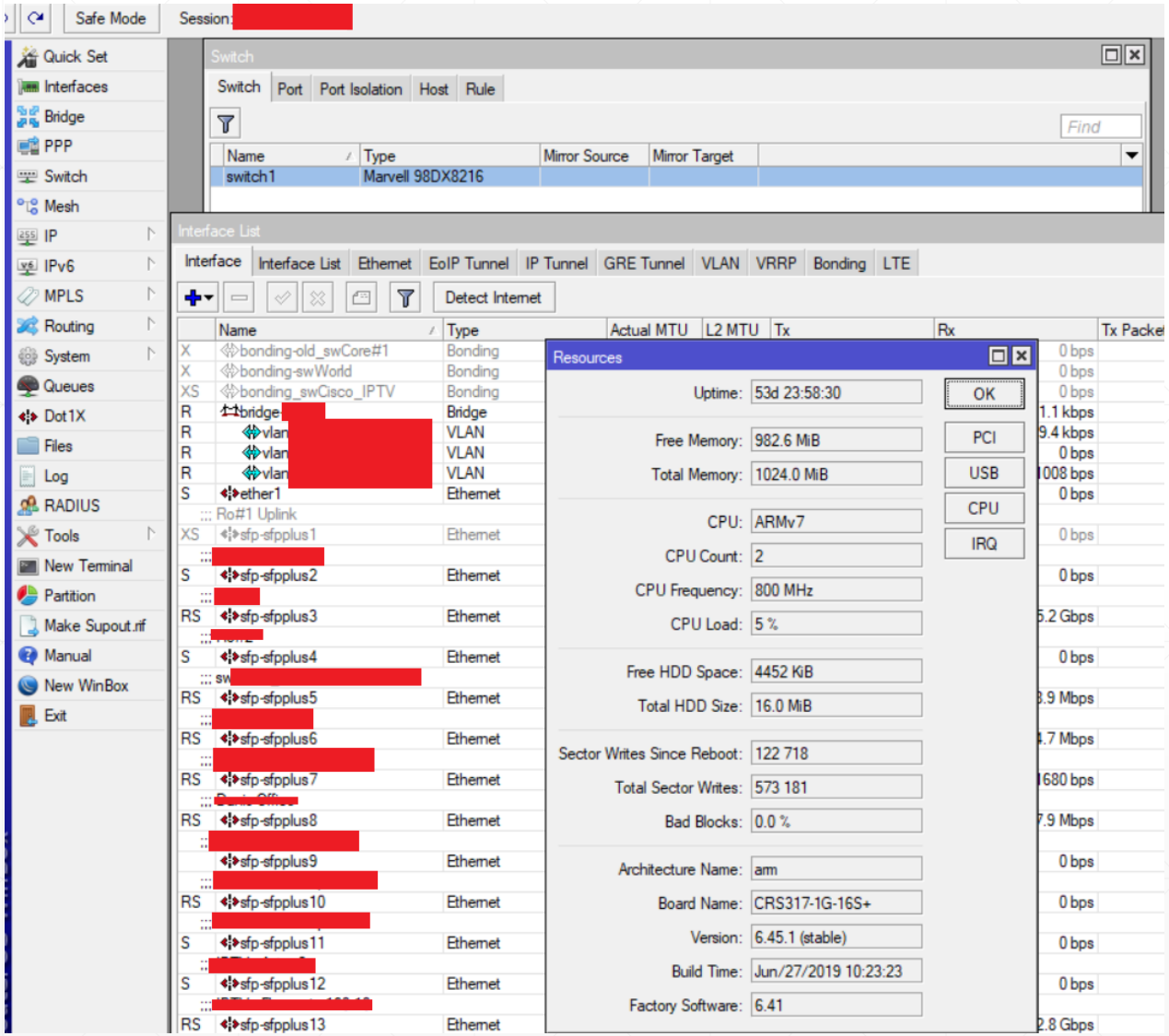


# Mikrotik CRS326-24G-2S+RM



# Mikrotik CRS326-24G-2S+RM

- Полноценный RouterOS L5



# Mikrotik CRS326-24G-2S+RM

- Mikrotik CRS326-24G-2S+RM (2 x 10Gbps uplinks, router) - ~240 USD
- Ubiquiti EdgeSwitch 24 Lite (2 x 1Gbps uplinks, very limited functionality) - ~ 220 USD
- D-Link DGS-1510-28 (4 x 1Gbps uplinks) - ~ 320 USD
- TP-Link T2600G-28TS (4 x 1Gbps uplinks) - ~ 260 USD
- Cisco SG300-28 (4 x 1Gbps uplinks) - ~500 USD












# Mikrotik CRS328-4C-20S-4S+RM

- ~ 2018
- 20 портов 1Gbps SFP, 4 порта COMBO 10/100/1000 RJ-45 – 1Gbps SFP, 4 порта 1/10Gbps SFP+
- RouterOS L5, Windows/SSH/Telnet/Webfig
- Dual boot RouterOS/swOS
- Full L2-managed switch + router (not L3 switch!!!)
- Active cooling, -20°C to 60°C!
- Dual internal power supply ☺, max 43W
- Chipset Marvell 98DX3236
- IGMP snooping, LACP trunks, DHCP snooping & option 82, VLANs, RSTP, ACLs, etc
- ~ 450 USD !!!






# Mikrotik CRS328-4C-20S-4S+RM

- Non-blocking Layer 2 switching capacity
- 16K host table
- IEEE 802.1Q VLAN
- Supports up to 4K simultaneous VLANs
- Port isolation
- Port security
- Broadcast storm control
- Port mirroring of ingress/egress traffic
- STP / RSTP / MSTP
- Access Control List
- MikroTik neighbor discovery
- SNMP
- 10218-byte jumbo frames support
- IGMP snooping
- IEEE 802.3ad and static link aggregation

- 20 SFP ports
- 4 ETH/SFP combo ports
- 4 SFP+ ports
- Non-Blocking throughput: 64 Gbps
- Switching capacity: 128 Gbps
- Forwarding rate: 95.2 Mpps
- RJ45 serial console port
- Dual PSU
- Maximum power consumption: 43 W
- Temperature based fan control
- 1U rackmount

# Mikrotik CRS328-4C-20S-4S+RM

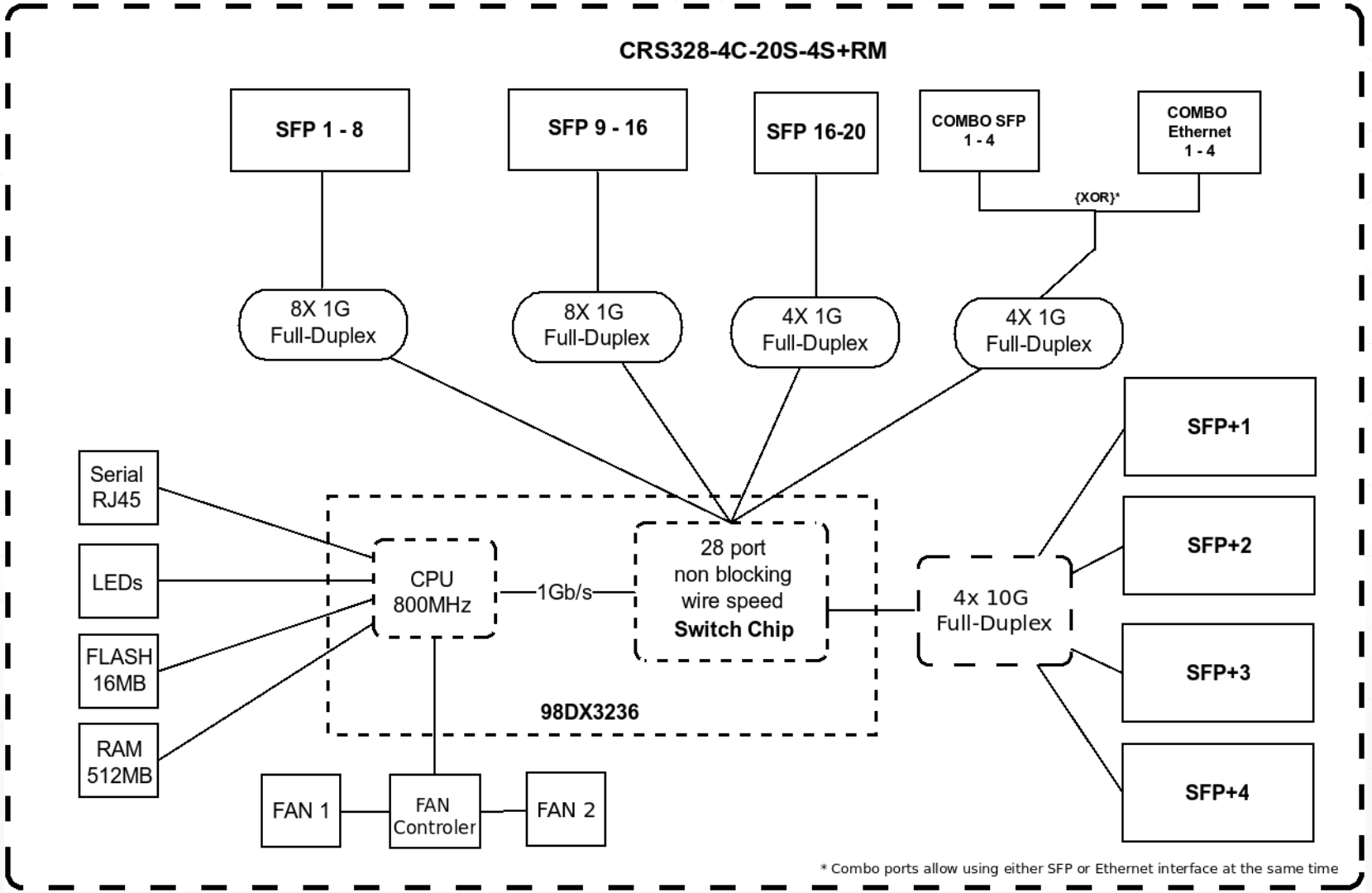
## Switching results

| CRS328-4C-20S-4S+RM | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mode | Configuration | 1518 byte | | 512 byte | | 64 byte | |
| | | kpps | Mbps | kpps | Mbps | kpps | Mbps |
| Switching | Non blocking Layer 2 throughput | 5,201.6 | 63,167.8 | 15,037.6 | 61,594.0 | 95,238.1 | 48,761.9 |
| Switching | Non blocking Layer 2 capacity | 5,201.6 | 126,335.5 | 15,037.6 | 123,188.0 | 95,238.1 | 97,523.8 |
| Switching | Non blocking Layer 1 throughput | 5,201.6 | 64,000.0 | 15,037.6 | 64,000.0 | 95,238.1 | 64,000.0 |
| Switching | Non blocking Layer 1 capacity | 5,201.6 | 128,000.0 | 15,037.6 | 128,000.0 | 95,238.1 | 128,000.0 |

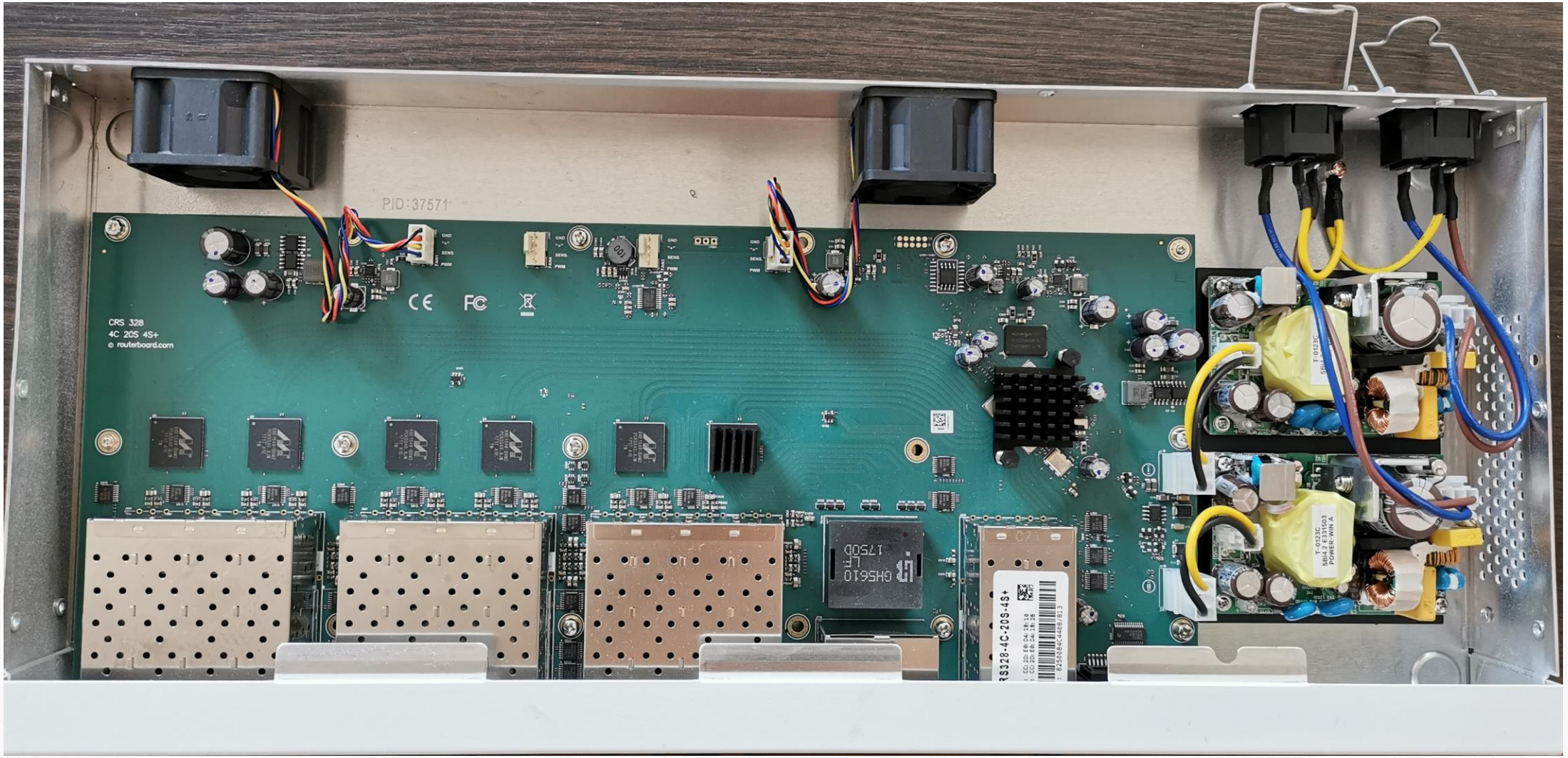
## Ethernet test results

| CRS328-4C-20S-4S+RM | | 98DX3236 all port test | | | | | |
|---|---|---|---|---|---|---|---|
| Mode | Configuration | 1518 byte | | 512 byte | | 64 byte | |
| | | kpps | Mbps | kpps | Mbps | kpps | Mbps |
| Bridging | none (fast path) | 104,3 | 1266.6 | 273,5 | 1120.3 | 449 | 229.9 |
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| Routing | 25 simple queues | 104,3 | 1266.6 | 136,9 | 560.7 | 137,4 | 70.3 |
| Routing | 25 ip filter rules | 64,8 | 786.9 | 65,9 | 269.9 | 65,8 | 33.7 |

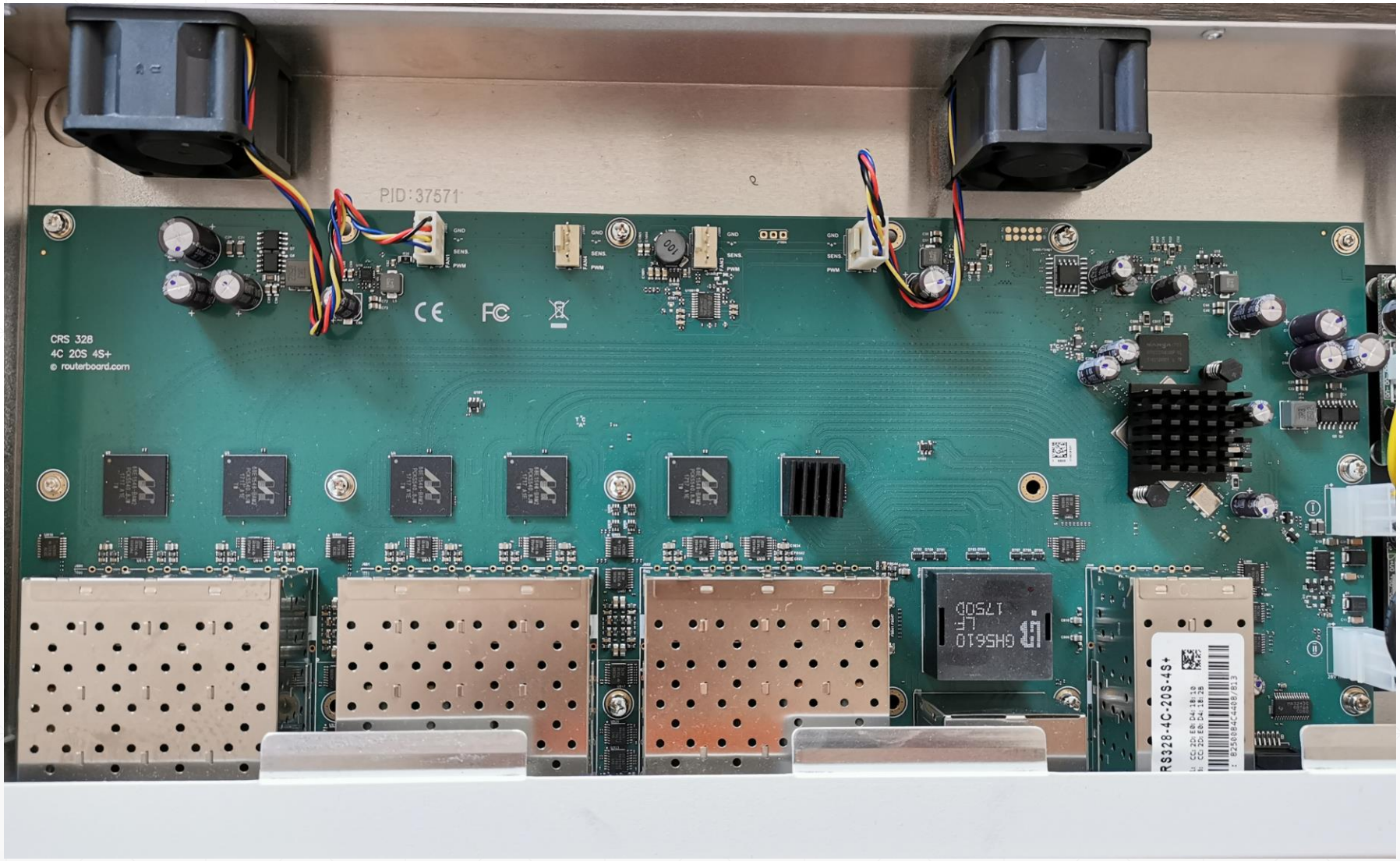
# Mikrotik CRS328-4C-20S-4S+RM



# Mikrotik CRS328-4C-20S-4S+RM

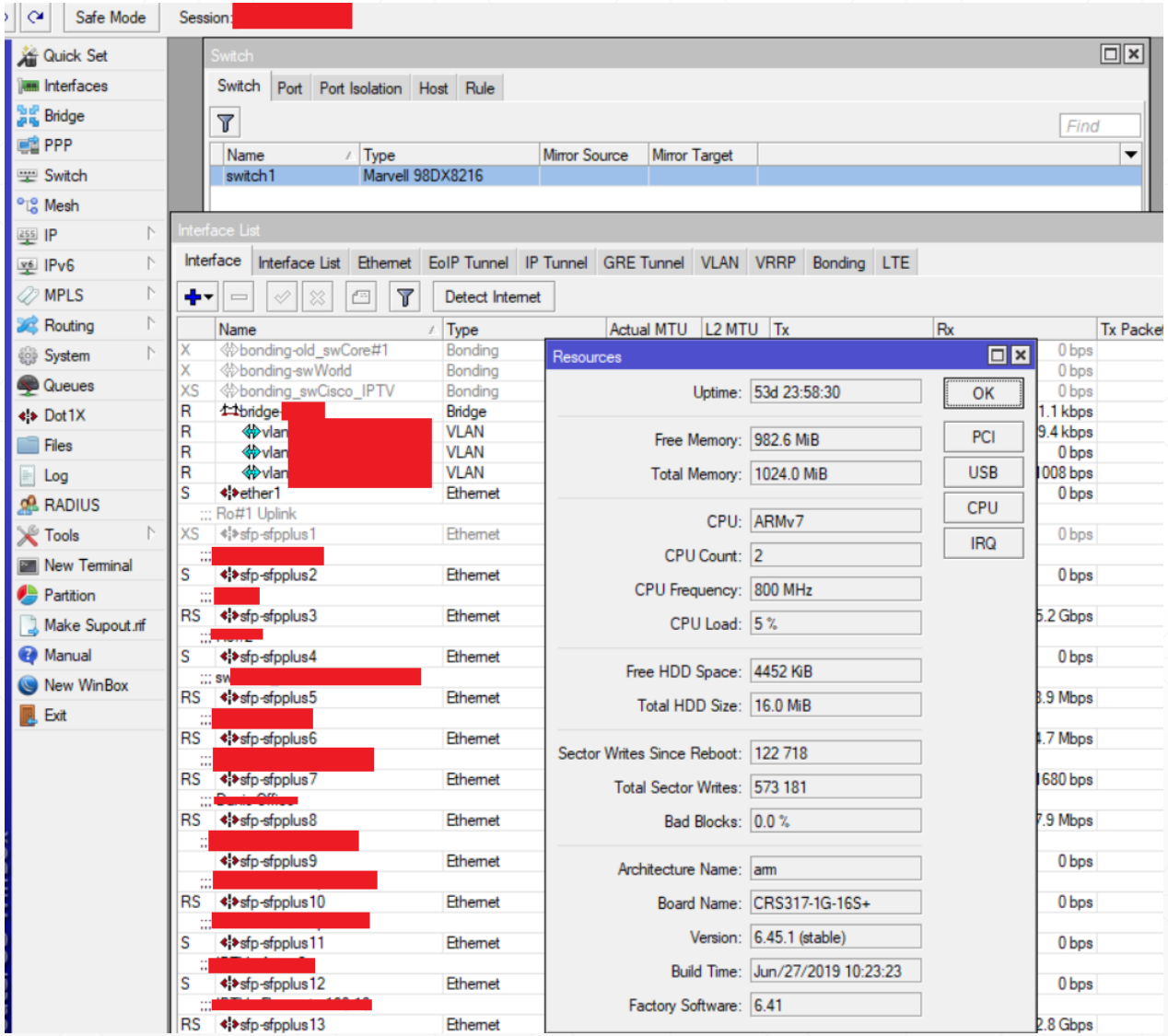


# Mikrotik CRS328-4C-20S-4S+RM



# Mikrotik CRS328-4C-20S-4S+RM

- Полноценный RouterOS L5



# Mikrotik CRS328-4C-20S-4S+RM

- Mikrotik CRS328-4C-20S-4S+RM (4 x 10Gbps uplinks, router) - ~450 USD
- D-Link DGS-1210-28XS/ME (4 x 10Gbps uplinks) - ~ 600 USD
- TP-Link T2600G-28SQ (4 x 10Gbps uplinks) - ~ 600 USD
- Cisco SG350-28SFP (4 x 1Gbps uplinks) - ~900 USD

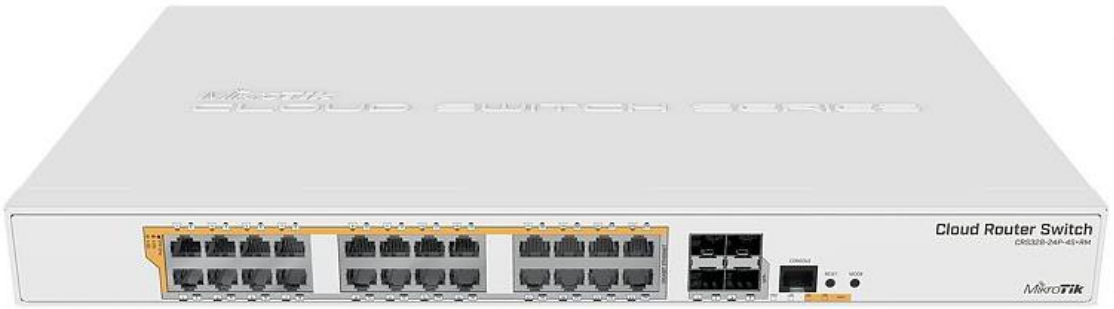







# Mikrotik CRS328-24P-4S+RM

- ~ 2018
- 24 порта 10/100/1000Mbps RJ-45 PoE, 4 порта 1/10Gbps SFP+
- Power over Ethernet 802.3at/af 48V
- Passive PoE 24V
- 450W for PoE, 30W per port
- RouterOS L5, Windows/SSH/Telnet/Webfig
- Dual boot RouterOS/swOS
- Full L2-managed switch + router (not L3 switch!!!)
- Active cooling, -20°C to 60°C!
- Chipset Marvell 98DX3236
- IGMP snooping, LACP trunks, DHCP snooping & option 82, VLANs, RSTP, ACLs, etc
- ~ 450 USD !!!



# Mikrotik CRS328-24P-4S+RM

## Switching features

- Non-blocking Layer 2 switching capacity
- 16K host table
- IEEE 802.1Q VLAN
- Supports up to 4K simultaneous VLANs
- Port isolation
- Port security
- Broadcast storm control
- Port mirroring of ingress/egress traffic
- STP / RSTP / MSTP
- Access Control List
- MikroTik neighbor discovery
- SNMP
- 10218-byte jumbo frames support
- IGMP snooping
- IEEE 802.3ad and static link aggregation

## Quick specifications

- 24 Gigabit Ethernet ports
- 4 SFP+ ports
- RJ45 serial console port
- Non-Blocking throughput: 64 Gbps
- Switching capacity: 128 Gbps
- Forwarding rate: 95.2 Mpps
- Maximum power consumption: 44 W (without PoE devices connected)
- Supports PoE+ IEEE 802.3at/af and 26 V Passive PoE)
- Temperature based fan control
- 1U rackmount
- Selectable power output per port (26 / 53 V)

# Mikrotik CRS328-24P-4S+RM

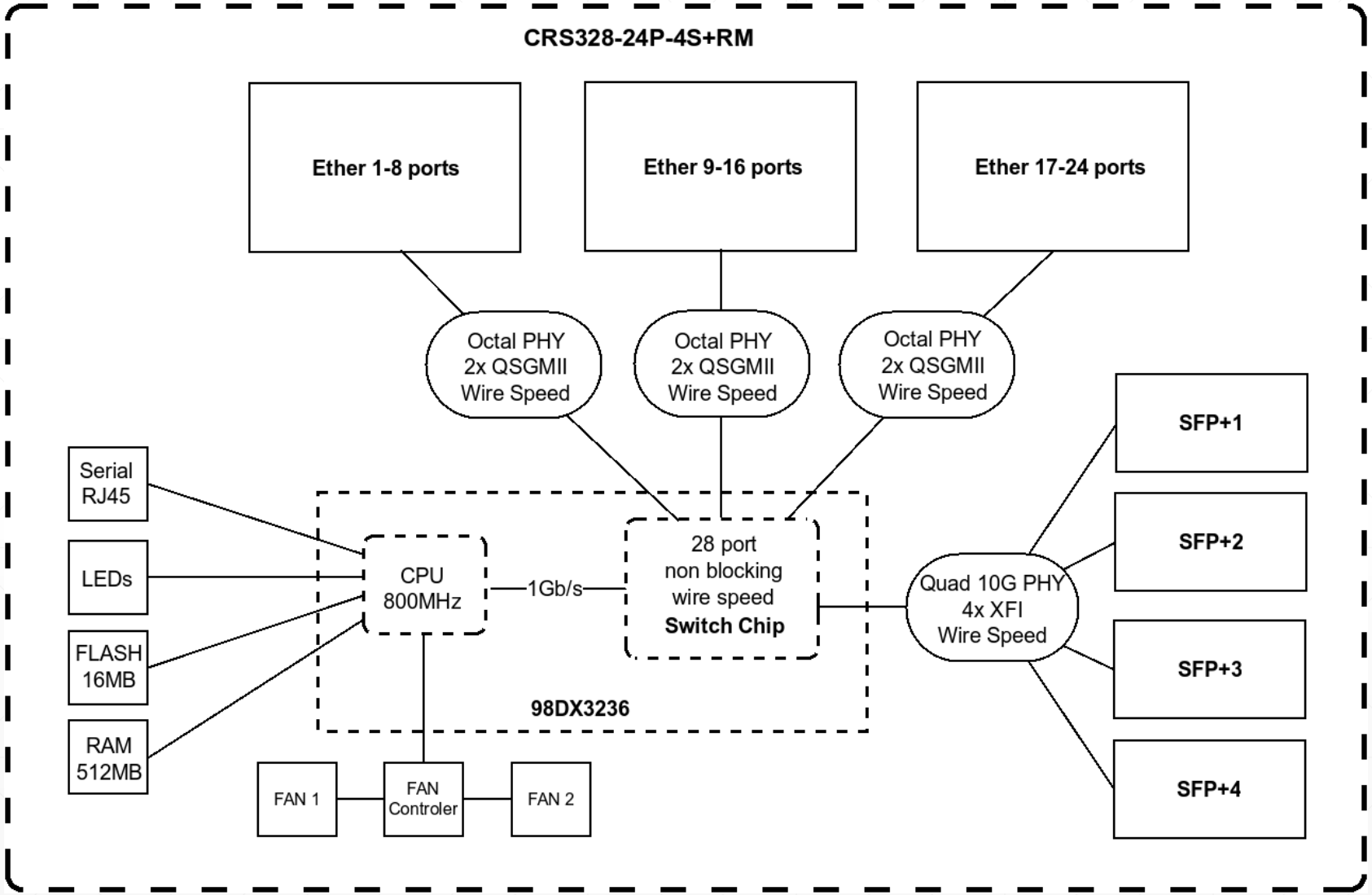
## Switching results

| CRS328-4C-20S-4S+RM | | | | | | |
|---|---|---|---|---|---|---|
| Mode | Configuration | 1518 byte | | 512 byte | | 64 byte | |
| | | kpps | Mbps | kpps | Mbps | kpps | Mbps |
| Switching | Non blocking Layer 2 throughput | 5,201.6 | 63,167.8 | 15,037.6 | 61,594.0 | 95,238.1 | 48,761.9 |
| Switching | Non blocking Layer 2 capacity | 5,201.6 | 126,335.5 | 15,037.6 | 123,188.0 | 95,238.1 | 97,523.8 |
| Switching | Non blocking Layer 1 throughput | 5,201.6 | 64,000.0 | 15,037.6 | 64,000.0 | 95,238.1 | 64,000.0 |
| Switching | Non blocking Layer 1 capacity | 5,201.6 | 128,000.0 | 15,037.6 | 128,000.0 | 95,238.1 | 128,000.0 |

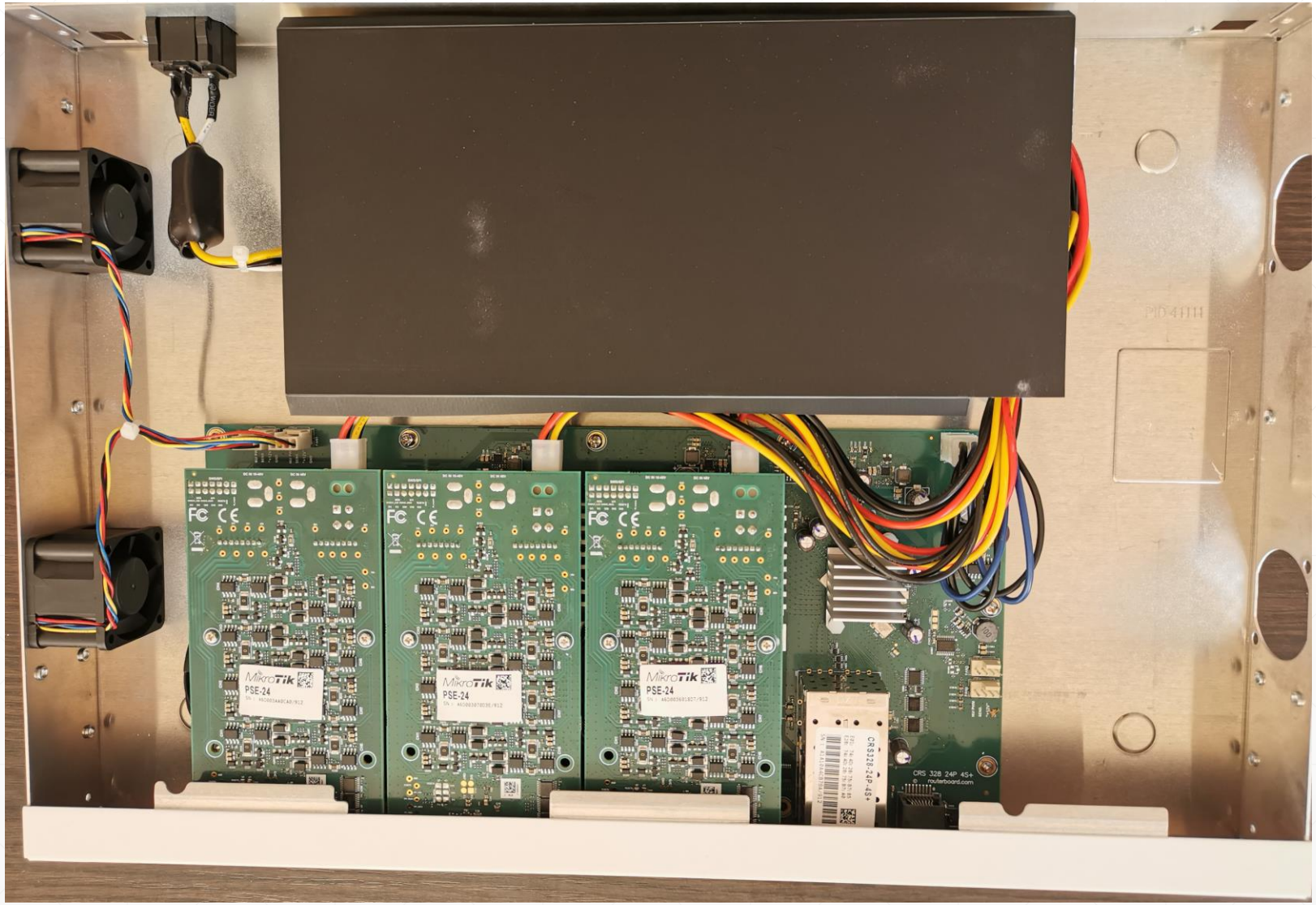
## Ethernet test results

| CRS328-4C-20S-4S+RM | | 98DX3236 all port test | | | | | |
|---|---|---|---|---|---|---|---|
| Mode | Configuration | 1518 byte | | 512 byte | | 64 byte | |
| | | kpps | Mbps | kpps | Mbps | kpps | Mbps |
| Bridging | none (fast path) | 104,3 | 1266.6 | 273,5 | 1120.3 | 449 | 229.9 |
| Bridging | 25 bridge filter rules | 104 | 1263.0 | 104,6 | 428.4 | 104,5 | 53.5 |
| Routing | none (fast path) | 104,3 | 1266.6 | 273,9 | 1121.9 | 343,5 | 175.9 |
| Routing | 25 simple queues | 104,3 | 1266.6 | 136,9 | 560.7 | 137,4 | 70.3 |
| Routing | 25 ip filter rules | 64,8 | 786.9 | 65,9 | 269.9 | 65,8 | 33.7 |

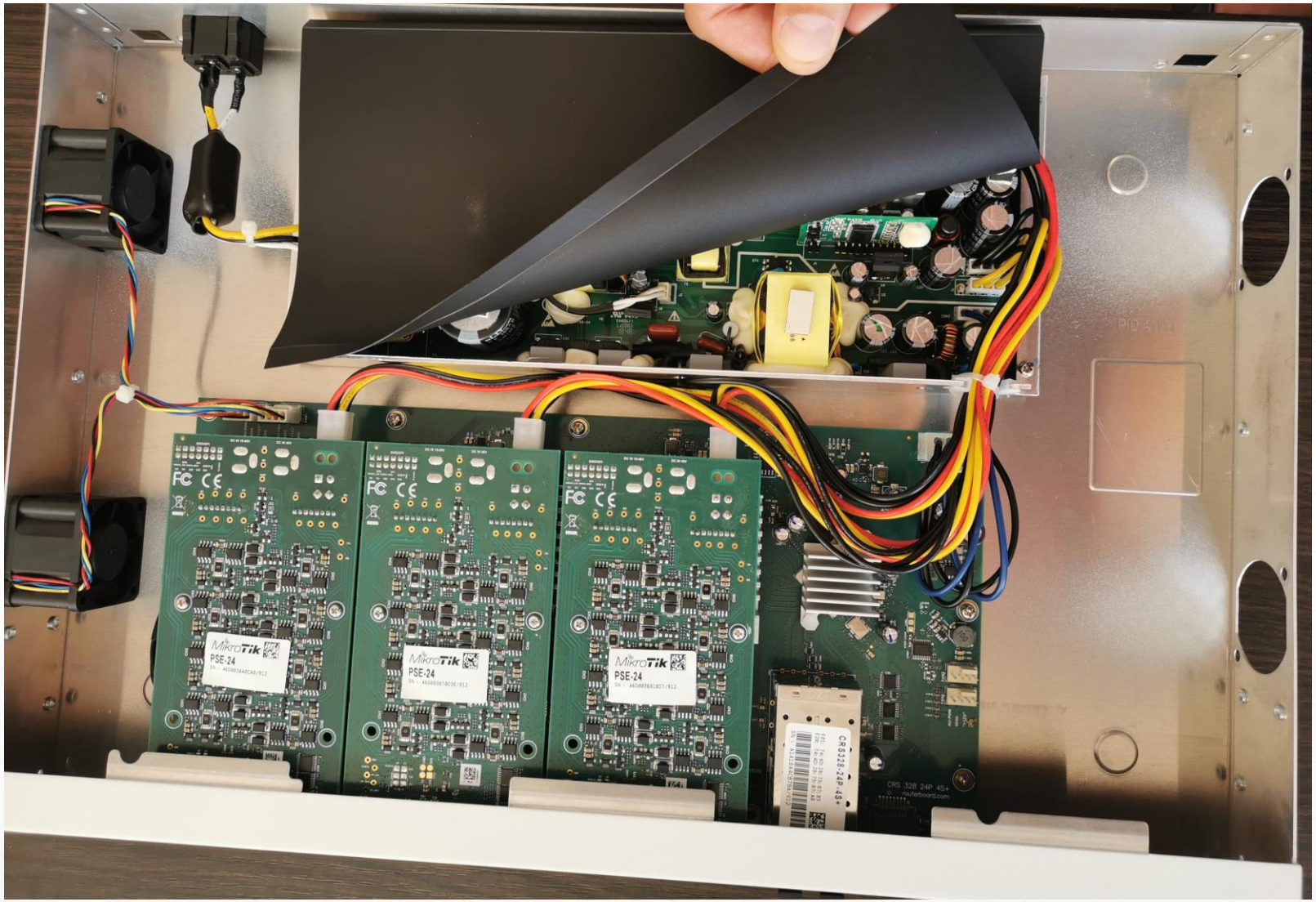
# Mikrotik CRS328-24P-4S+RM



# Mikrotik CRS328-24P-4S+RM

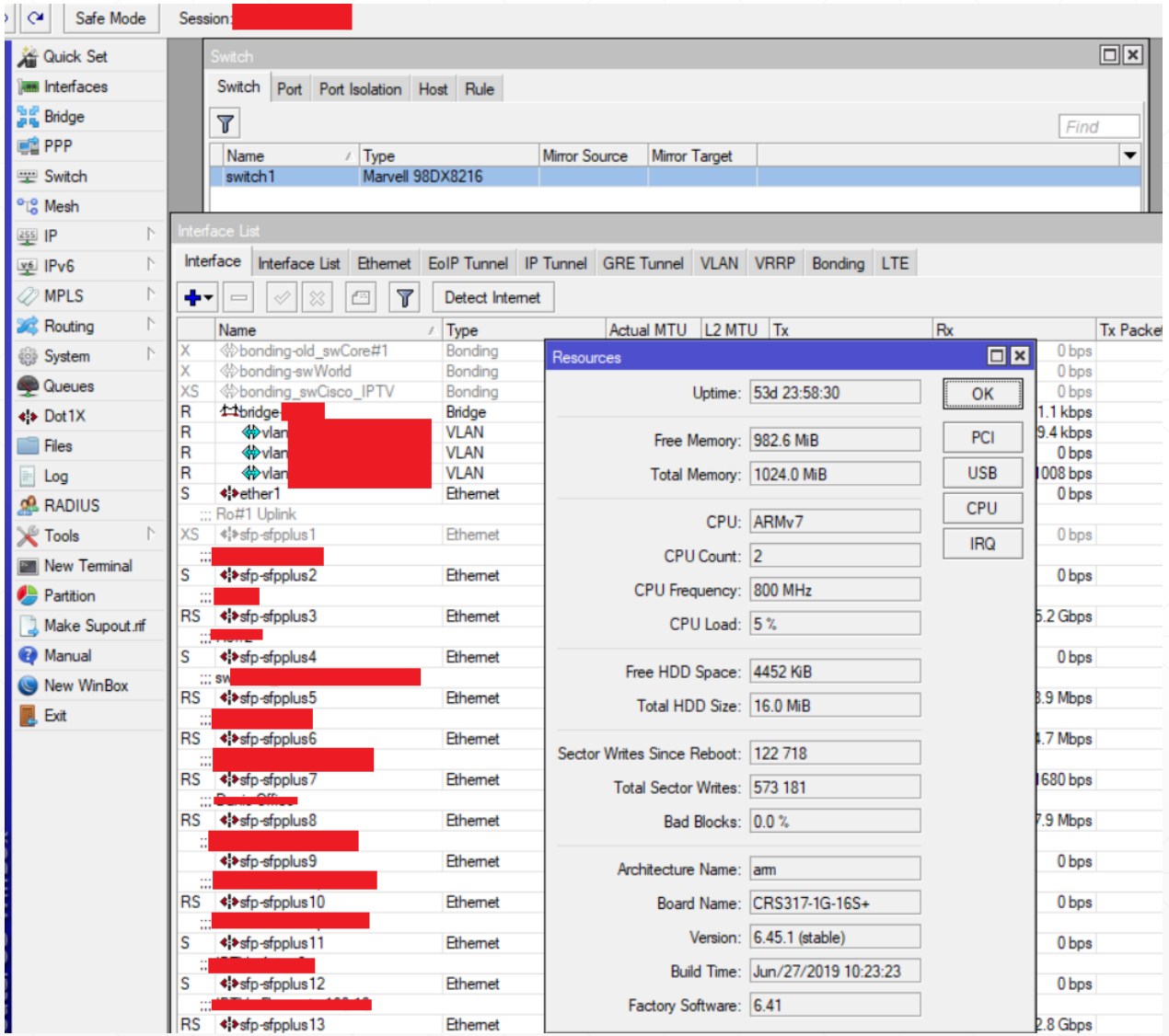


# Mikrotik CRS328-24P-4S+RM



# Mikrotik CRS328-24P-4S+RM

- Полноценный RouterOS L5



# Mikrotik CRS328-24P-4S+RM

- Mikrotik CRS328-24P-4S+RM (4 x 10Gbps uplinks, router) - ~450 USD
- Ubiquiti EdgeSwitch 24 500W (2 x 1Gbps uplinks) - ~ 570 USD
- D-Link DGS-1210-28MP (4 x 1Gbps uplinks) - ~ 600 USD
- TP-Link T2600G-28MPS (4 x 1Gbps uplinks) - ~ 520 USD
- Cisco SG350-28MP (2 x 1Gbps uplinks) - ~1100 USD





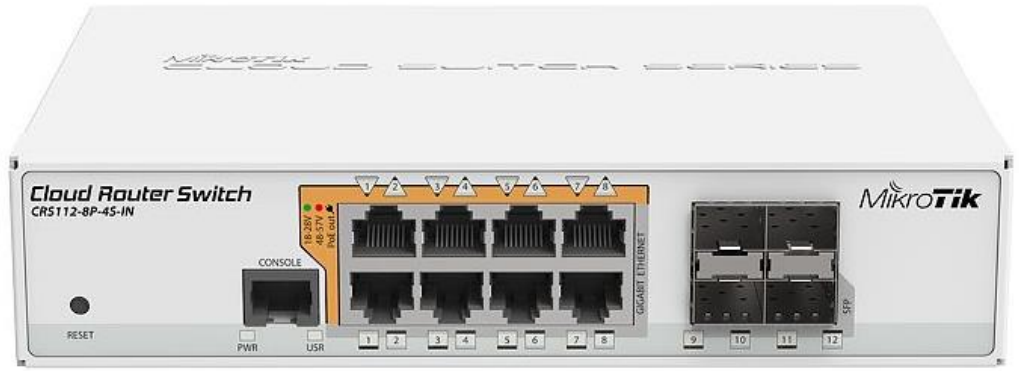


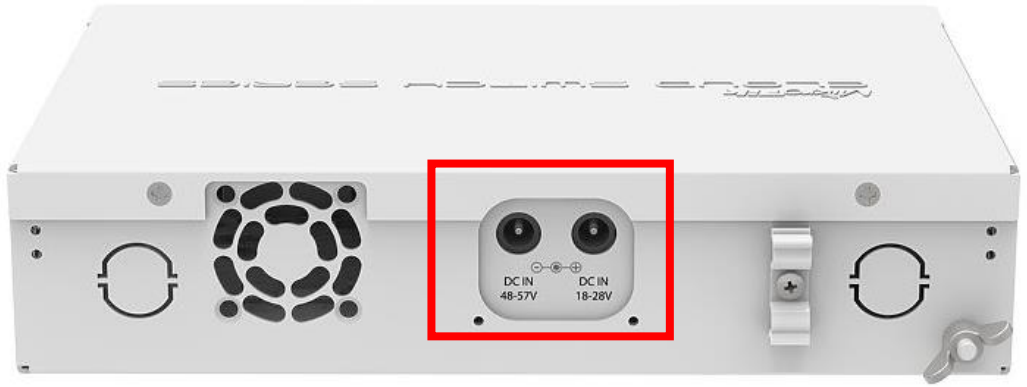





# Mikrotik CRS112-8P-4S-IN

- ~ 2017
- 8 портов 10/100/1000Mbps RJ-45 PoE, 4 порта 1Gbps SFP
- Desktop, rack-mount
- Power over Ethernet 802.3at/af 48V, Passive PoE 24V
- 150W for PoE, 20W per port
- RouterOS L5, Windows/SSH/Telnet/Webfig
- Passive cooling, -20°C to 60°C!
- Chipset QCA8511
- Старый чип, ограниченная функциональность L2 в «железе»
- Разные внешние БП для 24V и 48V. В комплекте только БП на 24V
- ~ 215 USD !!!






# Mikrotik CRS112-8P-4S-IN

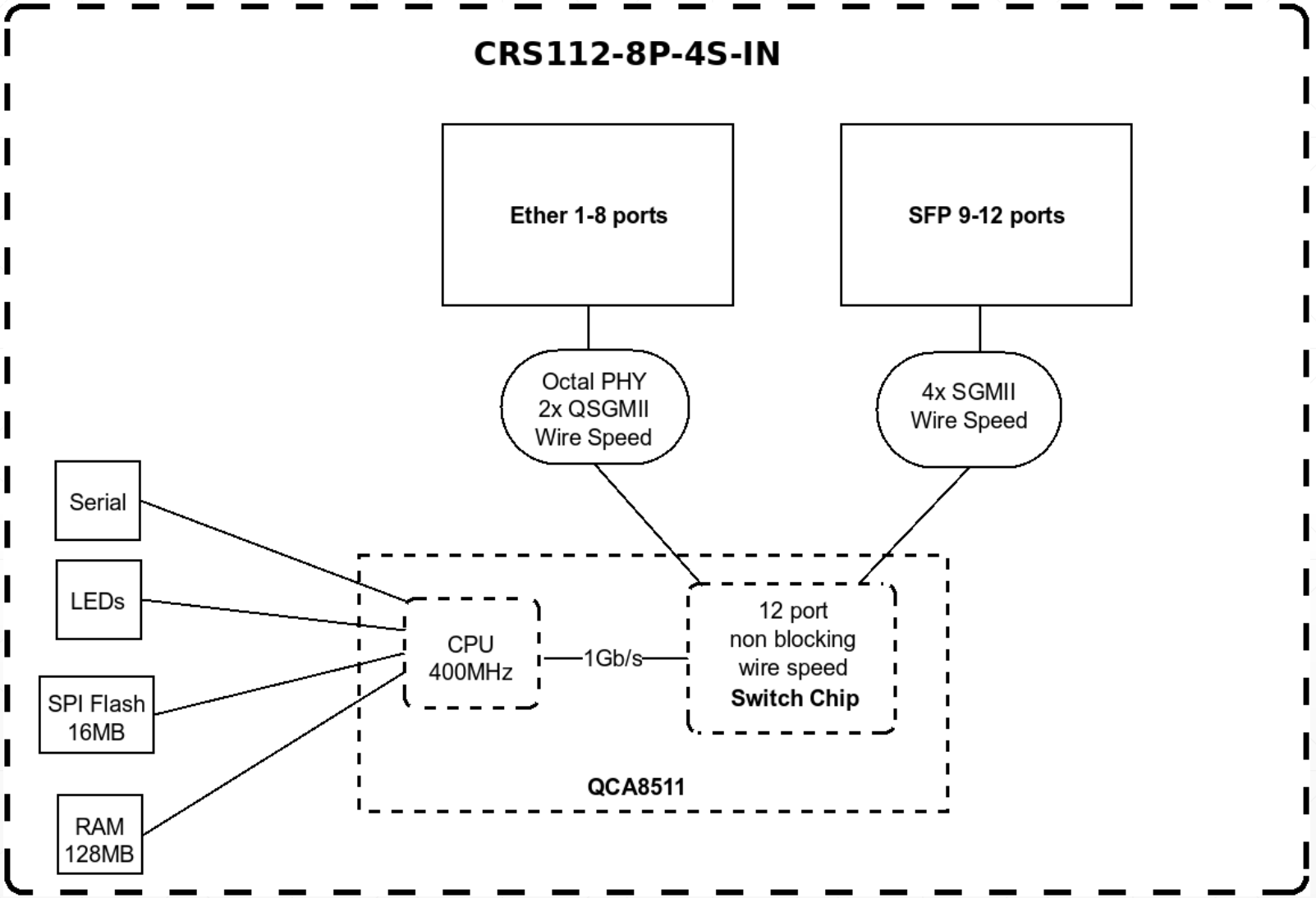
## Switching features

- Non-blocking Layer 2 switching capacity
- 16K host table
- IEEE 802.1Q VLAN
- Supports up to 4K simultaneous VLANs
- Port isolation
- Port security
- Broadcast storm control
- Port mirroring of ingress/egress traffic
- Rapid Spanning Tree Protocol
- Access Control List
- MikroTik neighbor discovery
- SNMP
- 9204-byte jumbo frames support
- IGMP snooping
- static link aggregation

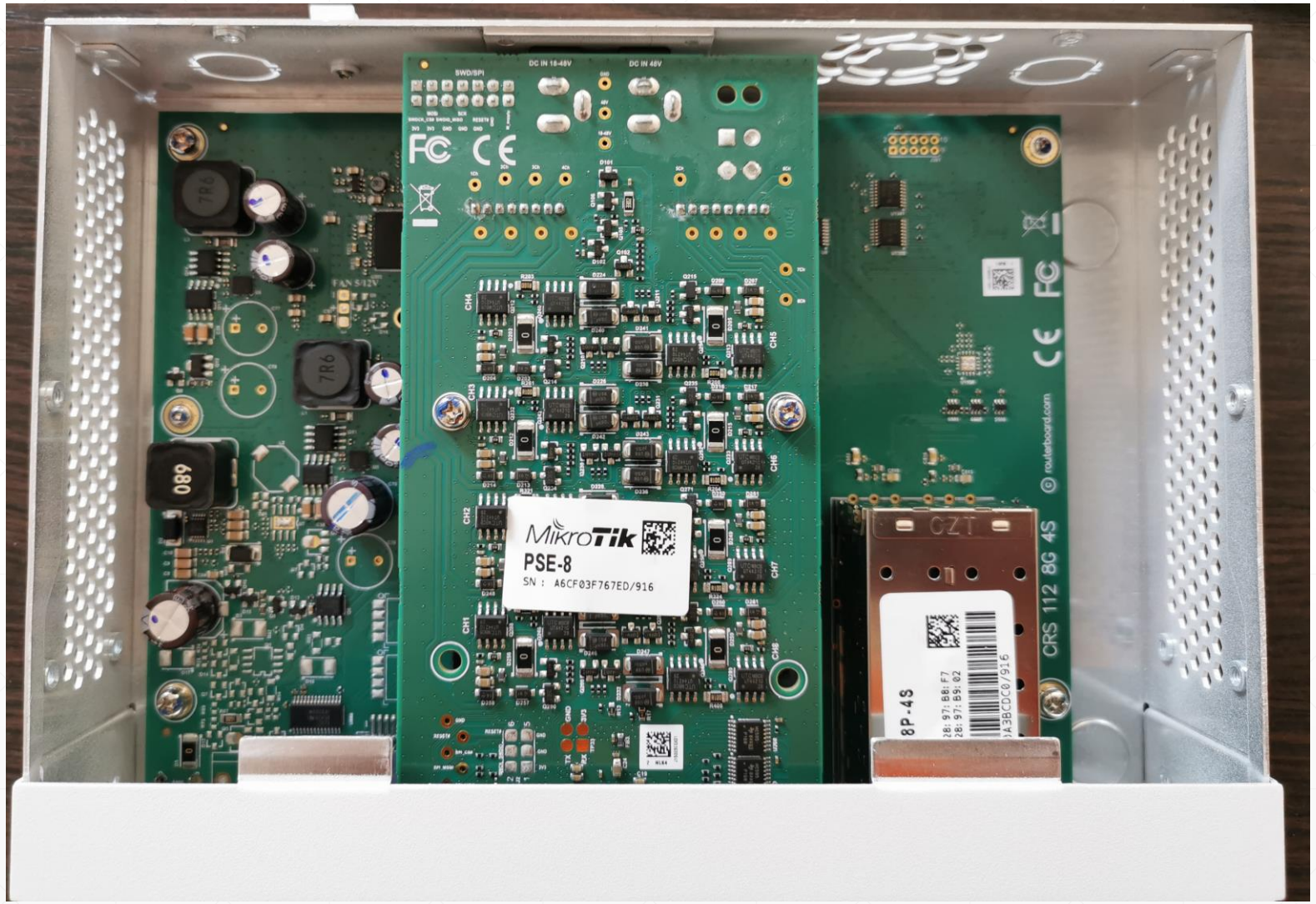
## Quick specifications

- 8 Gigabit RJ45 Ports
- 4 SFP Ports
- Non-Blocking Throughput: 12 Gbps
- Switching Capacity: 24 Gbps
- Forwarding Rate: 17.8 Mpps
- Maximum Power Consumption: 10 W (without PoE devices connected)
- Supports PoE+ IEEE 802.3at/af and 24 V Passive PoE
- Quiet, Fanless Operation
- Desktop-Rackmount

# Mikrotik CRS112-8P-4S-IN

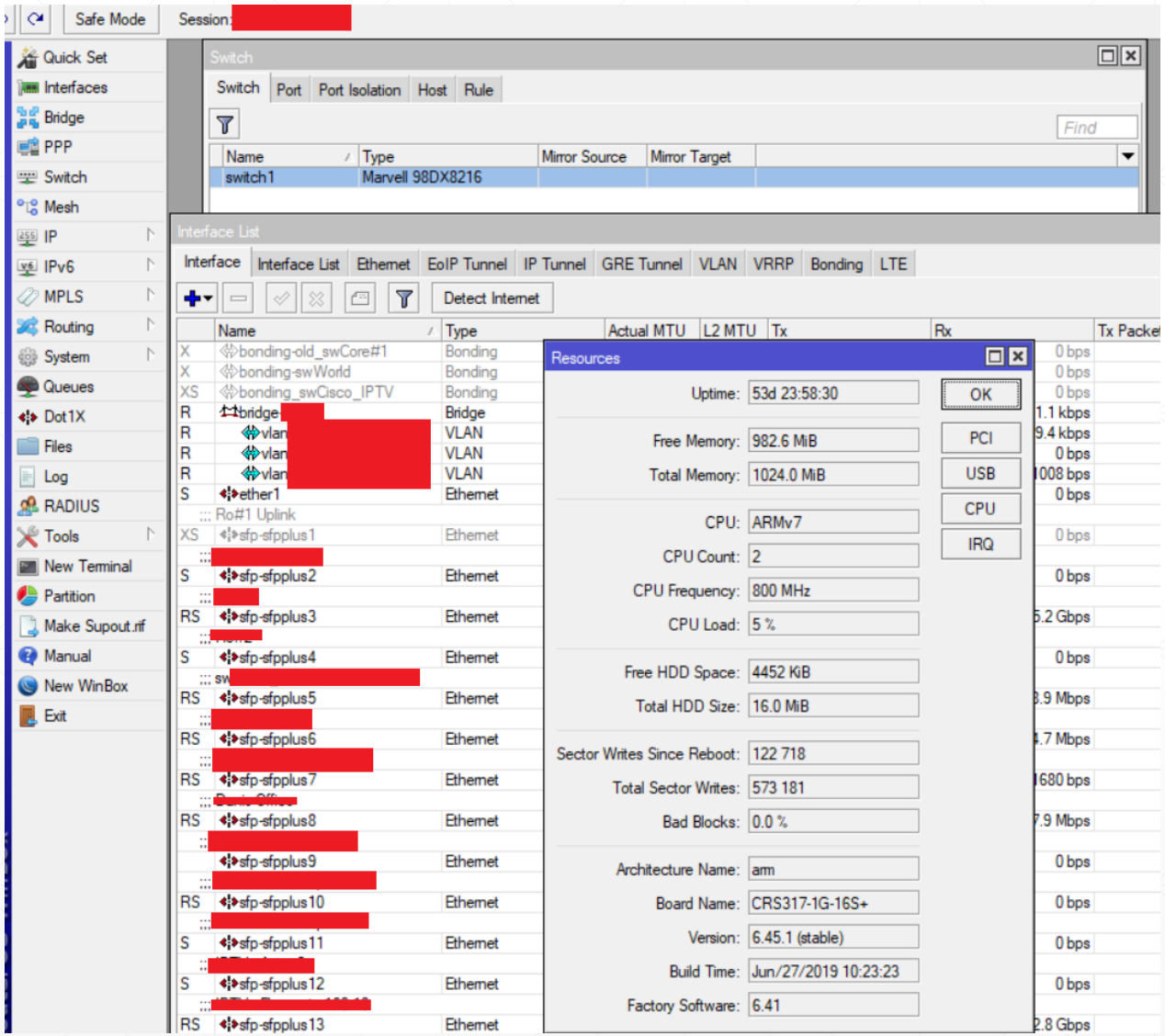


# Mikrotik CRS112-8P-4S-IN



# Mikrotik CRS112-8P-4S-IN

- Полноценный RouterOS L5



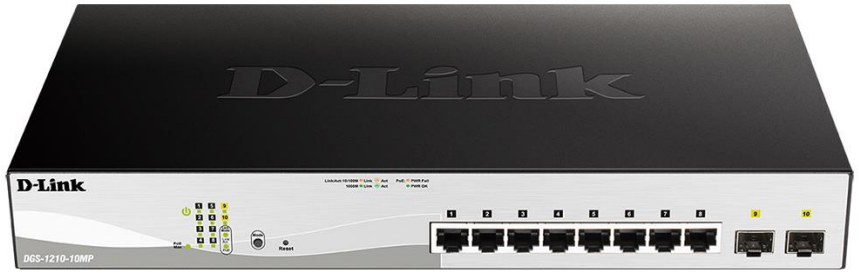
# Mikrotik CRS112-8P-4S-IN

- Mikrotik CRS112-8P-4S-IN (4 x 1Gbps uplinks, router) - ~215 USD
- Ubiquiti EdgeSwitch 8 150W (2 x 1Gbps uplinks) - ~ 215 USD
- D-Link DGS-1210-10MP (2 x 1Gbps uplinks) - ~ 260 USD
- TP-Link T2500G-10MPS (2 x 1Gbps uplinks) - ~ 230 USD
- Cisco SG350-10MP (2 x 1Gbps uplinks) - ~450 USD







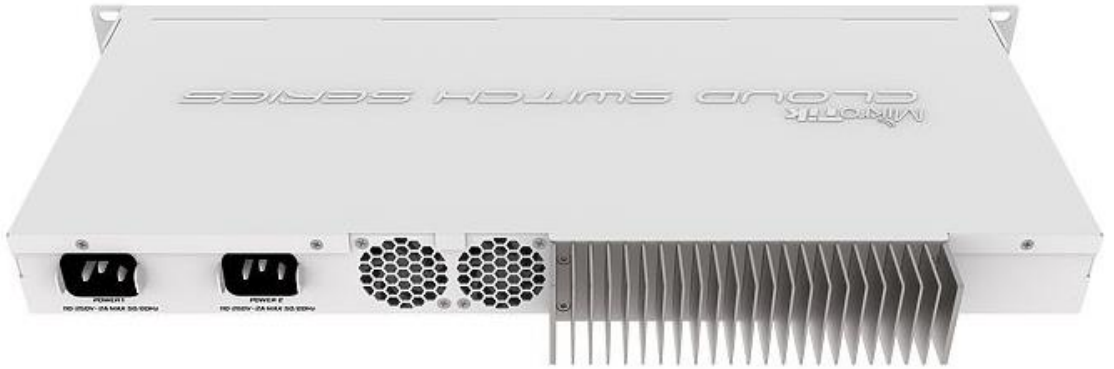





# Mikrotik CRS317-1G-16S+RM

- ~ 2017
- 16 портов 1/10Gbps SFP+, 1 порт 10/100/1000 RJ-45
- RouterOS L5, Windows/SSH/Telnet/Webfig
- Dual boot RouterOS/swOS
- Full L2-managed switch + router (not L3 switch!!!)
- Active cooling, -20°C to 60°C!
- Chipset Marvell 98DX8216
- MPLS hardware offload!!!
- IGMP snooping, LACP trunks, DHCP snooping & option 82, VLANs, RSTP, ACLs, etc
- ~ 480 USD !!!



# Mikrotik CRS317-1G-16S+RM

- Boot option for SwOS or RouterOS
- Non-blocking Layer 2 switching capacity
- 16K host table
- IEEE 802.1Q VLAN
- Supports up to 4K simultaneous VLANs
- Port isolation and Port security
- MSTP
- HW MPLS forwarding coming in future software update
- SFP 1.25 and SFP+ 10Gbit module support
- 800 MHz dual core CPU
- Dual power supplies

- Broadcast storm control
- Port mirroring of ingress/egress traffic
- Rapid Spanning Tree Protocol (RSTP)
- Link Aggregation (LACP)
- Access Control List
- MikroTik neighbour discovery
- SNMP v2/v3
- Rackmount and tabletop
- Supports -20 to +60 C ambient temperatures
- Passive cooling with automatic fan for high temperatures

# Mikrotik CRS317-1G-16S+RM

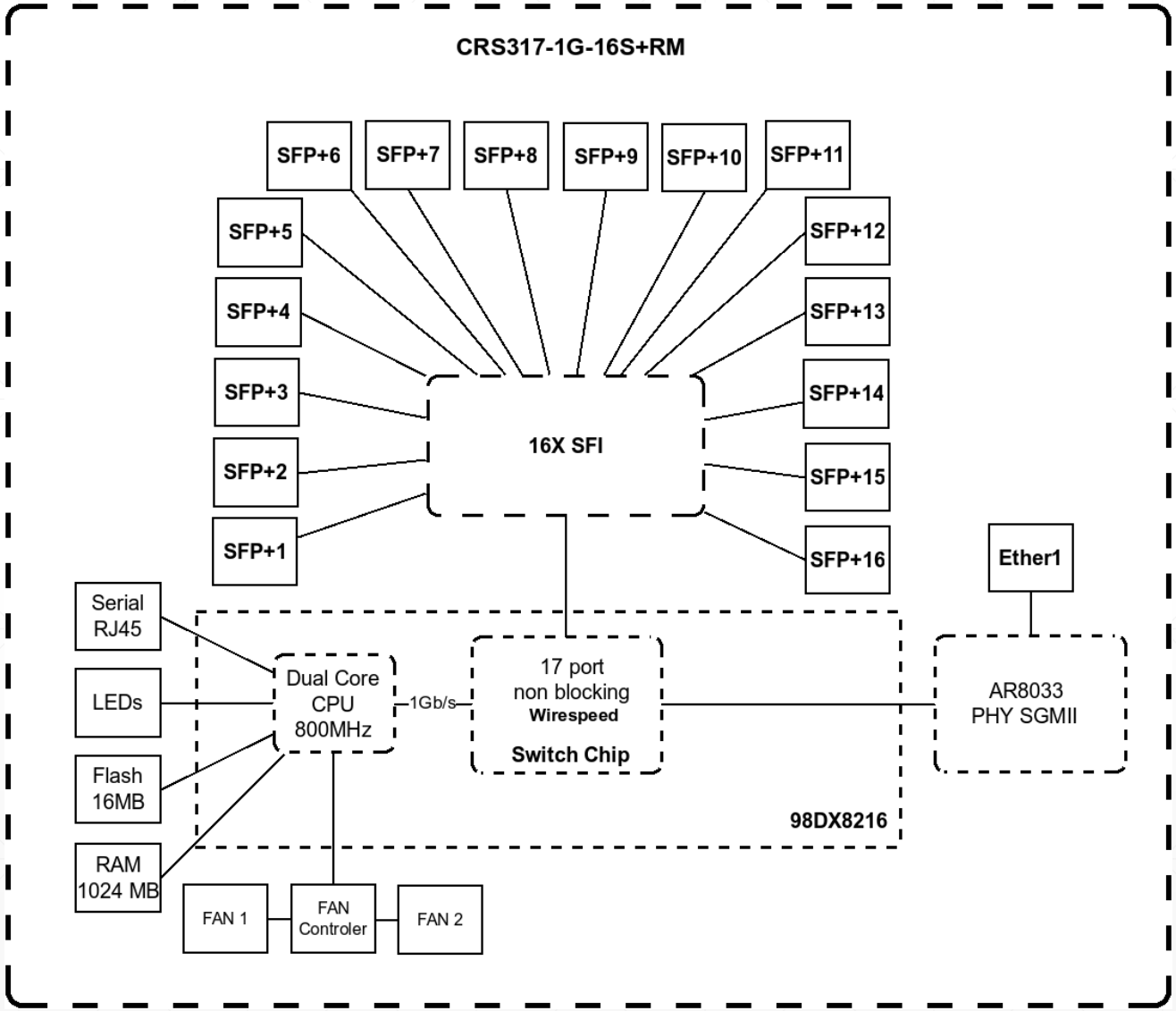
## Switching results

| CRS317-1G-16S+RM | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mode | Configuration | 1518 byte | | 512 byte | | 64 byte | |
| | | kpps | Mbps | kpps | Mbps | kpps | Mbps |
| Switching | Non blocking Layer 2 throughput | 13,085.2 | 158,906.4 | 37,828.9 | 154,947.4 | 239,583.3 | 122,666.7 |
| Switching | Non blocking Layer 2 capacity | 13,085.2 | 317,812.7 | 37,828.9 | 309,894.7 | 239,583.3 | 245,333.3 |
| Switching | Non blocking Layer 1 throughput | 13,085.2 | 161,000.0 | 37,828.9 | 161,000.0 | 239,583.3 | 161,000.0 |
| Switching | Non blocking Layer 1 capacity | 13,085.2 | 322,000.0 | 37,828.9 | 322,000.0 | 239,583.3 | 322,000.0 |

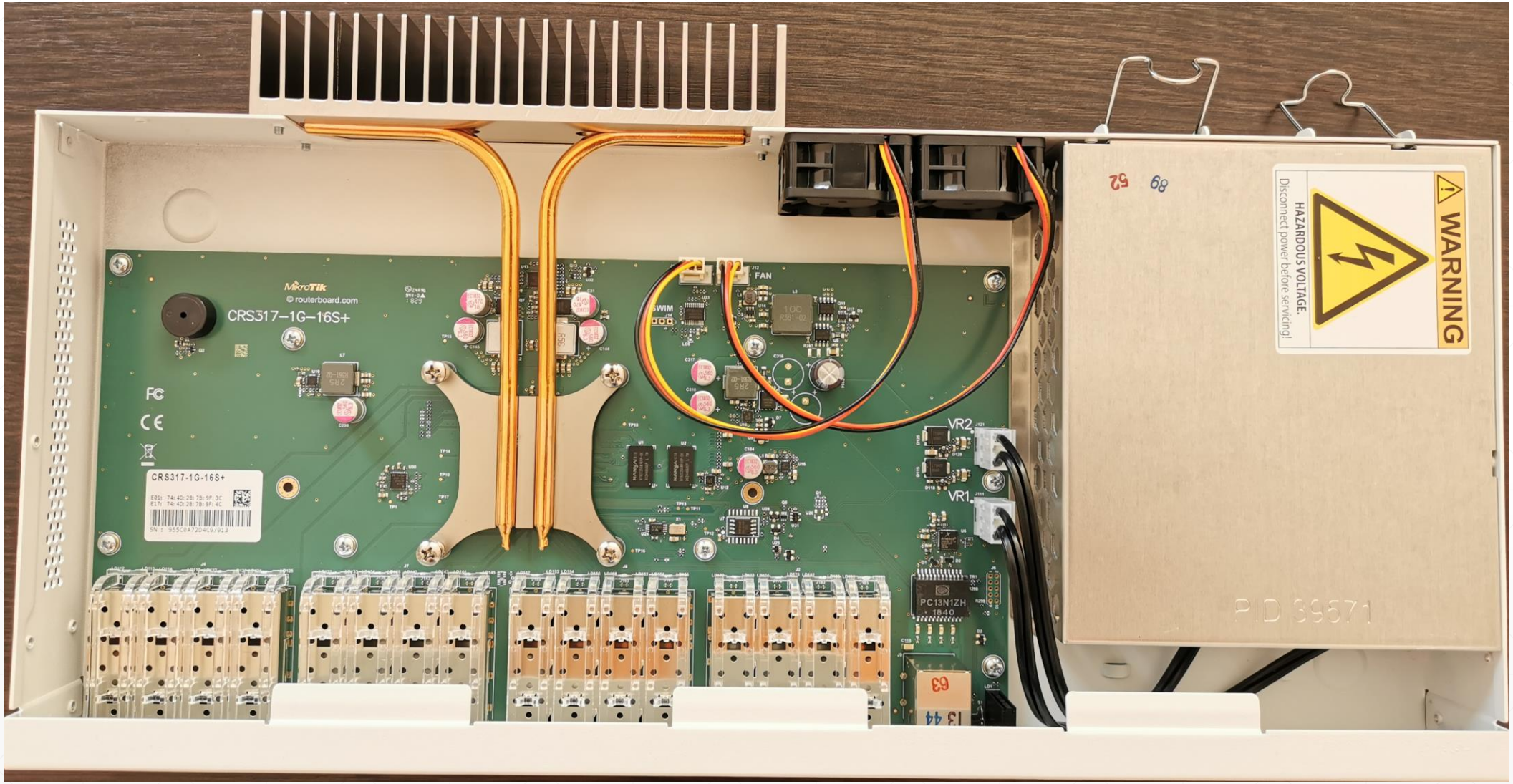
## Ethernet test results

| CRS317-1G-16S+RM | | 98DX8216B0 all port test | | | | | |
|---|---|---|---|---|---|---|---|
| Mode | Configuration | 1518 byte | | 512 byte | | 64 byte | |
| | | kpps | Mbps | kpps | Mbps | kpps | Mbps |
| Bridging | none (fast path) | 268.3 | 3258.2 | 361.2 | 1479.5 | 355.2 | 181.9 |
| Bridging | 25 bridge filter rules | 98.4 | 1195.0 | 98.6 | 403.9 | 98 | 50.2 |
| Routing | none (fast path) | 254.4 | 3089.4 | 309.8 | 1268.9 | 315.4 | 161.5 |
| Routing | 25 simple queues | 104.6 | 1270.3 | 104.4 | 427.6 | 104.6 | 53.6 |
| Routing | 25 ip filter rules | 104.6 | 1270.3 | 103.4 | 423.5 | 103.9 | 53.2 |

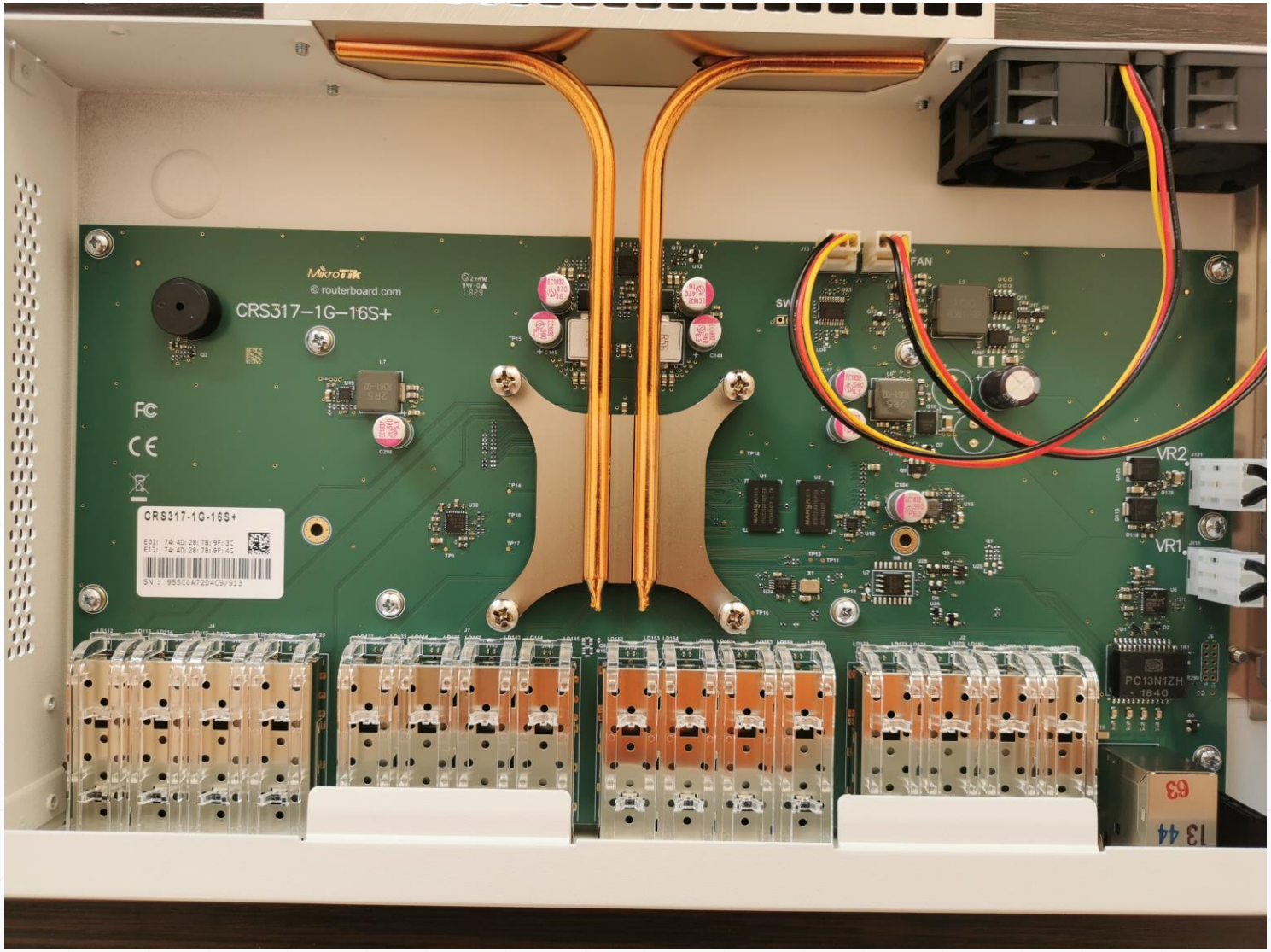
# Mikrotik CRS317-1G-16S+RM



# Mikrotik CRS317-1G-16S+RM

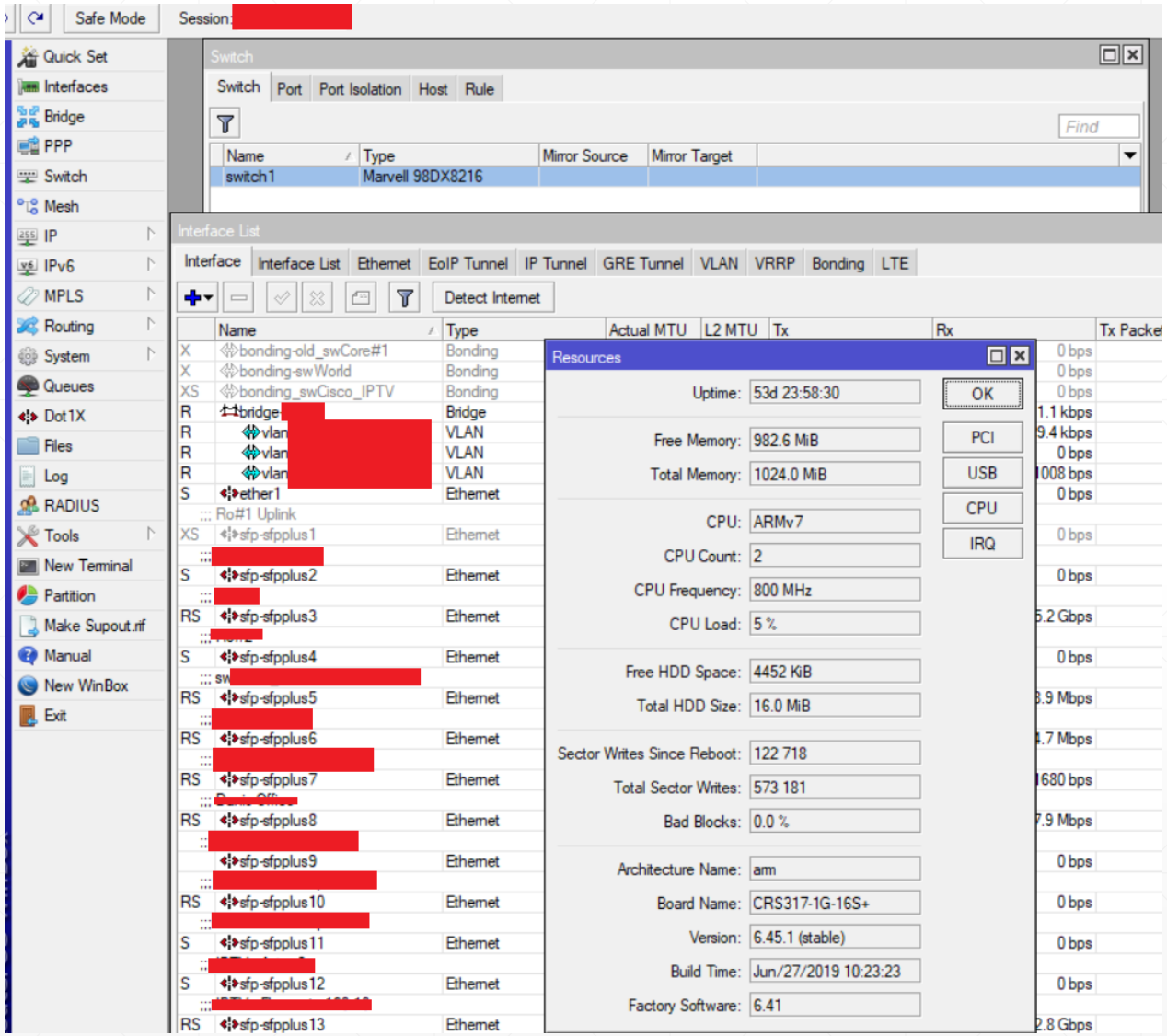


# Mikrotik CRS317-1G-16S+RM



# Mikrotik CRS317-1G-16S+RM

- Полноценный RouterOS L5



# Mikrotik CRS317-1G-16S+RM

- Mikrotik CRS317-1G-16S+RM (16 x 10Gbps, router) - ~480 USD
- D-Link DXS-1100-16SC (16 x 10Gbps, only L2) - ~ 1000 USD
- Cisco SG350XG-24F (24 x 10Gbps) - ~3000 USD






# Mikrotik CRS312-4C+8XG-RM

- ~ 2019
- 8 MultiGig-портов 1/2.5/5/10Gbps RJ-45, 4 combo-порта 10Gbps SFP+/RJ45
- RouterOS L5, Windows/SSH/Telnet/Webfig
- Dual boot RouterOS/swOS
- Full L2-managed switch + router (not L3 switch!!!)
- Active cooling, -30°C to 70°C!
- Chipset Marvell 98DX8212
- IGMP snooping, LACP trunks, DHCP snooping & option 82, VLANs, RSTP, ACLs, etc
- ~ 720 USD !!!






# Mikrotik CRS312-4C+8XG-RM

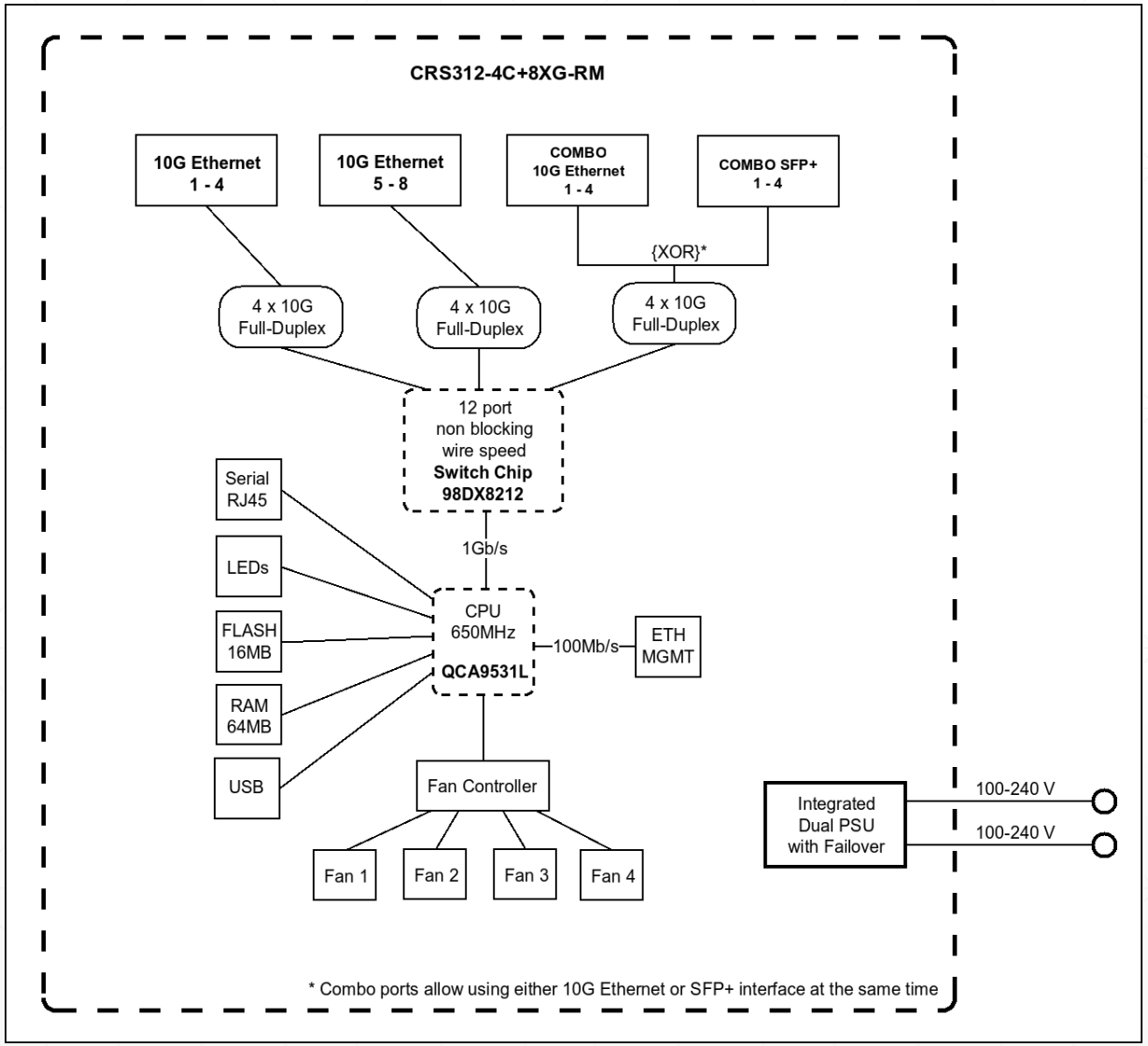
## Specifications

| | |
|---|---|
| Product code | CRS312-4C+8XG-RM |
| CPU | QCA9531, 650 MHz |
| Size of RAM | 64 MB |
| Storage | 16 MB flash |
| 10/100 Ethernet ports | 1 |
| 1G/2.5G/5G/10G RJ45 Ethernet ports | 8 |
| Combo 10G Ethernet / SFP ports | 4 |
| Supported input voltage | AC power supply 100 - 240 V |
| Redundant supply | Yes |
| USB port | USB type A |
| Serial port | RJ45 |
| Dimensions | 443 x 183 x 44 mm |
| Operating temperature | -30°C .. +70°C |
| Operating system | RouterOS or SwitchOS, License level 5 |
| Max power consumption | 60 W |

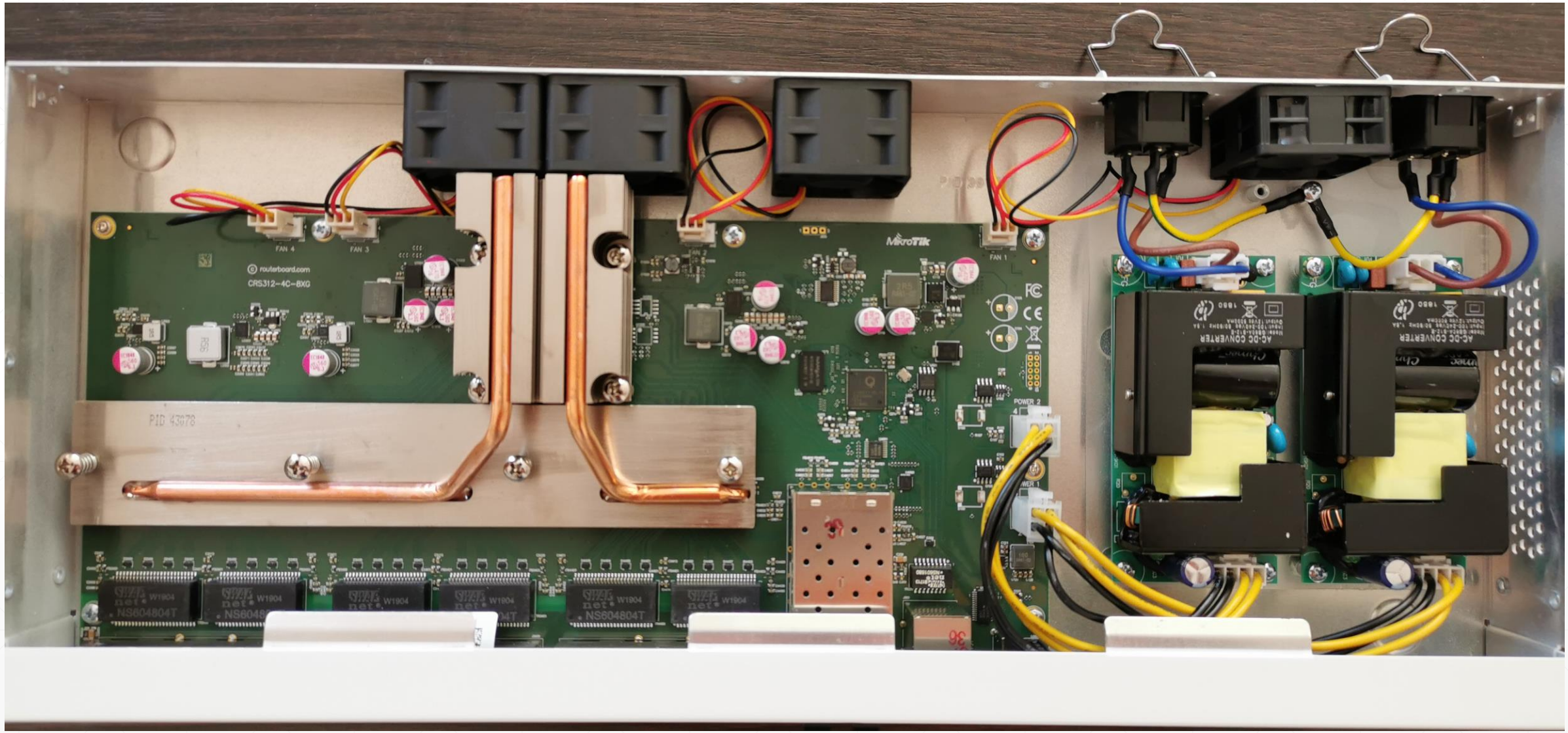
# Mikrotik CRS312-4C+8XG-RM

| CRS312-4C+8XG-RM | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mode | Configuration | 1518 byte | | 512 byte | | 64 byte | |
| | | kpps | Mbps | kpps | Mbps | kpps | Mbps |
| Switching | Non blocking Layer 2 throughput | 9,761.1 | 118,538.2 | 28,219.0 | 115,585.0 | 178,720.2 | 91,504.8 |
| Switching | Non blocking Layer 2 capacity | 9,761.1 | 237,076.5 | 28,219.0 | 231,169.9 | 178,720.2 | 183,009.5 |
| Switching | Non blocking Layer 1 throughput | 9,761.1 | 120,100.0 | 28,219.0 | 120,100.0 | 178,720.2 | 120,100.0 |
| Switching | Non blocking Layer 1 capacity | 9,761.1 | 240,200.0 | 28,219.0 | 240,200.0 | 178,720.2 | 240,200.0 |

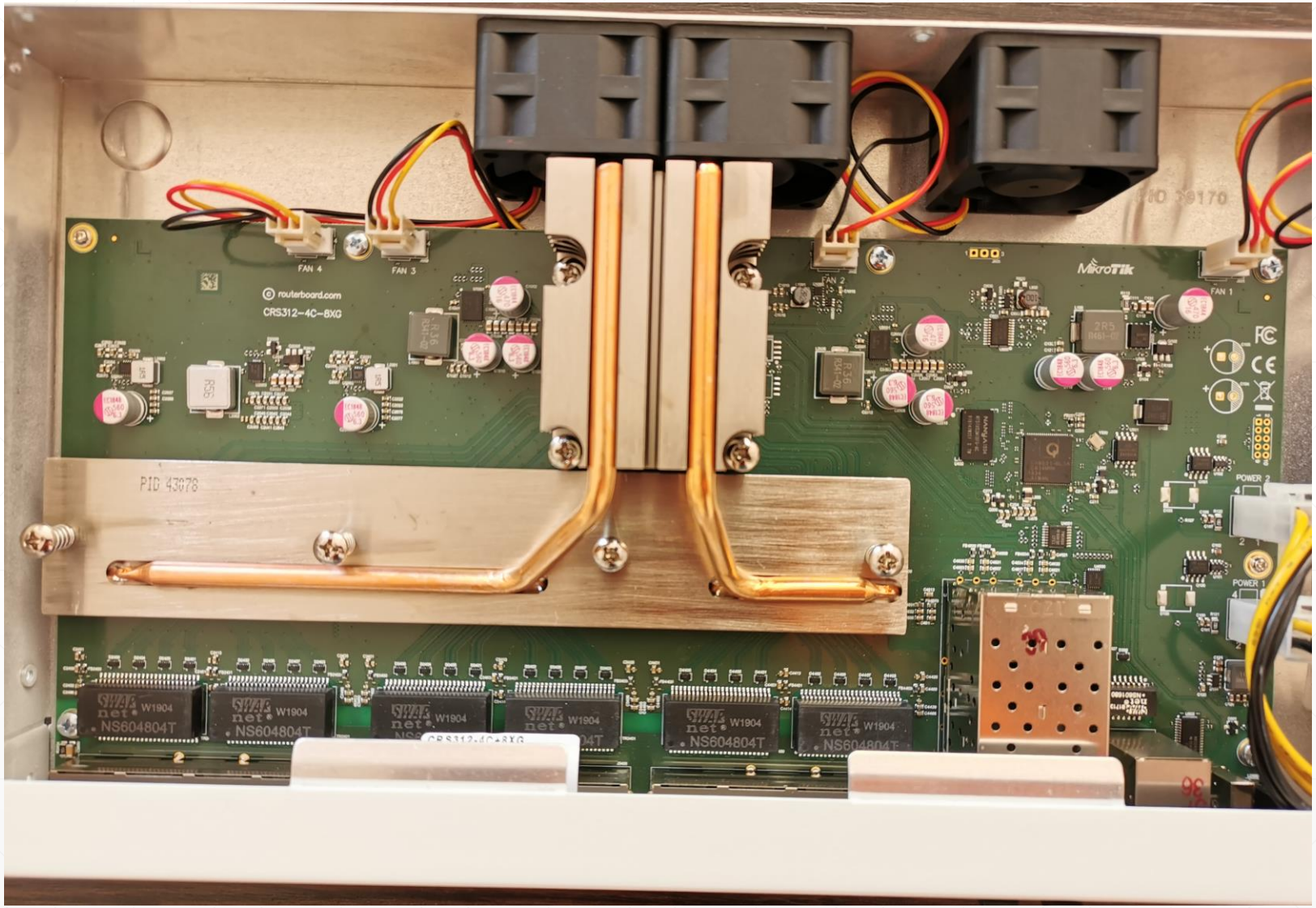
# Mikrotik CRS312-4C+8XG-RM



# Mikrotik CRS312-4C+8XG-RM



# Mikrotik CRS312-4C+8XG-RM

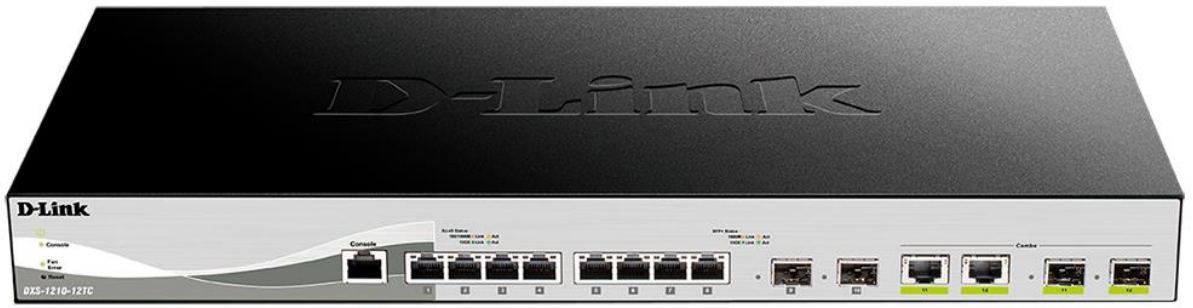


# Mikrotik CRS312-4C+8XG-RM

- Mikrotik CRS312-4C+8XGRM (12 x 10Gbps, router) - ~720 USD
- Ubiquiti EdgeSwitch 16 XG (12 x 10Gbps, only one power supply) - ~600 USD
- D-Link DXS-1210-12TC (12 x 10Gbps) - ~ 1800 USD
- Cisco SX350X-12 (12 x 10Gbps) - ~2500 USD







# Mikrotik CRS326-24S+2Q+RM

- ~ 2019
- 24 порта 10Gbps SFP+, 2 порта 40Gbps QSFP+
- RouterOS L5, Windows/SSH/Telnet/Webfig
- Dual boot RouterOS/swOS
- Full L2-managed switch + router (not L3 switch!!!)
- Active cooling, -20°C to 60°C!
- Chipset Marvell 98DX3232
- IGMP snooping, LACP trunks, DHCP snooping & option 82, VLANs, RSTP, ACLs, etc
- ~ 600 USD !!!





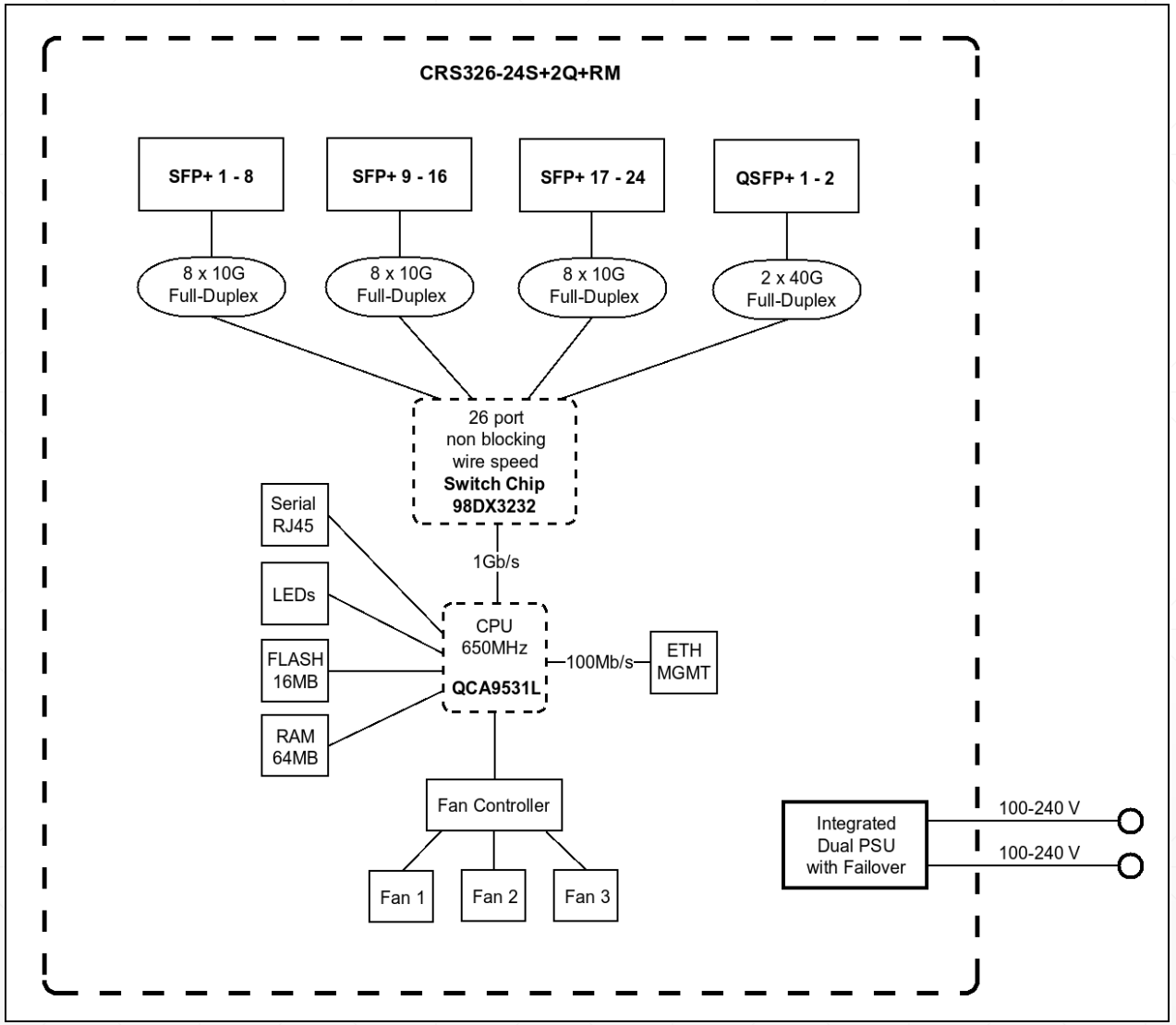

# Mikrotik CRS326-24S+2Q+RM

| | |
|---|---|
| Product code | CRS326-24S+2Q+RM |
| CPU | QCA9531, 650 MHz |
| Size of RAM | 64 MB |
| Storage | 16 MB flash |
| 10/100 Ethernet ports | 1 |
| 10G SFP+ ports | 24 |
| 40G QSFP+ ports | 2 |
| Supported input voltage | AC power supply 100 - 240 V |
| Redundant supply | Yes |
| USB port | USB type A |
| Serial port | RJ45 |
| Dimensions | 443 x 183 x 44 mm |
| Operating temperature | -20°C .. +60°C |
| Operating system | RouterOS or SwitchOS, License level 5 |
| Max power consumption | 69 W |

# Mikrotik CRS326-24S+2Q+RM

| CRS326-24S+2Q+RM | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mode | Configuration | 1518 byte | | 512 byte | | 64 byte | |
| | | kpps | Mbps | kpps | Mbps | kpps | Mbps |
| Switching | Non blocking Layer 2 throughput | 26,015.9 | 315,937.5 | 75,211.5 | 308,066.2 | 24,0652.5 | 12,3214.1 |
| Switching | Non blocking Layer 2 capacity | 26,015.9 | 631,874.9 | 75,211.5 | 616,132.3 | 24,0652.5 | 24,6428.2 |
| Switching | Non blocking Layer 1 throughput | 26,015.9 | 320,100.0 | 75,211.5 | 320,100.0 | 476,339.3 | 320,100.0 |
| Switching | Non blocking Layer 1 capacity | 26,015.9 | 640,200.0 | 75,211.5 | 640,200.0 | 476,339.3 | 640,200.0 |

# Mikrotik CRS326-24S+2Q+RM



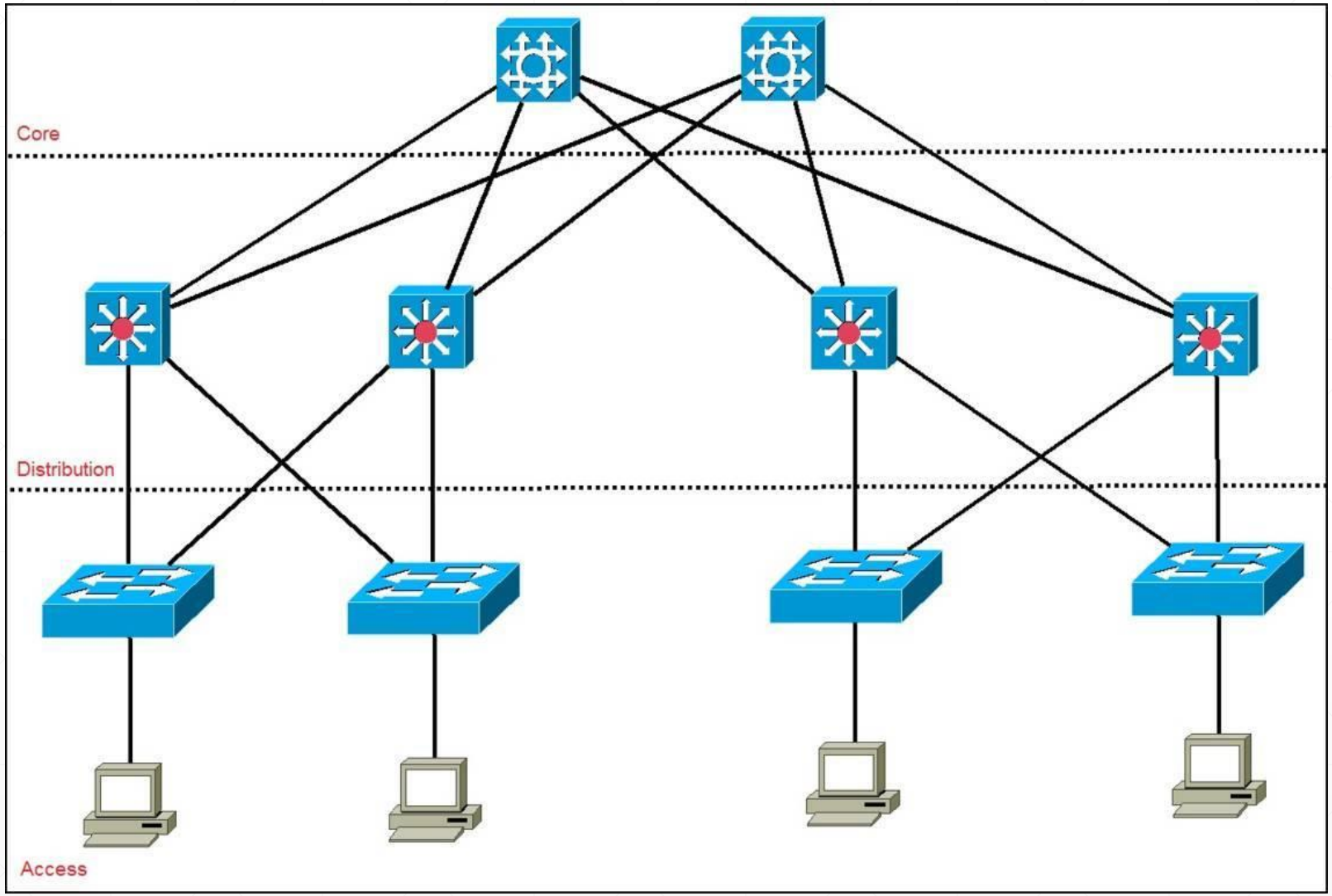
# Mikrotik CRS326-24S+2Q+RM

- Mikrotik CRS326-24S+2Q+RM(24 x 10Gbps, 2 x 40Gbps, router) - ~600 USD
- Cisco Nexus 5672UP-16G (48 x 10Gbps, 6 x 40Gbps, many features) - ~ 25000 USD
- Cisco Meraki MS425-16 (16 x 10Gbps, 2 x 40Gbps) - ~8000 USD






# Позиционирование коммутаторов Mikrotik

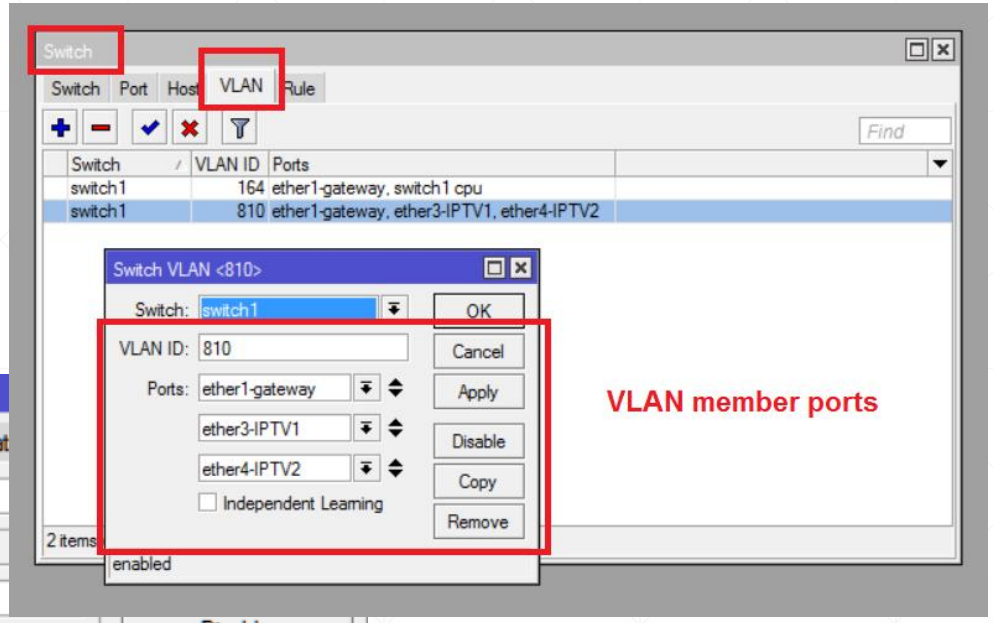


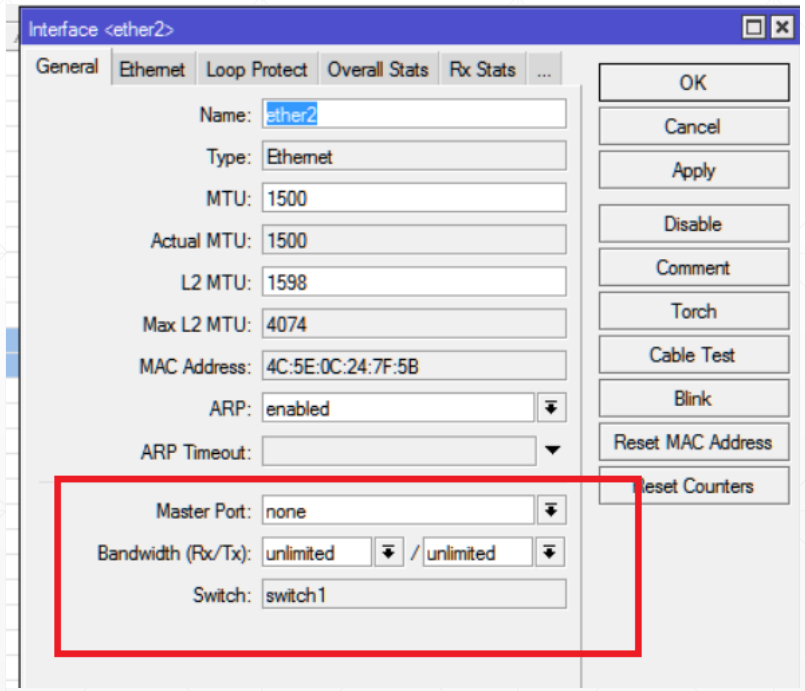
# Позиционирование коммутаторов Mikrotik

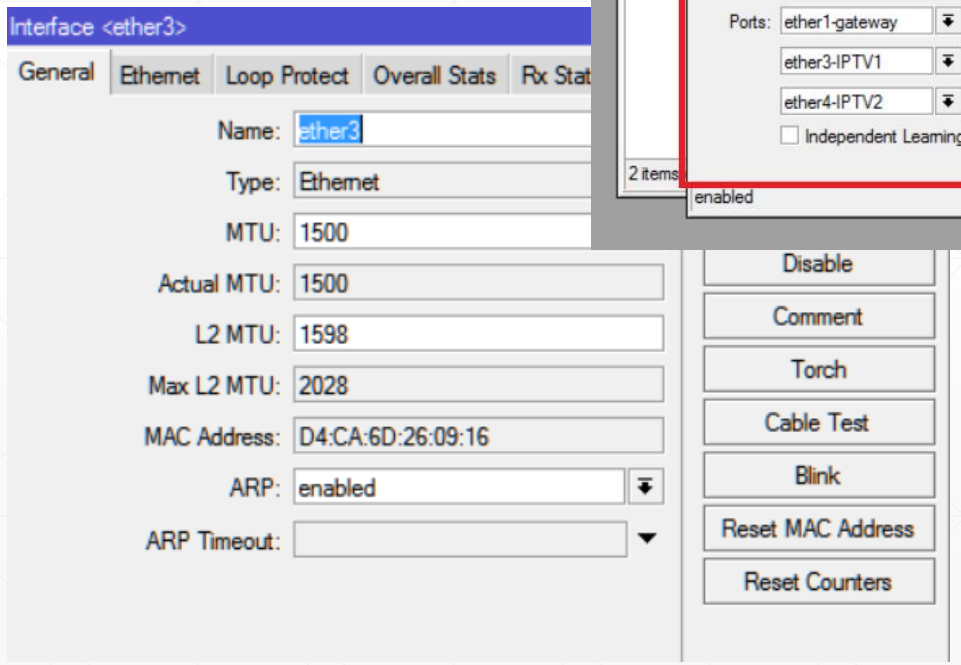
| Access layer | Distribution layer | Core/DC layer |
|---|---|---|
| CSS326-24G-2S+RM | CRS106-1C-5S | CRS305-1G-4S+IN |
| CRS326-24G-2S+RM | CRS105-5S-FB | CRS309-1G-8S+IN |
| CRS328-24P-4S+RM | CRS212-1G-10S-1S+IN | CRS317-1G-16S+RM |
| CRS112-8P-4S-IN | CRS328-4C-20S-4S+RM | CRS326-24S+2Q+RM |
| CSS106-5G-1S | | CRS312-4C+8XG-RM |
| CSS106-1G-4P-1S | | |
| CRS112-8G-4S-IN | | |

# Настройка CRS - bridge

- Старый метод – собирать аппаратный свитч через master/slave-порты
- Настройка VLAN в меню switch
- Отдельно настраиваются software/hardware bridge
- RSTP в software

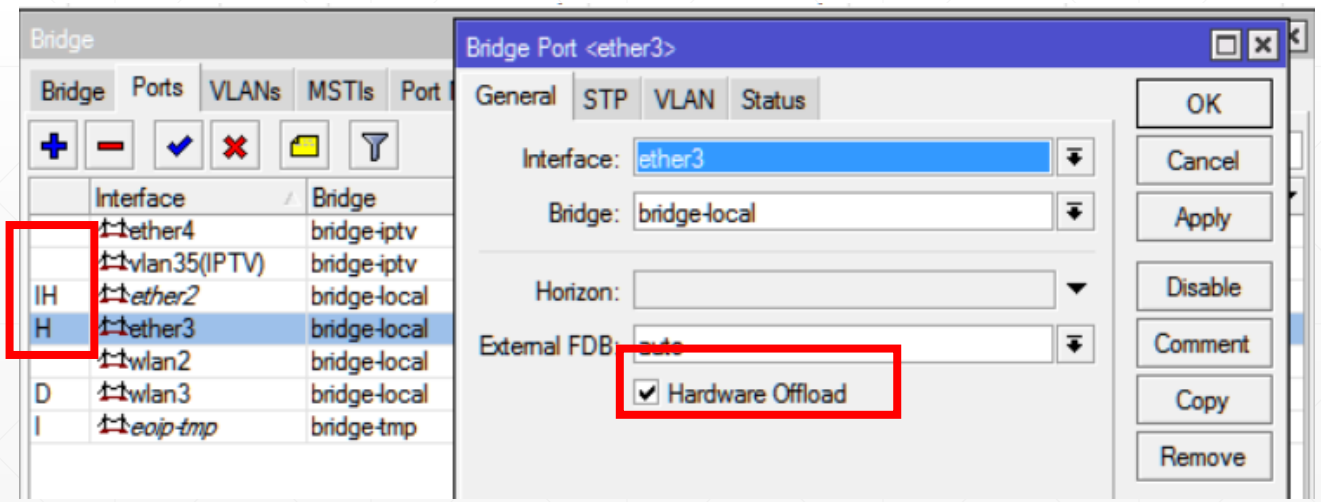


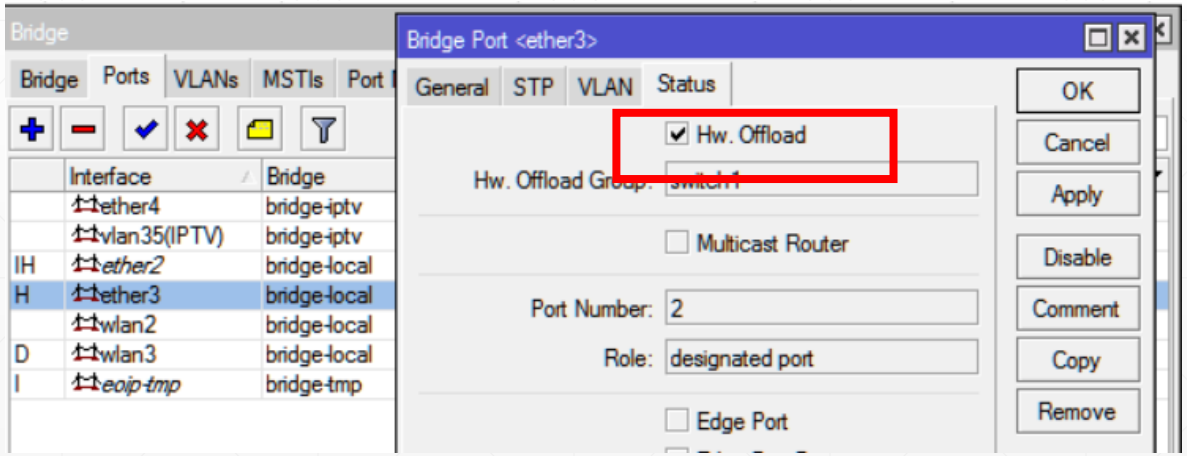



# Настройка CRS - bridge

- Новый метод настройки bridge с версии RouterOS 6.41.
- Единое меню настройки software/hardware bridge и всех(*) функций L2 на девайсах Mikrotik – наконец-то ПОЧТИ удобно
- Функция обработки «в железе» включается автоматически на портах
- H – hardware offload
- Если задействуются функции, не поддерживаемые «в железе», hw offload отключается
- Создавать можно несколько bridge, но **hw offload работает только для одного bridge**
- Решение проблемы с одним bridge – использование VLAN

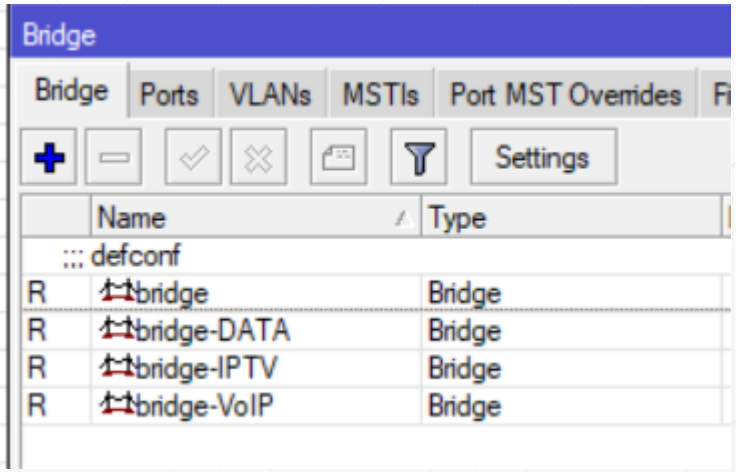


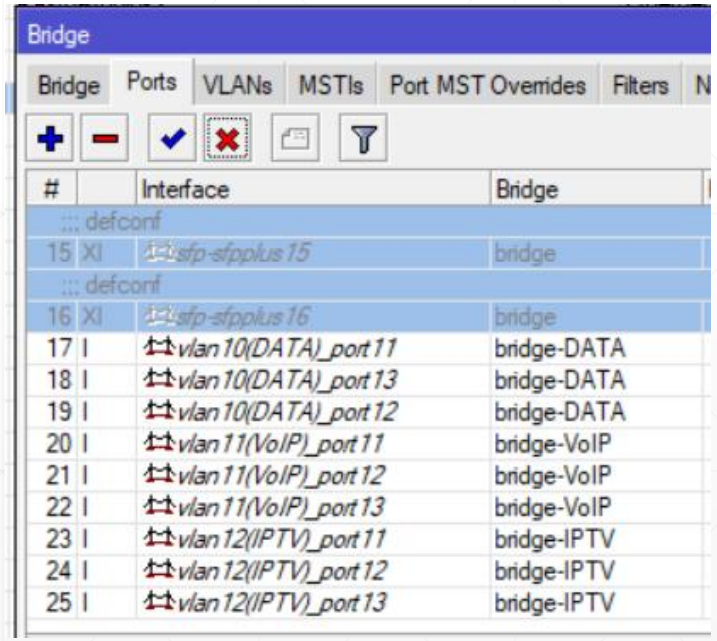



# Настройка CRS - VLAN

- Старый **ПРАВИЛЬНЫЙ** метод – software VLAN
- Объединение L3 VLAN subinterface в software bridge
- Долго настраивать, запутанно
- Нагрузка на процессор!!!
- CRS «тормозит», «плохой свитч»

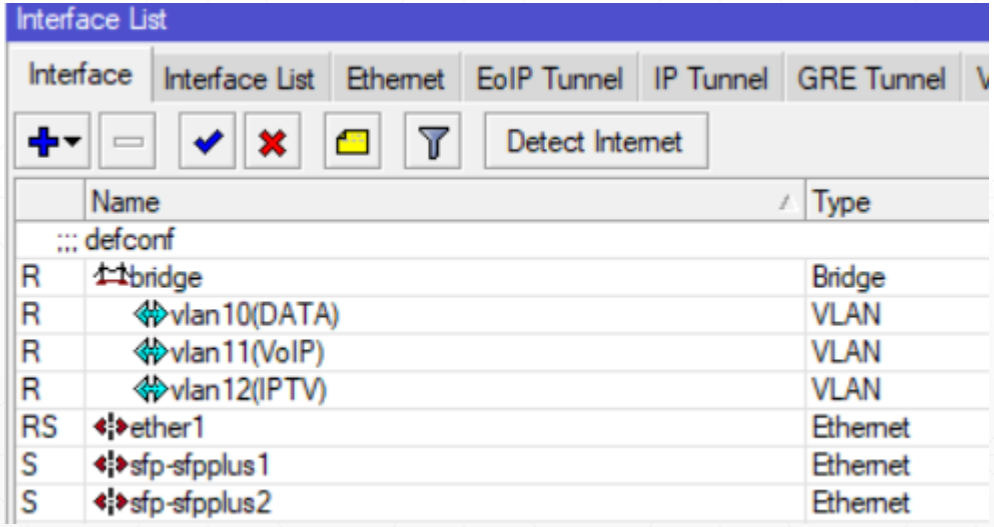
| | |
|---|---|
| sfp-sfpplus11 | Ethernet |
| vlan10(DATA)_port11 | VLAN |
| vlan11(VoIP)_port11 | VLAN |
| vlan12(IPTV)_port11 | VLAN |
| sfp-sfpplus12 | Ethernet |
| vlan10(DATA)_port12 | VLAN |
| vlan11(VoIP)_port12 | VLAN |
| vlan12(IPTV)_port12 | VLAN |
| sfp-sfpplus13 | Ethernet |
| vlan10(DATA)_port13 | VLAN |
| vlan11(VoIP)_port13 | VLAN |
| vlan12(IPTV)_port13 | VLAN |

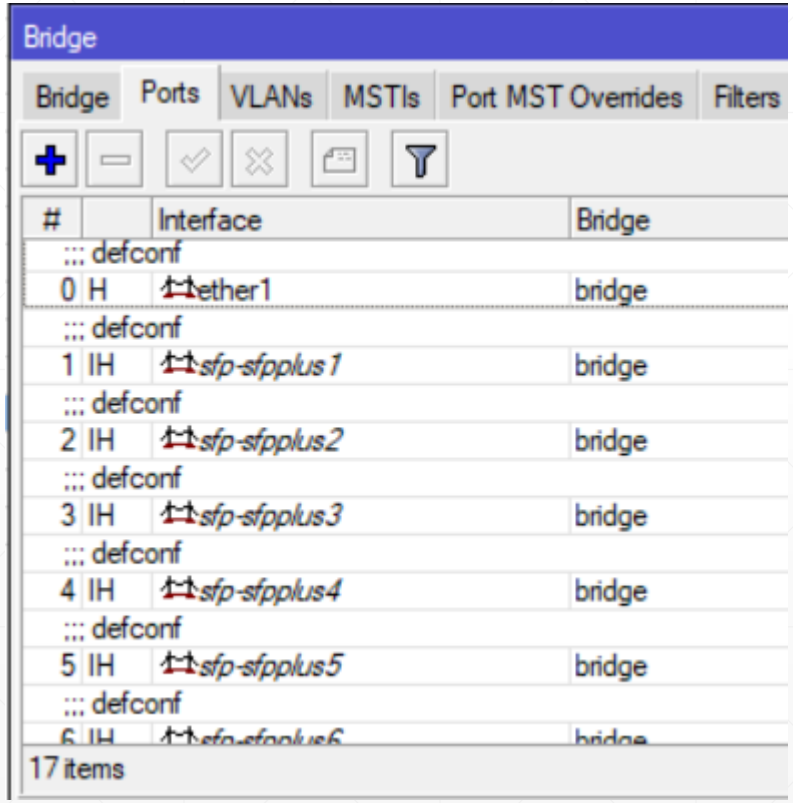


# Настройка CRS - VLAN

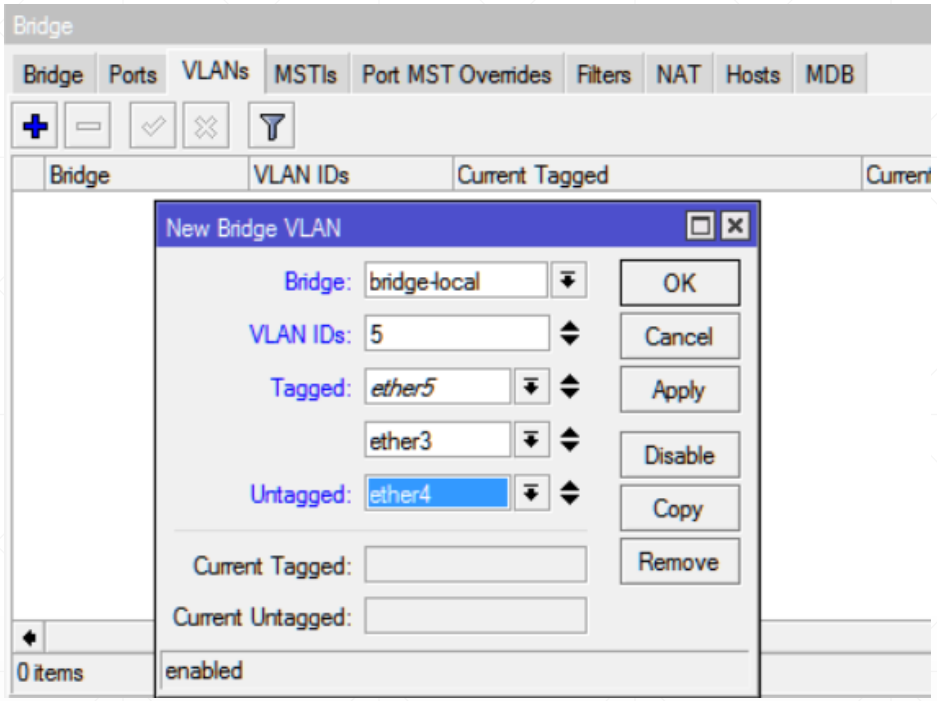
- **НЕПРАВИЛЬНЫЙ** старый метод – software VLAN привязать к bridge
- Работает, если повезет
- Все VLAN-ы работают на всех портах bridge
- Могут возникать L2-петли

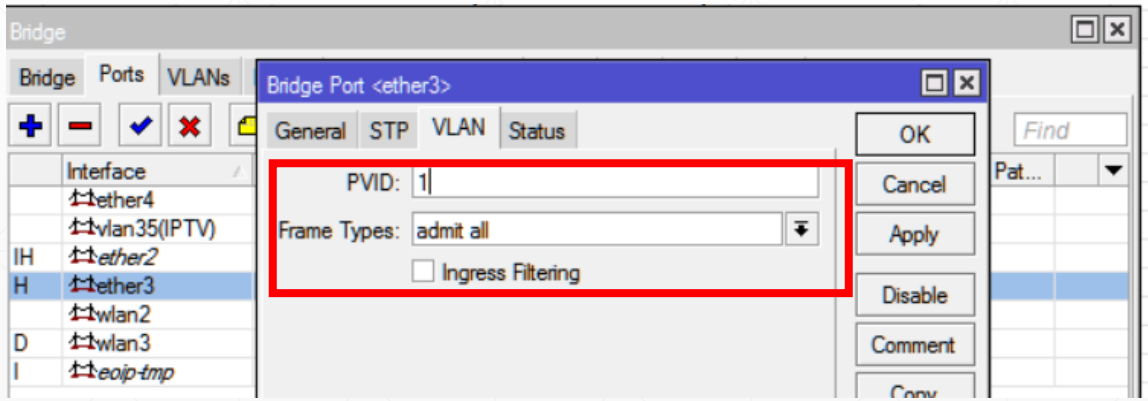


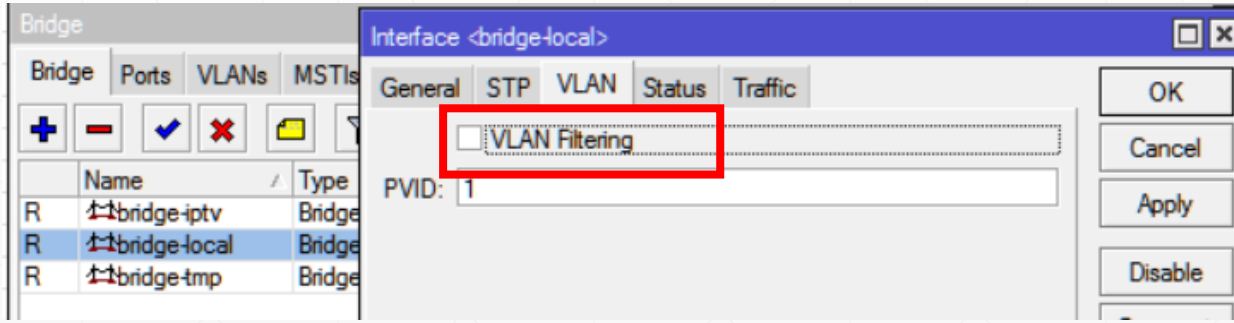



# Настройка CRS - VLAN

- Новый метод настройка VLAN в bridge
- Поддержка VLAN в железе (* см. таблицу дальше)
- Нет нагрузки на процессор
- Поддержка RSTP в железе

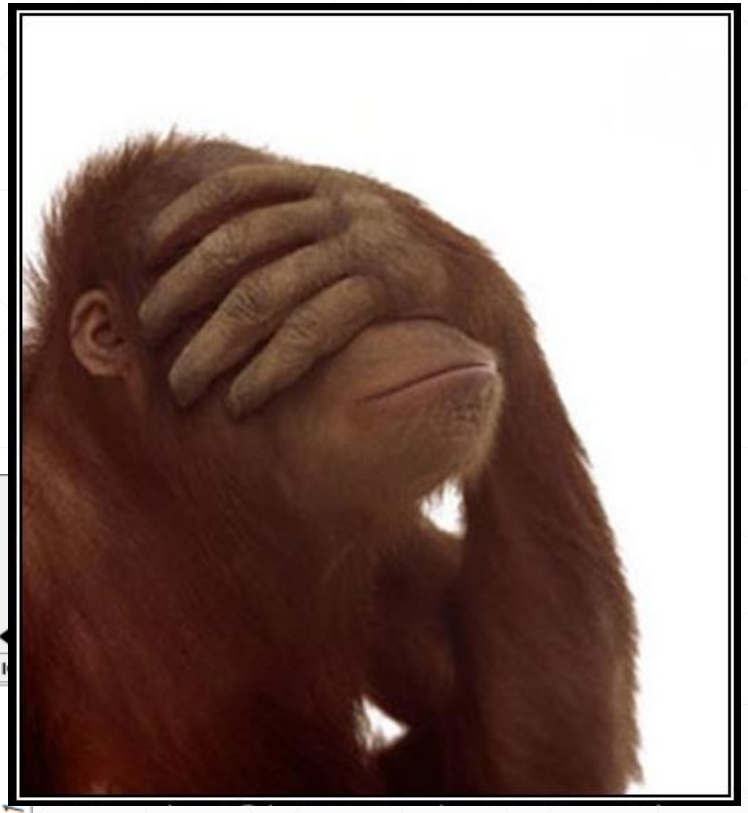


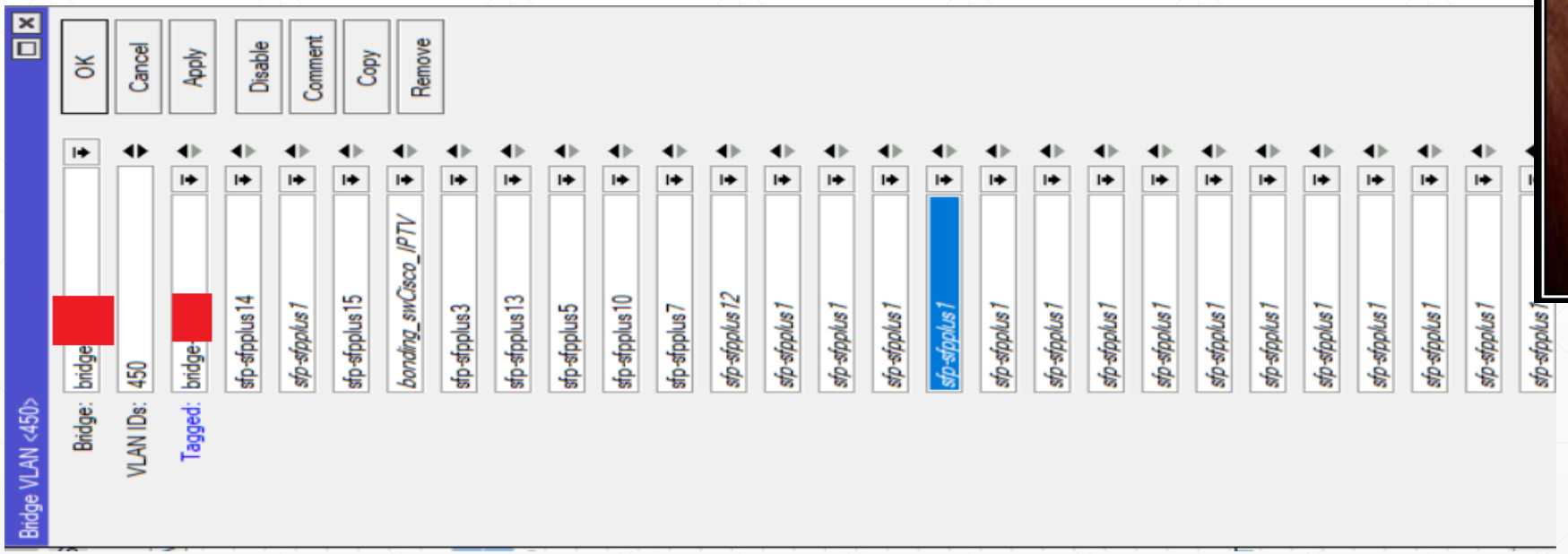



# Настройка CRS - VLAN

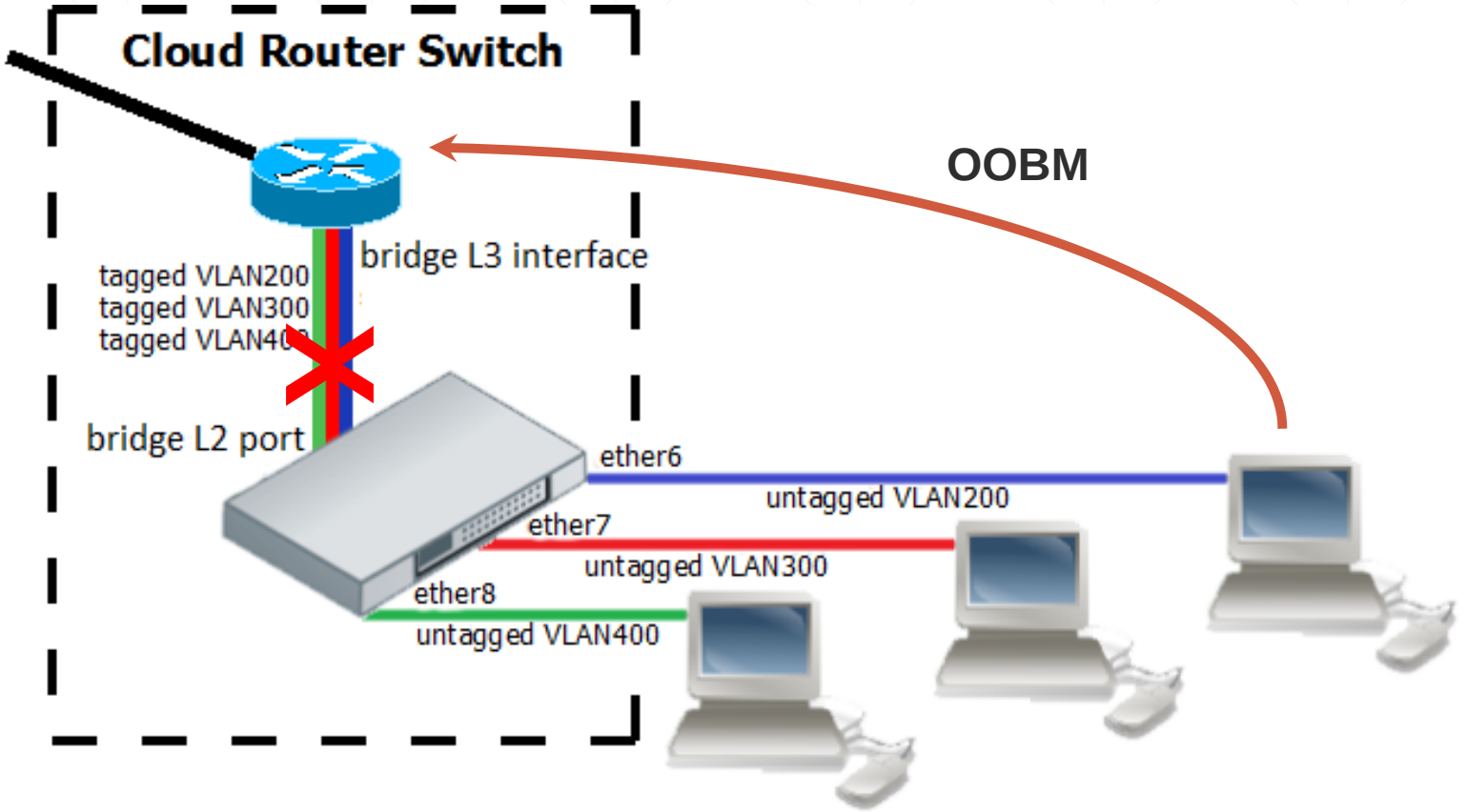
- Список интерфейсов в окне настройки VLAN не помещается на экране
- Нет прокрутки
- Хороший стимул переходить на 4к мониторы





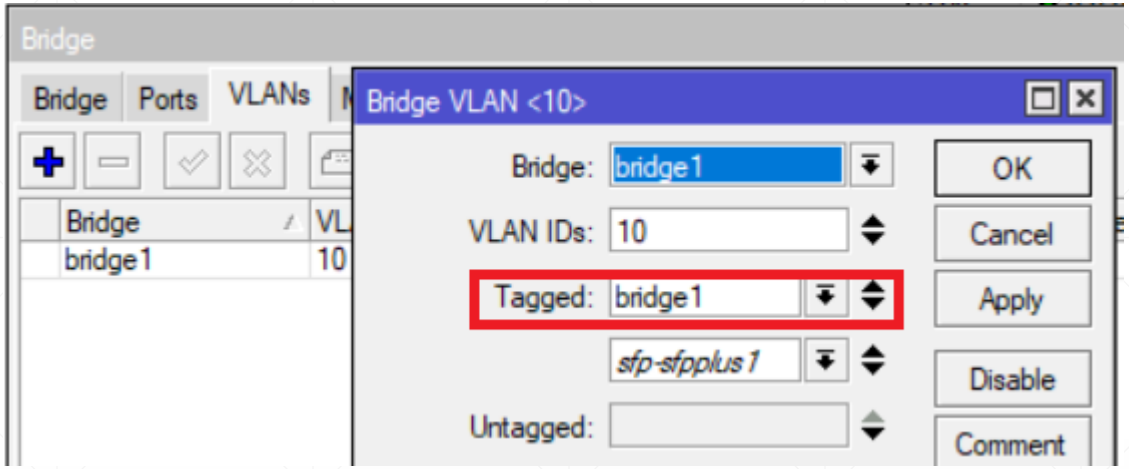
# Настройка CRS – Management VLAN

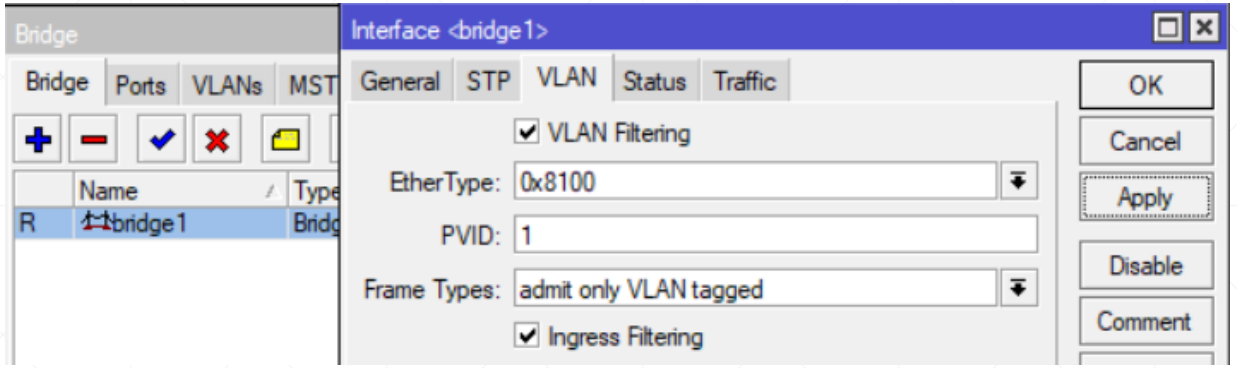
- CRS = router + switch, между которыми есть виртуальный линк – bridge
- RouterOS и весь менеджмент находятся на рутере
- При настройке VLAN есть риск потерять доступ к менеджменту из-за того, что порт коммутатора с PC и bridge-линк  в сторону рутера окажутся в разных VLAN между которыми не настроен InterVLAN routing
- Делайте настройку через OOBM-порт, который остается «подключенным» к рутеру мимо коммутатора или консоль

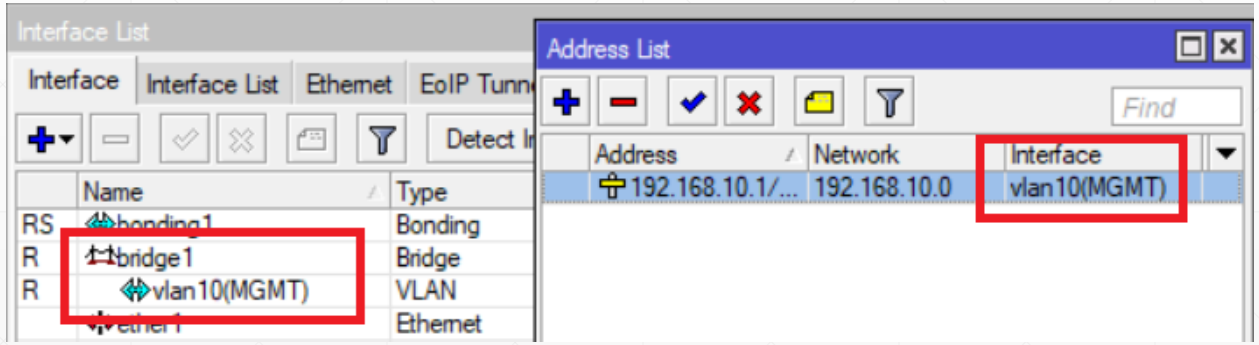


# Настройка CRS – Management VLAN

- Можно настраивать VLAN без OOBM-порта, работая через switch chip, но очень осторожно и в строгой последовательности

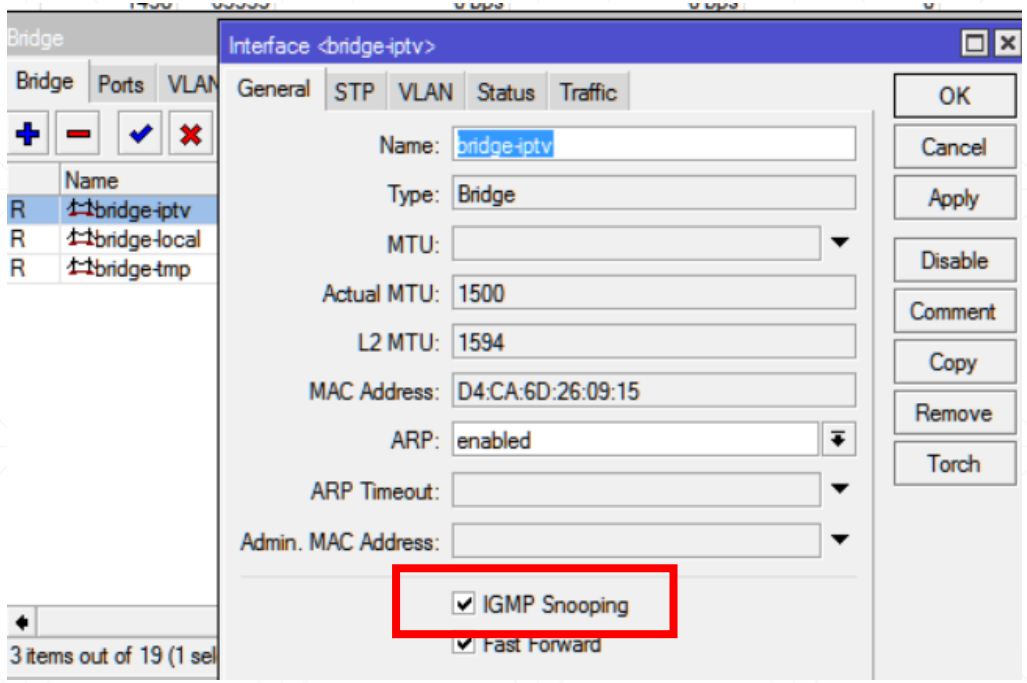


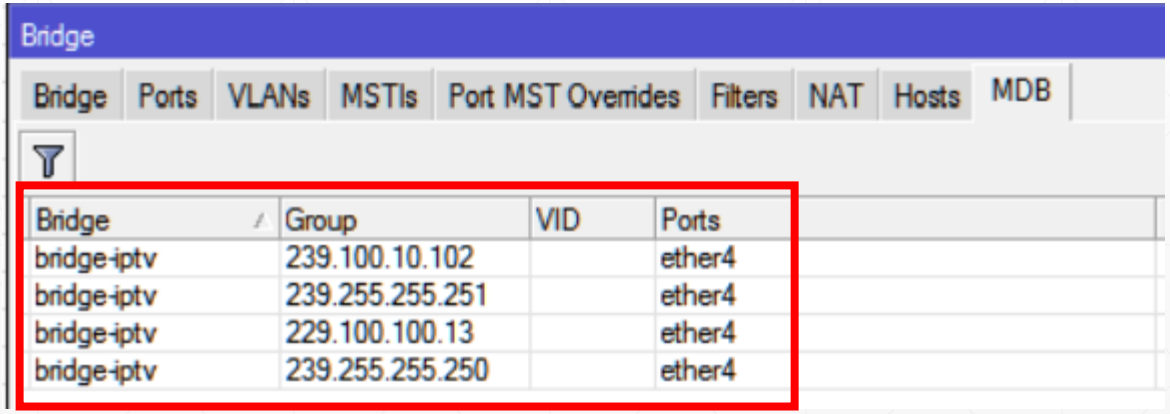



# Настройка CRS – IGMP snooping

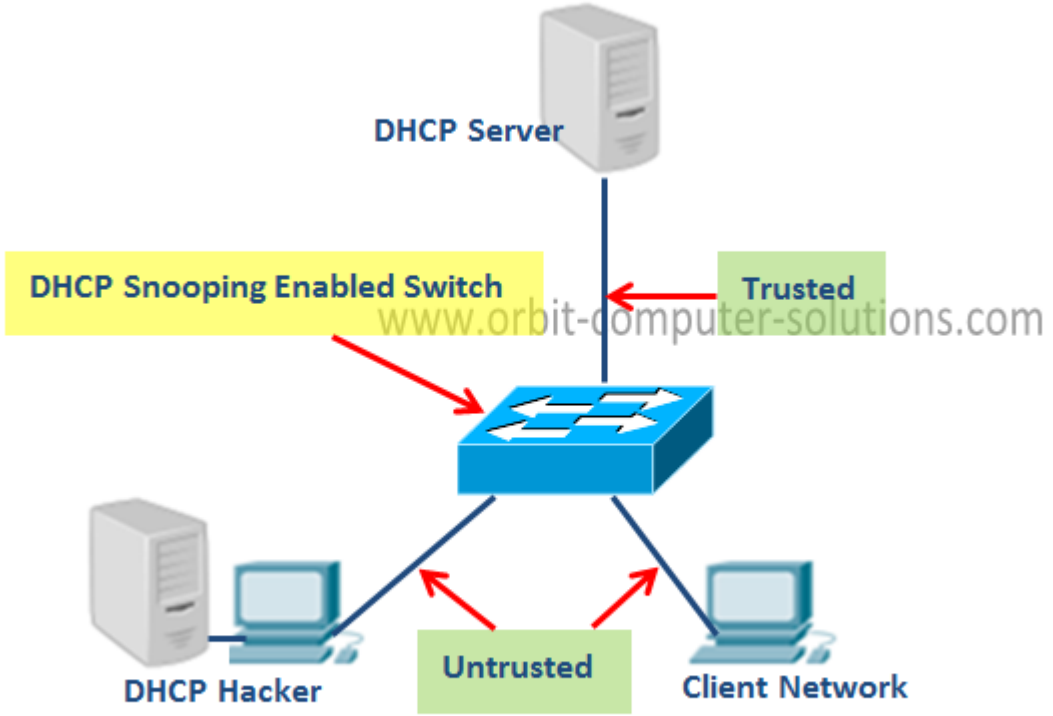
- Multicast-трафик передавался, как broadcast на все порты, загружая порты, CPU роутера и т.д.
- Поддержка IGMP snooping с версии ROS 6.40
- Включение IGMP snooping вызывает отключение hw offload (кроме CRS)
- Активация IGMP snooping делается в свойствах bridge-интерфейса
- Во вкладке MDB показан список Multicast-групп и портов

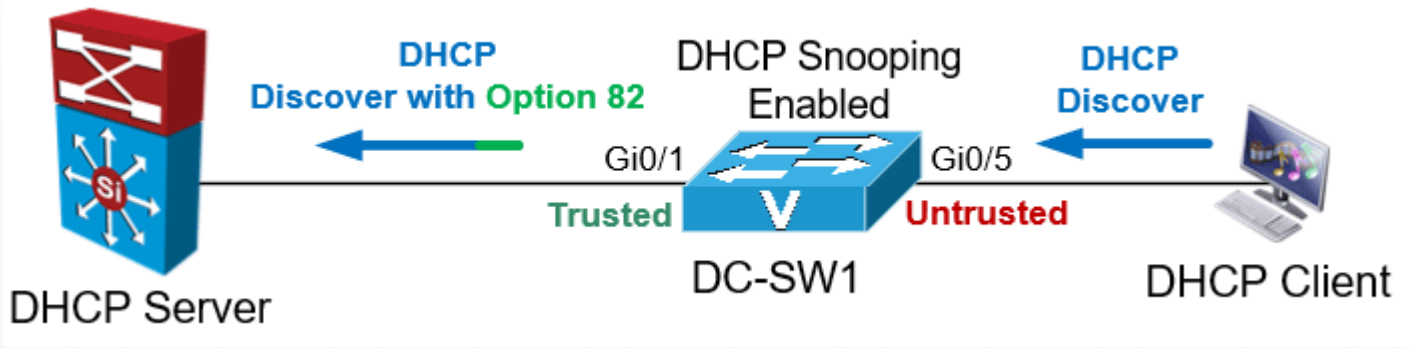


# Настройка CRS – DHCP snooping

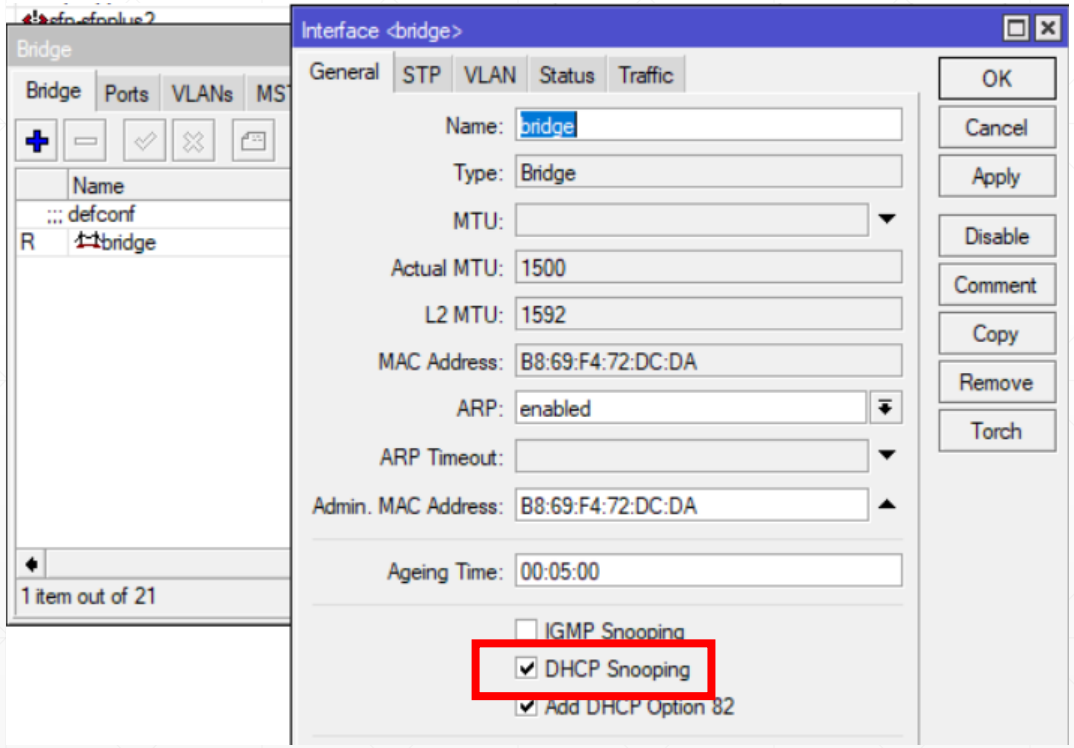
- Защита от неавторизированных DHCP-серверов
- Запрещены ответы от DHCP-серверов, подключенных к untrusted портам
- DHCP option 82 – коммутатор добавляет к DHCP-запросу идентификатор порта (ISP, биллинг)

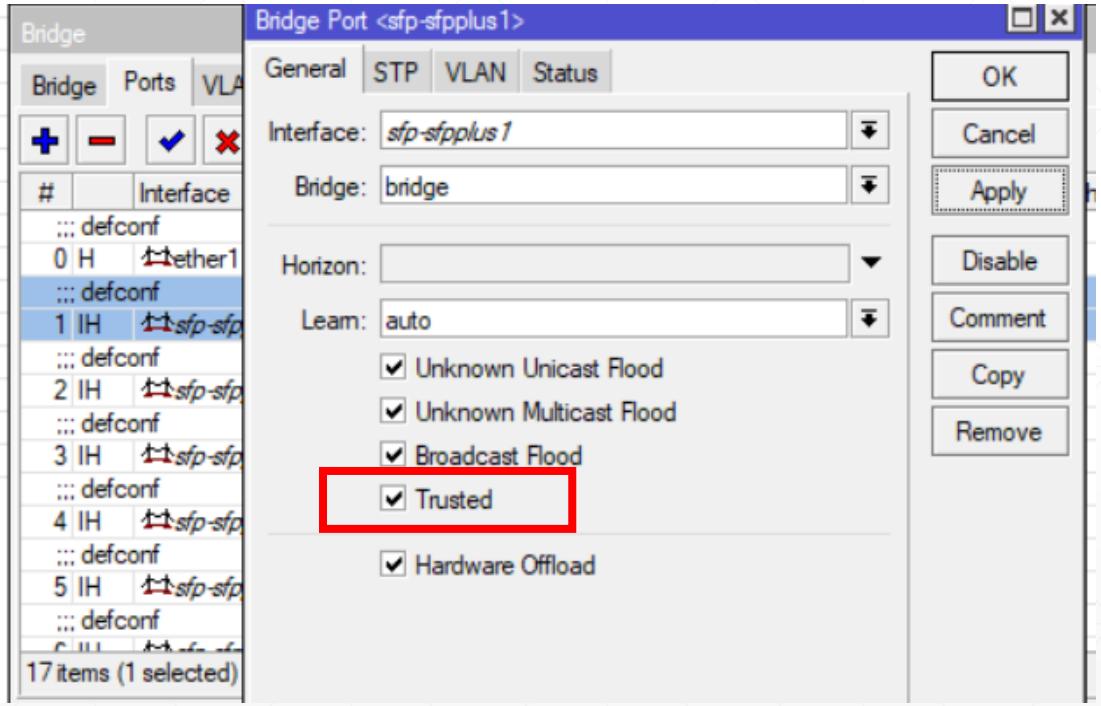


# Настройка CRS – DHCP snooping

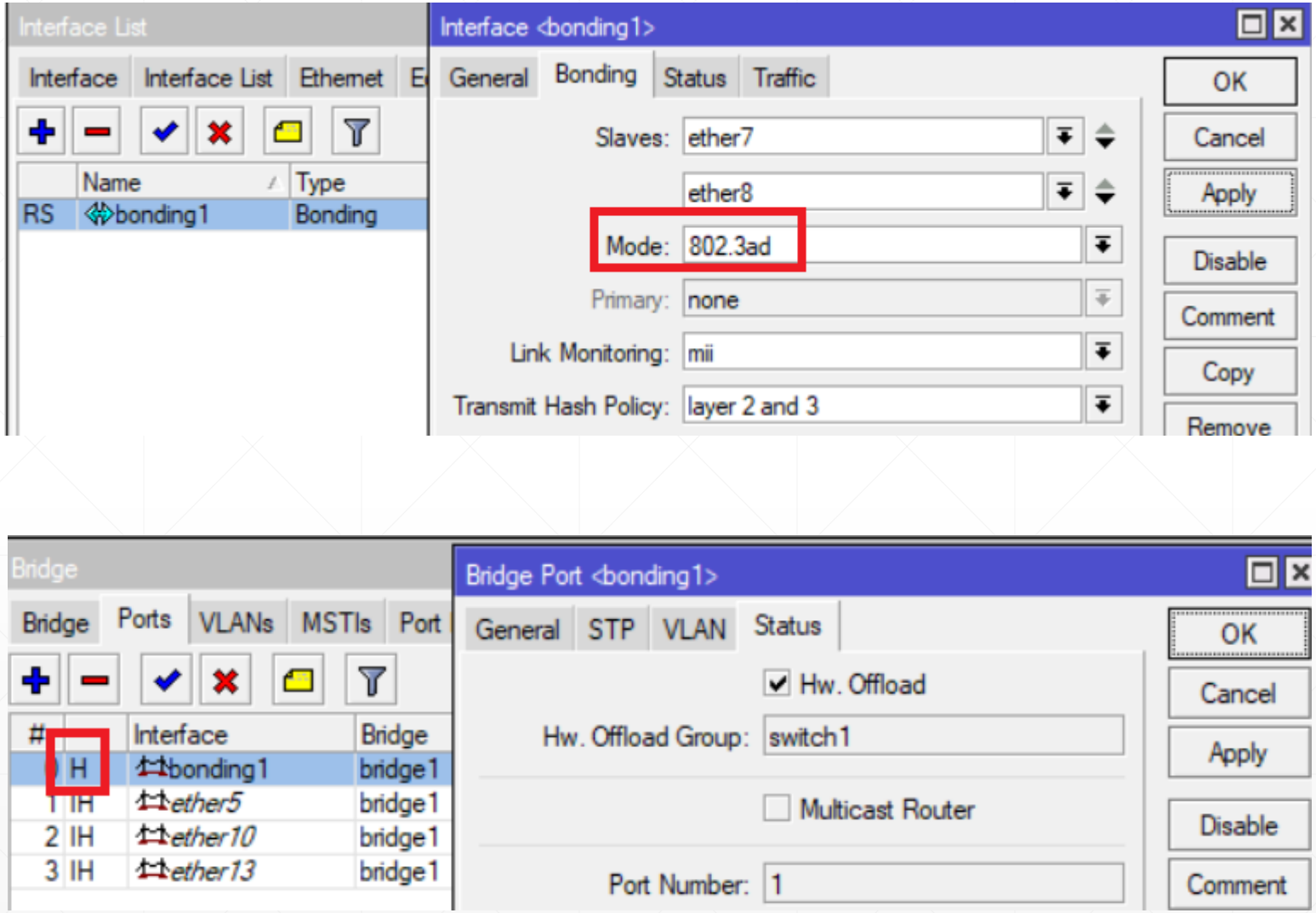
- При включении DHCP snooping не забывайте указать trusted порт



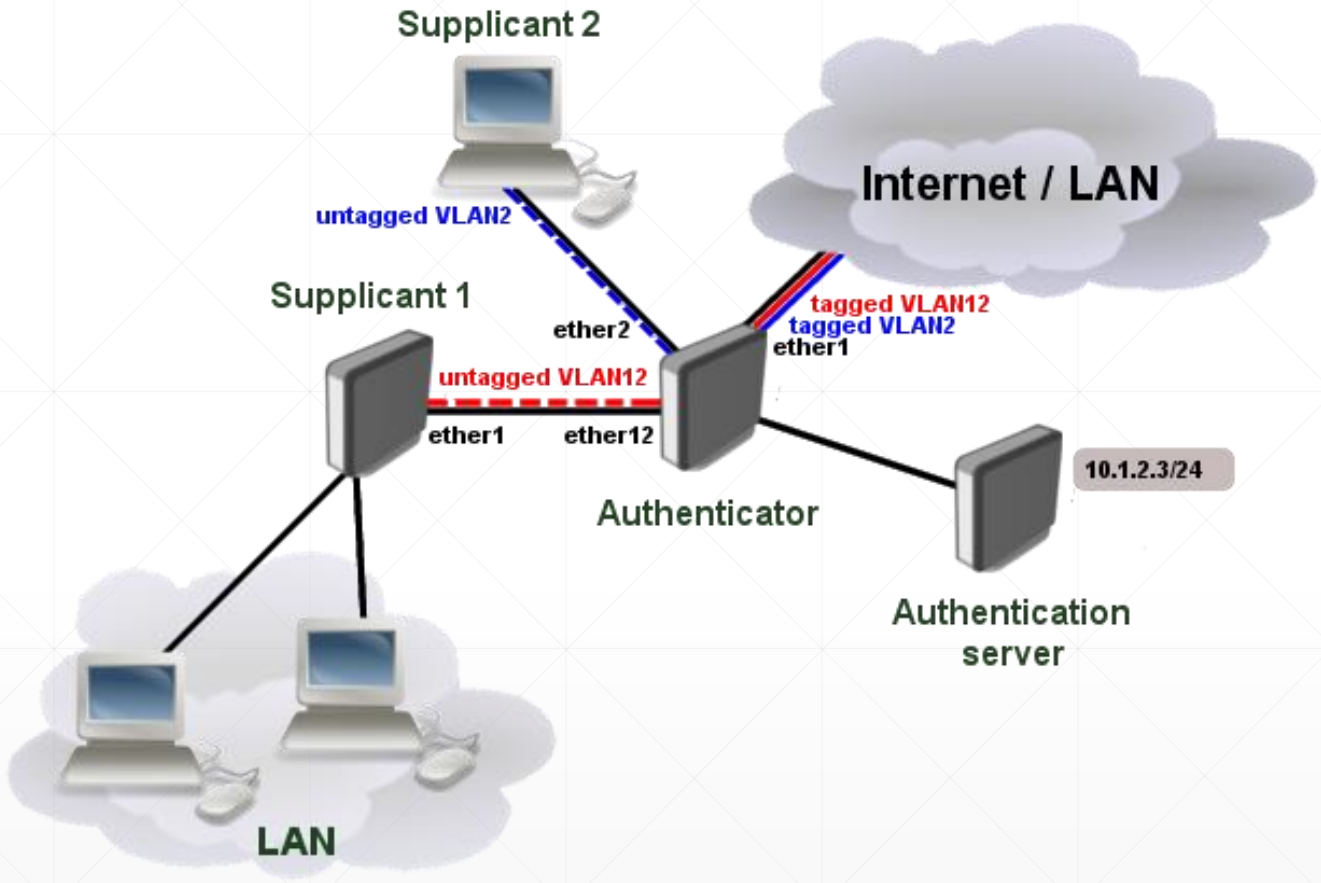
# Настройка CRS – LACP bonding

- Настройка bonding с поддержкой в «железе» не отличается от обычной настройки bonding в RouterOS:
  - Физические интерфейсы для bonding нужно убрать из bridge port
  - Создать интерфейс bonding, выбрать только протокол 8023.ad (LACP), добавить slave-интерфейсы
  - Добавить bonding-интерфейс в bridge port
  - Если чип поддерживает LACP в «железе», включится hw offloading
- Работает в «железе» только в CRS3xx



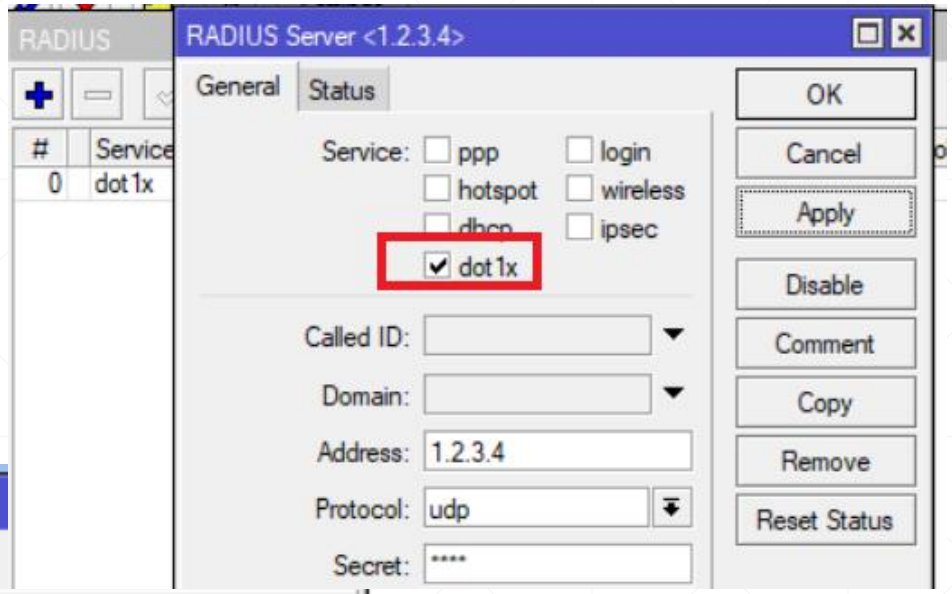
# Настройка CRS – 802.1x

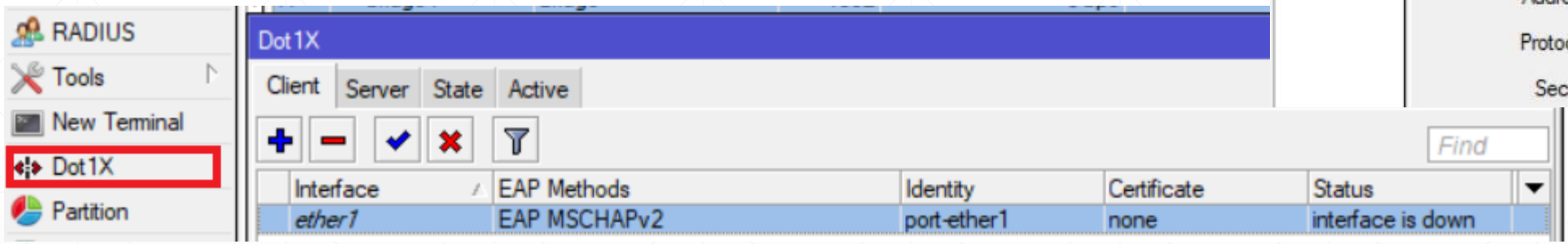
- Очень запрашиваемая Enterprise-клиентами фича
- Порт не включается, пока подключенное устройство не пройдет аутентификацию (сертификат, пароль, веб)
- Можно динамически присваивать порту untagged VLAN в зависимости от подключенного устройства и его аутентификации (RADIUS Tunnel-Type, Tunnel-Medium-Type and Tunnel-Private-Group-ID)
- Режимы работы dot1x в RouterOS – supplicant, authenticator
- Поддерживаемые методы аутентификации: EAP-TLS, EAP_TTLS, EAP-MSCHAPv2, PEAPv0/EAP-MSCHAPv2
- Хорошая поддержка клиентов в Windows/MacOS/Linux

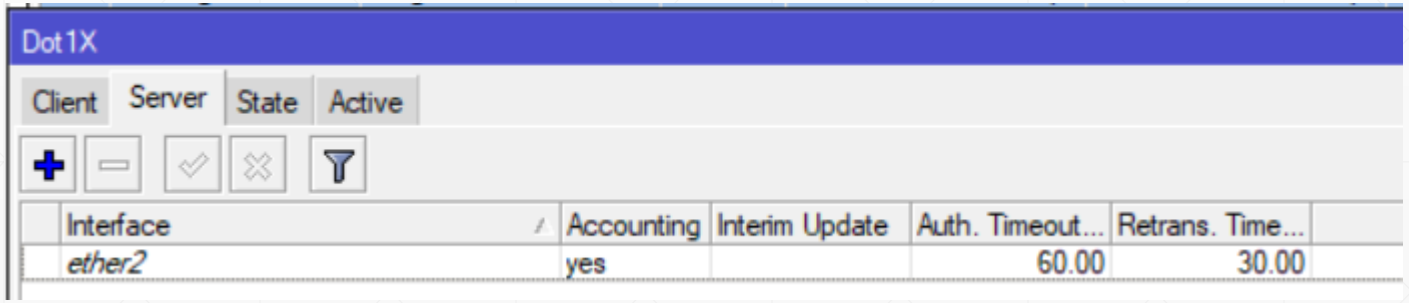


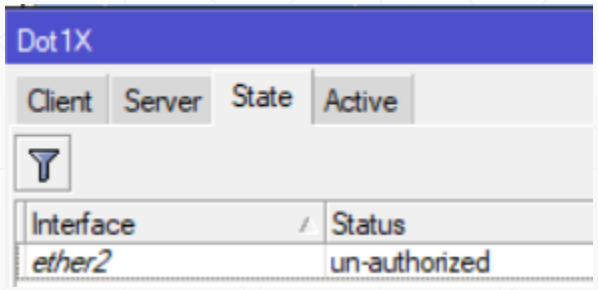
# Настройка CRS – 802.1x

- Интеграция с RADIUS-сервером
- Централизованный контроль сетевых портов на всех коммутаторах
- Возможность использования в качестве RADIUS-сервера Windows NPS и Active Directory



# Настройка CRS – other hardware features

- RSTP, MSTP
- MTU 9-10k, jumbo frame
- QinQ (0x88a8, 0x9100)
- Port security (еще есть на чем работать), flood protection, limit unknown broadcast/multicast
- Rate control (ingress/egress)
- ACL (based on L2/L3/L4)
- Port isolation
- Port mirroring

# L2 features in hardware

- Будьте внимательны при выборе модели устройства для L2
- Если включить функцию, которая не поддерживается в «железе», hw offloading отключится, пойдет нагрузка на процессор
- Все L2-функции есть в «железе» только у CRS3xx => берите CRS3xx

| RouterBoard/[Switch Chip] Model | Features in Switch menu | Bridge STP/RSTP | Bridge MSTP | Bridge IGMP Snooping | Bridge DHCP Snooping | Bridge VLAN Filtering | Bonding |
|---|---|---|---|---|---|---|---|
| CRS3xx series | + | + | + | + | + | + | + |
| CRS1xx/CRS2xx series | + | + | - | + [1] | + [1] | - | - |
| [QCA8337] | + | + | - | - | + [2] | - | - |
| [Atheros8327] | + | + | - | - | + [2] | - | - |
| [Atheros8227] | + | + | - | - | - | - | - |
| [Atheros8316] | + | + | - | - | + [2] | - | - |
| [Atheros7240] | + | + | - | - | - | - | - |
| [MT7621] | + | - | - | - | - | - | - |
| [RTL8367] | + | - | - | - | - | - | - |
| [ICPlus175D] | + | - | - | - | - | - | - |

# CRS=router+switch

- ~~На фига~~ Для чего ~~козе~~ свитчу ~~баян~~ RouterOS?
- У CRS **пока** нет полноценного L3 в «железе»
- Слабые процессор и память ограничивают производительность L3
- Feature-rich L2 switch, not router
- Зато полноценный RouterOS на коммутаторе позволяет:
  - использовать инструменты ROS  для дебага (sniffer, torch, copy-to-cpu, IP scan, etc)
  - пробрасывать быстро и легко туннели (EoIP, L2TP, etc) и попадать в любой VLAN на коммутаторе на расстоянии
  - Запускать сетевые сервисы, не требующие ресурсов (DHCP, FTP, TFTP, NTP, etc)
- У конкурентов нет подобных функций, либо они есть за большие деньги

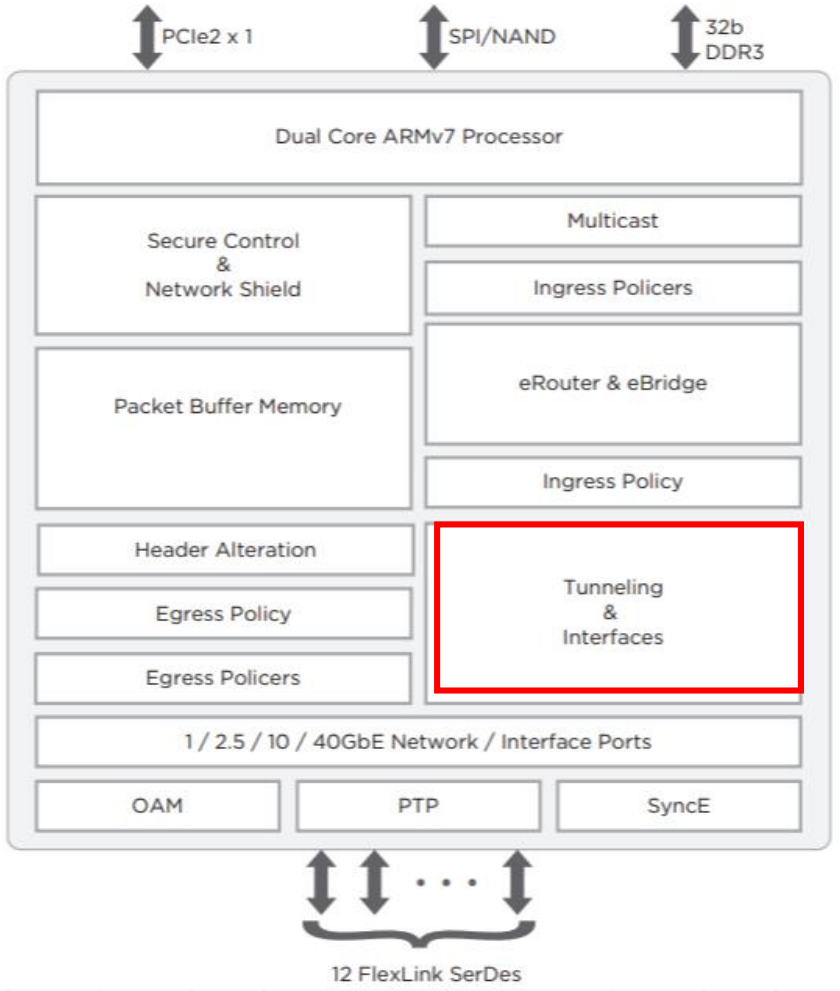


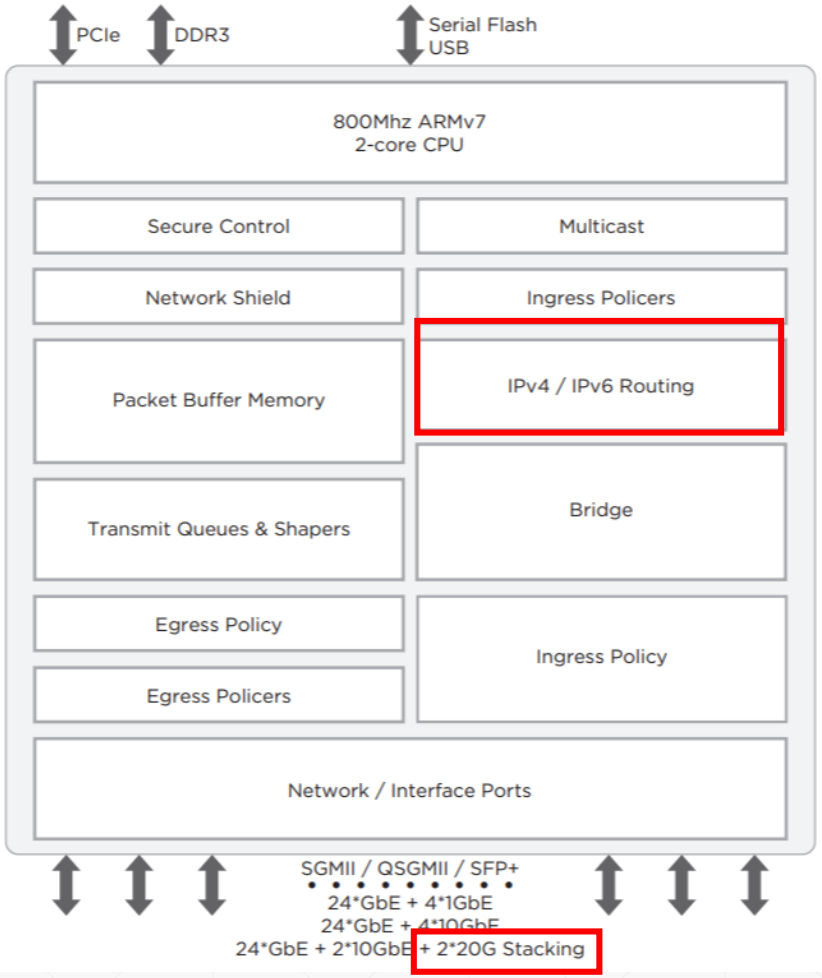
# Чего не хватает коммутаторам Mikrotik

- Внутренние блоки в CSS/CRS326 и любых других rack-mount моделях
- Еще подумать над интерфейсом настройки switch/bridge, сделать более user-friendly
- Стекирование через 10/40Gbps-порты
- 48-ми портовый коммутатор
- LLDP
- Одновременная работа QinQ и 802.1Q для задач ISP
- Dynamic VLAN configuration protocol – GVRP, MRP, аналог Cisco VTP – для упрощения настройки больших сетей
- L3 в «железе»
- SDN (Software Defined Networks) – добавить функции SDN (централизованное управление, мониторинг, аналитика) в The Dude (есть поддержка свитчинга в OpenFlow?)
- VXLAN, GRE в «железе»
- Netflow/sflow в «железе»

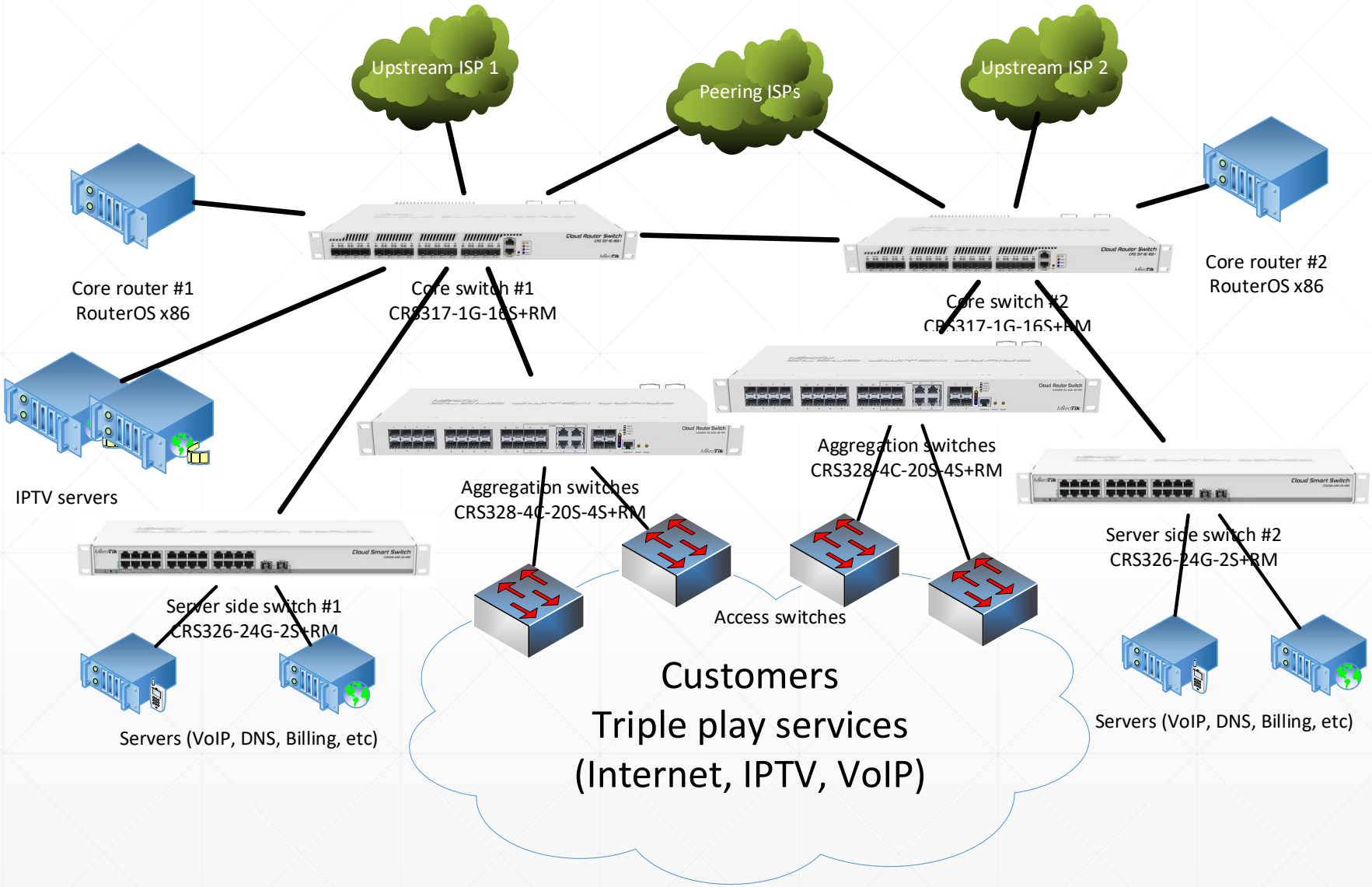
# Чего не хватает коммутаторам Mikrotik

- Чипы Marvell имеют поддержку L3, VxLAN, GRE, SDN, Stacking в «железе»
- Компании Mikrotik нужно «просто» дописать RouterOS
- Вся надежда на ROS v8 лет через 8?



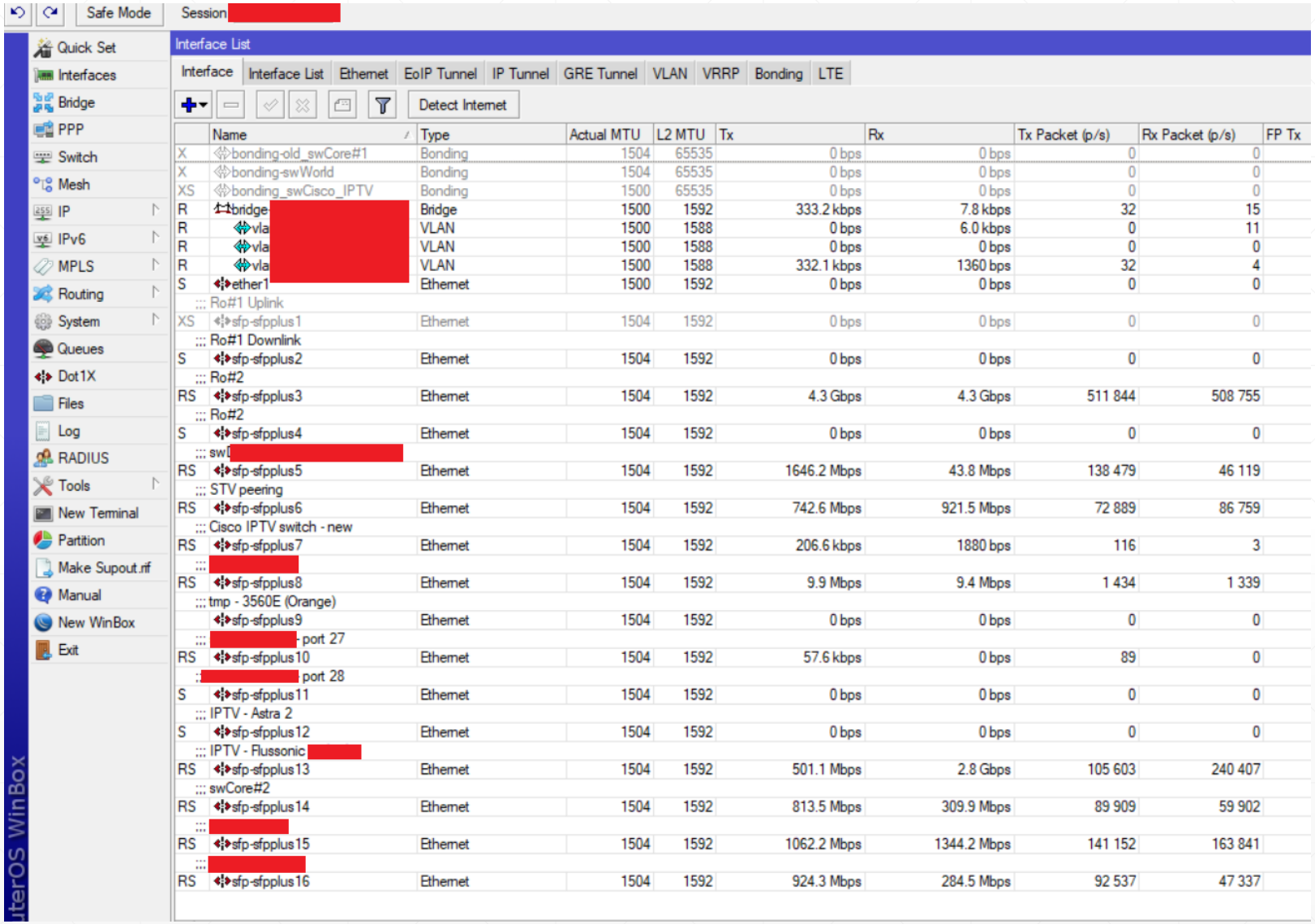
# Use case - small ISP core upgrade



# Use case - small ISP core upgrade

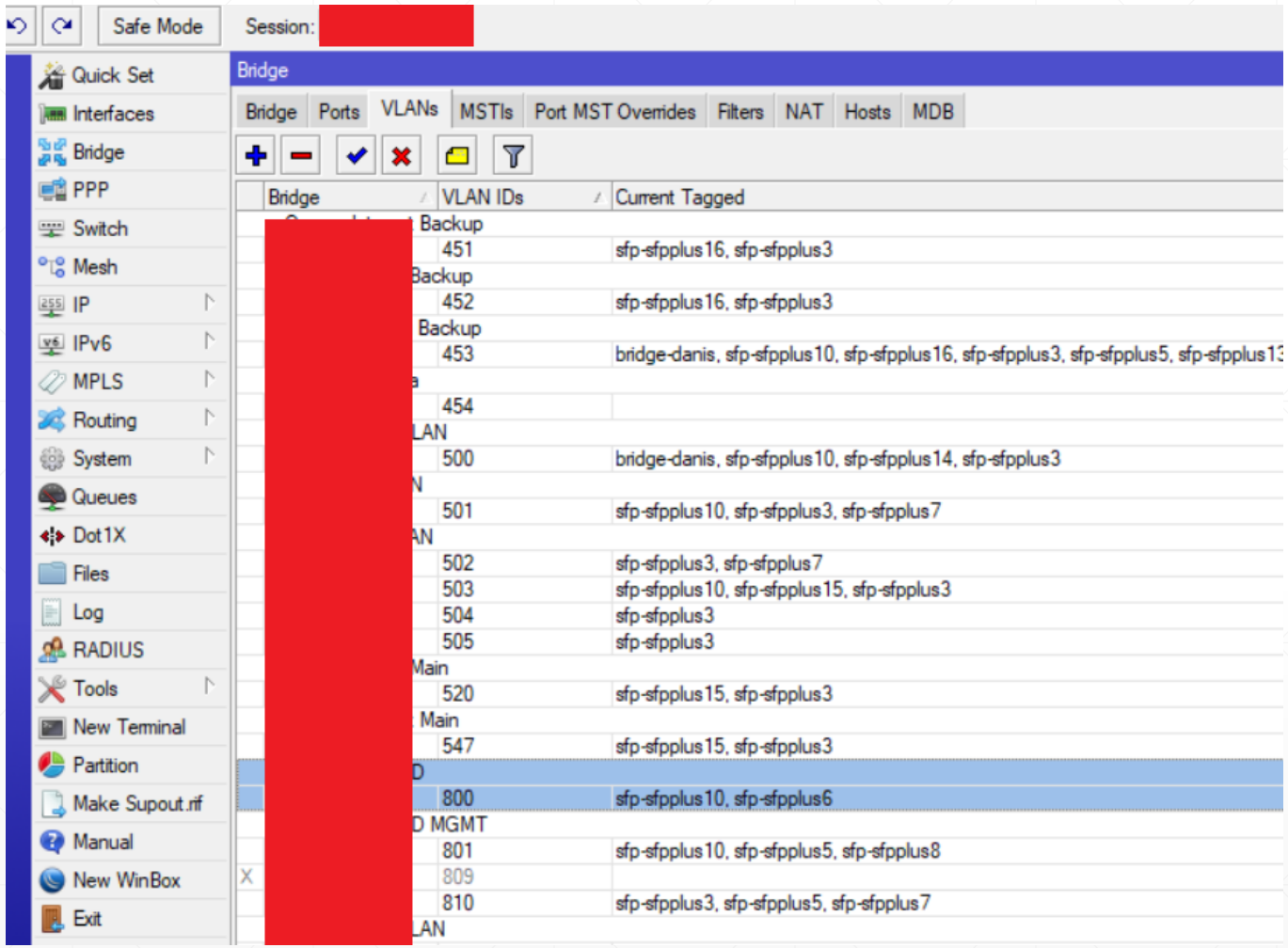
- До 20Gbps трафика
- Mikrotik and billing integration
- Dynamic QoS
- Dynamic clients blocking/unblocking
- IGMP snooping
- DHCP relay
- Cisco or Juniper БУ, refurbished ~ более 50k USD, новый ~ 200-400k USD
- Новые Mikrotik switches, DAC cables, SFP transceivers and refurb servers x86 ~ 5k USD

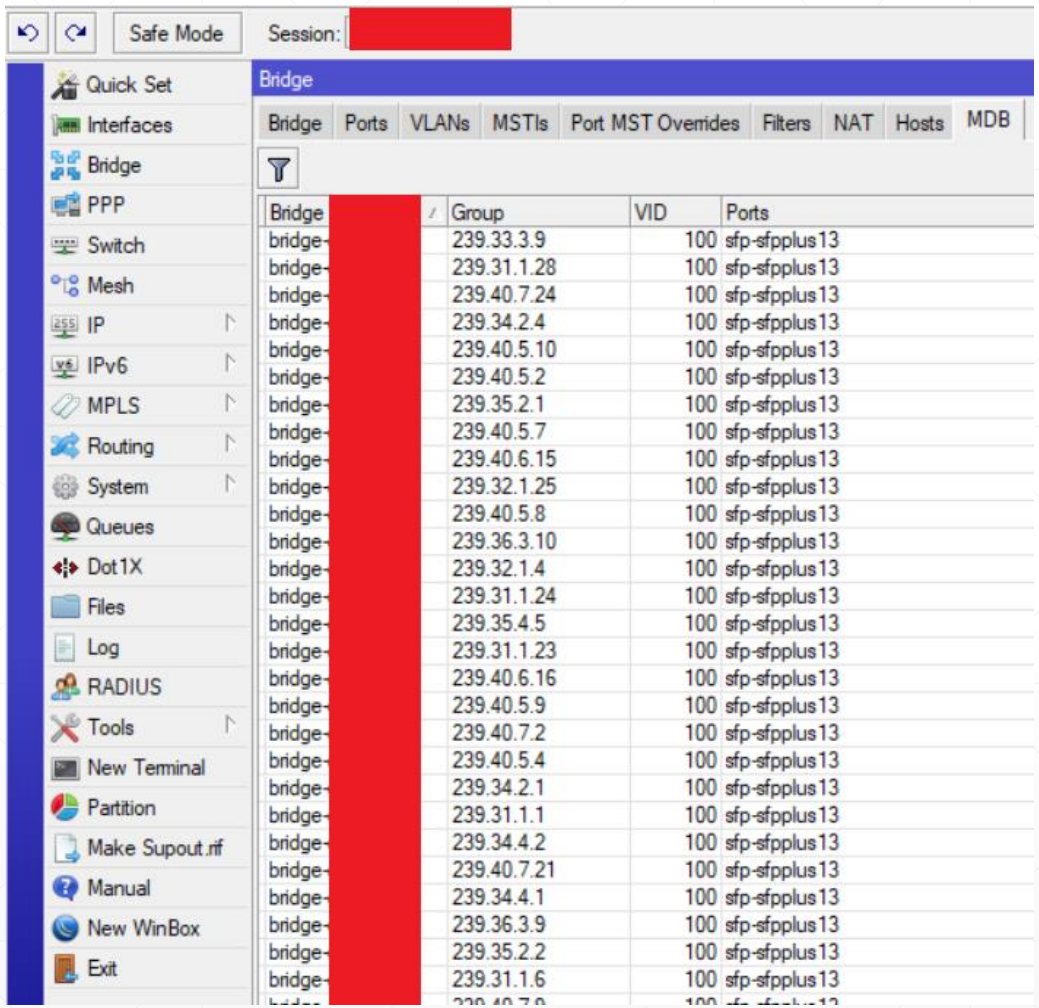
# Use case - small ISP core upgrade




| | Name | Type | Actual MTU | L2 MTU | Tx | Rx | Tx Packet (p/s) | Rx Packet (p/s) | FP Tx |
|---|---|---|---|---|---|---|---|---|---|
| X | bonding-old_swCore#1 | Bonding | 1504 | 65535 | 0 bps | 0 bps | 0 | 0 | |
| X | bonding-swWorld | Bonding | 1504 | 65535 | 0 bps | 0 bps | 0 | 0 | |
| XS | bonding_swCisco_IPTV | Bonding | 1500 | 65535 | 0 bps | 0 bps | 0 | 0 | |
| R | bridge [redacted] | Bridge | 1500 | 1592 | 333.2 kbps | 7.8 kbps | 32 | 15 | |
| R | vla [redacted] | VLAN | 1500 | 1588 | 0 bps | 6.0 kbps | 0 | 11 | |
| R | vla [redacted] | VLAN | 1500 | 1588 | 0 bps | 0 bps | 0 | 0 | |
| R | vla [redacted] | VLAN | 1500 | 1588 | 332.1 kbps | 1360 bps | 32 | 4 | |
| S | ether1 [redacted] | Ethernet | 1500 | 1592 | 0 bps | 0 bps | 0 | 0 | |
| | ;;; Ro#1 Uplink | | | | | | | | |
| XS | sfp-sfpplus1 | Ethernet | 1504 | 1592 | 0 bps | 0 bps | 0 | 0 | |
| | ;;; Ro#1 Downlink | | | | | | | | |
| S | sfp-sfpplus2 | Ethernet | 1504 | 1592 | 0 bps | 0 bps | 0 | 0 | |
| | ;;; Ro#2 | | | | | | | | |
| RS | sfp-sfpplus3 | Ethernet | 1504 | 1592 | 4.3 Gbps | 4.3 Gbps | 511 844 | 508 755 | |
| | ;;; Ro#2 | | | | | | | | |
| S | sfp-sfpplus4 | Ethernet | 1504 | 1592 | 0 bps | 0 bps | 0 | 0 | |
| | ;;; sw[redacted] | | | | | | | | |
| RS | sfp-sfpplus5 | Ethernet | 1504 | 1592 | 1646.2 Mbps | 43.8 Mbps | 138 479 | 46 119 | |
| | ;;; STV peering | | | | | | | | |
| RS | sfp-sfpplus6 | Ethernet | 1504 | 1592 | 742.6 Mbps | 921.5 Mbps | 72 889 | 86 759 | |
| | ;;; Cisco IPTV switch - new | | | | | | | | |
| RS | sfp-sfpplus7 | Ethernet | 1504 | 1592 | 206.6 kbps | 1880 bps | 116 | 3 | |
| | ;;; [redacted] | | | | | | | | |
| RS | sfp-sfpplus8 | Ethernet | 1504 | 1592 | 9.9 Mbps | 9.4 Mbps | 1 434 | 1 339 | |
| | ;;; tmp - 3560E (Orange) | | | | | | | | |
| | sfp-sfpplus9 | Ethernet | 1504 | 1592 | 0 bps | 0 bps | 0 | 0 | |
| | ;;; [redacted] - port 27 | | | | | | | | |
| RS | sfp-sfpplus10 | Ethernet | 1504 | 1592 | 57.6 kbps | 0 bps | 89 | 0 | |
| | ;[redacted] port 28 | | | | | | | | |
| S | sfp-sfpplus11 | Ethernet | 1504 | 1592 | 0 bps | 0 bps | 0 | 0 | |
| | ;;; IPTV - Astra 2 | | | | | | | | |
| S | sfp-sfpplus12 | Ethernet | 1504 | 1592 | 0 bps | 0 bps | 0 | 0 | |
| | ;;; IPTV - Flussonic [redacted] | | | | | | | | |
| RS | sfp-sfpplus13 | Ethernet | 1504 | 1592 | 501.1 Mbps | 2.8 Gbps | 105 603 | 240 407 | |
| | ;;; swCore#2 | | | | | | | | |
| RS | sfp-sfpplus14 | Ethernet | 1504 | 1592 | 813.5 Mbps | 309.9 Mbps | 89 909 | 59 902 | |
| | ;;; [redacted] | | | | | | | | |
| RS | sfp-sfpplus15 | Ethernet | 1504 | 1592 | 1062.2 Mbps | 1344.2 Mbps | 141 152 | 163 841 | |
| | ;;; [redacted] | | | | | | | | |
| RS | sfp-sfpplus16 | Ethernet | 1504 | 1592 | 924.3 Mbps | 284.5 Mbps | 92 537 | 47 337 | |

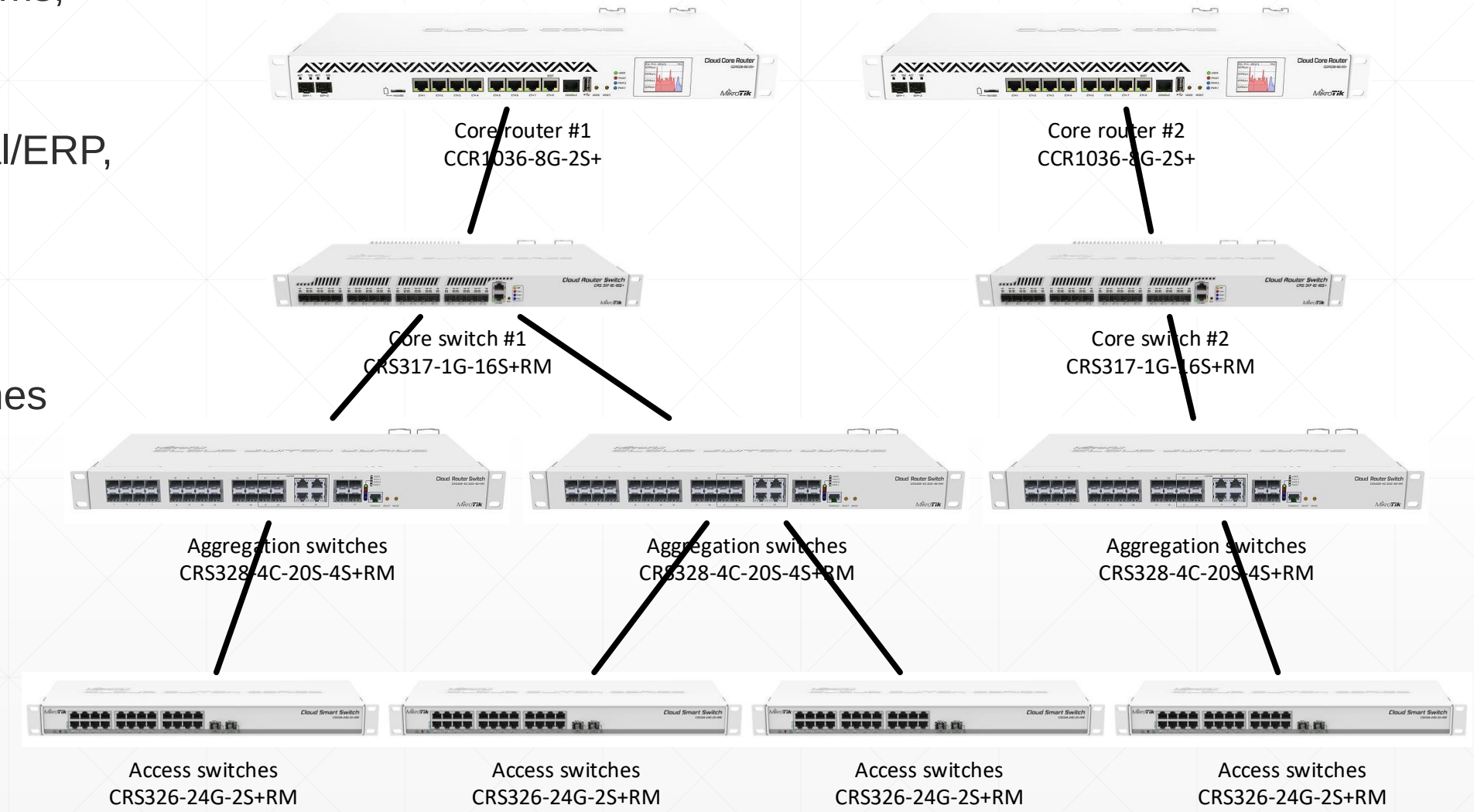
# Use case - small ISP core upgrade



# Use case - university campus network

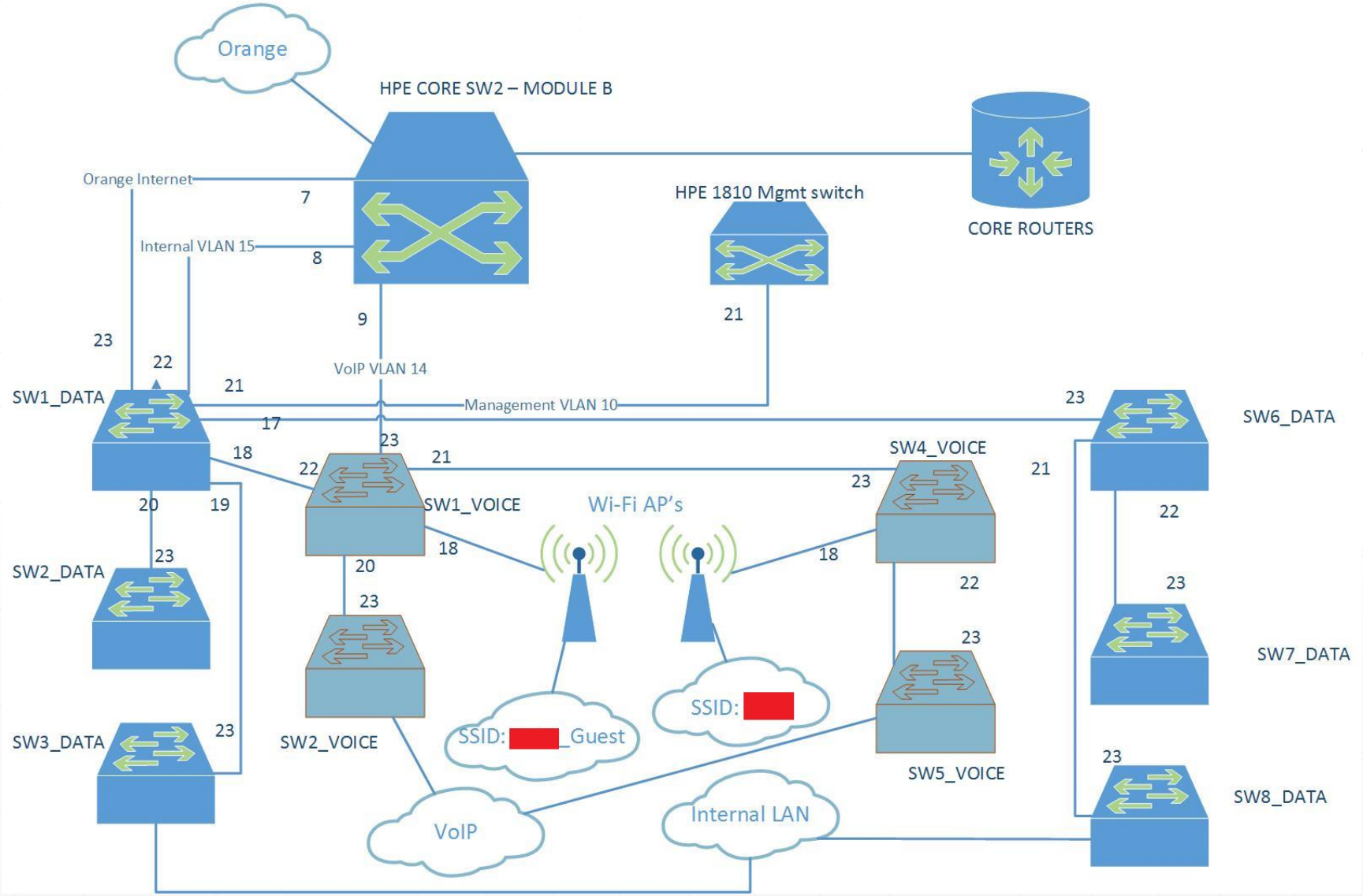
- Huge traffic: video cams, live online exams, university internal portal/ERP, students wifi access, VoIP, etc
- More than 100 switches
- VLANs
- ACL
- Port security
- Storm control



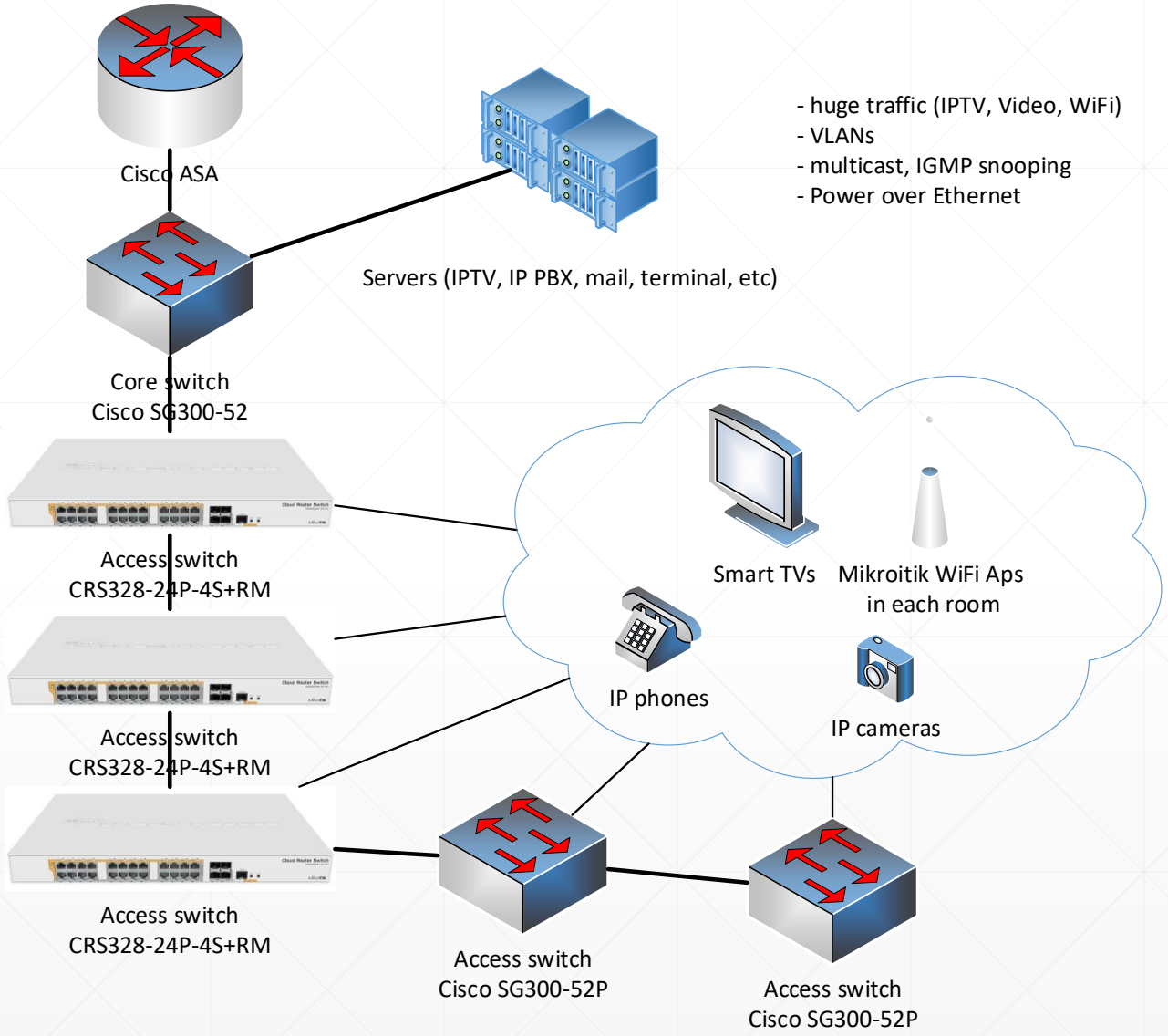
# Use case – Government organization

- CRS326-24G-2S+RM
- CRS328-24P-4S+RM
- 10 access switches
- Data, VoIP, WiFi

- VLANs
- STP
- DHCP snooping



# Use case - premium hotel in Chisinau



# Выводы

- Коммутаторы Mikrotik «повзрослели», их уже можно использовать в enterprise/ISP
- Небольшие проблемы были и есть, но они некритичны и решаются обновлением софта
- Дешевле конкурентов
- Хорошо принимаются рынком, практически отсутствует брак
- Железо позволяет добавлять новые фичи в софте, осталось «разогнать» компанию Mikrotik







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# КОНКУРС!

- Отправьте на номер **+373 69999975** минимум по одной причине и/или короткой истории, за что вы любите и ненавидите Mikrotik
- SMS/Viber/Telegram/WhatsApp
- Romana, Русский
- Маты запрещены!
- Автор самого оригинального сообщения получит приз –

  **Mikrotik hAP ac2**

- Вручение пройдет во время второй презентации в 16-30



# Ссылки

- https://mikrotik.com/products/group/switches
- https://wiki.mikrotik.com/wiki/SwOS
- https://wiki.mikrotik.com/wiki/Manual:CRS3xx_series_switches
- https://wiki.mikrotik.com/wiki/Manual:CRS3xx_VLANs_with_Bonds
- https://wiki.mikrotik.com/wiki/Manual:Interface/Bridge

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