FD.io CSIT Performance Dashboard

Presented on behalf of CSIT project by:
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https://lfnetworking.org
Topics

FD.io Overview
  • VPP and CSIT core projects

CSIT Dashboard - csit.fd.io
  • Infrastructure
  • UI and presentation layer

Usability Examples
  • Performance and efficiency comparisons
  • Failures, Anomalies and Root Cause Analysis

Discussion
<table>
<thead>
<tr>
<th>FD.io VPP and CSIT</th>
<th>Core Projects in LFN FastData.io</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Performance</th>
<th>VPP Vector Packet Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feature rich networking and host stack. VPP on COTS servers in many cases outperforms packet processing HW.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Portability</th>
<th>CSIT Continuous System Integration and Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPP runs on COTS hardware: AMD, ARM, Intel, OpenPOWER, Power64</td>
<td></td>
</tr>
<tr>
<td>VPP runs in any environment: bare-metal, VM, containers.</td>
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<table>
<thead>
<tr>
<th>Efficiency</th>
<th>Continuous benchmarking of VPP and DPDK.</th>
</tr>
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<tbody>
<tr>
<td>Allows ability to upscale and downscale.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>SDN</th>
<th>Performance testbeds with Xeon, Arm, AMD, Atom HW.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software programmable, extendable and flexible.</td>
<td></td>
</tr>
<tr>
<td>Bare-metal, VM, container test environments.</td>
<td></td>
</tr>
</tbody>
</table>

|                                | Executing 2,900 benchmarking tests daily. |
|                                | Open-source CI/CD infrastructure for benchmarking of SW data-planes, test data analytics and presentation. |
**CDash**

**AWS S3 storage**
- used for all data.

**ETL**
- from JSON to Parquet.
- running on premise.

**AWS beanstalk**
- application load balancing.
- EC2 instances (t3a.2xlarge).
- scalability.

**Plot.ly Dash**
- data dashboard.
- interactive UI.
- loads data frame partitions from S3 compatible storage.
CDash

17 ETL pipelines

~2.9k tests daily

~17.5k tests weekly

~50k performance tests per release

130 days
sliding window

2021 ...

Optimization
8GB RAM

JSON model

Parquet

rls2302
rls2306
CSIT-Dash
Customizable Views on Performance Data

Performance Trending
- Daily MRR* Data
- Weekly NDR PDR** Data
- Packet Latency
- Telemetry

* MRR – Maximum Receive Rate a.k.a. forwarding rate at maximum offered load
** NDR PDR – Non-Drop Rate (no loss), Partial Drop Rate (non-zero loss <0.5%)
CSIT-Dash
Customizable Views on Performance Data

Release Performance Data

- Iterative and Coverage Data
- Packet Throughput
- Packet Latency
- Results Statistics
- Comparison Tables
CSIT-Dash
Customizable Views on Performance Data

Additional Information
• Test Job Statistics
• Failures and Anomalies
• Documentation
CSIT Benchmark Areas and Methodologies

Tests

Benchmark Test Areas
- L2 Ethernet Switching
- IPv4, IPv6 Routing
- IPsec, Wireguard with IPv4 Routing
- SRv6 Routing
- Features: ACLs, NAT44-EI/ED, Policer, ...
- IPv4, IPv6 Tunnels
- KVM VMs vHost-user
- Docker Container Memif
- Drivers: DPDK, AVF, RDMA, AF_XDP

Test Methodologies
- Packet Throughput and Latency
- Stateful NAT44ed
- Stateful Host-stack
- Speedup Multi-Core
- Soak Tests
- Reconfiguration Tests

Test Topologies

Performance Testbed Variants*

*Testbed Topology - SUT Processor Model
<table>
<thead>
<tr>
<th>Processor Family</th>
<th>Model</th>
<th>Cores per Socket</th>
<th>Base Frequency GHz</th>
<th>L3 Cache (LLC) MB</th>
<th>Testbeds</th>
<th>NICs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLX Intel Xeon Cascade Lake</td>
<td>8280</td>
<td>28</td>
<td>2.6</td>
<td>38.5</td>
<td>3 x 2n-clx</td>
<td>x710-4p10GE, xxv710-2p25GE, e810-2p100GE, cx5-2p100GE</td>
</tr>
<tr>
<td>ICX Intel Xeon Ice Lake</td>
<td>8358</td>
<td>32</td>
<td>2.6</td>
<td>48</td>
<td>4 x 2n-icx 2 x 3n-icx</td>
<td>xxv710-2p25GE, e810-4p25GE, e810-2p100GE, cx7-2p200GE* xxv710-2p25GE, e810-4p25GE, e810-2p100GE, cx6-2p200GE*</td>
</tr>
<tr>
<td>SPR Intel Sapphire Rapids</td>
<td>8462Y+</td>
<td>32</td>
<td>2.8</td>
<td>60</td>
<td>2 x 2n-spr 1 x 3na-spr 1 x 3nb-spr</td>
<td>e810-4p25GE, e810-2p100GE, cx7-2p200GE cx7-2p200GE e810-4p25GE, e810-2p100GE</td>
</tr>
<tr>
<td>ZN2 AMD EPYC Zen2</td>
<td>7532</td>
<td>32</td>
<td>2.4</td>
<td>256</td>
<td>1 x 2n-zn2</td>
<td>x710-4p10GE, xxv710-2p25GE, cx5-2p100GE</td>
</tr>
<tr>
<td>TX2 Cavium ThunderX2 ARMv8.1</td>
<td>CN9975</td>
<td>28</td>
<td>2.0</td>
<td>28</td>
<td>1 x 2n-tx2</td>
<td>xl710-2p40GE</td>
</tr>
<tr>
<td>ALT Ampere Altra N1</td>
<td>Q80-30</td>
<td>80</td>
<td>3.0</td>
<td>32</td>
<td>1 x 3n-alt</td>
<td>xl710-2p40GE cx6-2p200GE*</td>
</tr>
<tr>
<td>SNR Intel Atom Snowridge</td>
<td>P5362B</td>
<td>24</td>
<td>2.2</td>
<td>27</td>
<td>1 x 3n-snr</td>
<td>e810-4p25GE</td>
</tr>
<tr>
<td>TSH Huawei TaiShan 2280</td>
<td>hip07-d05</td>
<td>32</td>
<td>2.2</td>
<td>-</td>
<td>1 x 3n-tsh</td>
<td>x520-2p10GE, cx4-2p25GE</td>
</tr>
</tbody>
</table>

* Being added
Comparison VPP v23.02 ICX vs CLX:

### Comparison for: VPP-RLS2302-23.02-RELEASE-1C-64B|78B-MRR

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ip6 CLX</td>
<td>7.49</td>
<td>0.16</td>
<td>8.08</td>
<td>0.03</td>
<td>17.57%</td>
</tr>
<tr>
<td>ip6 ICX</td>
<td>16.22</td>
<td>0.03</td>
<td>18.75</td>
<td>0.16</td>
<td>15.57%</td>
</tr>
<tr>
<td>ip6-udp-ip4base-ipv4-10kflows-mrr</td>
<td>10.00</td>
<td>0.02</td>
<td>11.62</td>
<td>0.05</td>
<td>15.36%</td>
</tr>
<tr>
<td>ip6-udp-ip4base-ipv4-scale20k-rnd-mrr</td>
<td>16.57</td>
<td>0.07</td>
<td>18.80</td>
<td>0.12</td>
<td>15.51%</td>
</tr>
<tr>
<td>ip6-scale20k-mrr</td>
<td>10.61</td>
<td>0.20</td>
<td>11.62</td>
<td>0.12</td>
<td>9.57%</td>
</tr>
<tr>
<td>ip6-scale20k-mrr</td>
<td>18.99</td>
<td>0.15</td>
<td>20.68</td>
<td>0.02</td>
<td>4.85%</td>
</tr>
</tbody>
</table>

Similar views for Xeon SPR vs ICX – results just arrived from VPP v23.06-rc1 pre-release testing.
## VPP per node metrics collected in CSIT performance tests

**VPP “show runtime”**
- Calls
- Clocks
- Suspends
- Vectors
- Vectors/Call

**VPP perfmon bundles**

**Intel platforms:** vpp git repo /src/plugins/perfmon/intel/bundle

- **inst-and-clock**
  - Calls
  - Packets
  - Packets/Call
  - Clocks/Packet
  - Instructions/Packet
  - IPC

- **cache-hierarchy**
  - L1 hit/pkt
  - L1 miss/pkt
  - L2 hit/pkt
  - L2 miss/pkt
  - L3 hit/pkt
  - L3 miss/pkt

**Arm platforms:** vpp git repo /src/plugins/perfmon/bundle/arm/

Currently not running in CSIT
Perfmon access to Arm counters requires newer kernel 5.17+ – work in progress ...

**NOTE:** VPP perfmon is VPP Developer Tool
Heavily dependant on Processor PMU counters

*Proceed with caution!*
Introducing VPP Telemetry Views

https://csit.fd.io/trending/

**CSIT-DASH**

<table>
<thead>
<tr>
<th>DUT</th>
<th>vpp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infra</td>
<td>2n-spr-100ge2p1e8100eq-avf</td>
</tr>
<tr>
<td>Area</td>
<td>IPv4 Routing</td>
</tr>
<tr>
<td>Test</td>
<td>ethip4-ip4scale200k-md</td>
</tr>
</tbody>
</table>

Frame Size

- [ ] All
- [ ] 64B

Number of Cores

- [ ] All
- [ ] 1C
- [ ] 2C
- [ ] 4C

Test Type

- [ ] All
- [ ] MRR
- [ ] NDR
- [ ] PDR

Normalization

- [ ] Normalize to CPU frequency 2GHz

**SELECT A METRIC**

- [ ] vpp.cache_hierarchy.l1_hit
- [ ] vpp.cache_hierarchy.l1_miss
- [ ] vpp.cache_hierarchy.l2_hit
- [ ] vpp.cache_hierarchy.l2_miss
- [ ] vpp.cache_hierarchy.l3_hit
- [ ] vpp.cache_hierarchy.l3_miss
- [ ] vpp.inst_and_clock.calls
- [ ] vpp.inst_and_clock.clocks_per_packets
- [ ] vpp.inst_and_clock.instructions_per_packets
- [ ] vpp.inst_and_clock.ipc
- [ ] vpp.inst_and_clock.packets
- [ ] vpp.inst_and_clock.packets_per_call
- [ ] vpp.runtime.calls
- [ ] vpp.runtime.clocks
- [ ] vpp.runtime.suspends
- [ ] vpp.runtime.vectors
- [ ] vpp.runtime.vectors_calls
# Performance trending – Throughput and efficiency metrics

## Xeon SPR vs ICX vs CLX

<table>
<thead>
<tr>
<th>Test</th>
<th>Measurement</th>
<th>VPP Nodes of Interest</th>
<th>Node Telemetry</th>
</tr>
</thead>
<tbody>
<tr>
<td>ip4scale200k-rnd</td>
<td>MRR</td>
<td>ip4-lookup</td>
<td>runtime.clocks&lt;br&gt;inst_and_clock.clocks_per_packet&lt;br&gt;cache_hierarchy.l3</td>
</tr>
<tr>
<td>ip6scale200k-rnd</td>
<td>MRR</td>
<td>ip6-lookup</td>
<td>runtime.clocks&lt;br&gt;inst_and_clock.clocks_per_packet&lt;br&gt;cache_hierarchy.l3</td>
</tr>
<tr>
<td>ipsec40tnlsw-aes256gcm</td>
<td>MRR</td>
<td>esp4-encrypt-tun&lt;br&gt;esp4-decrypt-tun</td>
<td>runtime.clocks&lt;br&gt;inst_and_clock.clocks_per_packet&lt;br&gt;cache_hierarchy.l3</td>
</tr>
</tbody>
</table>
Performance trending – Throughput and efficiency metrics
VPP IPv6 and IPv4 FIB scale tests

<table>
<thead>
<tr>
<th>Testbed-Platform</th>
<th>Test</th>
<th>Measurement</th>
<th>VPP Nodes of Interest</th>
<th>Telemetry</th>
</tr>
</thead>
<tbody>
<tr>
<td>2n-icx</td>
<td>ip6base</td>
<td>MRR</td>
<td>ip6-lookup</td>
<td>runtime.clocks</td>
</tr>
<tr>
<td></td>
<td>ip6scale20k-rnd</td>
<td></td>
<td></td>
<td>cache_hierarchy.{l3</td>
</tr>
<tr>
<td></td>
<td>ip6scale200k-rnd</td>
<td></td>
<td></td>
<td>cache_hierarchy.{l3</td>
</tr>
<tr>
<td></td>
<td>ip6scale2m-rnd</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2n-icx</td>
<td>ip4base</td>
<td>MRR</td>
<td>ip4-lookup</td>
<td>inst_and_clock.clocks_per_packet</td>
</tr>
<tr>
<td></td>
<td>ip4scale-2m</td>
<td></td>
<td></td>
<td>cache_hierarchy.{l3</td>
</tr>
<tr>
<td></td>
<td>ip4scale-2m-rnd</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Failures, Anomalies and Root Cause Analysis

<table>
<thead>
<tr>
<th>Link</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test cases failure</strong></td>
<td>All test cases affected by an infra issue.</td>
</tr>
<tr>
<td><strong>Test suites failure</strong></td>
<td>Reduction in test cases executed can be caused by failure in suite setups.</td>
</tr>
<tr>
<td><strong>Anomalies and testbeds</strong></td>
<td>Different testbeds of the same type show unequal performance, depending on NIC and driver.</td>
</tr>
<tr>
<td><strong>Anomalies and RSS</strong></td>
<td>Random RSS generates noise. Performance change depends on testbed type and scale.</td>
</tr>
<tr>
<td><strong>Scaling and anomalies</strong></td>
<td>Comparing scalability of a test, includes a transient regression and failures.</td>
</tr>
</tbody>
</table>
CSIT Resources

**Technical Papers**
- SPR 2Tbps IPsec (2023)
- “Benchmarking and Analysis of Software Data Planes” (2017)

**Technology Demonstrator Video Clips**
- “VPP: A Terabit Secure Network Data-plane” (Intel Xeon Icelake 07-APR-2021)
  - [https://www.youtube.com/watch?v=iPQQmjzE_g0](https://www.youtube.com/watch?v=iPQQmjzE_g0)
  - [https://www.youtube.com/watch?v=aLJ0XLeV3V4](https://www.youtube.com/watch?v=aLJ0XLeV3V4)

**FD.io Presentations**
- [https://wiki.fd.io/view/Presentations](https://wiki.fd.io/view/Presentations)

**Other FD.io Materials**
- [https://fd.io/](https://fd.io/)
- [https://fd.io/latest/whitepapers/](https://fd.io/latest/whitepapers/)
CSIT Resources

• **Project**
  • Wiki pages: [https://wiki.fd.io/view/CSIT](https://wiki.fd.io/view/CSIT)
  • Meetings: [https://wiki.fd.io/view/CSIT/Meeting](https://wiki.fd.io/view/CSIT/Meeting)
  • Mailing list: csit-dev@lists.fd.io

• **CDash**
  • Dashboard: [https://csit.fd.io](https://csit.fd.io)

• **Old Release Reports**
  • Wiki: [https://wiki.fd.io/view/CSIT#Test_Reports](https://wiki.fd.io/view/CSIT#Test_Reports)

• **Source Code**
  • Git repo: [https://git.fd.io/csit](https://git.fd.io/csit)
  • Github mirror: [https://github.com/FDio/csit](https://github.com/FDio/csit)
  • Gerrit reviews: [https://gerrit.fd.io](https://gerrit.fd.io)

• **Standalone libraries**
  • Speeding up binary search using shorter measurements: [https://pypi.org/project/MLRsearch/](https://pypi.org/project/MLRsearch/)
  • Locating changes in time series by grouping results: [https://pypi.org/project/jumpavg/](https://pypi.org/project/jumpavg/)