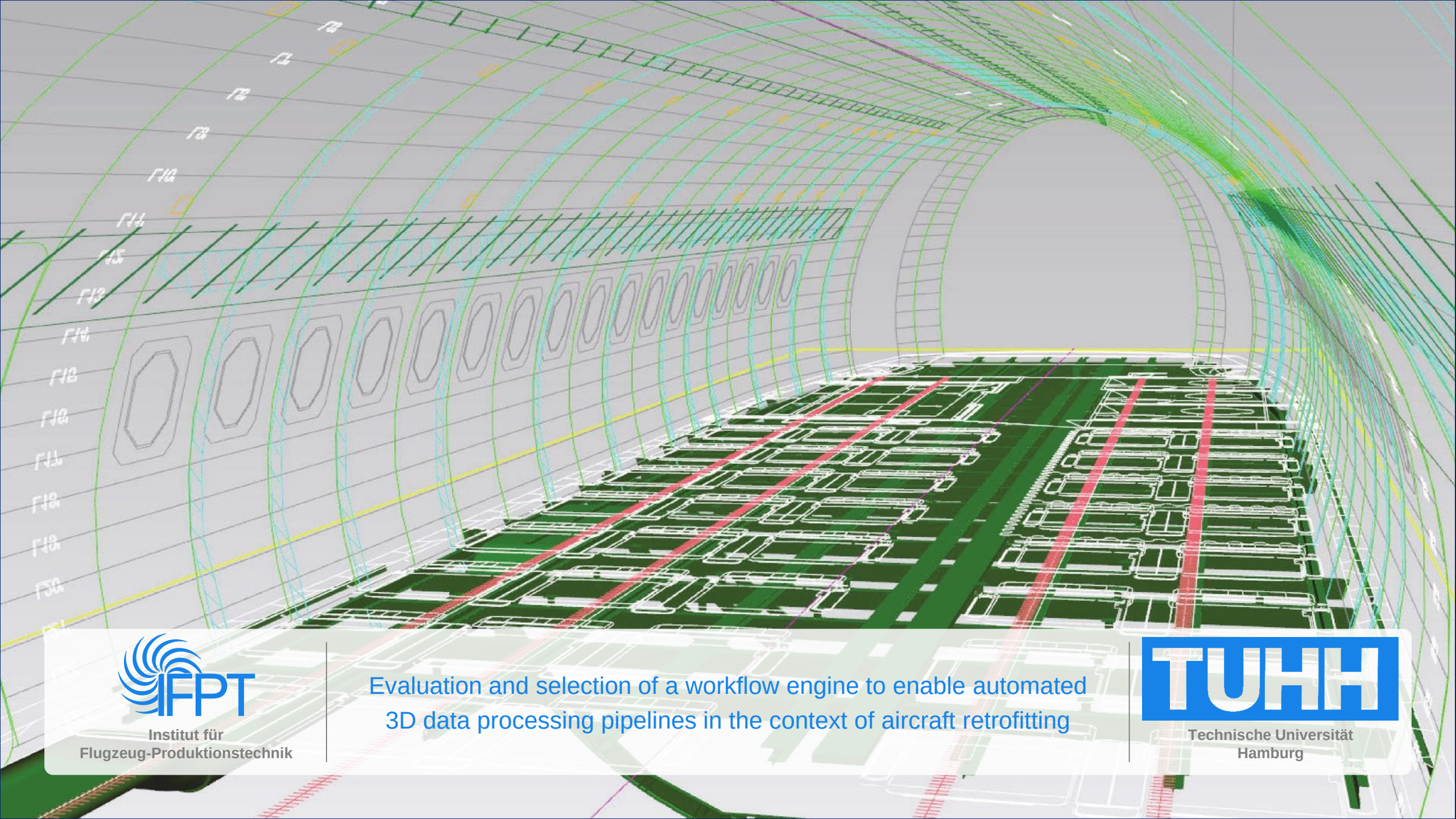
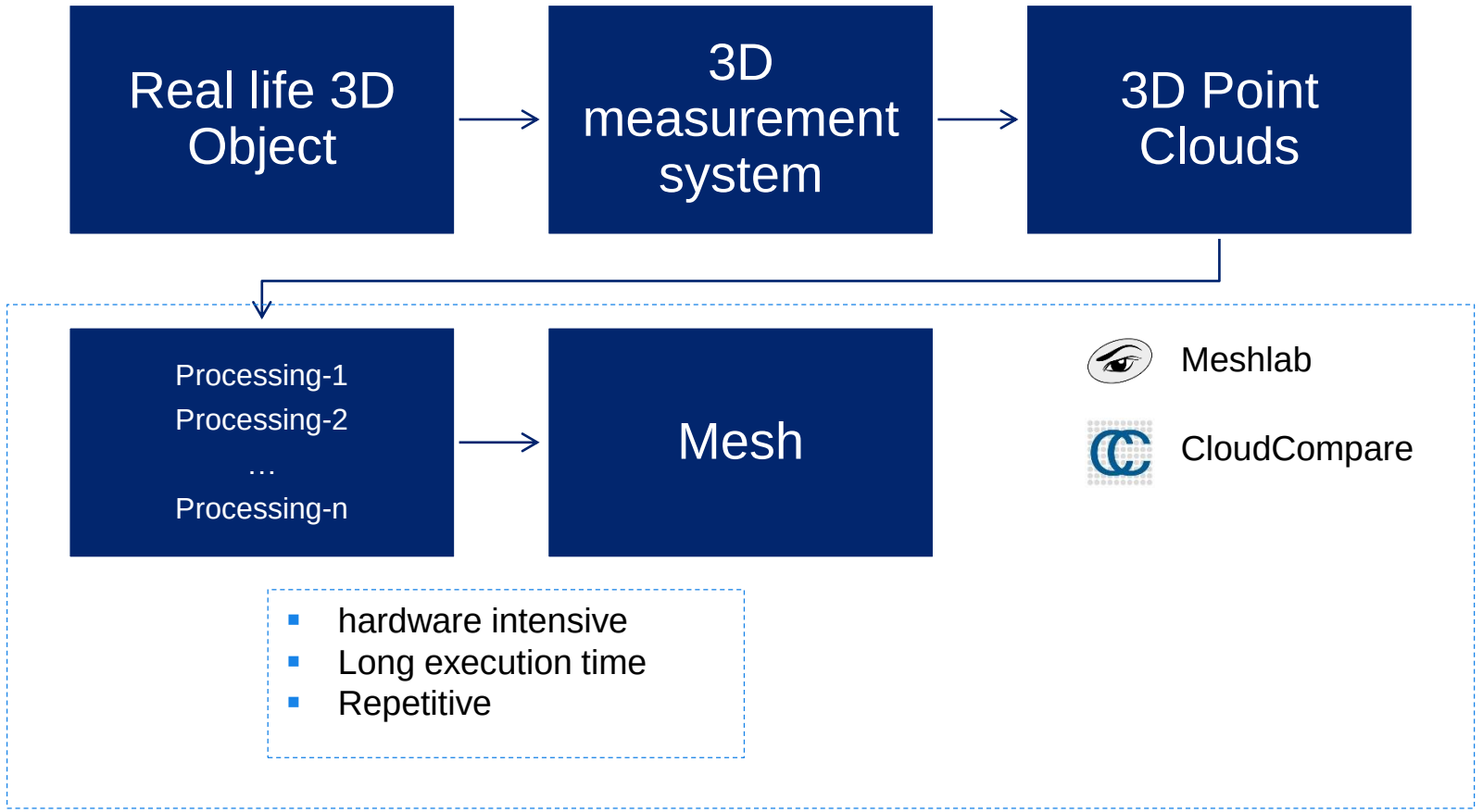


Evaluation and selection of a workflow engine to enable automated 3D data processing pipelines in the context of aircraft retrofitting

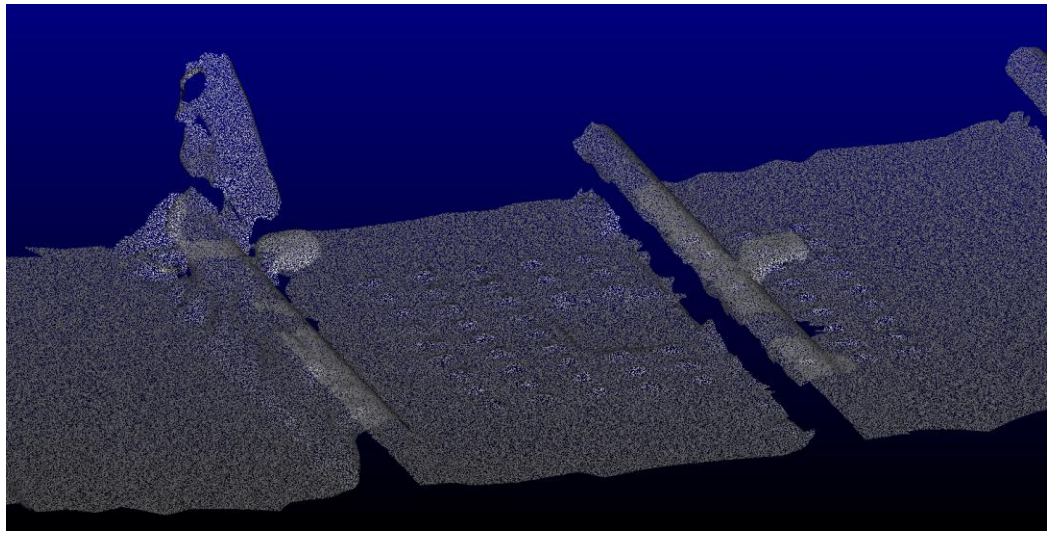
Institut für Flugzeug-Produktionstechnik

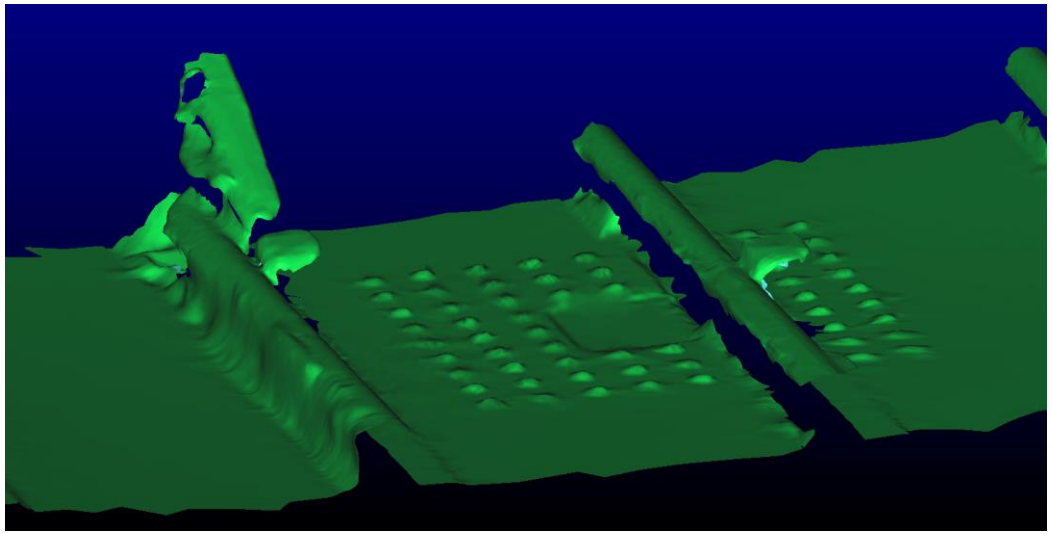
Technische Universität Hamburg


Real life 3D Object
3D measurement system
3D Point Clouds
Processing-1
Processing-2
…
Processing-n
Mesh
Meshlab
CloudCompare
hardware intensive
Long execution time
Repetitive

Artifacts generated by a 3D data processing pipeline

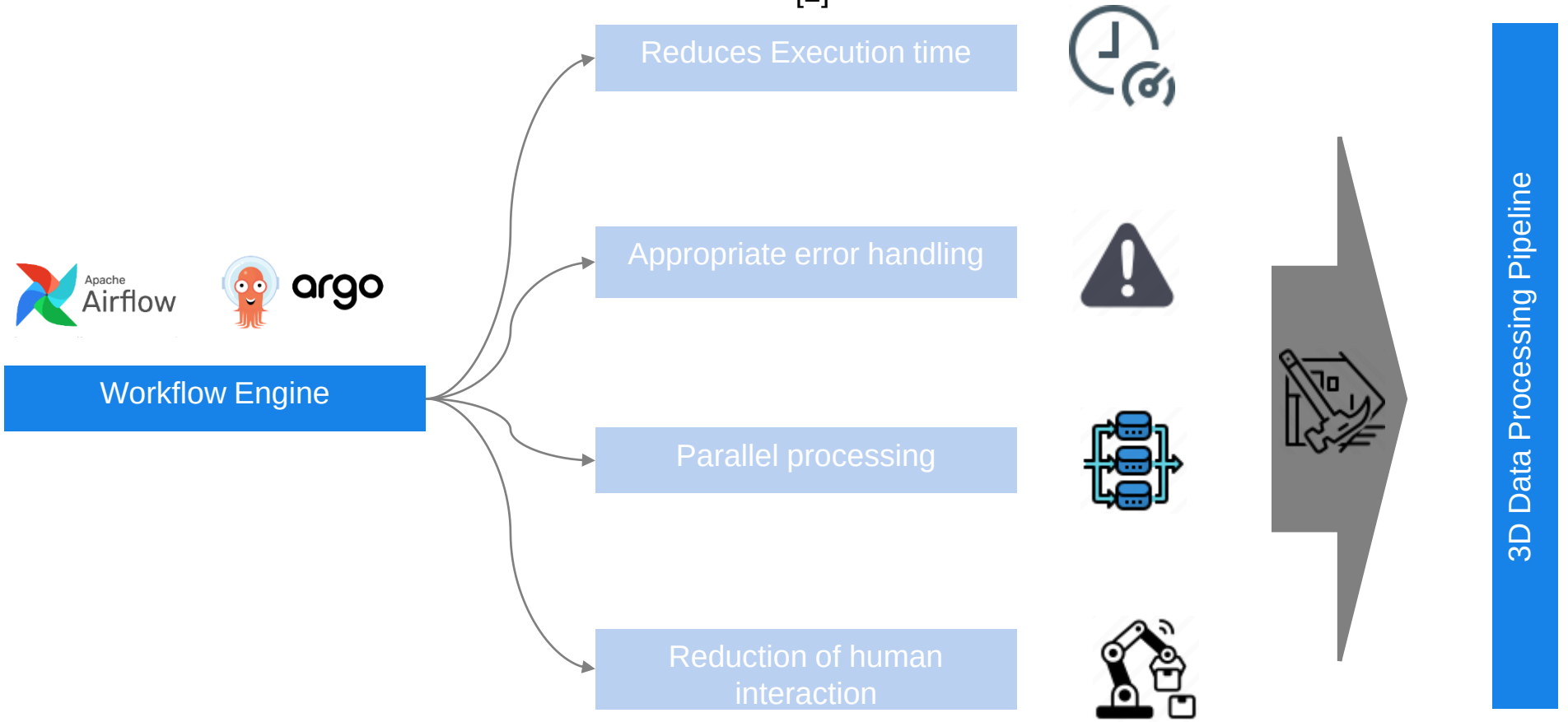
[1]





3D Data Processing using Workflow Engine

[2]



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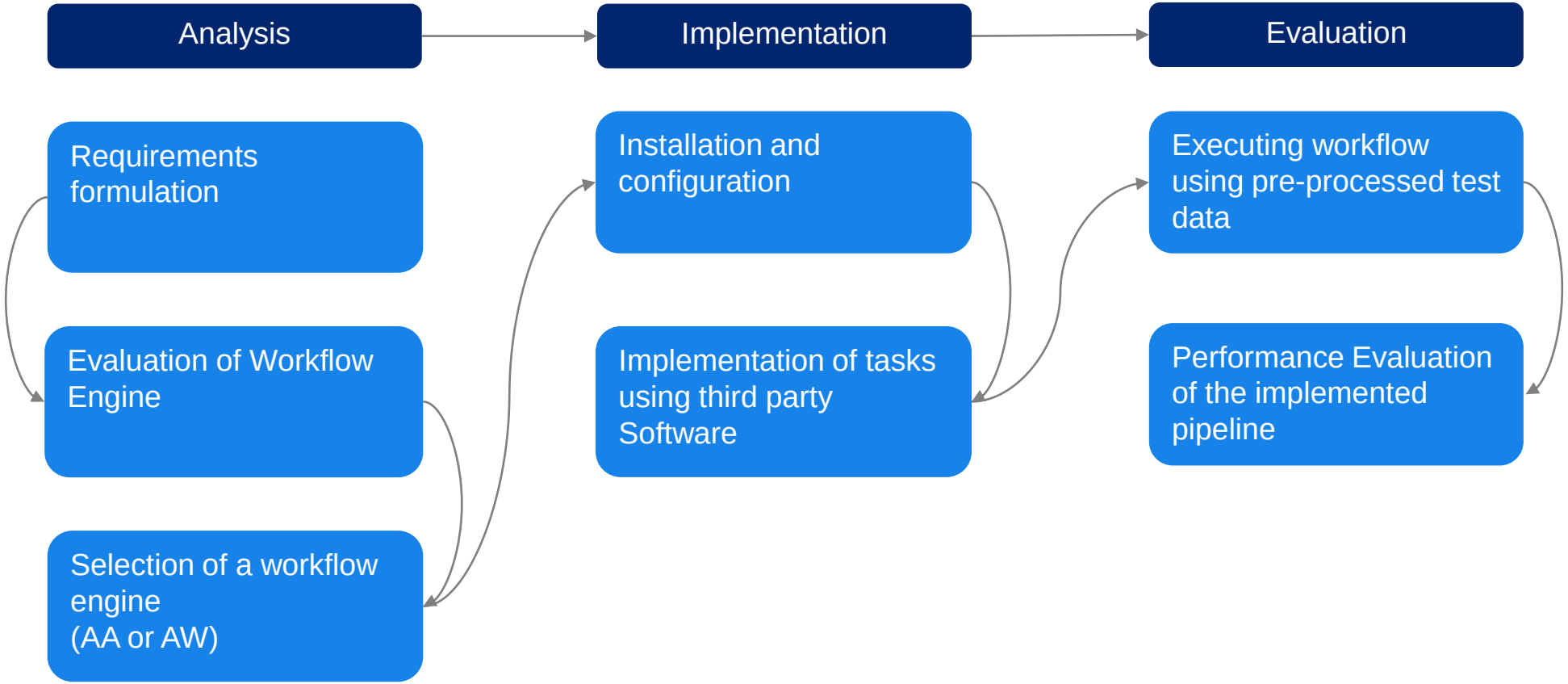
Core Project Tasks



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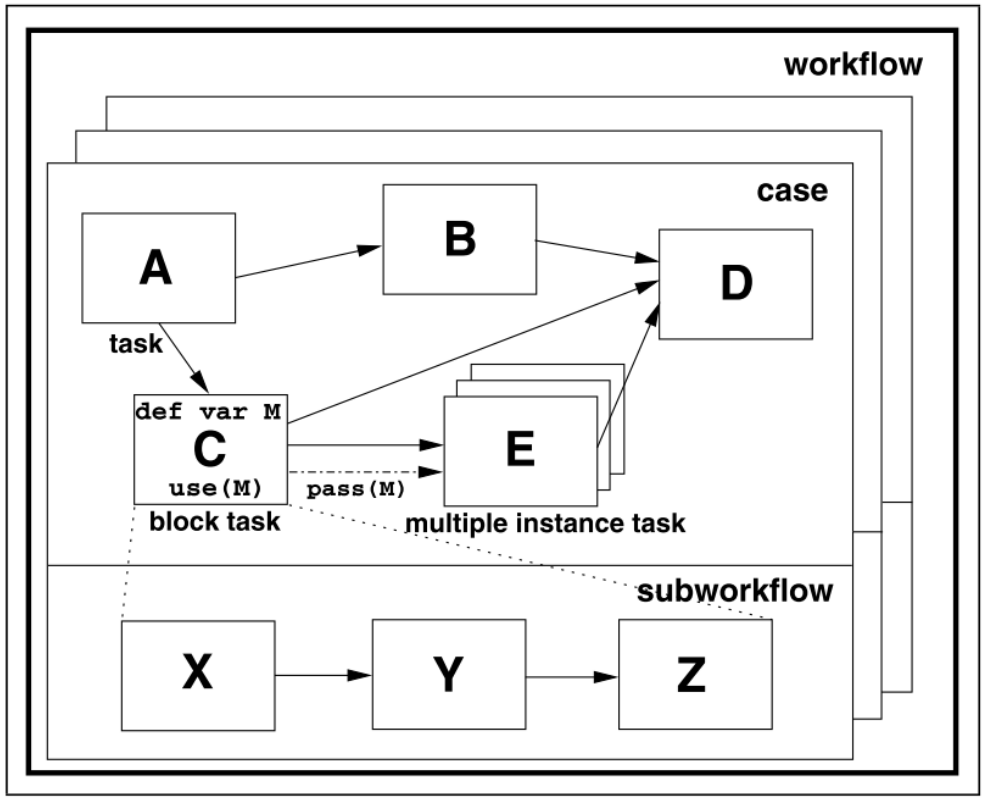
So what is a Workflow Engine?

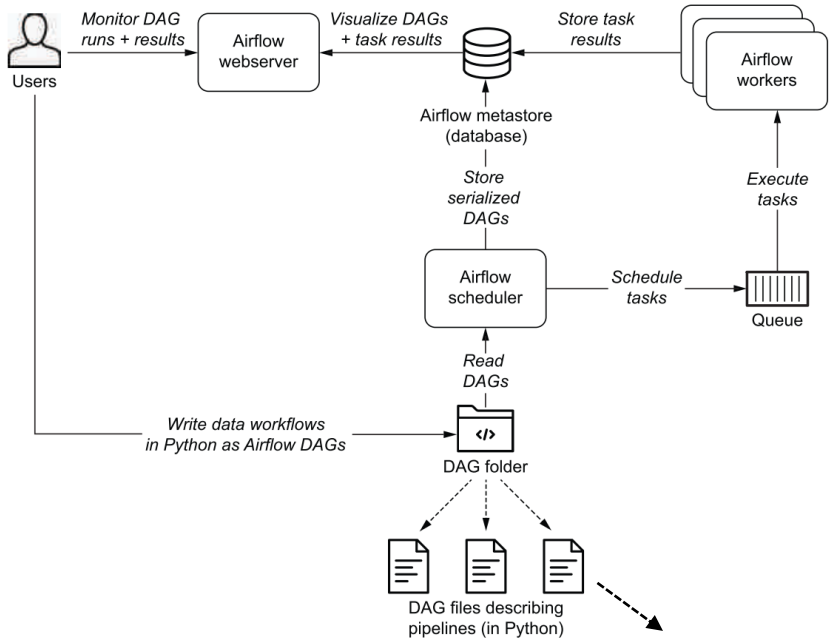
- Software systems that facilitate the automation of a workflow
- A workflow consists of several processes
- Defines Workflows in DAGs



[3]

[4]

Apache airflow

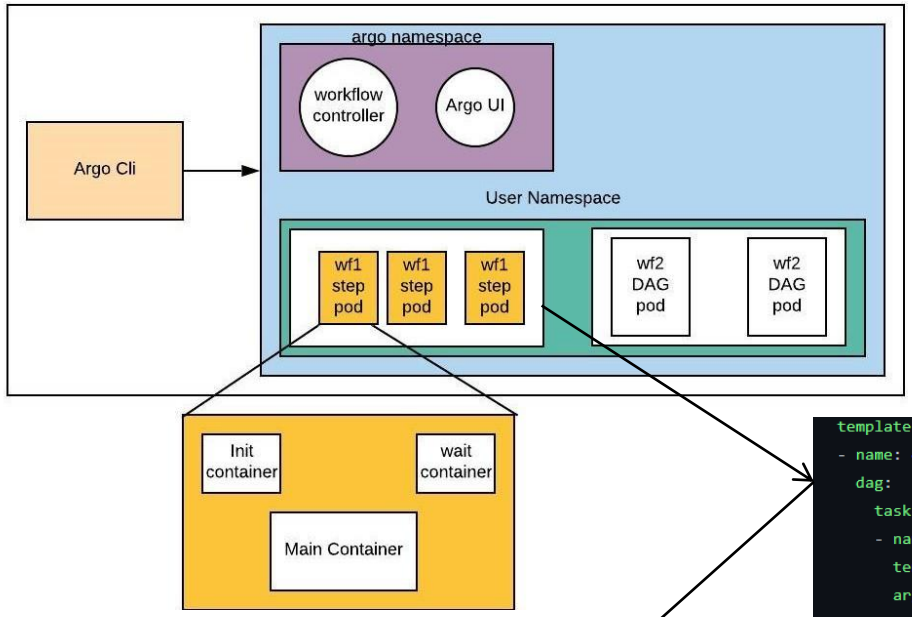



```python
t1 = BashOperator(
    task_id='print_date',
    bash_command='date',
)

t2 = BashOperator(
    task_id='sleep',
    depends_on_past=False,
    bash_command='sleep 5',
    retries=3,
)
```

Argo Workflow

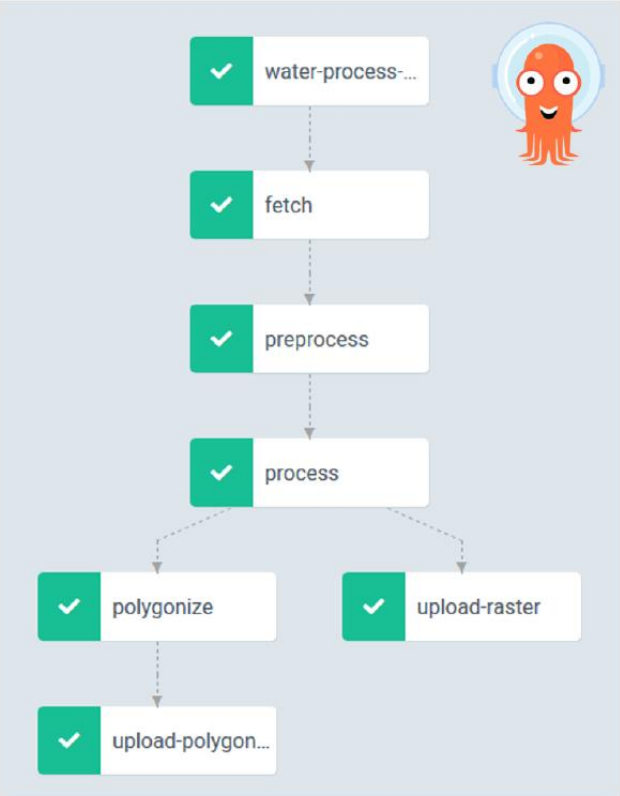
[5]



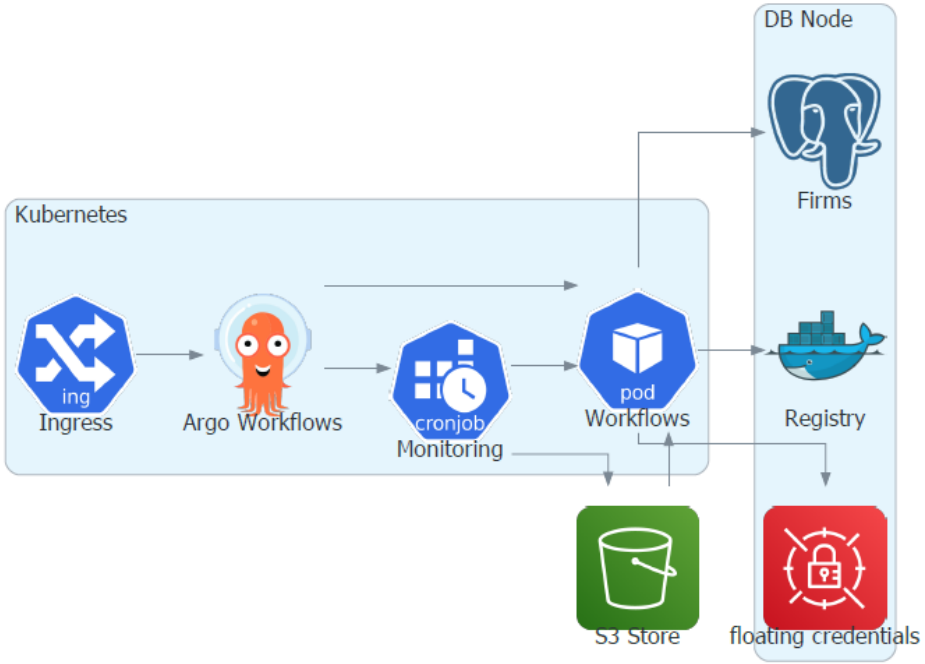

```yaml
- name: echo
  inputs:
    parameters:
    - name: message
  container:
    image: alpine:3.7
    command: [echo, "{{inputs.parameters.message}}"]
```

```yaml
templates:
- name: diamond
  dag:
    tasks:
    - name: A
      template: echo
      arguments:
        parameters: [{name: message, value: A}]
    - name: B
      depends: "A"
      template: echo
      arguments:
        parameters: [{name: message, value: B}]
    - name: C
      depends: "A"
      template: echo
      arguments:
        parameters: [{name: message, value: C}]
    - name: D
      depends: "B && C"
      template: echo
      arguments:
        parameters: [{name: message, value: D}]
```

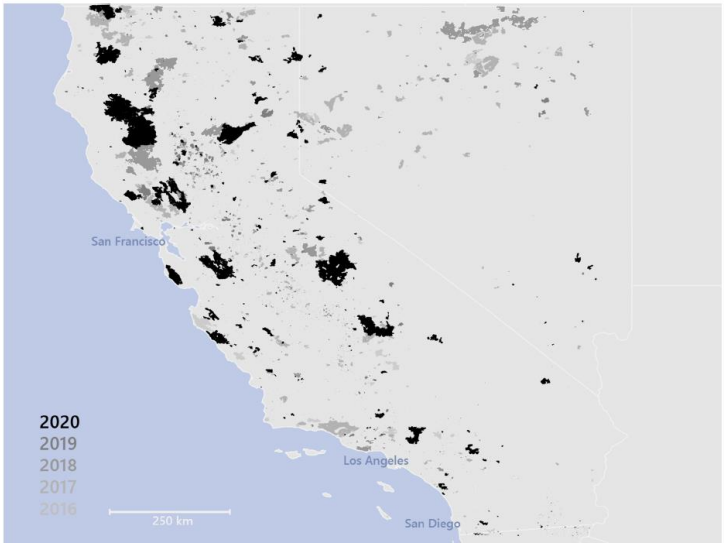
Scalable Processing Of Copernicus Sentinel satellite Images Using Argo Workflows [6]



DAG Structure



Processing Architecture



Results

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[7]

Functional Requirements

- Loading and saving 3D data object
- Containerization of tasks
- Artifact storage system
- Visual workflow editor
- Reusable task template
- Deployment in kubernetes

Non-Functional Requirements

- Notification system
- Detailed logs of the pipeline execution
- Version controlled DAG/Task editing
- Appropriate error handling
- Appropriate UI usability for non-expert

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Average Weight-score analysis

	Apache Airflow	**Argo Workflow**
Functional Requirements	3.4	4.2
Non-Functional Requirements	4.1	4.12

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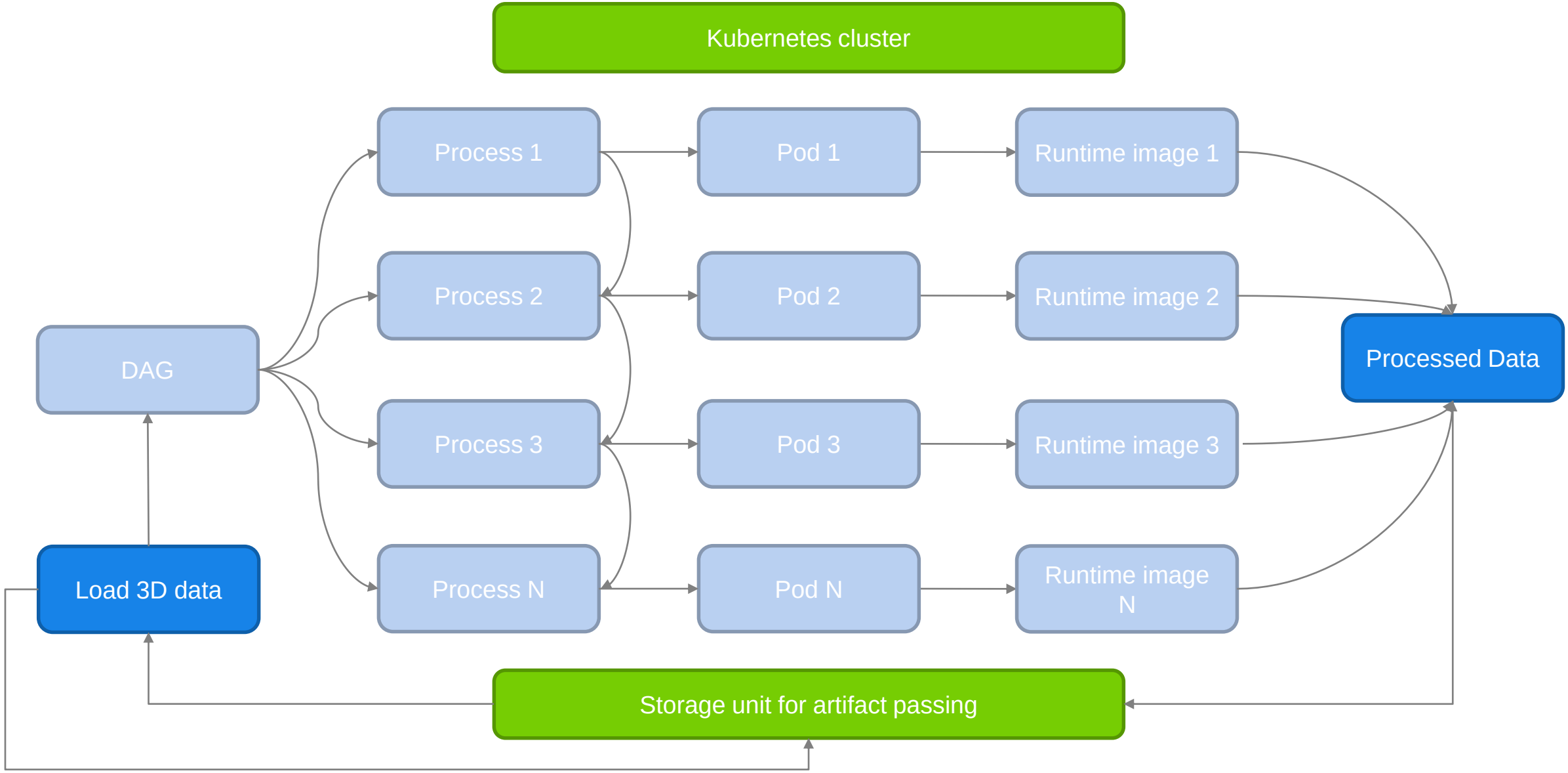
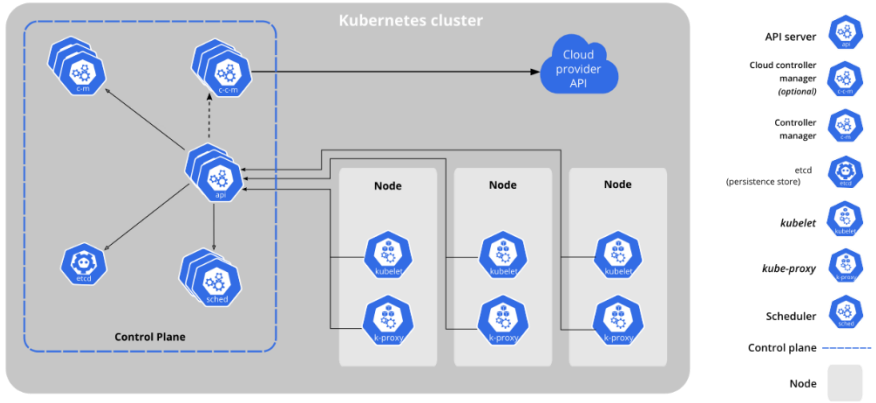
Conceptual Pipeline

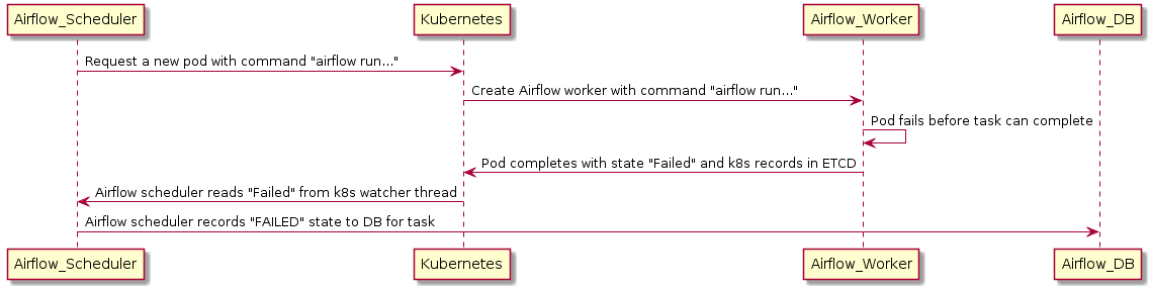


[8, 9, 10, 11]

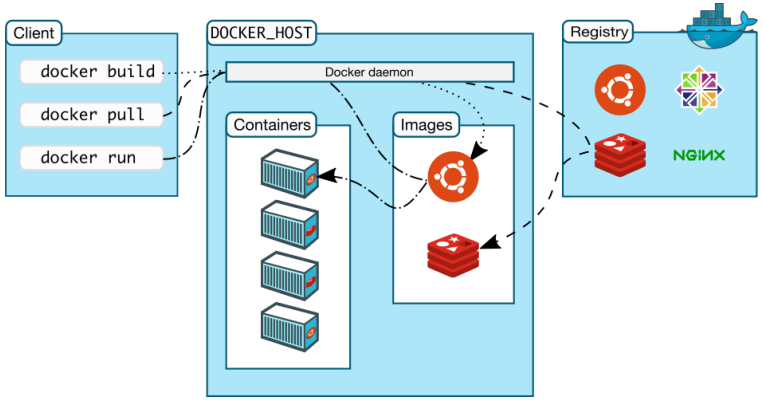
Kubernetes Cluster



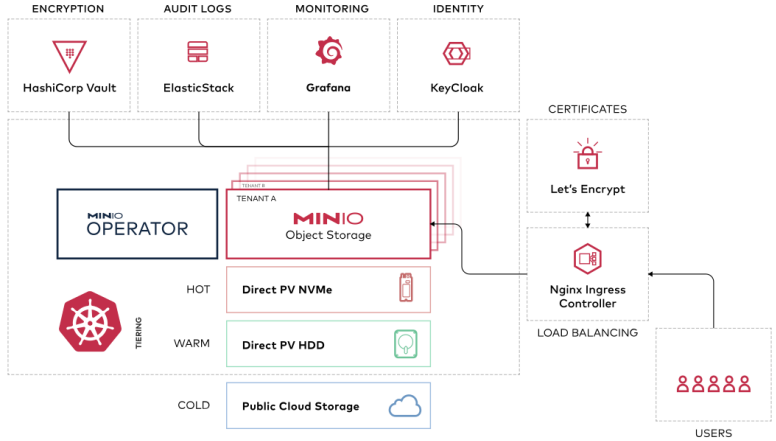
Fault Handling



Containerization of tasks



Artifact handling/Storage unit (s3)



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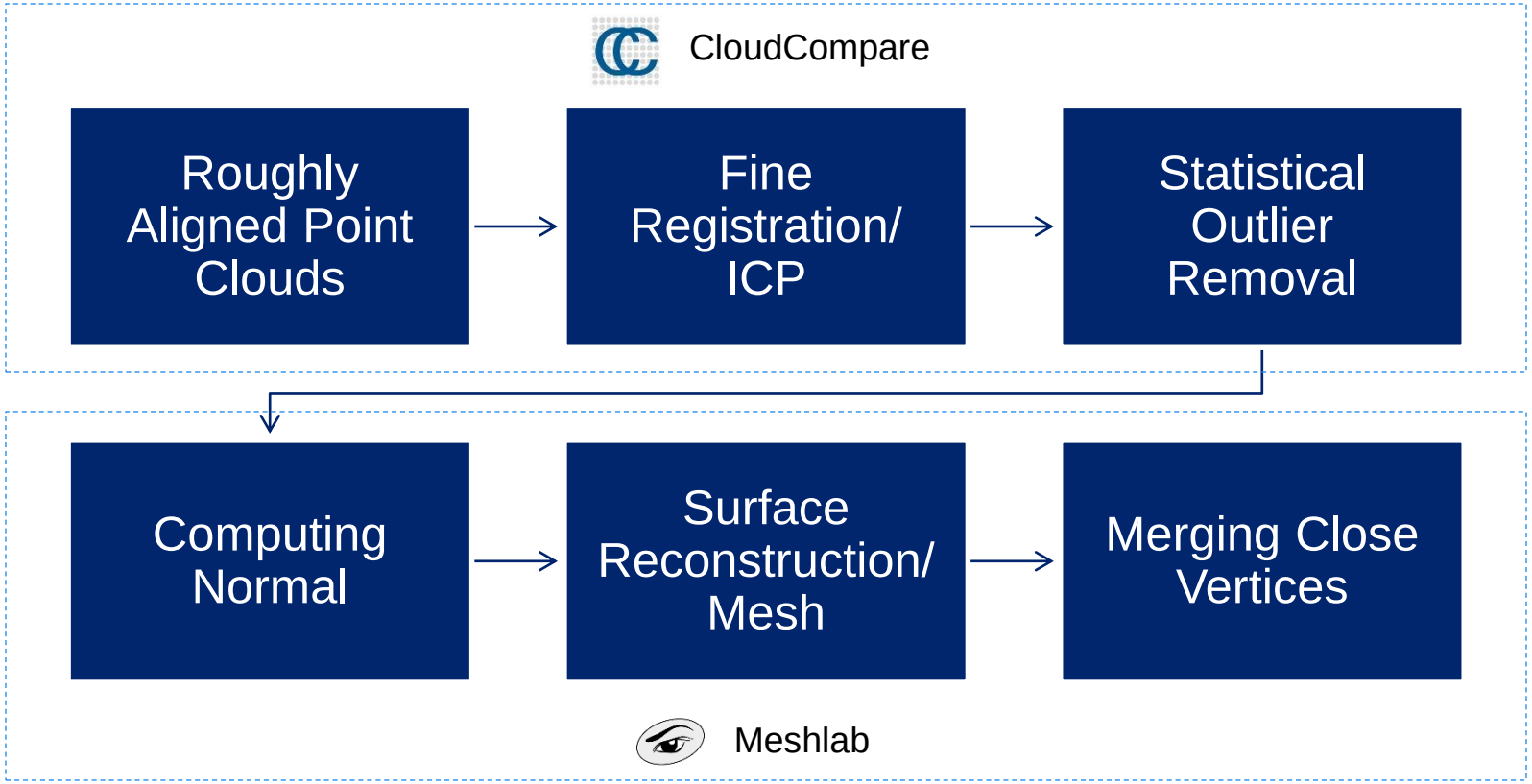
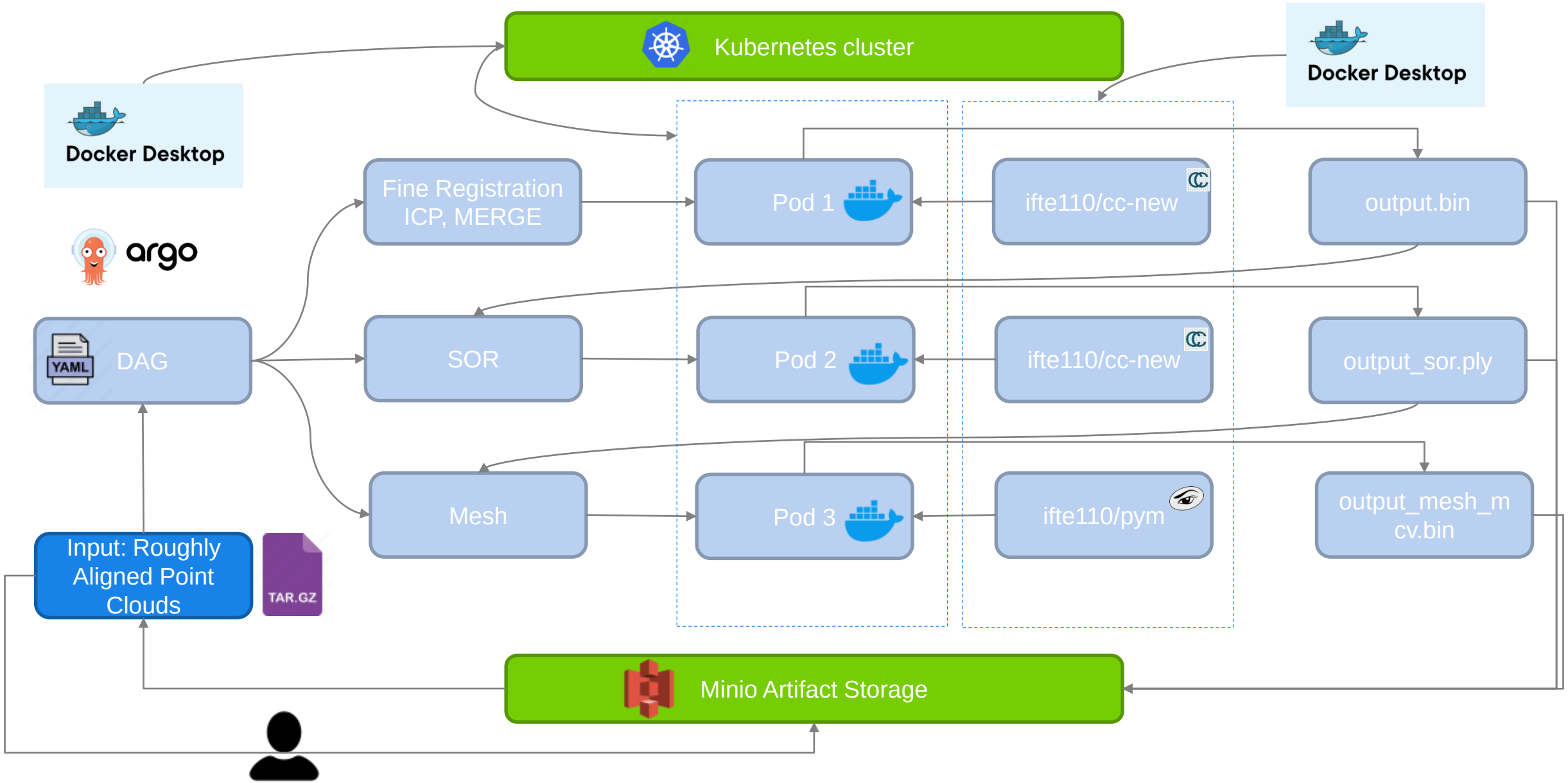
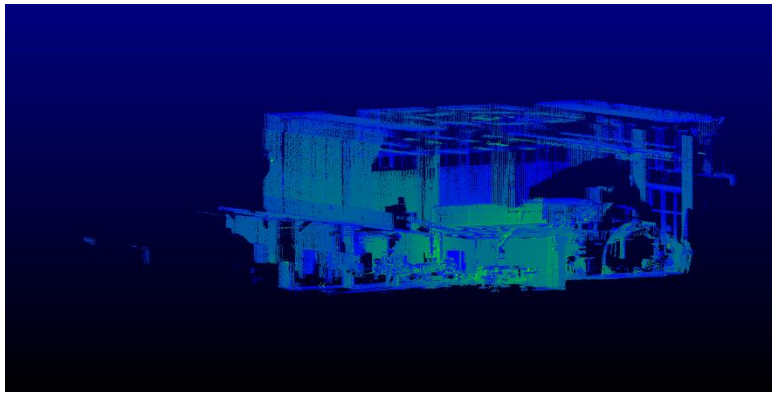
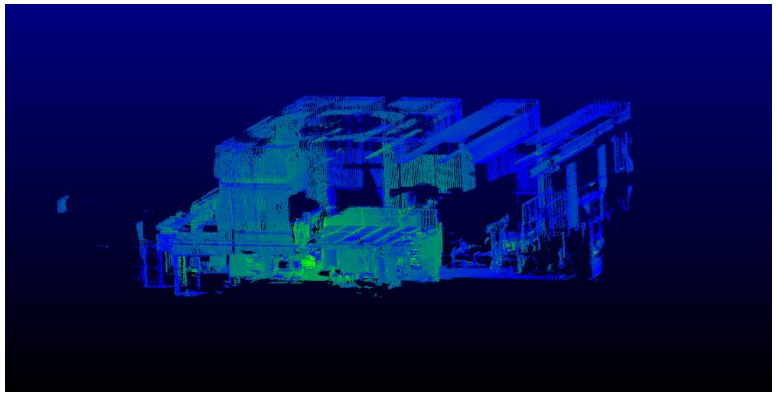

CloudCompare
Roughly Aligned Point Clouds
Fine Registration/ ICP
Statistical Outlier Removal
Computing Normal
Surface Reconstruction/ Mesh
Merging Close Vertices
Meshlab

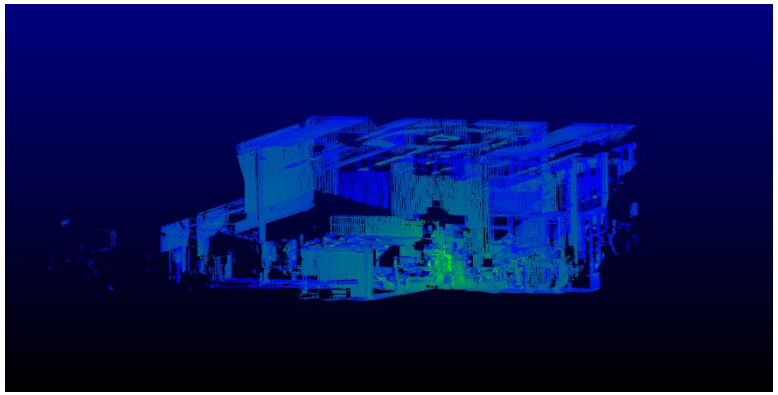
The automated pipeline



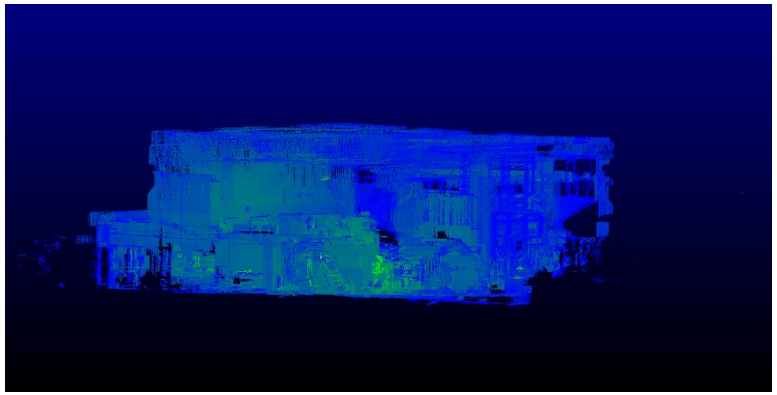
Input files (Roughly Aligned Point Clouds)

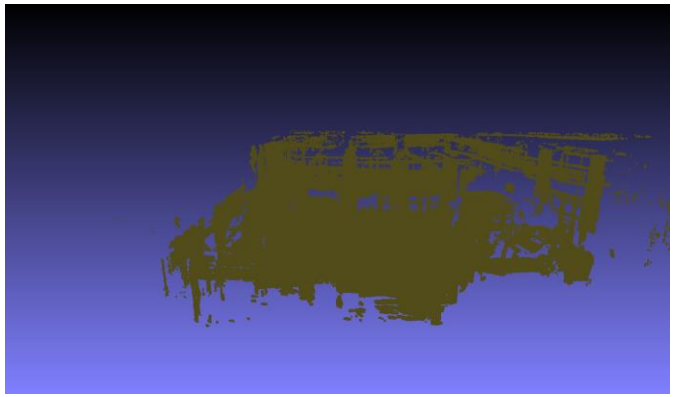


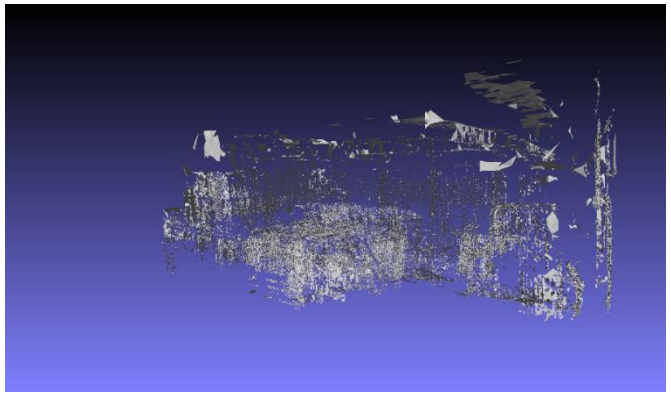


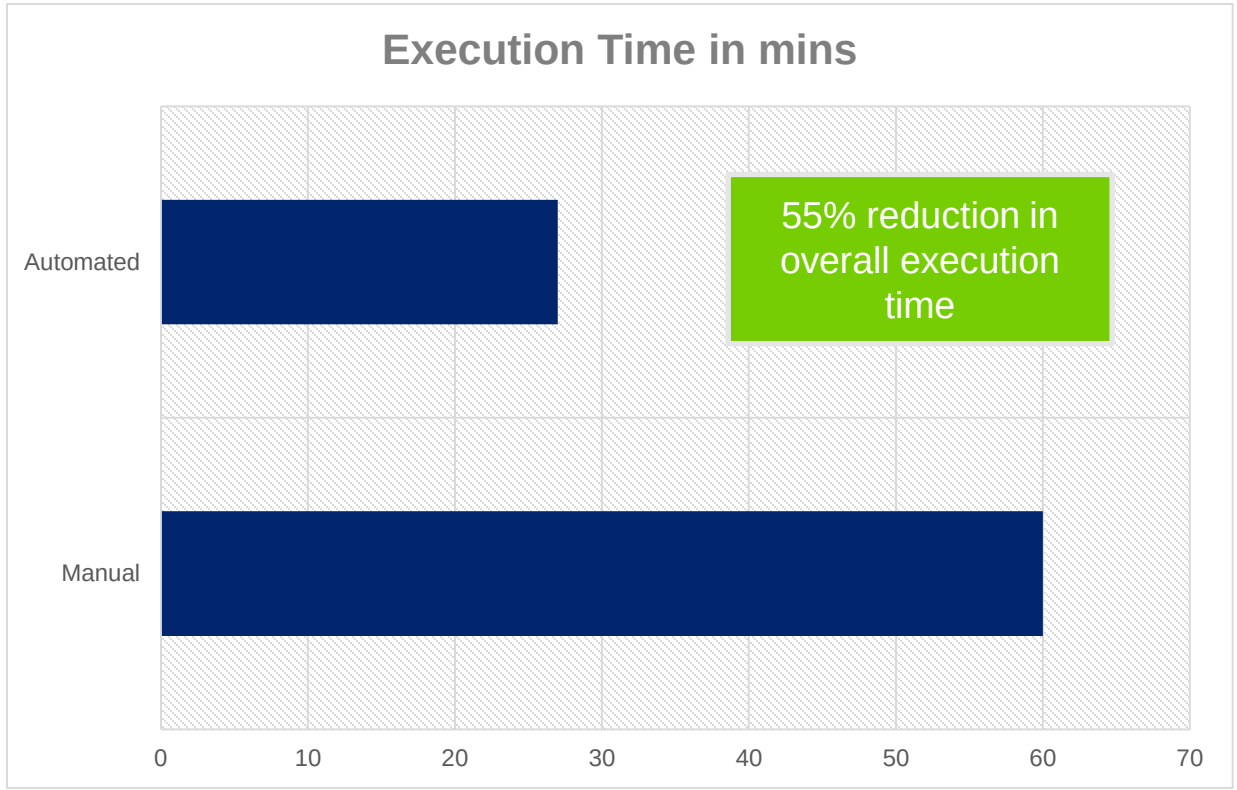


Output files









- Reduces Execution time
- Appropriate error handling
- Parallel processing
- Reduction of human interaction
- Third Party Software Integration
- Easy to use reusable task template

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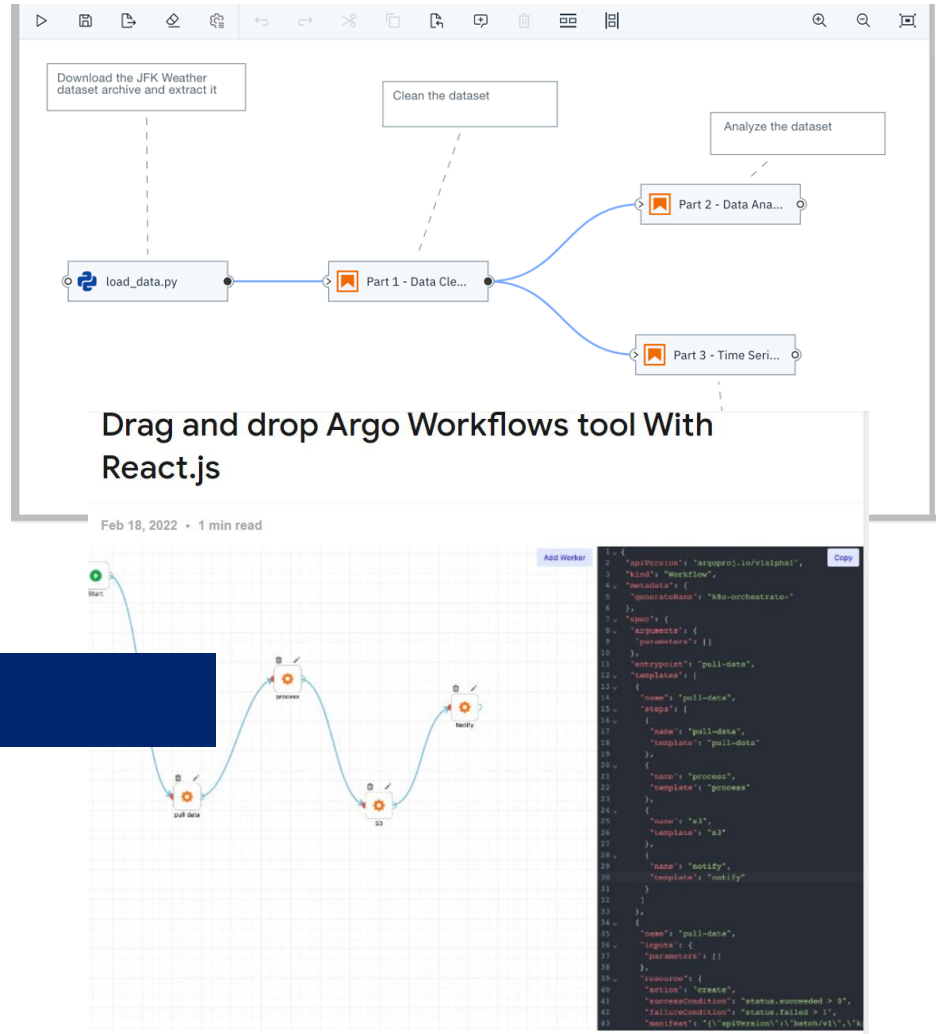
Level of Automation

- Ease of use
- Overall Exe Time
- Parallel Processing and Error Handling

Visual Workflow Editor [12, 13]



More computing power

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[6] Florian Fichtner, Nico Mandery, Maximilian Schwinger, Jonas Eberle, Michael Nolde, Torsten Riedlinger(2021): Scalable Processing Of Copernicus Sentinel satellite Images Using Argo Workflows. In: Proceedings of the 2021 conference on Big Data from Space, 18-20 May 2021, S. 77–80. DOI: 10.2760/125905.

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