CLICK-UP: Towards Software Upgrades of Click-driven Stateful Network Elements

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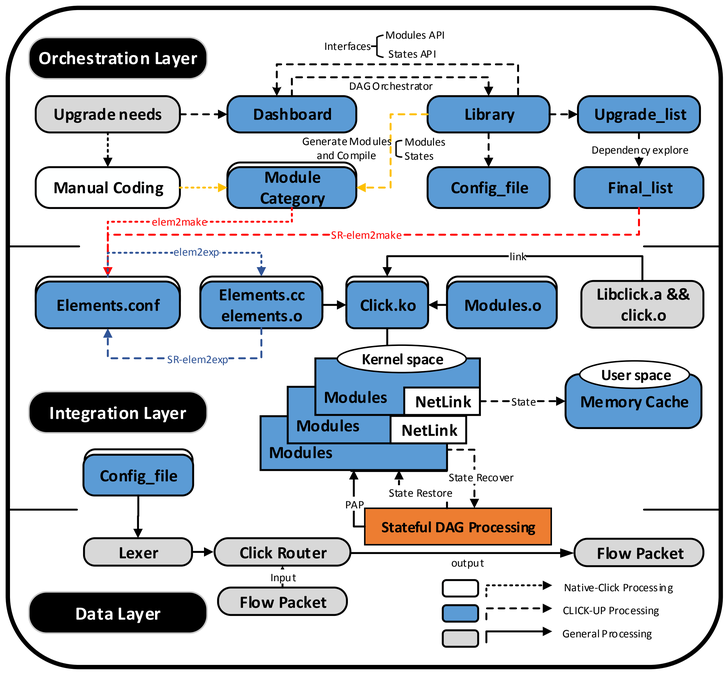
Contribution

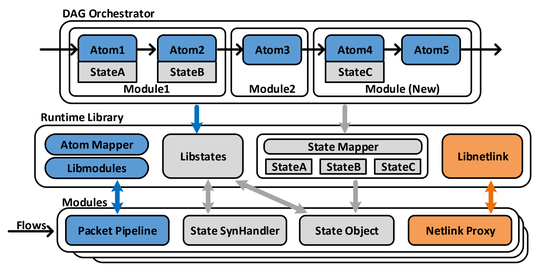
a. Explicitly integrate essential modules in a service context-aware manner, and cut down upgrade overheads.
b. Forcefully integrate a state synchronization scheme into modules, and avoid service disruption.
c. Employ a lightweight runtime library as the skeleton of upgrades, and ease orchestration.

Workflow of *CLICK-UP*

(1) The dashboard exposes the DAG orchestrator to operators, allowing operators to define their upgrade needs as a DAG. The DAG is based on well-known semantics and consists of a series of pipeline processing related atom functionalities, including their required service states.
(2) The DAG should be parsed to a set of Click modules (called elements), and its new state collection is integrated into the corresponding modules. All modules have a state synchronization mechanism and a state reconstruction bootstrap.
(3) The modules are compiled, built into kernel space, and the persistent storage in user space is initialized with a new version number. At the same time, former version related states are sent back to the module.
(4) The new configuration is created and the upgraded network element is rebooted with its former service states fulfilled by a recovery bootstrap.



Atom-based Orchestration



Orchestrating with atoms rather than elements

(1) The atoms are a series of core functionalities called atom functionalities, e.g., packet parsing, payload modification, and the like, each of which is easy for operators to follow.
(2) The atoms are in accordance with the most concise service context (essential modules/elements), which are logically consistent with upgrade intents.
(3) The state management is also based on atoms.

Source Code

The source code is at `https://github.com/CLICK-UP/`, the project website is at `https://click-up.github.io/`.

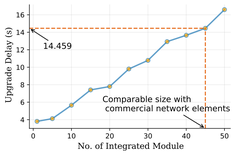
References

[1] J. Wang, Y. Huang, H. Qi, K. Li, S. Uhlig. CLICK-UP: Towards Software Upgrades of Click-driven Stateful Network Elements. In Proc. of *SIGCOMM'18 Posters and Demos*, 2018.

Pain Point-1

Time-consuming Integration

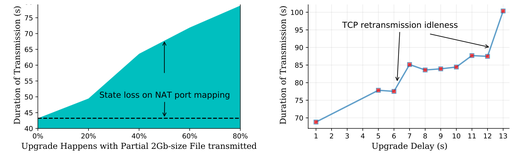
VNF	Elements	VNF	Elements
delay	6	ip601	13
demo	12	ip64-nat2	24
dnsproxy	7	ip64-nat3	26
fake-iprouter	23	ipsec-router	26
gnat01	14	local delay	13
gnat02	10	mazu-nat	20
grid	47	print-pings	7
ip64-nat	25	rewriter	12
fromhost-tunnel	21	thomer-nat	21
fastudpsrc	4	webgen	8



Integrating new modules with upgraded network elements is a time-consuming process. During this process, however, the packet-processing functionalities are out-of-work. This brings several issues including the inability to elastically scale out network functions on-demand and to quickly recover from downtime.

Pain Point-2

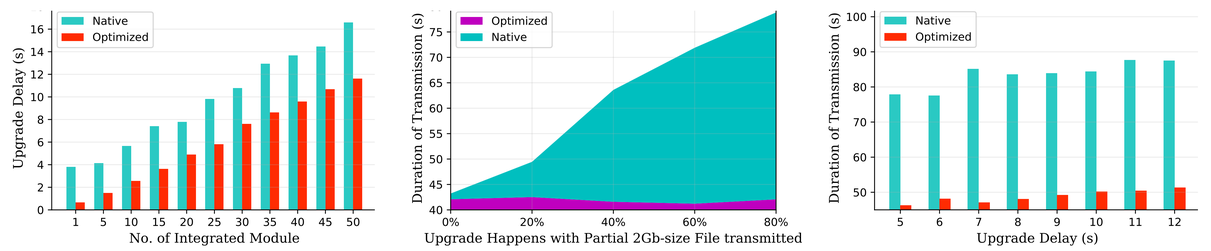
Stateful Service Disruption



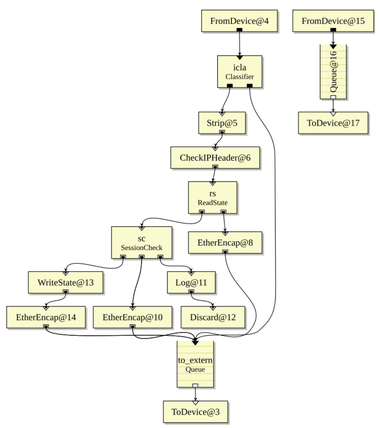
With no mechanism to reconstruct lost states for network elements, stateful functionalities are unable to correctly handle packets after upgrade, leading to service disruption. This may involve states such as connection information in a stateful firewall, address mappings in a network address translator (NAT), or server mappings in a stateful load balancer.

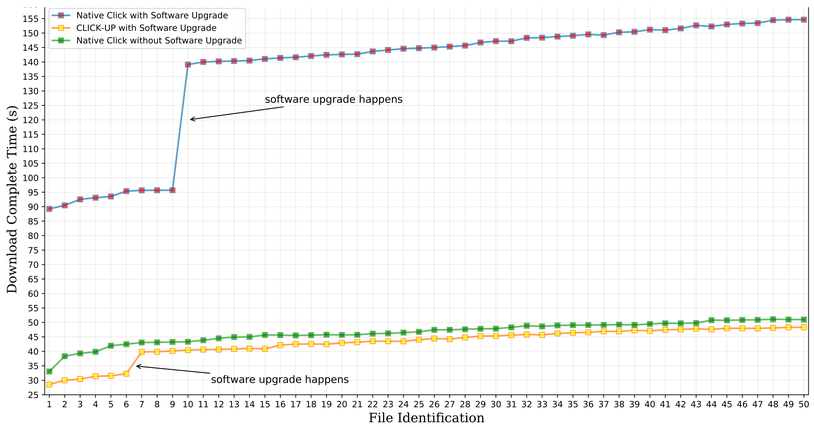
Power of *CLICK-UP*

Testbed Evaluation Results (PNAT)



Testbed Evaluation (Whitelist Firewall)





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