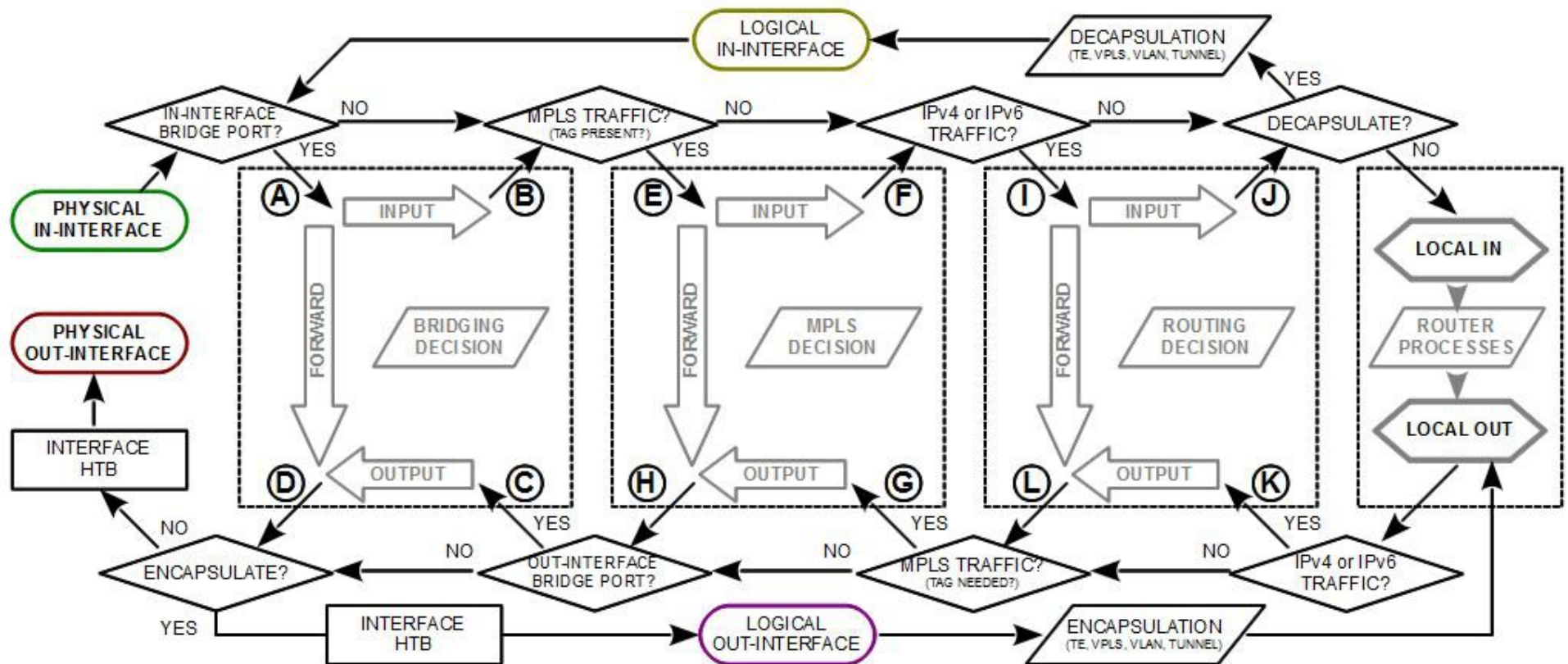
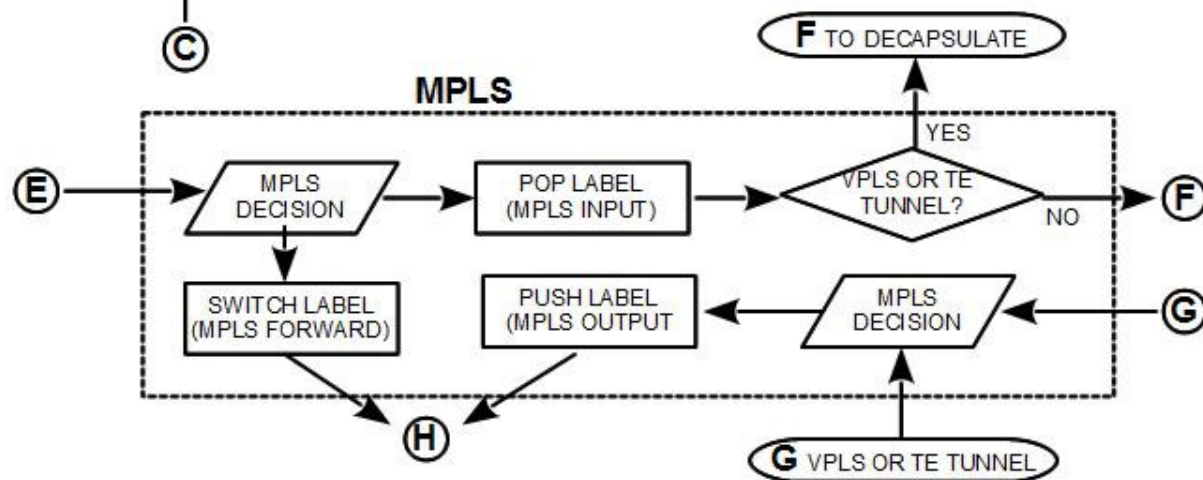
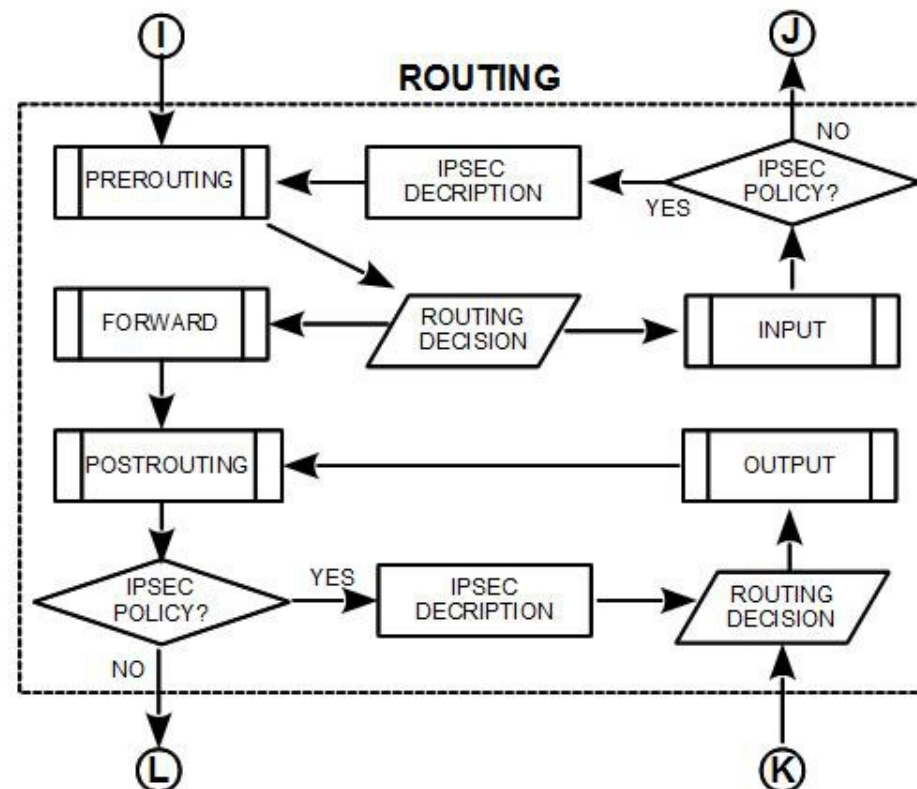
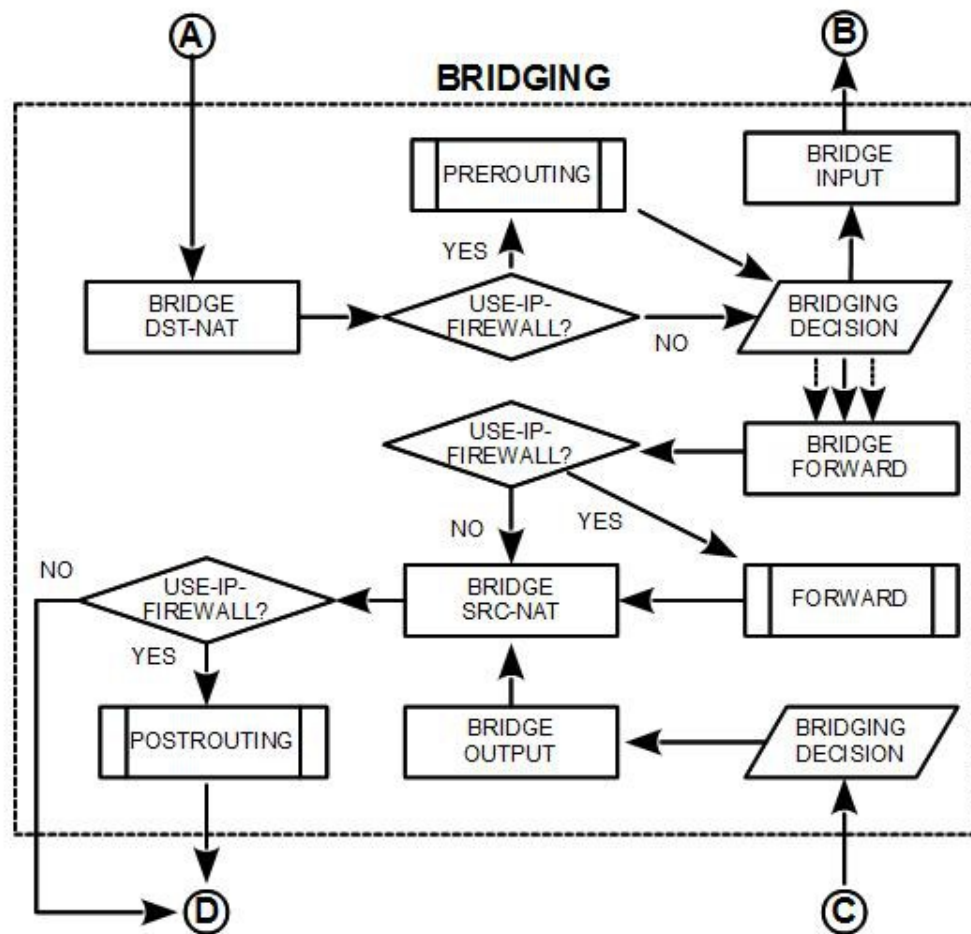


# ***FastPath Overview***

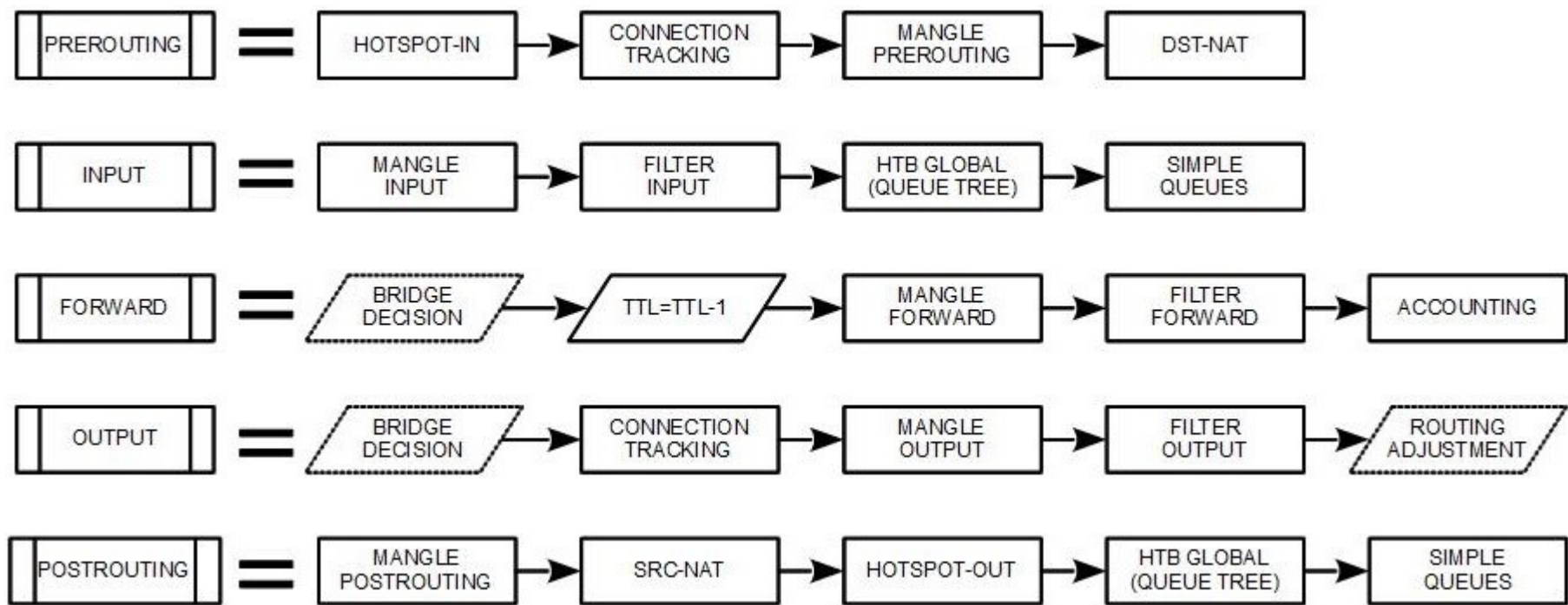
MUM Ukraine, 2015

# MikroTik RouterOS Packet Flow Diagram for version 6.x





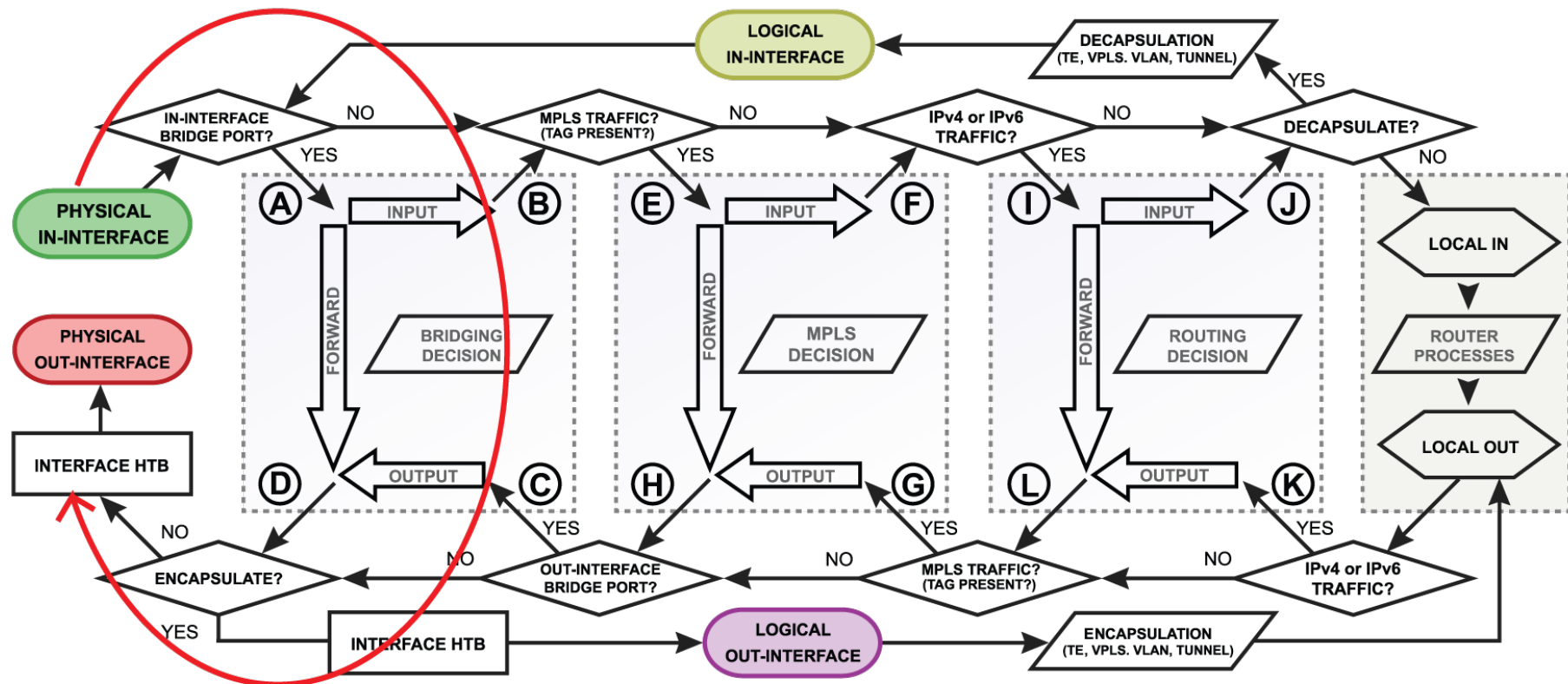
# Yes, still - Packet Flow Diagram (page 3)



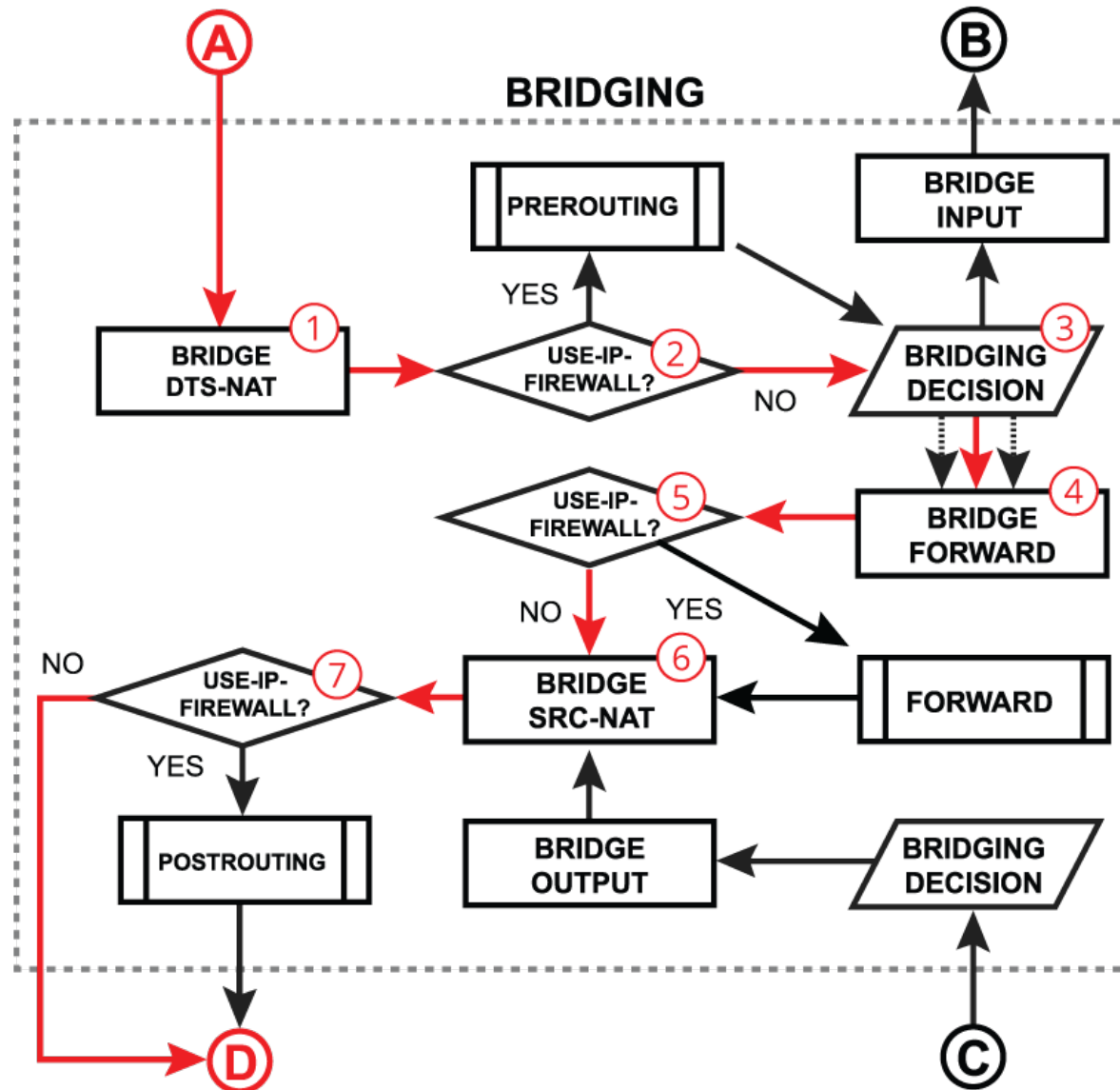
# “SlowPath”

- “Slow Path” is the regular way packets are processed in RouterOS
- For each packet RouterOS has to check the whole path of the packet
- In some cases it is a considerable number of steps

# Bridge Forwarding

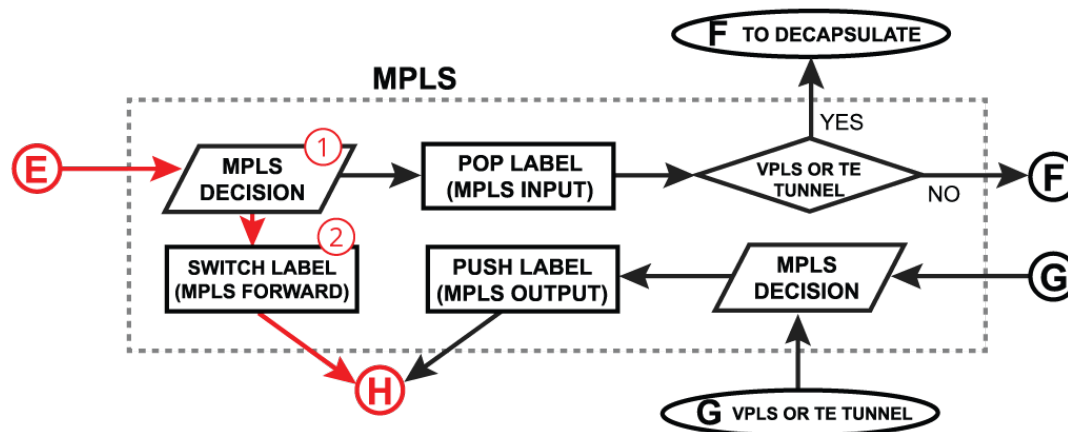
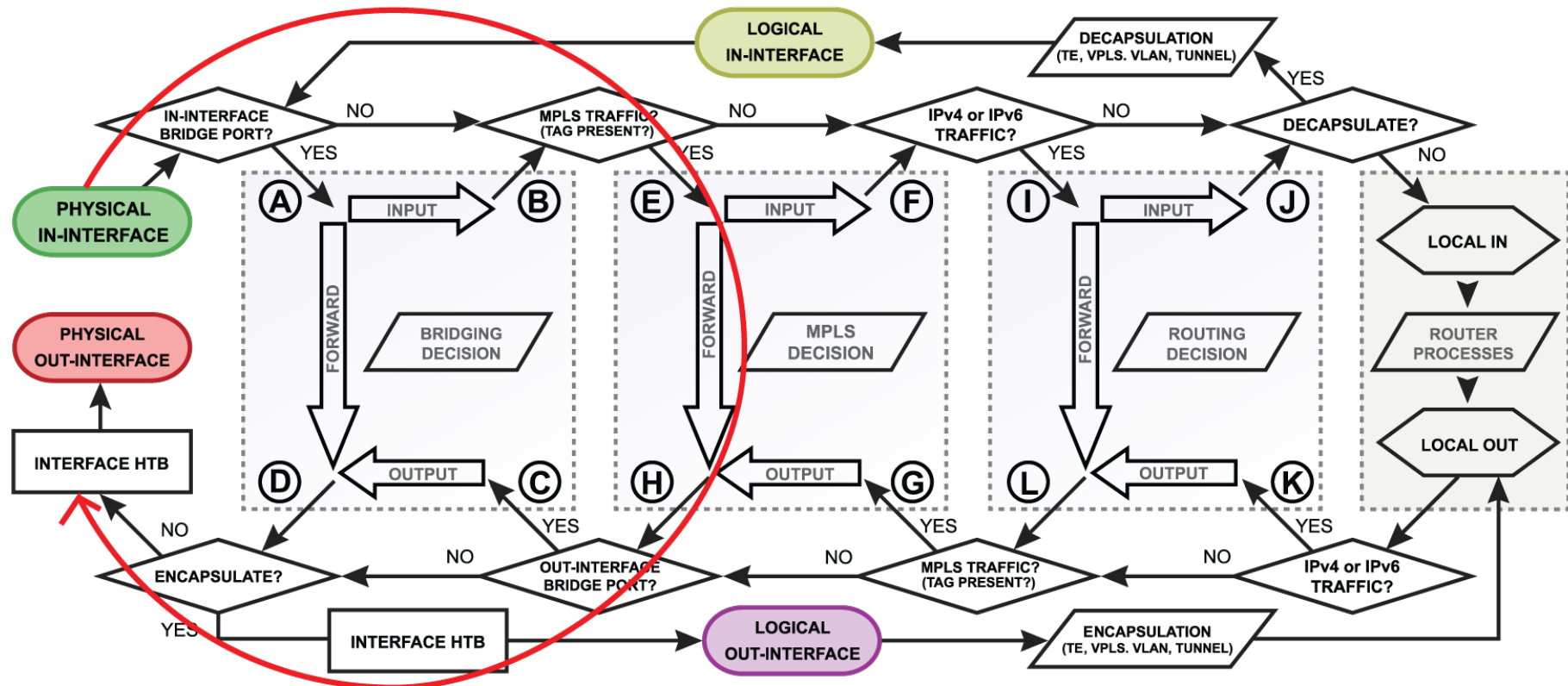


# Bridge Forwarding



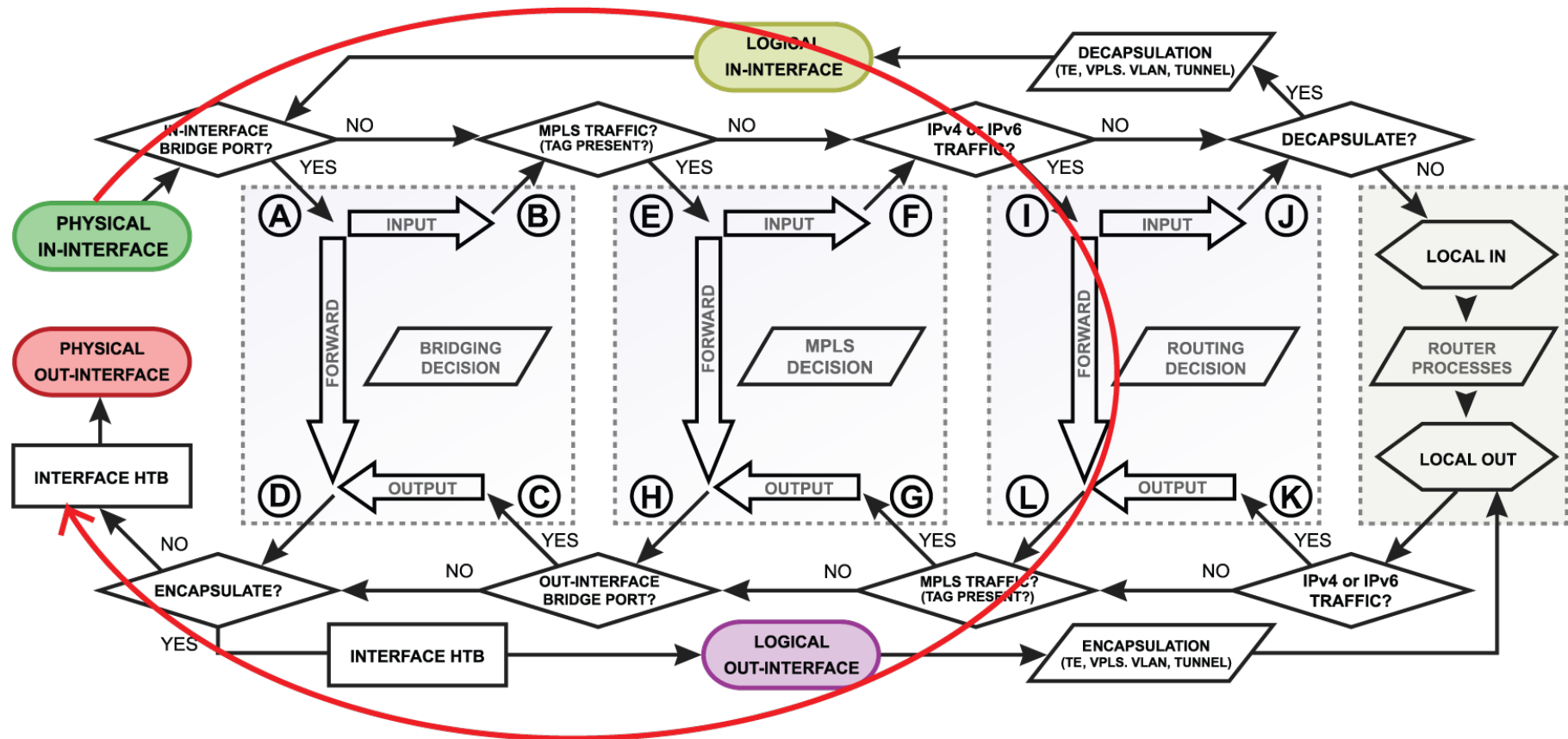


# MPLS Forwarding

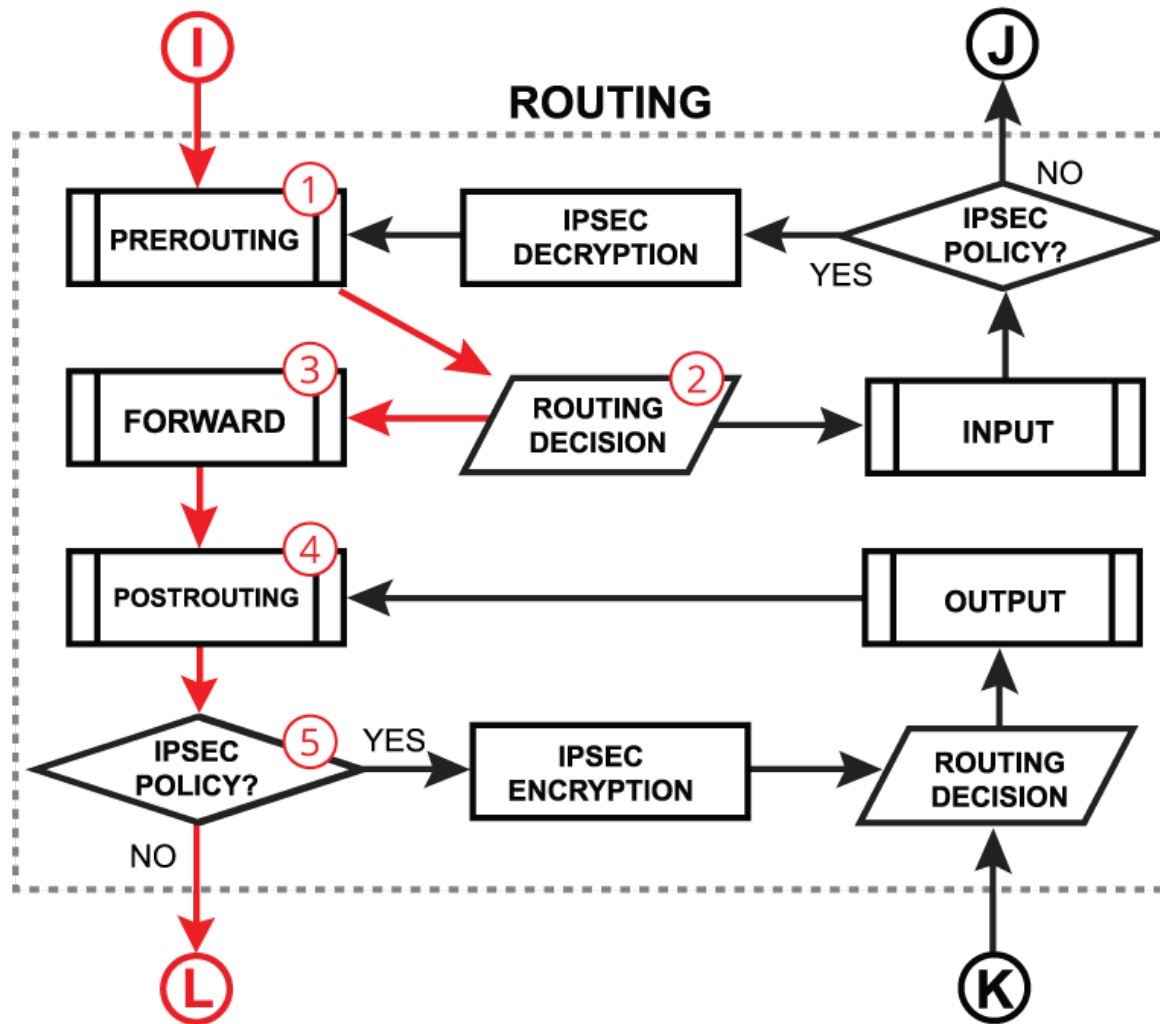




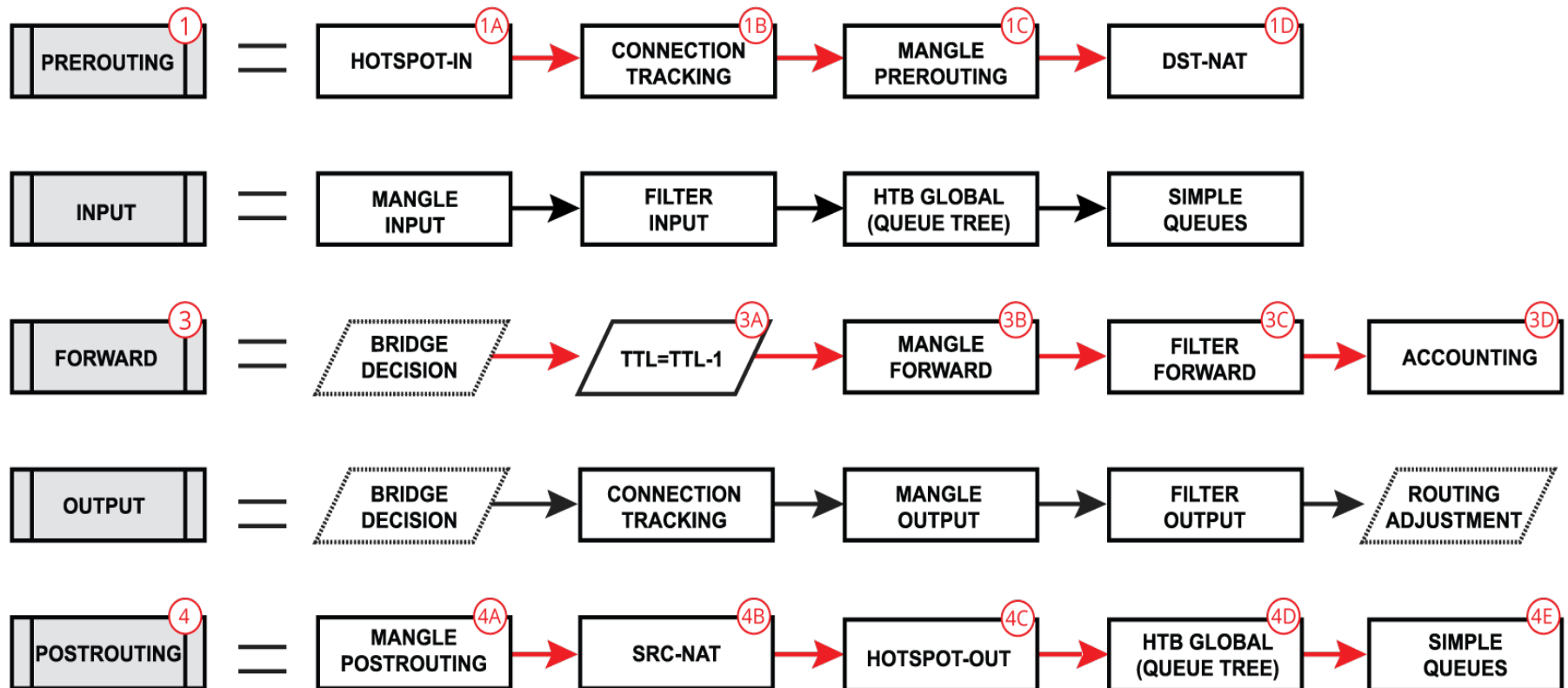
# Routing Forwarding



# Routing Forwarding



# Routing Forwarding



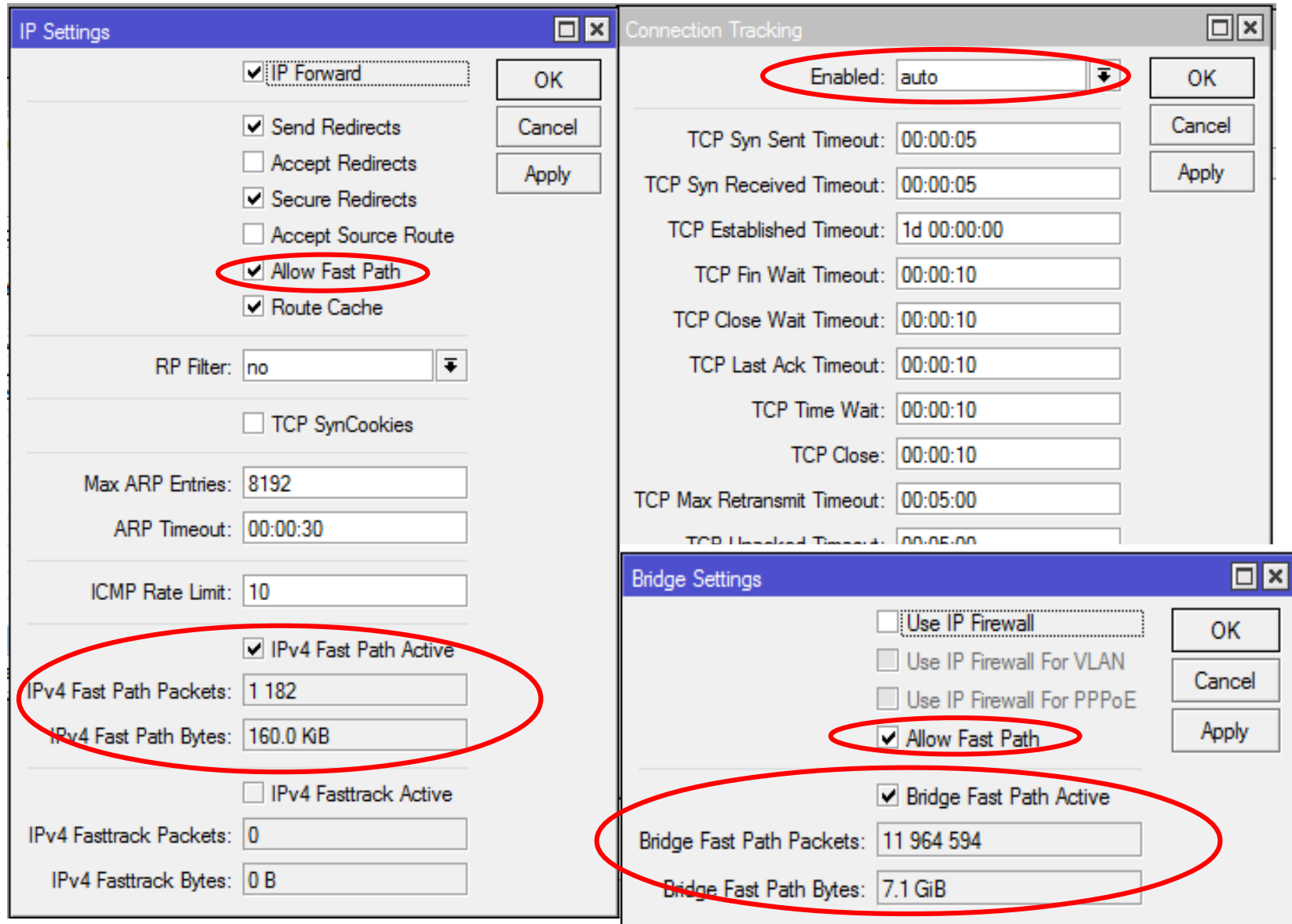
# Initial FastPath Implementation

- What if I have nothing else except default forwarding enabled? Do I need to go full process path?
- Solution: FastPath. It allows to forward packets without unnecessary processing
- FastPath requirements
  - Interface driver support
  - FastPath should be allowed in configuration
  - No configuration in specific facilities.

# Driver Support

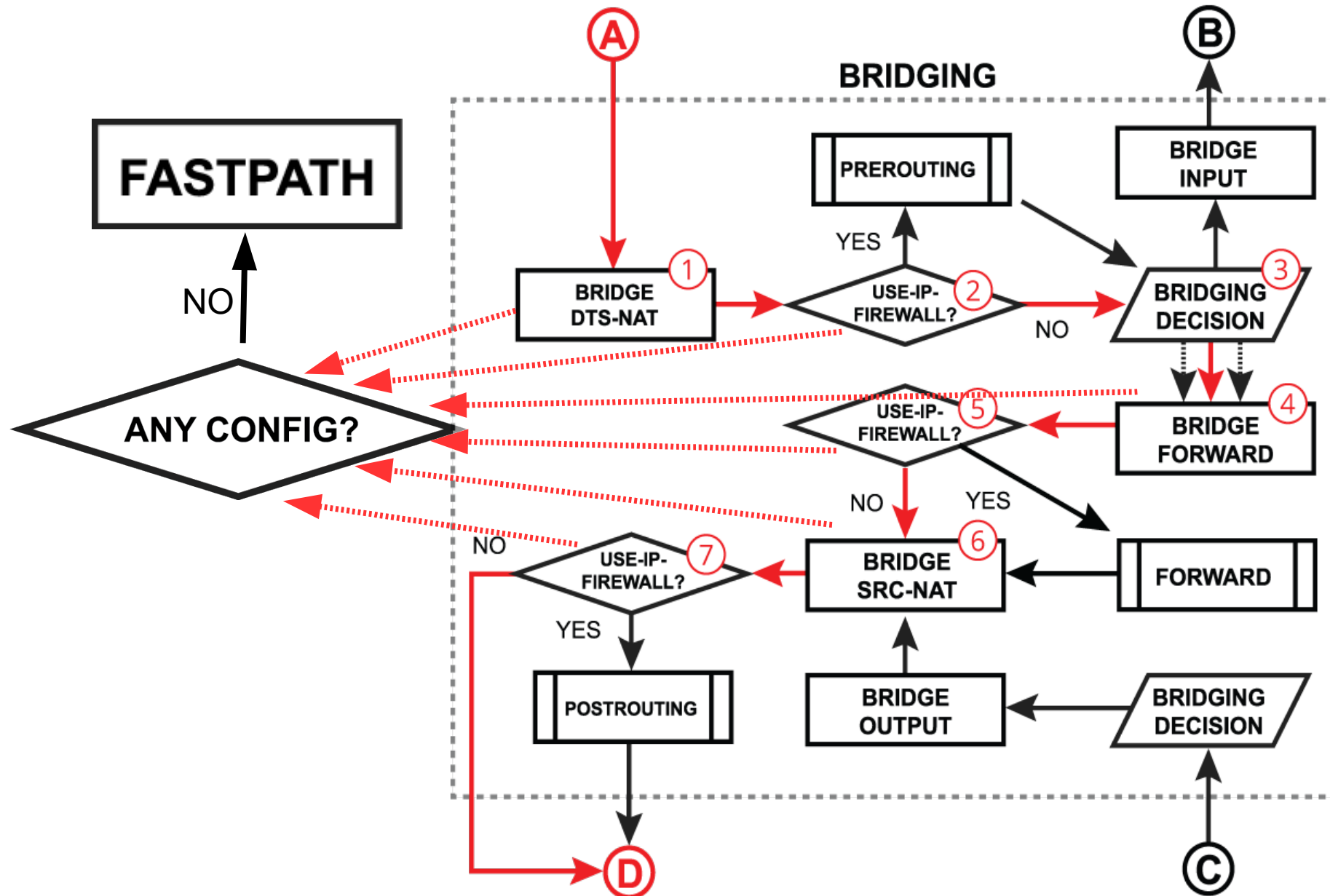
- CCR, CRS, RB7xx, RB9xx, hEX, hAP, wAP, cAP, mAP, SXT, Metal, Groove, DynaDish, OmniTIK series - all ports
- RB1100 series - ether1-11
- RB6xx series and RB800 - ether1,2
- RB1000, RB3011, RB2011 - all ports
- All Wireless interfaces, if **wireless-fp** or **wireless-cm2** package used

# Allow FastPath

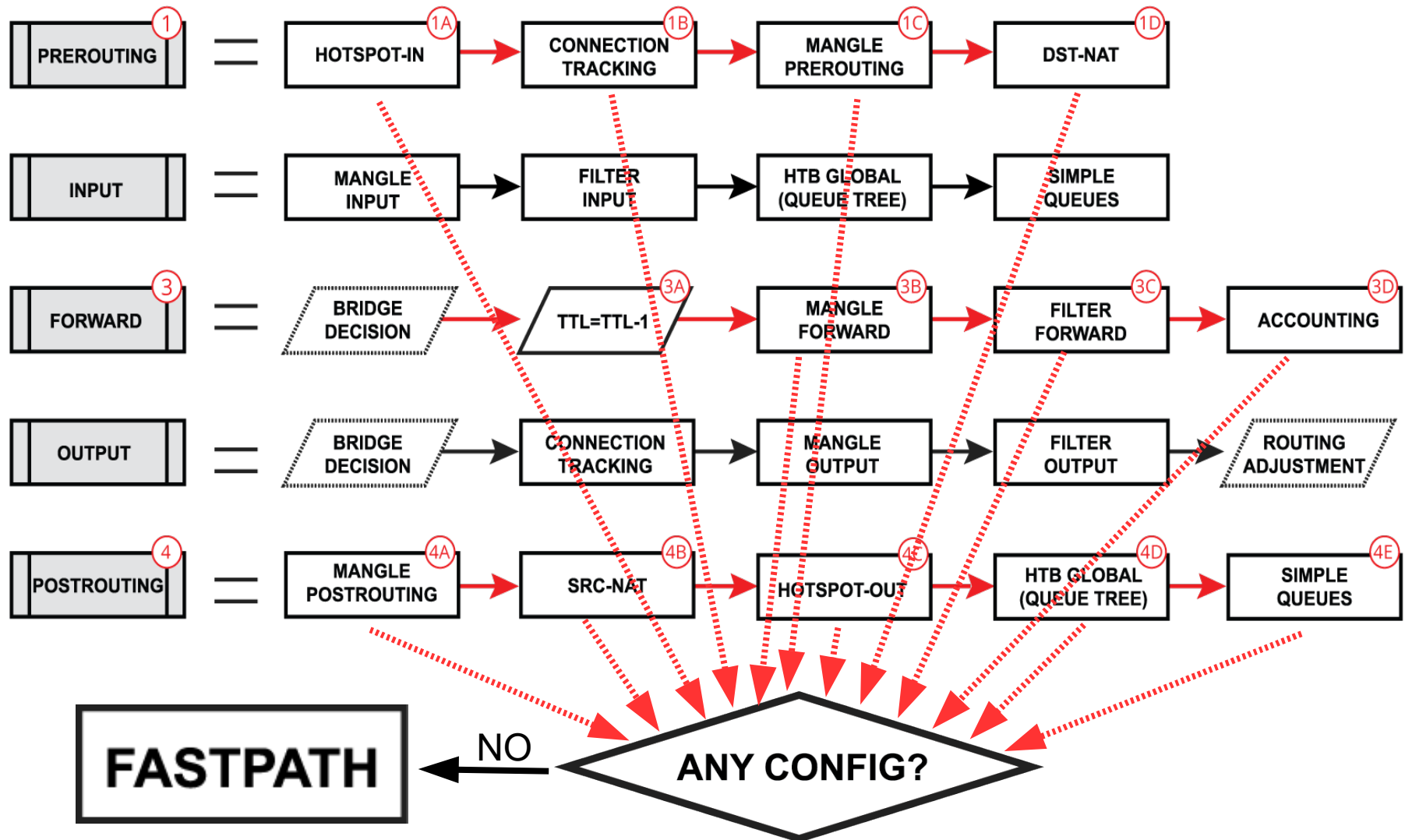




# Bridge Forwarding FastPath



# Routing Forwarding FastPath



# SlowPath vs FastPath

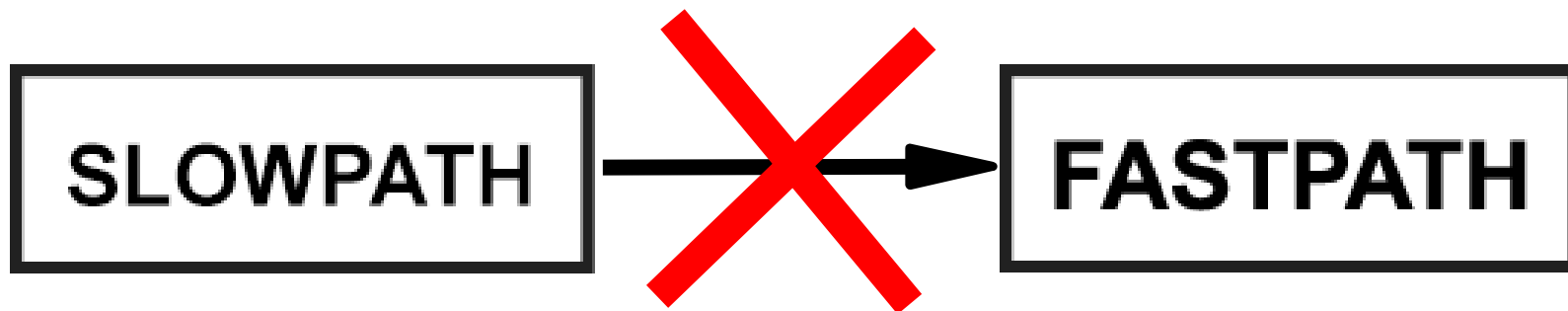
- What are the performance benefits of FastPath?

RB750Gr2 720Mhz		All port test		RouterOS v6.31rc2			
Mode	Configuration	64 byte		512 byte		1518 byte	
		kpps	Mbps	kpps	Mbps	kpps	Mbps
Bridging	none (fast path)	773.7	396.1	<u>234.9</u>	962.2	<u>81.2</u>	986.1
Bridging	25 bridge filter rules	114.6	58.7	112.3	460.0	<u>81.2</u>	986.1
Routing	none (fast path)	729.2	373.4	<u>234.9</u>	962.2	<u>81.2</u>	986.1
Routing	25 simple queues	184.8	94.6	178.4	730.7	<u>81.2</u>	986.1
Routing	25 ip filter rules	78.9	40.4	81.2	332.6	<u>81.2</u>	986.1

CCR1072 (1200Mhz, DDR1600)		RouterOS v6.31rc2					
Mode	Configuration	64 byte		512 byte		1518 byte	
		kpps	Mbps	kpps	Mbps	kpps	Mbps
Bridging	none (fast path)	<u>119,047.6</u>	60,952.4	<u>18,790.0</u>	76,963.8	<u>6,502.0</u>	78,960.3
Bridging	25 bridge filter rules	10,432.3	5,341.3	9,099.2	37,270.3	<u>6,502.0</u>	78,960.3
Routing	none (fast path)	94,668.4	48,470.2	<u>18,790.0</u>	76,963.8	<u>6,502.0</u>	78,960.3
Routing	25 simple queues	13,683.5	7,006.0	13,500.0	55,296.0	<u>6,502.0</u>	78,960.3
Routing	25 ip filter rules	6,104.0	3,125.2	6,125.5	25,090.0	5,247.6	63,726.9

# Half-FastPath

- What if an interface doesn't have FastPath support?

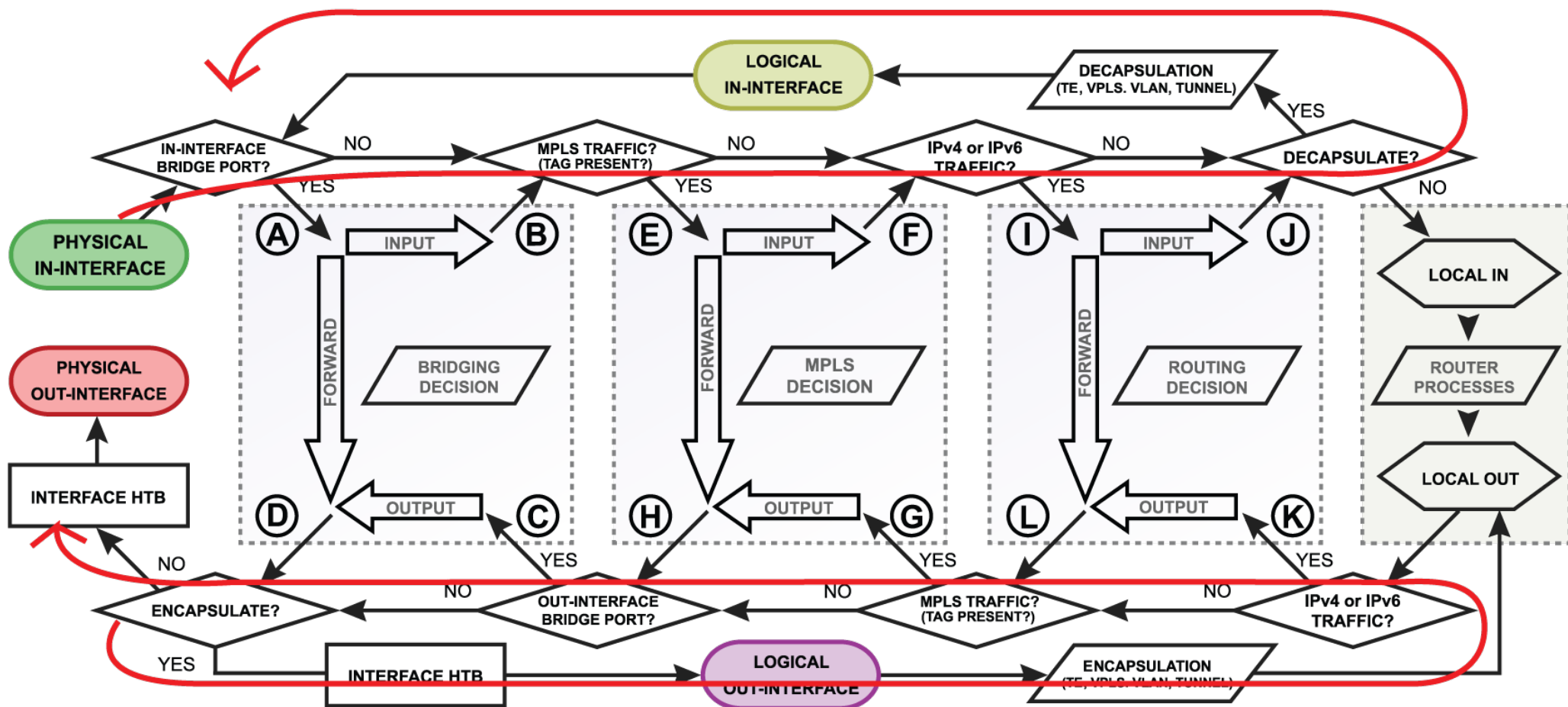


# FastPath for Logical Interfaces

FastPath is supported for these logical interfaces

- Bridge interfaces (since v6.29)
- VLAN interfaces (since v6.30)
- VRRP interfaces (since v6.30)
- Bonding interfaces - RX only (since v6.30)
- EOIP, GRE, IPIP interfaces – without IPSec encryption and without fragmentation (since v6.33)
- PPPoE client interface – without encryption and fragmentation (TBA)

# Logical Interfaces in RouterOS





# EOIP, GRE, IPIP and FastPath

- Per interface "allow-fast-path" setting
- Packet fragments and encrypted traffic **can't** be received in FastPath
- Traffic traveling in FastPath will be invisible to other router facilities (firewall, queues, etc)
- It is important to prepare your configuration (firewall, queues) for SlowPath part of tunnel traffic.

# FastPath for Features

- Traffic Generator (since v6.0) - the only way to simulate FastPath speeds.
- MAC-Winbox (since v6.33) – doesn't disable FastPath anymore
- MAC-Telnet (since v6.33) – doesn't disable FastPath anymore
- Traffic Flow (since v6.33) – can see FastPath traffic also
- Connection Tracking (since v6.29) – only for IPv4/TCP and IPv4/UDP connections.

# FastPath + Conntrack = FastTrack

Firewall									
Filter Rules NAT Mangle Service Ports Connections Address Lists Layer7 Protocols									
Tracking Find									
	Protocol	Timeout	TCP State	Orig./Repl. Rate	Orig./Repl. Bytes	Orig./Repl. Packets	Orig./Repl. Fasttrack Bytes	Orig./Repl. Fasttrack Packets	
SACFs	6 (tcp)	1d 00:04:02	established	54.4 kbps/1546.4 kbps	141.0 MiB/3662.3 MiB	2 737 217/2 717 ...	141.0 MiB/3662.1 MiB	2 737 213/2 716 883	
SACFd	17 (udp)	00:05:01		1984 bps/34.6 kbps	3107.7 KiB/6.5 MiB	9 070/10 870	3107.1 KiB/6.5 MiB	9 068/10 869	
SACFd	17 (udp)	00:04:33		0 bps/0 bps	2653.7 KiB/3491.0 KiB	6 630/5 828	2653.3 KiB/3490.9 KiB	6 628/5 826	
SACFs	17 (udp)	00:04:51		0 bps/0 bps	445.5 KiB/50.6 KiB	4 842/477	445.0 KiB/50.2 KiB	4 836/474	
SACFd	17 (udp)	00:04:55		0 bps/0 bps	858.6 KiB/3085.5 KiB	4 711/4 608	858.3 KiB/3085.4 KiB	4 709/4 607	
SACFs	17 (udp)	00:05:03		39.7 kbps/3.6 kbps	2856.8 KiB/507.5 KiB	4 566/3 922	2856.3 KiB/507.4 KiB	4 564/3 921	
SACFd	17 (udp)	00:01:52		0 bps/0 bps	1997.0 KiB/2866.6 KiB	4 536/4 754	1996.3 KiB/2866.6 KiB	4 534/4 753	
SACFs	6 (tcp)	1d 00:03:32	established	0 bps/0 bps	922.7 KiB/367.4 KiB	4 406/4 659	920.3 KiB/366.9 KiB	4 399/4 649	
SACFd	17 (udp)	00:01:43		0 bps/0 bps	262.7 KiB/1607.1 KiB	4 260/2 618	262.3 KiB/1607.1 KiB	4 258/2 617	
SACFs	17 (udp)	00:05:02		0 bps/0 bps	518.4 KiB/188.6 KiB	4 254/1 632	517.8 KiB/187.8 KiB	4 248/1 622	
SACFd	17 (udp)	00:05:03		3.1 kbps/39.5 kbps	1066.7 KiB/3245.1 KiB	3 977/5 265	1066.3 KiB/3245.0 KiB	3 975/5 264	
SACFd	6 (tcp)	00:00:00	time wait	0 bps/0 bps	232.7 KiB/2113.2 KiB	3 546/3 540	232.5 KiB/2113.1 KiB	3 541/3 537	
SACFd	17 (udp)	00:02:15		0 bps/0 bps	212.9 KiB/1922.1 KiB	3 154/3 048	212.7 KiB/1921.8 KiB	3 152/3 047	
SACFd	6 (tcp)	1d 23:59:02	established	6.6 kbps/38.0 kbps	217.6 KiB/1869.3 KiB	3 103/4 144	217.5 KiB/1869.3 KiB	3 101/4 143	
SACFs	6 (tcp)	1d 23:59:03	established	37.0 kbps/3.4 kbps	1093.6 KiB/75.3 KiB	2 614/1 111	1093.5 KiB/75.2 KiB	2 611/1 110	
SACFd	S - seen reply, A - assured, C - confirmed, F - fasttrack, d - dstnat				155.3 KiB/1588.4 KiB	2 504/1 973	154.9 KiB/1588.4 KiB	2 502/1 972	
SACFd	17 (udp)	00:04:48		0 bps/0 bps	162.5 KiB/1670.8 KiB	2 483/2 732	162.0 KiB/1670.7 KiB	2 480/2 730	
SACFd	17 (udp)	00:05:00		2.3 kbps/45.6 kbps	153.6 KiB/1617.9 KiB	2 436/2 701	153.3 KiB/1617.8 KiB	2 434/2 700	
SACFd	17 (udp)	00:05:02		992 bps/32.9 kbps	222.0 KiB/1548.0 KiB	2 133/2 608	221.7 KiB/1547.9 KiB	2 131/2 607	
SACFd	17 (udp)	00:03:13		0 bps/0 bps	136.6 KiB/1350.7 KiB	2 063/2 243	136.3 KiB/1350.7 KiB	2 061/2 242	
SACFd	17 (udp)	00:00:31		0 bps/0 bps	134.3 KiB/1451.4 KiB	2 029/2 316	134.0 KiB/1451.3 KiB	2 027/2 315	
SACFd	17 (udp)	00:05:01		3.2 kbps/39.5 kbps	121.1 KiB/1547.2 KiB	1 878/2 379	120.6 KiB/1547.2 KiB	1 876/2 378	
SACFd	17 (udp)	00:05:01		1984 bps/34.3 kbps	119.3 KiB/1259.9 KiB	1 832/2 100	118.7 KiB/1259.8 KiB	1 829/2 098	
SACFs	6 (tcp)	1d 23:59:02	established	34.0 kbps/4.2 kbps	1156.8 KiB/108.4 KiB	1 824/1 777	1156.8 KiB/108.4 KiB	1 822/1 776	
SACFd	6 (tcp)	00:00:00	time wait	0 bps/0 bps	113.1 KiB/1859.6 KiB	1 814/2 089	112.9 KiB/1859.5 KiB	1 810/2 086	
991 items out of 978 (1 selected)				Max Entries: 218032					

# FastPath + Conntrack = FastTrack

- Implemented as “fasttrack-connection” action for firewall filter/mangle, flags connection tracking entries as “Fasttracked”
- Works only with IPv4/TCP and IPv4/UDP
- Traffic traveling in FastTrack will be invisible to other router facilities (firewall, queues, etc)
- Some packets still will go the regular path to maintain connection tracking table timeouts
- Packet fragments **can't** be received in FastPath

# Fasttrack-Connection

IF Settings

☒ IP Forward OK

Firewall

Filter Rules NAT Mangle Service Ports Connections Address Lists Layer7 Protocols

+ - ✓ ✗ 📁 🔍 🔄 🔄 Find forward

#	Action	Chain	Src...	Dst...	Prot...	Src. Port	Dst. Port	In. I...	Out...	Bytes	Packets
... Drop new connections from internet that is not dst-natted											
52	✗ drop	forward						eth...		0 B	0
... fasttrack connections that have related and established packets											
53	🔗 fasttrack connection	forward								240.2 MiB	319 850
... accept related and established packets											
54	✓ accept	forward								240.2 MiB	319 850
... drop invalid packets											
55	✗ drop	forward								40.9 KiB	765
... drop data to bogon IP's											
56	✗ drop	forward						brid...		43.0 KiB	2 398
... Drop all other local subnets											
57	✗ drop	forward	!19...					brid...		0 B	0
... drop data from bogon IP's											
58	✗ drop	forward						eth...		0 B	0
... jump to viruses chain											

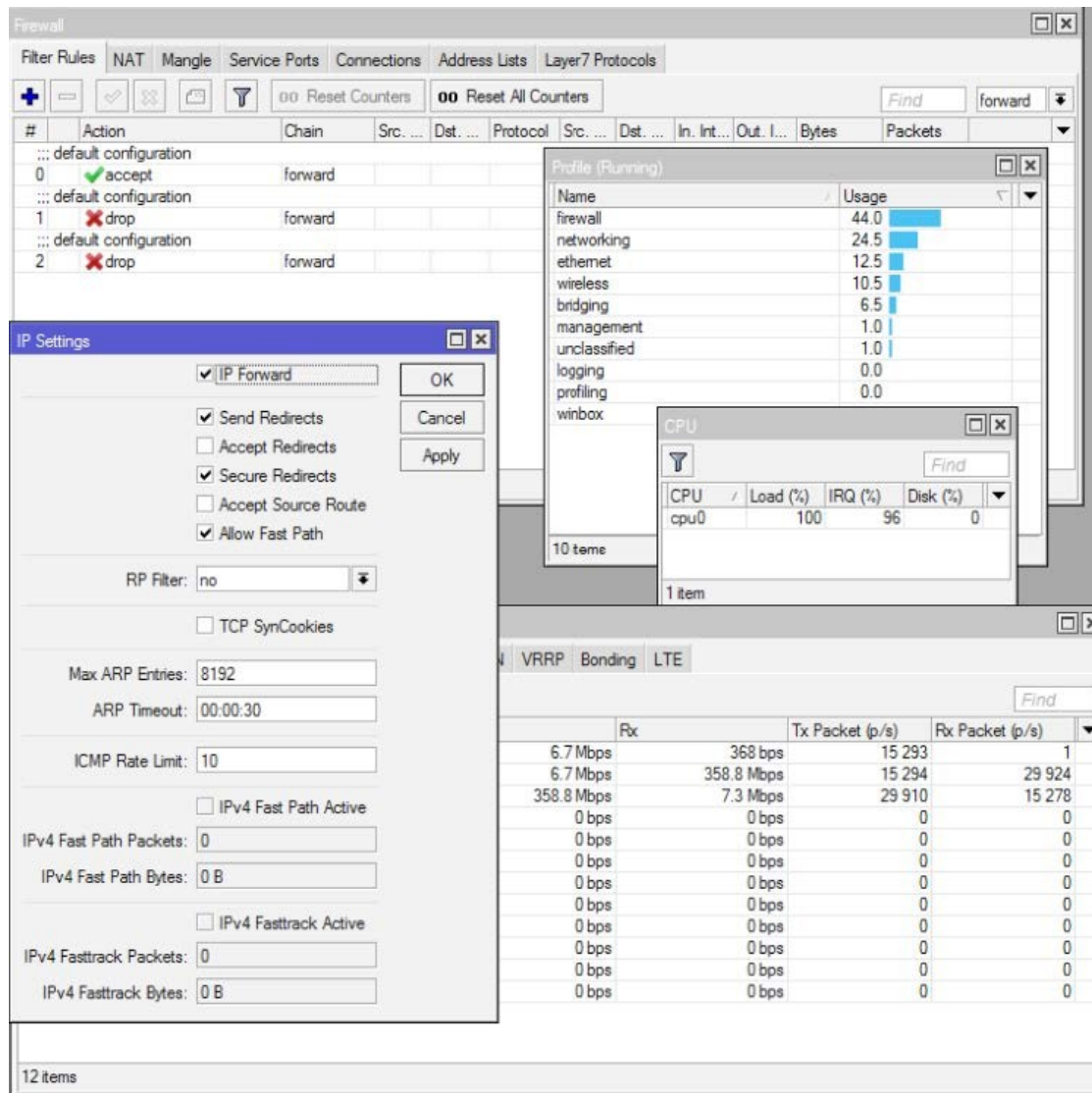
9 items out of 335 (1 selected)

☒ IPv4 Fasttrack Active

IPv4 Fasttrack Packets: 19 773 551

IPv4 Fasttrack Bytes: 15.1 GiB

# Without Fasttrack



- Board:  
RB2011UiAS-2HnD
- Configuration:  
default Home AP
- Throughput:  
358Mbps
- CPU load:  
100%
- Firewall CPU load:  
44%



# With Fasttrack

The screenshot displays the Mikrotik WinBox Firewall configuration interface. The 'Filter Rules' tab is active, showing a list of rules. Rule 0 is 'fasttrack connection' with action 'forward'. Rule 1 is 'accept' with action 'forward'. Rule 2 is 'drop' with action 'forward'. Rule 3 is 'drop' with action 'forward'. The 'IP Settings' dialog is open, showing 'IP Forward' checked, 'Send Redirects' checked, 'Accept Redirects' checked, 'Secure Redirects' checked, 'Accept Source Route' unchecked, and 'Allow Fast Path' checked. The 'RP Filter' is set to 'no'. The 'TCP SynCookies' checkbox is unchecked. The 'Max ARP Entries' is 8192, and the 'ARP Timeout' is 00:00:30. The 'ICMP Rate Limit' is 10. The 'IPv4 Fast Path Active' checkbox is unchecked. The 'IPv4 Fast Path Packets' is 0, and the 'IPv4 Fast Path Bytes' is 0 B. The 'IPv4 Fasttrack Active' checkbox is checked. The 'IPv4 Fasttrack Packets' is 91 731 558, and the 'IPv4 Fasttrack Bytes' is 84.5 GiB. The 'Profile (Running)' window shows the following usage: ethernet 36.0, idle 16.5, bridging 13.0, networking 12.5, wireless 8.0, unclassified 6.5, firewall 6.0, management 1.0, profiling 0.5, and winbox 0.5. The 'CPU' window shows the following statistics: CPU / Load (%) 86, IRQ (%) 82, and Disk (%) 0. The 'VRRP', 'Bonding', and 'LTE' tabs are also visible.

Name	Usage
ethernet	36.0
idle	16.5
bridging	13.0
networking	12.5
wireless	8.0
unclassified	6.5
firewall	6.0
management	1.0
profiling	0.5
winbox	0.5

CPU	Load (%)	IRQ (%)	Disk (%)
cpu0	86	82	0

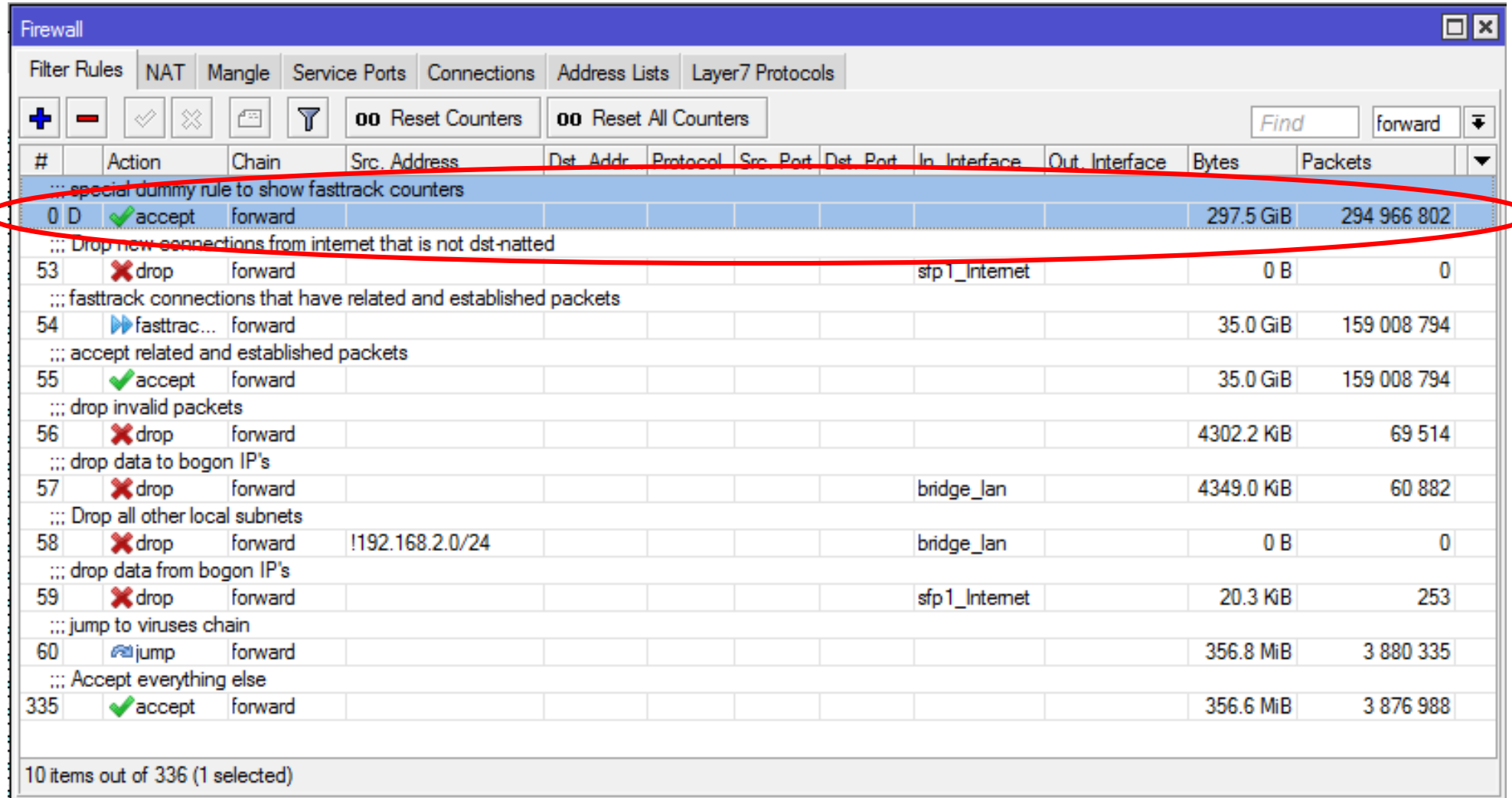
Rx	Tx Packet (p/s)	Rx Packet (p/s)
18.0 Mbps	368 bps	37 214
18.0 Mbps	890.6 Mbps	37 215
890.6 Mbps	17.9 Mbps	73 848
0 bps	0 bps	0
0 bps	0 bps	0
0 bps	0 bps	0
0 bps	0 bps	0
0 bps	0 bps	0
0 bps	0 bps	0
0 bps	0 bps	0
0 bps	0 bps	0
0 bps	0 bps	0
0 bps	0 bps	0
0 bps	0 bps	0
0 bps	0 bps	0
0 bps	0 bps	0

- Board: RB2011UiAS-2HnD
- Configuration: default Home AP
- Throughput: 890Mbps
- CPU load: 86%
- Firewall CPU load: 6%

# Fasttrack-connection

- “fasttrack-connection” action works similar to “mark-connection” action
- “fasttrack-connection” rule is usually followed by identical “accept” rule
- Most common Fasttrack implementations :
  - Fasttrack if connection reach connection-state=established and related
  - Fasttrack to exclude some specific connections from the queues
  - Fasttrack all local connections

# Special Dummy Rules



Firewall

Filter Rules NAT Mangle Service Ports Connections Address Lists Layer7 Protocols

+ - [check] [x] [filter] [00] Reset Counters [00] Reset All Counters Find forward

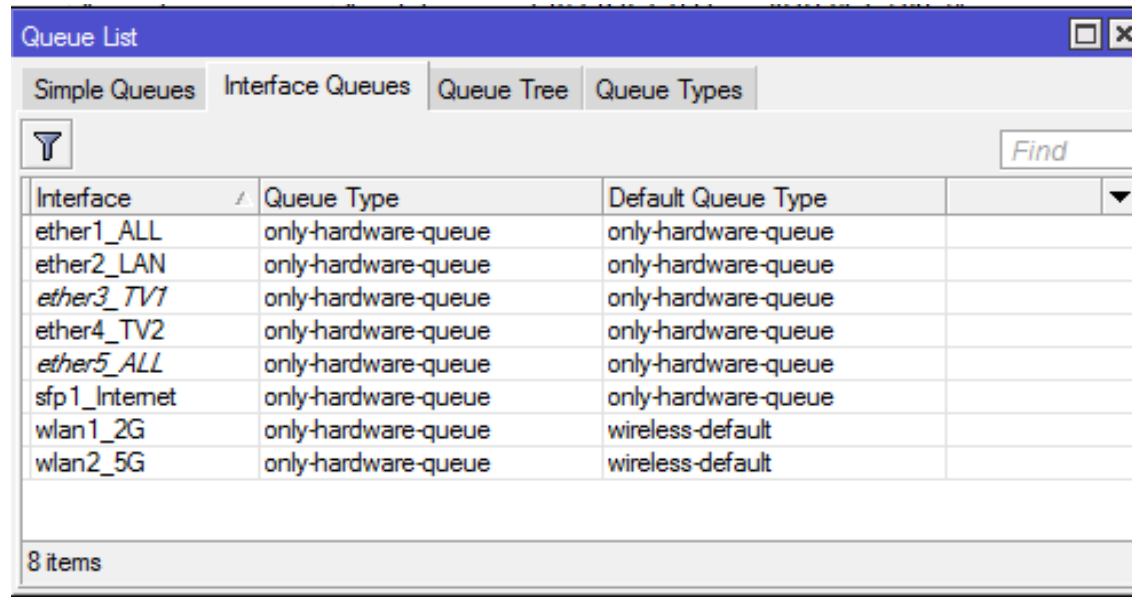
#	Action	Chain	Src. Address	Dst. Addr	Protocol	Src. Port	Dst. Port	In. Interface	Out. Interface	Bytes	Packets
::: special dummy rule to show fasttrack counters											
0	D [check] accept	forward								297.5 GiB	294 966 802
::: Drop new connections from internet that is not dst-natted											
53	[x] drop	forward						stp1_Intemet		0 B	0
::: fasttrack connections that have related and established packets											
54	[fasttrack] fasttrac...	forward								35.0 GiB	159 008 794
::: accept related and established packets											
55	[check] accept	forward								35.0 GiB	159 008 794
::: drop invalid packets											
56	[x] drop	forward								4302.2 KiB	69 514
::: drop data to bogon IP's											
57	[x] drop	forward						bridge_lan		4349.0 KiB	60 882
::: Drop all other local subnets											
58	[x] drop	forward	!192.168.2.0/24					bridge_lan		0 B	0
::: drop data from bogon IP's											
59	[x] drop	forward						sfp1_Intemet		20.3 KiB	253
::: jump to viruses chain											
60	[jump] jump	forward								356.8 MiB	3 880 335
::: Accept everything else											
335	[check] accept	forward								356.6 MiB	3 876 988

10 items out of 336 (1 selected)

# Special Dummy Rule

- This is not an actual rule, it is for visual information only
- Dummy rule shows user that some traffic is FastTracked
- Rule will show up as soon as there are at least one Fasttracked connection tracking entry.
- Rule will disappear only after last Fasttracked connection tracking table are fully timed out
- Dummy simple queue possible in future.

# Interface Queue and FastPath

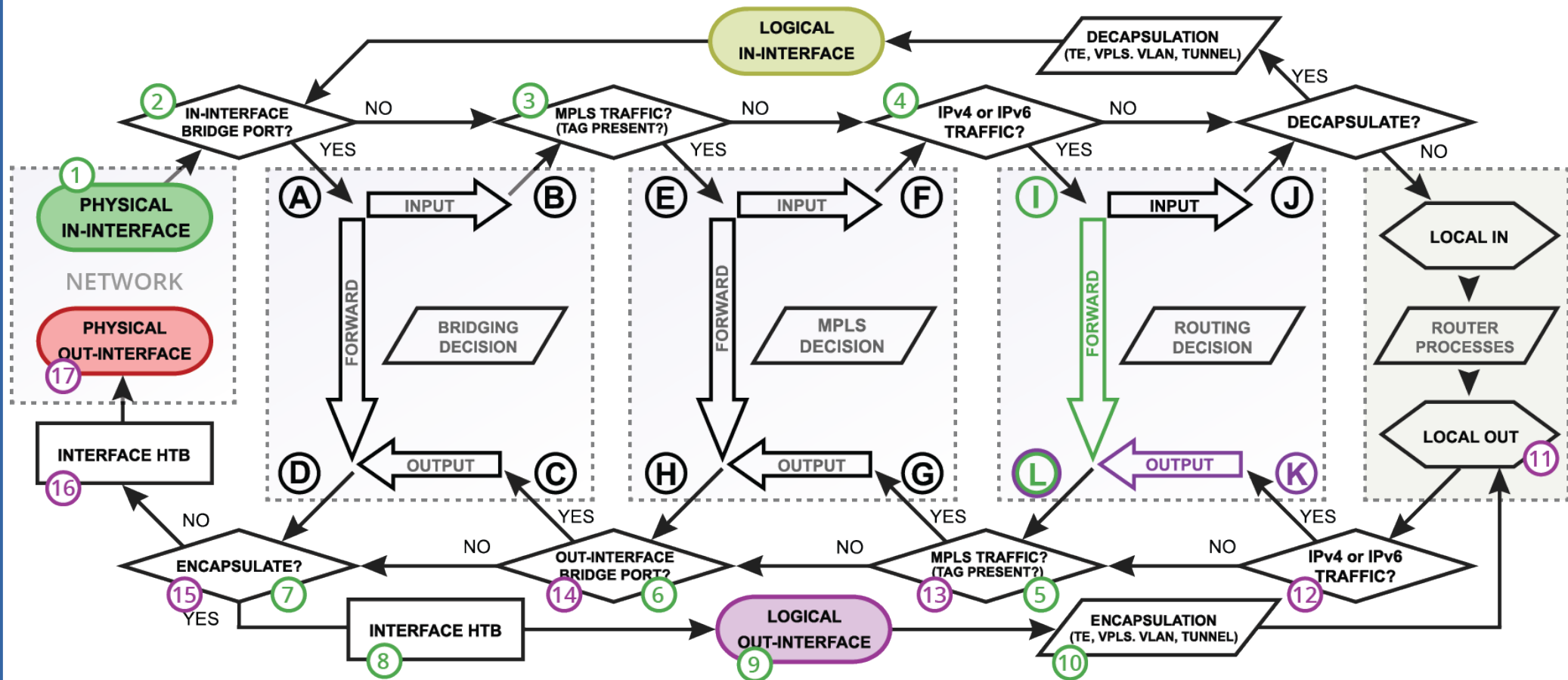
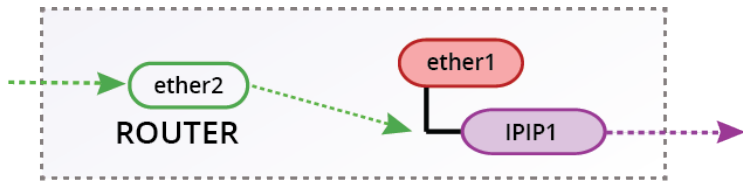


Interface	Queue Type	Default Queue Type
ether1_ALL	only-hardware-queue	only-hardware-queue
ether2_LAN	only-hardware-queue	only-hardware-queue
ether3_TV1	only-hardware-queue	only-hardware-queue
ether4_TV2	only-hardware-queue	only-hardware-queue
ether5_ALL	only-hardware-queue	only-hardware-queue
sfp1_Internet	only-hardware-queue	only-hardware-queue
wlan1_2G	only-hardware-queue	wireless-default
wlan2_5G	only-hardware-queue	wireless-default

8 items

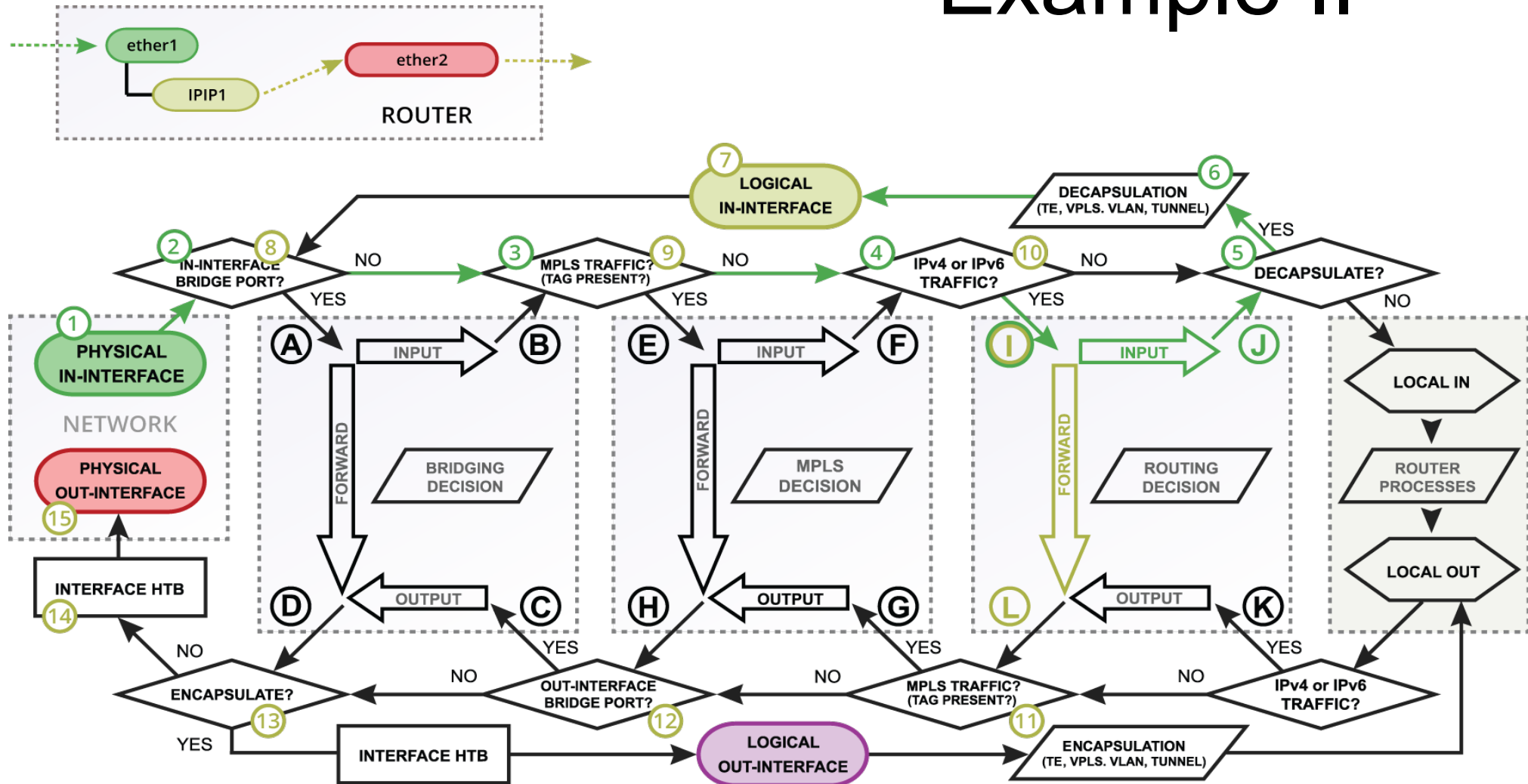
- Only interface queue that guarantees FastPath is “only-hardware-queue”
- Minimal impact on physical interfaces, as “Interface HTB” is the last step in the packet flow diagram

# Example I



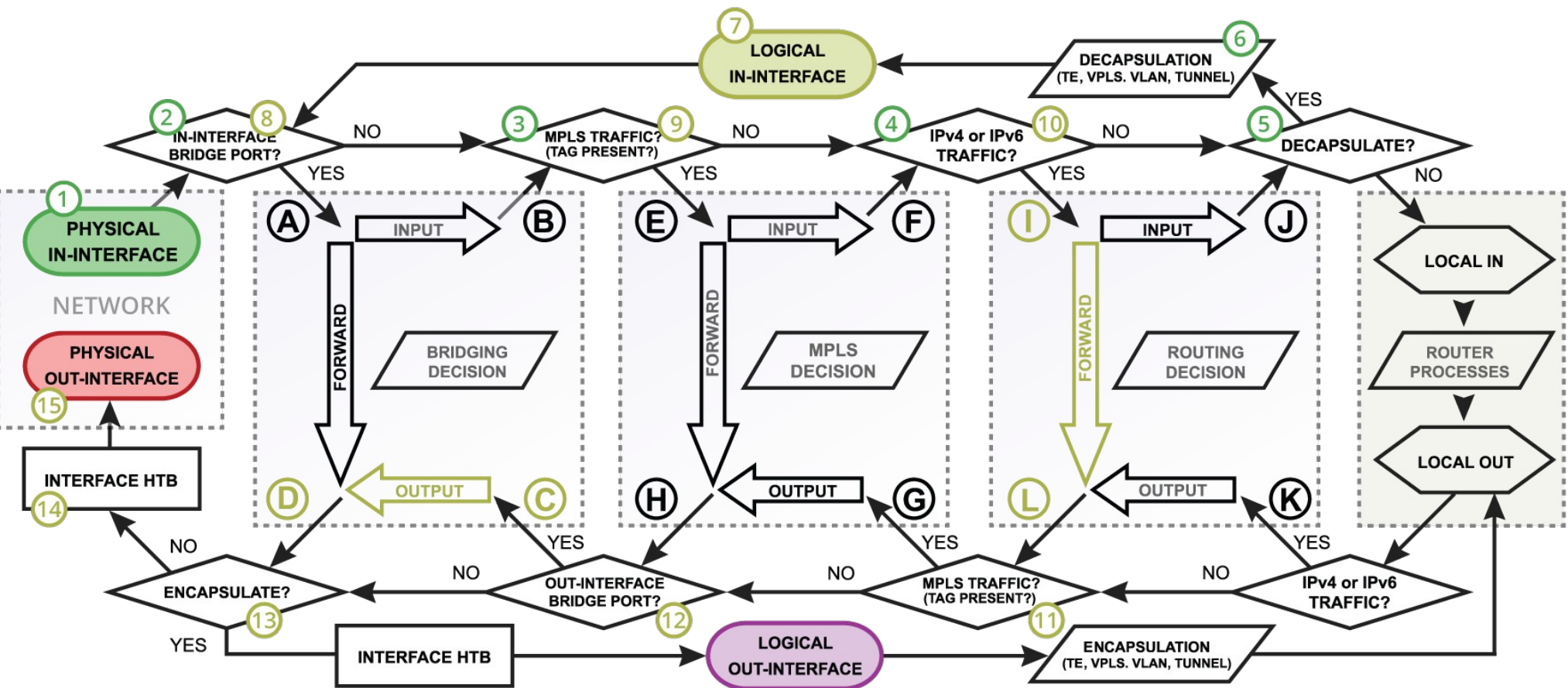
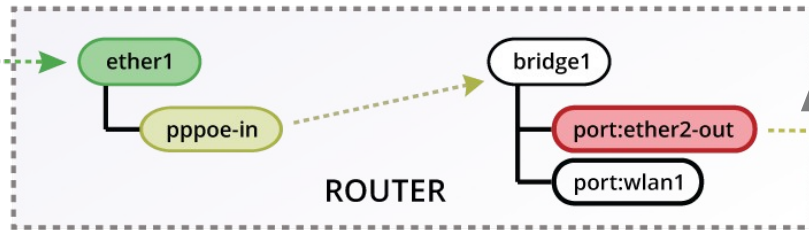


# Example II





# Advanced Example II



# Bottom Line

- FastPath is a feature that allows you to improve CPU performance in specific configurations
- You trade some RouterOS functionality for performance
- Packet fragments can't use FastPath, so plan your network's MTU/MSS carefully
- Fasttrack is a part of FastPath, it has the same requirements

# Questions!!!