



**Ingescape, a platform for  
collaborative and iterative HSI**

---

Stéphane Valès – [vales@ingenuity.io](mailto:vales@ingenuity.io)

March 2025

# RER A in Paris



- 1.2M pax & 600 trains /day
- 6000+ monitored devices
- Operated 18/7 + maintenance
- 60+ systems
- 9000+ requirements
- Legacy from the 80s/90s



# Before the modernization...



Phases	Build	Qualification	Run
1- Experimentation (2015- 2017)	8 months	4 months	1 year
2- Industrialization (2021-)	24 months	8 months	10+ years



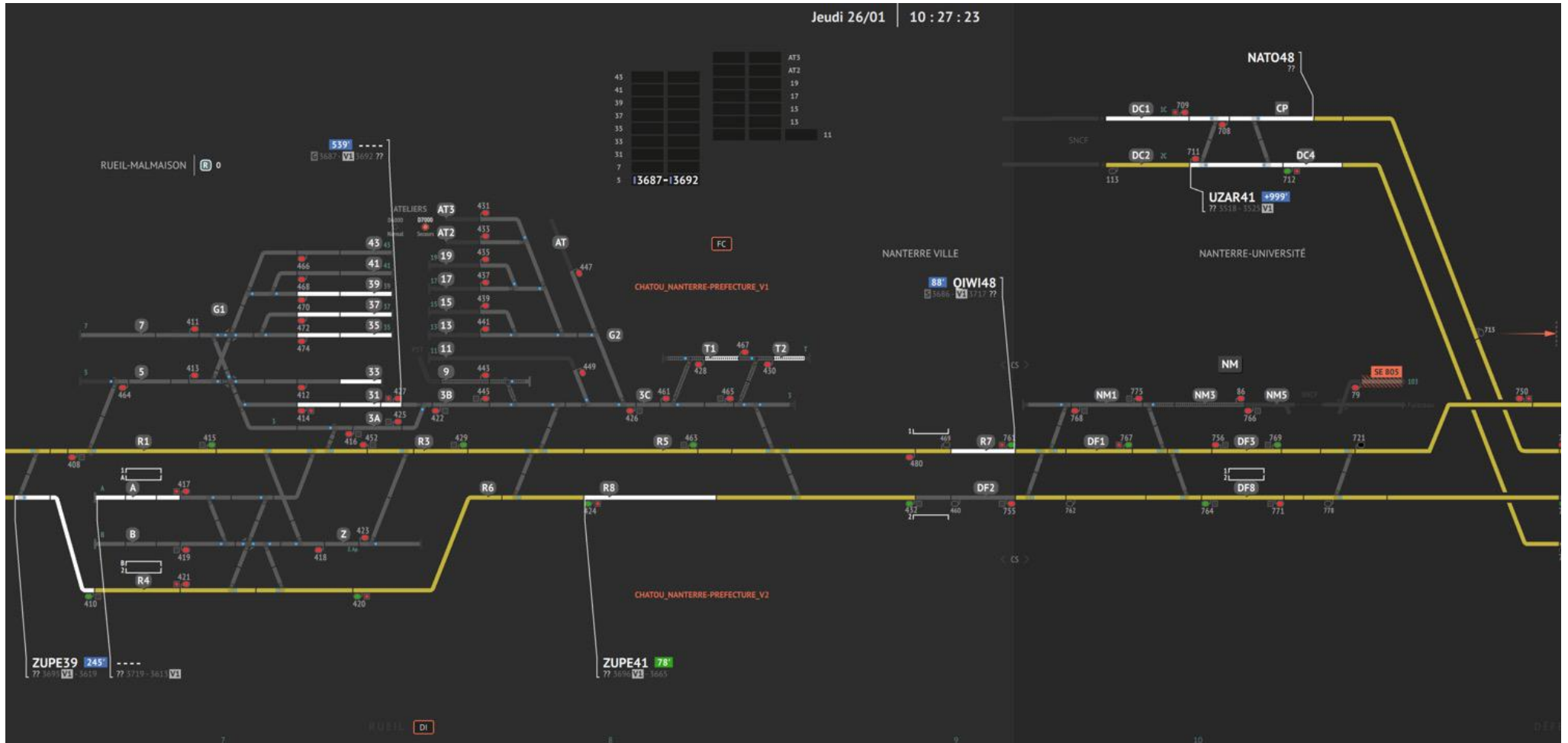
# User-Centered & Scenario-Based Design



# Fully-digitalized & collaborative work environment



# Real-time visual monitoring





# Command & Control on the line, missions, drivers and trains

Vendredi 18/11 21:43:20

JOINVILLE LE PARC | LA VARENNE | SUCY | BOISSY

1 Circulation | 2 Manœuvres | 3 Matériels & Missions

Traction Zones Cvt. Arg. Rectif. Arg. Annulation P. Caténaires Alarmes

JOINVILLE LE PARC | LA VARENNE | SUCY | BOISSY

**VOIE 1 | Nogent-Sur-Marne > Boissy-Saint-Leger**

R04 G	44R	49R	NELY98	20h36 <sup>00</sup> > 20h51 <sup>14</sup>
B07 R G	29N		NEMO02	20h45 <sup>00</sup> > 21h01 <sup>14</sup>
B06 G	44R		NEMO06	20h56 <sup>00</sup> > 21h12 <sup>14</sup>
H03 B	43V		WNWS08	21h05 <sup>00</sup> > 21h14 <sup>00</sup> +G Boissy 3.1-V21
V02 G B	48R		NEMO08	21h10 <sup>00</sup> > 21h26 <sup>00</sup> DECOUPLE Boissy Q2 +G Boissy B. 3-V10
B02 B R	44V	43R	NEMO10	21h25 <sup>00</sup> > 21h44 <sup>00</sup> DECOUPLE Boissy Q4 +G Boissy A. 1-V18 02
B04 B	48V	47V	NEMO14	21h44 <sup>00</sup> > 22h00 <sup>00</sup> DECOUPLE Boissy Q2 +G Boissy A. 1-V18 04
G03 B V	51V		NEMO16	21h57 <sup>00</sup> > 22h13 <sup>00</sup> DECOUPLE Boissy Q1 02
G04 V	49V		NEMO20	22h15 <sup>00</sup> > 22h31 <sup>00</sup> 04
V01 B	46V		NEMO22	22h25 <sup>00</sup> > 22h41 <sup>00</sup> DECOUPLE Germain Q4 +G Boissy 1-V16
V01 V	52V	41R	NEMO26	22h40 <sup>00</sup> > 22h55 <sup>00</sup> DECOUPLE Germain Q4
V04 R	45V	43R	NEMO28	22h55 <sup>00</sup> > 23h11 <sup>00</sup> DECOUPLE Germain Q2

**VOIE 2 | Nogent-Sur-Marne < Boissy-Saint-Leger**

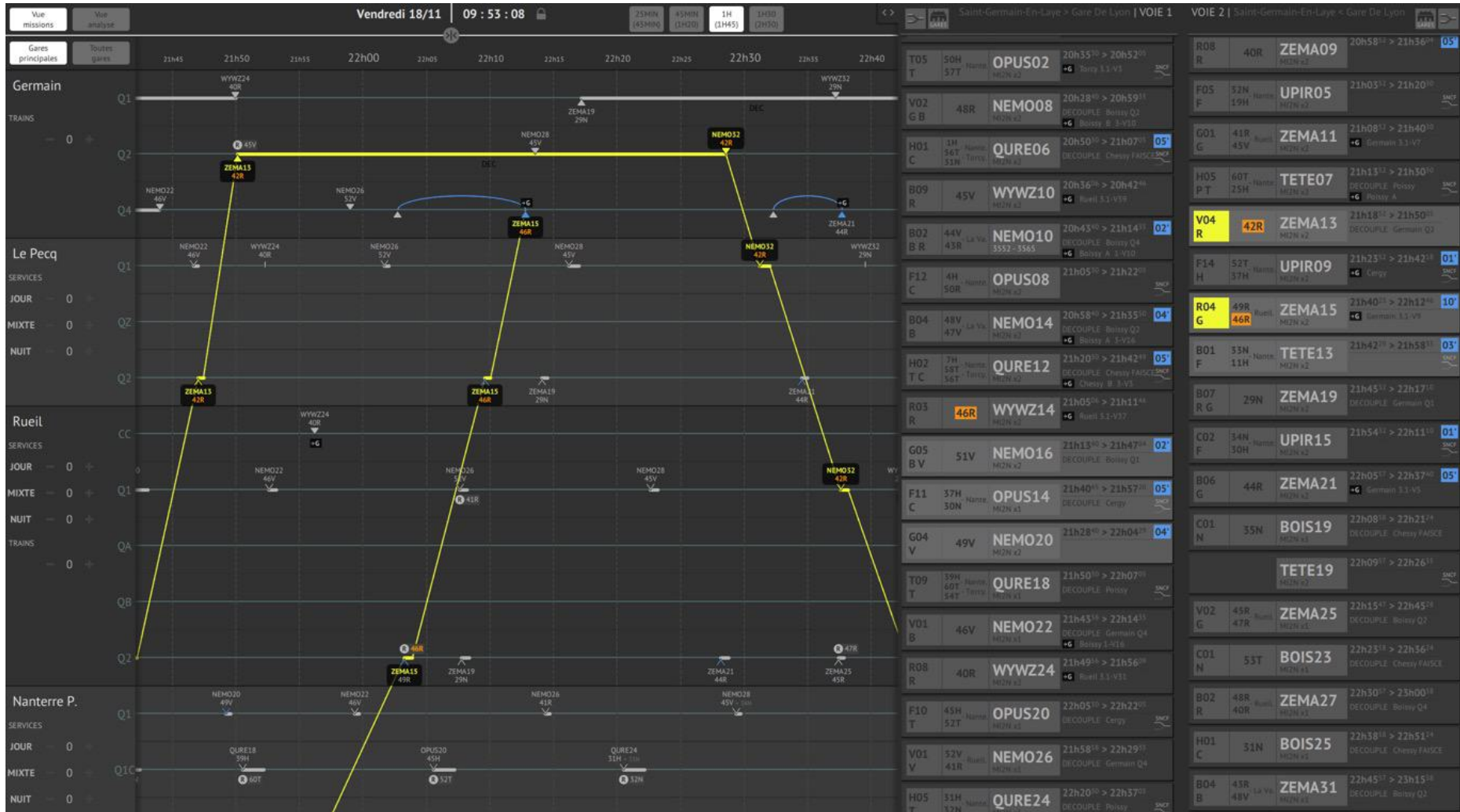
G01 G	41R	45V	ZEMA11	20h41 <sup>00</sup> > 20h59 <sup>00</sup> +G Germain 3.1-V7
V04 R	42R		ZEMA13	20h52 <sup>00</sup> > 21h09 <sup>00</sup> DECOUPLE Germain Q2
R04 G	49R	46R	ZEMA15	21h04 <sup>00</sup> > 21h21 <sup>00</sup> +G Germain 3.1-V9 10
B07 R G	29N		ZEMA19	21h18 <sup>00</sup> > 21h35 <sup>00</sup> DECOUPLE Germain Q1
B06 G	44R		ZEMA21	21h39 <sup>00</sup> > 21h56 <sup>00</sup> +G Germain 3.1-V5 05
V02 G	45R	47R	ZEMA25	21h50 <sup>00</sup> > 22h06 <sup>00</sup> DECOUPLE Boissy Q2
B02 R	48R	40R	ZEMA27	22h04 <sup>00</sup> > 22h21 <sup>00</sup> DECOUPLE Boissy Q4
B04 B	45R	48V	ZEMA31	22h20 <sup>00</sup> > 22h36 <sup>00</sup> DECOUPLE Boissy Q1
G05 V	47V		ZEMA33	22h34 <sup>00</sup> > 22h51 <sup>00</sup> DECOUPLE Boissy Q1
G04 V	49V		WRWN33	22h40 <sup>00</sup> > 22h44 <sup>00</sup> +G La Varenne 1.3-V9
G05 B	51V	50V	ZEMA37	22h50 <sup>00</sup> > 23h06 <sup>00</sup> DECOUPLE Boissy Q1
V01 R	41R		ZEMA39	23h05 <sup>00</sup> > 23h21 <sup>00</sup>

JOINVILLE LE PARC | LA VARENNE | SUCY | BOISSY

Joinville Le Parc

Confidential document – Do not distribute without agreement

# Real-time strategic management with decision support

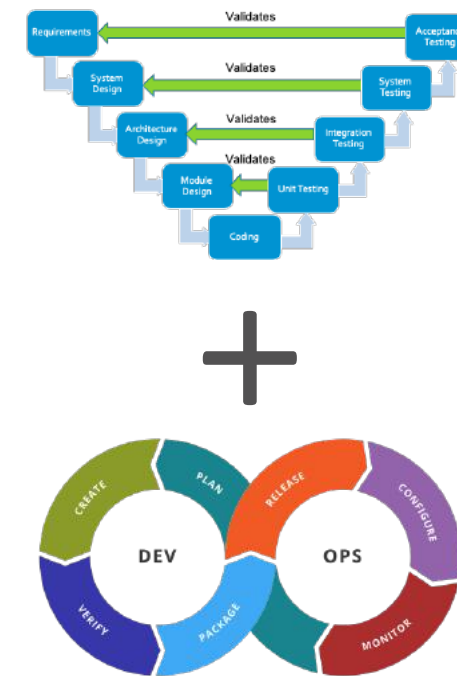




# V&V automation for the RATP RER A project

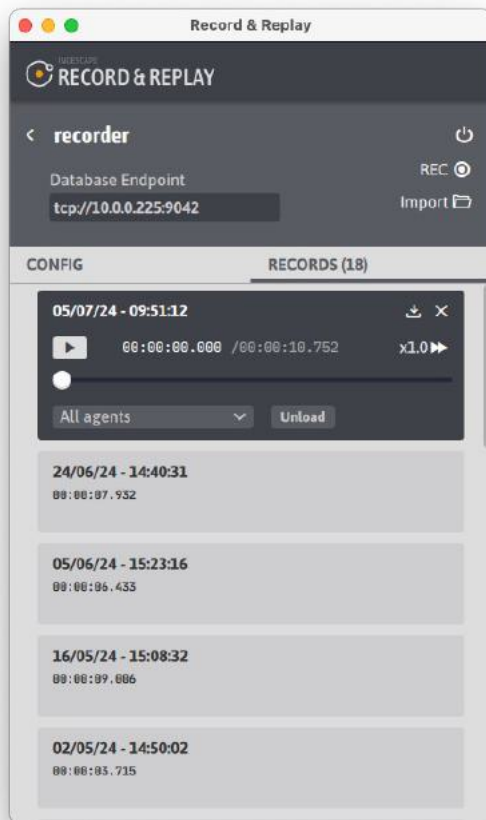


- 9000+ requirements translated into
  - 116 scripts
  - 144 392 lines
  - 20 189 test blocks
- 320 requirements with human-assisted verification
- 2537 requirements verified automatically
  - Tested via DevOps at every change
  - Results sent to HP ALM after each DevOps cycle



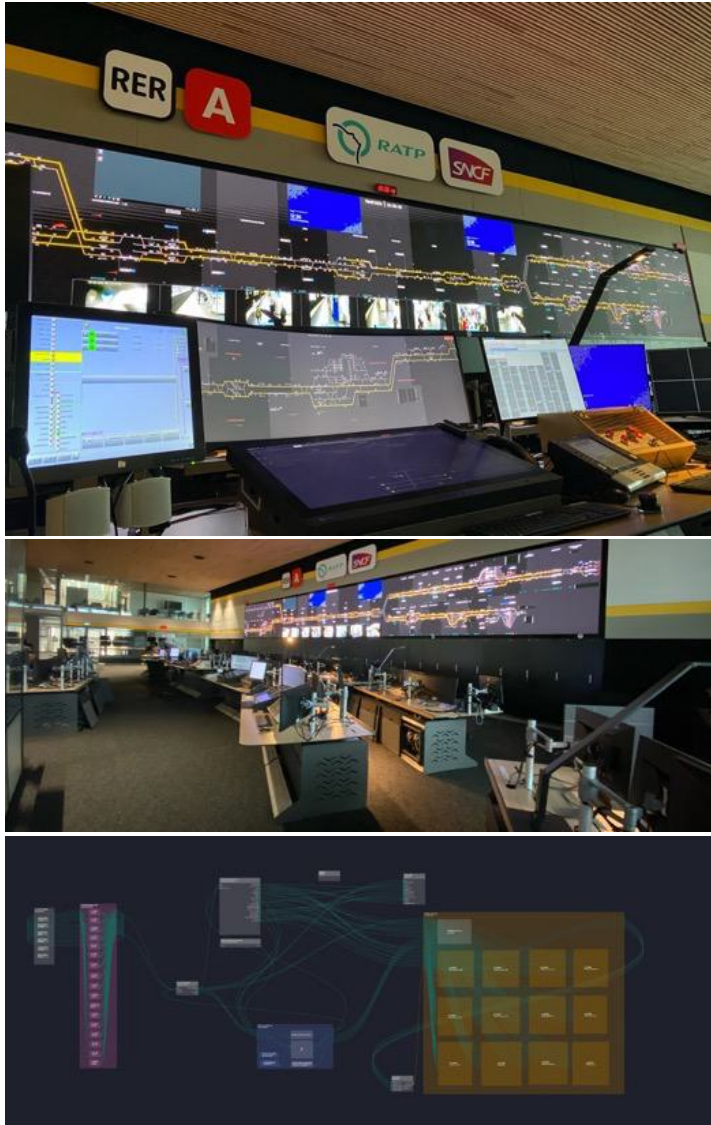
```
convTGTK_01_TKTE14_en_TKmetier_PML11.igsscript
convTGTK_01_TKTE14_en_TKmetier_PML11.igsscript No Selection
123 Conversion_TC_TK_TK_TE14 = "TE14_TK 11 0_05 00063"
124 sleep 200
125
126 "Placement de la valeur Fixe de l objet DI_AG à 1" "Numero de ligne : 5765 -
Equation: {<21100100, > 51100002}" {
127 block.timeout = 1000
128 Conversion_TC_TK_TK_TE14 = "TE14_TK 11 0_05 00061"
129 assert Conversion_TC_TK_TK = "TK_DI_AG 11 DI_AG 1 0"
130 assert Conversion_TC_TK_TK = "TK_RONFLEUR 11 Ronfleur_SIG 1 0"
131 assert Conversion_TC_TK_TK = "TK_DI_AG 11 DI_AG 1 0"
132 assert silence Conversion_TC_TK_TK 100
133 }
134 Conversion_TC_TK_TK_TE14 = "TE14_TK 11 0_05 00063"
135 "Envoi de la TC d acquittement de l alarme" {
136 block.timeout = 1000
137 Conversion_TC_TK_TC = "TC_ACQ 11 ACQ_OI_AG 1"
138 assert Conversion_TC_TK_TK = "TK_RONFLEUR 11 Ronfleur_SIG 0 0"
139 assert Conversion_TC_TK_TK = "TK_DI_AG 11 DI_AG 0 0"
140 assert Conversion_TC_TK_TK = "TK_DI_AG 11 DI_AG 0 0"
141 }
142 sleep 600
143
```

# Model-based support to Validation & Qualification



- **Continuous model-based supervision**
  - System is always observable & actionable
- **Model-based scripting**  
**+ No-code data record, replay & export**
  - For testing, assessments, in-depth analysis & training
- **Model-based Validation & Qualification**
  - With scenarios, context, simulations and humans in the loop, in addition to the system itself
  - Supporting multidisciplinary & regulated strategies

# Ingescape measured benefits



- **Integration & Verification time divided by 5**
  - Continuous model-based **integration**
  - **Formal expression of the requirements** through system scripts, always consistent with the models
  - **Verification & Validation**, automated and reusable in DevOps
  - Always using **realistic data**
  
- **On-site Validation & Qualification time divided by 8**
  - Most of the work is already **reliably** achieved on integration platforms with **trusted** context & data



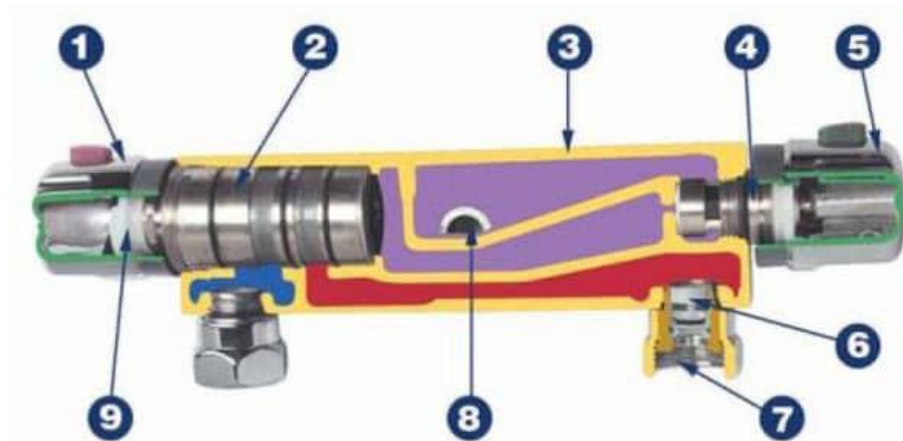
---

## A path to practical HSI...

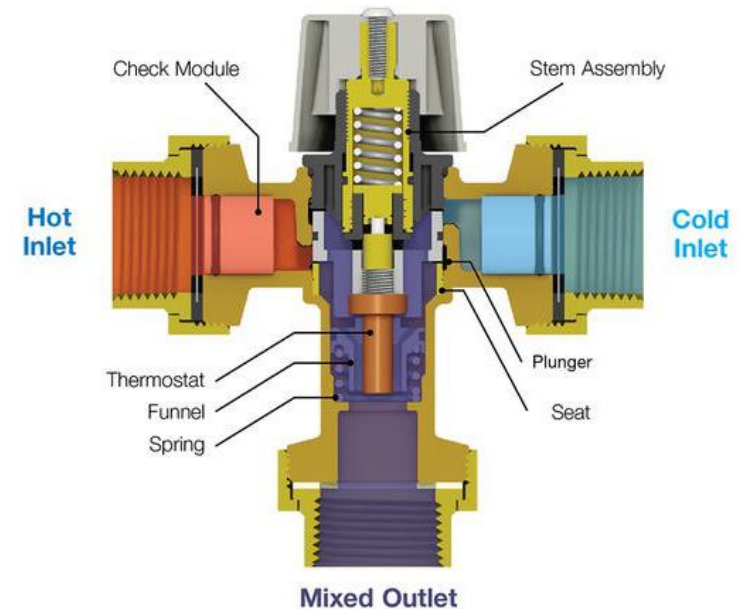
# The essence of HCI design

- Do you take showers ?

*Mitigeur thermostatique*



- ① Sélecteur de température
- ② Cartouche thermostatique
- ③ Corps
- ④ Tête céramique
- ⑤ Sélecteur de débit
- ⑥ Clapet antiretour
- ⑦ Écrou prisonnier
- ⑧ Sortie flexible de douche
- ⑨ Système d'étalonnage

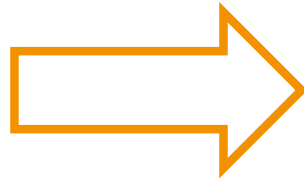


- Identify relevant system data, data to be displayed, and data to be manipulated by the users
- Define the logic between system data and user data (a.k.a. HCI functions)
- Find the best forms for data presentation and manipulation

# Which expertise and methodology for HCI ?

---

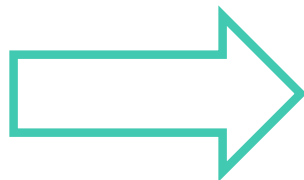
System  
+  
Human



## Multidisciplinary

- System expertise = engineers
- Human expertise = ergonomists
- Creators = designers & engineers

Analysis  
+  
Creativity  
+  
Evaluation



## Iterative

- Express the problems
- Create and improve solutions
- Evaluate the problems & solutions

## User-centered

- Human is the key to acceptability and performance
- A system is only a tool, even with A.I. and automation



# System users are not only the “end-users”

---

- Any system has to be

Designed  
Built  
Validated  
Used  
Maintained  
Disposed

All these steps require users in the loop, who interact with the system in various ways.

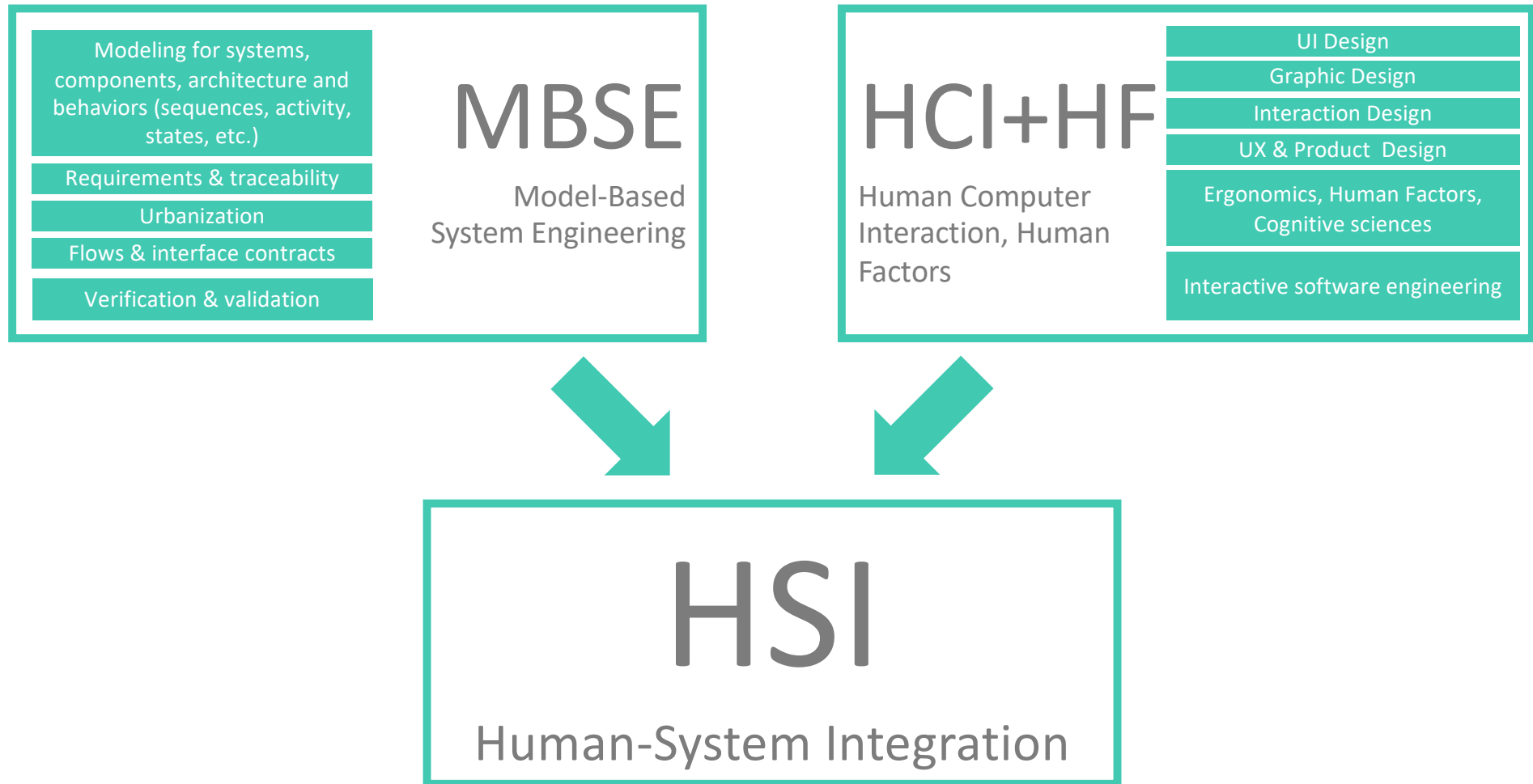
The key is to maintain consistency at all stages of the system lifecycle.

**Shocking revelation:** This is not done very well in most industries and most companies, because people lack

- A shared & evolutive vision, supported by a “common language”
- Really collaborative environments, practices and tools
- Properly trained managers and organizations

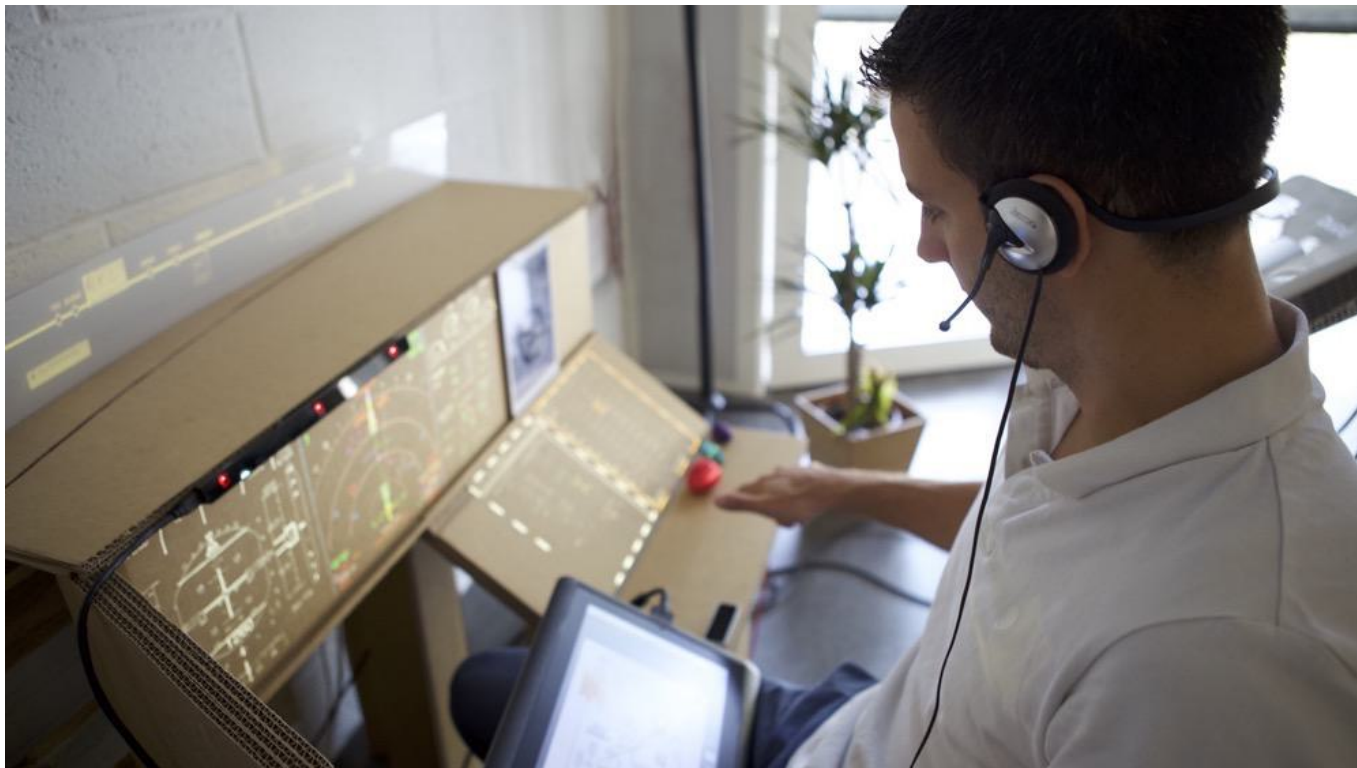
# A comprehensive approach to engineering interactive systems

---



# AIRBUS

**Advanced cockpit prototyping supporting state-of-the-art iterative and multidisciplinary methodologies**



[https://www.youtube.com/watch?v=9Gr1Le\\_F7jU](https://www.youtube.com/watch?v=9Gr1Le_F7jU)



# How did we handle these projects ?

---

- We have structured **multidisciplinary collaborations** in software teams and (re)conciliated **agile, user-centered and iterative methodologies**.
- We have developed the **technologies and tools** to support and accelerate the resulting processes.



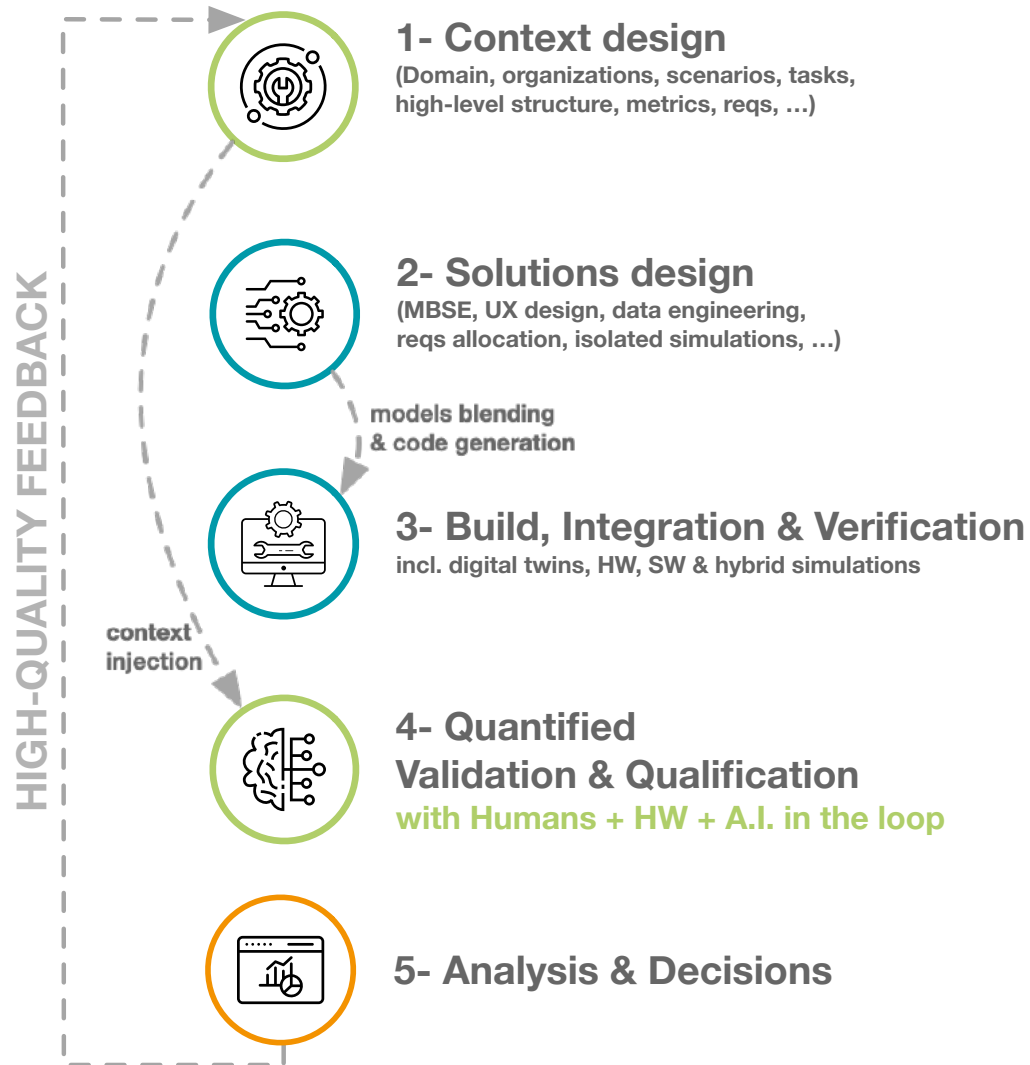
INGESCAPE

---

**Ingescape...**

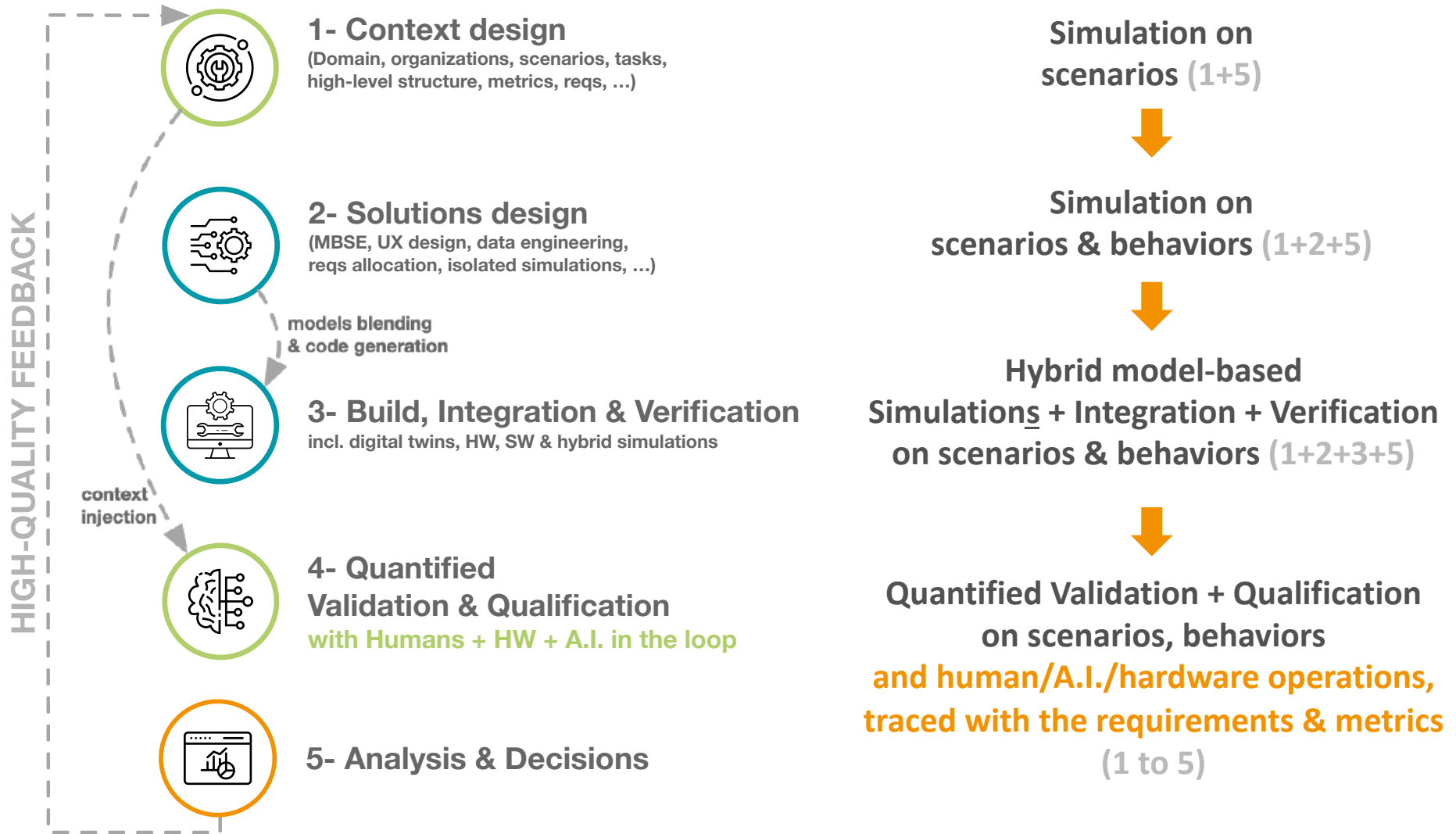
# The elastic process supported by INGESCAPE

## Design + Simulations + Operations



# The elastic process supported by INGESCAPE

## Design + Simulations + Operations





# Full-scale software interoperability

---



INGESCAPE  
Library

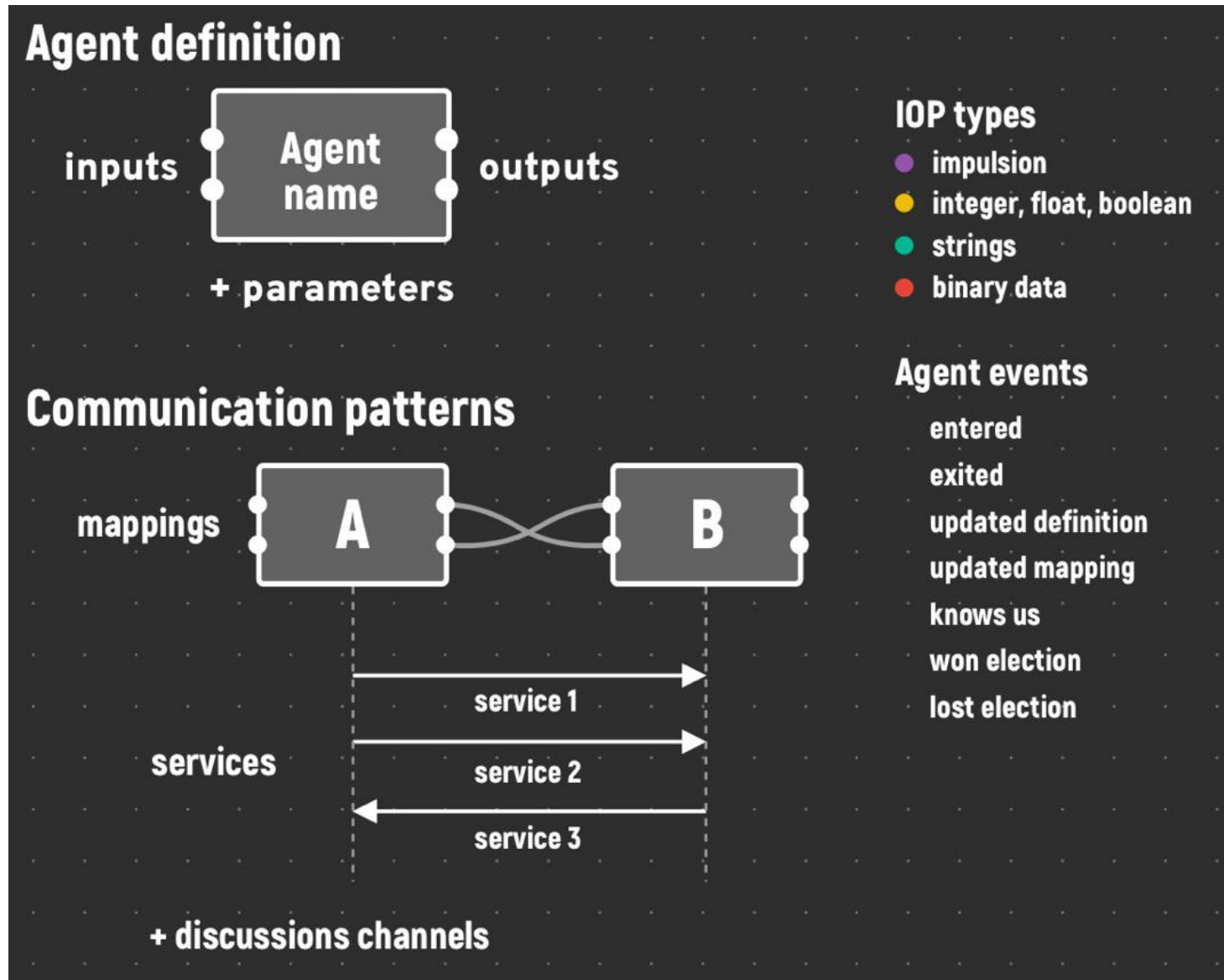
Any language, any OS, web, cloud, **open source**

Highly-supervised + fully-decentralized

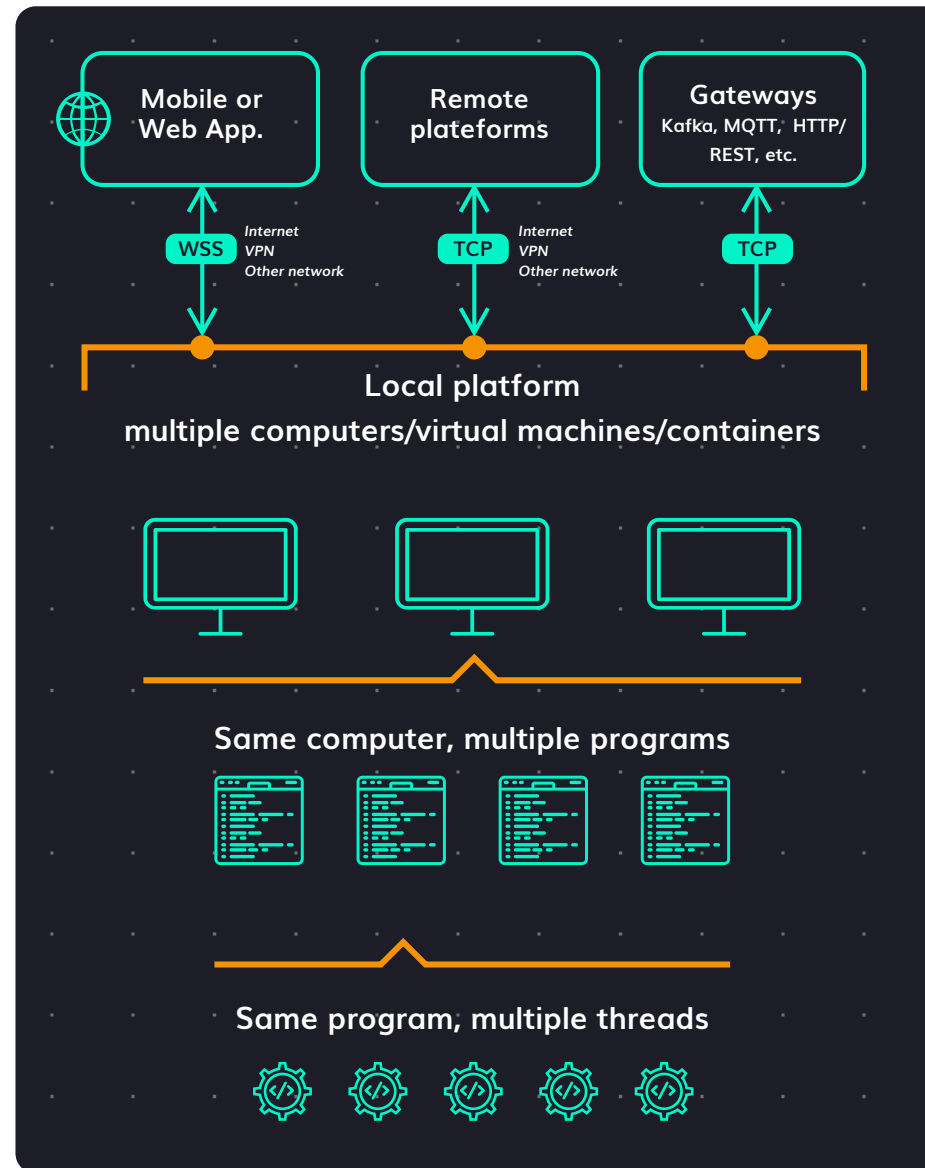
Model-based

<https://github.com/zeromq/ingescape>

# The Ingescape concepts in a single picture



# Scalability from worldwide systems to CPU-level high performance computing



# Where to get Ingescape and other resources ?

---

- **The open source Ingescape library repository**
  - <https://github.com/zeromq/ingescape>
- **The Ingescape Circle installer**
  - <https://repository.ingescape.com/circle-v4/win64/installer/latest>
  - <https://repository.ingescape.com/circle-v4/macos/installer/latest>