

ADDAPT

Adaptive Data and Power Aware
Transceivers for Optical Communications

Project overview

23.01.2014

www.addapt-fp7.eu





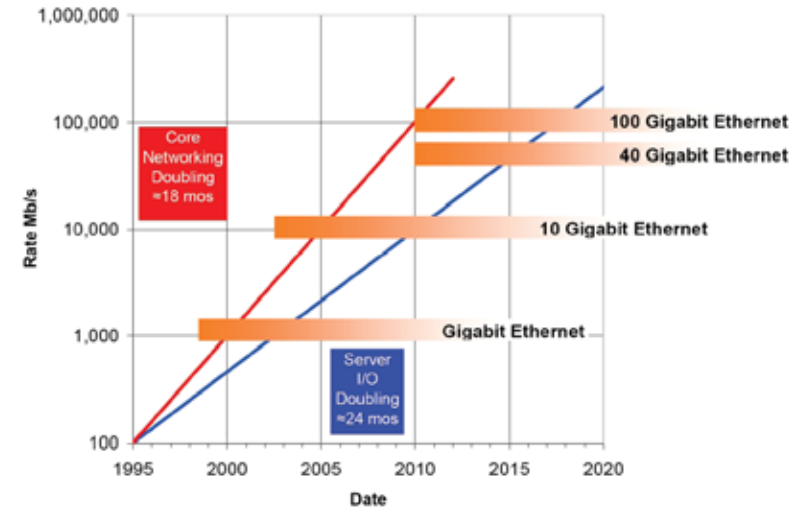
- Ø Project facts
- Ø Motivation & vision
- Ø Concept
- Ø Main objectives
- Ø Participants, structure & key tasks
- Ø Project organization
- Ø Application & impact
- Ø Conclusions
- Ø Contacts & information



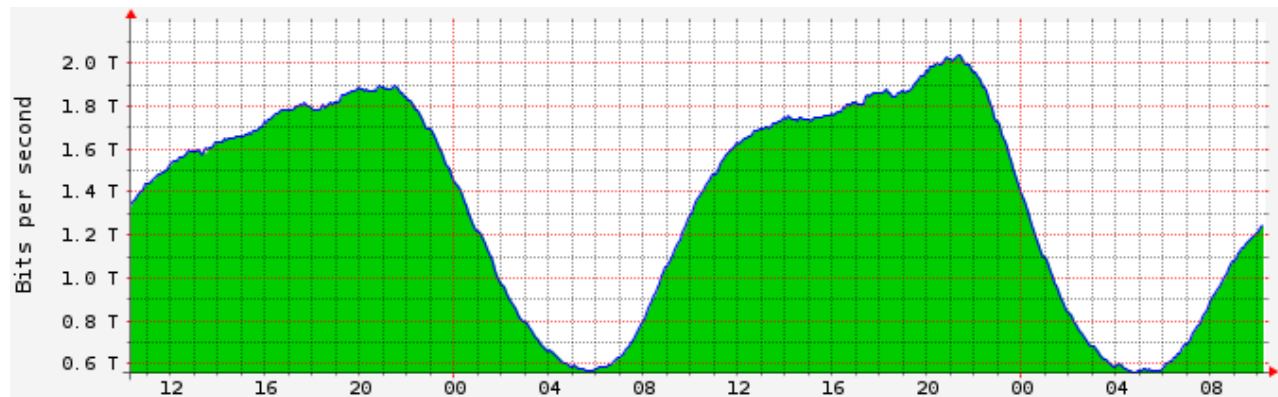
- Ø Project reference: 619197
- Ø Instrument: STREP
- Ø Start Date: 01/11/2013
- Ø Duration: 42 months
- Ø End Date: 30/04/2017
- Ø Overall Budget: 4 775 856 EUR
- Ø Overall EC funding: 3 138 508 EUR



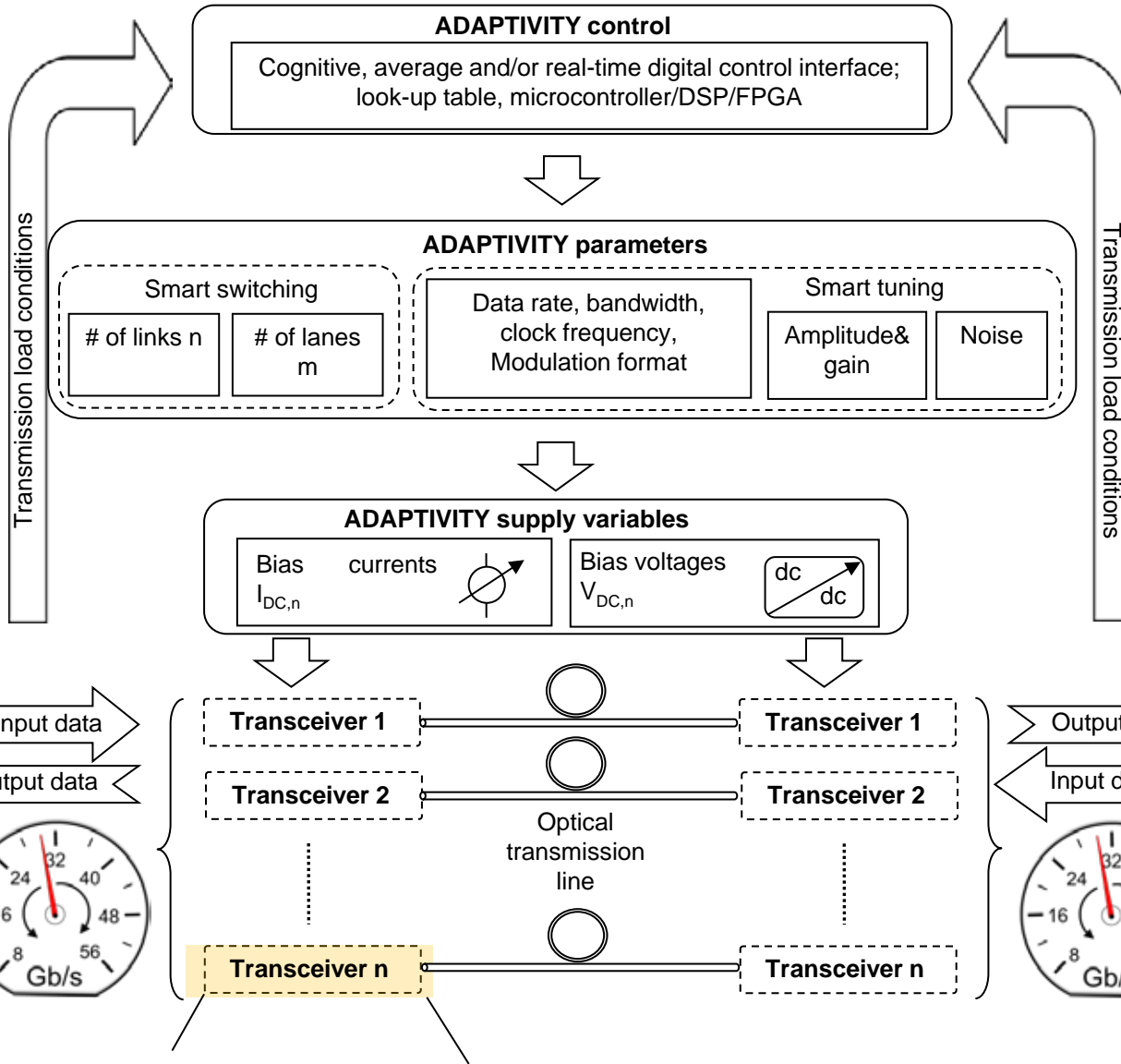
- ∅ I/O outlook:
 - higher performance request
 - reduction of power consumption and higher energy-efficiency necessary
- ∅ State of the art: optical links almost **not flexible, adaptive and reconfigurable**
- ∅ ADDAPT: First **adaptive optical components and modules with bandwidths up to 40 GHz and low power consumption**



Ledentsov et al., Proc. SPIE, vol. 7597, 2010



Aggregated traffic on all connected networks ports of Amsterdam Internet Exchange; www.ams-ix.net/statistics/, March 2013



Smart switching:

12 links to 56 Gb/s each
à 0.672 Tb/s

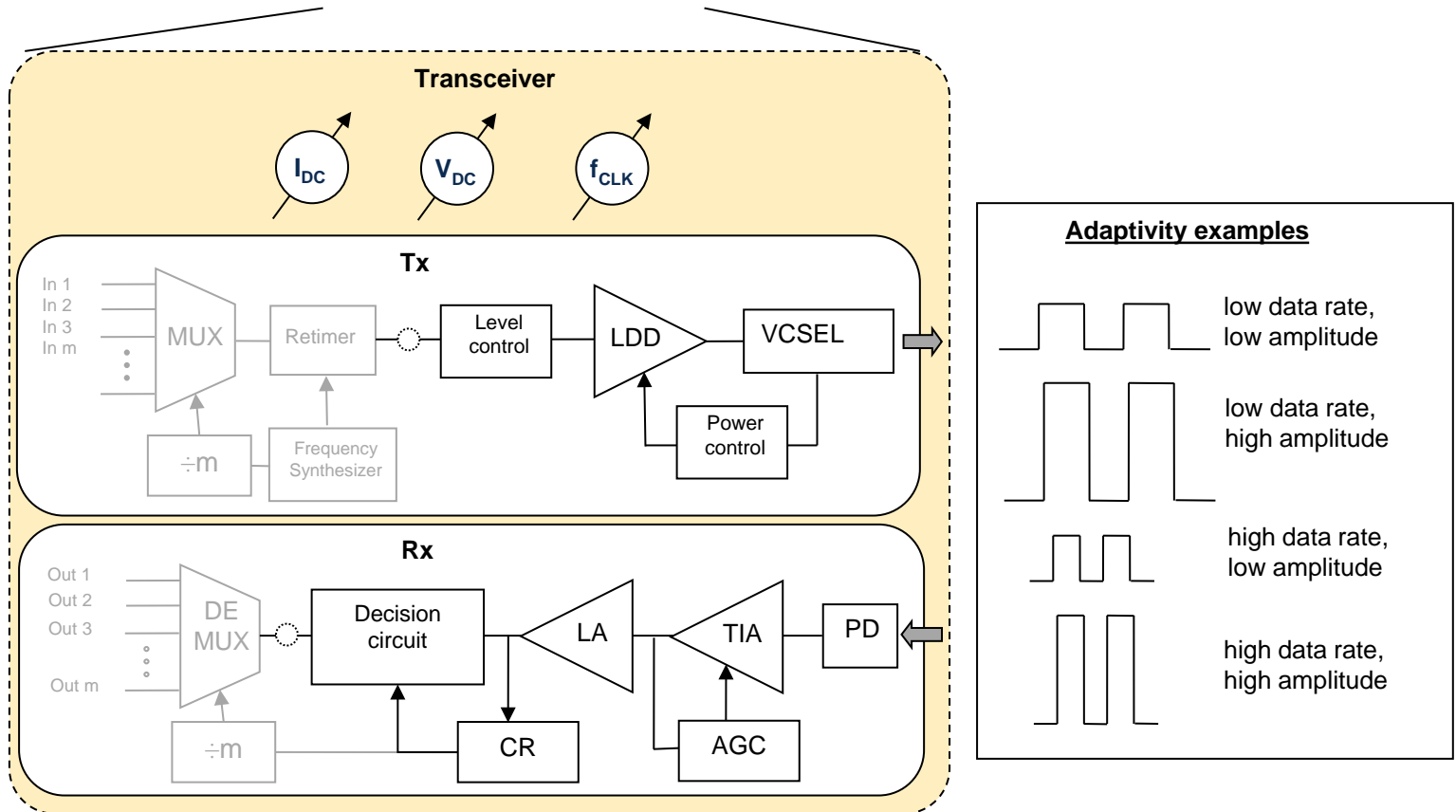
Power saving factor = 0.8
x (total #links/activated
#links)

à **1 active link ≈ power saving factor of 10**

Smart tuning:

8-56 Gb/s à 50 %
power saving expected

⊖ max. power saving factor of 20



- ∅ Design of adaptive high-speed energy-efficient transceiver system module including laser and photodiodes, driving and amplifying ICs, clock- and data recovery, adaptivity control
- ∅ Accompanied by assembling and packaging techniques
- ∅ Consideration of user/market, network and standardization aspects



Adaptivity:

- ∅ Power saving factor based on **smart switching** up to 10 for a link with 12 paths
- ∅ Power saving factor based on **smart tuning** up to 2 for the analog/mixed signal components (including VCSEL)
- ∅ Combined **power saving factor up to 20** by data rate scaling 0.672Tb/s - 8Gb/s

Optics:

- ∅ Low-cost **VCSEL** with **near-field coupling** for up to **56 Gb/s**, only 5 mA average bias current → Modulation power savings $\geq 50\%$ at minimum data rates (8 Gb/s)
- ∅ Low-cost **PD** with near-field coupling, **56 Gb/s**, $>90\%$ coupling efficiency, 0.6 A/W sensitivity

ICs:

- ∅ Reduction of energy consumption per bit including TIA, LDD and CDR by at least 30% using advanced **32 nm CMOS**
- ∅ High speed **up to 56 Gb/s**
- ∅ Goal is **~ 2 pJ/bit at 56 Gb/s** (dependent on the application)

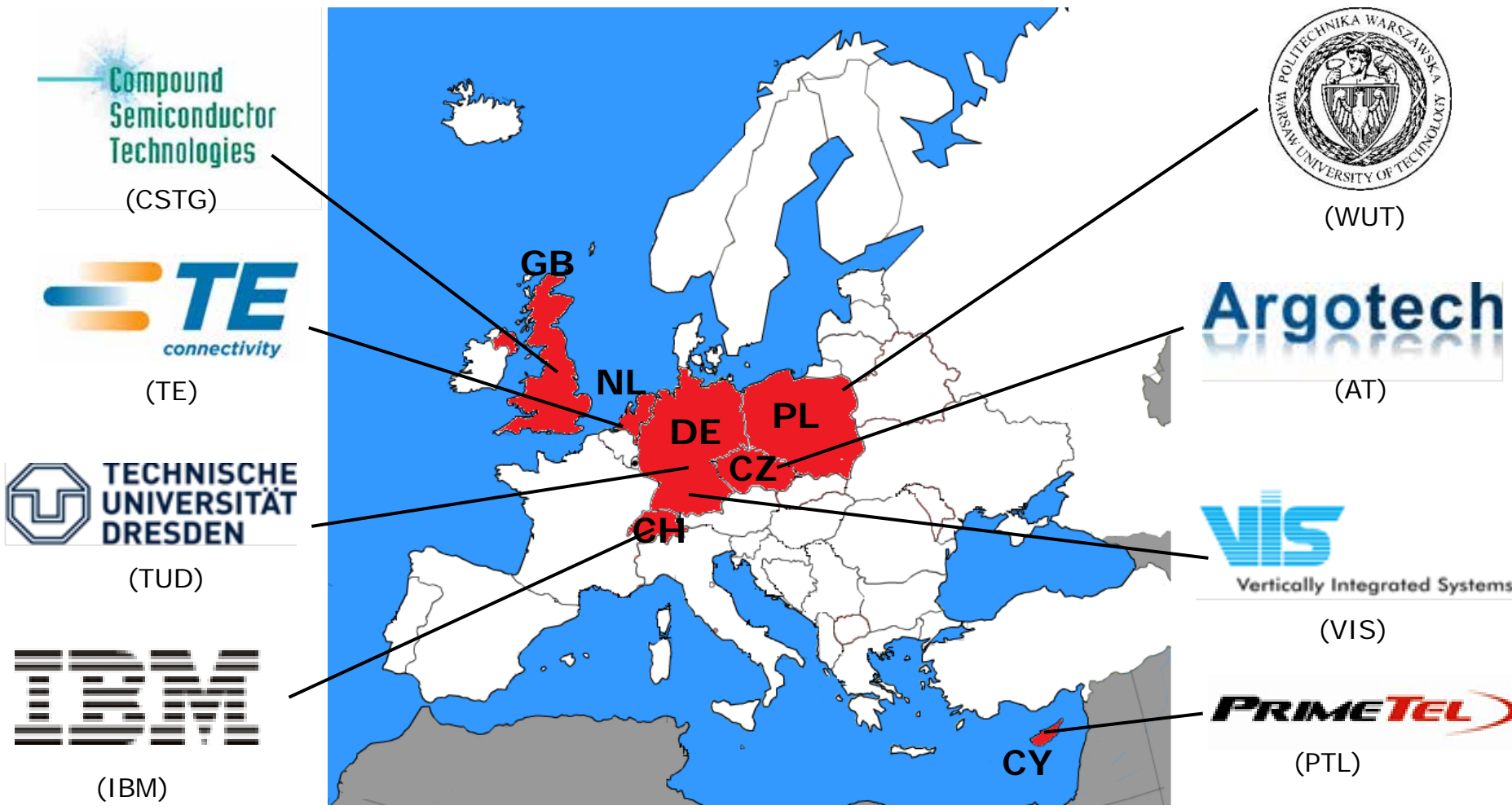
Packaging/Assembling:

- ∅ Capable of **data rates up to 56 Gb/s**
- ∅ Enable **small pitch sizes**
- ∅ Verification platform of **12 links for up to 0.672 Tb/s** and ≤ 10 m length

ADDAPT Participants, structure & key tasks (1)


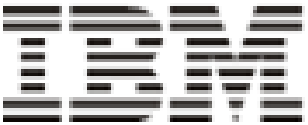








- Ø 6 EU member + 1 EU associated countries; 3 SMEs, 2 Universities and 3 large companies
- Ø Device designers and manufacturers, equipment supplier, network provider, R&D oriented

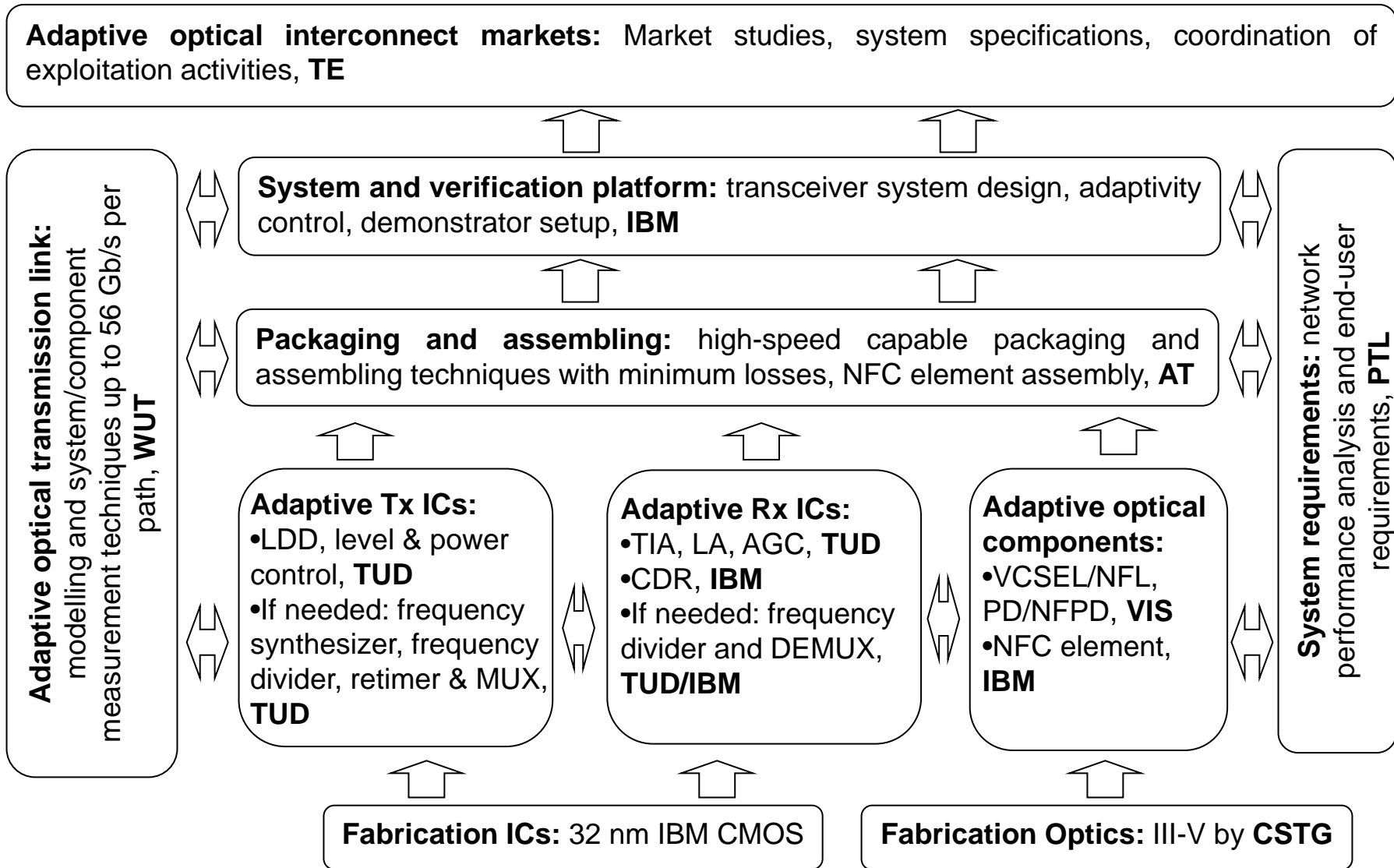


ADDAPT Participants, structure & key tasks (2)



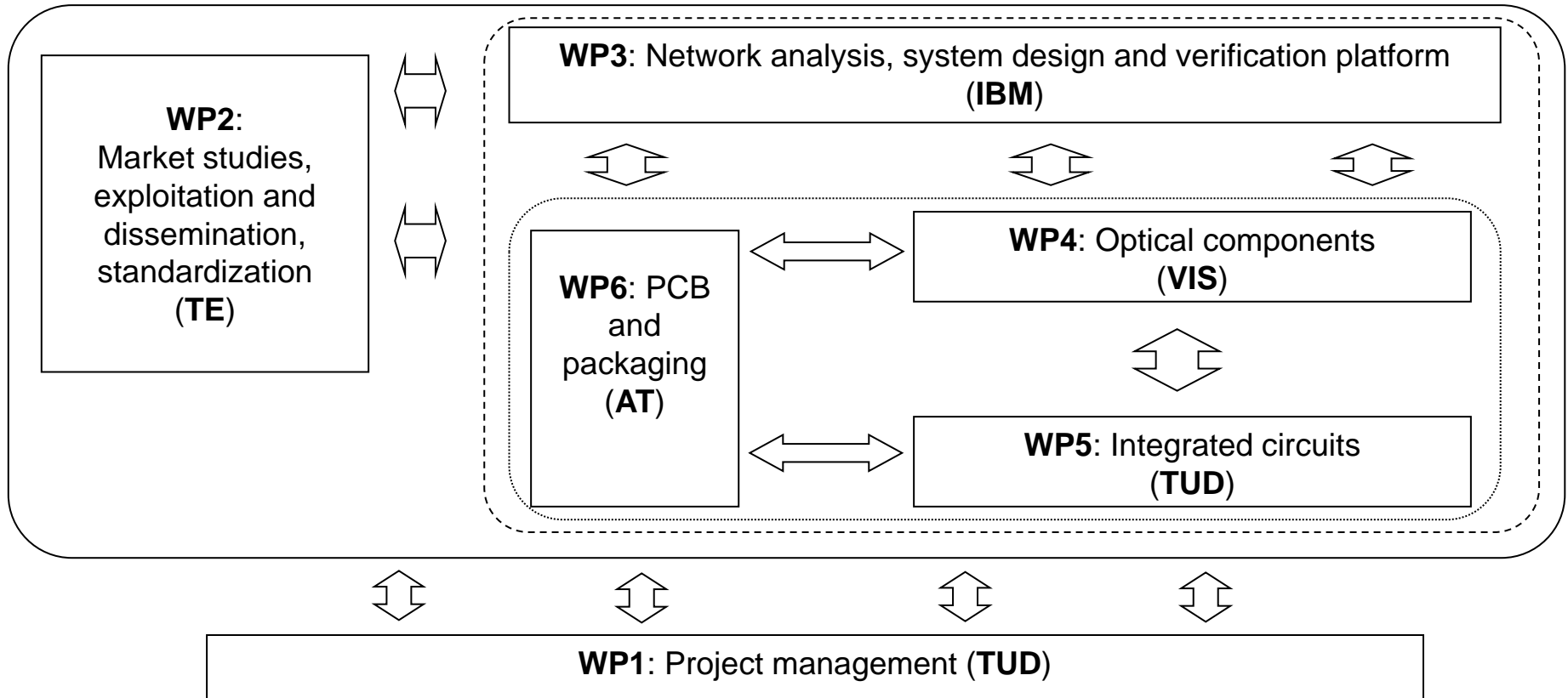
 <p>TECHNISCHE UNIVERSITÄT DRESDEN</p>	TUD	Coordination, energy-adaptive analog IC design
	IBM	System concept and design incl. adaptivity control and data protocol; CDR IC Design, development of NFC element
 <p>Vertically Integrated Systems</p>	VIS	Design of adaptive optical components
	AT	Carrier board design and packaging incl. NFC element assembly
	WUT	System design/modeling and measurements
	CSTG	Fabrication of optical components
	PTL	Network analysis; system demonstrations
	TE	Market study; exploitation management; support on system design and packaging

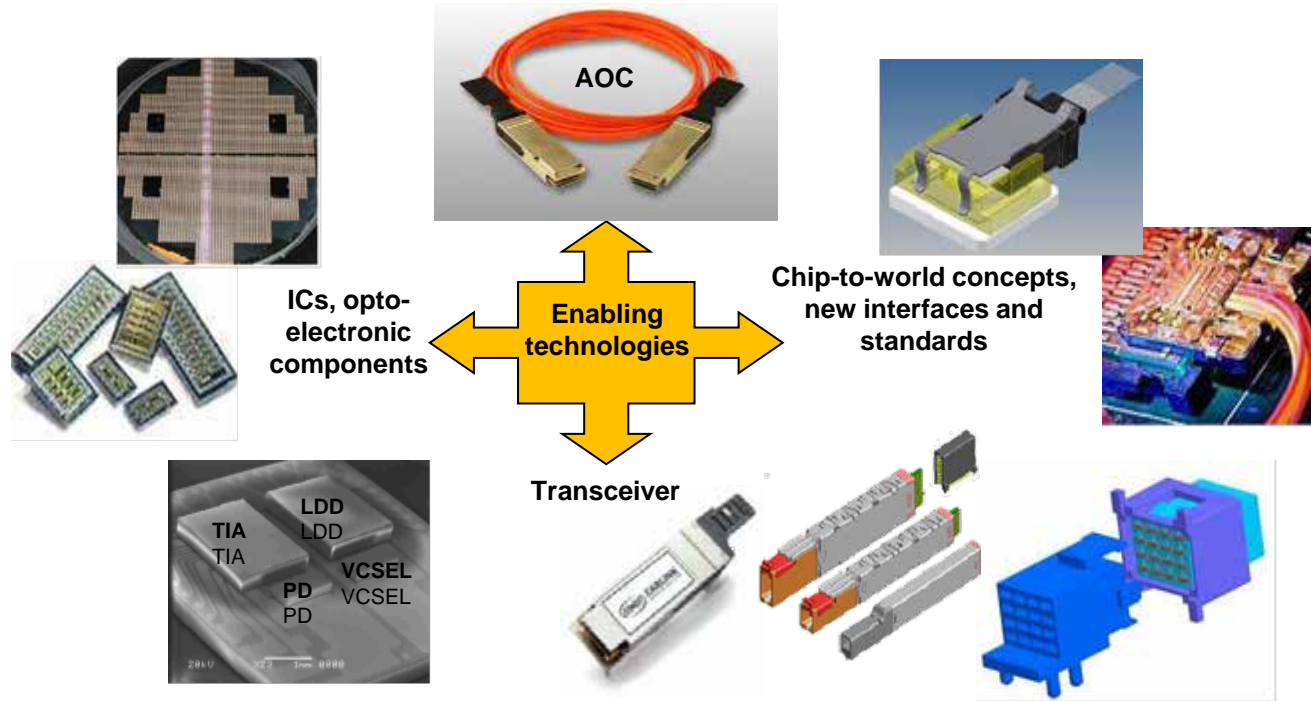
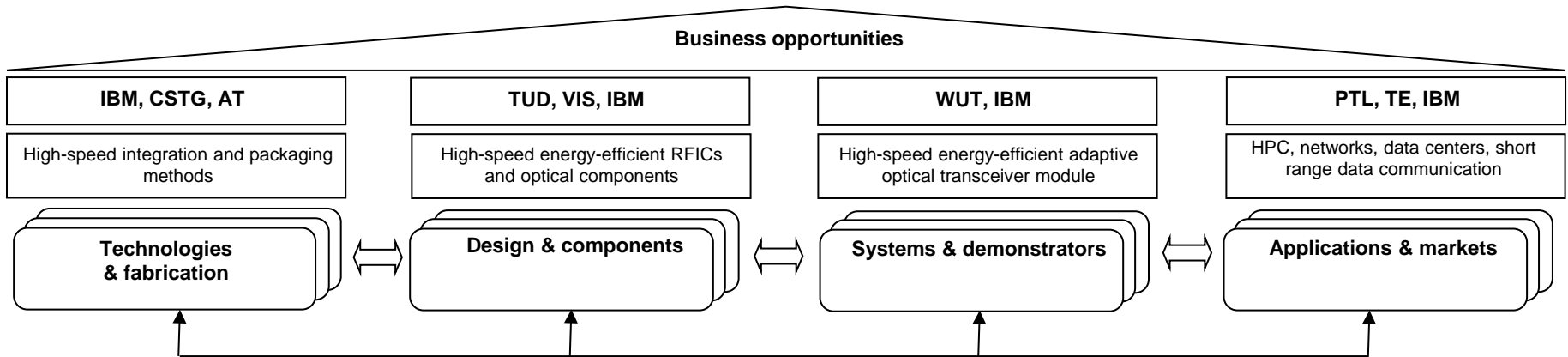
ADDAPT Participants, structure & key tasks (3)





∅ 6 work packages with leaders







High Impact:

Ø Huge market for e.g. FiberChannel and InfiiniBand standards for HPC, data center and cloud applications

HPC exascale roadmap (Benner, IBM, OIDA Roadmapping Workshop April 12-13, 2011)

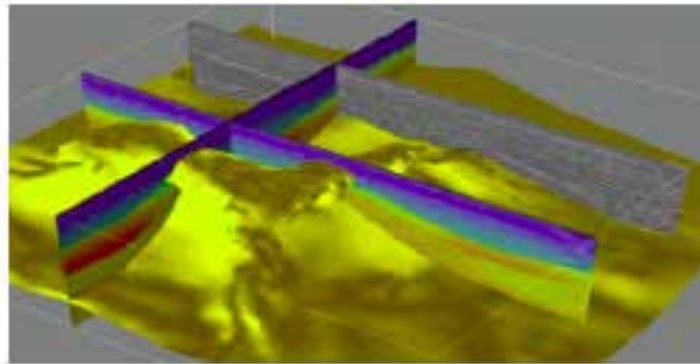
Year	Peak performance	# optical channels	Chanel data rate	Optics power consumption	Optics cost	Total power consumption	Machine Cost
2008	1 PF	48,000	5 Gb/s	0.012 MW	\$2.4M	2.5 MW	\$150M
2012	10 PF	2x10 ⁶	10 Gb/s	0.5 MW	\$22M	5 MW	\$225M
2016	100 PF	4x10 ⁷	14-25 Gb/s	2 MW	\$68M	10 MW	\$340M
2020	1EF	8x10 ⁸	~25 Gb/s	8 MW	\$200M	20 MW	\$500M

Ø Huge reduction of power consumption and operating costs

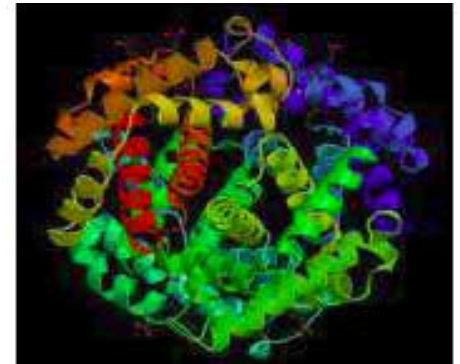
Ø Many HPC and further applications with social and ecologic impact:



climate modelling



geophysical modelling



biological modelling



- Ø Novel approach of adaptive circuits, components and modules for optical interconnects/communication
- Ø Involves advancements in design, fabrication and packaging
- Ø Consideration of standardization aspects, user and market requests
- Ø Significant contribution to energy reduction and bandwidth improvement of optical interconnects
- à **Challenging project and goals** but with **substantial research opportunities**
- à **Very promising potential for develop innovative devices and techniques with excellent chances for application and exploitation in future**



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