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

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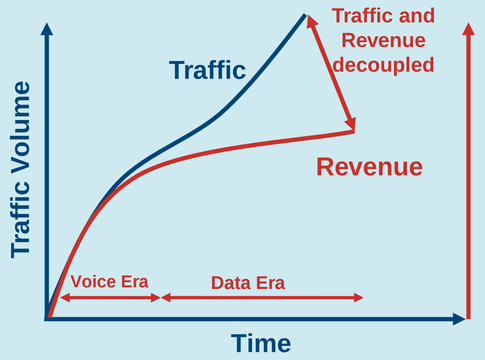
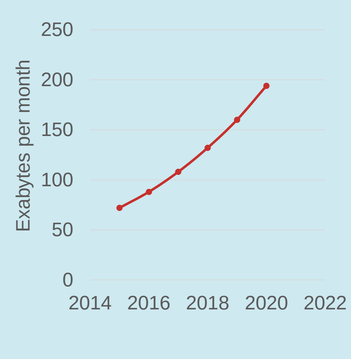
ABSTRACT

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

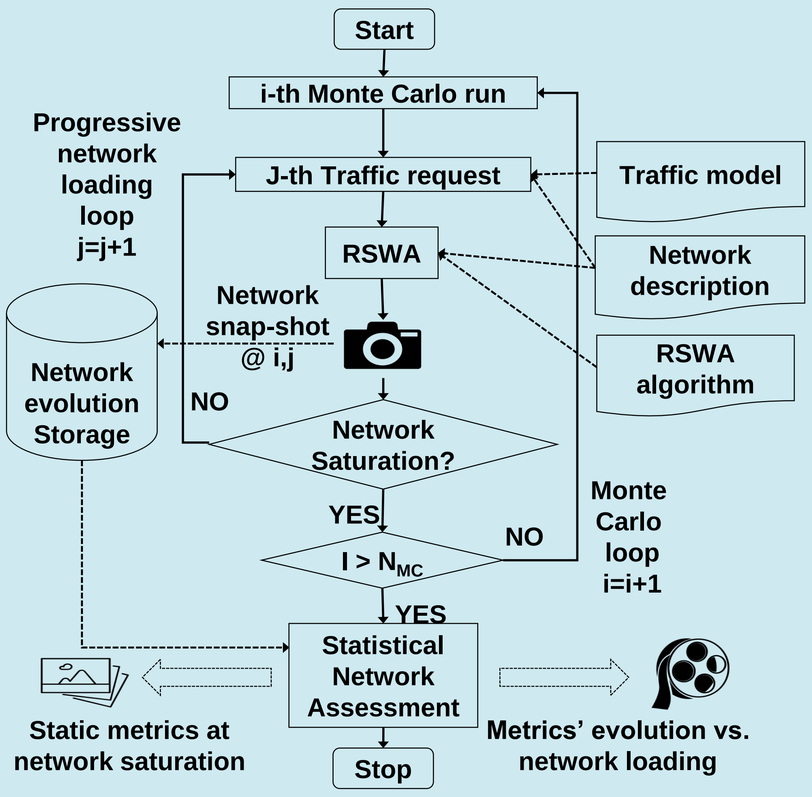
- In the next **5 years**, global IP traffic over internet will grow **3 times**, mostly driven by internet video, which is expected to grow 4 times in 5 years.
- At the same time **operators revenues are not following the same path,** and since the beginning of the so-called data-era we are assisting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





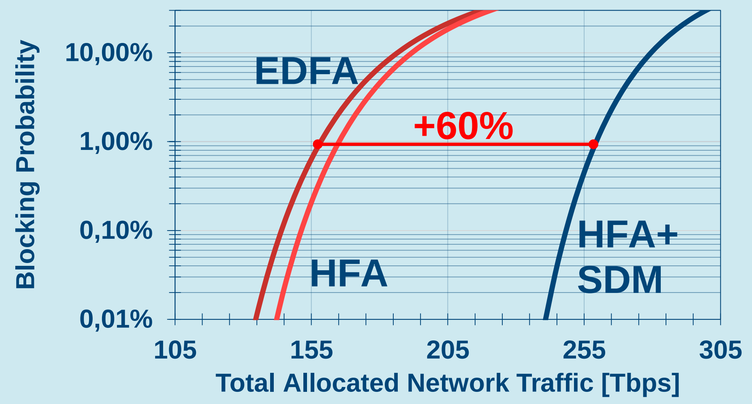
- In this complex scenario, the design and the upgrade strategies must be carefully planned in order **to sustain the growth of the traffic while maximize the return over the investment** over the installed equipment.
- To do so, given an optical network and the set of **physical layer technologies** (**fibers, amplifiers, transceivers,** etc.) that 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?

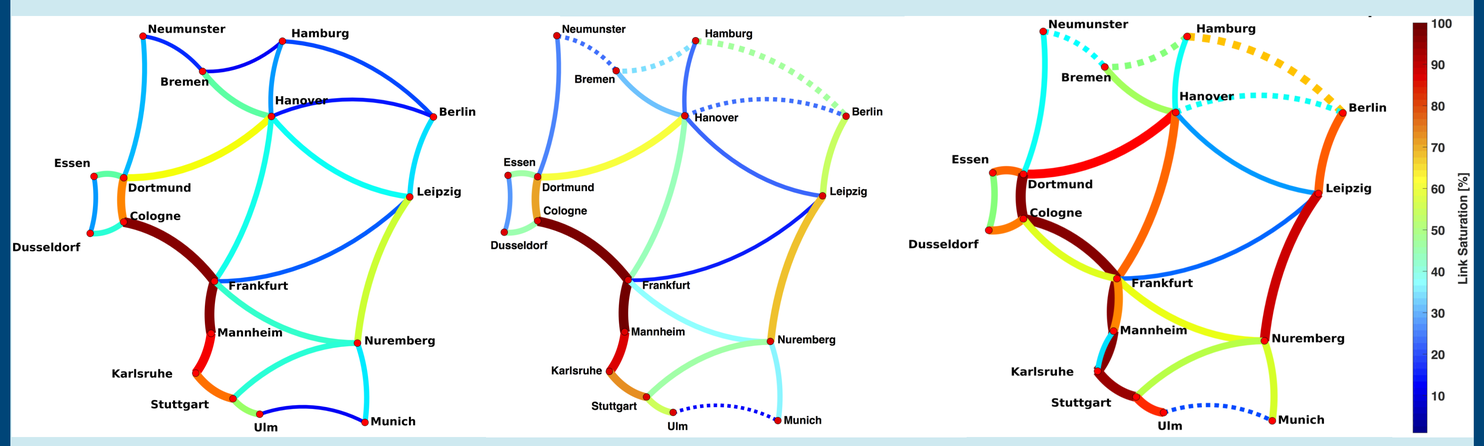
SNAP



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**s
  - **0 dB** noise figure **HFA**s
  - **18 dB** node loss
  - **QoT 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

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 metri**c 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 network links, and **fiber doubling** saturated links allow to **increase the average allocated network traffic for a given BP/QoS level up to 60%**.

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