Chair of Network Architectures and Services
School of Computation, Information and Technology
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5G Slicing with Programmable Data Planes

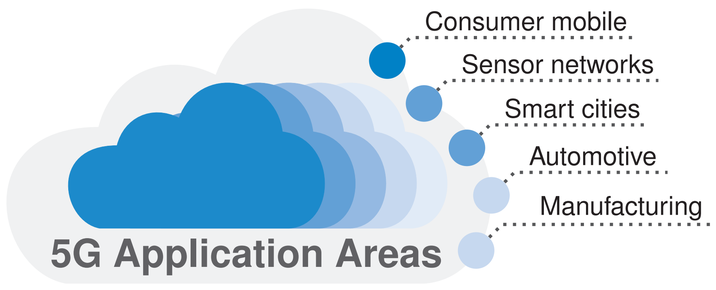
Motivation

Service classes in 5G networks

- Enhanced mobile broadband (eMBB)
- Massive machine type communication (mMTC)
- Ultra-reliable low-latency communication (URLLC)

Network slicing

- Divide physical resources into slices (for different applications etc.)
- Tenants rent slices from infrastructure operator



Implementation

Current implementations rely on architecture specific instructions [1, 2]

➔ Restrict to vanilla P4 architecture-independent instructions [3]

Investigated P4 targets

- Software-based target using t4p4s [4]
- Hardware-based switching ASIC

	Slicing approach		
. . . for each tenant	Table	Program	Hardware
Custom protocol stack	×	×	✓
Custom P4 table structures	×	✓	✓
Arbitrary code execution	×	✓	✓
No additional HW resources	✓	✓	×

Measurement Setup

P4 target as Device under Test (DuT)

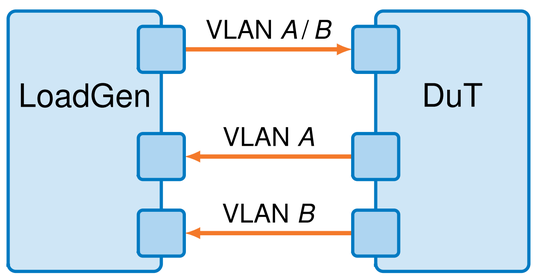
- Two tenants (*A* and *B*) use shared resources
- Baseline scenario: only one tenant runs
- Slicing scenario: two tenants run simultaneously

Tenant A

- Runs an Access Control List
- Total entries: 15 000 SW / 80 000 HW

Tenant B

- Runs a simple forwarder
- No table entries required



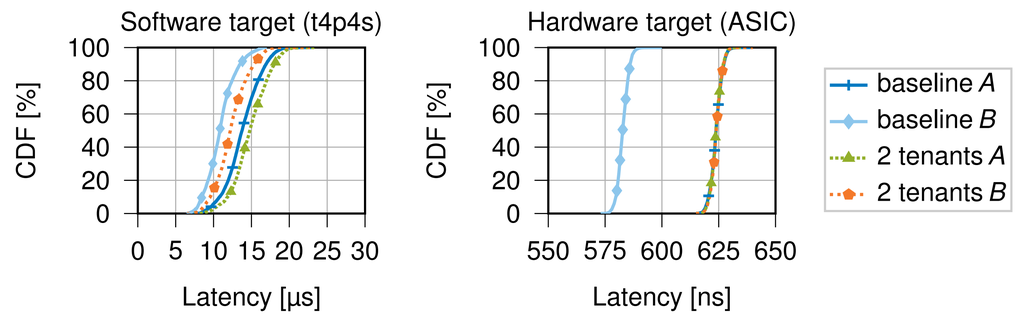
Program Slicing

Software target

- Latencies close to respective baselines
- Small increase due to slicing overhead

Hardware target

- Tenant *B's* latency shifts to tenant *A's* baseline
- Intensive resource usage affects all tenants

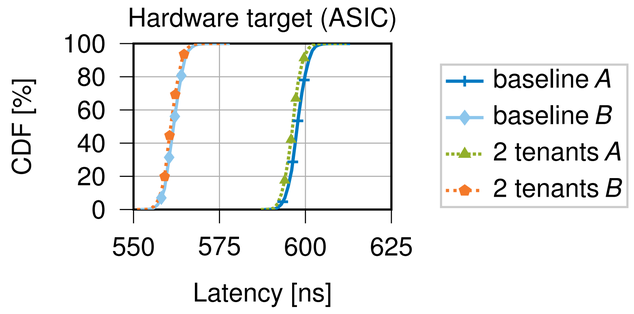


Hardware Slicing

Two tenants with A and B

- Latencies close to respective baselines
- Tenants do no affect each other
- Exclusive hardware slice for tenants

Limitation: number of available processing pipes of target



Conclusion

Software target

- Performance limited
- Less interference between single tenants

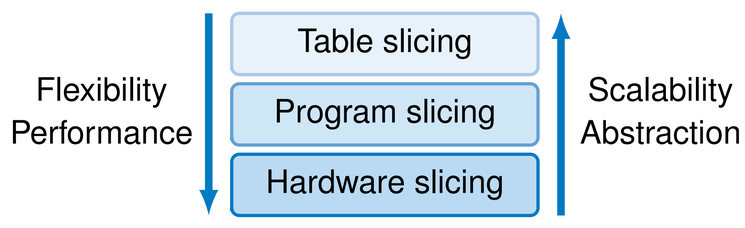
Hardware target

- High performance
- Suffering from resource intensive tenants
- Hardware slicing eliminates interference

P4 source code

https://bit.ly/3qfRWhk

➔ Estimation of service quality guarantees



[1] Y.-W. Chen, C.-Y. Li, C.-C. Tseng, and M.-Z. Hu, "P4-TINS: P4-driven Traffic Isolation for Network Slicing with Bandwidth Guarantee and Management," *IEEE Transactions on Network and Service Management*, 2022.
[2] T. Wang, X. Yang, G. Antichi, A. Sivaraman, and A. Panda, "Isolation Mechanisms for High-Speed Packet-Processing Pipelines," in *NSDI*. Renton, WA, USA: USENIX, 2022.
[3] E. Hauser, M. Simon, H. Stubbe, S. Gallenmüller, and G. Carle, "Slicing Networks with P4 Hardware and Software Targets," in *5G-MeMU '22: Proceedings of the ACM SIGCOMM Workshop on 5G and Beyond Network Measurements, Modeling, and Use Cases, Amsterdam, The Netherlands, August 22, 2022*, Ö. Alay and Y. Wang, Eds. ACM, 2022, pp. 36–42. [Online]. Available: https://doi.org/10.1145/3538394.3546043
[4] P. Vörös, D. Horpácsi, R. Kitlei, D. Leskó, M. Tejfel, and S. Laki, "T4P4S: A Target-independent Compiler for Protocol-independent Packet Processors," in *IEEE 19th International Conference on High Performance Switching and Routing, HPSR*, Bucharest, Romania, 2018.

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