Optical NoC Evaluation in a System-Level MP-SoC Platform

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Heterogeneous SoC

- MPSoC architectures with large scale parallelism
- Optical NoC integration to overcome interconnect challenges
Optical NoC: Current R&D

- Research is technology-dominated
  - Physical level research
  - New devices and architectures are defined
- System-level vision not considered yet
- Cooperation between system-level and physical-level designers is required
Overview

➢ Optical NoC – General view
➢ Optical NoC evaluation in System-Level platform
➢ Results
  • MPEG-4 application
    • Optical NoC vs. STBus: 2X speedup
    • Optical NoC vs. XBar: 3.5X speedup
  • Cavity detection application
    • Reducing programming effort
Technological solution

- Optical devices (passives and actives) above the classical integrated circuits
- Compatible with CMOS technology

Source: I. O’Connor, Ecole Centrale Lyon
Optical NoC Architecture

Electrical Part

Optical/Electrical Interface

Optical Part

λ-router

MUX

DEMUX

λ₁

λ₂

λ₃

λ₄

State « bar »

State « cross »

1

2

3

4

MPSoC 2006

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Optical NoC Architecture

- Multiple signals of different wavelengths in the same waveguide
  - No contention, high bandwidth density $\rightarrow$ 20 GB/s
  - Simple, scaleable interconnect $\rightarrow$ simpler prog. models
- Constant latency ($<1$ ns), function of:
  - Optical index of materials (Si, SiO$_2$)
  - Light propagation delay
  - Waveguide length
- Frequency limited by optical/electrical interfaces
  - Currently 100 MHz
ONoC Evaluation in a System-Level Platform

Applications
- MPEG4
  - Intensive inter-processor communication (40%)
- Cavity detection application
  - Memory consuming application

XBar @ 200 MHz
STBus @ 200 MHz
ONoC @ 100 MHz

StepNP Platform
MultiFlex Mapping
ONoC Evaluation in a System-Level Platform

Applications
- MPEG4
  - Intensive inter-processor communication (40%)
- Cavity detection application
  - Memory consuming application

XBar @ 200 MHz
STBus @ 200 MHz
ONoC @ 100 MHz

System-level model for ONoC and optical/electrical interfaces

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Results for MPEG4 Application

- ONoC vs. STBus: 2X speedup
- ONoC vs. XBar (5 cycle latency): 3.5X speedup

Results based on high-level STBus model.
More recent implementations of STBus may exhibit higher performances.
Summary

- System-Level Evaluation of MPSoC Integrating Optical NoC
  - First results for global simulation of MPSoC including optical network
- Cooperation between Physical Designers and System-Level Designers
  - Physical Design Team
    - Ecole Centrale de Lyon (Prof. Ian O`Connor)
  - System-Level Design Team
    - ST Microelectronics (MultiFlex Team) – MPSoC including STBus and XBar Networks
    - Ecole Polytechnique de Montreal – global modeling and simulation for Opto-Electrical MPSoC