Cognitive RF Network-on-Chip

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Introduction

- Development of manycore architecture with thousands of multiprocessor cores → growing demand in bandwidth and communication.
- Architectures built around a classical wired Network-on-Chip (NoC) interconnect are no longer suitable for latency and power consumption issues.

How to raise the communication performance within RF NoC architecture? → Cognitive function to determine spectrum access opportunities.

RF NoC

WiNoCoD Architecture: The Chip-Multi-Processors (CMP) in WiNoCoD [1] contains two levels of hierarchy (Figure 1):

- Cluster: 32 routers, wired NoC.

Orthogonal Frequency Division Multiple Access (OFDMA): RF requires a multiple access technique to share the available bandwidth among the different clusters of the NoC. OFDMA is used to achieve a flexible and dynamic allocation.

Modelling RF-Net architecture

To evaluate cognitive the RF NoC architecture, Noxim simulator was extended [3, 5].

Experimental results obtained for the optimal threshold value.

We propose a new routing algorithm called Threshold-Based Routing (TBR) to efficiently distribute the traffic on both wired and RF links [4]. The choice of threshold (in term of hops number) is a critical step conditioning a certain level of performance.

Scientific challenge:

Queue State Information (QSI) is used in [2] to allocate sub-carriers allocation among clusters. Using this approach, each cluster needs to transmit its QSI to the others. How can we avoid exchanging additional information through RF? → by using a cognitive function.

Energy detection in OFDMA system:

Energy detection was validated experimentally using real OFDMA signals sent between two development boards.

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Conclusion

- In this work, we propose to add a cognitive function based on energy detection to RF-NoC architecture which allow us to not transmit any additional data through RF such as the QSI [1].
- Efficient medium access control (MAC) protocol for resolving channel contention must be defined. More specifically, after the energy detection, we need a channel access mechanism to allocate the free spectral bands that considers collisions between clusters.

Figure 1: RF NoC architecture

Figure 2: Routing algorithm TBR

Figure 3: Average delay vs threshold

Figure 4: Average delay vs PIR under random traffic

Figure 5: IP throughput vs PIR under random traffic

Figure 6: Baseband processing of OFDMA system

Figure 7: Experimental transmission chain