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ENERGY SAVING IN GREEN OPTICAL NETWORKS

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ABSTRACT

-In this paper, we present a simple on energy efficiency in IP-over-WDM networks with dynamic circuit capability and compare two different load adaptive schemes, referred to as switch-on and switch-off. While the switch-off technique was already proposed for energy conservation, the switch-on approach is a new paradigm which is based purely on one-time implementations of dynamic circuit capability. Our results show that both approaches can significantly reduce the power consumption and decrease the necessary totally installed capacity, but unlike the switch-off scheme, the switch-on scheme does not affect the path redundancy in the network. Furthermore, switch-on can reduce the number of routing reconfigurations required in the network. While this seems ideal, our results also show that the switch-on scheme uses a large number of small capacity interfaces which may not be suitable from a network planning perspective as it might require frequent capacity upgrades, which alone is an interesting avenue for future research.

Index Terms—Energy efficiency; IP-over-WDM;

1. INTRODUCTION

The energy consumption of backbone networks continue number of bandwidth intensive applications such as video conferencing and high definition IPTV. There is an additional concern of heat dissipation from the limited locations in the backbone network which deals with energy consumption. Recently significant research has been carried out to reduce the energy consumption of IP over WDM backbone networks. This paper considers an Optical Burst Switching networks. The IP over WDM backbone network layer and the optical layer. The IP layer is responsible for the aggregation of data traffic from low end.The optical layer helps the IP routers to communicate with each other. Physical fibre links containing multiple fibres are used to interconnect optical switch nodes. Wavelengths travelling through each fibre undergo help transmit data. In order to maintain the signal quality in long distance transmissions.

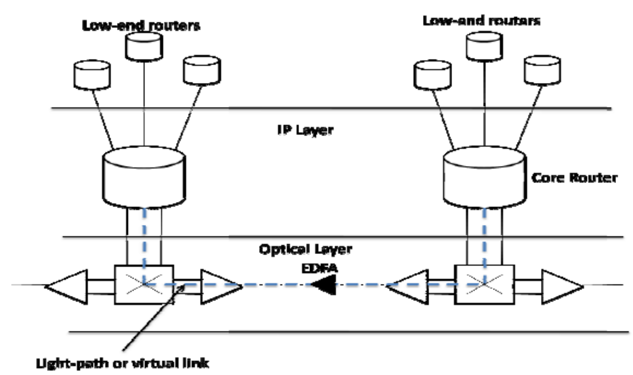

Figure 1 IP over WDM optical network

It is clear that a router port is the most energy consuming component in a node. Therefore switching component in the network. In this work we propose a dynamic sleep cycle where wavelengths and therefore routers are switched on and off dynamically, according the network status the burst dropping probability and traffic load on different links are monitored. According to the required QoS level, a burst dropping probability threshold is set. The higher the dropping probability the overall burst dropping probability is less than a certain threshold, the M links with the lowest load are selected to switch off half of their wavelengths. On the other hand, if the network dropping probability continues to increase with the rising arch valleys . When the load is low, it is theoretically possible to concentrate all the data traffic over a small subset of the links and devices, allowing the others to enter a power saving mode. Besides energy savings, this strategy, called "resource consolidation, needs to preserve the network connectivity and quality of service (e.g., ensuring a minimum path diversity, limiting the maximum link utilization, etc. However there is no satisfactory definition of the criticality of nodes in a network. aspects, such as between centrality, degree, closeness, eigenvectors.

2. MOTIVATIONS AND OBJECTIVES

Save energy Consciousness of environmental problems tied to Green- House Gases (GHG) increased during the recent years. All around the world, various studies started highlighting the devastating effects of massive GHG emissions and their consequences on the climate change. According to a report published by the European Union [1], a decrease in emission volume of 15%–30% is required before year 2020 to keep the global temperature increase below 2_C. GHG effects are not limited to the environment, though. Their influence on economy have also been investigated and their financial damage has been put in perspective with the potential economical benefits that would follow GHG reduction .In particular, projected that a 1/3 reduction of the GHG emissions may generate an economical benefit higher than the investment required to reach this goal. Political powers are also seeking to build a momentum around a greener industry, both in the perspective of enforcing a sustainable long-term development, and as a possible economic upturn factor on a shorter perspective. GHG reduction objectives involve many industry branches, including the Information and Communication Technology (ICT) sector, especially considering the penetration of these technologies in everyday life. Indeed, the volume of CO2 emissions produced by the ICT sector alone has been estimated to an approximate 2% of the total man-made emissions in . This figure is similar to the one exhibited by the global airline industry, but with higher increase perspectives. Moreover, when considering only developed countries such as the United Kingdom, this figure rises up to 10% . As the precise evaluation of these numbers is a difficult process, these projections are likely neither entirely accurate, nor up-to-date. Nevertheless, these studies all agree on the fact that ICT represents an important source of energy consumption and GHG emissions. Even if the incentives are still not clear (e.g., in term of regulations), there seems to be a clear innovation opportunity in making network devices and protocols aware of the energy they consume, so that they can make efficient and responsible (or "green") decisions.

3. ENERGY SAVING AND QOS

We have relatively compared different ranking strategies, and have evaluated their efficiency in reducing energy consumption. However, the energy saving objective shall affect neither the offered QoS, nor the network robustness. Yet, the greedy switch-off approaches considered so far tend to leave little space to redundancy, and even less means to control the redundancy level. An alternative option to control redundancy is to stop the process when reaching a preconfigured target maximum number of switched off nodes, selected by scanning the whole list if necessary.

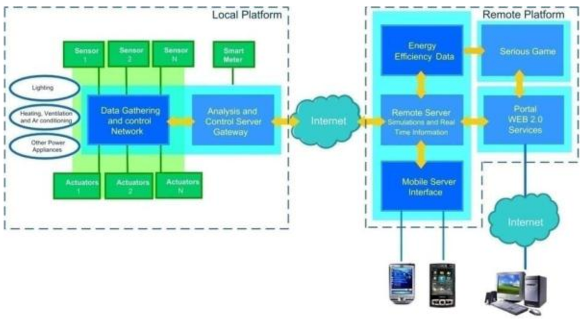

Figure 2 SAVE ENERGY Architecture

From a user perspective, the most important components in this architecture are the sensors and the client applications. The sensors will be placed in the pilots and the data measured by these sensors will in the end be presented using a serious game, web-portal, mobile application or a screen on a wall to the users. indicator of the QoS offered by the network. A maximum link load, denoted by _ hereafter, is imposed, as common practice in ISP networks, as minimum QoS guarantee. In order to evaluate the network energy consumption, we use here the energy model of as it is representative for actual current network devices. In this model, each IP link consumes an amount of power corresponding to a pair of transponders and a pair of IP interface ports. Each 10 Gbps transponder consumes 37W and each 1 Gbps port consumes 10W.

Energy consumption of a router port	1000 W
Energy consumption of an optical switch	85 W
Energy consumption of a multiplexer or a de-multiplexer using renewable energy	16 W
Energy consumption of a transponder	73 W
Electricity energy consumption of an EDFA	8 W

We simulated the effect of the resource consolidation algorithm presented above on both scenarios.

4. PERFORMANCE EVALUATION

For the purpose of this evaluation, the NSF net topology was used as both the basic IP topology and the transport network topology.

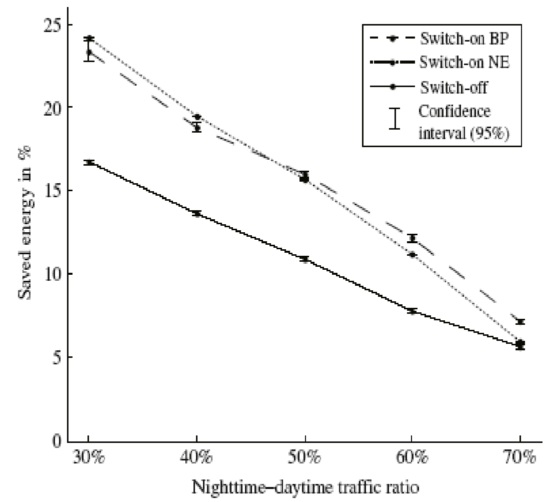

Figure 3 Energy saved for each scheme depends upon traffic ratio.

The IP network port granularities and their normalized power consumption, as well as the power consumption of optical transport circuits. The results show that considerable energy savings are always possible with load adaptive schemes and that they depend linearly on the off-peak/peak traffic ratio.

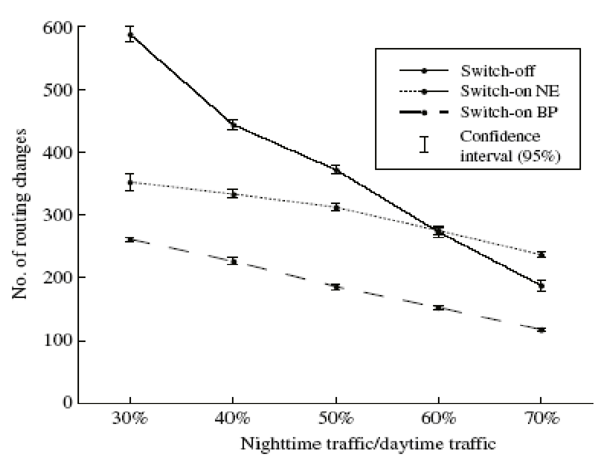

Figure 4 Fraction of flows that undergo rerouting during the transition from the peak to the off-peak time interval depends upon traffic ratio.

In other words, networks with a low difference between daytime and nighttime traffic do not benefit from load adaptive energy saving schemes as much as networks in which that difference is large. It can also be observed that both Switch-On schemes clearly outperform the Switch-Off scheme.

5. CONCLUSION

Although energy efficiency schemes can significantly reduce energy consumption, their impact on routing stability, degradation of quality of service, and network resilience have not been sufficiently studied to date. we believe that our study is an important contribution to the existing body of research on energy conservation, which typically does not consider the trade-offs relative to IP network routing stability, and network stability in general. Significant future research is ahead of us. Although we showed that both variants of the Switch-On schemes result in a reduced total network capacity, our approach requires a comparatively larger number of small capacity interfaces. Our future work will also include fast heuristics, which will allow us to study a wider range of network topologies and scenarios.

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