Green Model for Optical Networks

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**INTRODUCTION — POWER CONSUMPTION IS SKYROCKETING**

In the current Internet, the demand for bandwidth is increasing exponentially. ICT already accounts for 2 to 4% of the worldwide carbon emissions and by 2020 this share will double; projections indicate ICT will be the major power consumer by 2025. This growth rates are unsustainable and hinder economies based on know-how societies.

**THEORY — INNOVATIVE IDEAS TO REDUCE POWER CONSUMPTION**

All wireless and wired networks (i.e. WiFi, ADSL...) work over core network, which are large point to point optical connections - a core network is the central part of the telecom hierarchy and interconnects large cities. A core network has an oscillating traffic during day and night. At night, traffic may be even less than 10% of day traffic, whereby we are wasting resources and causing unnecessary power consumption. I propose to implement the following innovative ideas to decrease power consumption in low traffic demand periods:

- Enabling optical bypass, avoiding wasteful processing in intermediate nodes.
- Turning off underused linecards and rerouting the traffic to running links.
- Rerouting traffic powering off links with sparsely used optical amplifiers.
- Sharing optical amplifiers among channels.

**METHODS — FROM ONE IDEA TO ONE RESULT**

First of all, I designed a theoretical ring-mesh model which serves as a solid basis to study different topologies – the model is compatible with standard growth, redundancy protection and over subscription features. This model was tested with network traffic and its performance measured in term of power consumption. Relative savings of 28%, are achieved confirming our approach is tackling the issue in the right direction. I then extended the study to a commercial network - the Deutsche Telekom Network core system [Figure 1], which contains the Hamburg hub connecting Denmark with continental Europe. I ran the developed routing model with the Dijkstra algorithm, and considered the previous power consumption savers.

**RESULTS — SAVING MORE THAN 50% POWER CONSUMPTION**

I observed that in low traffic demand scenarios some links could be turned off and optical amplifiers pooled by different channels. Permuting among different scenarios, I observed that in low demand scenarios savings of 43% may be reached for the whole network and savings of 51% for a particular communication between two nodes.

**CONCLUSION — SAVING ENERGY AND MONEY**

The designed model could have an impact that leads to save around 34 million dkk per year.

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**Digital Control in Piezotransformer-based Converters**

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**INTRODUCTION**

Converters are today used in nearly all electronics from battery management in cell phones and laptops to fuel cell supplies to supply in a car. The demand for smaller and more efficient converters are increasing as the trend of electronics in general is going towards smaller size and larger processing power. In the struggle to obtain smaller converters, the switching frequency of the converters should be increased, resulting in high switching losses. To decrease these switching losses, resonance converters have been a popular choice to obtain zero voltage switching leading to great improvement in the efficiency while still maintaining small converter sizes.

In resonance converters piezoelectric transformers (PTs) have proven very useful as 1 PT can replace both magnetic transformer and resonance circuit leading to magnetic-less converters with a 4 times higher power density while still maintaining high efficiency. Ultimately, this leads to converter designs where efficiency is high and where component count and use of metals are low.

**BACKGROUND**

PT-based converters offer benefits such as electric isolation, less risk of fire, low noise, high power density, thin structure and the option to leave out bulky and expensive magnetics.

One of the greatest challenges when using magnetic-less, PT-based converters are control of the converter, which often demands many components in order to achieve good performance. This project has investigated the demands and simulated the performance of a digitally controlled converter.

**RESULTS**

The results have proven to show that control of PT-based converters can be done using digital control with close to equal performance. This is evaluated to increase flexibility of the converter use and decrease the component count – leading to even greater reduction in size and material use while still maintaining high efficiency.