LaKe: An Energy Efficient, Low Latency, Accelerated Key-Value Store

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Research Area: In-Network Computing
LaKe: Key-Value Store (KVS) made better

Networked applications (e.g., KVS) are inefficient due to power hungry CPUs.

Applications’ performance needs to scale, but is limited by power.

LaKe: Scalable in-network KVS using cache hierarchy.

Energy efficiency: x24 better than software KVS, x5.1 better than hardware KVS.
Datacenter for Networked Systems

Power Consumption

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>42%</td>
</tr>
<tr>
<td>Cooling</td>
<td>15.4%</td>
</tr>
<tr>
<td>Disk</td>
<td>14.3%</td>
</tr>
<tr>
<td>DRAM</td>
<td>11.7%</td>
</tr>
<tr>
<td>Network</td>
<td>8.4%</td>
</tr>
<tr>
<td>Misc</td>
<td>4.2%</td>
</tr>
<tr>
<td>Power Overhead</td>
<td>0.7%</td>
</tr>
</tbody>
</table>

Gap between networking and Computing

CPU is power-hungry

Computation growth is moderate, compared to networking.

Datacenter applications should be improved in terms of Power and Performance. Power Efficiency is important!!!

Highly energy efficient KVS

- **Main Storage**
- **L2 Cache**
- **L1 Cache**
- **Client**

- **In-kernel KVS** (host memory)
  - < 100s GB
- **In-NIC KVS** (on-board DRAM)
  - < 16GB
- **memcached** (host memory, HDD)
  - < 10 TB

Lake: Layered Key-value store

On-board DRAM

Shared-cache

PE0
LaKe: Layered Key-value Store

Classifier
(Network Datapath)

LaKe module

PE Network
(AXIS Interconnect IP)

PEN

PE1

PE0

Memory Network
(AXIS Interconnect IP)

CAM

SRAM Cont

DRAM Cont

Packet Buffer

Arbiter
(Network Datapath)

Packet Parser

Hash Func

Memory Allocator

SRAM Memory

Hash Table Access

Key Value Access

Packet DeParser

DRAM Memory
### Comparison with related work

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Memcached (SW)</td>
<td>238.84</td>
<td>0.962</td>
<td>9.938 [kqps/W]</td>
</tr>
<tr>
<td>Emu (HW)</td>
<td>1.21</td>
<td>1.932</td>
<td>47.121</td>
</tr>
<tr>
<td>LaKe (my system)</td>
<td>1.16</td>
<td>13.120</td>
<td>242.962</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>![x5.1]</td>
</tr>
</tbody>
</table>

LaKe achieves **x5.1** better power efficiency, keeping latency equivalent to Emu.

![i7-4770 + MellanoxNIC]

![i7-4770 + NetFPGA-SUME]
Thank you for your attention!!
Acknowledgement

This work is supported by JSPS Research Fellowship, The Leverhulme Trust and Isaac Newton Trust.