ADDAPT

Adaptive Data and Power Aware Transceivers for Optical Communications

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Instrument: STREP

Contact
Coordinator:
Prof. Frank ELLINGER
Tel: +49 351 463 38735
Frank.Ellinger@tu-dresden.de
Operational manager:
Dr. Ronny HENKER
Tel: +49 351 463 33084
ronny.henker@tu-dresden.de

Affiliation and Address:
Chair for Circuit Design and Network Theory, Dresden University of Technology, Barkhausenbau 119, Helmholtzstrasse 18, D-01069 Dresden, GERMANY
Fax: +49 351 463 38736

Web site:
www.addapt-fp7.eu

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Project Partners:
- Technische Universität Dresden (TUD), DE
- IBM Research GmbH (IBM),CH
- VI Systems GmbH (VIS), DE
- Argotech as (AT), CZ
- Politechnika Warszawska/ Warsaw University of Technology (WUT), PL
- Compound Semiconductor Technologies (CSTG), GB
- PrimeTel PLC (PTL), CY
- TE Connectivity (TE), NL

Vision, Aim & Results

Existing optical networks are driven by dynamic user demands but operate statically at their maximum performance and do not offer much adaptability. Thus the links are not energy-efficient. ADDAPT aims at the development and technology take-up of dynamic transceiver subsystems. By implementing performance and power adaptivity from system down to optical device, electrical circuit and transistor level, flexible energy-efficient optical transmission links are enabled which pave the way for massive reductions of CO_2 emission and costs.

The concept of ADDAPT is shown in Fig. 1. Depending on the actual data load, the number of activated link paths and individual device parameters like bandwidth, clock rate, modulation format and gain are adapted to enable lowering the supply power. Several control types are investigated: cognitive adaption based on predetermined or time averaged loads and real-time adaption. Driven by control units including smart algorithms, the devices can be tuned from 7 to 56 Gb/s. Novel adaptive directly modulated lasers and photodetectors designed for near-field light coupling are developed to allow self-aligned low-cost waveguide assemblies with minimum optical power losses. Laser bandwidths beyond 30 GHz and power consumption can be traded off and controlled by driver circuits. Circuits such as amplifiers, drivers and clock data recoveries are designed in energy-efficient 14 nm CMOS and can be adjusted via current sources, dc/dc converters and switches. High-speed, low-loss packaging solutions using glass or ceramics are developed. An optical communication platform tailored for data centers is designed with 4 link paths and 10 m link distance for verification of speed adaption from 0.224 Tb/s to 7 Gb/s with power saving factors of up to 7.

ADDAPT is market and standard driven and combines the complementary competences of 3 large companies, 3 SMEs and 2 universities including device manufacturers, suppliers of communication equipment and network operators. Involved EU and associated countries are the Netherlands, Czech Republic, Poland, United Kingdom, Cyprus, Switzerland and Germany.
By the end of ADDAPT the fastest and most energy efficient VCSEL-based fully CMOS NRZ optical link was developed with world record switching time and unique adaptive tuning. All components, which are developed in ADDAPT, show advances beyond the state of the art. The complete system link achieves error-free performance at 40 Gb/s with energy-efficient 4 pJ/bit and unique adaptive features like rapid on/off switching below 10 ns as well as dynamic bandwidth and power scaling which enable power

savings up to 80 %. The results in several world records at the time of it finalization:

- Fastest CMOS optical receiver (64 Gb/s)
- Fastest CMOS optical receiver with CDR (60 Gb/s)
- Lowest power optical receiver above 32 Gb/s
- Fastest CMOS optical transmitter (45 Gb/s)
- Fastest VCSEL-based NRZ CMOS link today (40 Gb/s)
- Lowest VCSEL link power consumption above 32 Gb/s (4 pJ/bit)
- CMOS RX showing sensitivity on par with SiGe (around -9 dBm OMA)
- Fastest rapid turn-on delay: 7 ns
- Highest HF package bandwidth applied with wire bonding (70 GHz)

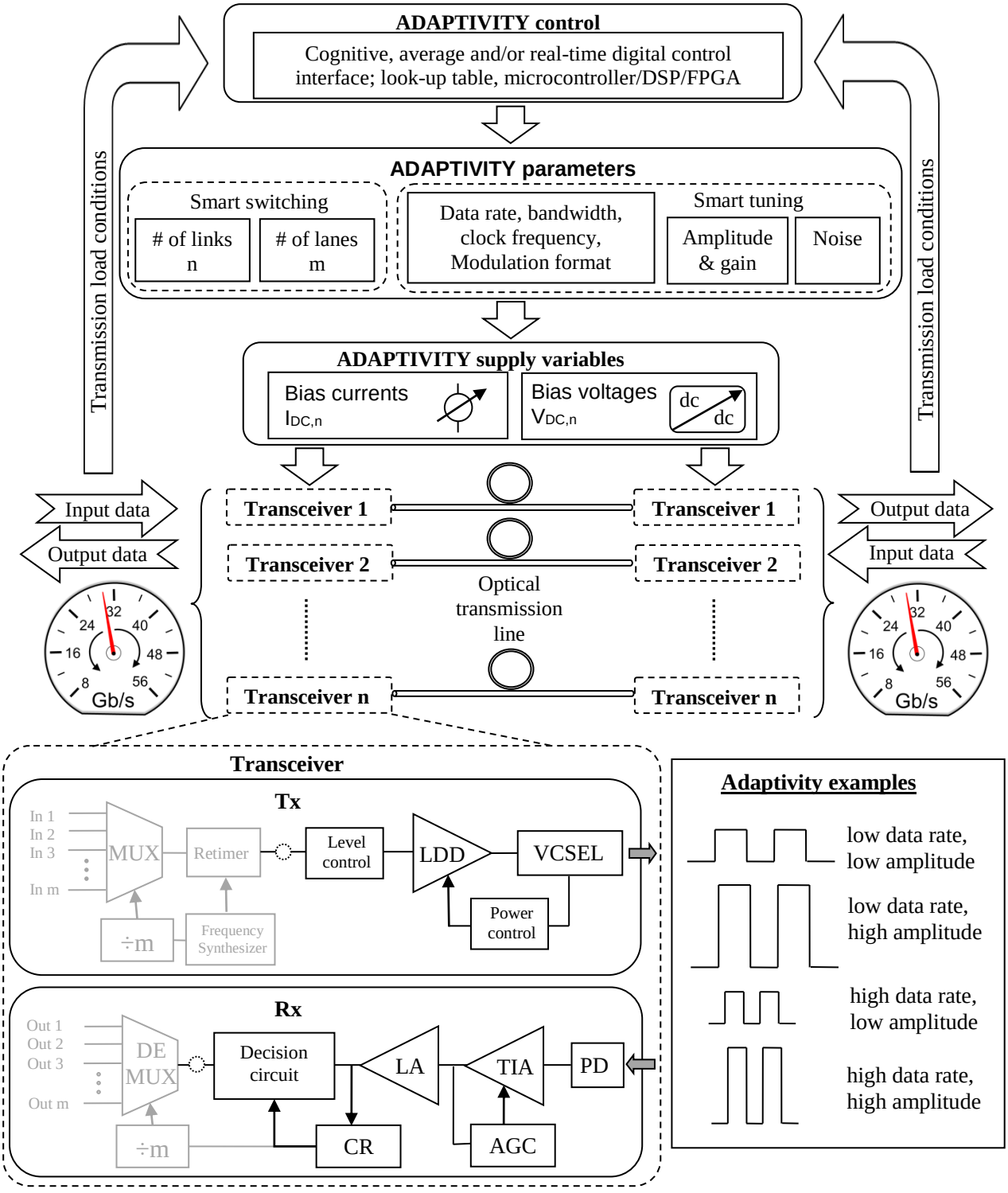

Figure 1: ADDAPT concept