Openflow-based Server Load Balancing Gone WILD

Richard Wang, Dana Butnariu, Jennifer Rexford
Key Tradeoffs
1. Fast Enough
2. Scalable
3. Programmability
4. Cost

Load Balancing

Data Center

Internet

Replica 1

Replica 2

Replica 3

Popular Service
Key Tradeoffs
1. Fast Enough
2. Scalable
3. Programmability
4. Cost
Key Tradeoffs
1. Fast Enough
2. Scalable
3. Programmability
4. Cost
Challenges

1. Number of Microflow Rules
2. Controller Load

Data Center

Replica 1: 37.5%
Replica 2: 50%
Replica 3: 12.5%
Proactively Install Rules

Issues

1. Wildcards Rules
2. Connection Affinity

Internet

S1
S2
S3
S4

NOX Controller

Replica 1 37.5%
Replica 2 50%
Replica 3 12.5%

Data Center
Wildcard Rules on Client IPs

Replica 1: 3/8 (37.5%)
Replica 2: 4/8 (50%)
Replica 3: 1/8 (12.5%)

Switch:
- 111* → R3
- 110* → R2
- 101* → R2
- 100* → R2
- 011* → R2
- 010* → R1
- 001* → R1
- 000* → R1
Minimizing Wildcard Rules

Switch

Replica 1
Replica 2
Replica 3

<table>
<thead>
<tr>
<th>Replica 1</th>
<th>3/8</th>
<th>37.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replica 2</td>
<td>4/8</td>
<td>50%</td>
</tr>
<tr>
<td>Replica 3</td>
<td>1/8</td>
<td>12.5%</td>
</tr>
</tbody>
</table>

00* → R1
111* → R3
110* → R2
101* → R2
100* → R2
1* → R2
011* → R3
00* → R1

Switch
Connection Affinity

- Old Rule: 0* \rightarrow \text{Replica 1}
- Transition Rule: 0* \rightarrow \text{Controller}
- New Rule: 0* \rightarrow \text{Replica 2}

Switch:
- C2 \rightarrow \text{Replica 2}
- C1 \rightarrow \text{Replica 1}
- 00* \rightarrow \text{Replica 2}
Evaluation

Before

Old Rule

Transition

New Rule

36 Clients, 16 MB File, WGET every 10 s
Multiple Switches

Minimize Number of Rules
Opportunistically Combine Wildcard Rules
Conclusion

- Proactively Installing Rules in Openflow

1. Connection Affinity
2. Effective Distribution
3. Fast Enough
4. Scalable
5. Programmability
6. Cost
Questions?