Technology Brief

Dynamic Device Personalization (DDP)
Intel® Ethernet 800 Series

Program the Ethernet Pipeline with Dynamic Device Personalization (DDP)

The Intel® Ethernet 800 Series implements DDP to enable a fully programmable packet-processing pipeline. DDP profiles dynamically optimize the pipeline for the network protocols called for by a given use case. The network adapter can therefore deliver higher throughput while freeing CPU resources for other priority tasks.

The scope of network processing handled by general-purpose commercial off-the-shelf (COTS) computer hardware continues to grow. Media-delivery workloads multiply, even as 5G networks are being rolled out worldwide using containerized cloud-native network functions (CNFs). Likewise, CNF-based security and network services such as virtual firewalls and load balancers are replacing older generations of dedicated hardware appliances. These types of traffic can introduce additional protocols to the networking stack, and COTS network controllers must address that increased level of complexity.

Enhanced Dynamic Device Personalization (DDP) is a technology of Intel Ethernet 800 Series that allows the packet processing pipeline to be reconfigured dynamically to meet the changing protocol needs of on-demand use cases. At driver load, DDP applies default or custom profiles that support the required protocols and packet types, optimizing the pipeline for throughput and the ability for intelligent CPU offload to preserve processor cycles for other work.

DDP configuration profiles can be changed without reloading the NVM image, and new profile packages can be developed to support emerging protocol requirements. This flexibility enables the packet pipeline to be dynamically optimized for specific workloads on demand, to drive up throughput and efficiency. The technology is currently being used widely in communications workloads such as the 5G user plane function (UPF), virtualized radio access networks (vRANs), and edge computing.

Note: The discussion of DDP in this technology brief is specific to the Intel Ethernet 800 Series.

Enabling the dynamic packet-processing pipeline with DDP

DDP enables the Ethernet controller to perform deeper processing on more diverse protocols by making logic available that is tailored to the specific workload and traffic type. Improved protocol recognition and handling enables the packet processing pipeline, illustrated in Figure 1, to handle packet identification, classification and distribution on the network adapter.

By having the protocol definitions in the parse graph, the parser can provide more information about the packet for use in the following stages of the pipeline. This capability allows for access-control-list (ACL) and quality-of-service (QoS) filtering in addition to sending packets to specific queues via Intel Ethernet Flow Director or receive-side scaling (RSS). The network stack or user space applications are therefore able to perform packet processing more efficiently, helping increase throughput and reduce latency.

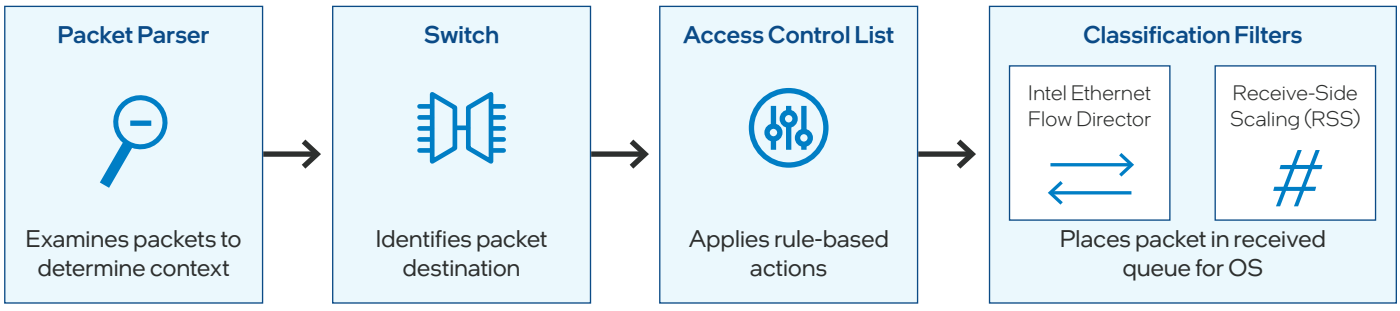

Figure 1. Receive packet-processing pipeline stages.

In the on-adapter workflow, the packet parser is the point of ingress for received traffic, examining packets to generate context based on packet attributes. The process benefits from the ability to look as deeply as possible into packets in order to gain information about packet contents that can help process it efficiently. By enabling the parser to recognize more of the protocols relevant to a given workload, DDP makes it possible to look deeper into packets, as illustrated in Figure 2.

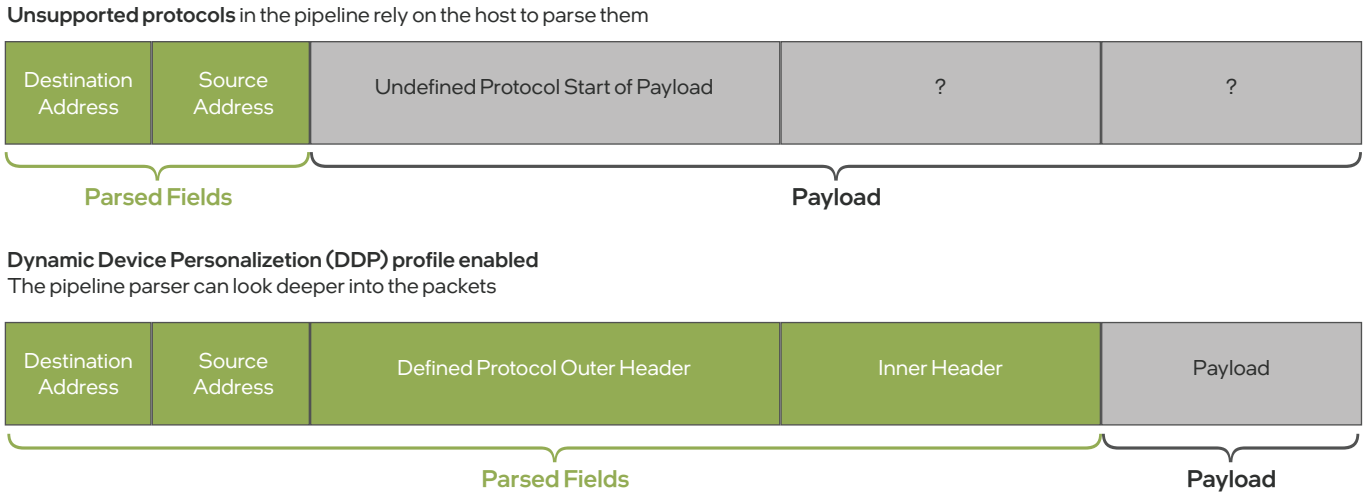

Figure 2. Deep packet inspection enabled by DDP.

The switch stage of the pipeline uses that enhanced context to help identify packet destinations, and the access control list (ACL) stage uses it to more effectively apply security policy and other rules. Classification filters apply various additional means to help determine packet destination and then place packets in the proper queues for the OS.

Why parser programmability matters

The analogy of an automated mail sorting system, as represented in Figure 3, helps illustrate the value of a programmable parser within the packet-processing pipeline. Here, physical mail must be sorted and directed to the correct department recipient, but the automated sorting system (analogous to the parser) is only able to recognize a limited number of department names (analogous to protocols). Therefore, it can automatically route a portion of the incoming mail, but the rest must be routed to the mail room (analogous to the CPU) for manual delivery, which is more resource-intensive.

Having more of the needed protocols available in the parser definitions enables the parser to classify packets more efficiently. Recognizing each protocol enables the parser to look one layer deeper into a packet before considering the remainder to be a payload. Because the controller lacks the ability to load and store every network protocol it could encounter across workloads, DDP provides defined packages of protocols for specific use cases that can be loaded on demand as needed. This programmability fundamentally extends the ability of general-purpose network hardware to tailor its operation to the needs of specific traffic types and protocol stacks, for higher efficiency and performance.

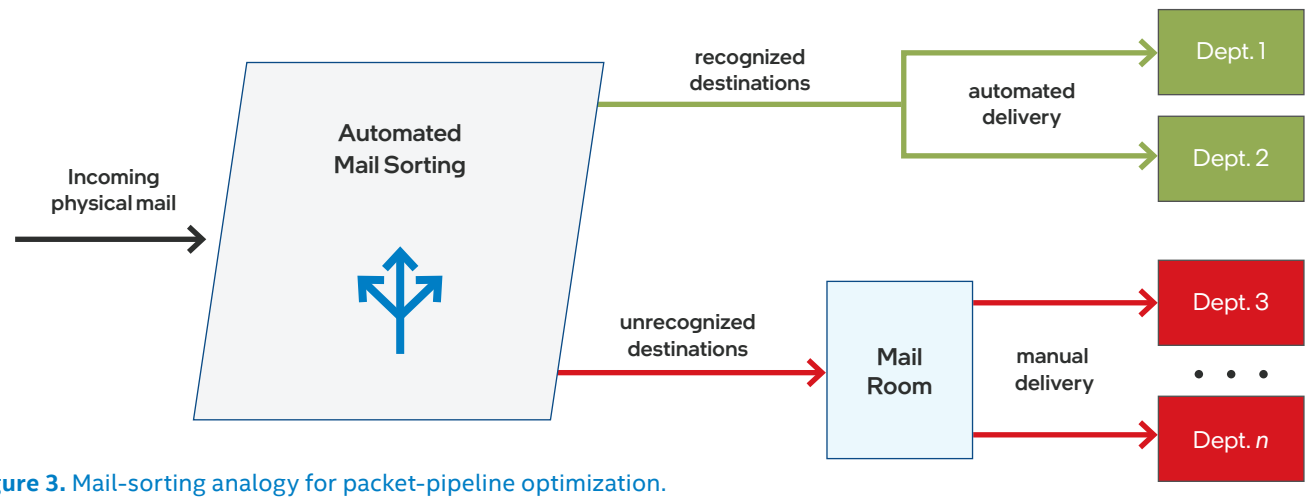

Figure 3. Mail-sorting analogy for packet-pipeline optimization.

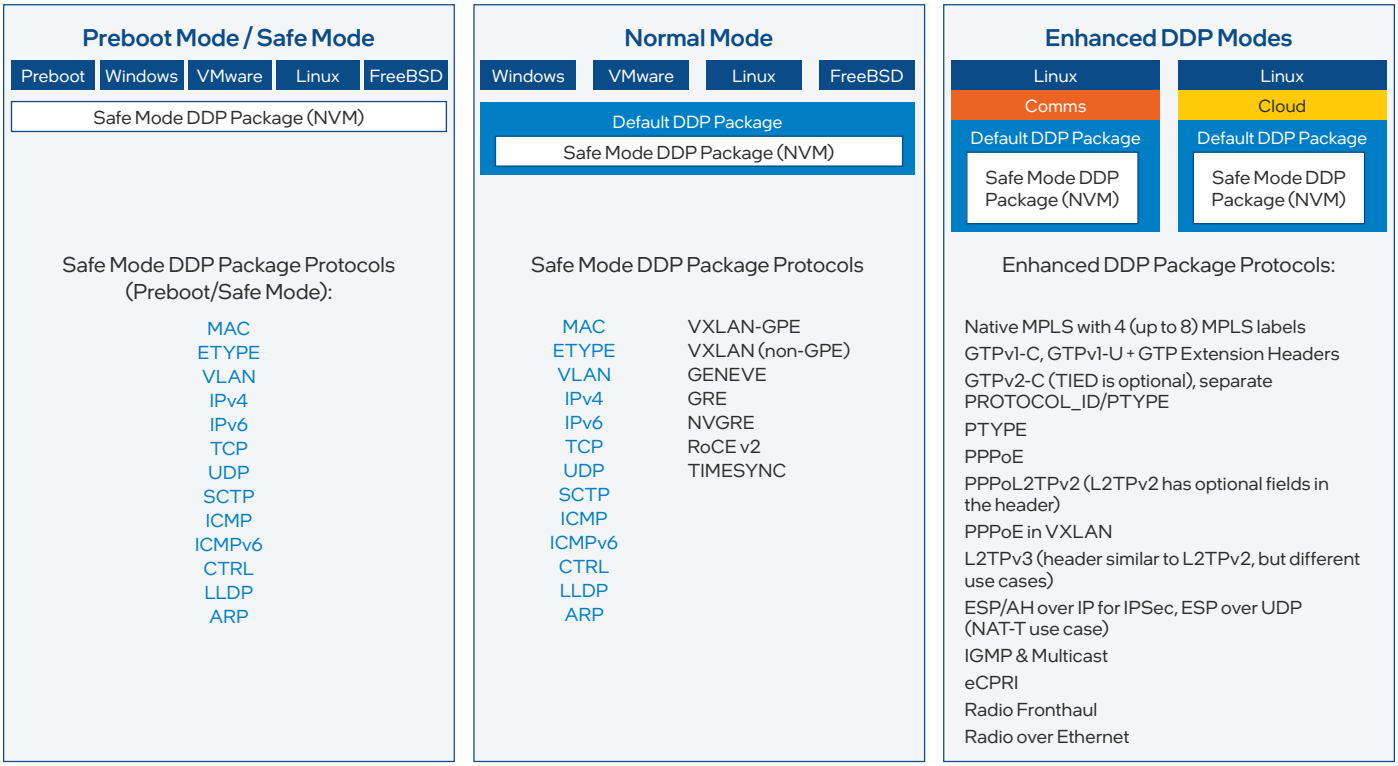

Figure 4. DDP packages supported by the Intel Ethernet 800 Series.

Protocol enablement with DDP pipeline packages

The DDP protocol packages loaded by the Intel Ethernet firmware vary across operating modes, as illustrated in Figure 4. During pre-boot, the firmware loads the Safe Mode DDP package, which supports a minimal set of protocols for basic packet handling. Safe Mode also provides a reversion point for baseline protocol support in the event that other DDP packages fail to load.

When the OS loads, the 800 Series driver loads the Default DDP package to enable DDP Normal Mode, which provides expanded protocol coverage that builds on what is available in Safe Mode. It provides baseline support for well-known protocols and configurations, providing the required capabilities for OS certification, key Intel Ethernet technologies, and basic switch rules across OSs. This package is compiled with Windows and ESXi drivers and is available in the **lib/firmware** directory on Linux OSs. It is available under OBL Commercial Use License.

Enhanced DDP packages are built on top of the Default DDP package to serve specific market segments with corresponding protocol sets. For example, the Comms enhanced DDP package is intended to serve the market-specific needs of the telecommunications industry, providing protocols that include GTPv1 and v2, PPoE, PFCP, and others. Additional protocols can be added over time, and all protocols included in the default package are also available. Enhanced DDP packages are delivered to end customers by Intel under the Software License Agreement via support.intel.com. Solution providers also distribute general availability and custom packages via the Intel Resource and Documentation Center.

Increase performance by programming new protocol support at runtime

The ability to reconfigure network adapters on demand, without having to migrate workloads off of the server, avoids the overhead of system restarts or reloading the NVM firmware image. Parsing new protocols in the network controller at runtime improves packet processing performance. Segment-specific profiles for the Intel Ethernet 800 Series enhance flexibility with workload-specific protocols at driver initialization, with independent programmability with different protocols for each adapter in a system.

- **Enable workloads to request services based on requirements.** With DDP, orchestration can request personalized services, updating the adapter's functionality by loading specific profiles on demand. If multiple adapters are present, each can have its own profile without affecting the others.
- **Increase efficiency using fewer devices.** Devices have a limited set of protocols that they support by default. The DDP profile package loads additional protocols on top of the device's default definition. Access to more protocols can reduce the need for more devices.
- **Make workload optimizations on demand.** Using DDP to reconfigure the pipeline enables classifying additional protocols inline to distribute packets to specified queues on the device's host interface. This capability avoids the need for CPU cores to perform classification or load balancing for specific packet types.

Conclusion

DDP enables programmability of the packet-processing pipeline by dynamically tailoring the protocol stack available, based on the needs of specific workloads. Enhanced DDP packages provide open-ended flexibility to create custom pipelines on demand, increasing throughput and offloading traffic processing from the OS, which saves on processor resources. The Intel Ethernet 800 Series uses DDP to adapt to the needs of emerging workloads, delivering extensibility to optimize unknown future traffic flows.

Learn more: www.intel.com/ethernet

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