Acceleration of Complex models simulation

May 24rd 2018

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- Innovation challenges and achievements.

- How did we get there and leverage MathWorks.

- Further details on solutions adopted.

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Key Takeaways

1. Model Based Design has been used for the complete design, implementation and testing of complex IRST state of the art systems.

2. MBD process has proven be more robust and efficient than traditional workflows:

   1. Easier validation of the design.

   2. Smooths transition from design to implementation.

   3. Verification & virtual integration are improved.

3. Special care is needed in the implementation of very complex models to accelerate execution times

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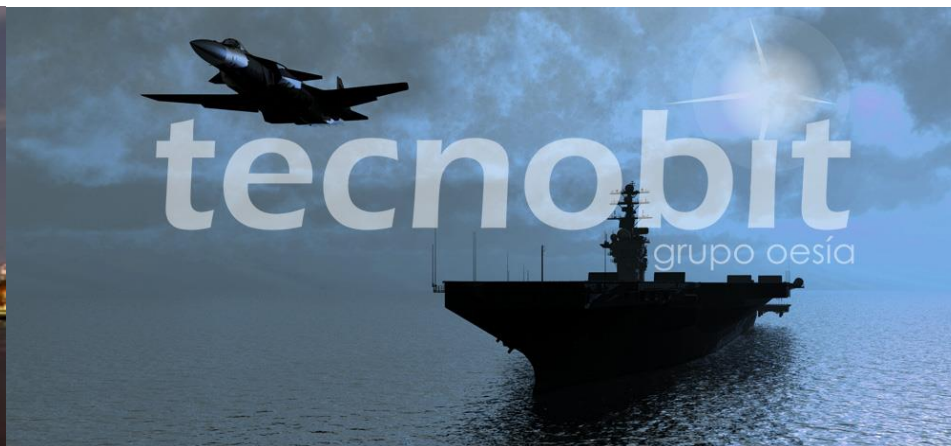- Further details on solutions adopted.

- Concluding remarks

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Innovation challenges and achievements.

- Systems validation and verification needs to be carried out as soon as possible in the development phase to

  reduce risks at latter phases (integration and deployment).

- Sufficiently accurate and representative systems models need to be created to achieve robust verification before

  detailed design and integration.

- Let's put some numbers to models size & execution time:

  - Number of model blocks: 2800

  - Number of validation test cases: 1000

  - Average execution time per test/case (on a single computer): 9 min --> 9min x 1000 ≈ 1 week

- An approach is needed to reduce the execution time while maintaining model representativeness the system.

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How did we get there and leverage MathWorks.

- Two techniques were used achieve better performance:

  - Parallelize the model as much as possible in a controlled way among a cluster of multicore computers.

  - Compile time consuming parts.

- Two strategies were studied together with Mathworks consultancy services to achieve effective parallelism:

  - Strategy 1: Divide the model intro separate parts each of which can be deployed on a designated machine and core among the cluster. UDP protocol was used for communication among the model parts.

  - Strategy 2: Achieve division and interface between parts by using the Robotics System Toolbox.

How did we get there and leverage MathWorks

- Strategy 1:

  - It proven to be feasible. Tests where made on a part of the model to split part of the model onto various cores of the same machine.

  - This solution required custom implementation of scheduler that was time consuming and costly (concurrent function call generation).

  - Models run under Simulink, even though models were compiled

 - Strategy 1 was finally discarded.

- Strategy 2:

  - The use of Robotics System Toolbox was explored in order to avoid the need for custom implementation of scheduler. (based on standard toolbox)

  - ROS (Robots Operating System) allows to:

    o deploy the parts of the model over different nodes of a network.

    o Transparently manage the data transfer between the different computing nodes.

  - Only master computer needs Simulink license. All other computers need just Linux with ROS installed (open source).
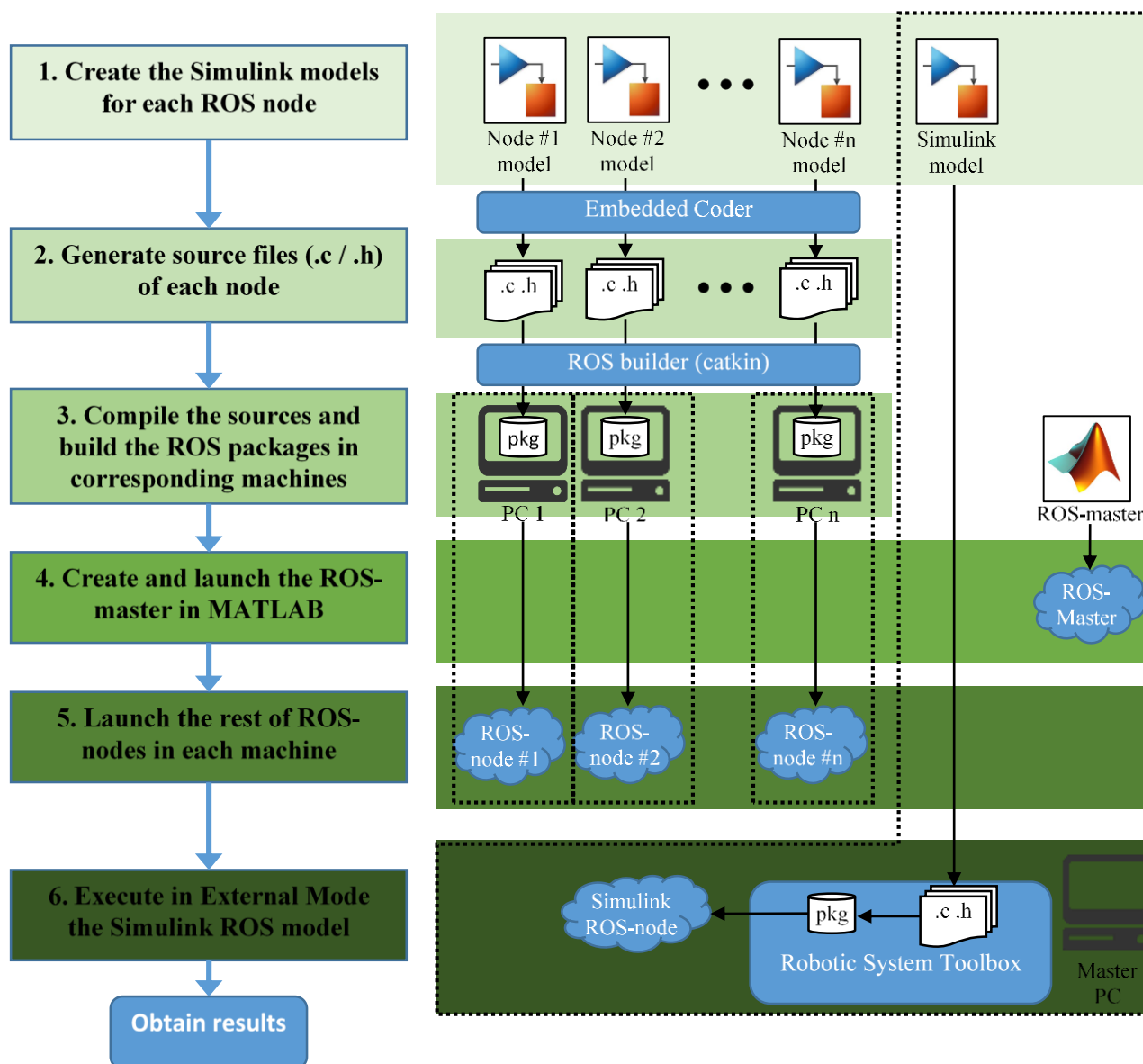
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- In a pipeline system the simulation or ROS is organized as follows:
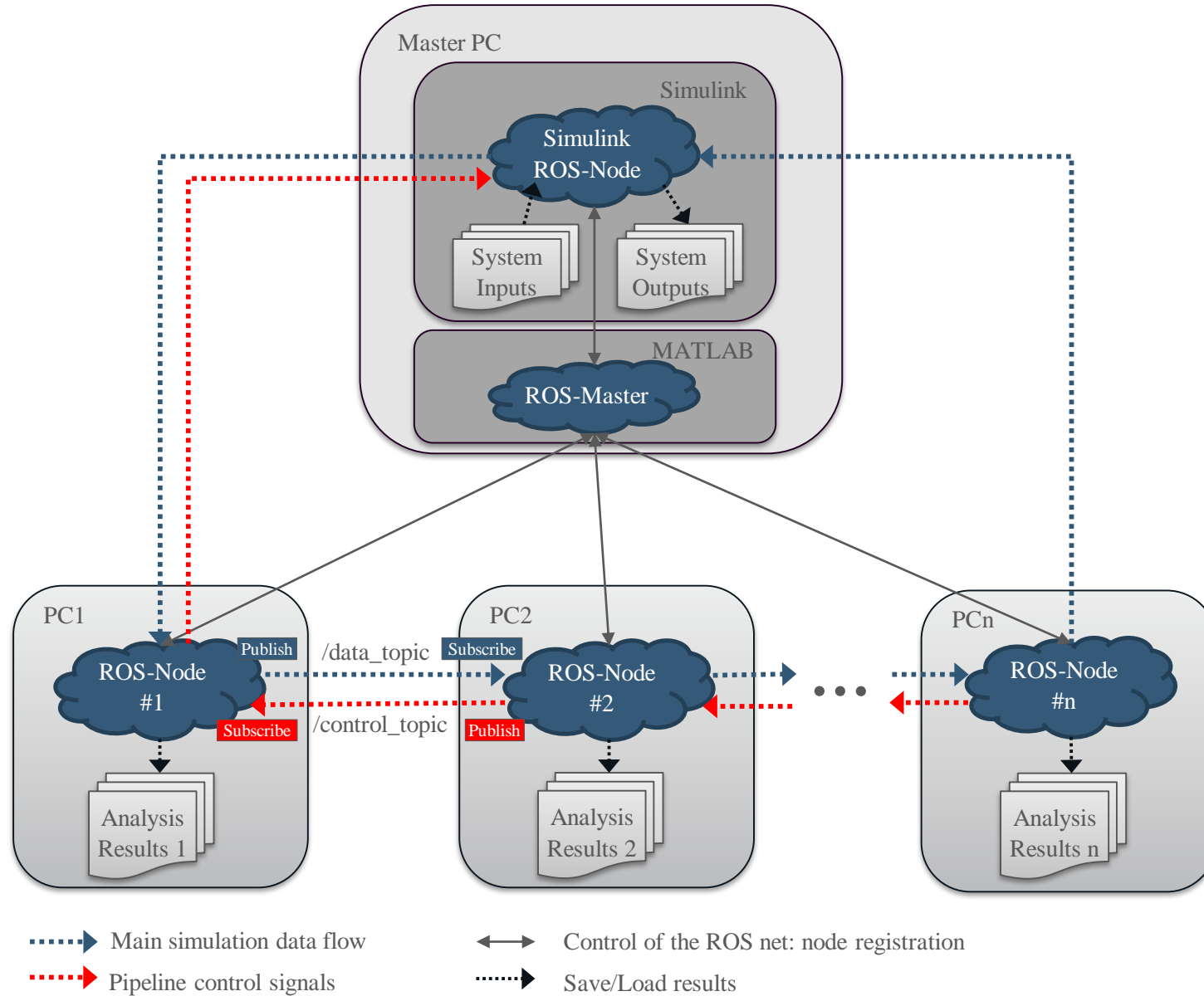
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- The model was accelerated to acceptable limits: Test case from 9 minutes to 3 seconds (x180 improvement!!!)

  - 3 sec x 1000 ≈ 1h instead of 1 week

- Acceleration of simulations achieved allowed us to exploit the advantages of detailed system level modelling:

  - System design was matured and validated at PDR (Preliminary Design Phase) prior to implementation & integration.

  - Consistency of high level design and implementation was maintained over the implementation phase by the use of the same test cases.

  - Integration phase was easier as implementation was matured.