DEFENCE AND SPACE

Systema-Thermica

European Space Thermal Engineering Workshop 2021

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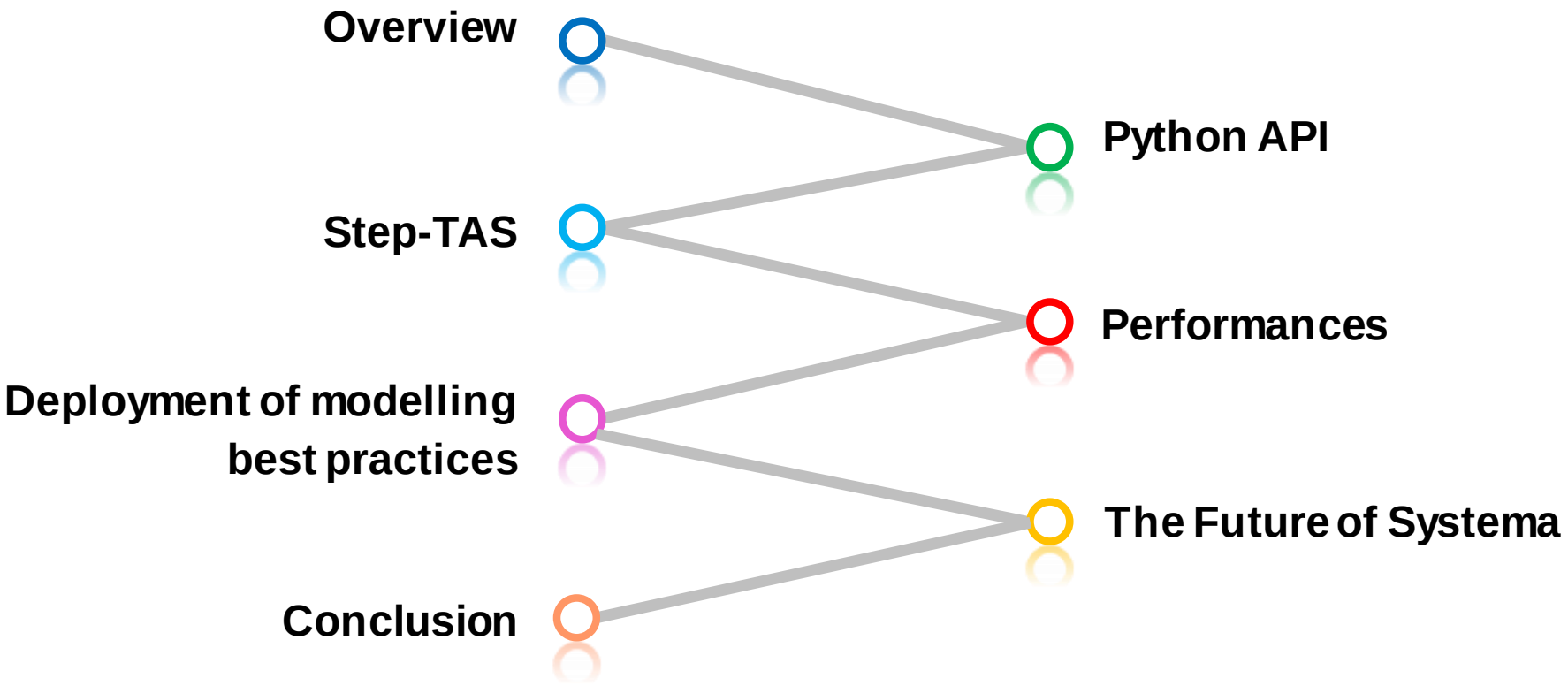
12th-14th of October, 2021

AIRBUS

Systema

Agenda



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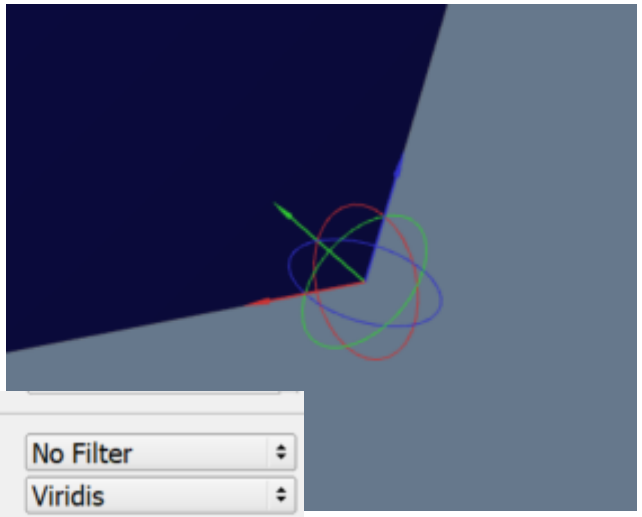
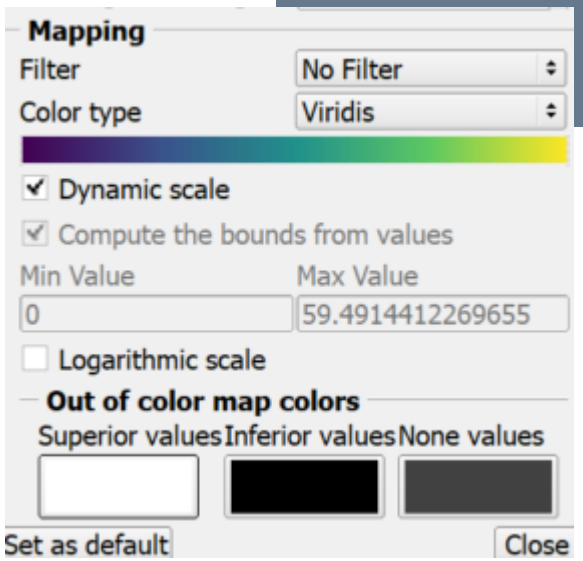
Overview

4.5.3b → 4.8.3P3 → 4.9.1 → …

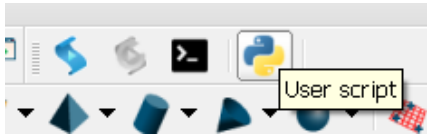
- **Systema - Thermica 4.8.3P3 on May 2021:**
  - Bugfix on Thermisol
- **Systema - Thermica 4.9.1 Sept. 2021:**
  - The main effort has been put on performances & optimisations
  - Minor improvements on Thermica & Thermisol
- **User Interface / Connecting with other softwares**
  - Step-TAS improvements
  - New 3D ergonomic features
  - Improvement of the Python library





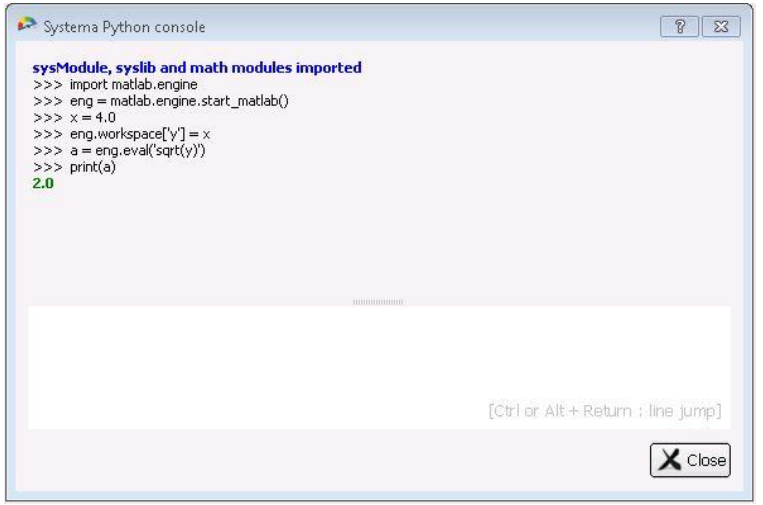
Python API improvements

Since Systema 4.5, the Systema Python API has been continously improved as demonstrated in the previous ESTEW presentation.



In Systema 4.9.0, a big effort has been made to enrich the Python API to grant:

- The access to Orekit methods
- The management of any kind of kinematics laws
- The management of variables



The Python API provides now a very complete and powerful way to :

- Add your own functionnalities to Systema and enrich the graphical user interface
- Integrate Systema to your own tools suite

New methods are available in the Python API to:

- Determine if an application property is overloaded or not
- Create a single computation point in a mission file
- Create a set of sequence intervals in a mission file

STEP-TAS

Systema

Within the framework of a joint work between ESA and our team, we had the opportunity to improve the STEP-TAS/Systema interface. In the previous versions, some features such as:

- The validation check at import and export with dedicated error messages
- The support of new shapes such as antenna with focal
- The possibility to import and export irregular meshing
- And finally there is now an automatic fix of the coplanarity of exported quadrangles

In the 4.9.1 version, complementary features have been added:

- Import/export of the bulk properties including activity
- Import/export of the transverse properties of materials
- Import/export of the radiative enclosures
- Export of 4,5 and 6 faces boxes as boxes
- Issue when exporting 4 points truncated sphere
- Avoid creating multiple materials with the same properties on export
- Improvement of infinite solid by plane cutters management

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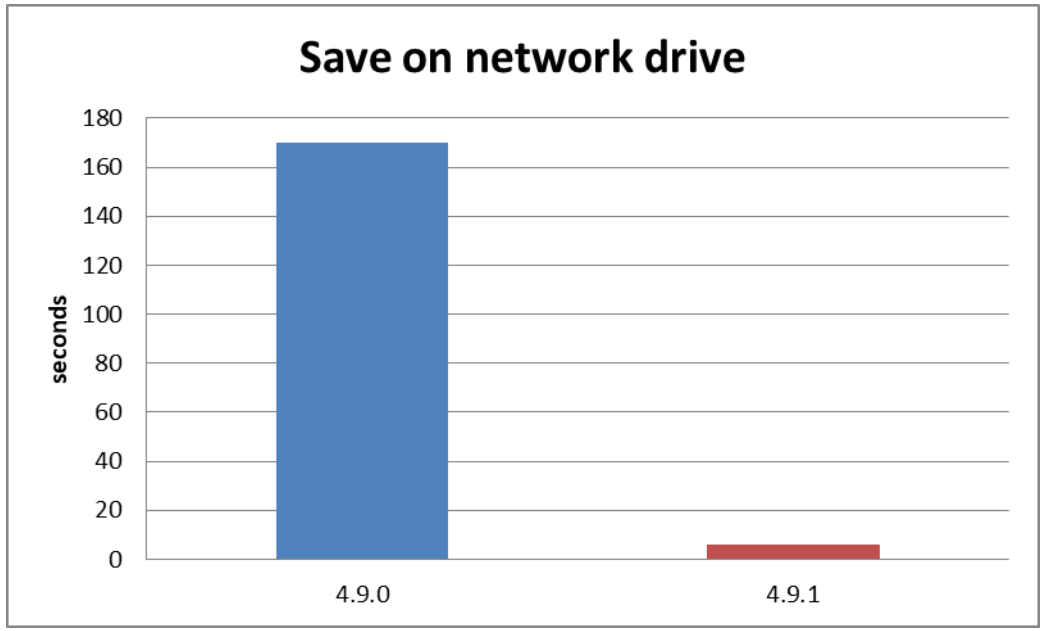
Performances

Systema 4.9.1 main objective has been to work on performance when using the software. The test case here is done with the following inputs :

- Number of Thermal Nodes : 25.174
- Number of GL : 54.602
- Number of GR : 5.904.564
- Number of GF : 530



4.9.0	4.9.1
170s	6s

Performances

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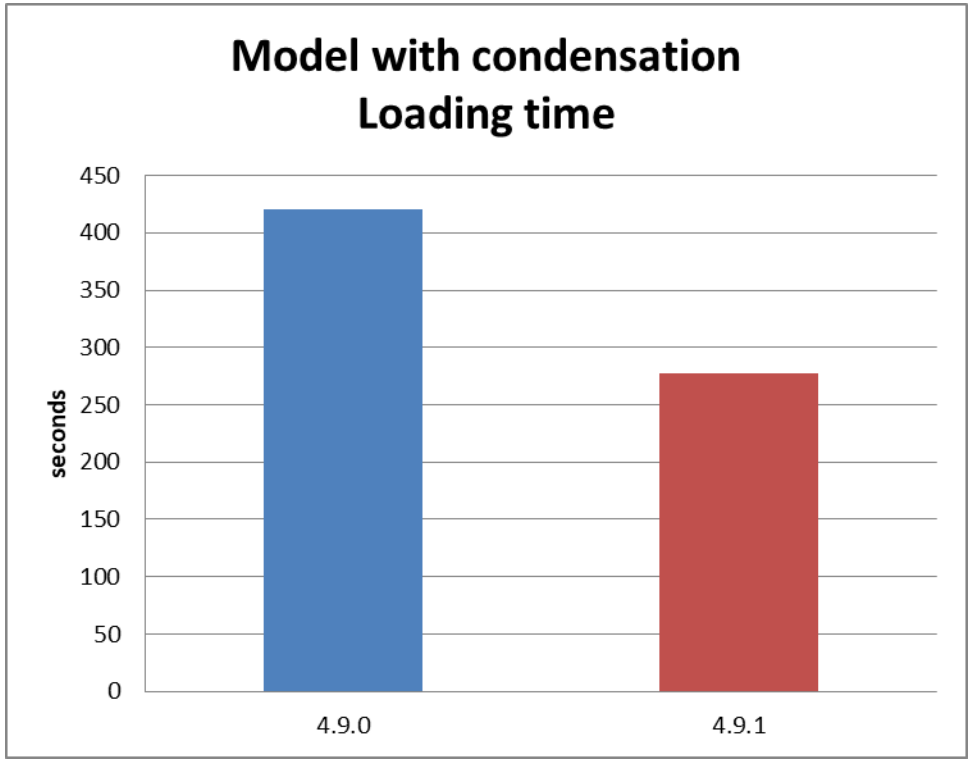

4.9.0	4.9.1
420s	277s

Performances

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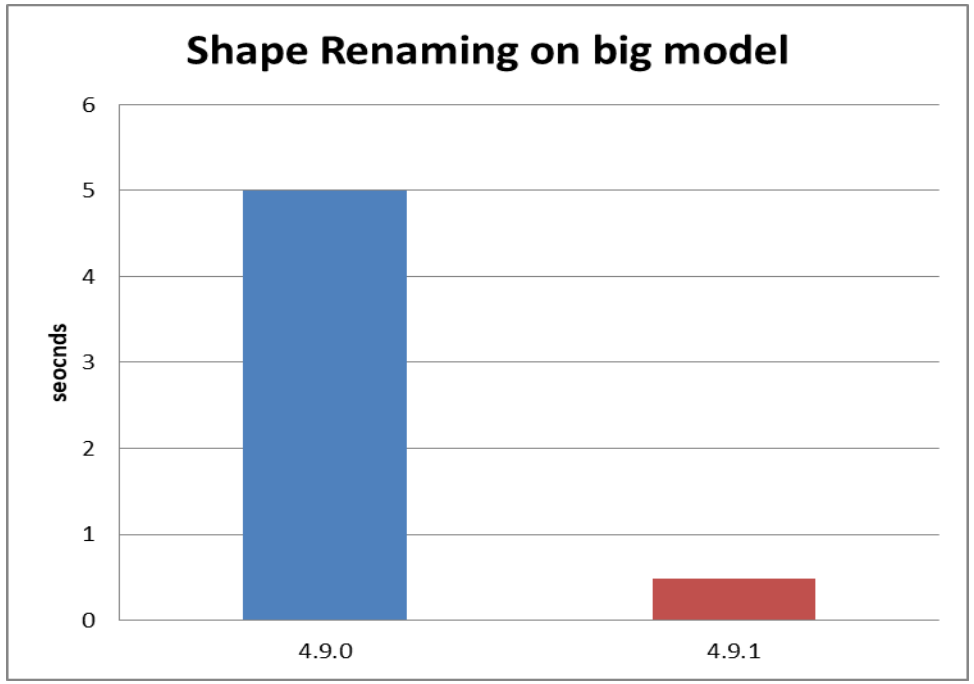

4.9.0	4.9.1
5s	0.48s

Performances

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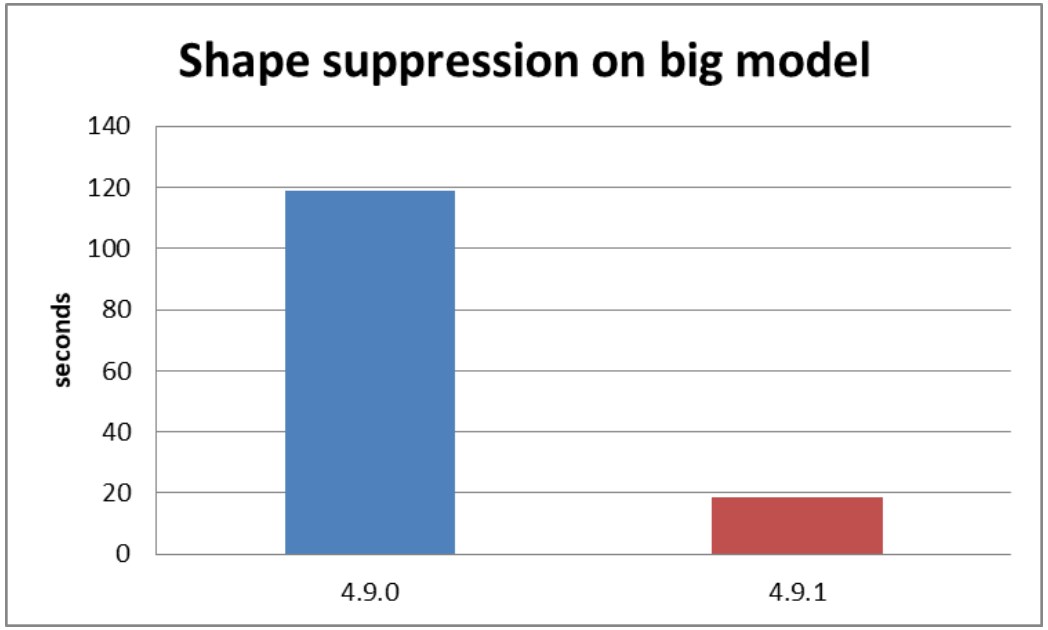

4.9.0	4.9.1
119s	18.7s

Performances

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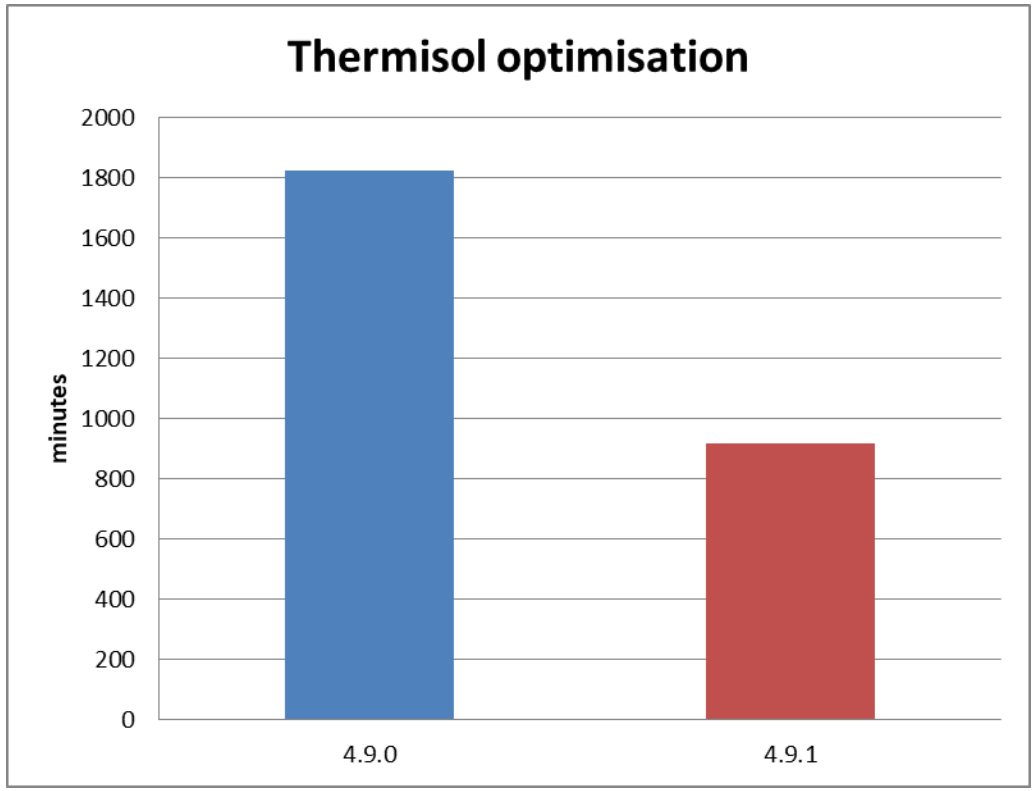

4.9.0	4.9.1
1 826mn	919mn

Performances

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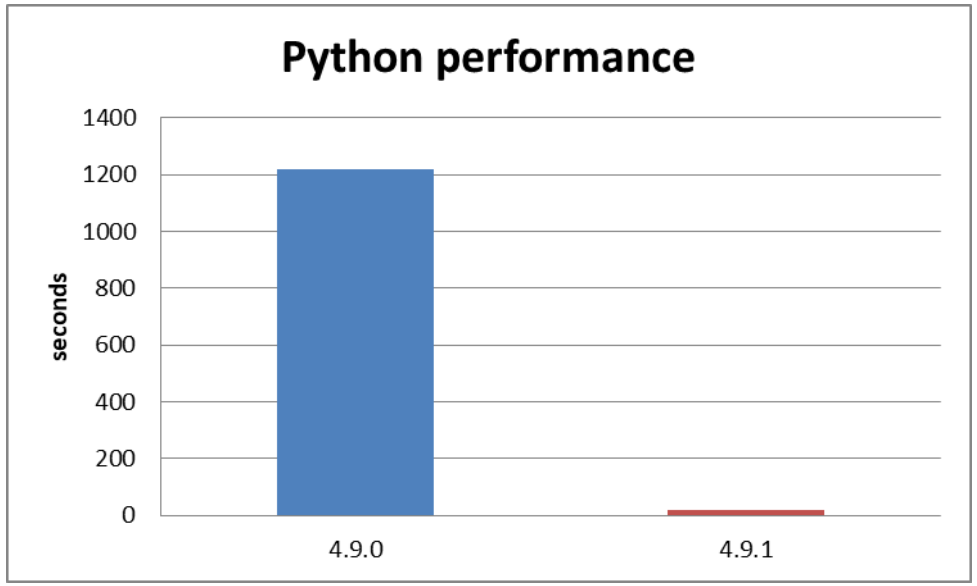

4.9.0	4.9.1
1 220s	18s

**Doing symmetry with script on star trackers with meshing*

Systema

Deployment of modelling best practices with Systema

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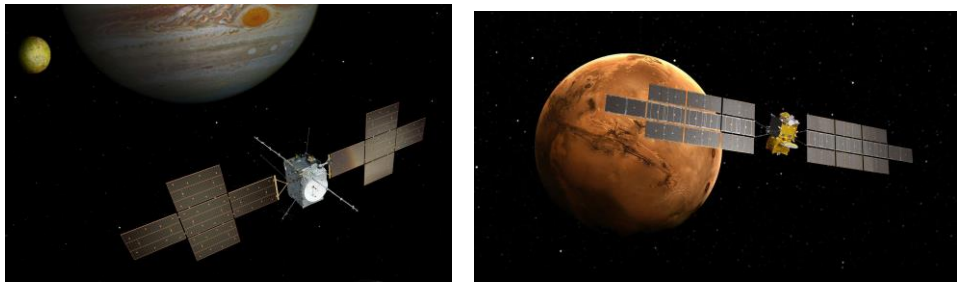
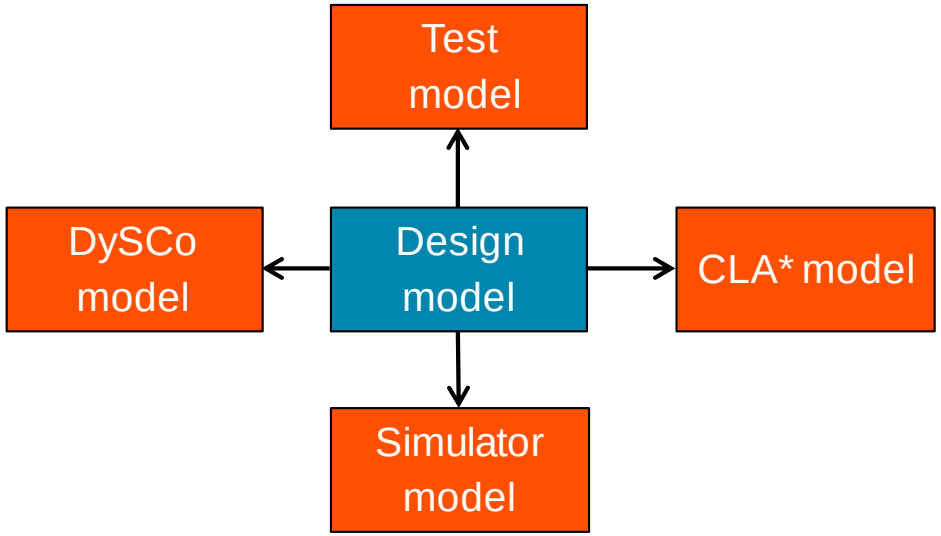
Objectives & motivations

- Emphasis on model quality to:
  - Increase software performances
  - Facilitate model updatability and re-use
  - Enable easy model exchanges (format conversion)
  - Control results accuracy/computation duration balance



JUICE and MSR-ERO spacecraft views

- Various motivations:
  - Ongoing major projects involving many actors contributing to the spacecraft thermal model (JUICE, MSR-ERO, …)
  - Increase in satellite complexity and model size
  - Growing direct re-use of the design model
  - Need for data continuity, traceability and automation



Design model re-use diversification

*Coupled launcher analysis: simplified S/C model delivered to launcher authority for launch cases simulation

Best practices deployment

- Sources:
  - ESA ECSS – Thermal Analysis Handbook (public)
  - Software providers user guides (public)
  - Company thermal analysis process (internal)

- Examples:
  - Generic: Model updates should be tracked with a software configuration tool (e.g. subversion, git, …)
  - Tool dependent (Systema): Do not use the simplified RCN conduction with cutters
  - Recommended checks: Internal cavity nodes shall not have no direct couplings to space
  - …

- Difficulties:
  - Very frequent model updates but reduced time allocated to model reviews
  - Guidelines to be adapted to the projects and associated tools (Systema, ESATAN, NX, …)
  - Difficult knowledge management on modelling tools (external stakeholders, people turnover, …)

→ **Use continuous integration tools to apply best practices:**

Updates tracking with git

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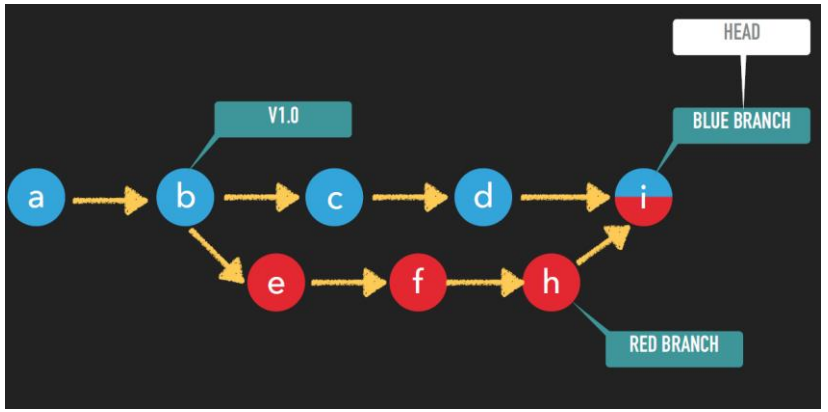
- Git is a version control software tracking changes in files. It is:
  - Open-source and cross-platform
  - Decentralized and flexible
  - Well tested (since 2005), optimized and integrated to other tools
  - The official version control tool at Airbus



Evolutions of model states as depicted in Git

- Using Git for thermal modelling:
  - Facilitates concurrent modelling with its branching/merge capability
  - Provides a model updates history with dates and usernames
  - Users can reach previous model versions at any time, enabling analysis folder cleaning and archiving

Update MZ design and PMU radiator stiffeners.	Antoine Caugant	5 months ago
Update battery modelling (radiator is mm thick instead of mm).	Antoine Caugant	5 months ago
Update PPS model and associated Qi/Qr	Antoine Caugant	5 months ago
Regenerate dissipations with new battery values (BOL/EOL).	Antoine Caugant	5 months ago
Update the PPU hk to fit the CAD baseplate cuttouts.	Antoine Caugant	7 months ago
Move PPU TM to wall node close to new TRP	Antoine Caugant	7 months ago

Example of thermal model Git tree

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Continuous integration with GitLab

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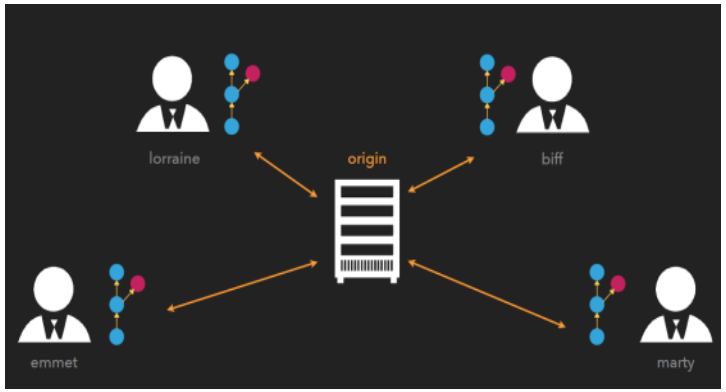
- GitLab is a web-tool integrating:
  - A central Git server
  - Online peer review tools
  - Integrations with other tools like Jira
  - Jobs automation through pipelines

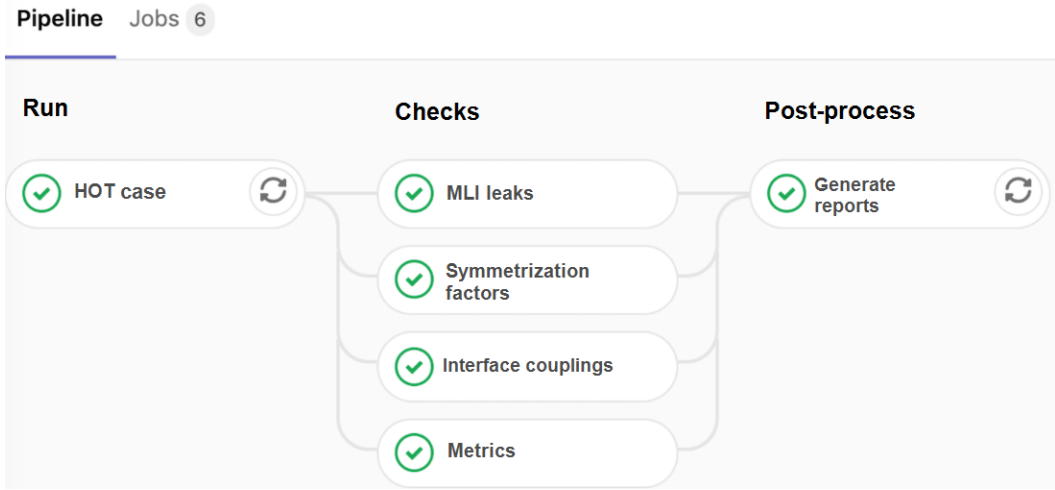
Jira Software

CI/CD



GitLab central server

- Using GitLab for thermal analysis:
  - Centralize model updates in a generic common space
  - Automatically links model updates and Jira tickets
  - Automate execution of runs, checks, metrics generation and post-processing through pipelines



GitLab pipeline thermal example

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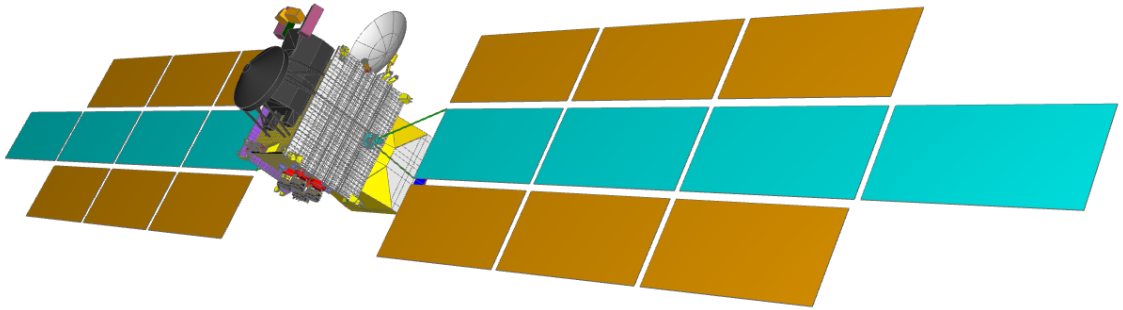
Use case: MSR-ERO PDR model

- Applying continuous integration enabled the detection of:
  - Important number of surfaces (>30,000)
  - Meshing condensation multiple definitions
  - Meshing opening/edition/saving time above average
  - 40 unused materials
  - …



MSR-ERO thermal meshing

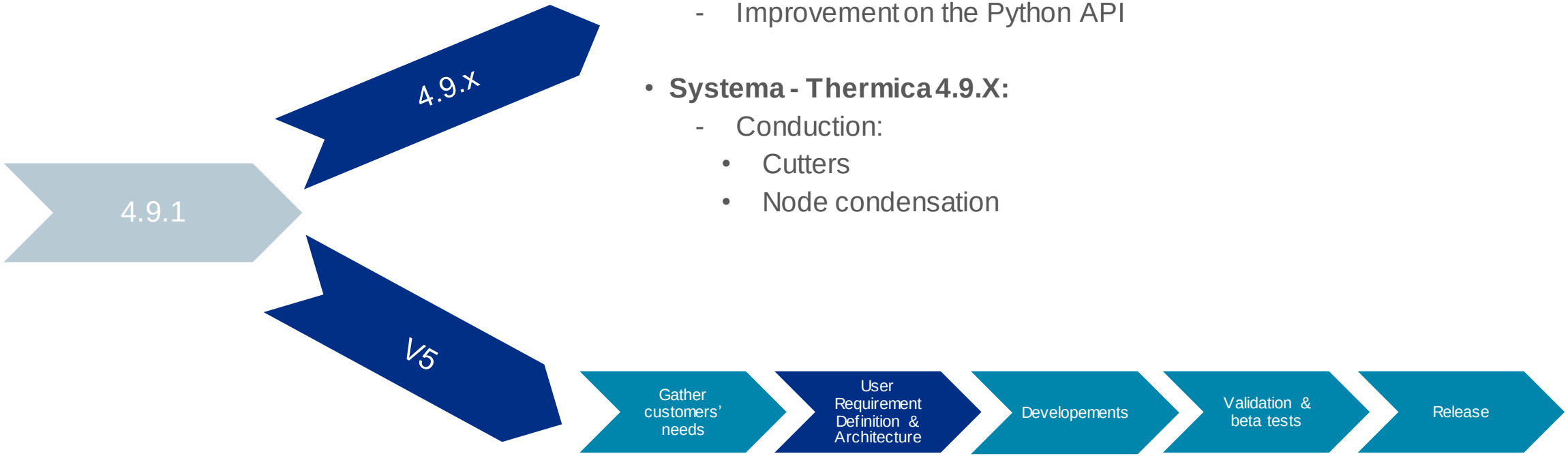
- Proposed actions:
  - Using a more recent version of Systema (4.9.1) reduced:
    - ✓ Meshing opening time by 30%
    - ✓ Model edition time by 90%
    - ✓ Meshing saving time on a Network drive by 80%
  - Rationalization of meshing condensation reduced SYSMSH size by 20%
  - Unused materials were deleted for more clarity
  - Reduction of some structural elements was recommended for next phases
  - …

Clear interest demonstration of the methodology

The future of Systema

- **Systema 4.9.2 LTS (?):**
  - No new major features expected
  - Improvement on the Python API

- **Systema - Thermica 4.9.X:**
  - Conduction:
    - Cutters
    - Node condensation



Systema V5

Survey results :

- Around 50 to 60 answers throughout the entire survey
- Participants from : ADS, OHB, Swedish Institute of technology, Epsilon, Sodern, ArianeGroup, Aerospacelab, Hemeria, and resellers.
- 50% are daily users of the software
- 75% are using LTS version 4.8.3P and only 30% the latest version.
- Over 90% of users are interfacing with other disciplines for Model Exchange (mainly Mechanical and Power).
- Systema is well embedded in internal processes

- Data Management
- Performance
- CAD management
- Meshing capabilities/control
- Analysis automation
- Automatic reporting

Conclusion

- Systema LTS V4.8.3P3 and Systema V4.9.1 are now available for download.
- Main improvements concern the performance and user experience.
- Better Step-TAS compatibility and a richer Python API

- The best practices approach seems to show interesting benefits
- It is still in an early development phase at Airbus
- Interest to share with the community

- Systema V4.9.2 to be exptected for next year (Thermica oriented).
- Systema V5 definition is on-going.

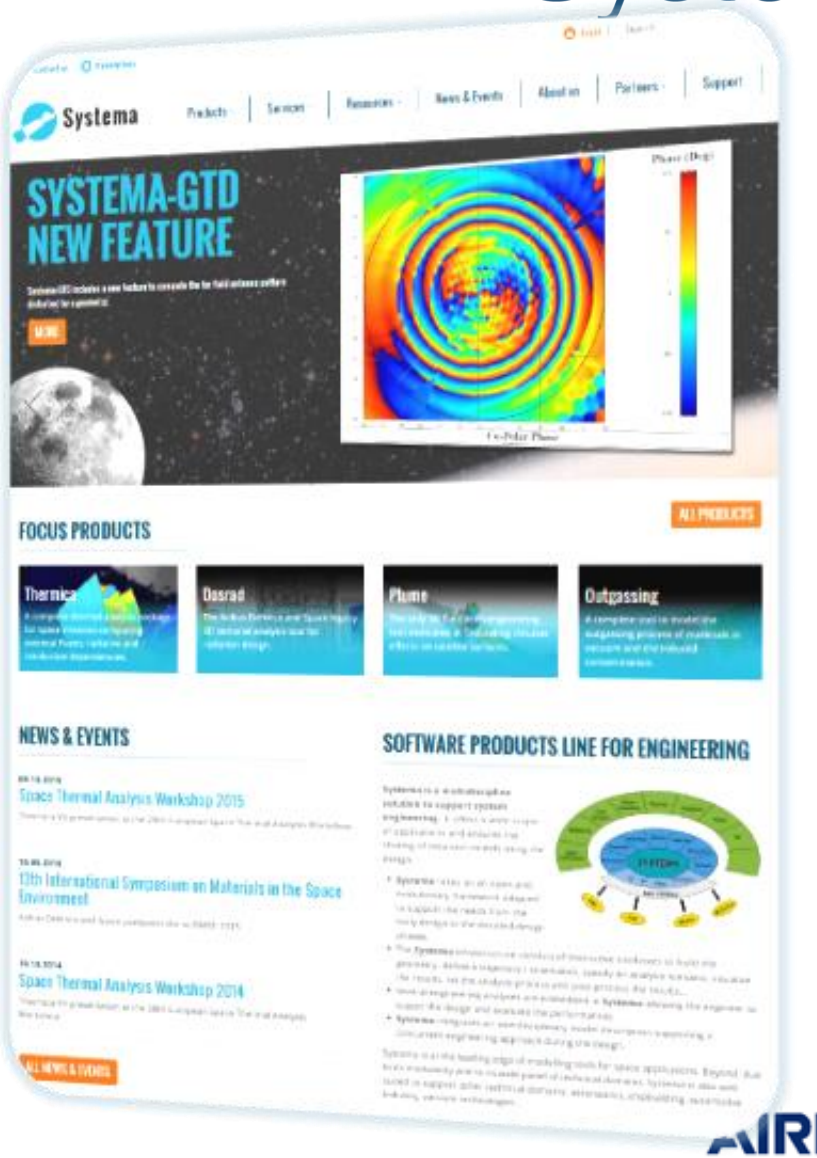
Keep in touch

- Visit our website: www.systema.airbusdefenceandspace.com

- Visit our linkedIn: www.linkedin.com/company/systema4

- Contact us by e-mail: engineering.software@airbus.com

- Use the hotline service: +33 (0)5 31 96 80 00



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Thanks for attention!

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