

PIXEL - Port IoT for Environmental Leverage

Technical presentation of user stories, models and algorithms

PEOPLE

CATIE

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Phd, European

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- ## and connected port

Available solutions

- # Terminal Operating Systems (TOS)

- # Port operations simulation

- ## Port Community Systems (PCS)

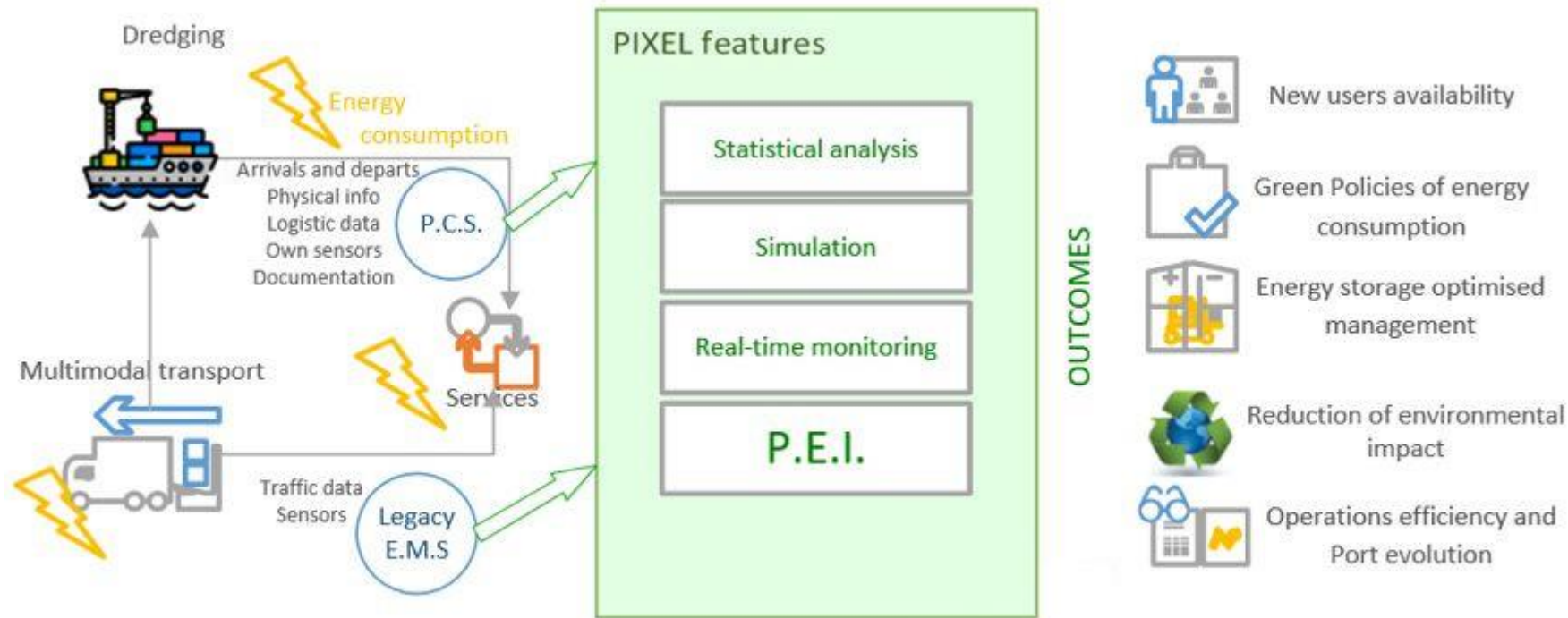
- # Digital freight shipping & collaboration solutions

- ## Sensors & asset tagging

PIXEL Ports participating in PIXEL



Use Cases & User Stories – GPMB

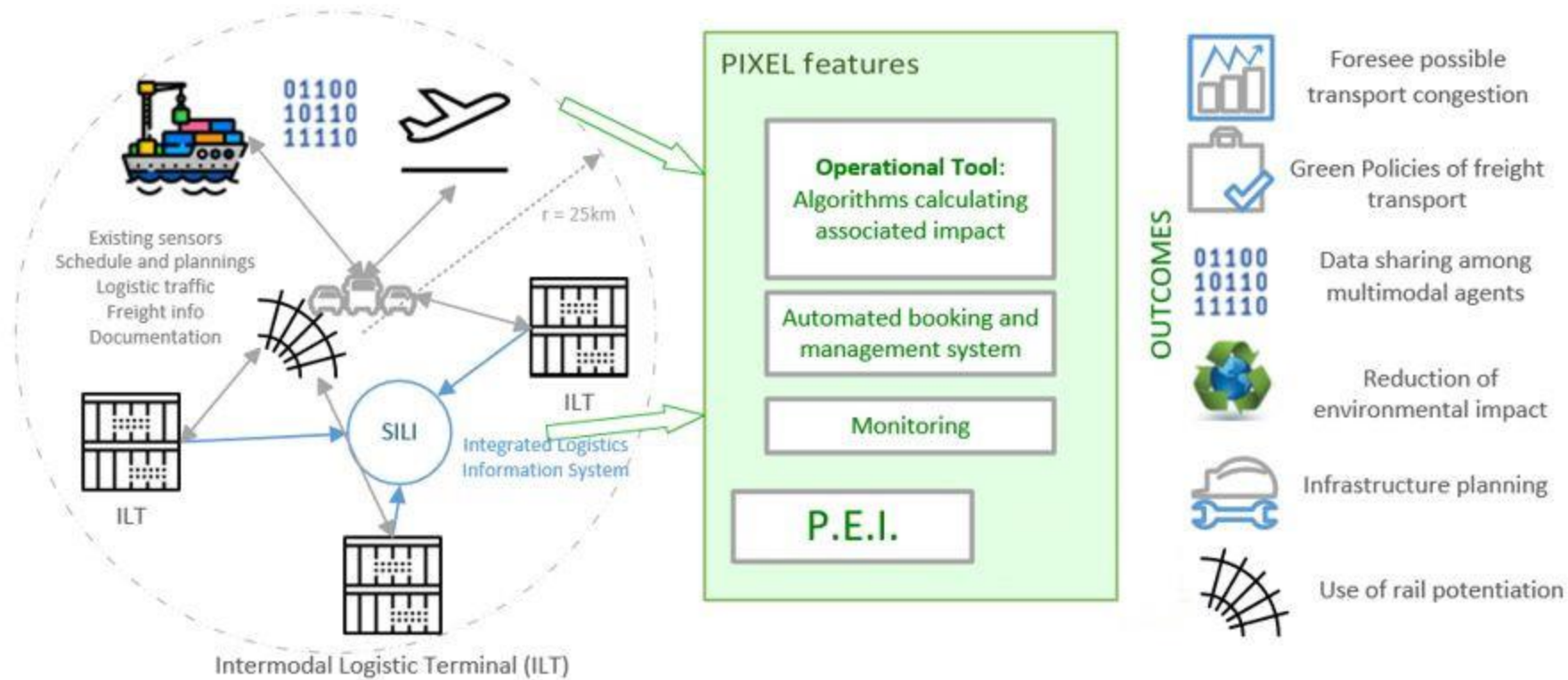


As an...	I want to...	So that...
Energy manager	Evaluate/Quantify the energy consumption of each logistic chain model by measuring the consumption of each element related to loading/unloading considering technical features	I could determine the relative share of each energy in the targeted logistic model and identify the potentially interesting elements for renewable energy injection.
	Link the results calculated before, namely:	I could determine the energy consumption of

WP3 Use Cases & User Stories – ASPM + SDAG



Porto di Monfalcone
AZIENDA SPECIALE
Camera di Commercio Venezia Giulia



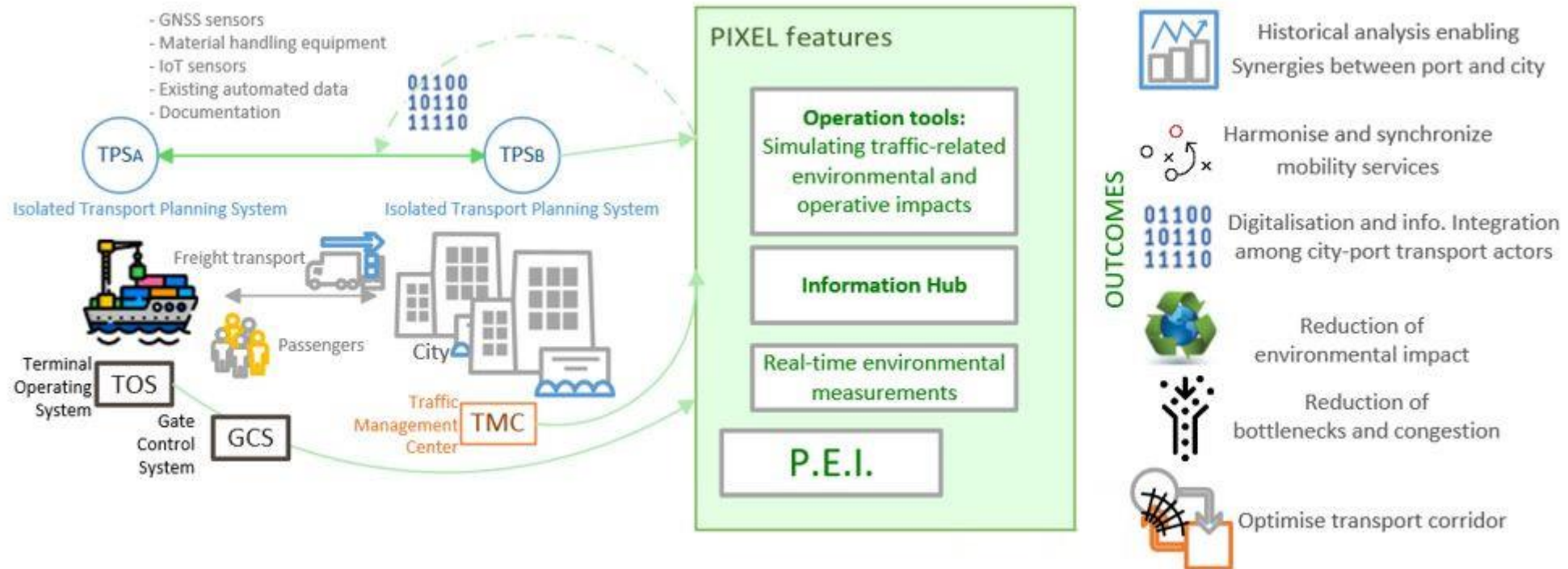
As a...	I want to...	So that...
Parking area manager	have anticipations or simulation of the traffic congestion in the port/surrounding using data coming from PMIS, new parking sensors and SILI platform.	I can estimate the number of trucks coming to SDAG and I can evaluate the use of all available resources (ports, inland ports and railway) to address the traffic towards other multimodal transport and support the



WP3 Use Cases & User Stories – T



THESSALONIKI
PORT
AUTHORITY S.A.



As an/a...	I want to...	So that...
Environmental operator (PPA)	Estimate the influence of the air emissions related with the port activities (cruise and passenger terminals) at the city	The port will develop air pollution dissemination models based on evaluation of air quality measurements and meteorological data
	To estimate the impact of the current inbound	We can regulate the number of working



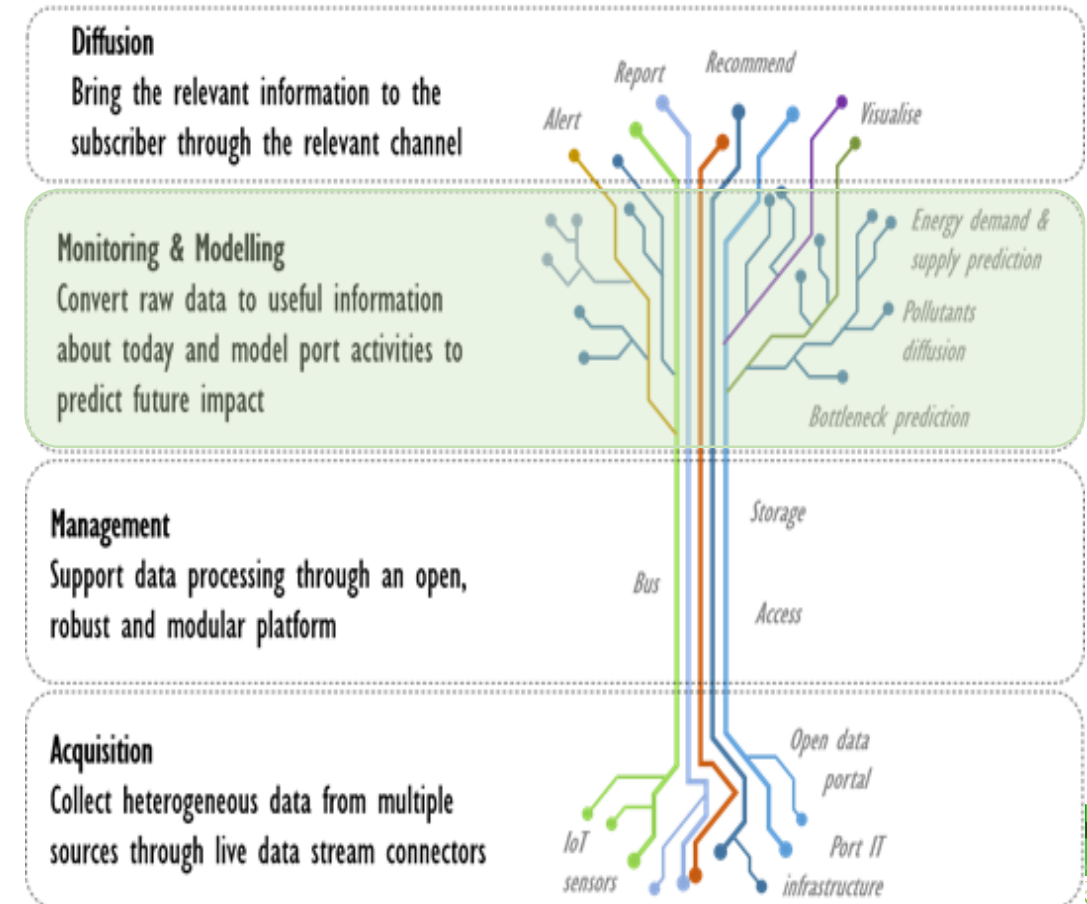
Models and predictive algorithms overview

What is the starting point?

- **Lack of tools** to calculate, estimate or predict impacts on energy consumption, transport networks, and environmental pollution of ports activities.
- Ports need 1) **tools using available data** and not just theoretical models 2) **predictive algorithms** that contribute to **the optimization of port-operation** processes and resources.
 - GPMB: **energy consumption** related to ships operations
 - Monfalcone: modelling the **traffic** inside the port, setting up a model for the evacuation of slabs
 - ThPA and PPA: estimate the **air and noise emissions** related with the port activities

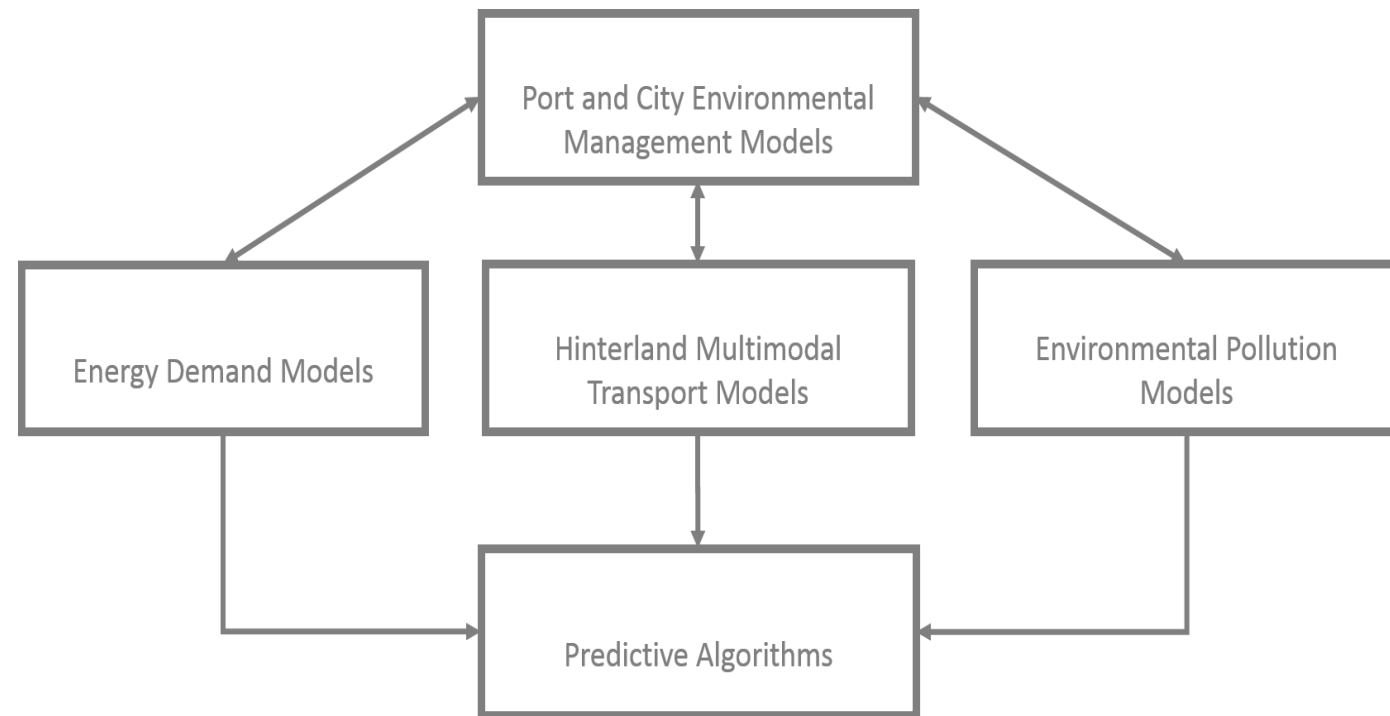
What do we want to achieve?

A **modular** and **adaptable** approach for modelling port activities

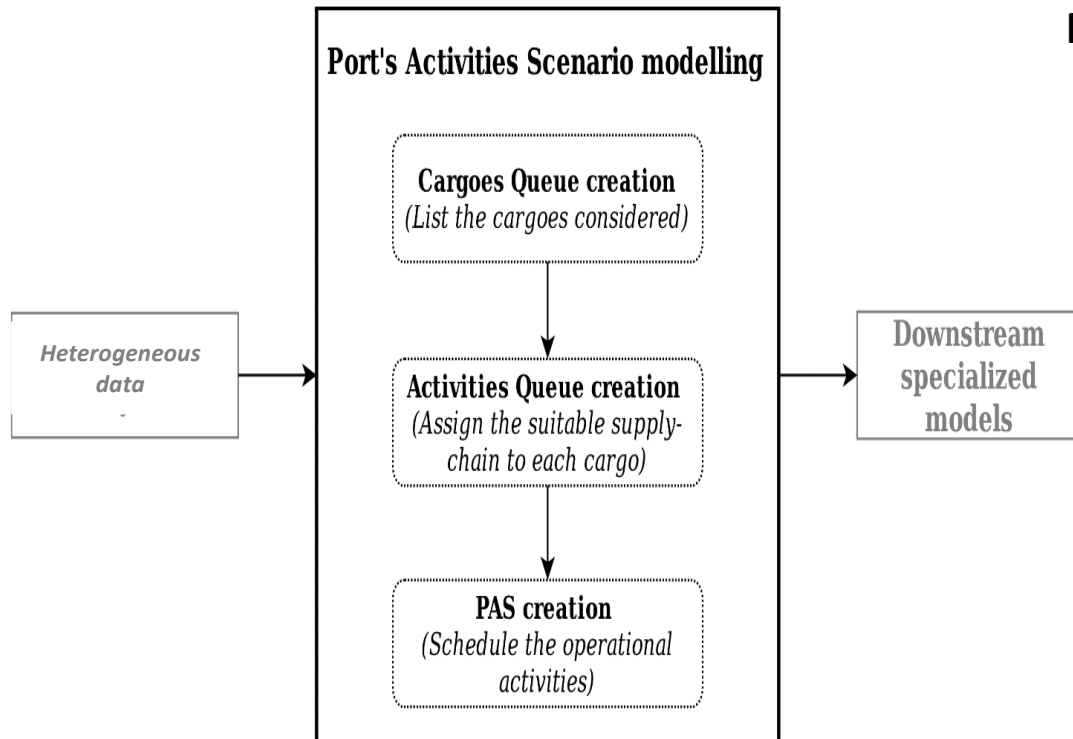


Models and predictive algorithms overview

- ✓ **Consistent methodology** to **model port's activities** and give **multicriteria results** (raw results) about the Port and City Environmental Management Model
- ✓ Modelling of production and demand of **energy**, multimodal **transport** and **environmental pollution**
- ✓ **Interaction** between models
- ✓ Based on port's **reality** and on **available** data



PIXEL models components



Port Activities Scenario (PAS) model

- ✓ Modelling of the supply chain and port's activities
- ✓ Enables to build activity scenarios that are used to identify:
 - Energy sources
 - Emissions of pollutants
 - Estimate the flow of cargoes entering or leaving the port
- ✓ Provides a tool that allows calculation of environmental impact

PIXEL models components

Energy Models

- ✓ To optimize the energy flows inside the port, a prerequisite is to manage and **quantify energy consumption and production**
- ✓ Enable such quantification for small and medium ports with a **focus on energy consumption associated to cargo transition**
- ✓ Provide a **methodology for energy balance** between production and consumption in order to **help port on investment**

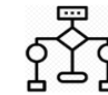


Boat Planning

Start	Type	Tonnage
16/05/18 12:15	Cereal	6502
25/05/18 23:06	Sol.Bulk	15284
29/05/18 16:32	Sol.Bulk	751
02/06/18 05:57	Liq.Bulk	6548
...



Assignment



Supply Chain

Dock	Sequence
452	{Crane1 > Conv.Belt3 >> ...}
421	{Pump4 > ...}
421	{Pump2 > ...}
310	{Hopper >> Schuller > ...}
...	...



Assignment

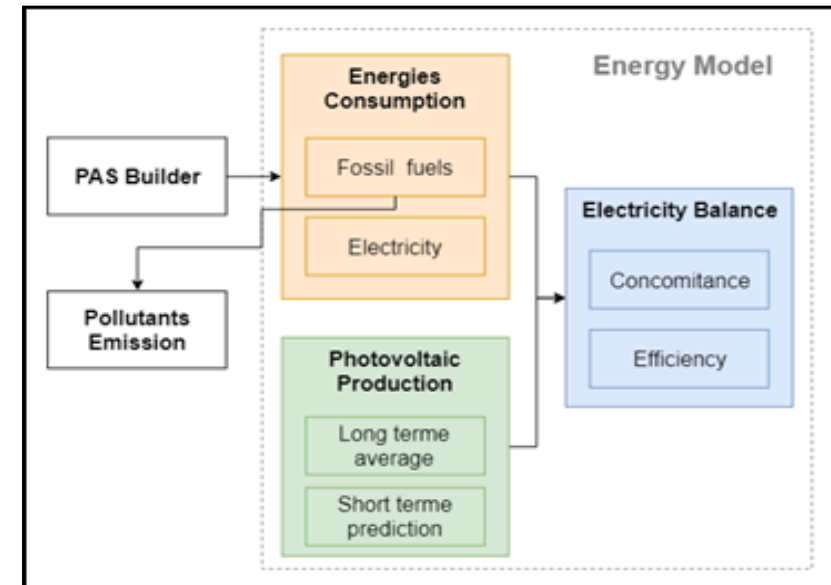


Machine Specification

Energy	Cons.	Debit	Status
Electric	4.5 (kW)	52 (cont./h)	Ok
Fuel B405	15 (L)	32 (T/h)	Ok
Fuel H56	28 (L)	125 (m³/h)	HS [dates]
Electric	31 (kW)	32 (T/h)	Ok
...

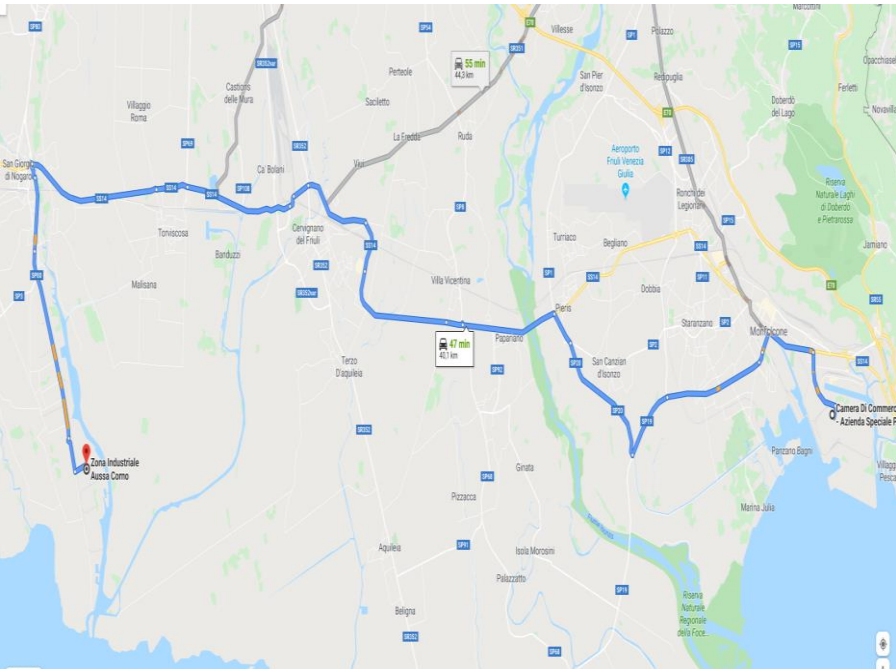


Energies Consumption Planning



PIXEL models components

Hinterland multimodal transport models

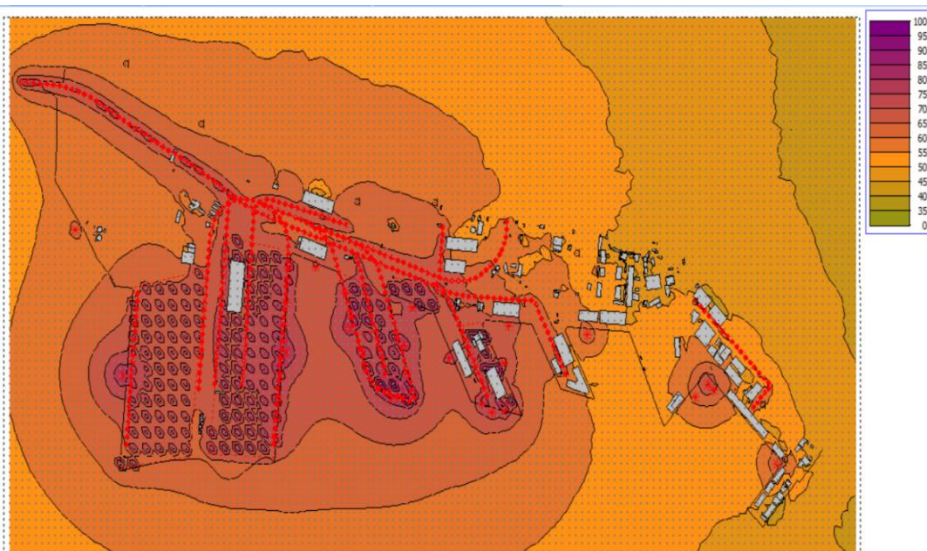


- ✓ Help to understand if a different port management and hinterland management (with different conditions) has a positive impact on congestions
- ✓ An effective decision support tool to optimize the re-routing of trucks:
 - Intermodality model : slab evacuation used as an example
 - Model of traffic and parking inside port premises: focus on modelling congestion events
- ✓ Help for new planning procedures and reduction of environmental impacts

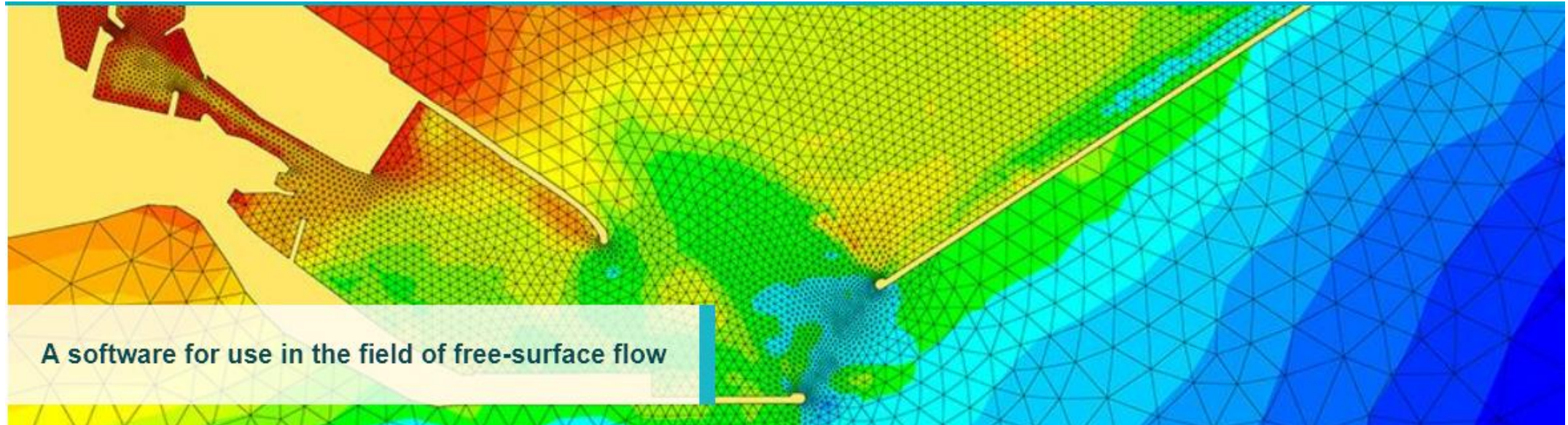
PIXEL models components

Environmental dispersion models

- ✓ Sources of emissions generated by the supply chain of cargo are not negligible and have direct effects on the port environment
- ✓ Simulate the air and noise pollutant dispersion caused by various activities and operations taking place within the port. Ports clearly express their needs for this two models
- ✓ Noise pollution: CNOSSOS-EU and ISO 9613.1/2
- ✓ Air pollution: AERMOD model have been integrated



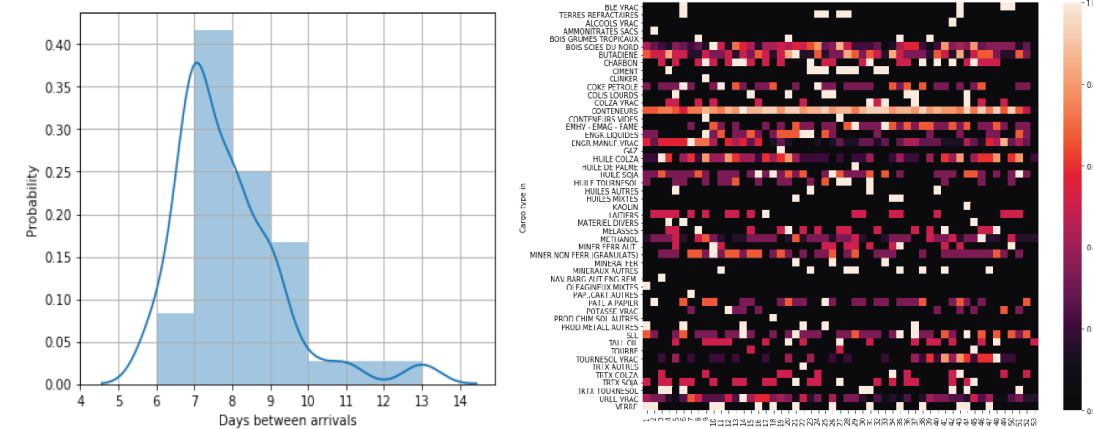
PIXEL models components



Water and soil pollution models

- Use of Telemac-Mascaret (open-source software)
- 2D approach with a simple but representative geometry: simplified bathymetry (uniform depth in the port for example) and contours

PIXEL predictive algorithms



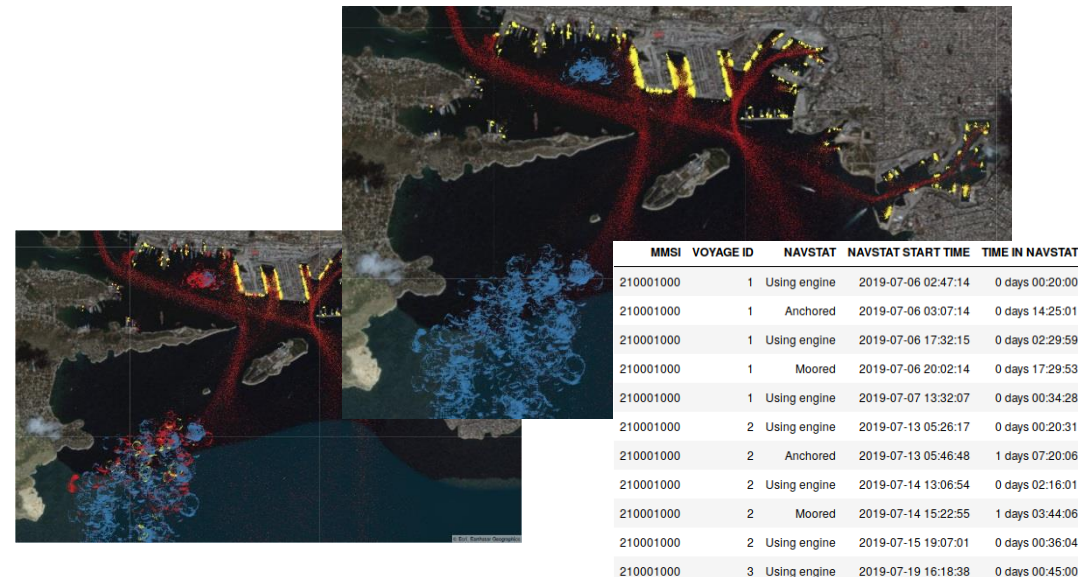
Vessel calls prediction

- ✓ Vessel call data from ports databases and FAL forms
- ✓ Provide general statistical analysis and visualisations
- ✓ Prediction of vessel call duration (ETD) for GPMB
 - Accuracy exceeded internal ETD predictions
- Prediction of a vessel call (long-term trends)

GPMB vessel ETD prediction included in PIXEL DEMO

Prediction based on AIS data and satellite imagery

- ✓ AIS data obtained (installation of AIS receiver, AISHub)
- ✓ ML supported AIS data cleaning (e.g. nav. status)
- ✓ AIS based traffic analysis (e.g. waiting times)
- ✓ Satellite imagery based ship traffic analysis
- AIS based port call ETA estimation

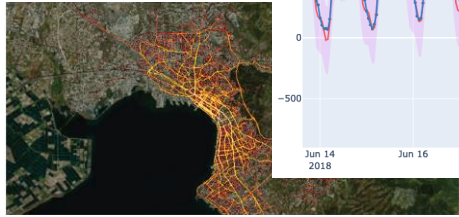
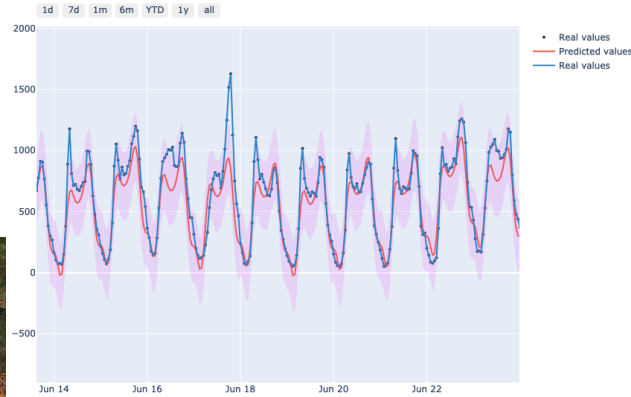


MTS/IEEE OCEANS 2019 conference publication
and presentation of **AIS + satellite imagery** work

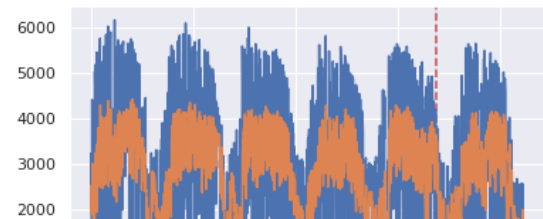


PIXEL predictive algorithms

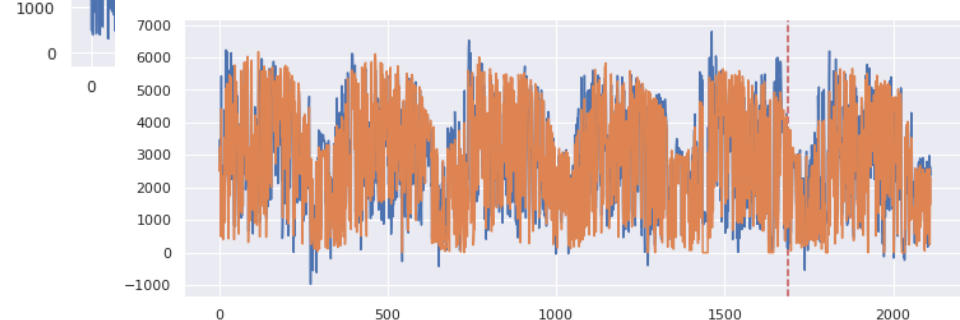
Forecasts and real values



Time-Series Prediction



Time-Series Prediction



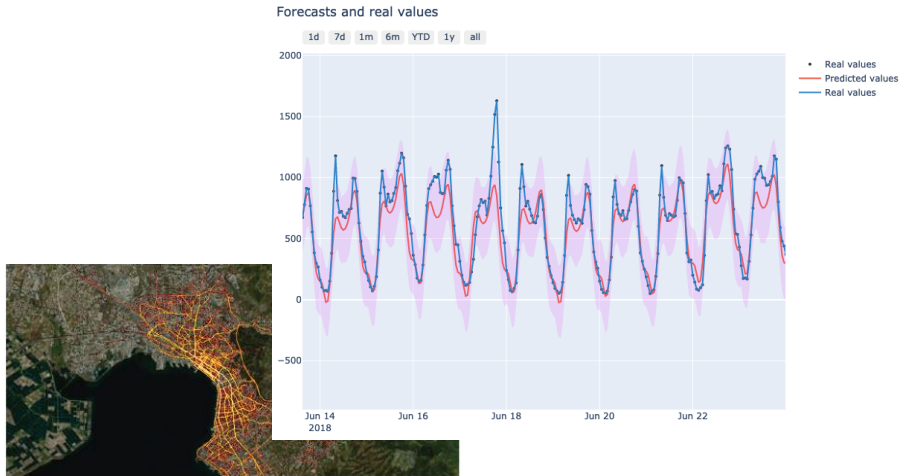
Analysis and prediction of road traffic conditions

- ✓ Obtained traffic data:
 - **SILI system** (ASPM, SDAG)
 - ThPA (Thessaloniki open-data and **port gate data**)
 - PPA (TomTom/HERE open-data)
- ✓ Baseline predictions of traffic volume/average speed
 - Advanced predictions of traffic volume/average speed
 - Some results exceeding open-source SOTA libraries
 - Identify traffic congestions

Prediction on renewable energy production

- ✓ Obtained data from a real PV system (energy production, weather conditions, temperature and wind for 6 years)
- ✓ Prediction of energy production for next day including weather data (Long Term Short Memory algorithm) with good accuracy.
 - Include temperature and wind data

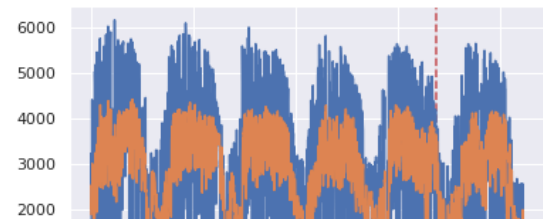
PIXEL predictive algorithms



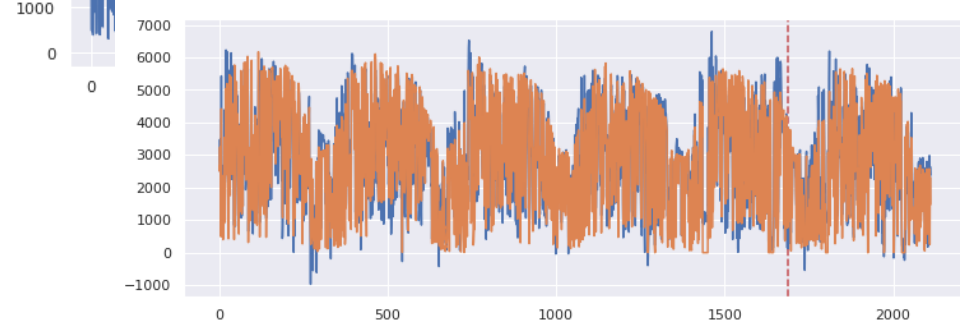
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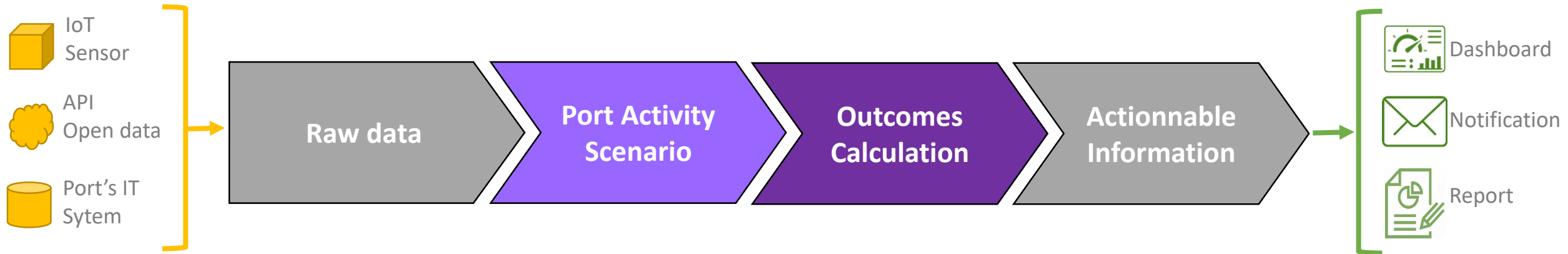


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Zoom on the Port Activity Scenario : Approach

Convert raw data into actionable knowledge through chained elementary transformations.



Build the PAS

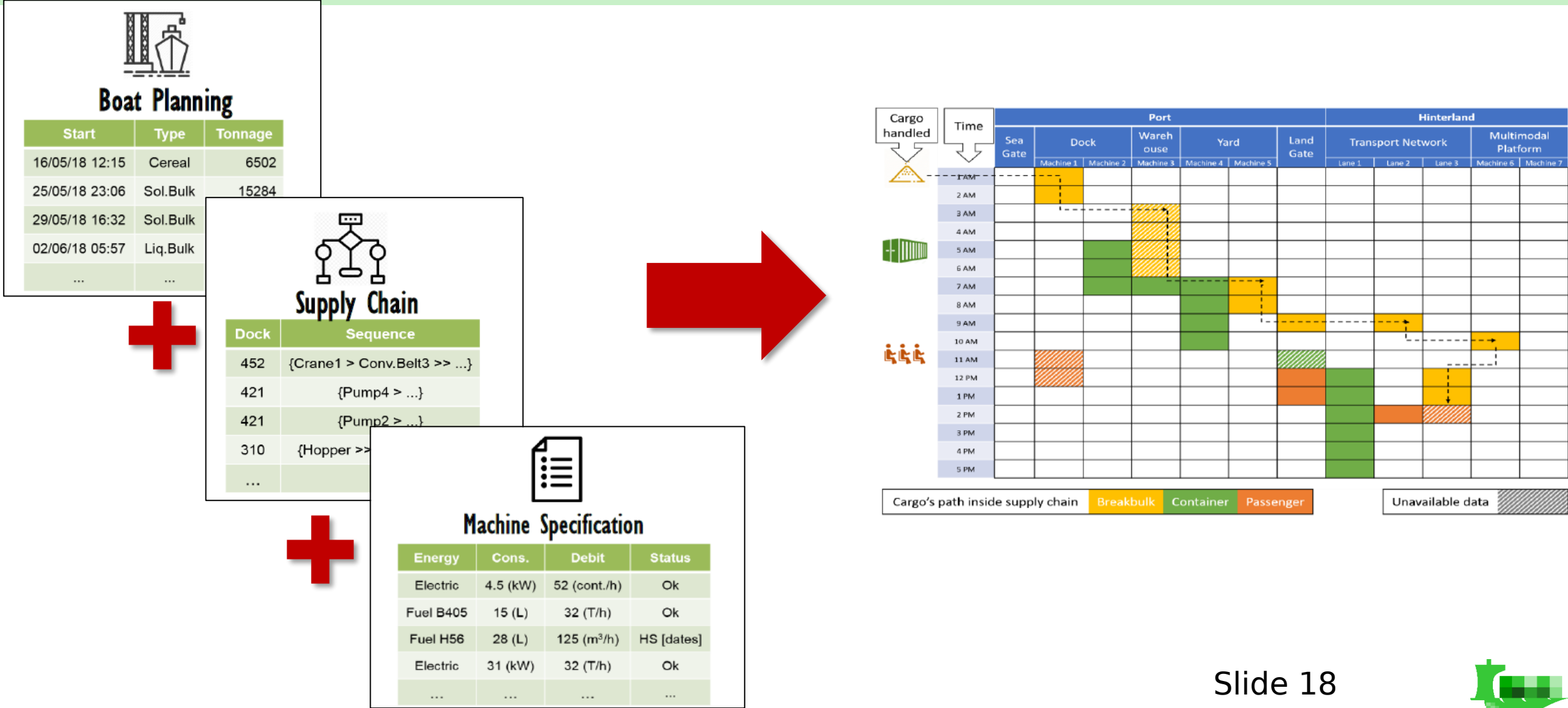
- For the considered set of hypothesis, list every port's atomic operations and project them across the time dimension to build Port Activity Scenario.

Calculate the outcome

- For every activity of the PAS, determine the resources use and automation.

Slide 17

Zoom on the Port Activity Scenario : Approach



Zoom on the Port Activity Scenario : Approach

Flexibility:

1. Modelized perimeter (see side, warehouse, hinterland side) is inherited from inputs perimeter.
2. Through inputs of different orientations, the model allows to address different use cases.

Minimalist	Rich setup
Live stream	Monitoring
Consolidated historical	Assessment
Estimated future	Forecast
« What if » scenario	Explore

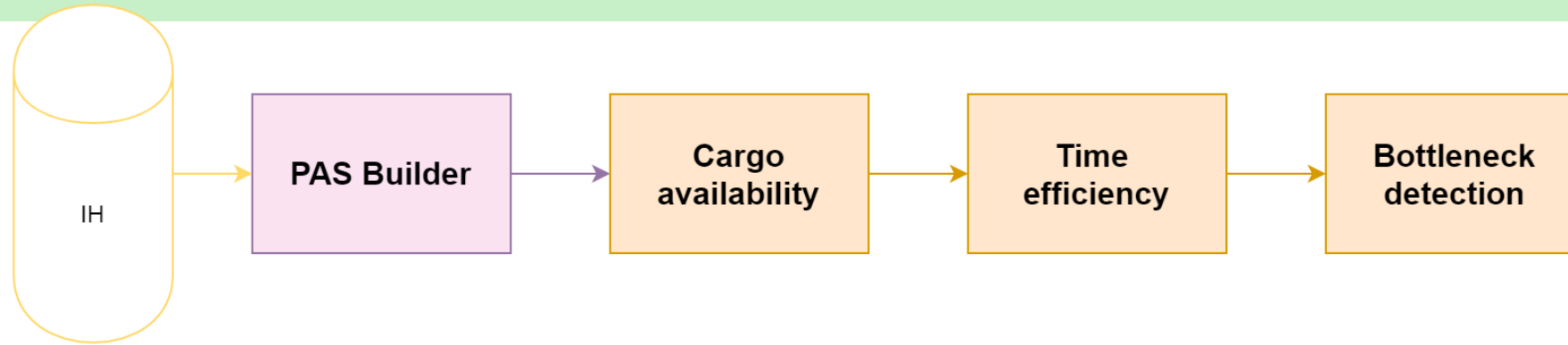
Zoom on the Port Activity Scenario : Approach

Plasticity:

1. Model's output accuracy & precision scales with inputs.
2. User can freely choose his optimal balance in the simplicity vs precision trade-off.

Minimalist	Rich setup
Vessels call (FAL form)	Billing data (dock, effective amount & arrival time...)
Supply-chain described as a whole (only one step)	Meticulous dissection (unit operations)
Basic machine specifications (no dependency to the context)	Specification dependency to context (throuput and consumption for each suitable cargo type)
	IoT/Sensor (weather station, PV production, road congestion...)
	Optional parameters (priority, uptime)

Zoom on the Port Activity Scenario : Approach



Purpose:

- Specialized calculations downstream of PAS builder
- Add information in PAS
- Convert & export PAS data

I/O:

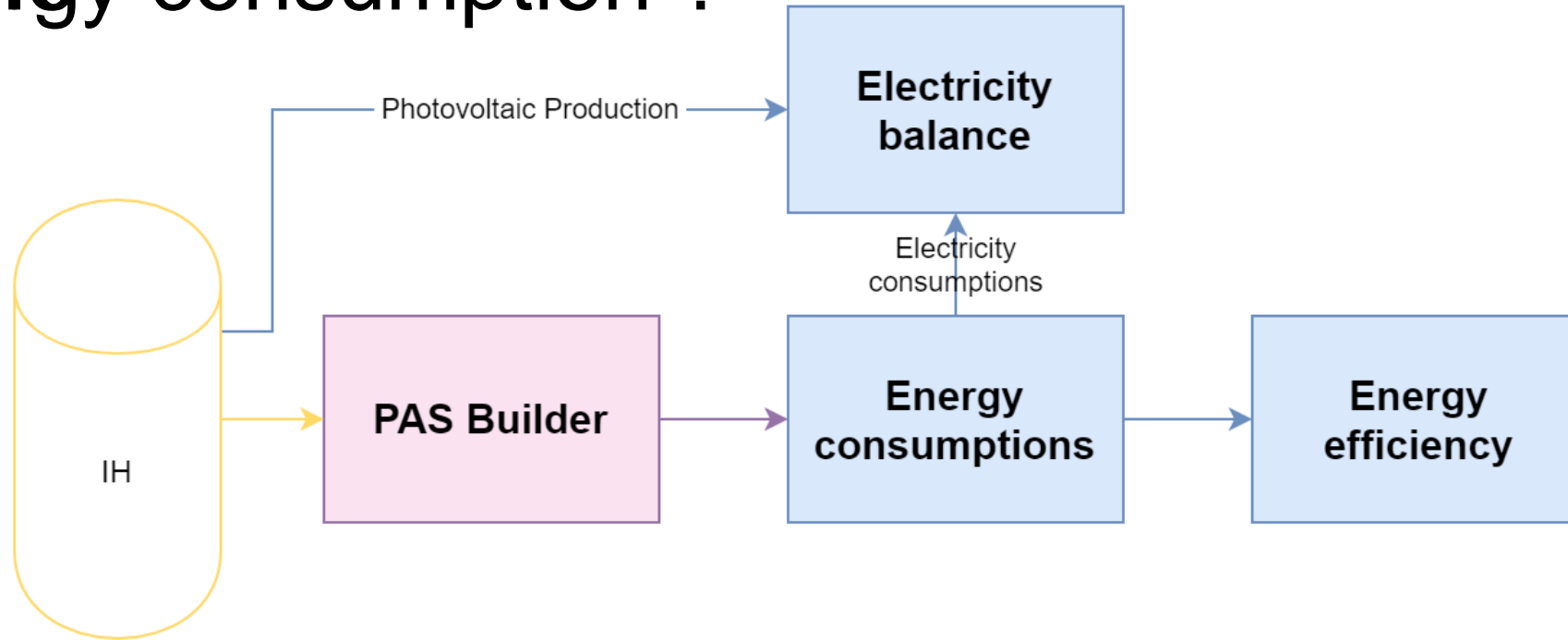
- Input: previous state of the PAS (+ data taken from Information Hub)
- Output: new state of the PAS (+ data added to Information Hub)

Modularity:

- Preset sequence of modules adapted to needs (and data available)

Slide 21

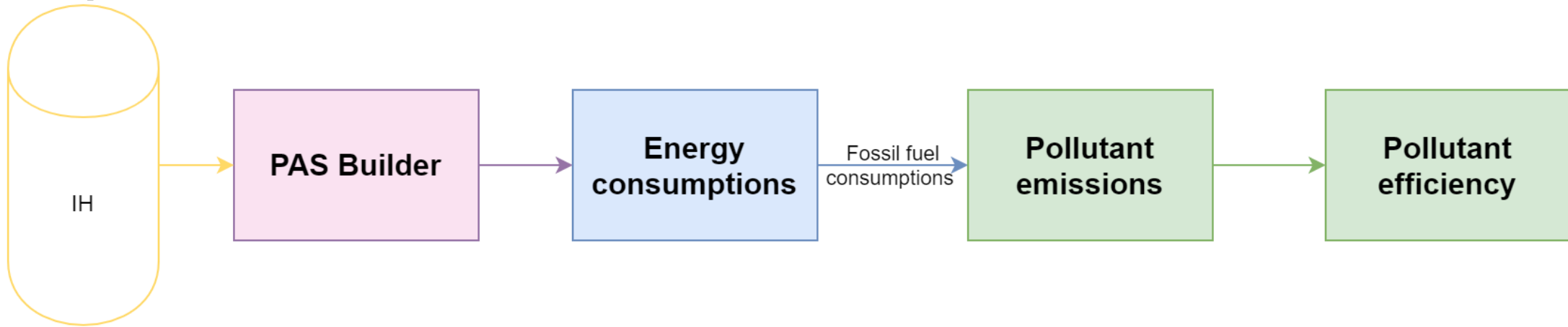
Zoom on the Port Activity Scenario : How to use it for energy consumption ?



Forecast:

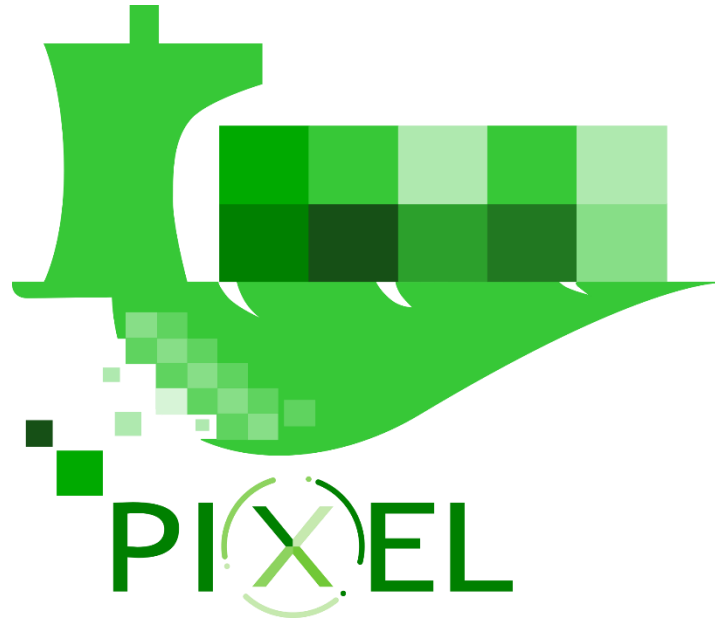
1. Probable electricity consumption annual peak with those vessel calls
 - Trigger notification (email)
2. Compare photovoltaic plant's electrical production versus consumption
 - Alert local grid manager for incoming production

Zoom on the Port Activity Scenario : How to use it for pollutants emissions



Assessment:

1. From consolidated historic data, quantify GHG emissions for each cargoes
 - Creates automatic report
2. Send port's emissions to atmospheric transport model
 - Evaluates risk for the neighboring city



Questions ?