VPN PERFORMANCE EXPERIMENT

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INTRODUCTION

MASTER’S THESIS

- Experiment is part of my WIP thesis
- Comparison between IPsec, Wireguard and OpenVPN
  - Initially feature comparison (mostly literature review)
  - Evolved to mostly performance comparison
- Motivation
  - Personal interest
  - Lot of ”non-scientific” information

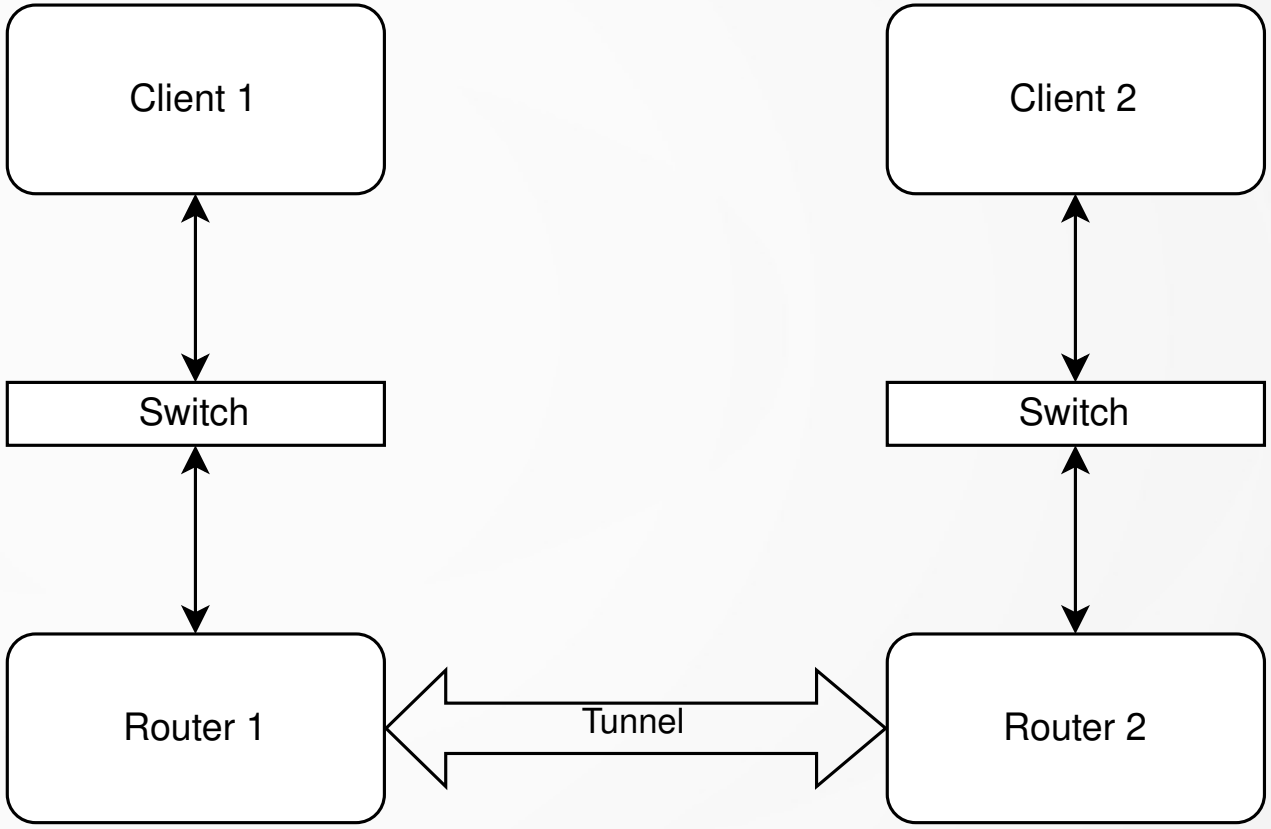
THE GOAL

- Try new stuff
  - Protocols new to me
  - New features like IP-TFS
- KISS (somewhat)
  - Generic hardware
  - See what an average sysadmin can expect
  - Keep ’tweaking’ minimal
- See what happens and try to figure out why

SETUP

GENERA INFO AND TOPOLOGY

- IPv6 only
- Hardware servers
- 10 Gb Ethernet
- Clients
  - Traffic generators / receivers
- Extensive scripting



ROUTERS

- CPU: Intel Xeon E3-1230 v6 @ 3.5GHz (4 cores, no SMT)
- NICs: Intel X540-AT2 (10 Gigabit)
- MoBo: Supermicro X11SSW-TF version 1.02
- OS: Fedora 44 Server
- Kernel: 7.1.3-200.fc44.x86_64

BENCHMARKS

PROTOCOLS

- IPsec
  - Base
  - IP-TFS
  - Routed
  - Per-CPU SA
  - Offloading
- Wireguard
- OpenVPN
  - Data Channel Offloading (DCO)

MEASUREMENTS

- Pcap (all 4 servers)
- Iperf3 outputs (clients)
- CPU usage (routers)
- Power usage (routers)

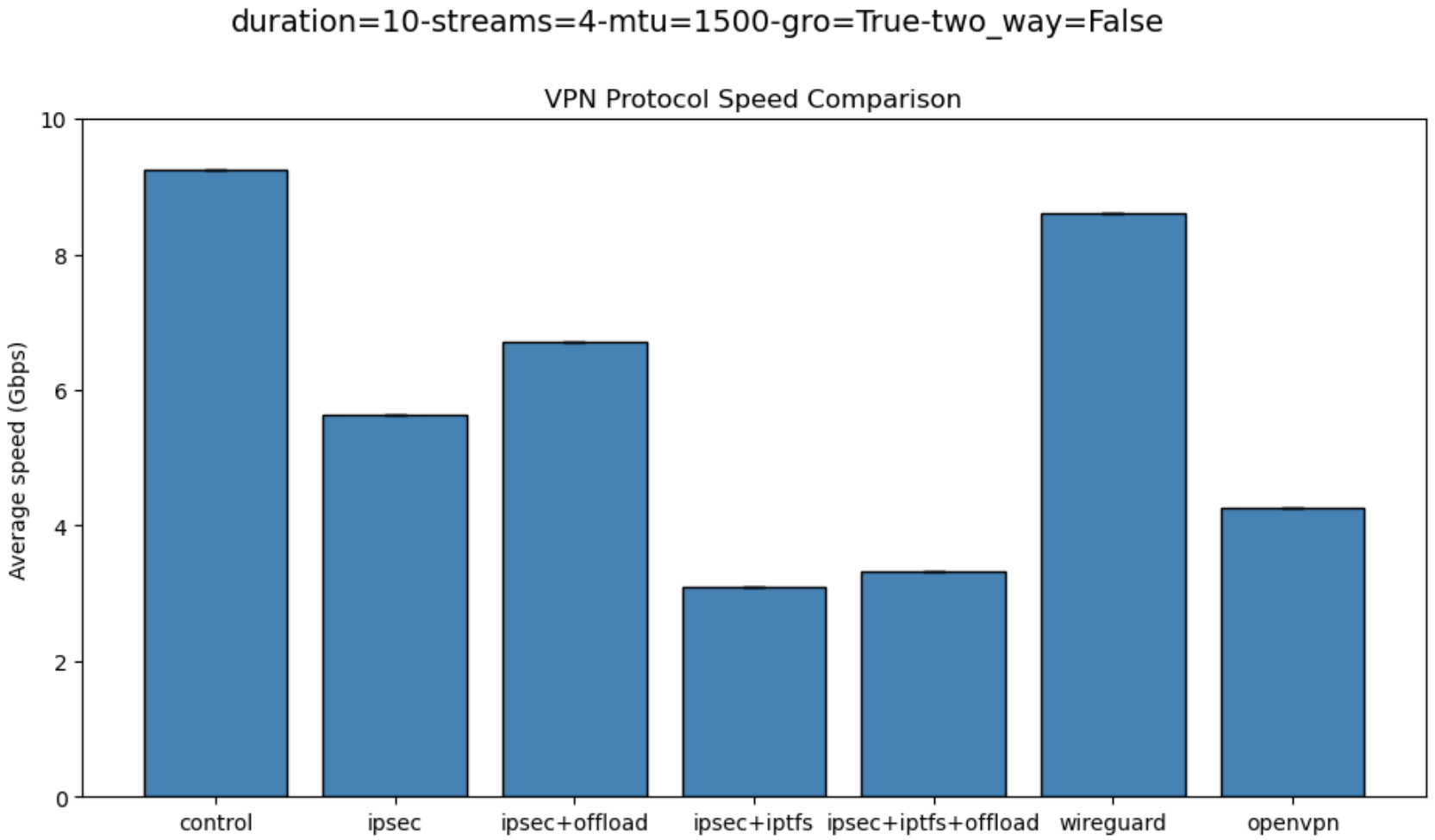
PARAMETERS

- Number of TCP streams
- Test duration
- MTU (1500 and 9000)
- Two-way traffic
- Generic Receive Offload (GRO)
- Boring ones
  - Duration
  - Repetition

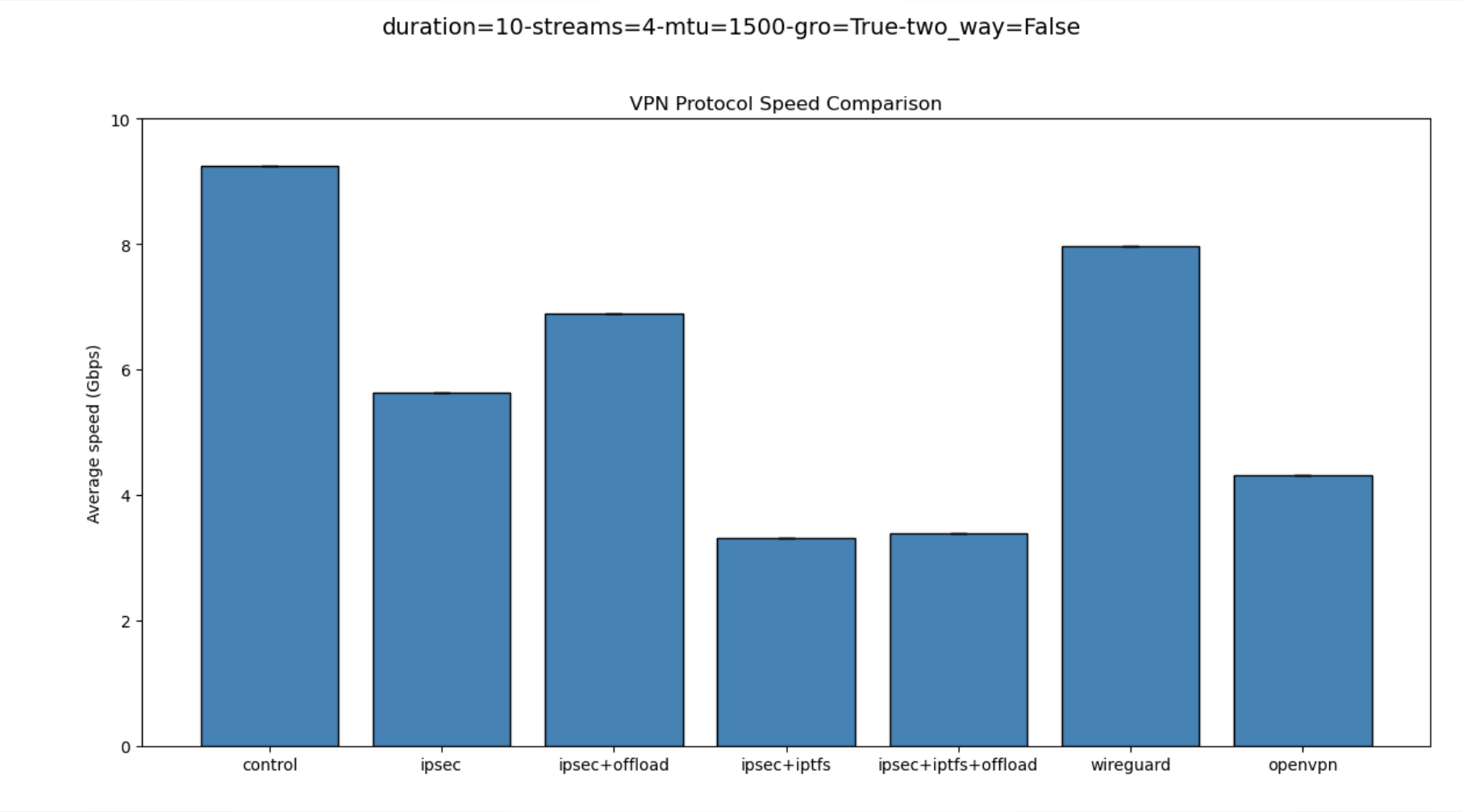
RESULTS

INITIAL SPEED COMPARISON

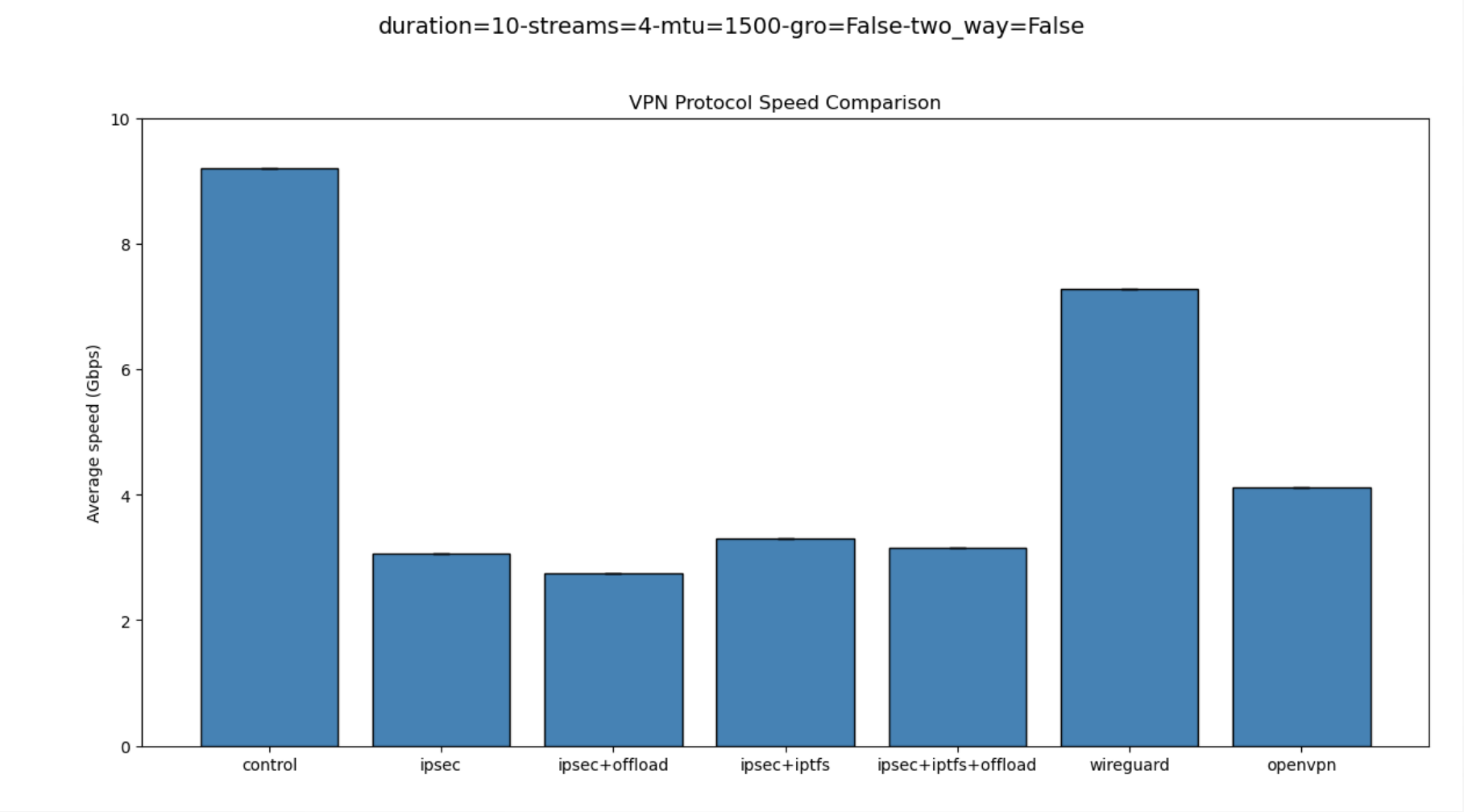
Protocol	Speed (Gb/s)
Control	9.25
IPsec	5.63
IPsec (esp6_offload)	6.70
IP-TFS	3.10
IP-TFS (esp6_offload)	3.32
Wireguard	8.59
OpenVPN	4.26



GRO ENABLED


duration=10-streams=4-mtu=1500-gro=True-two_way=False
VPN Protocol Speed Comparison
Average speed (Gbps)
0
2
4
6
8
10
control
ipsec
ipsec+offload
ipsec+iptfs
ipsec+iptfs+offload
wireguard
openvpn

GRO DISABLED

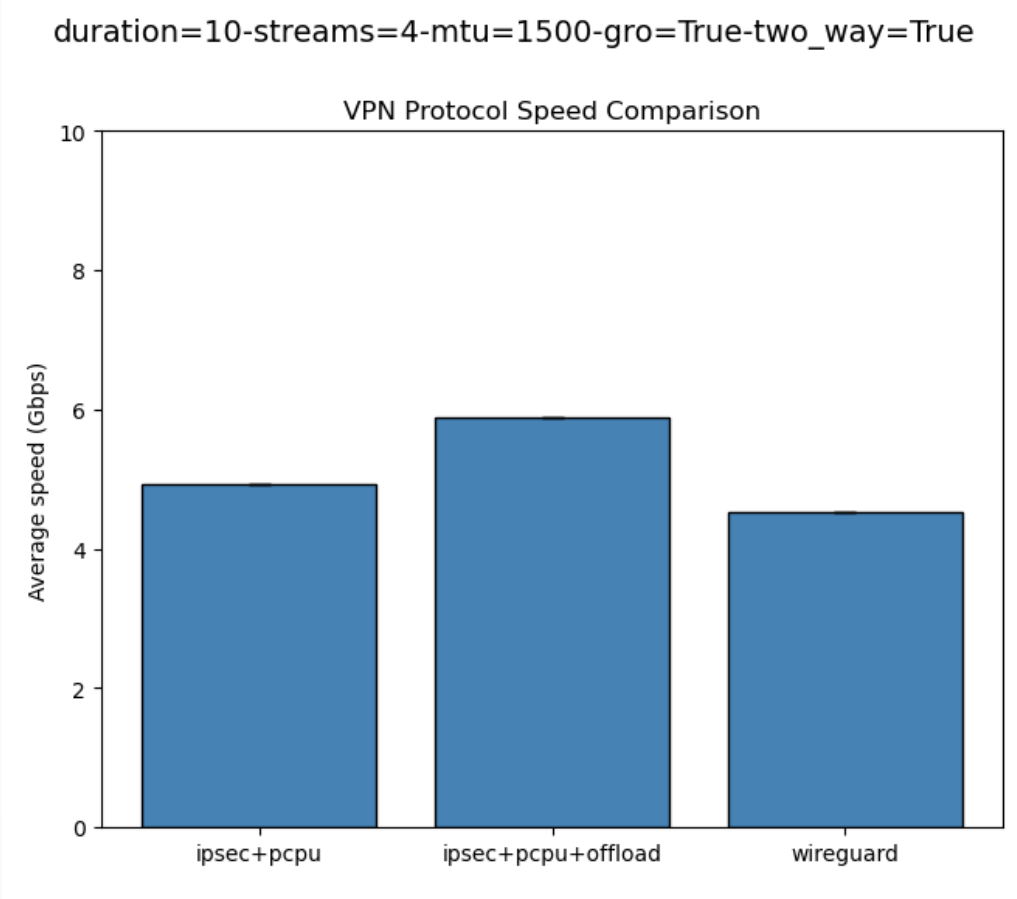


CPU AND POWER USAGE

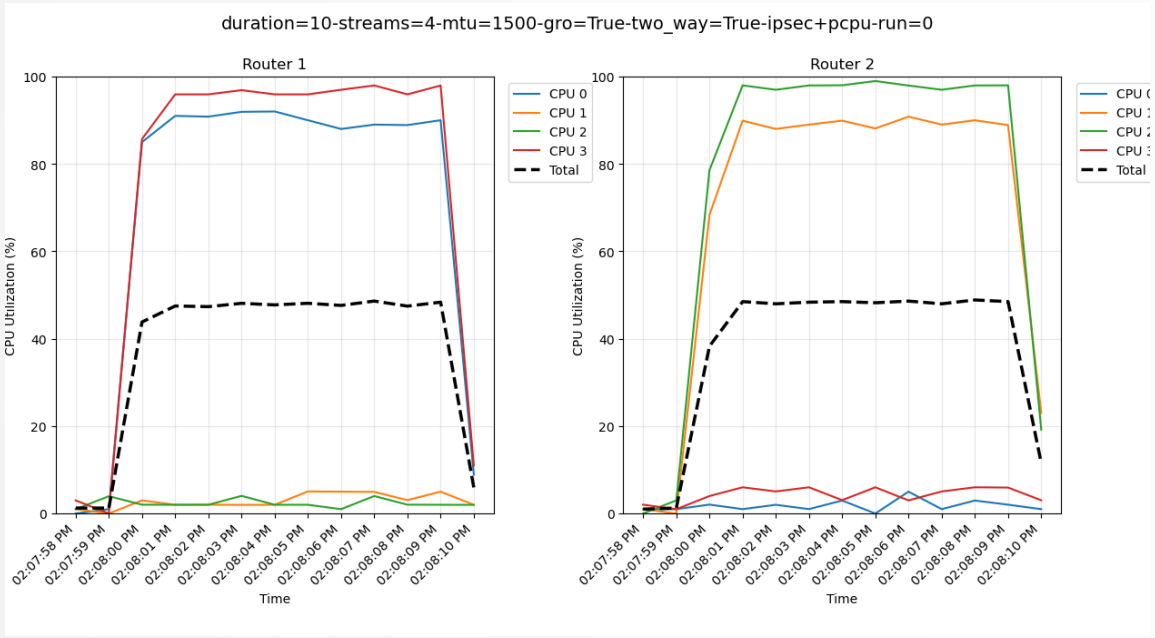
Protocol	CPU %	Power (W)	Speed (Gb/s)
Idle	0	50	0
Control	14	65	9.25
IPsec	24	65	5.63
Wireguard	62	77	8.59
OpenVPN	23	65	4.26

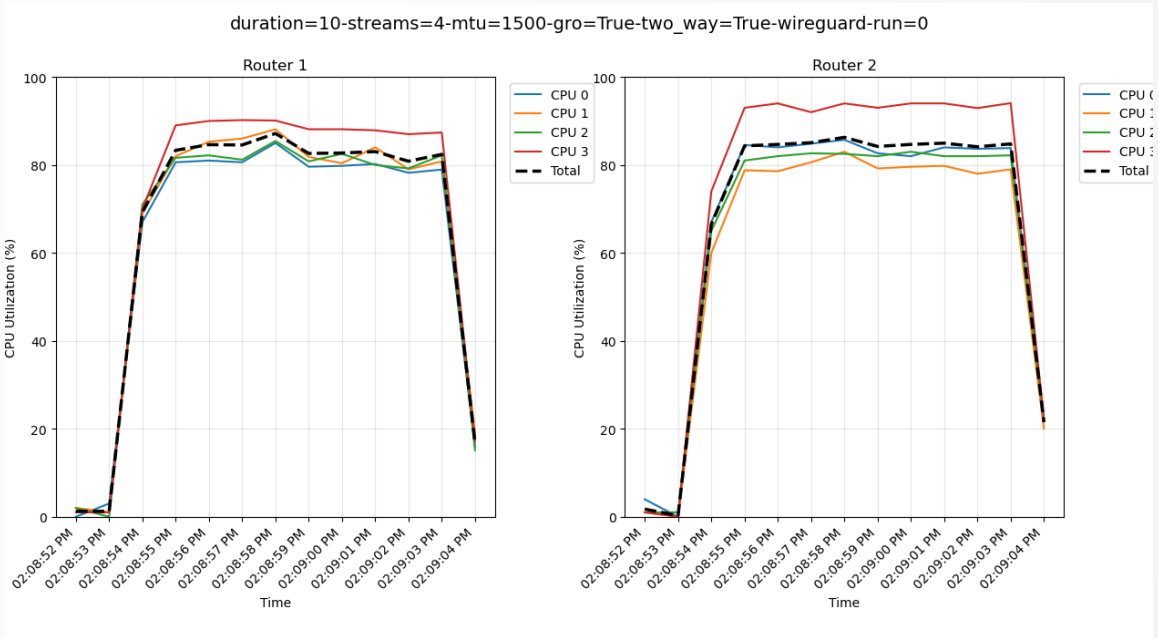
TWO WAY TRAFFIC

- Total throughput stays same(ish) with all protocols
- Inconsistency in IPsec
  - Sometimes the streams end up on different cores → good performance
  - Usually both ways on same core → bad performance
  - Becomes consistent with per-CPU SA:s



TWO WAY TRAFFIC





FUTURE PLANS

FUTURE PLANS

- Nothing new for the thesis
  - Limit the scope
  - Get it done
- Flamegraphs?
- Proper per-CPU SA testing?
- EESP?
- Specialized hardware?
- FreeBSD?

SUMMARY

SUMMARY

- Happy with the performance (all protocols)
- IP-TFS performance tests
- GRO important for IPsec seemed weird
- Two-way traffic caused interesting things in IPsec
- Per-CPU SA:s did not feel like they worked “correctly”
- Rabbit hole

THANK YOU!

Questions / Discussion