WP10 – T10.4 – UC10.4 Industrial Inspection

ZG3D - Parellelization of an industrial inspection system

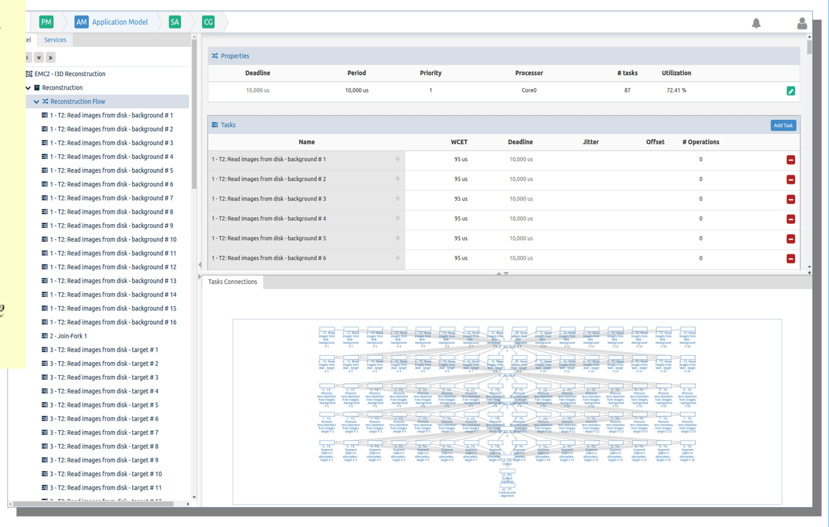
Abstract

- A **comparison** beetwen a **sequential** and a **parallel** model of the work performed at the inspection system to build a 3D representation of any digitized object is presented.
- The Use Case is based on a task of **3D object reconstruction** used in an industrial inspection framework to distinguish different objects and to find surface defects based on texture comparison.
- Modelled **"Application Software"** with one periodic flow representing the sequential and the parallel execution tasks of the reconstruction process. Modelled **"Execution Platform"** as 16 cores (two processors with 8 cores each one) to host the task set software model.
- **Implemented optimization** to exploit coarse- and fine-grain parallelism of the reconstruction process to take advantage of multi-core execution platforms.
- Execution times of each task have been measured and added to the application model. The art2kitekt tool suite provides a **Minimal Response Time** analysis for sequential and parallel execution of the modelled application.

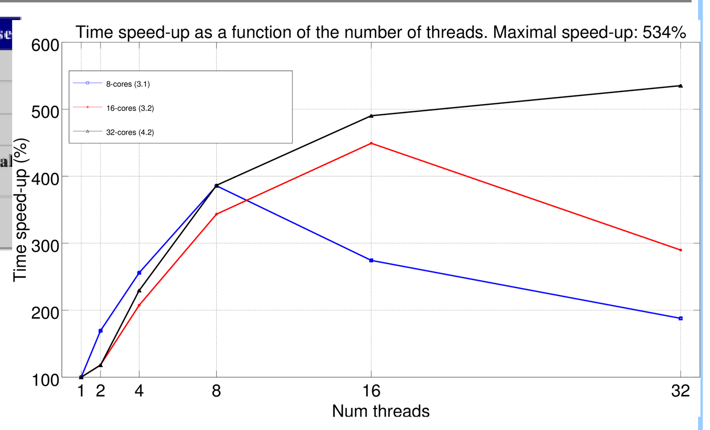
Application Software

- One flow to model the application software: parallel tasks (1 to 4) and common tasks (5 to 7).

- ***1 - Load cameras number and calibration:*** *Reading sub-process accessing disk storage.*
- ***2 - Reading images from disk:*** *Equivalent to the previous "Load distorted background/target images" sub-process also accessing disk storage.*
- ***3 - Remove lens-object distortion from images:*** *Equivalent to the previous "Undistort background/target images" computation intensive sub-process.*
- ***4 - Segment silhouettes:*** *Another step of the intensive computation process.*
- ***5 - Octree computing:*** *The most performance requiring stage and heavily parallelized with OpenMP directives.*
- ***6 - Surface marching cubes computing:*** *This subtask cannot be parallelized, and thus it is carried out once every octree computation has finished.*
- ***7 - Centroid and alignment:*** *Again, this task cannot be parallelized and it is initiated after the "Surface marching cubes computing".*



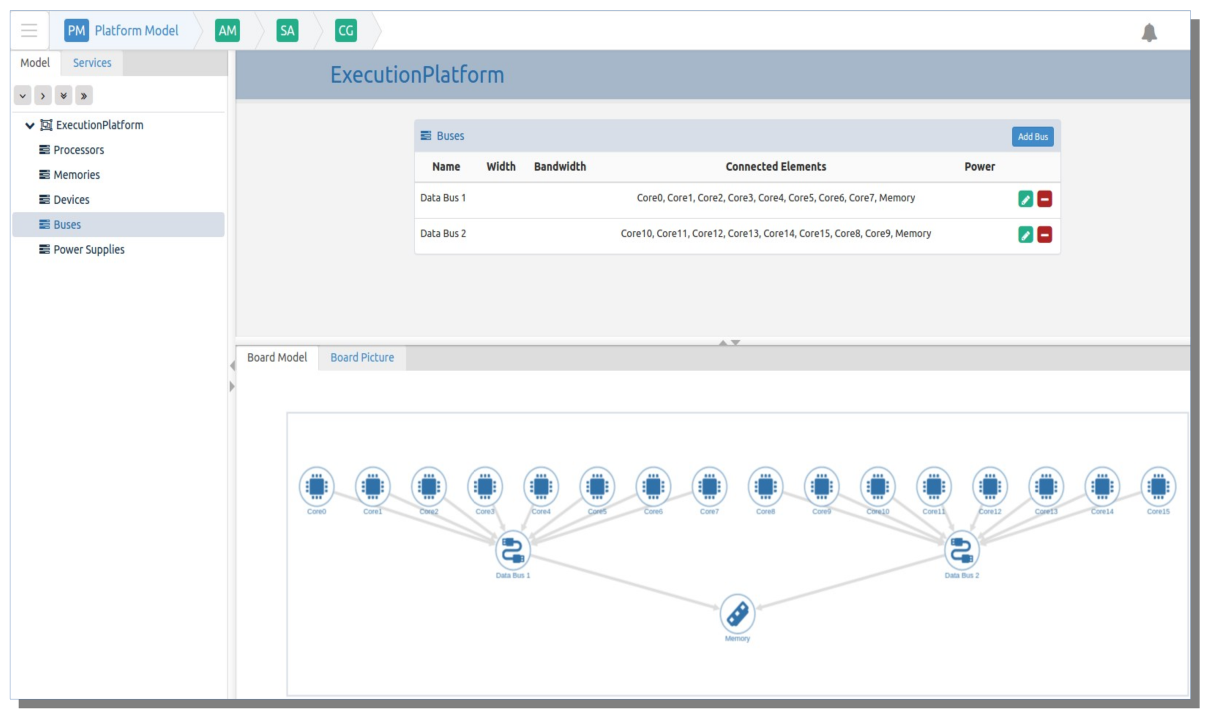
Reconstruction time for object A										Experiment number / purpose
1	2	3	4	5	6	7	8	9	10	
16.824	3.212	1.566	1.218	0.998	0.393	0.351	24.562	5.996	7.738	1) Base Response Time
16.613	3.157	1.496	1.176	0.979	0.376	0.351	24.148	5.829	7.535	2) Sequential interference
8.589	1.435	0.858	0.847	0.658	0.356	0.071	12.814	3.14	4.225	3.1) Max productivity with real cores
4.991	0.956	0.394	0.848	0.481	0.294	0.032	7.996	2.198	3.005	3.2) Hyper threading improvement



- 3D reconstruction time saving according to number of cores (see time VS cores). Steps 3,4,5,6,7 are considered.

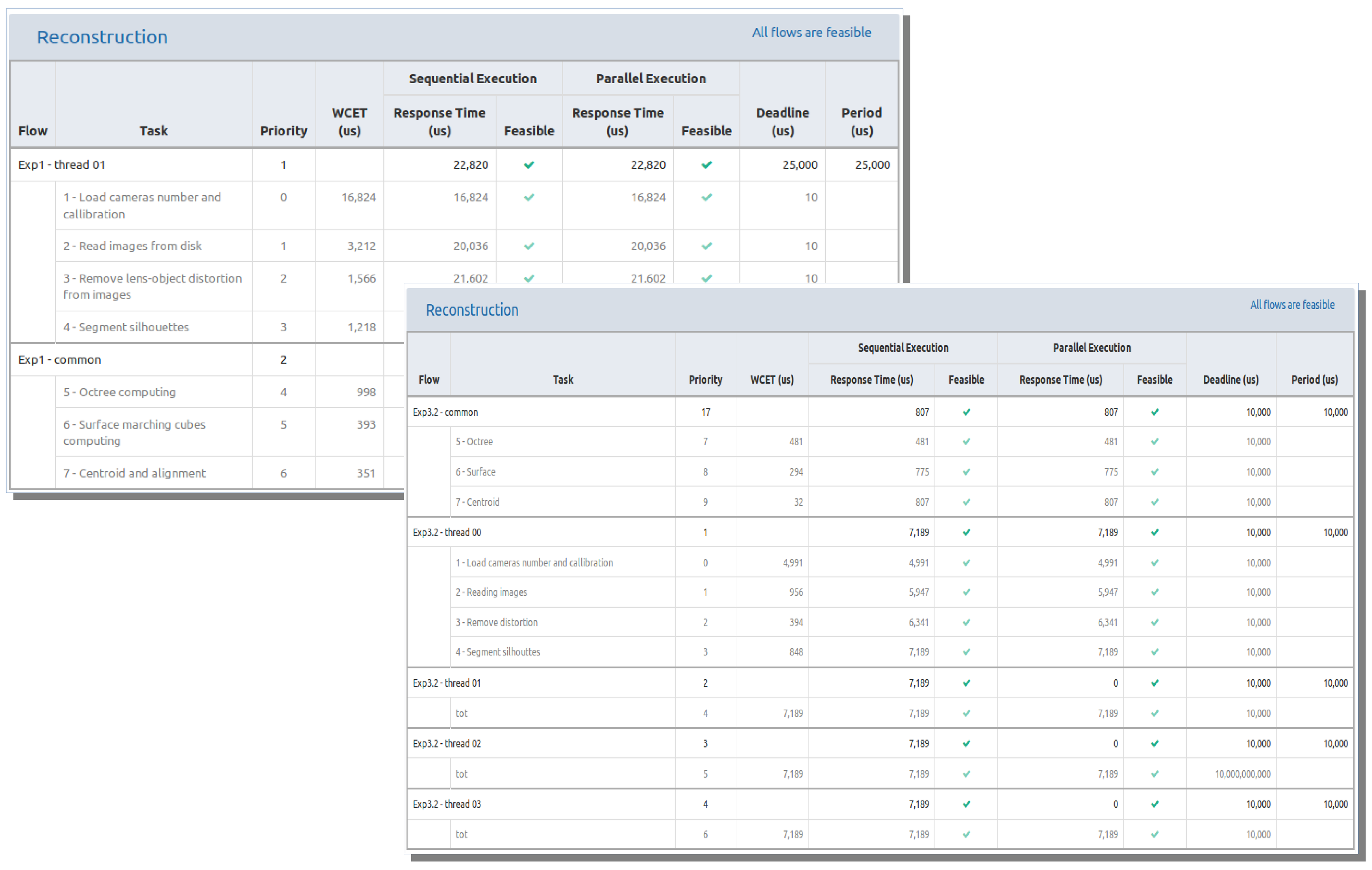
Execution Platform

- A multi-core execution platform has been predefined, with 2 processors, 16 cores and multithreading capabilities.
- Implemented parallelism into single and double object reconstruction.



System Analysis - MRT

- The implemented **Minimum Response Times** algorithm is fast enough to be executed "on the fly". The engineer is able to manually test several possible options and see the result immediately.



Reconstructed 3D object

- The objective of the Use Case is to compare between sequential and parallel models for a task of **3D object reconstruction**.
- The set of **images acquired from 16 cameras** are processed to build a 3D model of any object digitized by the inspection system.
- An **increased** overall **inspection performance** has been achieved with OpenMP parallelization over the previously described execution platform.
- **Reduction of** computation time in a roughly **500%** has been achieved by exploiting coarse parallelism (detailed results at D10.4, section 5) and thus decreasing **latency**.

Conclusion

- A tool suite named ***art2kitekt*** developed as an integrated software tool for designing and analyzing mixed criticality, real-time systems has been applied to perform the modeling and off-line analysis for a given hardware platform and software task set, with high performance demand.
- An engineeering process of design and analysis guided by the tool has been performed. A set of parallel tasks aimed to reconstruct a 3D object have been optimized to perform as fast as possible on a virtual multi-core execution platform.

Contributing Partners:

15Q-ITI

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The research leading to these results has received funding from the European Commission through the ARTEMIS Joint Undertaking under grant agreement n° 621429 and from the Spanish Ministry of Industry, Energy and Tourism.

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