Steady-state Availability Evaluation of Multi-Tenant Service Chains

L. De Simone[1], M. Di Mauro[2], R. Natella[1], and F. Postiglione[2]

[1]Department of Electrical Engineering and Information Technologies (DIETI),
University of Napoli Federico II, Italy.
E-mail: luigi.desimone@unina.it, roberto.natella@unina.it
[2]Department of Information and Electrical Engineering and Applied Mathematics
(DIEM), University of Salerno, Italy.
E-mail: mdimauro@unisa.it, fpostiglione@unisa.it

Nowadays, many telecommunication service providers (or tenants) share the same service infrastructure for cost optimization purposes, the so-called multi-tenant Network Service Chains (NSCs). These novel infrastructures are enabled by the Network Function Virtualization (NFV) paradigm that relies on the decoupling of the physical layer (i.e. hardware) from the service logic (i.e. software). NFV allows turning classic network appliances (e.g. routers, switches, etc.) into software instances often referred to as Virtualized Network Functions (VNFs). The composition (or *chaining*) of more VNFs results in NSCs which represent the modern way of providing network services. NSCs are failure-prone structures since the failure events can occur both at the physical and at the service logic layer. In this paper, we propose a methodology to ease the computation of the steady-state availability of multi-tenant NSCs, and to identify an NSC configuration respecting high steady-state availability constraints while minimizing deployment cost in terms of redundant subsystems. In our proposal, we: $i)$ model an NSC as a Multi-State System, where the state is the delay introduced by the system and derived from queuing theory; $ii)$ adopt an extended version of Universal Generating Function (UGF) technique, dubbed Multidimensional UGF (MUGF), to efficiently compute the delay introduced by the interconnections of various VNFs forming a service chain; $iii)$ define and solve an optimization problem that allows retrieving, in a numerical setting, an optimal NSC deployment which minimizes the costs and guarantees high availability requirements (defined in terms of the delay metric), at the same time. The whole assessment is supported by an experimental part relying on IP Multimedia Subsystem, an NSC-like infrastructure widely adopted in the modern 5G-based networks to manage multimedia contents.

Keywords: Reliability, Availability, Universal Generating Function, Network Service Chains.

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