A Survey of Network Function Placement

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Classification

Network Function Placement

Hardware NF placement

- Independent Passive NFs
- Chained NFs

Software NF placement

- Thread-base Framework
- VM-based Framework
- Other

Other
Hardware NF Placement

- Independent Passive NFs
  - passive monitor
  - trade-off between COVERAGE and COST

- Chain NFs
  - Service Chain: require Correctness, Efficiency (e.g. firewall - IDS - proxy)
  - min LATENCY
Hardware NF Placement

<table>
<thead>
<tr>
<th>NF type</th>
<th>Location</th>
<th>Traffic steering</th>
<th>Placement objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent NFs</td>
<td>in-line</td>
<td>optional</td>
<td>max cov./min cost</td>
</tr>
<tr>
<td>Chained NFs</td>
<td>off-line</td>
<td>compulsory</td>
<td>min latency</td>
</tr>
</tbody>
</table>

**TABLE I**
Comparison between independent passive NFs & chained NFs.
Classification

Network Function Placement

Hardware NF placement

Independent Passive NFs

Chained NFs

Software NF placement

Thread-base Framework

VM-based Framework

Other
Software NF Placement

Monolithic Consolidating - CoMb

- multiple application on hardware platform
- location independent
Software NF Placement

Cross-border On-path Placement - MIDAS

- Location dependent
- Steps
  1) compute utilization balancing across NFPs and location dependency
  2) select CoMb servers
Software NF Placement

Path Loosely Controlled Placement – E2

- minimize inter-server traffic

Steps

1) redraw the service chain into pGraph
2) determine the number of instances of each NF
3) convert pGraph to iGraph
4) actual instance placement

Figure 4: Transformations of a pGraph (a) into an iGraph (b, c, d).
Software NF Placement

Path Tightly Controlled Placement – VNP-OP

• Control the Routing Path by SDN
• minimize the cost
  ■ VNF deployment cost
  ■ Energy cost
  ■ Traffic forwarding cost
  ■ Penalty for SLO violation
• Reduce to Trans-shipment problem, NP-hard
Software NF Placement

Unordered Placement-PACE

• Service Chain can be UNORDERED and partially unordered
• more flexible
• Satisfy more requests
Other

Element-based Framework-Slick

- implement NFs as a chain of lightweight functions (element)
- steps
  1) Consolidate element if necessary
  2) place element
  - element’s inflation factor
  - \( \log(\frac{f_{out}}{f_{in}}) \quad f: \text{traffic volumes} \)
  - place negative inflation factor near source
Other

Distributed NFs-CSamp

• Create a new NF: monitor NFs
• Avoiding redundant measurements: hash-based packet selection
• Distributed redundant elimination have been implemented
Other

Host-based Framework - ETTM

- place at endpoints
- provide fault-tolerance and reliability
## Software NF Placement

<table>
<thead>
<tr>
<th>NFV form</th>
<th>NFV framework</th>
<th>Placement strategy</th>
<th>On path?</th>
<th>Mangling NF?</th>
<th>Location dependency?</th>
<th>Order preserve?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thread-based</td>
<td>CoMb [25]</td>
<td>Monolithic consolidating</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
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<tr>
<td></td>
<td>MIDAS [1]</td>
<td>Cross-border on-path placement</td>
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<td>x</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>VM-based</td>
<td>E2 [22]</td>
<td>Path-loosely-controlled placement</td>
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<td>x</td>
<td>x</td>
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<td>Statos [10]</td>
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<td>x</td>
<td>✓</td>
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<tr>
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<td>x</td>
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<td>PACE [18]</td>
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<tr>
<td>Other Forms</td>
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<td>✓</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>ETTM [8]</td>
<td>Monolithic consolidating</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
</tr>
</tbody>
</table>

**TABLE II**
Comparison between different NFV frameworks
Challenges & Future Work

- NFV offers new opportunities for performance optimization.
- Performance of ensure correct forwarding in face of mangling NFs.
Conclusion

• issue both hardware and virtualized NFs
• design and strategy of each NFs placement
• future challenges and opportunities