FastPath Overview
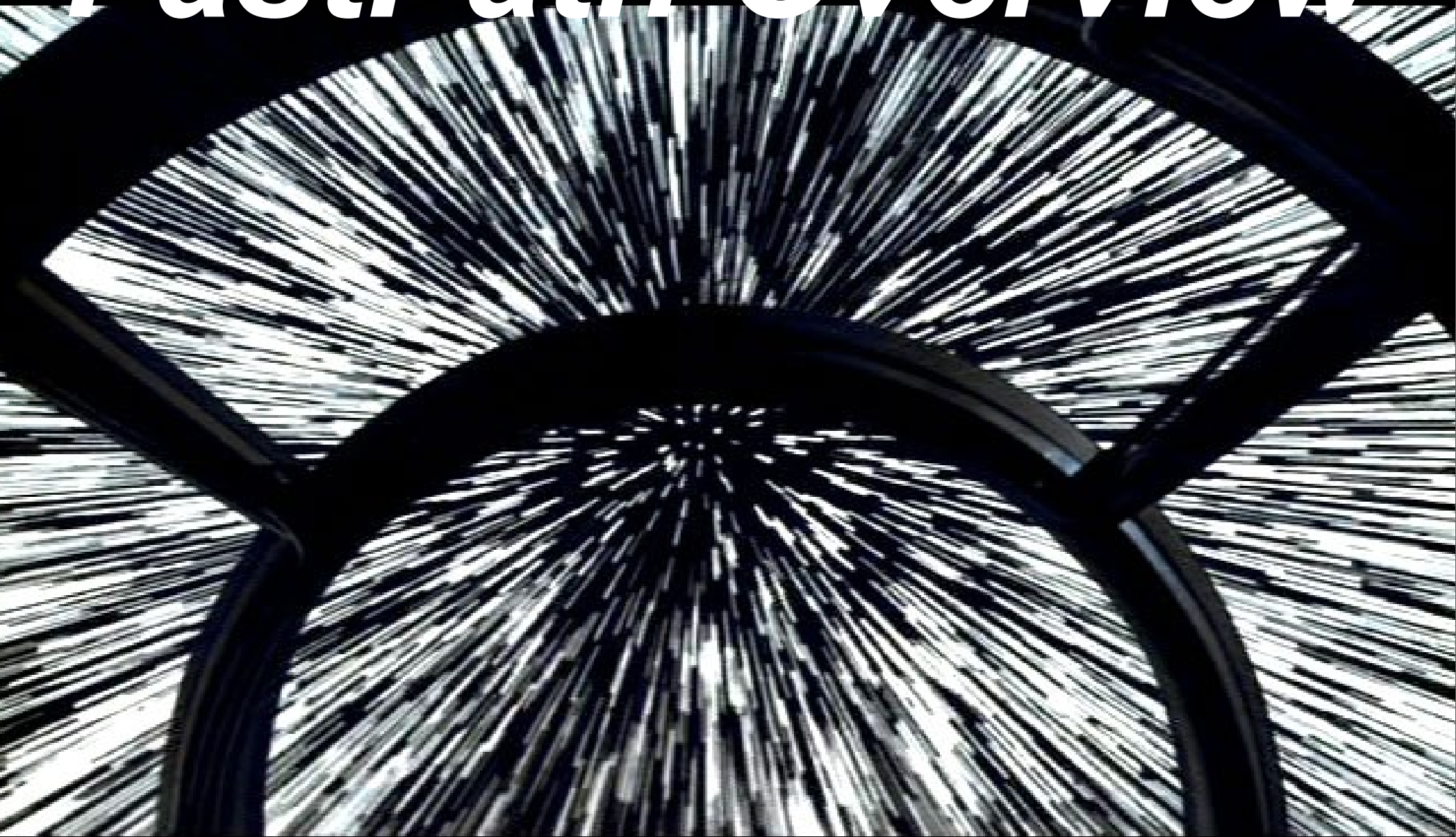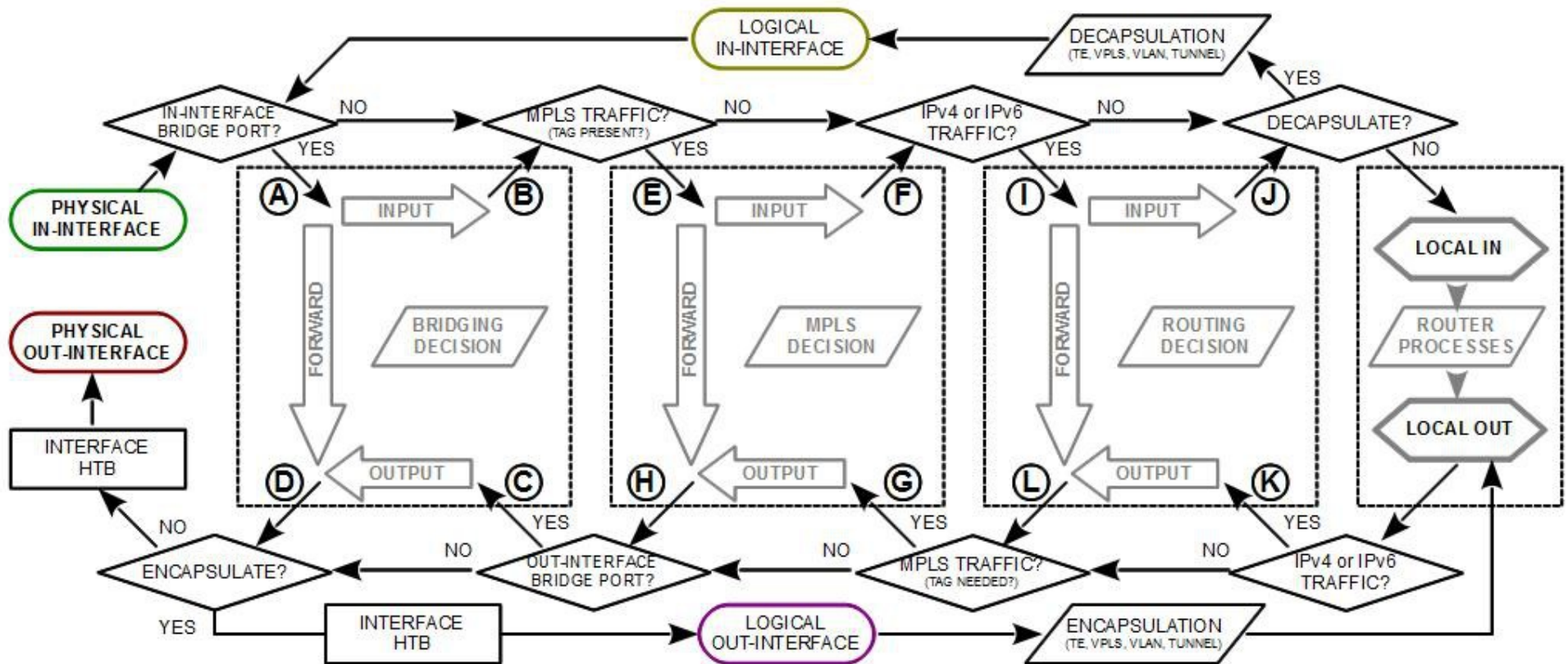
MUM Moldova, 2015

MikroTik RouterOS Packet Flow Diagram
for version 6.x

BRIDGING

- A → BRIDGE DST-NAT → USE-IP-FIREWALL?
  - YES → PREROUTING → BRIDGING DECISION
  - NO → BRIDGING DECISION
- BRIDGE INPUT → B
- BRIDGING DECISION → BRIDGE FORWARD (dashed)
- BRIDGE FORWARD → USE-IP-FIREWALL?
  - NO → BRIDGE SRC-NAT
  - YES → FORWARD → BRIDGE SRC-NAT
- BRIDGE SRC-NAT → USE-IP-FIREWALL?
  - NO → D
  - YES → POSTROUTING → D
- C → BRIDGING DECISION → BRIDGE OUTPUT → BRIDGE SRC-NAT

ROUTING

- I → PREROUTING → ROUTING DECISION
  - → FORWARD
  - → INPUT
- IPSEC DESCRIPTION → PREROUTING
- IPSEC POLICY?
  - NO → J
  - YES → IPSEC DESCRIPTION
- INPUT → J
- FORWARD → POSTROUTING
- OUTPUT → POSTROUTING
- POSTROUTING → IPSEC POLICY?
  - NO → L
  - YES → IPSEC DESCRIPTION → ROUTING DECISION → OUTPUT
- ROUTING DECISION → K

MPLS

- E → MPLS DECISION
  - → POP LABEL (MPLS INPUT) → VPLS OR TE TUNNEL?
    - YES → F TO DECAPSULATE
    - NO → F
  - → SWITCH LABEL (MPLS FORWARD) → H
- G → MPLS DECISION → PUSH LABEL (MPLS OUTPUT) → H
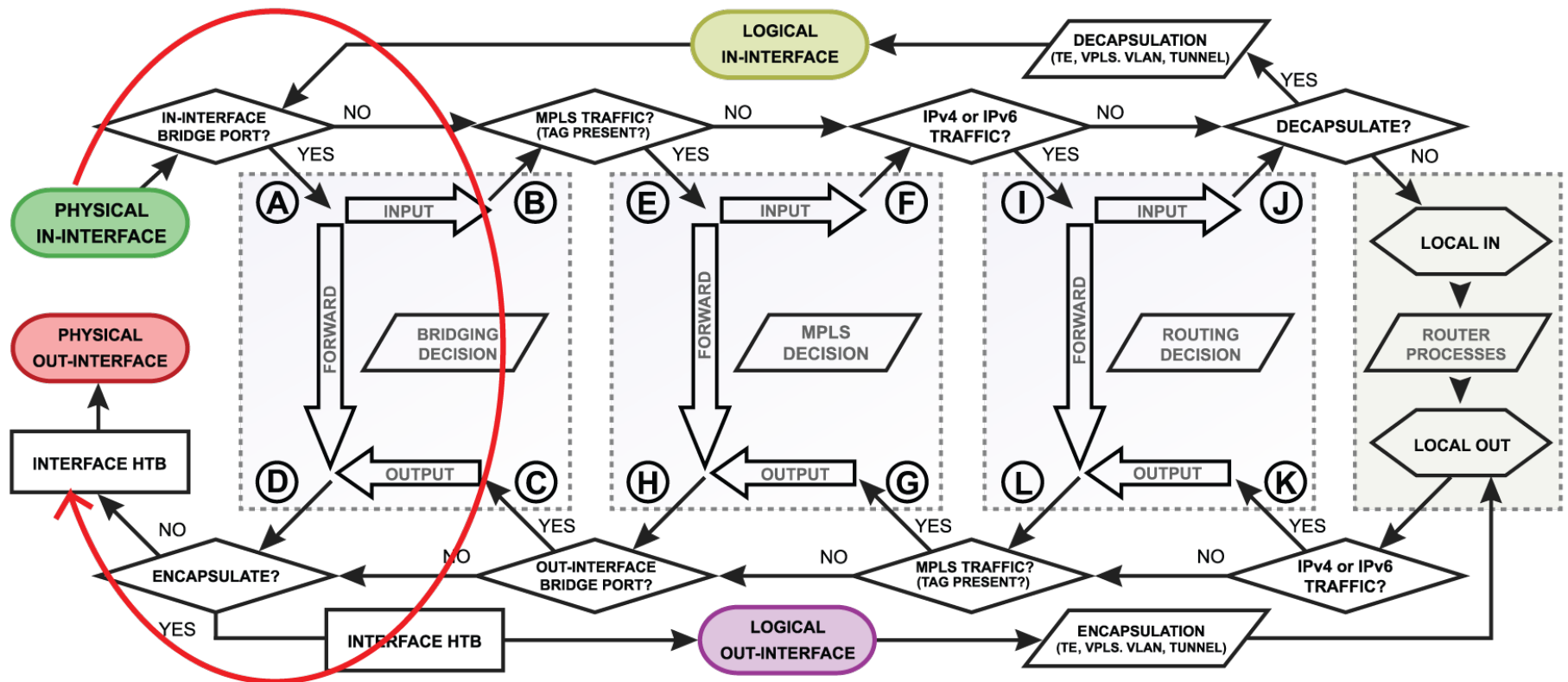- G VPLS OR TE TUNNEL → MPLS DECISION
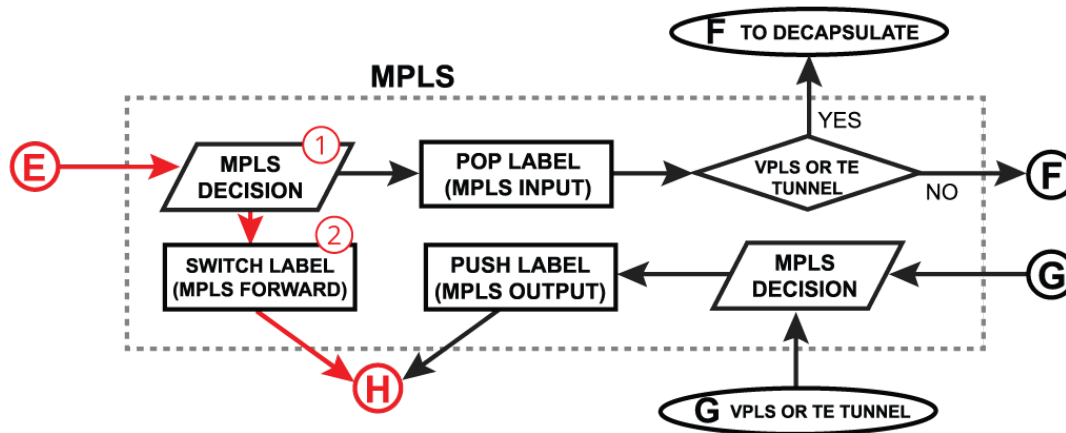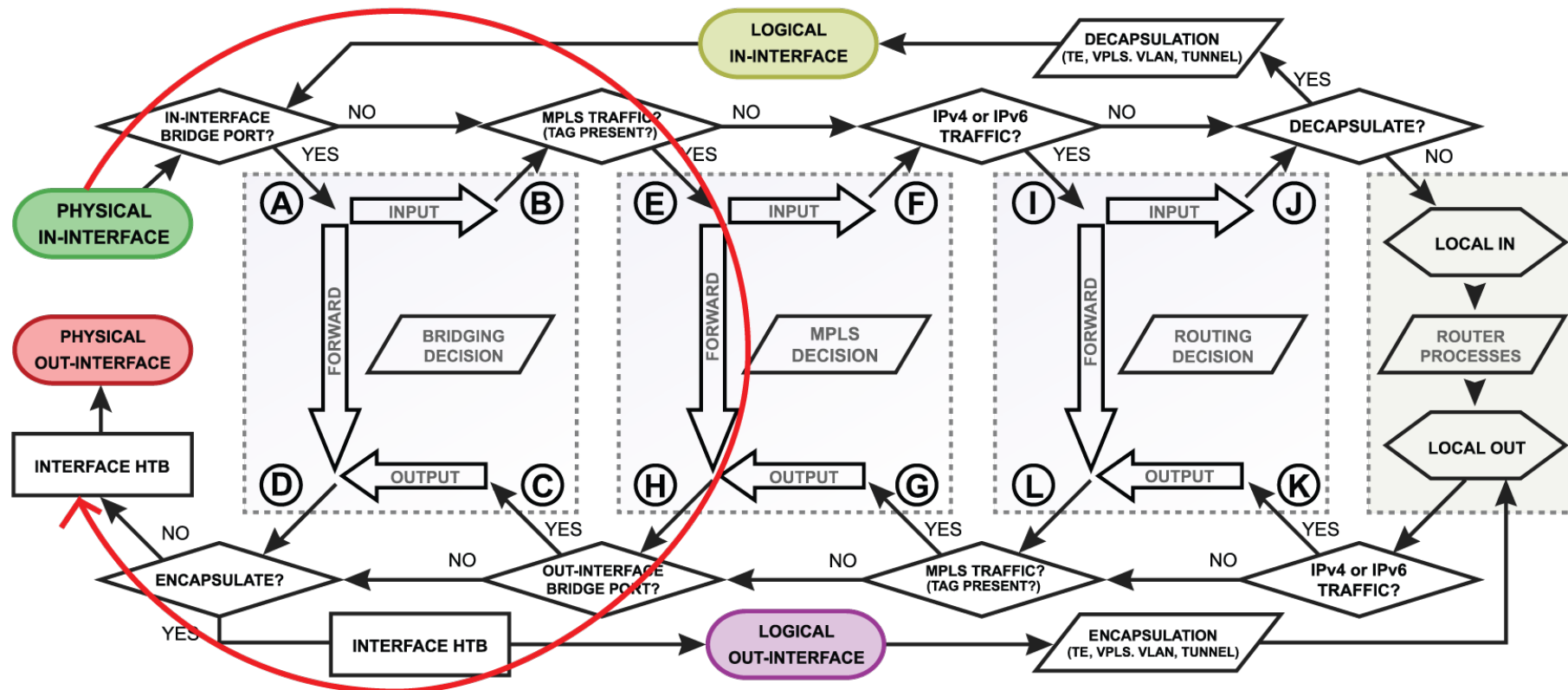
Yes, still - Packet Flow Diagram (page 3)
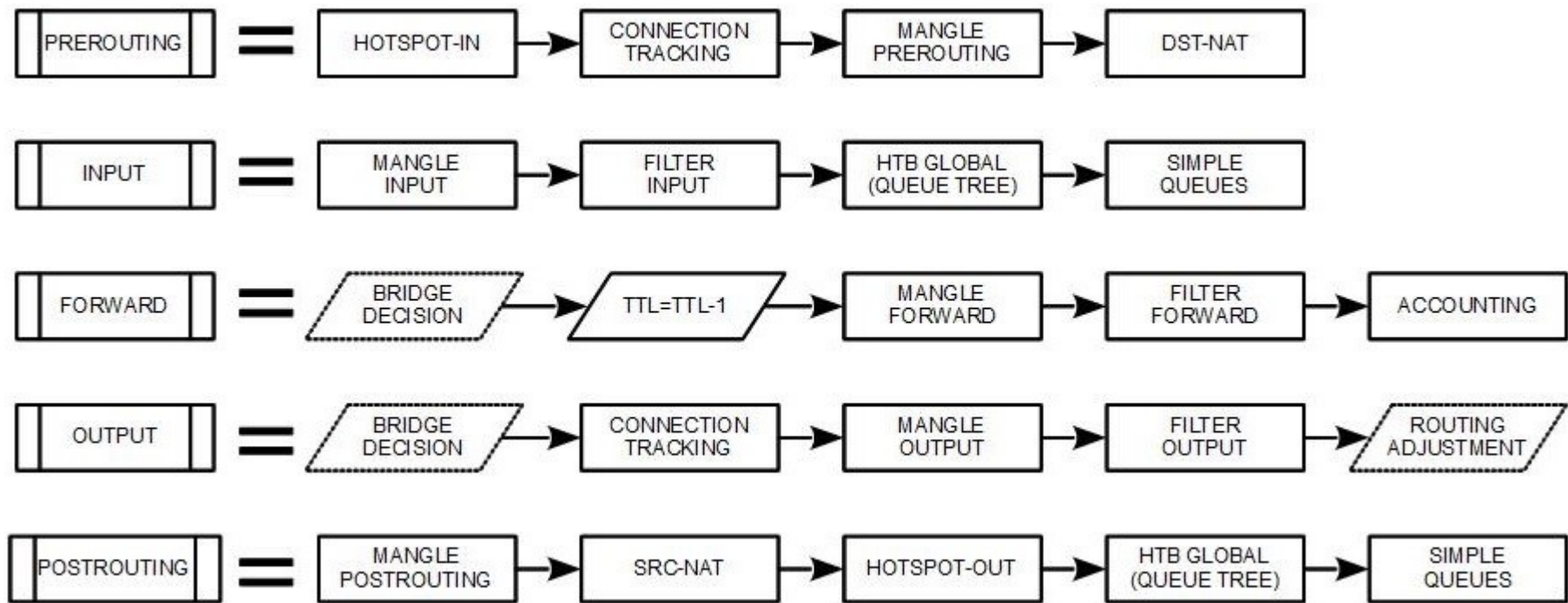
"SlowPath"

- "Slow Path" is the regular way packets are processed in RouterOS

- For each packet RouterOS has to check the whole path of the packet

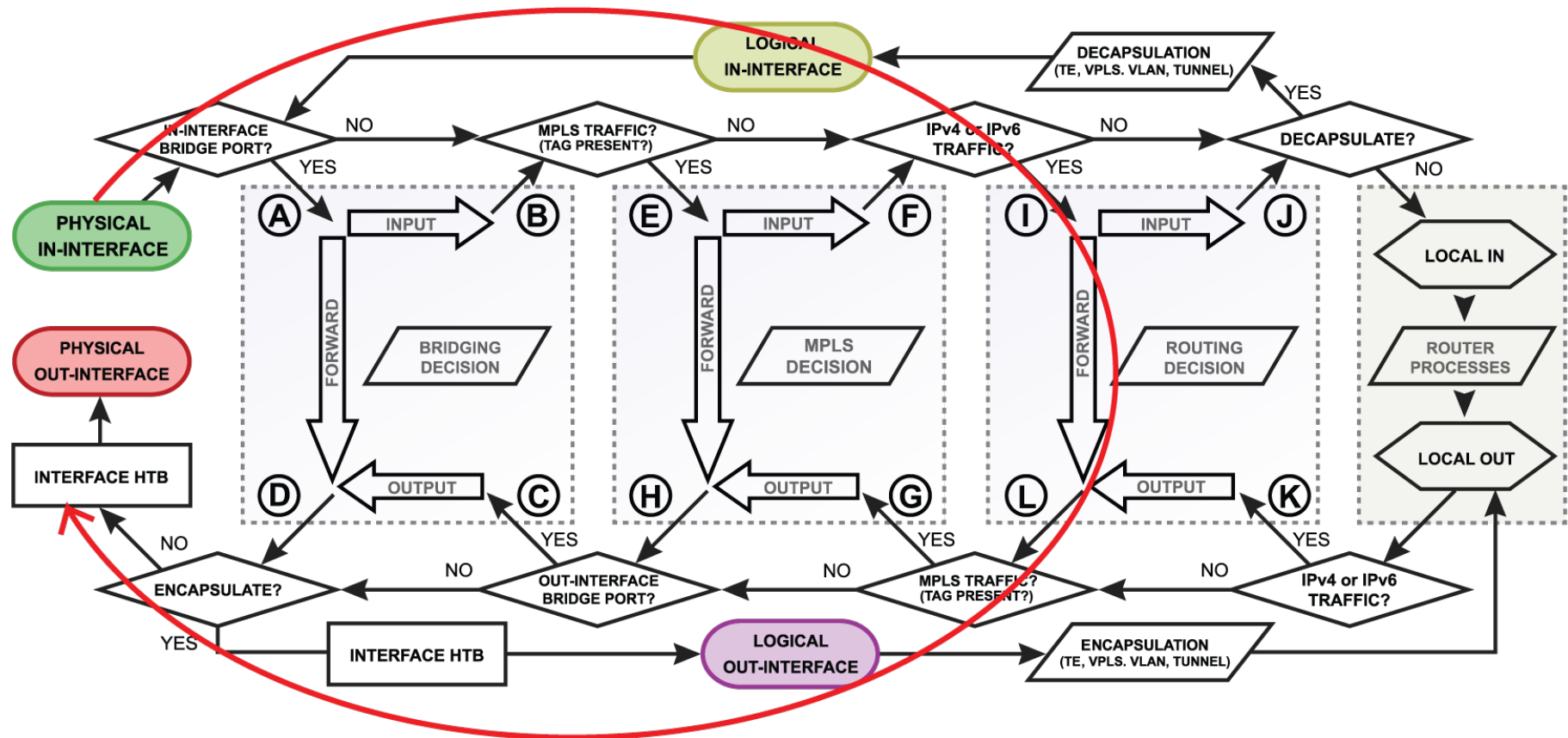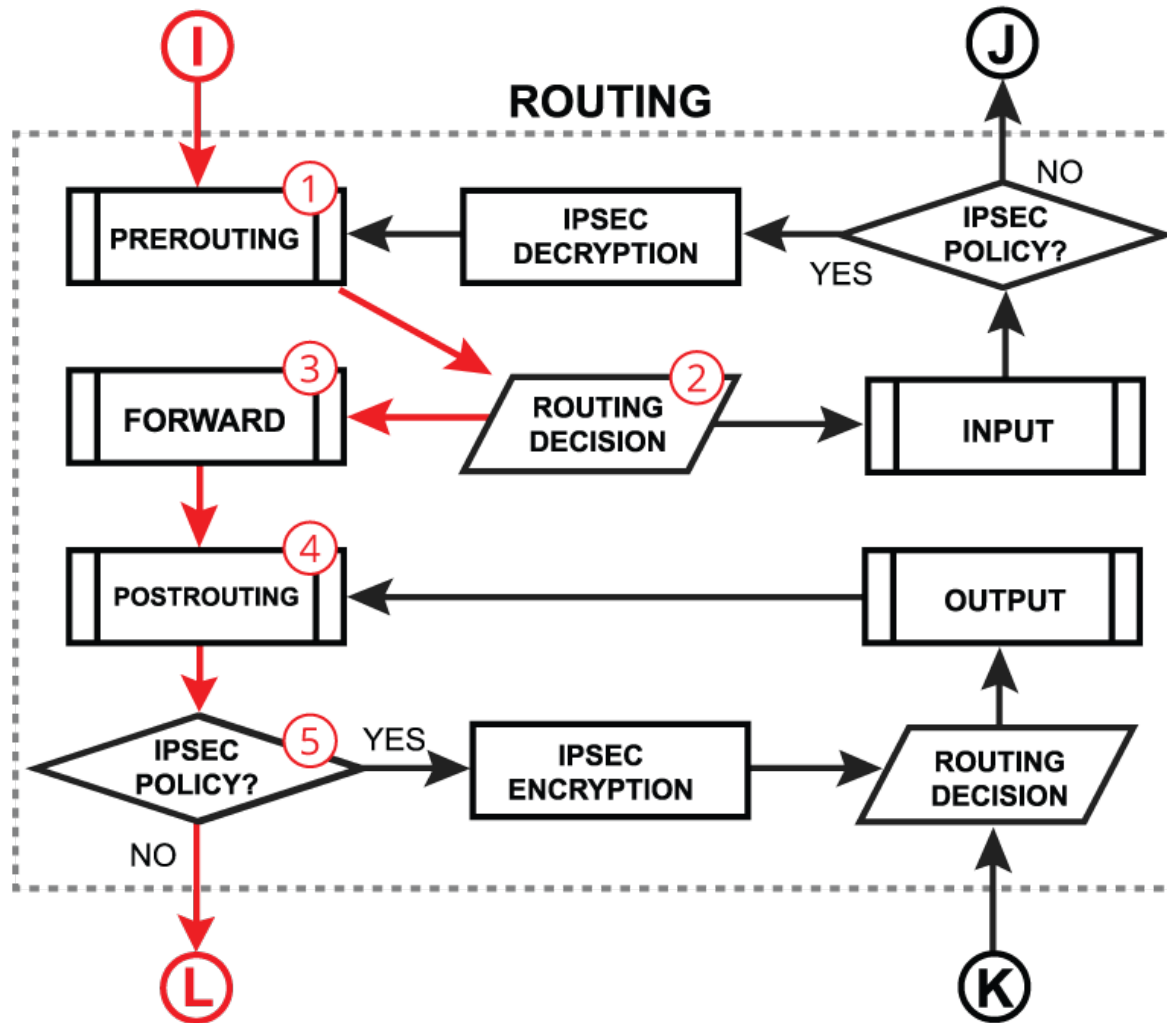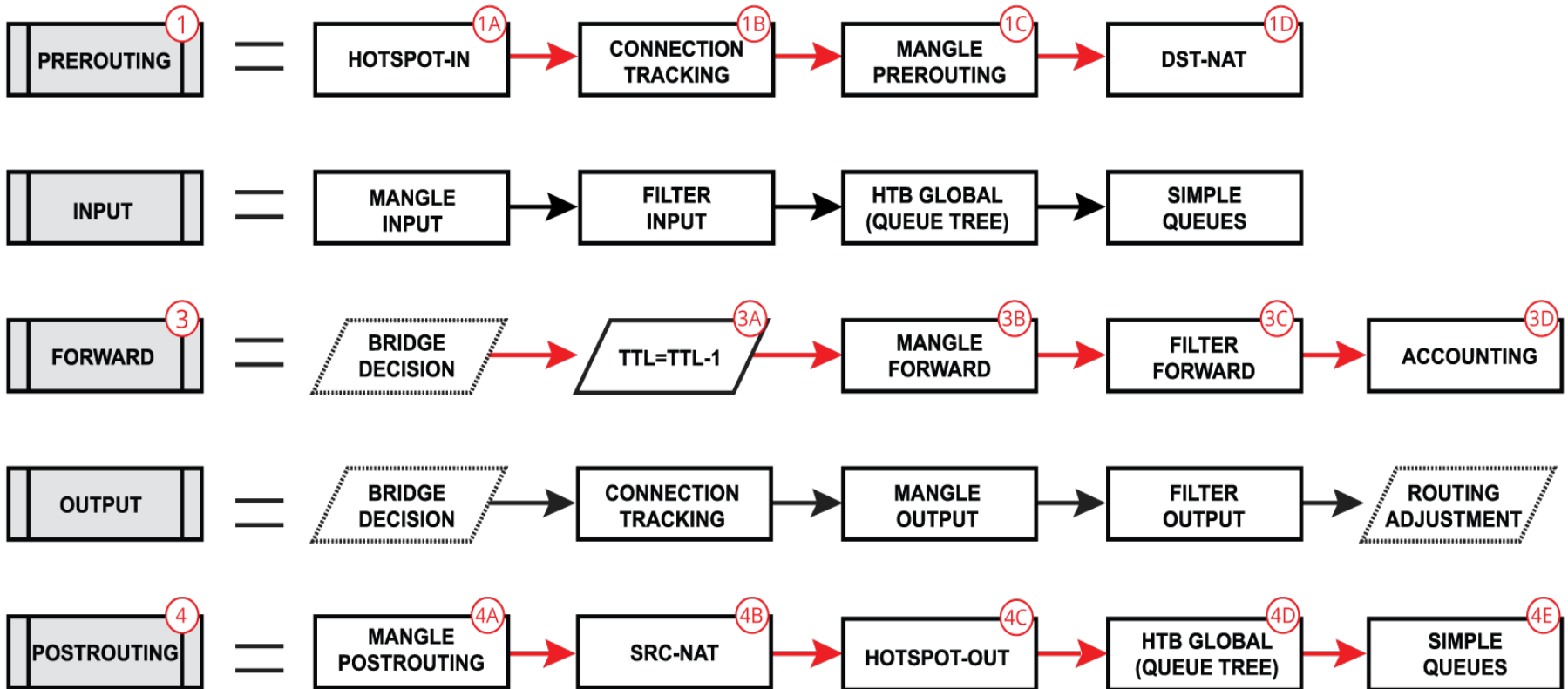- In some cases it is a considerable number of steps

Bridge Forwarding

Bridge Forwarding

MPLS Forwarding

Routing Forwarding

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Routing Forwarding

Routing Forwarding

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Initial FastPath Implementation

- FastPath is interface driver extension, that allows to receive/process/send traffic without unnecessary processing

- Interface driver now can talk directly to specific RouterOS processes skipping all other

- 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
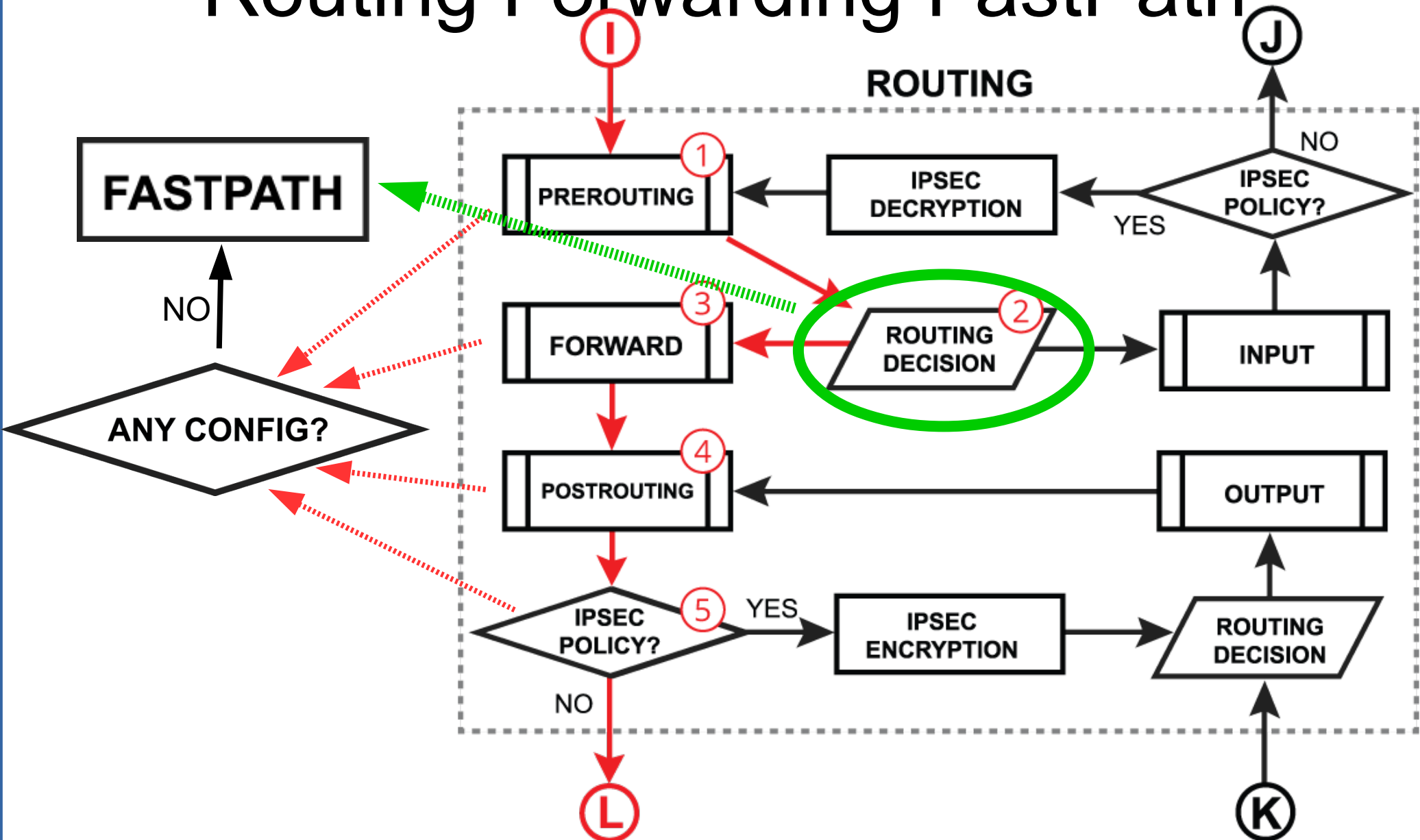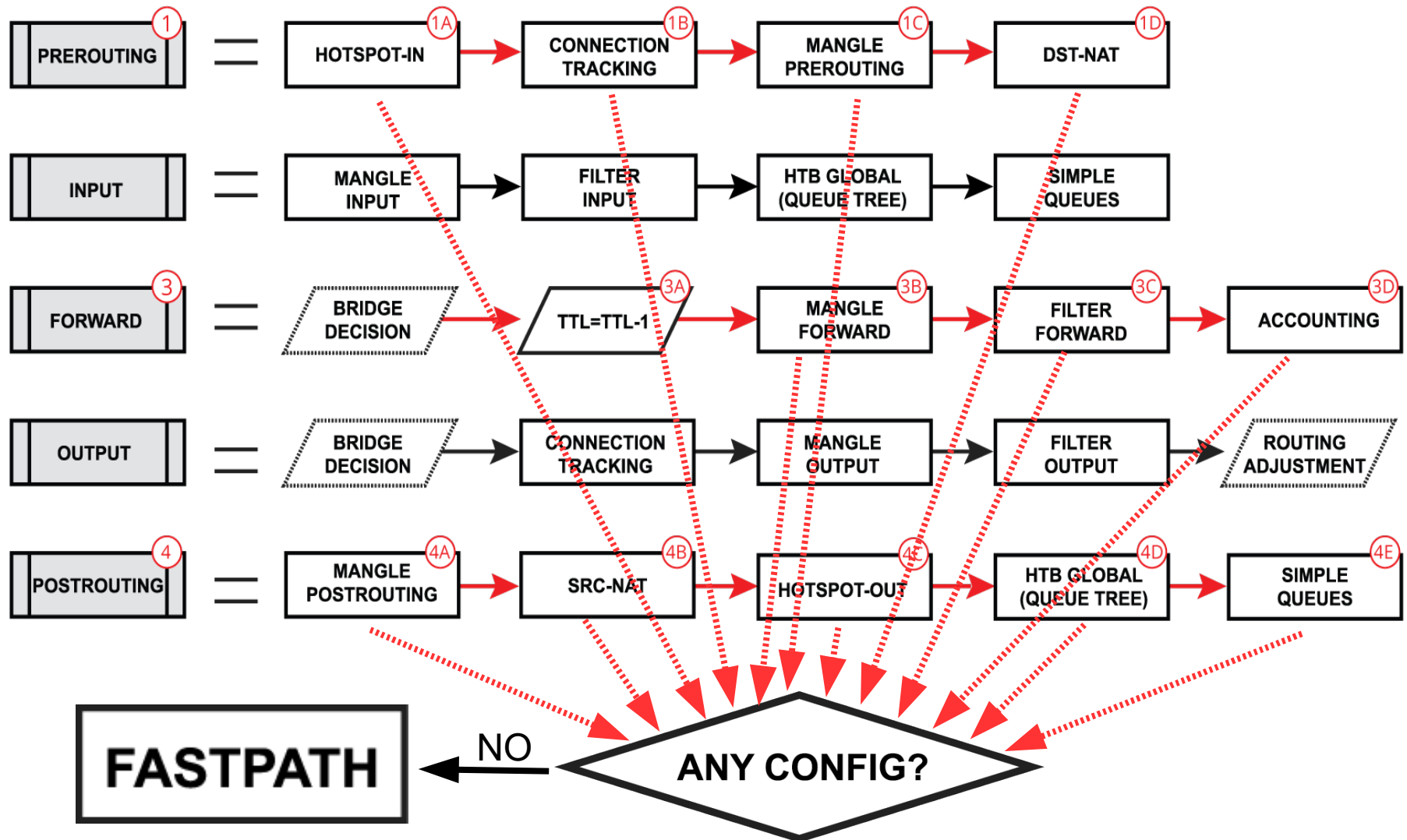
Allow FastPath

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Bridge Forwarding FastPath

Routing Forwarding FastPath

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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

Half-FastPath

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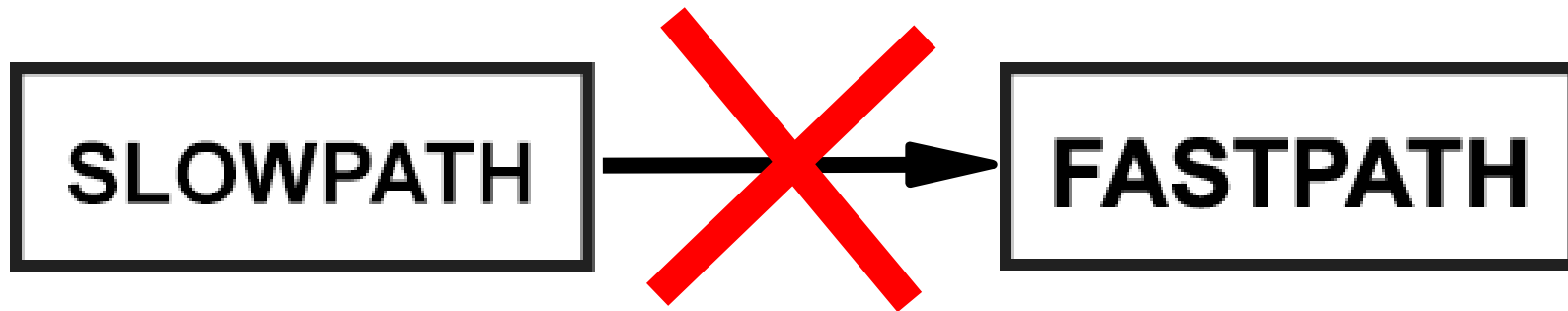
FastPath for Logical Interfaces

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 **(coming soon)**

Logical Interfaces in RouterOS
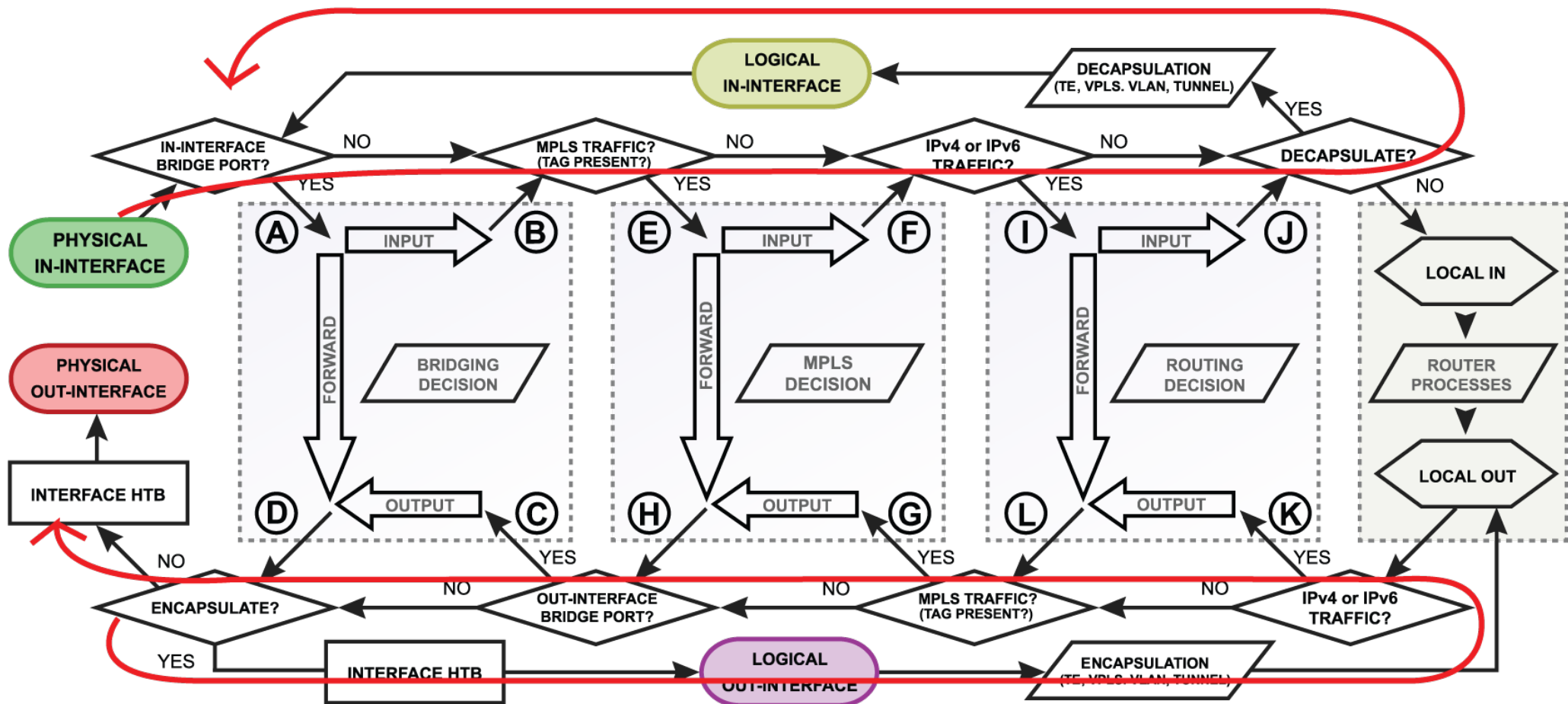
EOIP, GRE, IPIP and FastPath

- 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)*

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 still will go the regular path to maintain conntrack entries

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

Routing Forwarding FastPath

Fasttrack-Connection

Without Fasttrack

- Board:
  RB2011UiAS-2HnD

- Configuration:
  default Home AP

- Throughput:
  358Mbps

- CPU load:
  100%

- Firewall CPU load:
  44%

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With Fasttrack

- Board:
  RB2011UiAS-2HnD

- Configuration:
  default Home AP

- Throughput:
  890Mbps

- CPU load:
  86%

- Firewall CPU load:
  6%

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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.
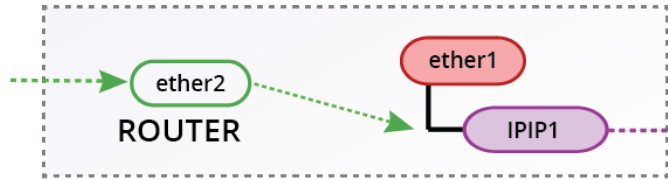
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Interface Queue and FastPath

• 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

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- Ether1 and ether2 have FastPath support
- IPIP1 "allow-fast-path" setting enabled
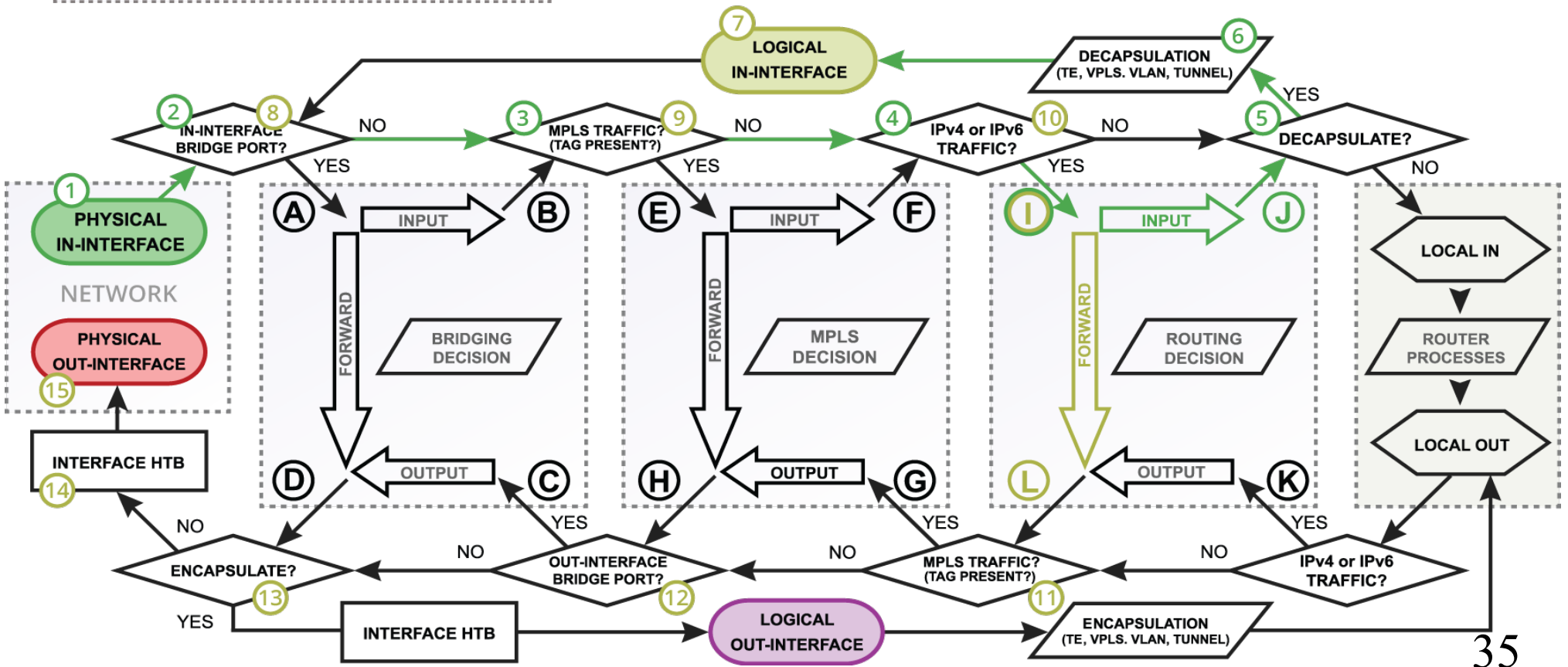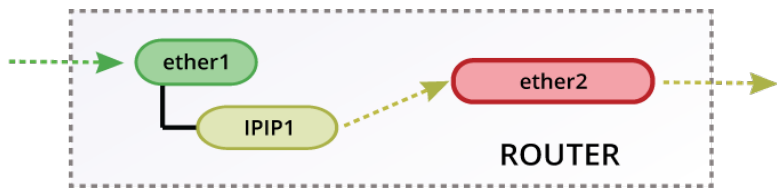- IP forwarding FastPath allowed
 - TCP "FastTraked" connection
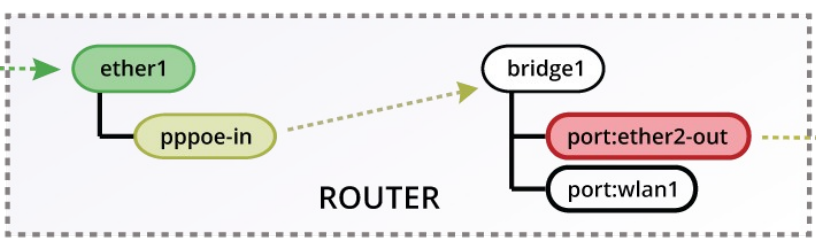 - Simple queues
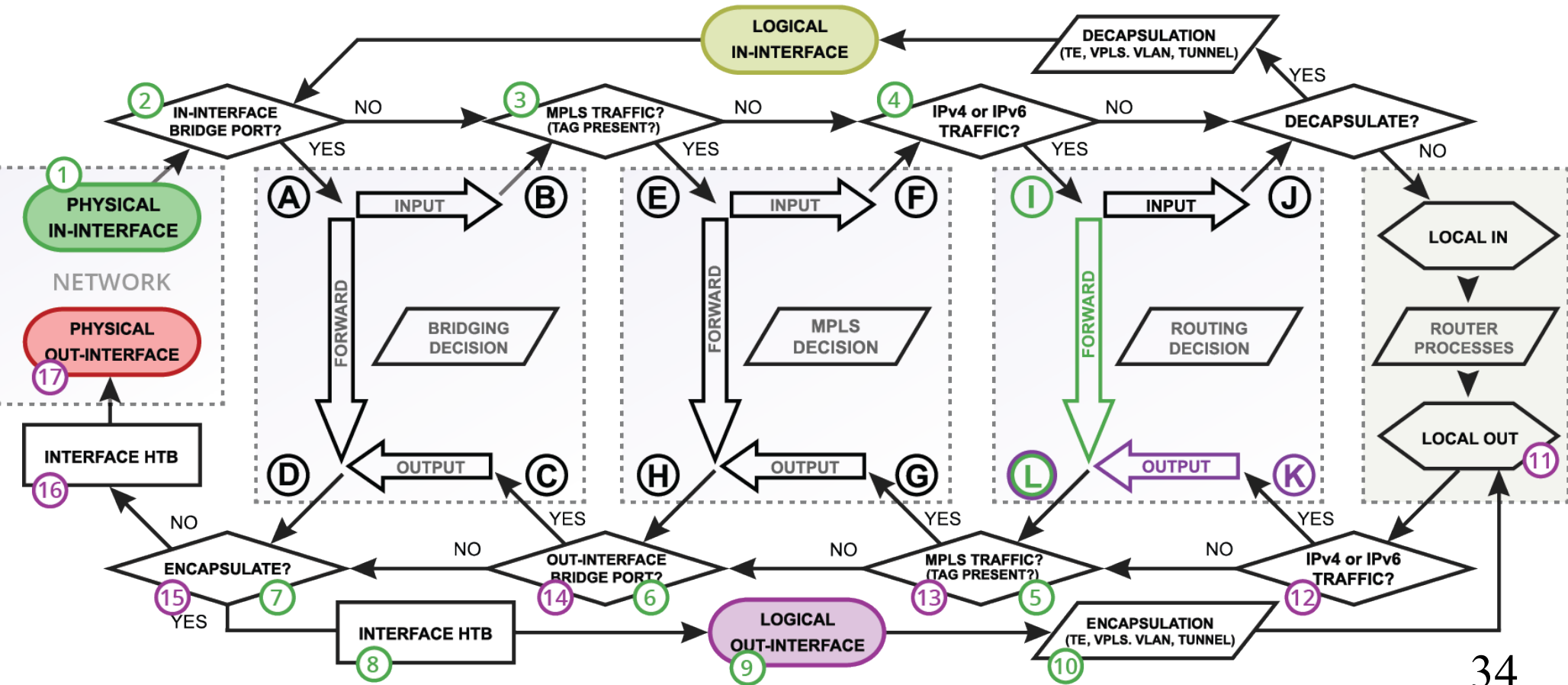
- ether1 and ether2 have FastPath support
- IPIP1 "allow-fast-path" setting enabled
- IP forwarding FastPath allowed

- ICMP traffic
- NAT

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

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

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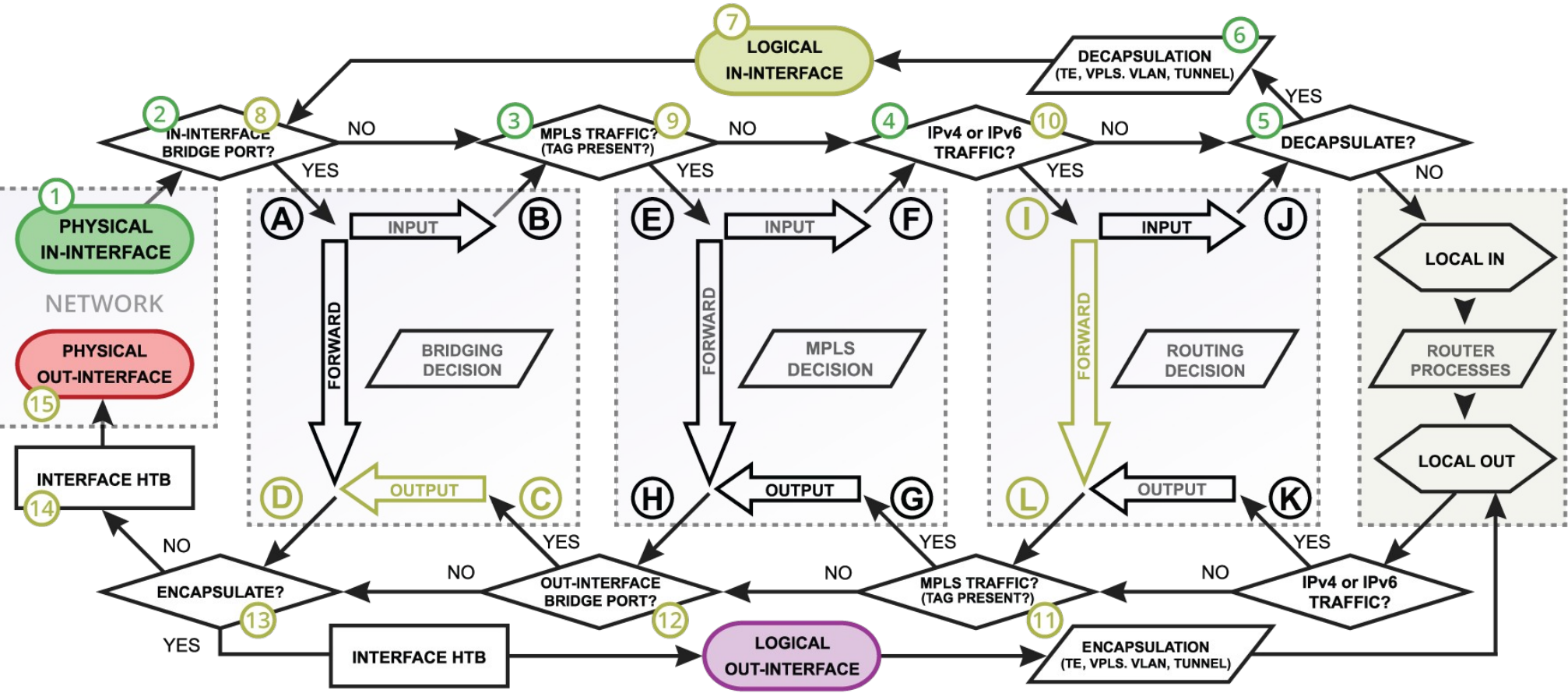
Bottom Line

• 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, no FastTracked conenctions ect.

Questions!!!