Chair of Communication Networks
Department of Electrical and Computer Engineering
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# Firewall offloading based on SDN and NFV

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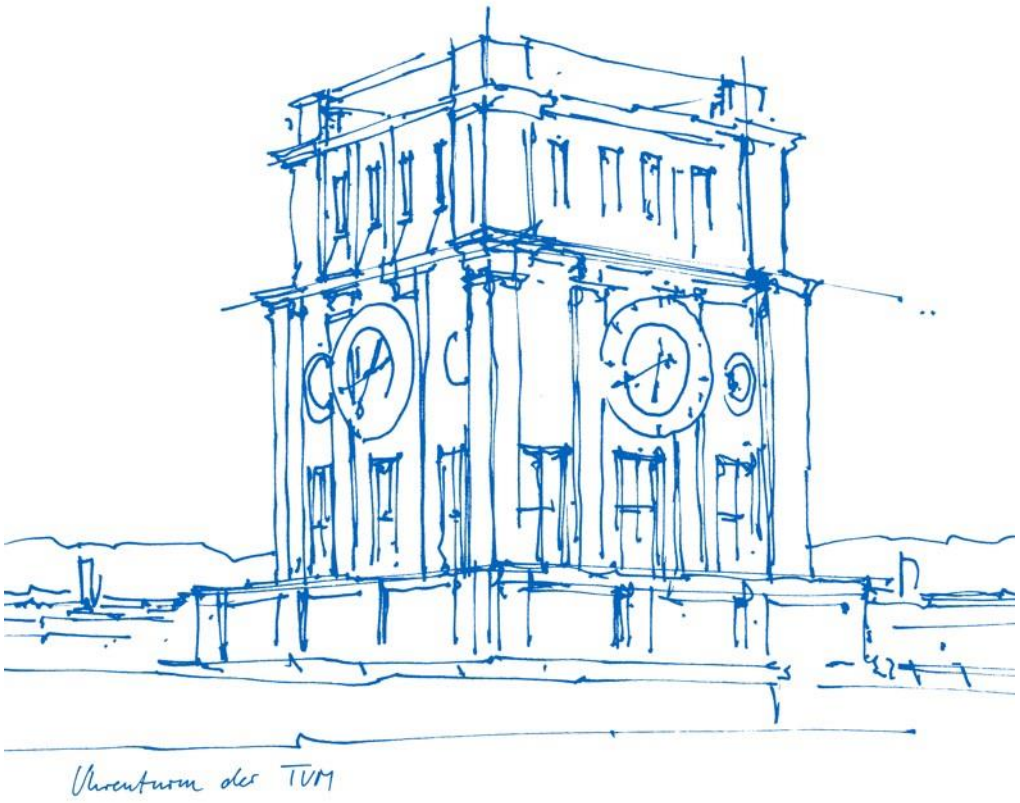


# Overview

- Introduction
  - Motivation
  - Main security requirements
- Network Function Virtualization
  - State of the Art
  - SDN & NFV Architecture
- Offloading Approach
  - ByteLim Logic
- Conclusion and open Questions

# Motivation

**Software Defined Networking:**

Central control improves programmability and makes innovations easier

**Network Function Virtualization:**

Run Network Functions on Commodity Hardware and in the cloud

- ✓ Reduce costs
- ✓ Use available resources flexible

→ How can we guarantee a certain security level in these environments?

→ How can security related network functions be virtualized?

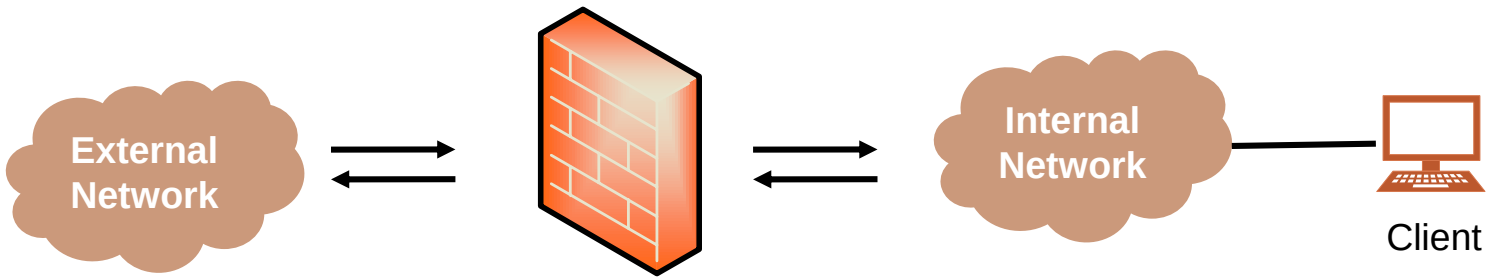
# Main Security Requirements

- Isolation of services
  - Authentication and Authorization of devices/users/services
  - Isolation of flows

  → Stateless firewalling
- Stateful Firewalling
  - Check states of protocols
    - e.g. TCP, SIP
  - Normalization
    - e.g. filter non-standard DNS replys, filter html

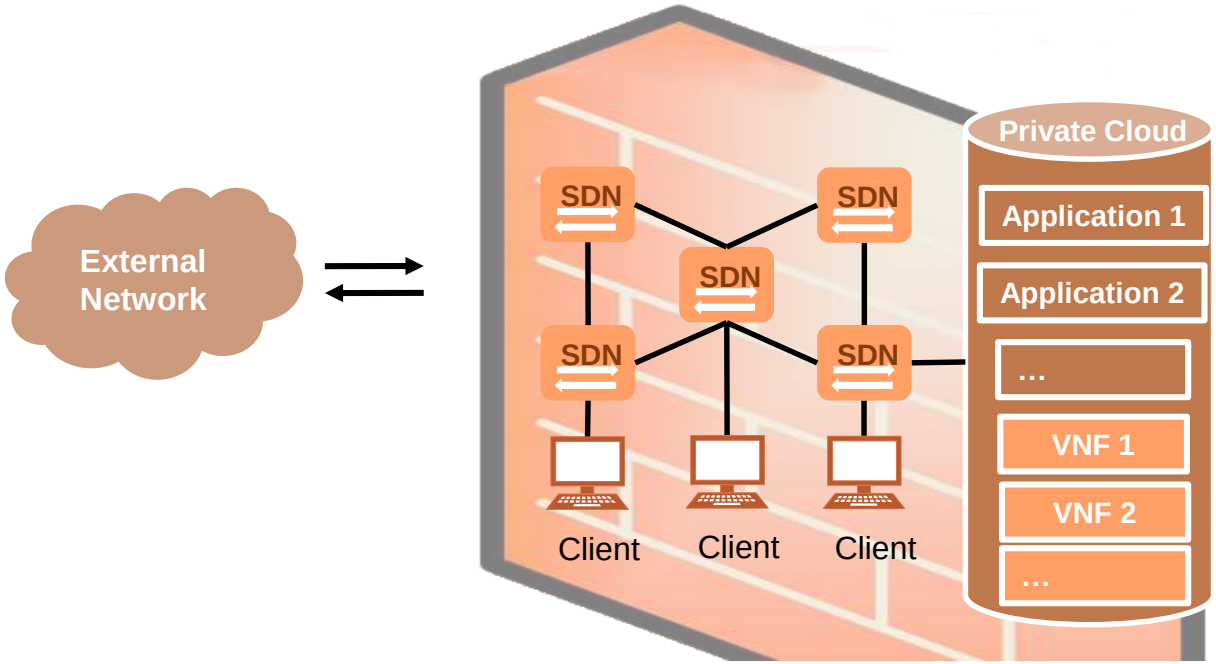
Stateless < Stateful < Application Layer

# State of the Art Firewalls




- Firewall Resides on the Networks‘ Edge
- Control Plane (State) and Forwarding Plane not decoupled

# SDN and NFV Network Security Architecture




**No distinct edge of the network**

→ Firewall has to filter „everywhere“

→ Higher Load on Firewalls

→ Potentially higher security

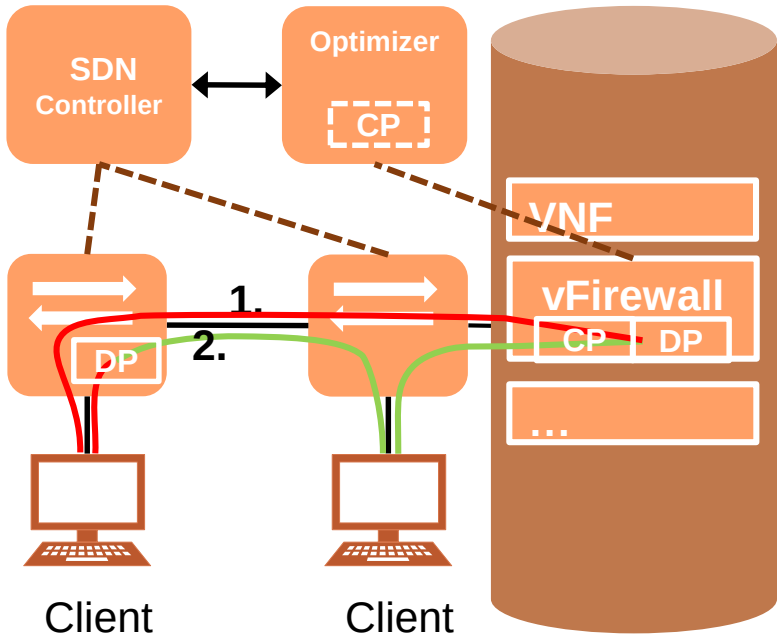
# Offloading Approach

Combine NFV and SDN

- Traffic steering with SDN
- Some parts of the Network function with SDN
- Some parts offloaded to NE

- More Complex

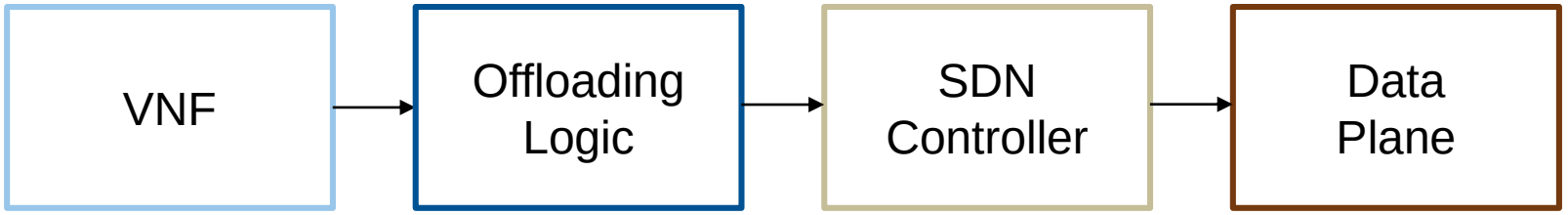
+ leverages benefits of both approaches




Example TCP:

1. Connection Setup using VNF
2. Established connection using Hardware

# Building Blocks




- VNF signals connection state to Logic
- Logic decides for Offloading Flow
- Command to SDN Controller
- SDN Controller installs necessary rules in Hardware

# Challenges

- Flow setup in switch

Can cause duplicates, packet loss and (short time) connection interruption

- Lack of Hardware

Current OpenFlow switches handle header rewrite in software – very low throughput

- Offloading Decision:

Flow classification algorithms needed

**Which Flows can be offloaded and what are the gains?**

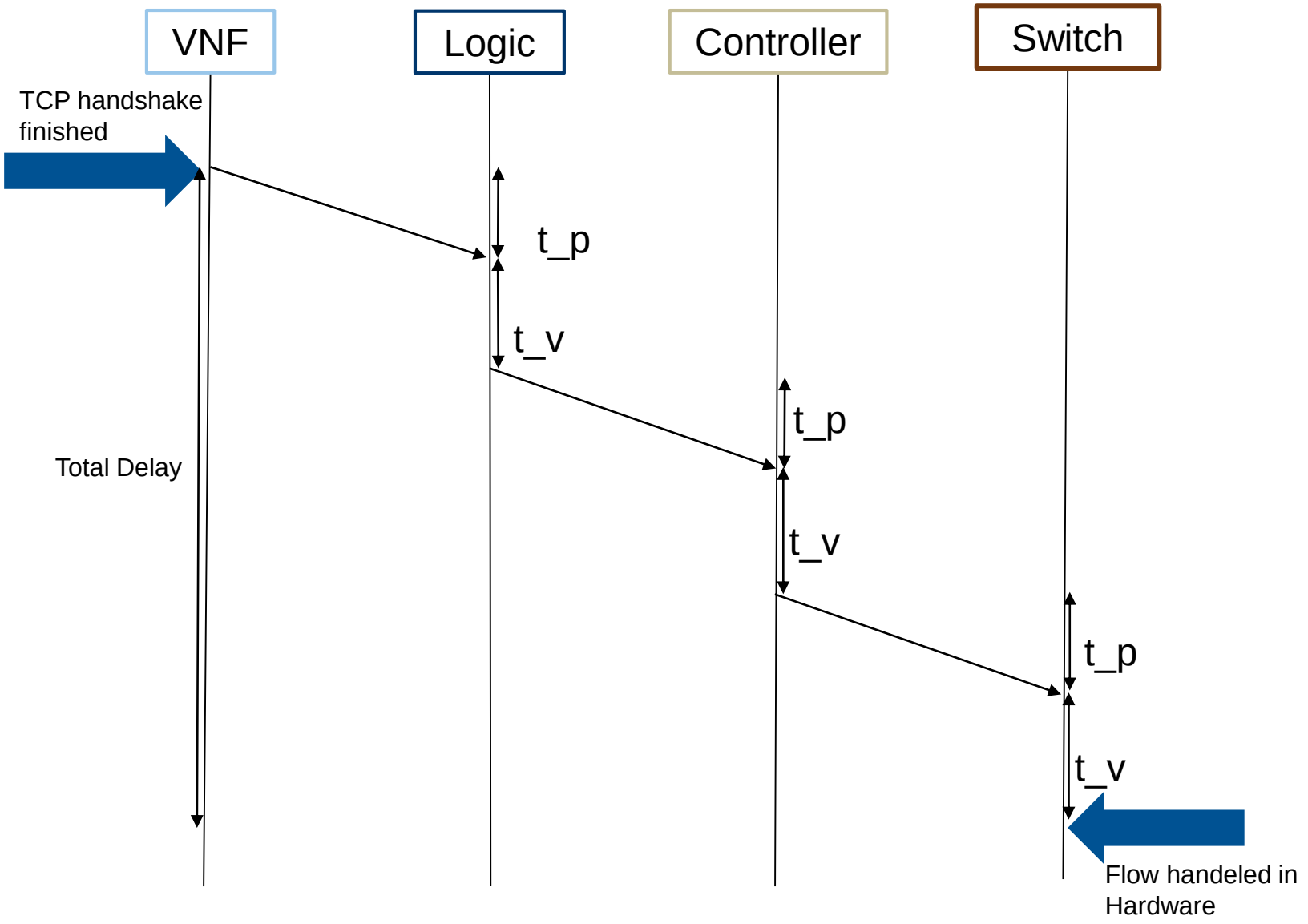
# Challenges

**Which Flows can be offloaded and what are the gains?**

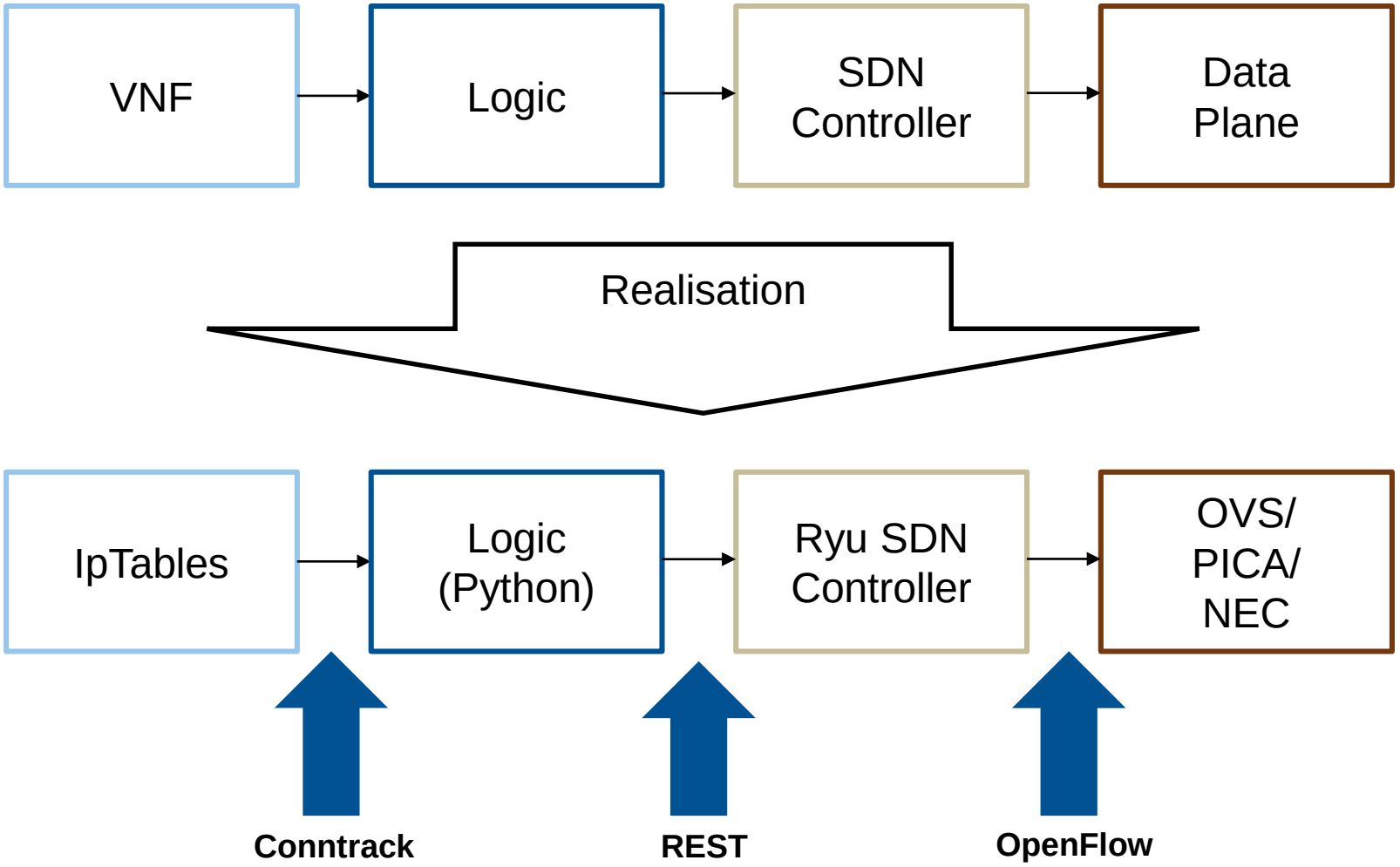
→**What limits the usage of Offloading?**

- Flow capactiy in the hardware
- Flow Setup Rate
- Delay from decision to active Offloading

# Constraint: Delay in the complete system



# Building Blocks Realisation



# Total Delays

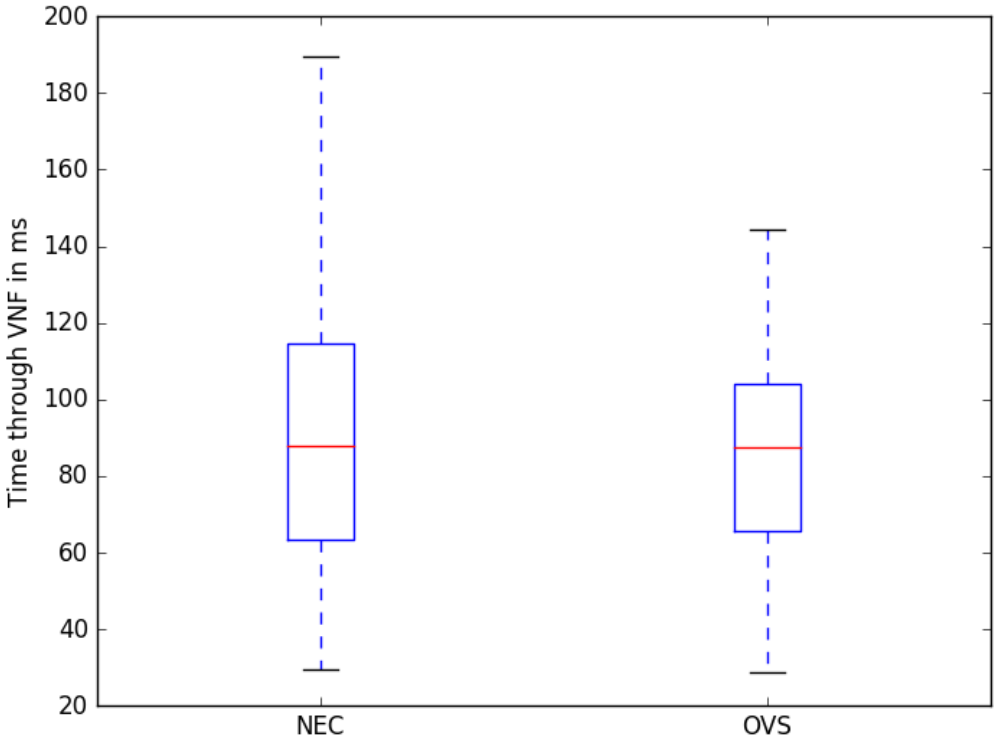
**Results:**

- ~ 100 ms for OVS & NEC

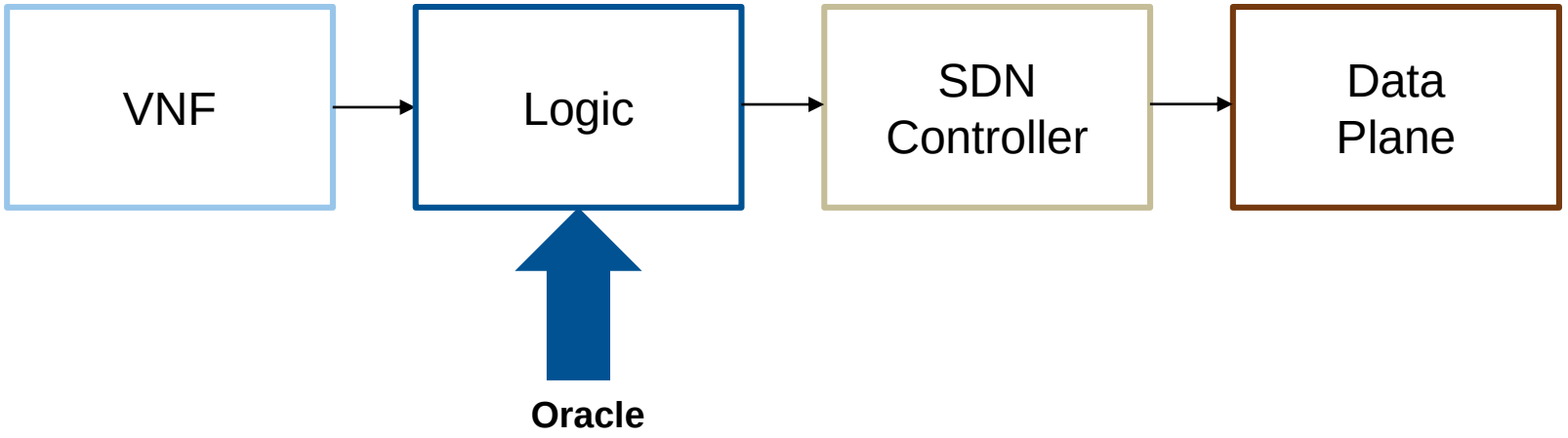
**Implications:**

- Not feasible for short lived flows like DNS
- Delay > RTT

→ Effects on TCP algorithm



# Effects of Logic on Performance




- Which Flow metrics must be estimated by the Oracle?
- Gain i.e. cost of flow through VNF proportional to packet count

➔ **Offload Flows with many Packets**

# Bytelimit Logic

- Logic decides based on Flowsize
  - Flows above a threshold are offloaded
- Oracle predicts Flowsize based on used application

**Mathematical Description:**

$\boldsymbol{f(x)}$: PDF of flow size

$x$: Flow size

$P(x)$: PDF of Packets

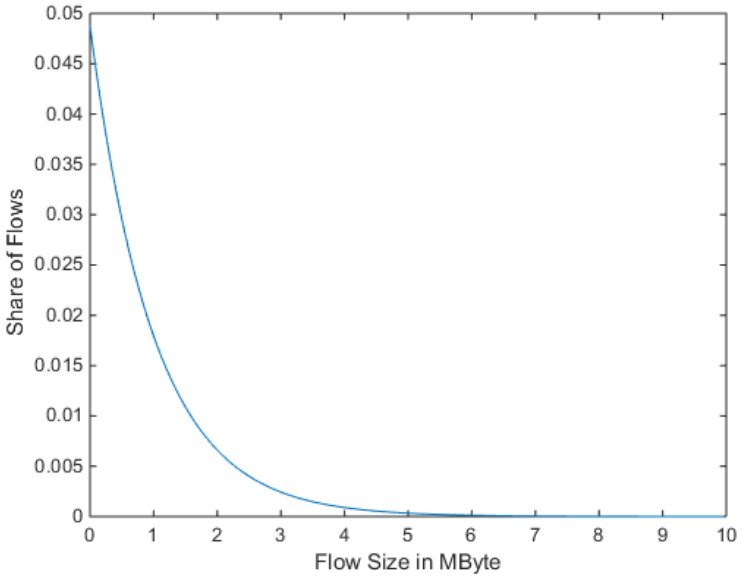
$$P(x) = f(x) * \mathrm{x} = \int f(x) \cdot x \, dx$$

$$\overset{discrete}{\Longrightarrow} \mathrm{P} = \mathrm{F} \cdot X$$

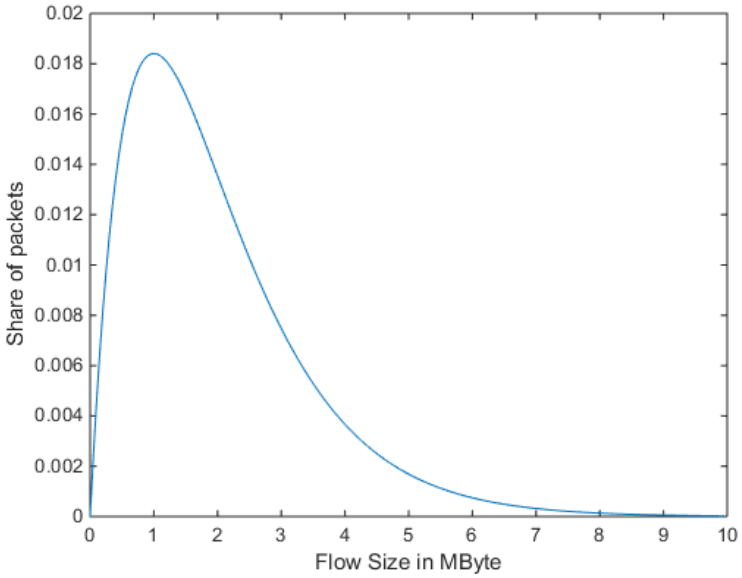
# Bytelimit Logic

**Example: Negative Exponentially distributed Flowsize**

Share of Flows **f(x)**




Share of Packets **P(x)**

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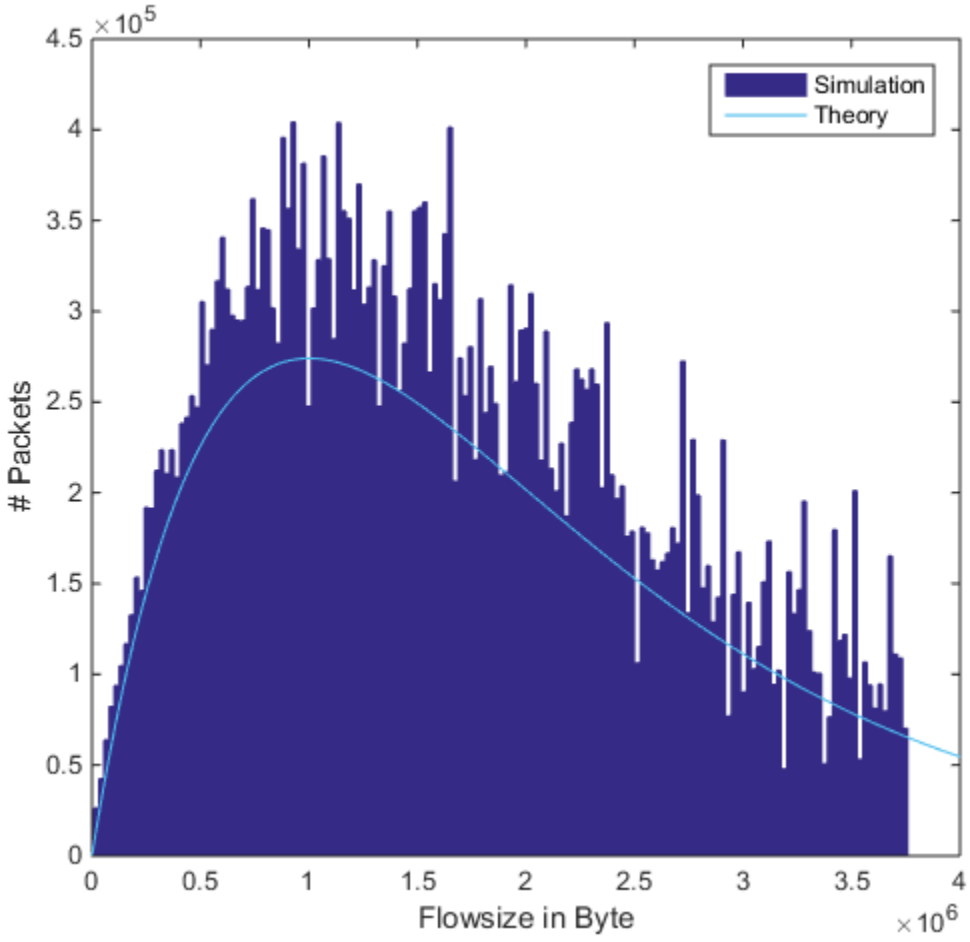
# Bytelimit Logic

**Simulation vs Theory**

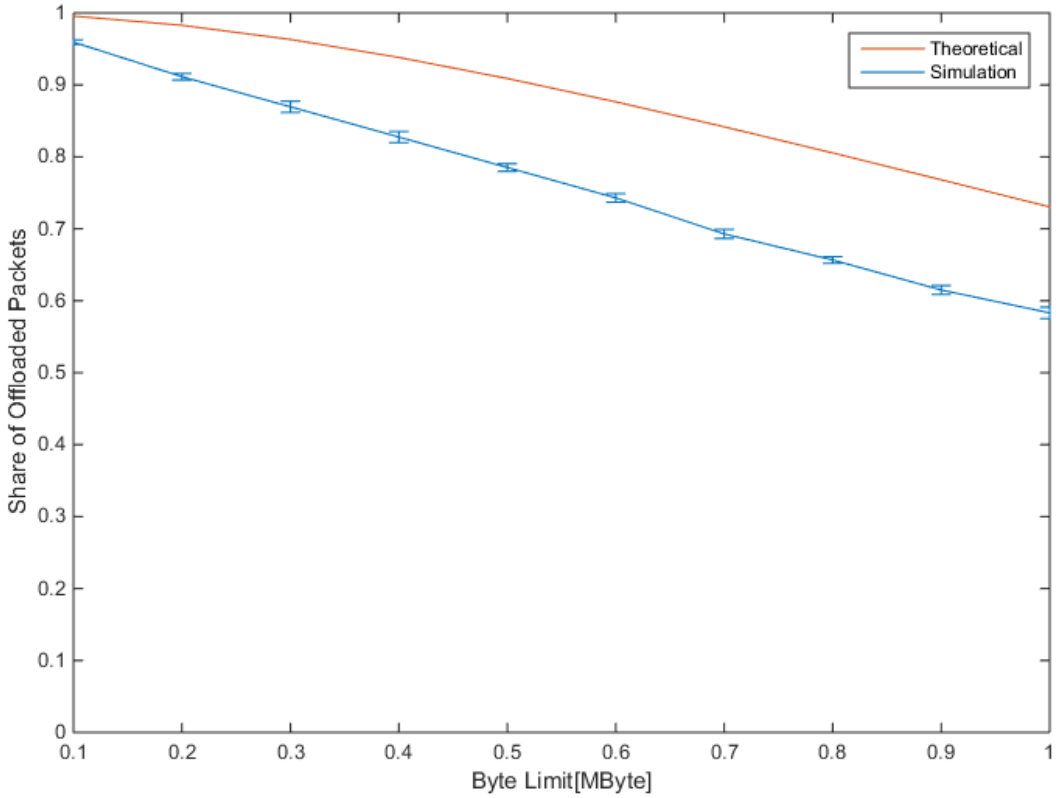
- Trendline similar
- Very big flows are hard to simulate



# Bytelimit Logic

**Simulation vs Theory**

- Trendline similar
- Offset between simulation and theory
- Very big flows are hard to simulate



# Conclusion and Open Questions

- Basic building blocks for offloading developed
- Bytlim logic shows promising results
  - Difference between simulation and theory should be evaluated

**Open:**

- How to predict Bytesize?
  - Simple classification by {source IP, Port}

# Questions?