Impairment Aware Network Digital Twin

Description

The evolution of Internet depends strongly on the optical network's ability to handle the challenges of the ever growing traffic, the management of the energy consumption and, but not limited to, the capacity to add on new functionalities without imposing strong changes to the optical infrastructure.

The challenges are threefold. First, as always, the users' ever-increasing capacity needs must be met while simultaneously meeting new requirements, notably curbing the energy consumption's uncontrolled growth in data center networks, and slashing end-to-end latency by orders of magnitude. Since the numerous required optical-to-electronic conversions are a bottleneck on both issues, optical functionalities (OFs) have been proposed, such as all-optical wavelength conversion or packet switching. However, their decades-old promise to solve these challenges has not materialized outside research labs, because they are too complex to handle from the network's point of view. This dovetails with the second challenge: handling the complexification of the network due to the emergence of new services such as network slicing and network function virtualization. The commonly accepted answer to the latter is the software-defined network (SDN) ecosystem. However, SDN mostly doesn't concern itself with the physical layer; even recent control interfaces such as TAPI deal with the feasibility of a data connection between nodes, not the physical impairment details that would be required to manage optical functionalities. And, thirdly, a strong push is underway to integrate quantum key distribution (QKD) into the network as a physics-based security function. QKD, as a class of OFs, is likely to hit the same obstacles that prevented the general deployment of other OFs.

Objectives

Our overall approach is to tackle all three challenges by redefining the abstractions in which networks are expressed. The aim is to accommodate optical network functions, moving away from the classical layered-network model, which cannot accommodate the non-idealities of optical functionalities. As an intermediate step, the development of a "digital twin" (that is, a network simulator that mirrors the physical state of the actual network) would help identify the relevant abstractions as part of the development process, using generic programming techniques to encapsulate optical functions' non-idealities while making their full benefits available through high-level interfaces likely modeled on the SDN ecosystem.

Work program

Over 6 months, the intern will:

- contribute to an ongoing network simulation development effort, specifically aimed at generic handling of optical functions in a network;
- perform a bibliographical study of the state of the art.

The work may lead to a PhD thesis.

Requirements

Strong knowledge of generic programming techniques is required, preferably in the Python language. Also, applicants should have a Master's level in either networking or optical communications.

Environment

This internship is jointly supervised by Cédric Ware, Professor, Télécom Paris and Mounia Lourdiane, Assistant Professor, Télécom SudParis. These institutes are two of the top schools of engineering in France, both founding members of Institut Polytechnique de Paris.

The work will be located on their common campus: 19 place Marguerite Perey, 91120 Palaiseau.

Contacts

Pr. Cédric Ware (cedric.ware@telecom-paris.fr)

Dr. Mounia Lourdiane (mounia.lourdiane@telecom-sudparis.eu)