On the Placement of Management and Control Functionality in Software Defined Networks

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SDN-based management & control approach

- Support for both static and dynamic resource management applications
- Layered and modular architecture
- Separation of concerns
  - Short vs. long term operations
  - “Management” vs. “control”
Placement of management and control functionality

• The degree of distribution depends both on the physical infrastructure as well as the type of applications to consider.

• Which parameters to take into account to decide on the number of managers (LMs)/controllers (LCs)?
  - Reduction of the communication delay without significantly increasing the signalling overhead.
Assumptions and definitions

One-to-one mapping
LM-LC

Switch weight

Cluster
A placement problem

• Given a network topology, determine:
  ➢ the number of LMs to deploy
  ➢ their location
  ➢ the set of switches to which these are connected

  in order to satisfy a given objective.

• Proposed approach based on a modified version of the leader node selection algorithm developed by Clegg et al. in [1].

Placement algorithm

• Greedy approach – LMs are iteratively added in the network one-by-one.

• Relies on two tuneable parameters
  ➢ Initial Placement Metric (based on properties taken from the graph theory)
  ➢ Ending Threshold (based on the optimization objective)

• Parameters configured based on topological factors and management application requirements.
Which objective(s) to optimize?

• Management application-centric approach
  ➢ Objective(s) and parameters selected based on the application requirements

• Abstraction of the management application
  ➢ Frequency of (re)configurations
  ➢ Overhead
    Volume of information to process
    Volume of information to maintain
    Volume of information to exchange
Management application abstraction (1/3)

- Frequency of (re)configurations
  - High
  - Low

- Information level
  - Atomic
  - Aggregated
Management application abstraction (2/3)

Frequency of (re)configuration

- High
  - Online monitoring
  - Semi-reactive content placement
  - Traffic load-balancing
  - Energy management
  - Proactive content placement
  - Proactive cluster-based server selection

- Low
  - Reactive cluster-based server selection
  - Information level
  - Aggregated
  - Atomic
Management application abstraction (3/3)

<table>
<thead>
<tr>
<th>Frequency of (re)configuration</th>
<th>Information level</th>
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<tbody>
<tr>
<td>High</td>
<td>Aggregated</td>
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1. Minimize latency SW-LM
2. Optimize cluster size based on SW weight
1. Optimize cluster size based on #SWs
2. Minimize latency SW-LM

1. Optimize cluster size based on SW weight
2. Minimize latency SW-LM
Algorithm variants

• P\text{distance}
  - Objective: latency reduction
  - Ending condition: threshold based on the measure of LM-SW distance reduction

• P\text{cluster}
  - Objective: trade-off between latency reduction and homogeneity of the cluster size distribution based on the number of switches
  - Ending condition: threshold based on the measure of LM-SW distance reduction and threshold based on unbalance degree

• P\text{weight}
  - Objective: trade-off between latency reduction and homogeneity of the cluster size distribution based on the switch weight
  - Ending condition: threshold based on the measure of weighted LM-SW distance reduction
Influence of the Initialization Criteria

- Investigate the influence of three commonly used topological metrics based on 4 topologies
  - Betweenness centrality
  - Clustering coefficient
  - Average distance factor

Average distance factor
Ending condition and LM distribution

\( \text{P}_{\text{distance}} \)

\( \text{P}_{\text{weight}} \)

\( \text{P}_{\text{cluster}} \)
Conclusions

• Management application-centric placement approach for distributed management and control entities.

• Different variants of the placement algorithm to account for applications with different requirements.

• Potential future research directions
  ➢ Refinement of the abstraction of management applications.
  ➢ Investigate cases with N-to-M mapping LM-LC.
Questions?