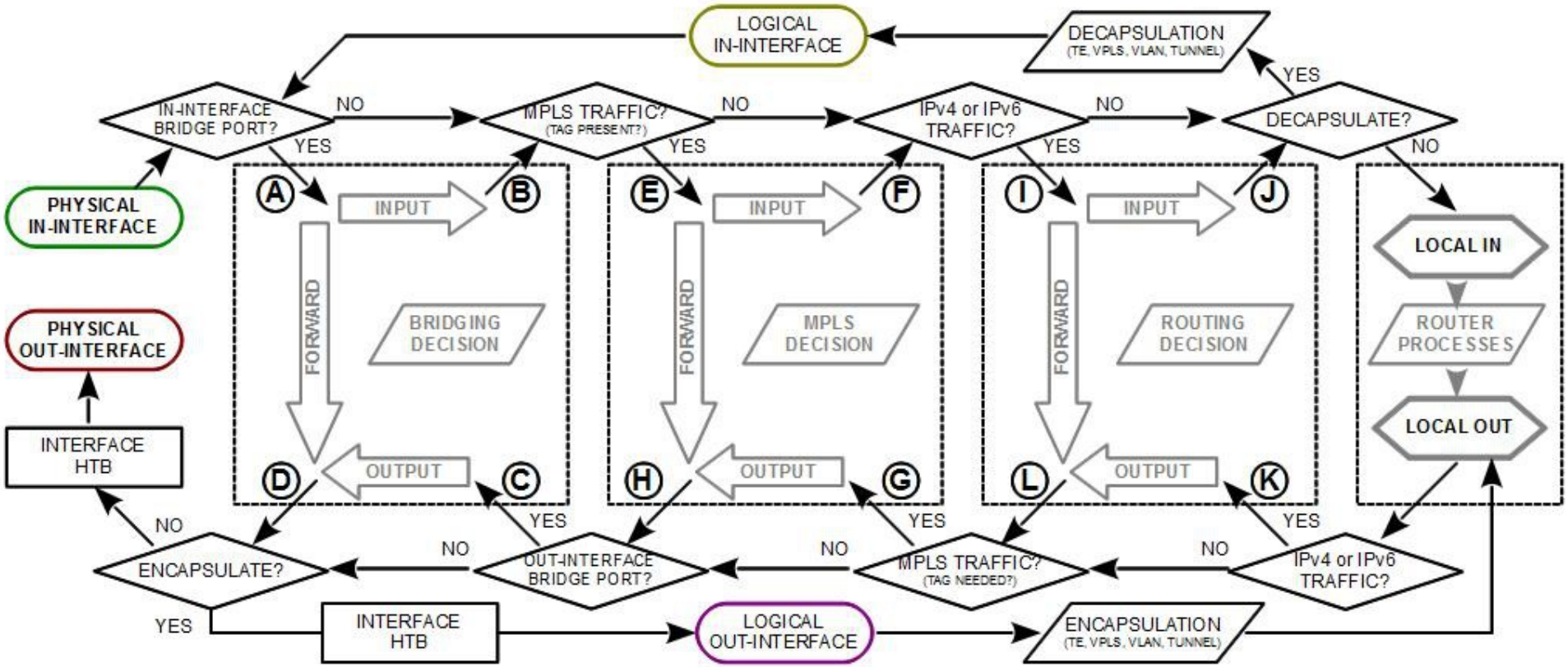
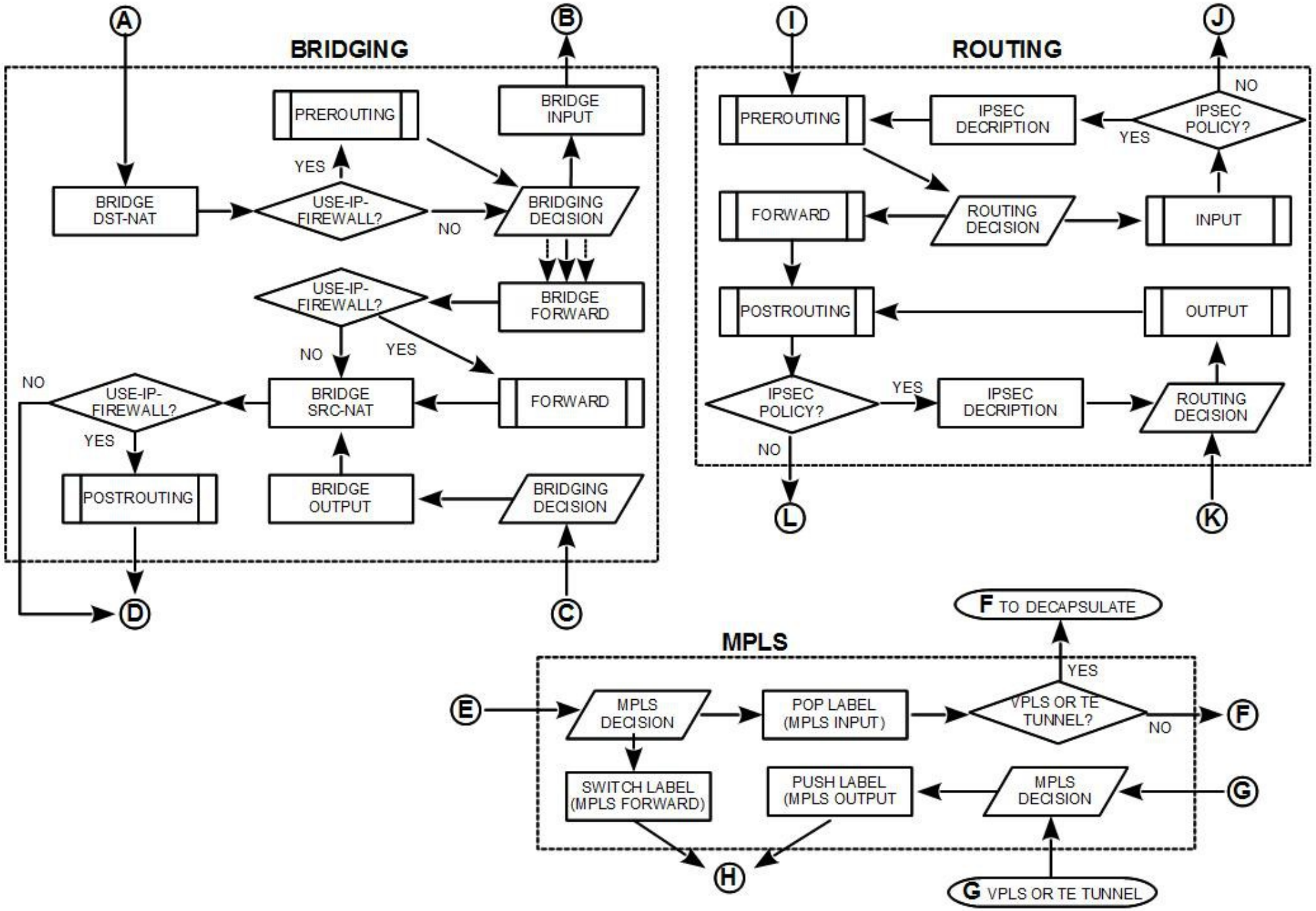
# *FastPath Overview*

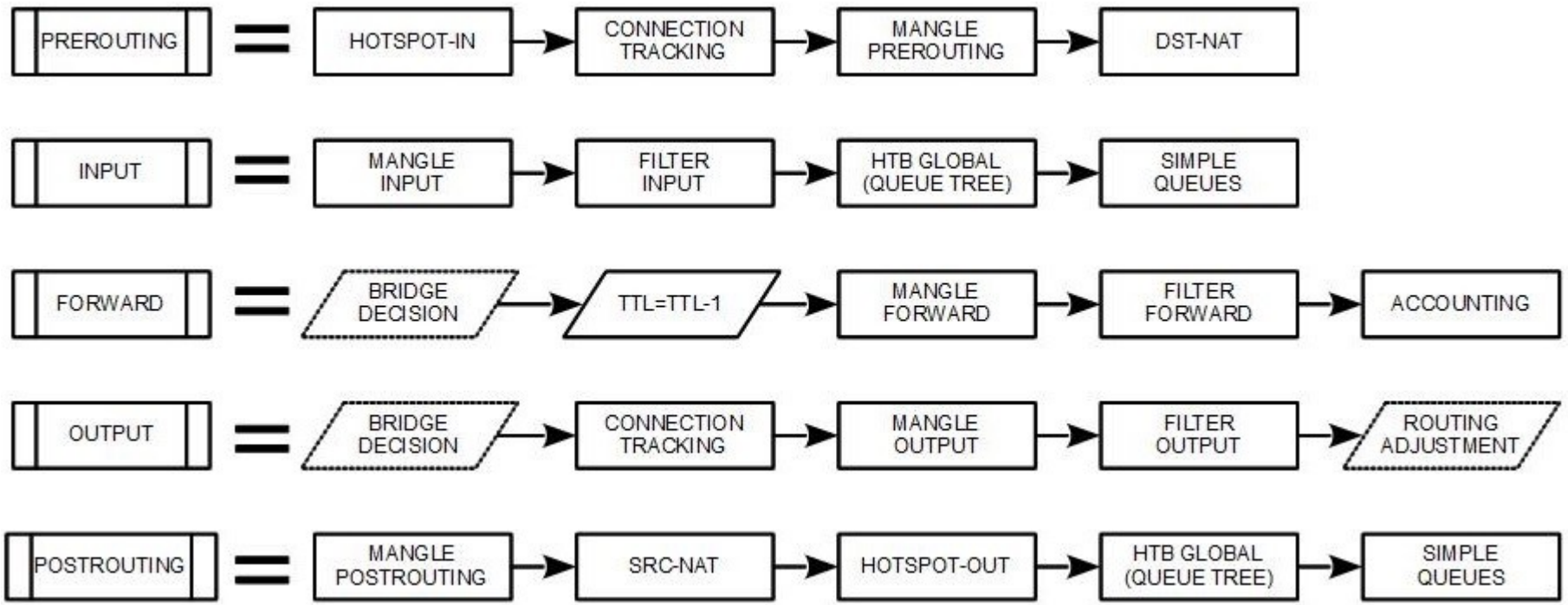
MUM Ukraine, 2015

# MikroTik RouterOS Packet Flow Diagram for version 6.x




A
BRIDGING
B
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
ROUTING
J
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

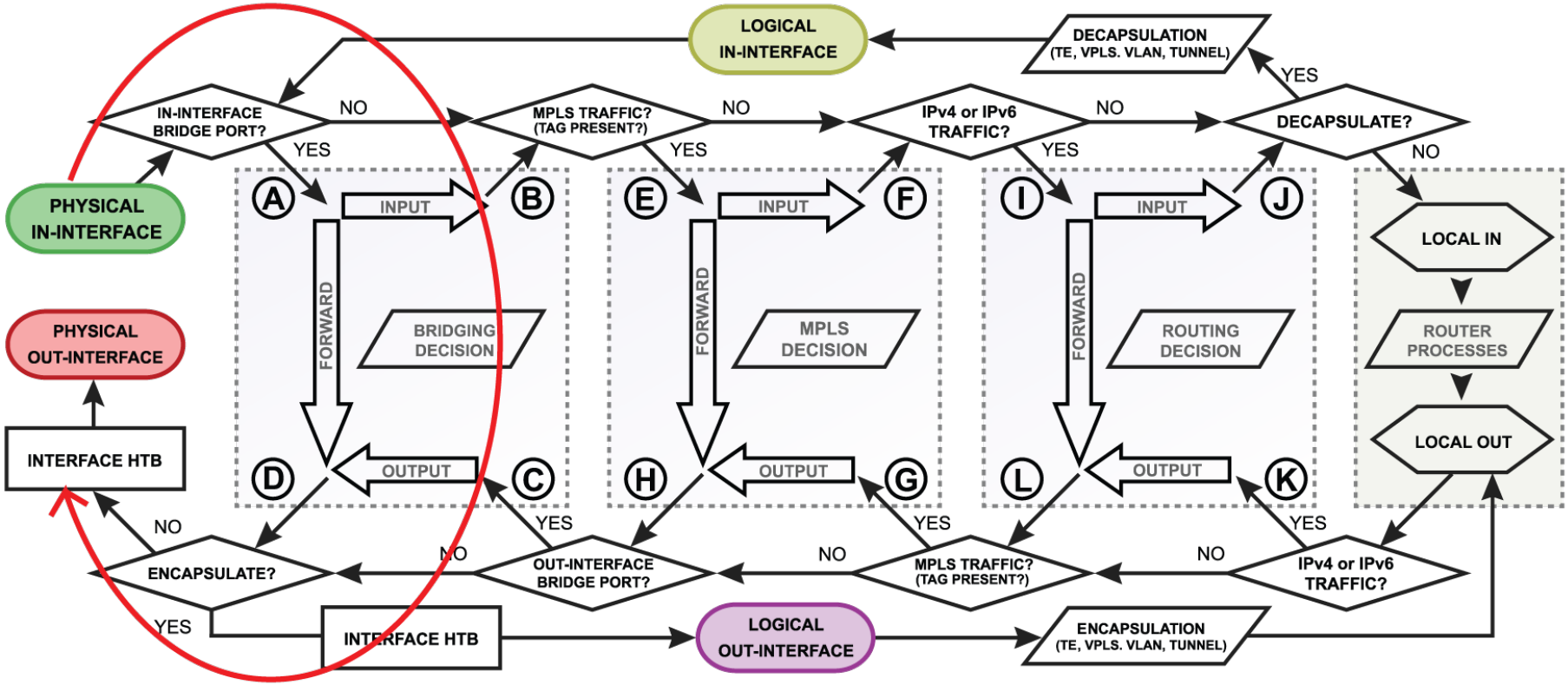
# Yes, still - Packet Flow Diagram (page 3)



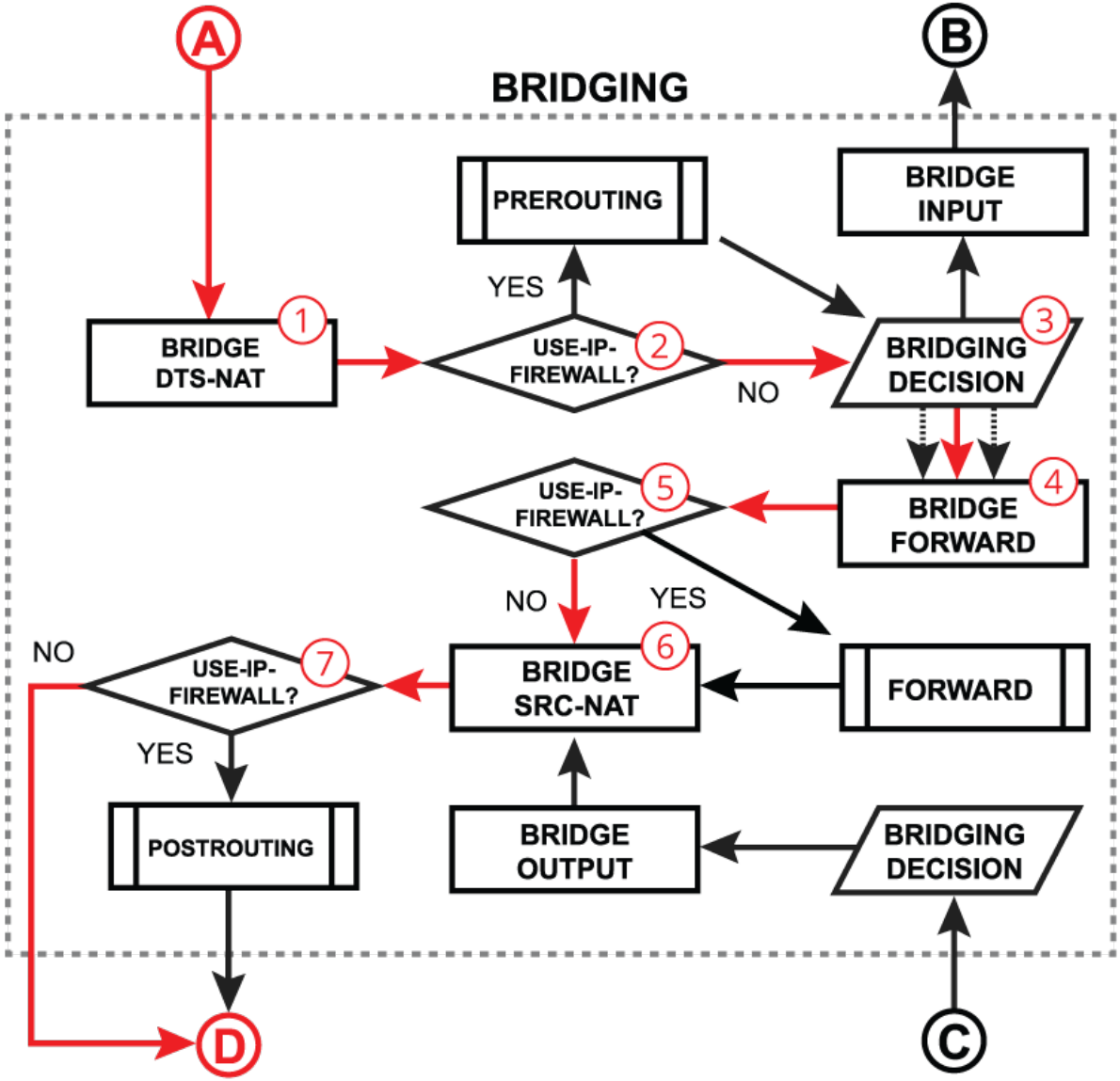
# “SlowPath”

- “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

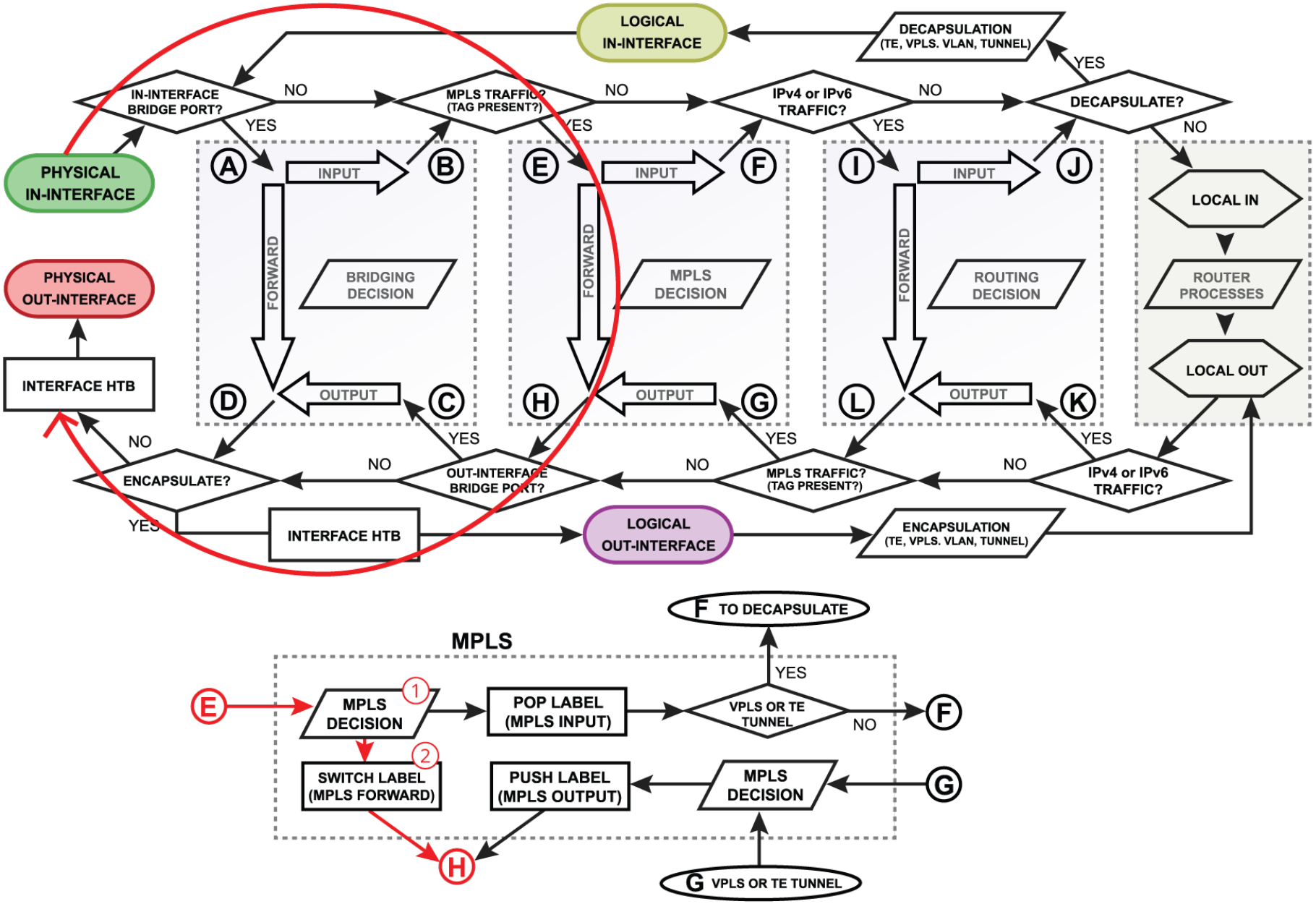
# Bridge Forwarding



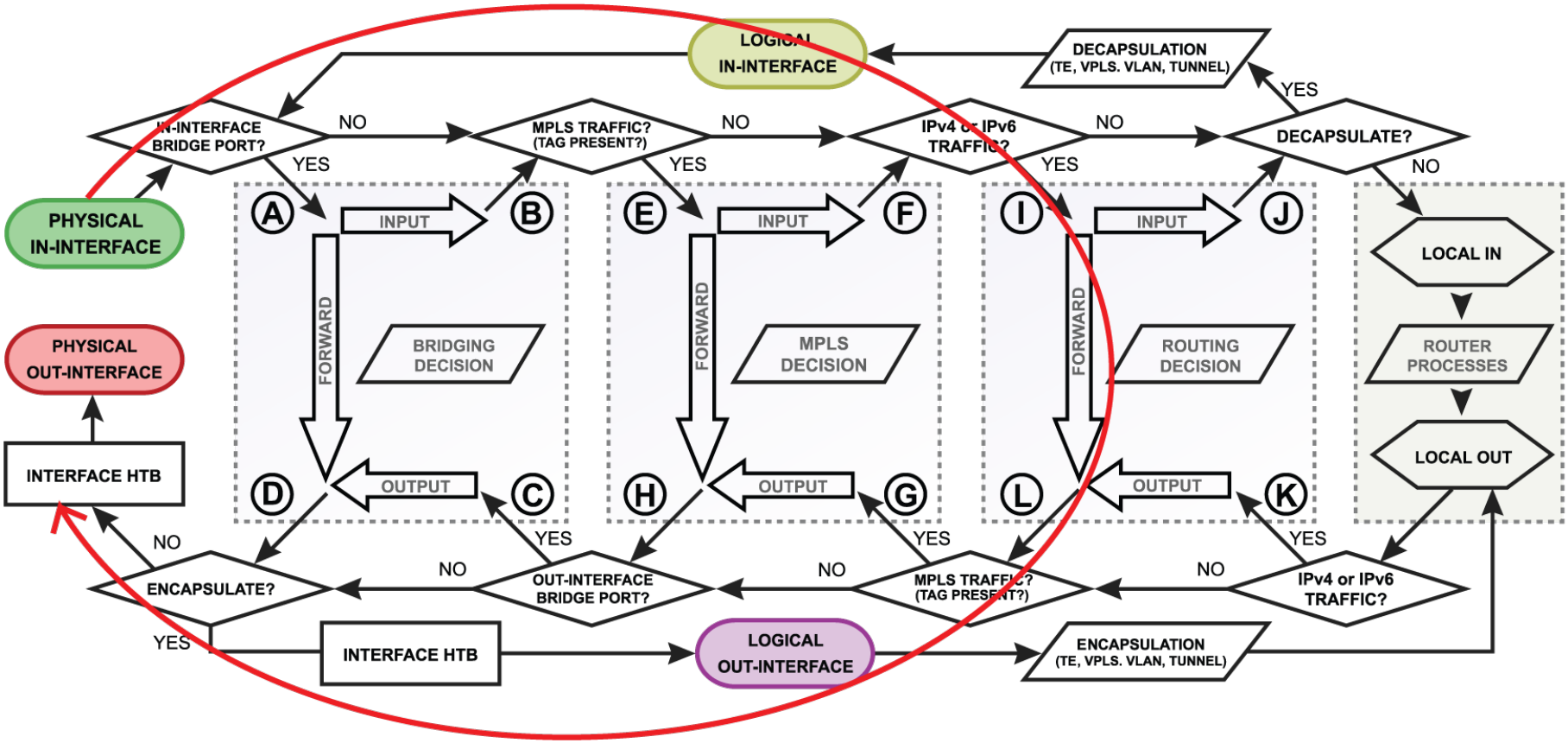
# Bridge Forwarding



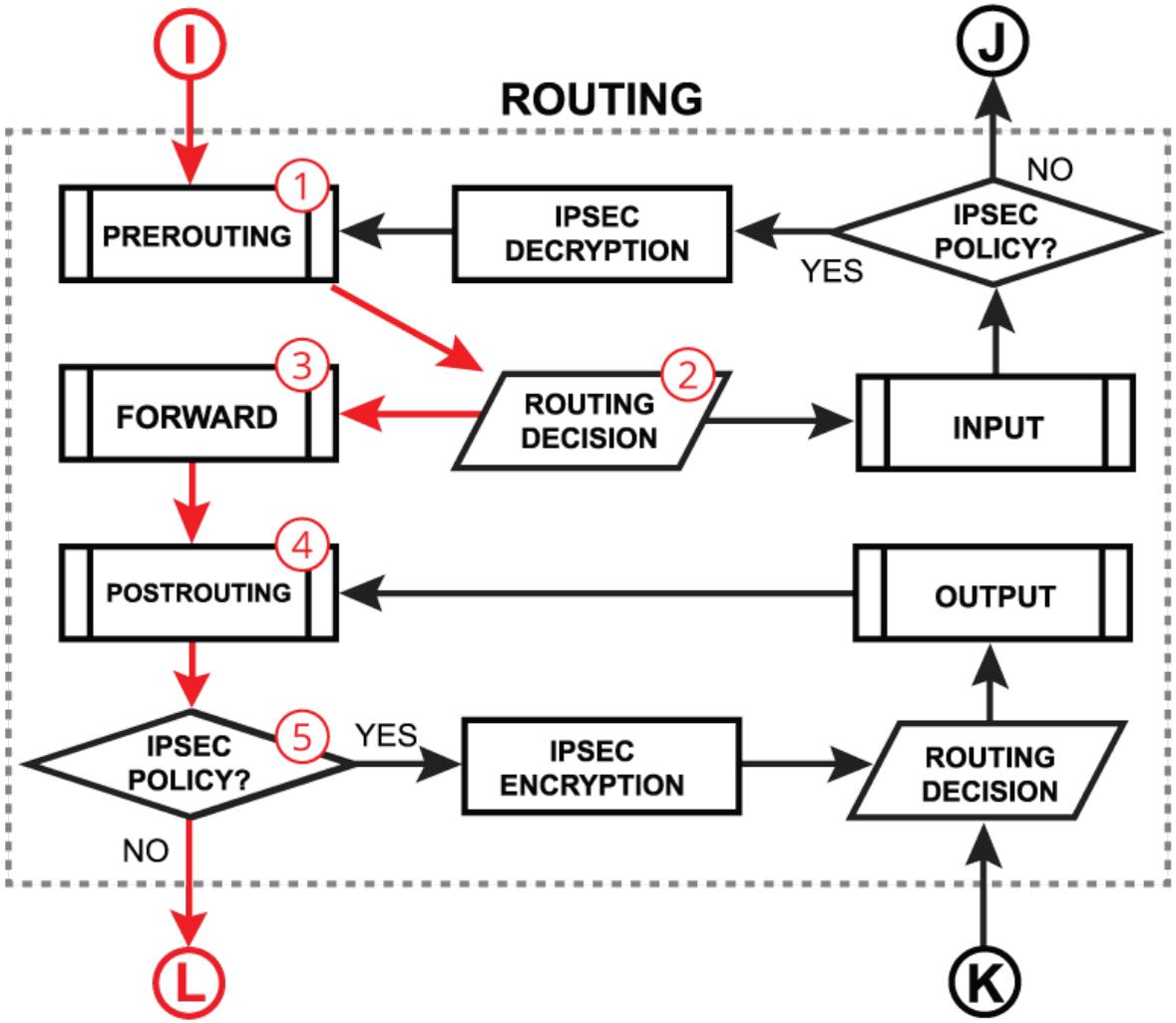
# MPLS Forwarding



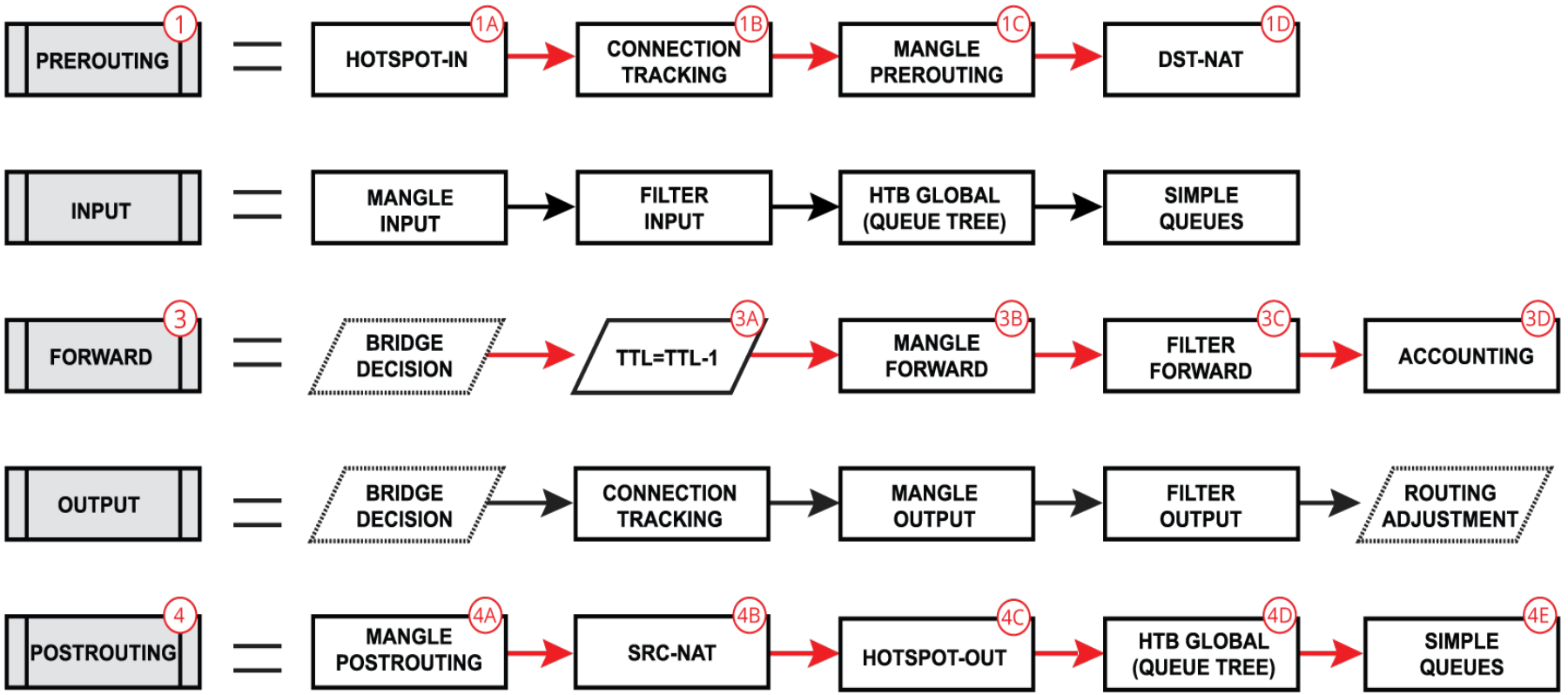
# Routing Forwarding



# Routing Forwarding



# Routing Forwarding



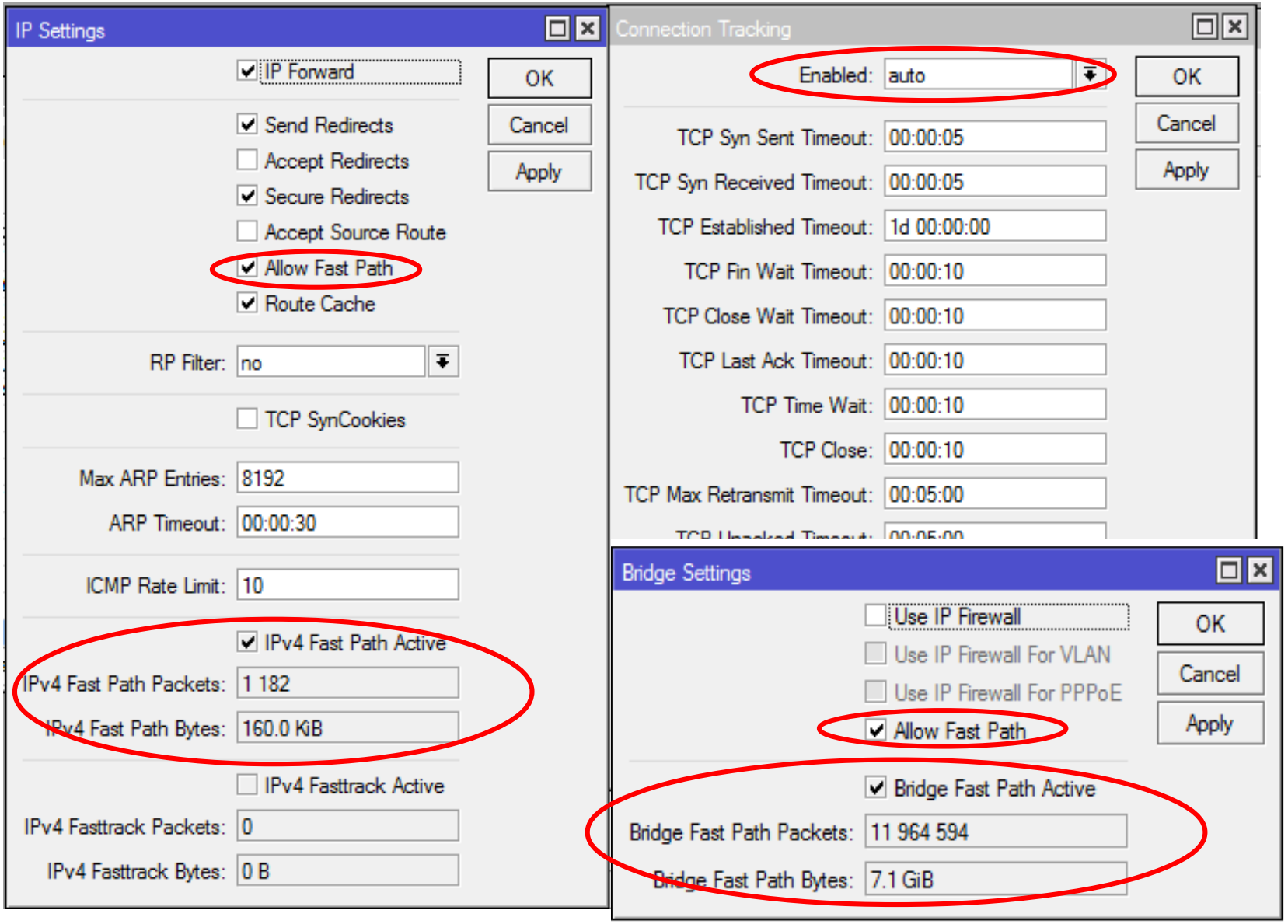
# Initial FastPath Implementation

- 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.

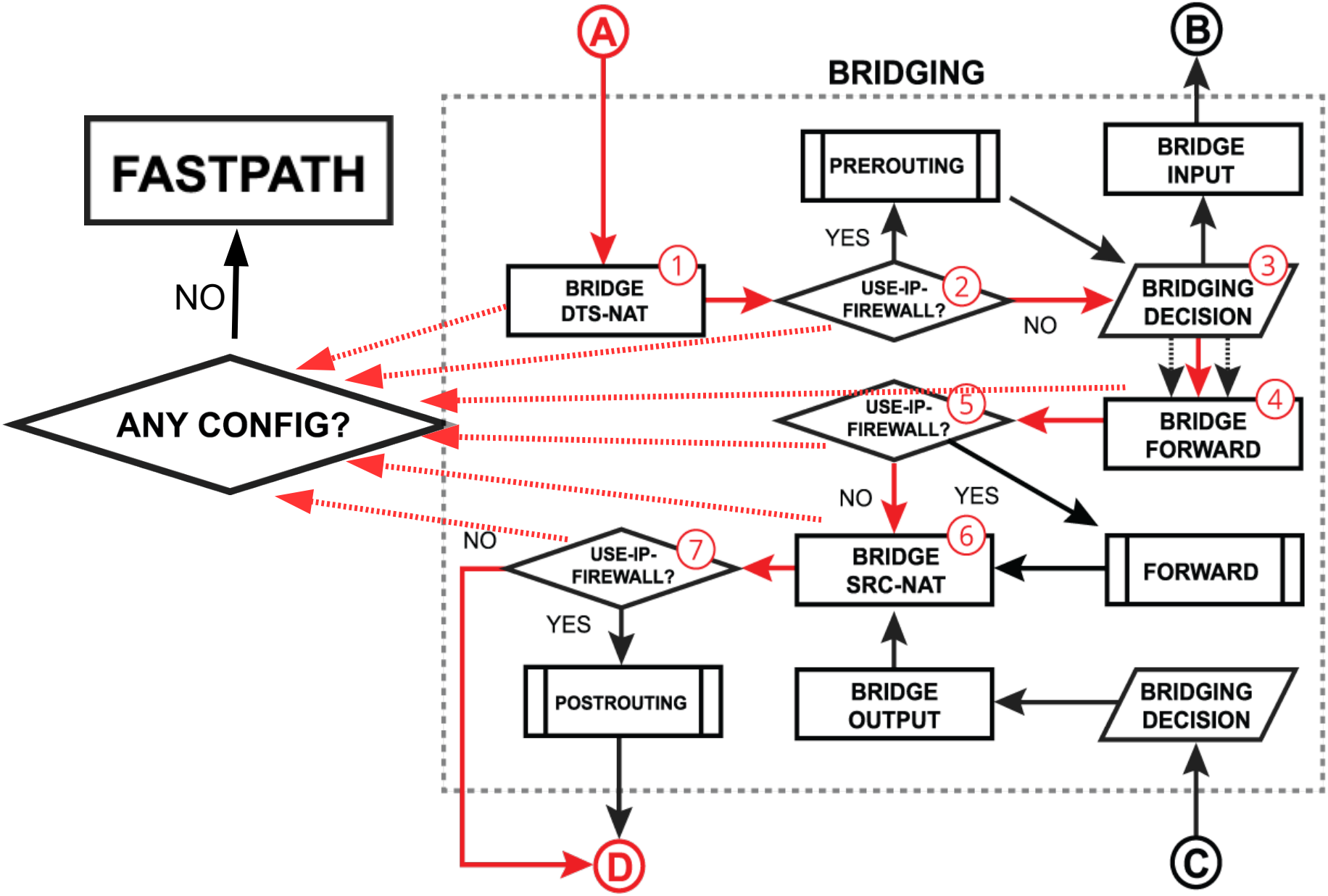
# Driver Support

- 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

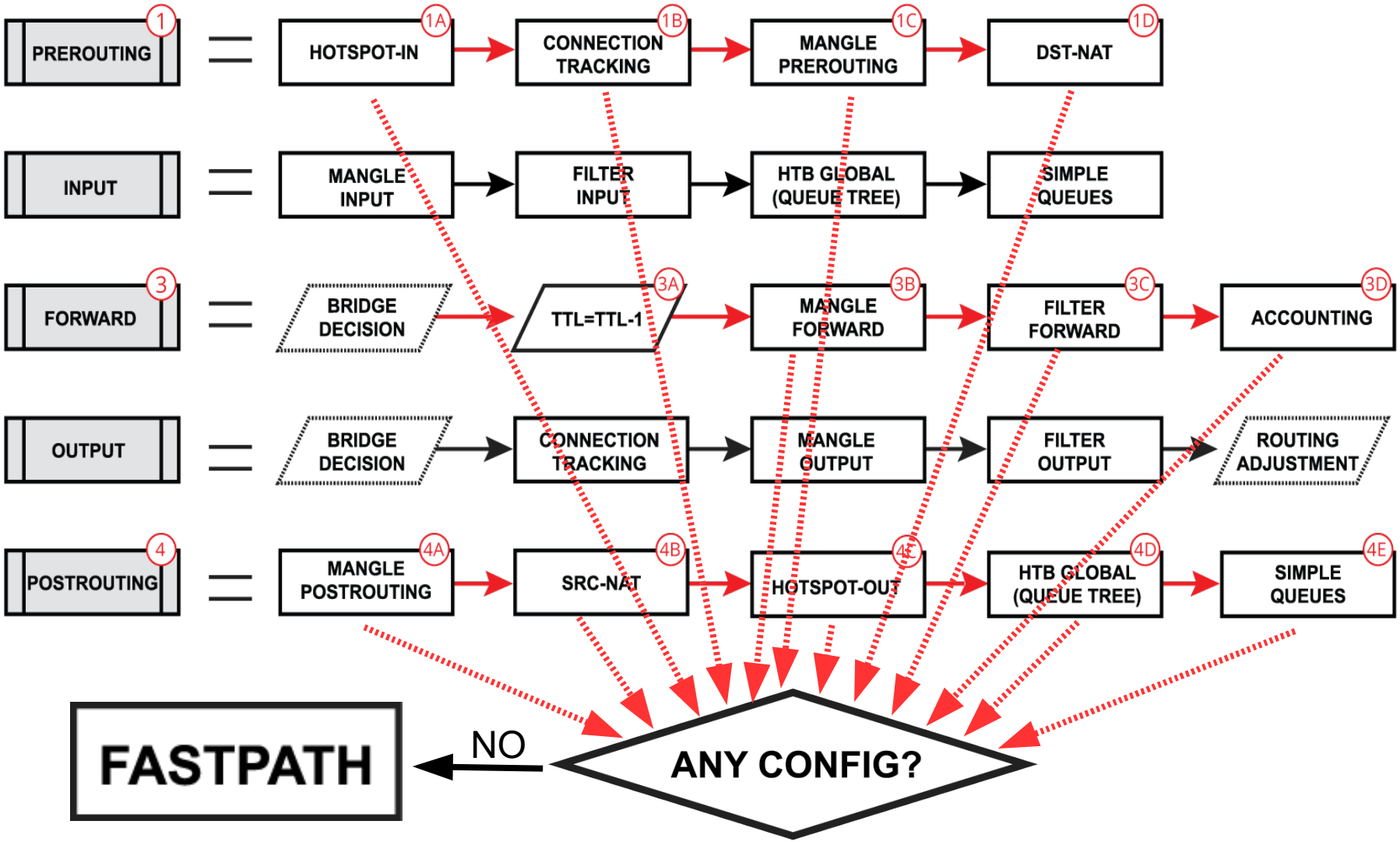
# Allow FastPath



# Bridge Forwarding FastPath



# Routing Forwarding FastPath



# SlowPath vs FastPath

- What are the performance benefits of FastPath?

**RB750Gr2 720Mhz** **All port test** **RouterOS v6.31rc2**

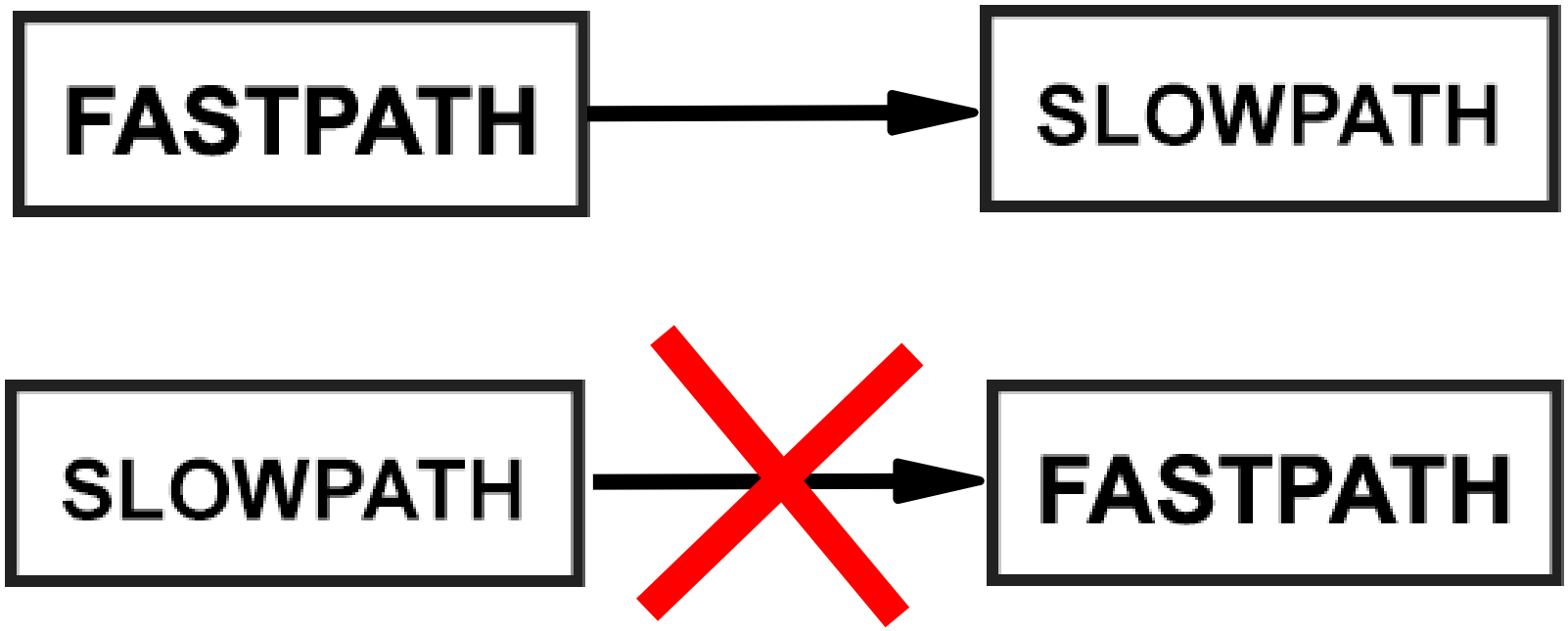
| Mode | Configuration | 64 byte | | 512 byte | | 1518 byte | |
|---|---|---|---|---|---|---|---|
| | | kpps | Mbps | kpps | Mbps | kpps | Mbps |
| Bridging | none (fast path) | 773.7 | 396.1 | **234.9** | 962.2 | **81.2** | 986.1 |
| Bridging | 25 bridge filter rules | 114.6 | 58.7 | 112.3 | 460.0 | **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 doesn't have FastPath support?

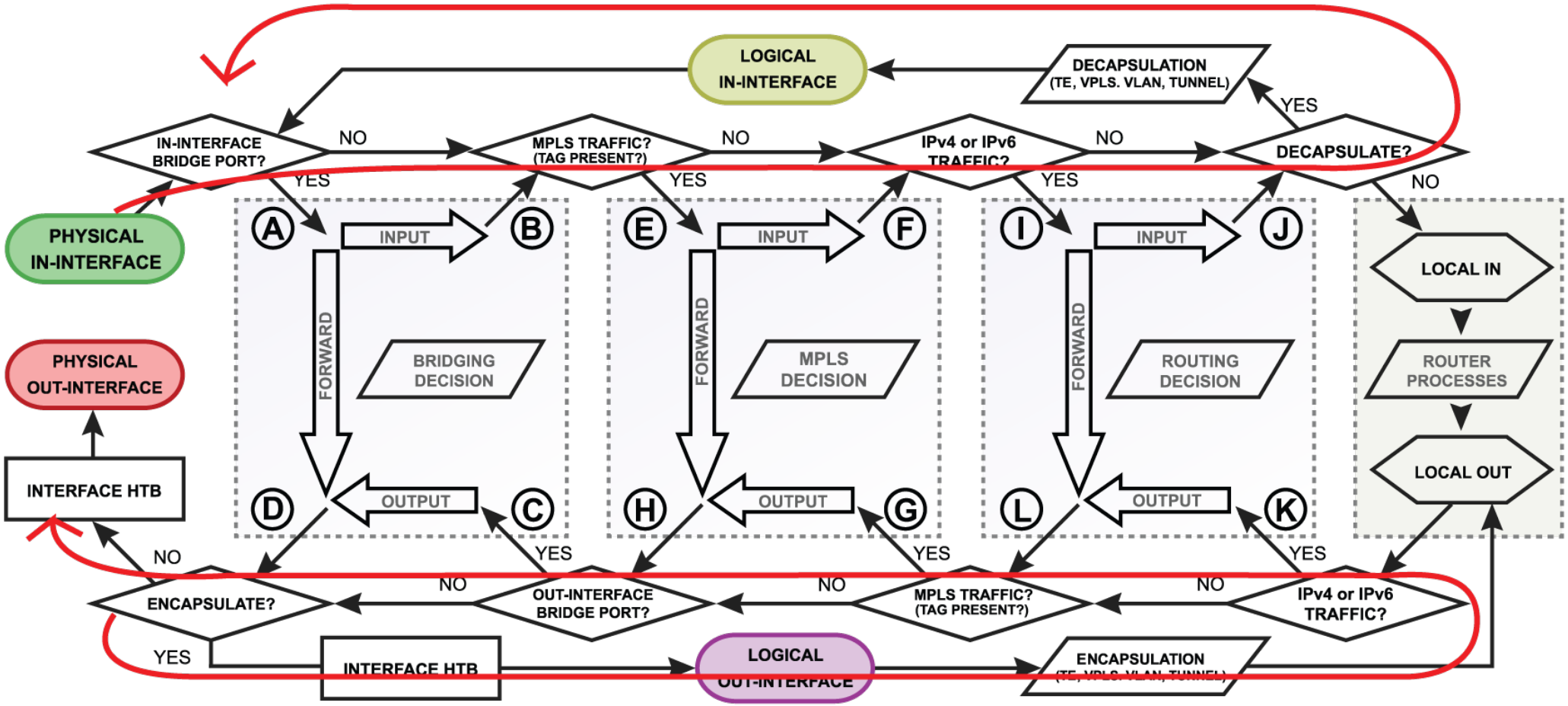


# FastPath for Logical Interfaces

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



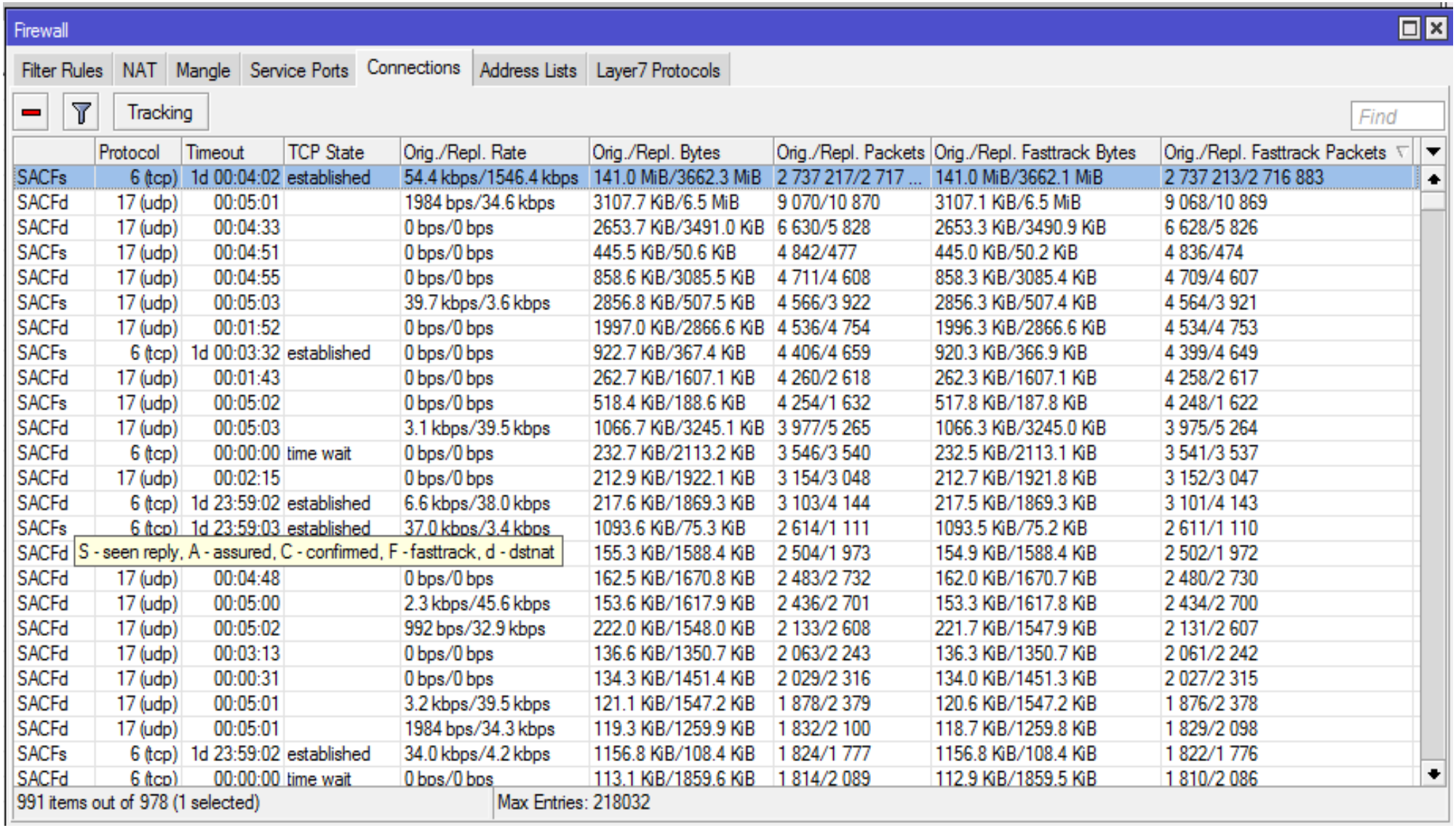
# EOIP, GRE, IPIP and FastPath

- 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.

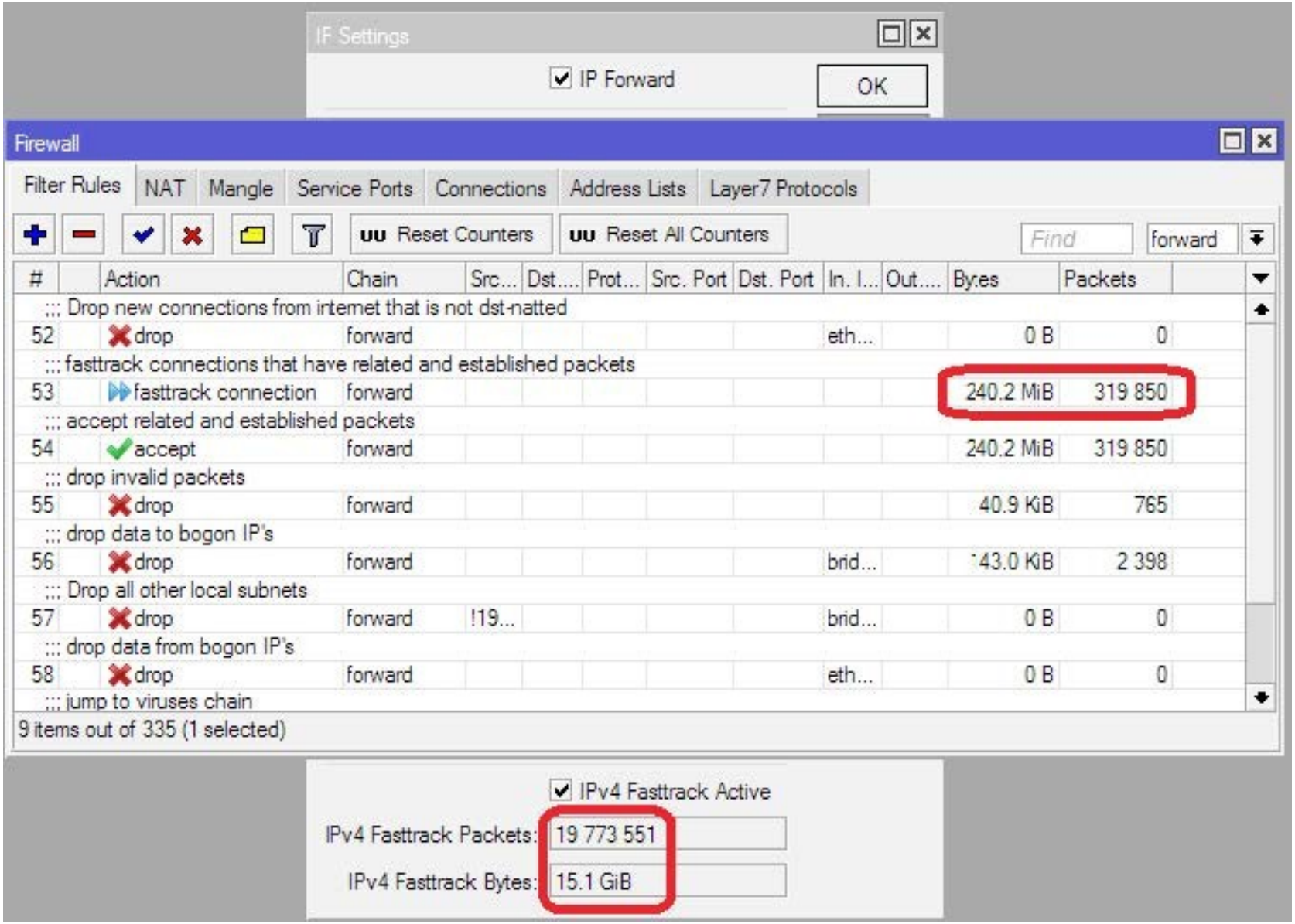
# FastPath + Conntrack = FastTrack



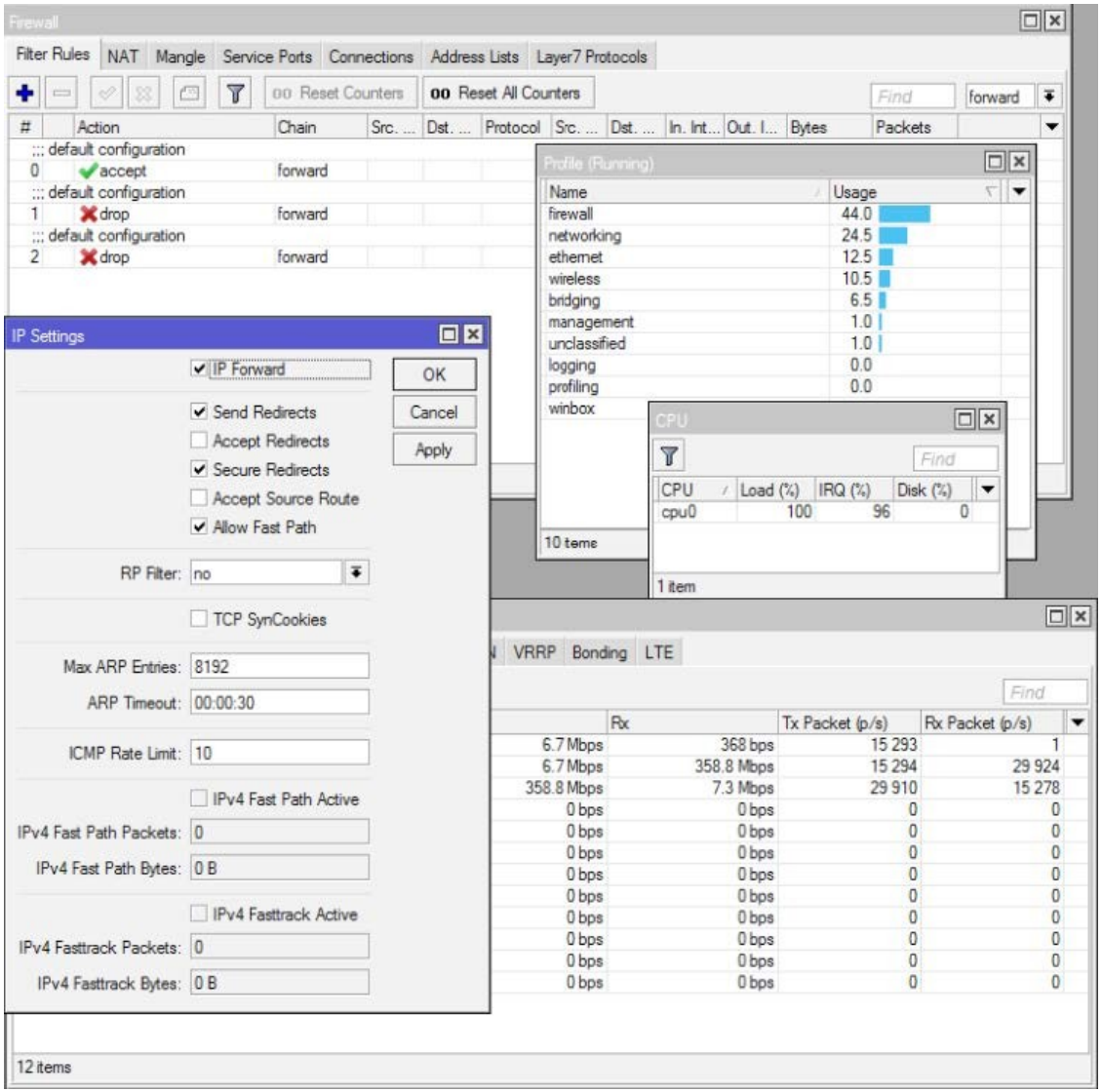
# FastPath + Conntrack = FastTrack

- 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

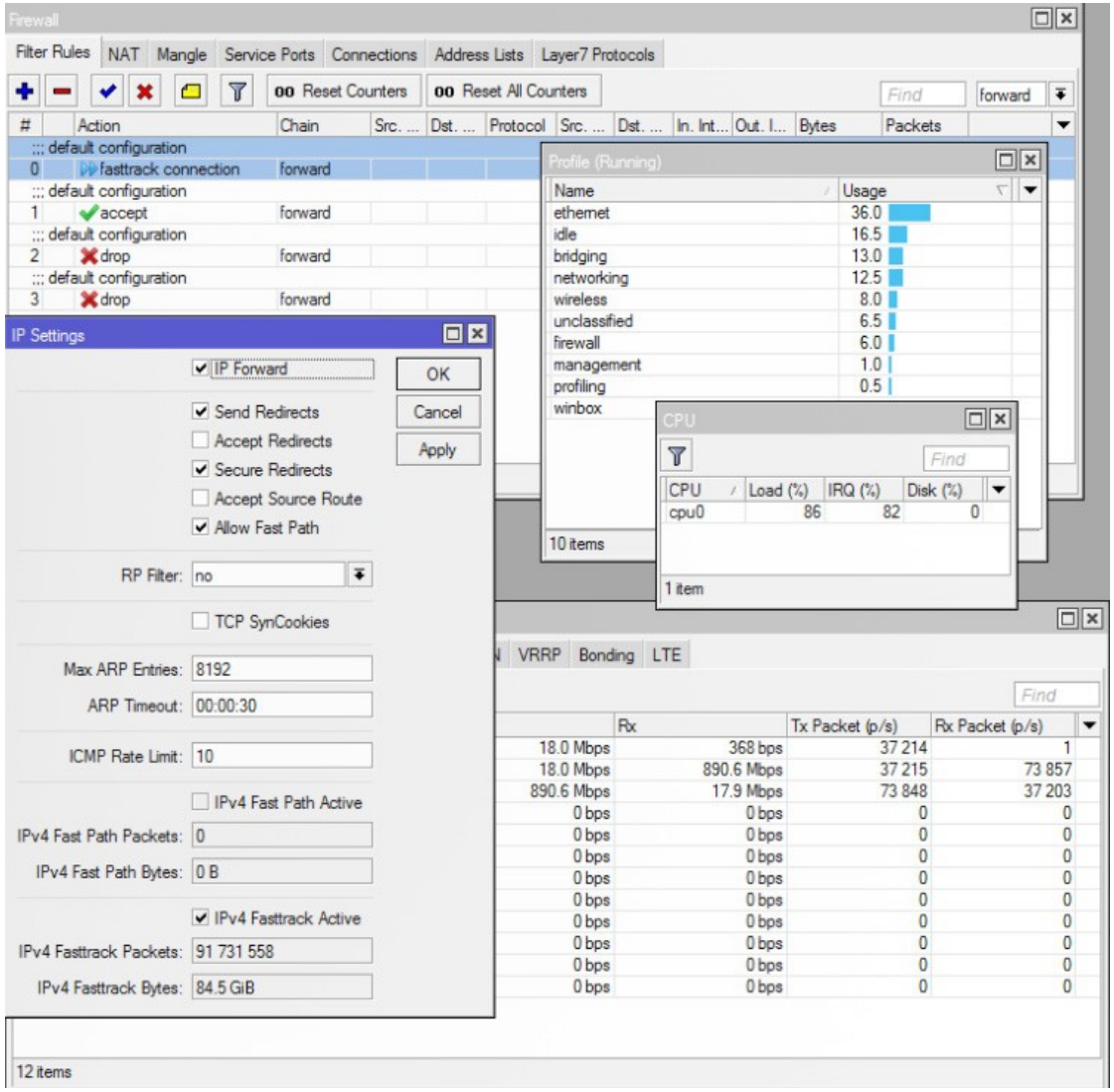


# Without Fasttrack




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

# With Fasttrack

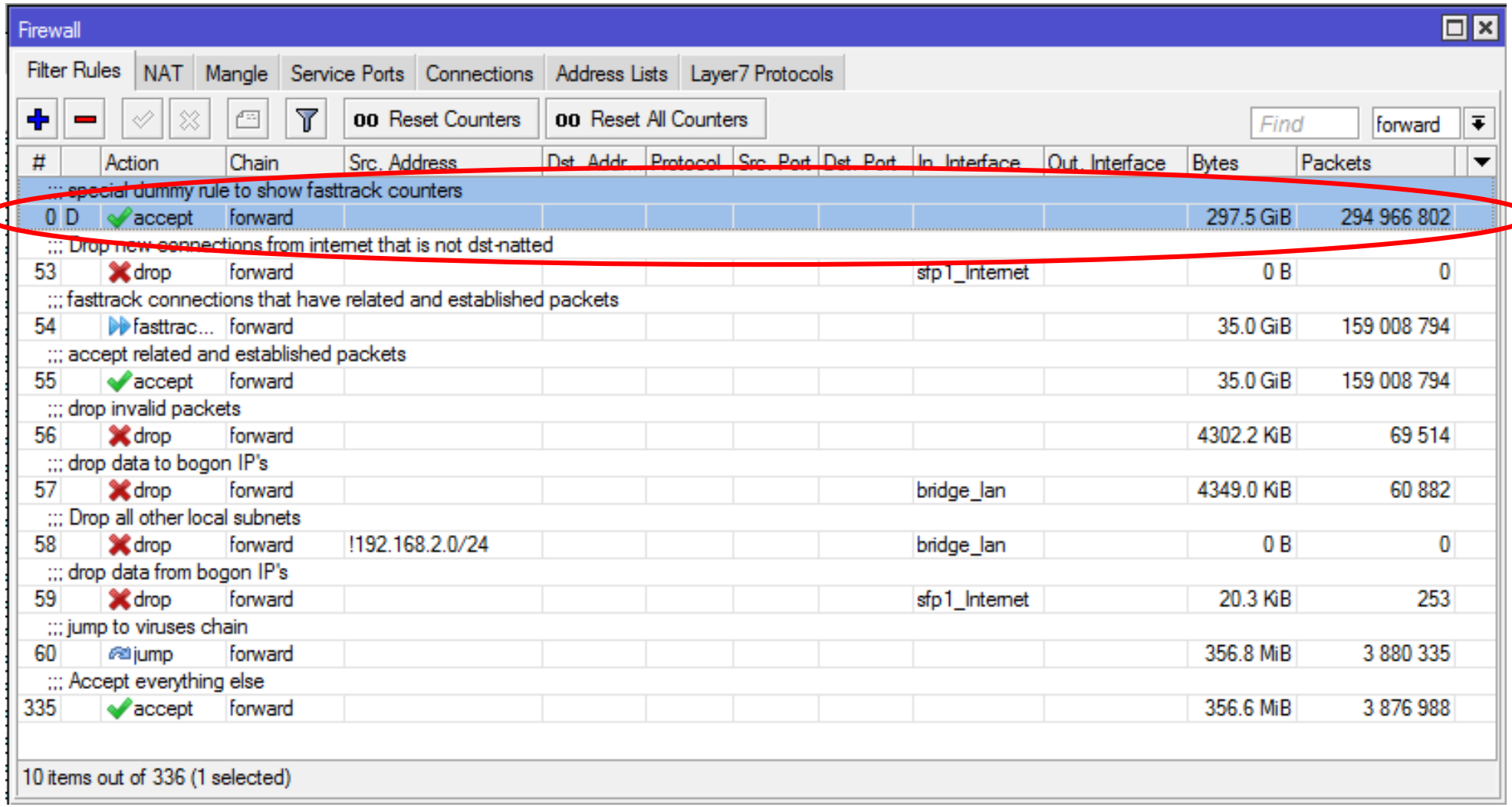



- Board: RB2011UiAS-2HnD
- Configuration: default Home AP
- Throughput: 890Mbps
- CPU load: 86%
- Firewall CPU load: 6%

# 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

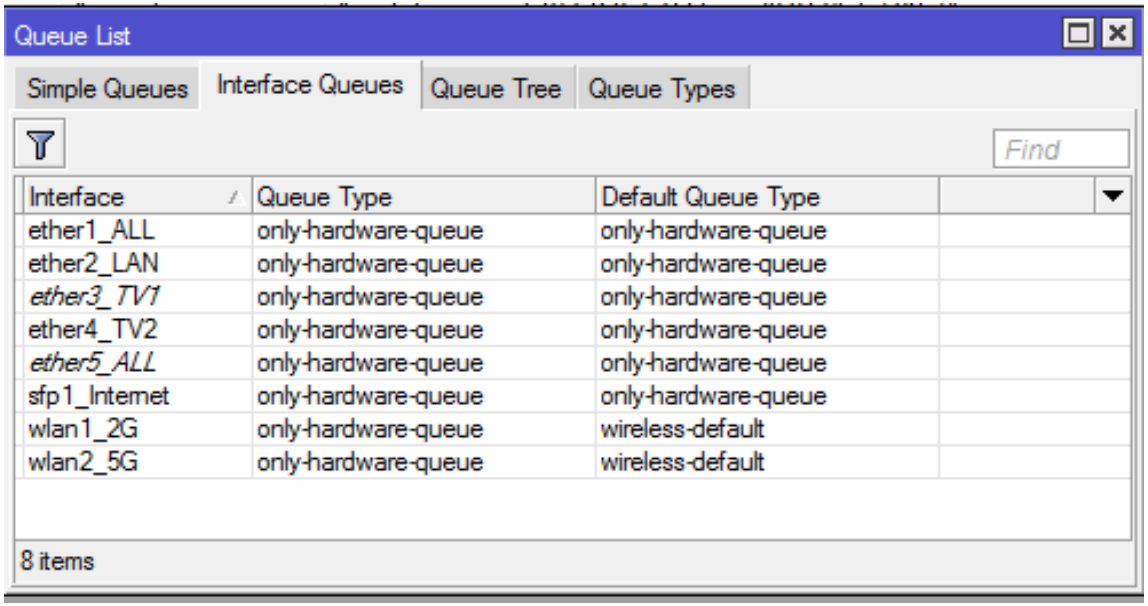
# Special Dummy Rules



# Special Dummy Rule

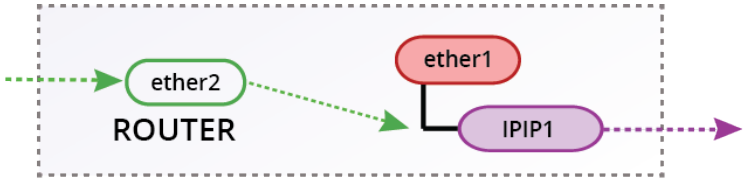
- This is not an actual rule, it is for visual information only
- Dummy rule shows user that some traffic is FastTracked
- Rule will show up as soon as there are at least one Fasttracked connection tracking entry.
- Rule will disappear only after last Fasttracked connection tracking table are fully timed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

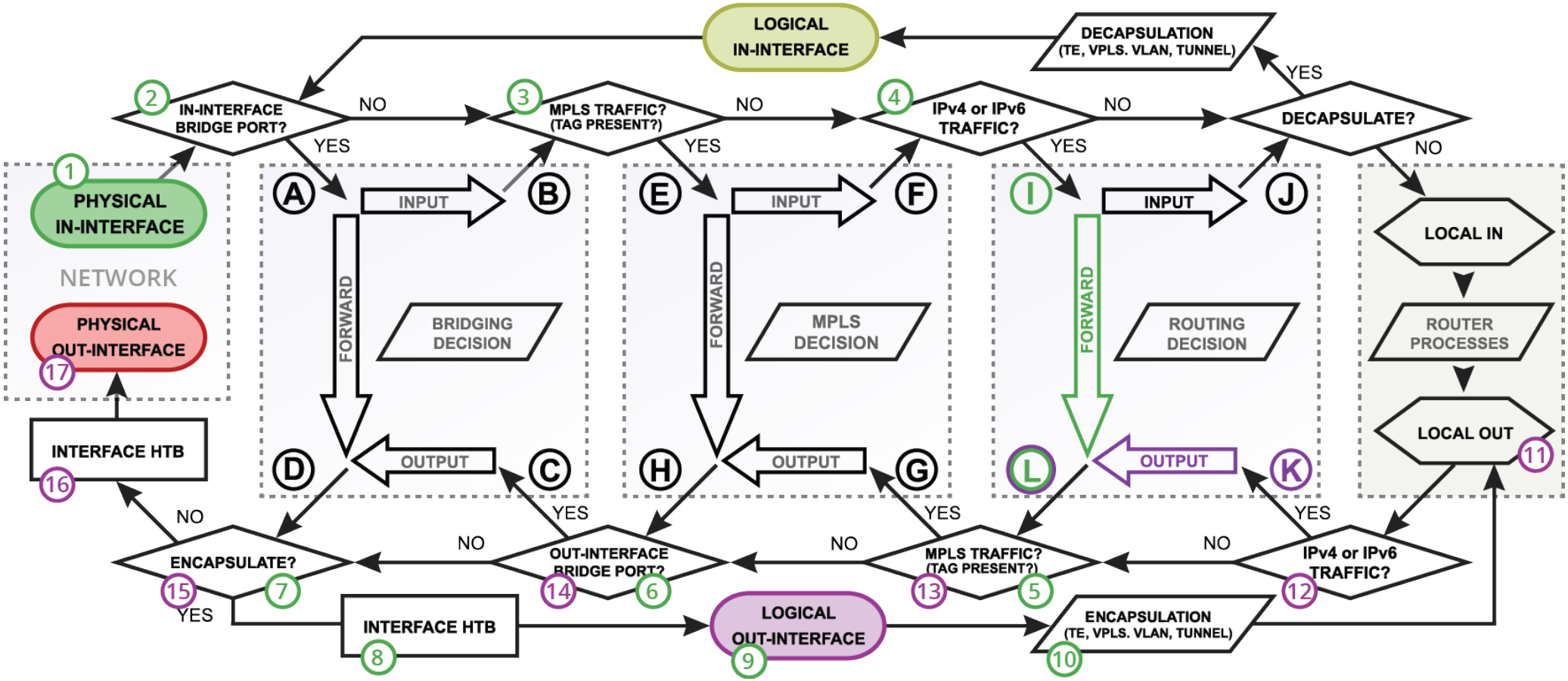
# Interface Queue and FastPath



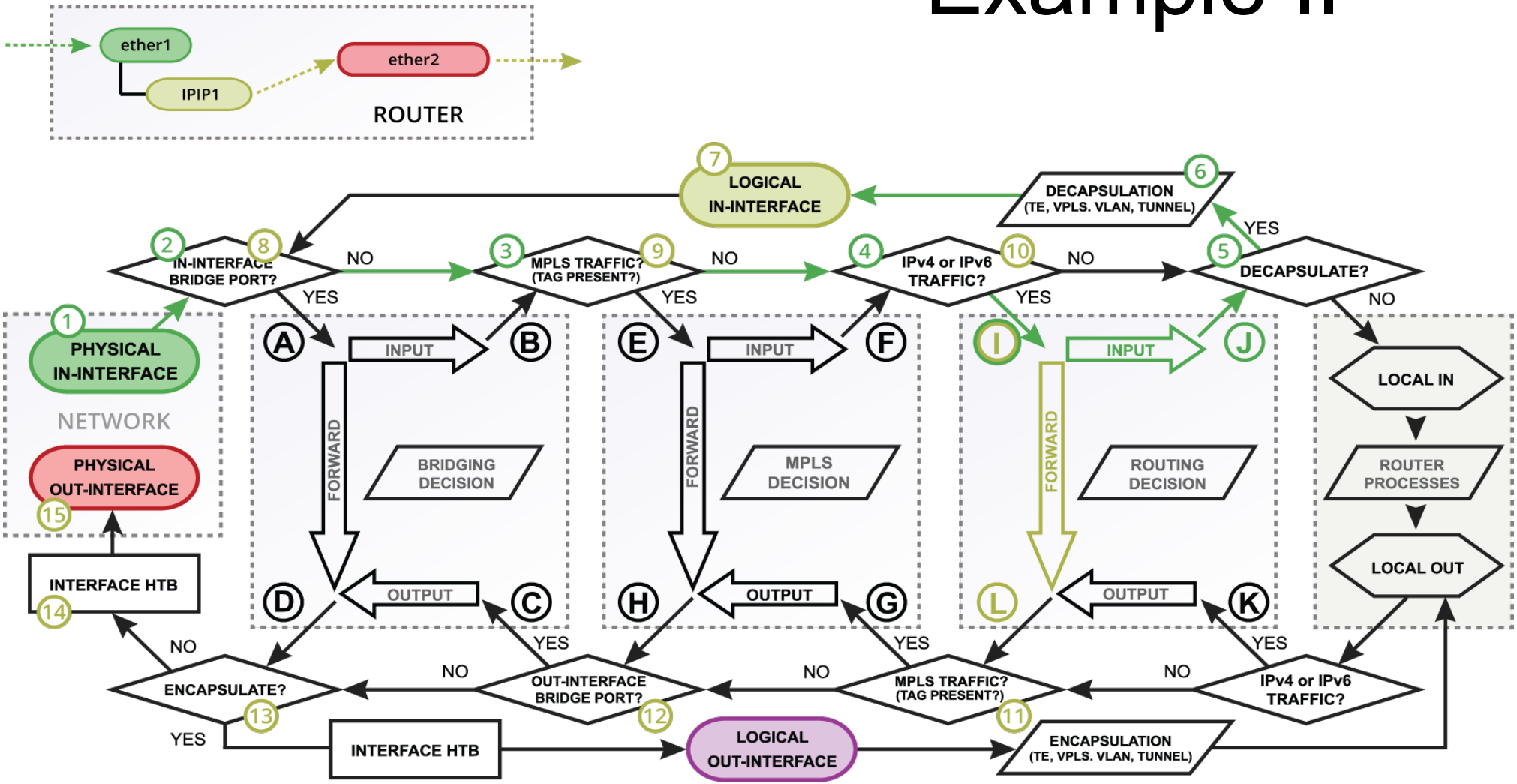

- Only interface queue that guarantees FastPath is "only-hardware-queue"
- Minimal impact on physical interfaces, as "Interface HTB" is the last step in the packet flow diagram

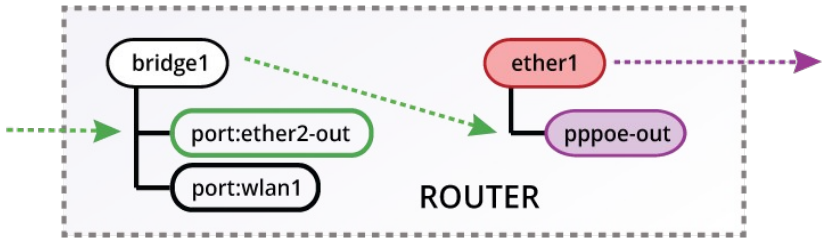
# Example I


ether2
ether1
IPIP1
ROUTER

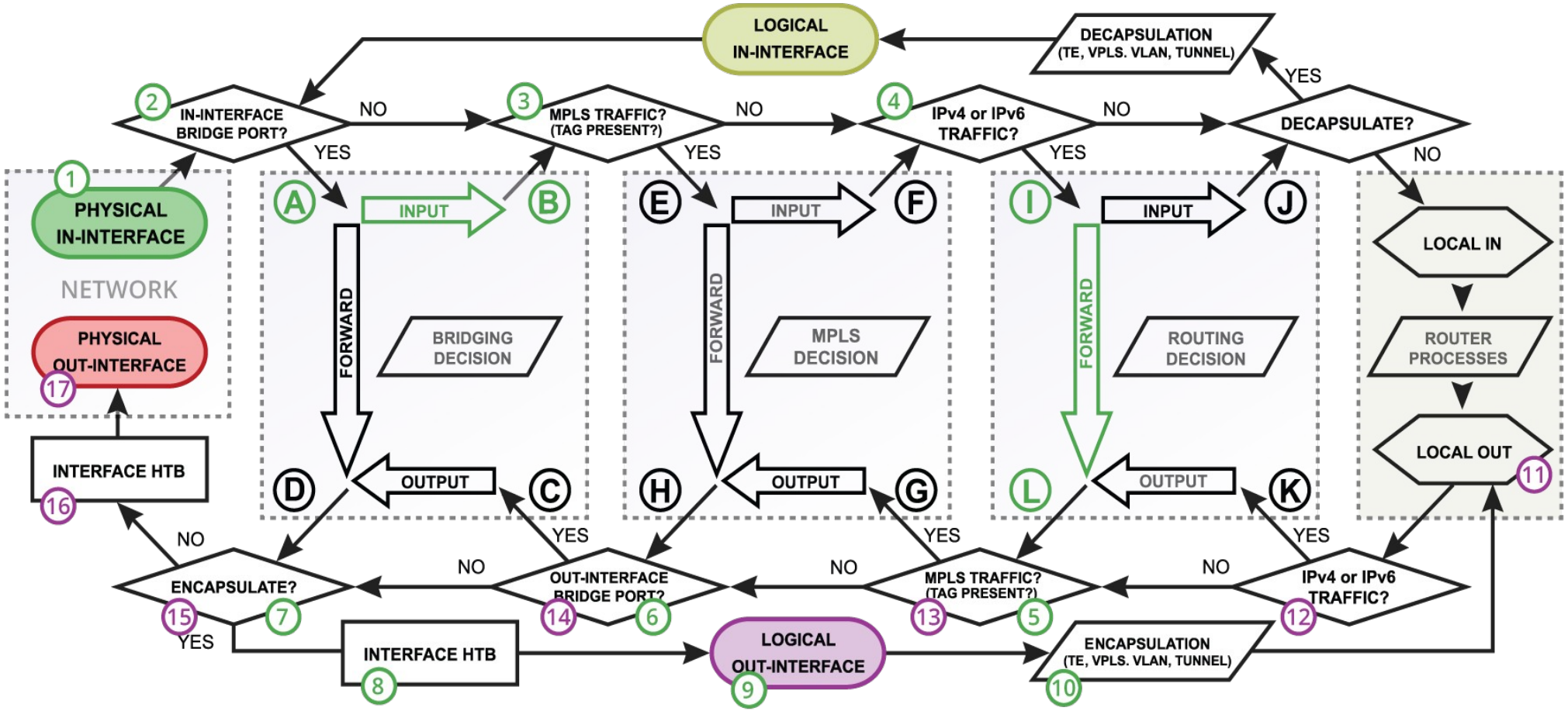

LOGICAL IN-INTERFACE
DECAPSULATION (TE, VPLS. VLAN, TUNNEL)
YES
2 IN-INTERFACE BRIDGE PORT?
NO
3 MPLS TRAFFIC? (TAG PRESENT?)
NO
4 IPv4 or IPv6 TRAFFIC?
NO
DECAPSULATE?
NO
YES
YES
YES
1 PHYSICAL IN-INTERFACE
NETWORK
PHYSICAL OUT-INTERFACE 17
A
INPUT
B
FORWARD
BRIDGING DECISION
D
OUTPUT
C
E
INPUT
F
FORWARD
MPLS DECISION
H
OUTPUT
G
I
INPUT
J
FORWARD
ROUTING DECISION
L
OUTPUT
K
LOCAL IN
ROUTER PROCESSES
LOCAL OUT 11
INTERFACE HTB 16
NO
YES
NO
YES
NO
YES
NO
YES
ENCAPSULATE? 15 7
OUT-INTERFACE BRIDGE PORT? 14 6
MPLS TRAFFIC? (TAG PRESENT?) 13 5
IPv4 or IPv6 TRAFFIC? 12
YES
INTERFACE HTB 8
LOGICAL OUT-INTERFACE 9
ENCAPSULATION (TE, VPLS. VLAN, TUNNEL) 10

# Example II

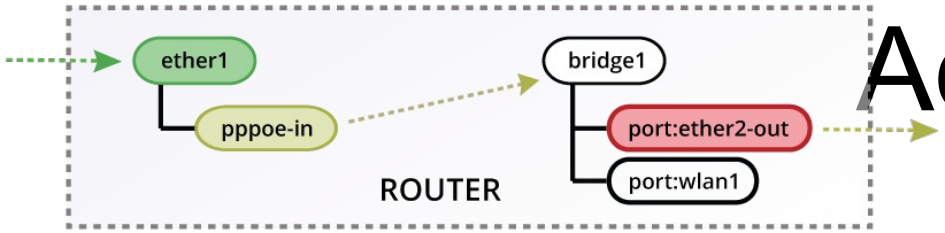

ether1
IPIP1
ether2
ROUTER
7
LOGICAL
IN-INTERFACE
6
DECAPSULATION
(TE, VPLS. VLAN, TUNNEL)
YES
2
8
IN-INTERFACE
BRIDGE PORT?
NO
3
9
MPLS TRAFFIC?
(TAG PRESENT?)
NO
4
10
IPv4 or IPv6
TRAFFIC?
NO
5
DECAPSULATE?
NO
YES
YES
YES
1
PHYSICAL
IN-INTERFACE
NETWORK
PHYSICAL
OUT-INTERFACE
15
A
INPUT
B
FORWARD
BRIDGING
DECISION
D
OUTPUT
C
E
INPUT
F
FORWARD
MPLS
DECISION
H
OUTPUT
G
I
INPUT
J
FORWARD
ROUTING
DECISION
L
OUTPUT
K
LOCAL IN
ROUTER
PROCESSES
LOCAL OUT
INTERFACE HTB
14
NO
YES
NO
NO
YES
YES
ENCAPSULATE?
13
OUT-INTERFACE
BRIDGE PORT?
12
MPLS TRAFFIC?
(TAG PRESENT?)
11
IPv4 or IPv6
TRAFFIC?
YES
INTERFACE HTB
LOGICAL
OUT-INTERFACE
ENCAPSULATION
(TE, VPLS. VLAN, TUNNEL)

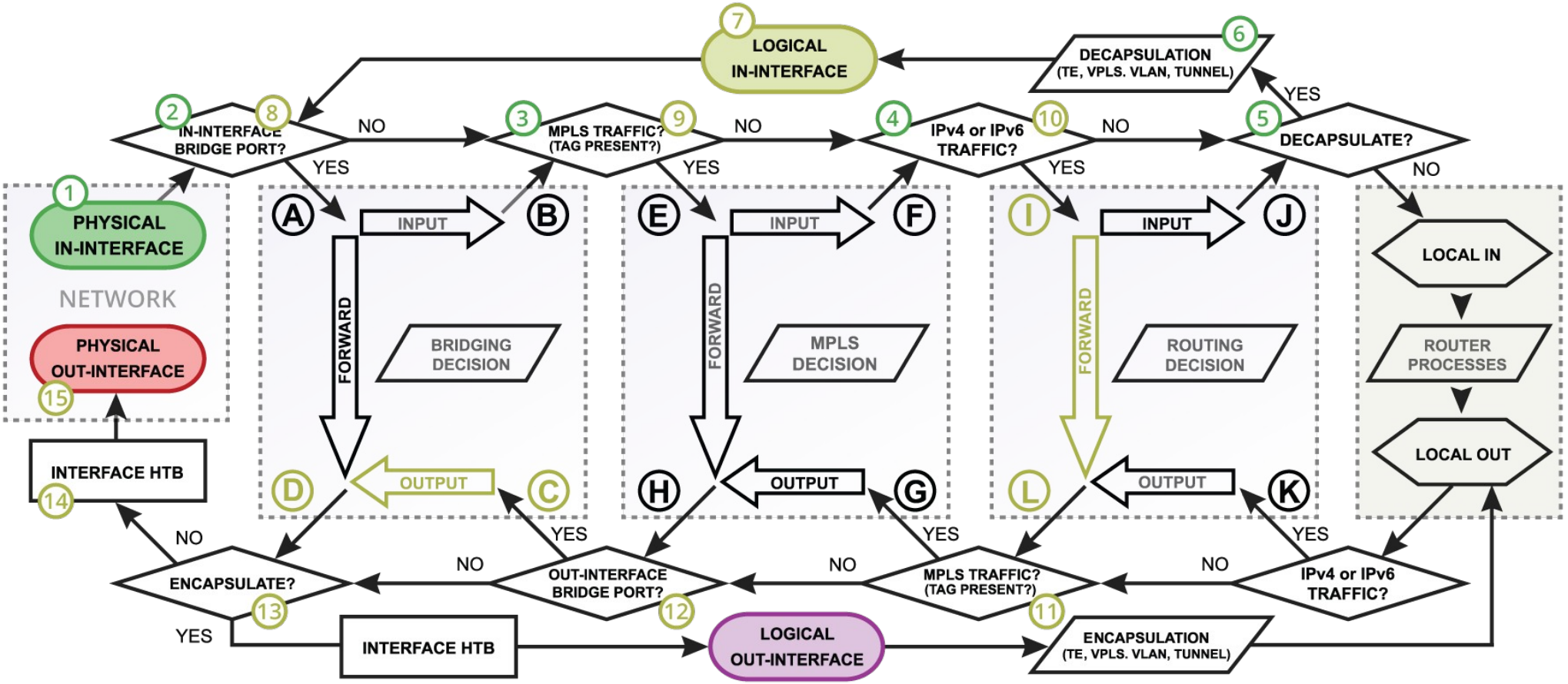



# Advanced Example I



# 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!!!