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Influencing Linux‘s TSN Qdiscs in Real-Time

Motivation

Information-Centric Networking (ICN) [1] and Named-Data Networking (NDN) [2] bring a new concept into computer networking where the data instead of the endpoints of a connection is addressed. Instead of sending a request to a specific server, the user can send out a request (interest) for a specific piece of information. The network then handles the request, routing the interest towards the information producer. The producer then returns the information (data packet) to the user/client with the help of forwarders distributed across the network.

In recent work [3], we built up on this concept, introducing pub-sub-like communication over ICN using interests that persist on the network forwarders. These interests are soft-state and must be periodically refreshed to keep their state. The solution is tailored for low-latency communication within TSN and is integrated within the EnGINE Framework [4,5], an experiment orchestration tool tailored for TSN experimentation.

Since those interest packets dictate how much traffic will be sent on the reverse path, one could use those for resource reservation. In such case, each interest could result in a modification of qdiscs configured on the path a data packet would follow. As only limited related work on live qdisc reconfiguration exists [6], your goal would be to implement a programmatical method of qdisc (re-)configuration (using the netlink interface) and its integration with both the EnGINE Framework and the NDN solution from [3]. Subsequently, you will need to evaluate the performance and impact of your solution against static deployments.

Your Tasks

- Implementation of a method for programmatically changing qdisc configuration during runtime using netlink, without calling tc utility commands
- Integration of your solution within the EnGINE framework [4]
- Integration of the configuration method with the NDN low-latency concept [3] to enable resource reservation along the interest’s path
- Validation of the performance of such qdisc reconfiguration scheme within NDN

Requirements

- General knowledge of computer networking
- Good understanding of C and C++
- Knowledge of Ansible is a plus, but can be learned during the thesis

References

[1] Dirk Kutscher, Suyong Eum, Kostas Pentikousis, Ioannis Psaras, Daniel Corujo, Damien Saucez, Thomas C. Schmidt, and Matthias Wählisch. 2016. Information-Centric Networking (ICN) Research Challenges. RFC 7927.
[2] Lixia Zhang, Alexander Afanasyev, Jeffrey Burke, Van Jacobson, kc claffy, Patrick Crowley, Christos Papadopoulos, Lan Wang, and Beichuan Zhang. 2014. Named Data Networking. SIGCOMM Comput. Commun. Rev. 44, 3 (jul 2014), 66–73.
[3] Marcin Bosk and Jörg Ott. 2024. Towards Domain-Specific Time-Sensitive Information-Centric Networking Architecture. In 4th International Workshop on Time-Sensitive and Deterministic Networking (TENSOR), co-located with IFIP Networking 2024.
[4] Rezabek, Filip, Marcin Bosk, Thomas Paul, Kilian Holzinger, Sebastian Gallenmüller, Angela Gonzalez, Abdoul Kane et al. "Engine: Flexible research infrastructure for reliable and scalable time sensitive networks." Journal of Network and Systems Management 30, no. 4 (2022): 74.
[5] Marcin Bosk, Filip Rezabek, Kilian Holzinger, Angela Gonzalez Marino, Abdoul Aziz Kane, Francesc Fons, Jörg Ott, and Georg Carle. 2022. Methodology and Infrastructure for TSN-Based Reproducible Network Experiments. IEEE Access 10 (2022), 109203–109239.
[6] Von Arnim, C., Gessner, G., Jarwitz, M., Lechler, A., & Riedel, O. (2022). Updating the Linux TAPRIO Scheduler in Deterministic Time. 2022 IEEE 27th International Conference on Emerging Technologies and Factory Automation (ETFA), 1–7. https://doi.org/10.1109/ETFA52439.2022.9921594

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