POLITECNICO DI TORINO

Dipartimento di Automatica e Informatica

PhD in Computer and Control Engineering

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Supervisor

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# Novel Paradigms to Data Center Software Network Services

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## 1. Introduction

Today, typical software Network Functions (NFs) implementations across data center networks rely on kernel-bypass approaches (e.g., DPDK), or fixed kernel applications (e.g., Open vSwitch), which are subject to several limitations such as *(i)* high **CPU utilization**, *(ii)* **poor integration** with the kernel subsystem and *(iii)* **application semantic unawareness**.

## 2. Goal

This PhD project proposes a new paradigm to build in-kernel NFs that overcome the previous limitations by providing a **better** resource **utilization** and a **good integration** with the other kernel subsystems. Moreover, these NFs can be **dynamically compiled** and **optimized** at runtime based on the different application semantic and runtime behavior.

## 3. In-Kernel Network Services

To enable the creation of complex in-kernel NFs we designed **Polycube** (Figure 1), a framework based on the Linux eBPF subsystem. Polycube NFs include an efficient in-kernel data plane and a flexible userspace control plane with strong characteristics of isolation, persistence and composability [1].

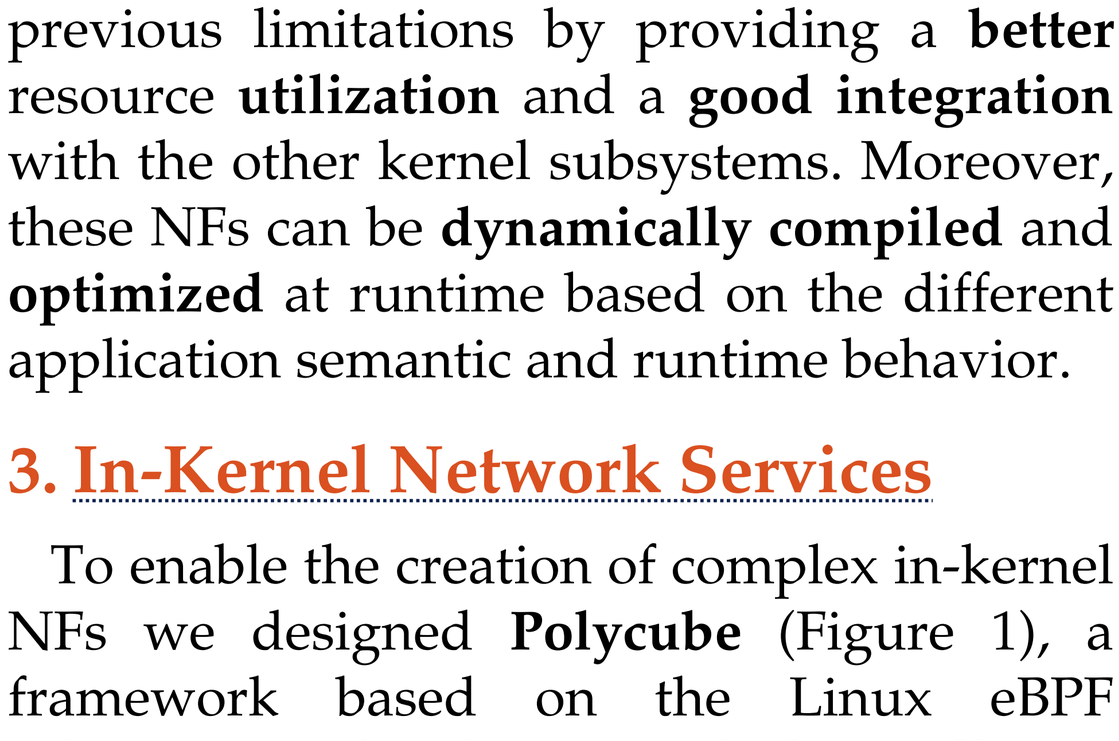


Figure 1. High-level architecture of Polycube.

## 4. Dynamically adaptive NFs

This new model of building and deploying NFs introduces the possibility to adopt a **dynamic approach** to the **data path compilation** where not only the static features but also the **runtime data** are exploited to further optimize the output program.

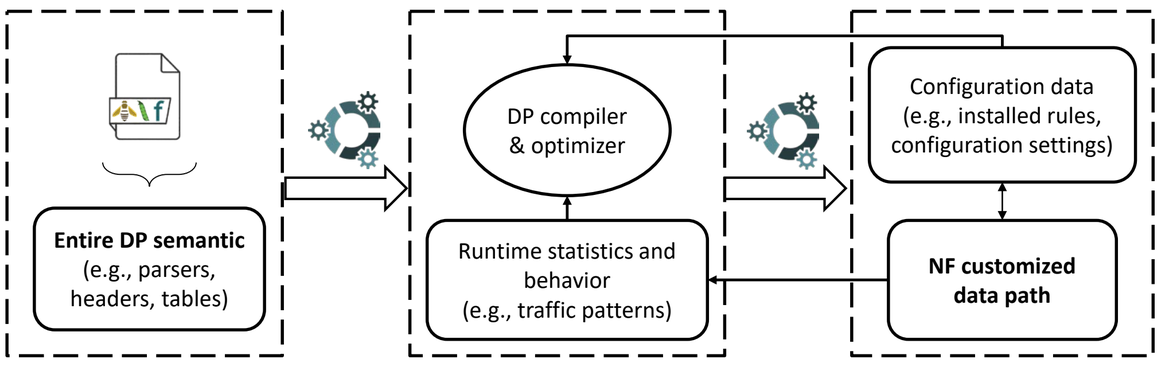


Figure 2. Dynamic NFs compilation and optimization

## 5. Results

Experiments have shown the advantages of this novel approach in both being able to overcome the performance of existing network applications (e.g., **iptables** [2]) and enabling the integration with programmable hardware devices such as **SmartNICs** [3].

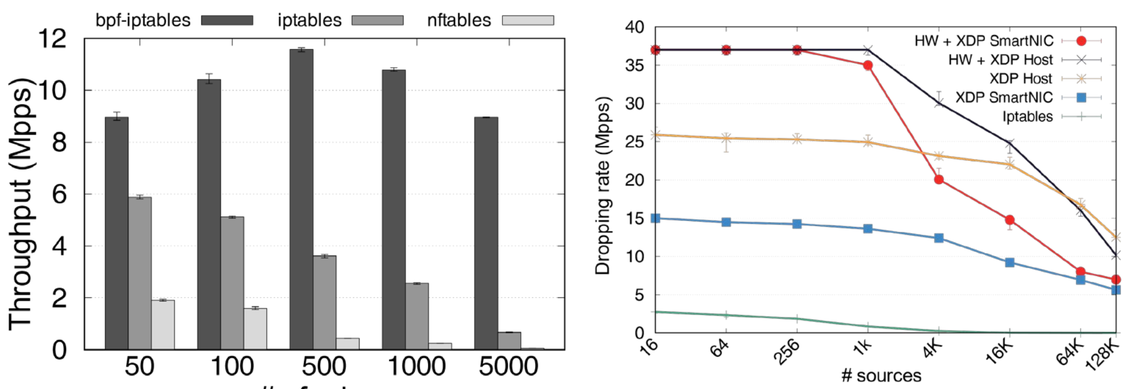


Figure 3. (a) bpf-/iptables performance comparison. (b) DDoS Mitigation performance of eBPF+SmartNIC combination.

## 6. References

1. Miano, S., Bertrone, M., Risso, F., Bernal, M.V., Lu, Y., Pi, J. and Shaikh, A., 2019. A Service-Agnostic Software Framework for Fast and Efficient In-Kernel Network Services. *ACM/IEEE ANCS.*
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3. Miano, S., Doriguzzi-Corin, R., Risso, F., Siracusa, D. and Sommese, R., 2019. Introducing SmartNICs in Server-Based Data Plane Processing: The DDoS Mitigation Use Case. *IEEE Access, Volume 7.*