User Meeting

New Delhi, India

August 2015

More than 100 MUM events

MikroTik

- MikroTik is located in Latvia (Europe)
- More than 160 employees
- Established 1996
- RouterOS created in 1997
- RouterBOARD created in 2002
- First MUM in Prague 2006
- Biggest MUM in 2014, Indonesia - 2000 people


Iceland
Finland
Sweden
Norway
Russia
Estonia
Lithuania
Den-
mark
Ireland
United
Kingdom
Belarus
Kazak
Nether-
lands
Belgium
Germany
Poland
Ukraine
Luxembourg
Czech Republic
Slovakia
Mol-
dova
France
Switzer-
land
Liecht.
Austria
Hungary
Romania
Slove-
nia
Croatia
Georgia
Azerb
Armenia
Monaco
San
Marino
Bosnia and
Herzego-
vina
Serbia
Andorra
Portugal
Spain
Italy
Monte-
negro
Bulgaria
Mace-
donia
Al-
ba-
nia
Vatican City
Turkey
Greece
Syria
Iraq

What we do

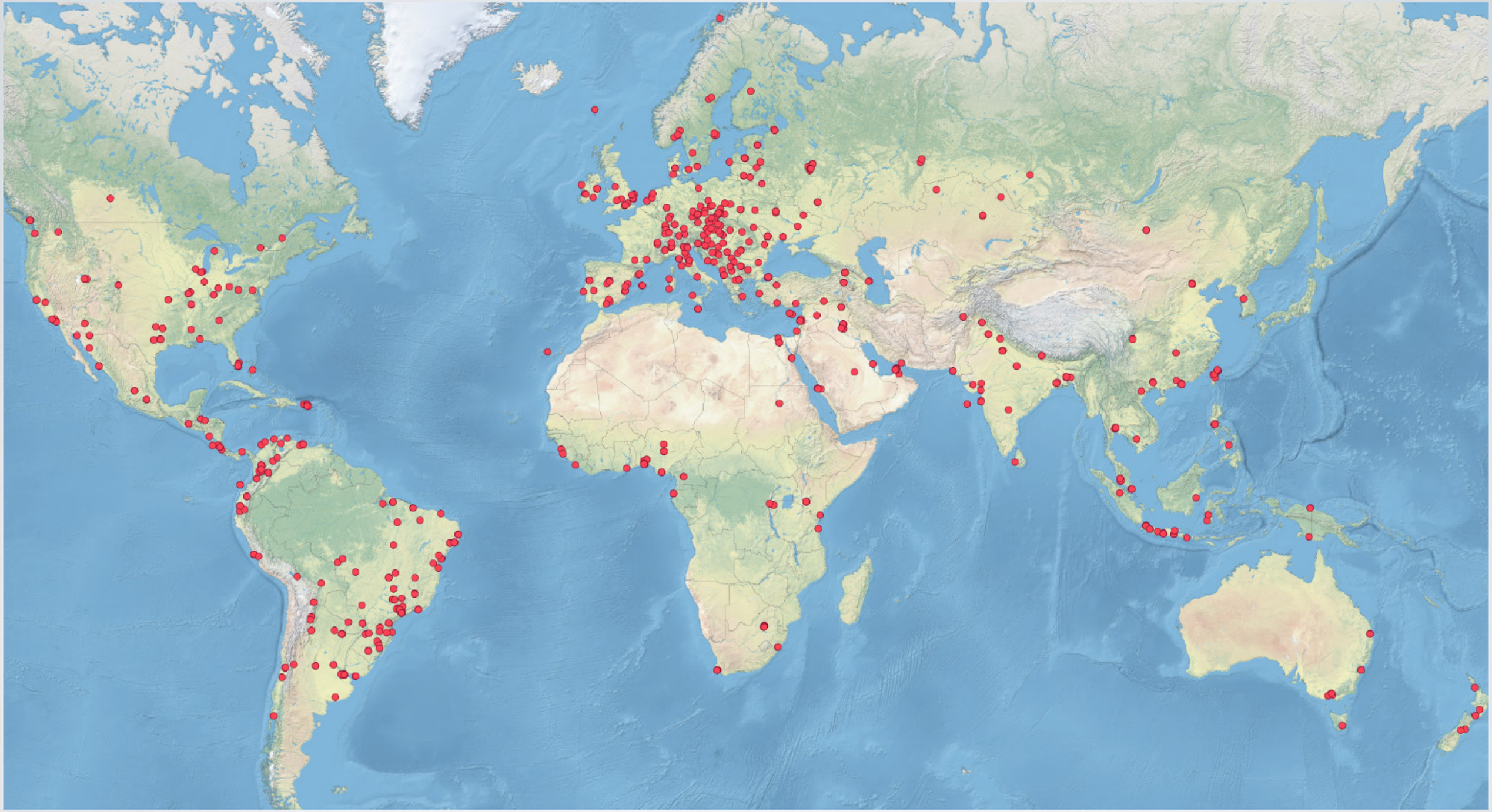
- MikroTik provides routing and wireless equipment for all possible uses: RouterBOARD, Cloud Core Router, Cloud Router Switch
- Our RouterOS software now supports most common and many special features

RouterOS

- MikroTik RouterOS is the operating system of RouterBOARD hardware
- Routing, firewall, bandwidth management, wireless access point, backhaul link, hotspot gateway, VPN server and more
- Stand-alone operating system based on the Linux v3.3.5 kernel

Why us

- Millions of RouterOS powered devices currently routing the world
- 19 years of developing networking software and hardware
- Over 20’000 RouterOS trained and certified network engineers



Why us

- More than 1600 training classes in the last year
- World wide network of certified consultants
- Offering products that support simple CPEs to complex enterprise networks
- Thousands of pages of documentation, examples, application notes, and guides

MikroTik at the MUM

- Janis Jankovskis (Sales, Training)
- Uldis Cernevskis (Support)
- Sergejs Boginskis (Support, Training)

After the MUM

- Presentation slides - wiki.mikrotik.com
- Videos - youtube.com/mikrotik
- License will be emailed

Special thanks

JRS Communication Pvt Ltd. (logistics)

Krauss Communication (t-shirts)

MUM India 2015

- Product series;
- New products;
- Partnership;
- New software features;
- CCR update

MUM India 2015

- 12:30 lunch with tickets

13:30	Mikrotik cloud features and corporate VPN using mikrotik cloud features by Soumil Gupta Bhaya (Blinknet, India)
14:00	Wireless 802.11ac standard : overview and features by Tanmoy Dey (Blinknet, India)
14:30	CAPSMAN workshop by Uldis Cernevskis (MikroTik, Latvia)
15:15	User's Self Service Portal and Internet Load Balancing by Vikas Kumar Gupta (Tara Consultants Pvt Ltd., India)
15:45	Mikrotik in FTTH by Saurabh Nagpal (Multilink, India)
16:15	Firewall Case Study by Mankomal Singh (Krauss International, India)
17:00	Raffle and closing of MUM
17:15	Evening drinks (beer and soft drinks) sponsored by MikroTik, socializing and networking

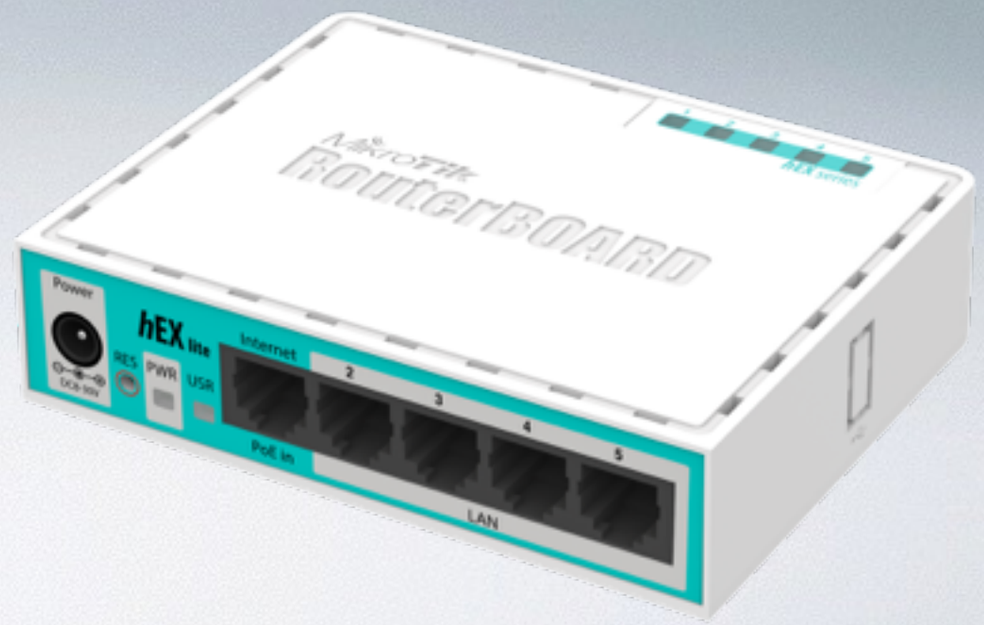
PRODUCT SERIES

ETHERNET ROUTERS

- From small to big, for every need
- RouterBOARD and CCR series
- Desktop and Rackmount

hEX lite

- Improved popular RB750
- 850MHz CPU with overclock to 1GHz
- 5 Fast Ethernets



$39.95

NEW

hEX

- Improved popular RB750GL
- 720MHz CPU
- 300MHz DDR2 RAM
- 5 Gigabit Ethernets

$59.95

hAP lite

- Very affordable home Access Point
- Full RouterOS functionality
- 2.4GHz dual chain 802.11n
- 4 Fast Ethernets
- 650MHz CPU
- Powered with 5V (from USB)

$21.95

PowerBox

- Outdoor Ethernet router
- Powers other devices over PoE
- Weatherproof and pole mountable

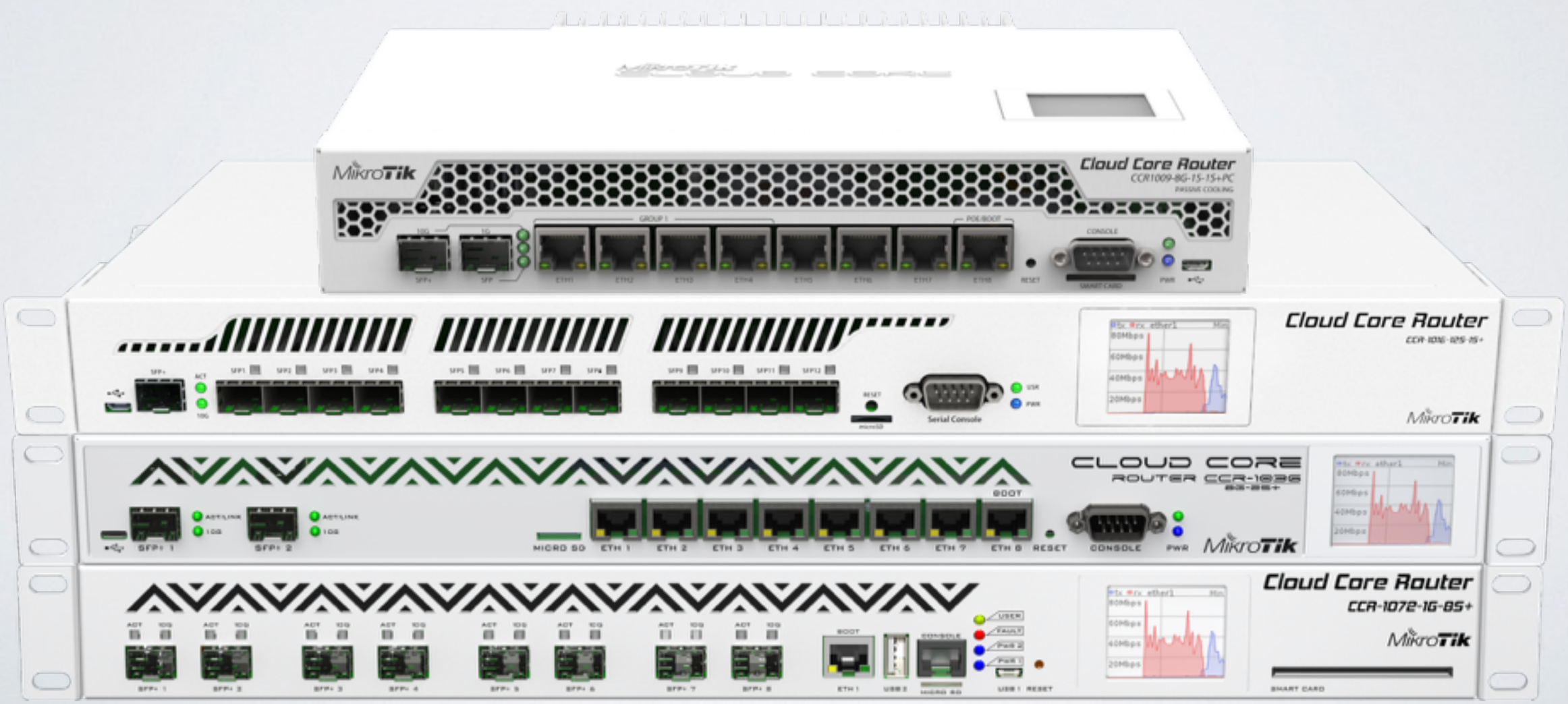
$69

RB2011

- Rackmount and desktop case
- 10 Ethernet ports;
- 1 SFP port

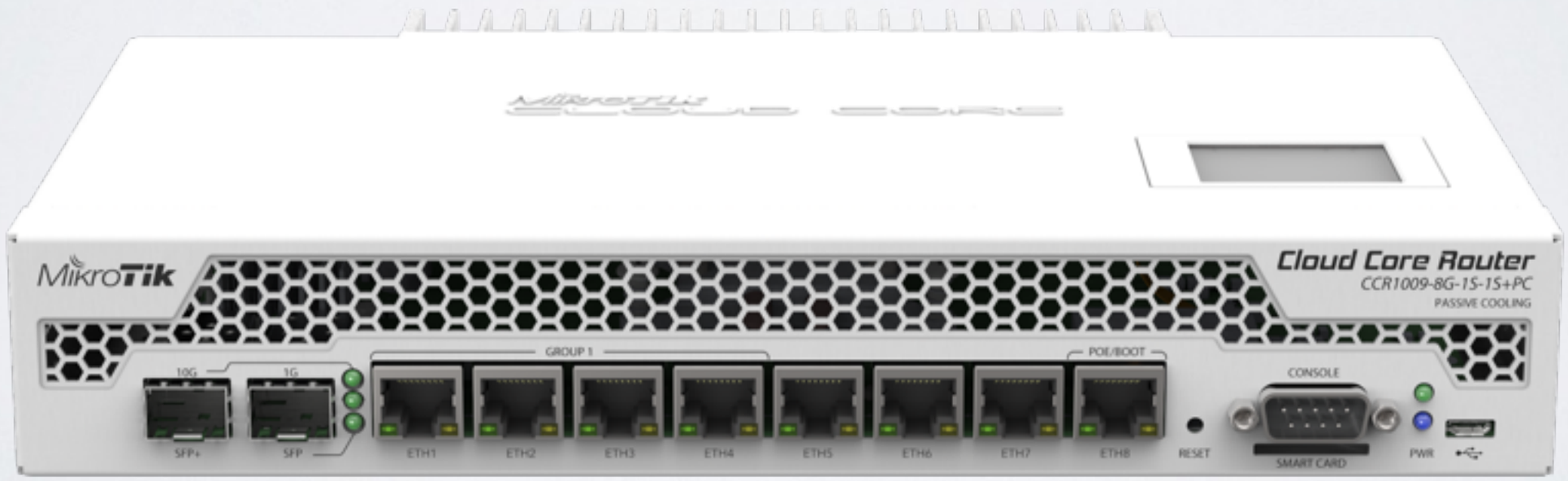
CCR series

- 9x, 16x, 36x, **72x** cores;
- Extreme performance, hardware acceleration;
- 1Gbps Ethernet, SFP and SPF+ ports;



CCR1009 PC

- 9 core TILERA networking CPU
- Silent, passive cooling case
- 8 Gigabit Ethernet, 1 SFP and 1 SFP+



$495

CCR1072

- 72 core 1GHz TILERA CPU
- Dual hot-swap PSU
- 8 SFP+ interfaces
- 16GB ECC RAM

$3050

CCR1072

CCR1072-1G-8S+		Tile 72 Core (1200Mhz, DDR1600) Max possible throughput					
Mode	Configuration	1518 byte		512 byte		64 byte	
		kpps	Mbps	kpps	Mbps	kpps	Mbps
Bridging	none (fast path)	6,502.0	78,960.3	18,790.0	76,963.8	119,047.6	60,952.4
Bridging	25 bridge filter rules	6,502.0	78,960.3	9,099.2	37,270.3	10,432.3	5,341.3
Routing	none (fast path)	6,502.0	78,960.3	18,790.0	76,963.8	94,668.4	48,470.2
Routing	25 simple queues	6,502.0	78,960.3	13,500.0	55,296.0	13,683.5	7,006.0
Routing	25 ip filter rules	5,247.6	63,726.9	6,125.5	25,090.0	6,104.0	3,125.2

CCR1072-1G-8S+		Tile 72 Core (1000Mhz, DDR1600) Max possible throughput					
Mode	Configuration	1518 byte		512 byte		64 byte	
		kpps	Mbps	kpps	Mbps	kpps	Mbps
Bridging	none (fast path)	6,502.0	78,960.3	18,790.0	76,963.8	98,873.5	50,623.2
Bridging	25 bridge filter rules	5,764.8	70,007.7	8,240.2	33,751.9	8,866.3	4,539.5
Routing	none (fast path)	6,502.0	78,960.3	18,790.0	76,963.8	76,201.0	39,014.9
Routing	25 simple queues	6,502.0	78,960.3	11,073.5	45,357.1	11,444.4	5,859.5
Routing	25 ip filter rules	4,664.7	56,648.1	5,200.3	21,300.4	5,321.0	2,724.4

S+2332LC10D

- Bidirectional SFP+ 10G module kit
- Two SFP+ modules
- Up to 10KM distance

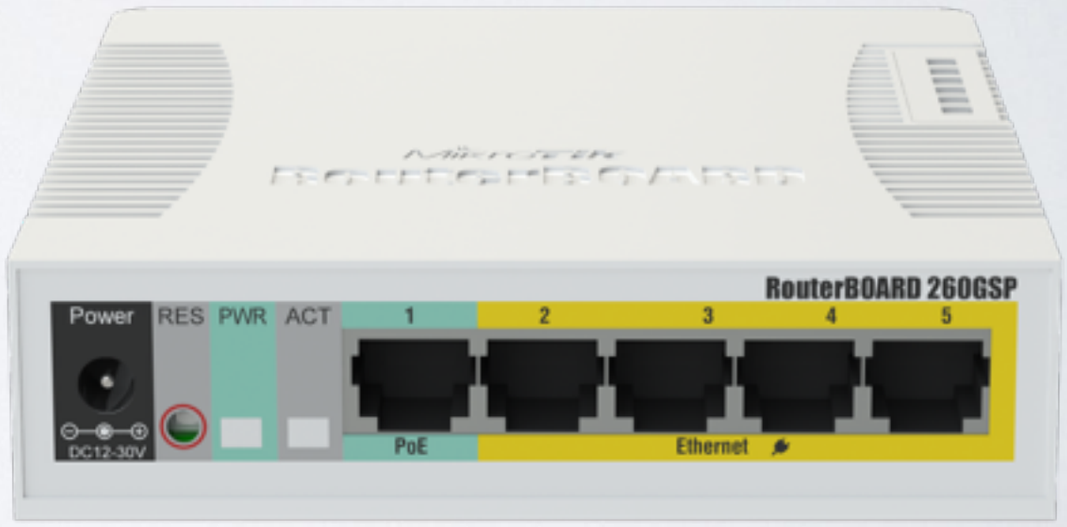
$349

SWITCHES

- Simple or Sophisticated
- CRS gives Layer 3 features
- 5 to 24 port devices

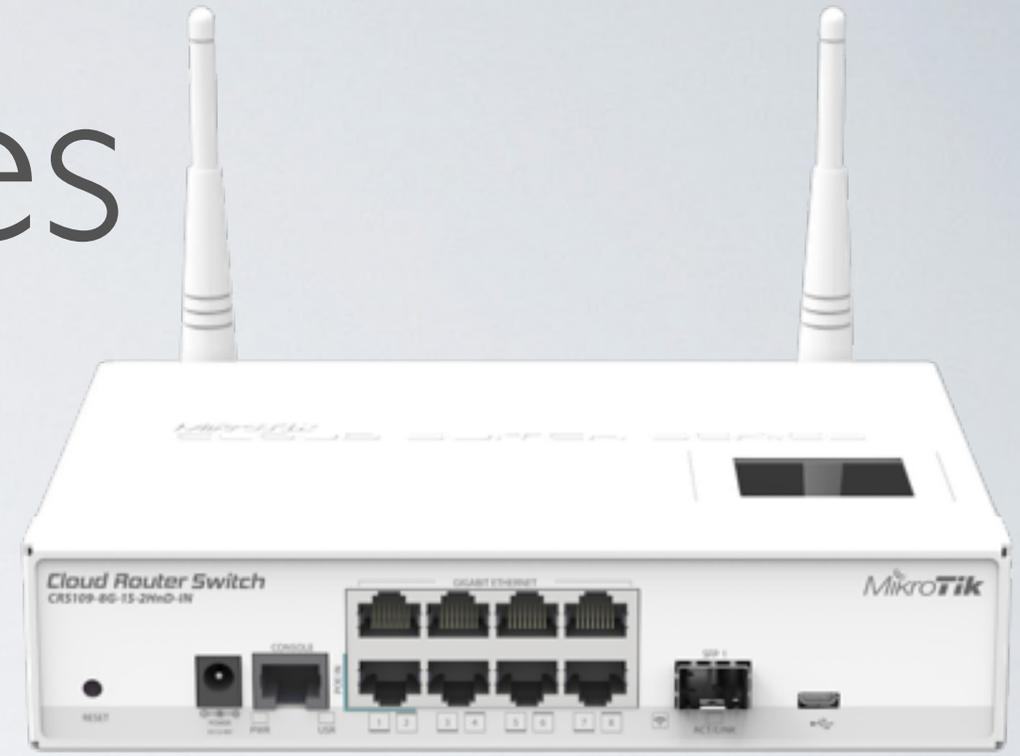
RB260GSP

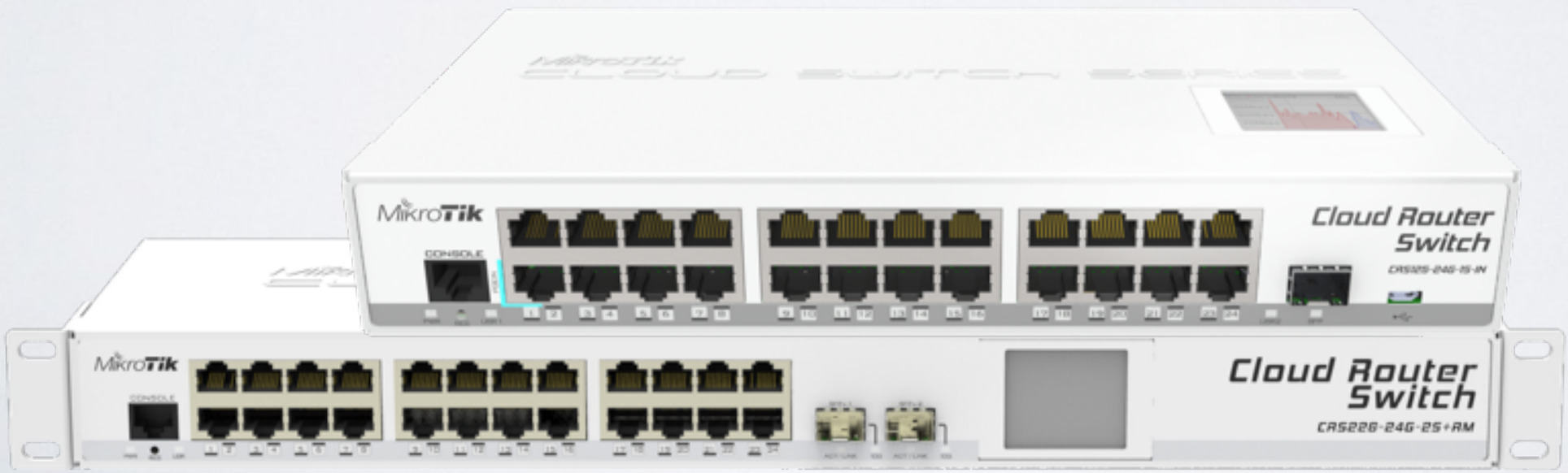
- Small Switch
- Runs SWoS
- Powers other devices over PoE



CRS series

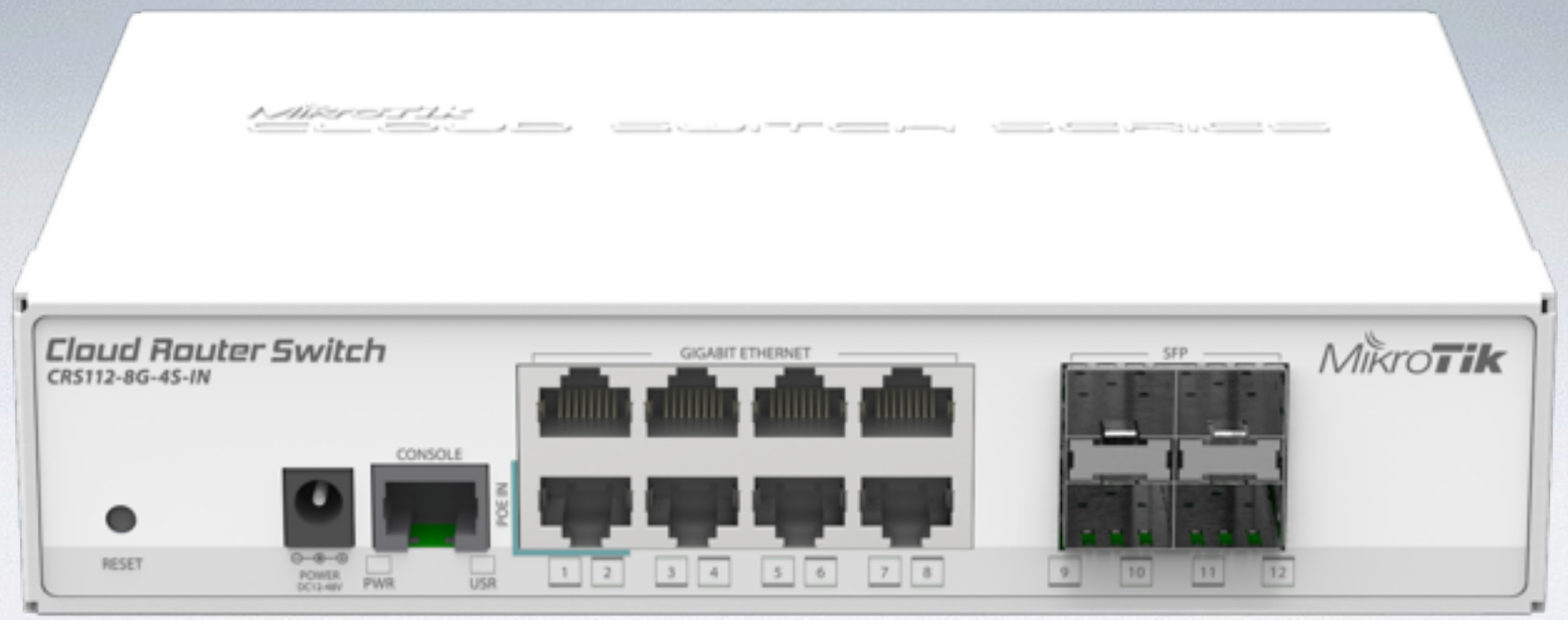
- 3 layer switches
- Run on MikroTik RouterOS
- From 8 to 26 network ports
- Ethernet, SFP, wireless





CRS112-8G-4S-IN

- Small size desktop switch, powered by RouterOS
- 4 SFP ports and 8 Gigabit Ethernet



$139

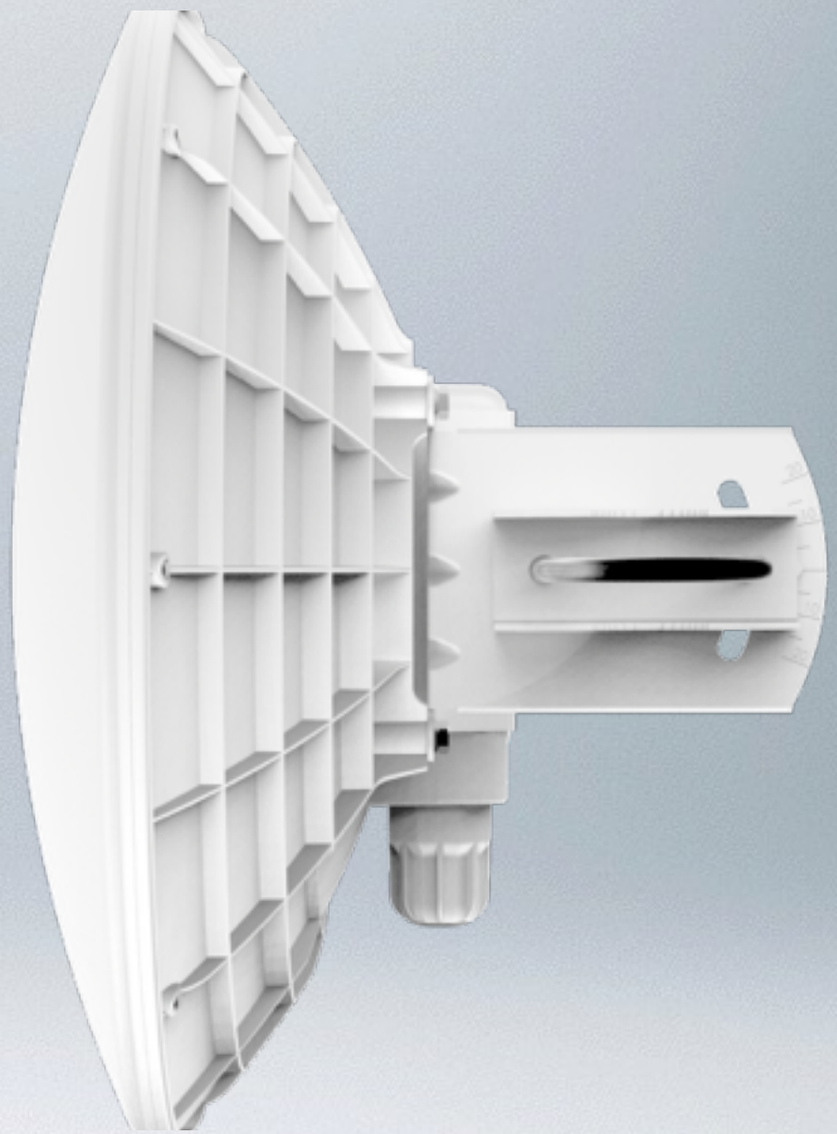
WIRELESS SYSTEMS

- Professional outdoor links
- AP, PtP, PtMP, etc
- Rugged and powerful
- 802.11ac technology

QRT 5 AC

- 802.11ac upgrade for QRT 5
- Same design and antenna
- Same robust design with upgraded internals for 802.11ac

$199



DynaDish

DynaDish 5

- New 802.11ac outdoor device
- Ideal for long distance point-to-point links
- 5GHz dual chain board integrated into 23dBi dish antenna with 8 degree beam width
- 720Mhz CPU 300MHz DDR2
- One Gigabit Ethernet port

$179

NetMetal

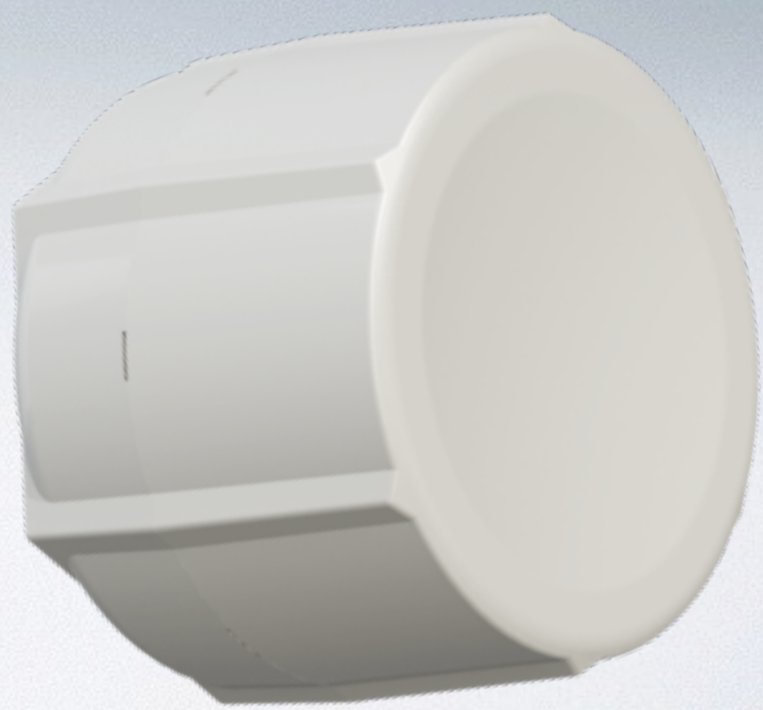
- Waterproof metal enclosure
- 1 Gbps, 1SFP
- 3x3 wireless 802.11ac
- 4 types available

SXT

- Compact AP/CPE
- 60-90 degree antenna
- Middle-range wireless links
- Different types available

SXT HG5 AC

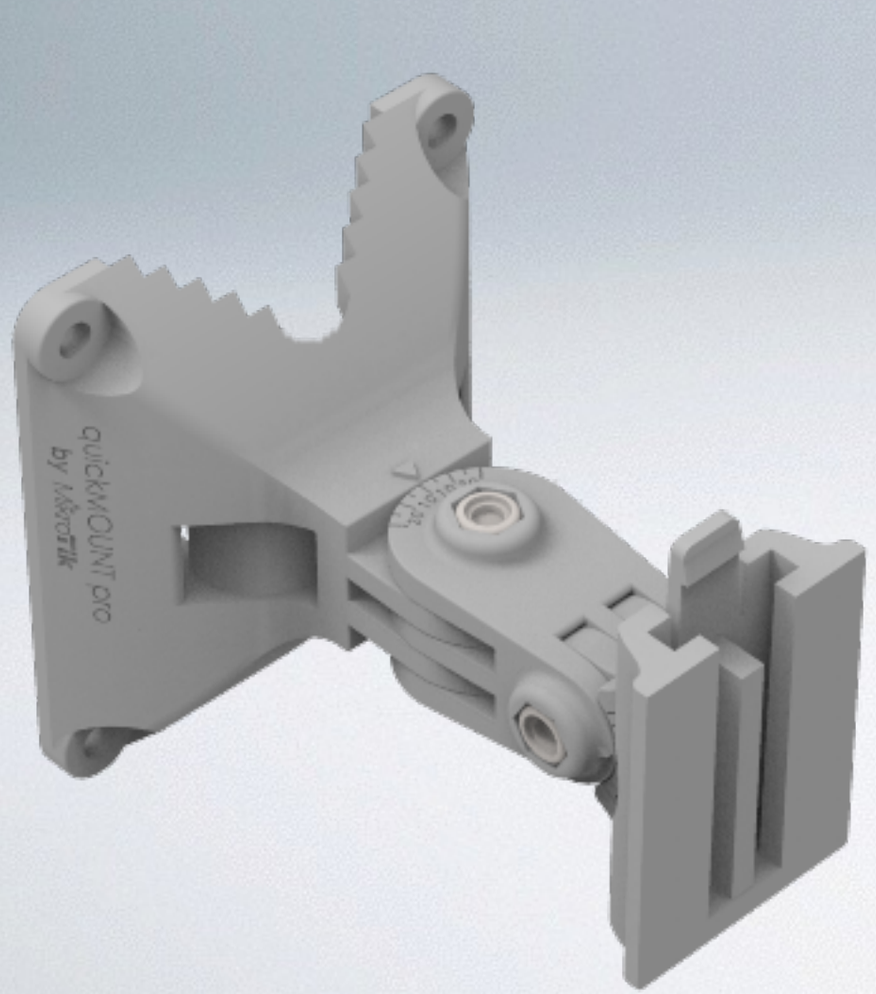
- 802.11ac upgrade for SXT HG5
- 720Mhz CPU
- DDR2
- 17dBi

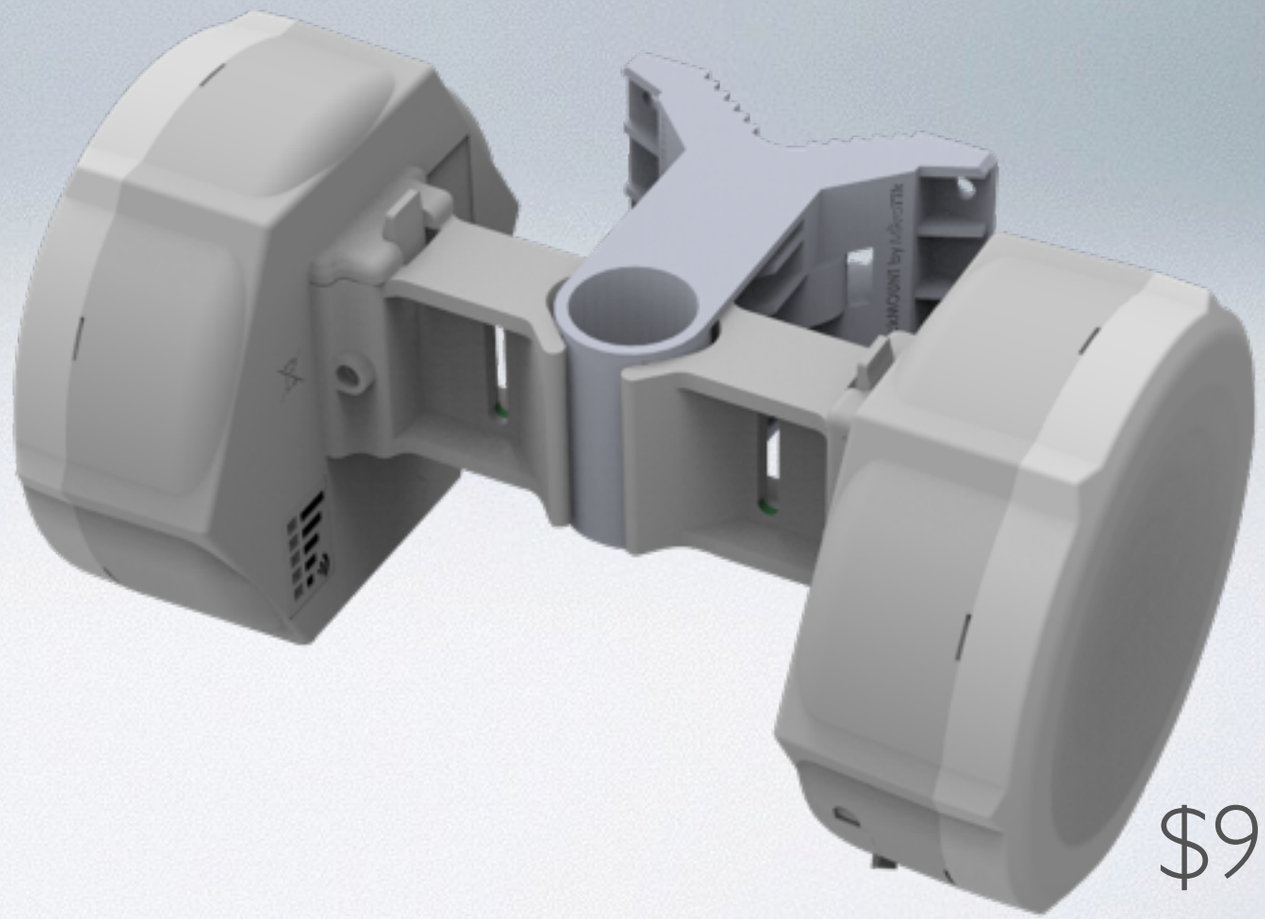


$119

QuickMount

- Easy to mount to wall, SXT or other devices
- Able to mount two SXT units for repeater setup

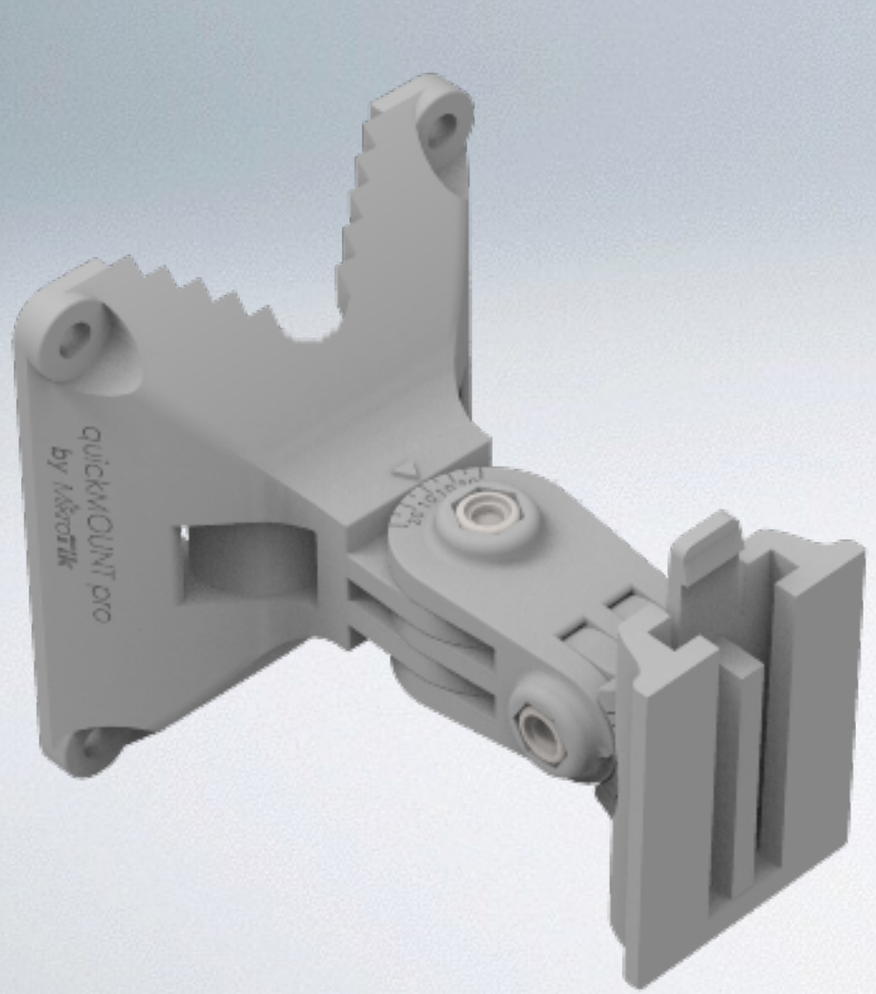


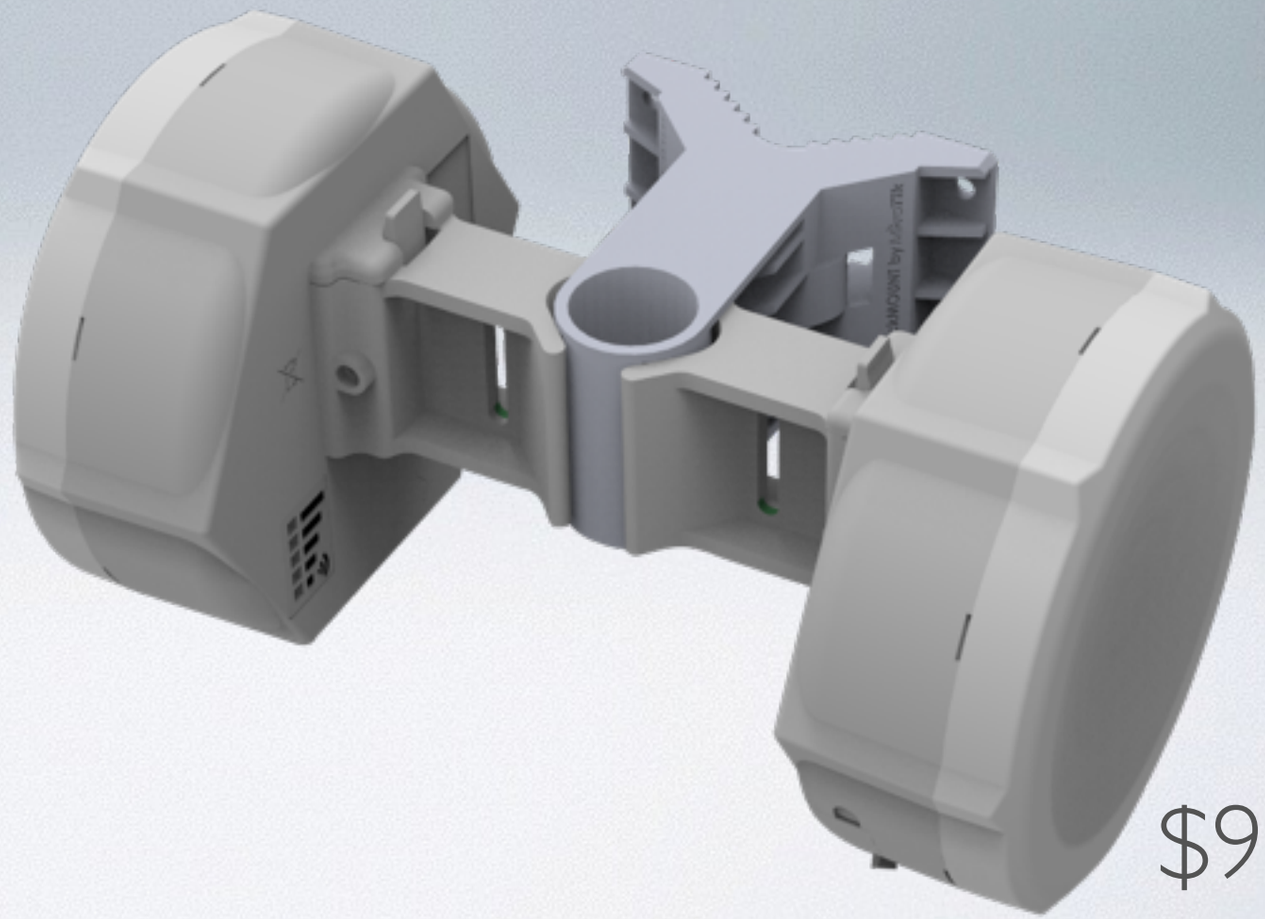


$9.50

QuickMount PRO

- Easy to mount to wall, SXT or other devices
- Able to mount two SXT units for repeater setup
- Pro model allows precise alignment





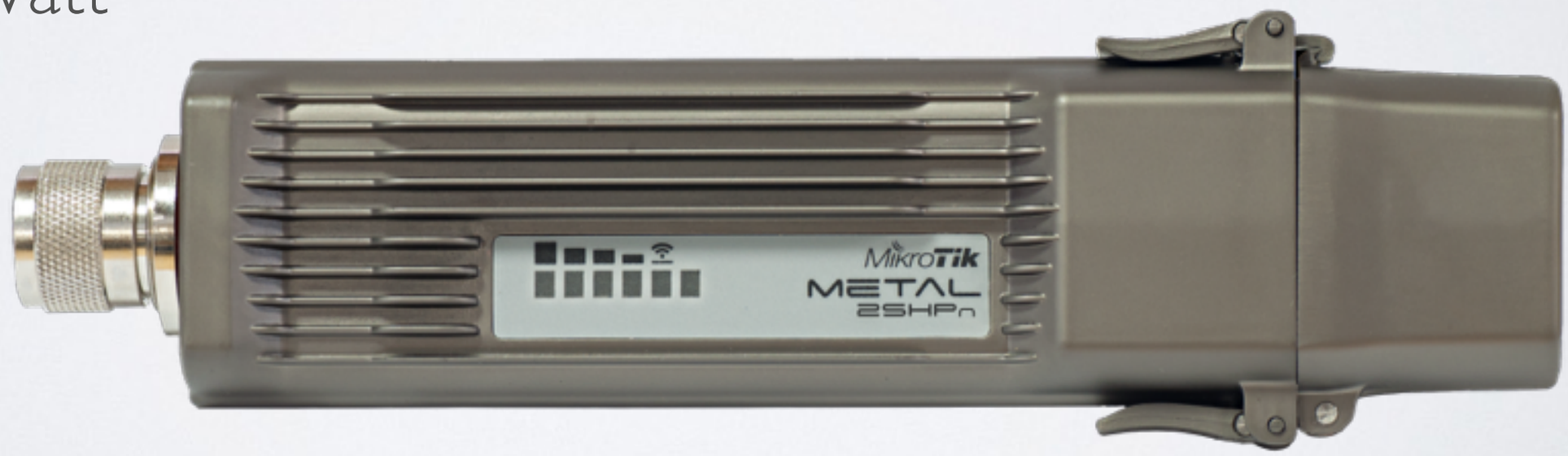
$9.50

Basebox

- 2GHz and 5GHz AP/CPE
- Based on RB912
- RP-SMA connectors

Metal

- 2GHz, 5GHz, 900MHz AP/CPE
- Metal and waterproof
- 1.6 Watt



FOR HOME AND OFFICE

- Low cost and small
- Good looking and friendly
- LCD touchscreen, file sharing, Quickset

mAP

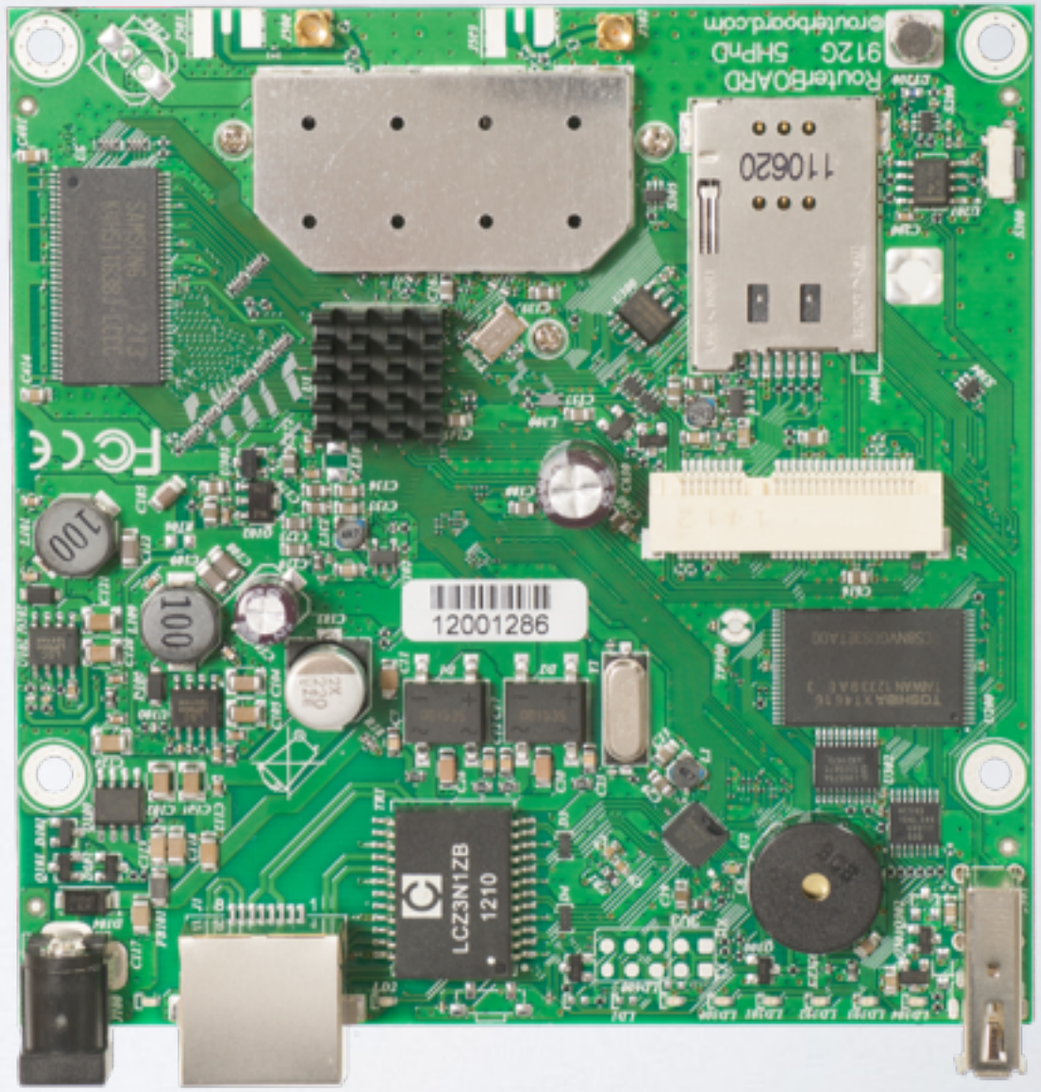
- 2GHz AP
- Small and compact
- USB, PoE-out

cAP

- 2GHz ceiling AP
- Small and compact
- Designed for CAPsMAN

ROUTERBOARD

- Build your own device
- Use custom case
- Upgrade or expand with ease
- Choose model based on ports, features and speed



INTERFACES AND MORE

- Wireless cards
- SFP modules
- Adapters
- Converters
- Antennas

SPF modules

- 1.25Gbps and 10Gbps
- Single, Multi modes
- Different distances

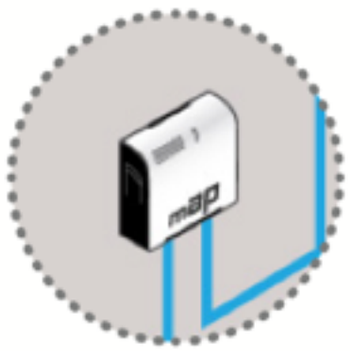
Wireless cards

- 802.11 a/b/g/n/ac
- 2GHz, 5GHz
- miniPCI-e, miniPCI

Antennas

- mANT30
- Regular and precise alignment
- Radome cover

from the home …



The first port of the mAP is connected to the Internet router. The second provides connectivity and power to a SXT unit outside the building.

The SXT provides Internet to the neighbours across the street or connects to WISP for Internet.

The phone is connected to the wireless Internet provided by the mAP.

… to the global network

cAP

cAP is the Controlled Access Point, a device that is managed by the CAPsMAN manager.

SXT

CLIENT BUILDING

SXT

CONTROL CENTER

WIRELESS DEVICES

Devices are connected to cAP

CLOUD CORE ROUTER

This device is the CAPsMAN controller. It is connected to the client building over the wireless link managed by two SXT devices. All cAP devices in the building are controlled by the CAPsMAN. It sees all connected client computers, and manages all settings of the Access Points (cAPs) in that building.

ALL PRODUCTS

- Include free software upgrades for life
- Run the same RouterOS software
- Can be purchased from our worldwide distributor network

NEW PRODUCTS

Q3

hAP

- Upgrade for/replaces RB951-2n
- 2.4GHz dual chain 802.11n
- 5 Fast Ethernets
- 650Mhz CPU
- 300MHz DDR2 RAM
- PoE-in
- PoE-out on port 5

$45

Q3

hAP ac lite

- Our first dual concurrent home Access Point
- 2.4GHz dual chain 802.11n
- 5GHz single chain 802.11ac
- 5 Fast Ethernets
- 650MHz CPU
- 300MHz DDR2 RAM
- PoE in

Q4

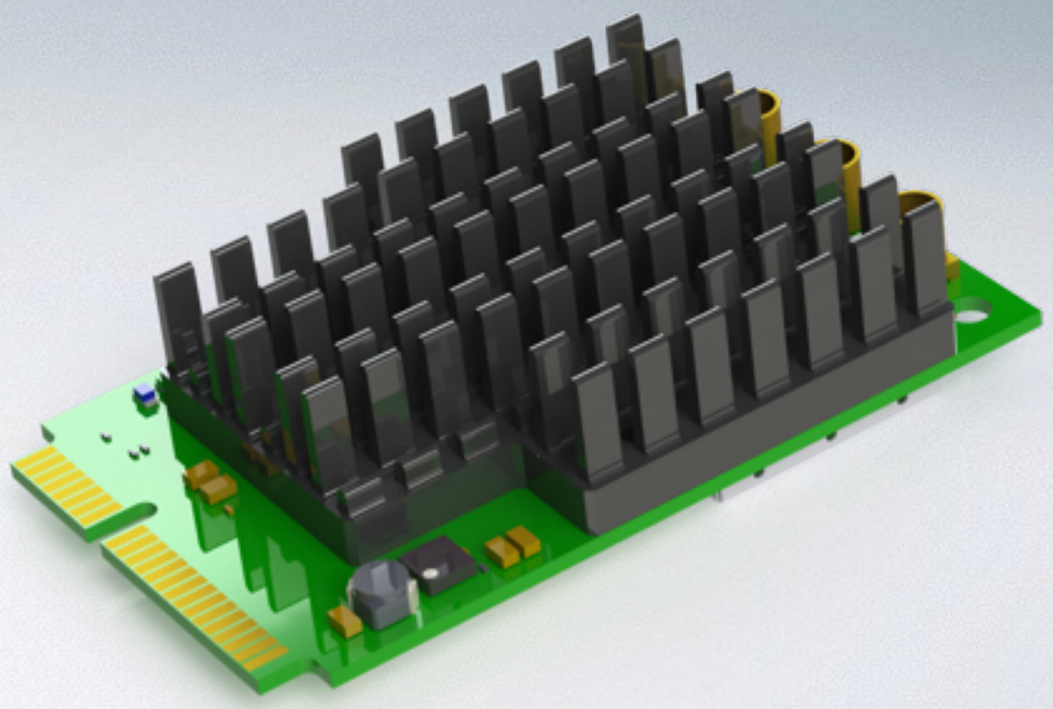
hAP ac

- Our first Gigabit dual concurrent home AP
- 2.4GHz high power 2 chain 802.11n
- 5GHz high power 3 chain 802.11ac
- 5 Gigabit Ethernet & 1 SFP cage
- 720MHz CPU
- 300MHz DDR2
- PoE in
- PoE-out on port 5

Q4

R11e-5HacT

- miniPCIe card with 5GHz triple chain 802.11ac
- Upgrade your existing devices to 802.11ac standard



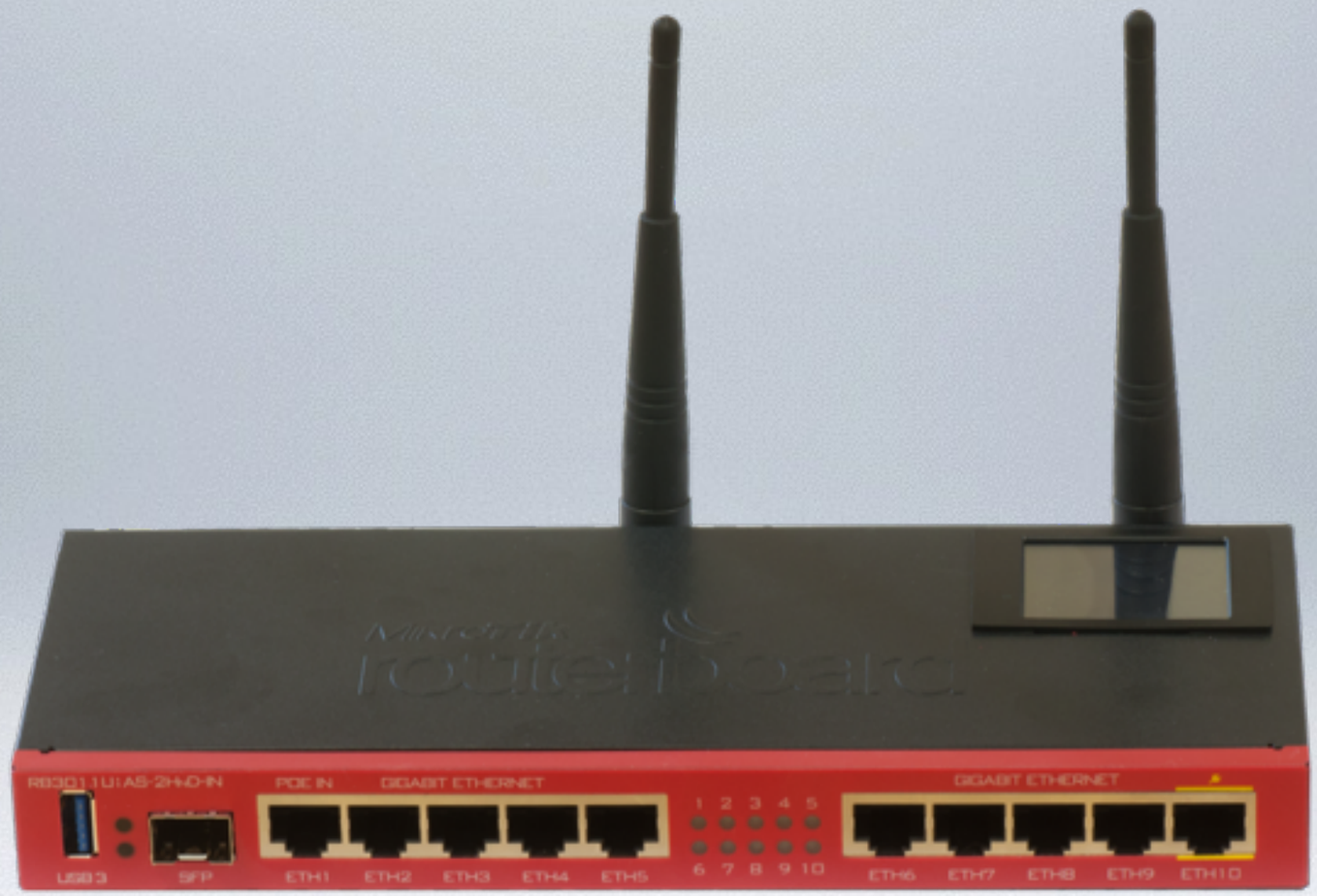
Q3

RB3011 Series

- Upgrade for RB2011 Series
- Dual core 1.4GHz ARM CPU
- More than 2x performance
- 10x Gigabit Ethernets
- Regular size USB3
- Rackmount and Indoor wireless AP
- miniPCIe slot and SFP port

Q3

RB3011 Series



- RB3011UiAS-RM: $179
- RB3011UiAS-2HnD-IN: $199

WAP

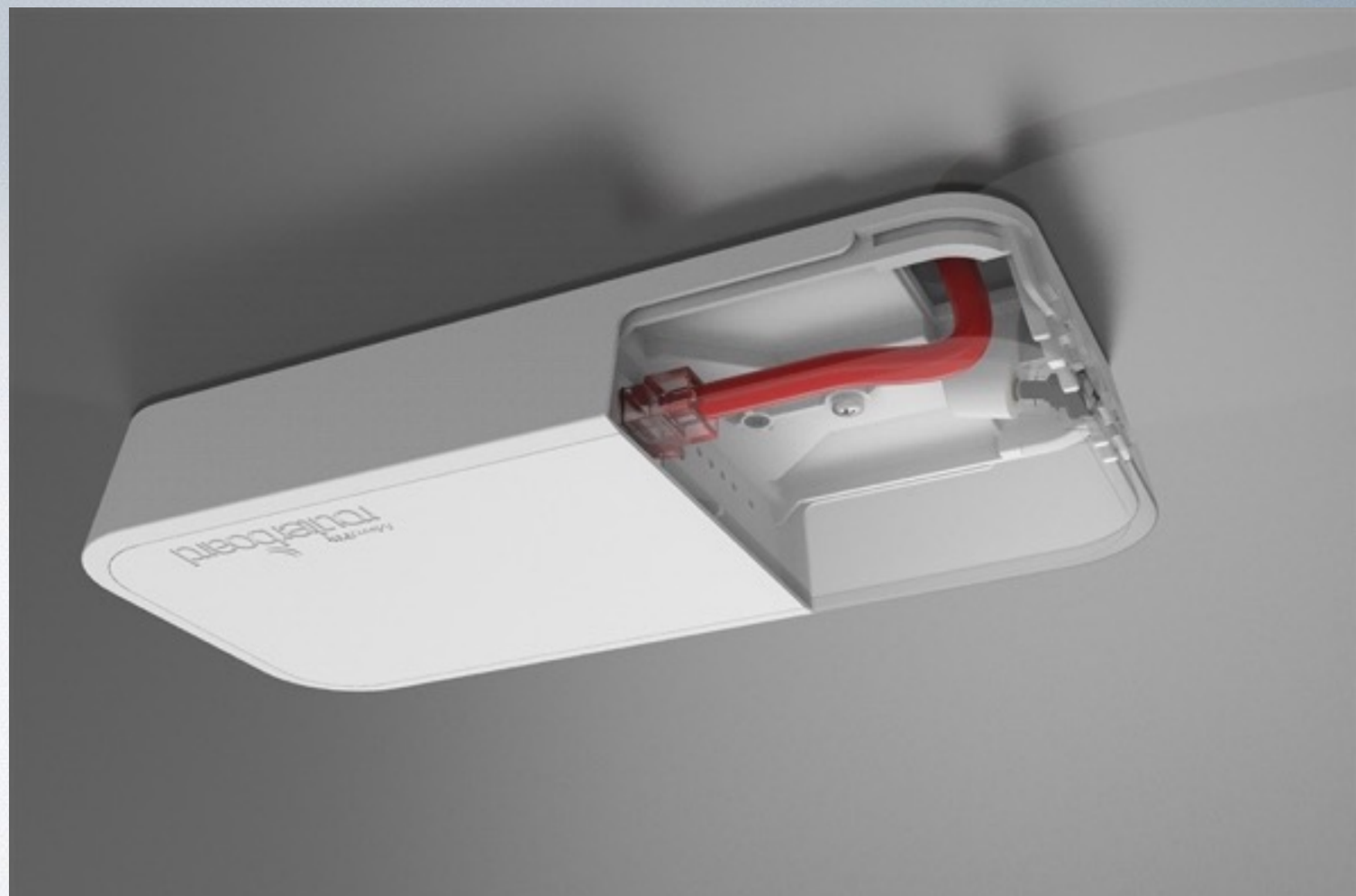
now

$45

now

WAP

- Small weatherproof AP
- 360 degree antenna
- 1x 100Mbps port
- 802.11 b/g/n



now

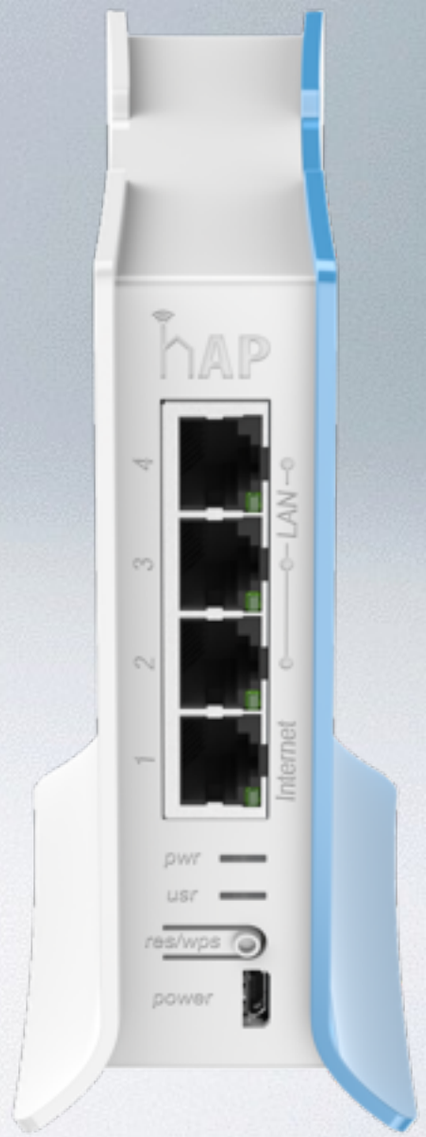
hAP lite tower

$21.95

now

hAP lite tower

- Small AP
- 4x 100Mbps port
- 802.11 b/g/n



PARTNERSHIP

NEED HELP?

- Ask a local **distributor**
- Read the manual **wiki.mikrotik.com**
- Email **support@mikrotik.com**
- Hire a **consultant**
- Attend a training class or join an Academy class in a University

NEED HELP

Contents:

Asia

Multilink Computers

New Delhi, **India**
Tel: North India: +91 9810083595, East India: +91 9310044400, West India +91 9310157692, South India: +91 9560089119
Write e-mail

Tara Consultants Pvt Ltd

Nehru Place, New Delhi, **India**
Tel: 011-46570273, 91-9811686026
Write e-mail

JRS Communication Pvt Ltd.

New Delhi, Gujrat, Kolkata, Hyderabad, Chennai, **India**
Tel: 9311107222, 9910903463
Write e-mail

RAH Infotech

Mumbai, **India**
Tel: 91 9899164651/ 91 9310536849
Write e-mail

Saibaba Infocom

Mumbai, **India**
Tel: 91 9156575859
Write e-mail

ACE MICROELECTRONICS

New Delhi, **India**
Tel: 01141676502
Write e-mail

Tecnika Solutions

New Delhi, **India**
Tel: 011 41605045, +91 9717047137
Write e-mail

Vishal Trading

Kalkaji, New Delhi, **India**
Tel: 919214842409, 917742444426
Write e-mail

Go IP Global Services Pvt. Ltd.

New Delhi, **India**
Tel: Tel : +91 11 26443518-19, 9971161671, 9899872200
Write e-mail

NEED HELP - CONSULTANTS

Contents:

Asia

Manoj Kumar MUM
MTCNA, MTCRE, MTCTCE, MTCWE
Faridabad, **India**
Wireless Networks: desing, implementation, analysis & troubleshooting of WLAN, PtP and PtMP. High-Speed Wireless Links. Tunnel and VPN (IPSec, PPtP, L2TP) Bridging & Routing (Dymamic and Static). Firewall (Filtering Policies) . Hotspot, PPPoE, Queueing, Bandwidth Management, Firewall, Security. Hotspot, WISP administration experience, Load balancing, Advanced Wireless Security, > > Bridging, STP RSTP, WDS, Mesh, Network Monitoring, Caching and WebProxy,Remote Assistance and on-site Support.
Tel: +919818763764
Write e-mail

Dawinder Singh
MTCNA, MTCRE, MTCTCE
Amritsar, **India**
Tel: 91-9814138141
Write e-mail
Web: www.webtecz.com

Kushal Sharma MUM
MTCNA, MTCWE
New Delhi, **India**
Bridging & Routing (Dymamic and Static). Firewall (Filtering Policies) . Hotspot, PPPoE, Queueing, Bandwidth Management, Firewall, Security, Routing (Static, OSPF, BGP), Hotspot, VoIP, WISP administration experience, Load balancing, Wireless Security, Bridging, STP RSTP, WDS, Mesh,Traffic Shaping, QoS, Network Monitoring, Caching and WebProxy, Video security, Remote assistance and on-site Support
Tel: 9990761166 & 9990761155
Write e-mail
Web: rectusindia.com

Imran Khan
MTCNA, MTCTCE
Kosi Kalan, U.P, **India**
ISP / Carrier networks design, implementation, analysis and problem solving. QoS, PPPoE,Hotspot, Load Balancing, Failover links, Bandwidth management, routing, firewall and Mangle,Radius engineering, Mesh, WDS, Queues, Web Proxy and Caching, VPN (PPTP, L2TP, EoIP), PtP and PtMP Wireless Links, Nstreme Dual, Network Security Others advanced configurations
Tel: +919219533213 & +919045865717
Write e-mail

Juzer Poonawala
MTCWE
Surat, **India**
High speed wireless links, point to multipoint links, for IPSec VPN Solution, PPTP VPN, L2TP, Routing Solutions including OSPF and BGP, Setups for Hotspot and WiFi over Mikrotik.
Tel: 919687605200

NEED HELP - TRAINING

Contents:

Asia

Soumil Gupta Bhaya, Blinknet Solutions Pvt. Ltd.
Rating: 4.9/5 (43 votes)
Average student result: 79%
MTCNA
Kolkata, **India**
Tel: +919830352107
Write e-mail

RMA - WARRANTY

- RMA is provided by distributor or seller of the board!
- MikroTik warrants devices for 12months
- Distributors may apply different terms and conditions
- Ask your distributor for more information

HOW TO PARTICIPATE

- Become a distributor
- Take classes and become a certified trainer
- Start offering consulting services
- Coordinate a new MikroTik academy in a local University
- Create accessories and enclosures with the MFM program

WHAT THEN

Consultant → Configures and helps

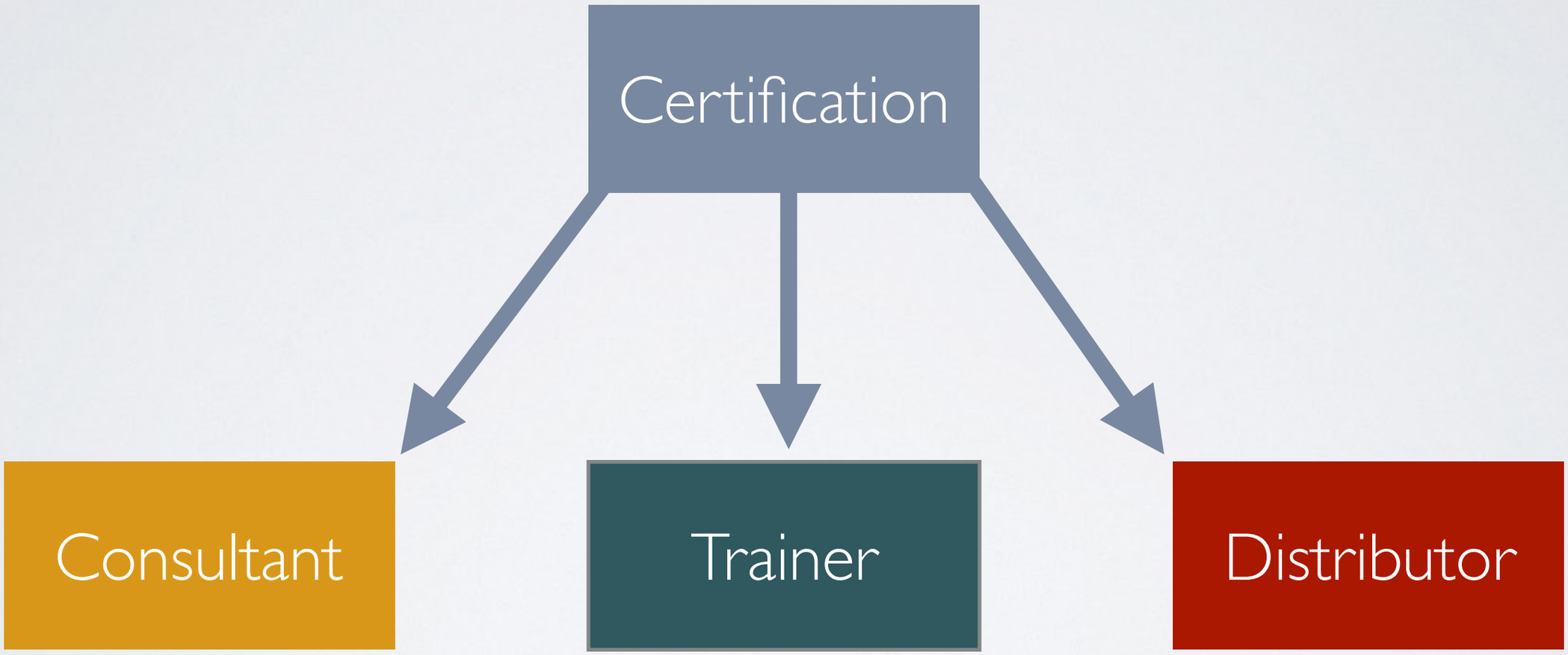
Trainer → Certifies and advances

Distributor → Offers products and services

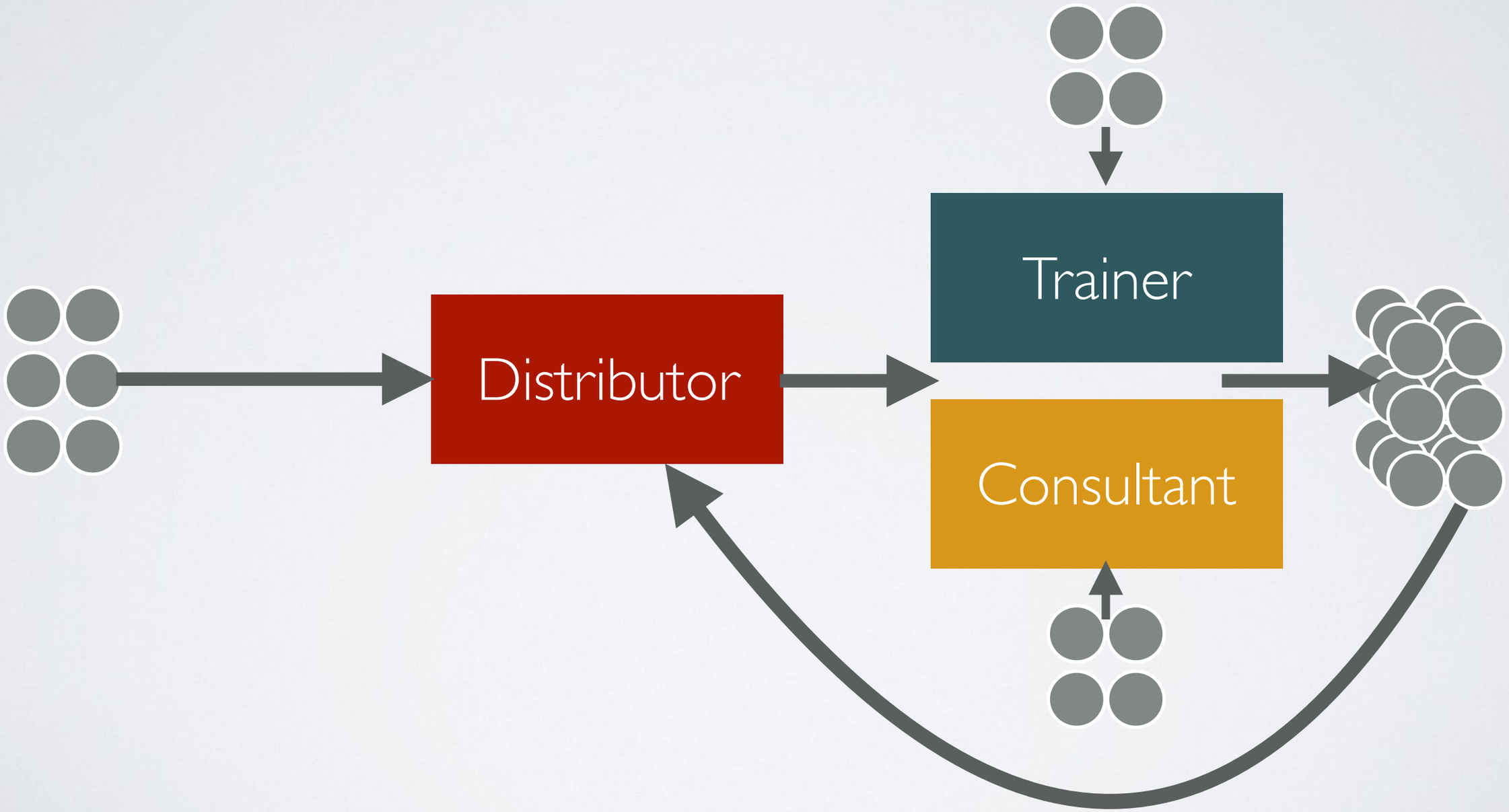
To become:

- **consultant**, get a certificate from trainers
- **trainers**, get a certificate from MikroTik

WHY LEARN

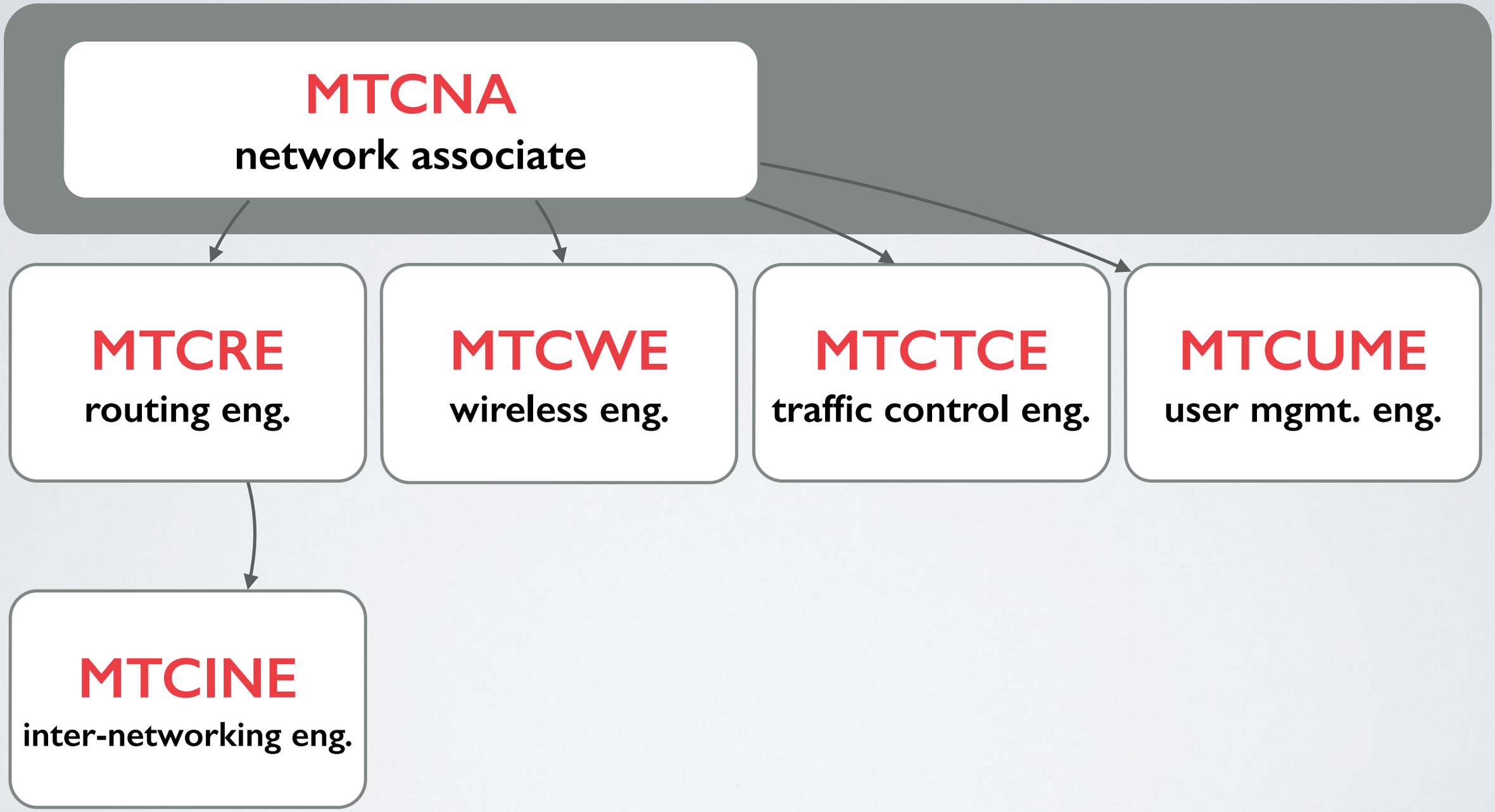


Benefit for everybody



MIKROTIK TRAINING

MikroTik Certification training



MikroTik trainers

Contents:

Asia

Soumil Gupta Bhaya, Blinknet Solutions Pvt. Ltd.

Rating: 4.9/5 (43 votes)
Average student result: 79%
MTCNA
Kolkata, **India**
Tel: +919830352107
Write e-mail

Become a Trainer

- Get MTCNA and one engineer level certificate
- >75% for both certificates
- Attend MikroTik Train the Trainer event
- Start doing training in your region!

ACADEMY

Training institutions

MikroTik Training Centres

separate entities (companies or individuals) conducting intensive public or private training sessions and certification tests according to the official MikroTik Training Outline

MikroTik Academies

educational institutions such as universities, technical schools, colleges, vocational schools, and other educational institutions offering semester time based Internet networking courses for their academic students using MikroTik RouterOS as a learning tool

MikroTik Certification training

covered by MikroTik academy course

MTCNA
network associate

MTCRE
routing eng.

MTCWE
wireless eng.

MTCTCE
traffic control eng.

MTCUME
user mgmt. eng.

MTCINE
inter-networking eng.

Academy Trainer

- basic networking course
- RouterOS used as learning tool
- includes MTCNA certification test
- fully covers MTCNA outline

Coordinators

Appointed Coordinators

- regional field of action
- not exclusive, there can be more than one coordinator in a country
- well informed about the education system in their country

How can coordinators apply?

- inform us about your ideas training@mikrotik.com
- you will be approved upon successful implementation of MikroTik Training in the curriculum of at least one educational institution

Benefits

benefits for Students

- the most cost effective way to acquire knowledge in networking (no costs to MikroTik)
- opportunity to acquire a MTCNA certificate

benefits for Educational Institutions

- upgrade the existing curriculum with a networking course covering the latest state-of-art features without any additional financial investment
- opportunity to attract more students by handing out MikroTik certificates

Benefits

benefits for Training Centres - Coordinators

- preparing Academy Trainers for teaching MikroTik course (sponsored by MikroTik)
- publicity – presence in MikroTik webpage and newsletters source of students for engineer level courses

benefits for Distributors

- advertising possibilities in exchange to the equipment for a class
- source of knowledgeable engineers (possible employees?)

MikroTik offers

support to MikroTik Training Centres

- credit to MikroTik Training Centres which prepare Academy trainers for free or at the reduced cost

support to Academies - MikroTik Academy classroom package - (FREE)!

- training outline & materials
- Academy Trainer shirts
- pens, notepads
- free routers for the labs
- online MTCNA certificates and RouterOS Level 4 software licenses to students

Requirements

requirements for Educational Institutions

- motivation
- space and all the equipment needed for the labs
- appropriate Internet access
- MikroTik Academy Trainer
- approved training materials

requirements for Academy Trainers

- must be a lecturer at the educational institution
- MTCNA certificate (score at least 75%)
- any MikroTik engineer level certificate (score at least 75%)
- appropriate teaching skills

How to apply?

how can Educational Institutions apply?

- fill out the application form online

http://www.mikrotikacademy.com/academyform

evaluation procedure (performed by coordinators or MikroTik)

- educational institution validation check
- verification of the Academy Trainer:
  - if he/she is a lecturer at educational institution indeed
  - presence of required certifications
- verification of training materials

Contacts

http://www.mikrotikacademy.com
training@mikrotik.com

SOFTWARE FEATURES

RoMON

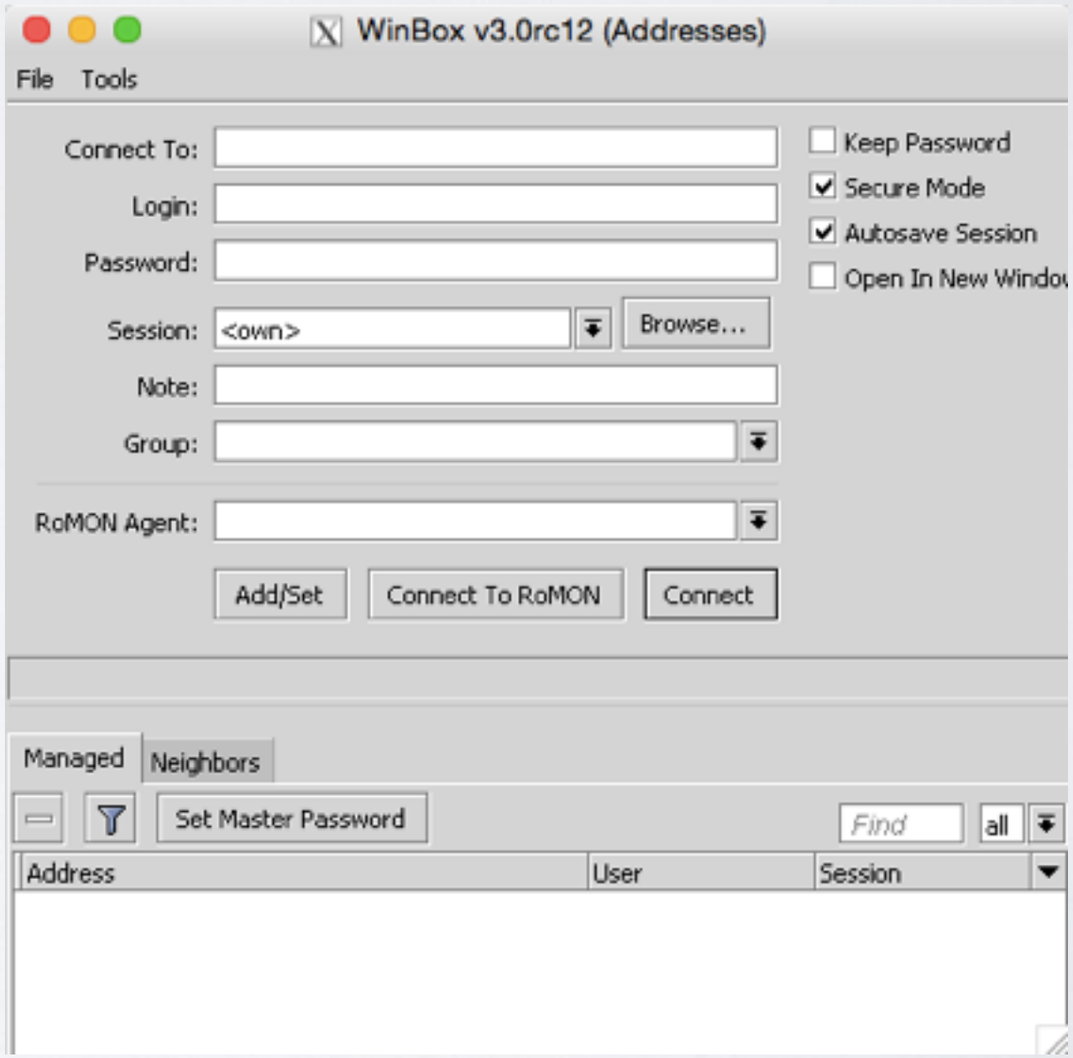
Router Management Overlay Network

Features

- Works similar to neighbour discovery, but over multiple hops
- Secure Layer 2 style access to all MikroTik devices with a physical connection or through a L2 tunnel
- Discover, manage and upgrade your entire network with an easy tool
- MAC Winbox/SSH/ping on **steroids**
- More info in our manual: http://wiki.mikrotik.com/wiki/Manual:RoMON

Winbox 3

- Sort, group and protect saved devices
- Save, load and move device lists
- Save all layout preferences and move them between devices
- RoMON support



FastTrack

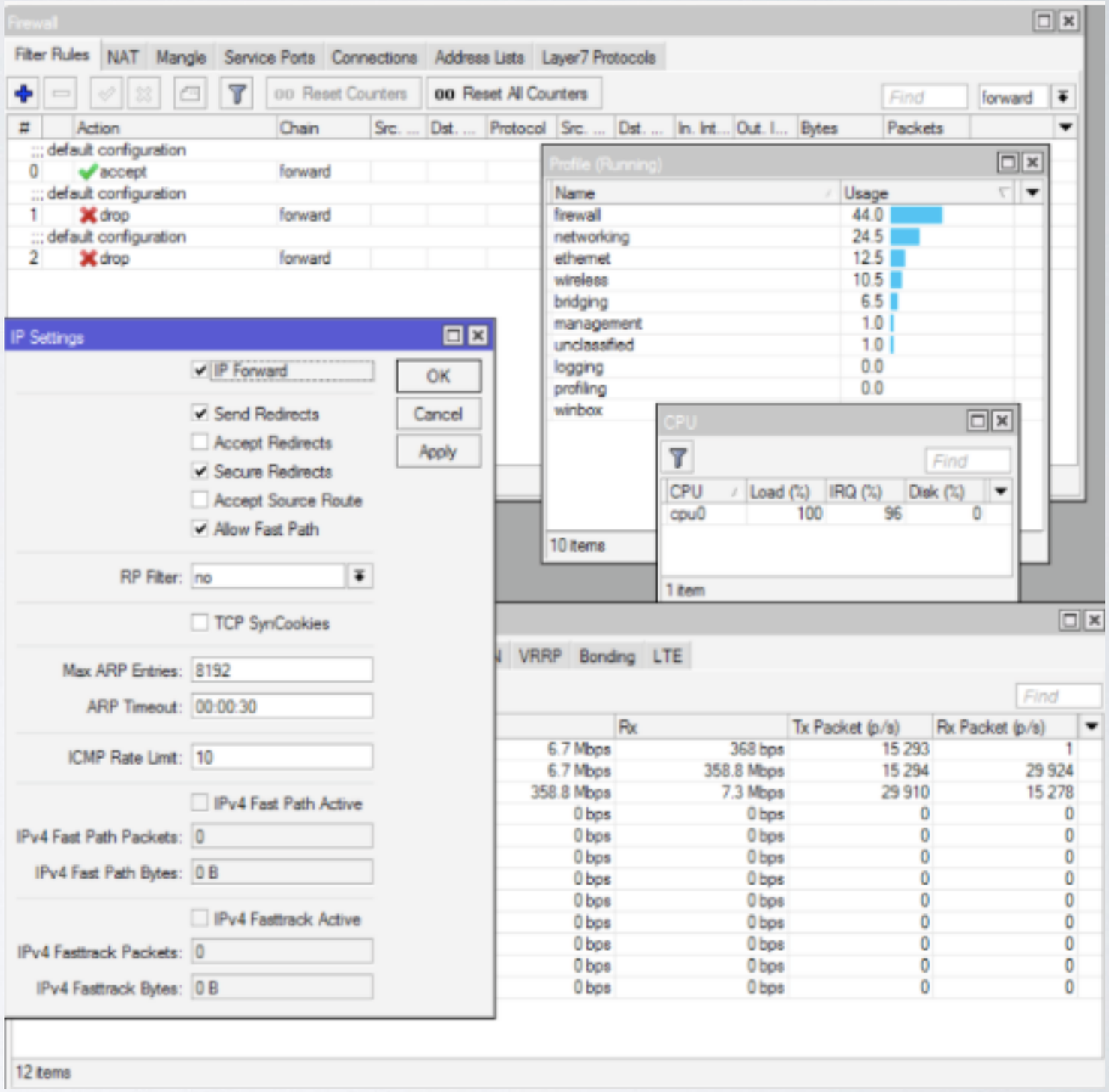
FastPath + Conntrack = FastTrack

Real-life example

- Board: RB2011UiAS-2HnD
- Factory default configuration tested with single TCP stream

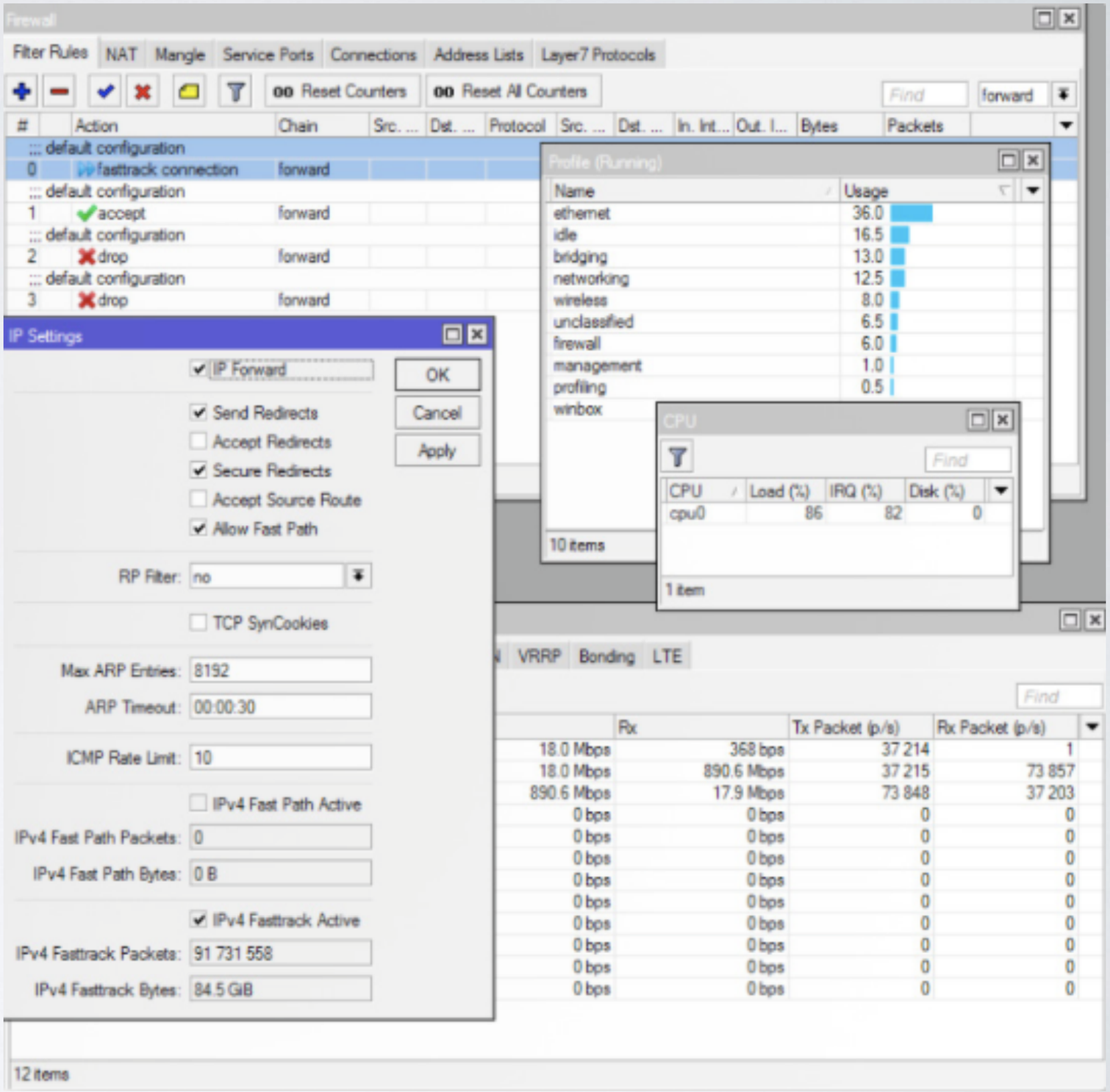
Before FastTrack

- 360Mbps throughput
- CPU @100%
- 44% of CPU on firewall



After FastTrack

- 890Mbps throughput
- CPU @86%
- 6% of CPU on firewall



Implementation

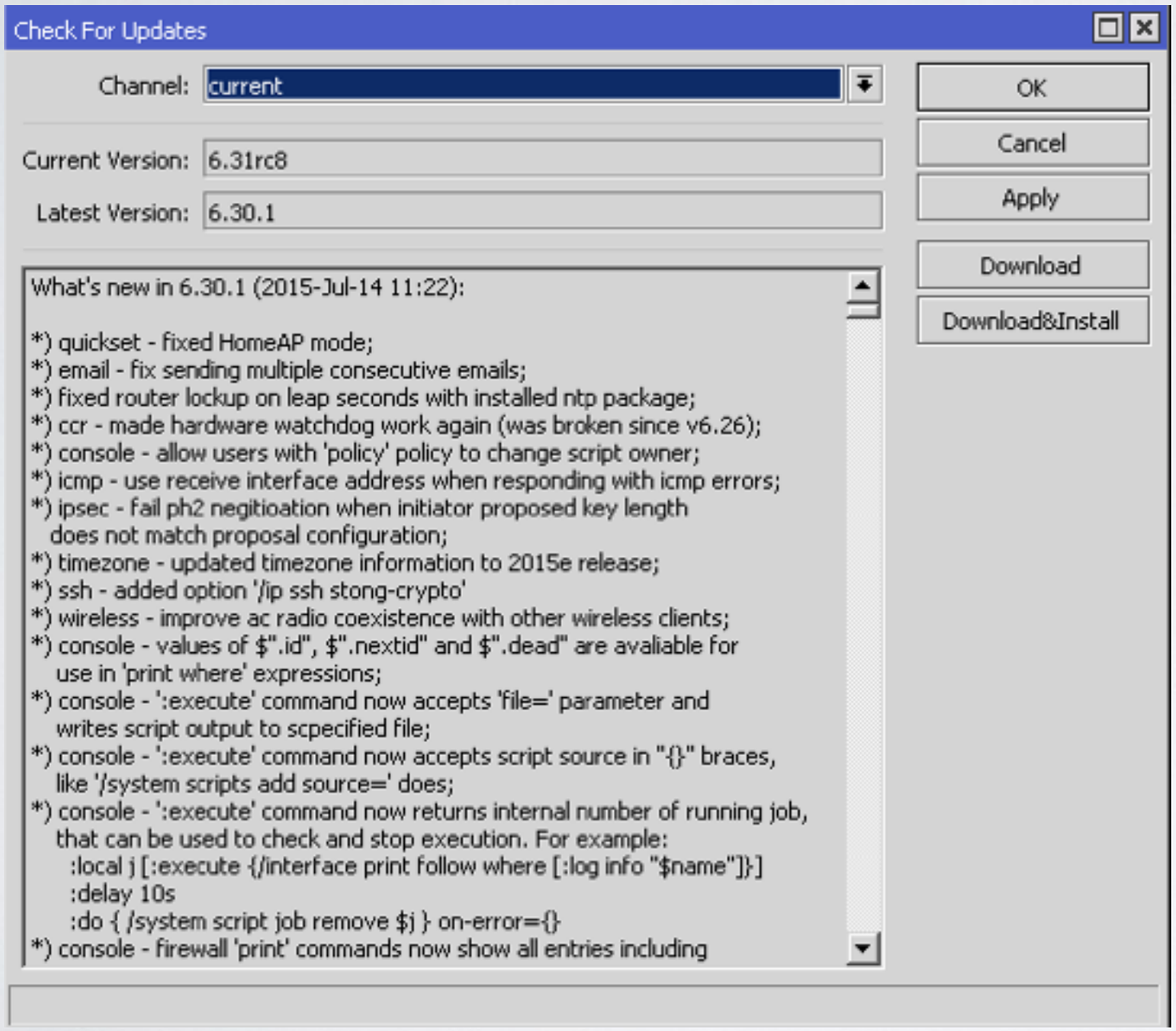
- Implemented as action for firewall filter/mangle
- Flags connection tracking entries as "FastTracked"
- Works with IPv4/TCP and IPv4/UDP
- Some packets still will go the regular path to maintain connection tracking table

New RouterOS version release system

RouterOS version types

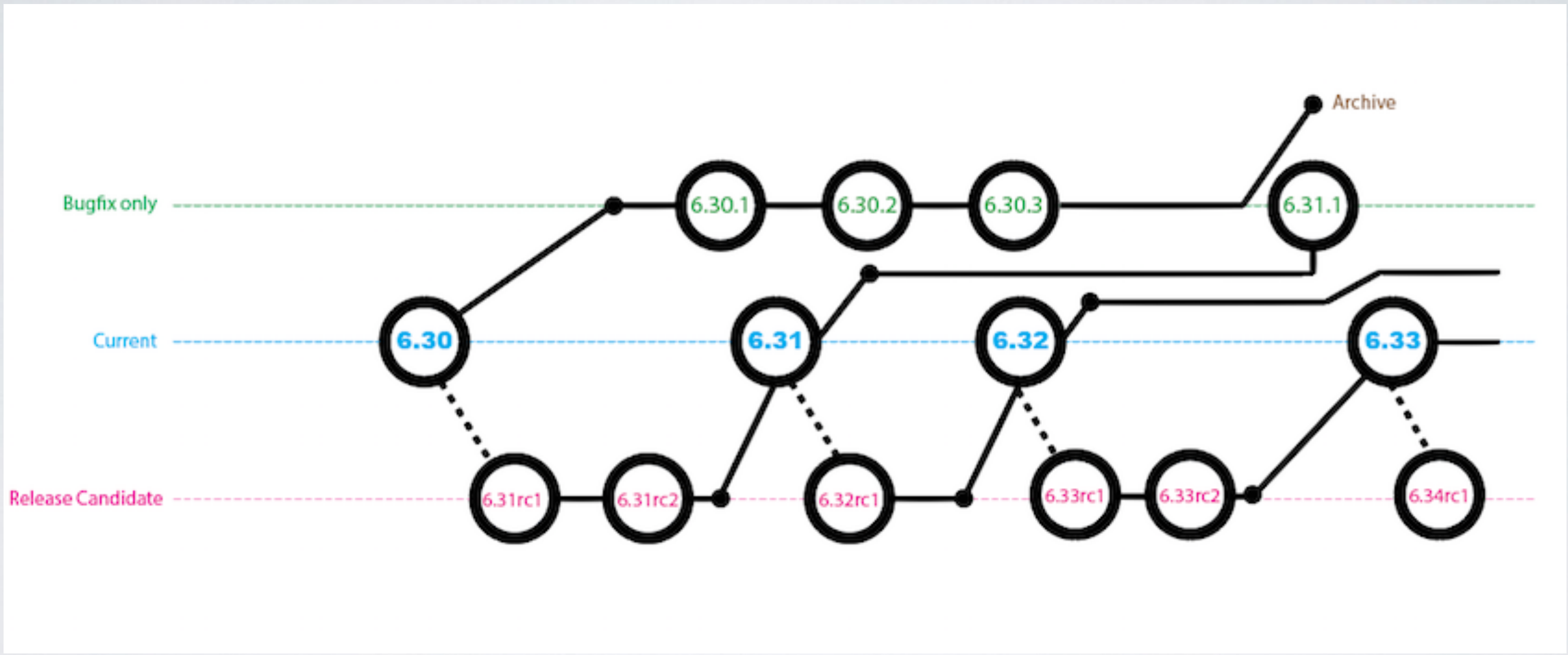
- Bugfix only - latest version with bug fixes included
- Current - current version
- Release candidate - latest release candidate version
- Development - latest version of v7 beta version

Example



Bugfix only - 6.30.3
Current - 6.31
Release candidate - 6.32rc1
Development - 7.0beta

Life cycle


Archive
Bugfix only
6.30.1
6.30.2
6.30.3
6.31.1
Current
6.30
6.31
6.32
6.33
Release Candidate
6.31rc1
6.31rc2
6.32rc1
6.33rc1
6.33rc2
6.34rc1

CHR

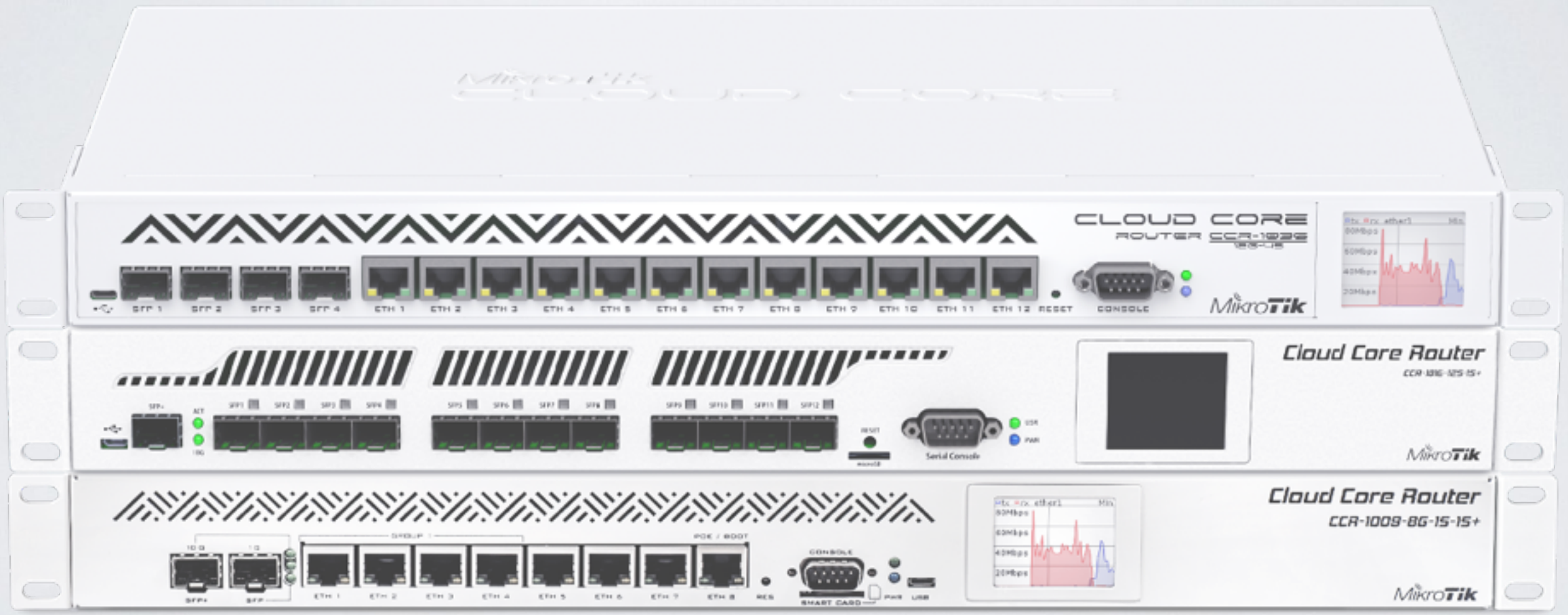
Cloud Hosted Router

- Special virtual machine image
- No traditional license key
- 1Mbit limit per interface = free use
- Unlimited subscriptions coming soon
- All features
- Optimised for VMware, VirtualBox and more

CHR

For beta download, see Announcements section in our user forum: http://forum.mikrotik.com

Status update
CCR and RouterOS v6



Tile Architecture

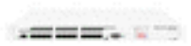
- RouterOS supports TILE-Gx processors with 9, 16, 36, or 72 identical processor cores (tiles) ONLY on CCR devices

- Tile architecture provide hardware accelerated AES encryption, automatic RPS and IRQ management

- Complete set of DDR3 memory and I/O controllers integrated into CPU.

- Runs on first ever 64-bit RouterOS v6 (tile)

Current CCR

	**CCR1009-8G-1S** 1U rackmount, 8x Gigabit Ethernet, 1xSFP cage, 9 cores x 1.2GHz CPU, 1GB RAM, RouterOS L6	$425.00
	**CCR1009-8G-1S-1S+** 1U rackmount, 8x Gigabit Ethernet, 1xSFP cage, 1xSFP+ cage, 9 cores x 1.2GHz CPU, 2GB RAM, LCD panel, Dual Power supplies, SmartCard slot, RouterOS L6	$495.00
	**CCR1016-12G** 1U rackmount, 12x Gigabit Ethernet, LCD 16 cores x 1.2GHz CPU, 2GB RAM, 17.8mpps fastpath, Up to 12Gbit/s throughput, RouterOS L6	$645.00
	**CCR1016-12S-1S+** 1U rackmount, 12xSFP cage, 1xSFP+ cage, 16 cores x 1.2GHz CPU, 2GB RAM, LCD panel, Dual Power supplies, RouterOS L6	$745.00
	**CCR1036-12G-4S** 1U rackmount, 12x Gigabit Ethernet, 4xSFP cages, LCD 36 cores x 1.2GHz CPU, 4GB RAM, 24 mpps fastpath, Up to 16Gbit/s throughput, RouterOS L6	$995.00
	**CCR1036-8G-2S+** 1U rackmount, 8x Gigabit Ethernet, 2xSFP+ cages, LCD 36 cores x 1.2GHz CPU, 4GB RAM, 41.5mpps fastpath, Up to 28Gbit/s throughput, RouterOS L6	$1,095.00
	**CCR1036-12G-4S-EM** 1U rackmount, 12x Gigabit Ethernet, 4xSFP cages, LCD 36 cores x 1.2GHz CPU, 16GB RAM, 24 mpps fastpath, Up to 16Gbit/s throughput, RouterOS L6	$1,195.00
	**CCR1036-8G-2S+EM** 1U rackmount, 8x Gigabit Ethernet, 2xSFP+ cages, LCD 36 cores x 1.2GHz CPU, 16GB RAM, 41.5mpps fastpath, Up to 28Gbit/s throughput, RouterOS L6	$1,295.00

Multicore processing

- After Ethernet frame is successfully received by Interface driver each frame get assigned by Linux Kernel to a specific core
- Re-assigning frames to a different core is very “expensive” process and should be avoided as much as possible
- Processing frames on different cores might take different amount of time – packet order might change during the parallel processing
- Some processes/features requires set of frames to be under control of the same core

Fast Path

- Fast Path allows to forward packets without additional processing in the Linux Kernel. It reveals hardware's true potential.
- Currently RouterOS has Fast Path handlers for: ipv4 routing, traffic generator, mpls, bridge
- More handlers will be added in future
- Fast Path requirements:
- Fast Path should be allowed in configuration
- Interface driver must have support
- Specific configuration conditions

Fast Path throughput

CCR1072-1G-8S+ (1200Mhz) **RouterOS v6.19rc6**

Mode	64 byte		512 byte		1518 byte	
	kpps	Mbps	kpps	Mbps	kpps	Mbps
Bridging	69,777.7	45,774.2	18,800.0	79,712.0	6,502.0	79,896.6
Routing	55,641.0	36,500.5	18,800.0	79,712.0	6,502.0	79,896.6
CCR1036-8G-2S+ (1200Mhz)						
Bridging	39,764.6	26,085.6	6,579.0	27,895.0	2,274.0	27,942.9
Routing	34,086.1	22,360.5	6,579.0	27,895.0	2,274.0	27,942.9
CCR1016-12S-1S+ (1200Mhz)						
Bridging	15,244.5	10,000.4	4,695.0	19,906.8	1,624.0	19,955.7
Routing	13,186.3	8,650.2	4,695.0	19,906.8	1,624.0	19,955.7
CCR1009-8G-1S-1S+ (1200Mhz)						
Bridging	10,491.1	6,882.2	2,817.0	11,944.1	974.0	11,968.5
Routing	8,217.1	5,390.4	2,817.0	11,944.1	974.0	11,968.5

- Underlined results - max wire speed reached

Traffic Generator

- Traffic Generator is a bandwidth-tool evolution
- Full Winbox support (coming soon) results - max wire speed reached
- “Quick” mode

- Traffic Generator can:
- Determine transfer rates, packet loss
- Detect out-of-order packets
- Collect latency and jitter values
- Inject and replay *.pcap file
- Working on TCP protocol emulation

Throughput in millions pps

Interface List

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

	Name	Type	MTU	L2 MTU	Tx	Rx	Tx Packet...	Rx Packet (...
RS	ether1	Ethernet	1500	1590	478.5 Mbps	465.8 Mbps	996 885	970 618
RS	ether2	Ethernet	1500	1590	477.2 Mbps	480.3 Mbps	994 356	1 000 701
RS	ether3	Ethernet	1500	1590	475.1 Mbps	513.4 Mbps	989 969	1 069 736
RS	ether4	Ethernet	1500	1590	476.6 Mbps	492.0 Mbps	993 024	1 025 024
RS	ether5	Ethernet	1500	1590	475.8 Mbps	501.4 Mbps	991 399	1 044 710
RS	ether6	Ethernet	1500	1590	478.4 Mbps	469.2 Mbps	996 816	977 502
RS	ether7	Ethernet	1500	1590	478.1 Mbps	471.7 Mbps	996 120	982 714
RS	ether8	Ethernet	1500	1590	482.7 Mbps	408.8 Mbps	1 005 632	851 693
RS	ether9	Ethernet	1500	1590	477.1 Mbps	487.0 Mbps	994 065	1 014 717
RS	ether10	Ethernet	1500	1590	478.2 Mbps	468.2 Mbps	996 343	975 495
RS	ether11	Ethernet	1500	1590	479.2 Mbps	455.3 Mbps	998 539	948 640
R	ether12	Ethernet	1500	15				
RS	sfp1	Ethernet	1500	15				
RS	sfp2	Ethernet	1500	15				
RS	sfp3	Ethernet	1500	15				
RS	sfp4	Ethernet	1500	15				

16 items out of 17

```
[admin@RouterOS] > interface monitor-traffic aggregate
    rx-packets-per-second:  15 577 081
      rx-drops-per-second:           0
     rx-errors-per-second:           0
       rx-bits-per-second:      7.4Gbps
    tx-packets-per-second:  15 576 803
      tx-drops-per-second:           0
     tx-errors-per-second:           0
       tx-bits-per-second:      7.4Gbps
-- [Q quit|D dump|C-z pause]
```

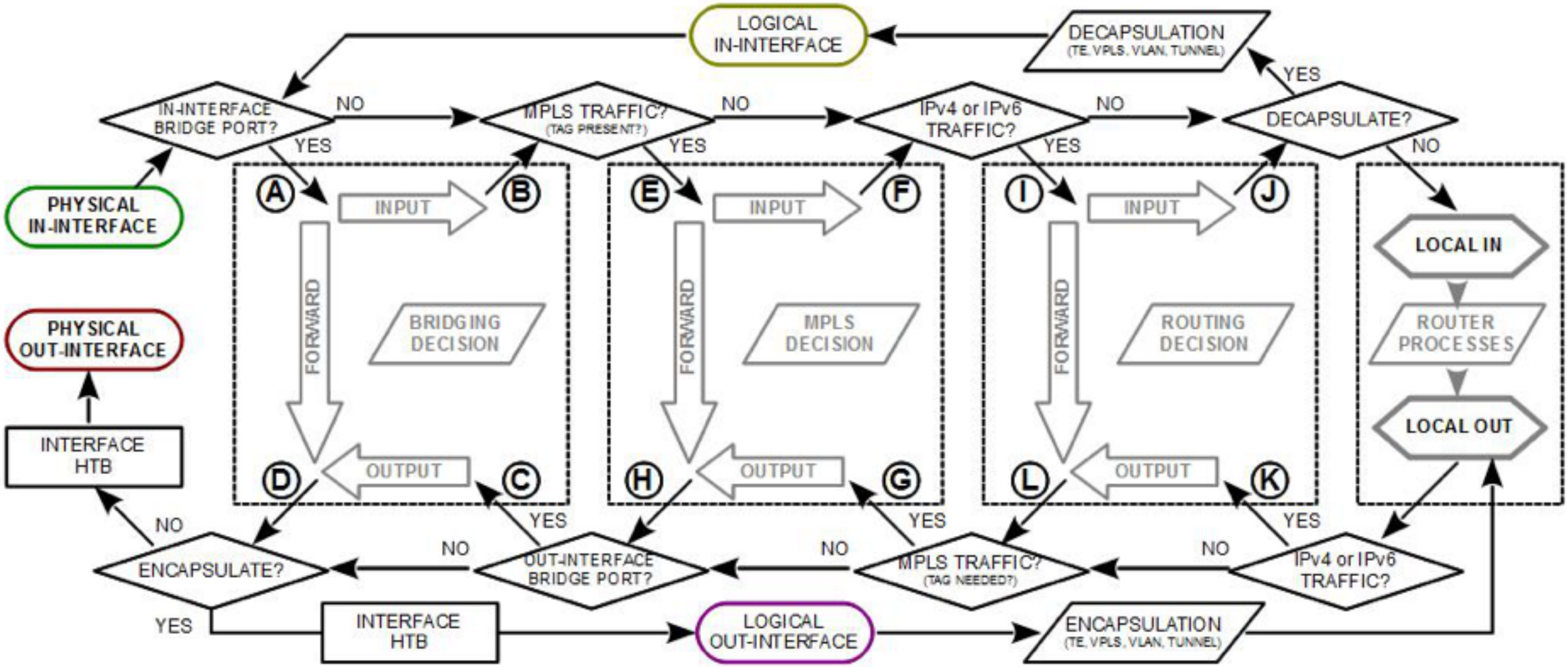
RouterOS on CCR

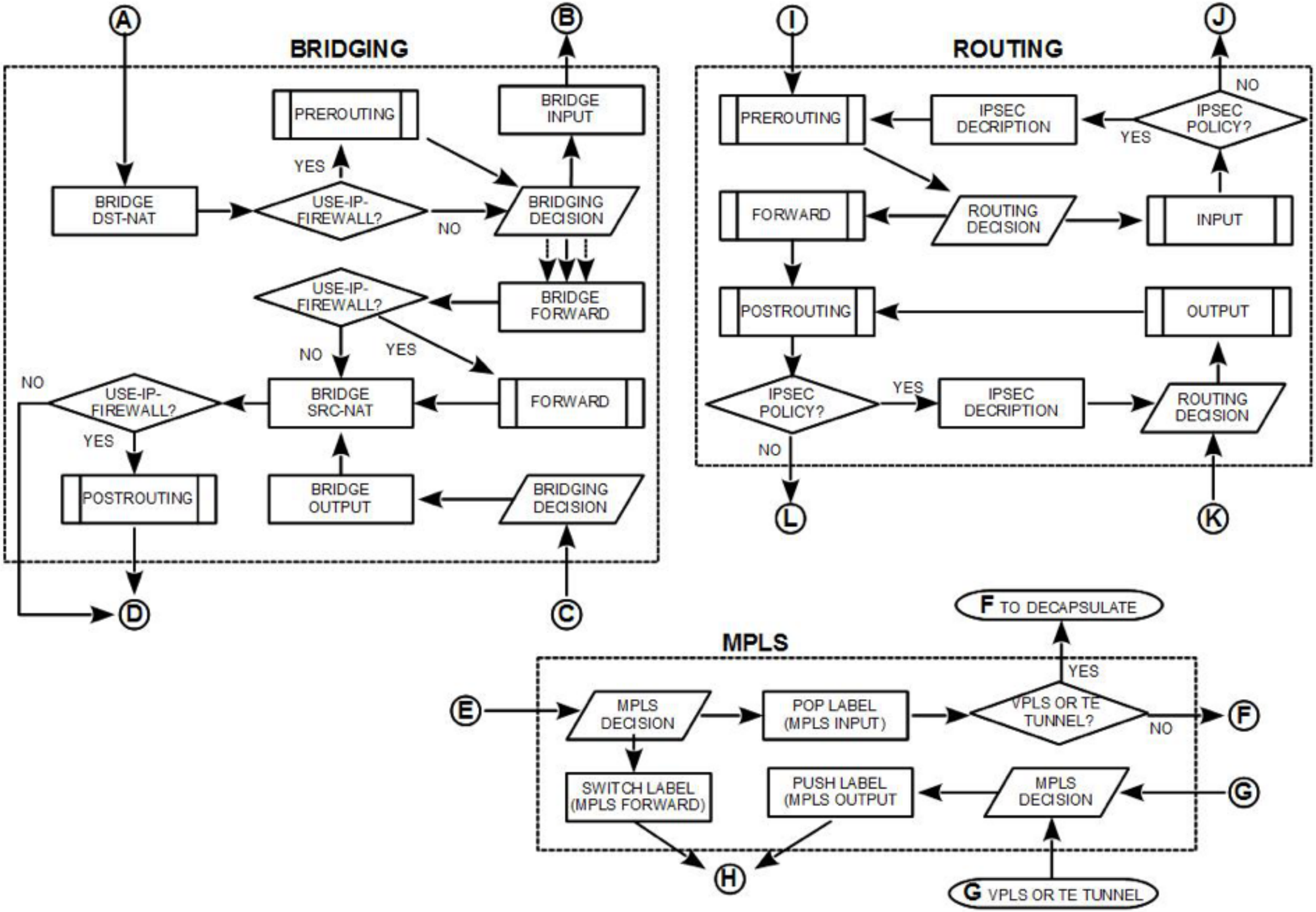
- Previous slides indicate that hardware is very, very fast.
- What about when we start using RouterOS features?
- Answer:

CCR1036-8G-2S+ (1200Mhz) **All port test** **RouterOS v6.19rc6**

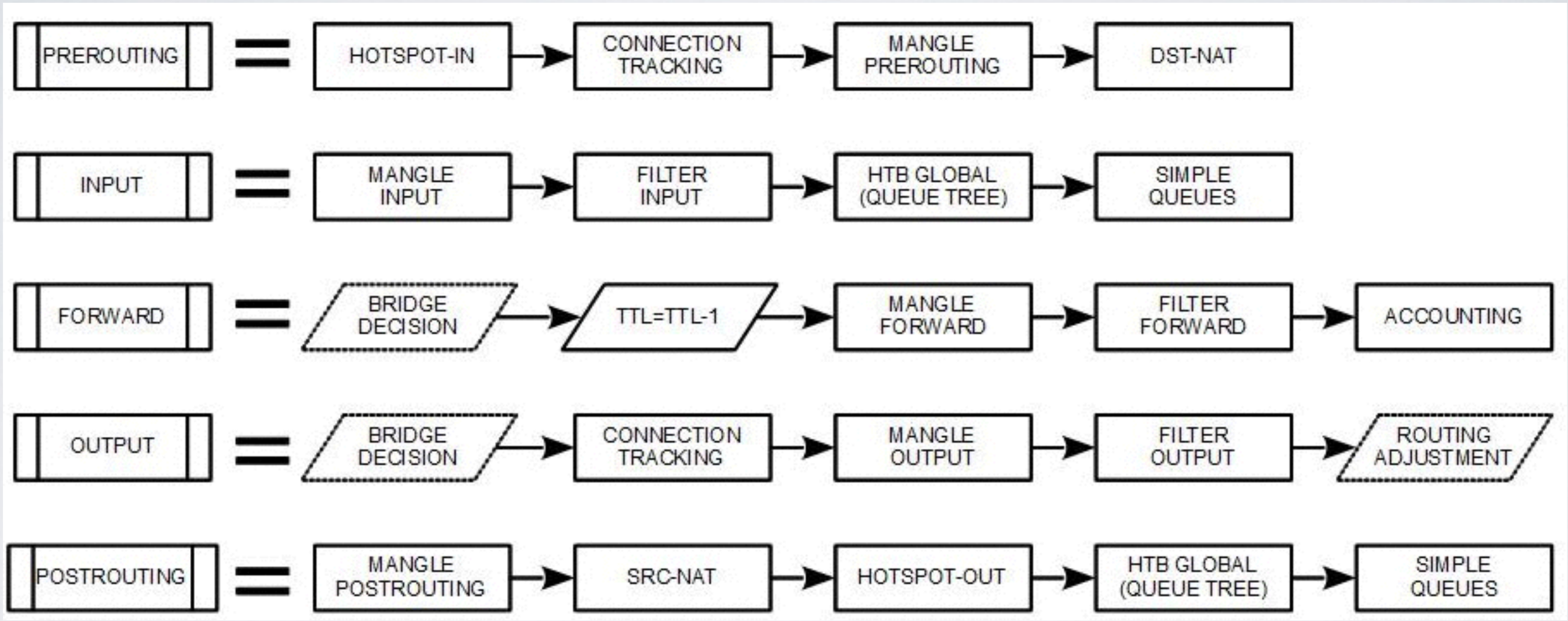
Mode	Configuration	64 byte		512 byte		1518 byte	
		kpps	Mbps	kpps	Mbps	kpps	Mbps
Bridging	none (fast path)	39,764.6	26,085.6	6,579.0	27,895.0	2,274.0	27,942.9
Bridging	25 bridge filter rules	5,704.8	3,742.3	5,451.4	23,113.9	2,274.0	27,942.9
Routing	none (fast path)	34,086.1	22,360.5	6,579.0	27,895.0	2,274.0	27,942.9
Routing	25 simple queues	8,353.1	5,479.6	5,243.2	22,231.2	2,274.0	27,942.9
Routing	25 ip filter rules	3,481.8	2,284.1	3,392.9	14,385.9	1,956.7	24,043.9

MikroTik RouterOS Packet Flow Diagram for version 6.x

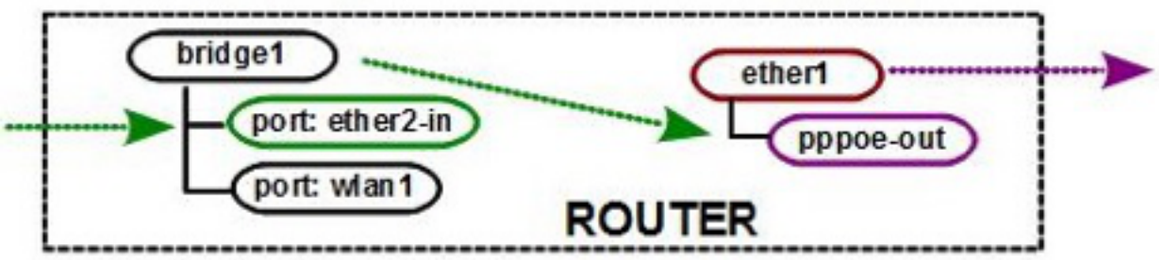



A
B
BRIDGING
PREROUTING
BRIDGE INPUT
YES
BRIDGE DST-NAT
USE-IP-FIREWALL?
NO
BRIDGING DECISION
USE-IP-FIREWALL?
BRIDGE FORWARD
NO
YES
NO
USE-IP-FIREWALL?
BRIDGE SRC-NAT
FORWARD
YES
POSTROUTING
BRIDGE OUTPUT
BRIDGING DECISION
D
C
I
J
ROUTING
PREROUTING
IPSEC DECRIPTION
NO
IPSEC POLICY?
YES
FORWARD
ROUTING DECISION
INPUT
POSTROUTING
OUTPUT
IPSEC POLICY?
YES
IPSEC DECRIPTION
ROUTING DECISION
NO
L
K
F TO DECAPSULATE
MPLS
YES
E
MPLS DECISION
POP LABEL (MPLS INPUT)
VPLS OR TE TUNNEL?
NO
F
SWITCH LABEL (MPLS FORWARD)
PUSH LABEL (MPLS OUTPUT
MPLS DECISION
G
H
G VPLS OR TE TUNNEL

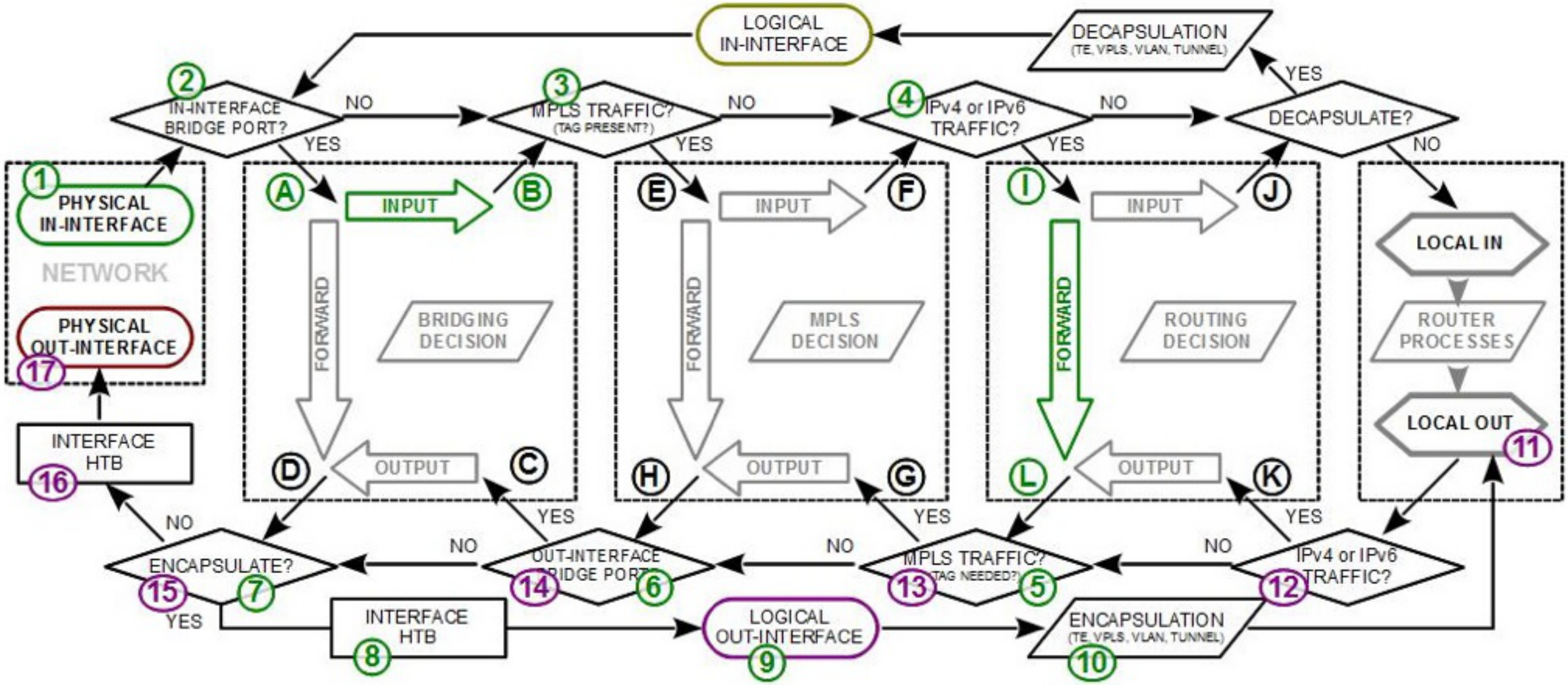
Packet flow diagram



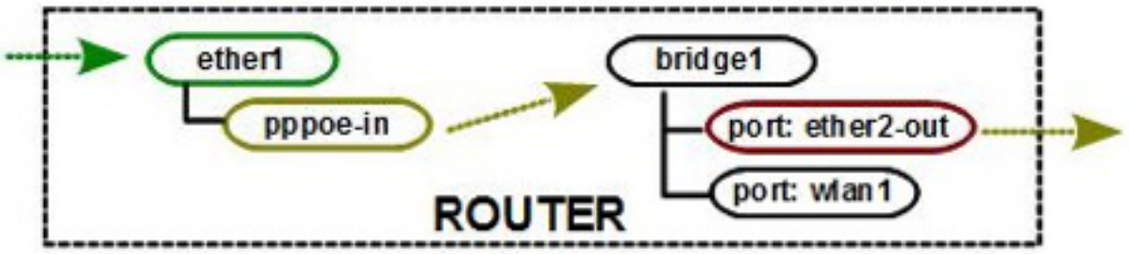
Packet Flow Scenario:



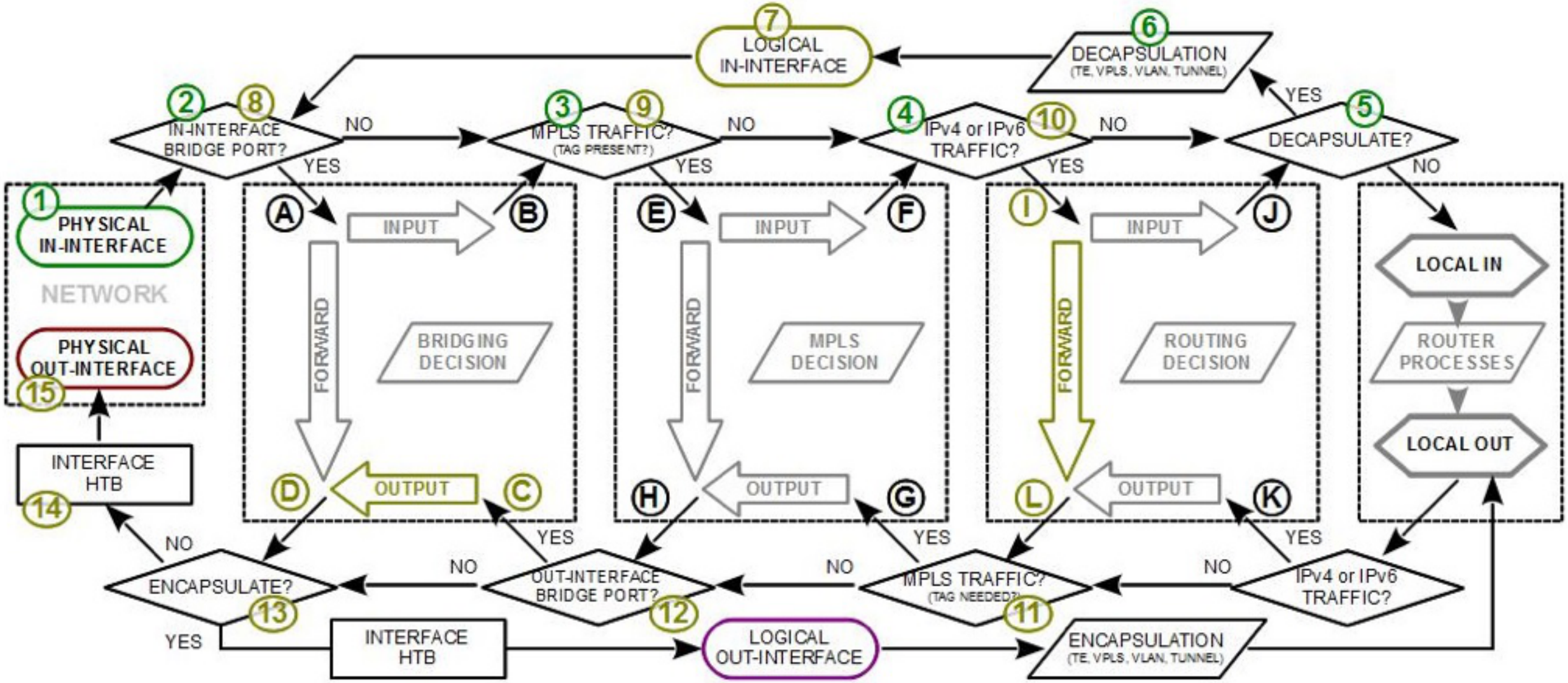
This Scenario in Packet Flow Diagram:



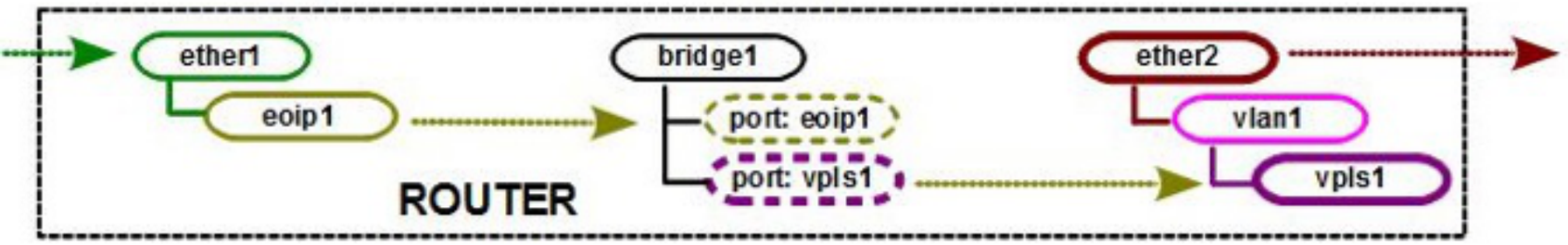
Packet Flow Scenario:



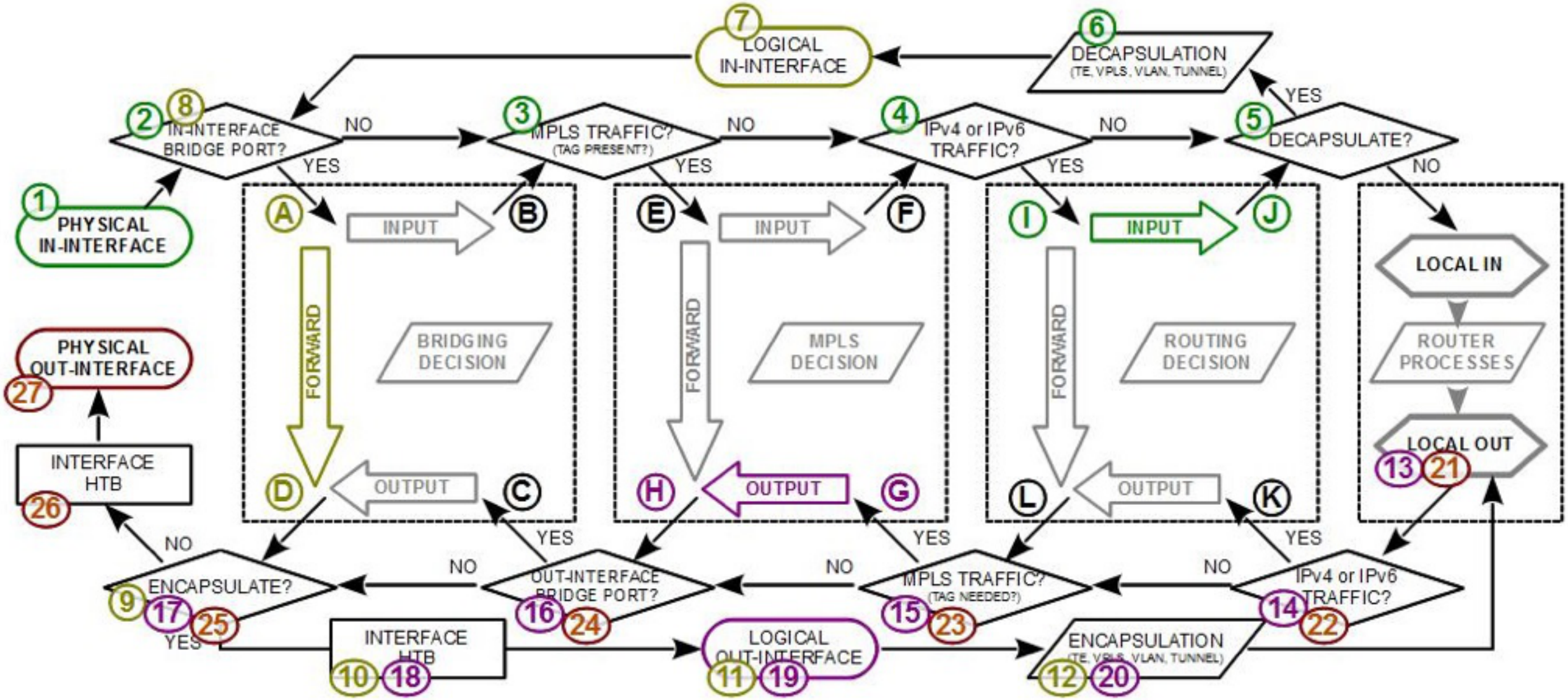
This Scenario in Packet Flow Diagram:



Packet Flow Scenario:



This Scenario in Packet Flow Diagram:



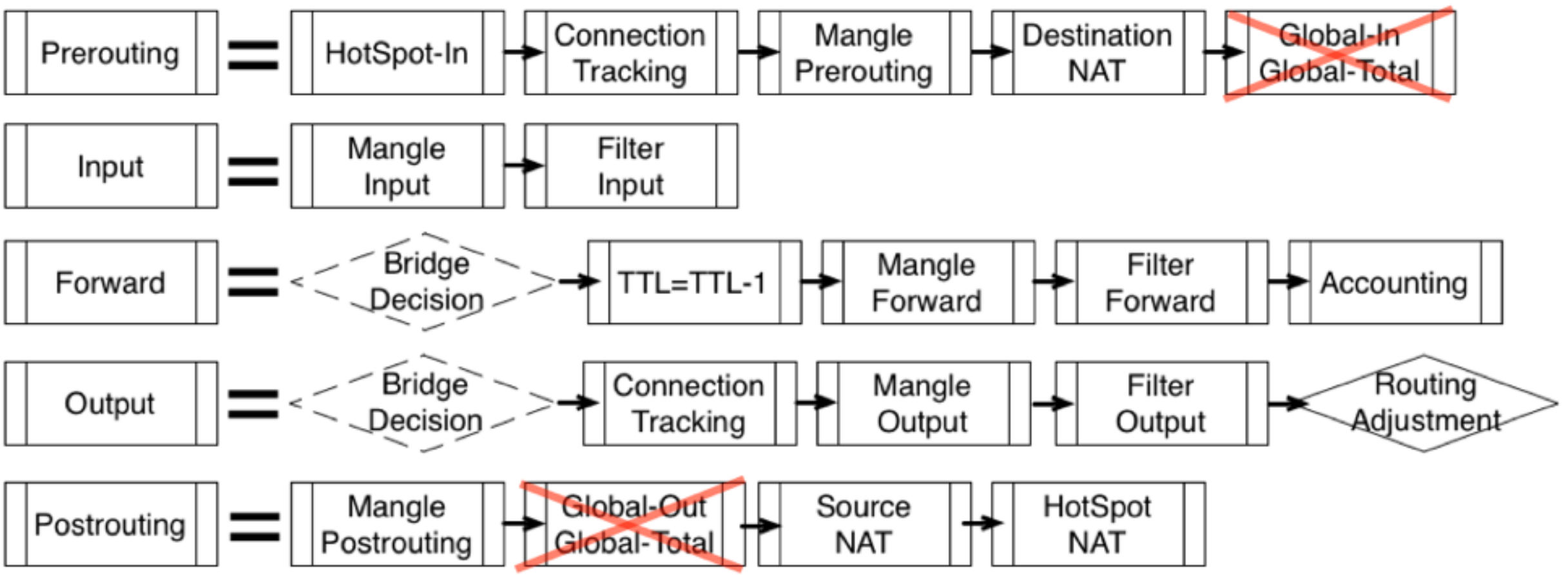
Queues and Multi-core

- Packets spend most part of the processing time waiting in queues.
- In order not to waste CPU core cycles on waiting, current core will just leave packet in the queue.
- Packet will be taken out of the queue by random CPU core, that works on that queue at the time.
- In short: queues shuffles packet assignments to CPU cores.

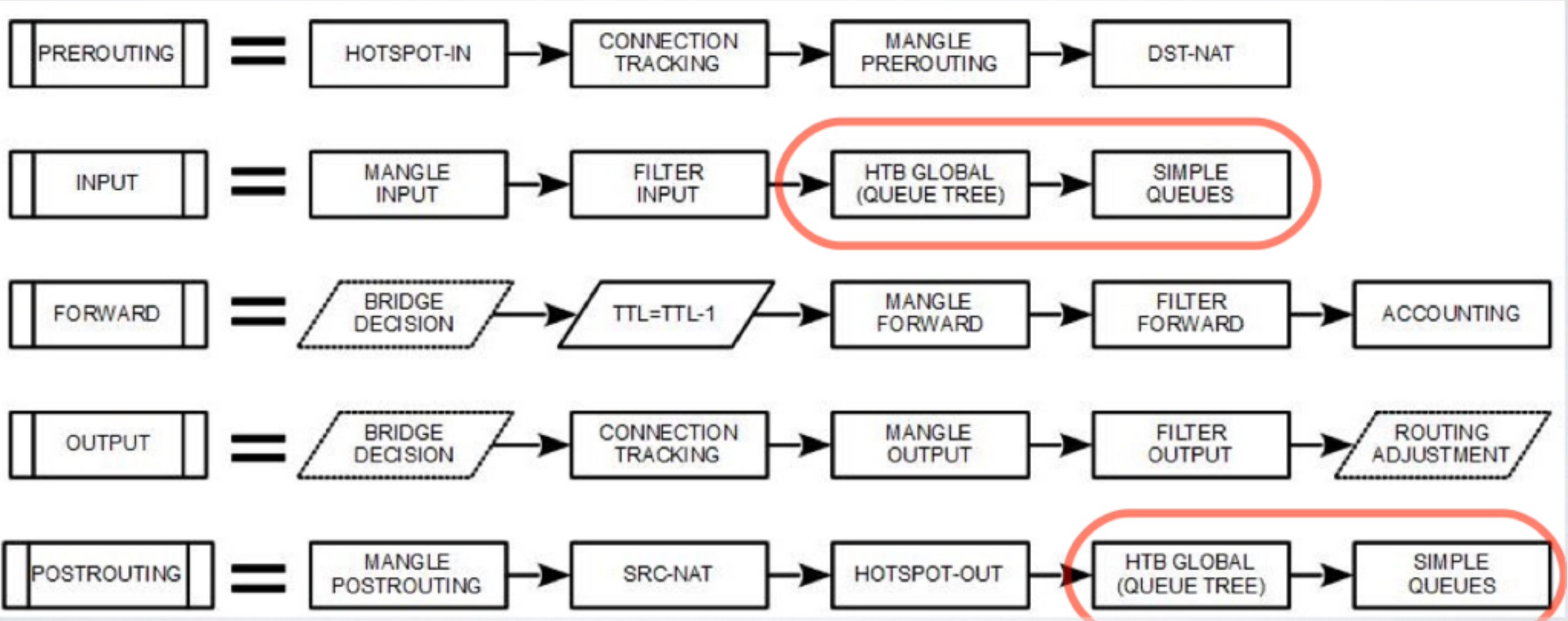
Packet Flow Changes

- In RouterOS v5.x there was several places where packets were queued, so CPU core assignments shuffle happened several times
- In RouterOS v6.x QoS system was redesigned so that queuing happens in the same place respectively to other processes in the router – at the end.

HTB in RouterOS v5.x

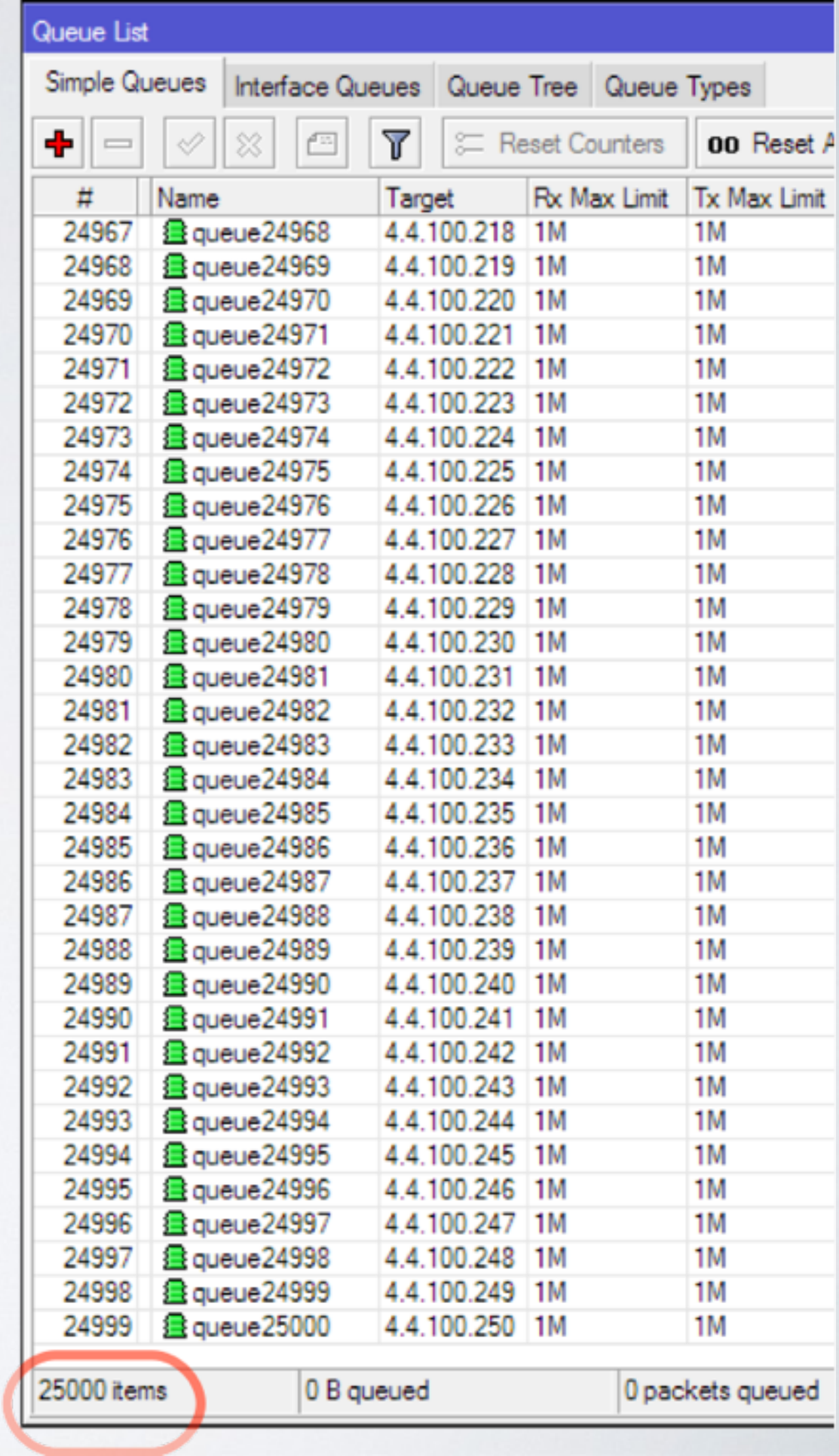


HTB in RouterOS v6.x



Simple Queues

- Matching algorithm has been updated
- based on hash
- faster miss-matches
- Optimal performance on Multi-core devices requires at least 32 top level simple queues, so that queuing process can be distributed properly



Queue Tree and CCR

- Whole HTB tree from Kernel perspective is and will be one queue so only one CPU core can work on HTB at the same time.

- Same optimisation as in simple queues (at least 32 top-level queues, faster matching) will come to queue tree in one of the next versions.

- Suggestions:

- Use Interface HTB as much as possible to offload traffic from HTB "global"

- Use simple queues

Queue changes in v6.19

- In RouterOS v6.19 we introduced a software patch to improve queue performance
- Before CPU core just left packets in the queue and random other core was taking them out "later".
- Now CPU core that leave packets in the queue will have to take some packets out, in the same instant moment.
- In case when queue limit is not reached, same packets will be left in and taken out of the queue by the same CPU core, making this process seamless

PPTP,L2TP and PPPoE on CCR

- Changes introduced in v6.8:
- kernel drivers for PPP, PPPoE, PPTP, L2TP now are lock-less on transmit & receive
- all ppp packets (except discovery packets) now can be handled by multiple cores
- MPPE driver now can handle up to 256 out-of-order packets (Previously even single out-of-order packet was dropped)
- roughly doubled MPPE driver encryption performance

PPTP,L2TP and PPPoE on CCR

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- MPPE driver now can handle up to 256 out-of-order packets (Previously even single out-of-order packet was dropped)
- roughly doubled MPPE driver encryption performance

Single PPTP Tunnel Performance on CCR1036

Encryption	Conntrack	Version	64 byte	512 byte	1024 byte	1280 byte	1518 byte
No	No	6.7	135,788	143,454	148,728	147,046	71,400
No	No	6.8rc1	2,123,150	2,336,314	2,305,772	1,865,984	958,942
No	Yes	6.7	98,818	88,294	89,442	100,090	36,826
No	Yes	6.8rc1	1,191,870	1,215,884	1,201,644	1,179,104	32,738
Yes	No	6.7	47,432	38,180	30,830	27,042	13,206
Yes	No	6.8rc1	190,894	233,676	239,462	190,820	80,828
Yes	Yes	6.7	39,062	29,884	22,560	21,062	12,826
Yes	Yes	6.8rc1	189,266	233,676	239,462	190,820	14,192

Single L2TP Tunnel Performance on CCR1036

Encryption	Conntrack	Version	64 byte	512 byte	1024 byte	1280 byte	1518 byte
No	**No**	**6.7**	120,906	123,428	197,486	197,846	84,290
No	**No**	**6.8rc1**	3,708,612	3,522,140	2,312,554	1,868,990	1,214,036
No	**Yes**	**6.7**	98,120	105,438	103,230	101,506	50,160
No	**Yes**	**6.8rc1**	1,687,126	1,580,948	1,382,294	1,302,770	53,170
Yes	**No**	**6.7**	62,894	47,598	35,628	32,038	19,238
Yes	**No**	**6.8rc1**	212,052	234,962	226,366	215,688	91,830
Yes	**Yes**	**6.7**	47,432	37,134	29,408	26,614	16,464
Yes	**Yes**	**6.8rc1**	212,052	231,364	206,372	208,552	22,782

Single PPPoE Tunnel Performance on CCR1036

Encryption	Conntrack	Version	64 byte	512 byte	1024 byte	1280 byte	1518 byte
No	**No**	**6.7**	294,828	305,358	302,276	305,326	N/A
No	**No**	**6.8rc1**	5,519,320	4,633,852	2,376,862	1,912,372	N/A
No	**Yes**	**6.7**	277,156	260,386	192,272	183,856	83,844
No	**Yes**	**6.8rc1**	2,730,596	2,462,744	2,103,608	1,910,588	80,028
Yes	**No**	**6.7**	71,730	51,084	37,940	33,894	N/A
Yes	**No**	**6.8rc1**	212,052	239,322	228,588	208,552	N/A
Yes	**Yes**	**6.7**	56,286	43,412	33,318	29,754	19,358
Yes	**Yes**	**6.8rc1**	234,840	234,962	226,366	208,552	29,004

CCR and packet fragments

- Currently Connection Tracking requires packet to be re-assembled before further processing
- It is impossible to ensure that all fragments of the packet are received by the same CPU core
- We plan to:
  - add full support to Path MTU Discovery to all tunnels and interfaces
  - Update Connection Tracking to handle fragments.

Tunnel update in v6.20/6.22

- EoIP,GRE,IPIP,6to4 tunnels have new features:
  - mtu=auto (calculated automatically)
  - dscp (inherit or specific value)
  - clamp-tcp-mss
  - tunnels go down when no route to destination (eliminate unnecessary packet sending attempts)
  - keepalive, keepalive-retries settings
- Bridge and PPPoE server have mtu=auto feature.

IP Firewall and CCR

- Each Firewall rule takes a dedicated place in system memory (RAM)
- CPU core need to process packets through whole list of firewall rules before it is captured
- In RouterOS v6.19 we introduced Linux Kernel patch that allow us to fully utilise unique Tilera TileGx processor cache and memory management features
- All memory heavy processes now should work faster (especially firewall)

Changes in firewall

- Firewall now has “all-ether”,”all-wireless”,”all-vlan”,”all-ppp” as possibilities in interface matching (only 2 dynamic “change-mss” rules)

- In RouterOS v6.19 we introduced patch that:

  - optimised option matching order with-in a rule – simple options will be matched before getting to more complex options

  - Rules that can't possibly match any packets because of current configuration, will be marked as invalid and skipped (with comment that explains why)

Firewall Rule Matching Order

- 1)in-interface, 2)out-interface, 3)protocol, 4)fragment, 5)src-mac-address, 6)in-bridge-port, 7)out-bridge-port, 8)src-address, 9)dst-address,10)src-address-type,11)dst-address-type,12)dst-address-list, 13)src-address-list,14)ttl,15)dscp, 16)packet-size,17)ipv4-options,18)dst-port, 19)src-port, 20)port, 21)tcp-flags, 22)tcp-mss, 23)icmp-options, 24)ingress-priority, 25)priority, 26)packet-mark, 27)routing-mark, 28)hotspot, 29)connection-mark, 30)connection-state, 31)connection-bytes, 32)connection-limit, 33)connection-rate, 34)connection-type, 35)random, 36)psd, 37)nth, 38)limit, 39)dst-limit, 40)per-connection-classifier, 41)p2p, 42)content, **43)layer7-protocol**

Layer 7

- Layer-7 is the most "expensive" firewall option, it takes a lot of memory and processing power to match each connection to regexp string.

- Layer-7 should be used only as trigger – to add connection-mark or address-list entry

- Direct action (like accept, drop) should be done by rules that work with those connection marks or address-lists, not by layer-7 rule

- Make sure that if layer-7 rule is matched once then same connections will not get to layer-7 rule.

Routing RouterOS v6.x

- Packet routing can utilise all cores
- All dynamic routing protocols (more precisely - routing table updates and protocol calculations) are limited to a single core.
- One BGP full feed will take <3min to load on CCR
- Two BGP full feeds will take <8min to load on CCR
- Currently board with 256Mb RAM can only hold 2 BGP full feeds
- Searching a specific set of routes takes too long.

Routing RouterOS v7.x

- More that 10x faster routing table calculations
- One BGP full feed will take ~1,5min to load on CCR
- Two BGP full feeds will take <2min to load on CCR
- Much more scalable (60 BGP fool feeds no problems)
- Uses much less RAM
- full BGP feed takes ~36MB RAM
- 12 million routes takes ~500MB RAM
- Completely isolated VRFs
- Much more faster route table searches

IPSec and CCR

- Hardware acceleration support for aes-cbc + md5|sha1|sha256 Authenticated Encryption with Associated Data (AEAD) was added on CCR in RouterOS v6.8

- Now CCR1036 can handle 3,2Gbps encrypted IPSec traffic

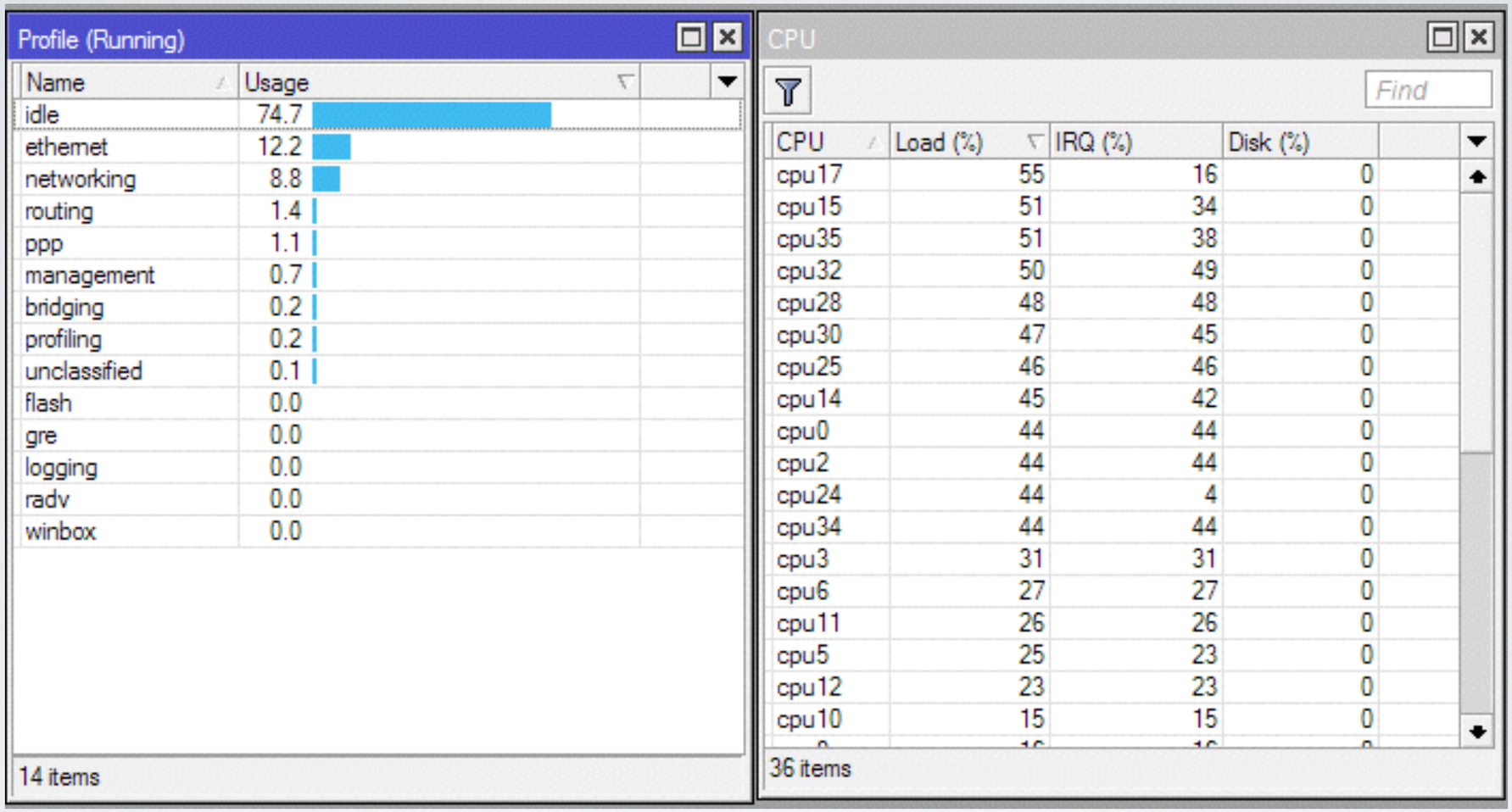
- Maintaining ~80% CPU load

- No fragmentation (1470byte packets)

- Many peers (100 separate tunnels)

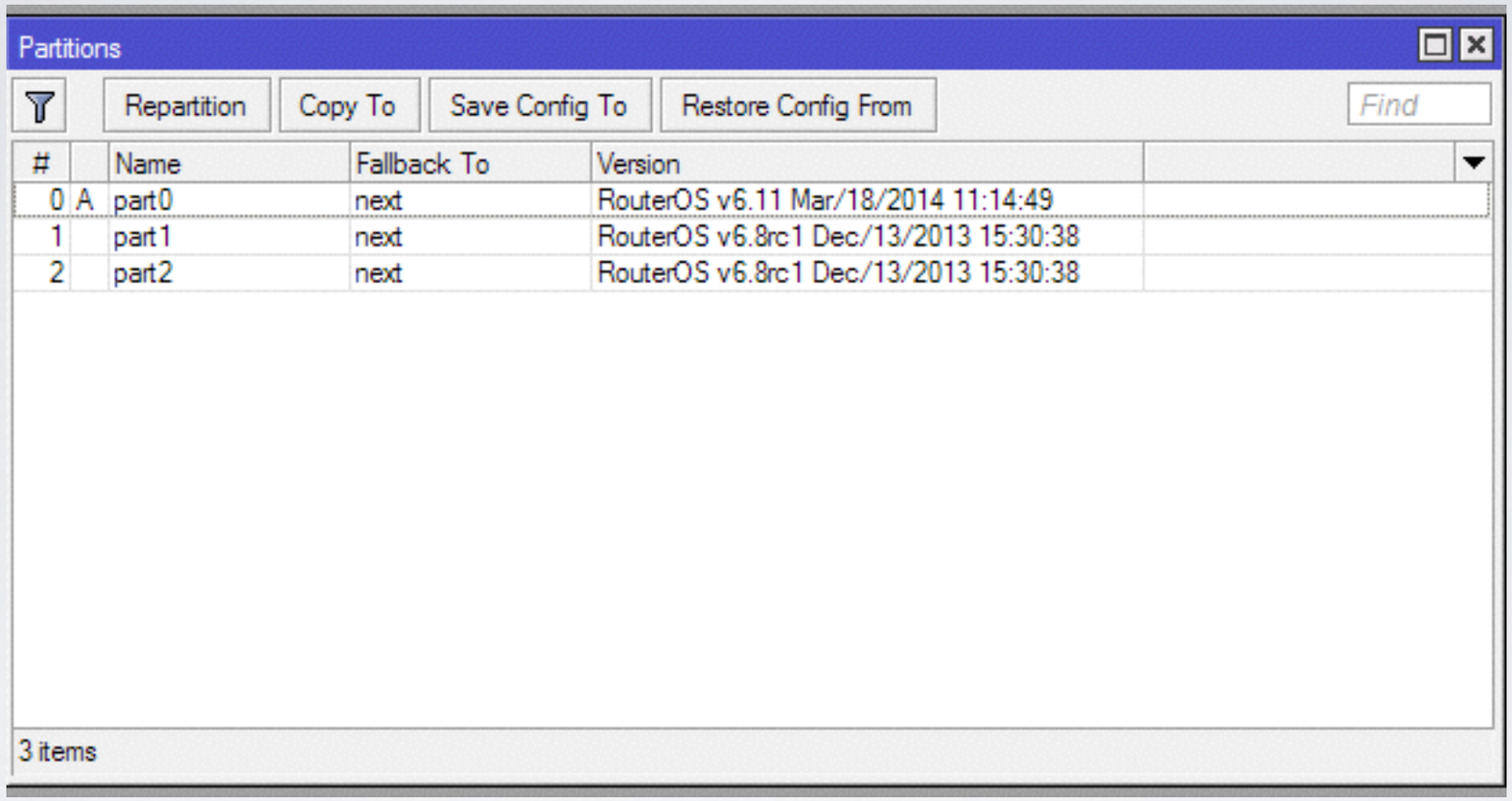
- AES128 was used

Tools



- /system resources cpu
- /tool profile

Partitions



- Partition will always allow you to keep one working copy of RouterOS just one reboot away and backup configuration before mayor changes

Enjoy the MUM!