Dynamic Reconfiguration in NoC-based MPSoCs in the Avionics Domain

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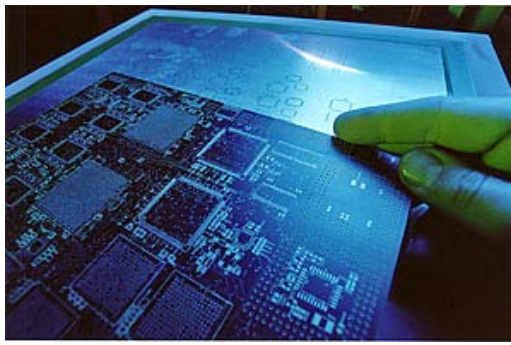
Multi-Core Processors in the Avionics Domain

Avionic industry with its long development cycles is interested in adopting multi-core processors.

Main drivers are:

- Concentration of the same functionality on fewer devices to reduce:
  - weight
  - power
  - costs



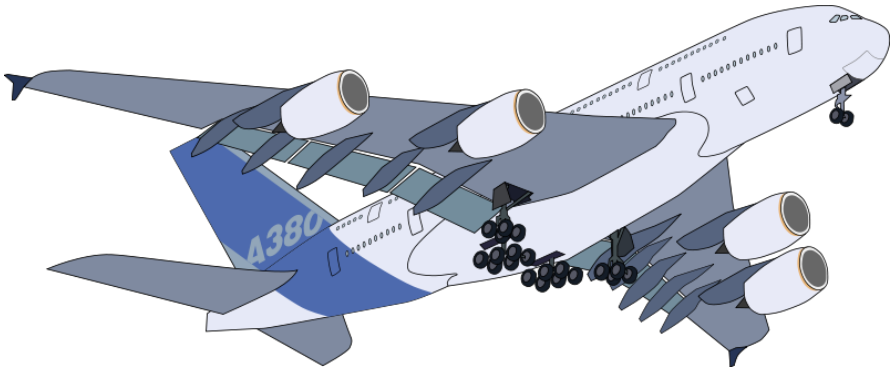
- Interest in simple cores to improve predictability
- Higher performance as a result of parallelization

Avionic Software Characteristics

- Trend towards a shared computing platform (Integrated Modular Avionics)

- Necessary: time and space partitioning to achieve isolation (ARINC 653)

- Functionality is implemented in tasks:
  - synchronous (fixed period) and asynchronous (data-driven, event-driven)
  - varying criticality levels (Design Assurance Level)



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NoC-based Multi-Core Processors

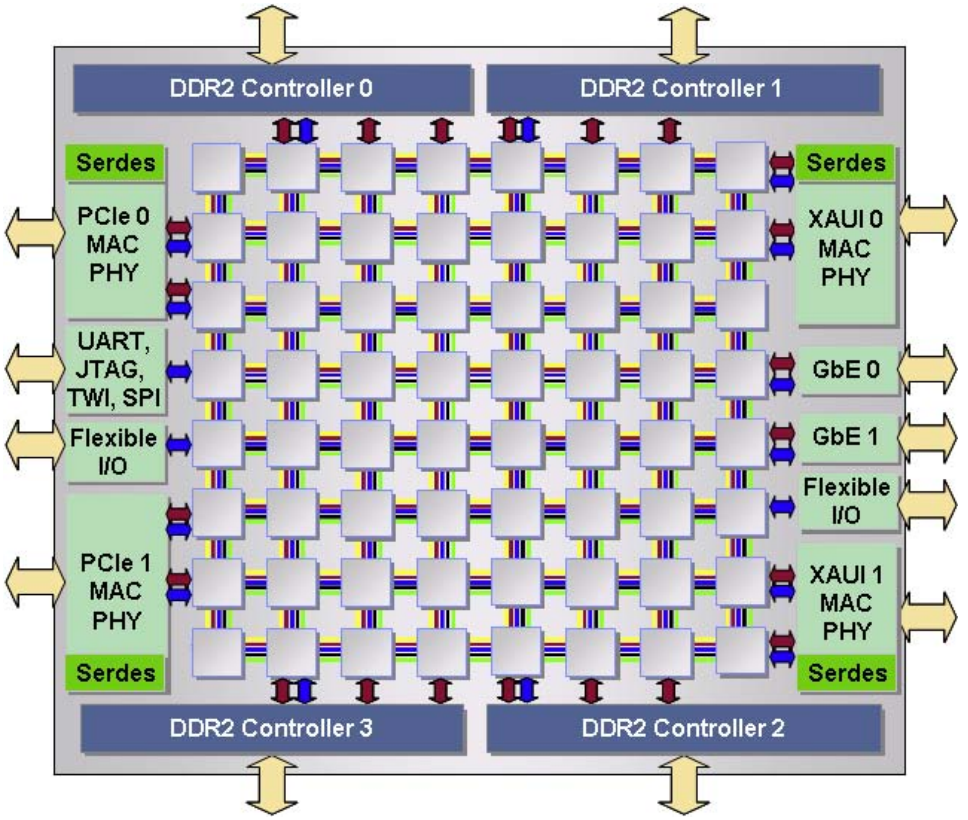
... with a Tilera TILE*Pro*64.

Why?

- Network-On-Chip (NoC) is a scalable on-chip interconnect
- Many cores: 64 cores (100 cores)
- Distributed memory

Our Research focus:

- Dynamic Reconfiguration of software on multi-core processors with adaptive partitioning



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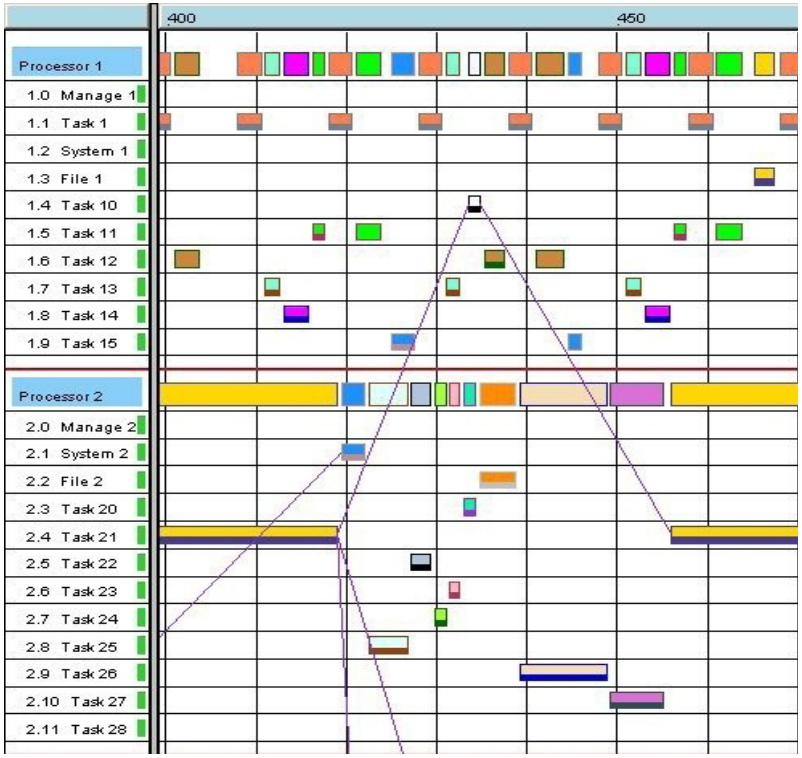
Towards Adaptive Partitioning

- State-of-Practice:
  - static/fixed scheduling and fixed allocation of partitions at design time



- Our research direction:
  - Combine critical, non-critical, synchronous and asynchronous tasks/partitions on a multi-core processor
  - Shape and size of partitions can be fixed or reconfigured at run-time

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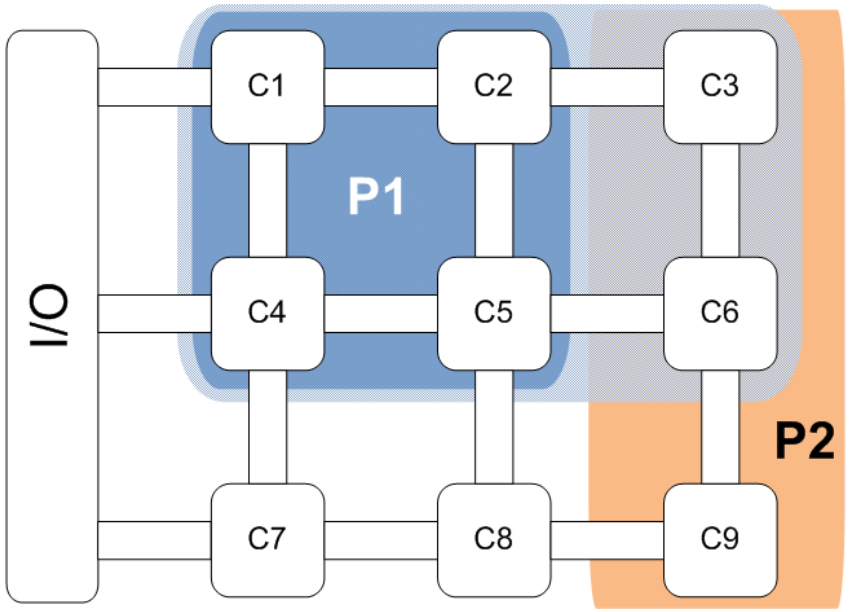
Advantages of Adaptive Partitioning: Reshaping (I)



- Partition P2 is idle
- Partition P1 extends and temporarily "borrows" resources from P2

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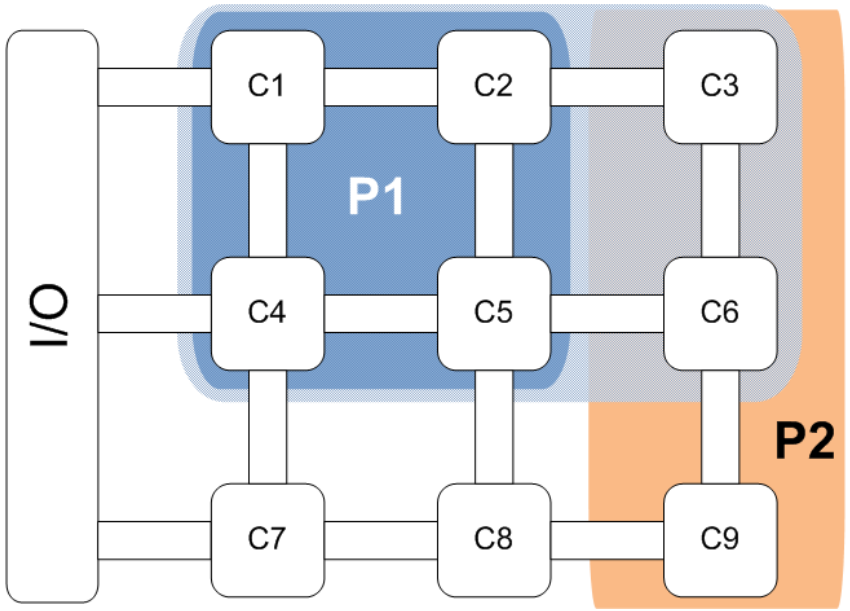
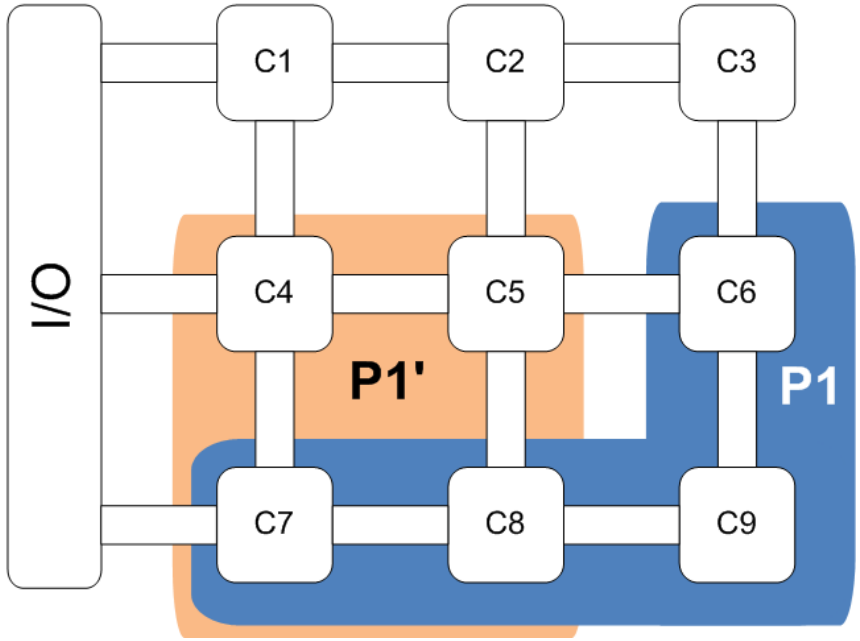
Advantages of Adaptive Partitioning: Reshaping (II)





- Partition P2 is idle
- Partition P1 extends and temporarily "borrows" resources from P2

- Partition 1 changes its shape to minimize "hops" between cores

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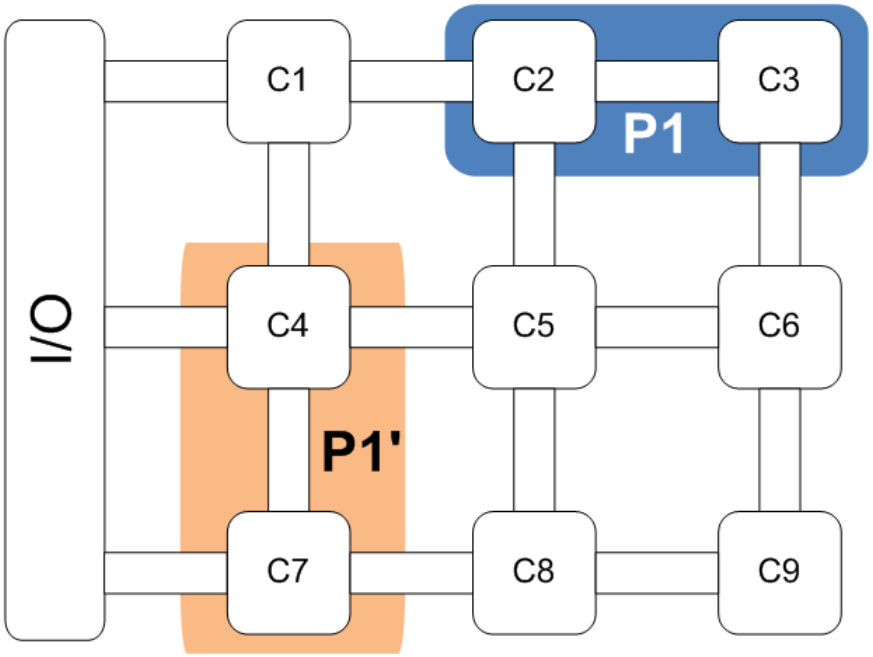
Advantages of Adaptive Partitioning: Relocation (I)



- Partition P1 needs to access I/O
- P1 "moves" closer to I/O controller to minimize path distance and I/O latency

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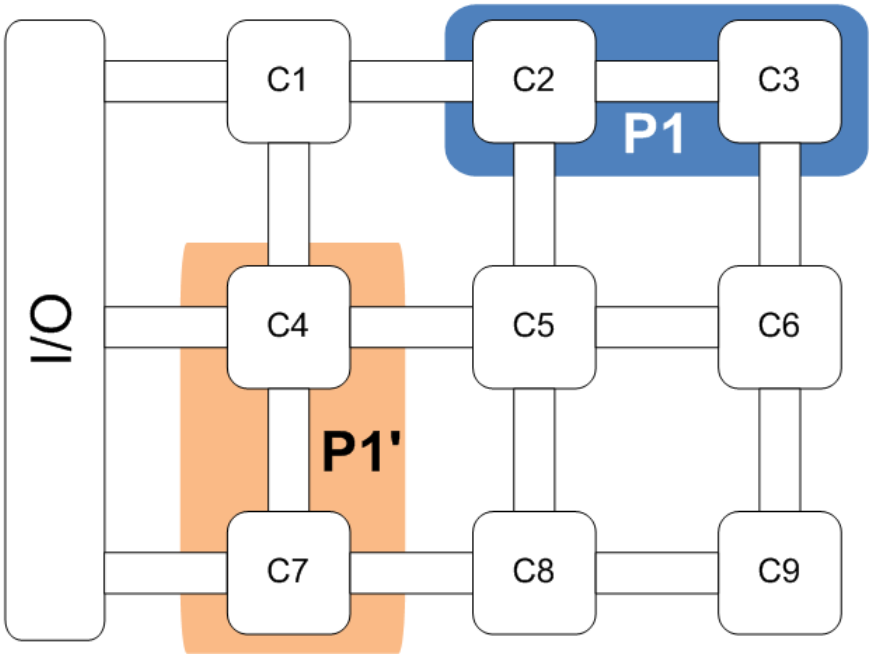
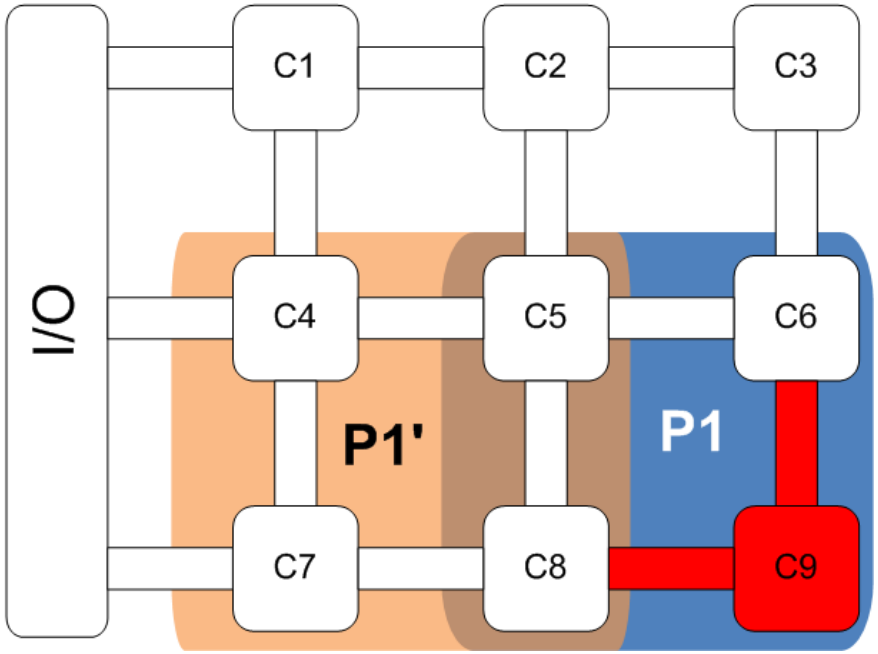
Advantages of Adaptive Partitioning: Relocation (II)





- Partition P1 needs to access I/O
- P1 "moves" closer to I/O controller to minimize path distance and I/O latency

- Partition P1 uses Core C9, which exhibits faults
- Partition P1 moves to a new location

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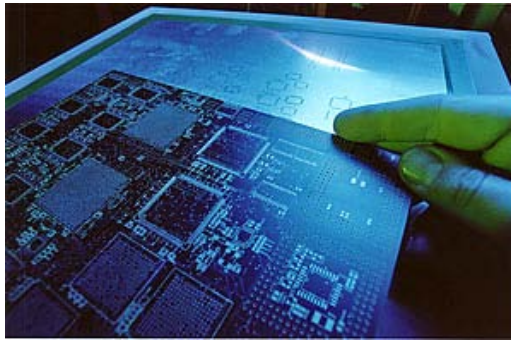
Outlook: Current Research at FIRST

- Migration of partitions on a NoC-based multi-core processor
  - Task and data migration mechanisms (predictability, impact on timing)
  - Coordination pattern (master/slave, distributed, ...)

- Partition isolation
  - How to segregate partitions?
  - How to verify the segregation?



- Partitioning in the engineering process
  - How to incorporate "partitioning" in a distributed engineering process?

Thank you for your attention

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