

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, MTCTSE, 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, гарнитур
- 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



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



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



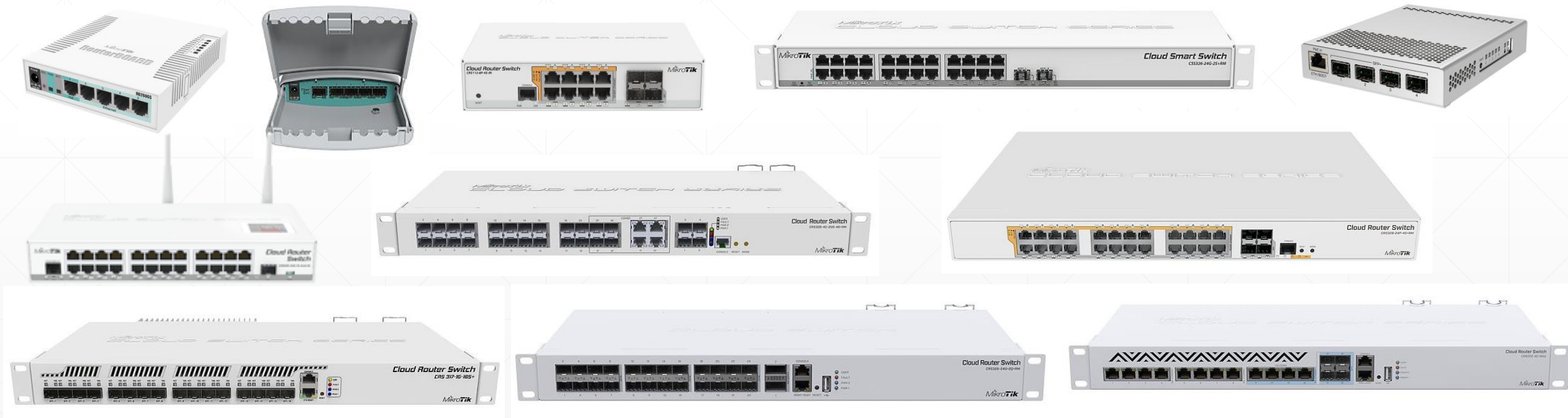
- CRS226, ~2015, RouterOS, 24x1Gbps ports + 2x10Gbps SFP+, full managed L2 switch + router, QCA8519 chip, VLAN, ACL, more features, etc



- 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

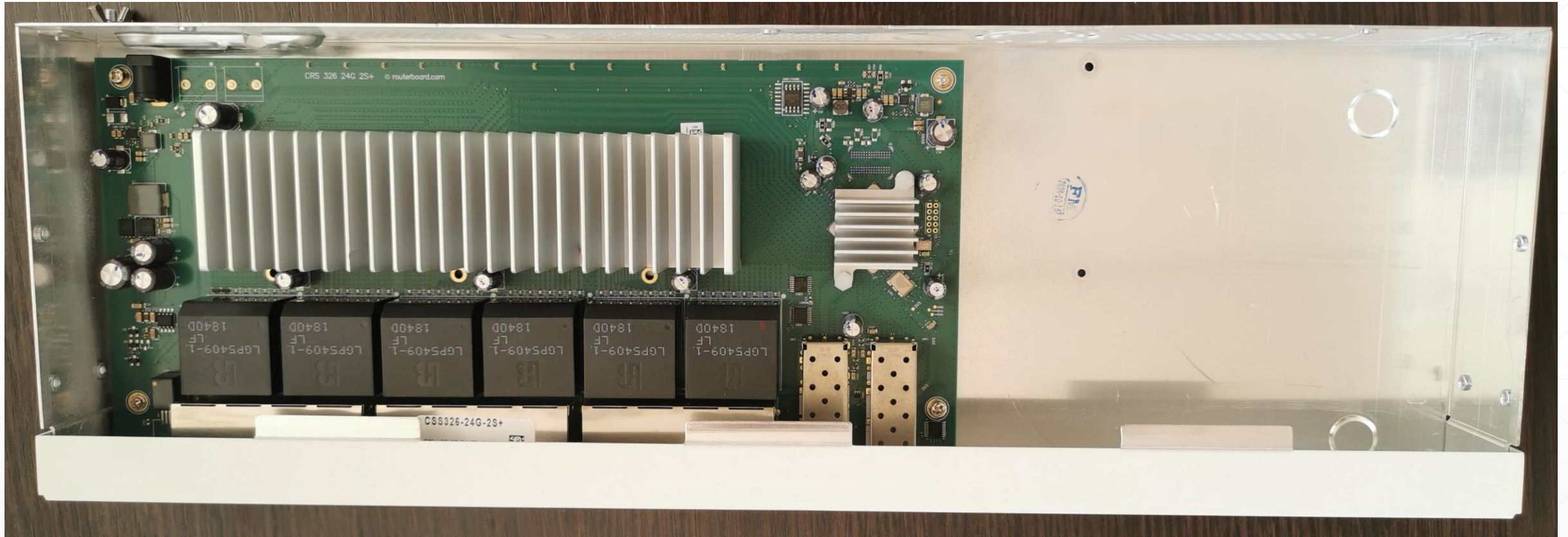
Mikrotik CSS326-24G-2S+RM

MikroTik SwOS

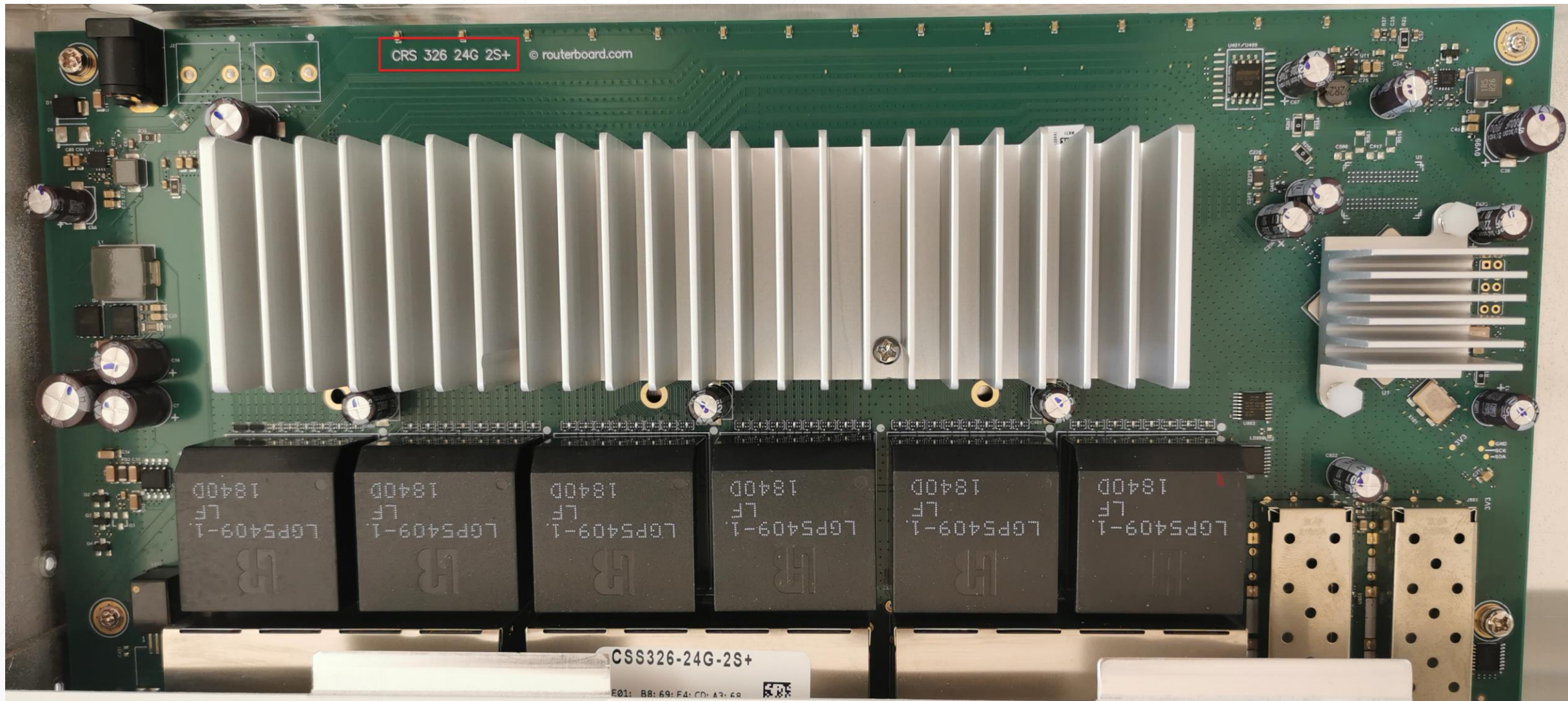
Link SFP Port Isolation LAG Forwarding RSTP Stats Errors Hist VLAN VLANs Hosts IGMP SNMP ACL System Upgrade

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

Mikrotik CSS326-24G-2S+RM



Mikrotik CSS326-24G-2S+RM



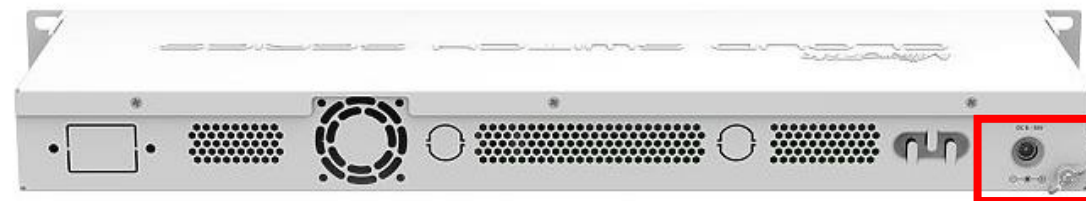
Mikrotik CSS326-24G-2S+RM

- 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

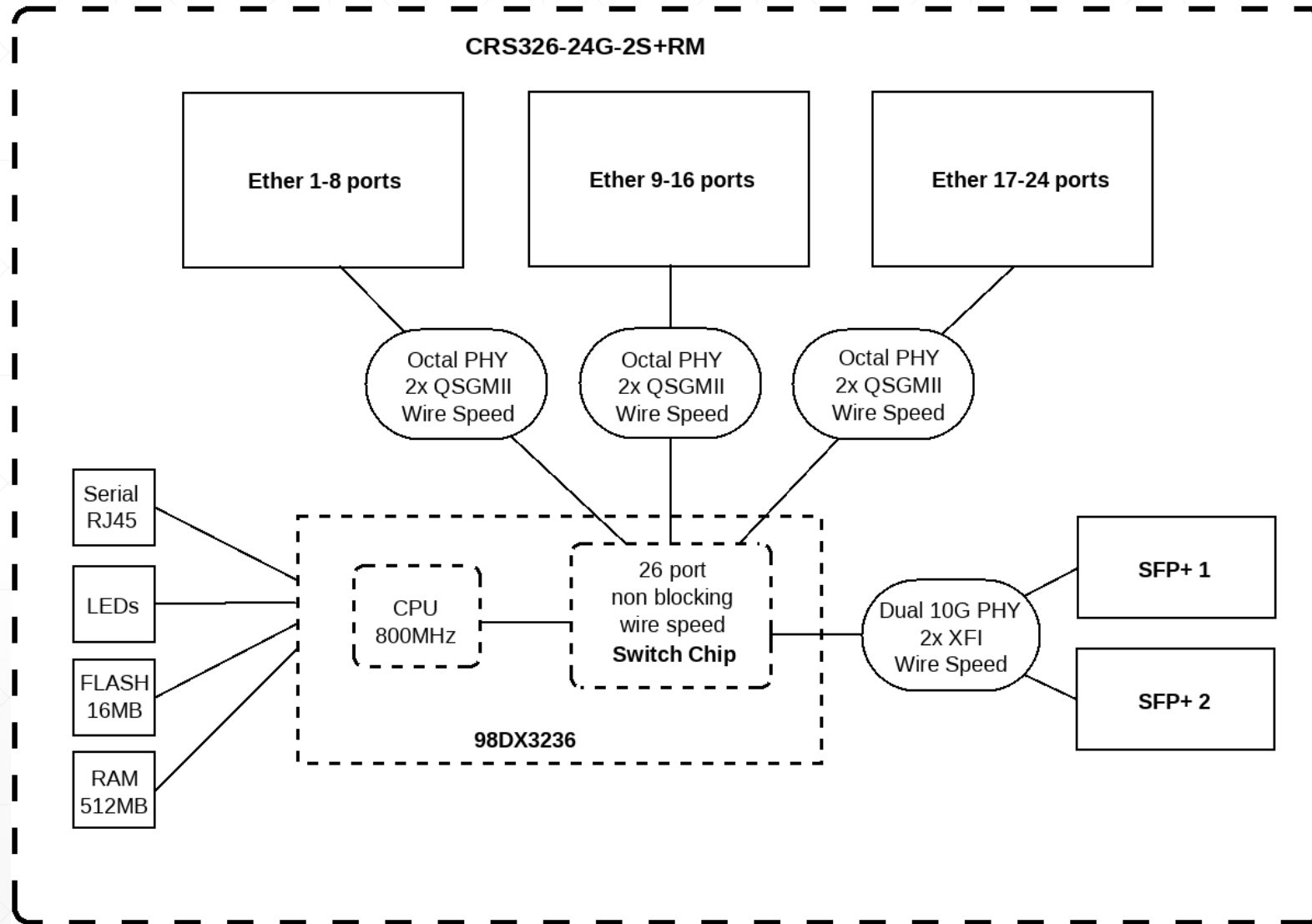
Switching results

CRS326-24G-2S+RM		1518 byte		512 byte		64 byte	
Mode	Configuration	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
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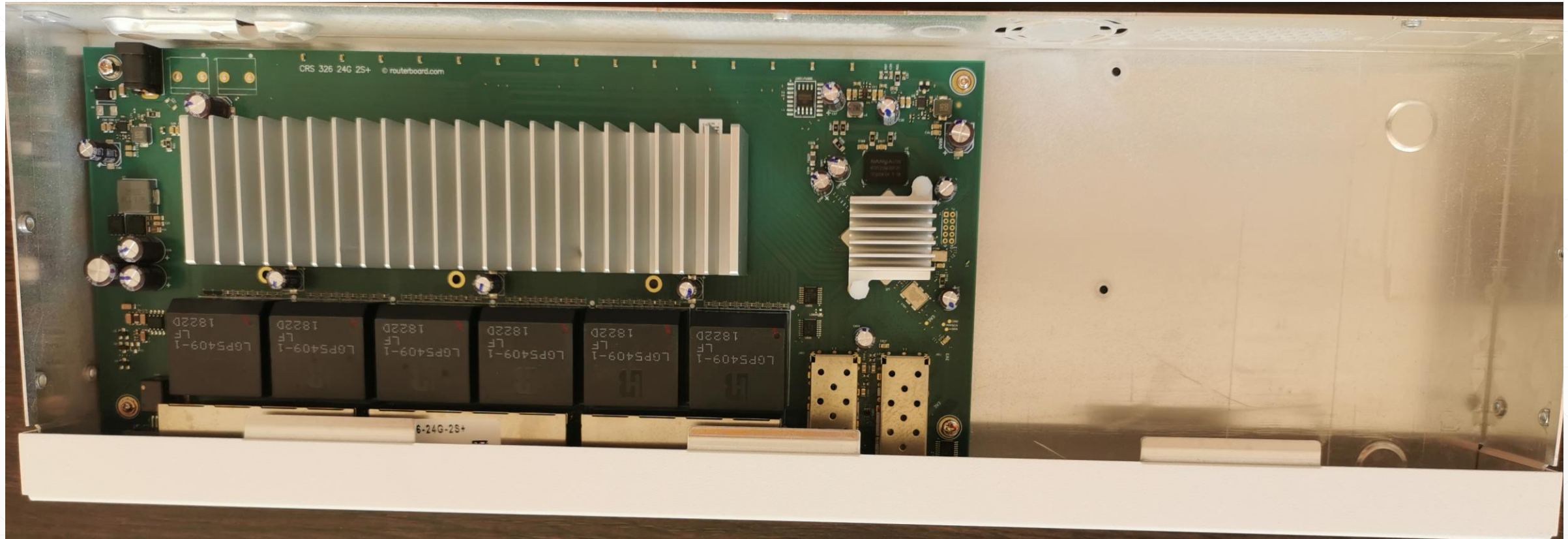
Ethernet test results

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

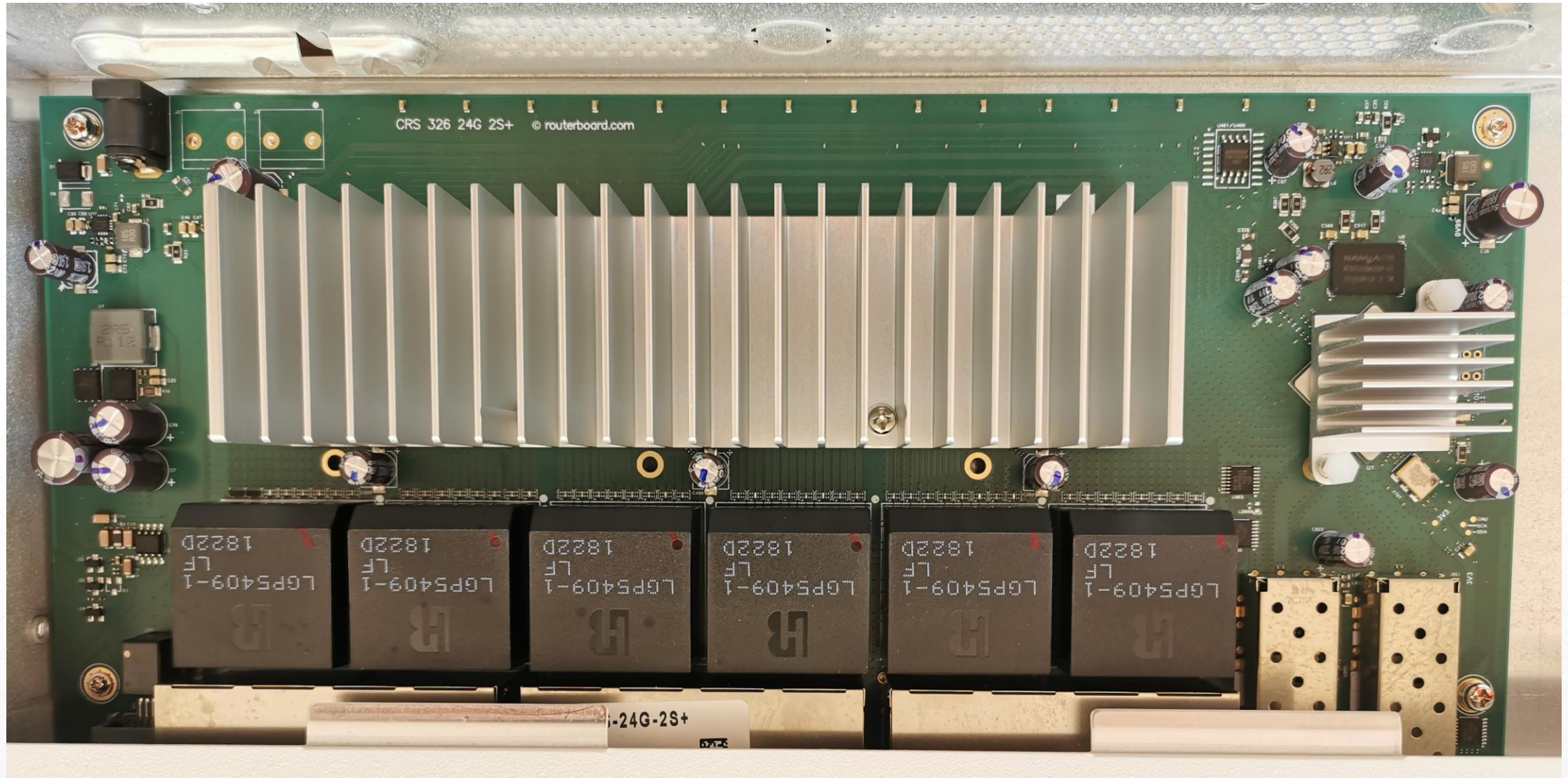
Mikrotik CRS326-24G-2S+RM



Mikrotik CRS326-24G-2S+RM



Mikrotik CRS326-24G-2S+RM



Mikrotik CRS326-24G-2S+RM

- Полноценный RouterOS L5

The screenshot displays the Mikrotik WinBox interface. On the left is a navigation menu with categories like Quick Set, Interfaces, Bridge, PPP, Switch, Mesh, IP, IPv6, MPLS, Routing, System, Queues, Dot1X, Files, Log, RADIUS, Tools, New Terminal, Partition, Make Supout.tif, Manual, New WinBox, and Exit. The main window is divided into several panes:

- Switch:** A table with columns for Name, Type, Mirror Source, and Mirror Target. The entry 'switch1' is selected, with Type 'Marvell 98DX8216'.
- Interface List:** A table with columns for Name, Type, Actual MTU, L2 MTU, Tx, Rx, and Tx Packets. It lists various interfaces including bonding, bridge, vlan, ether, and sfppplus.
- Resources:** A pop-up window showing system statistics:
 - Uptime: 53d 23:58:30
 - Free Memory: 982.6 MiB
 - Total Memory: 1024.0 MiB
 - CPU: ARmv7
 - CPU Count: 2
 - CPU Frequency: 800 MHz
 - CPU Load: 5 %
 - Free HDD Space: 4452 KiB
 - Total HDD Size: 16.0 MiB
 - Sector Writes Since Reboot: 122 718
 - Total Sector Writes: 573 181
 - Bad Blocks: 0.0 %
 - Architecture Name: am
 - Board Name: CRS317-1G-16S+
 - Version: 6.45.1 (stable)
 - Build Time: Jun/27/2019 10:23:23
 - Factory Software: 6.41

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

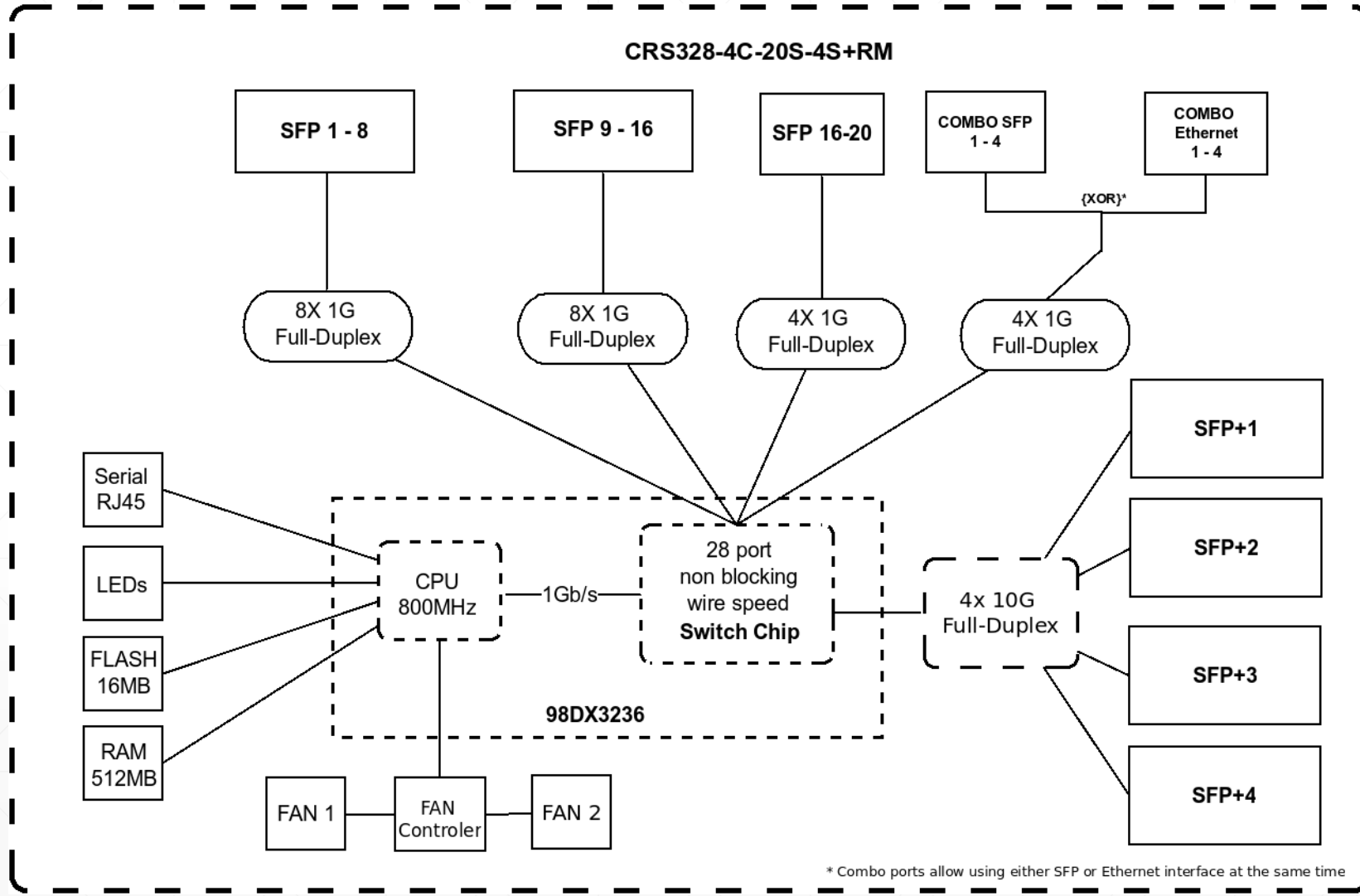
Switching results

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

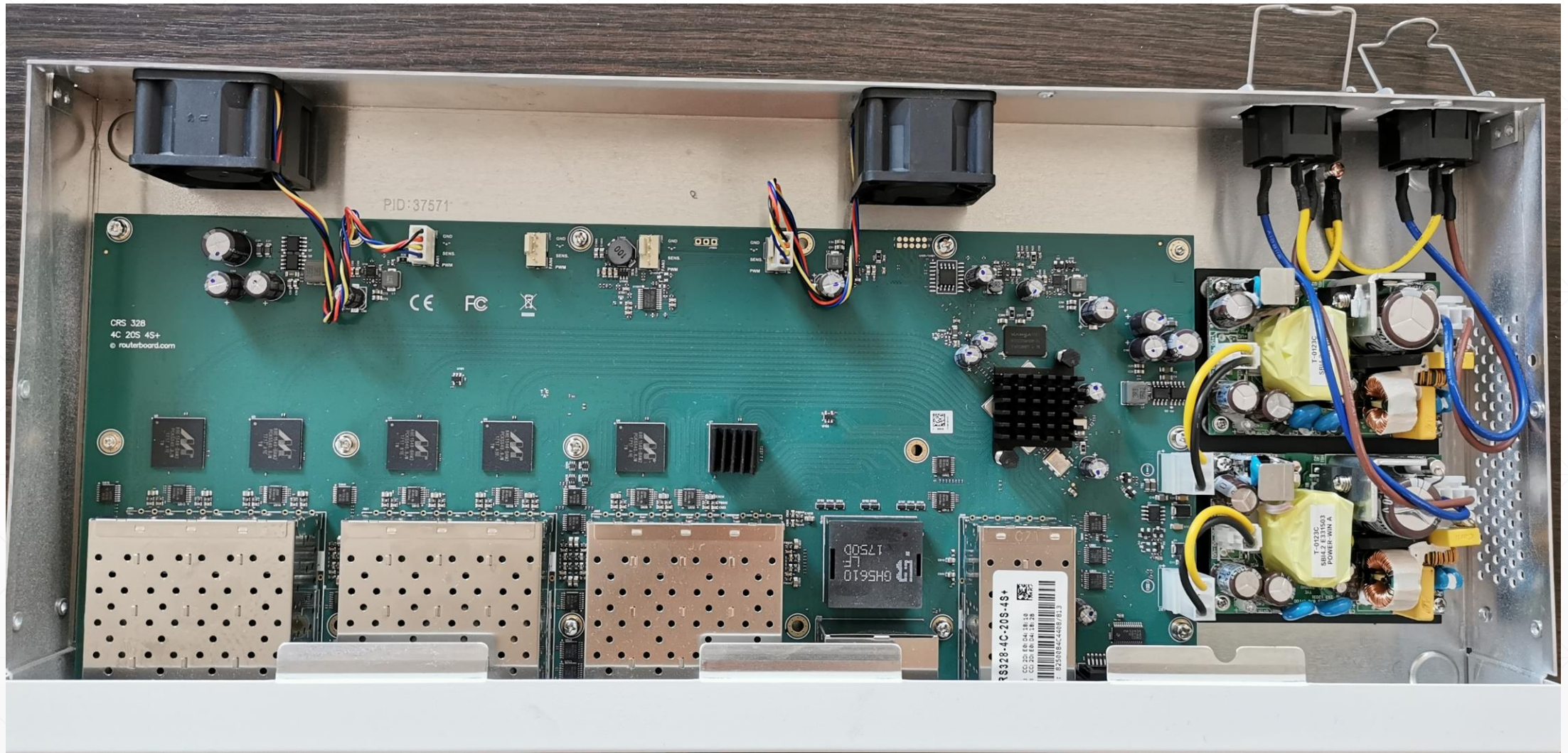
Ethernet test results

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
Bridging	25 bridge filter rules	104	1263.0	104,6	428.4	104,5	53.5
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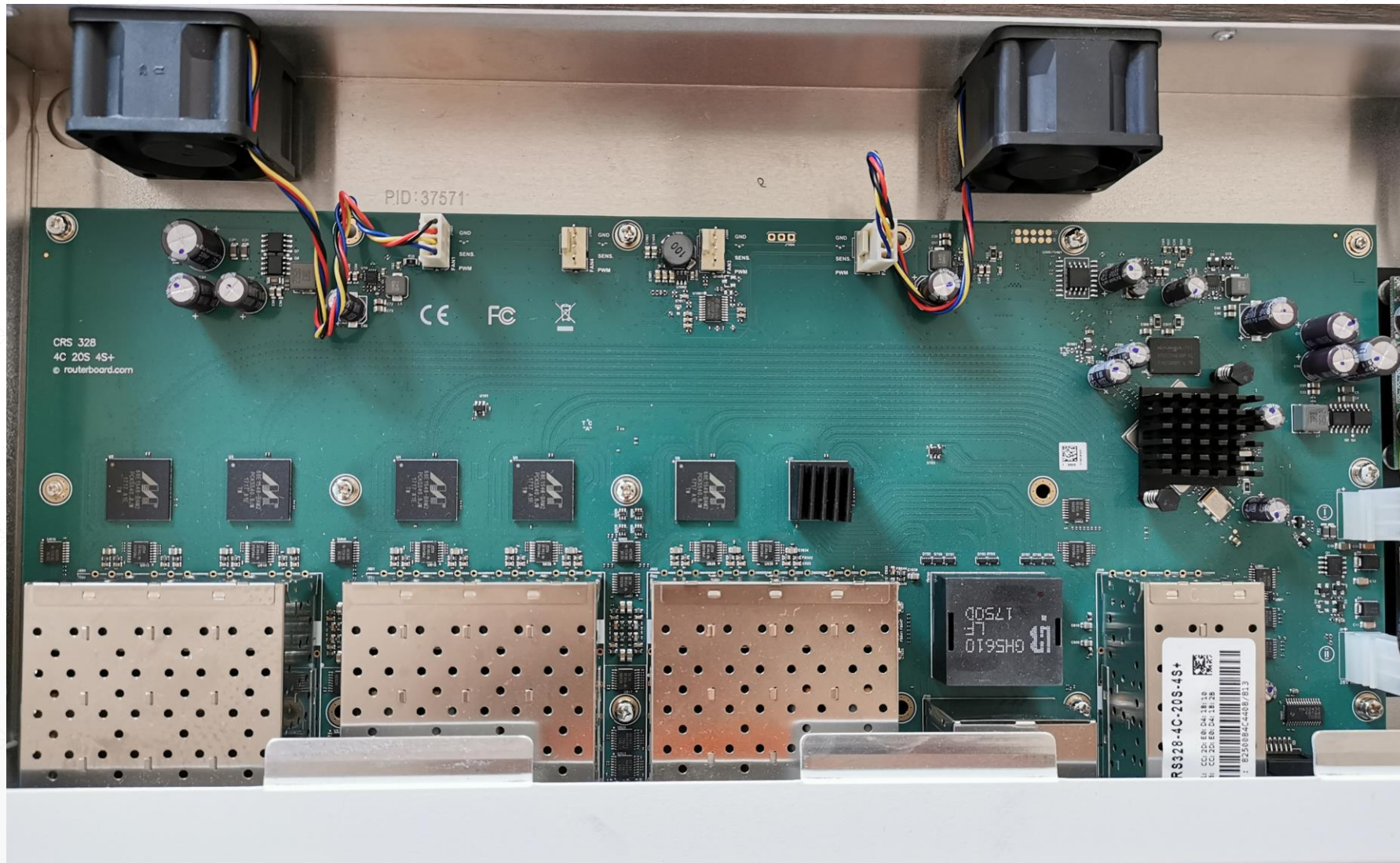
Mikrotik CRS328-4C-20S-4S+RM



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



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



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

- Полноценный RouterOS L5

The screenshot displays the Mikrotik WinBox interface. On the left is a sidebar menu with categories like Quick Set, Interfaces, Bridge, PPP, Switch, Mesh, IP, IPv6, MPLS, Routing, System, Queues, Dot1X, Files, Log, RADIUS, Tools, New Terminal, Partition, Make Supout.rf, Manual, New WinBox, and Exit. The main window is titled 'Switch' and shows a table with columns for Name, Type, Mirror Source, and Mirror Target. Below this is the 'Interface List' tab, which contains a table of network interfaces. A 'Resources' dialog box is open in the foreground, displaying system information.

Name	Type	Actual MTU	L2 MTU	Tx	Rx	Tx Packet
X	bonding- old_swCore#1					0 bps
X	bonding-swWorld					0 bps
XS	bonding_swCisco_IPTV					0 bps
R	bridge					1.1 kbps
R	vlan					9.4 kbps
R	vlan					0 bps
R	vlan					1008 bps
S	ether1					0 bps
XS	Ro#1 Uplink					0 bps
XS	sfp-sfpplus1					0 bps
S	sfp-sfpplus2					0 bps
RS	sfp-sfpplus3					5.2 Gbps
S	sfp-sfpplus4					0 bps
RS	sfp-sfpplus5					3.9 Mbps
RS	sfp-sfpplus6					1.7 Mbps
RS	sfp-sfpplus7					1680 bps
RS	sfp-sfpplus8					7.9 Mbps
RS	sfp-sfpplus9					0 bps
RS	sfp-sfpplus10					0 bps
S	sfp-sfpplus11					0 bps
S	sfp-sfpplus12					0 bps
RS	sfp-sfpplus13					2.8 Gbps

Resource	Value
Uptime	53d 23:58:30
Free Memory	982.6 MiB
Total Memory	1024.0 MiB
CPU	ARMv7
CPU Count	2
CPU Frequency	800 MHz
CPU Load	5 %
Free HDD Space	4452 KiB
Total HDD Size	16.0 MiB
Sector Writes Since Reboot	122 718
Total Sector Writes	573 181
Bad Blocks	0.0 %
Architecture Name	arm
Board Name	CRS317-1G-16S+
Version	6.45.1 (stable)
Build Time	Jun/27/2019 10:23:23
Factory Software	6.41

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

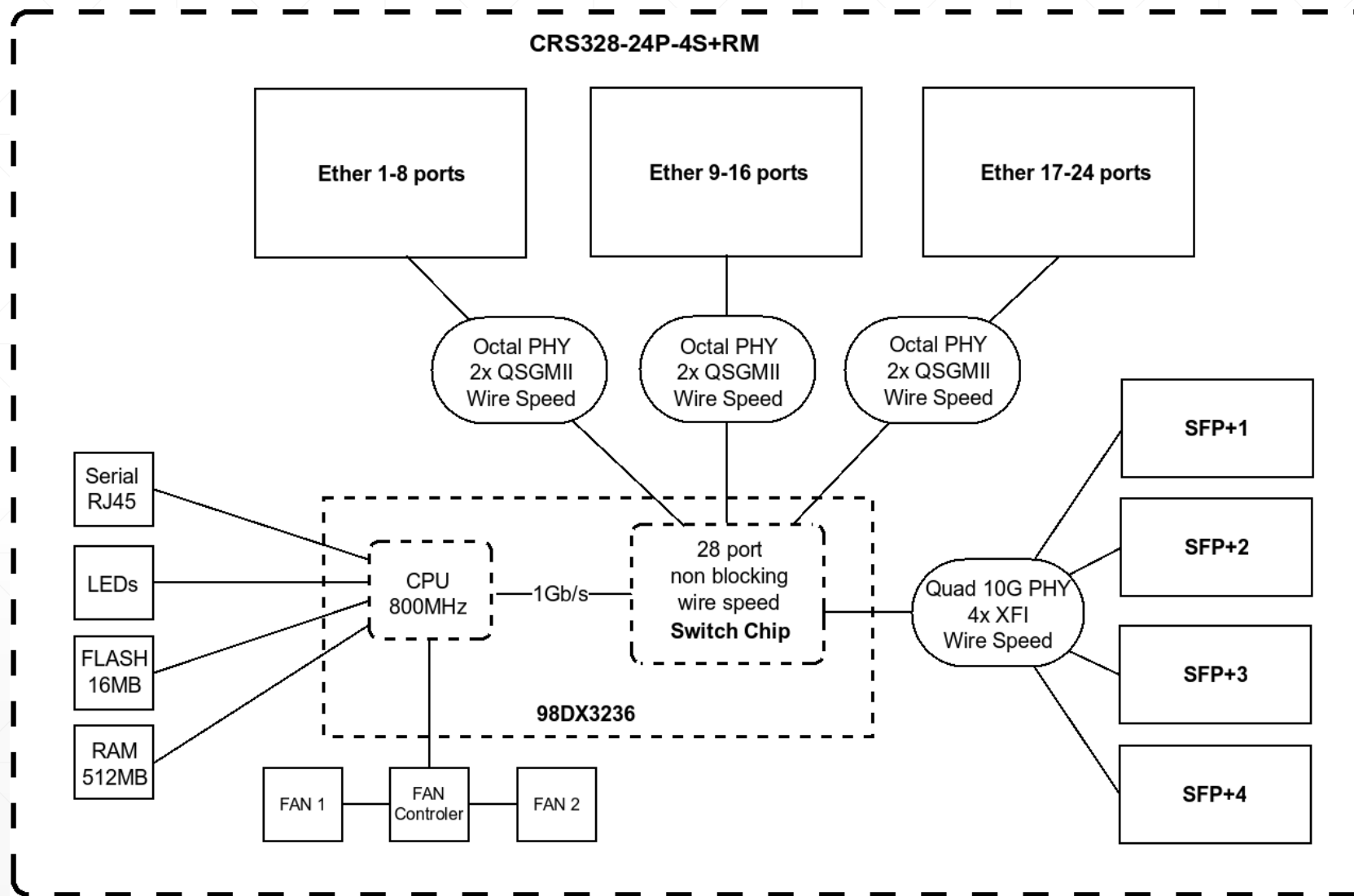
Switching results

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

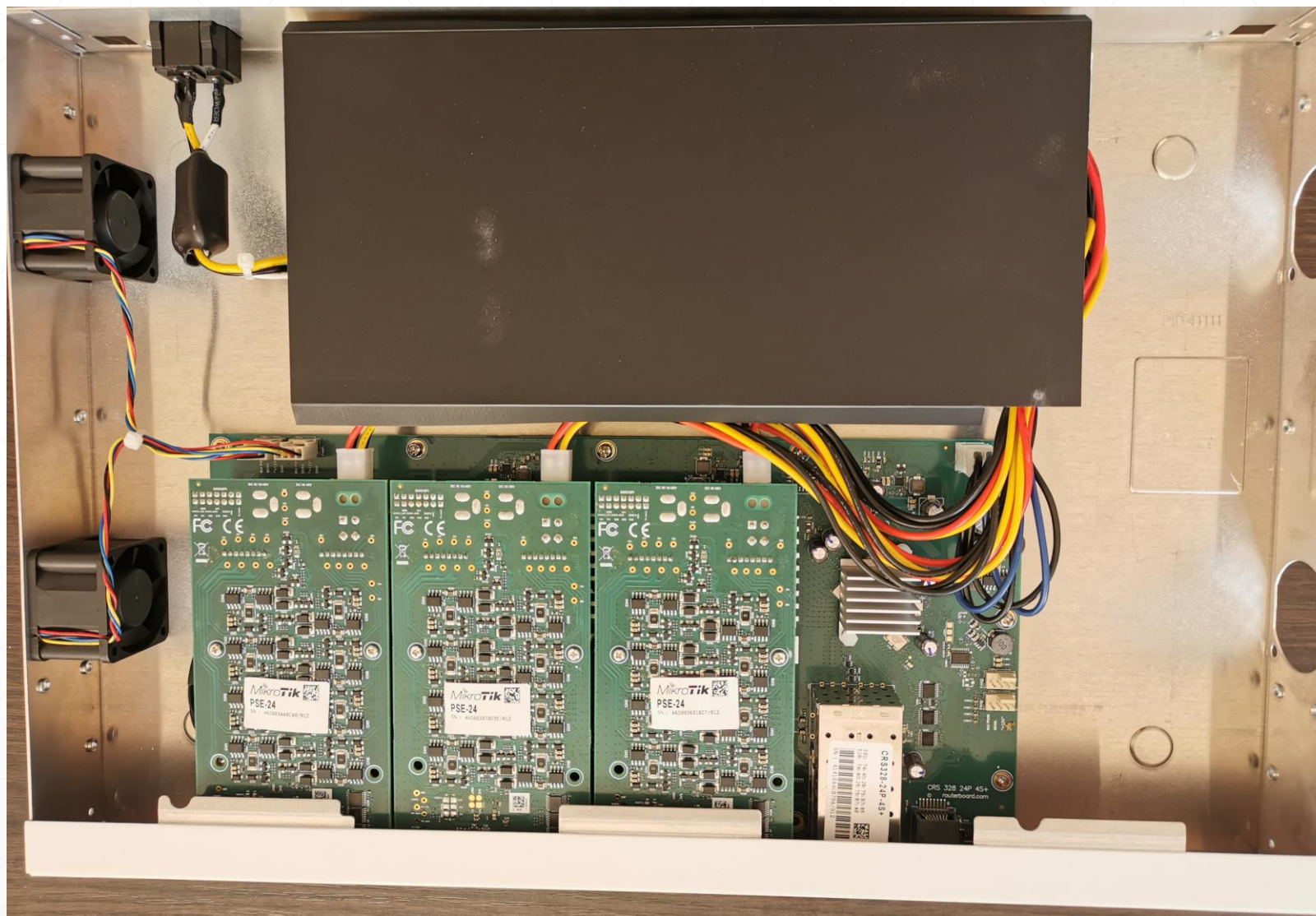
Ethernet test results

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

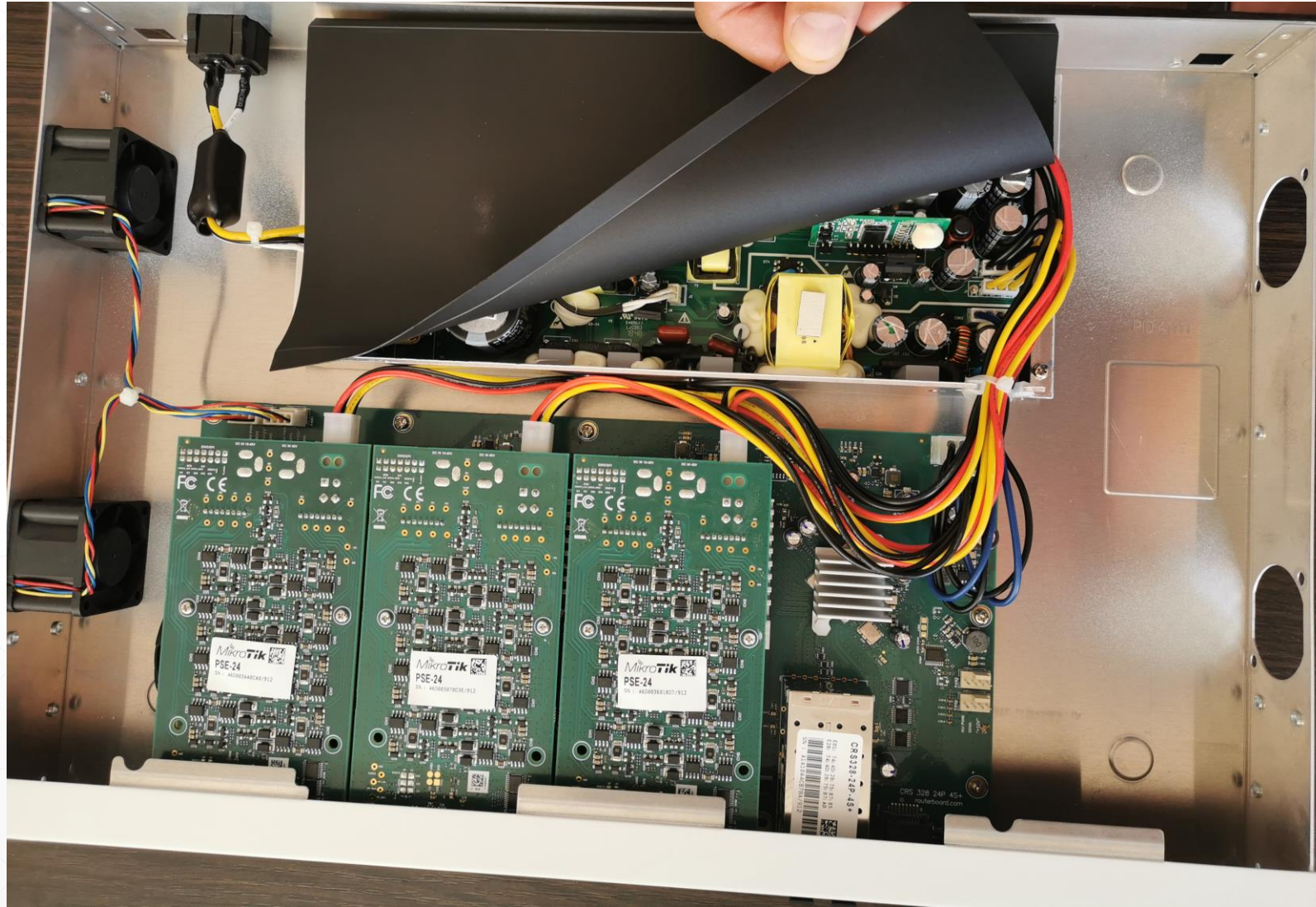
Mikrotik CRS328-24P-4S+RM



Mikrotik CRS328-24P-4S+RM



Mikrotik CRS328-24P-4S+RM



Mikrotik CRS328-24P-4S+RM

- Полноценный RouterOS L5

The screenshot displays the Mikrotik WinBox interface. The main window shows the 'Switch' configuration page with a table of switch configurations:

Name	Type	Mirror Source	Mirror Target
switch1	Marvell 98DX8216		

Below this, the 'Interface List' window is open, showing a table of interfaces:

Name	Type	Actual MTU	L2 MTU	Tx	Rx	Tx Packets
bonding-old_swCore#1	Bonding					0 bps
bonding-swWorld	Bonding					0 bps
bonding_swCisco_IPTV	Bonding					0 bps
bridge	Bridge					1.1 kbps
vlan	VLAN					9.4 kbps
vlan	VLAN					0 bps
vlan	VLAN					008 bps
ether1	Ethernet					0 bps
Ro#1 Uplink						0 bps
sfp-sfpplus1	Ethernet					0 bps
sfp-sfpplus2	Ethernet					0 bps
sfp-sfpplus3	Ethernet					5.2 Gbps
sfp-sfpplus4	Ethernet					0 bps
sfp-sfpplus5	Ethernet					8.9 Mbps
sfp-sfpplus6	Ethernet					4.7 Mbps
sfp-sfpplus7	Ethernet					680 bps
sfp-sfpplus8	Ethernet					7.9 Mbps
sfp-sfpplus9	Ethernet					0 bps
sfp-sfpplus10	Ethernet					0 bps
sfp-sfpplus11	Ethernet					0 bps
sfp-sfpplus12	Ethernet					0 bps
sfp-sfpplus13	Ethernet					2.8 Gbps

The 'Resources' window is also open, displaying system information:

- Uptime: 53d 23:58:30
- Free Memory: 982.6 MiB
- Total Memory: 1024.0 MiB
- CPU: ARMv7
- CPU Count: 2
- CPU Frequency: 800 MHz
- CPU Load: 5%
- Free HDD Space: 4452 KiB
- Total HDD Size: 16.0 MiB
- Sector Writes Since Reboot: 122 718
- Total Sector Writes: 573 181
- Bad Blocks: 0.0 %
- Architecture Name: arm
- Board Name: CRS317-1G-16S+
- Version: 6.45.1 (stable)
- Build Time: Jun/27/2019 10:23:23
- Factory Software: 6.41

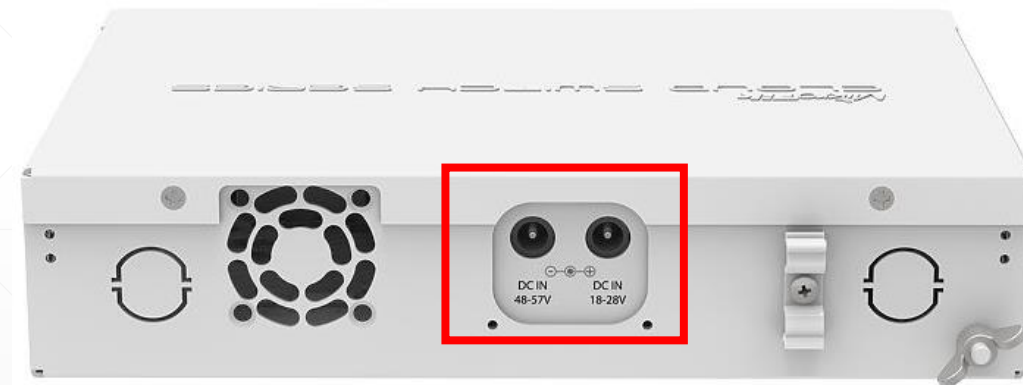
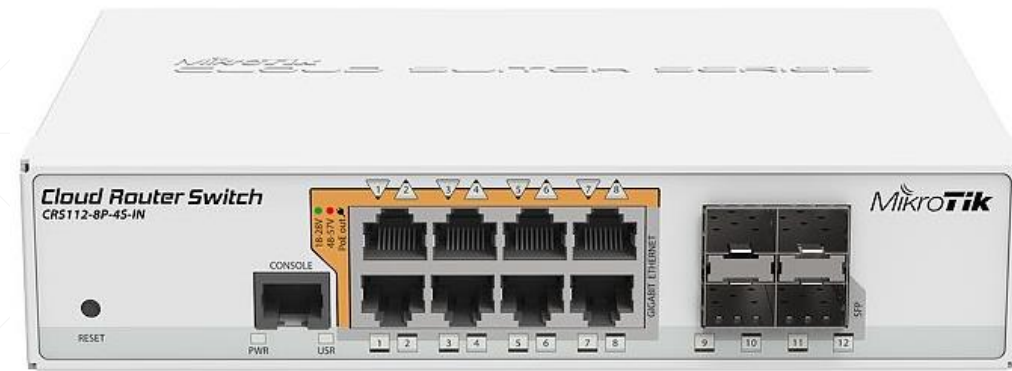
Mikrotik CRS328-24P-4S+RM

- 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

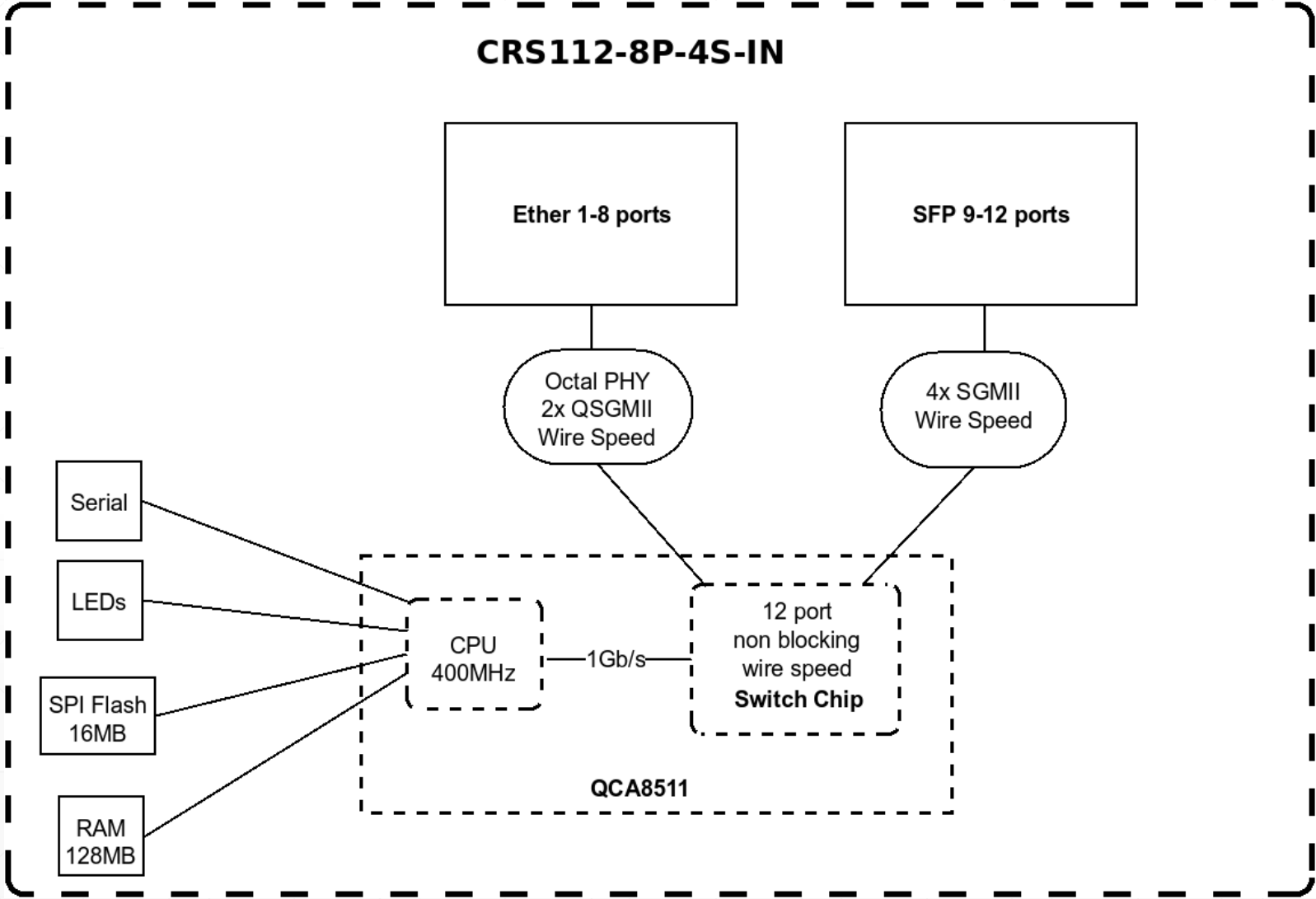
Switching features

- 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

- Полный RouterOS L5

The screenshot shows the Mikrotik WinBox interface for a Mikrotik CRS112-8P-4S-IN switch. The main window displays the 'Switch' configuration, showing a table with columns for Name, Type, Mirror Source, and Mirror Target. The 'Interface List' window is open, showing a table of interfaces with columns for Name, Type, Actual MTU, L2 MTU, Tx, Rx, and Tx Packets. The 'Resources' window is also open, displaying system information such as Uptime, Free Memory, Total Memory, CPU, CPU Count, CPU Frequency, CPU Load, Free HDD Space, Total HDD Size, Sector Writes Since Reboot, Total Sector Writes, Bad Blocks, Architecture Name, Board Name, Version, Build Time, and Factory Software.

Name	Type	Actual MTU	L2 MTU	Tx	Rx	Tx Packets
bonding-old_swCore#1	Bonding					0 bps
bonding-swWorld	Bonding					0 bps
bonding_swCisco_IPTV	Bonding					0 bps
bridge	Bridge					1.1 kbps
vlan	VLAN					9.4 kbps
vlan	VLAN					0 bps
vlan	VLAN					1008 bps
ether1	Ethernet					0 bps
Ro#1 Uplink						
sfp-sfpplus1	Ethernet					0 bps
sfp-sfpplus2	Ethernet					0 bps
sfp-sfpplus3	Ethernet					5.2 Gbps
sfp-sfpplus4	Ethernet					0 bps
sw						0 bps
sfp-sfpplus5	Ethernet					3.9 Mbps
sfp-sfpplus6	Ethernet					1.7 Mbps
sfp-sfpplus7	Ethernet					1680 bps
sfp-sfpplus8	Ethernet					7.9 Mbps
sfp-sfpplus9	Ethernet					0 bps
sfp-sfpplus10	Ethernet					0 bps
sfp-sfpplus11	Ethernet					0 bps
sfp-sfpplus12	Ethernet					0 bps
sfp-sfpplus13	Ethernet					2.8 Gbps

Resource	Value
Uptime	53d 23:58:30
Free Memory	982.6 MiB
Total Memory	1024.0 MiB
CPU	ARMv7
CPU Count	2
CPU Frequency	800 MHz
CPU Load	5 %
Free HDD Space	4452 KiB
Total HDD Size	16.0 MiB
Sector Writes Since Reboot	122 718
Total Sector Writes	573 181
Bad Blocks	0.0 %
Architecture Name	am
Board Name	CRS317-1G-16S+
Version	6.45.1 (stable)
Build Time	Jun/27/2019 10:23:23
Factory Software	6.41

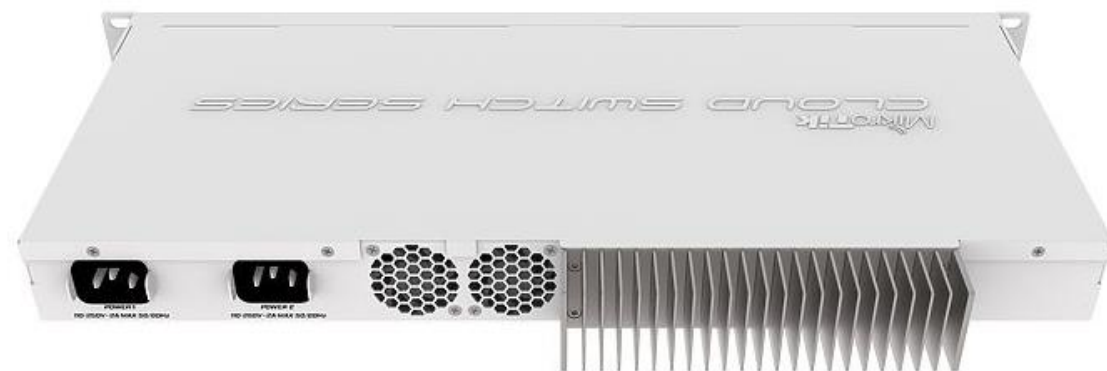
Mikrotik CRS112-8P-4S-IN

- 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

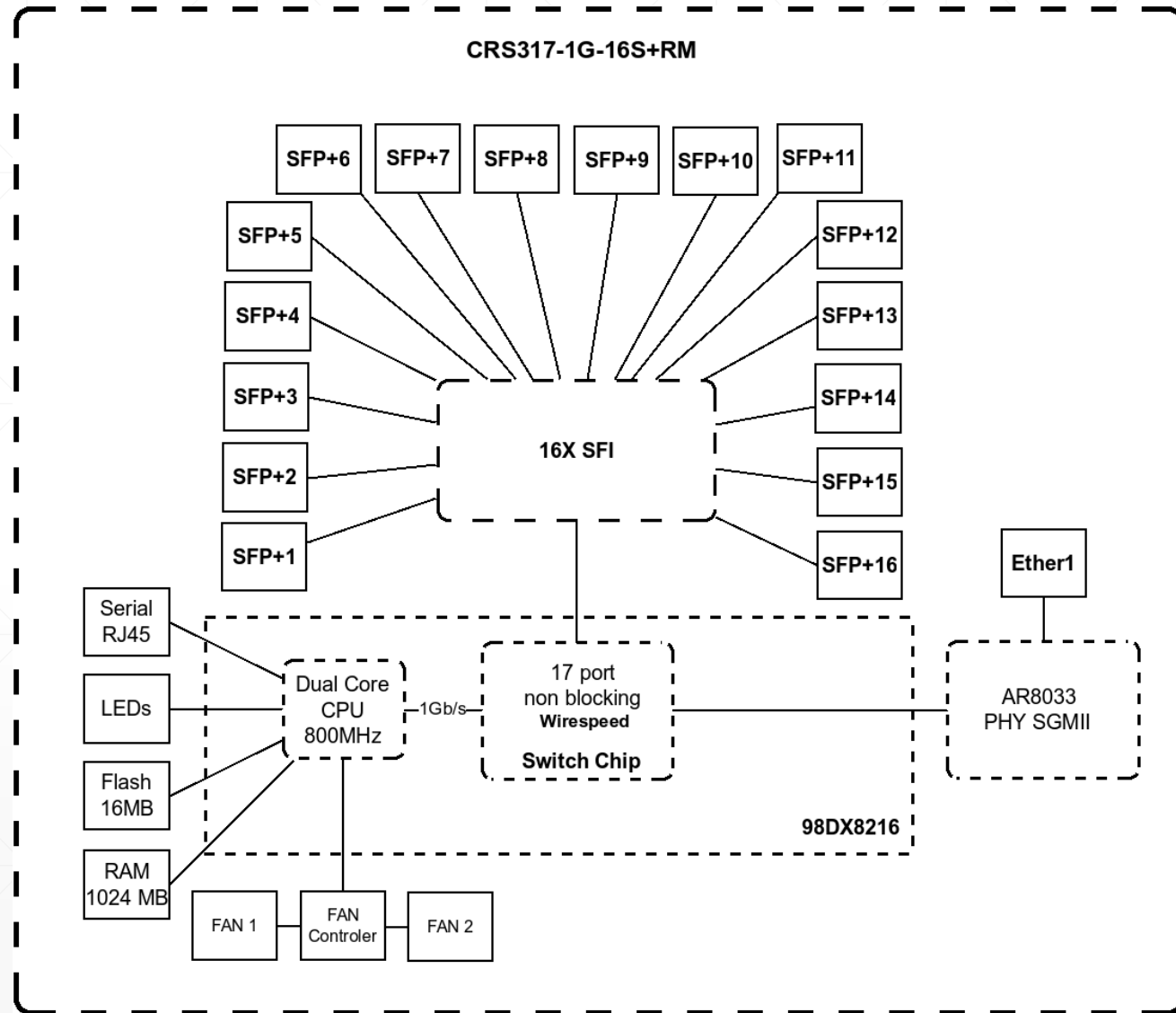
Switching results

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

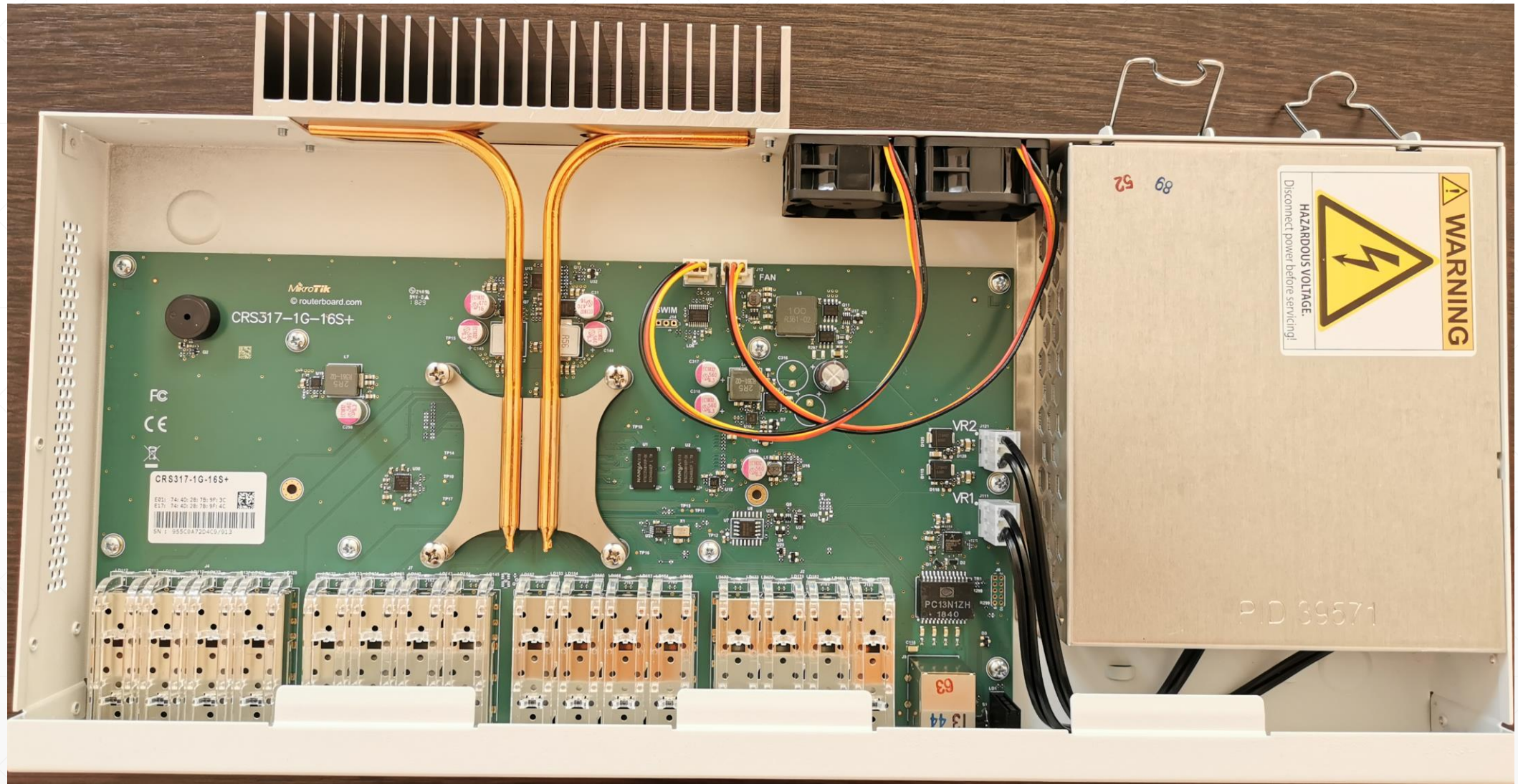
Ethernet test results

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

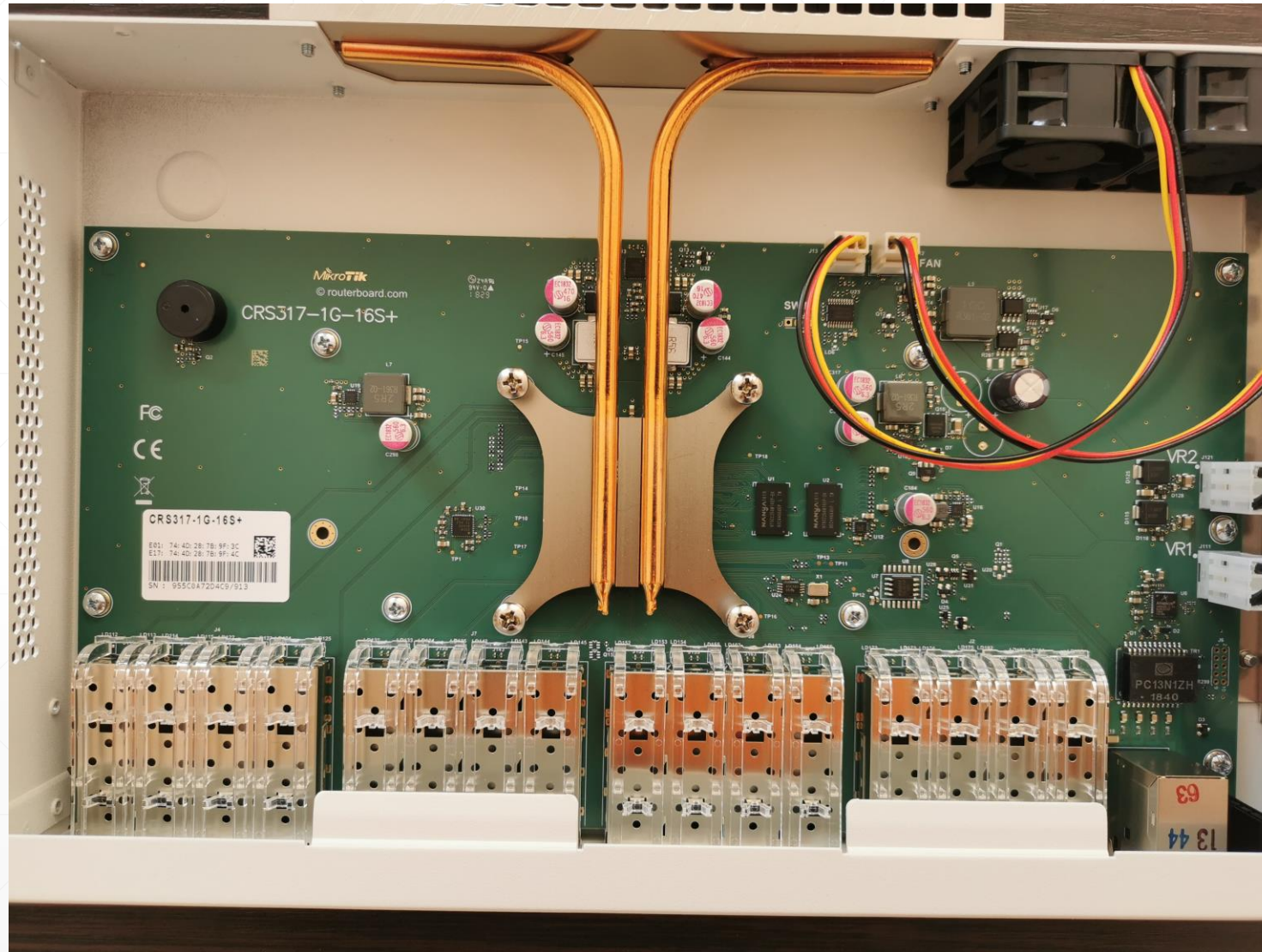
Mikrotik CRS317-1G-16S+RM



Mikrotik CRS317-1G-16S+RM



Mikrotik CRS317-1G-16S+RM



Mikrotik CRS317-1G-16S+RM

- Полноценный RouterOS L5

The screenshot displays the Mikrotik WinBox interface. On the left is a navigation menu with categories like Interfaces, Bridge, PPP, Switch, Mesh, IP, IPv6, MPLS, Routing, System, Queues, Dot1X, Files, Log, RADIUS, Tools, and New Terminal. The main area is divided into several panels:

- Switch:** A table showing switch configuration for 'switch1' with type 'Marvell 98DX8216'.
- Interface List:** A table listing various interfaces including bonding, bridge, VLANs, and Ethernet ports (ether1, sfp-sfpplus1-13).
- Resources:** A detailed system information window showing:
 - Uptime: 53d 23:58:30
 - Free Memory: 982.6 MiB
 - Total Memory: 1024.0 MiB
 - CPU: ARMv7
 - CPU Count: 2
 - CPU Frequency: 800 MHz
 - CPU Load: 5%
 - Free HDD Space: 4452 KiB
 - Total HDD Size: 16.0 MiB
 - Sector Writes Since Reboot: 122 718
 - Total Sector Writes: 573 181
 - Bad Blocks: 0.0 %
 - Architecture Name: am
 - Board Name: CRS317-1G-16S+
 - Version: 6.45.1 (stable)
 - Build Time: Jun/27/2019 10:23:23
 - Factory Software: 6.41

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

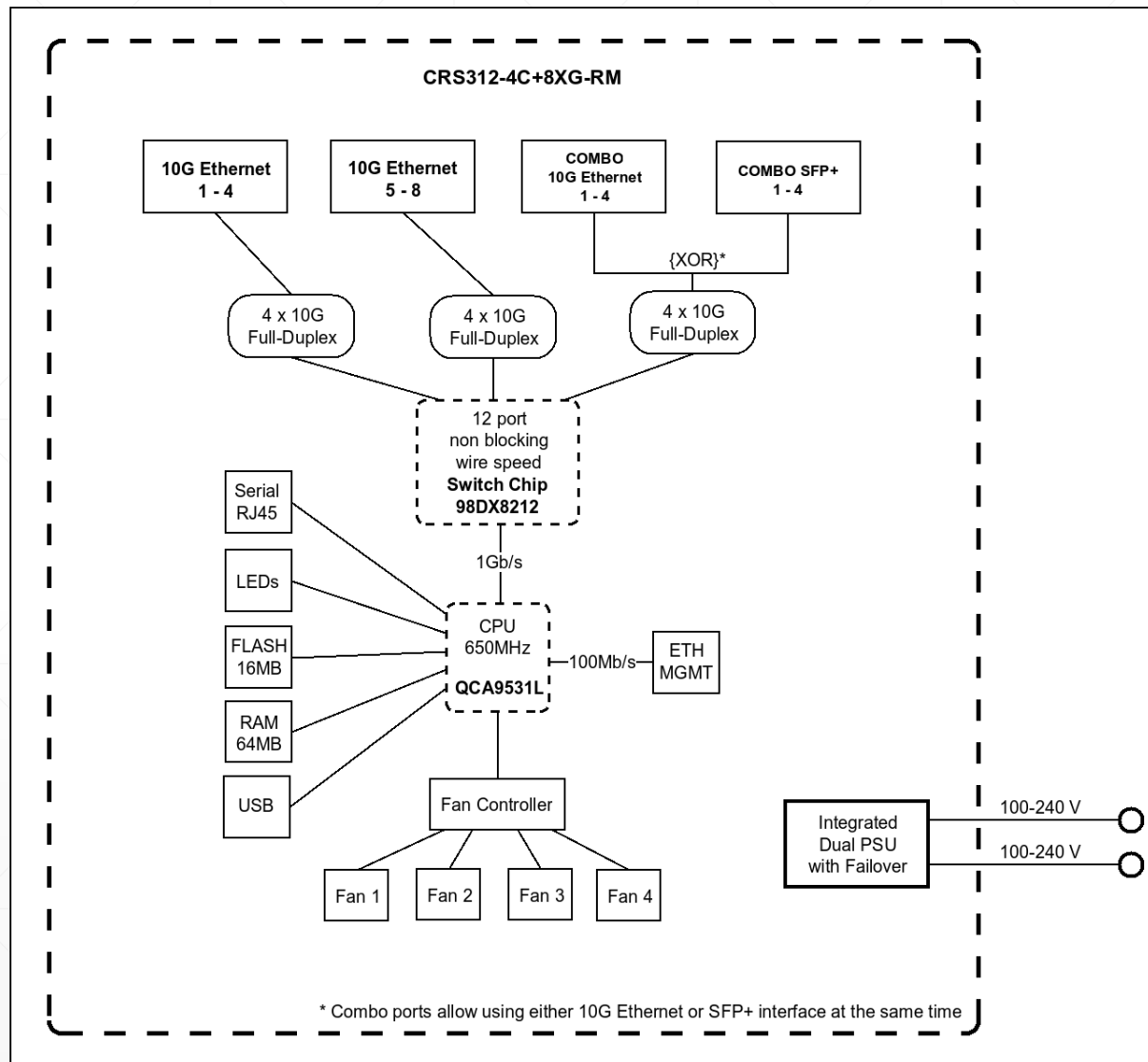
Product code	CRS312-4C+8XG-RM
CPU	QCA9531, 650 MHz
Size of RAM	64 MB
Storage	16 MB flash
10/100 Ethernet ports	1
1G/2.5G/5G/10G RJ45 Ethernet ports	8
Combo 10G Ethernet / SFP ports	4
Supported input voltage	AC power supply 100 - 240 V
Redundant supply	Yes
USB port	USB type A
Serial port	RJ45
Dimensions	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

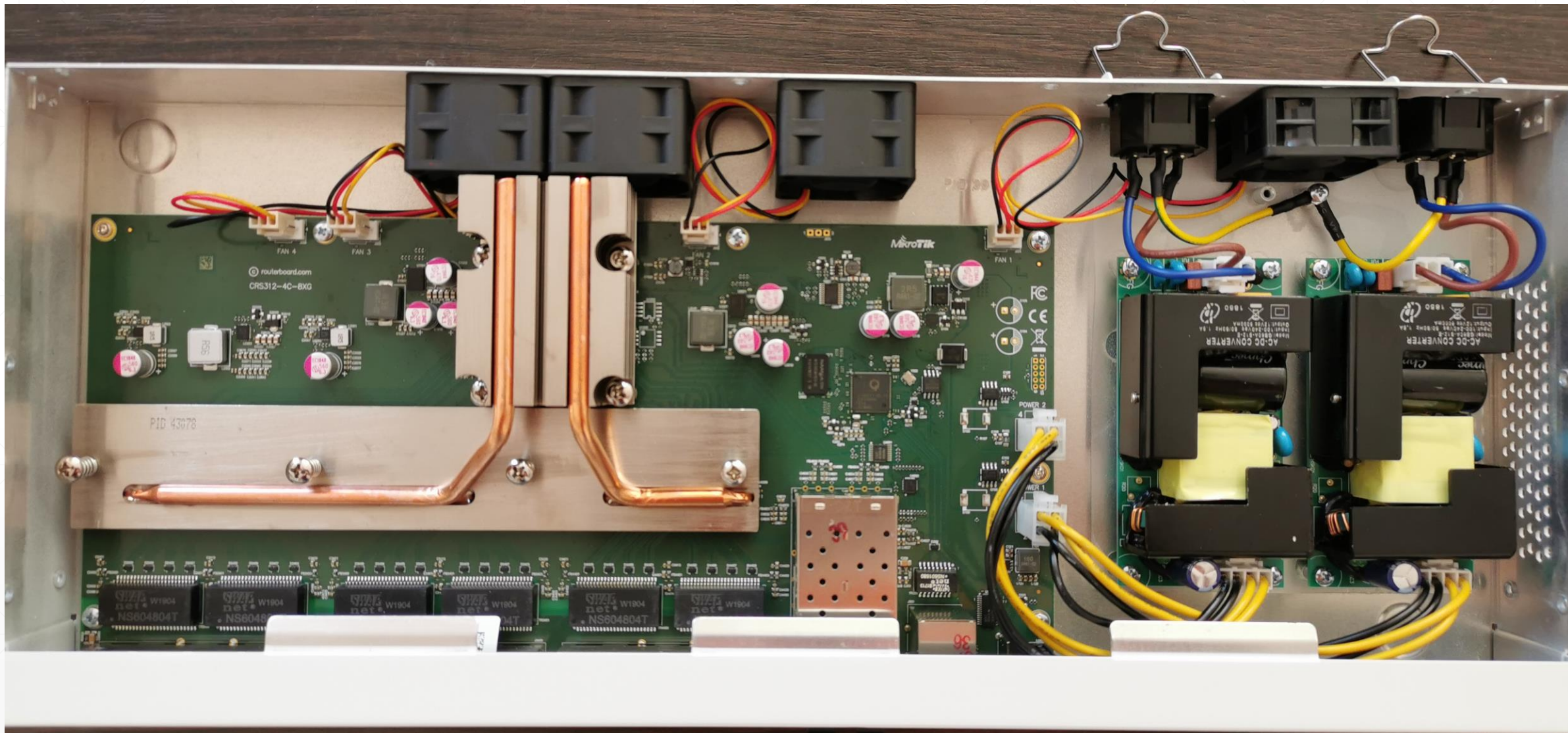
CRS312-4C+8XG-RM

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

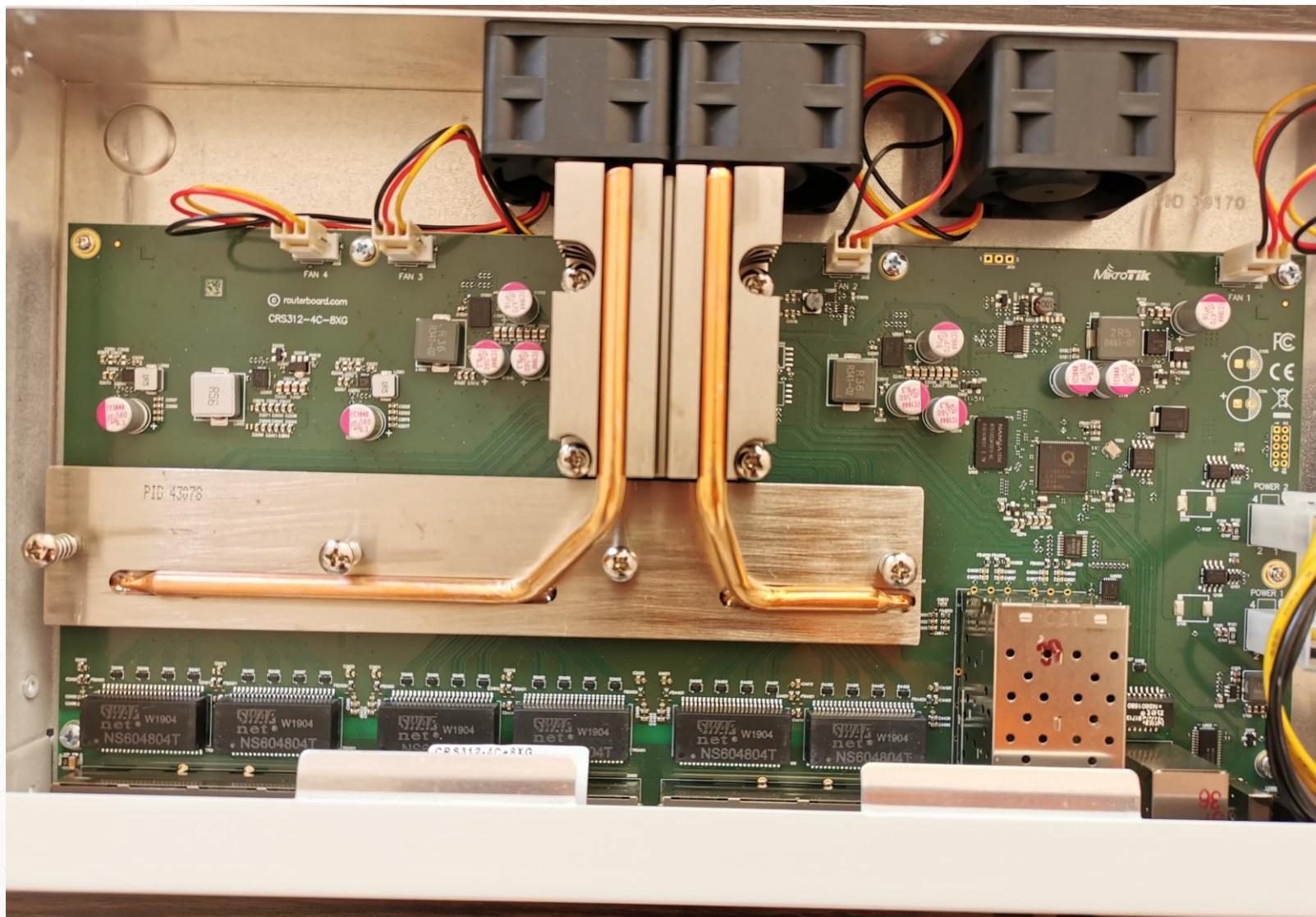
Mikrotik CRS312-4C+8XG-RM



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

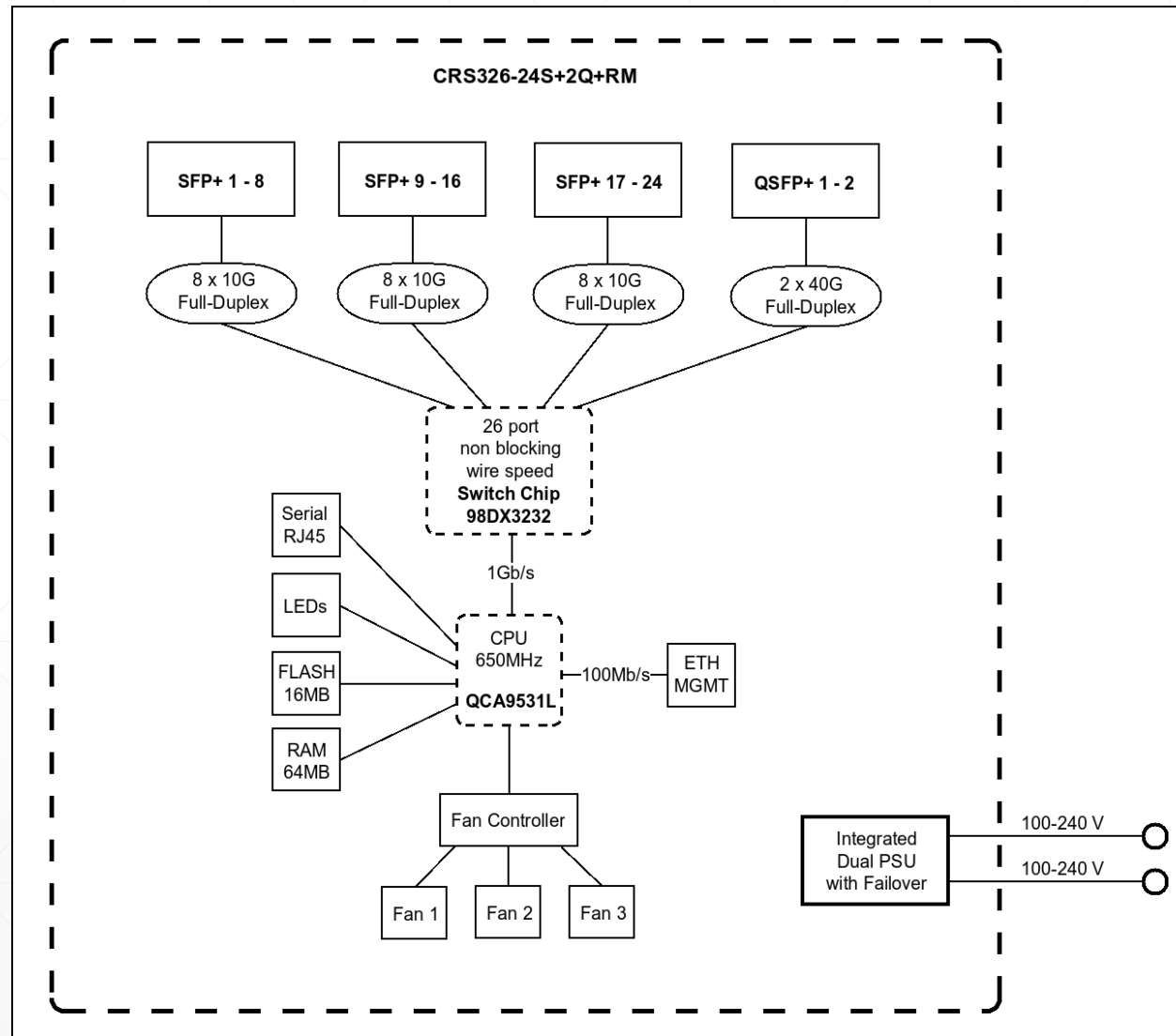
Product code	CRS326-24S+2Q+RM
CPU	QCA9531, 650 MHz
Size of RAM	64 MB
Storage	16 MB flash
10/100 Ethernet ports	1
10G SFP+ ports	24
40G QSFP+ ports	2
Supported input voltage	AC power supply 100 - 240 V
Redundant supply	Yes
USB port	USB type A
Serial port	RJ45
Dimensions	443 x 183 x 44 mm
Operating temperature	-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

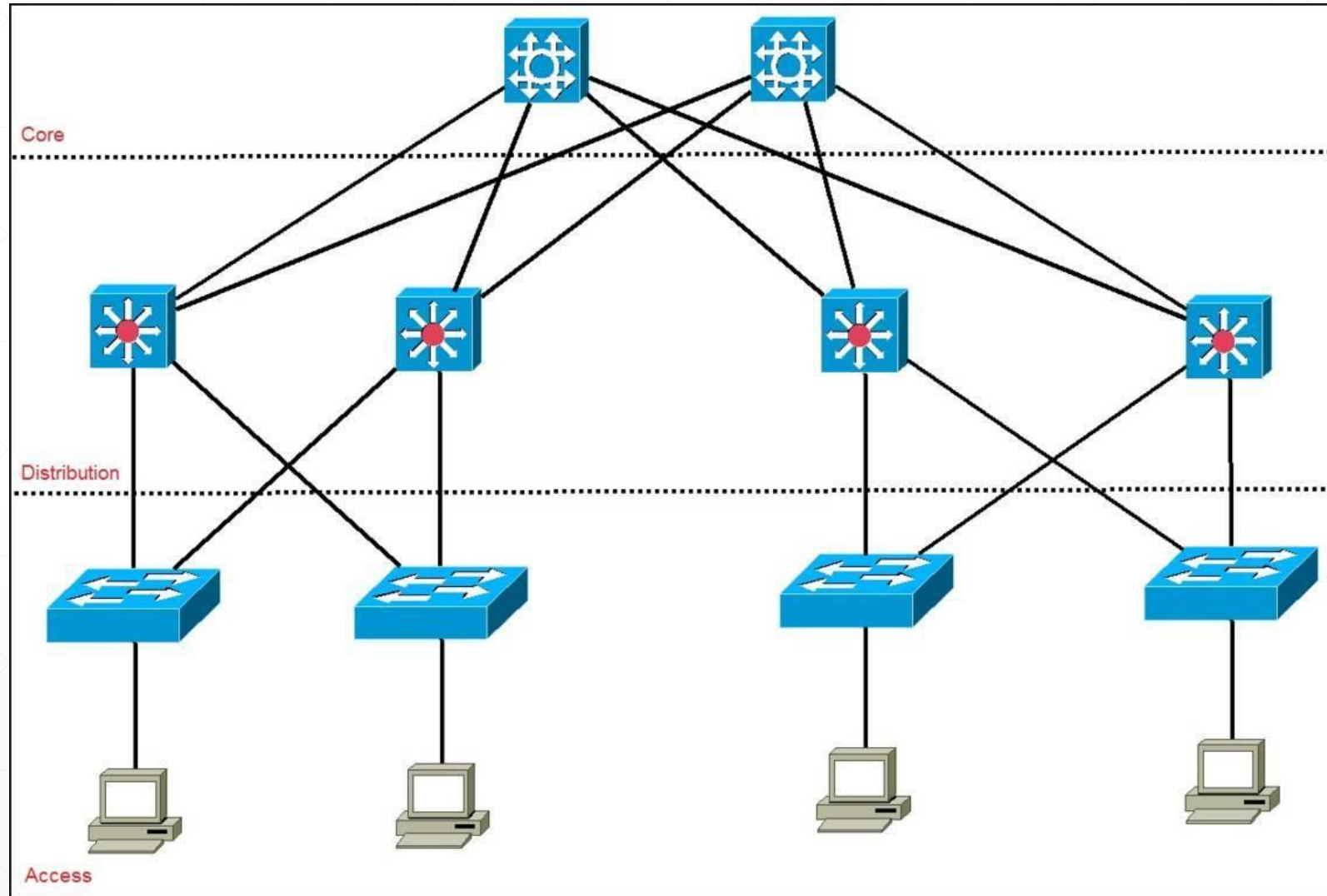


Mikrotik CRS326-24S+2Q+RM

- 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

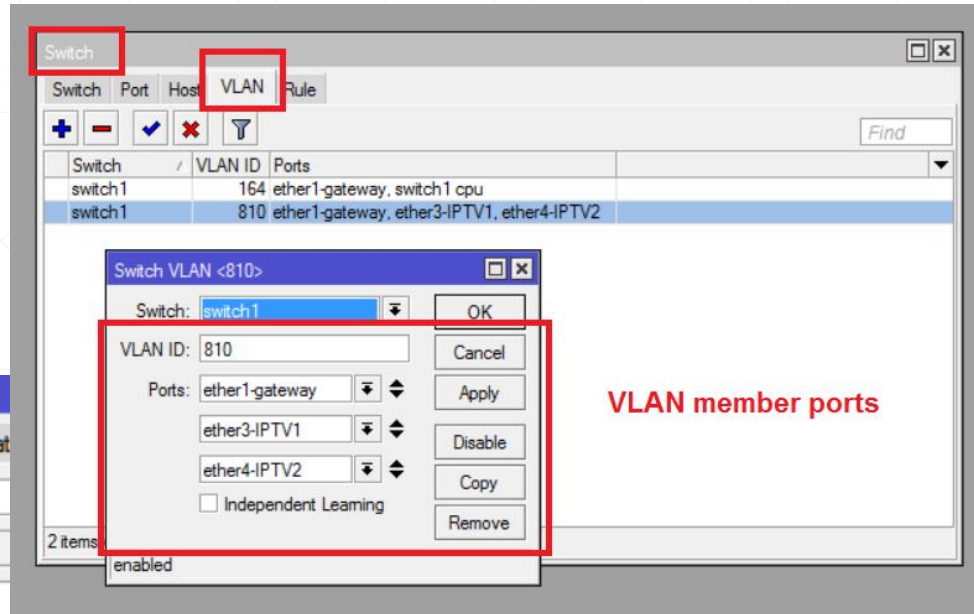
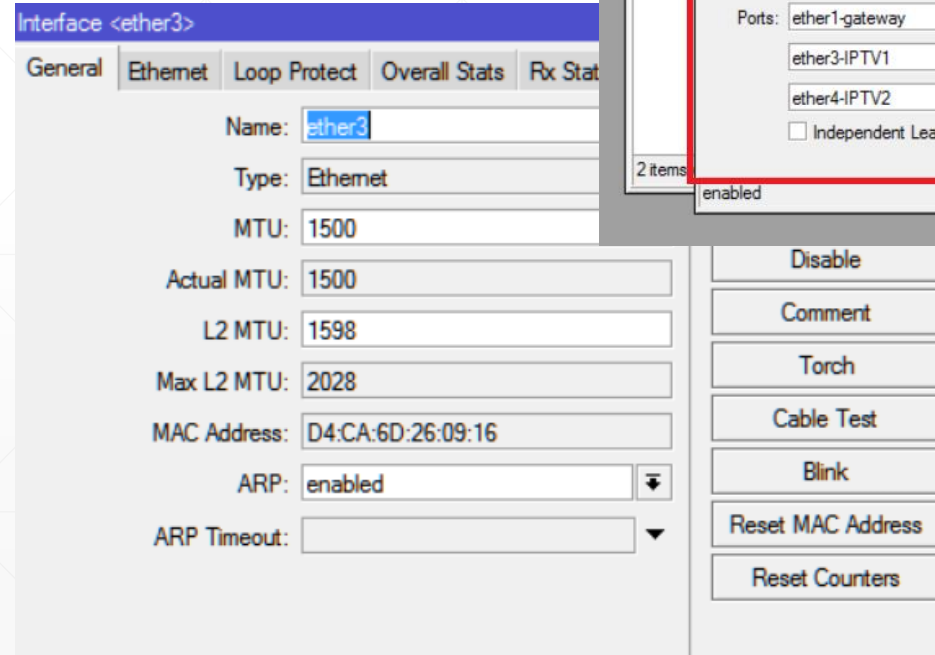
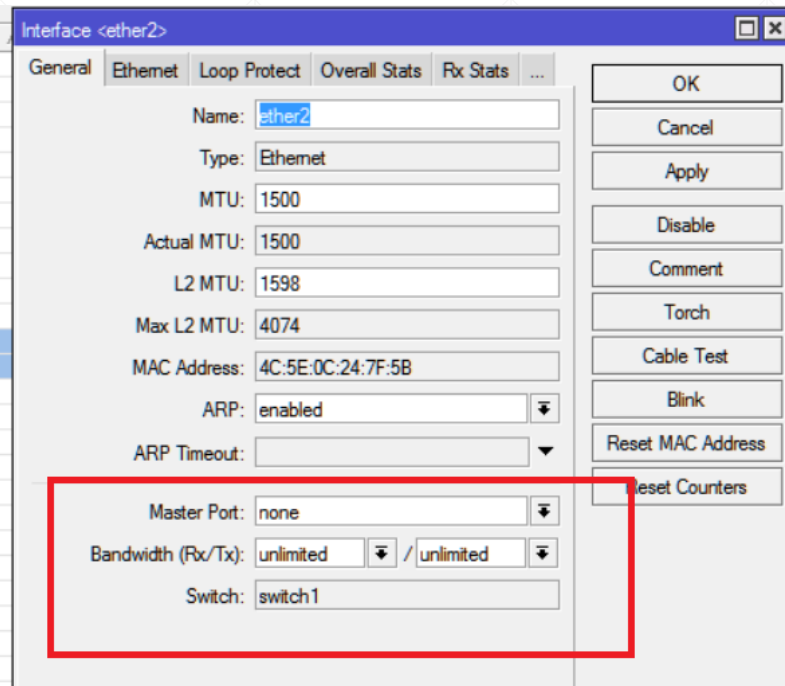


Позиционирование коммутаторов Mikrotik

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

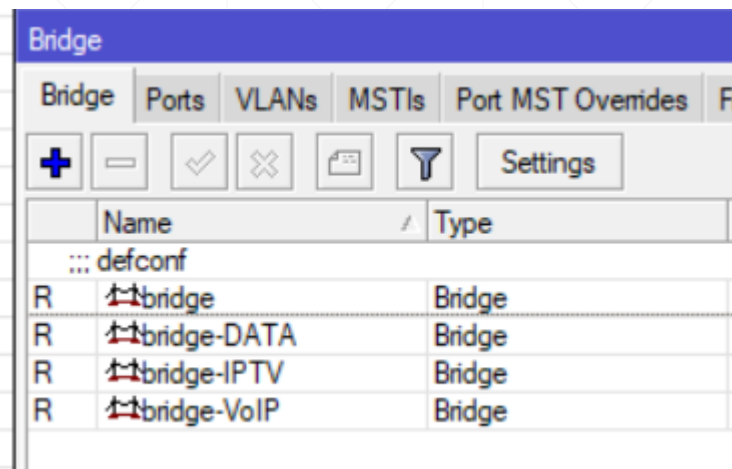
The image displays two screenshots of the Mikrotik WinBox interface. The left screenshot shows the 'Bridge' configuration window with a table of bridges and a 'Bridge Port <ether3>' window where 'Hardware Offload' is checked. The right screenshot shows the same configuration but with 'Hw. Offload' checked in the 'General' tab of the 'Bridge Port <ether3>' window.

Interface	Bridge
ether4	bridge-iptv
vlan35(IPTV)	bridge-iptv
ether2	bridge-local
ether3	bridge-local
wlan2	bridge-local
wlan3	bridge-local
eoip-tmp	bridge-tmp

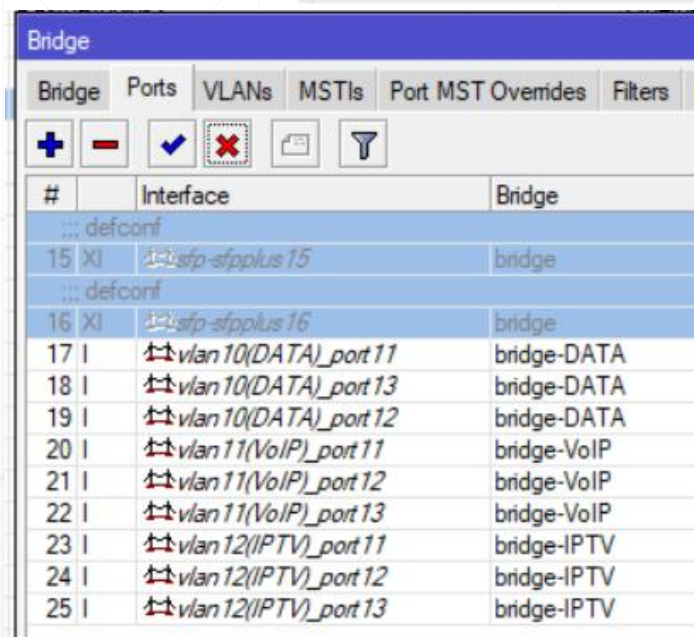
Настройка CRS - VLAN

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

↔sfp-sfpplus 11	Ethernet
↔vlan10(DATA)_port11	VLAN
↔vlan11(VoIP)_port11	VLAN
↔vlan12(IPTV)_port11	VLAN
↔sfp-sfpplus 12	Ethernet
↔vlan10(DATA)_port12	VLAN
↔vlan11(VoIP)_port12	VLAN
↔vlan12(IPTV)_port12	VLAN
↔sfp-sfpplus 13	Ethernet
↔vlan10(DATA)_port13	VLAN
↔vlan11(VoIP)_port13	VLAN
↔vlan12(IPTV)_port13	VLAN



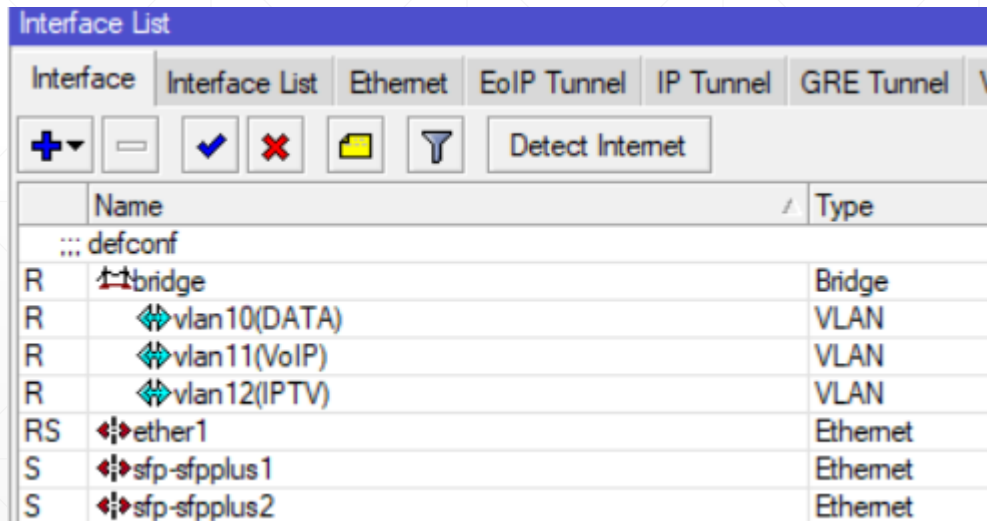
Name	Type
bridge	Bridge
bridge-DATA	Bridge
bridge-IPTV	Bridge
bridge-VoIP	Bridge



#	Interface	Bridge
15	sfp-sfpplus 15	bridge
16	sfp-sfpplus 16	bridge
17	vlan 10(DATA)_port 11	bridge-DATA
18	vlan 10(DATA)_port 13	bridge-DATA
19	vlan 10(DATA)_port 12	bridge-DATA
20	vlan 11(VoIP)_port 11	bridge-VoIP
21	vlan 11(VoIP)_port 12	bridge-VoIP
22	vlan 11(VoIP)_port 13	bridge-VoIP
23	vlan 12(IPTV)_port 11	bridge-IPTV
24	vlan 12(IPTV)_port 12	bridge-IPTV
25	vlan 12(IPTV)_port 13	bridge-IPTV

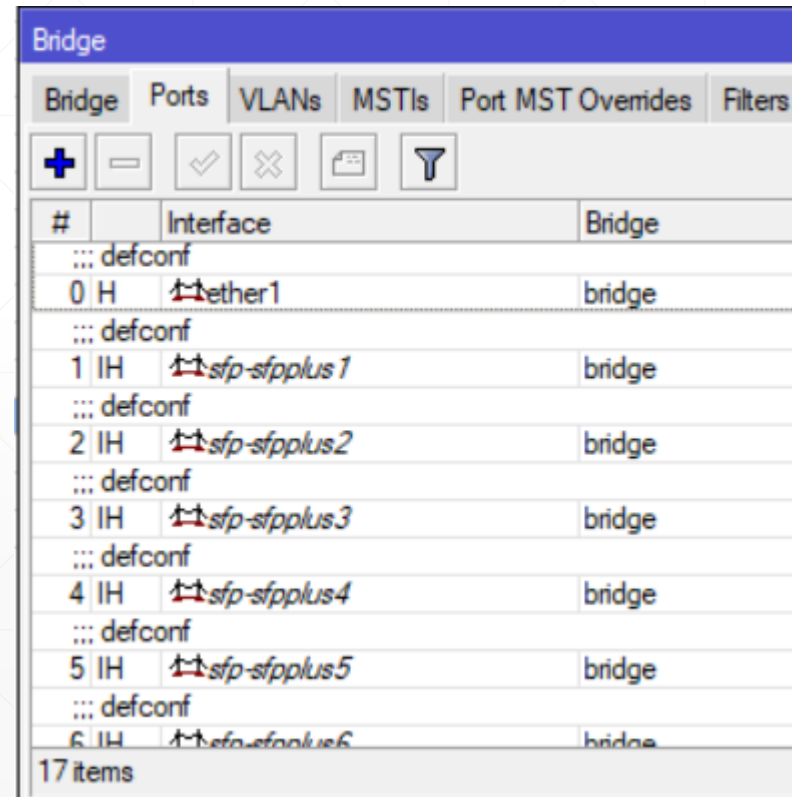
Настройка CRS - VLAN

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



Interface List

Interface	Name	Type
...	defconf	
R	bridge	Bridge
R	vlan10(DATA)	VLAN
R	vlan11(VoIP)	VLAN
R	vlan12(IPTV)	VLAN
RS	ether1	Ethernet
S	sfp-sfpplus1	Ethernet
S	sfp-sfpplus2	Ethernet



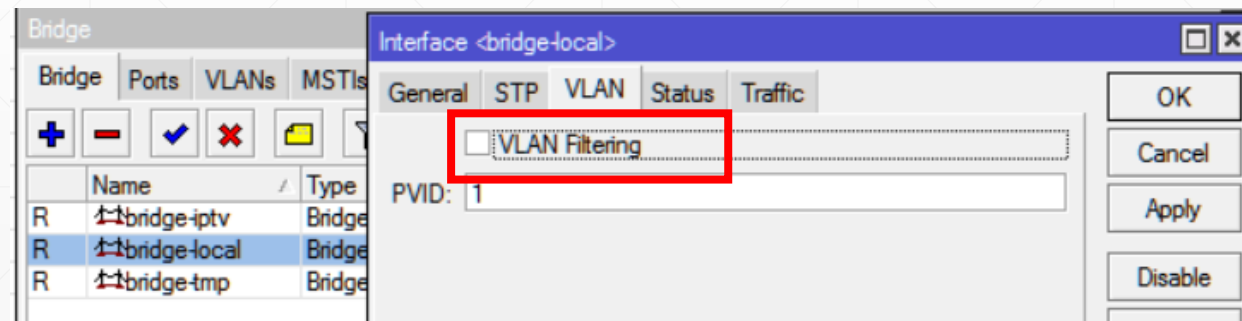
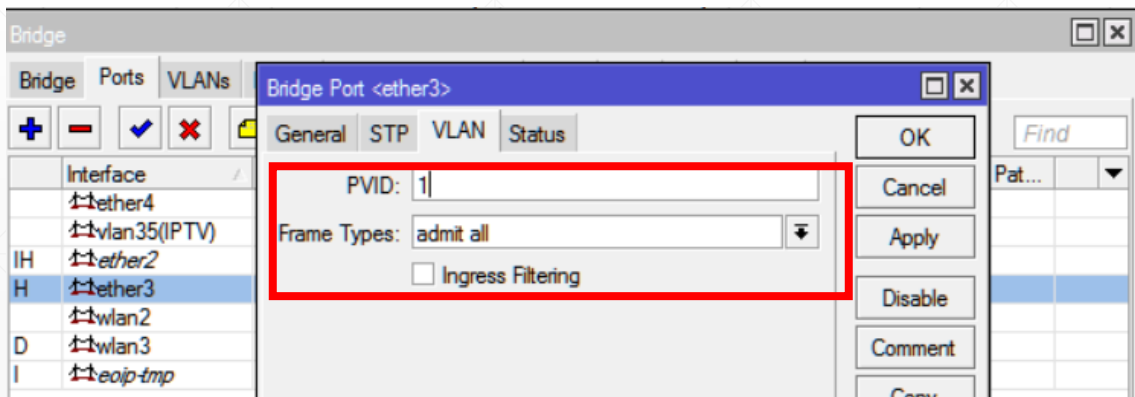
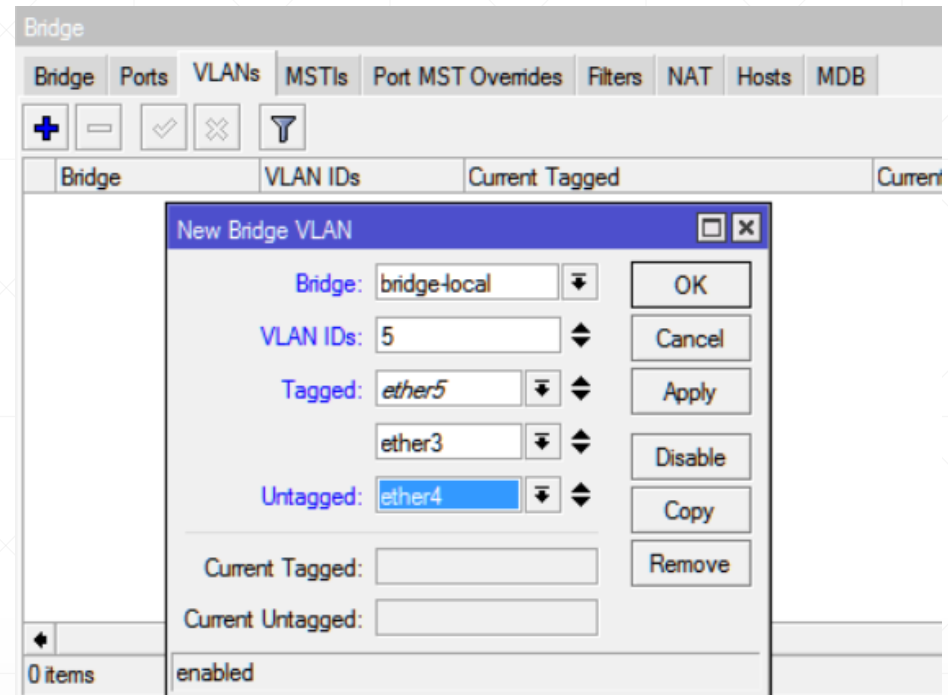
Bridge

#	Interface	Bridge
...	defconf	
0 H	ether1	bridge
...	defconf	
1 IH	sfp-sfpplus1	bridge
...	defconf	
2 IH	sfp-sfpplus2	bridge
...	defconf	
3 IH	sfp-sfpplus3	bridge
...	defconf	
4 IH	sfp-sfpplus4	bridge
...	defconf	
5 IH	sfp-sfpplus5	bridge
...	defconf	
6 IH	sfp-sfpplus6	bridge

17 items

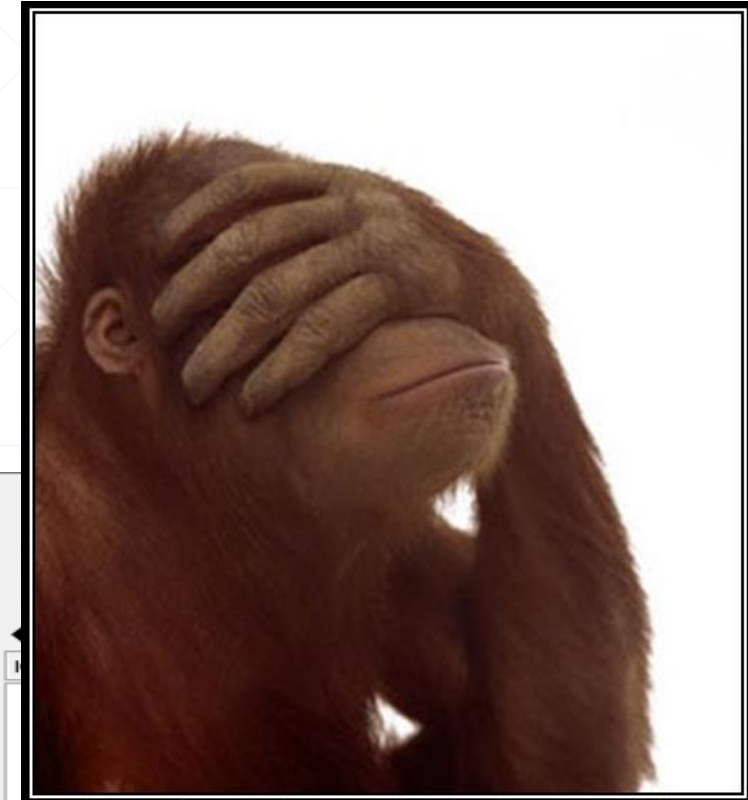
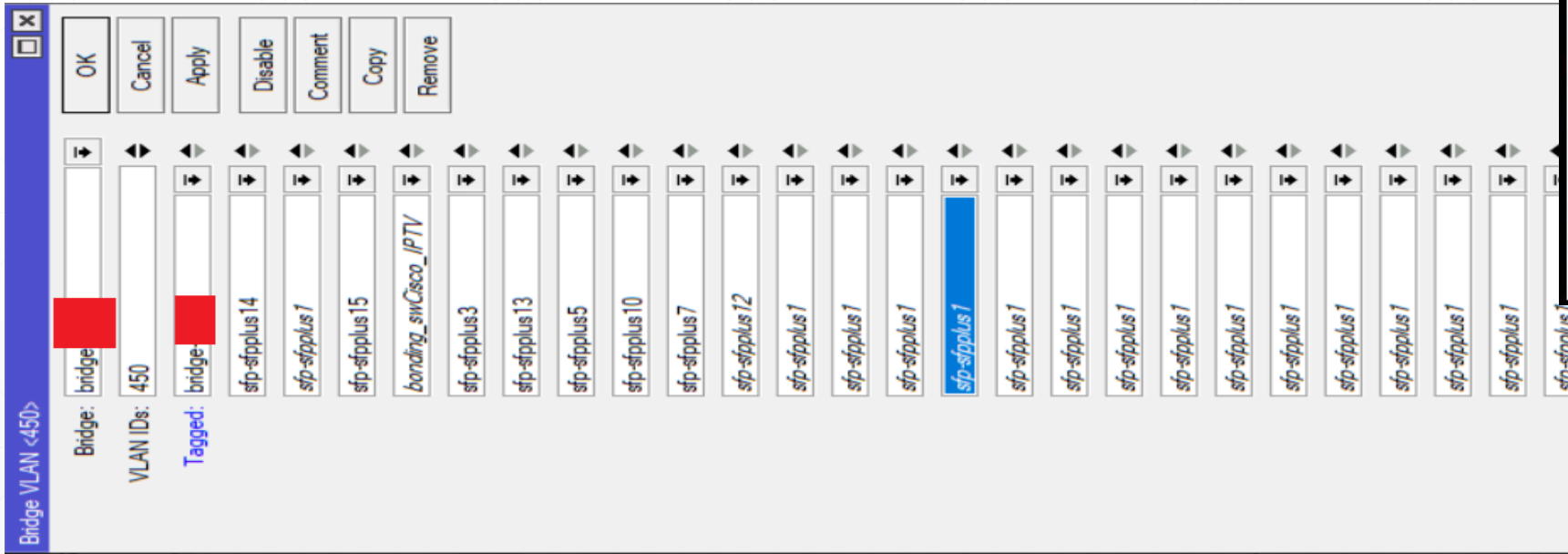
Настройка CRS - VLAN

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



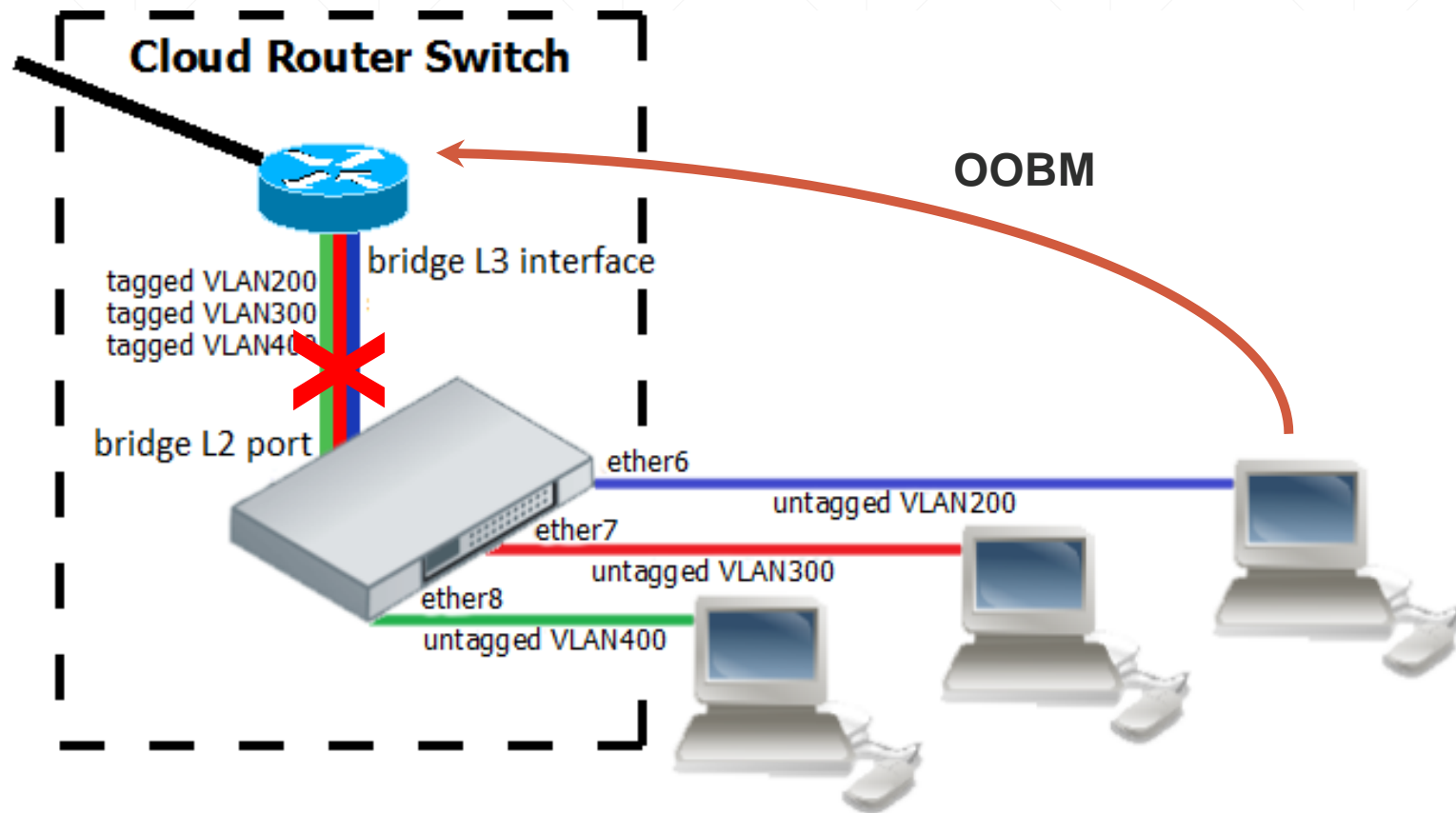
Настройка CRS - VLAN

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



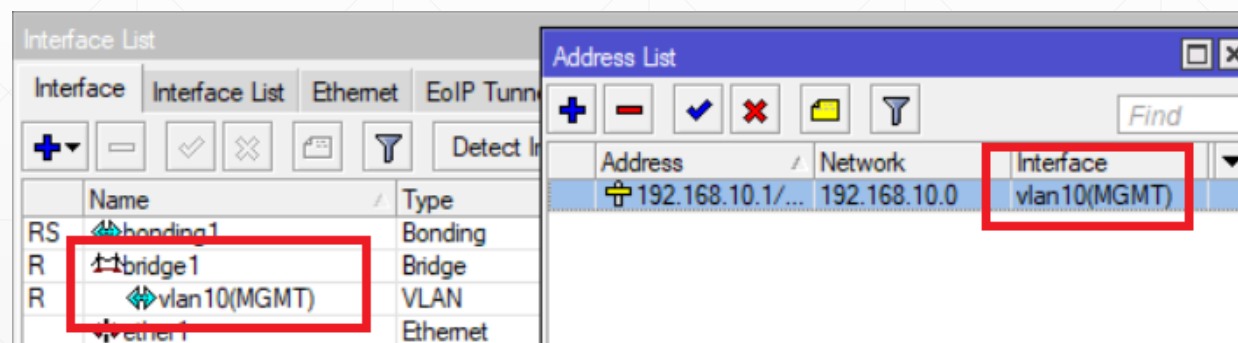
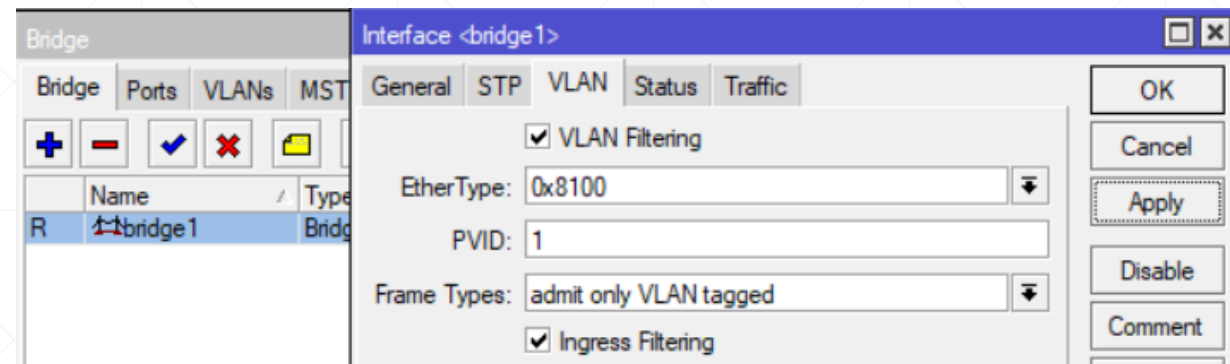
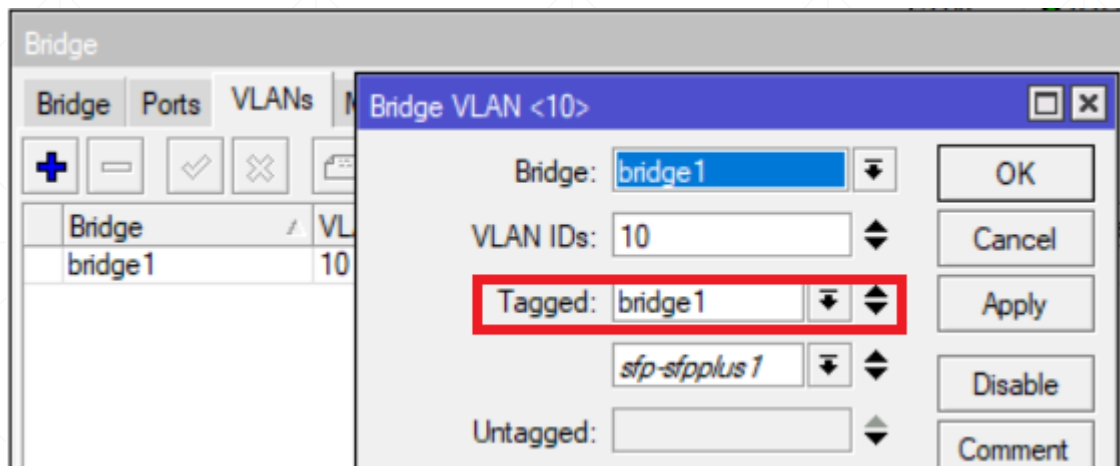
Настройка CRS – Management VLAN

- 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



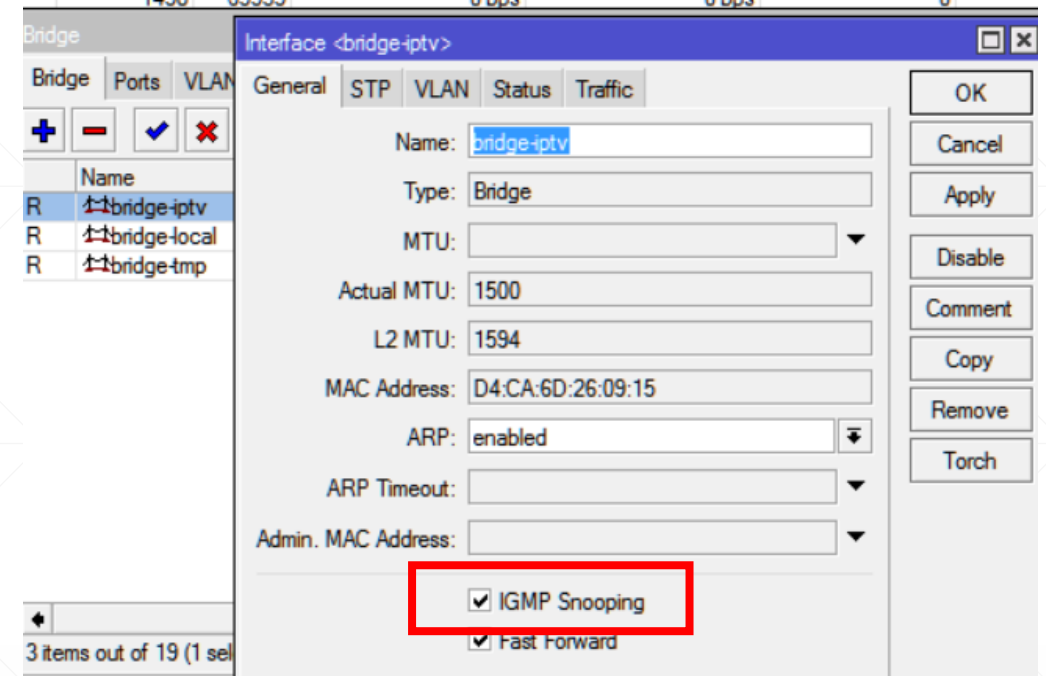
Настройка CRS – Management VLAN

- 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

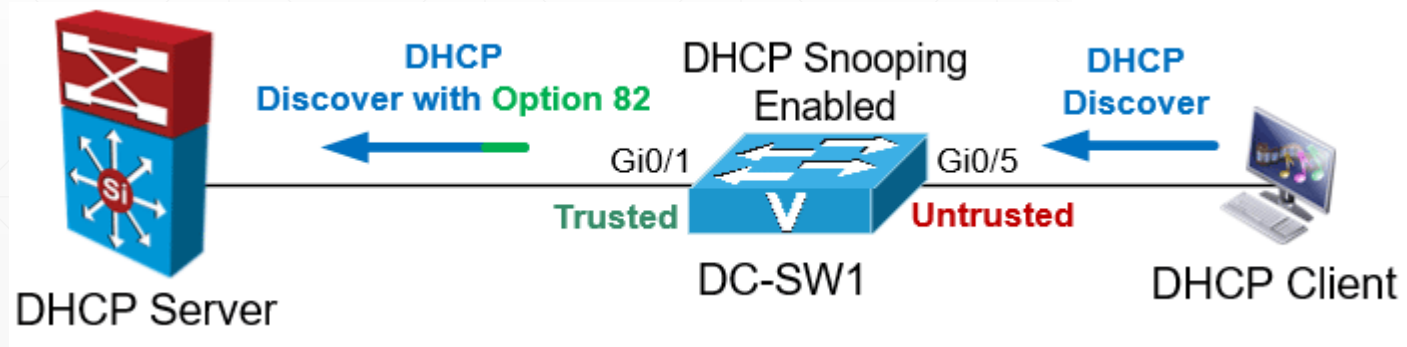
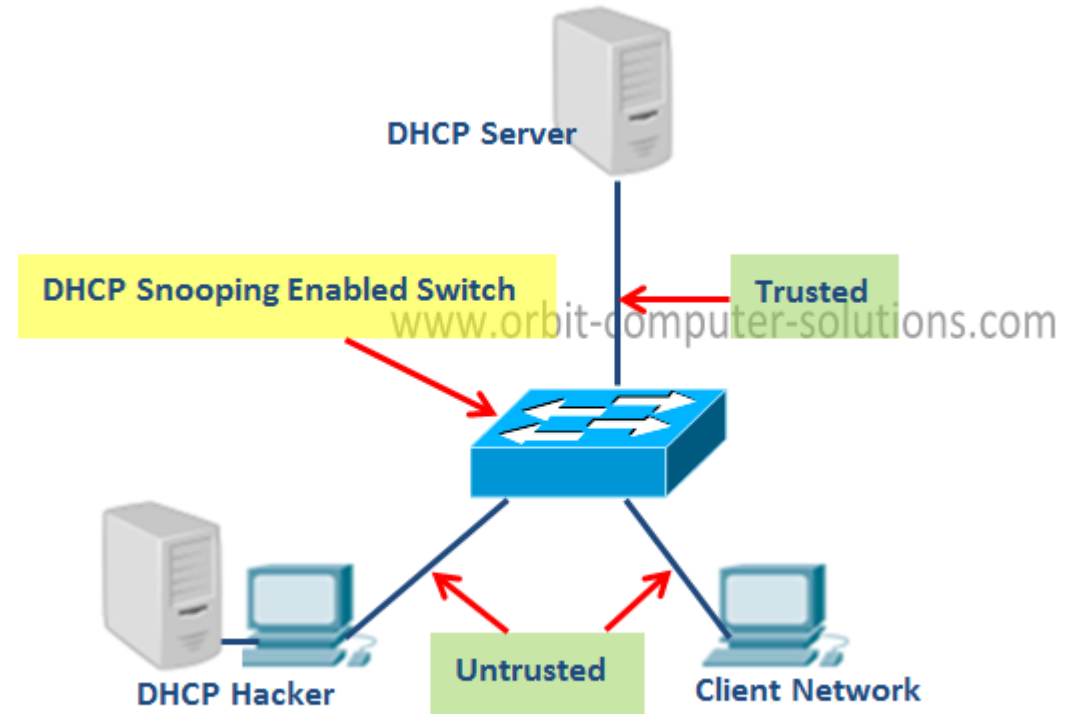


The screenshot shows the Mikrotik WinBox interface for the MDB (Multicast Database) configuration. The table below lists the configured Multicast groups and their associated ports.

Bridge	Group	VID	Ports
bridge-iptv	239.100.10.102		ether4
bridge-iptv	239.255.255.251		ether4
bridge-iptv	229.100.100.13		ether4
bridge-iptv	239.255.255.250		ether4

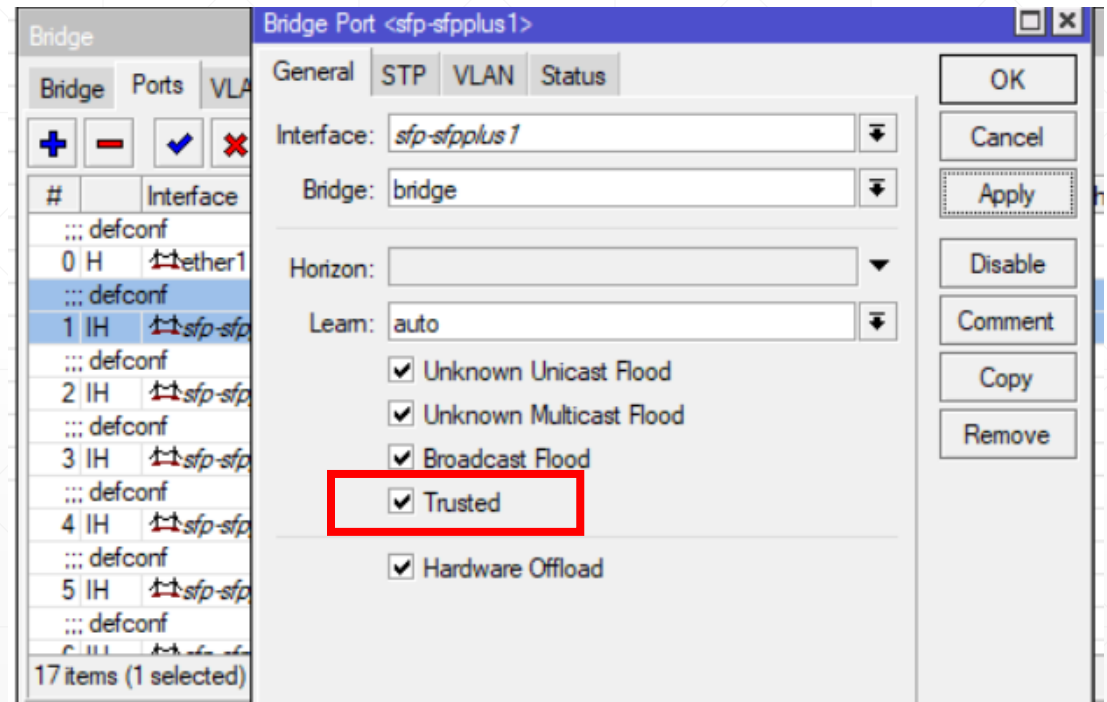
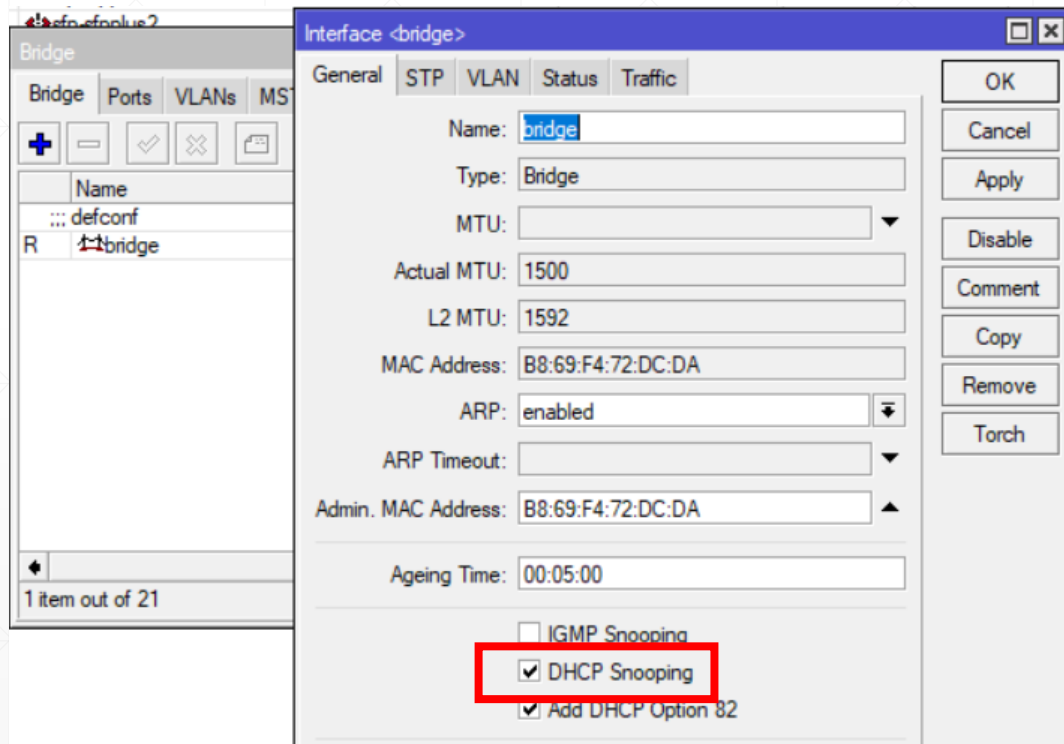
Настройка CRS – DHCP snooping

- 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)



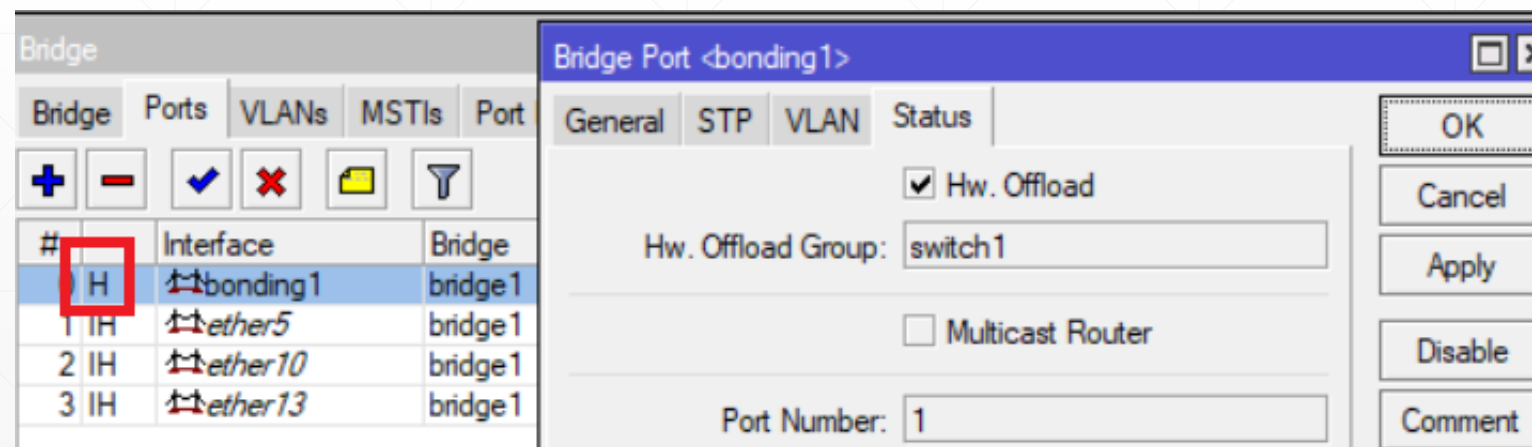
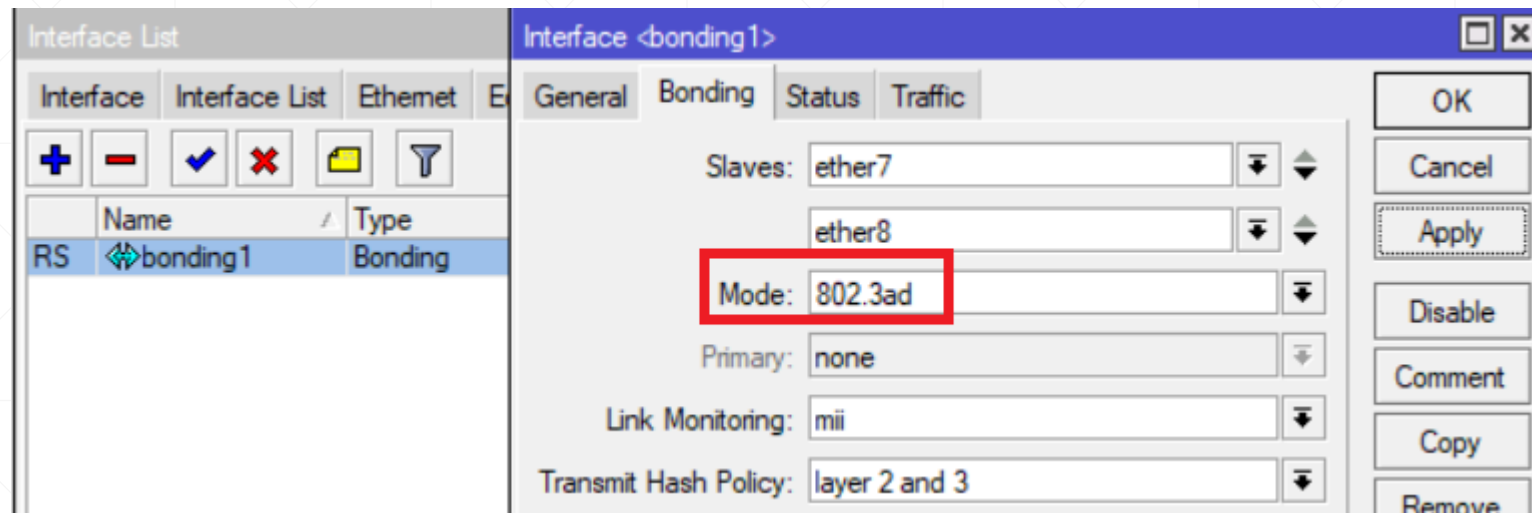
Настройка CRS – DHCP snooping

- При включении DHCP snooping не забывайте указать trusted порт



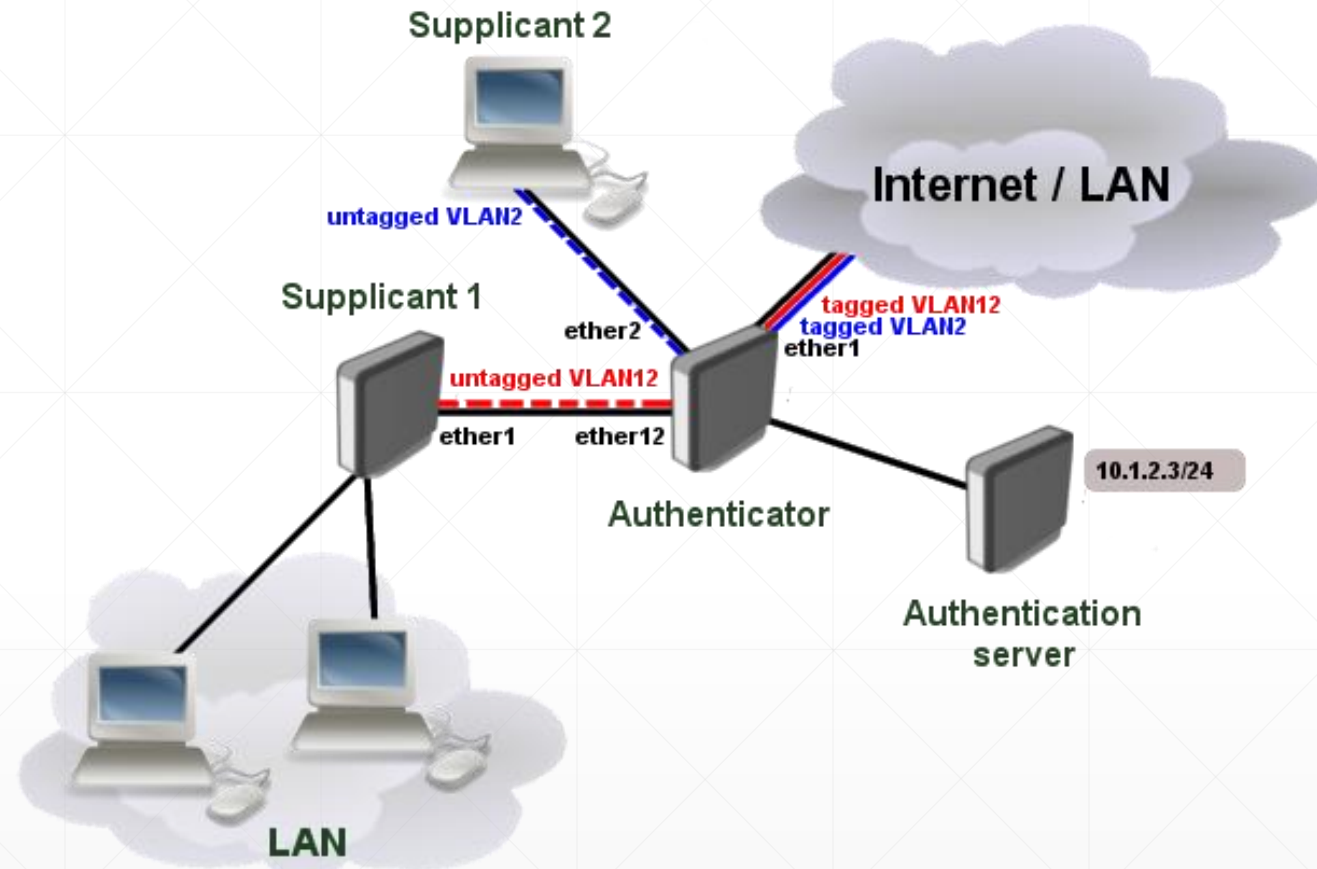
Настройка CRS – LACP bonding

- 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 802.3ad (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



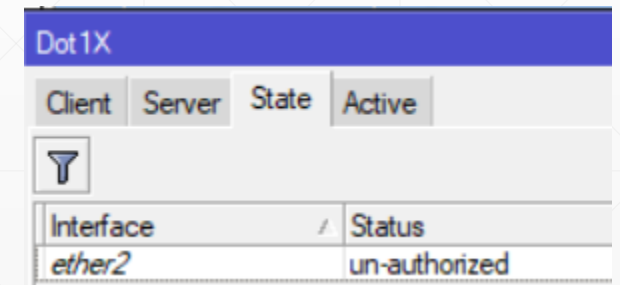
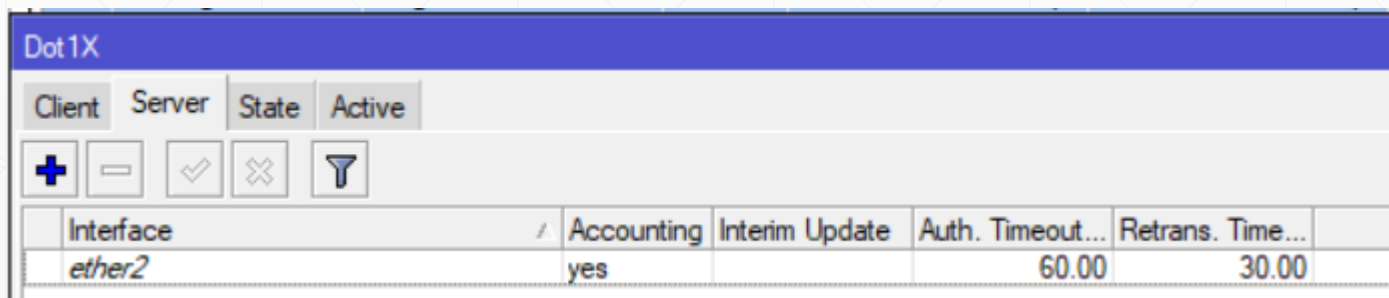
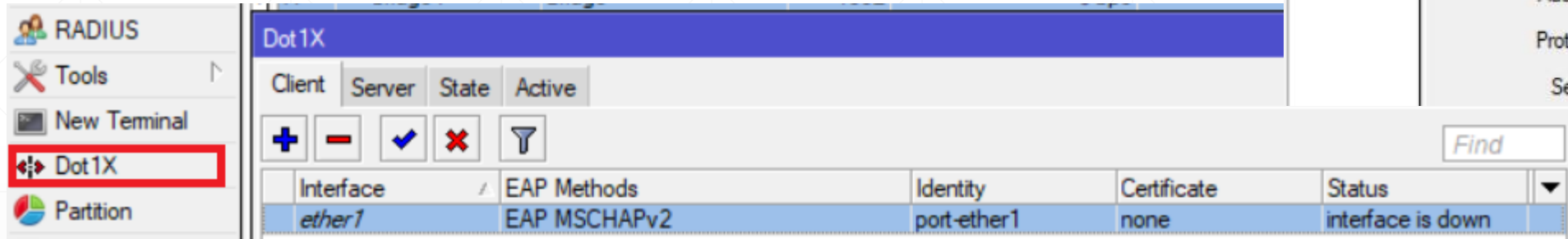
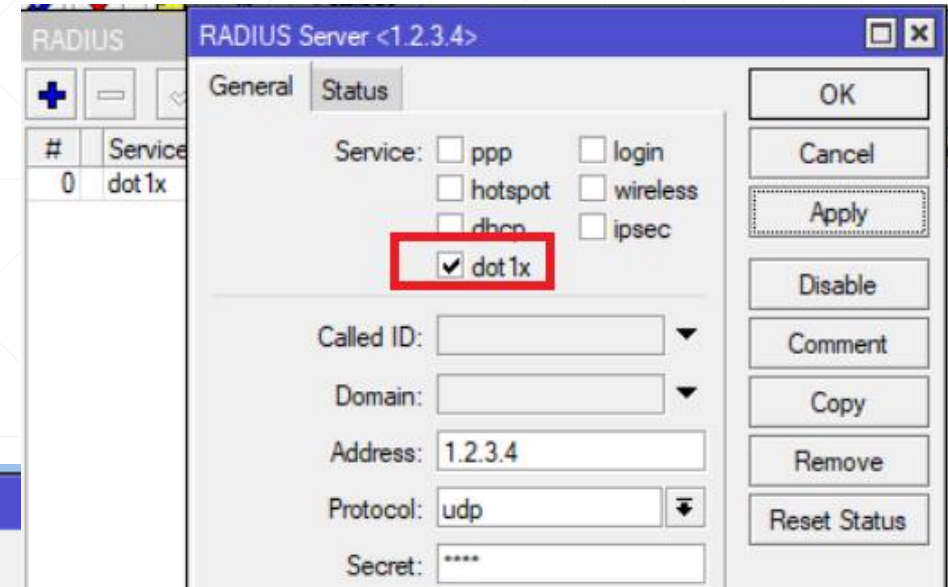
Настройка CRS – 802.1x

- 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

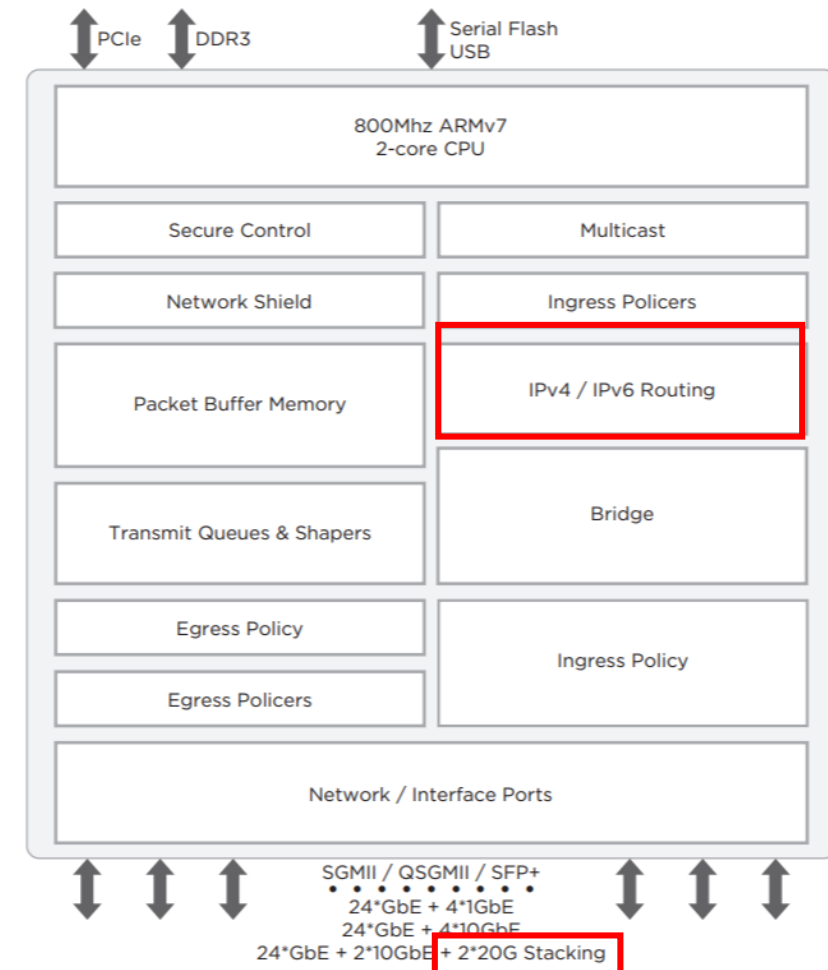
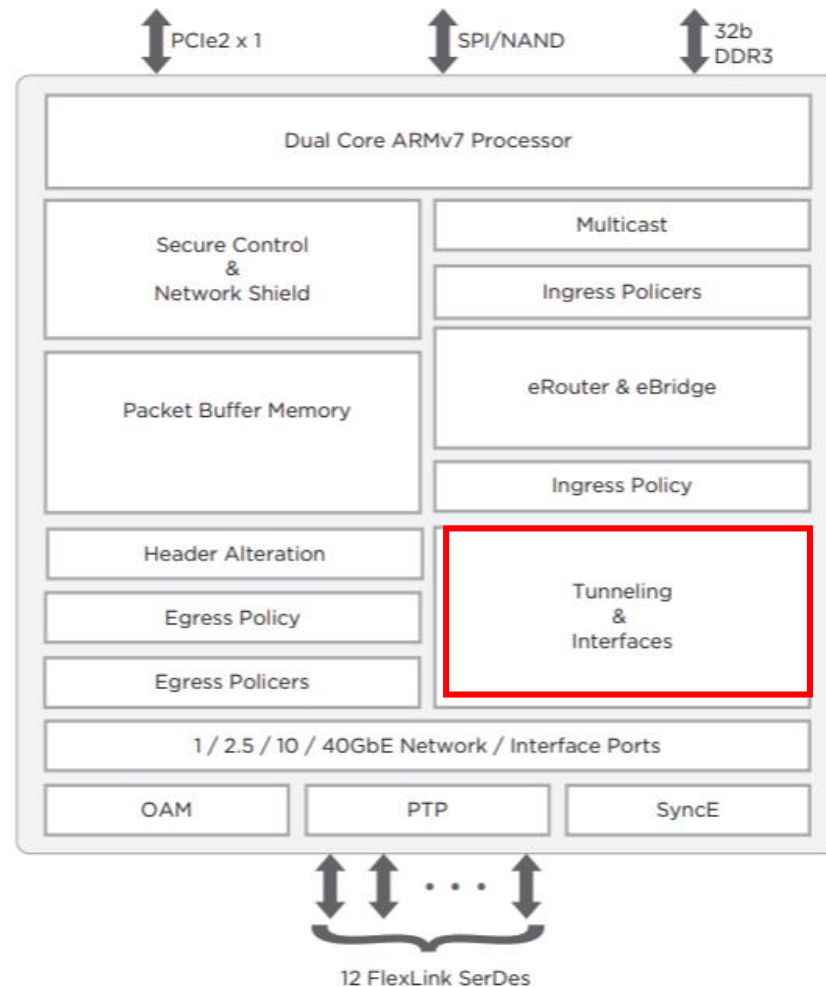


Чего не хватает коммутаторам Mikrotik

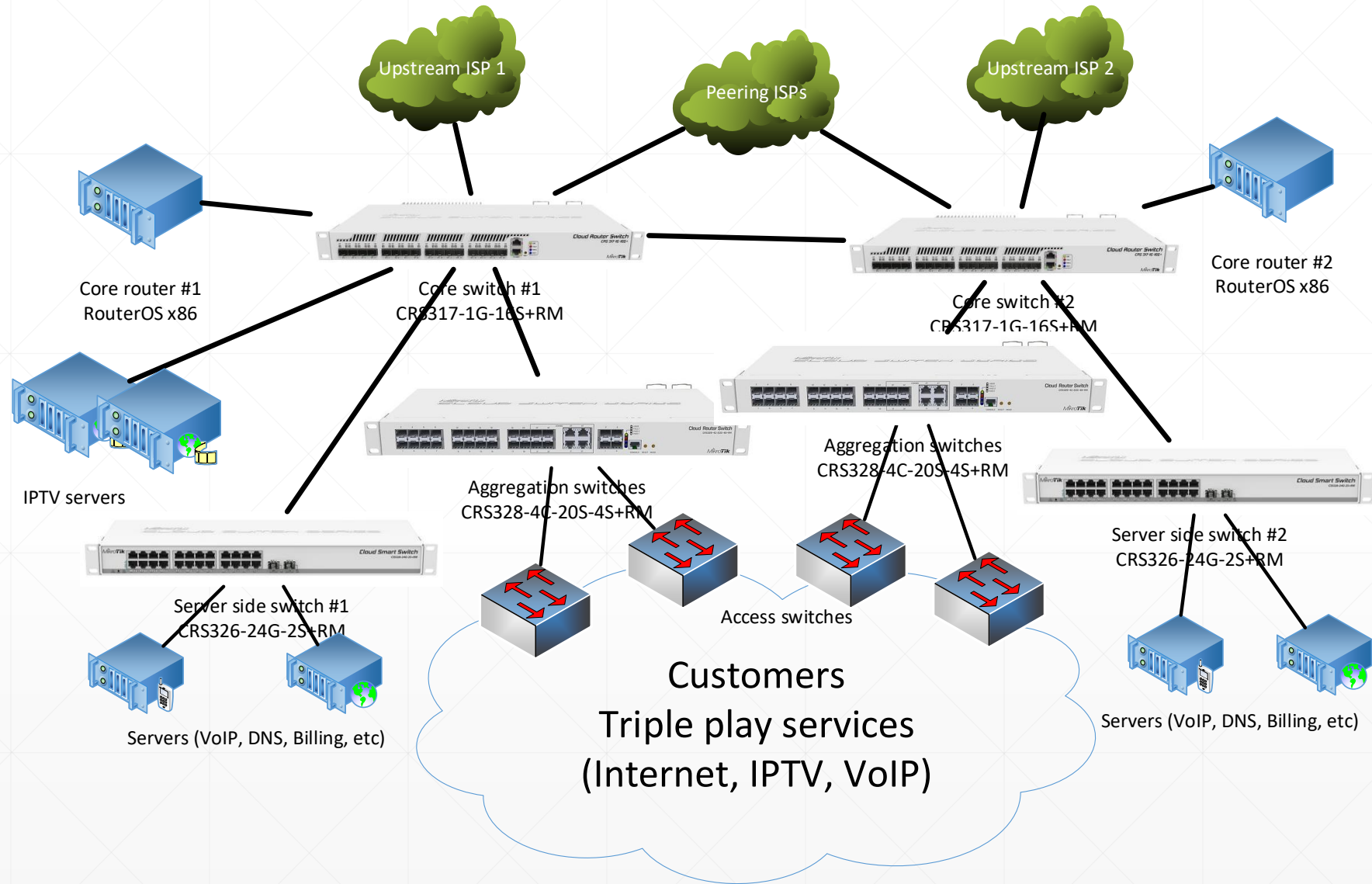
- Внутренние блоки в CSS/CRS326 и любых других rack-mount моделях
- Еще подумать над интерфейсом настройки switch/bridge, сделать более user-friendly
- Стекирование через 10/40Gbps-порты
- 48-ми портовый коммутатор
- LLDP
- Одновременная работа QinQ и 802.1Q для задач ISP
- Dynamic VLAN configuration 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

Safe Mode Session [REDACTED]

Interface List

Interface	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	Bridge	1500	1592	332.2 kbps	7.8 kbps	32	15	
R	vla	VLAN	1500	1588	0 bps	6.0 kbps	0	11	
R	vla	VLAN	1500	1588	0 bps	0 bps	0	0	
R	vla	VLAN	1500	1588	332.1 kbps	1360 bps	32	4	
S	ether1	Ethernet	1500	1592		0 bps	0 bps	0	0
::: Ro#1 Uplink									
XS	sfp-sfplusplus1	Ethernet	1504	1592		0 bps	0 bps	0	0
::: Ro#1 Downlink									
S	sfp-sfplusplus2	Ethernet	1504	1592		0 bps	0 bps	0	0
::: Ro#2									
RS	sfp-sfplusplus3	Ethernet	1504	1592	4.3 Gbps	4.3 Gbps	511 844	508 755	
::: Ro#2									
S	sfp-sfplusplus4	Ethernet	1504	1592		0 bps	0 bps	0	0
::: sw1									
RS	sfp-sfplusplus5	Ethernet	1504	1592	1646.2 Mbps	43.8 Mbps	138 479	46 119	
::: STV peering									
RS	sfp-sfplusplus6	Ethernet	1504	1592	742.6 Mbps	921.5 Mbps	72 889	86 759	
::: Cisco IPTV switch - new									
RS	sfp-sfplusplus7	Ethernet	1504	1592	206.6 kbps	1880 bps	116	3	
:::									
RS	sfp-sfplusplus8	Ethernet	1504	1592	9.9 Mbps	9.4 Mbps	1 434	1 339	
::: tmp - 3560E (Orange)									
	sfp-sfplusplus9	Ethernet	1504	1592		0 bps	0 bps	0	0
::: - port 27									
RS	sfp-sfplusplus10	Ethernet	1504	1592	57.6 kbps	0 bps	89	0	
::: - port 28									
S	sfp-sfplusplus11	Ethernet	1504	1592		0 bps	0 bps	0	0
::: IPTV - Astra 2									
S	sfp-sfplusplus12	Ethernet	1504	1592		0 bps	0 bps	0	0
::: IPTV - Flussonic									
RS	sfp-sfplusplus13	Ethernet	1504	1592	501.1 Mbps	2.8 Gbps	105 603	240 407	
::: swCore#2									
RS	sfp-sfplusplus14	Ethernet	1504	1592	813.5 Mbps	309.9 Mbps	89 909	59 902	
:::									
RS	sfp-sfplusplus15	Ethernet	1504	1592	1062.2 Mbps	1344.2 Mbps	141 152	163 841	
:::									
RS	sfp-sfplusplus16	Ethernet	1504	1592	924.3 Mbps	284.5 Mbps	92 537	47 337	

Use case - small ISP core upgrade

Bridge

Bridge	VLAN IDs	Current Tagged
Backup	451	sfp-sfpplus16, sfp-sfpplus3
Backup	452	sfp-sfpplus16, sfp-sfpplus3
Backup	453	bridge-danis, sfp-sfpplus10, sfp-sfpplus16, sfp-sfpplus3, sfp-sfpplus5, sfp-sfpplus13
LAN	454	
LAN	500	bridge-danis, sfp-sfpplus10, sfp-sfpplus14, sfp-sfpplus3
LAN	501	sfp-sfpplus10, sfp-sfpplus3, sfp-sfpplus7
LAN	502	sfp-sfpplus3, sfp-sfpplus7
LAN	503	sfp-sfpplus10, sfp-sfpplus15, sfp-sfpplus3
LAN	504	sfp-sfpplus3
LAN	505	sfp-sfpplus3
Main	520	sfp-sfpplus15, sfp-sfpplus3
Main	547	sfp-sfpplus15, sfp-sfpplus3
D	800	sfp-sfpplus10, sfp-sfpplus6
D MGMT	801	sfp-sfpplus10, sfp-sfpplus5, sfp-sfpplus8
X	809	
LAN	810	sfp-sfpplus3, sfp-sfpplus5, sfp-sfpplus7

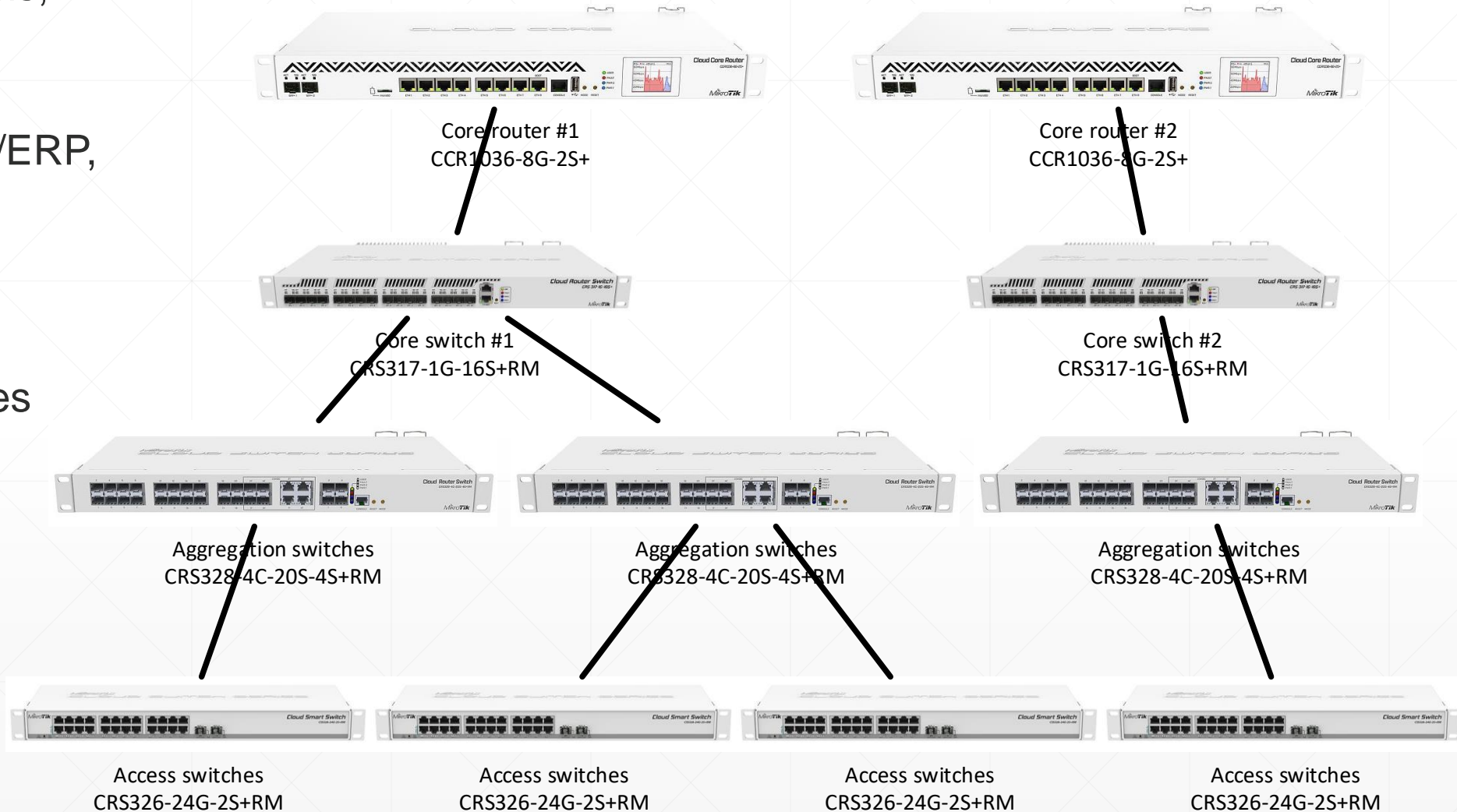
Bridge

Bridge	Group	VID	Ports
bridge-	239.33.3.9	100	sfp-sfpplus13
bridge-	239.31.1.28	100	sfp-sfpplus13
bridge-	239.40.7.24	100	sfp-sfpplus13
bridge-	239.34.2.4	100	sfp-sfpplus13
bridge-	239.40.5.10	100	sfp-sfpplus13
bridge-	239.40.5.2	100	sfp-sfpplus13
bridge-	239.35.2.1	100	sfp-sfpplus13
bridge-	239.40.5.7	100	sfp-sfpplus13
bridge-	239.40.6.15	100	sfp-sfpplus13
bridge-	239.32.1.25	100	sfp-sfpplus13
bridge-	239.40.5.8	100	sfp-sfpplus13
bridge-	239.36.3.10	100	sfp-sfpplus13
bridge-	239.32.1.4	100	sfp-sfpplus13
bridge-	239.31.1.24	100	sfp-sfpplus13
bridge-	239.35.4.5	100	sfp-sfpplus13
bridge-	239.31.1.23	100	sfp-sfpplus13
bridge-	239.40.6.16	100	sfp-sfpplus13
bridge-	239.40.5.9	100	sfp-sfpplus13
bridge-	239.40.7.2	100	sfp-sfpplus13
bridge-	239.40.5.4	100	sfp-sfpplus13
bridge-	239.34.2.1	100	sfp-sfpplus13
bridge-	239.31.1.1	100	sfp-sfpplus13
bridge-	239.34.4.2	100	sfp-sfpplus13
bridge-	239.40.7.21	100	sfp-sfpplus13
bridge-	239.34.4.1	100	sfp-sfpplus13
bridge-	239.36.3.9	100	sfp-sfpplus13
bridge-	239.35.2.2	100	sfp-sfpplus13
bridge-	239.31.1.6	100	sfp-sfpplus13
bridge-	239.40.7.2	100	sfp-sfpplus13

Use case - university campus network

- Huge traffic: video cams, live online exams, university internal portal/ERP, students wifi access, VoIP, etc

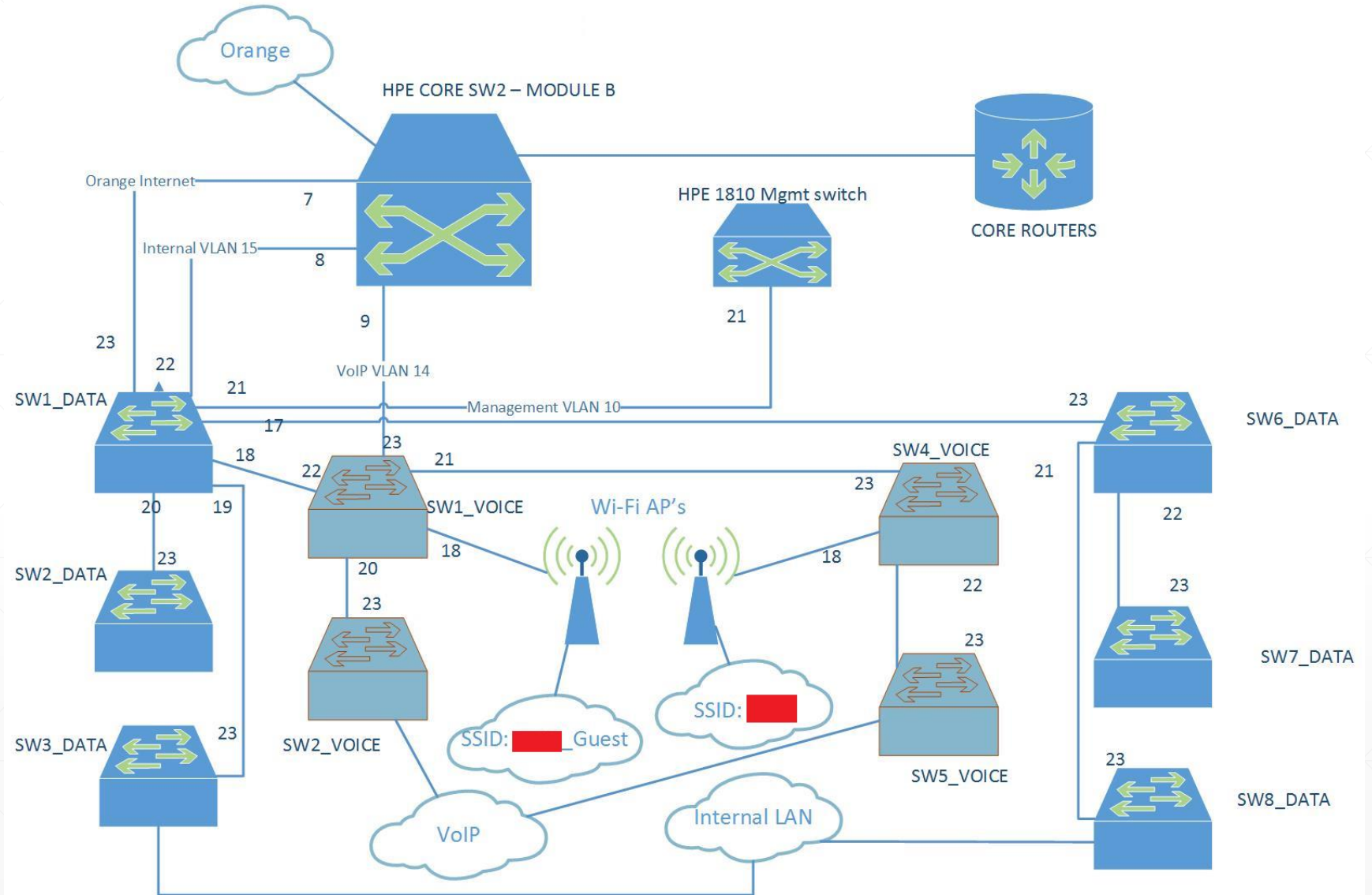
- More than 100 switches
- VLANs
- ACL
- Port security
- Storm control



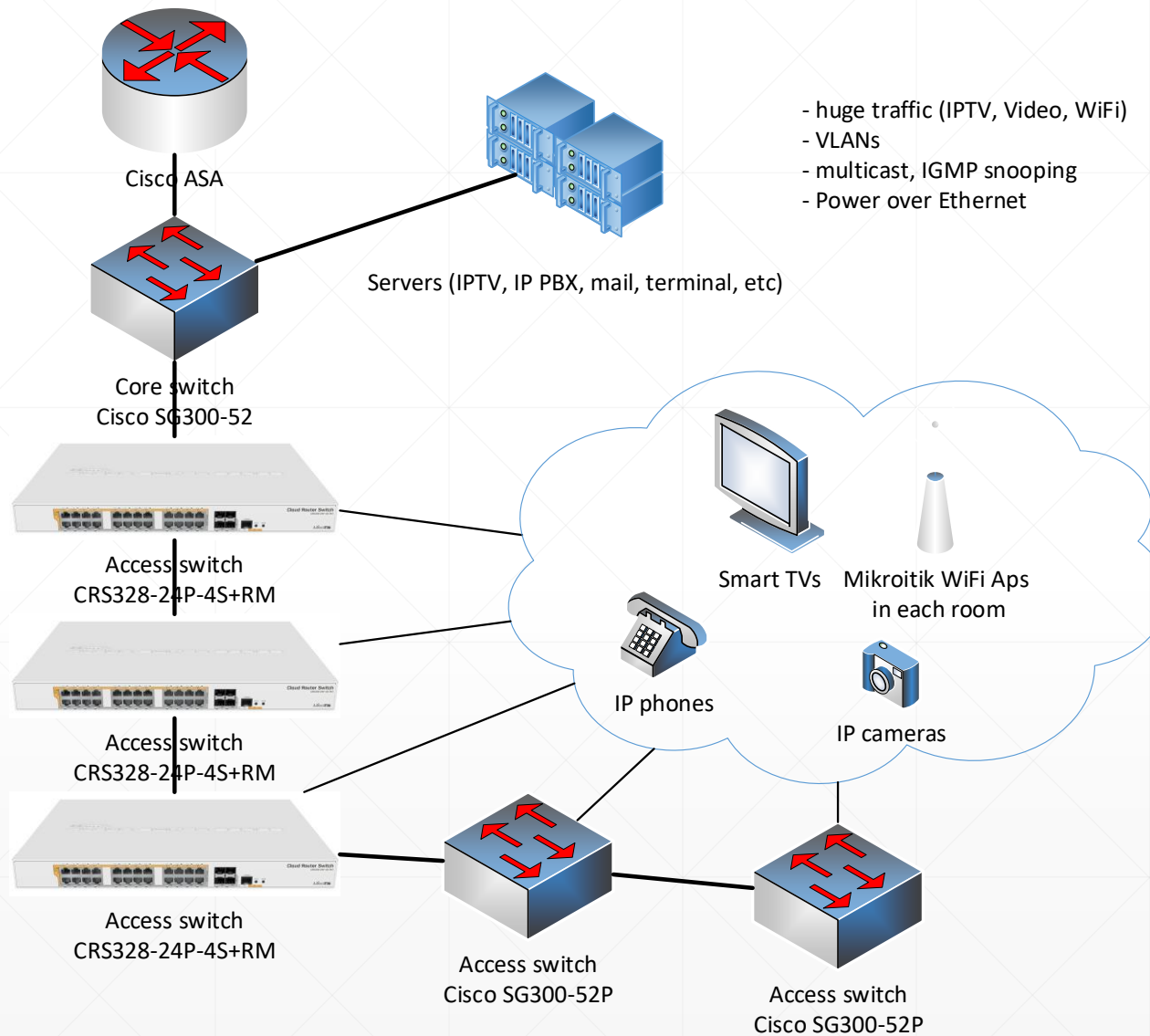
Use case – Government organization

- 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 не критичны 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
- Романа, 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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