HUB PERFORMANCE
Airport Capacity Planning

dgac direction générale de l'Aviation civile

Unlocking Efficiency in Security Screening: A Parametric Digital Model for Optimized Checkpoints

Introducing a cutting-edge parametric digital model of a Security Screening Checkpoint (SSCP) developed with Emulate3D

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The Technical Service for Civil Aviation

- Certifying and evaluating equipments
- Experts for innovation in security
- Airport consulting
- Projects of national interest

Hub Performance

- **French Value Added Reseller (VAR)**
  - Pre-Sales, Sales
  - Training (Certified)
  - Technical Support / Hotline
  - Integration / Coaching
- **25+ Years Expert in modelling automated systems**

Agenda

- Context
- Project objectives
- System architecture
- Runtime Interface
- KPIs and results
- Simulation use cases
- Benefits and limitations

TG Concept – new innovative screening line : the X-Lane

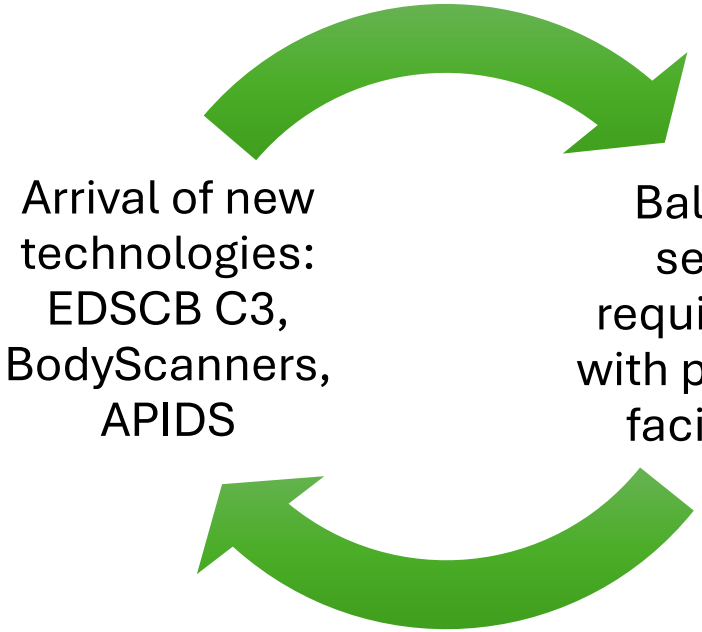
Context

- Growing complexity of checkpoint screening
- Necessity to develop a SSCP simulation tool
- Authoring a guidance document on cabin baggage inspection

Context

Rohde&Schwarz QPS 201™

Tirana International Airport, Albania



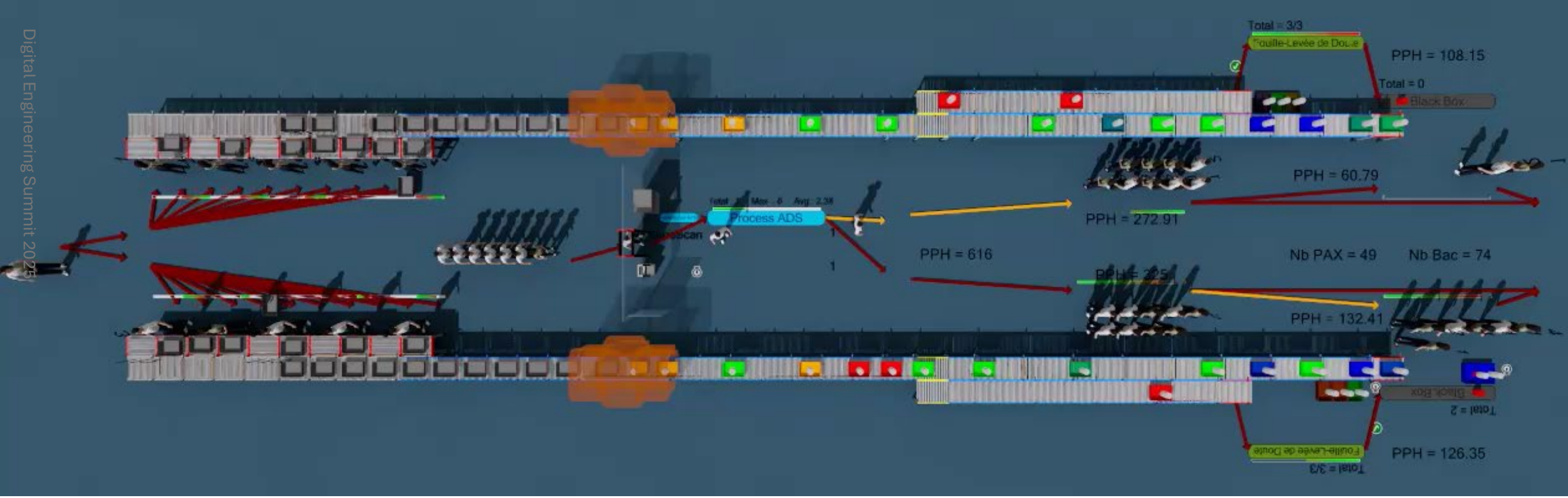
Arrival of new technologies: EDSCB C3, BodyScanners, APIDS

Balancing security requirements with passenger facilitation

Thales HELIXVIEW™ project

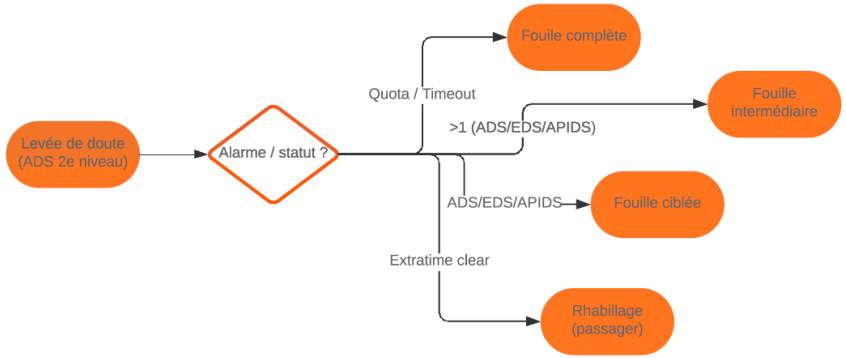
Project Objectives

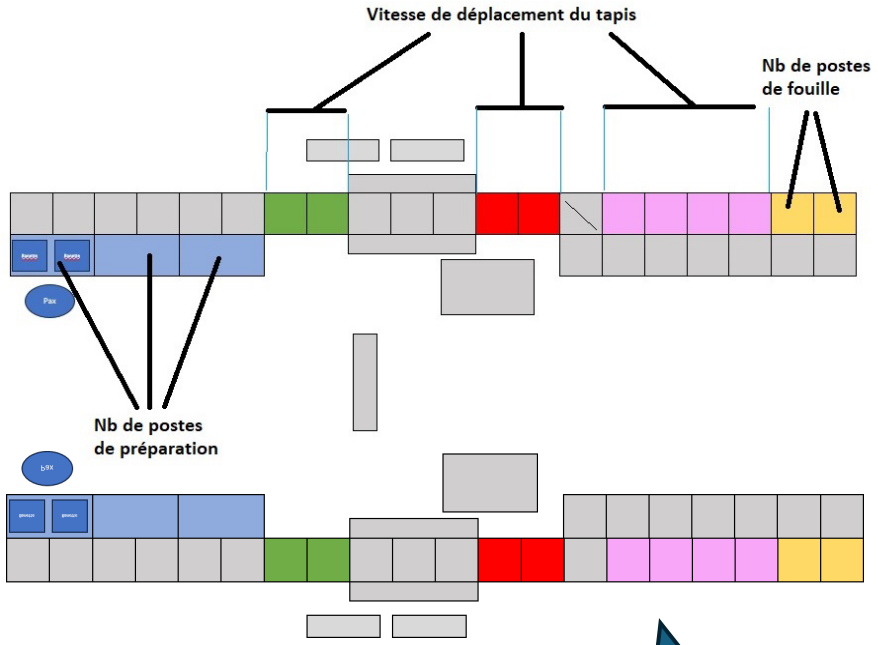
- Build a parametric simulation of a checkpoint line
- Use Emulate3D Runtime for maximum usability
- Support quick scenario testing and comparison



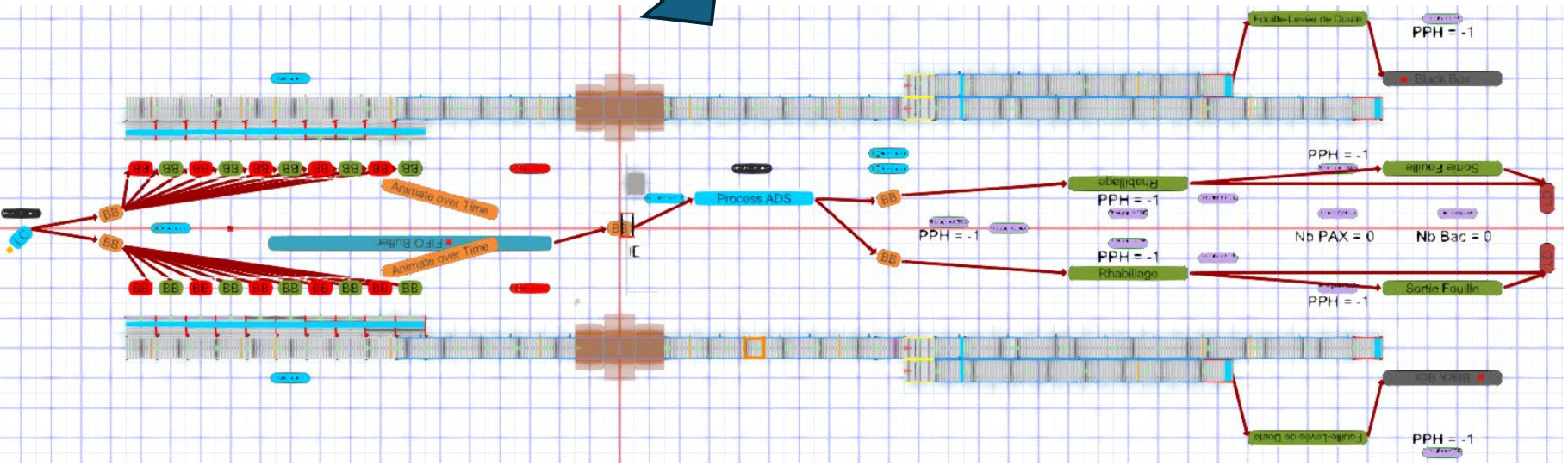
System Architecture

- Passenger and tray flow synchronization
- Key areas: preparation, scanner, EDS, recheck, retrieval
- 48 parameters
- Complex routing based on alarms (EDS, APIDS, operator)



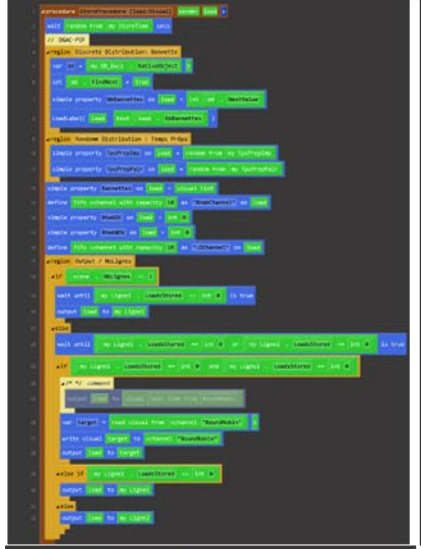


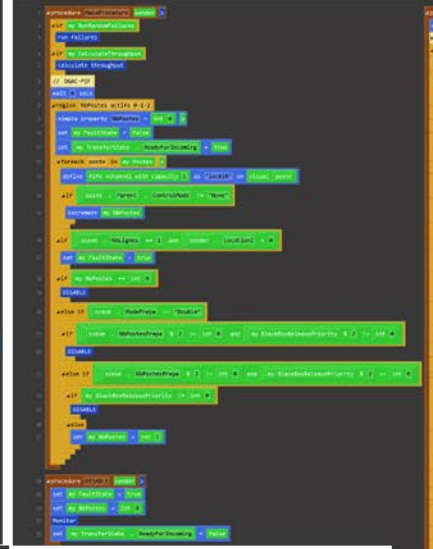
- Scope / Constraints
  - Runtime users
  - 100% Parametric
    - Physical
    - Functional
    - Numerical
  - Complex Tray/Pax synchronization
    - Multiple Operation modes

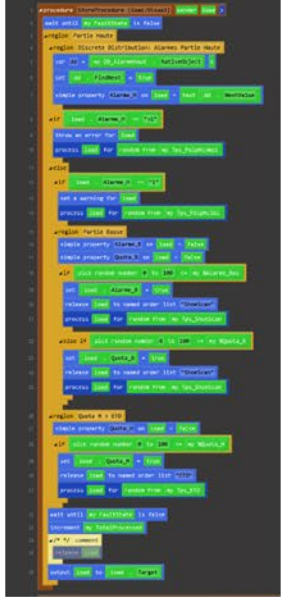


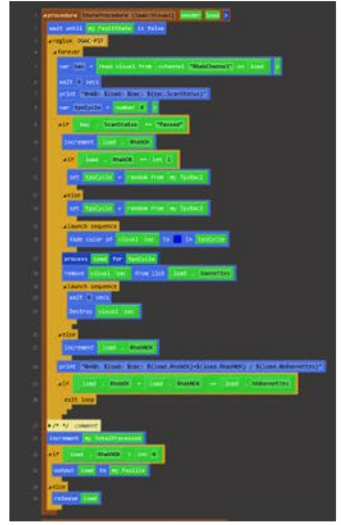
From Specification to Model Concept

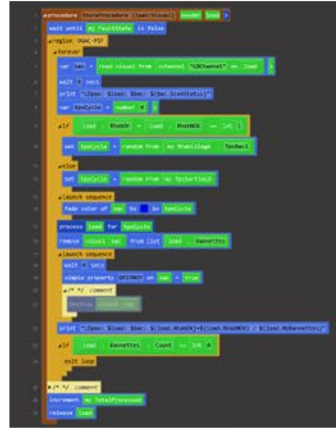
- Smart Conveyors
  - Single/Multi Zone Accumulation
  - Popup Transfer
- Black Box V3
  - Load Creator & Deleter
  - Animate over Time
  - Process (Time+Parallel)
  - FIFO Buffer
- Baggage Handling
  - Collector Belt Controller
  - Screening Machine & Operators
- Discrete Distribution
- Custom Plug-In
- Data Collection

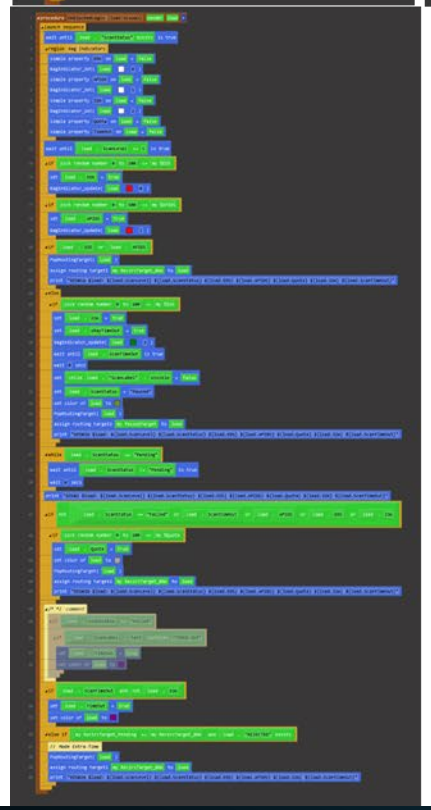


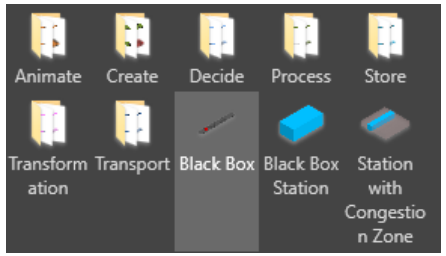






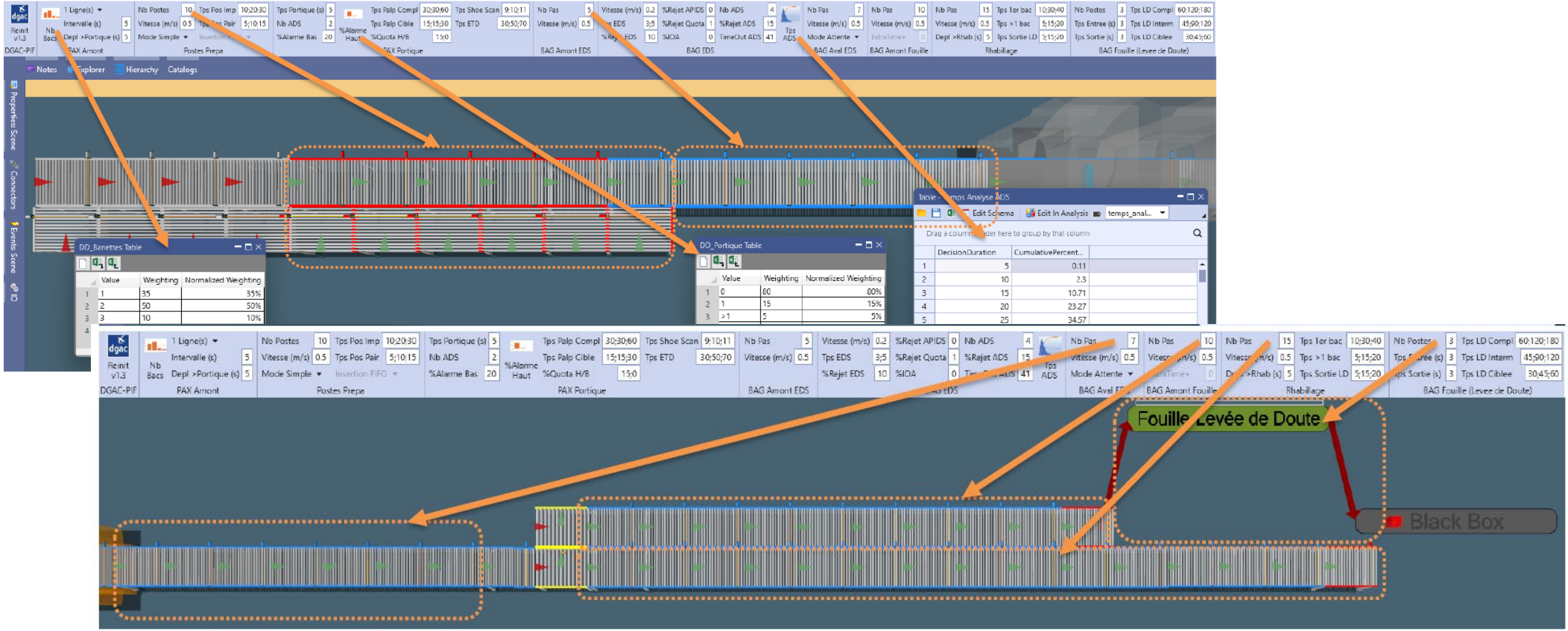






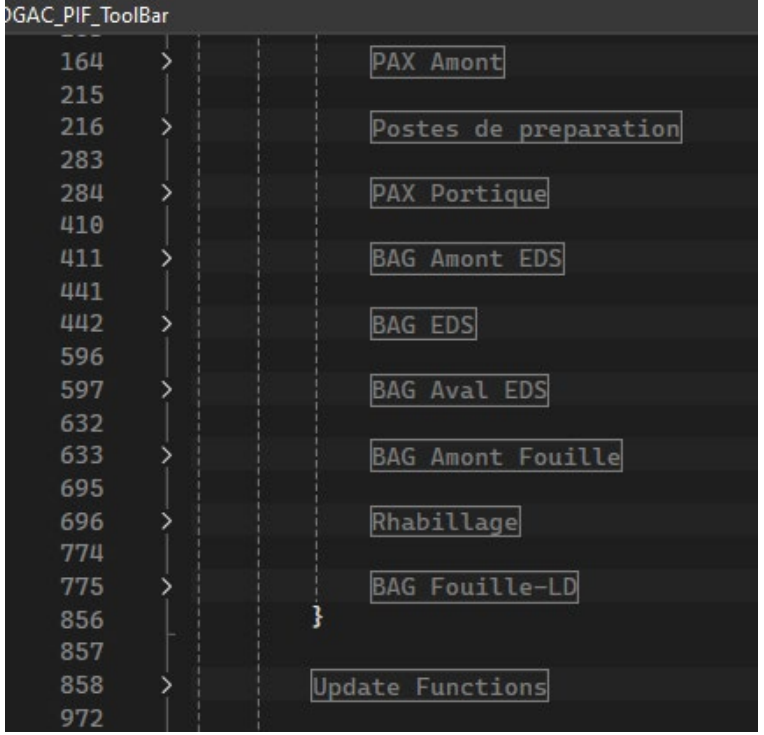
Behind the Scene

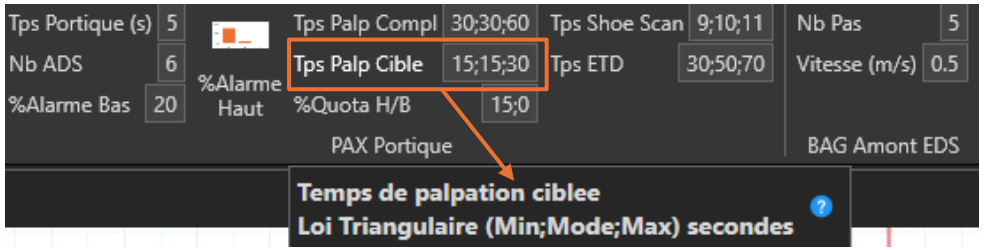
- Black Box Quick Logic managing Tray&Pax Flows
  - Asset used for Preparation stations
- xRay Machine custom OnBlocked Quick Logic to adapt to complex decision process
- Channels used to synchronize Tray&Pax Logics

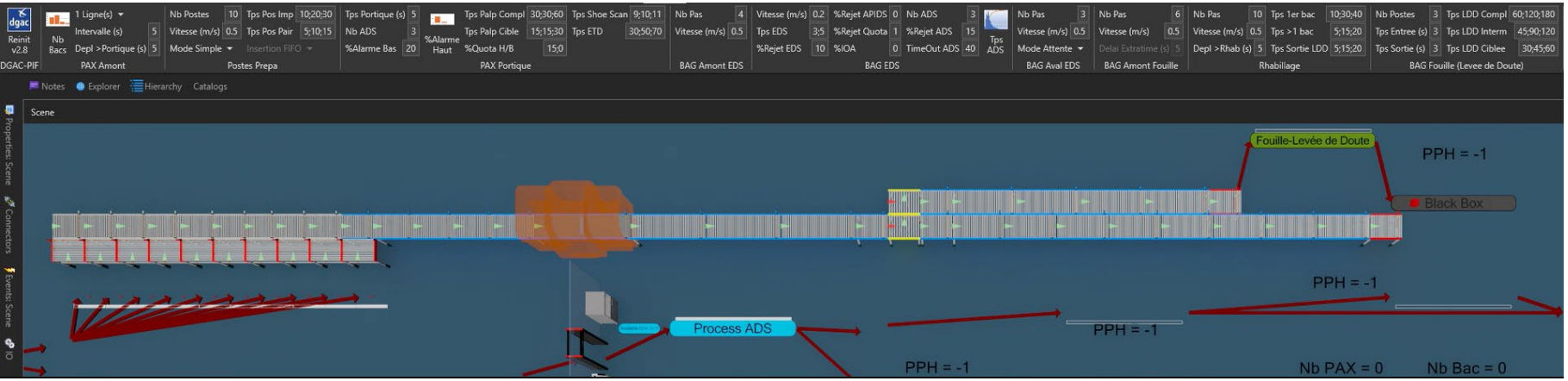


Runtime Interface

- Full control via custom plug-in
- Quick Access toolbar for frequent actions
- Real-Time animation and parameters adjustment







The Custom Plug-In

- 48 settings
  - 9 Groups
- 1000+ lines
- Sequential coding
  - Group by Group
  - Edit Fields, Buttons, Choice Lists
    - Tables Display
  - Dynamic Data Control
  - Mouseover Help
- Dynamic model update on Value Changed
- Simple Properties Clean-Up

KPIs and Results

- Passenger throughput (pax/hour)
- Tray management and waiting times
- Scenario comparisons:
  - layout, alarm rates, line setups

	Indicateur	Définition
Indicateurs mesurés à un instant T (image)	**Throughput_Portique :**	*PPH*
	Process (Time) Portique	Débit passager au portique en pax/h
	VariableTracker_PortiqueInOut :	
	Pax FIFO Buffer LoadsStored	Nombre de PAX dans la file d'attente amont du portique
	Process (Time) Portique LoadsStored	Nombre de PAX en cours de traitement ADS en aval du portique
	Throughput1 :	*PPH, Ligne1 (haut)*
	BB_Pax-Rhab1	Débit passager au rhabillage en pax/h
	BB_Pax-LD1	Débit passager à la LDD en pax/h
	BB_Bac-LD1	Débit Bannettes à la LDD en pièces/h
	EndOfLine1	Débit passager en bout de ligne en pax/h
	Throughput2 :	*PPH, Ligne2 (bas)*
	BB_Pax-Rhab2	Débit passager au Rhabillage en pax/h
	BB_Pax-LD2	Débit passager à la LDD en pax/h
	BB_Bac-LD2	Débit Bannettes à la LDD en pièces/h
	EndOfLine2	Débit passager en bout de ligne en pax/h
Indicateurs globaux	**TimeInSystem_PAX :**	
	Count	Nombre de PAX ayant passé le PIF
	MinTime	Temps de présence sur PIF minimum
	MaxTime	Temps de présence sur PIF maximum
	AvgTime	Temps de présence sur PIF moyen
	TimeInSystem_Bac :	
	Count	Nombre de bac ayant passé le PIF
	MinTime	Temps de présence sur PIF minimum
	MaxTime	Temps de présence sur PIF maximum
	AvgTime	Temps de présence sur PIF moyen

Label	Count	MinTime	MaxTime	AvgTime
TimeInSystem_PAX	16	105.7518	306.9713	165.312

Label	Count	MinTime	MaxTime	AvgTime
TimeInSystem_Bac	22	72.99737	251.1171	122.1224

```
procedure MainProcedure sender
  foreach Target in my Targets
    Track Variable visual Target

thread Track Variable {target : Visual} sender target
  forever
    if my DelayCollection
      wait for experiment to start
    wait my SampleInterval secs
    report that format "$target ${sender.TargetProperty}" is target ? my TargetProperty at current time
```

Time	Pax FIFO Buffer LoadsStored	Process (Time) Portique LoadsStored
60	0	0
120	0	1
180	0	0
240	0	0
300	1	1
360	0	1
420	1	1
480	0	1
540	0	3
600	0	2
660	0	1
720	0	3

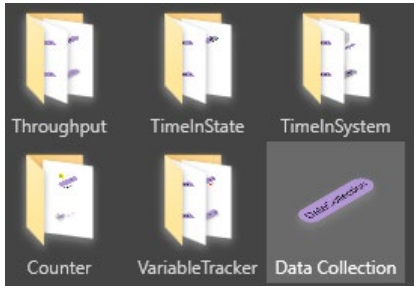
```
procedure MainProcedure sender
  foreach Target in my Targets
    Track Throughput Target
    Report Throughput Target

thread Track Throughput {target : Visual} sender target
  forever
    if my Targets . Count == 1
      set display to show "PPH" as round ( pph for target , 2 )
    if my DelayCollection
      wait for experiment to start
    wait for target . TransferState . OnProcess to fire
    increment counter target

thread Report Throughput {target : Visual} sender target
  report that target is 0 at current time
  forever
    wait my SampleInterval secs
    report that target is pph for target at current time
```

Time	BB_Pax-Rhab1	BB_Pax-LD1	EndOfLine1	BB_Bac-LD1
0	0	0	0	0
60	0	0	0	0
120	180	0	30	0
180	200	40	80	40
240	210	60	165	90
300	240	96	180	96
360	250	100	170	130
420	257.1428571	102.8571429	188.5714286	145.714286
480	255	120	210	150
540	253.3333333	120	240	140
600	264	114	228	132
660	267.2727273	109.0909091	240	136.363636
720	270	115	235	130

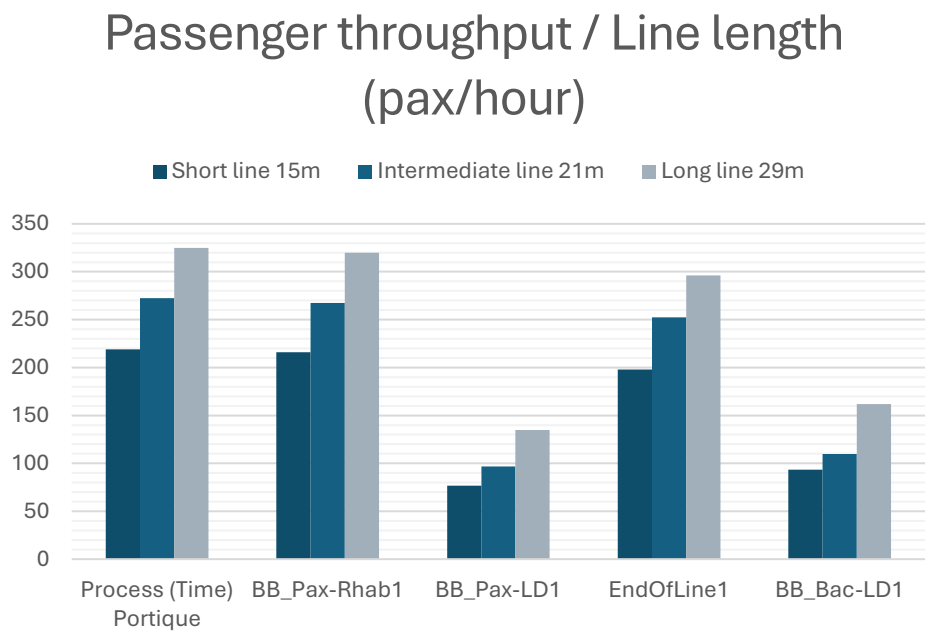
Data Collection

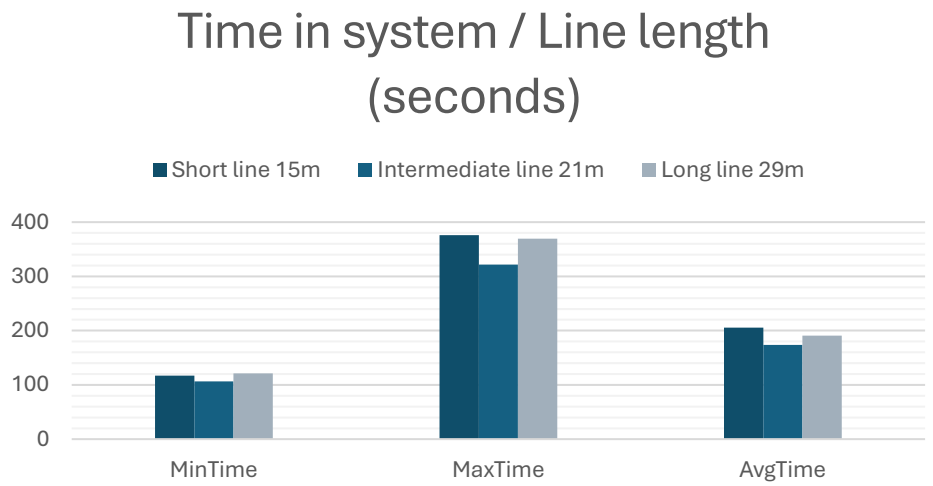


- 2 TimeInSystem
  - Tray / Pax Counting & Timing
- 1 Variable Tracker
  - Pax Queuing
- 9 Throughput (TSE)
  - For Black Boxes
  - 4 per lane + 1 common

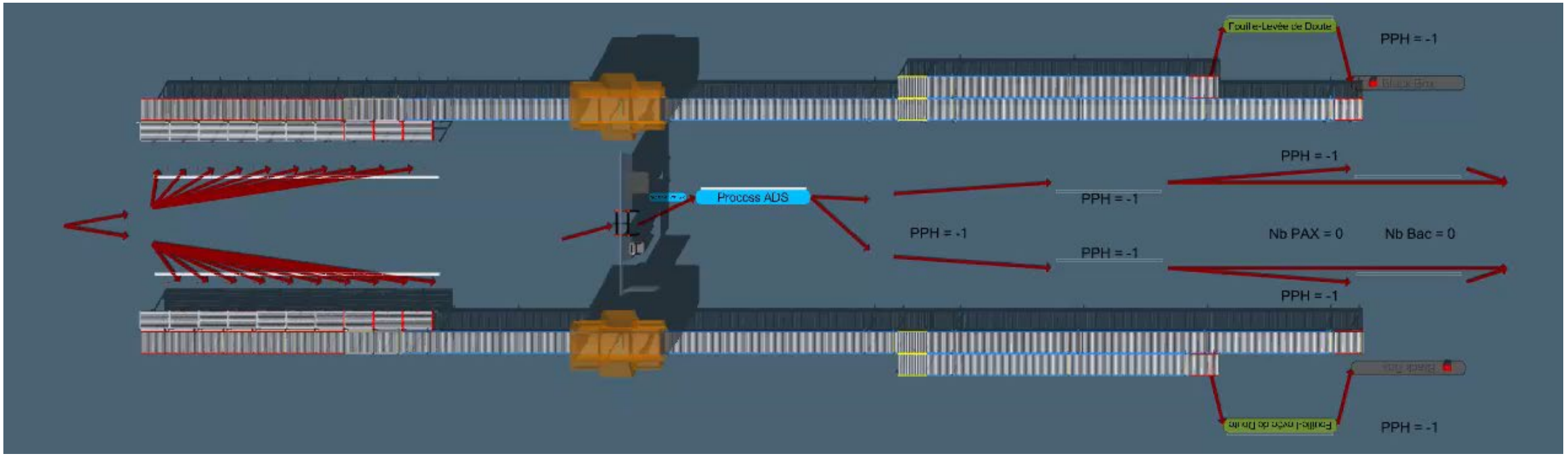
Use Case: Airport Layout Optimization

- Use simulation to validate airport layouts
- Test configurations before implementation
- Scenario comparison : Development of an 'experience report' to provide recommendations on line design characteristics



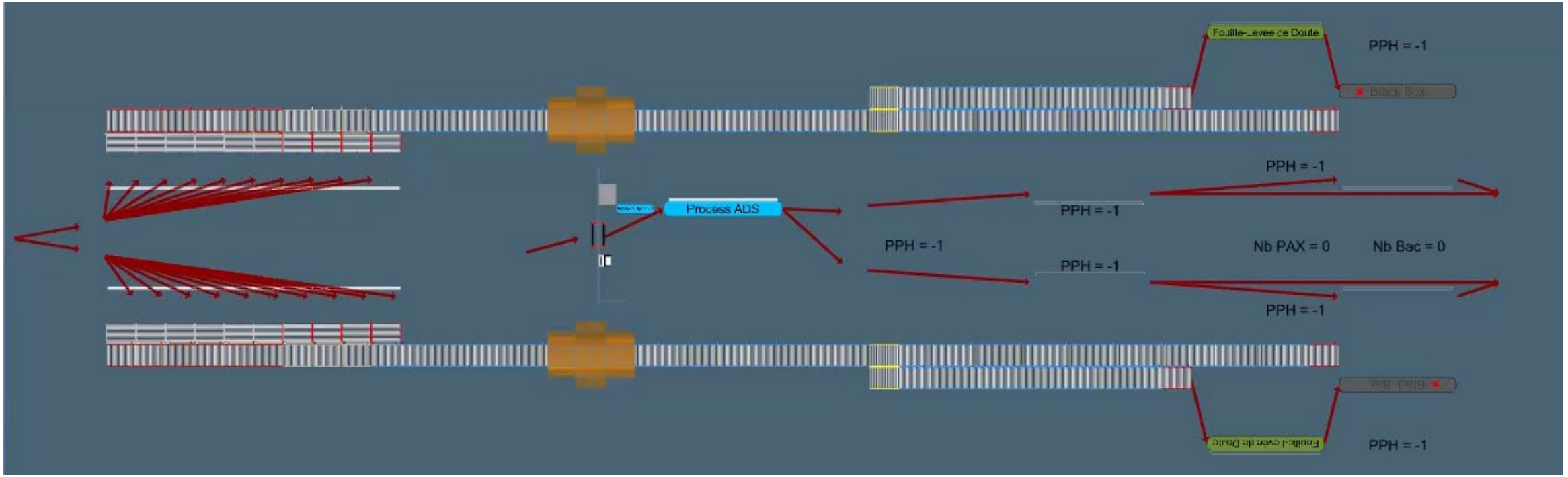


Use Case Scenario 1 : Short line congested



- Simple case of a real airport project
- Short single line (13m) with minimal staffing
- Quick saturation after 10 min at peak flow

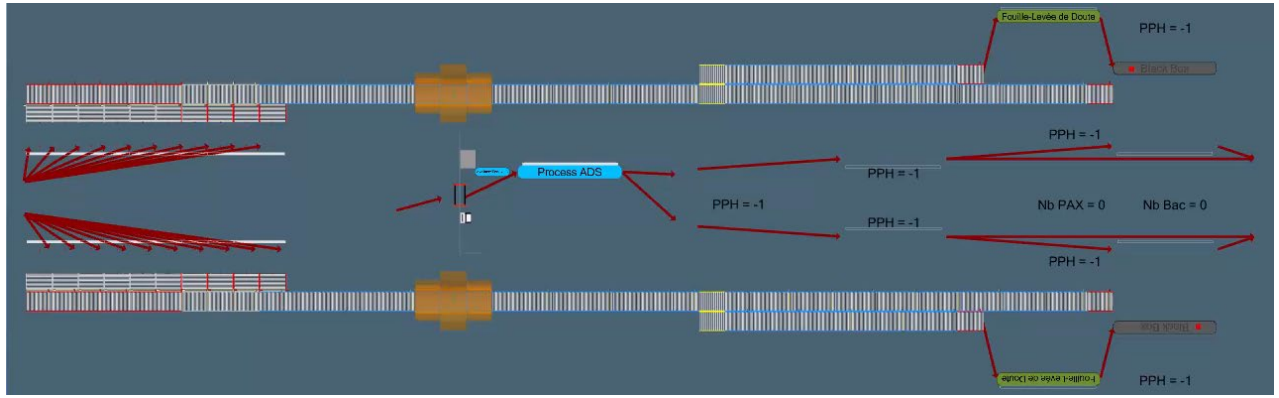
Use Case Scenario 2 : Impact of the EDS downstream line length on Timeout



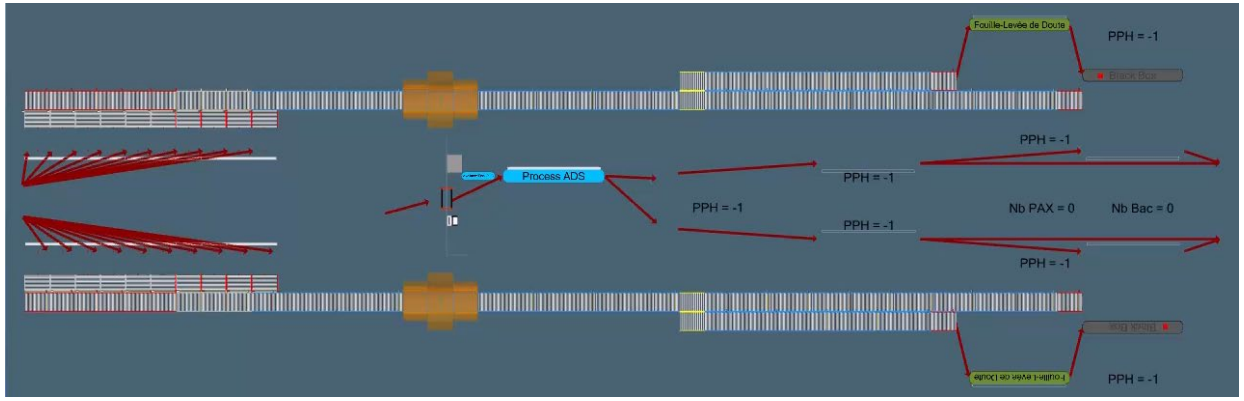
- Long single 25m line
- 4 agents on image analysis
- EDS downstream line length maximized to 7 meters
- Line saturates due to Timeout, despite important staffing
- Result : need to elaborate a correlation between the EDS downstream line length and the number of image operators

Use Case Scenario 3 : Impact of « IOA » option

Without IOA



With IOA



- Comparison between 2 identical single lines of 21m with and without IOA (Image On Alarm)
- Allows us to measure the impact of the IOA option and to anticipate the needs
- Results : IOA increases the flow of clear trays.
  - Less operators needed, less re-check stations needed

Benefits & Limitations

Strengths of the simulation model:

- Highly flexible and fully parametric: easy scenario configuration
- Accurate logic matching real-world checkpoint operations, including twin-line configurations
- Fast iteration and comparison of configurations

Current limitations:

- No option to save plug-in configuration
- The model only operates in saturated mode (maximum passenger flow)
- No outlier behaviors for trays or passengers

Roadmap for improvement:

- Integration with real-world operational data (live or historical)
- Addition of degraded modes and failure scenarios (e.g. missing staff, failed equipment)
- AI-based optimization of configurations

Conclusion

Emulate3D enables realistic simulation of airport checkpoints

Model supports design validation and scenario testing

Simulation considers not only security performance but also passenger facilitation, flow smoothness, and waiting time reduction

Thank you! — Questions?