ICT-STREAMS

Silicon Photonics Transceiver and Routing technologies for High-End Multi-Socket Server Blades with Tb/s Throughput interconnect & interfaces

ICT-STREAMS fact sheet

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Project website:
URL: www.ict-streams.eu

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Consortium:

- Aristotle University of Thessaloniki (GR)
- Centre National de la Recherche Nationale - Laboratoire de photonique et de nanostructures (LPN) (F)
- IBM Research Zurich GmbH (CH)
- Interuniversitair MicroElektronica Centrum -IMEC (BE)
- Politecnico di Milano (IT)
- ST MICROELECTRONICS (IT)
- iMinds (BE)
- Vario Optics AG (CH)
- Amphenol FCI (D)

THE CHALLENGE

With processor chip size fragmentation having already reached its limits in trying to accommodate more cores, efforts for improving cost- and energy-efficiency in extreme-parallel computing are focusing on the next-level of hierarchy: **chip-to-chip communication in server-board and intra-rack designs forms currently the hot-spot of high-end servers industry** towards reducing physical space, network complexity and resources (switches and cables), while enabling higher performance per Watt. The new server-board roadmap seeks eagerly for solutions that can bring more and more processors on the same board in order to increase performance at a reduced cost and energy envelope, allowing at the same time for almost linear reductions in physical space requirements and linear increases in throughput densities.

MISSION STATEMENT

This is where ICT-STREAMS steps in, aiming to develop a radically new optical technology for direct chip-to-chip, board level interconnection paradigm that overcomes the current limitations of server-board designs. ICT-STREAMS targets the deployment of a holistic mid-board transceiver and router device portfolio exploiting silicon photonic technologies and introducing WDM both as a capacity-enhancing as well as a low-energy routing mechanism. It **aims to deliver a 1.6 Tb/s mid-board transceiver together with a 25.6 Tb/s-throughput mid-board routing engine onto the same electro-optic PCB, releasing a point-to-**

point-linked 16-socket server board, increasing server-board density and throughput by >400% and 1600% respectively, with 10 fold reduced energy consumption.

OBJECTIVES

The overall objective of ICT-STREAMS is to develop the necessary Silicon Photonics Transceiver and Routing technologies towards a new, power efficient, WDM-based, Tb/s, optical on-board interconnection paradigm that enables multiple high bandwidth, point-to-point direct links on the board level, as a step forward to the realization of exa-scale computing systems. The core objectives of ICT-STREAMS are:

- Develop **50 Gb/s energy efficient photonics and electronics** transceiver components
- Develop **III-V on Si planar lasers and nano-amplifiers** for WDM interconnection
- Develop a **Thermal drift compensation subsystem** (TDCS) employing non-invasive integrated monitors
- Develop a low-loss, low cost **single-mode polymer Electro-optical PCB** host platform and establish a cost-efficient electro-optic integration process
- Develop software controlled, energy efficient **WDM Embedded Optic Modules with 1.6Tb/s throughput**
- Develop **a 25Tb/s throughput EOPCB-mounted, loss-less 16x16 WDM routing platform**
- **Establish Optical Path Interconnect (OPI) prototype: establish and evaluate ICT-STREAMS on-board optical chip-to-chip interconnection system for multi-socket server boards**

TARGET TECHNOLOGY BREAKTROUGHS

Optical Engines: ICT-STREAMS optical engine will push the performance envelope of transceivers technology by means of number of WDM channels (32x) and channel data rate (50Gb/s) towards a 1.6Tb/s throughput optical engine with 3.75pJ/bit target power efficiency.

Embedded Optics and Assembly: Photonic technology industrialization requires a practical, compact, reliable and cost-effective solution for embedding optical devices. ICT-STREAMS single mode polymer Electro-Optical PCB employing adiabatic optical coupling concept with high-density, high-frequency RF and optical I/O interfaces aims to drive things further enabling single step chip-to-board assembly, relaxing manufacturing time and cost requirements.

Thermal Drift Compensation: High density integrated active optical components may trigger severe thermal crosstalk phenomena affecting overall WDM wavelength tenability. ICT-STREAMS will address this ever-lasting challenge of active photonic devices with an innovative Thermal Drift Compensation system employing non-invasive, wavelength monitoring and control technology for WDM Silicon Photonics components that will bring significant impact on the real-life applicability of Si-Pho technology.

III-V on Si laser Integration: ICT-STREAMS approach has some decisive differences to state-of-the art concepts pursued by others in the field of InP on Si, enabling complete embedding of the gain structure in the back-end of the line (BEOL) process steps and making this laser fabrication method fully CMOS compatible, while the integrated in-plane lasers will require no mechanical beam alignment to the Silicon chip.

In-line Amplification: ICT-STREAMS proposes a new amplification paradigm based on PhC-SOA nanoamplifiers. The new amplifier designs address the requirement of optical interconnection systems deploying advanced features and smart routing functionalities for optical power balanced links in, with enhanced power efficiency compared to today's solutions.

HPC/DC architectural designs breakthrough: ICT-STREAMS leverages WDM parallel transmission to a powerful routing technology that resolves current bandwidth and switch-latency barriers, allowing for 25Tb/s aggregate throughput, contention-free, on-the-fly massive data movements for multi-socket any-to-any interconnection. Such a 16-socket server blade configuration would enable Exascale computing in a quarter of the physical size required with today's standards. ICT-STREAMS interconnection system also strongly supports novel Rack Scale Architectures for compute, memory, and storage resources disaggregation concepts.