



Human Computer Interaction course

Part 2

ENSEEIHT

December 2024

Course content

- Course 1
 - HCI, HSI, distributed systems, interactive software engineering
 - First contact with Ingescape
 - Presentation of the exam
- Course 2
 - **HCI & UX methodologies**
 - **Visual programming with Ingescape**
- Course 3
 - Software design patterns for HCI development
 - Generating code and crossing models for interactive applications
 - Verification & Validation applied to interactive systems
- Course 4
 - Methodologies for multidisciplinary and iterative System Engineering, notions of HSI
 - Human Factor assessments, why and how
 - Co-simulation and data record/replay with Ingescape
- Course 5
 - Practical exchanges on your exam projects using system architecture models

What are objectives of HCI projects ?

- Objective

- Create systems that answer **final users needs** in an **efficient way** inside **real operational environment**

- Associated challenges

- Solutions design
 - Ability to achieve
 - Research on efficiency and users satisfaction

HCI is based on Multidisciplinary

- Ergonomics, Human Factors and cognitive sciences
 - To address all issues relative to human being, so that solutions fit the people who use them (comfort, efficiency, safety).
 - To introduce methods on user analysis and effective evaluation processes
- User-centered design (UCD), UX, UI and interactions design, graphic design... that bring all aspects of HMI creation
 - For specifying the task flow, interface content, intuitive navigation path, information architecture, UI overall appearance, layout...
 - ... by putting users at the center of the design and development
- Interactive software Engineers & Developers
 - To ensure the system design, the software implementation and the complete integration in collaboration with the teams of customers.

What is User eXperience design ?

The inclusion of observation and analysis of the **user activity** throughout a product design process, whether digital or not.

- User experience (UX) design aims at products that provide meaningful and relevant experiences to users.
- The user experience is the set of user perceptions during their interaction with a product, device, service, company...

Utilisateurs & co.

Utilisateur final

- a des besoins
- s'exprime en (mauvaises) solutions
- peut être très divers/diffus
- détient les clés du **succès global**

Représentant des utilisateurs

- UN utilisateur dont les propos n'engagent que lui

Expert métier

- a la pression de son chef qui s'imagine qu'il détient les solutions
- connaît effectivement bien le domaine et donc les besoins
- s'exprime en solutions ... avec aplomb et arguments construits
- n'est pas créatif

Client

- paye et valide
- a besoin de contrôle
- veut un ROI rapide et important
- a une vision idéalisée des solutions qu'il attend
- détient les clés de la **convergence** du projet dans les **délais**

Marketing

- croit connaître le besoin
- croit détenir des solutions
- connaît bien la stratégie
- détient les clés du **succès commercial**

Expert données/contenus

- se demande ce qu'il fait là (ou ce que nous faisons là)
- détient les clés de la **pertinence** et de la **cohérence**

Expert technique

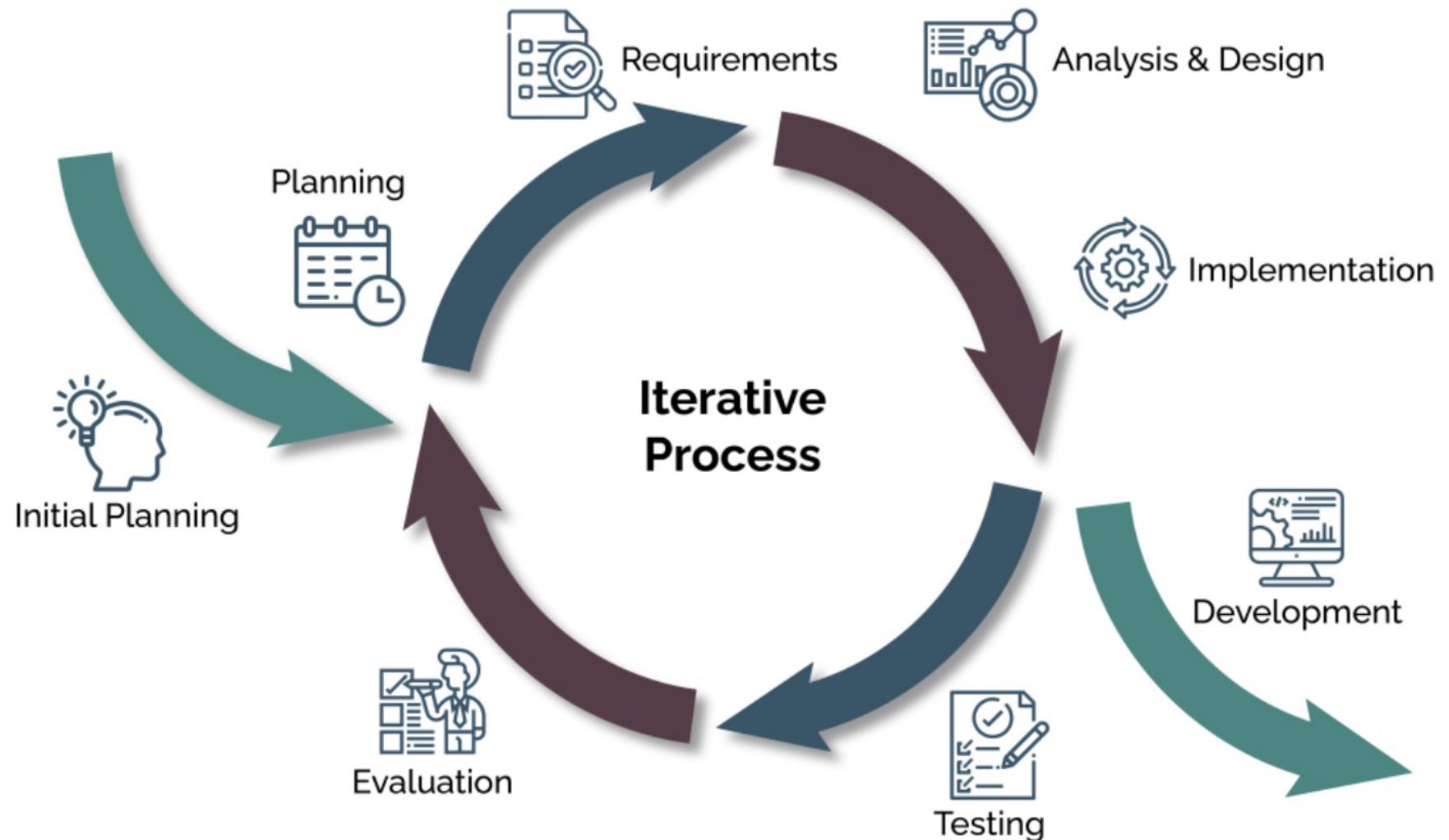
- a peur du chaos
- a peur de se trouver en situation de pression
- détient les clés de **l'intégration opérationnelle**

Voilà pourquoi il faut créer une **dynamique d'adhésion et de contribution collective !!**

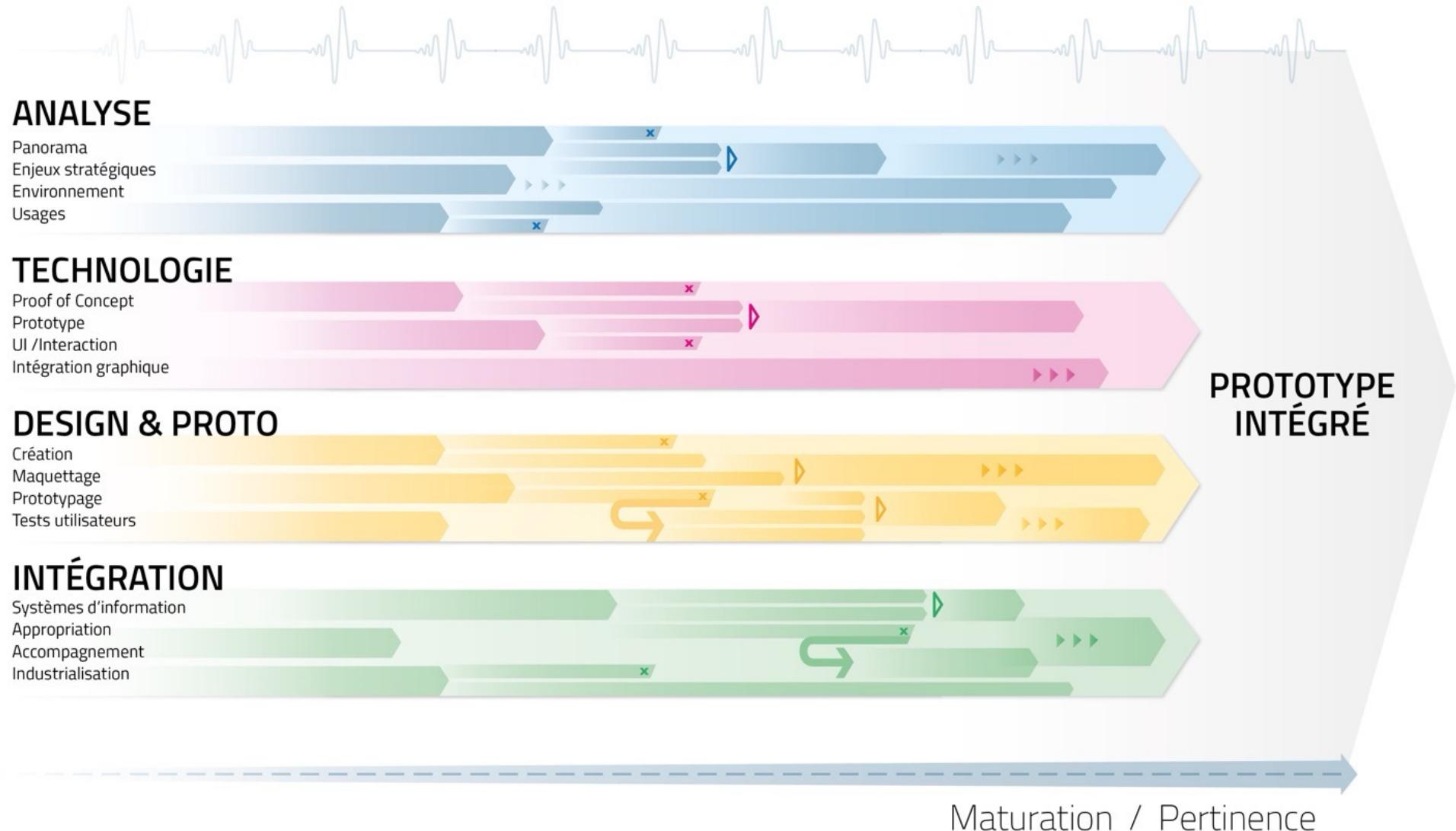
HCI design process includes different phases

- Initial analysis
 - Project issues and objectives
 - User research
 - Technologies and system
- High-level concepts definition
 - What problem needs to be addressed and how ?
- Solutions detailed design
 - Functional specifications (requirements)
 - User Interface and Interactions
 - Graphic Design
 - Logical and technical Architecture
- Prototypes implementation & evaluations

... but is highly iterative

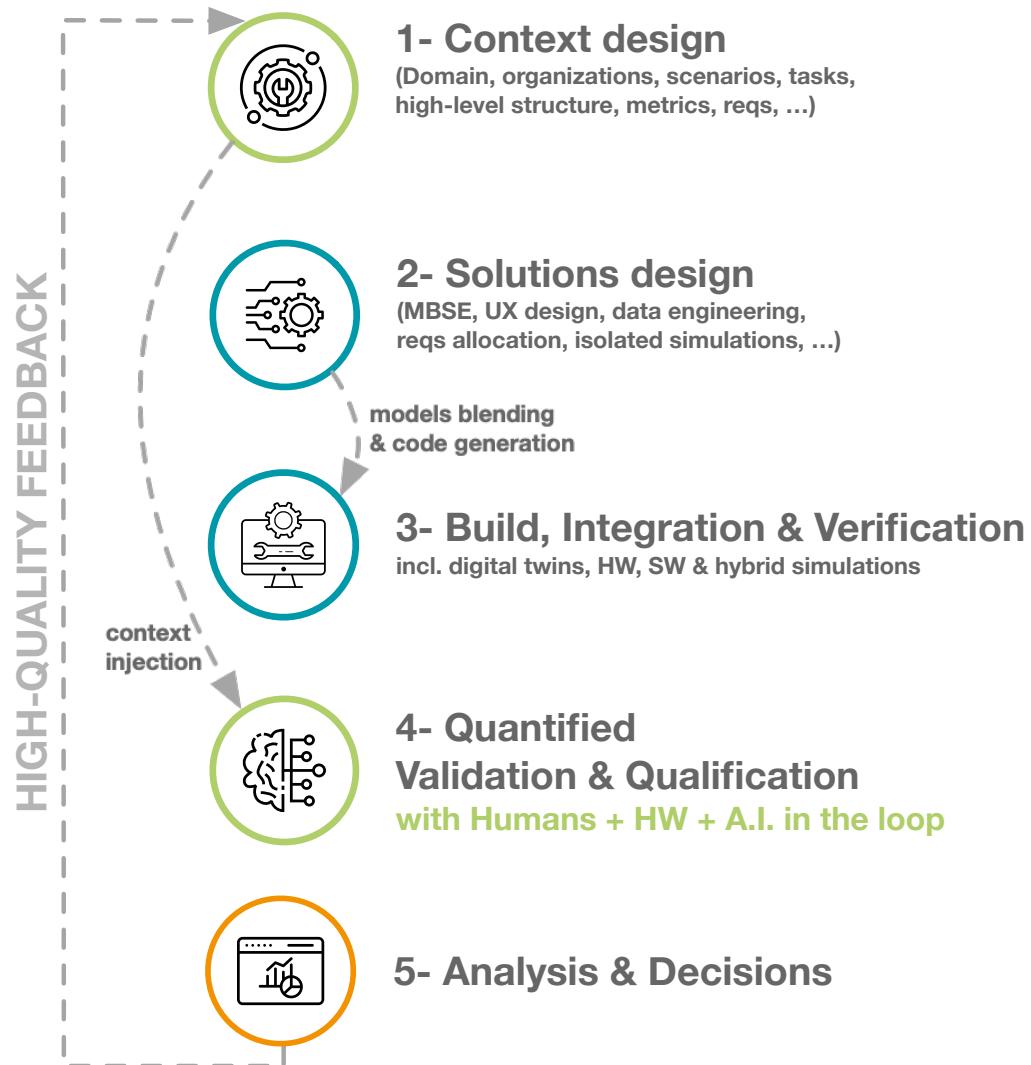


Solution is built progressively



The elastic process supported by INGESCAPE

Design + Simulations + Operations



The elastic process supported by INGESCAPE

Design + Simulations + Operations

in a NUTSHELL



enrich knowledge

imagine solutions

control development

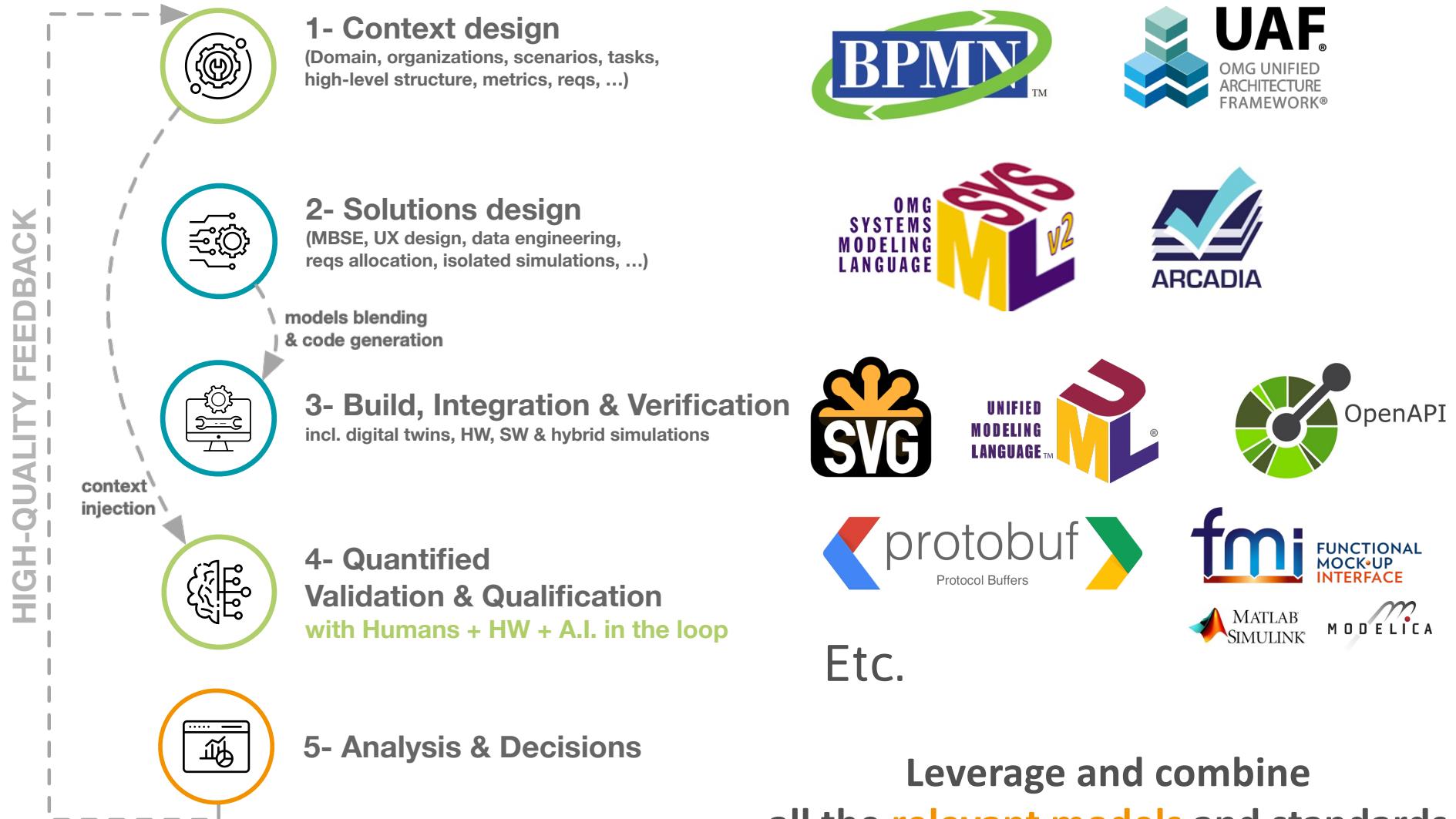
ensure fitness for use

foster vision

The elastic process supported by INGESCAPE

Design + Simulations + Operations

OPEN



Context design: What are the objectives ?

- Centralize knowledge about
 - Project
 - Issues and objectives
 - Resources constraints : budget and planning
 - Users
 - User Characteristics and profiles (specific skills, knowledge, experiences)
 - Needs
 - Existing (or projected) activity analysis and context of use
 - Tasks and operating scenarios
 - Technologies and systems
 - Technical Environment and Constraints
 - Existing systems analysis
 - Input/Output Data

➔ It's important to keep a broad view during this first phase !

Context design: How to proceed ?

- Users Interviews & Observations
- Documentation research
- State of the art of alternative solutions
- Existing tools analysis
- Workshops with
 - Customers
 - Technical teams
 - The other stakeholders...

Example

PCVA: Poste de Commandes de Véhicule Autonomes



Paris2Connect
Inventer la ville de demain

- PCVA: poste de supervision unique pour les expérimentations de véhicules autonomes du réseau RATP, composé de plusieurs navestistes
- L'un des projets de Paris2Connect: infrastructure numérique urbaine mutualisée pour de la Smart City, de la connectivité et de la mobilité autonome, dans une démarche inclusive et respectueuse de l'environnement

PCVA: navettes autonomes



EasyMile EZ 10



PCVA: navettes autonomes



Milla Pods

PCVA: navettes autonomes



Milla Van

PCVA - Experimentations

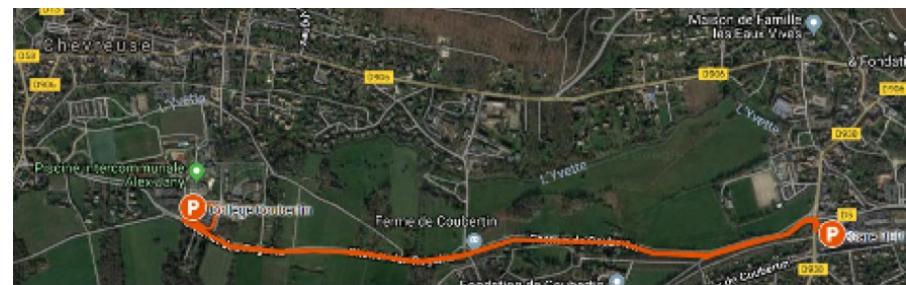
■ Vincennes

- 2 shuttle constructors
- Fixed Time Table



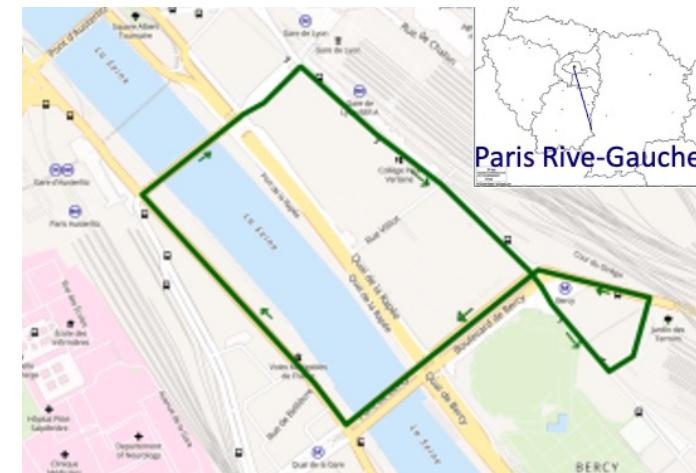
■ Saint Rémy

- On-demand transportation



■ 3 Gares

- Connected Infra-structure



PCVA – Project Objectives

- Innovation project
- Experimentation and exploration
- Users roles and activities not established
 - Need to have highly iterative process during the development
 - Changing functional scope
- Diversity of input data that can evolved

PCVA – Operating Scenarios

- Launch of shuttles and daily opening of the line
- Nominal management of the line
 - Regulation of the shuttles to regulate passages and respect the timetable
 - Traffic lights and intersections crossing
 - Reservations management
- Incidents
 - Incident on the line: presence of obstacles
 - Security incident: passengers discomfort
 - Failure or anomaly of a vehicle or infrastructure
- Vehicle fleet maintenance

PCVA – Data providers

- Shuttle
- Connected lights
- Videos
- On-demand Transportation Application (reservations)
- Users on the field
- Connected infrastructure (videos, algorithms results, presence and motion sensors)

PCVA - Utilisateurs



SUPERVISEUR

Accès à l'ensemble des modules

- Surveillance
- Régulation; gestion des SD
- Commande de véhicules et manœuvres
- Gestion de la flotte des véhicules
- Gestion des incidents



SAFETY-DRIVER

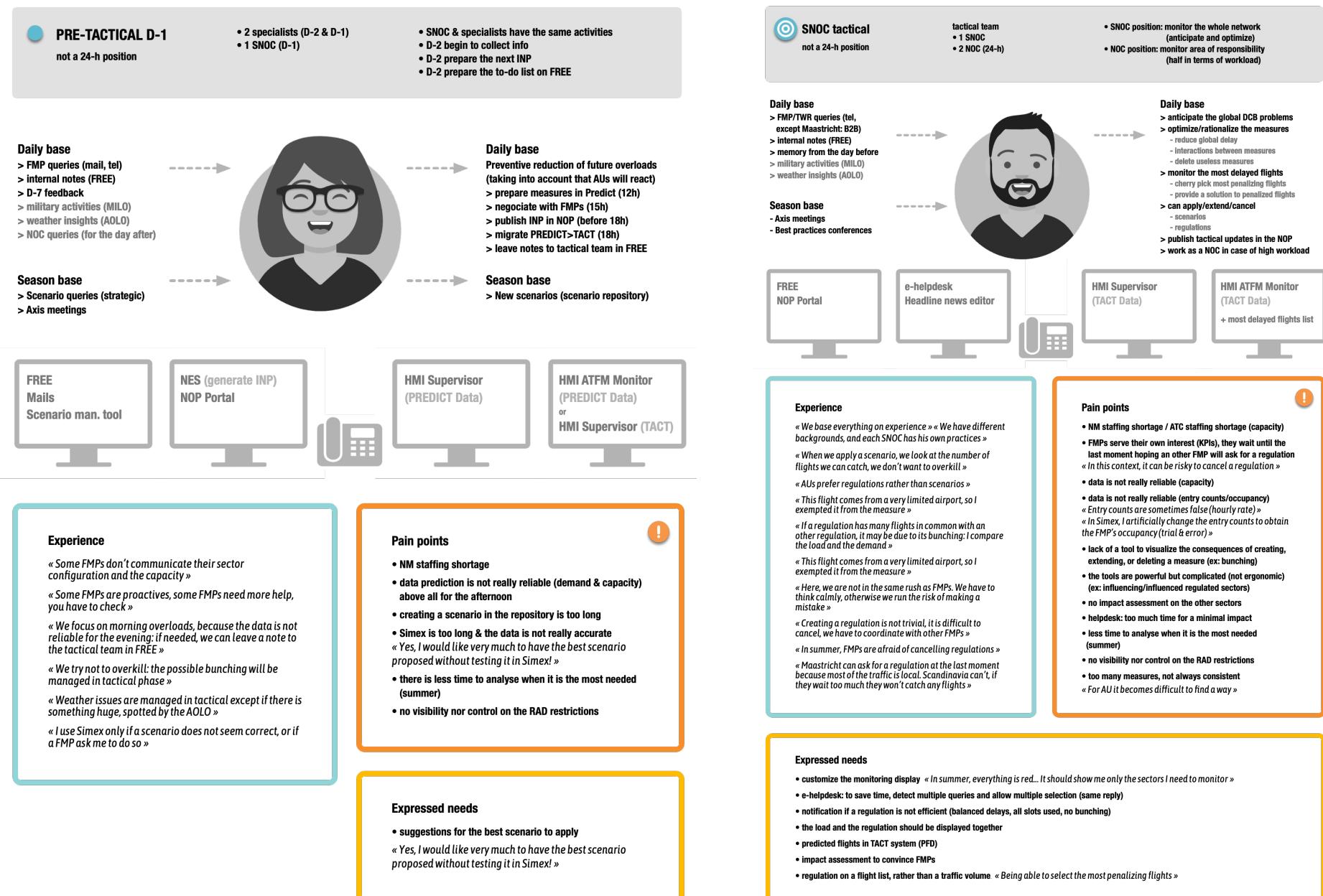
- Centré sur son service et son véhicule
- Commandes de véhicules et manœuvres
- Gestion des incidents



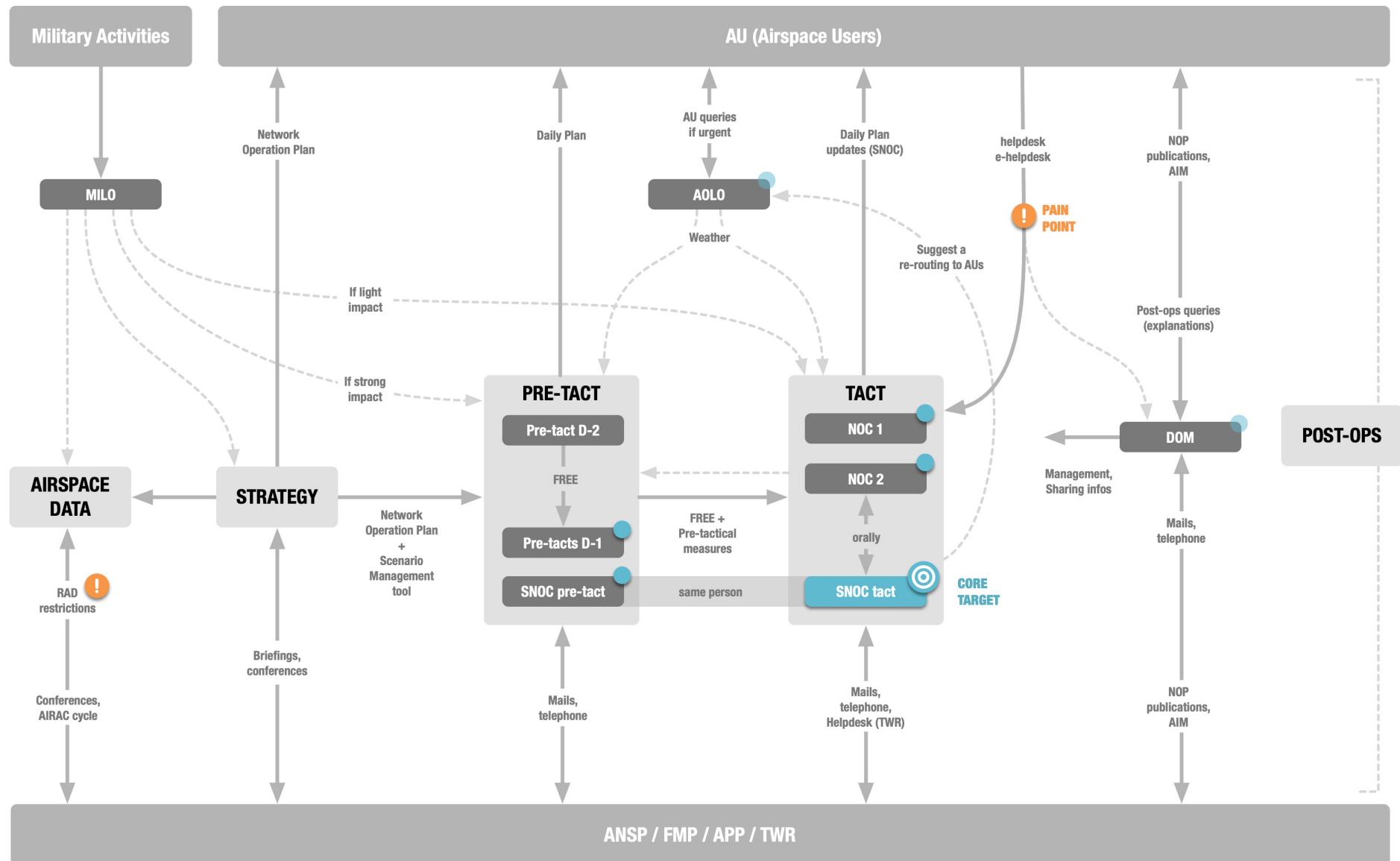
AGENT DE TERRAIN

- Commandes de véhicules et manœuvres
- Gestion de la flotte de véhicules
- Gestion des incidents

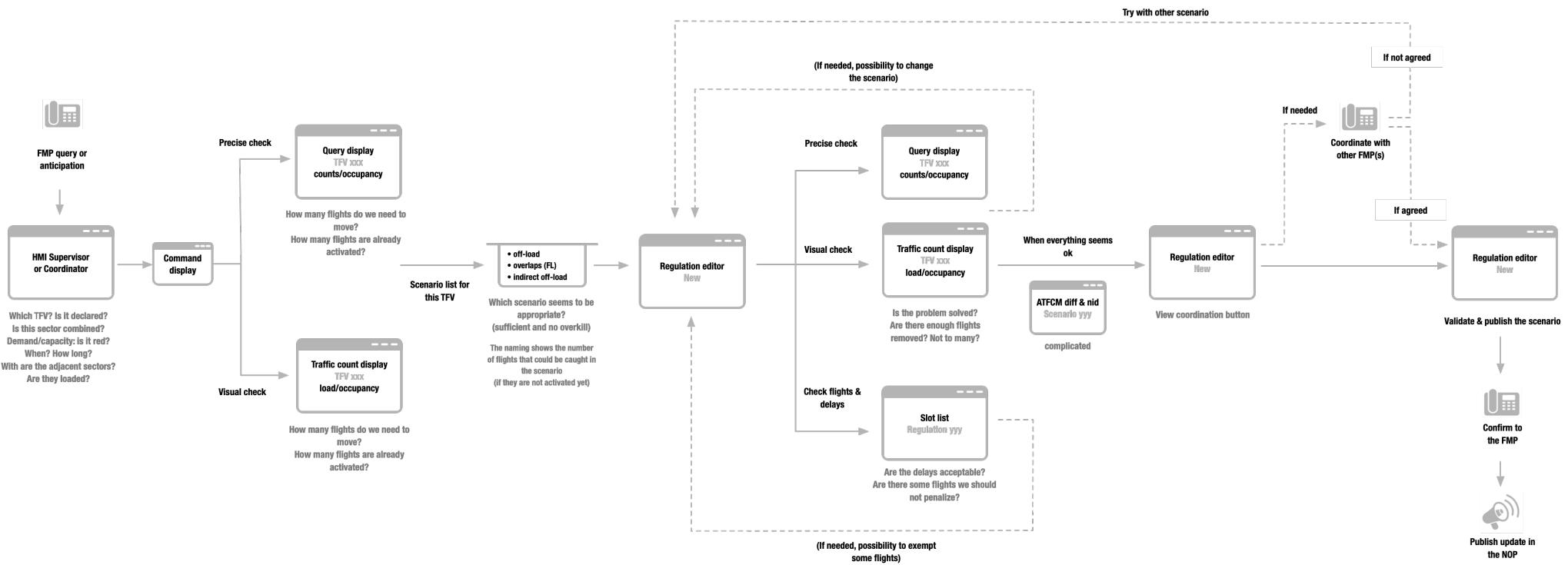
Other example: persona / user cards



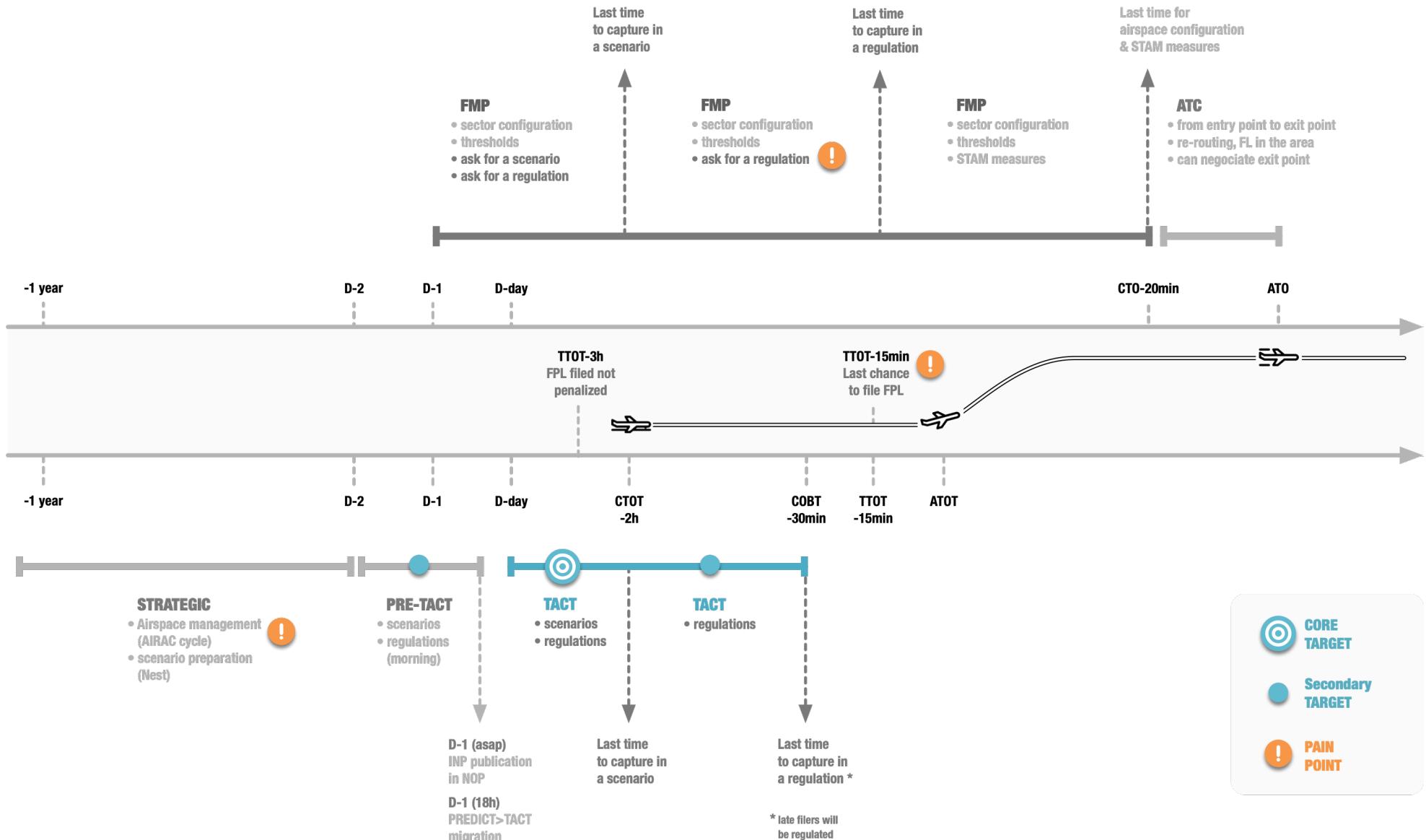
Other example: interactions between stakeholders



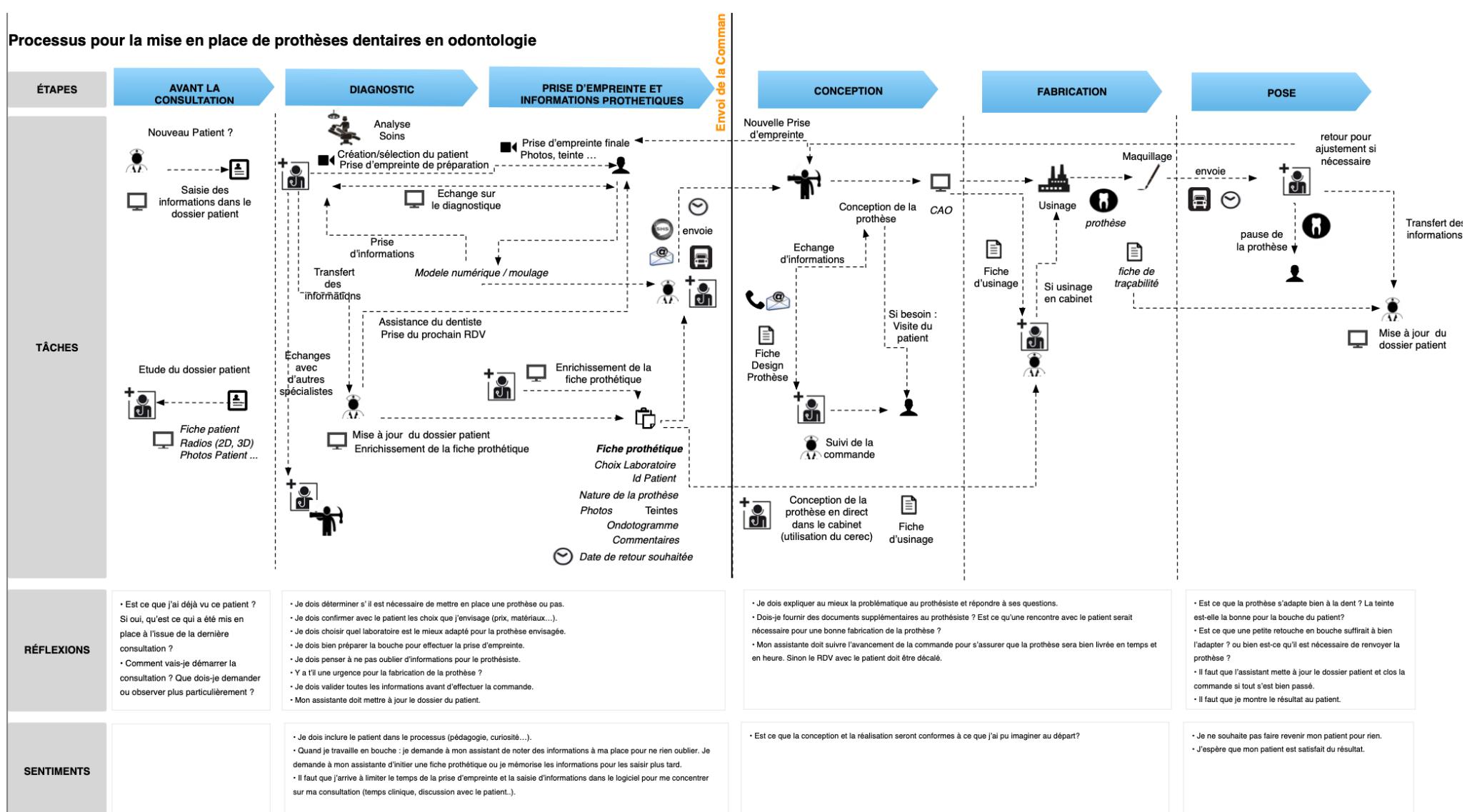
Other examples: workflows



Other example: timelines



Other exemple : experience map



High-level concepts definition

- What problem needs to be addressed and how ?
- Allowed to have
 - Clear idea of the project objectives
 - Coherent area of work
 - Consolidated general concepts
- Concepts could be defined by
 - Data definition and model
 - First functional analysis and breakdown
 - Architecture principles
 - Technological bases description : hardware, display format, interactions means...
 - Interface global layout and workflows
 - Etc.

PCVA – Information & Functions Analysis

Equipements

- Affichage des informations détaillées
- Etat de fonctionnement
- Commandes : bouger caméra ? piloter un feu ?

Incidents / Todo List

- Edition : création, localisation, caractérisation
- Suivi : statut et progression, procédures, instructions pour le SD/l'agent terrain
- Commandes véhicule (selon le type)

Véhicules

- Affichage des informations d'exploitation
- Etat, Pannes et Anomalies
- Commandes :
 - > portes, Stop&go, phares, vidéo
 - > messages IV
- Courses : Safety Driver, dessertes et horaires
 - > Créer une course HLP sans voyageur
 - > Éditer la course en cours
 - > Désaffecter le véhicule de son service
- Actions de maintenance : créer, supprimer, début/fin, caractérisation, état du véhicule associé (disponibilité)

Régulation

- Au niveau d'une course :
 - > Crédit : trajet, horaires (effectuée depuis mission prédefinie, de type HLP, ou création automatique selon réservations)
 - > Modification : horaires de départ, retenues en station, passage en omnibus.
 - > Suppression (gestion SD et véhicule ?)
- Affectation de véhicules et de SD à une courses (et aux suivantes)
- Gestion de l'état de la ligne (en cas d'incidents, travaux)
 - > station indisponible
 - > interruption de ligne : mise en place d'un service provisoire, durée associée, et option de remise à l'heure
- Actions de régulation globales ligne :
 - > Pilotage de dérives
 - > Vision et pilotage des fréquences de dessertes
- Chargement d'un nouveau tableau de marche
- Annotation permettant d'éditer les points remarquables sur la ligne

PCVA – User Interfaces Modules

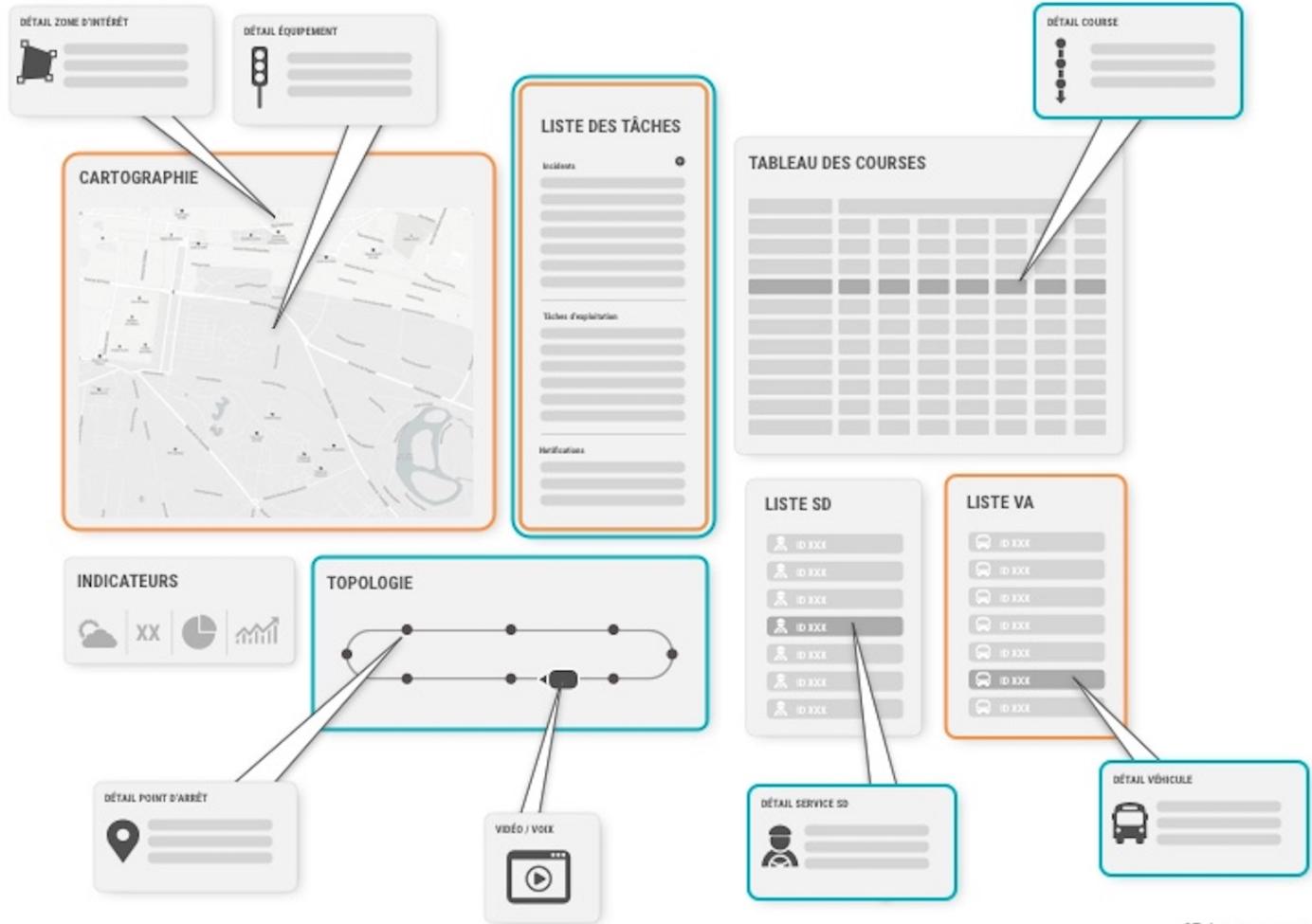
PCVA | PROFILS ET MODULES



SUPERVISEUR

Accès à l'ensemble des modules

- Surveillance
- Régulation; gestion des SD
- Commande de véhicules et manœuvres
- Gestion de la flotte des véhicules
- Gestion des incidents



PCVA – HMI global Concept

PCVA | VUES GLOBALES IHM



SUPERVISEUR



Utilisation en bureautique

- Un module = une fenêtre
- Affichage à la demande
- Dimensionnement et positionnements libres
- Accès à des configurations adaptées aux cas d'usages et postes de travail



SAFETY-DRIVER



Utilisation en mobilité

- Accès à un ensemble de vues agrégant un ou plusieurs modules
- Vues spécifiques aux profils et cas d'usages



AGENT DE TERRAIN



Detailed design: Prototyping



- Prototypes allow to evaluate solutions at each step of the process.
- At each iteration
 - Solutions refinement
 - Functional scope increase
 - Prototypes more and more faithful and integrated

Detailed Design: Participative workshops



Detailed Design

- What are "participatory design sessions with the customer" for?

Not really for solution creation ...

But allow rather to

- **Consolidated** elements that need to be discussed (use cases, information hierarchy, integration, issues, etc.)
- **Evaluated** design faced to reality : operational and technical context
- **Validated project progression and choices**

➔ And especially to create membership and work around a common vision

- Need to be completed with :

- Regular and targeted workshops with all of stakeholders
- and consolidation and analysis work

PCVA – HMI Design

Tableau des courses

[] X

Pai SD | Pai VA | Pai PA

CREER UNE COURSE

09:00 09:30 10:00 10:30 11:00 11:30 12:00 12:30 13:00 13:30

E02
QUAI FORT > PORTE JAUNE

E03
FORT NELL > SABOTIERS

N05
MAIRIE DE VILLENIERS > TREMBLAY

N06

SABOTIER > PORTE JAUNE

PORTE JAUNE > MAIRIE

FORT NELL > PARC FLORAL

TREMBLAY > QUAI

SD | E04

MAIRIE DE VILLENIERS > QUAI PORT

PA DEPART > PA ARRIVÉE

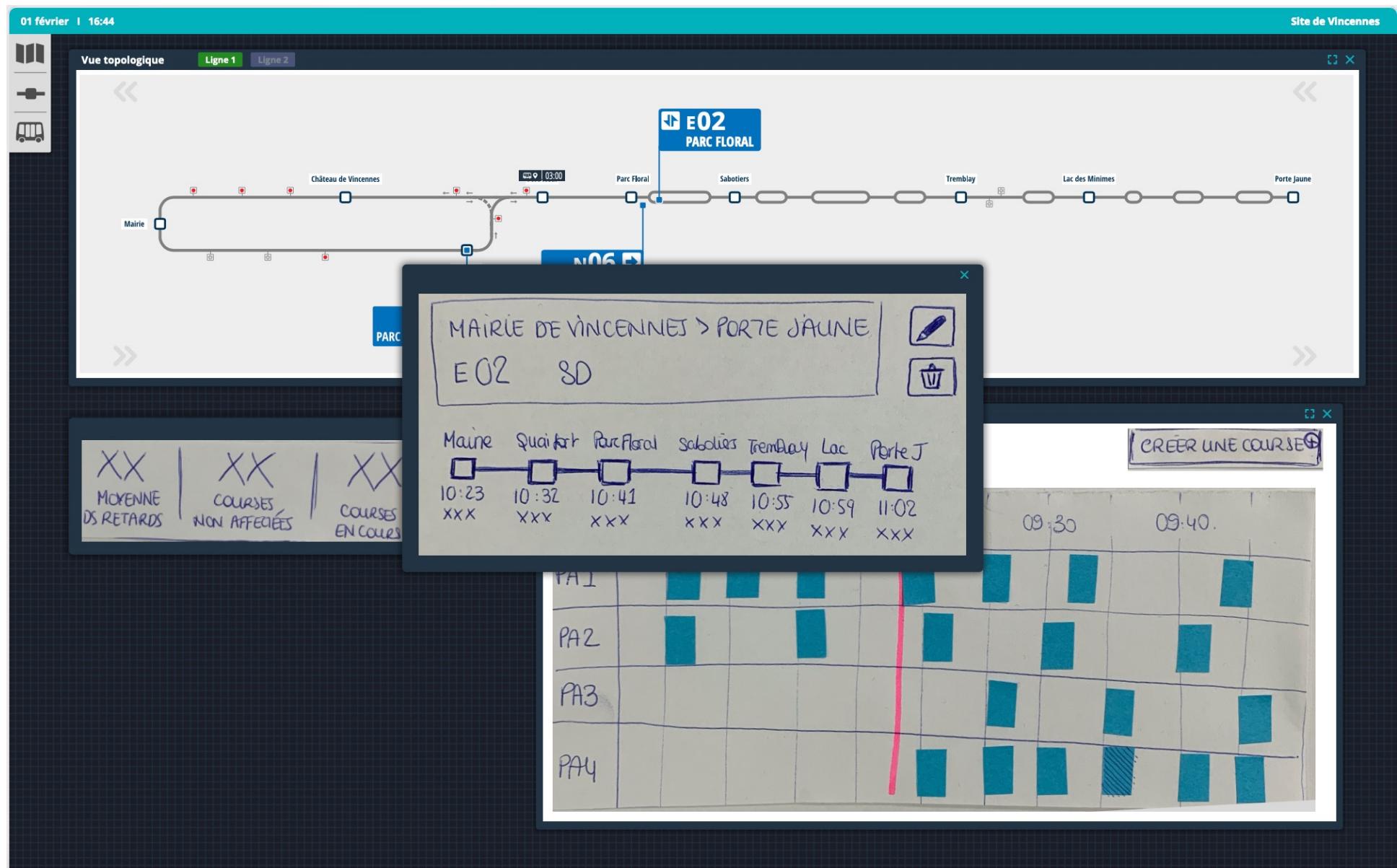
VA ▾ SD ▾

X

PA1 PA2 PA3 PA4 PA5 PA6

<input type="checkbox"/>					
XXX	XXX	XXX	XXX	XXX	XXX
XXX	XXX	XXX	XXX	XXX	XXX

PCVA - HMI Design



PCVA - HMI Design

03 janvier | 15:26:33 3 sites 2 utilisateurs connectés

Liste des événements Vincennes

Événements courants

- 09:24 Fort Neuf - Parc Flo. | Route barrée
- 09:24 - | Route barrée
- 09:26 Parc Flo. - Sabotiers | Encombrement Manifestation
- 09:24 - | Encombrement
- 09:24 Fort Neuf - Parc Flo. | Vigilance
- 09:24 - | Vigilance

Historique des événements

Indicateurs d'exploitation Vincennes

Événements	Événements d'urgence	Kilomètres parcourus	Départs Porte Jeune
2 2 2	00 00 depuis lh	00 Km	00 00 depuis lh

Vincennes

s03 00 m/h Mairie V.

Démarrer

Créer une course Pas de SD

100%

Tableau des courses Vincennes

Créer une course

	15:25	15:26	15:30	15:35	15:40	15:45
s03						
s01						
s02						

Flotte de véhicules autonomes Vincennes

Événements Nombre de Km Vitesse moyenne Événements d'urgence

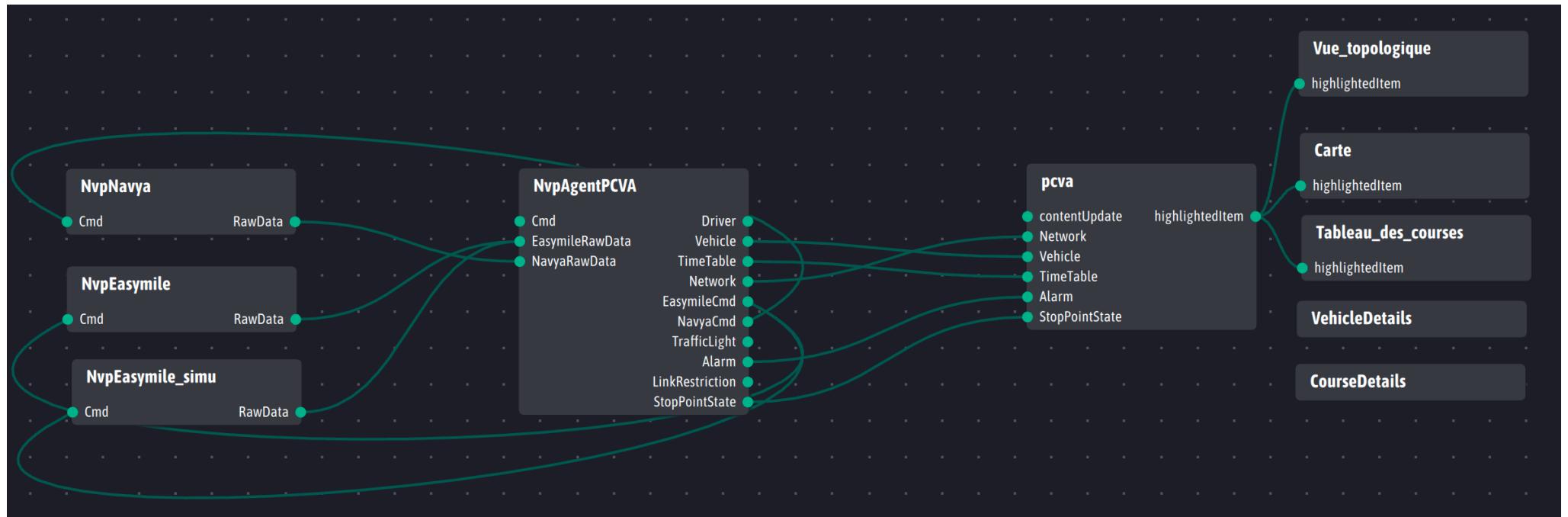
s03	Mairie V.	-	- Km	- Km/h	00 / 00 depuis lh
s01	Château V.	-	- Km	- Km/h	00 / 00 depuis lh
s02	Porte J.	-	- Km	- Km/h	00 / 00 depuis lh

Vue topologique Vincennes

The map displays a network of roads connecting various locations in Vincennes. Key locations labeled include Mairie, Château de Vincennes, Fort-R, Fort Neuf, Parc Floral, Quai Fort, Sabotiers, Tremblay, Lac des Minimes, and Porte Jaune. Three vehicles are tracked: s01 (at Château de Vincennes), s02 (at Porte Jaune), and s03 (at Mairie). Event icons (red, orange, yellow) are placed along the route segments between Château de Vincennes and Porte Jaune, indicating active incidents like route blocks or jams. A legend at the bottom right indicates the meaning of these colors.

PCVA – Solution Architecture

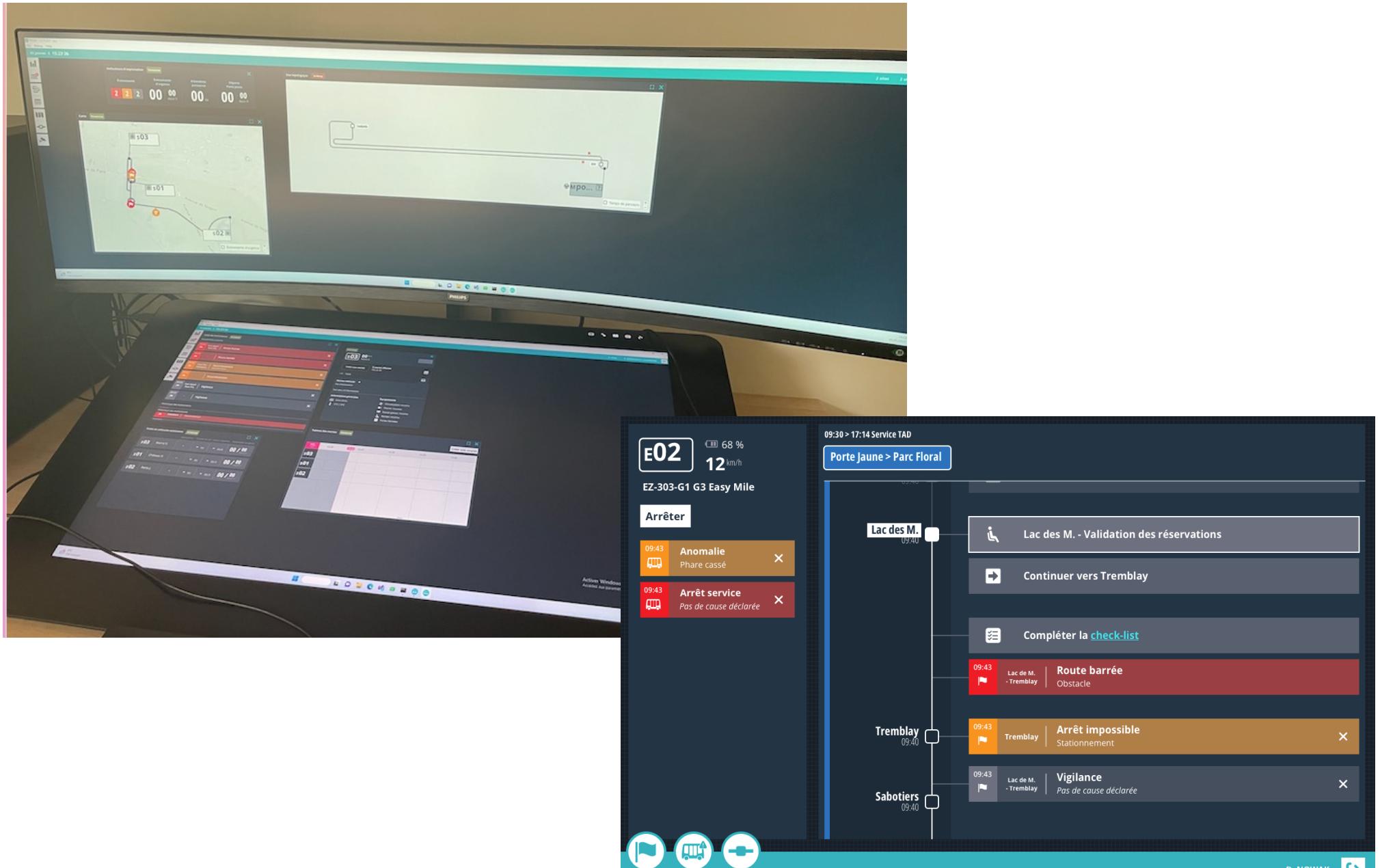
- Agents breakdown and definition
 - Data Inputs / Outputs
 - Services
- Exchange Protocol and Data Format



Software prototypes implementation

- Technologies and architecture should be chosen in order to allow
 - User Evaluations
 - Creativity and flexibility during the software development
 - Facilities to developers on the creation of rich and heterogeneous interactive environments
- Iterations remain very important during implementation
 - Begin with limited functional scope with only major functions
- Complexity and integration levels should be adapted to the maturity level of the function
 - Technology is a powerful medium... but should not overshadow the UX process.

PCVA Poste de Commandes de Véhicules Autonomes



PCVA Poste de Commandes de Véhicules Autonomes

03 janvier | 15:26'33

3 sites | 2 utilisateurs connectés

Liste des événements [Vincennes]

Événements courants

- 09:24 Fort Neuf - Parc Flo. | Route barrée
- 09:24 - | Route barrée
- 09:26 Parc Flo. - Sabotiers | Encombrement Manifestation
- 09:24 - | Encombrement
- 09:24 Fort Neuf - Parc Flo. | Vigilance
- 09:24 - | Vigilance

Historique des événements

Indicateurs d'exploitation [Vincennes]

Événements	Événements d'urgence	Kilomètres parcourus	Départs Porte Jaune
2 2 2	00 00 depuis 1h	00 Km	00 00 depuis 1h

Vincennes

s03 00 m/h Mairie V. Démarrer

Créer une course 0 course affectée Pas de SD

100%

Tableau des courses [Vincennes]

Créer une course

	15:25	15:26	15:30	15:35	15:40	15:45
s03						
s01						
s02						

Flotte de véhicules autonomes [Vincennes]

Événements	Nombre de Km	Vitesse moyenne	Événements d'urgence	
s03 Mairie V.	-	- Km	- Km/h	00 / 00 depuis 1h
s01 Château V.	-	- Km	- Km/h	00 / 00 depuis 1h
s02 Porte J.	-	- Km	- Km/h	00 / 00 depuis 1h

Vue topologique [Vincennes]

Temps de parcours

Evaluations Methodologies

- Observations
- Interviews and surveys
- Use of operating scenarios
- Use of standards
 - Heuristic evaluation, Ergonomics Criteria
- Quantitative experimentations

Some relevant rules to conclude

- Always keep in sight the project objectives
- Adapt the project, methods, solutions in the face of unforeseen events and opportunities
- Iterate as soon as possible and continuously
 - Share information and solutions : it's a team work !
- Best solution is often the simplest
 - « Si c'est compliqué, tu t'es planté ! »

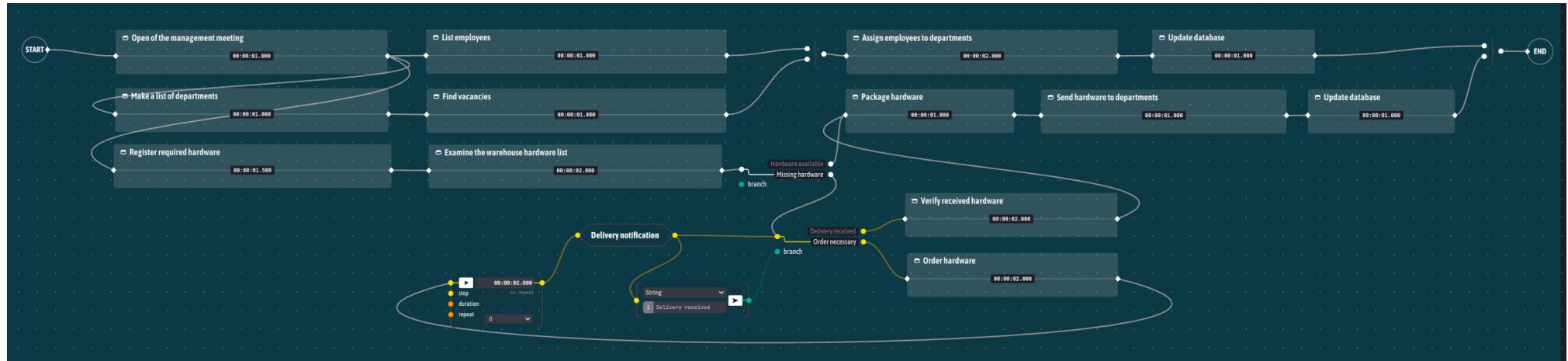
Visual programming with Ingescape

Visual programming ...

- Allow to create programs by manipulating elements *graphically* rather than by specifying them *textually*.
- Allow low-cost prototypes achievement
 - Prototypes could be implemented by all members of the team and notably designers.
 - Give the possibility to conduct assessments very early in the creative process.

Visual programming: define & test workflows

- Demo = Circle introduces visual programming tools



Reminders

Calendar

Friday December 6 th	<ul style="list-style-type: none">• Groups formation (3 students per group)• Each group registers by sending an email to n7@ingenuity.io with the student names and subject chosen
Monday December 16 th	<ul style="list-style-type: none">• 1st practical work session, assisted by the Ingenuity team• Technical choices, compilation, debug environment
Wednesday December 18 th	<ul style="list-style-type: none">• Practical exchanges on your exam projects<ul style="list-style-type: none">• Short briefs
Wednesday January 8 th	<ul style="list-style-type: none">• 2nd practical work session, assisted by the Ingenuity team• Continuous testing, V&V scripting, live integration
Friday January 10 th	<ul style="list-style-type: none">• Last practical work session, assisted by the Ingenuity team• Integration and testing with the white board and other agents
Monday February 3 rd	<ul style="list-style-type: none">• Project delivery to n7@ingenuity.io (less than 9MB) or Github<ul style="list-style-type: none">• Documentation, ingescape platform for integration and tests, V&V scripts, source code, compiled code

Course 5 : December 18th

- Practical exchanges on your exam projects

- Short brief
 - =~ 5 min per group
 - 1 slide per group
 - Content of your slide
 - Title: name of your agent
 - Group members
 - Clearly communicate your vision
 - Go straight to the point: few words to describe what you intend to do
 - If possible, add an illustration of your agent
 - Snapshot of your agent in Ingescape Circle, paper mockup, etc.

- Your slide **MUST** be ready by **12:00 noon on December 17th**

- Google slides: bit.ly/HCIBriefsN7

Evaluation criteria

- Quality of the proposed User eXperience /5
 - Utility, efficiency, comfort, robustness
- Completeness of the integration with the white board /5
 - Use of the white board's inputs, outputs and services in your own agent
 - Bonus points if you interact with other agents for an extended user experience.
- System engineering /5
 - Agent requirements
 - Minimal specifications for your agent (less is more)
 - Complete V&V scripts with traceability to your requirements
- Coding /5
 - Documentation
 - Ability for the teachers to compile and run the code
 - Clarity, concision and robustness

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/>
- The license and resources for this course
 - <https://ingescape.com/n7>
- The open repository for the Whiteboard agent
 - <https://gitlab.ingescape.com/learn/whiteboard>
- Cheat sheets for Ingescape
 - Python: <https://ingescape.com/ingescape-python/>
 - NodeJS: <https://ingescape.com/ingescape-nodejs/>
 - Java: <https://ingescape.com/n7/java/>
 - C# and HTML/CSS/JS: Ask us.