

Open Programmable Data Path: Towards White Box 2.0

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The first generation of white box network device disaggregates the network operating system from the hardware. It uses a common abstraction interfaces to hide the hardware details so it allows the operators to customize and apply the same applications over heterogeneous network devices. However, these devices are still equipped with fixed functions which leave little room for operators to freely program their behavior beyond the predefined feather set.

Operators have strong motivation to gain the full visibility of their networks for various purposes: to gain insights on network states, to detect anomalies and attacks, for customer care and billing, for network planning and optimization, etc. Existing tools and protocols cannot meet all the requirements. It is also infeasible to try to pre-allocate resource to monitor all the points on the data path all the time. Therefore, it requires the capability to dynamically and incrementally deploy probing points and rules in order to extract data from the data plane in real time. Big data analytics engine can be deployed on top of the open programmable data path by including the network nodes as the programmable streaming data source.

Likewise, operators need the ability to be able to hitlessly update the data path in real time and on demand, in response to the analytical results from the previous step in a closed loop control system. This is critical to realize a self organized and self optimized network infrastructure in future network operator's DevOps environment.

The above requirements ask for the second generation of white box which is embodied by the truly open programmable data plane devices. It is enabled by programmable chips and an open programming interface which is exposed to network operators and other third parties. Protocol Oblivious Forwarding (POF) is such a framework, centered on an enhanced OpenFlow interface. On the controller side, it can use some high level languages (e.g., P4) to define the basic forwarding behavior of the data path. In addition, it provides APIs to allow the controller to dynamically reconfigure the data path, satisfying the observability and controllability requirements mentioned earlier. We have been able to demonstrate such a system based on an NP-based platform.

To fully realize the vision, many research challenges remain: the flexible and high performance chip architecture, the standard interface and protocol, the universal data path abstraction, the languages for static and dynamic data path programming, and application orchestration framework, etc. Numerous applications (e.g., network OAM) and new network architectures (e.g., ICN) can be tested and validated through a testbed with open programmable data path.

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