

QLF NETWORKING

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[Shankar @ ngkore](#)

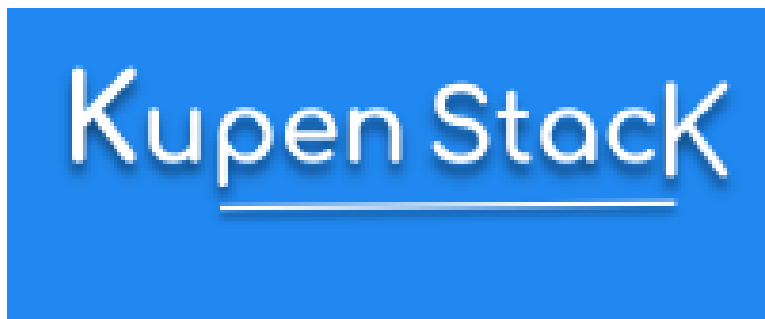
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L3aF Integration with 5G – User Plane Function



Who we are?





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L3AF

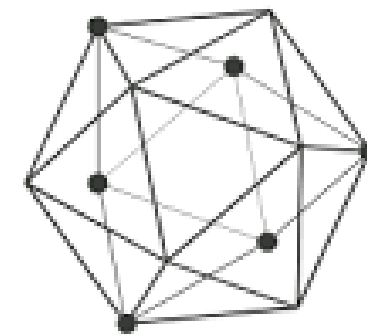
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Our
collaboration:



OpenInfra



HYPERLEDGER
FOUNDATION





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User Plane Function ?

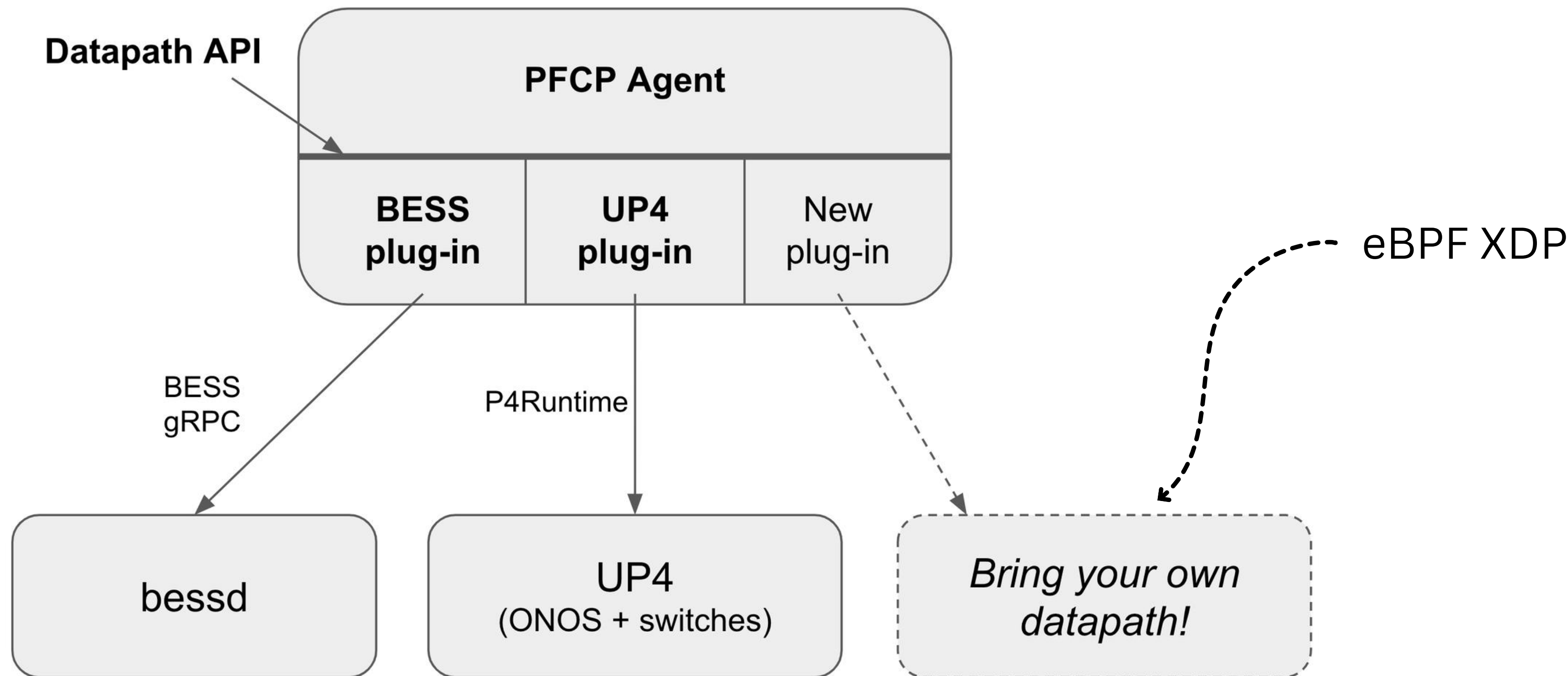
- Perform packet forwarding and forwarding policy enforcement for user data traffic.
- Ensures that data packets are delivered to the appropriate destinations based on the defined network policies and quality of service (QoS) requirements.
- The UPF also supports various functions related to traffic management, such as packet inspection, filtering, and deep packet inspection (DPI).
- Also enables some advanced 5G features, including network slicing.



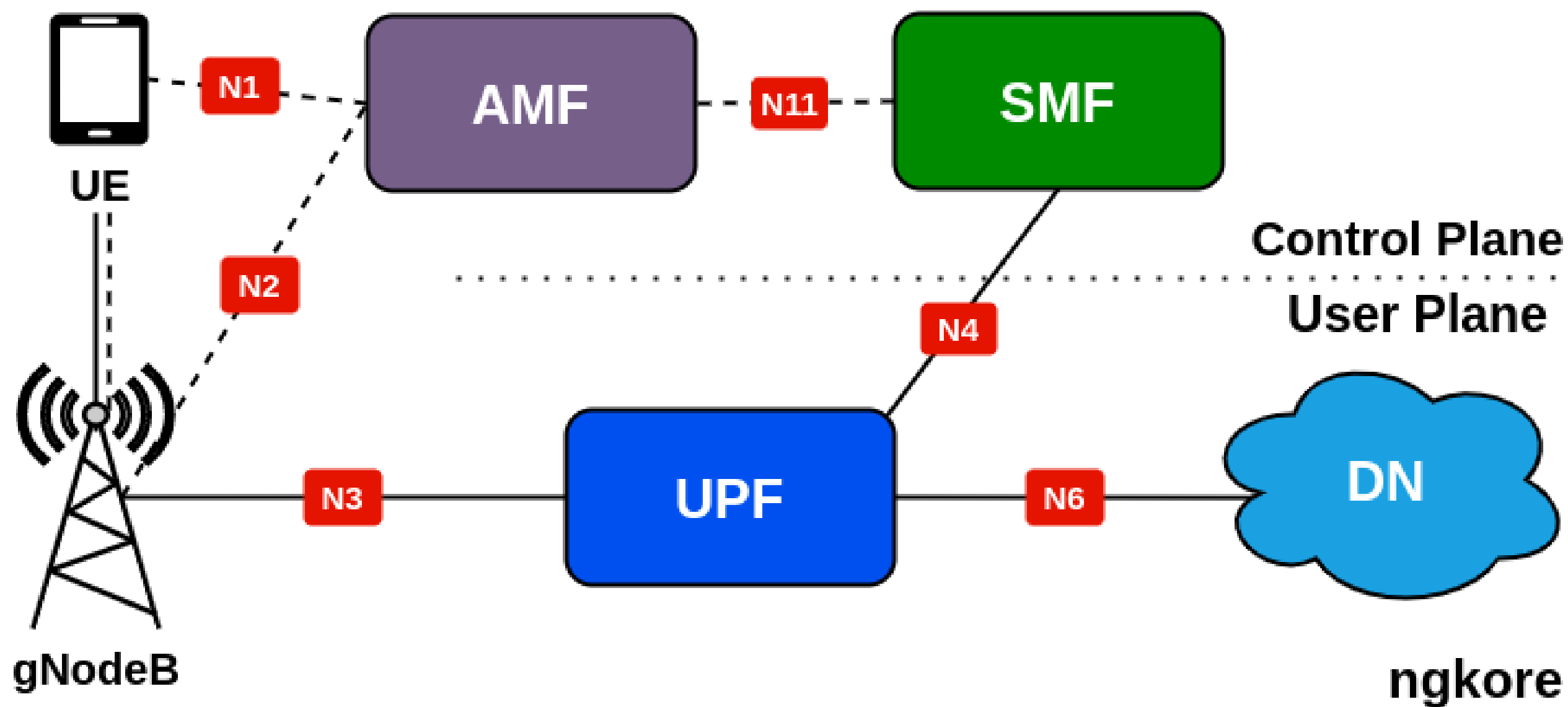
UPF Architecture:

The UPF implementation consists of two layers:

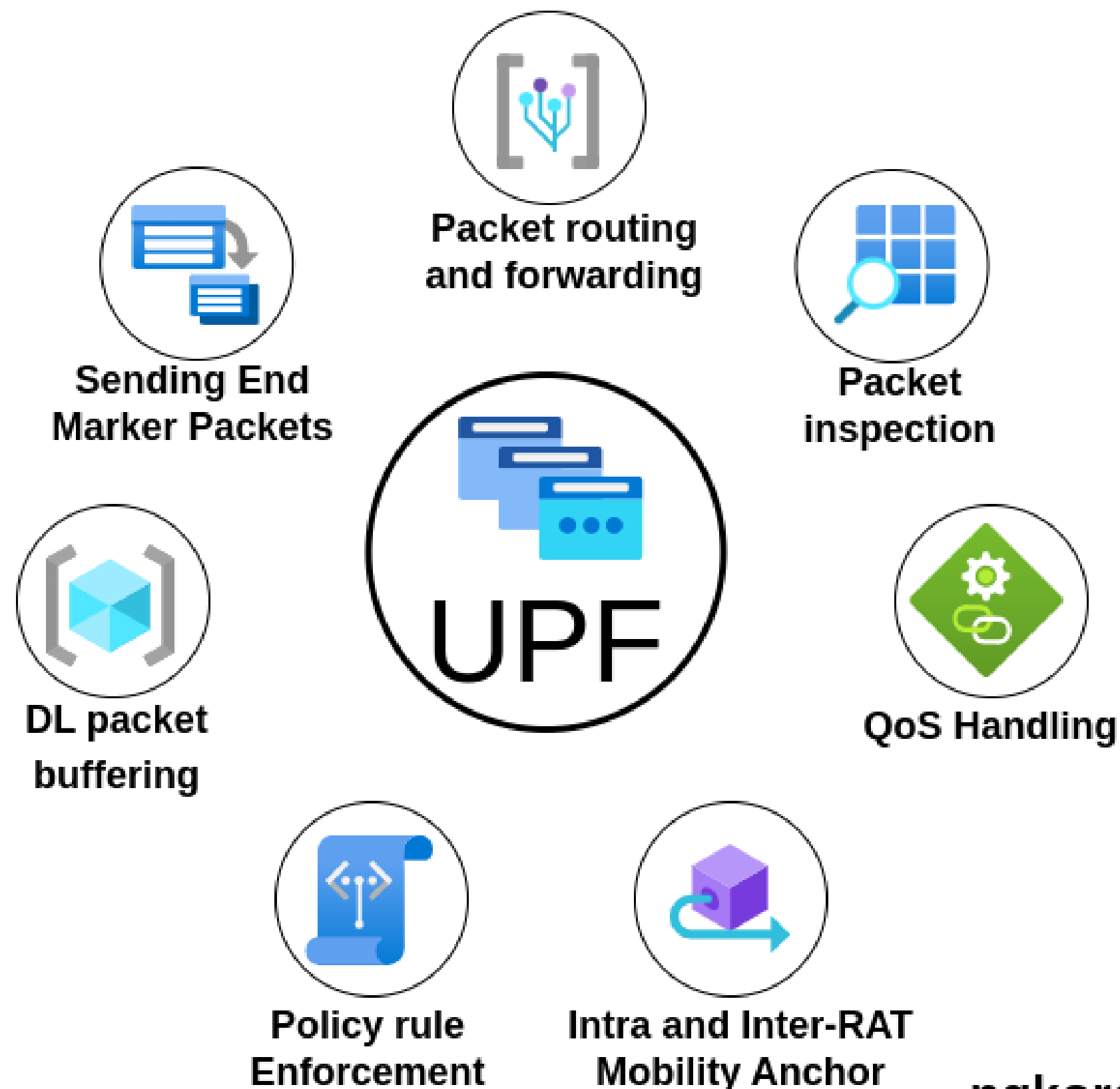
- PFCP Agent (pfcpiface): a Go-based implementation of the PFCP northbound API used to interact with the mobile core control plane.
- Datapath: responsible for the actual data plane packet processing.



UPF in 5G- Architecture



The Versatility of UPF:





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Our old Friend: DPDK

Using DPDK to accelerate packet processing in UPF:

- Only specific NICs are supported. i.e H/W dependency
- PMD keeps NIC usage all-time high.
- Integration with non-DPDK apps is a bit challenging.



eXpress Data Path

- In-kernel fast path. Not bypass.
- Does not req dedicating full CPU cores to Packet processing (unlike DPDK).
- More compatible with NICs, but with comparatively less performance.
- Can be dynamically re-programmed without any service interruption.



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eXpress Data Path

Some

limitations:

- Limited program size.

- Managing multiple eBPF XDP progs can be a tough task, especially in Multi-node ecosystems.
- No way to monitor or see metrics of progs.
- No standard interface to control or integrate it with other sidecar applications.



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L3AF comes into
play

Complete lifecycle management of eBPF
programs in the kernel



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L3AF over XDP:

- It can orchestrate and manage multiple eBPF programs.
- Use PQL and Grafana to see metrics and monitoring of programs.
- Reads configuration data and manages the execution and monitoring of eBPF programs.
- Community-driven eBPF package marketplace where L3AF users can obtain a variety of eBPF programs developed by multiple sources.



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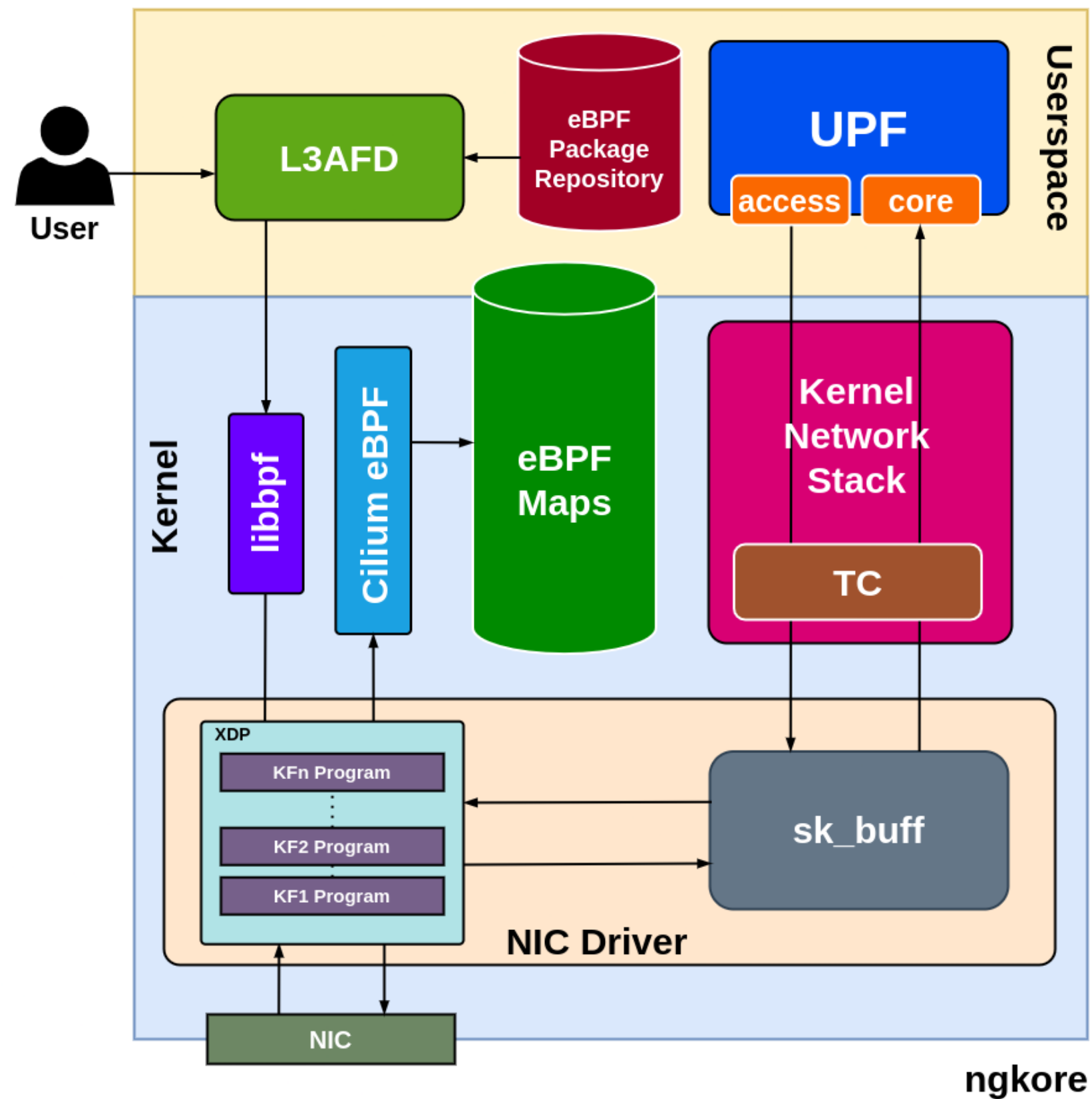
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UPF + L3AF:

Without AFXDP



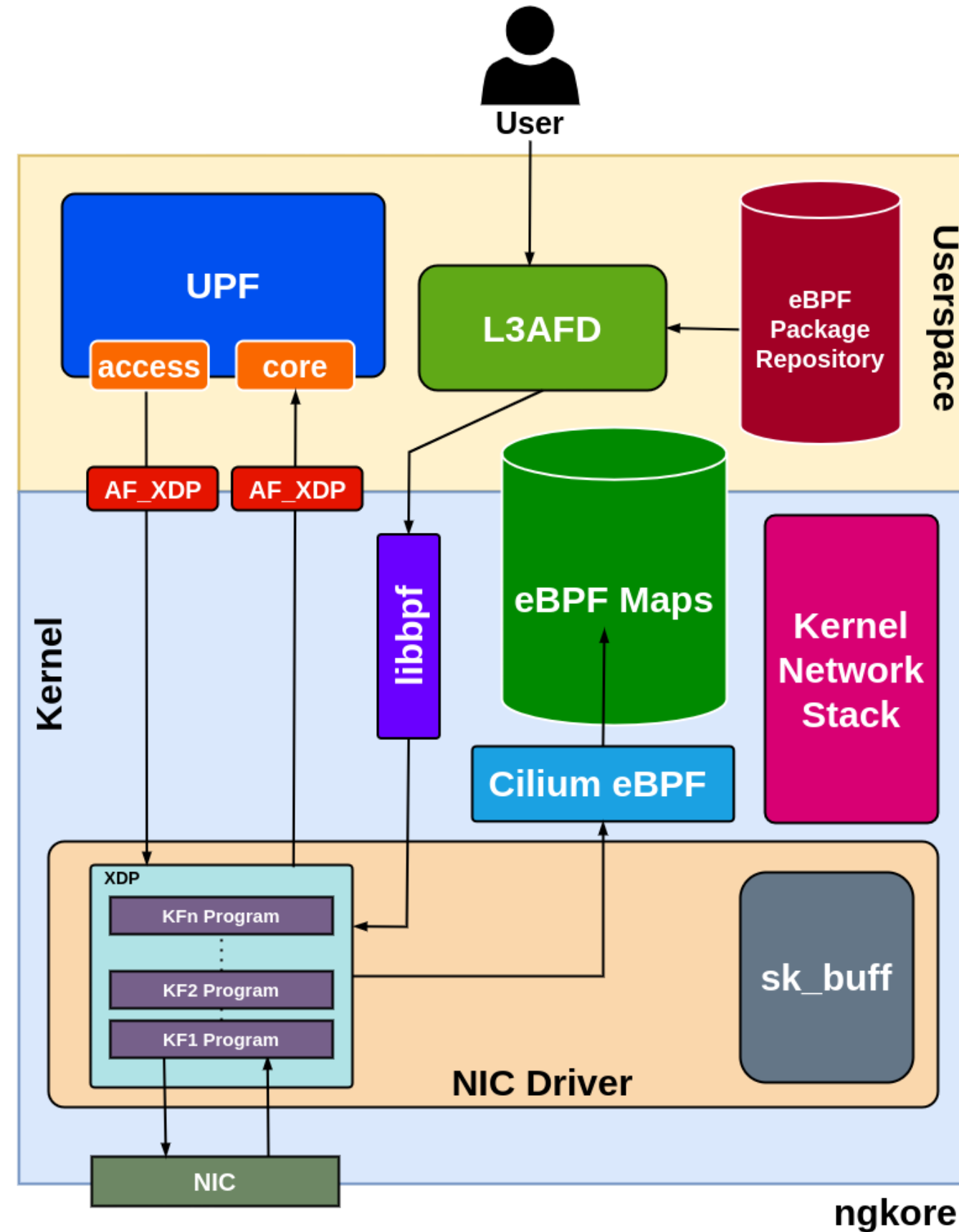


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With
AFXDP





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Advantages:

We have ambitious future plans, including

- Faster and scalable dataplane using ebpf programs & L3af
- This integration will enable more advanced packet processing capabilities and further enhance the overall performance of L3af.
- Also, L3af aims to explore the potential of packet processing solely within the kernel using eBPF, offering improved efficiency and reduced overhead.



Future Plans with L3AF:

It enables developers to

- orchestrate multiple eBPF programs to enhance UPF functionality
- resulting in efficient packet processing and improved network performance.
- L3af provides horizontal and vertical scaling options
- allowing the deployment of multiple UPFs with multiple eBPF programs.



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UPF LOGIC

- Complete UPF packet processing logic in kernel using eBPF programs
- Currently, we are undertaking significant strides in integrating AF_XDP sockets with the UPF and XDP.
- By doing so, we aim to extend the flexible, efficient management capabilities of the L3AF system to the modules currently under UPF



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Overall, these developments signify a bold reimagining of our network architecture, leveraging cutting-edge technologies such as eBPF, AF_XDP, and L3AF for optimized network management. By continually striving to innovate, we aim to drive forward network efficiency, reduce latency, and provide robust and reliable network performance.



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Horizontal and Vertical Scaling:



Horizontal Scaling

- Increase no. of UPFs
- L3AF can be a key component in managing horizontal scaling by coordinating the distribution and execution of eBPF programs across multiple UPF nodes.
- L3AF's ability to manage and monitor these programs can aid in load balancing, which is essential in effective horizontal scaling.



Vertical Scaling

- Increase capability of UPF
- Involves the addition of more resources to an existing node, such as more processing power or memory.
- The observability provided by eBPF and L3AF can be used to monitor the system's performance, helping to determine when vertical scaling might be necessary.



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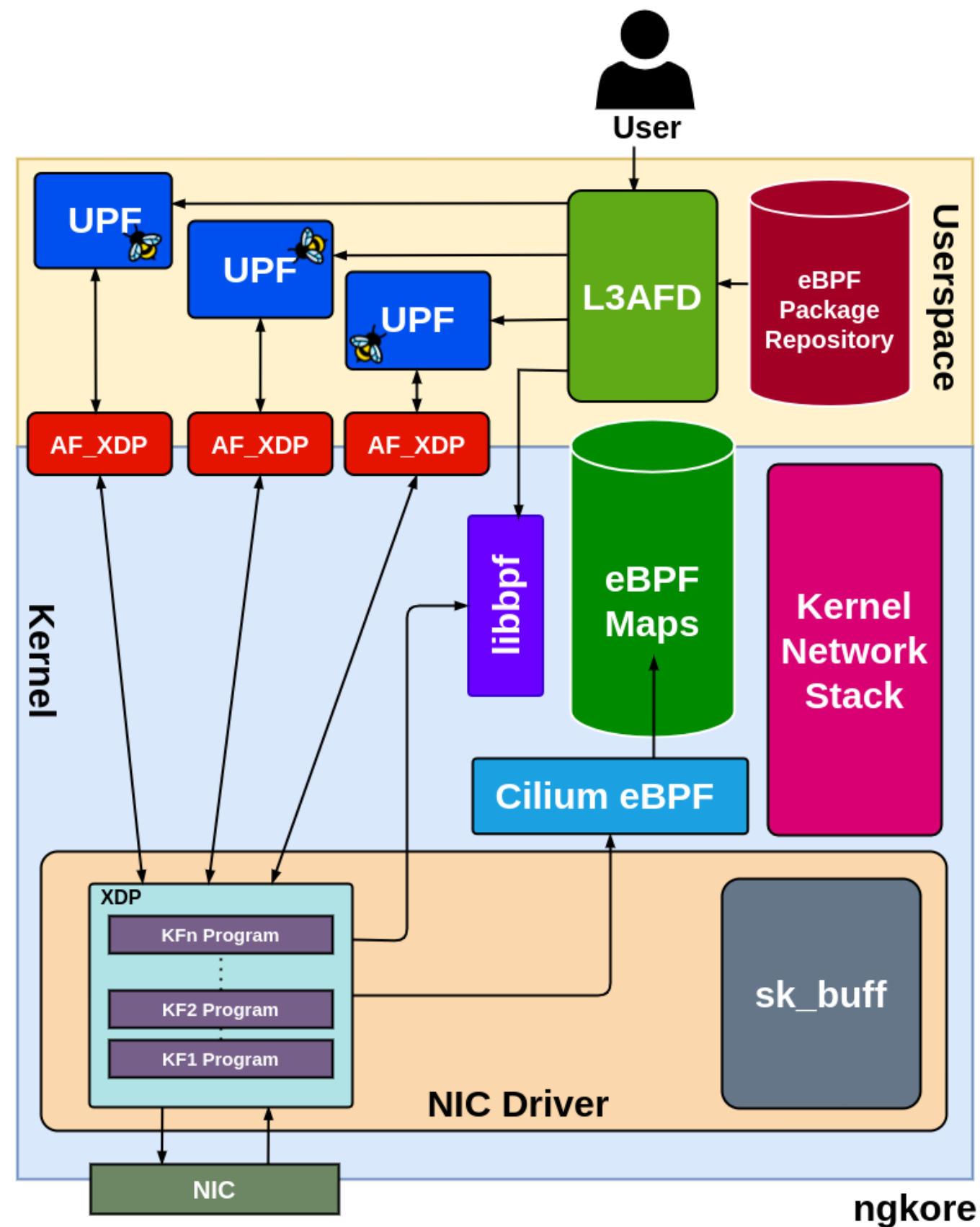
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So points to note here

multiple
UPF





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What We've Achieved

- We have currently tested L3AF with our upf using the afxdp socket and importing all the ebpf programs at the xdp hookpoint and then bypassing the kernel network stack.
- We have also tried testing it with the UPF of sdcore and have got favorable results.
- Our team of researchers is busy writing upf related ebpf programs and some of which are being orchestrated by l3af and some of them are still in the process.
- We have tested with l3af's own ebpf package repository as well as our own ebpf programs.
- Our goal is to make fully scalable upf with fast packet processing technology using ebpf and l3af.
- We have already seen better performance after integrating ebpf and l3af. For now, we can't tell the exact benchmarking numbers but soon we will share that too.



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References:

- An In-Kernel Solution Based on XDP for 5G UPF: Design, Prototype and Performance Evaluation- <https://ieeexplore.ieee.org/document/9615553>
- <https://github.com/navarrothiago/upf-bpf>
- <https://www.youtube.com/watch?v=vlrrrLtwEvU>



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For any query:

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A background image of a golden wheat field under a bright, hazy sky. The wheat stalks are in sharp focus in the foreground, creating a sense of depth and texture. The overall color palette is warm, dominated by yellows and oranges.

DLF

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