Model Calibration for System Engineers

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Outline

1. **LTS-Optim**
    1. Ecosystem and constraints
    2. The Web-PIDO proposition

2. **Usecase**
    1. Background
    2. Model and Test campaign

3. **Implementation**
    1. Fitting problem
    2. pSeven workflow and live demo

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Product Strategy

Air Cycle Machines

Compressors

Pneumatic Valves

Air Cycle Air Conditioning

Heat Exhangers

Smart Actuators

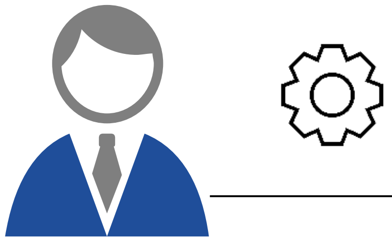
Controllers and Power Electronics

Vapor Cycle Cooling Pack

LTS-OPTIM

SYS. engineer
Product engineer

- A product to design
- A model to calibrate
- A process to capture
- …



- Proposition of a solution
- Refinement of business rules
- Solution improvement

OPTIM

- Collection of the need
- Analysis
- Exploration problem

- Formulation of the need
- Business rules, Modeling choices
- Users feedback

Ecosystem and Constraints

IT

- Hardware provider
- Security rules
  - Accounts and access rights

M&Tools

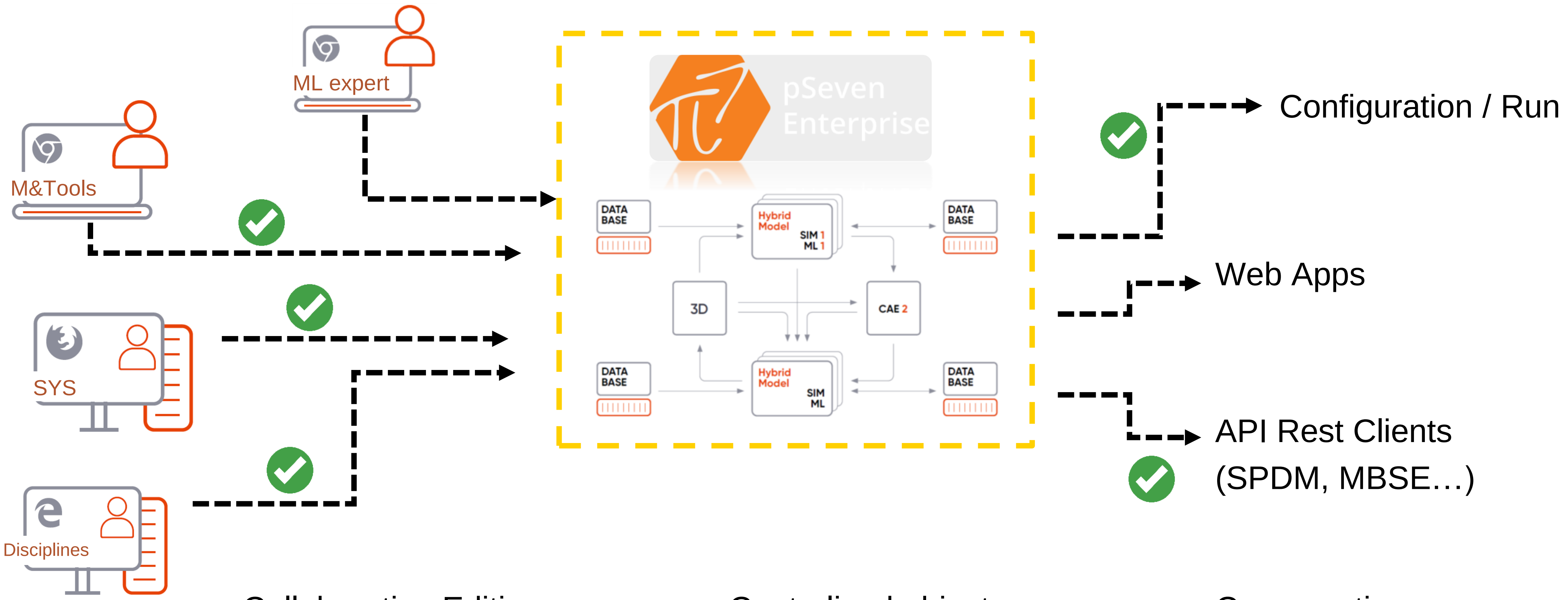
- Collection of the need
- Iterations with business teams

End-users

- Disciplines / SYS
- Specification
- Multiple profiles
  - Consumption
  - Workflow edition

Installation, Maintenance
Back/Front development

The « Web PIDO » Proposition



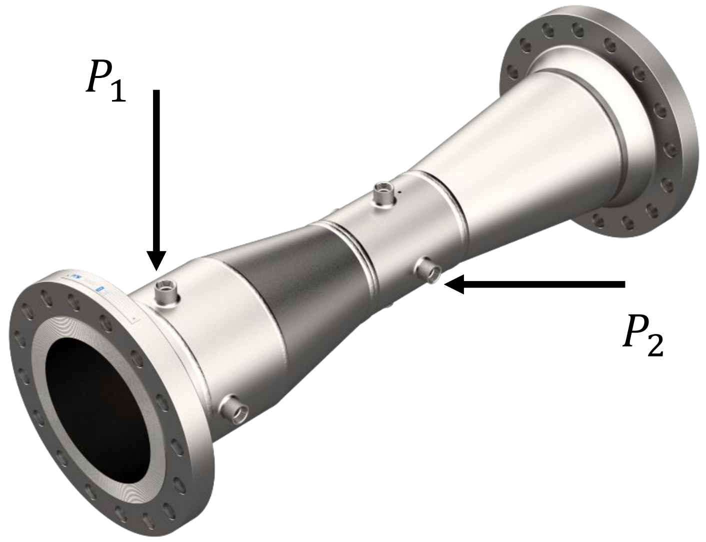
Collaborative Editing

Centralised object
(pSeven workflow)

Consumption

Usecase

Calibration of a Venturi Meter



- ✓ A tube with a **convergent-divergent** cross-section
- ✓ A **differential pressure** sensor

Background

- Measurement of P_{diff} (the differential pressure between P_1 and P_2) allows to compute the flow-rate (Q_m) through the conduct

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Model

Formula for flow rate computation

$$Q_m = \boldsymbol{K_1} \times \left(1 - \boldsymbol{K_2} \times \frac{P_{diff}}{P_{rel} + P_{amb}}\right) \times \sqrt{\frac{(P_{rel} + P_{amb}) \times P_{diff}}{T_{bleed} + 273.15}}$$

- P_{rel}: relative pressure at a specific part of the system
- P_{amb}: ambient pressure
- T_{bleed}: bleed temperature depending on the configuration
- P_{diff}: differential pressure (non-linear weighting function)

Test campaign

Test bed setup to produce reference data

Several operationnal conditions

Associated ENGINE BLEED		INLET PRESSURE @PBMAPS		
		1barg	2.5barg	4.1barg
INLET TEMPERATURE @BOCTS	75°C		T04	
	200°C	T02	T01	T03
	260°C		T05	

Opposite ENGINE BLEED		INLET PRESSURE @PBMAPS
		2.5barg
INLET TEMPERATURE @ opp BOCTS	200°C	T06

APU BLEED		INLET PRESSURE @PBMAPS
		2.5barg
APU TEMPERATURE (INNOVA data)	150°C	T07
	260°C	T08

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Fitting problem

Agreed with the SE team

Objective

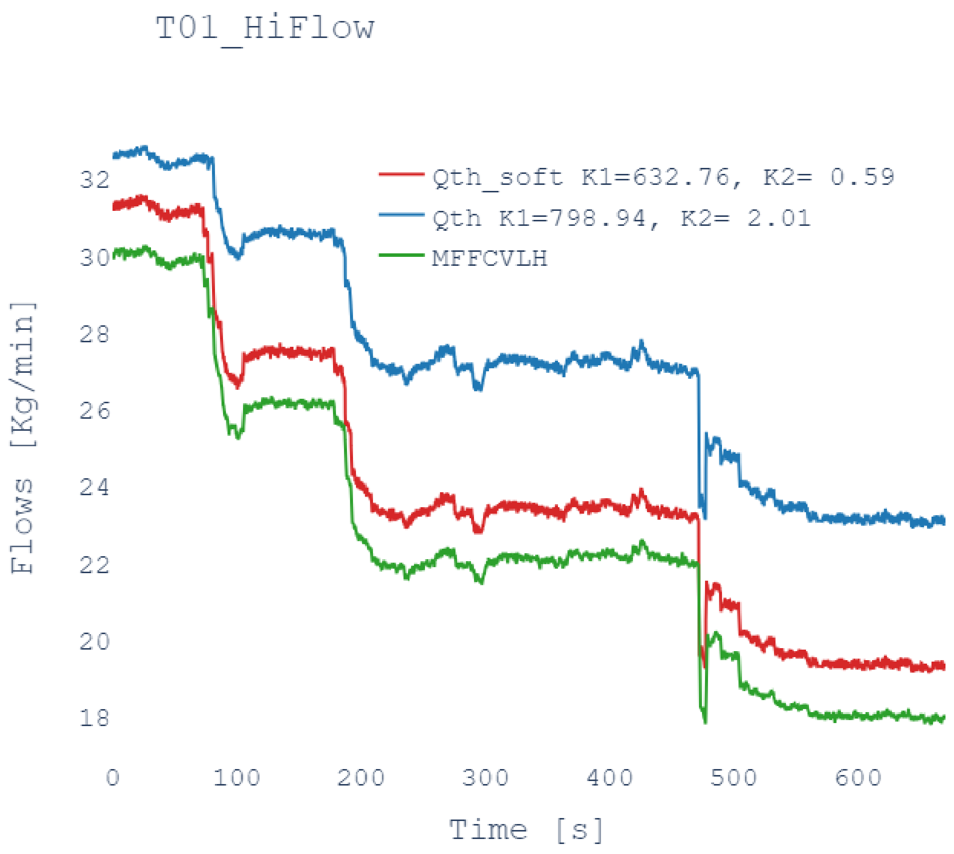
$$\searrow \sum RRMS^i$$

Constraints

$$RRMS^i \leq 0.5, \forall i$$

$$(K_1, K_2) \in [k_1^{low}, k_1^{up}] \times [k_2^{low}, k_2^{up}]$$

Design space



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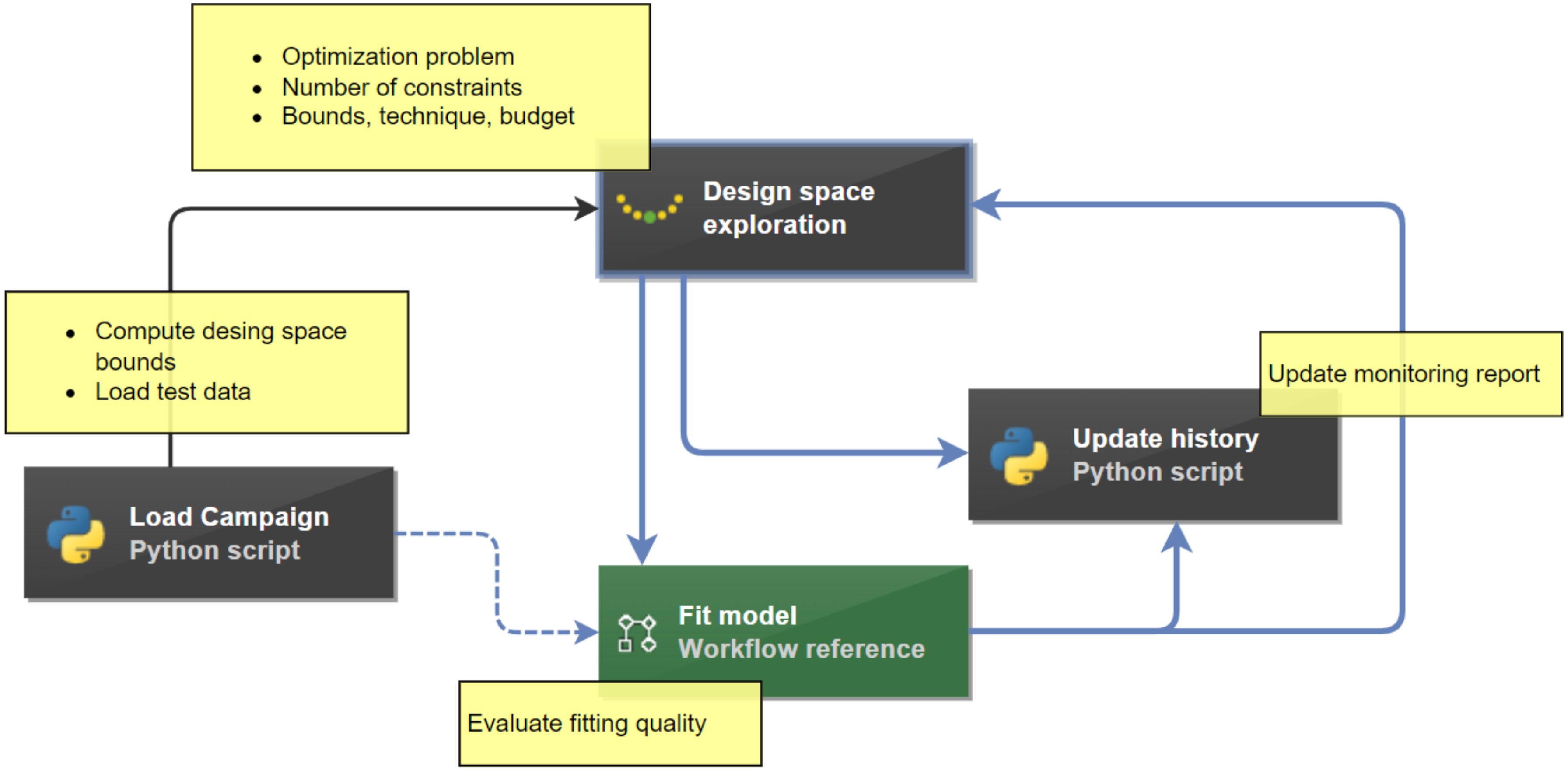
pSeven Workflow



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Next steps

- **Develop Studio**
  - Usecases, Teams, Models, Disciplines
  - *Version management (via user blocks)*

- **Develop Web Apps**
  - Frontend development for previous studio usecases
  - *Versions management, toward « CI/CD »*

- **Connection to external tools via REST API**
  - SPDM, MBSE, Databases

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Thank you

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