Automated VNF Testing with Gym: A Benchmarking Use Case

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***Abstract*—In the growing landscape of Virtualized Network Function (VNF) development processes and methodologies fueled by enabling technologies for virtualization, the myriad of customization options unveil unprecedented SW/HW configuration knobs and hazards. Underlying execution environments multiplex resources imposing hard-to-predict relationships between VNF performance metrics (e.g., latency), allocated infrastructure assets (e.g., vCPU), and stimuli workloads. Gym is a framework designed to enable automated testing and to extraction of such relationships by the means of VNF performance profiles, walking through a cause-effect path towards agile DevOps methodologies for NFV. The demo showcases the implementation of Gym through exemplified live extraction of VNF metrics for analytics use cases, such as comparison factors between physical network functions and pre-deployment infrastructure dimensioning.**

I. Introduction

In our initial work on VNF Benchmarking as a Service (VBaaS) [1], we introduced the problem statement of VNF benchmarking based on "trust, but verify" principles in seek of standardized performance testing allowing proper evaluation of candidate platforms and locations to host (chains of) VNFs with respect to target Key Performance Indicator (KPI)s. VBaaS idealized the utilization of VNF and infrastructure performance metrics to uphold network service lifecycle workflows. As Network Function Virtualization (NFV) matures through the realization of proof of concepts and early commercial products, identified challenges towards wider rollouts include the need of carrier-grade testing and operational standards to match service-continuity and performance predictability levels of current physical infrastructures [2].

Software-oriented processes applied to Network Function Virtualization (NFV) call for automated testing practices spanning platform portability, functional correctness, and performance benchmarking for each candidate VNF version before turning it available for deployment. A single line of code change passing all functional tests could also undermine the VNF performance for specific workloads and platforms —a risk that calls for standardized testing methods [3], [4] towards adequate VNF benchmarks. Such a multi-dimensional testing landscape with multiple configuration knobs introduces challenges towards useful performance profiles delivering valuable assessments for different stakeholders at different stages, e.g., during VNF development, for pre-deployment NFV Infrastructure (NFVI) validation, or even for Service Level Agreement (SLA) compliance at run-time.

II. Gym: A VNF Testing Framework

We advocate for a framework that defines a minimum set of standardized interfaces while allowing user-defined tests along a catalogue of reusable VNF testing procedures and reports with wide- and well-defined system configuration descriptors, workload parametrization (linking to specific traffic generation tools and their parameters), KPI computation, along all supporting code and data expected from a standardized and reproducible benchmarking methodology. Outcomes of automated performance tests can be used as inputs of orchestration algorithms and/or parameters to support business decisions such as pricing and allocation of resources to fulfill SLAs.

Taking roots in the former design efforts of VBaaS [1], our early envisioned abstractions evolved into the framework implementation, baptized as **Gym** [5]. Our approach is based on the development of a skeleton of software components delivering the abstractions and tool set in support of practical methodologies to validate, benchmark, and dimension VNFs [4]. Gym is mainly characterized by: *(i)* Modular architecture with stand-alone programmable components; *(ii)* Simple messaging system following generic Remote Procedure Call (RPC) guidelines; *(iii)* Extensible set of testing tools and target metrics; *(iv)* Rich test definition through dynamic compositions of modules; *(v)* And flexible methods for output processing and results visualization.

Gym aims at introducing new opportunities to different NFV actors. VNF developers can rely on the framework to add automated, repeatable VNFs performance profiling to their agile Continuous Integration and DevOps practices. Service Providers might enhance offered Quality of Service (QoS) with tested-deployed scenarios (e.g., varying workloads in multiple sites), containing transparent sets of operational VNF metrics, targeting Continuous Deployment. Cloud/Infrastructure Providers, when extensively testing VNFs in their execution environments, can use Gym to implement SLA compliance methods to increase the infrastructure reliability and operational efficiency (e.g. energy consumption).

III. Demonstration

Gym design principles will be shown demonstrating characteristics of Interoperability, Configurability, Repeatability and Comparability [5]. Utilizing the set of Gym modular components (Agent, Monitor, Manager, Player), a walk-through in the day of a VNF benchmark will be presented highlighting each

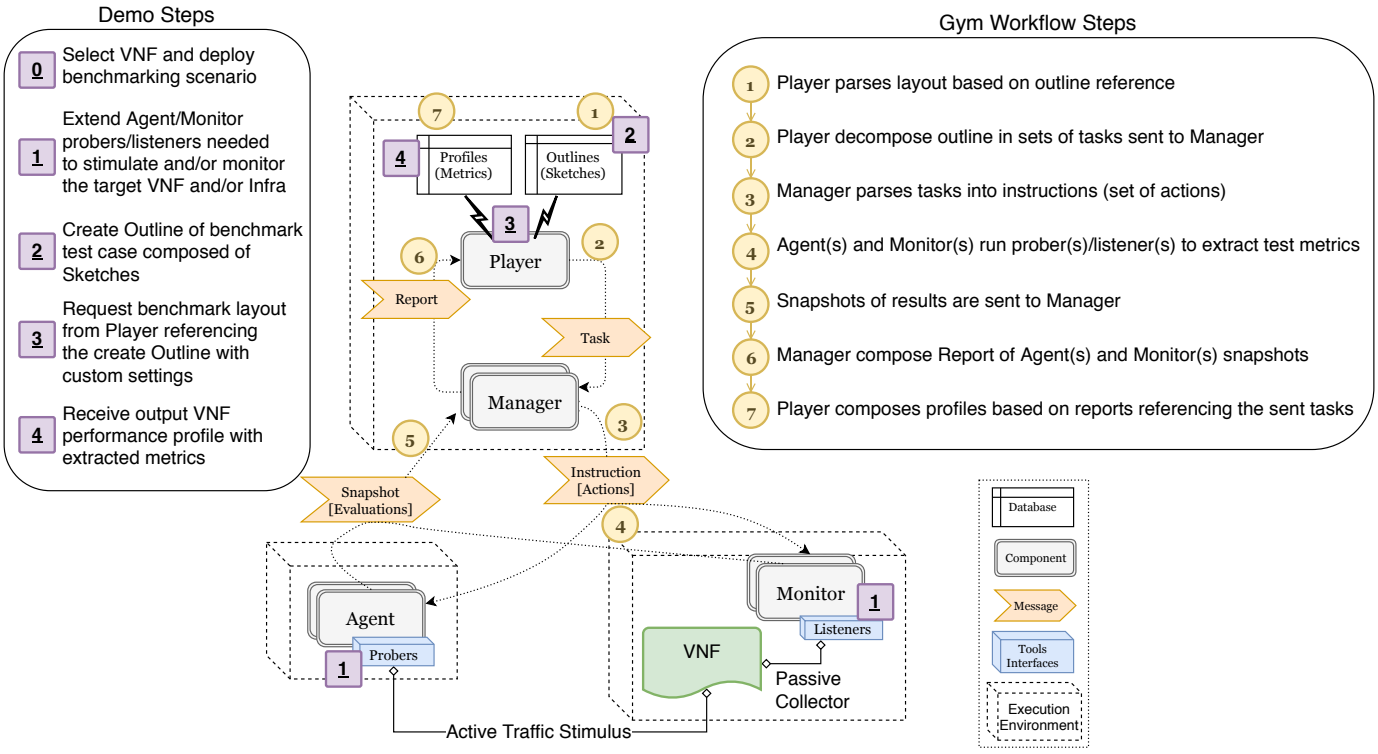

Figure 1. Gym Demonstration Scenario and Workflow.

step of interaction among Gym's components to realize the extraction of performance metrics. In summary, all the procedures of Gym's messaging system and workflow will demonstrate the framework operational and management capabilities. Along the presentation, consistency (test vs. production workload - precision), stability (heterogeneous environment tests - recall) and goodness (relevance of extracted metrics - accuracy) of the results will be discussed as challenging factors in the design and implementation of Gym.

As organized in Fig. 1, the demo[1] steps will showcase the view of a VNF developer utilizing Gym to profile a VNF in a particular execution environment. Each demo step will be presented and referenced by prototyped code, information models, log analysis, and the VNF extracted metrics. Basically, at the end of the demo, it will be possible to understand how Gym offers a meaningful apparatus to express VNF testing abstractions that can be certainly explored in continuous development and integration methodologies.

IV. Concluding Remarks

As an architectural framework and an open source artifact,[2] despite the proof of concept demos, Gym is still very much in its infancy. We expect Gym to keep evolving, not only in terms of low-level debugging but broadly driven by the community. Currently, Gym stands as a reference implementation in the VNF Benchmark Methodology draft [3] being developed in Benchmarking Methodology Working Group (BMWG) in Internet Engineering Task Force (IETF). We envision user-contributed extensions in Gym to support different testing tools, to evaluate newborn VNFs, and to allow users to build and replicate tests by reporting profiles and maintaining common repositories for reproducible research practices involving VNF testing and analytics.

[1]Technical Requirements. The demo will be presented using a laptop and a network topology based on Raspberry Pi 3 devices. Setup time is about 30 minutes and the needed facilities include Internet access and power source for the hardware equipment.

[2]https://github.com/intrig-unicamp/gym full release scheduled for Q3/2018)

Acknowledgments

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