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Research results of the DESI project

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Project summary

Project title:	DESI - End-to-End Energy-Sensitive ICT Production
BMWi code:	01 ME11013A
Term:	01/06/2011 to 30/11/2014
Consortium:	Deutsche Telekom AG / Telekom Innovation Laboratories
	Alcatel-Lucent Deutschland AG
	Cisco Systems (JouleX GmbH when the project started)
	Konrad Zuse Centre for Information Technology Berlin
	Power and Air Condition Solution Management GmbH & Co. KG
Project director:	Dr. Heiko Lehmann, Deutsche Telekom AG
Website:	www.desi-it2green.de

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Research topics

The DESI project has three main areas:

- Load-dependent operation of individual hardware elements: Measurement of power consumption and implementation of power management of individual network elements (such as routers)
- Load-dependent operation of the telecommunications network: The supply chain of ICT services is integrated across all elements under the conditions of stable and quality-assured network operations
- Controllability of individual consumers: A unified control system for ICT elements and energy storage is developed and implemented as an example

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Energy demand analysis for OTN switches

The power consumption of the Alcatel-Lucent OTN switches 1830 PSS-64 and 1830 PSS-36 was analysed

- These network elements transfer 3.8 terabit/s and have power consumption of 2.1 W per Gbit/s. This means they are already among the most energy-efficient products in their class
- However: In full load operation, the 1830 PSS-64 must dissipate the heat output of 11.5 kW over an area of just 0.15 m². This creates significant cooling and space requirements, since only every 9th rack can be fitted

Conclusion:

- Sharply rising power density in network elements due to ongoing miniaturisation of integrated circuits
- Load-adaptive operation and cooling optimisation are still technical requirements and also have substantial potential for energy savings

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Power consumption optimisation with OTN switches

Optimisation of the fan control temperature through capacity-related adjustment of the fan speed:

- (Savings per configuration 50–300 watts)

Sleep mode on I/O cards:

- Almost 100% savings through low-power mode
- However, it must be ensured that the module software can be operational again with sufficient speed

Sleep mode for optical ports on I/O cards:

- Very complex design and architectural proposals for energy conservation for future generations of products have been developed in the project

Sleep mode for port groups on I/O cards:

- Power Save mode (powering off) for port groups through hardware extensions
- Approx. 20 watt savings per port group on the demonstrator

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Power consumption optimisation with OTN switches

Adaptive voltage scaling for switching ASICs:

- Reduction of leakage current with high transistor density by adaptive voltage adjustment (voltage scaling / undervolting)

Energy-saving modes on embedded control processors:

- Finding: Large differences with different processor architectures (Intel, PowerPC, ARM)
- Measures make sense for central processors with greater processing power on which control software is operated, for example
- Embedding the control processor power management into existing software modules (Linux CPU freq driver)

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Energy efficiency through optical bypasses

- Through a telecommunications network topology optimised with optical bypasses, cost and energy savings of up to 50% could be achieved
- In order to limit the IP transit traffic in transit routers, dynamic use is made of direct router-to-router connections in the optical network, so-called optical bypasses, which achieve savings in two ways:
  1. Due to the average reduction in expensive router ports
  2. Through the use of the energy-efficient optical transport network (OTN)

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Control of load-adaptive operation

Development of a demonstrator for continuous control of all network elements, in particular for the shutdown of selected network elements during the night:

- A network element energy-optimised on the module, system and network level, including certification
- Activation of storage capacity in the UPS of the telecommunications network using an ICT system (production grade)
- The WAN communication-enabled local Power Efficiency Management solution, applied to local area networks
- New energy consumption models in ICT networks, computation of optimal dynamic configurations

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Calculation of potential savings

A hierarchical network model was developed for Germany, and the energy requirements of the individual network levels and potential savings through load-adaptive mode were calculated:

- End-user networks: 42,000 GWh annually about 30% savings possible
- Access networks: 800 GWh annually about 20% savings possible
- Aggregation networks: 260 GWh annually about 2% savings possible
- Core networks: 120 GWh annually about 20% savings possible

The energy savings are achieved in particular by reducing the electricity needs of approximately 40% of all telecom network nodes, especially from midnight to approx. 9 AM.

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Making use of the results

In the short term:

- Product range of network elements: Energy-optimised 1830 PSS-36 and 1830 PSS-64 systems are commercially available
- Product range Power Efficiency Management solution: Use of the existing solution in the service provider network area, incl. specific extensions from the cloud
- Roll-out of selected derivatives of the DESI storage controller: Peak demand management, network fee reduction
- Various standardisations in the area of “load-dependent operation”

In the medium term:

- Energy savings through load-dependent network operation in approx. 8 years
- Joint optimisation and control of WDM/OTN and IP networks is still difficult (Software Defined Networking promises a solution here)

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Patents and publications

- 7 patents
- 15 national and international scientific publications
- 2 contributions to standardisation:
  - Draft of ETSI EN 300 119-6: Engineering requirements for harmonized racks and cabinets with extended features
  - Draft of ETSI EN 300 119-7: Engineering requirements for subracks in harmonized racks and cabinets with extended features

Presentations:

- Bell Labs Open Day, Stuttgart, November 2012 (DESI-DECORE part demonstrator I/O cards Port Group Power Save)
- CeBIT, Hanover, March 2014 (DESI overall demonstrator)
- Bell Labs Future X Days, November 2014