FastPath Overview

MUM Ukraine, 2015
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
MPLS Forwarding

MPLS Forwarding Diagram:

- **IN-INTERFACE BRIDGE PORT?**
  - Yes: Proceed to B
  - No: Proceed to D

- **B**
  - Input
  - Bridging Decision
  - Forward
  - Output
  - Encapsulate?
  - Yes: Proceed to C
  - No: Proceed to D

- **C**
  - Interface HTB
  - Logical Out-Interface
  - Forward
  - Output
  - Yes: Proceed to F
  - No: Proceed to D

- **D**
  - Interface HTB
  - Logical In-Interface
  - Forward
  - Input
  - Encapsulate?
  - Yes: Proceed to E
  - No: Proceed to D

- **E**
  - MPLS Traffic?
  - Yes: Proceed to F
  - No: Proceed to D

- **F**
  - IPv4 or IPv6 Traffic?
  - Yes: Proceed to I
  - No: Proceed to J

- **I**
  - Input
  - Routing Decision
  - Forward
  - Output
  - Encapsulation (TE, VPLS, VLAN, Tunnel)
  - Yes: Proceed to K
  - No: Proceed to I

- **J**
  - Local In
  - Router Processes
  - Local Out
  - No: Proceed to J

- **K**
  - IPv4 or IPv6 Traffic?
  - Yes: Proceed to L
  - No: Proceed to J

- **L**
  - Input
  - Forward
  - Output
  - Encapsulation (TE, VPLS, VLAN, Tunnel)
  - Yes: Proceed to K
  - No: Proceed to L

- **MPLS**
  - MPLS Decision
  - Pop Label (MPLS Input)
  - VPLS or TE Tunnel
  - No: Proceed to F

- **F TO DECAPSULATE**
  - Yes: Proceed to E
  - No: Proceed to F

- **G**
  - MPLS Decision
  - Push Label (MPLS Output)
  - VPLS or TE Tunnel
Routing Forwarding

1. PREROUTING
2. ROUTING DECISION
3. FORWARD
4. POSTROUTING
5. IPSEC POLICY?
6. IPSEC ENCRYPTION
7. ROUTING DECISION
8. INPUT
9. OUTPUT
10. NO
11. YES

Routing process flowchart:
- Prerouting:
  - IPsec Decryption
  - Routing Policy
  - Forwarding
  - Routing Decision
  - Postrouting
  - IPsec Encryption
  - Routing Decision
  - Input
  - Output
Routing Forwarding

1. PREROUTING
   - HOTSPOT-IN → CONNECTION TRACKING → MANGLE PREROUTING → DST-NAT

2. INPUT
   - MANGLE INPUT → FILTER INPUT → HTB GLOBAL (QUEUE TREE) → SIMPLE QUEUES

3. FORWARD
   - BRIDGE DECISION
     - TTL=TTL-1 → MANGLE FORWARD → FILTER FORWARD → ACCOUNTING

4. OUTPUT
   - BRIDGE DECISION
     - CONNECTION TRACKING → MANGLE OUTPUT → FILTER OUTPUT → ROUTING ADJUSTMENT

5. POSTROUTING
   - MANGLE POSTROUTING → SRC-NAT → HOTSPOT-OUT → HTB GLOBAL (QUEUE TREE) → SIMPLE QUEUES
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

[Image of configuration settings for IP Forward, Send Redirects, Accept Redirектs, Secure Redirects, Accept Source Route, Route Cache, TCP SynSent Timeout, TCP SynReceived Timeout, TCP Established Timeout, TCP Fin Wait Timeout, TCP Close Wait Timeout, TCP Last Ack Timeout, TCP Time Wait, TCP Max Retransmit Timeout, TCP Hold Timeout, IPv4 Fast Path Active, IPv4 Fast Path Packets, IPv4 Fast Path Bytes, Bridge Fast Path Active, Bridge Fast Path Packets, Bridge Fast Path Bytes]
Bridge Forwarding FastPath

1. BRIDGE DTS-NAT
2. USE-IP-FIREWALL?
3. BRIDGE DECISION
4. BRIDGE FORWARD
5. USE-IP-FIREWALL?
6. BRIDGE SRC-NAT
7. USE-IP-FIREWALL?
8. POSTROUTING

ANY CONFIG?

FASTPATH

NO

PREROUTING

BRIDGE INPUT
Routing Forwarding FastPath

1. PREROUTING
   - HOTSPOT-IN
   - CONNECTION TRACKING
   - MANGLE PREROUTING
   - DST-NAT

2. INPUT
   - MANGLE INPUT
   - FILTER INPUT
   - HTB GLOBAL (QUEUE TREE)
   - SIMPLE QUEUES

3. FORWARD
   - BRIDGE DECISION
   - TTL=TTL-1
   - MANGLE FORWARD
   - FILTER FORWARD
   - ACCOUNTING

4. OUTPUT
   - BRIDGE DECISION
   - CONNECTION TRACKING
   - MANGLE OUTPUT
   - FILTER OUTPUT
   - ROUTING ADJUSTMENT

5. POSTROUTING
   - MANGLE POSTROUTING
   - SRC-NAT
   - HOTSPOT-OUT
   - HTB GLOBAL (QUEUE TREE)
   - SIMPLE QUEUES

FASTPATH → ANY CONFIG?

NO
SlowPath vs FastPath

- What are the performance benefits of FastPath?

<table>
<thead>
<tr>
<th>Mode</th>
<th>Configuration</th>
<th>RB750Gr2 720Mhz</th>
<th>All port test</th>
<th>RouterOS v6.31rc2</th>
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<td>64 byte</td>
<td>512 byte</td>
<td>1518 byte</td>
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<td>Mbps</td>
<td>kpps</td>
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<td>773.7</td>
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<td>234.9</td>
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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

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<th>Action</th>
<th>Chain</th>
<th>Src...</th>
<th>Dst...</th>
<th>Prot...</th>
<th>Src. Port</th>
<th>Dst. Port</th>
<th>In. L...</th>
<th>Out. L...</th>
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<th>Packets</th>
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<td>240.2 MB</td>
<td>319 850</td>
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<td>drop invalid packets</td>
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<td></td>
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<td>40.9 KB</td>
<td>765</td>
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<td>drop data to bogon IP’s</td>
<td>forward</td>
<td>brid...</td>
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<td></td>
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<td>143.0 KB</td>
<td>2 398</td>
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<td>57</td>
<td>Drop all other local subnets</td>
<td>forward</td>
<td>119...</td>
<td>brid...</td>
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<td>0</td>
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<td>58</td>
<td>Fasttrack connection</td>
<td>forward</td>
<td>eth...</td>
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<td>0 B</td>
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</table>

**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

- 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

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</tbody>
</table>

0 D: Special dummy rule to show fasttrack counters

- Drop how connections from internet that is not dst-natted
- Fasttrack connections that have related and established packets
- Accept related and established packets
- Drop invalid packets
- Drop data to bogon IP's
- Drop all other local subnets
- Drop data from bogon IP's
- Jump to viruses chain
- Accept everything else
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
Advanced Example 1
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!!!