Post-Doctorate Position: Performance studies of optical switching technologies

The constant development of online data services such as peer to peer, audiovisual services and more recently social networks has resulted in an exponential growth of traffic in core networks. The trend will probably be true as well for the coming years with the generalization of de-linearized high definition audiovisual services (VOD, HDTV, 3D HDTV) and also driven by the development broadband access, through optical access or 4G mobile. This trend is clearly a challenge for networks of the future since they will have to face higher and higher capacity demands, with high constraints on reliability, flexibility still with low cost and energy consumption. Indeed many of today's research is focused indeed on solutions able to satisfy these constraints: virtualization, cloud computing, content delivery networks, information centric networking, …

Optical layer as a federating layer will of course be the basis for these next generation networks. Indeed with constant growth of traffic volumes in the core networks, the question of optical transmission systems capacity is a constant issue and progress in the domain have allowed to reach capacities of several tens of Terabit/s on a single fibre. Besides this evolution towards higher data rate, the constant "cost" actor has pushed for more transparency and optical bypass to save on transponders and transit in upper layers. This has been allowed by efficient reconfigurable optical add-drop multiplexers (ROADM).

The increase of channel rates however raises the question of channel use efficiency. It is probable that if the IP core network grows as today, the core part of the networks will have to support native 100Gbit/s demands between core IP routers. The traffic increase in the head routers in the IP hierarchy may then have to support hundreds of terabytes of traffic essentially for transit between the internet peers and the end users. The before mentioned evolutions may push for a different way of building the network, redistributing the traffic more evenly in the network. In such condition, the question will rise on the channel efficiency and a less energy consuming aggregation layer may then be required to fill the huge optical pipes efficiently in order to save on IP interfaces. With the contents migrating closer to the user and the increase of access rates, the metro networks may have to support more important traffic increase than core networks. And the question of aggregation will be even more crucial due to the role of this network segment (backhauling). The balance between transit and aggregation tips towards aggregation today because it is cheaper to efficiently fill one optical channel than to multiply direct links towards the head node of the collecting network. But the fact that this is realized thanks to systematic resort to electronics (packets or TDM switches) may considerably increase the energy consumption of the metropolitan part of the network.

In this context, the challenge for optical networks is to conciliate cost (to reduce the number of transponders and the number and size of equipments in general), capacity (to increase fiber capacity), flexibility (to allow fine granularity management), energy consumption (green IT).
Optical transparency and optical bypass already provide cost savings and reduced power consumption by saving on Optical to Electronic to Optical (OEO) conversions. Optical transparency is compatible with high channel rates and high capacity transmission solutions. But as it only deals with wavelength granularity its flexibility is reduced and high channel throughput is difficult to obtain without resorting to electronic grooming facilities. Sub-wavelength optical switching technologies

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may also offer this additional feature. A plethora of optical switching solutions have been proposed in the literature with different technologies and architectures ranging from point to point solutions fast optical circuit switching, optical flow / burst / label / packet switching, time driven switching, to multi-point solutions such as light-trails and multicast trees, …

The present research work aims at defining clear criterion and performances of the most promising solutions for different network context in order to benchmark them. The focus of the post-doc is primarily the evaluation of dynamic resource allocation mechanisms and possibly traffic engineering solutions within optical domains in the above described framework. Although a large body work exists related to the design of access protocols for WDM WAN networks, the question remains open. This question is currently under investigation within Orange Labs with the objective of proposing a solution technologically feasible (OBS, DOCS, hybrid), while striking an interesting compromise between efficiency, cost and flexibility.

The traffic granularity at which control and forwarding shall be performed is an open and challenging issue. In ICN, for instance, end-users request contents at the chunk level, corresponding to a typical IP packet. In contrast, optical networking (dynamic optical circuit switching and/or OBS) typically require longer transfer units for efficiency reasons. This may prove an important argument that needs to be taken into account.

The work is mostly design oriented and involves the development of evaluation models in the domain of stochastic modeling (analysis, simulations) and optimization techniques for planning issues taking into account the cost and energy dimensions. Knowledge of optical technologies would be appreciated.

The study will be part of corporate research activities and will also offer national and international collaborative framework, in particular with INRIA research laboratory and GreenTouch initiative.

Post-doctorate duration is 12 months in Lannion Orange Labs.

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