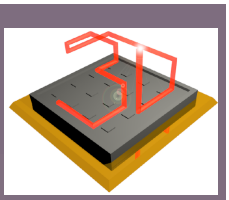
3D-Optical-ManyCores

3D Many-Core Architectures based on Optical Network on Chip

UMR CNRS 6082 – FOTON - Fonctions Optiques pour les Technologies de l'informatiON
INRIA Rennes – Bretagne Atlantique – IRISA UMR CNRS 6074
UMR CNRS 5270 - Institut des Nanotechnologies de Lyon - Ecole Centrale de Lyon



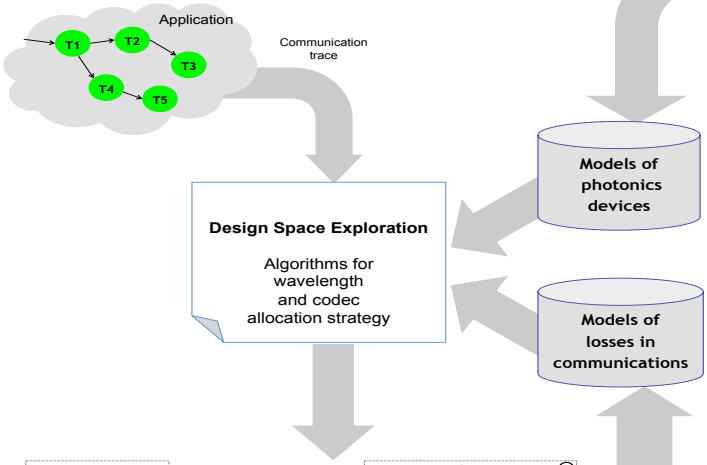
Aim of the Project

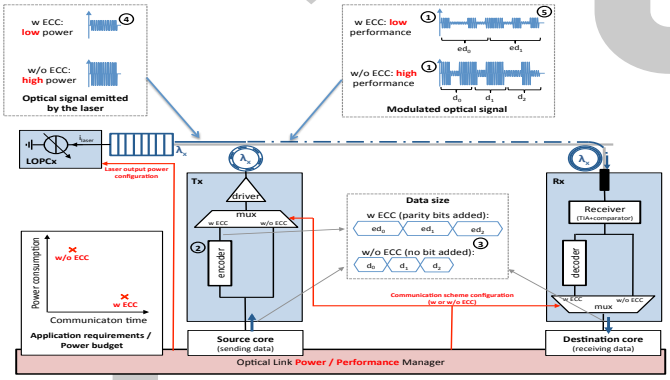
3D-OPTICAL-MANYCORES investigates how the introduction of novel optical technologies could improve the energy efficiency and enhance the data rate of interconnects used in many-core architectures for embedded and high-performance computing. The Project takes advantage of 3D technologies for designing a specific photonic layer suitable for a flexible and energy efficient high-speed optical network on chip (ONoC).

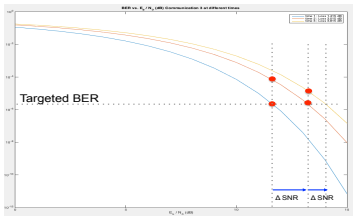
3D-OPTICAL-MANYCORES combines the expertise of leading research groups focusing on energy-efficient computer architectures, optical integration of semiconductor materials on silicon platform and optical communications. The consortium presents an added value by gathering all those expertise and consolidating interactions between the different actors and research communities in the fields of interconnects and optical networks on chip.

Contributions

CHALLENGES 1 & 3



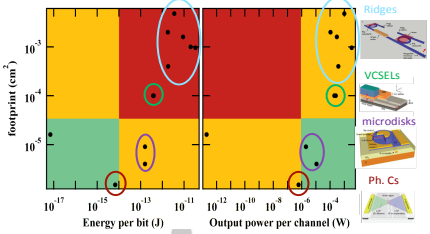




- Reduction of laser power consumption
-
- Efficient communications infrastructure

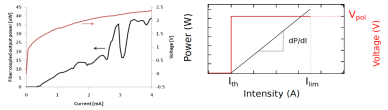
CHALLENGE 2

Survey of µ-scale lasers on-chip:



- Three key specifications for on-chip integration can be identified
- Microdisks and Photonic crystal cavities are close to direct eligibility
- The eligibility of ridges and VCSELs require power and footprint scalability, enabled by their high output power.

Simplified model of eligible lasers sources:



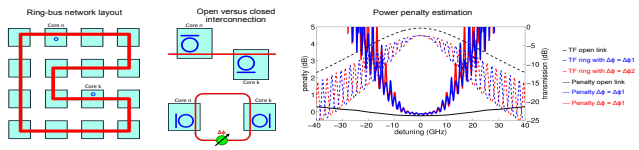
[1]: T. Spuesens, in: 2009 6th IEEE Int. Conf. Group IV Photonics, 2009: pp. 202–204.

Towards a demonstrator of monolithically integrated laser on Si:

- ✔ P-i-n diode on Si
- ✔ Optical confinement
- ✖ Direct bandgap active area

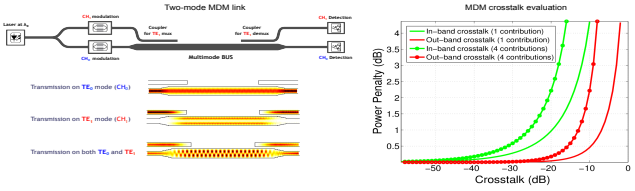
CHALLENGE 4

Spurious resonances in ring-based networks on chip



- Ring-network topologies induce complex resonant effects that may impact the transmission performance of on-chip networks exploiting microrings for channel add-drop multiplexing.
- This effect has been assessed numerically for different network sizes and bit-rates.

Mode division multiplexing for on-chip interconnects



- Mode division multiplexing (MDM) is envisioned as a possible solution to increase the throughput of on-chip networks with a reduced number of integrated laser sources.
- A systematic comparison between MDM and wavelength division multiplexing (WDM) is being carried out in order to asses potentials and limitations of the two strategies.

Outcomes

3D-OPTICAL-MANYCORES Project designs and optimizes flexible and energy efficient high-speed optical NoC making use of 3D technologies.

- Novel devices, in particular light sources and nonlinear elements that can be monolithically integrated on the silicon platform are investigated.
- High- and low-abstraction models for the simulations of optical links and complete ONoCs making use of such devices are addressed.
- The potential of novel all-optical signal processing functionalities exploiting micro- and nano-optical devices for the proposed architectures.

Team Members

- **UMR CNRS 6082 – FOTON - Fonctions Optiques pour les Technologies de l'informatiON**
  Pascal Besnard, Christophe Peucheret, Patrice Féron, Yoan Léger, Olivier Durand, Alberto Parini, Yannick Dumeige, Yann Boucher, Ronan Tremblay, Charles Cornet
- **INRIA Rennes – Bretagne Atlantique – IRISA UMR CNRS 607**
  Olivier Sentieys, Daniel Chillet, Cédric Killian, Jiating Luo, Van-Dung Pham , Ashraf Elantably
- **UMR CNRS 5270 - Institut des Nanotechnologies de Lyon - Ecole Centrale de Lyon**
  Sébastien Le Beux, Ian O'Connor, Xavier Letartre, Christelle Monat