POLITECNICO DI TORINO

Dipartimento di Automatica e Informatica

PhD in Computer and Control Engineering

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Supervisor

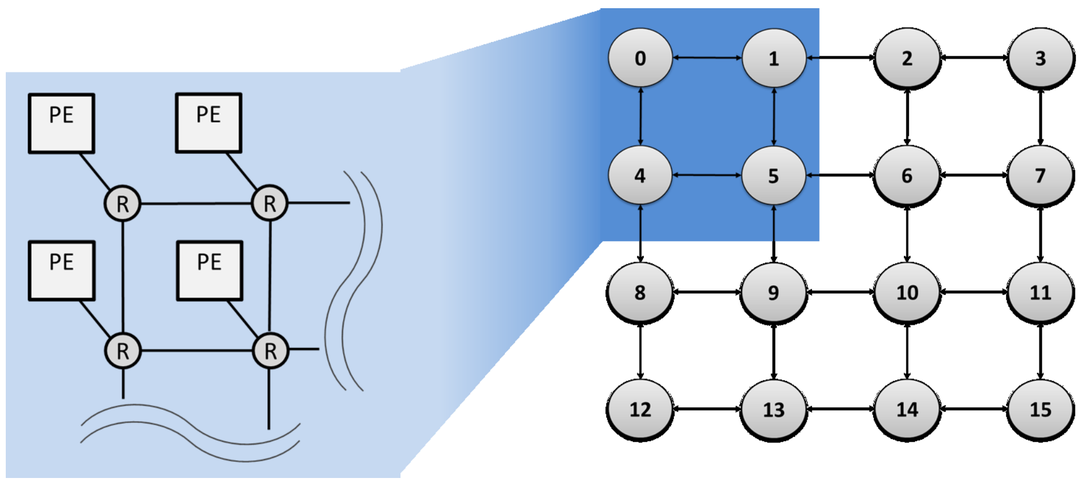
*Massimo Violante*

# High-performance computing systems for harsh environments based on commercial-off-the-shelf components

PhD Candidate: *SERHIY AVRAMENKO*

## 1. Introduction

Lately, **network-on-chip** (NoC) interconnection architecture, is becoming a trend for multi-processor system-on-chip (MPSoC). Basically a NoC is a net of routers (R) connected, by physical links, with processing elements (PE) ; where the latter can be a processor, memory or any IP.




Internal structure of the NoC-based system (on the right)




4x4 mesh topology NoC-based system

This kind of devices are designed with the emphasis on performance. On the other hand, safety critical industry, especially avionic industry, has a set of strict reliability requirements, which are not addressed by the commercial off-the-shelf (COTS) MPSoC. One of the main issues is the interconnection which is shared by all the applications. This hinders the fault segregation, especially for what it concerns **time interference**.

## 2. Goal

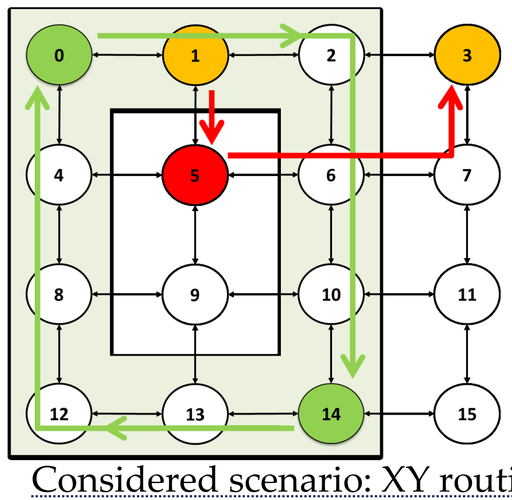
The goal of this research is to allow the usage of NoC-based COTS MPSoC in safety critical systems, in particular in avionic domain.

## 3. Proposed solution

The proposed solution consists in creating a dedicated communication channel for each critical application (i.e., between its nodes). This dedicated channels are created in such a way that they do not overlap and thus no congestion is possible.

The implementation of the proposed solution is done by a SW module to be inserted in a real-time OS. The mechanism is based on the assumption that the routing algorithm (used by the NoC) is deterministic and know, and the topology is known as well. This assumption allows to know the path, a given packet will take, by only knowing the source and destination coordinates. The proposed SW module is thus able to block any faulty packets before these are injected into the network.

The proposed solution imply a cost in terms of connectivity, as portions of the NoC become dedicated to one application only and thus are not usable by no other application. In order to mitigate this drawback, a redirection SW module has been developed. In detail, each non-critical node can be used to retransmit the packets, improving in this way the overall connectivity.




| | Critical traffic latency | |
|---|---|---|
| | MAX | AVERAGE |
| baseline | 655 | 311.6 |
| w/ proposed solution | 305 | 305 |

Considered scenario: XY routing; 0 and 14 are only critical nodes; node 5 is used as redirection node for node 1 to 3 communication

## 4. Results

The proposed solution has been tested using a simulated 4x4 NoC with XY routing. Experimental results show how the time interference have been eliminated as the critical traffic latency becomes deterministic. Furthermore the redirection feature allows the non-critical application to see almost no connectivity reduction even under scenarios in which large part of the NoC resources has been dedicated to critical applications.

## 5. References


- S. Avramenko, S. Esposito and M. Violante, "RTOS for mixed criticality applications deployed on NoC-based COTS MPSoC," 19th Latin-American Test Symposium (LATS), 2018.
- S. Avramenko, S. Esposito and M. Violante, "Efficient Software-Based Partitioning for Commercial-off-the-Shelf NoC-based MPSoCs for Mixed-Criticality Systems," 24th IEEE International Symposium on On-Line Testing and Robust System Design (IOLTS), 2018.