

Visualization of Network Emulation Enabled by Katharà

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- Reproducibility issues: Transparent, deployable, and **reproducible** research papers are highly required, yet hard to achieve. All elements (e.g. software, data, scripts, testbeds) must be easy to access and redeployed by reviewers and other researchers[1].
- With platform like *Github*¹, it is very easy to publish and share scripts, data, and even software used in the experiments.
- A flexible, easy-to-deploy, cheap testbed, however, is not trivial to obtain.
- Network emulators has gained a lot of attention from research community, offering a wide range of advantages but still far from fully reproducible.
- Leveraged by recent technology advancements, a prototype of a cloud-based, multi-tenency **Network-Emulator-as-a-Service** (NEaaS) is developed, aiming to provide a testing platform capable of reproducibility.

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¹<https://docs.github.com/en/get-started/using-git/about-git>

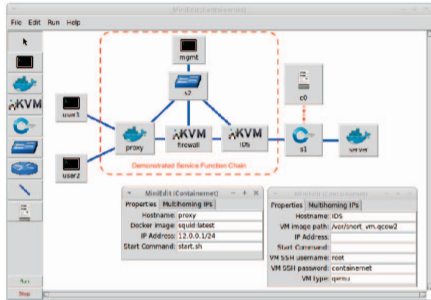


Figure 1: Docker container as devices in Containernet

1 Mininet:

- "...a network emulation orchestration system..."[2]
- Pros: lightweight and agile
- Cons: no Docker container support, limited options to control resources

2 Containernet:

- An improved adaptation of Mininet, designed by M. Peuster et al.[3]
- Docker containers as virtual hosts
- More options for resource limitation

Note: Both are CLI tools.

1 GNS3:

- A free network software emulator
- Pros: **GUI** support.
- Cons: Hardware/OS restrictions

2 Katharà[4]:

- The successor of Netkit
- Pros: Containers as virtual hosts & network scenario concept.
- Cons: No **GUI**.

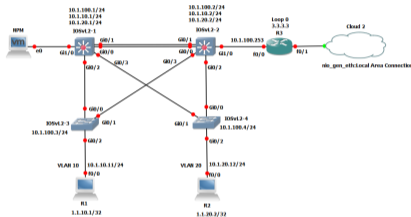


Figure 2: GNS-3 graphic interface

All aforementioned emulators have certain inherent disadvantages, such as:

- **No GUI support**
- **Installation restrictions**
- **Steep learning curve**
- **Single-host application**

Several important recent technology developments:

- **Cloud computing**
- **PWA**
- **laC**
- **Kubernetes**

Question: Given those difficulties and achievements, how to make a better network emulator?

Key design concepts

- 1 GUI support via browser
- 2 As-a-service model
- 3 Containerized architecture
- 4 Automated infrastructure management

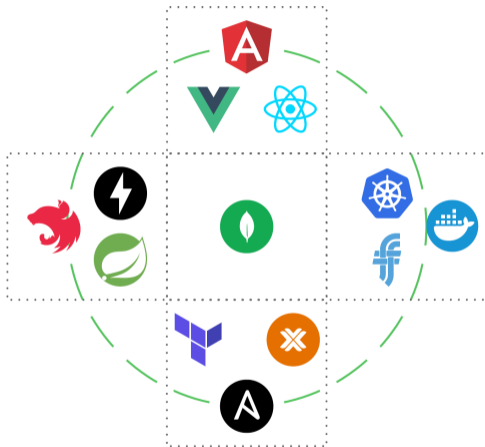


Figure 3: Tech stack

Prototype architecture

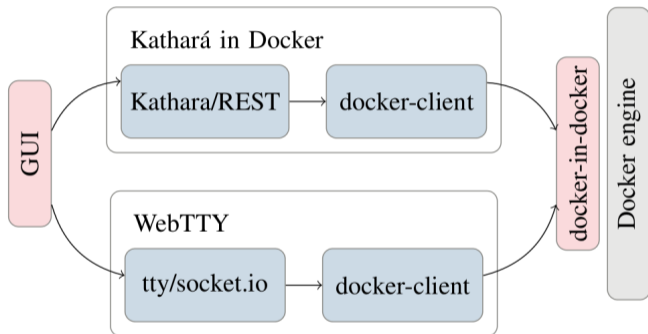


Figure 4: Single user prototype

Components

- 1 GUI
- 2 Katharà-in-Docker
- 3 WebTTY
- 4 Dind

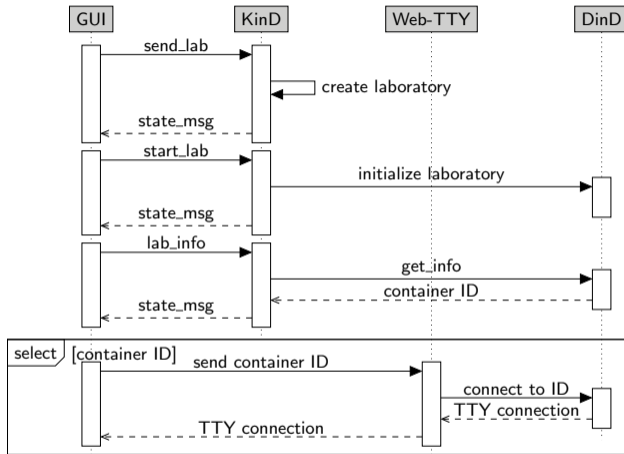


Figure 5: Micro-service interactions

Characteristics	Mininet	Containernet	GNS3	Kathara	Kathara-UI
Scalability	+	+	-	+	+
Flexibility	-	-	+	+	+
Extensibility	-	-	(limited)	(limited)	+
QoE	-	-	+	(limited)	+
Realism	+	+	+	+	+
Cost	+	+	+	+	+

Table 1: Features comparison of network emulators

This prototype presents some promises, but there are a lot of works need to be done:

- Better interaction mechanisms (using WS)
- Kubernetes orchestrator
- User management plane (multitenancy)
- Automated resource management. (Ansible, Proxmox)

- [1] R. G. Bergman and R. L. Danheiser, "Reproducibility in chemical research," *Angewandte Chemie International Edition*, vol. 55, no. 41, pp. 12 548–12 549, 2016.
- [2] N. Handigol, B. Heller, V. Jeyakumar, B. Lantz, and N. McKeown, "Reproducible network experiments using container-based emulation," in *Proceedings of the 8th International Conference on Emerging Networking Experiments and Technologies*, ser. CoNEXT '12. Association for Computing Machinery, 2012, p. 253–264.
- [3] M. Peuster, H. Karl, and S. van Rossem, "Medicine: Rapid prototyping of production-ready network services in multi-pop environments," in *2016 IEEE Conference on Network Function Virtualization and Software Defined Networks (NFV-SDN)*, 2016, pp. 148–153.
- [4] M. Scazzariello, L. Ariemma, and T. Caiazzi, "Kathará: A lightweight network emulation system," in *NOMS 2020 - 2020 IEEE/IFIP Network Operations and Management Symposium*, 2020, pp. 1–2.

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