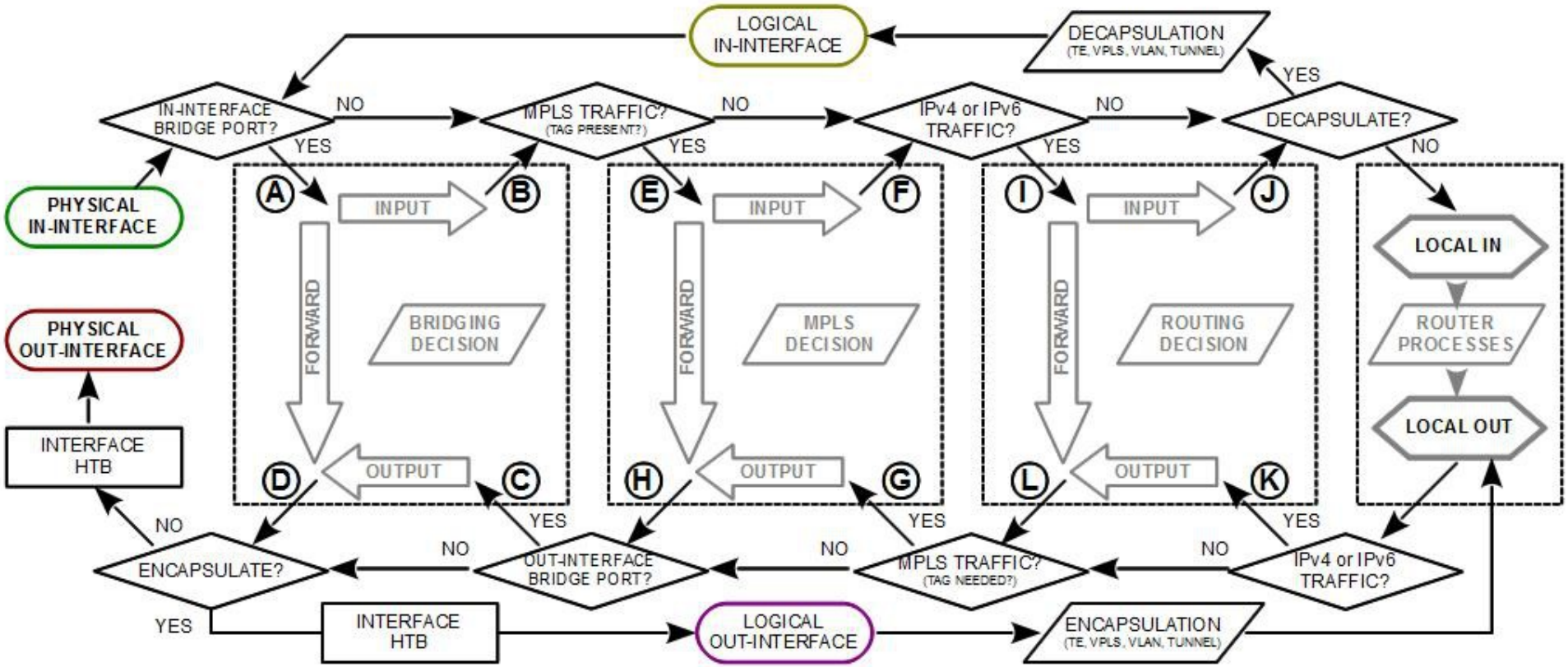
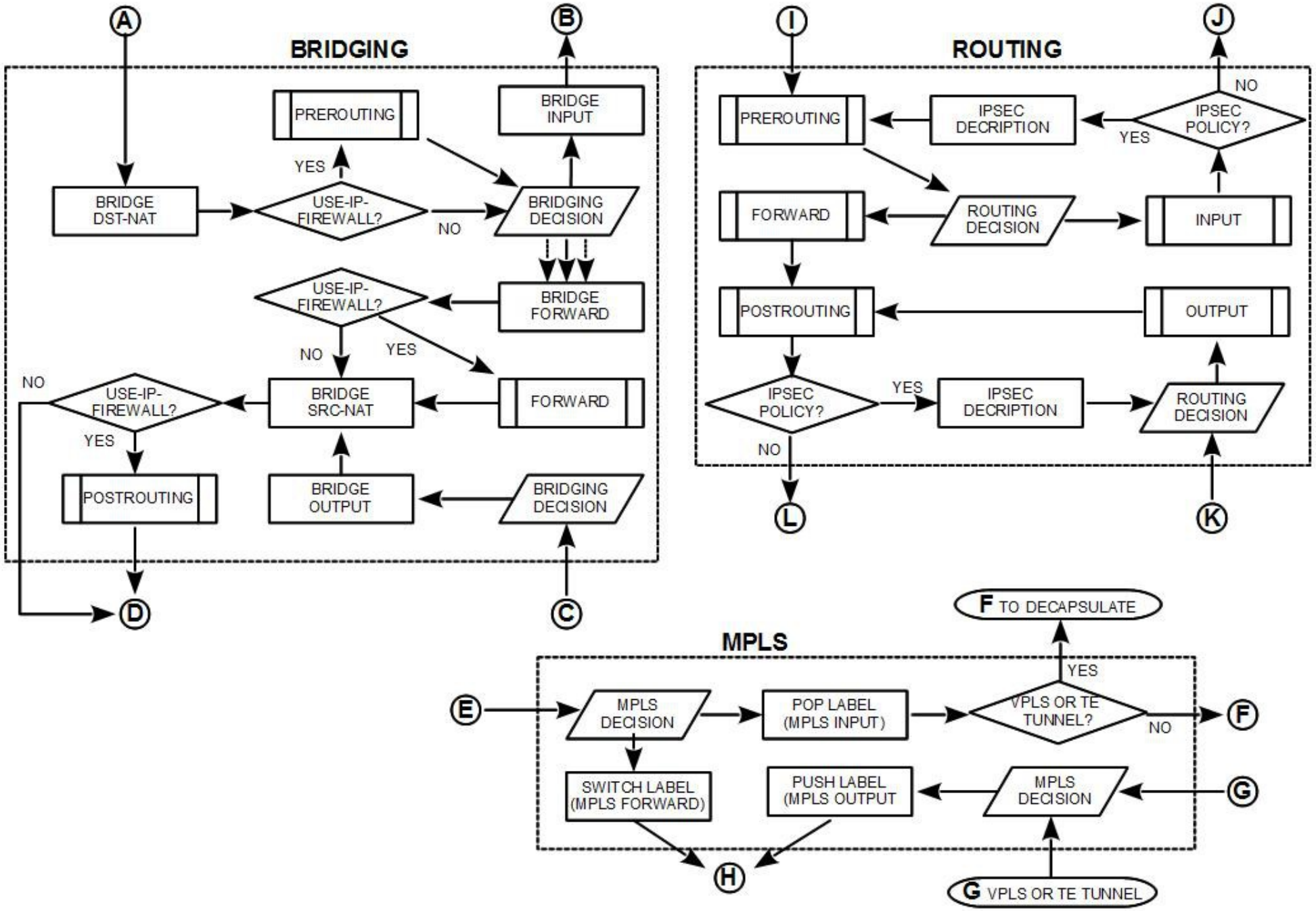
FastPath Overview

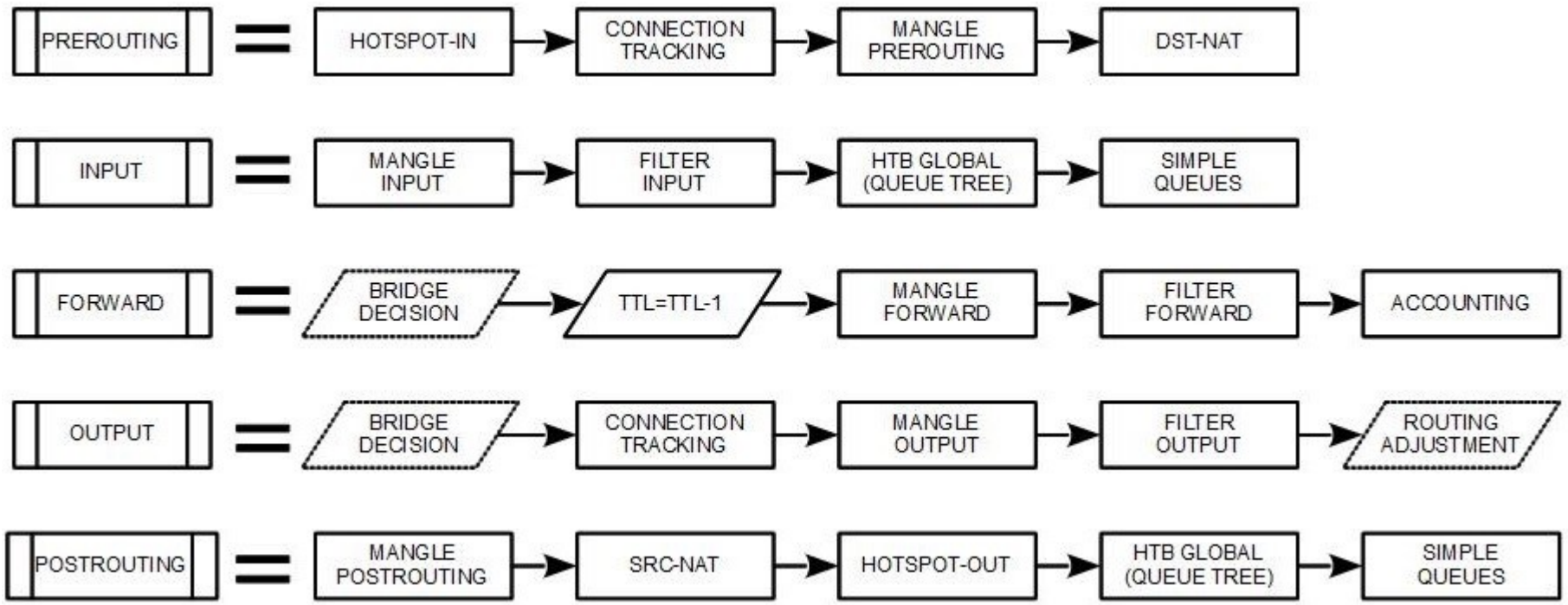
MUM USA, 2016

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
NO
PREROUTING
IPSEC DECRIPTION
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

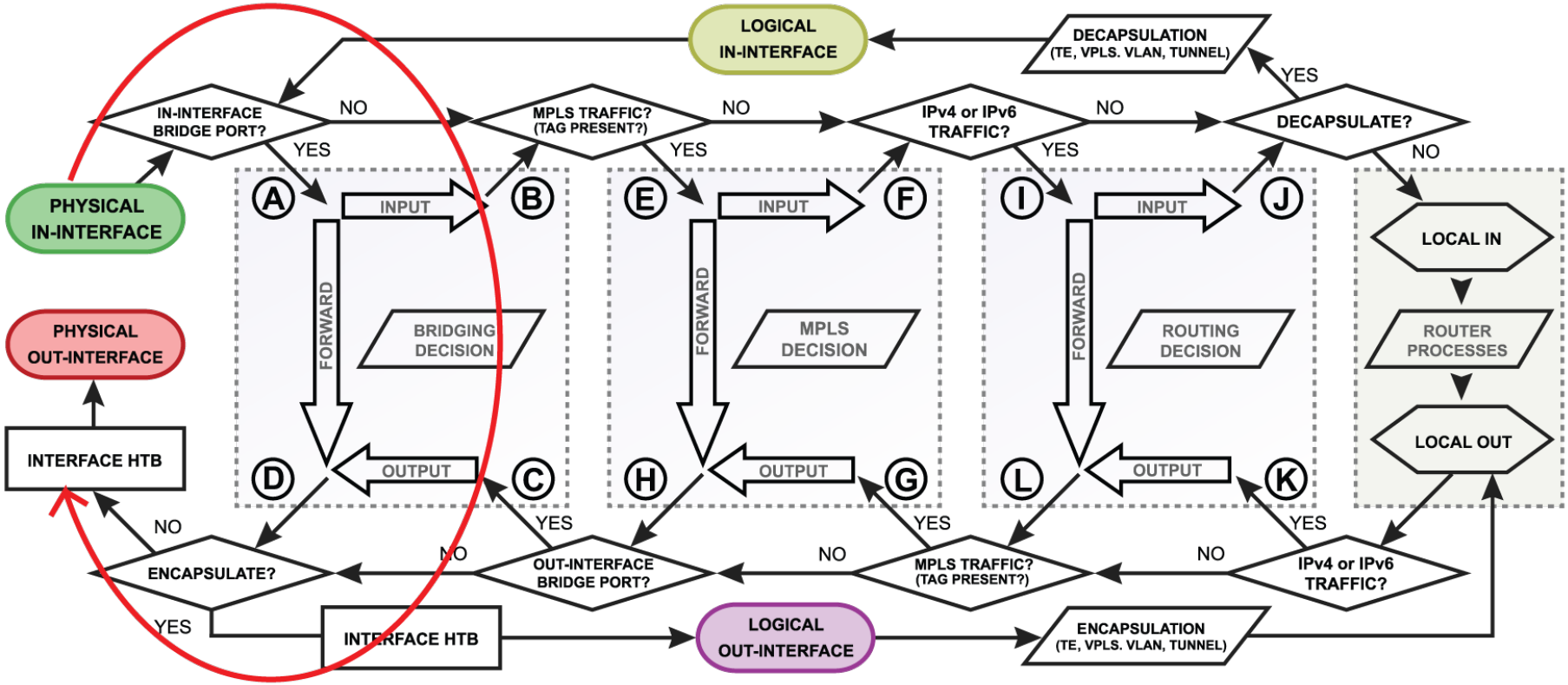
Yes, still - Packet Flow Diagram (page 3)



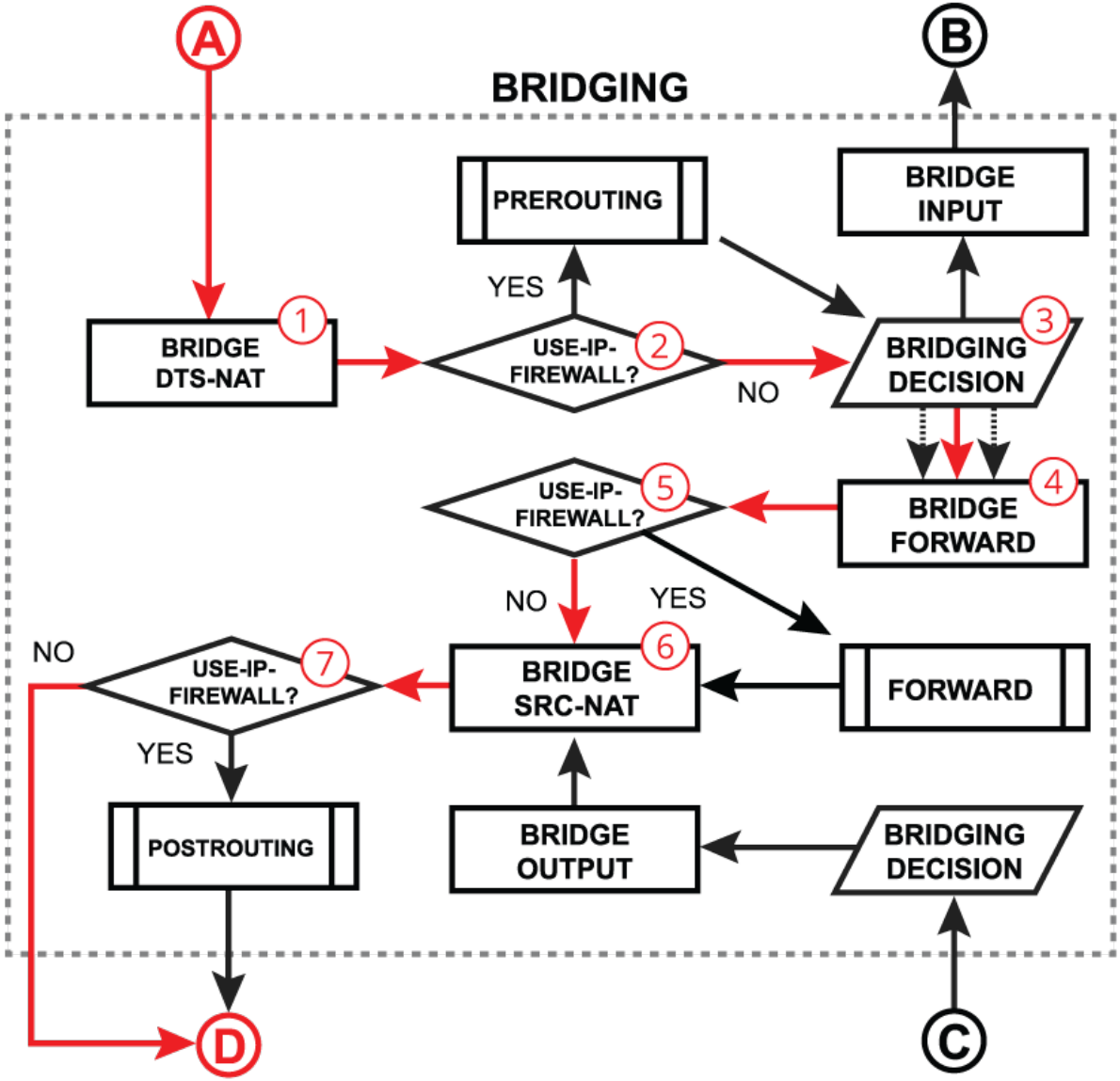
“SlowPath”

- “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

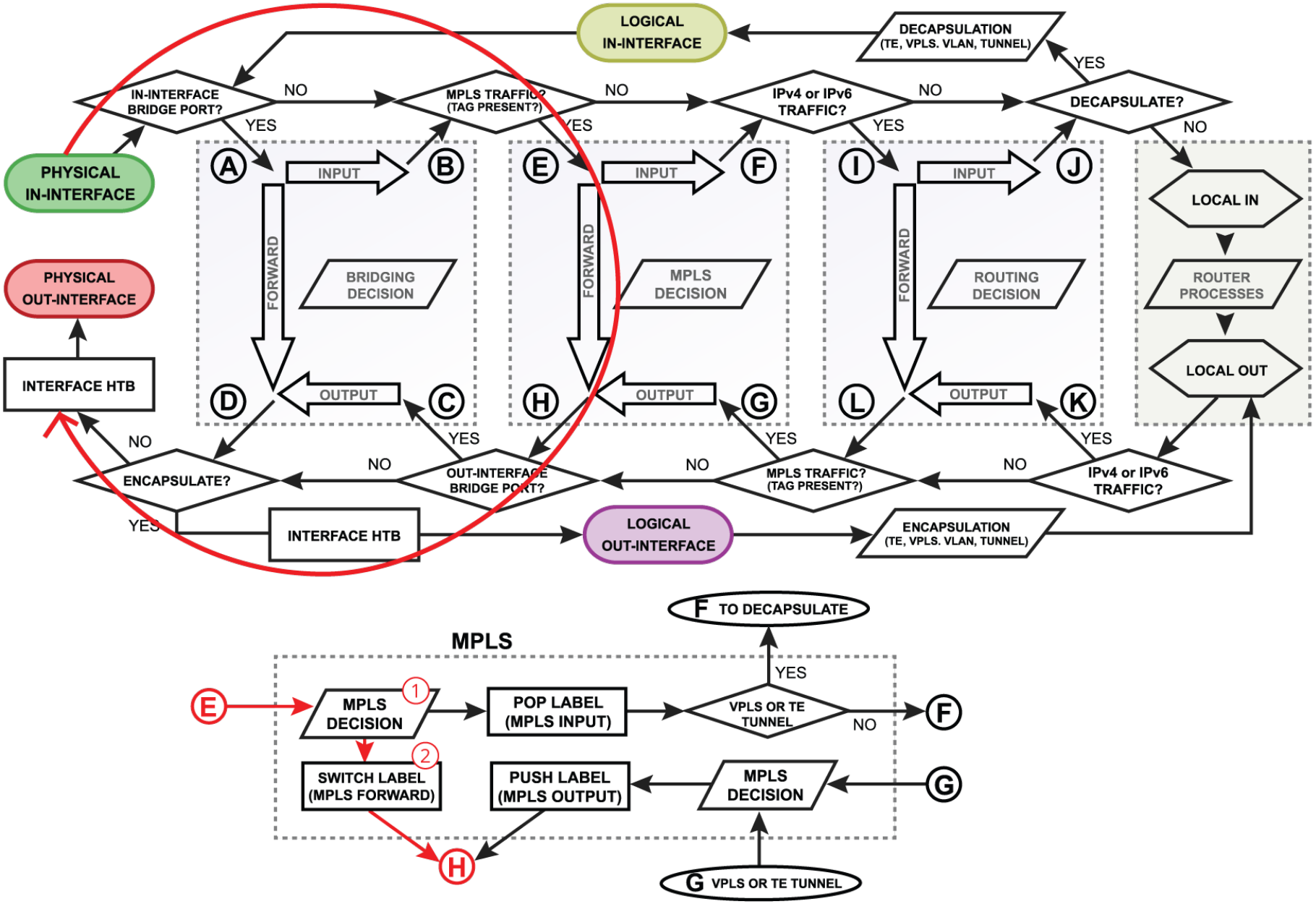
Bridge Forwarding



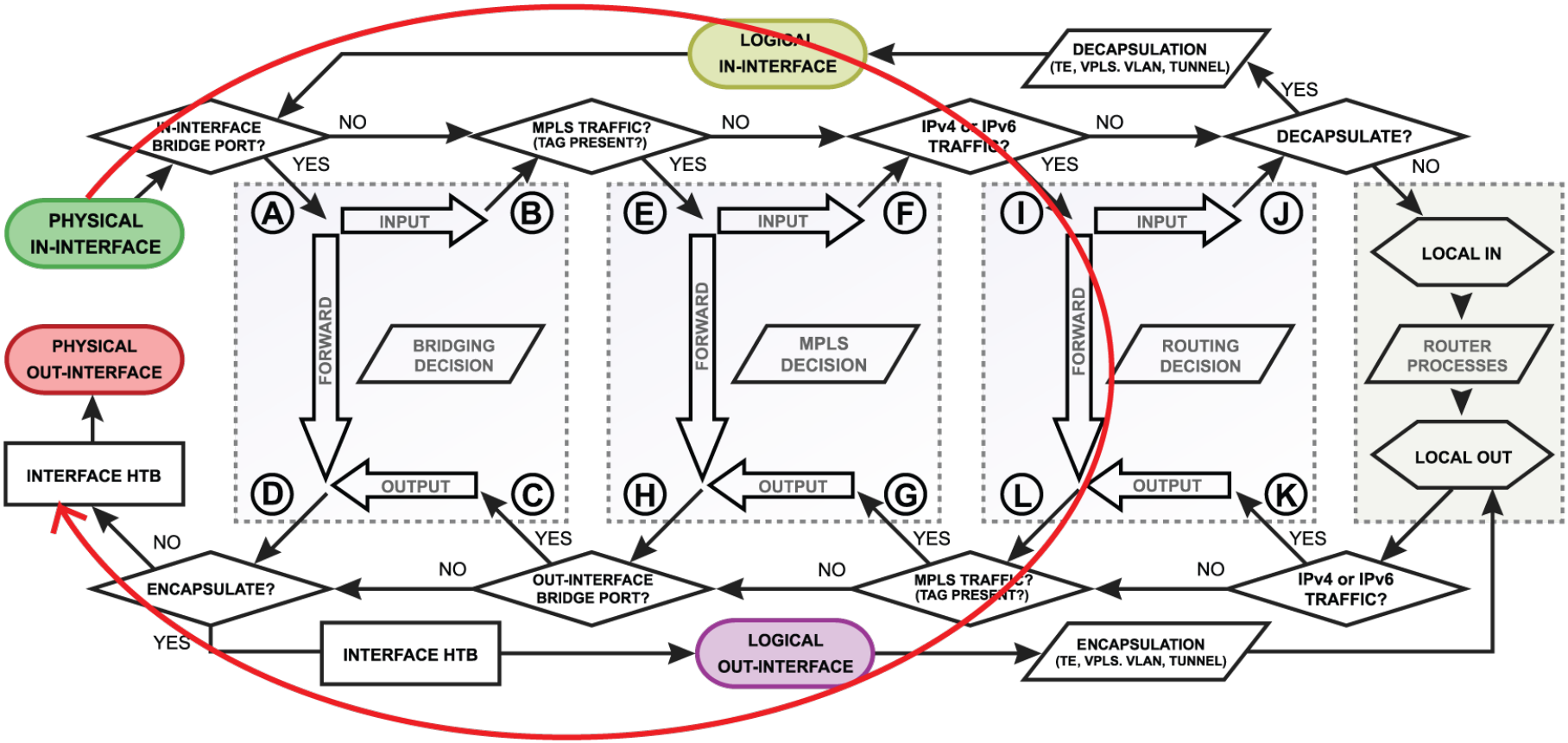
Bridge Forwarding



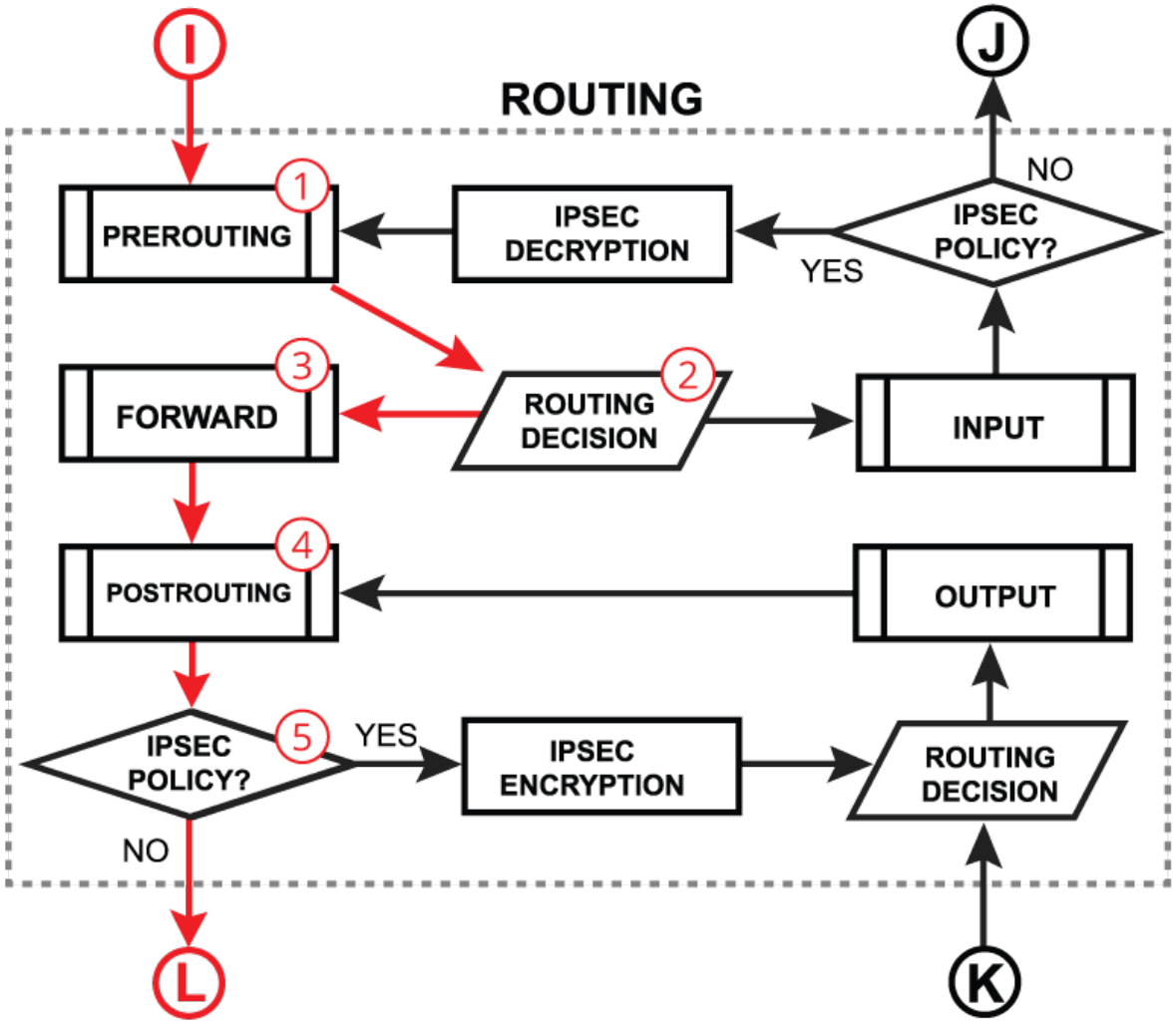
MPLS Forwarding



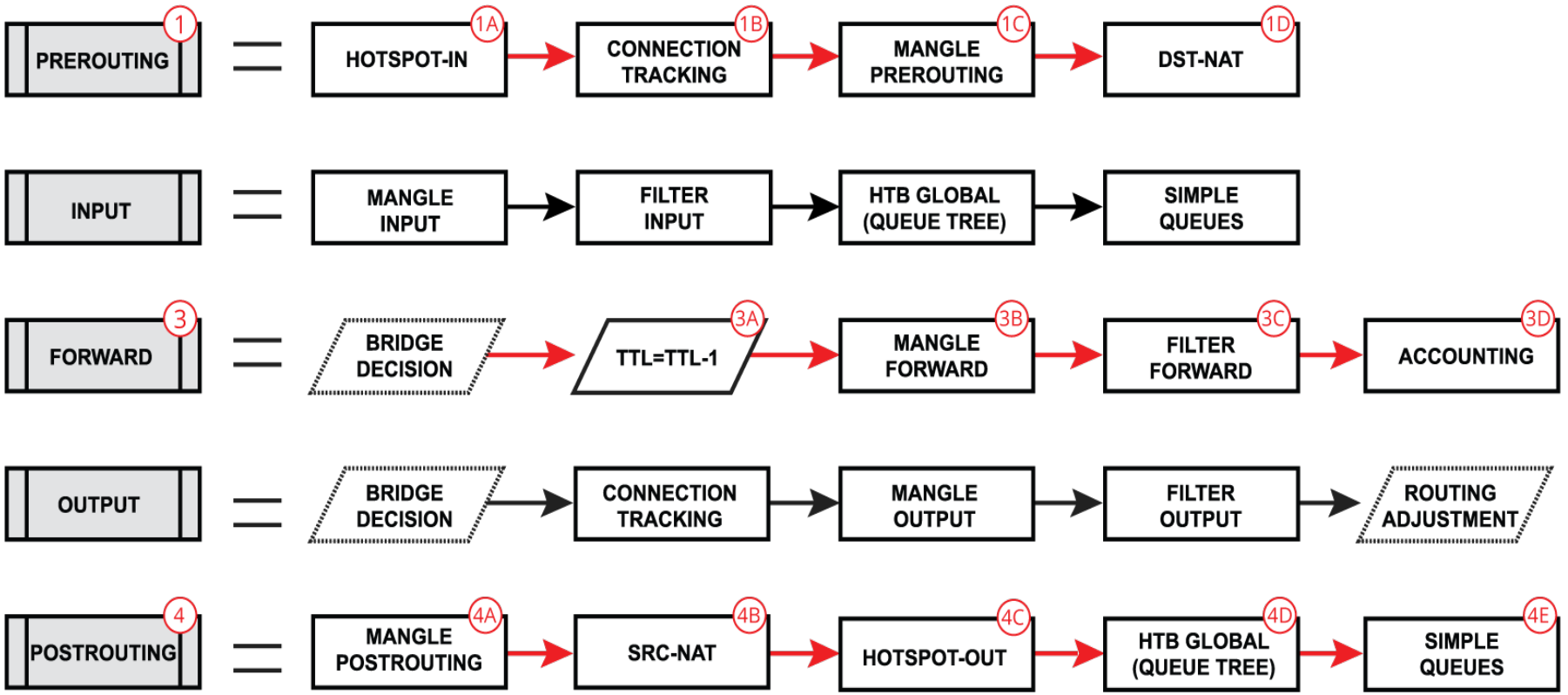
Routing Forwarding



Routing Forwarding



Routing Forwarding



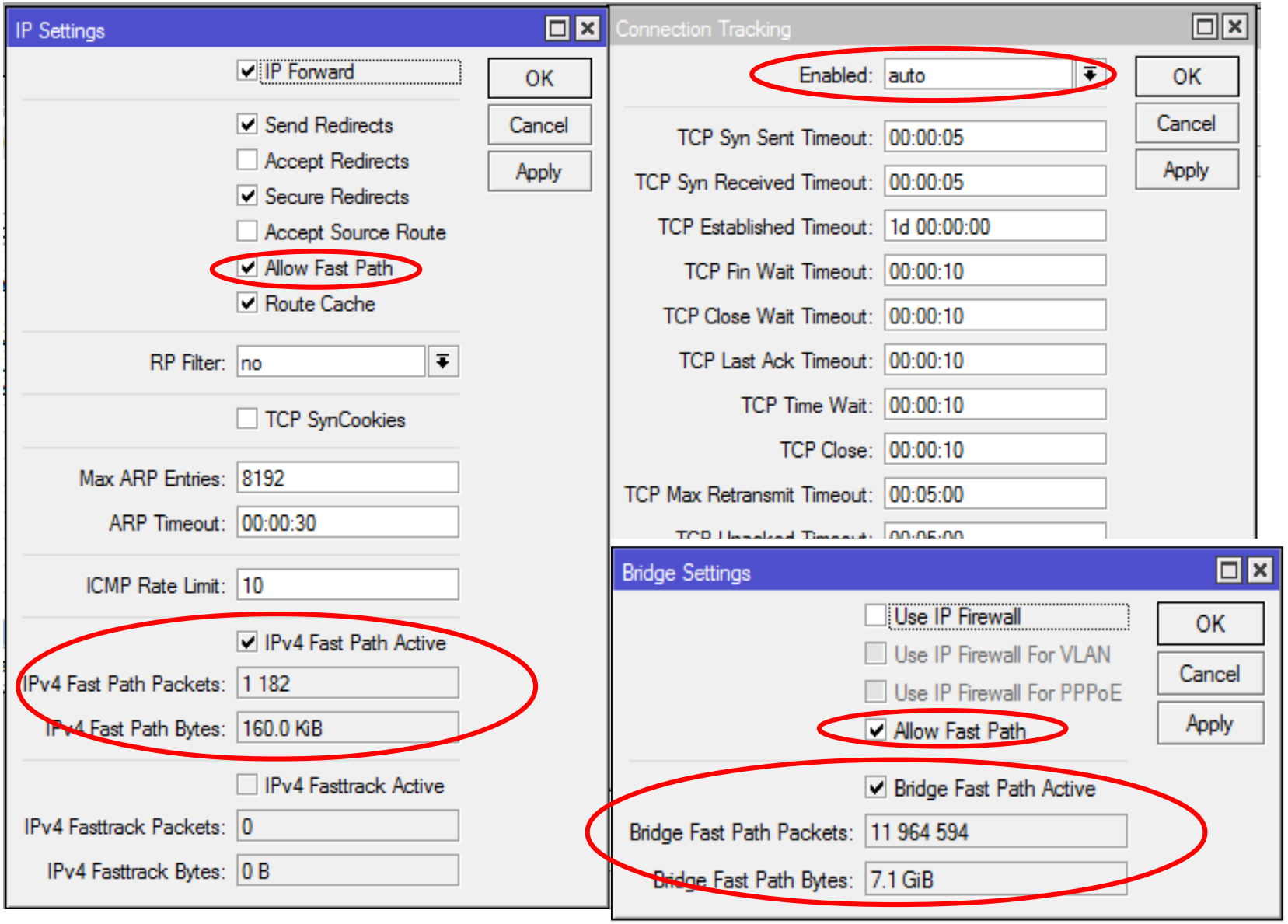
Initial FastPath Implementation

- FastPath is an interface driver extension, that allows you to receive/process/send traffic without unnecessary processing.
- Interface driver can now talk directly to specific RouterOS processes - skipping all others
- FastPath requirements
  - Interface driver support
  - FastPath should be allowed in configuration
  - No configuration in specific facilities.

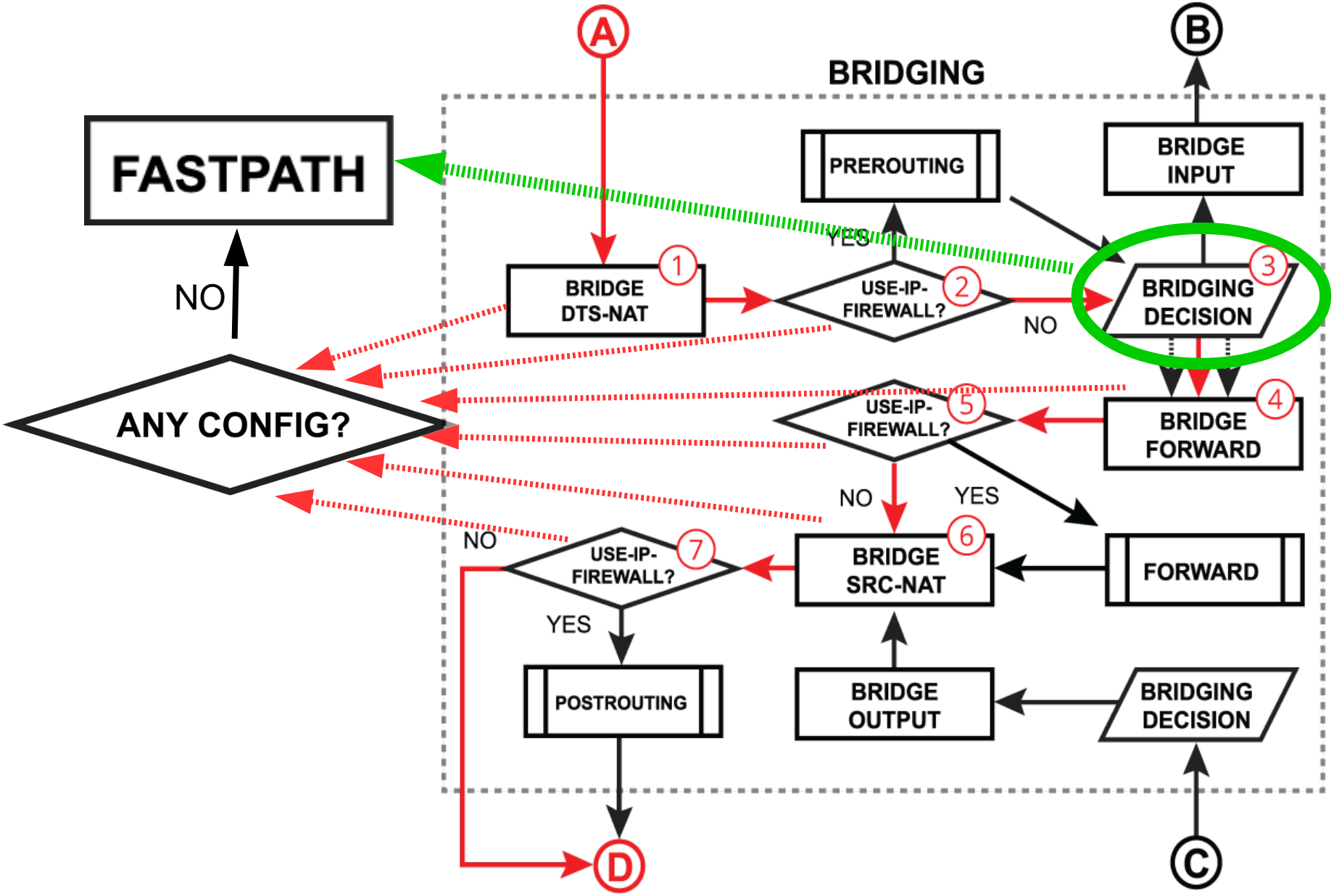
Driver Support

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

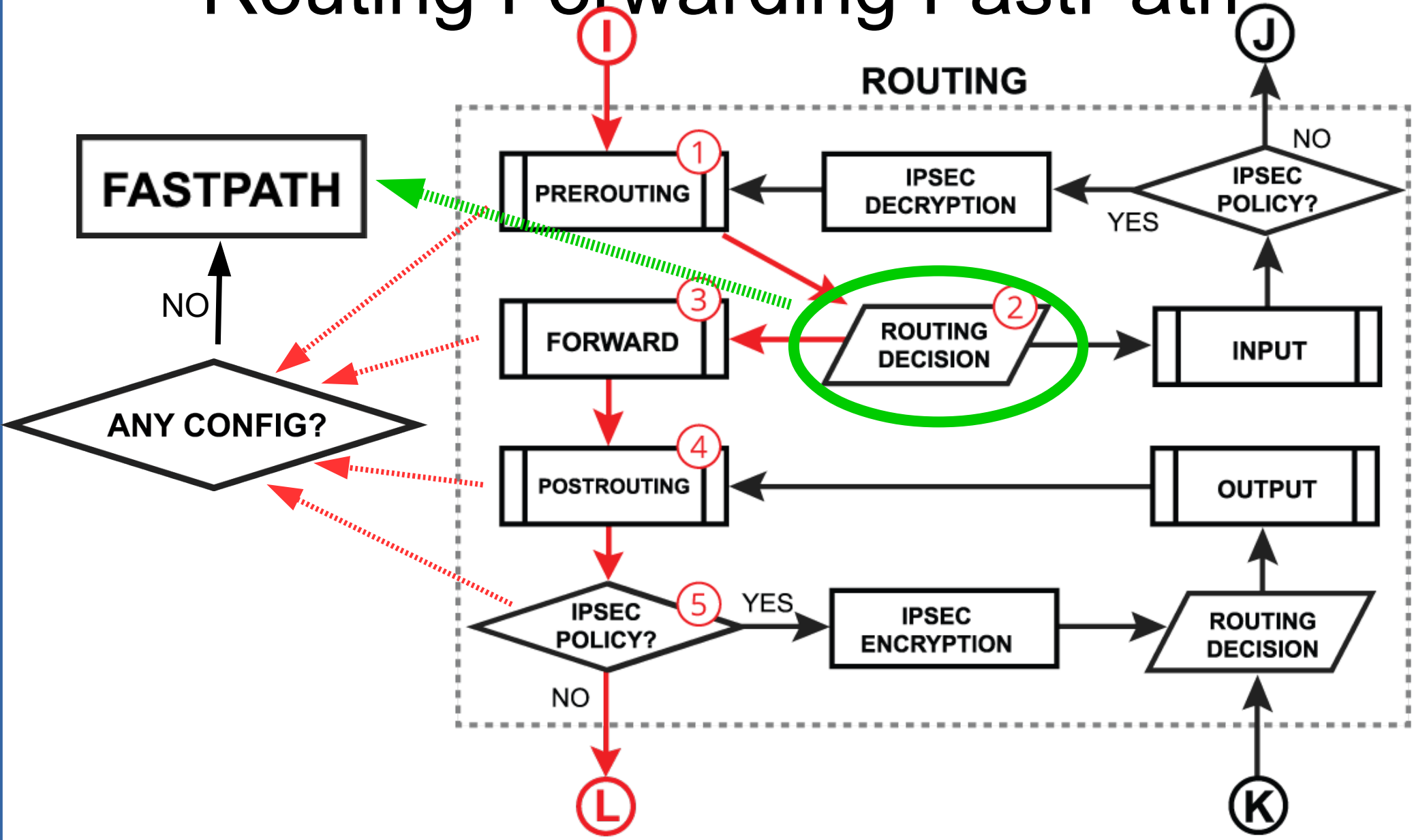
Allow FastPath



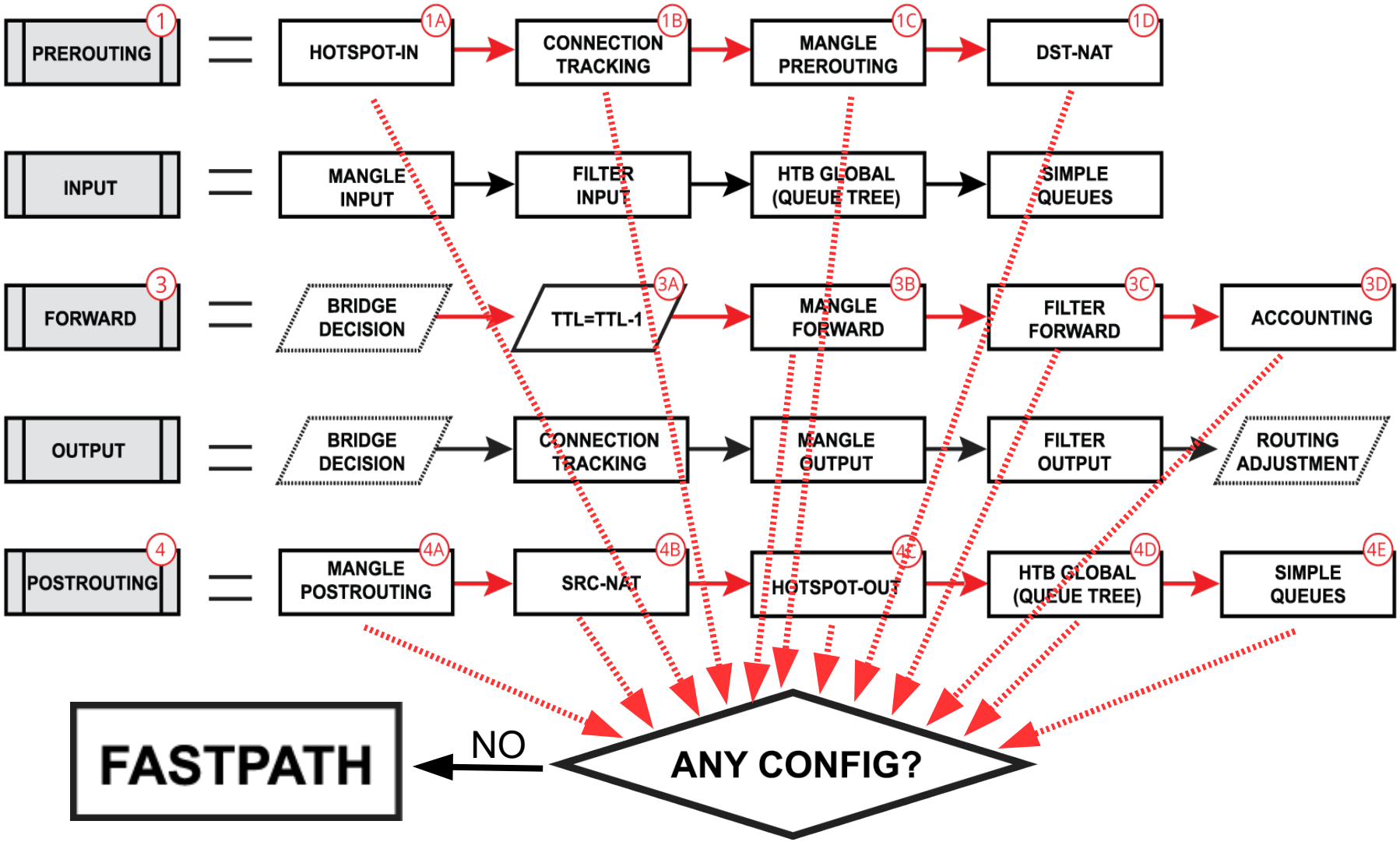
Bridge Forwarding FastPath



Routing Forwarding FastPath



Routing Forwarding FastPath



SlowPath vs FastPath

- What are the performance benefits of regular 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	**234.9**	962.2	**81.2**	986.1
Bridging	25 bridge filter rules	114.6	58.7	112.3	460.0	**81.2**	986.1
Routing	none (fast path)	729.2	373.4	**234.9**	962.2	**81.2**	986.1
Routing	25 simple queues	184.8	94.6	178.4	730.7	**81.2**	986.1
Routing	25 ip filter rules	78.9	40.4	81.2	332.6	**81.2**	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)	**119,047.6**	60,952.4	**18,790.0**	76,963.8	**6,502.0**	78,960.3
Bridging	25 bridge filter rules	10,432.3	5,341.3	9,099.2	37,270.3	**6,502.0**	78,960.3
Routing	none (fast path)	94,668.4	48,470.2	**18,790.0**	76,963.8	**6,502.0**	78,960.3
Routing	25 simple queues	13,683.5	7,006.0	13,500.0	55,296.0	**6,502.0**	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

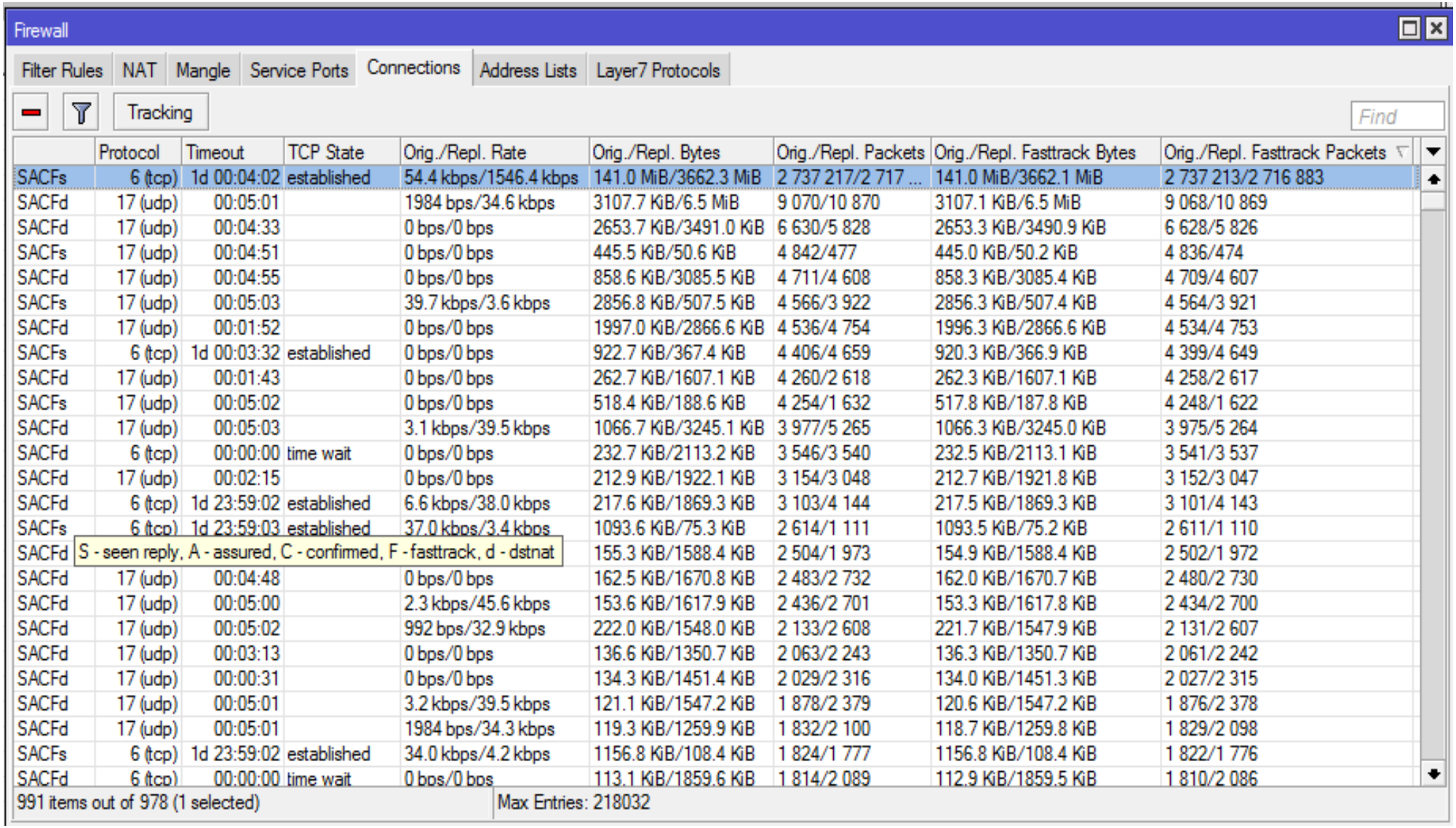
FastPath for Features

- 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)*

FastPath + Conntrack

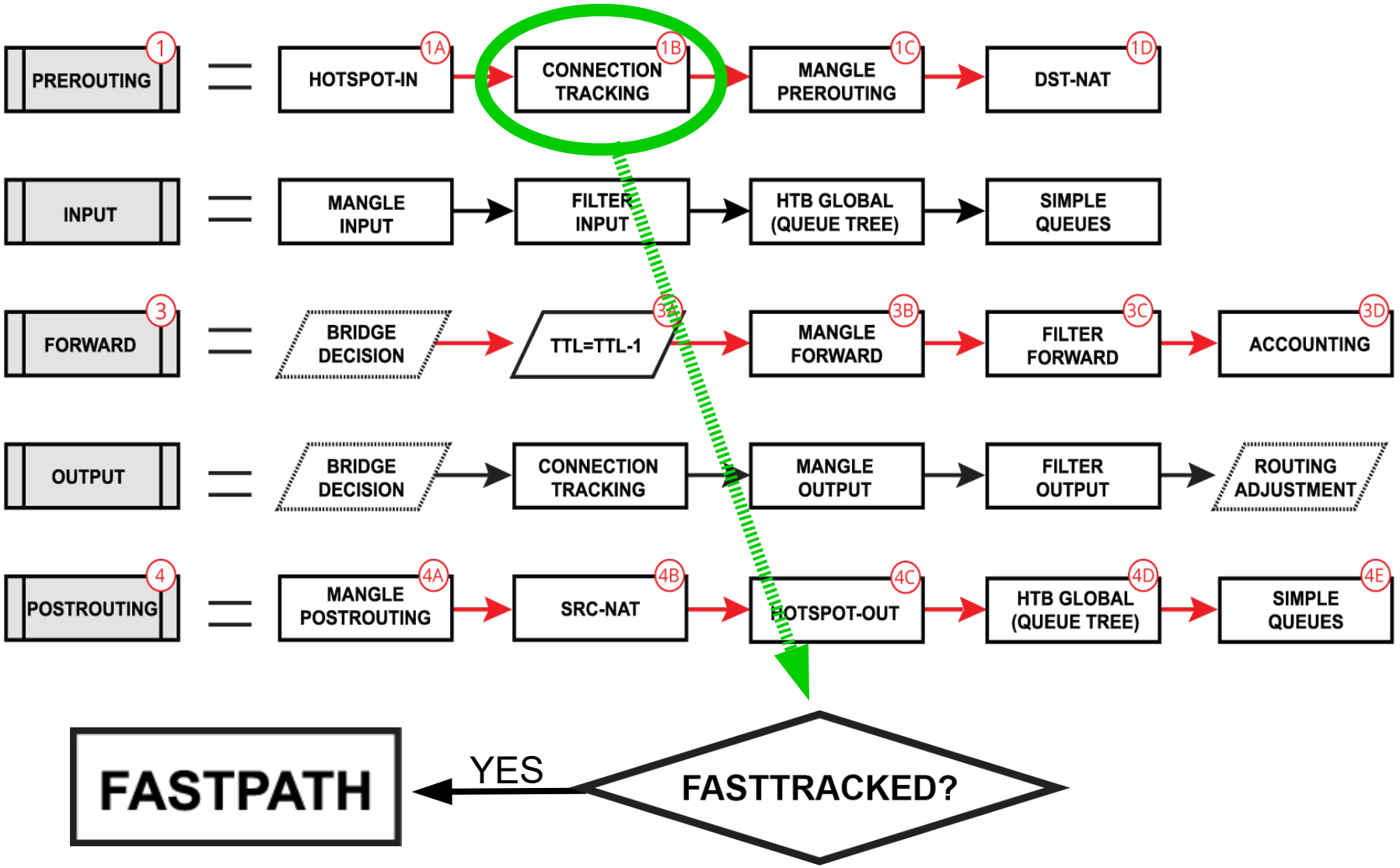
- Conntrack entries now have “Fasttracked” flag
- Implemented as “fasttrack-connection” action for firewall filter/mangle
- Packets from “Fasttracked” connections are allowed to travel in FastPath
- Works only with IPv4/TCP and IPv4/UDP
- Traffic traveling in FastPath will be invisible to other router facilities (firewall, queues, etc)
- Some packets will still follow the regular path to maintain conntrack entries

FastPath + Conntrack = FastTrack

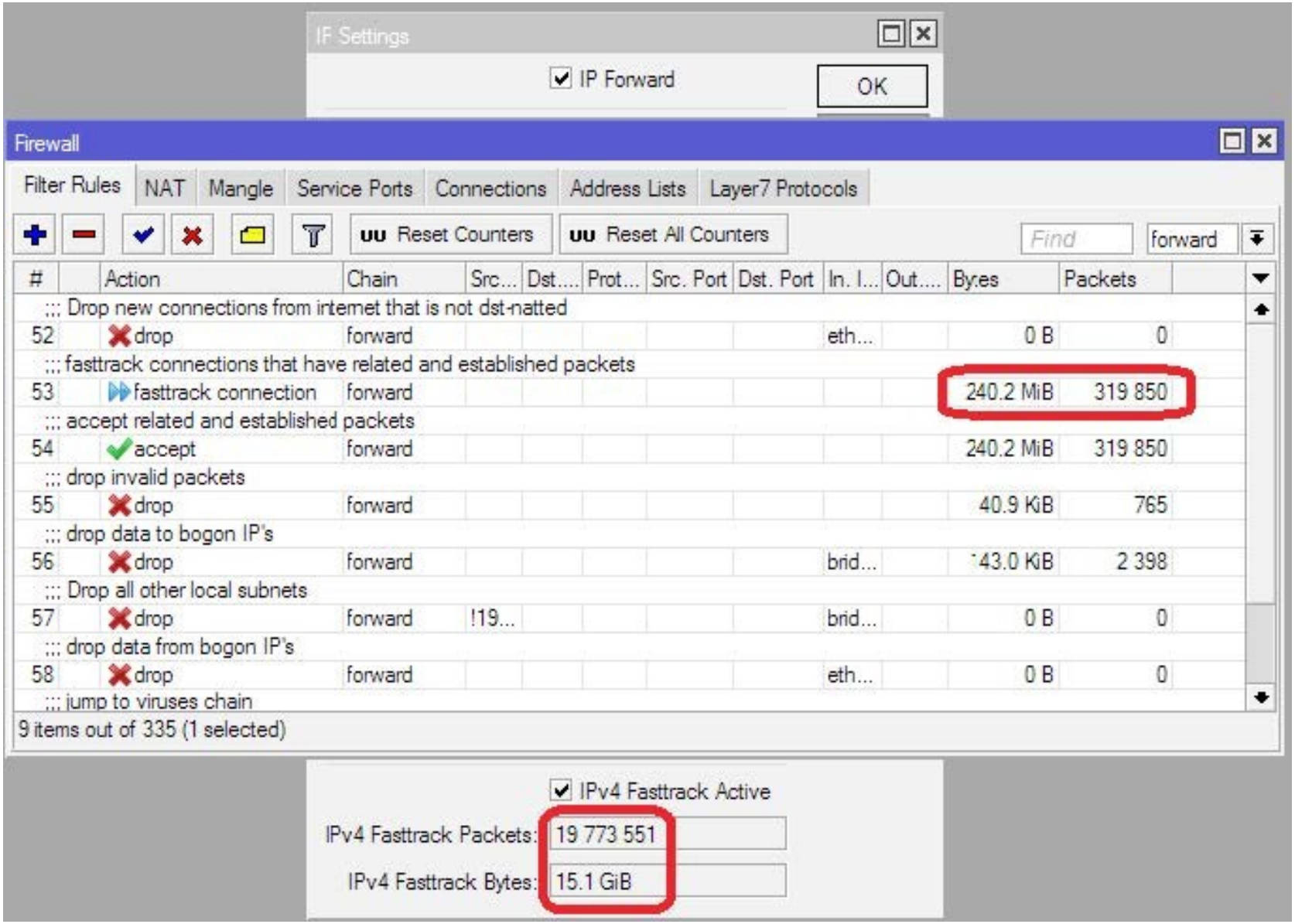


	Protocol	Timeout	TCP State	Orig./Repl. Rate	Orig./Repl. Bytes	Orig./Repl. Packets	Orig./Repl. Fasttrack Bytes	Orig./Repl. Fasttrack Packets
SACFs	6 (tcp)	1d 00:04:02	established	54.4 kbps/1546.4 kbps	141.0 MiB/3662.3 MiB	2 737 217/2 717 ...	141.0 MiB/3662.1 MiB	2 737 213/2 716 883
SACFd	17 (udp)	00:05:01		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	6 (tcp)	1d 23:59:03	established	37.0 kbps/3.4 kbps	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

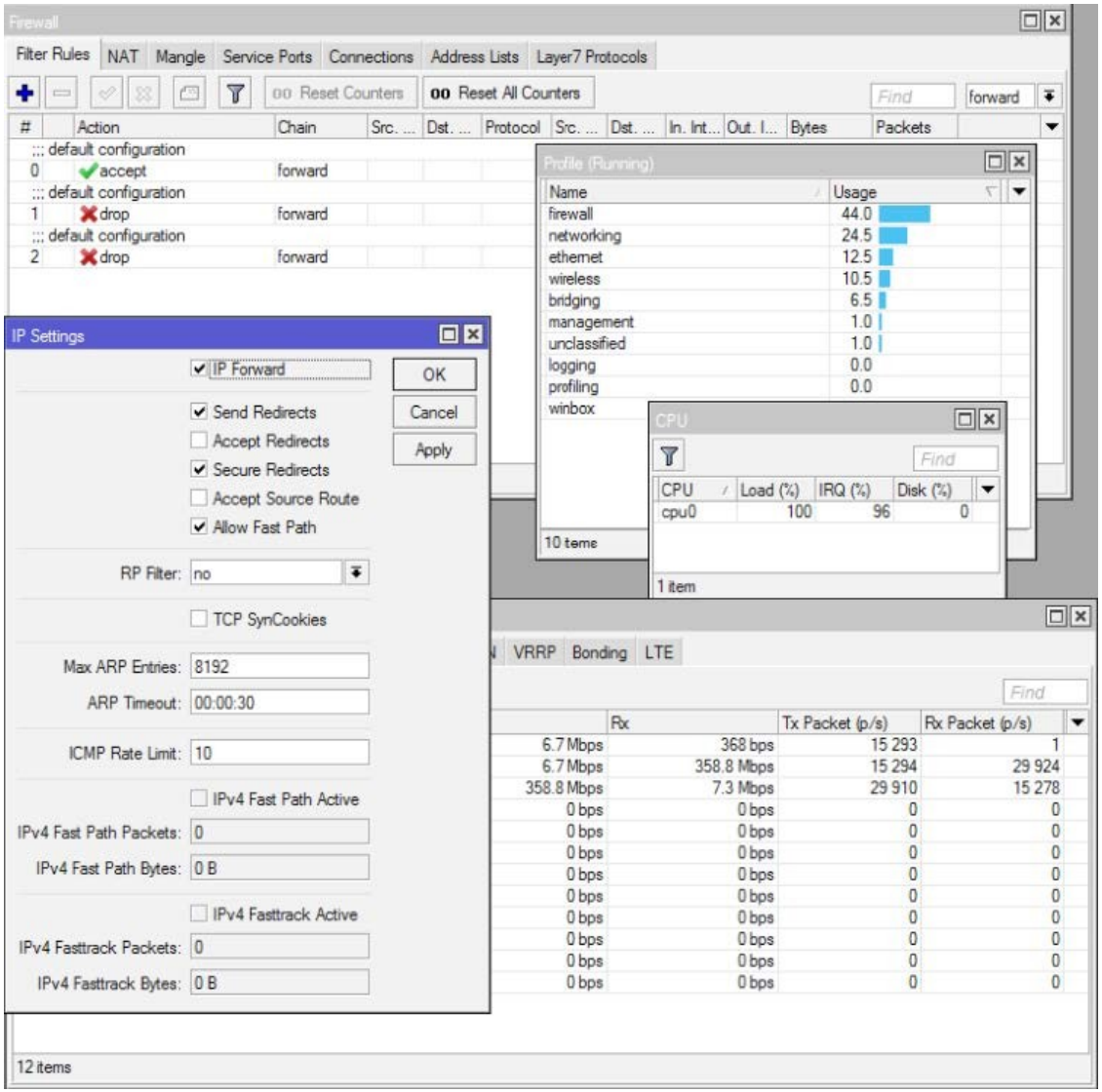
Routing Forwarding FastPath



Fasttrack-Connection

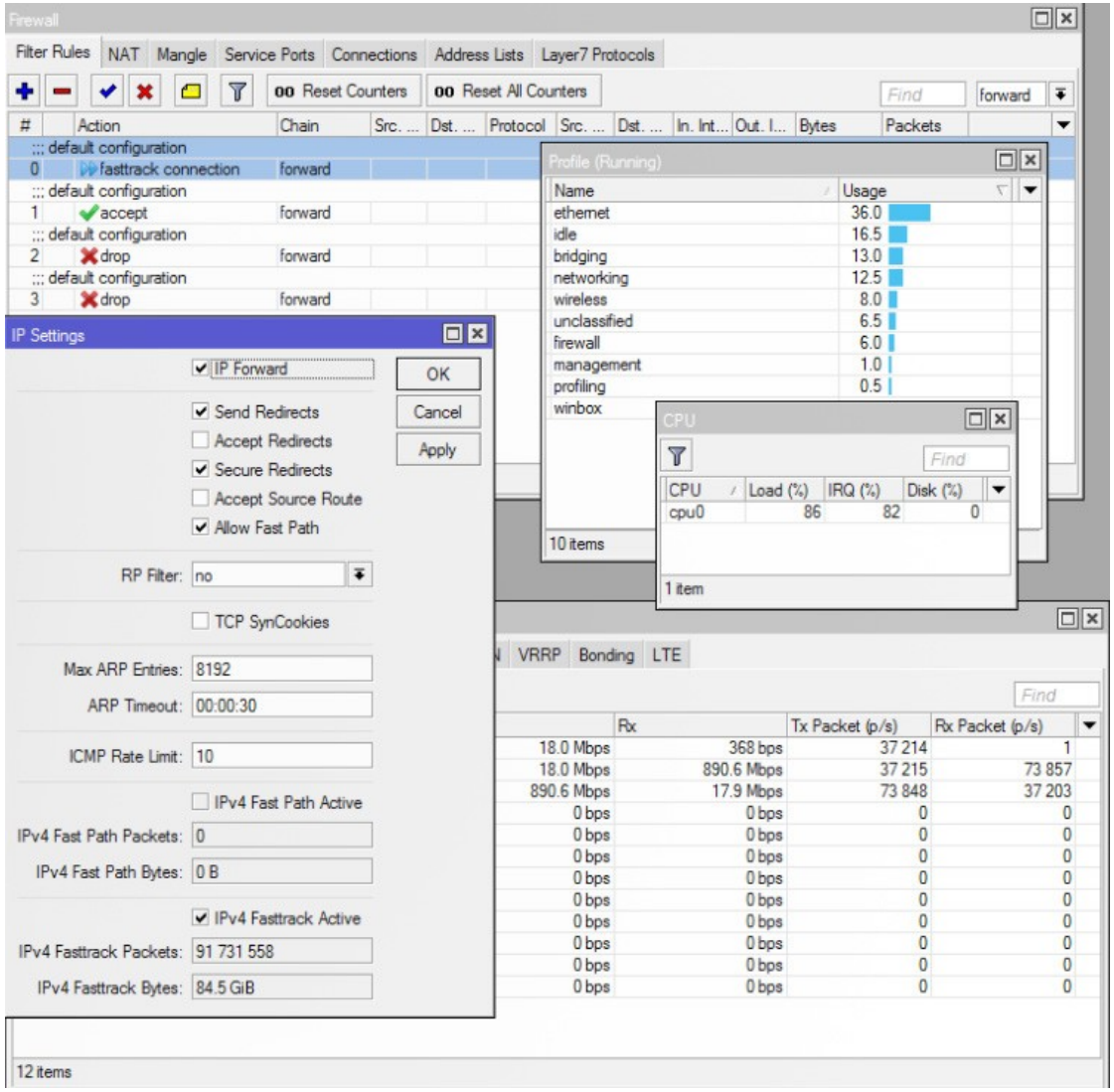


Without Fasttrack



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

With Fasttrack

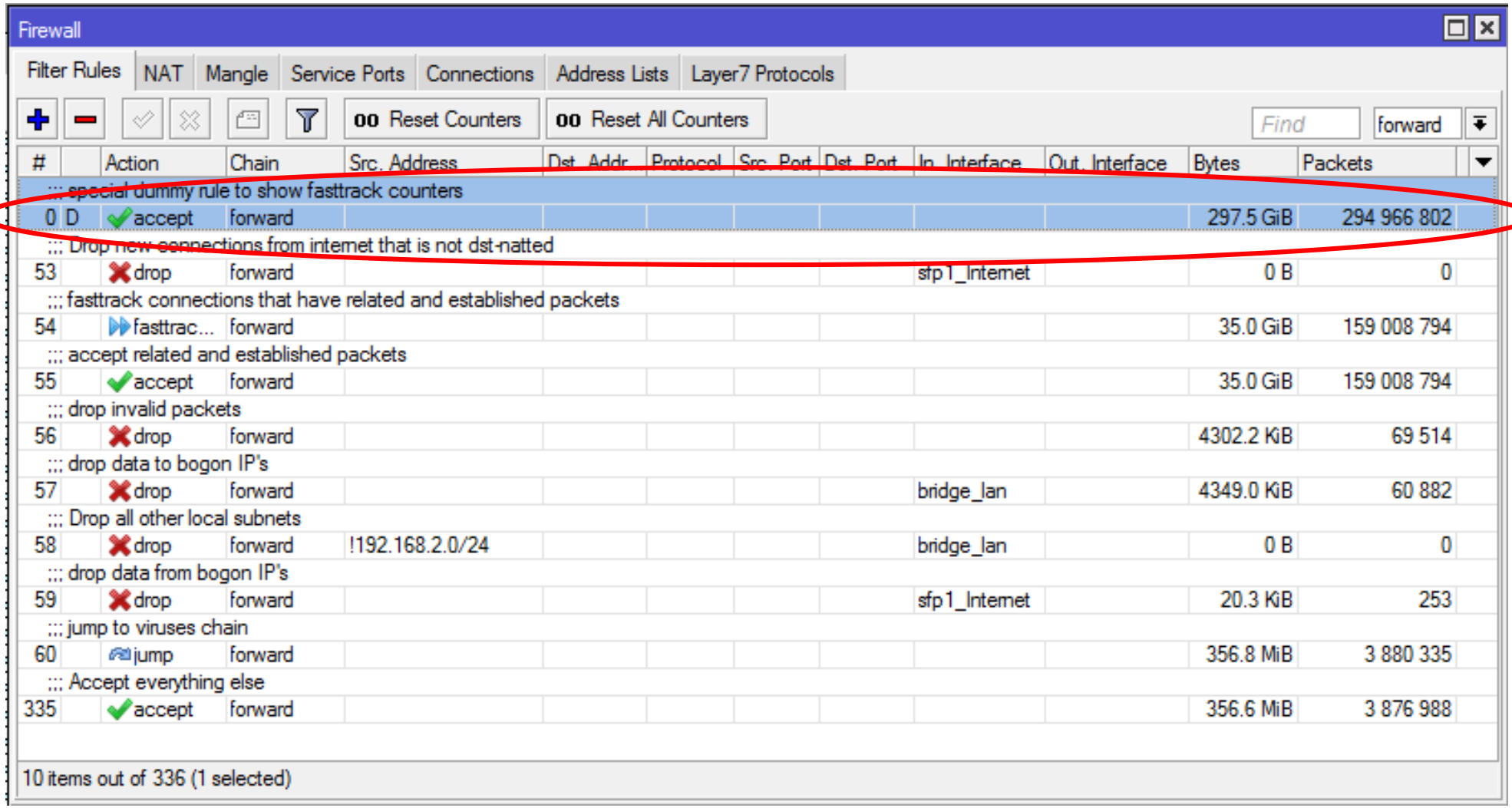


- Board: RB2011UiAS-2HnD
- Configuration: default Home AP
- Throughput: 890Mbps
- CPU load: 86%
- Firewall CPU load: 6%

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

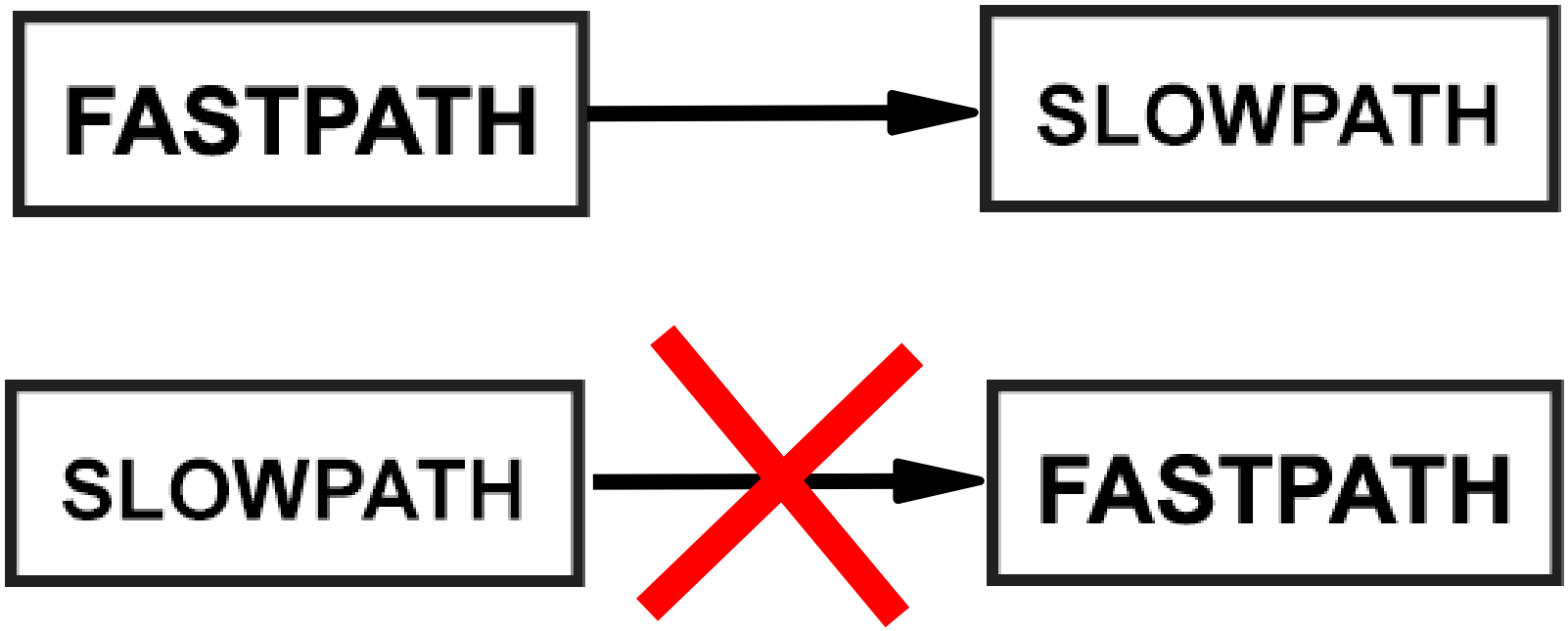


Special Dummy Rule

- This is not an actual rule, it is for visual information only
- Dummy rule shows user that some traffic traveling in FastPath and will not reach their firewall rules
- 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

Half-FastPath

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

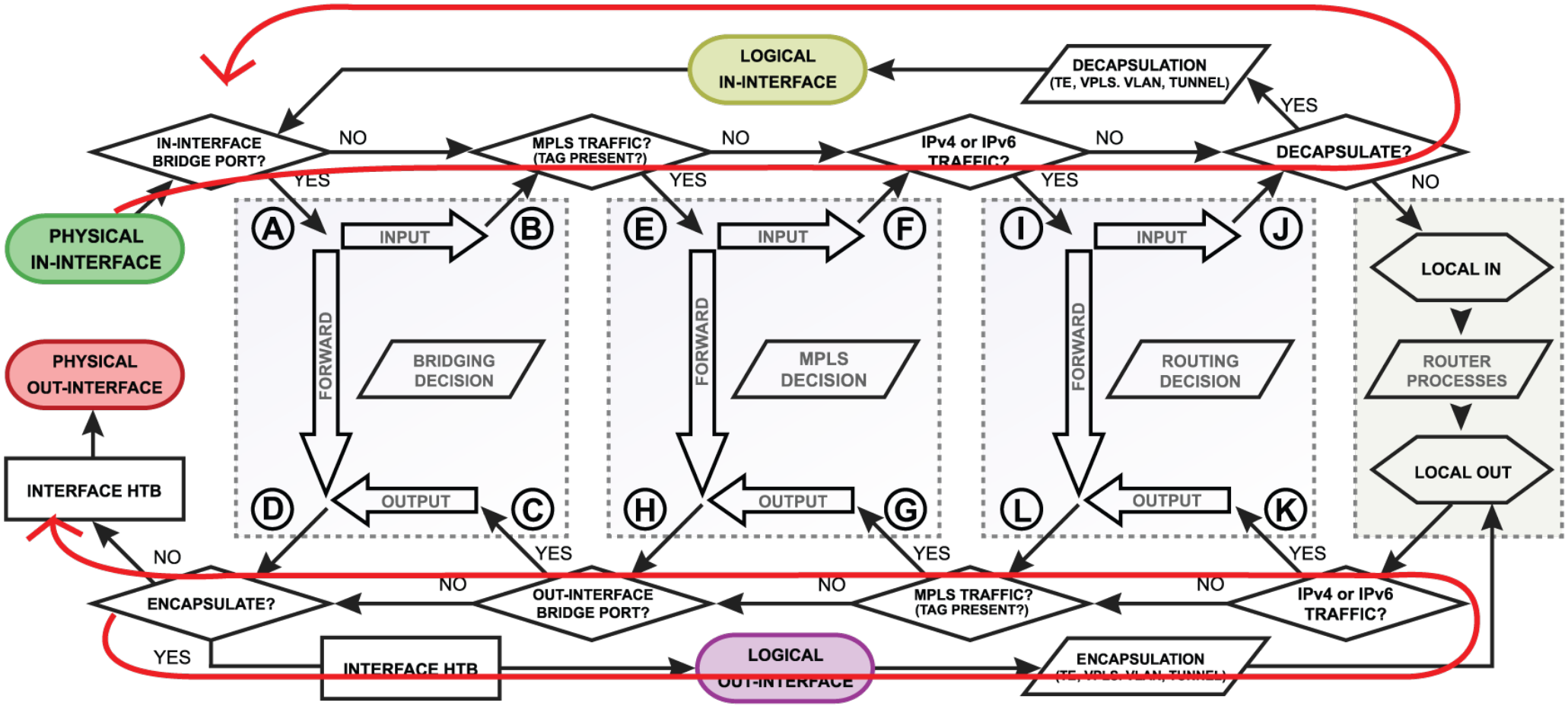


FastPath for Logical Interfaces

FastPath is supported for these logical interfaces (without encryption and no fragmentation)

- Bridge (since v6.29)
- VLAN (since v6.30)
- VRRP (since v6.30)
- Bonding - RX only (since v6.30)
- EOIP, GRE, IPIP (since v6.33)
- PPPoE client **(since v6.35)**
- L2TP **(since v6.35)** (PPPoE client + L2TP = LNS)

Logical Interfaces in RouterOS



PPPoE FastPath Performance

- Without fragmentation and encryption

Setup: CCR1036<--10G-->CCR1036 **In kpps**

Conntrack	FastPath	Version	Packet size			
			64B	512B	1024B	1280B
No	N/A	6.7	294.8	305.4	302.3	305.3
No	N/A	6.8rc1	5,519.3	4,634.2	2,378.9	1,913.1
No	**FastPath**	**6.35rc34**	**26,065.1**	**4,634.2**	**2,378.9**	**1,913.1**
Yes	N/A	6.7	277.2	260.4	192.3	183.9
Yes	N/A	6.8rc1	2,730.6	2,462.7	2,103.6	1,910.6
Yes	No	6.35rc34	3,065.6	3,001.7	2,378.9	1,913.1
Yes	**Fasttrack**	**6.35rc34**	**12,379.1**	**4,634.2**	**2,378.9**	**1,913.1**

EOIP, GRE, IPIP, L2TP 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.

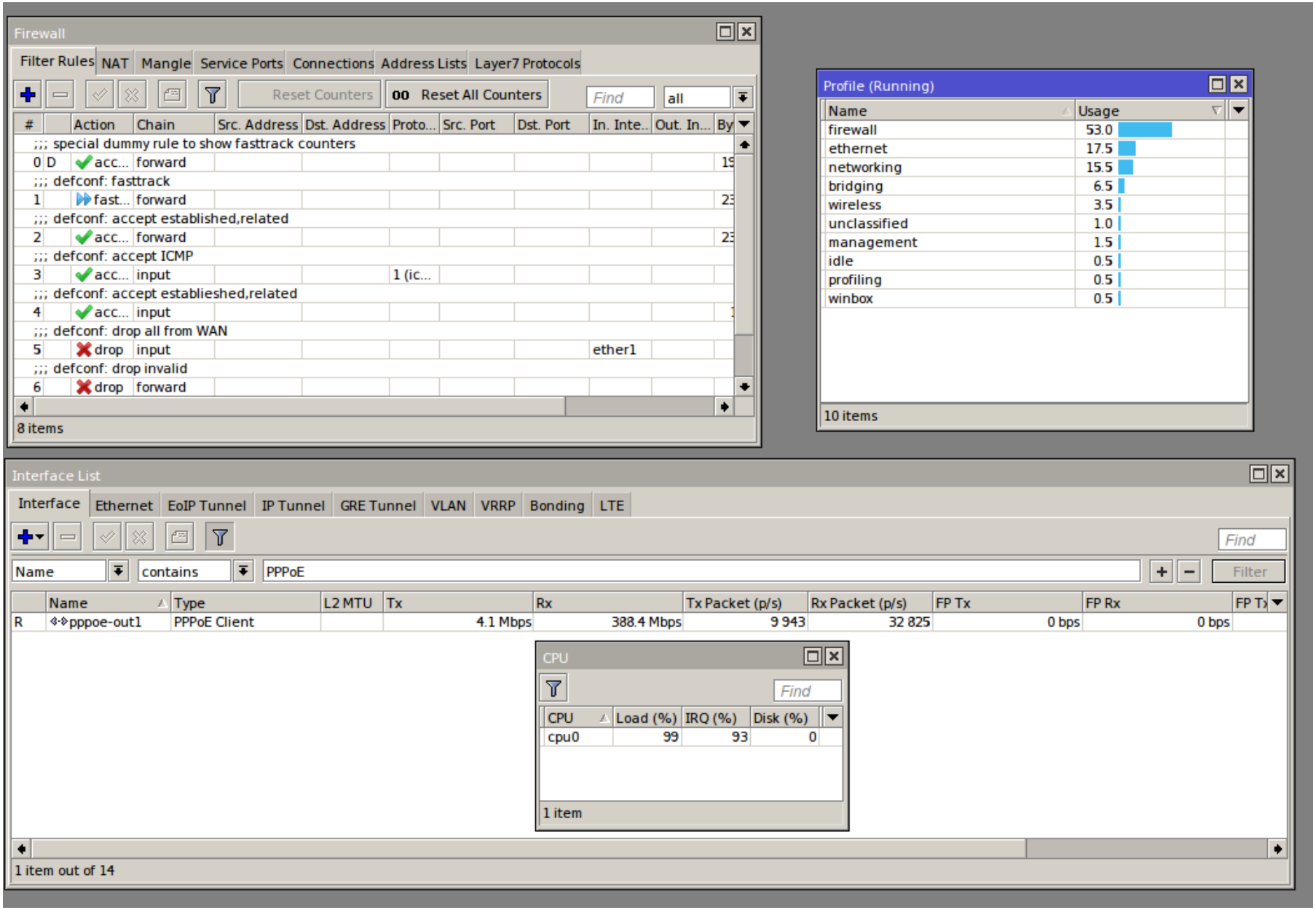
L2TP FastPath Performance

- Without fragmentation and encryption

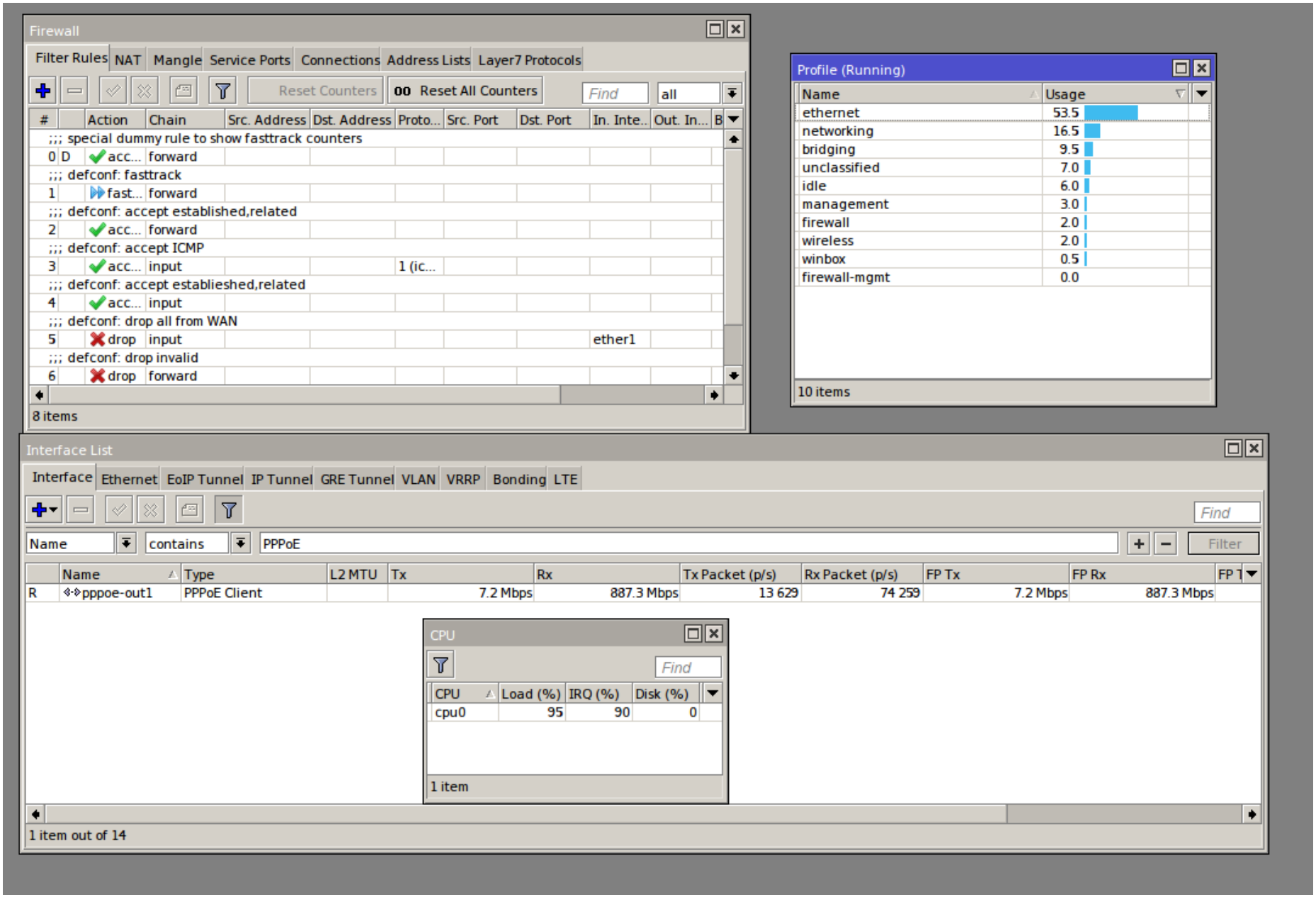
Setup: CCR1036<--10G-->CCR1036 **In kpps**

Conntrack	FastPath	Version	Packet size			
			64B	512B	1024B	1280B
No	N/A	6.7	120.9	123.4	197.5	197.8
No	N/A	6.8rc1	3,708.6	3,522.1	2,312.6	1,869.8
No	**FastPath**	**6.35rc34**	**19,645.0**	**4,385.4**	**2,312.6**	**1,869.8**
Yes	N/A	6.7	98.1	105.4	103.2	101.5
Yes	N/A	6.8rc1	1,687.1	1,580.9	1,382.3	1,302.8
Yes	No	6.35rc34	2,379.5	2,320.3	2,156.8	1,869.8
Yes	**Fasttrack**	**6.35rc34**	**8,109.3**	**4,385.4**	**2,312.6**	**1,869.8**

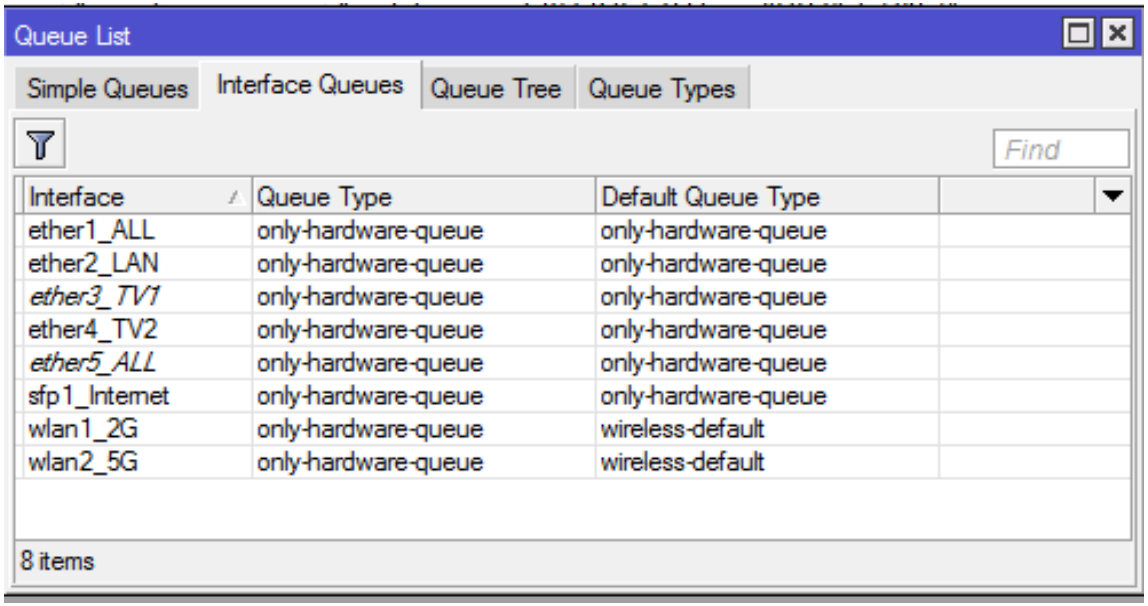
Without pppoe-client Fastpath Support



With pppoe-client Fastpath Support

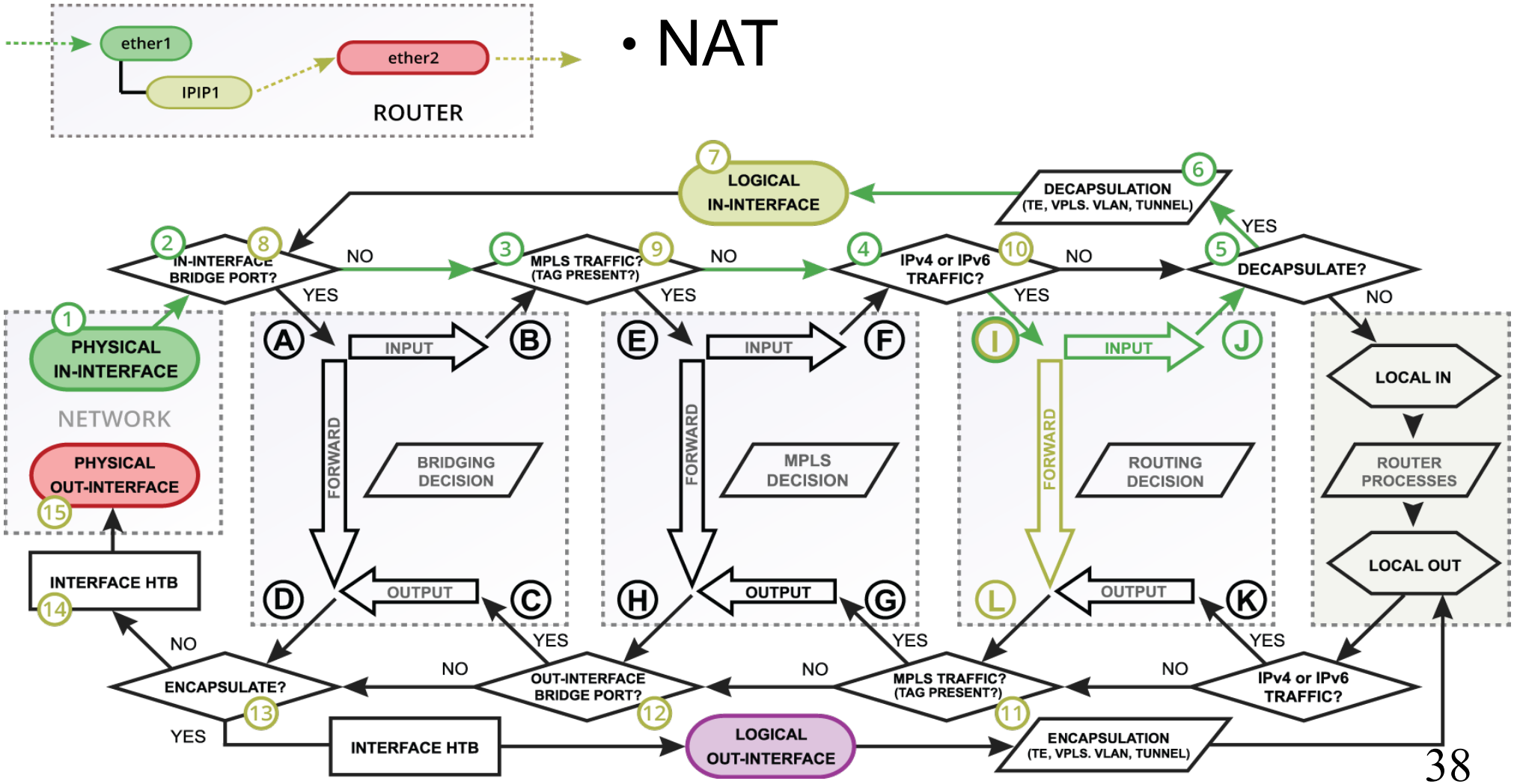


Interface Queue and FastPath

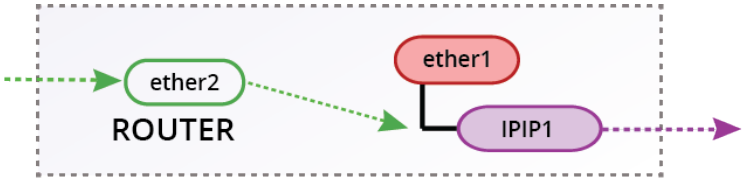


- Only interface queue that guarantees FastPath is “only-hardware-queue”
- Minimal impact on performance, as “Interface HTB” is the last step in the packet flow diagram

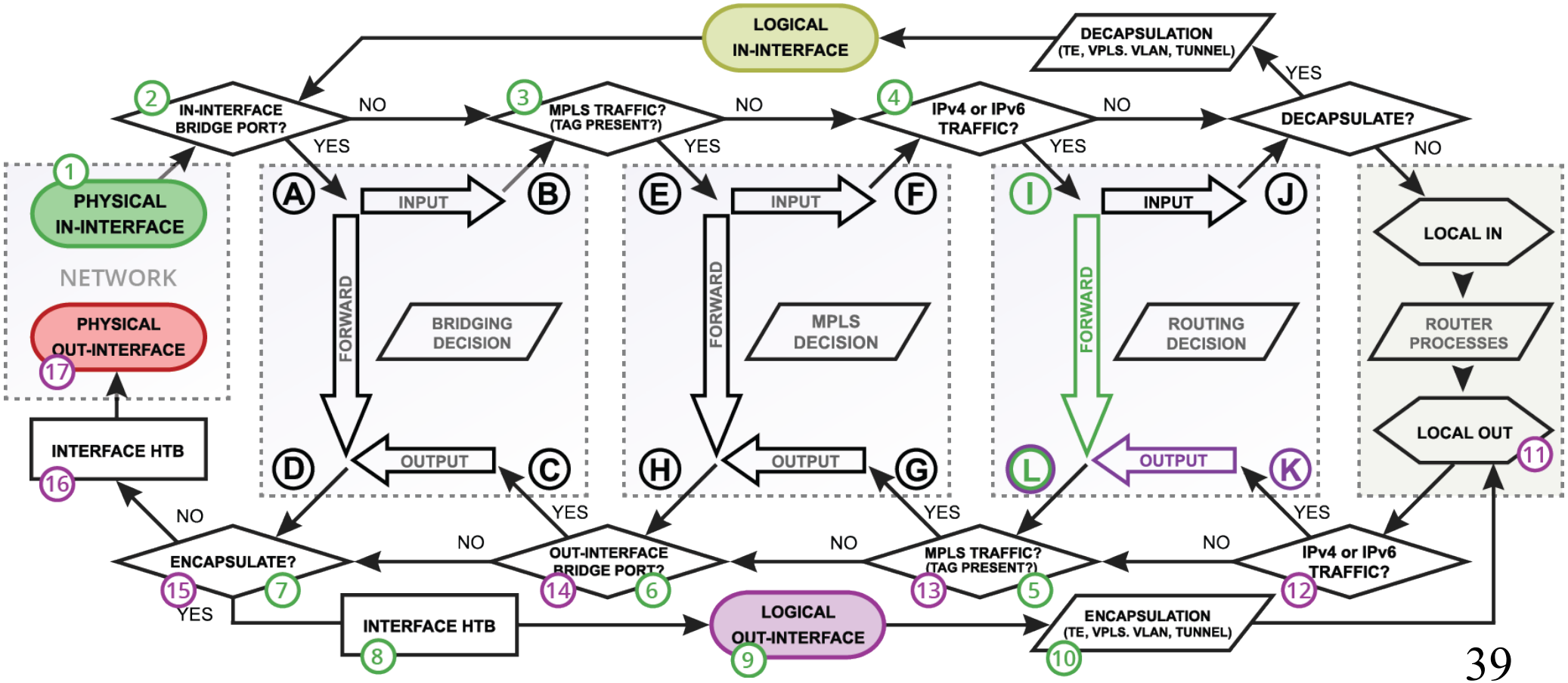
- ether1 and ether2 have FastPath support
- IPIP1 "allow-fast-path" setting enabled
- IP forwarding FastPath allowed
- ICMP traffic
- NAT

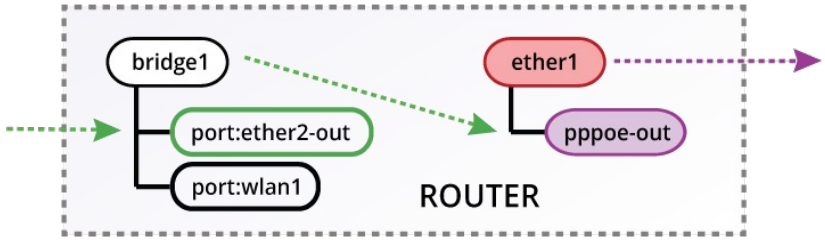


- ether1 and ether2 have FastPath support
- IPIP1 "allow-fast-path" setting disabled
- IP forwarding FastPath allowed

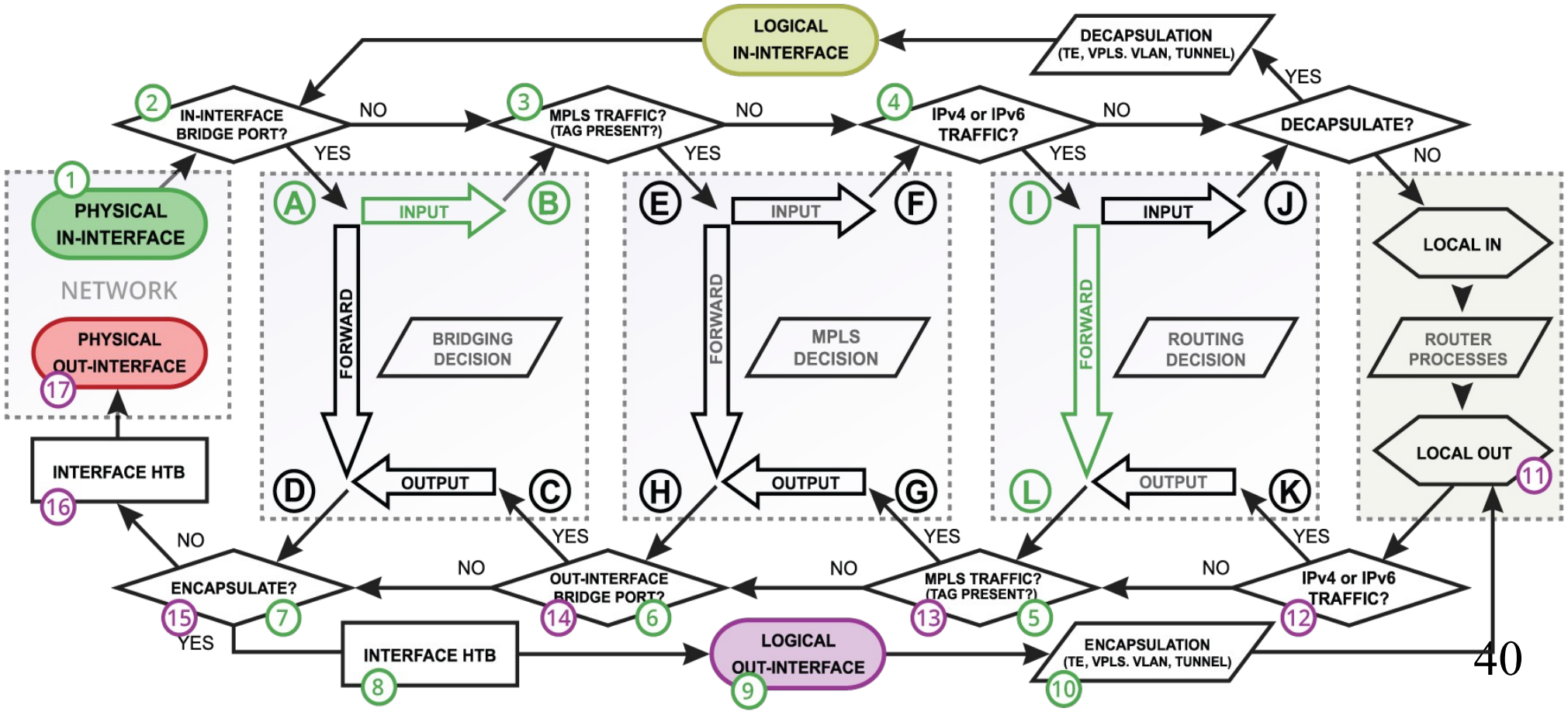


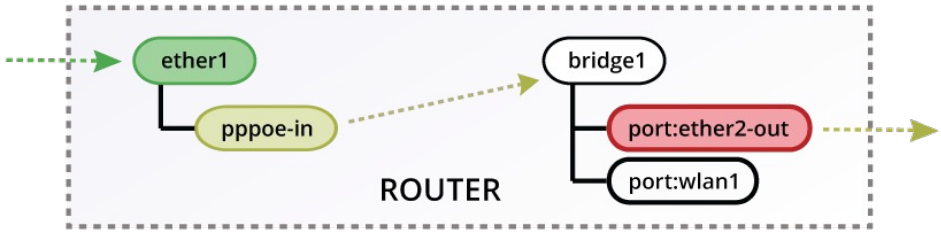
- TCP “FastTraked” connection
- Simple queues



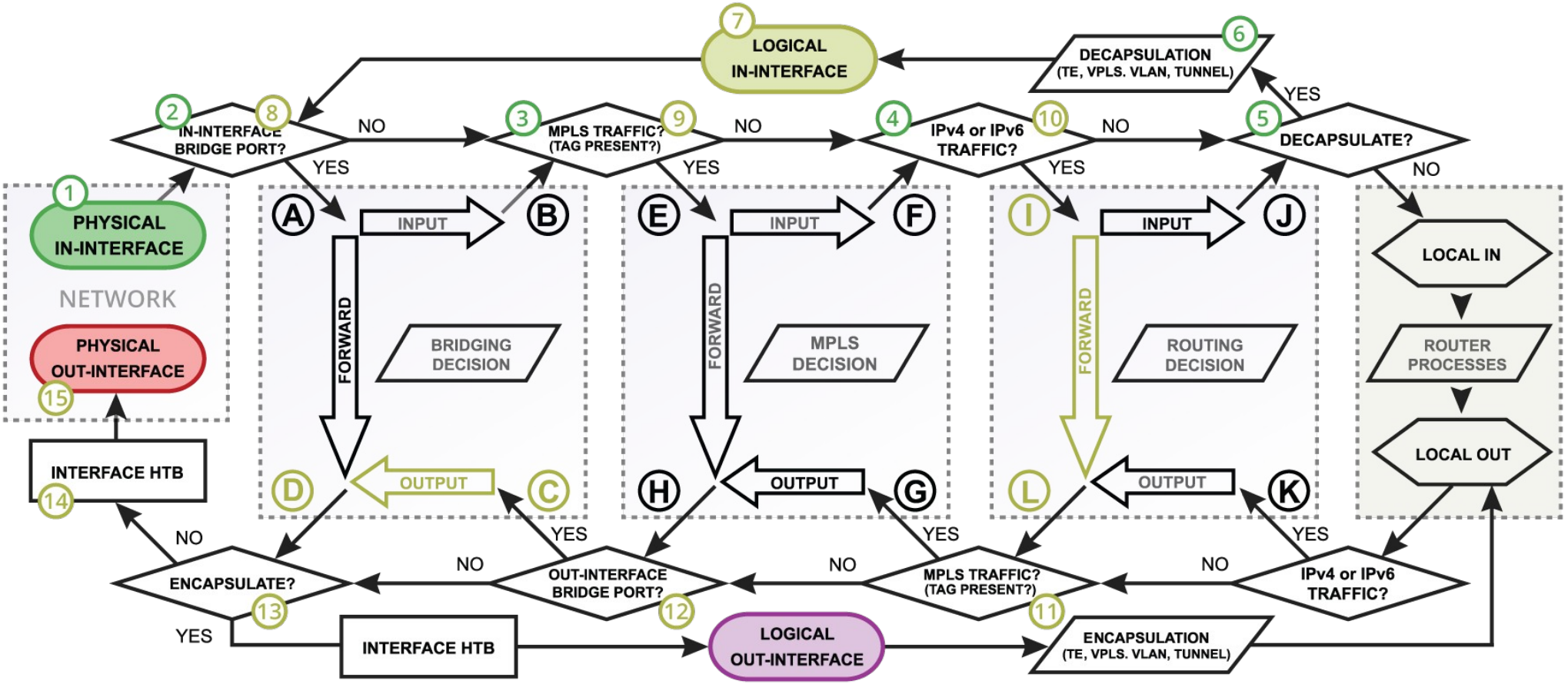


- ether1 and ether2-out have FastPath support
- IP forwarding FastPath allowed
- IPv6/TCP connection





- ether1 and ether2-out have FastPath support
- IP forwarding FastPath allowed
- “FastTracked” TCP connection



Bottom Line

- FastPath is a feature that allows you to reduce CPU load in specific configurations
- You trade some RouterOS functionality for performance
- Packet fragments can't use FastPath, so plan your network's MTU/MSS carefully
- Core thing needed for FastPath is interface driver support, without it there is no FastPath and no FastTracked connections.

Questions!!!