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TOWARDS A MODEL-BASED APPROACH TO SUPPORT PHYSICAL TEST PROCESS OF AIRCRAFT HYDRAULIC SYSTEMS

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1.Context

- The physical integration of an aircraft consists of the assembly of several complex subsystems such as the hydraulic system.

- The cleanliness of the developed hydraulic subsystem is ensured by performing several tests before the integration phase.
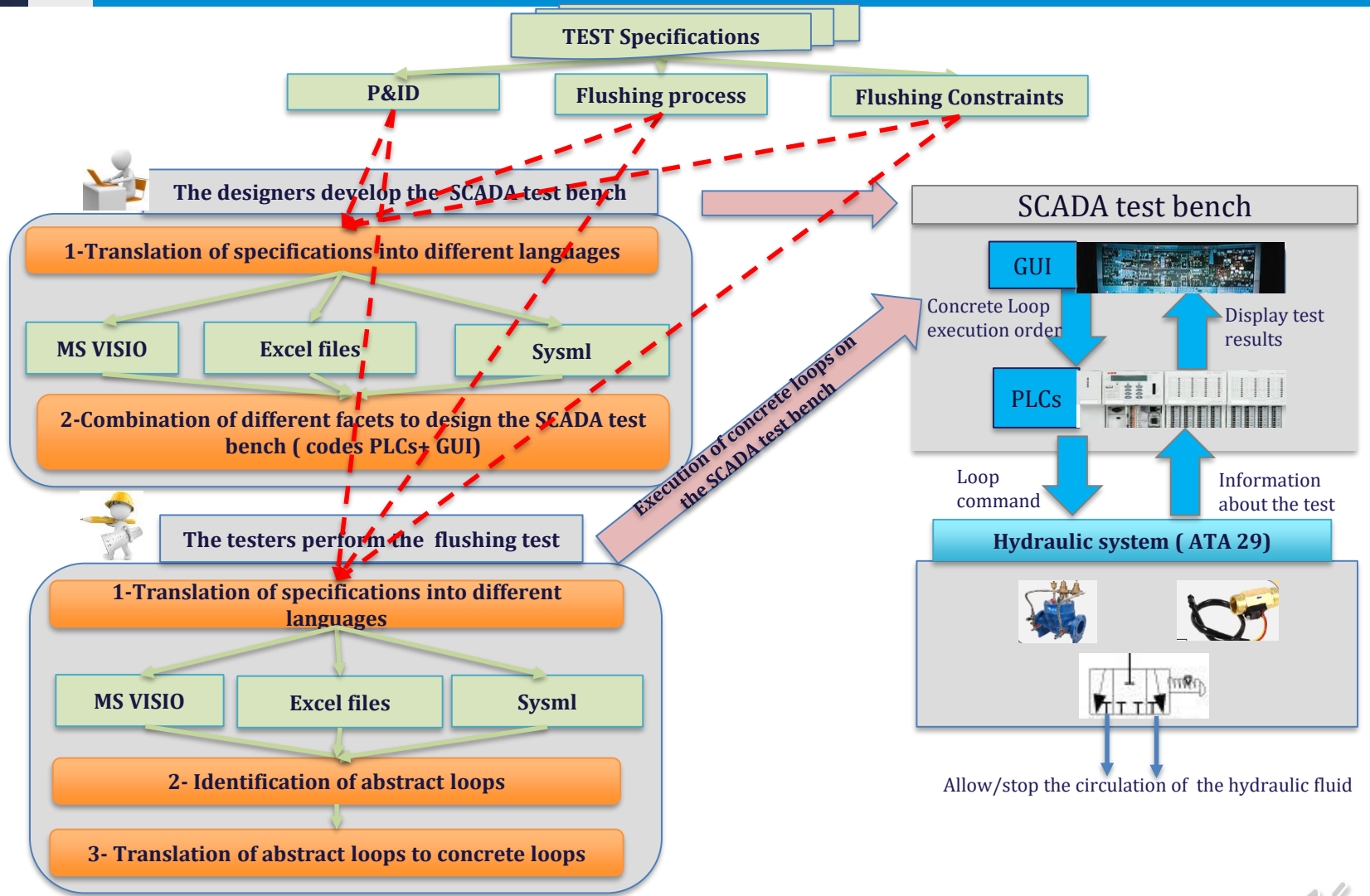

ATA 29
The hydraulic subsystem

Plan

1. Context

2. Problematic

3. Contribution

4. Validation

5. Summary

6. Perspectives

2.Problematic (1/2)

TEST Specifications

P&ID — **Flushing process** — **Flushing Constraints**

The designers develop the SCADA test bench

1-Translation of specifications into different languages

- MS VISIO
- Excel files
- Sysml

2-Combination of different facets to design the SCADA test bench (codes PLCs+ GUI)

The testers perform the flushing test

1-Translation of specifications into different languages

- MS VISIO
- Excel files
- Sysml

2- Identification of abstract loops

3- Translation of abstract loops to concrete loops

Execution of concrete loops on the SCADA test bench

SCADA test bench

GUI

Concrete Loop execution order

Display test results

PLCs

Loop command

Information about the test

Hydraulic system (ATA 29)

Allow/stop the circulation of the hydraulic fluid

PLCs: Programmable Logic Controller
SUT: System Under Test
SCADA: Supervisory Control And Data Acquisition
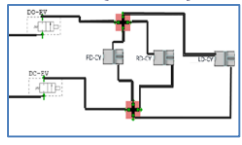**P&ID**: Piping and instrumentation diagram

1. Context
2. Problematic
3. Contribution
4. Validation
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6. Perspectives

2.Problematic (2/2)

Flushing process:
a.   Choose the loop
b.   Isolate the loop.
   c.   Open the generation valve

Physical architecture (P&ID):

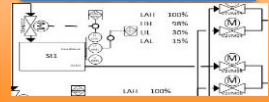**Flushing constraints:** pressure= 1000 bars

Document based specification

1. Specification translation

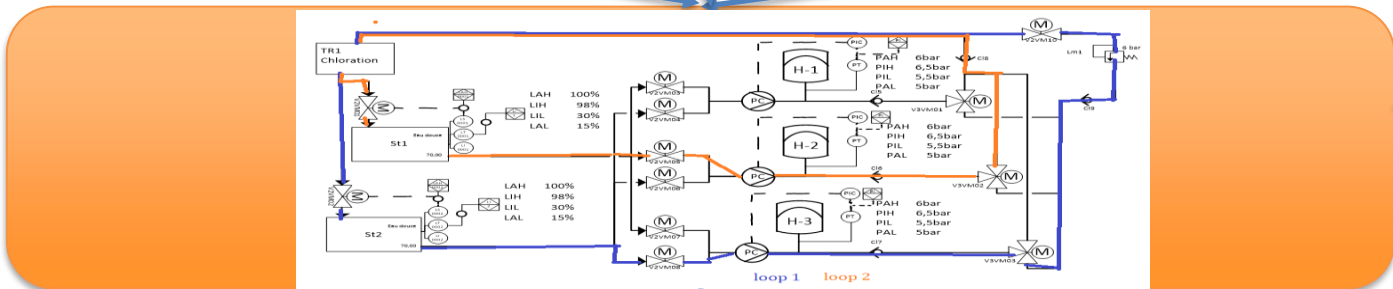| Excel files	MS VISIO	SYSML

Different languages

2. Identification of abstract loops

loop 1   loop 2

Manual operation

3. Translation of abstract loops into concrete loops

a.   **Choose the loop 1.**
b.   **Isolate the loop 1:** close the valve witch supply the component ST1 to allow the fluid flow just trough the loop 1 (to component ST2). Open all valves and components of the loop 1 in the state witch allow the fluid to reach the component needed to be flushed.
c.   **Open the generation valve**: and the pressure must be at 1000 bars.
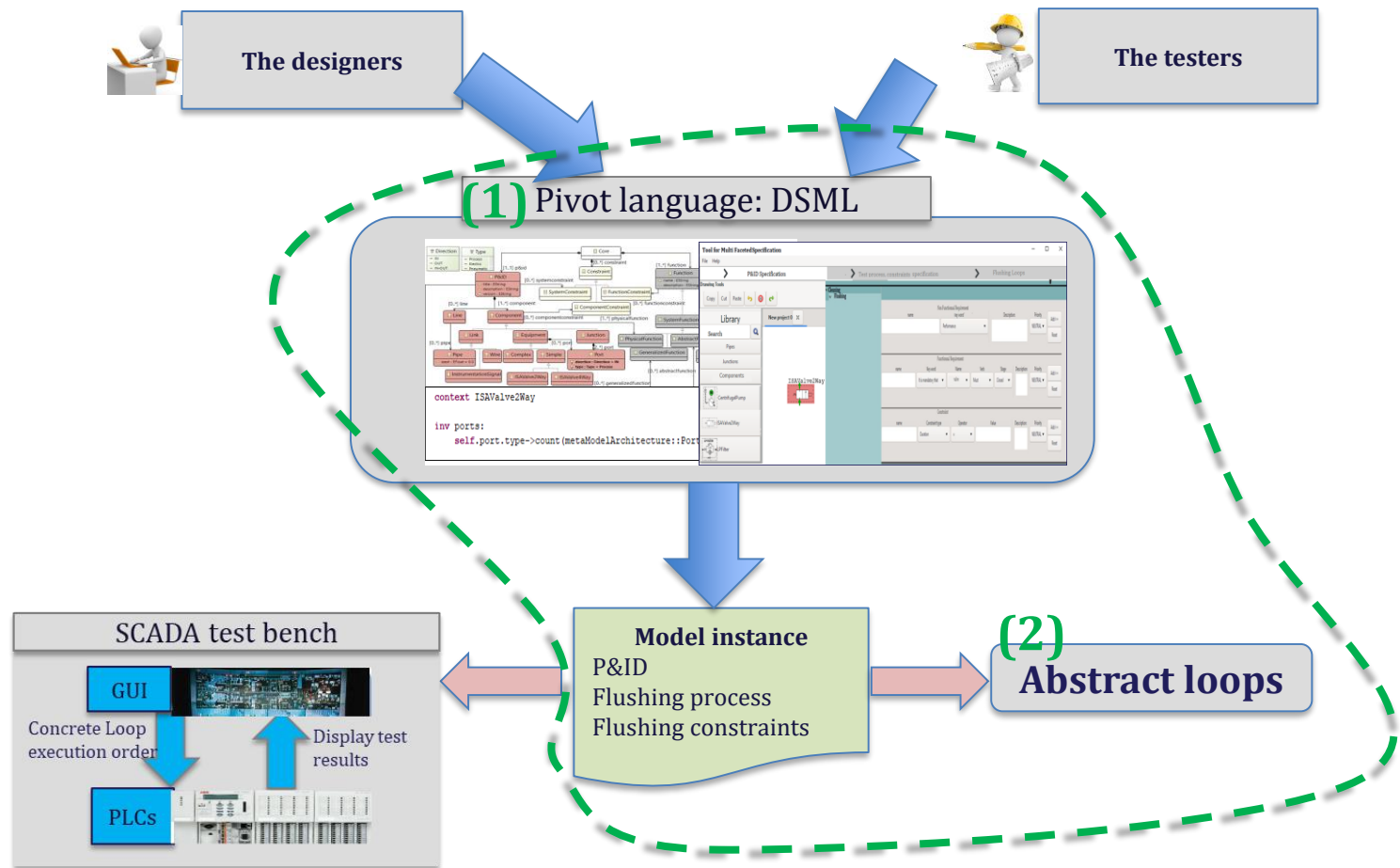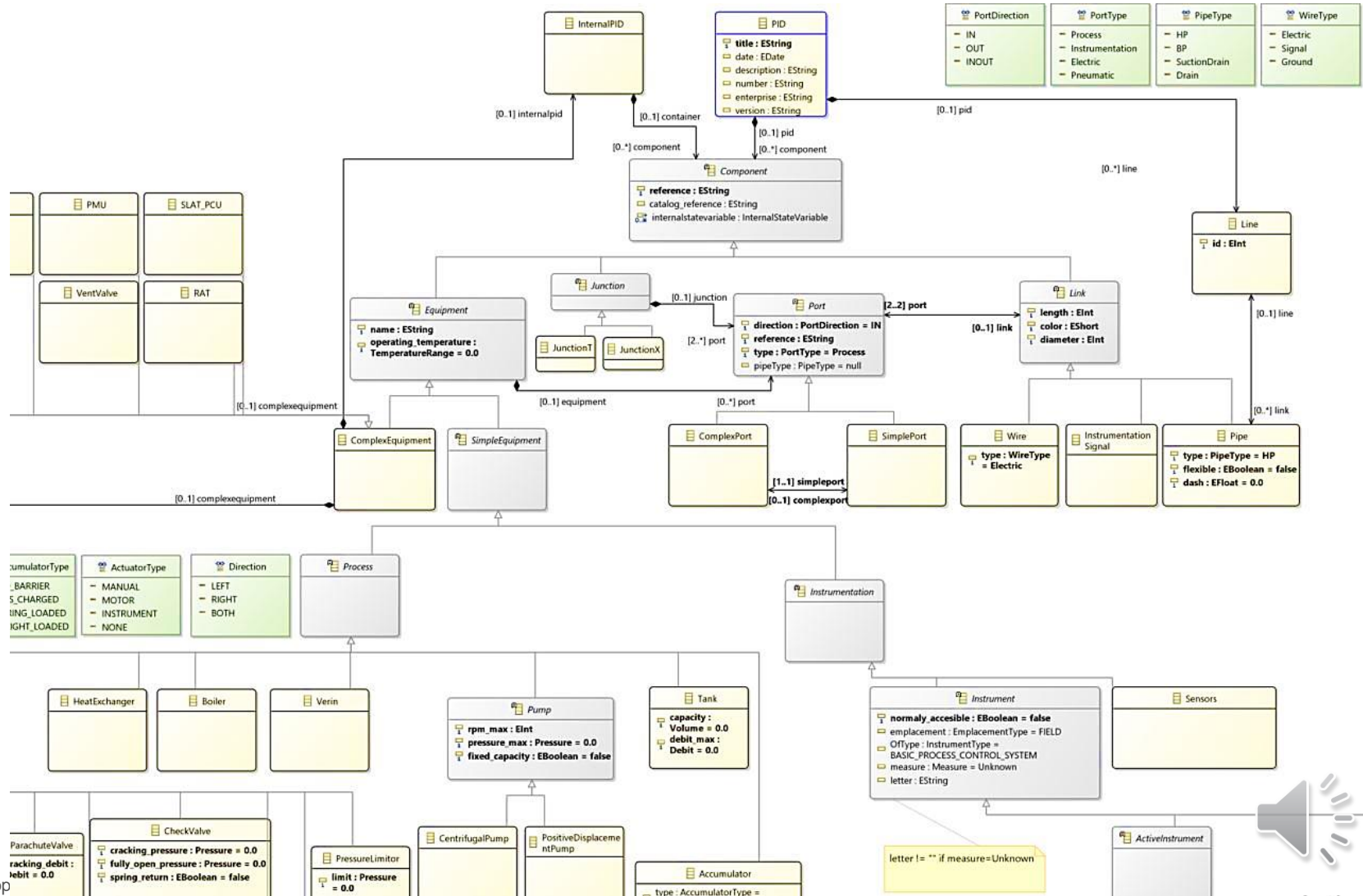
Manual operation

Plan

1. Context

2. Problematic

3. Contribution

4. Validation

5. Summary

6. Perspectives

1. Context
2. Problematic
3. Contribution
4. Validation
5. Summary
6. Perspectives

3.Contribution (1/5)

The designers

The testers

(1) Pivot language: DSML

SCADA test bench

GUI

Concrete Loop
execution order

Display test
results

PLCs

Model instance
P&ID
Flushing process
Flushing constraints

(2)

Abstract loops

PLCs: Programmable Logic Controller
SUT: System Under Test
SCADA: Supervisory Control And Data Acquisition
P&ID: Piping and instrumentation diagram

7

1. Context
2. Problematic
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4. Validation
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6. Perspectives

3.Contribution (2/5)

(1). The pivot language: DSML
a. Abstract syntax

1. Context
2. Problematic
3. Contribution
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6. Perspectives

3.Contribution (3/5)

(1). The pivot language: DSML

     c.   Concrete syntax: a tool for multi-faceted specification

9

1. Context
2. Problematic
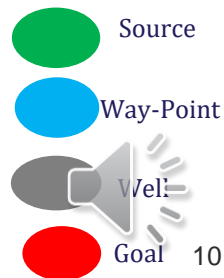3. Contribution
4. Validation
5. Summary
6. Perspectives

3.Contribution (4/5)
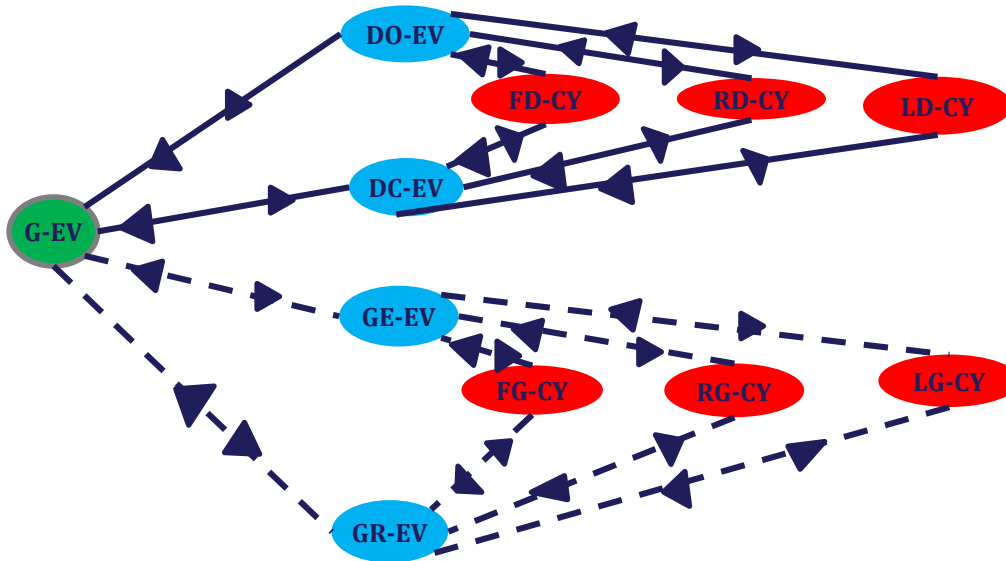
(2). Automation of abstract loops generation

2.1 Graph generation
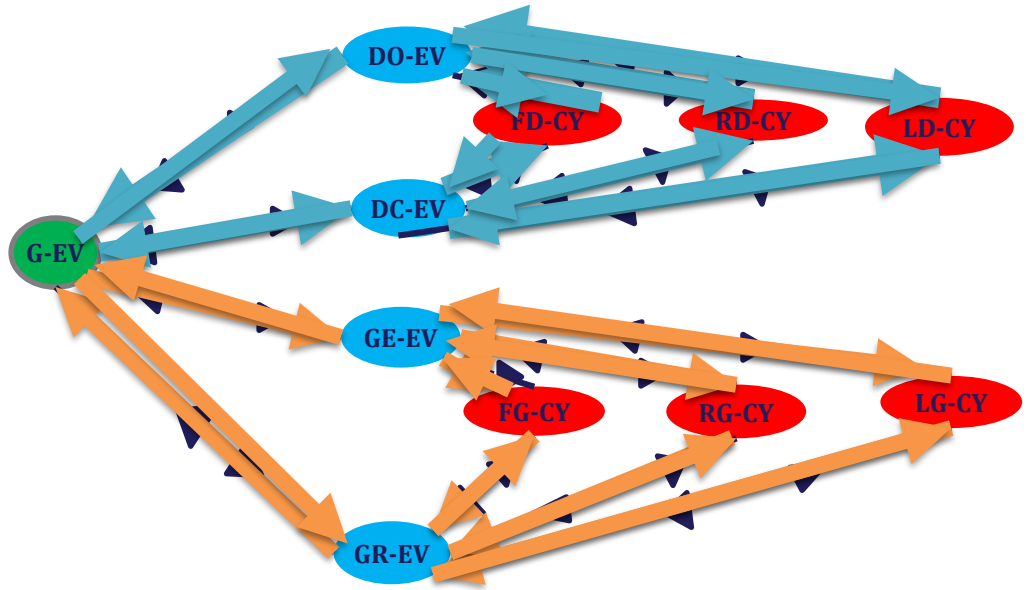

2. 2 Components classification

1. Context
2. Problematic
3. Contribution
4. Validation
5. Summary
6. Perspectives

3.Contribution(5/5)

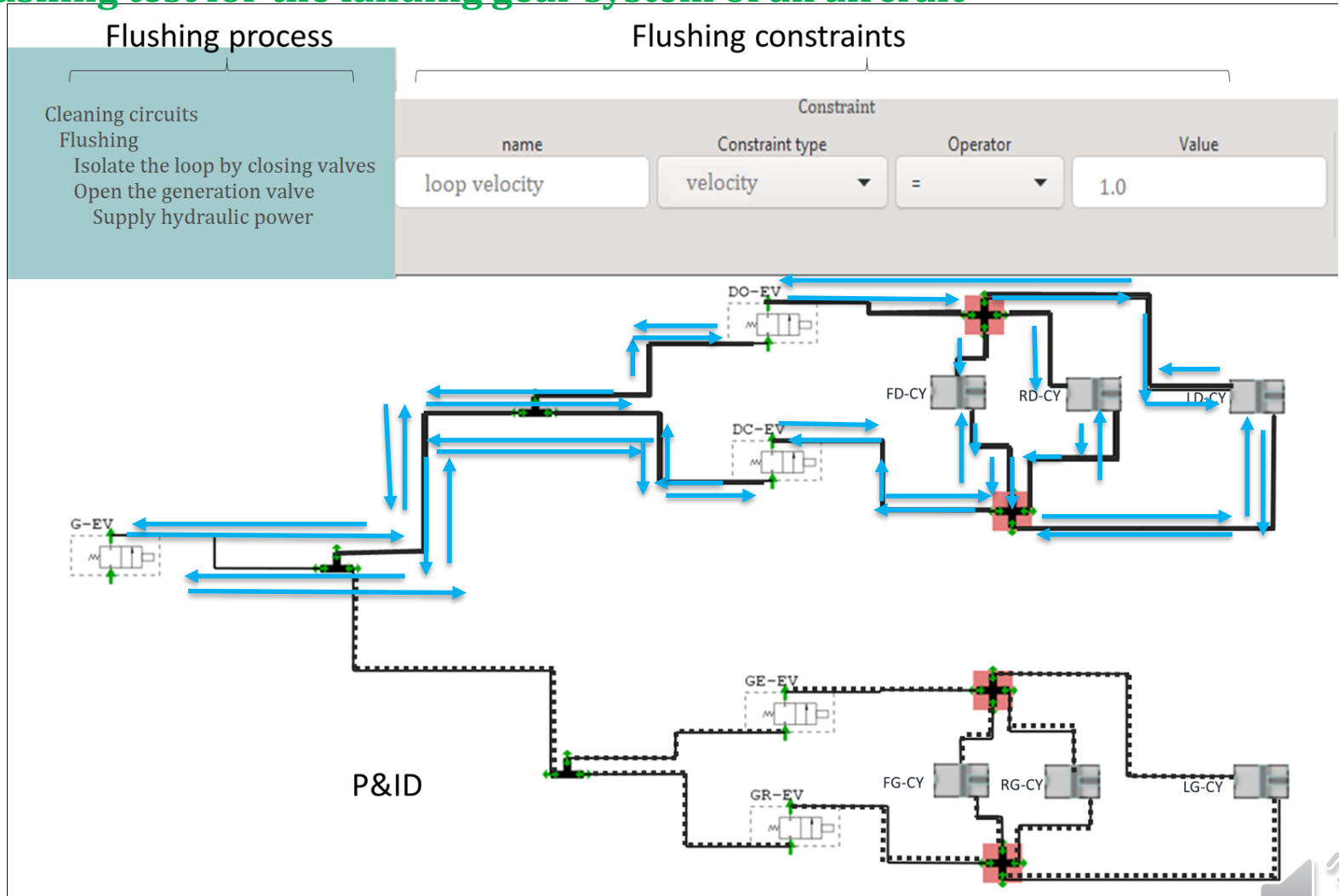## (2). Automation of abstract loops generation
2. 3 Abstract loop generation

Plan

1. Context

2. Problematic

3. Contribution

4. Validation

5. Summary

6. Perspectives

1. Context
2. Problematic
3. Contribution
4. Validation
5. Summary
6. Perspectives

4. Validation

Flushing test for the landing gear system of an aircraft

Plan

1. Context

2. Problematic

3. Contribution

4. Validation

5. Summary

6. Perspectives

4.Summary

Testing is the most important step that cannot be neglected in the design of aircraft hydraulic systems.

Testing hydraulic systems can be time consuming and tedious, depending on a large number of components and constraints that need to be considered.

We first proposed a pivot language to unify the specification of all facets in one language. This language is supported by a proposed tool that is closer to the domain.

Using this tool, experts from different domains can easily create specification models without learning a new language.

Our goal is to reduce this design effort by providing an approach that allows testers to easily define test models (P&ID, test constraints, test process) and generate the required loops.

1. Context
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5.Perspectives

- Consider the flushing constraints (length of the loop, velocity, flow, and pressure conditions) on the optimization algorithm.

- Add a success process that is used to evaluate the cleanliness of a flushed component.

THANK YOU

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