SNAP-driven Updates of Physical Layer to Improve Performances of Photonic Networks

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ABSTRACT
We use the Statistical Network Assessment Process (SNAP) to derive physical layer upgrade strategies for topological weaknesses in a German topology. Given a target blocking probability, we evaluate the effectiveness of selective introduction of hybrid amplification and SDM fibers, showing up to 60% increase in capacity.

MOTIVATIONS
- In the next 5 years, global IP traffic over internet will grow 3 times, mostly driven by internet video, which is expected to grow 4 times in 5 years.
- At the same time, operators revenues are not following the same path, and since the beginning of the so-called data-era we are assisting to a decoupling of revenues from carried traffic.

- In this complex scenario, the design and the upgrade strategies must be carefully planned in order to sustain the growth of the traffic while maximizing the return over the investment over the installed equipment.
- To do so, given an optical network and the set of physical layer technologies (fibers, amplifiers, transceivers, etc.) that are already installed or are going to be installed in it, telecom operators must be able to answer to question like:
  - Which are the most critical sections of the network?
  - What section of the network should be upgraded?
  - Which physical layer technology should be used?

RESULTS
- We consider a German topology made of 17 nodes and 26 links, and we perform a progressive traffic loading analysis with 200G grooming size.
- We consider 10k Monte Carlo realizations.
- We evaluate blocking probability vs total allocated traffic.
- We assume:
  - Locally-Optimized-Globally-Optimized Settings (LOGO)
  - SMF fiber
  - 5 dB noise figure EDFA
  - 6 dB noise figure HFA
  - 16 dB node loss
  - QoS based routing metric
  - Kmax = 25

- SDM via fiber doubling yields largest improvement.
- 60% capacity increase with 11% upgrade of links.
- A better network utilization has been achieved.
- The process can be iterated to achieve further optimization.

SNAP

CONCLUSIONS
- The Statistical Network Assessment Process (SNAP) has been proposed as a methodology to highlight networking merits of physical layer technologies in reconfigurable transparent optical networks.
- SNAP outputs can be used to drive network design and upgrade strategies in a physical layer aware manner.
- SNAP has been used to derive the evolution of a Grade-of-Service metric as the blocking probability vs the total allocated network traffic.
- Observing link saturation heat maps, topologies striking features and bottlenecks have been observed.
- Based on them, physical layer upgrade strategies have been proposed and tested through SNAP.
- We showed that selectively placing Hybrid Erbium/Raman Amplifiers in underutilized网络 links, and fiber doubling saturated links allow to increase the average allocated network traffic for a given BP/QoS level up to 60%.

BIBLIOGRAPHY