NFOpt: Eliminating Redundant Logic in NF Programs using Operation-Time Configurations

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Introduction

Background

Network functions (NFs) are critical components in the network data plane. Their efficiency is important to the whole network's end-to-end performance. And a lot of works recognize this critical efficiency issue and propose the corresponding optimization, such as accelerating the NF execution, parallelizing NF (chains), and consolidating NFs. A recent trend of DevOps inspires us to propose an orthogonal approach — using the operation-time configurations to optimize NF programs.

Contributions:

- Show the existence of redundant logic in NFs in the scenario of DevOps.
- Design compiler-based solutions called NFOpt to eliminate the redundant logic.
- Evaluation NFOpt on commodity NFs and platform NFs completely.

NFOpt Overview

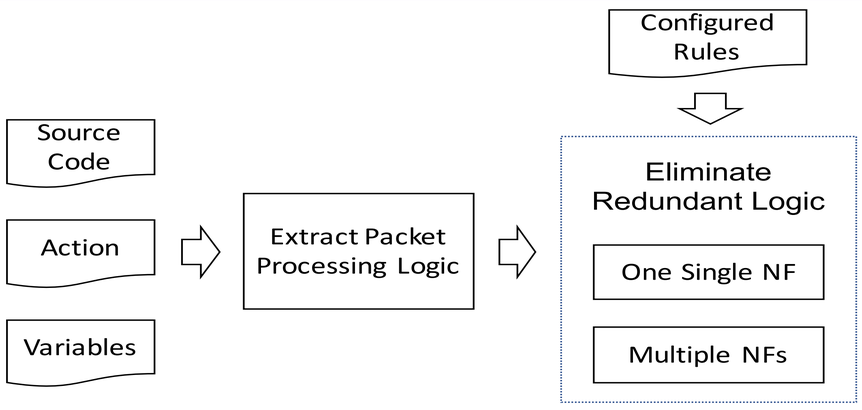


Figure 1: NFOpt Overview

Taking as input:

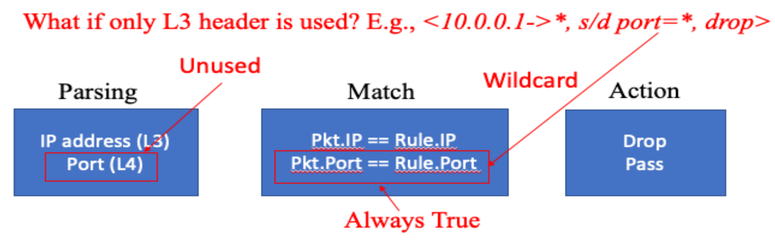
- NF Source Code,
- NF Configuration
- Identified Variables and Actions

Program Analyzing Techniques:

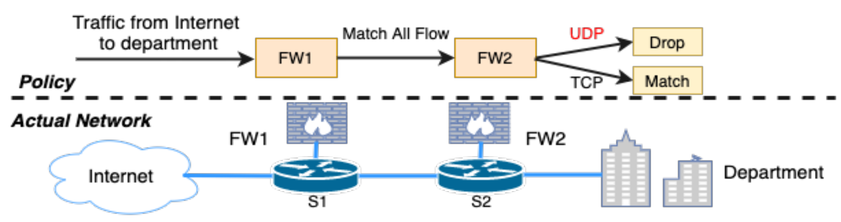
- Constant Propagation & Expression Fold
- Dead Code Elimination
- Common Sub-expression Elimination
- Copy Propagation
- Symbolic Execution
- Program Slicing

Eliminating three kinds of NF redundant logic:

- Unused Logic.



- Duplicate Logic.
- Overwritten Logic.



Evaluation

Unused Logic Redundancy

- Unused Layer Redundancy

The throughput of the two IDSes and the firewall increase significantly. (e.g., 15% for Snort, 21% for OpenNetVM-Firewall, 15%-10× and 40% to 3× for Suricata in single-thread mode and multi-thread mode, respectively)

- Unused Protocol Redundancy

When the proportion of UDP packets increases to 50%, removing the redundancy can achieve 40% and 2.5× performance gain for Snort and Suricata, respectively. In OpenNetVM-Firewall, configurations are embedded in code, the compiler would apply some optimizations before we apply NFOpt, the performance gain is moderated.

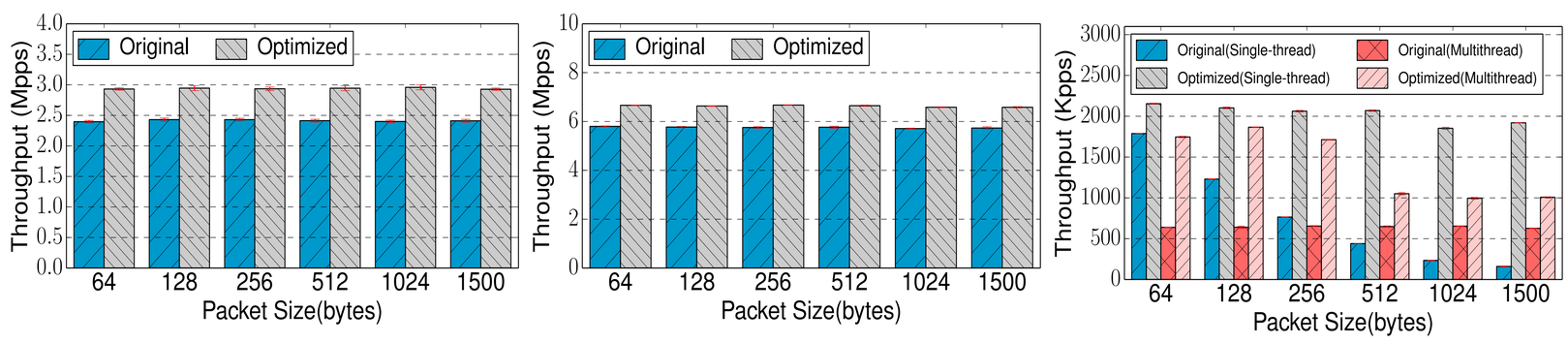


Figure 2: Eliminate Unused Layer Logic Performance Gain of OpenNetVM-FW(left), Snort (middle), Suricata (right)

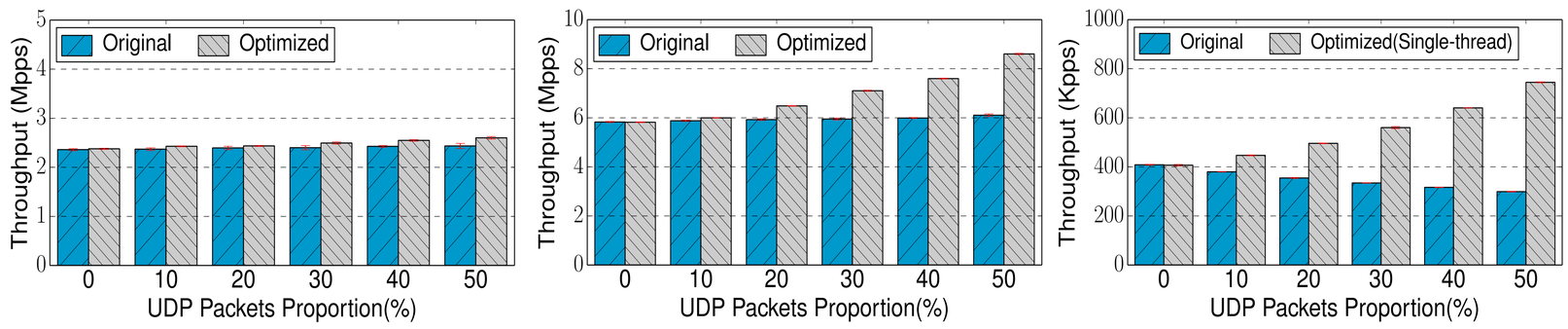


Figure 3: Eliminate Unused Protocol Logic Performance Gain of OpenNetVM-FW(left), Snort (middle), Suricata (right)

Duplicated Logic Redundancy

The Duplicated Logic elimination can help improve throughout by more than 25% for monitor and Snort IDS chain, and improve throughout by nearly 55% for the two OpenNetVM-Firewall instances.

Overwritten Logic Redundancy

After the elimination of the Overwritten Logic elimination Optimized program can achieve about 7% performance gain in both case when UDP proportion reaches to 50%.

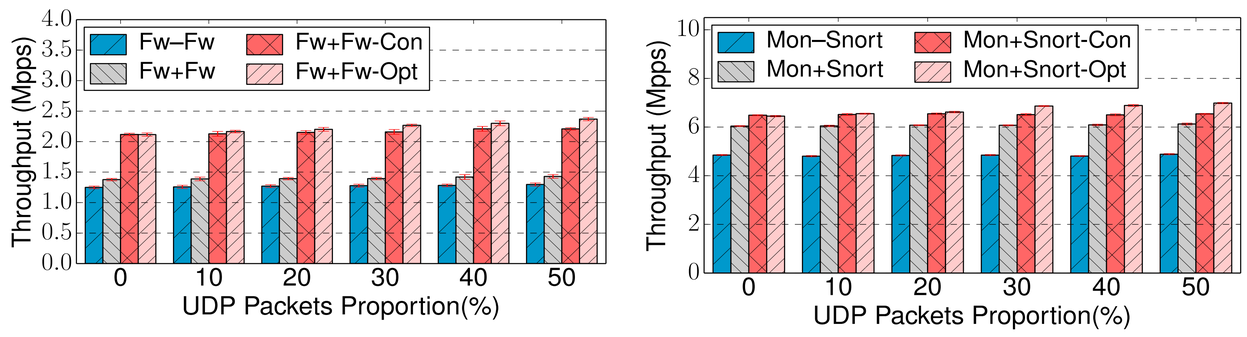


Figure 4: Performance Gain of Eliminating Duplicate Logic and Overwritten Logic

References

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