Politecnico di Torino
Dipartimento di Automatica e Informatica

PhD in Computer and Control Engineering
XXXVI cycle

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Orchestrating Edge Computing Services with Efficient Data Planes

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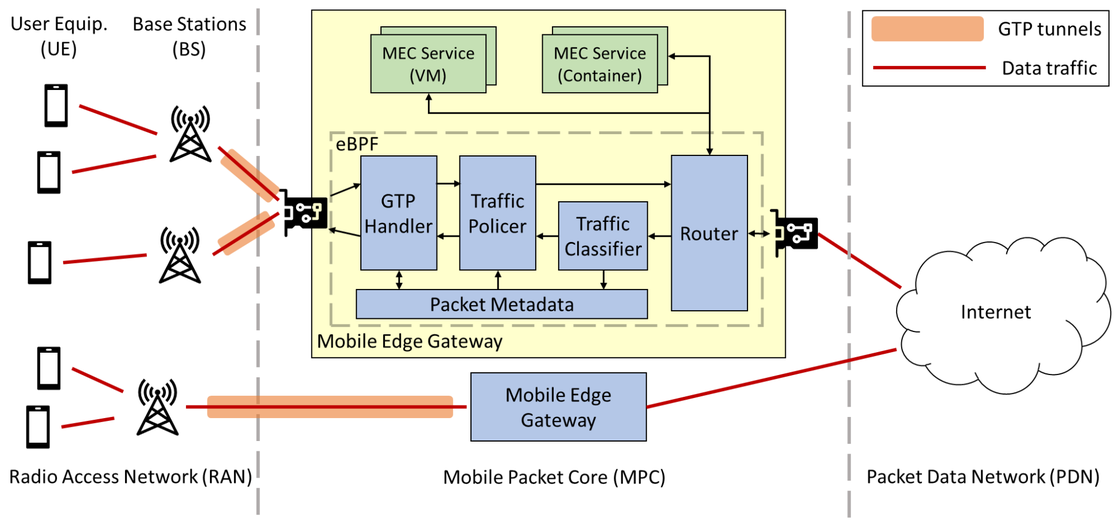
1. Introduction

With the advent of Multi-access Edge Computing (MEC), telco operators are moving their network functions (NFs) to small, distributed data centers close to the end user. This infrastructure must be shared with low latency applications running at the edge. However, the high performance of common data plane technologies based on kernel-bypass (e.g., DPDK), comes at the cost of rigid resource partitioning and difficult integration with applications leveraging the TCP/IP stack. In this respect, the eBPF/XDP technology looks a more appealing solution, thanks to its capability to process packets in the kernel, achieving a higher level of integration with non-data plane applications albeit with lower performance than DPDK.

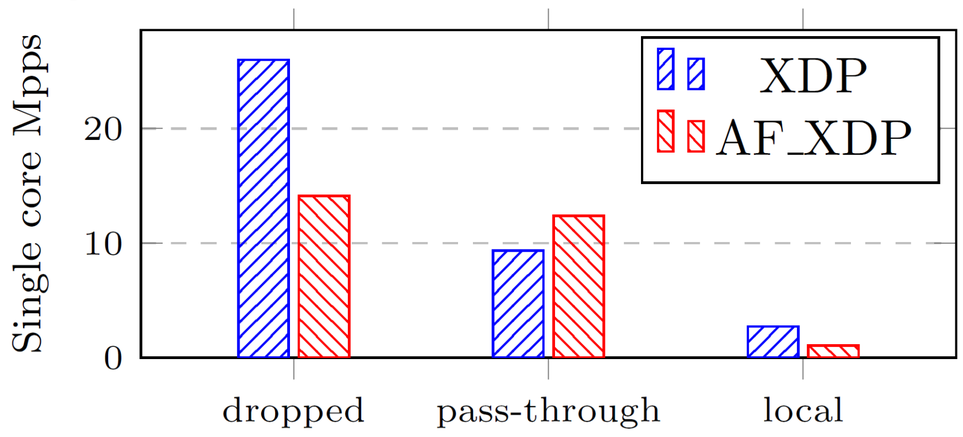
2. A 5G Mobile Gateway with eBPF



We assessed whether eBPF/XDP can provide a suitable framework to support the telco user plane. We selected a 5G mobile gateway (a.k.a UPF) as use case, that is the network function in charge of implementing the user plane in the 5G core network. We designed and developed the open-source prototype in the figure, composed of four modules based on eBPF/XDP. Our results showed how eBPF is a suitable technology to provide telco NFs and can guarantee performance close to the ones of DPDK [1].

3. Comparing User Space and In-kernel Packet Processing

While the XDP technology provides high speed packet processing and a high degree of integration with the Linux TCP/IP stack, it is subject to the limitations of the eBPF virtual machine, that prevents the use of most optimized data structures and the execution of some operations (e.g. packet enqueuing). Given the possibility for XDP programs to efficiently redirect packets in user space through AF_XDP sockets, we studied the performance of in-kernel vs user space packet processing applied to the traffic pattern typical of the edge, composed of a mix of dropped traffic (e.g., due to firewalling), pass-through traffic, processed by NFs and then directed to the internet, and local traffic, processed by NFs and directed to local applications, possibly running on the same server. Our results showed how in-kernel processing is faster for dropped and local traffic, while moving packets to user space yields better performance for pass-through one.



4. References

1. F. Parola, F. Risso and S. Miano, "Providing Telco-oriented Network Services with eBPF: the Case for a 5G Mobile Gateway," 2021 IEEE 7th International Conference on Network Softwarization (NetSoft), 2021, pp. 221-225