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Press release

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Making the internet more energy efficient through systemic optimisation

Researchers at Chalmers University of Technology, Sweden, recently completed a 5-year research project looking at how to make fibre optic communications systems more energy efficient. Among their proposals are smart, error-correcting data chip circuits, which they refined to be 10 times less energy consumptive. The project has yielded several scientific articles, in publications including Nature Communications.

Streaming films and music, scrolling through social media, and using cloud-based storage services are everyday activities now. But to accommodate this digital lifestyle, a huge amount of data needs to be transmitted through fibre optic cables – and that amount is increasing at an almost unimaginable rate, consuming an enormous amount of electricity.

This is completely unsustainable – at the current rate of increase, if no energy efficiency gains were made, within ten years the internet alone would consume more electricity than is currently generated worldwide. Electricity production cannot be increased at the same rate without massively increasing the usage of fossil fuels for electricity generation, in turn leading to a significant increase in carbon dioxide emissions.

“The challenge lies in meeting that inevitable demand for capacity and performance, while keeping costs at a reasonable level and minimising the environmental impacts,” says Peter Andrekson, Professor of Photonics at the Department of Microtechnology and Nanoscience at Chalmers.

Peter Andrekson was the leader of the 5-year research project ‘Energy-efficient optical fibre communication’, which has contributed significant advances to the field.
In the early phase of the project, the Chalmers researchers identified the biggest energy drains in today’s fibre optic systems. With this knowledge, they then designed and built a concept for a system for data transmission which consumes as little energy as possible. Optimising the components of the system against each other results in significant energy savings.

Currently, some of the most energy-intensive components are error-correction data chips, which are used in optical systems to compensate for noise and interference. The Chalmers researchers have now succeeded in designing these data chips with optimised circuits.
“Our measurements show that the energy consumption of our refined chips is around 10 times less than conventional error-correcting chips,” says Per Larsson-Edefors, Professor in Computer Engineering at the Department of Computer Science and Engineering at Chalmers.

At a systemic level, the researchers also demonstrated the advantages of using ‘optical frequency combs’ instead of having separate laser transmitters for each frequency channel. An optical frequency comb emits light at all wavelengths simultaneously, making the transmitter very frequency-stable. This makes reception of the signals much easier – and thus more energy efficient.

Energy savings can also be made through controlling fibre optic communications at the network level. By mathematically modelling the energy consumption in different network resources, data traffic can be controlled and directed so that the resources are utilised optimally. This is especially valuable if traffic varies over time, as is the case in most networks. For this, the researchers developed an optimisation algorithm which can reduce network energy consumption by up to 70%.

The recipe for these successes has been the broad approach of the project, with scientists from three different research areas collaborating to find the most energy-saving overall solution possible, without sacrificing system performance.

These research breakthroughs offer great potential for making the internet of the future considerably more energy-efficient. Several scientific articles have been published in the three research disciplines of optical hardware, electronics systems and communication networks.

“Improving the energy efficiency of data transmission requires multidisciplinary competence. The challenges lie at the meeting points between optical hardware, communications science, electronic engineering and more. That’s why this project has been so successful” says Erik Agrell, Professor in Communications Systems at the Department of Electrical Engineering at Chalmers.

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Original publication:

Energy-Efficient High-Throughput VLSI Architectures for Product-Like Codes in the Journal of Lightwave Technology
Phase-coherent lightwave communications with frequency combs, in the journal Nature Communications
Joint power-efficient traffic shaping and service provisioning for metro elastic optical networks, in the journal IEEE/OSA Journal of Optical Communications and Networking,