BBC: Wireless Interconnect Network on chip for Broadcast-Based parallel Computing

Thierry Le Gouguec (*Lab_STICC/DIM*)
Cédric Quendo (*Lab_STICC/DIM*)
Pierre-Marie Martin (*Lab_STICC/DIM*)
Ihsan El Masri (PhD) (*Lab_STICC/DIM*)
Christian Roland (*Lab_STICC/IAS*)
Jean Philippe Diguet (*Lab_STICC/MOCS*)
Johann Laurent (*Lab_STICC/MOCS*)
Olivier Sentieys (*INRIA/CAIRN*)
Cédric Killian (*INRIA/CAIRN*)
Joel Ortiz (INRIA/CAIRN-Lab-STICC/IAS)
Daniel Chillet (*INRIA/CAIRN*)
Dominique Morche (CEA-LETI)

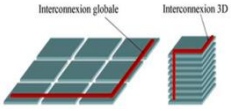
Background

Data production will continue to grow:
- Faster chips and communications
- Powerful chips and board
- Many-core architecture development
- Parallelism

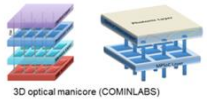
Wired interconnects bottlenecks:
- impedance matching, crosstalk, high power consumption, latency and transmission delay, point-to-point…

Proposed solutions to overcome interconnect problems are:
- 3D interconnects
- Optical Interconnects (See "3D Manycores" project)
- RF guided interconnect
- **RF Wireless interconnect**

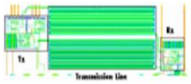
Our main focus in this project will be on **RF Wireless Interconnect**

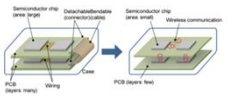


3D interconnects



optical interconnects


RF guided interconnects


RF wireless interconnects

Objectives of BBC project

Main objectives of BBC project:
- evaluation of the contribution of RF-radio link for the intra-chip interconnect
- definition of new opportunities for parallelism management and concurrent memory accesses

Answer to the question:
"In which cases RF wireless links are attractive and in which cases other solutions are preferable?"

- Comparison with other new interconnect solutions, especially with the results issues from "3D Manycores" ComInLabs project

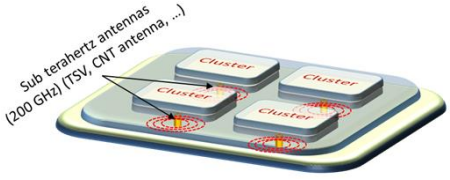
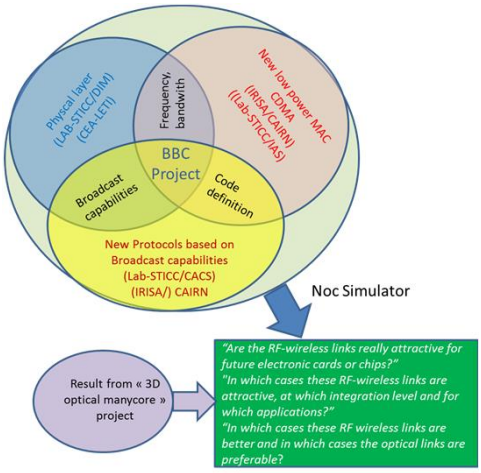


Illustration of a Wireless network on Chip

Global organization

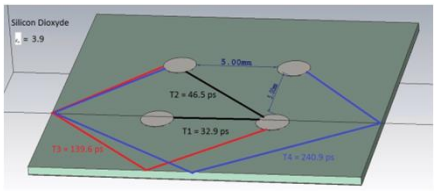


BBC project organization

Three Work-Packages:
- WP1: Physical layer
- WP2: New low power MAC
- WP3: New protocols based on Broadcast

WP1: Physical Layer

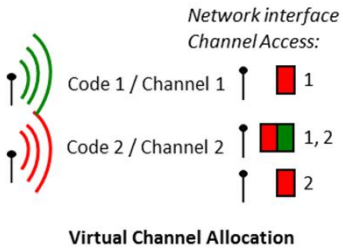
- Study of the feasibility of **intra-chip wireless communications**
- Evaluation of **expected link budget**
- Study of potential **sub-terahertz integrated antennas**: TSV (through-silicon vias) and/or CNT (carbon nanotube) antennas
- Evaluation of EMC problems
- Estimation of **energy per bit**
- Wireless distributed clock synchronization



f (GHz)	200		
Material	Silicon	Silicon Dioxyde	Air
Relative Permittivity	11,9	3,9	1
Propagation Time (PS)			
Direct Path			
T1: 2 adjacent antennas	57,49	32,91	16,67
T2: 2 diagonal antennas	81,31	46,55	23,57
Indirect Path			
T3: 2 diagonal antennas	243,93	139,64	70,71
T4: 2 adjacent antennas	419,74	240,29	121,68

Example of delay estimation for different wave travels

WP2: Medium Access

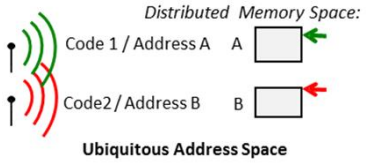


Virtual Channel Allocation

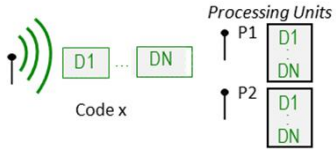
Study the best access techniques
- to **share the medium between clusters**?
- to **enable new features** that we intend to push in the project (**broadcast**, flexibility, low-power)?
- Should we use **error correcting codes** to trade-off transceiver linearity, silicon area and transmission power against power consumption and data rate?

WP3: New protocols based on broadcast

- Exploit NoC **broadcast** capabilities to shared memory resources and **coherence management** including dynamic memory allocation and distributed caches improvements
- Develop **new communication APIs** to minimize "barrier synchronization" latency and to enable and speedup load balancing in many-core architectures



Ubiquitous Address Space



Broadcast Message Passing :

Examples of new protocols based on broadcast