Development and Operation of Networks-on-Chip

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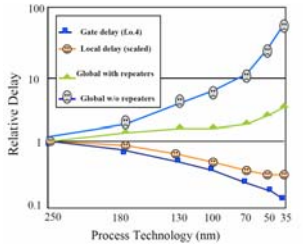
Current Situation and Outlook

Issues of current and future technologies:

- Power dissipation
- Power density
- Leakage currents
- Interconnects
- Clock distribution
- Parameter variability
- Crosstalk
- Verification
- Reliability
- Costs
- Productivity
- Memory-Wall
- ...



„Power outperforms Performance."

Network-on-Chip:

- Promising properties to overcome or mitigate current issues:
  - Modularity
  - Encapsulation
  - Portability
  - Reuse
  - Scalability
  - Parallelism
  - ...

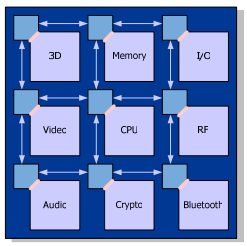
Computing in time

Computing in time and space

Algorithm-on-Chip

System-on-Chip

Network-on-Chip



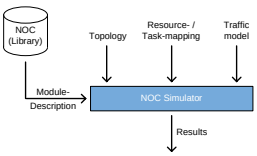
NoC-Simulator and the Design Flow

Related work:

- Prototyping, Test-Chips:
  - Star topology for multimedia applications [Lee, 2003]
  - 4x4 mesh network with traffic generators [Mullins, 2006]
- Parametrizable VHDL-model ported to FPGA [Zeferino, 2004]
- Emulation framework on an FPGA [Genko, 2005]
- High-level VHDL [Sigüenza, 2002]
- SystemC approach and design flow [Jalabert, 2004]
- Event-based C++ Simulator [Wiklund, 2004]
- ...

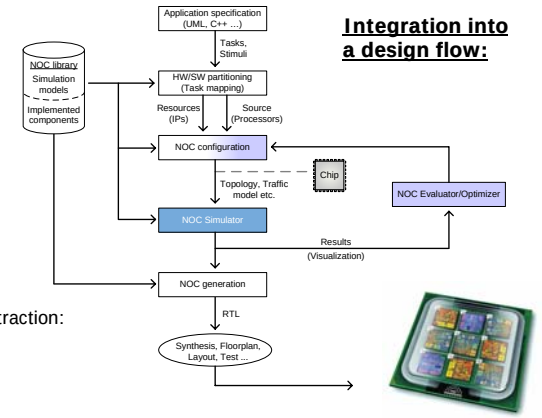
Chosen approach:

- Modules are characterized by:
  - Delay
  - Power dissipation
  - Area
  - Network related behavior
  - ...



- High level of abstraction:
  - Modules
  - Logic gates
  - Transistors

Integration into a design flow:



Preliminary Results and Intended Investigations

Router activity:

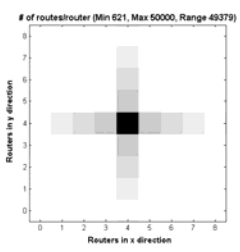
From dimension-ordered to adaptive routing schemes

Open issues:

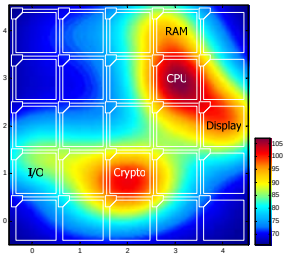
- System control
- Load balancing, task mapping
- Composability of functions/tasks/services
- Exploitation of parallel structure
  - Programming models
  - Distributed memory
- Benchmarking
- Design-space exploration
- Test and verification
- Hardware reconfiguration
- Reliability, Self-healing
- ...

System control / monitoring:

- Centralized or distributed
- Dynamic power management
  - Power consumption, supply voltage drop
  - Temperature, power-down mode
- Distribution of hot spots:
  - Tasks
  - Communication
  - All issues of power



Congestion of control messages in a centralized control system



Application example for the temperature distribution of a 5x5 mesh network

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