GEN: A GPU-Accelerated Elastic Framework for NFV

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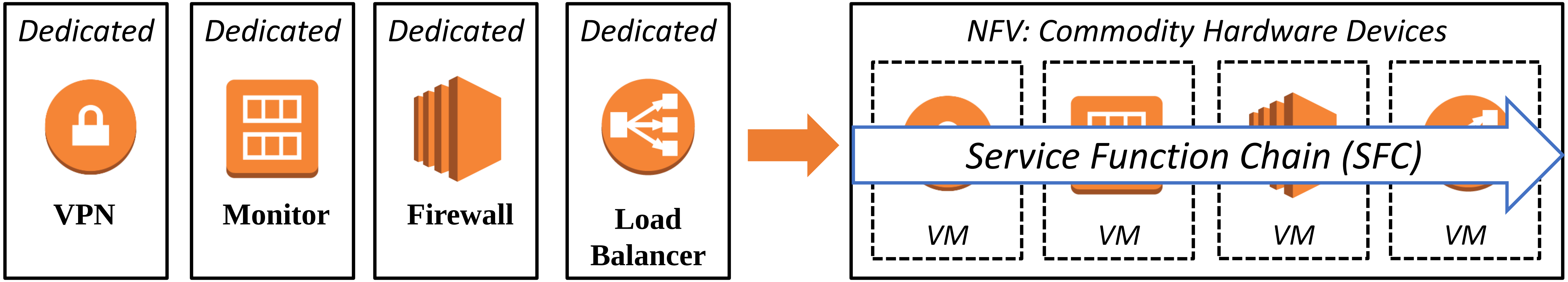
Network Function Virtualization (NFV)



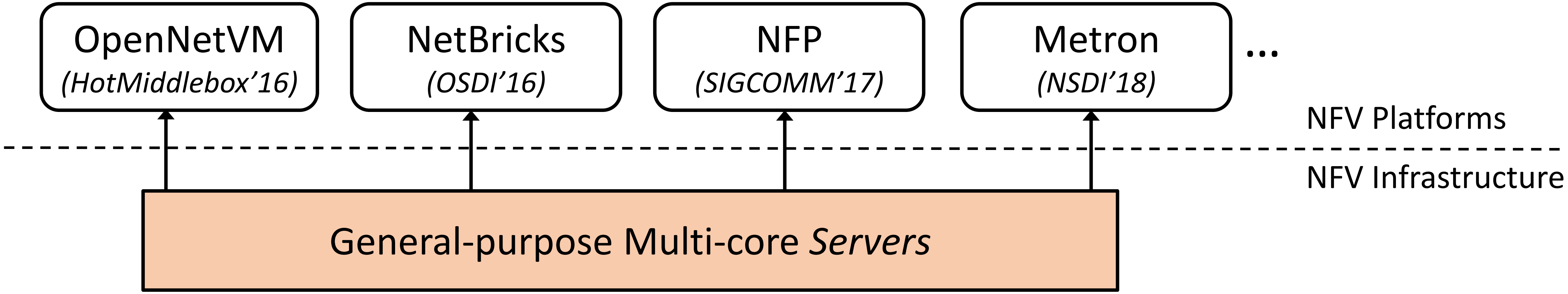
Virtualization Techniques

Low cost

Elasticity control

Service provisioning flexibility

CPU-based NFV



- Problems
  - Low *performance* with negative improvement expectation
  - Coarse-grained *scaling*

Problems of CPU-based NFV

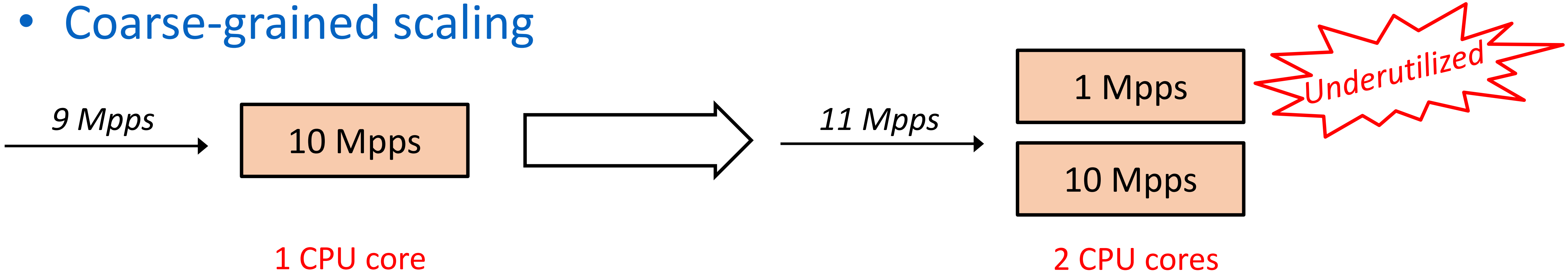
- Low performance with negative improvement expectation
  - Hard to achieve high performance (e.g., 40~100Gbps) for a wide range of NFs

IPSec *(AES & SHA1)*	NIDS (Aho-Corasick)
2.6 ~ 7.7 Gbps	4.2 ~ 10.4 Gbps

E5-2650 v2 (8 Cores, 2.6 GHz)

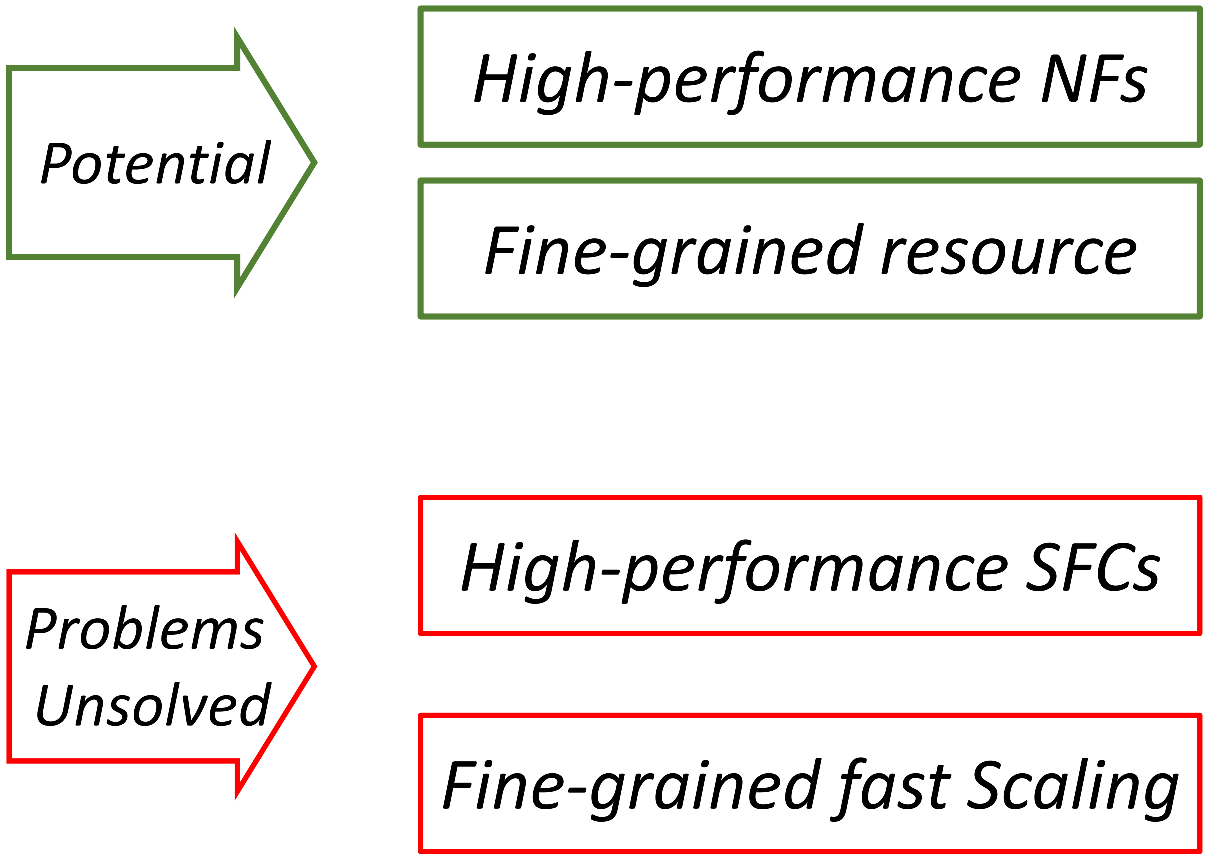
Go, Younghwan, et al. "APUNet: Revitalizing GPU as Packet Processing Accelerator." *NSDI*. 2017.

  - The slow/end of Moore's Law
- Coarse-grained scaling



GPU as An Accelerator for NFV

- Benefits of GPU
  - Massive processing cores
  - Fine-grained computing units
- Existing work
  - Router *(PacketShader, SIGCOMM'10)*
  - SSL proxy *(SSLShader, NSDI'11)*
  - NIDS *(Kargus, CCS'12)*
  - IPSec *(NBA, EuroSys'15)*
  - NFV framework *(G-NET, NSDI'18)*

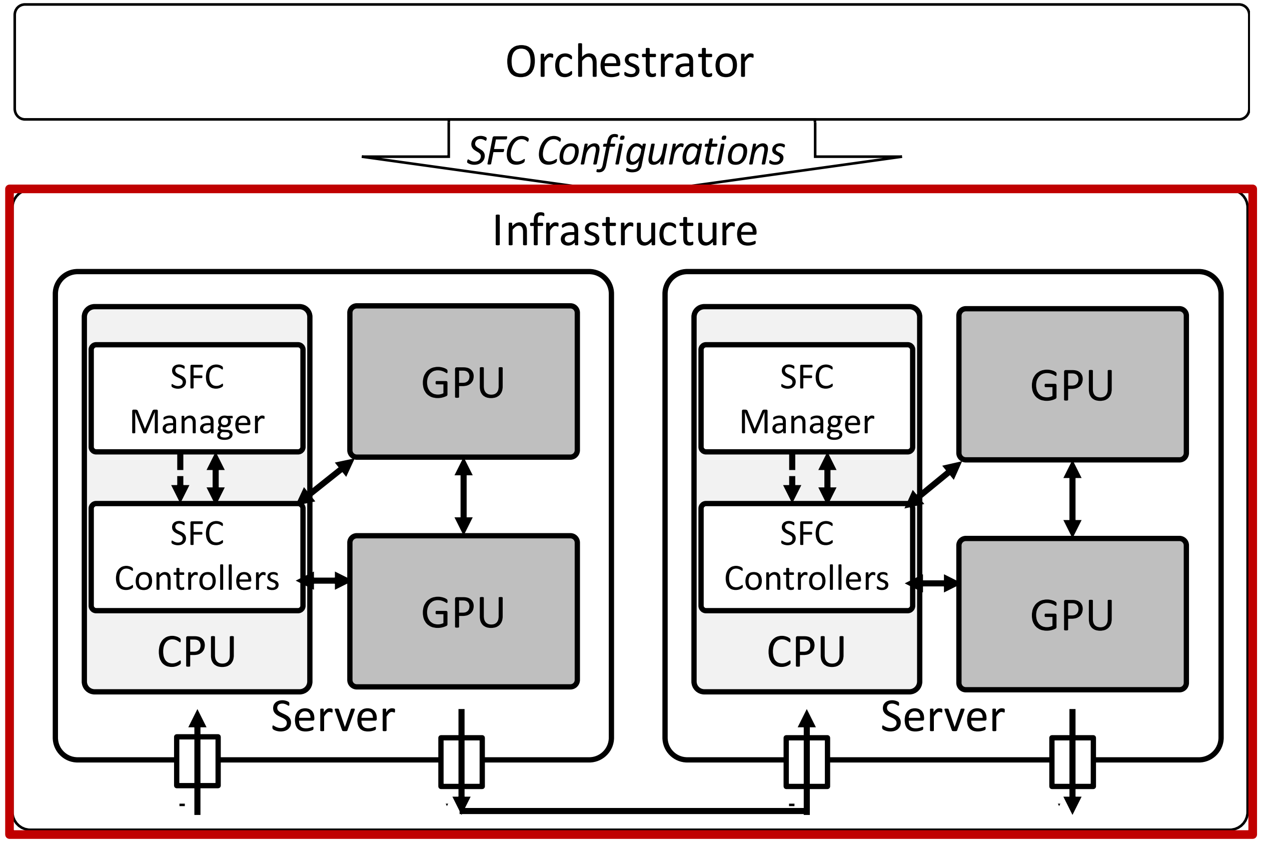


GEN exploits ***GPU*** *to support*

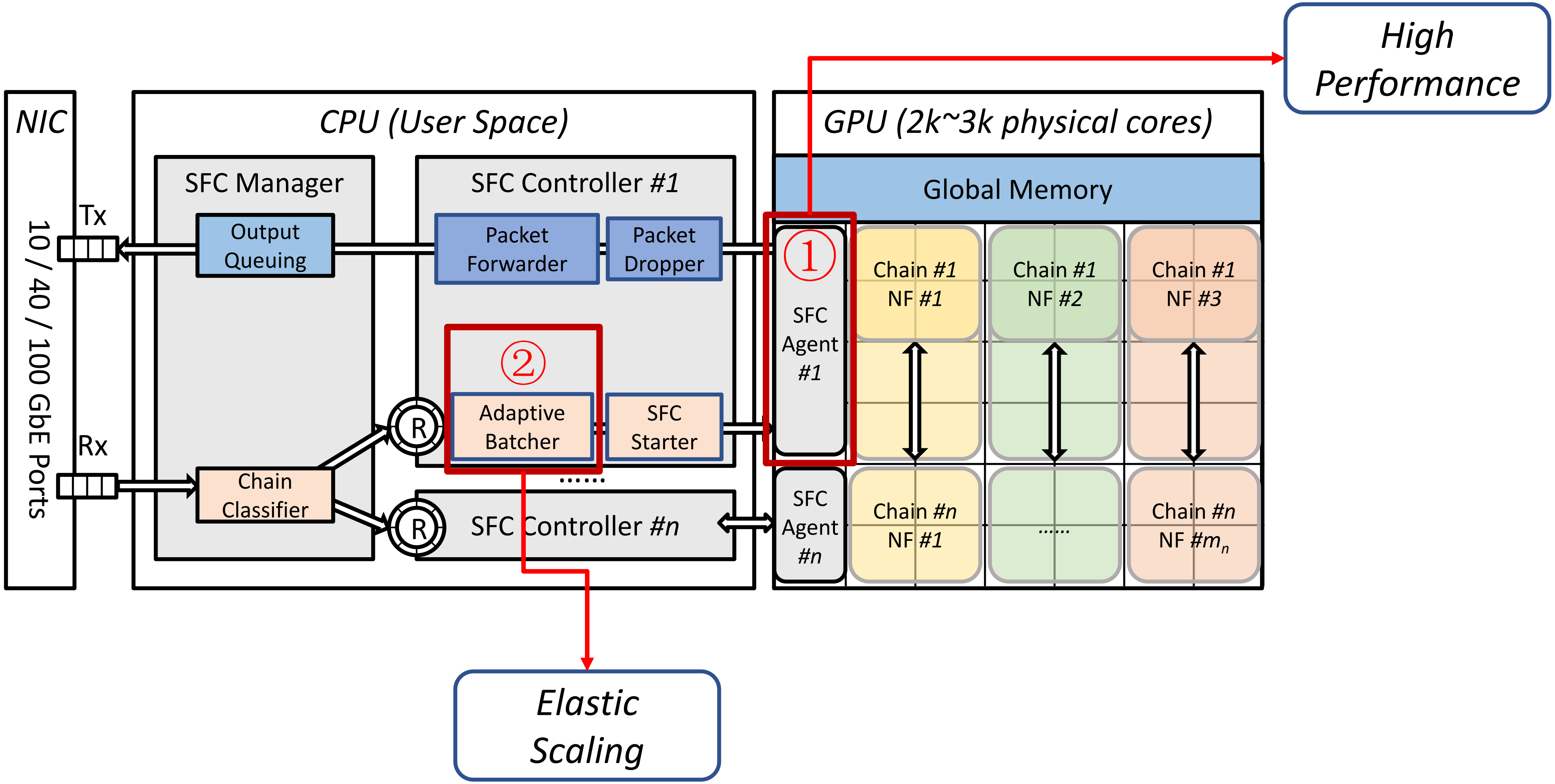
high-performance SFCs

with ***fine-grained scaling***

GEN Framework Overview

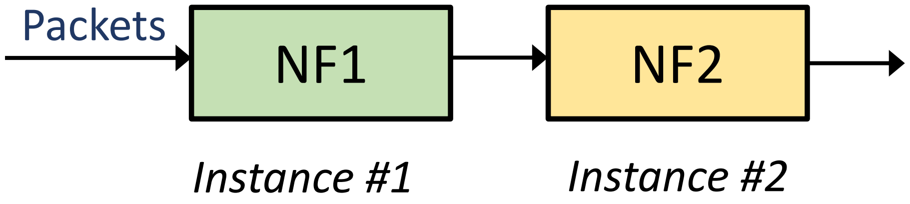


Infrastructure Design

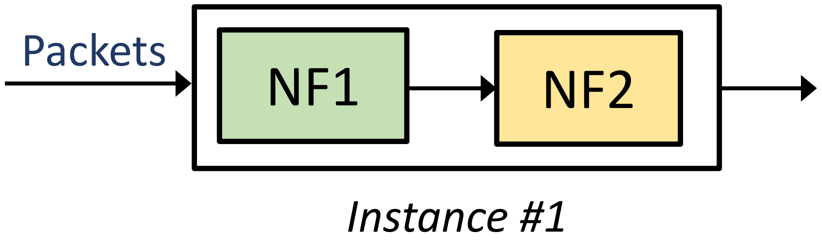


Problem #1: SFC Model Selection

Pipelining



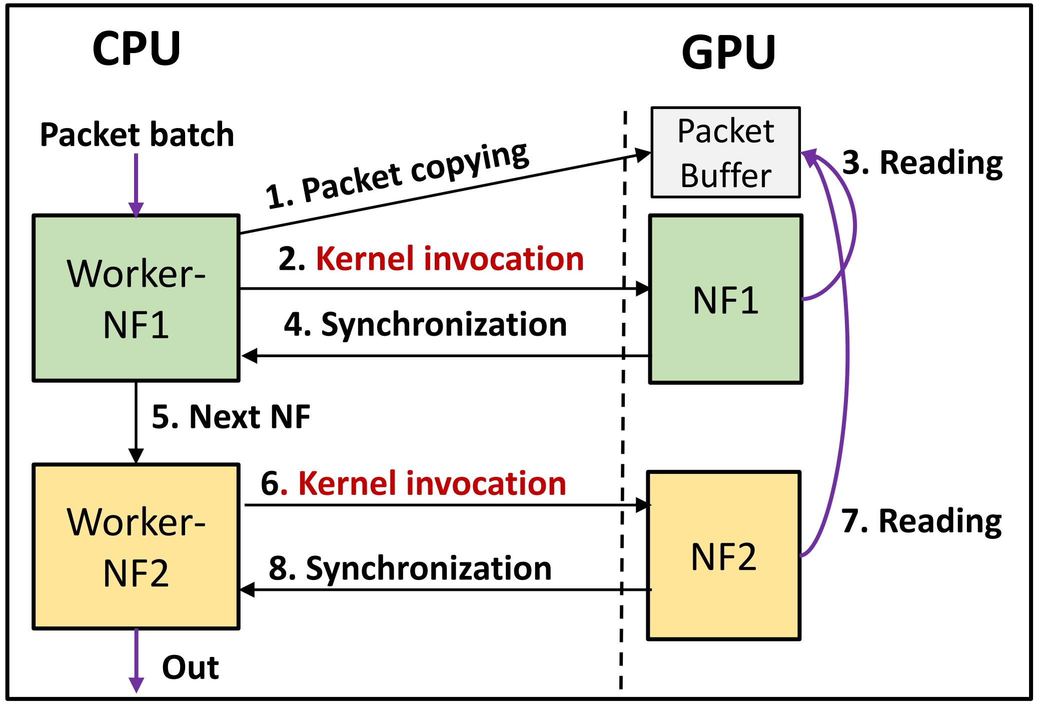
Run-to-completion (RTC)



SFC Model Selection: Pipelining

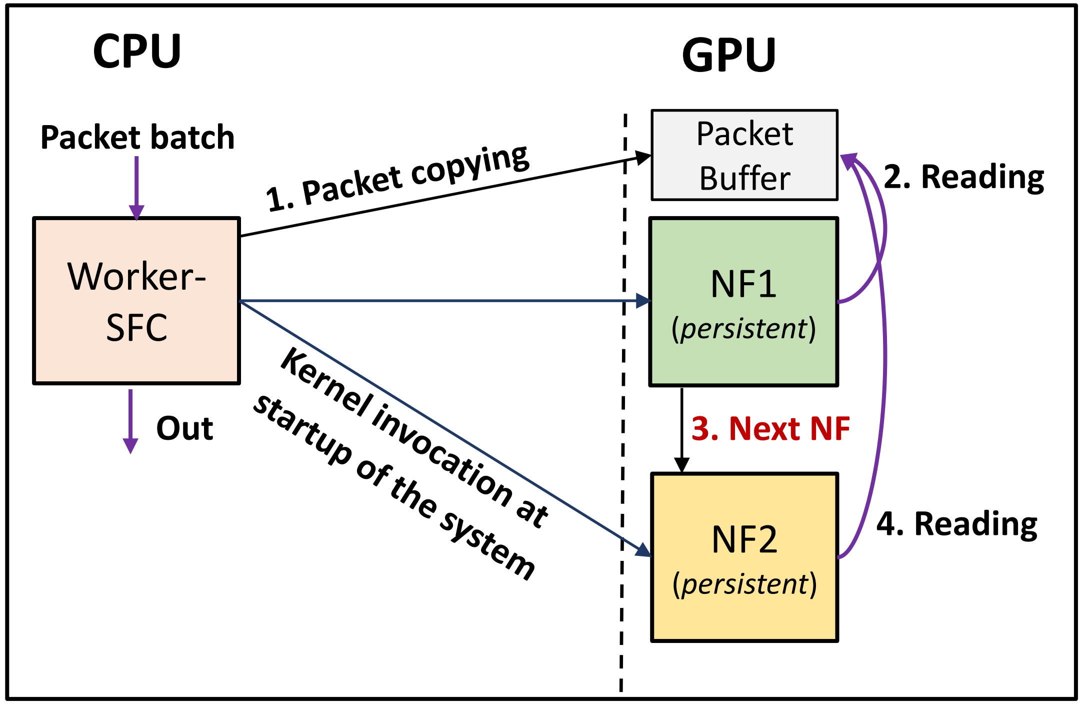
- Two potential ways to support pipelining in GPU

Sequenced invocations



High overhead from frequent kernel invocations (~5us per invocation)

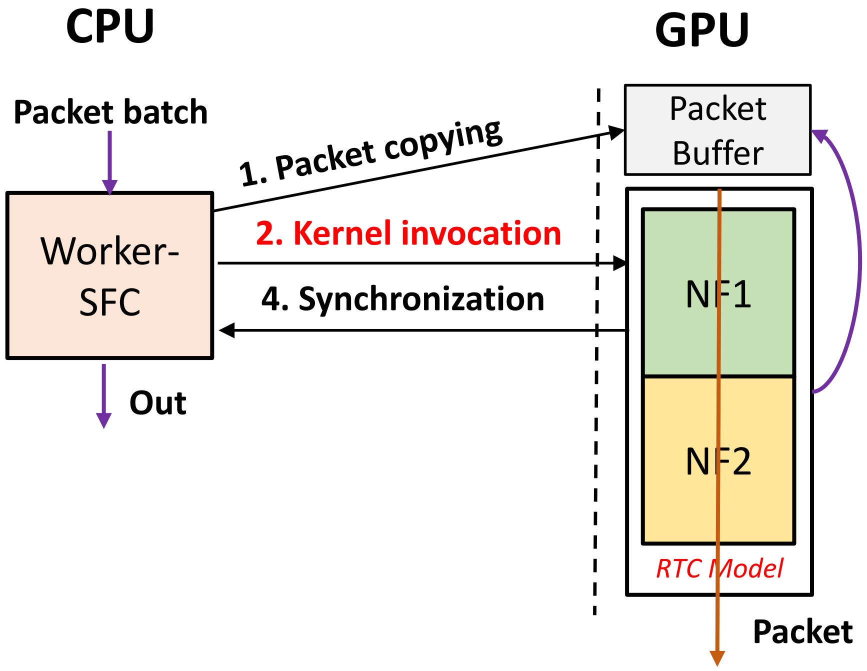
Persistent kernels



Hard and costly scaling

SFC Model Selection: RTC

- RTC-based Model



Less kernel invocations (once per SFC)

Easier scaling (not persistent)

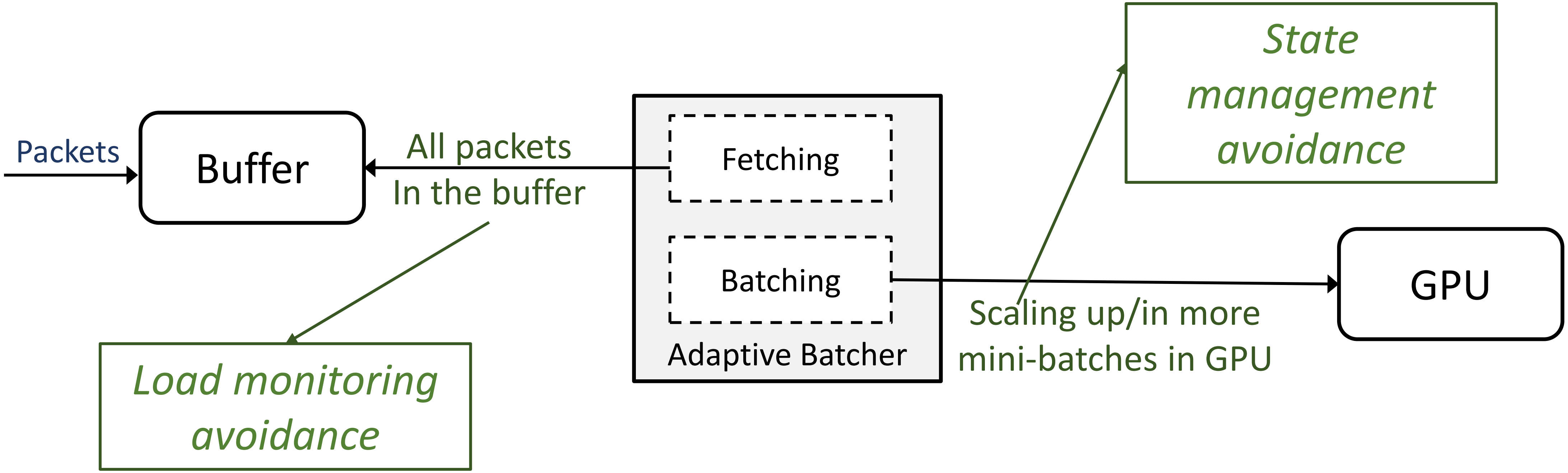
- NFs are integrated into a specific *SFC Agent* ⟸ *kernel fusion*
- SFC Agent (in GPU) is Launched by *SFC Starter (in CPU)*

Problem #2: Elastic Scaling

- Avoid monitoring NF load for scaling
  - Avoid deciding *when* to scale
  - Avoid deciding to what *extent* an NF should be scaled
  - Avoid considering how to quickly carry out NF scaling
- Avoid state management caused by scale out / in
  - Intuition: Use scale up / down to avoid state management
- *Adaptive Batcher*

Elastic Scaling – Adaptive Batcher

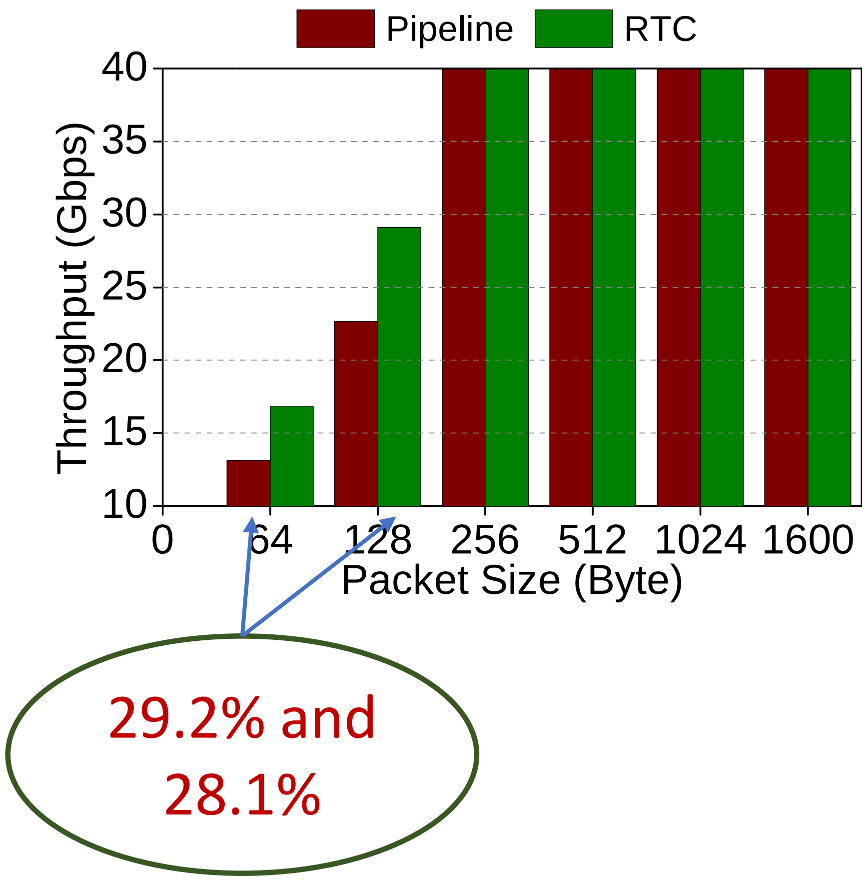
- Design of the adaptive batcher
  - Keeping the buffer occupancy at a low level
  - Scaling up/in GPU resource provisioning

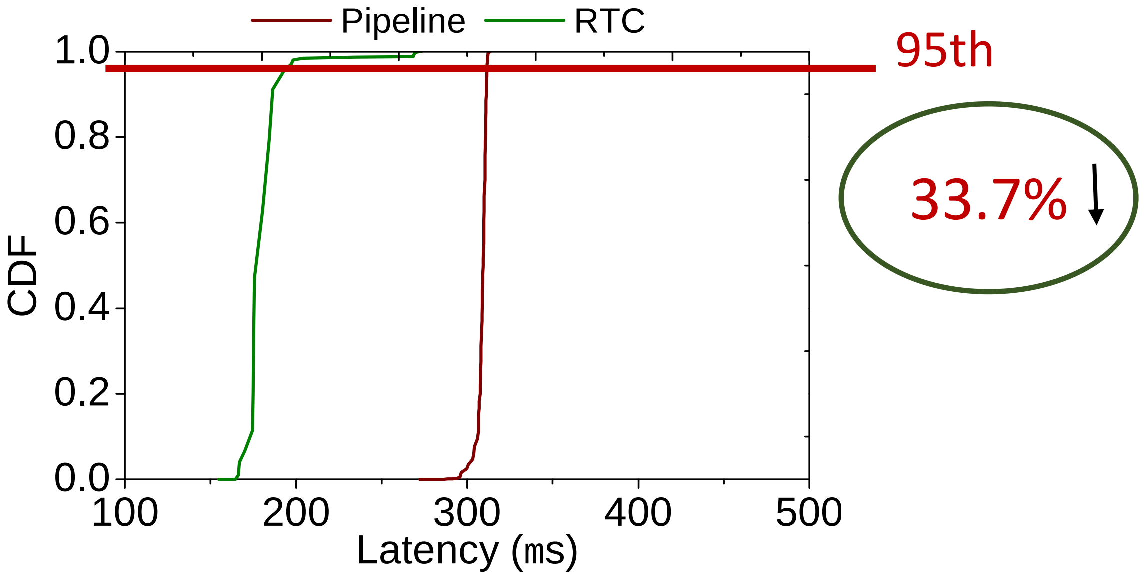


Preliminary Evaluation

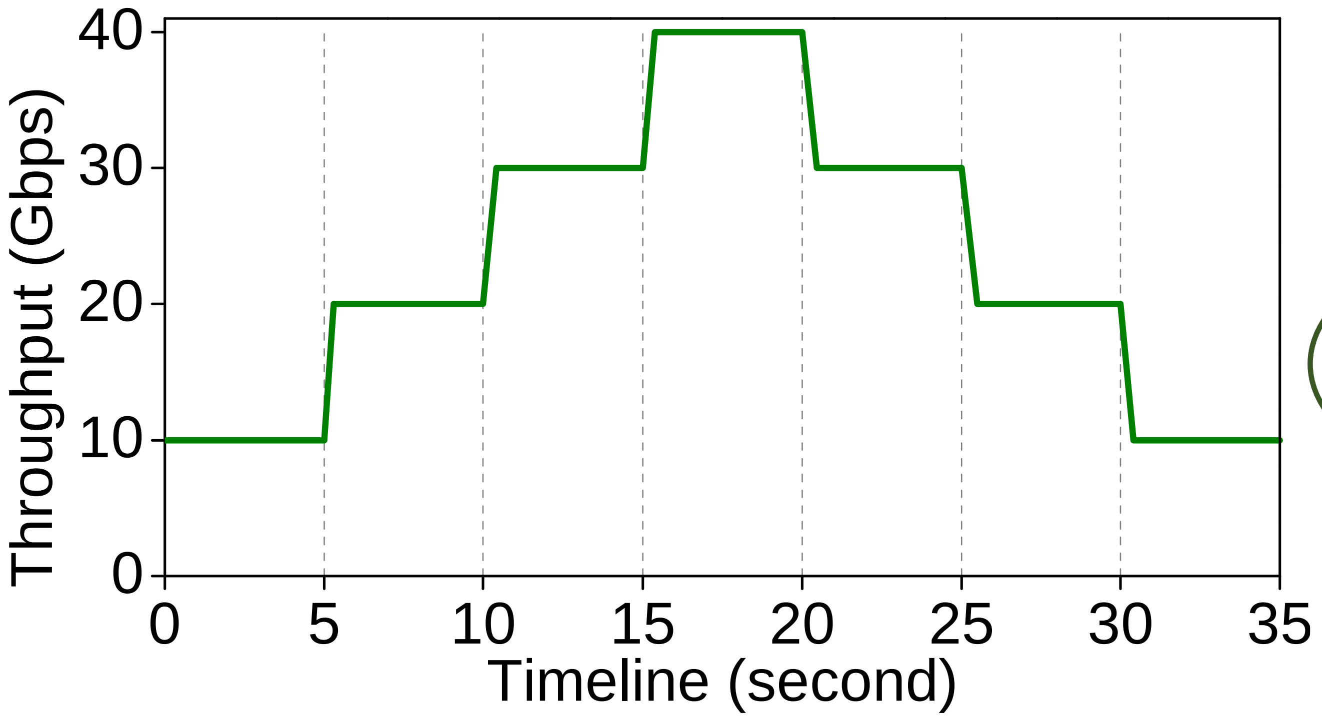
- Hardware
  - CPU: Two Intel Xeon E5-2650 v4 (10 physical cores)
  - GPU: NVIDIA TITAN Xp
  - NIC: Two Intel X520 (40 Gbps in total)
- Software
  - DPDK 17.11 for networking IO
  - CUDA 8.0 for GPU programming
- NFs & SFCs
  - IPV4Router (1k entries) → NIDS (3k rules) → IPSec (SHA1 & AES-128-CBC)

Performance of RTC *vs.* Pipelining





Fast Elastic Scaling



Fast converging (< *100ms*)

Conclusion and Future Work

- Gen: a GPU-accelerated elastic framework for NFV
  - High-performance SFC
  - Elastic scaling

- Future work
  - More SFC performance enhancement in GPU
  - Coordination between CPU and GPU
  - Impact of dynamic traffic load

Thank You

http://netarchlab.tsinghua.edu.cn