Leveraging eBPF for Intent-Driven Application-Centric End-to-End Segment Routing over IPv6

Bridging the Gap between Application-Requirements and Network Routing Decisions

Graduate

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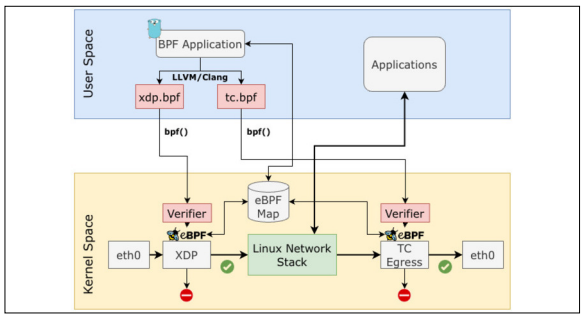
Introduction: In today's digital era, the rapid evolution of applications significantly shapes how people work, communicate, and interact with technology. New hypes like artificial intelligence will become more and more critical. As these applications become increasingly complex and essential day-to-day, the underlying network infrastructure must evolve to meet their demanding requests. A fundamental shift of the traditional routing paradigms is required to achieve a more application-centric model. It is necessary to make changes that allow networks to adapt dynamically to the application's needs and scale accordingly to meet demand.

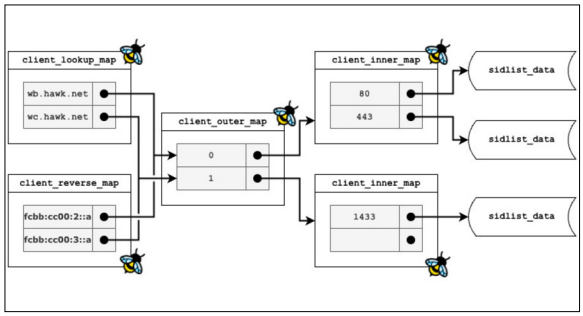
Approach / Technology: The goal was to develop a client/server application with the Go programming language and the Extended Berkeley Packet Filter (eBPF) that enables Segment Routing over IPv6 (SRv6) on end devices. This combination established the foundation to control the path from source to destination via end devices rather than through the network. Building on this, eBPF is utilized for packet matching by focusing on destination IPv6 addresses and ports. This function is essential for ensuring packets are accurately encapsulated with SRv6. The encapsulation information is based on high-level intents, which are translated to operational objectives.

Conclusion: This research embarked on an ambitious plan to bridge the gap between application requirements and network routing decisions. The goal was to define application-centric requirements for the traffic to be routed accordingly. By leveraging the dataplane capabilities that eBPF brought and the advanced possibilities of SRv6, an application was developed that achieved the intended objectives. The application can read high-level intents, which then translates to operational objectives. With the intent and the application-based traffic matching, an application-centric framework is born, which can differentiate various application traffic and encapsulate that according to the intent. The application allows application developers to define their requirements simply without interacting with the network.

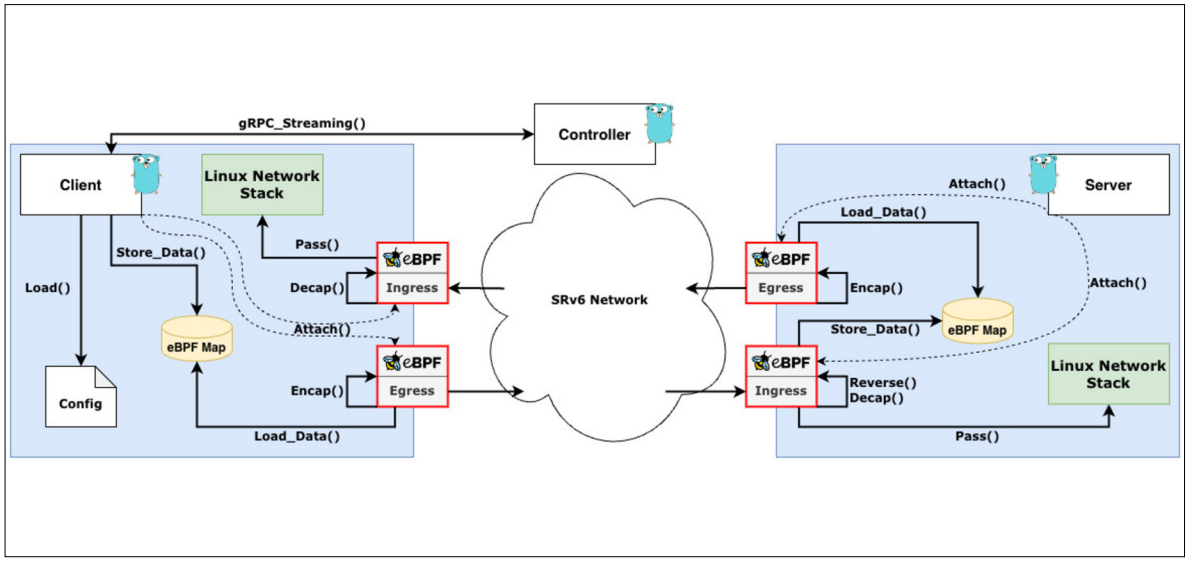
eBPF Architecture
Own presentment



eBPF Map Structure for Traffic Matching
Own presentment



Application Architecture
Own presentment



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