5G resilience through network programmability

Context
Current advances in artificial intelligence (AI) and network programmability (including software-defined networking, programmable data-planes, and network functions virtualization, which are key components for a 5G infrastructure) are opening up new opportunities in realizing the telecommunications industry’s quest for autonomous, self-healing networks. Contrary to legacy networking equipment, programmable networks have decoupled the control and data planes, thereby effectively allowing services and network components to organically and dynamically grow and shrink, average out demand amongst themselves, and assign limited resources to core functions in a failure situation.

Requirements
Given the crucial importance of telecommunications to society, customers have come to expect and demand that services are “always on” and can be reached from anywhere on any device. Unfortunately, the network is bound to fail at some point. The cause of such failures might be unintentional or intentional (hacks). This leads to an important architectural requirement, namely resilience. Which elements and where and when must be built into the network in order to recover quickly, and ideally autonomously, from an attack or malfunction that affects a large part of the (virtualized) network?

Challenges
Network programmability imposes new challenges and opportunities for operating an efficient and highly reliable data communications infrastructure, since traditional architectural concepts might no longer be valid. For example, the use of Virtual Networking Functions (VNFs) enables new redundancy schemes, in which a malfunction within the network can easily be restored by replacing the responsible VNF by a new healthy one, possibly at a different location. On the other hand, shared use of the virtual network infrastructure by many different VNFs with time-varying resource demands complicates the capacity management process of the underlying hardware resources and introduces a new class of continuity risks that have to be dealt with. Programmability alone is insufficient, as the question of how to program the network remains. Through network monitoring and AI techniques, a closed-loop system could be developed to provide the intelligence needed to deploy a secure and resilient self-healing network.

Focus
Within the scope of the cooperation between KPN and TU Delft, our aim is to focus on developing algorithms (e.g., for auto-restoration of VNF graphs/service chains) and tools (e.g., to provide fast fail-over through P4) to support 5G resilience through programmable networks.