P4 Programmable Data-Plane Switches

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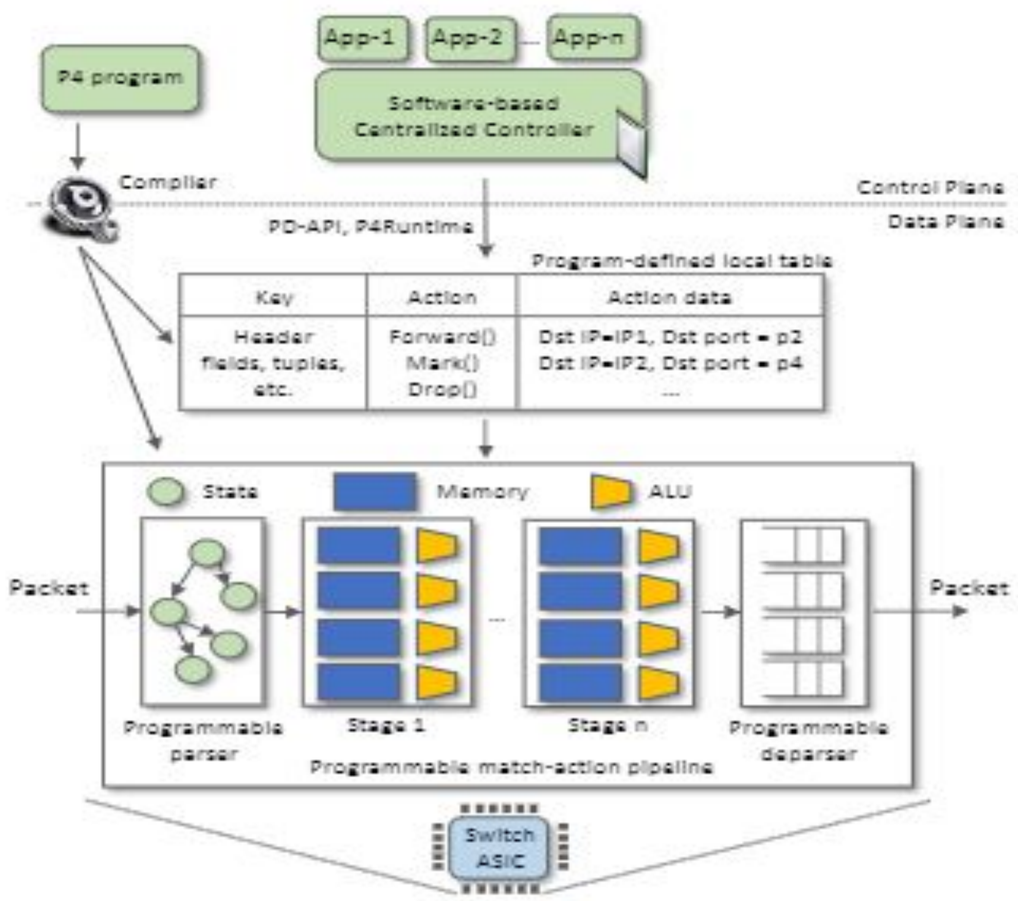
Background

Most network switches available to the consumer are unmanaged, a user plugs in the ethernet cable and it just works. All that these switches do is check the destination address and forward the packet out of the appropriate port. Vendors like Cisco and Juniper offer another type of switch, the managed switch. These types of switches work off the same basic idea as an unmanaged switch, but with added configurability and features. These switches can be configured in a variety of ways, such as disabling unused ports to lock down the security of the switch or tying ports to VLANs to run different networks on the same physical hardware. In 2014, P4 (Programming Protocol-Independent Packet Processors) was developed as a domain-specific programming language to define packet processing. P4 does not have any native support for either Ethernet or IP, meaning everything must be defend by the programmer. The data-plane refers to the part of the switch software that is concerned with forwarding packets. It is designed for speed and regularity. There is also a control pane, which contains some control logic, like QoS to decide which application to prioritize (such as video).

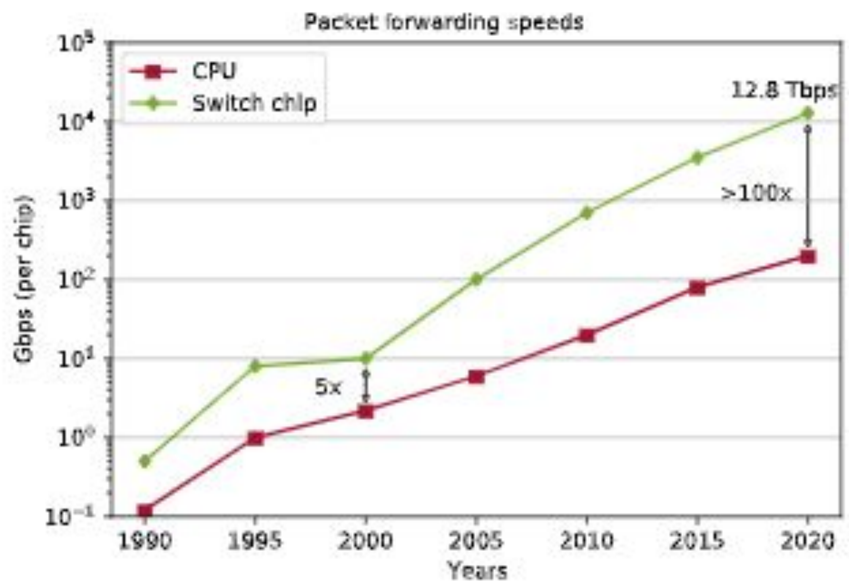


Purpose

The rollout of new features depends on the vendors themselves and features are hard-coded. In order to innovate, those vendors would have to go through a lengthy and expensive design process to include new features. With data-plane programmability, researchers and engineers can develop new protocols and packet processing applications cheaper and much quicker. This programmability opens these devices up to many use cases that would benefit from running applications directly on the switch.

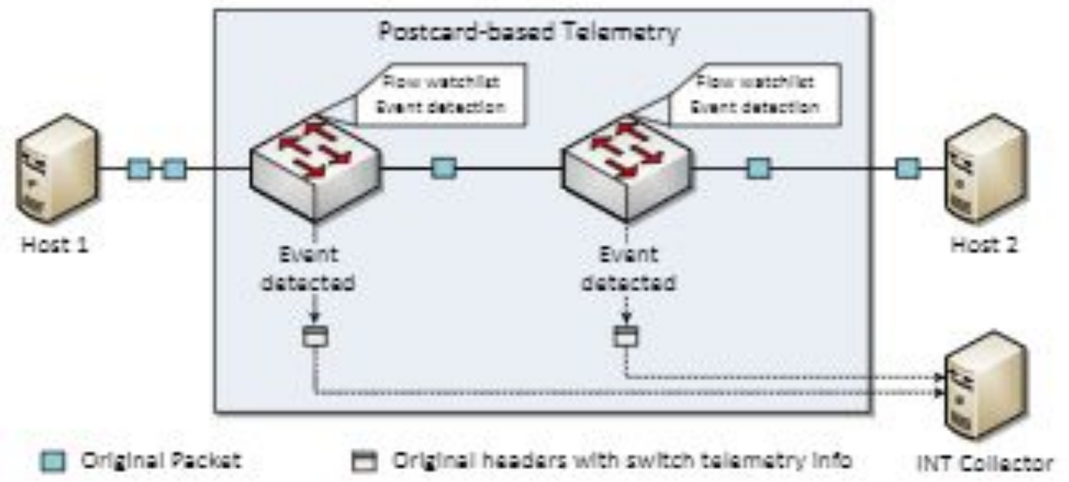
Technology

P4 is target-independent, meaning that it can be compiled for many different machines, such as ASCIS, CPUs, and purpose-built switch processors. The compiler must be fit for the target device, however. Running the switch on silicon meant for fast packet switching does provide a significant speed benefit (over 100x).

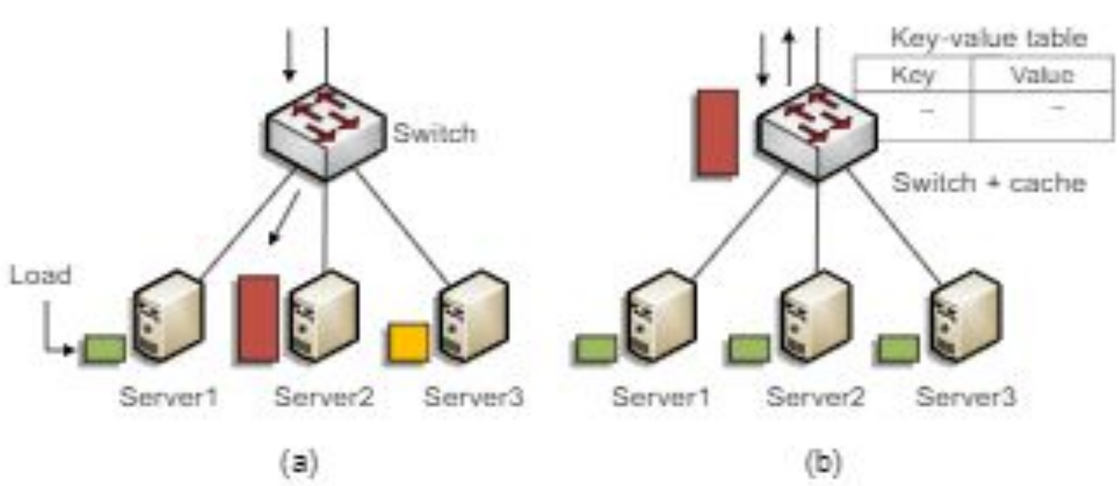


Applications

The applications of this switch are up to the programmers and engineers who develop them. One of the more basic examples is implementing In-Band Network Telemetry (INT) to keep real-time data of network health. The switches can add metadata to each packet that will later be removed and stored. This data can be used to mitigate network congestion and keep the usage fair.



These switches can also be used for load balancing. Normal load balancers work by pretending to be the server IP that is contacted for the web page. The balancer keeps tract of the load and evenly distributes it by sending the request to one actual server in a pool of servers.



E. F. Kfoury, J. Crichigno and E. Bou-Harb, "An Exhaustive Survey on P4 Programmable Data Plane Switches: Taxonomy, Applications, Challenges, and Future Trends," in *IEEE Access*, vol. 9, pp. 87094-87155, 2021, doi: 10.1109/ACCESS.2021.3086704.

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