A Novel Parallel Traffic Control Mechanism for Cloud Computing

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Outline

- Introduction
- Weaknesses of HTB
- Parallel HTB
- Experiments
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Traffic Control in Cloud Computing

- Control the outbound bandwidth
  - require an effective bandwidth management
  - traffic scheduler & shaper

- Hierarchical Service
  - idea of cloud computing
  - different service level
  - an attempt of customized SLAs on bandwidth

- A Contradiction
  - different service levels vs. user experience
  - a possible solution : HTB
Hierarchical Token Bucket

- **HTB**
  - a traffic control algorithm
  - currently implemented in Linux kernel
  - a module of TC (Traffic Control)

- **Basic idea**
  - bandwidth borrowing
  - make full use of resource
  - a solution for the contradiction
  - hierarchical service & better user experience
HTB allows bandwidth borrowing to break AR!
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Weaknesses of HTB

- **Processing speed**
  - 500Mbps at most
  - not eligible for cloud computing

- **Reasons**
  - the inherent limitation of sequential program
  - usage of spin-lock in kernel
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Basic Idea

- Lock-free FIFOs based pipelining
  - port HTB from kernel to user space
  - based on multi-core architecture
  - try to eliminate necessity of using locks
  - reduce concurrency
  - selectively apply lock-free structures
  - make it run in a 1-way 2-stage pipeline fashion
Eliminate Locks

- Basic 2 operations of HTB: *enqueue* & *deque*
- Remove *htb_activate* and *htb_deactivate* in the 2 operations
- Critical region is reduced to only the packet queues
- A tradeoff: using locks but no empty queues

vs.

eliminate locks to parallelize HTB but might exist empty queues
Lock-free FIFOs

- Selectively used as the packet queue
- Eliminate time of lock/unlock operations
- Make it possible for HTB to run in a pipelined fashion
- We haven’t adopted the advanced cache-line distance and cache-line aggregation techniques in [1], because unnecessary

Stage1  Lock-free FIFO  Stage2

enqueue  dequeue

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Bandwidth Allocation

- 2 Scenarios: 1Gbps bandwidth & 2Gbps bandwidth
- The number of users of Scenario 2 are 2 times of that of Scenario 1
- Bandwidth for a user is 0.5Mbps/1Mbps and 2Mbps/12Mbps, for common service(require low band) and special service(require high band)
- Trace files are used in the experiments

```
1G/1G
125M/650M*8
2.5M/13M*50
0.5M/1M 2M/12M
```

TOTAL BANDWIDTH
USER GROUP
USER
APPLICATION
Results

- Exp.1 ~ Exp.4: 1Gbps. Exp.5 ~ Exp.6: 2Gbps
- Exp.1: all users have traffics. Exp.2: 2/3 of users have traffics
- Exp.3 ~ Exp.4: 64B pkt len. Exp.3: use parallel HTB, Exp.4: use HTB
- Exp.5 :all users have traffics. Exp.6: 2/3 of users have traffics

<table>
<thead>
<tr>
<th>FILE</th>
<th>#Packets</th>
<th>#Pkt Len.</th>
<th>#Max Len.</th>
<th>#Min Len.</th>
<th>#Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>File-1</td>
<td>2,397,696</td>
<td>782</td>
<td>1500</td>
<td>64</td>
<td>800</td>
</tr>
<tr>
<td>File-2</td>
<td>2,397,696</td>
<td>782</td>
<td>1500</td>
<td>64</td>
<td>533</td>
</tr>
<tr>
<td>File-3</td>
<td>9,765,925</td>
<td>64</td>
<td>64</td>
<td>64</td>
<td>800</td>
</tr>
<tr>
<td>File-4</td>
<td>4,795,392</td>
<td>782</td>
<td>1500</td>
<td>64</td>
<td>1600</td>
</tr>
<tr>
<td>File-5</td>
<td>4,795,392</td>
<td>782</td>
<td>1500</td>
<td>64</td>
<td>1067</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exp.</th>
<th>#Trace</th>
<th>#MPPS</th>
<th>#Mbps</th>
<th>#Enq.</th>
<th>#Deq.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>File-1</td>
<td>1.29</td>
<td>1008</td>
<td>0.39</td>
<td>0.54</td>
</tr>
<tr>
<td>2</td>
<td>File-2</td>
<td>1.29</td>
<td>1006</td>
<td>0.39</td>
<td>0.57</td>
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<tr>
<td>3</td>
<td>File-3</td>
<td>14.1</td>
<td>941</td>
<td>0.39</td>
<td>0.53</td>
</tr>
<tr>
<td>4</td>
<td>File-3</td>
<td>6.7</td>
<td>427</td>
<td>0.64</td>
<td>1.11</td>
</tr>
<tr>
<td>5</td>
<td>File-4</td>
<td>2.60</td>
<td>2033</td>
<td>0.39</td>
<td>0.54</td>
</tr>
<tr>
<td>6</td>
<td>File-5</td>
<td>2.59</td>
<td>2026</td>
<td>0.39</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Parallel HTB can reach 2Gbps for common packet lengths, 300% improvement of the traditional HTB
Results

Output traffic rate of the total traffic

Output traffic rate of a selected user
THANKS!

Questions Are Welcome