


IPIC 2023

9th International
Physical Internet Conference

June 13-15, 2023
Athens, Greece

PILL

THE PHYSICAL INTERNET LIVING LAB (PILL)

imec | VUB mobilise analysing mobility, mobilising people | EMPOWERING LOGISTICS

AGENDA

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imec

An Cant

Joris Finck

Philippe Michiels

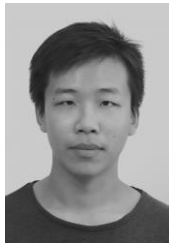
Vitor Lemos

Dries Van Bever

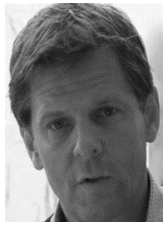
VUB mobilise
analysing mobility, mobilising people

Cathérine Cassan

To accelerate the transition to a more sustainable and socially just mobility and logistics system



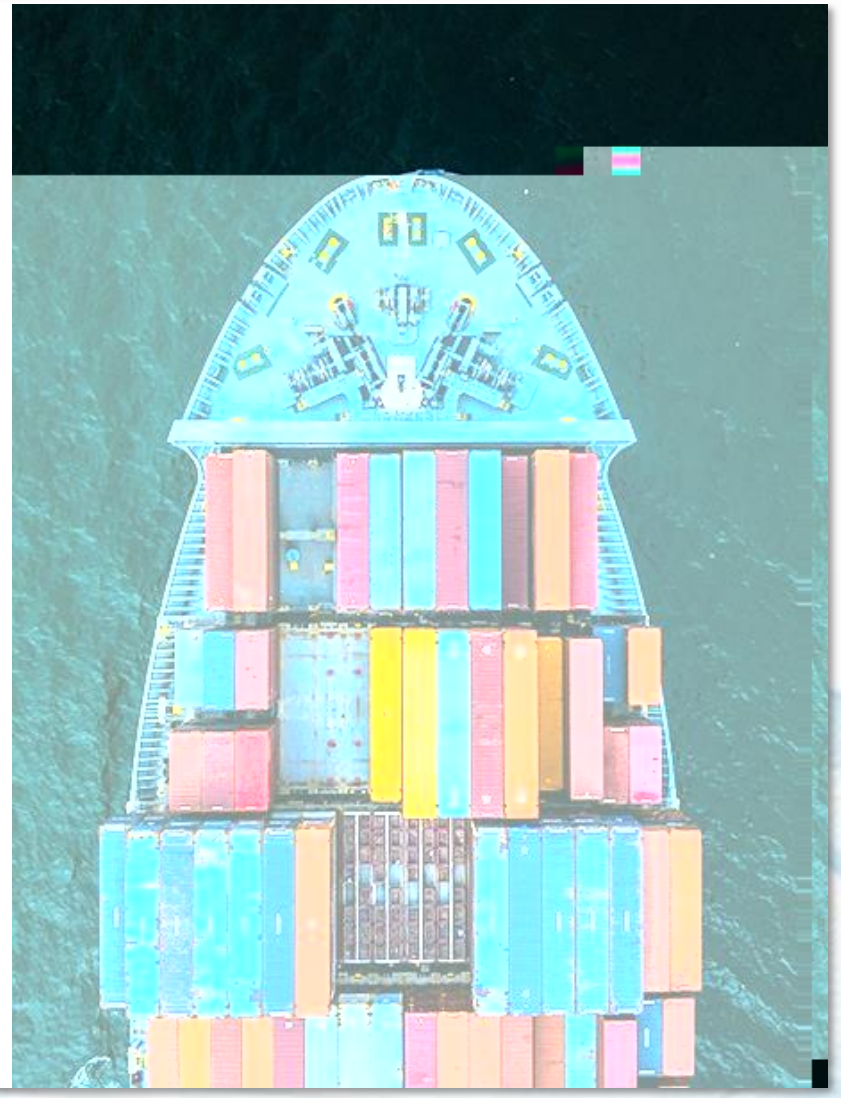
Shiqi Sun



Geert Verbelen

EMPOWERING LOGISTICS

PILL in a nutshell



Joris Finck

Philippe Michiels

What is the PILL project?

Goals

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The PILL project will result in

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PHYSICAL INTERNET LIVING LAB

imec VUB mobilise analysing mobility, mobilising people

EMPOWERING LOGISTICS

PILL Advisory Board

Context: Hinterland container transport

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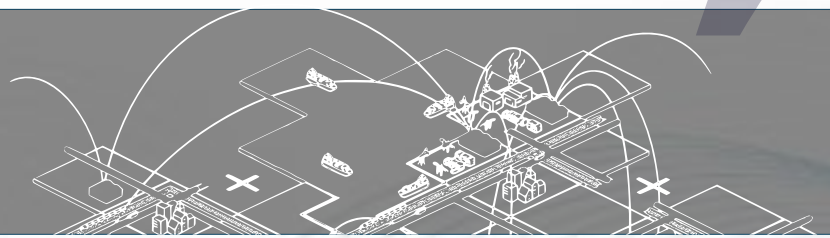
Value Proposition

CURRENT SCOPE
HINTERLAND CONTAINER TRANSPORT

SOCIETAL VALUE	ECONOMICAL VALUE
	
	
	

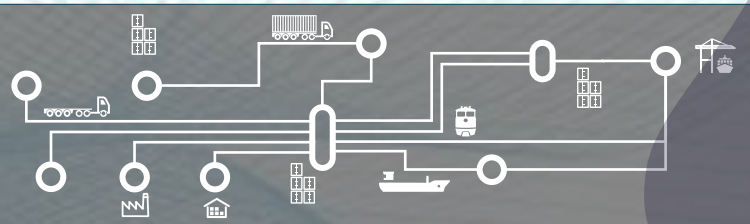
A layered approach to π

routing
track trace
planning
real-time data
order & trading
...



secure data sharing
role based access control
standards and interop
decentral trust

physical internet client



π foundation (1): a network of Nodes and Capabilities

TRANSFER

Transfer of π-carriers from their inbound π-vehicles to their outbound π-vehicles.

HUB

The intermodal transshipment of π-containers from an incoming π-mover to a departing π-mover.

STORE

Storage of π-containers during mutually agreed upon target time window.

GATEWAY

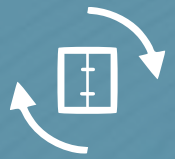
π-depots are nodes were empty π-containers can be retrieved from or returned to their owner.

DEPOT

π-depots are nodes were empty π-containers can be retrieved from or returned to their owner.

COMPOSER

Constructing or deconstructing composit e π-containers from specified sets of π-containers.



SERVICE PROVIDER

Nodes were services around π-containers are provided, such as customs clearance, weighing, fumigation.

More capabilities to be included in the future.

π foundation (2): Movers

SCHEDULED MOVERS

Operating between fixed nodes at scheduled times.

FLEXIBLE MOVERS

Unscheduled operation between variable nodes.

π foundation (3): Network State

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π foundation (4): Route Finding in PI

$$P_c(s, n) \rightarrow s', n'$$

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-
-
-

$s =$

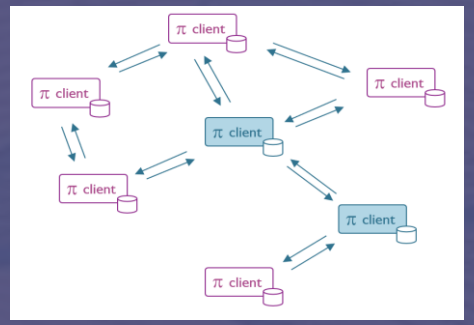
Container state	(full or empty)
Container location	(a π-node)
Container ready	(a point in time)
Mover id	(a π-mover)
Mover modality	(road, rail or inland waterway)
Mover state	(with our without container)
Mover location	(a π-node or a π-vertex

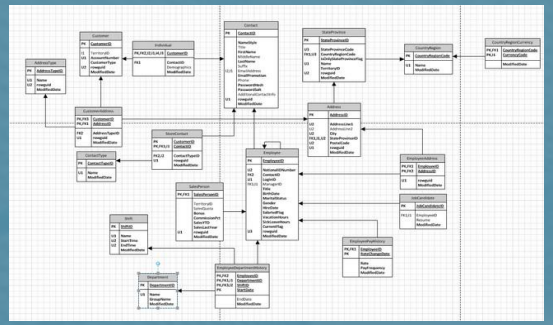
$c =$

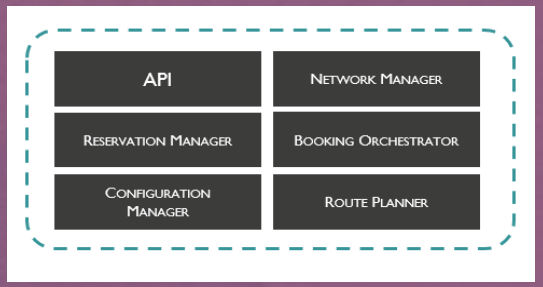
order type	(import or export)
pick-up location	(a π-node)
drop-off location	(a π-node)
composer location	(a π-node)
composition time window	(a start and end time)
earliest pick-up	(a point in time)
latest drop-off	(a point in time)

PILL Components

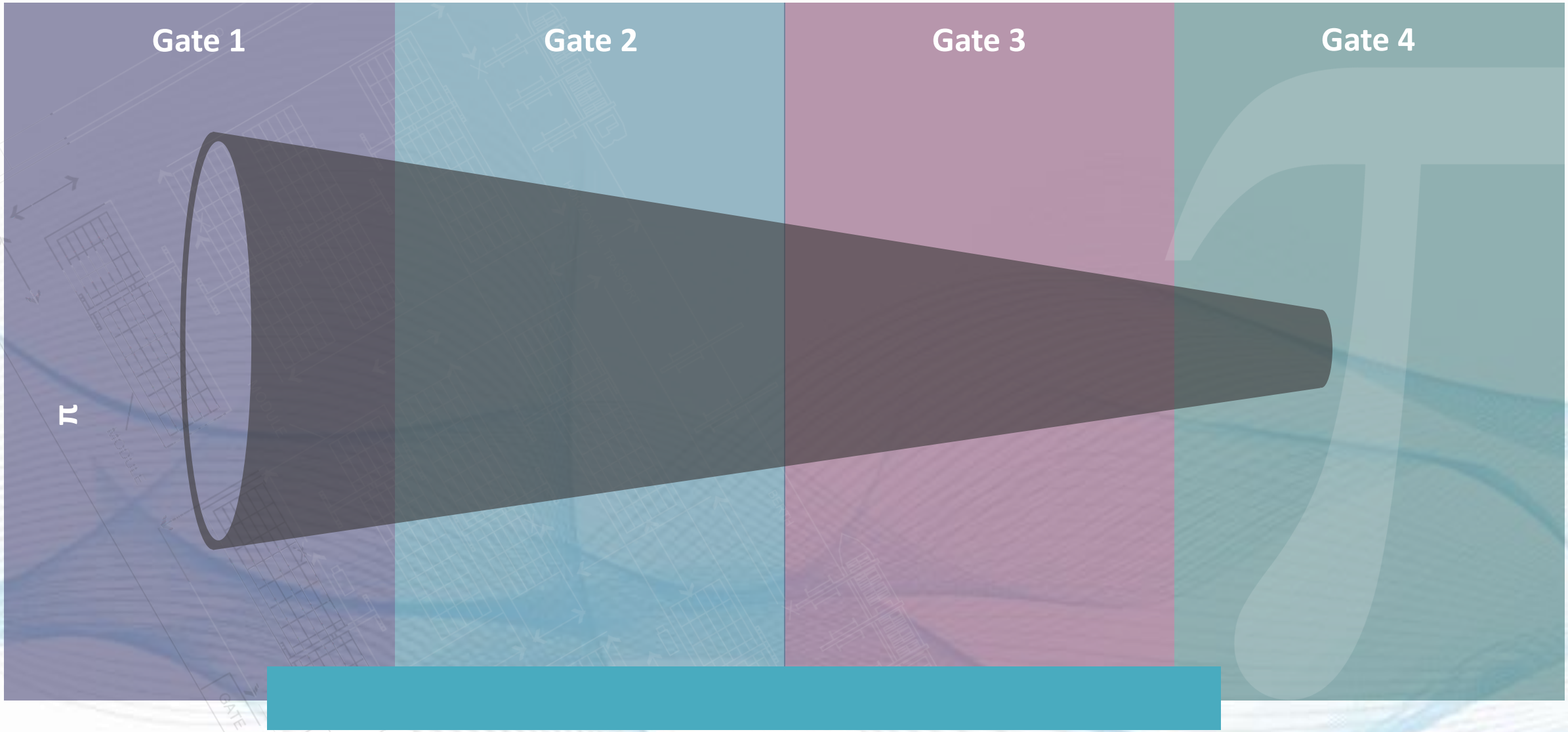
OPEN DECENTRAL NETWORK	OPEN DATA MODEL	OPEN SOURCE PI-Client	ROUTING ENGINE & SIMULATION MODEL





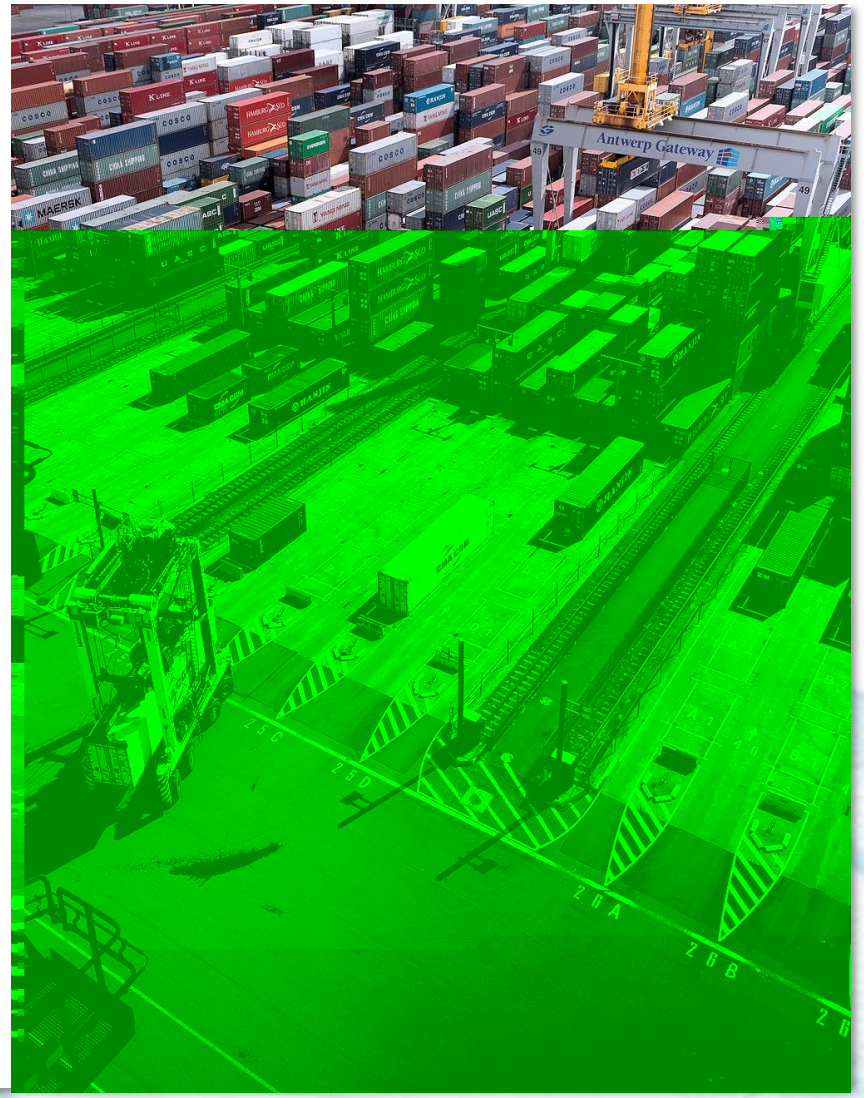


Steppingstones

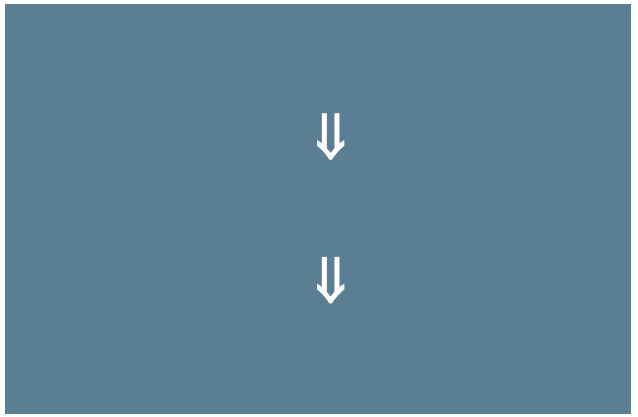


The π-client

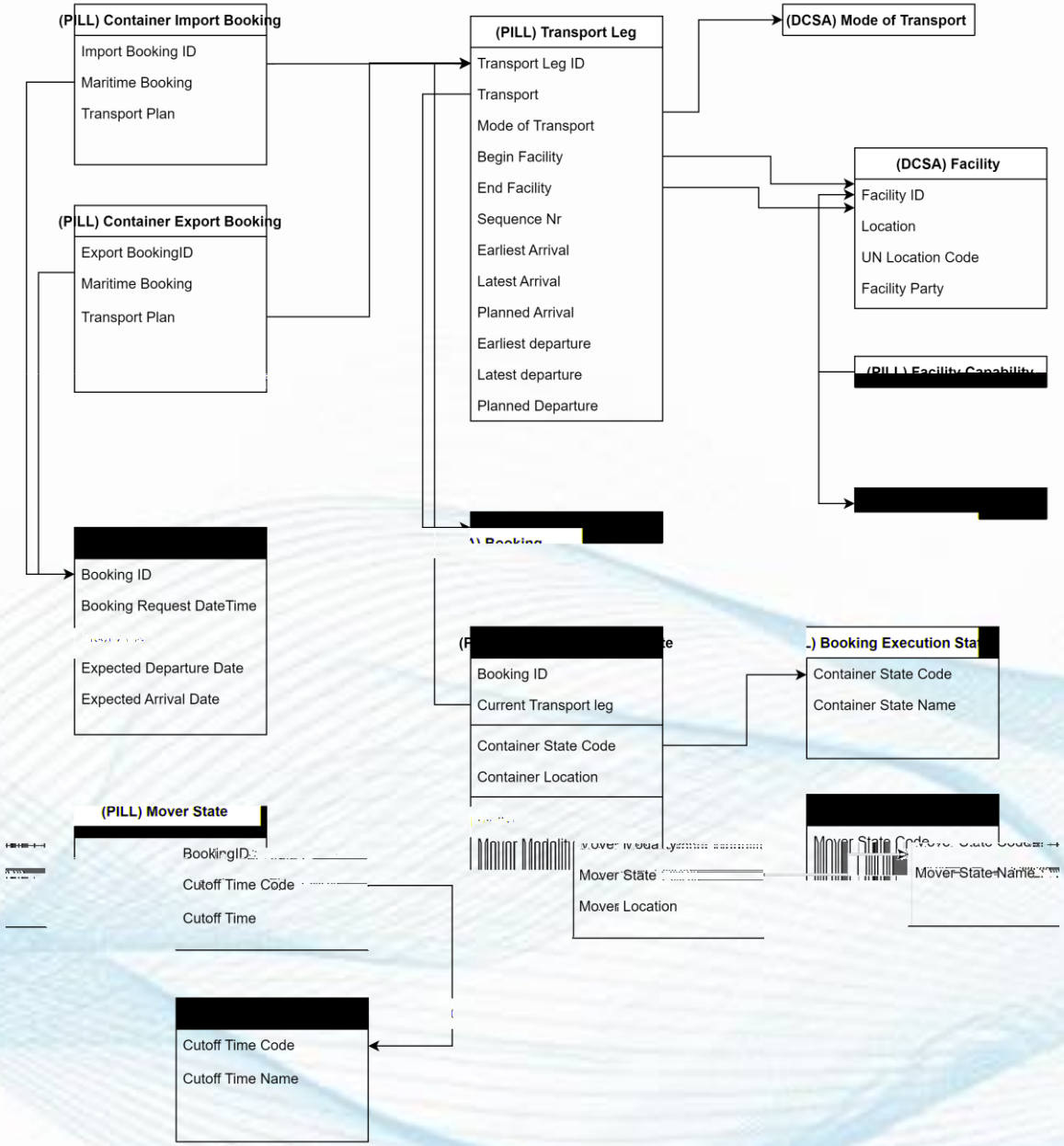
Philippe Michiels



The importance of an open network

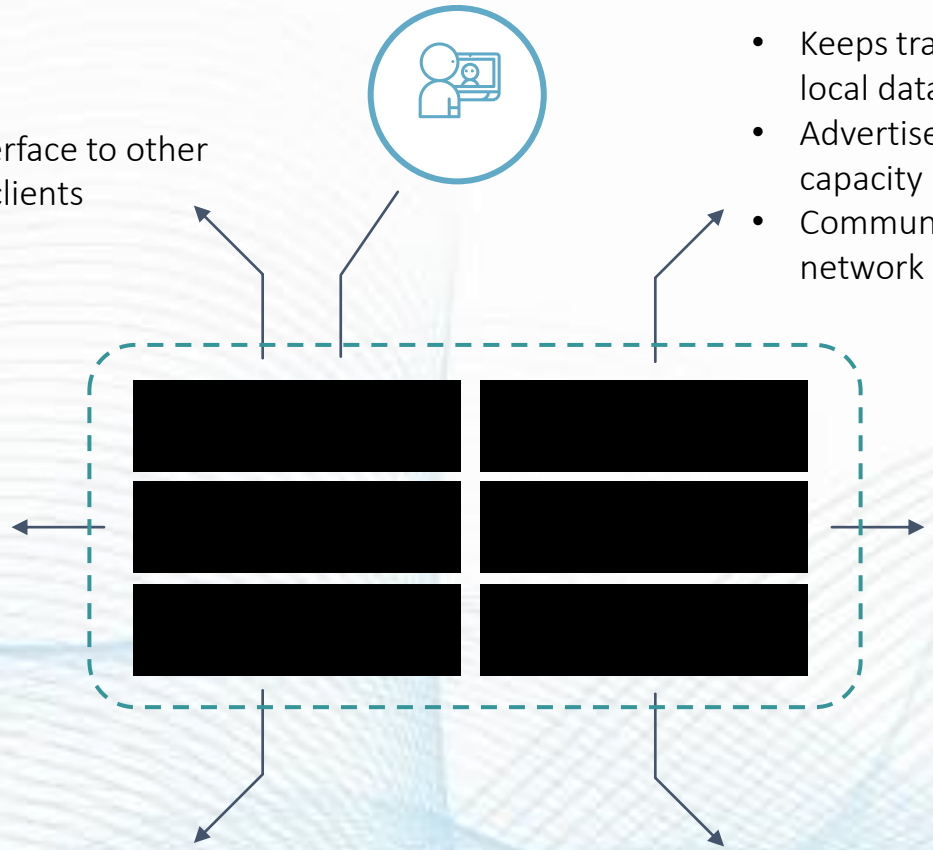


Data model


(PILL) Container Import Booking
Import Booking ID
Maritime Booking
Transport Plan
(PILL) Container Export Booking
Export BookingID
Maritime Booking
Transport Plan
(PILL) Transport Leg
Transport Leg ID
Transport
Mode of Transport
Begin Facility
End Facility
Sequence Nr
Earliest Arrival
Latest Arrival
Planned Arrival
Earliest departure
Latest departure
Planned Departure
(DCSA) Mode of Transport
(DCSA) Facility
Facility ID
Location
UN Location Code
Facility Party
Booking ID
Booking Request DateTime
Expected Departure Date
Expected Arrival Date
Booking ID
Current Transport leg
Container State Code
Container Location
Container State Code
Container State Name
(PILL) Mover State
Cutoff Time Code
Cutoff Time
Mover State
Mover Location
Mover State Name
Cutoff Time Code
Cutoff Time Name


LOGISTICS

π-client components



Interface to other
Π- clients

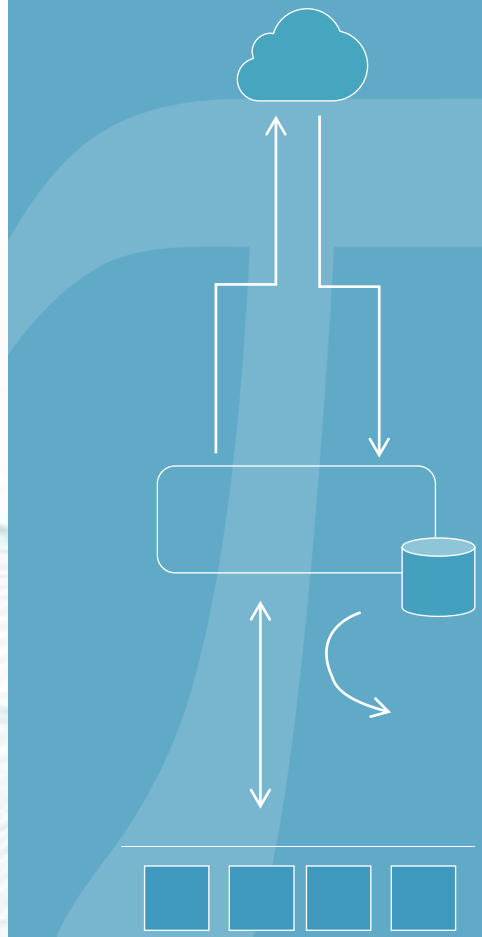
- Keeps track of the Π-network in a local database
- Advertises capabilities and capacity
- Communicates changes to the network

Connects with backend ERP systems for validating capacity and registering reservations

Manages bookings, saves and compares the routes, takes care of reservations with other clients

Keeps Π-client configuration, entity details and node config and capabilities

Plug-in module that uses the locally stored network state for route planning



Deliverable: π-blueprint

PILL will lead to the setup and rollout of an experimental Physical Internet network.

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Validating the π-blueprint

Dries Van Bever

Shiqi Sun

Physical Internet Key Principles

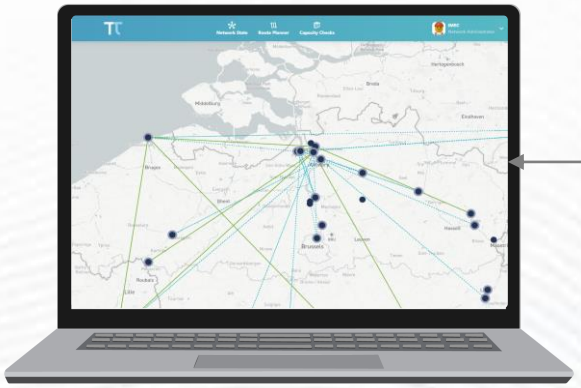
DECENTRALISED NETWORK

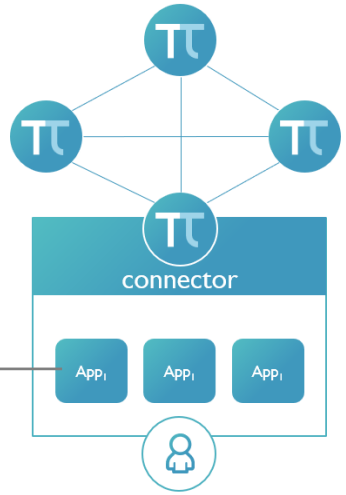
PLANNING & RESILIENCE

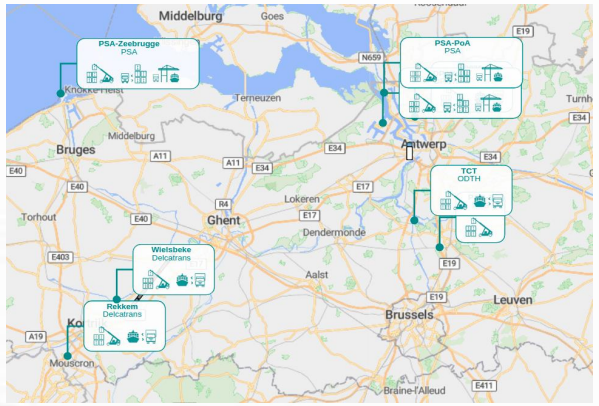
INTEROPERABILITY & AUTOMATION

AGENT-BASED SIMULATION

PILL POC components







ROUTE PLANNER

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→ *INTEROPERABILITY & AUTOMATION*

→ *PLANNING & RESILIENCE*

PI-CLIENT

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→ *DECENTRALISED NETWORK*

SIMULATION MODEL

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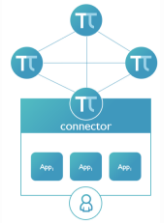
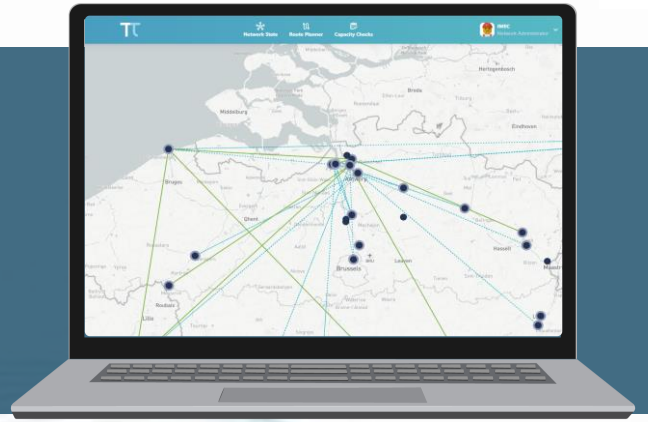
→ *AGENT-BASED SIMULATION*

PILL validation plan



1

π-CLIENT LIVING LAB



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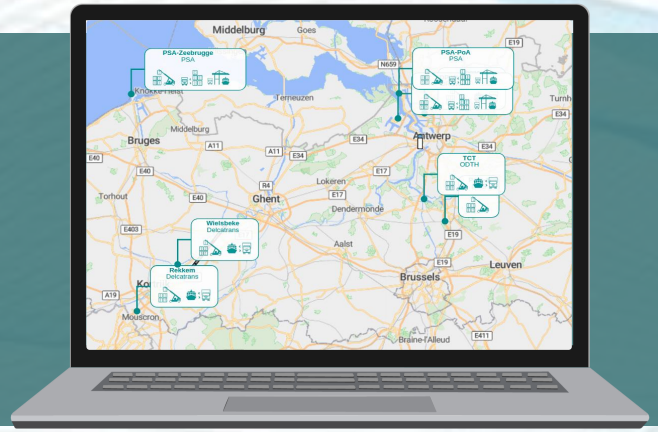
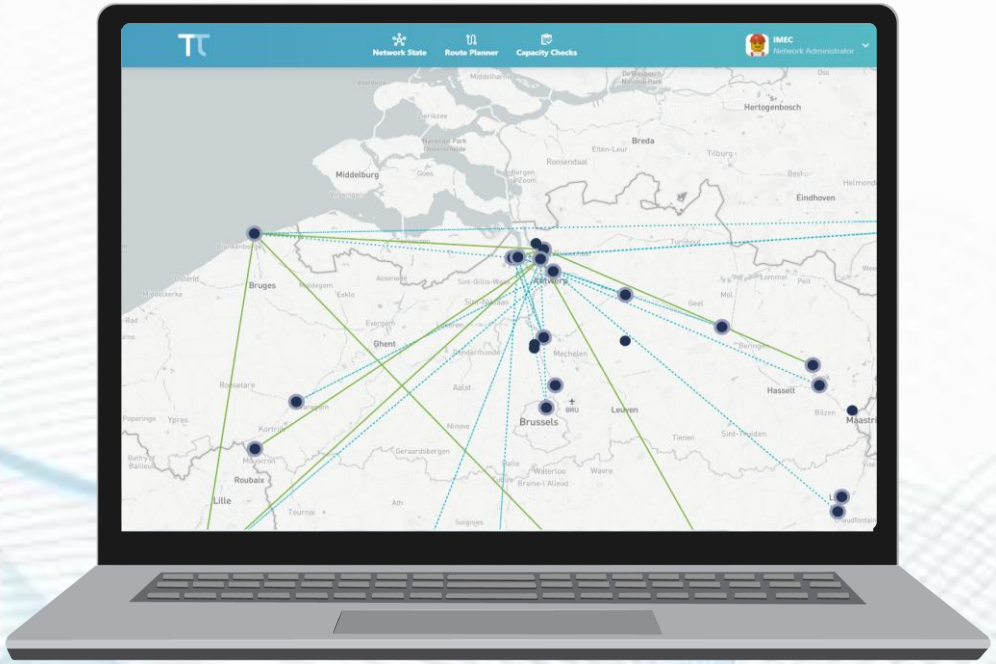
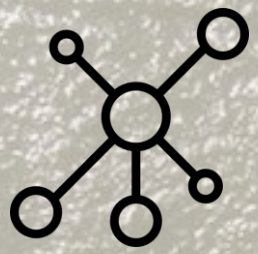
ABM SIMULATION TESTING





THE π-CLIENT LIVING LAB

FOCUS NEEDED TO KICKSTART THIS PROJECT



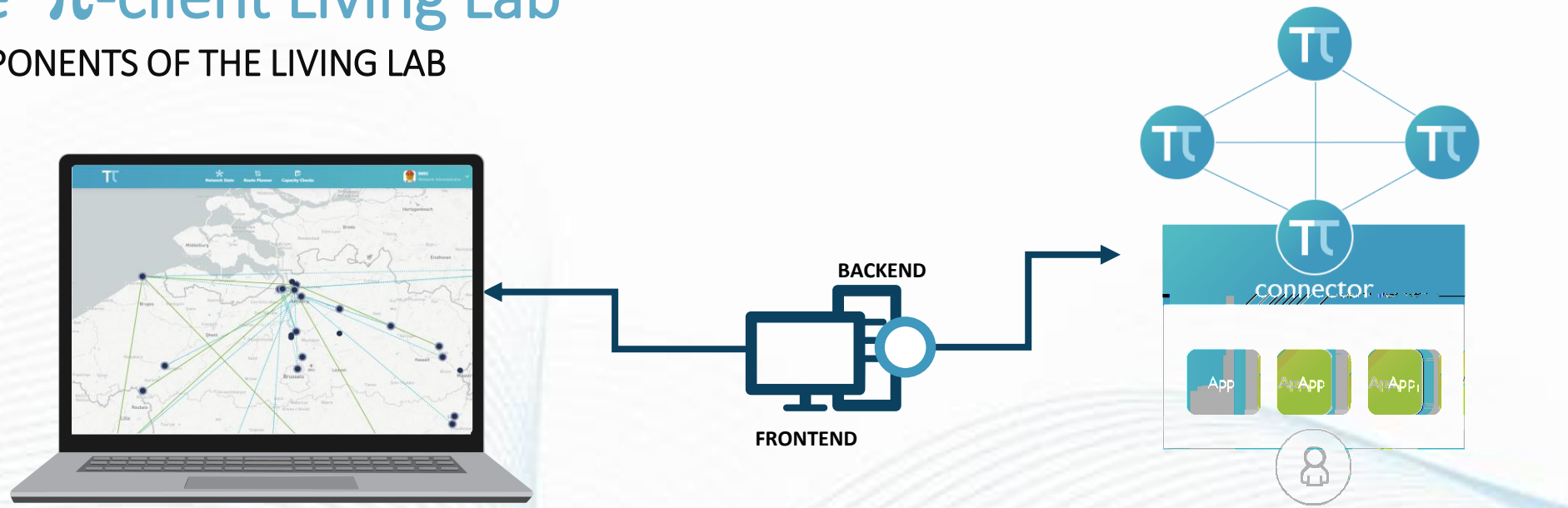
LOGISTICS NETWORK

SPOT CONTAINER TRANSPORT

HINTERLAND CONNECTION

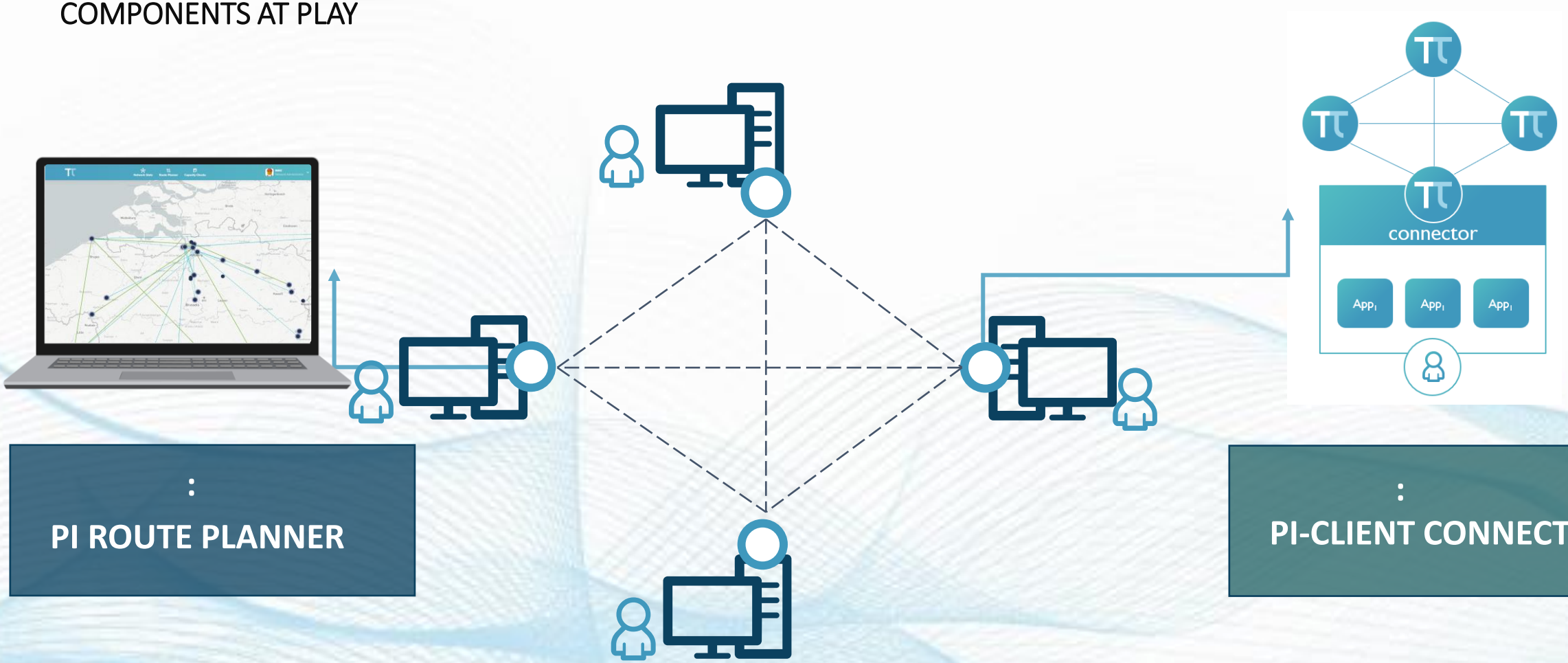
The π-client Living Lab

COMPONENTS OF THE LIVING LAB



The π-client Living Lab

COMPONENTS AT PLAY



:
PI ROUTE PLANNER

:
PI-CLIENT CONNECTOR

The π-client Living Lab

THE PI ROUTE PLANNER

operates on a PI-network

planning & resilience

data sharing &

interoperability

Capabilities

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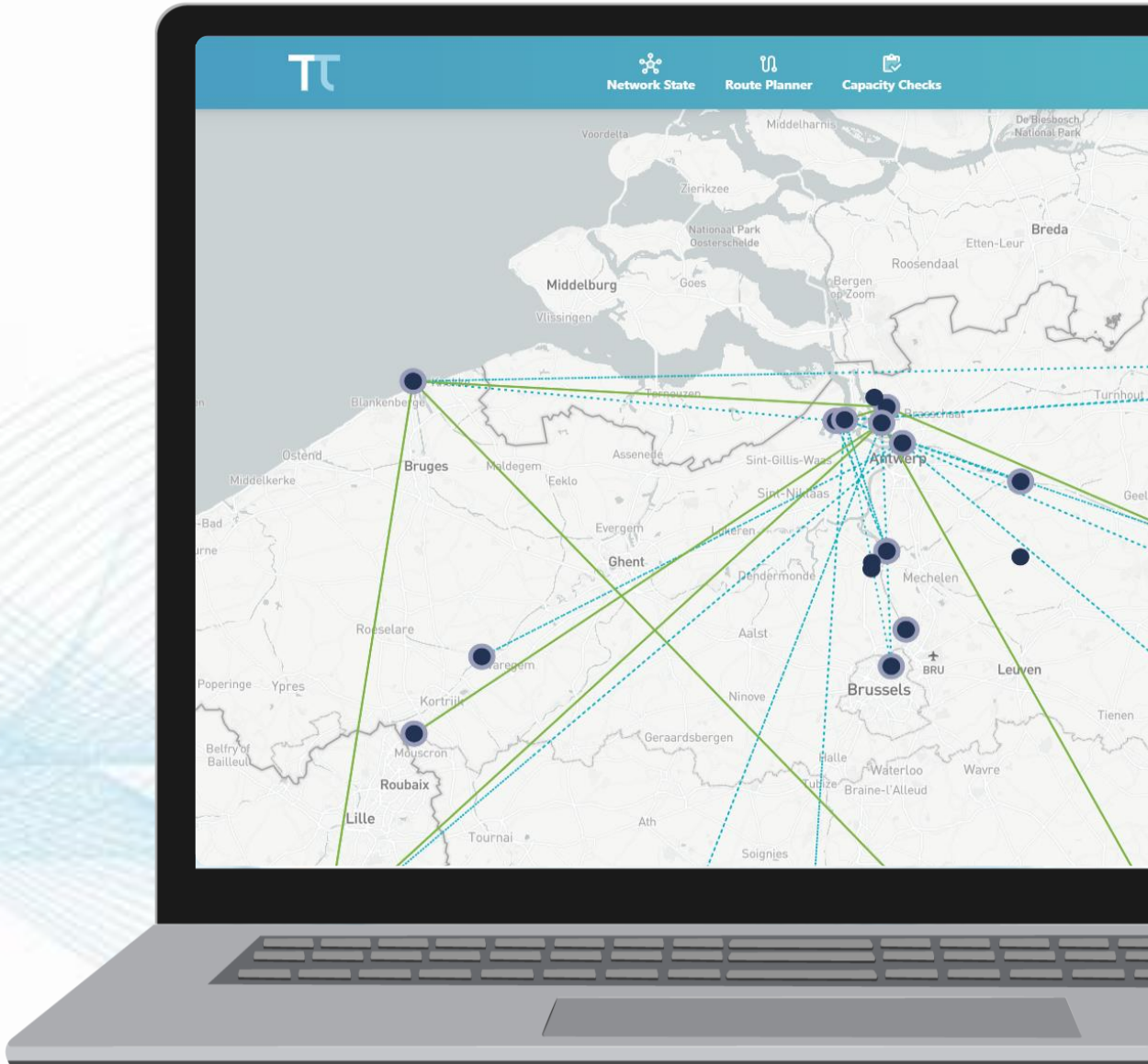
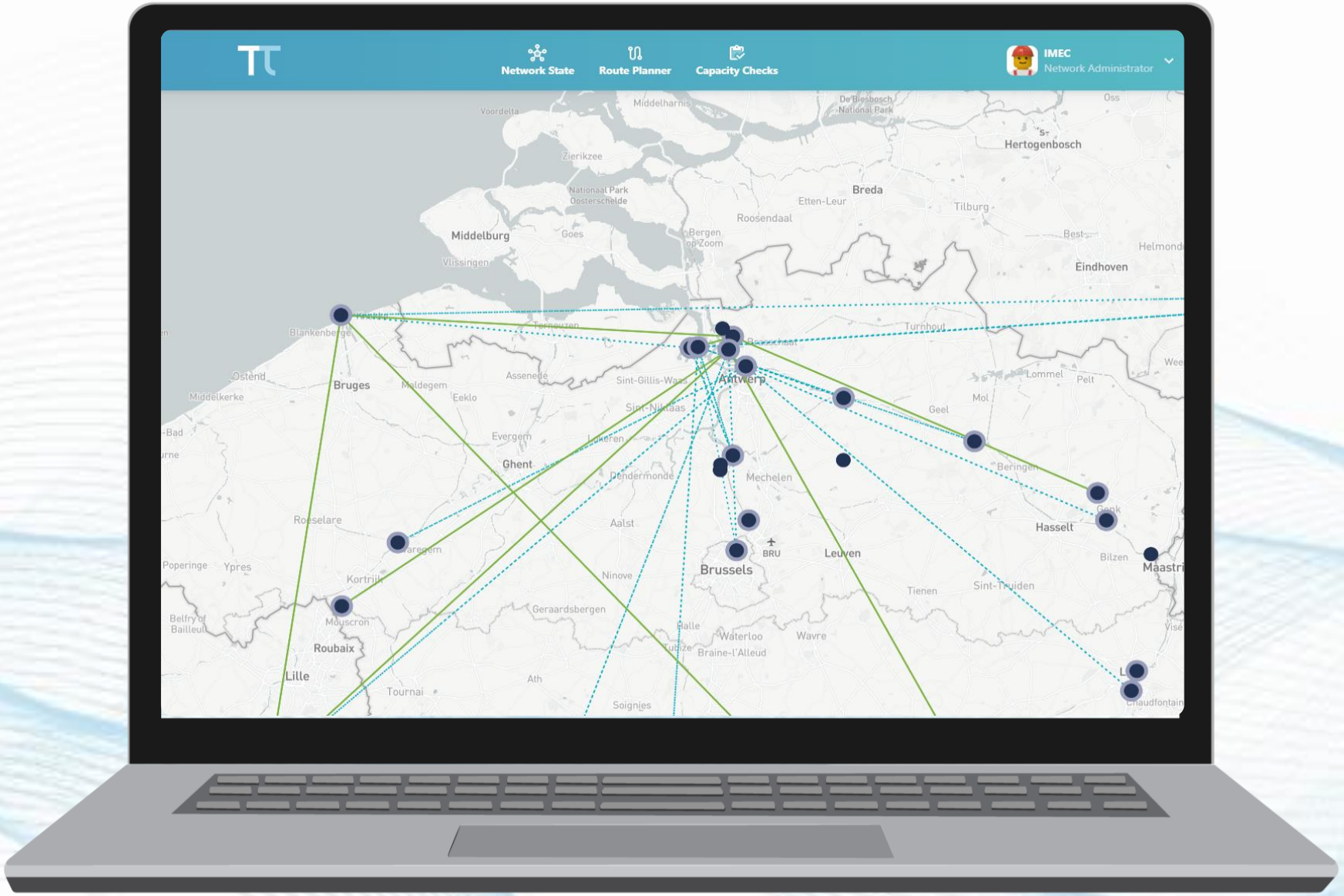
Network state =



Demo


Network State
Route Planner
Capacity Checks
IMEC
Network Administrator
Hertogenbosch
Breda
Middelburg
Eindhoven
Bruges
Antwerp
Ghent
Brussels
Leuven
Hasselt
Roubaix
Lille
Tournai

The π-client Living Lab

LIVING LAB TEST

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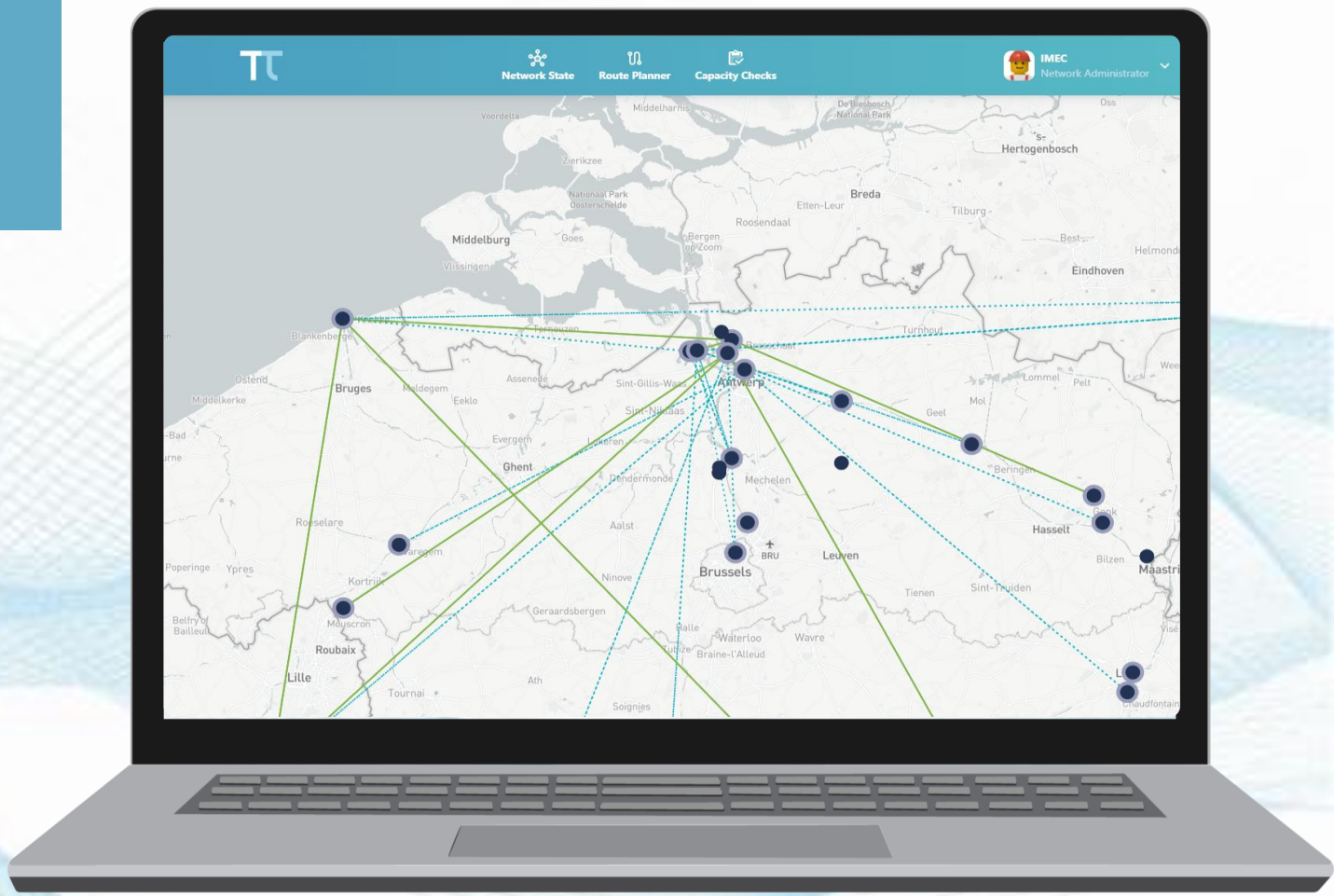
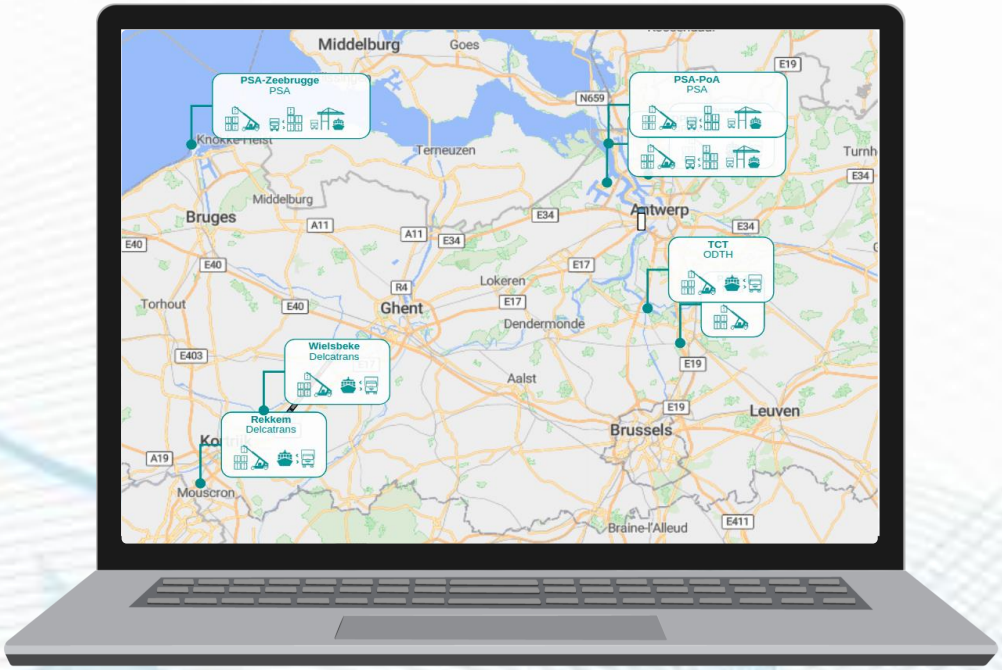


The π-client Living Lab

CONCLUSIONS OF LIVING LAB

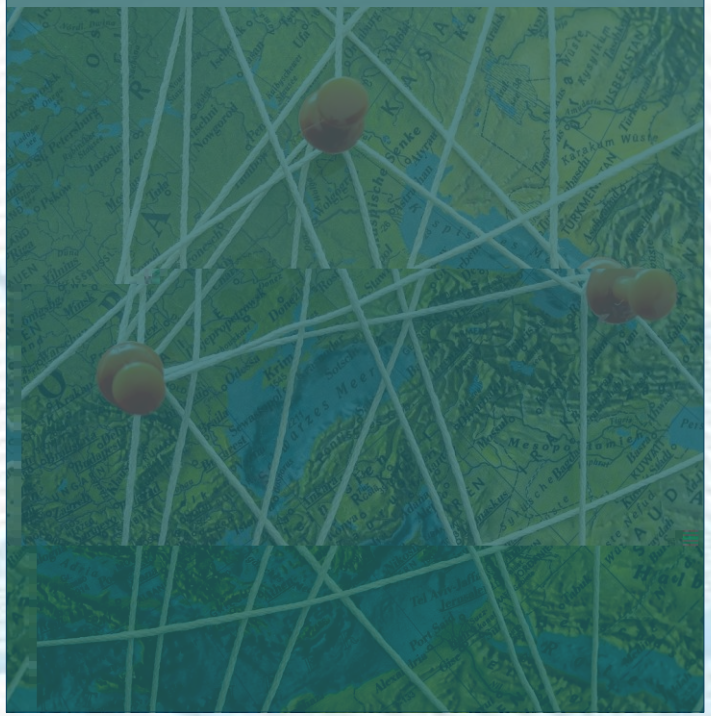
DECENTRALISED NETWORK	✓
DATA MODEL	? ✓
INTEROPERABILITY	✓
PI BUSINESS VALUE	✓



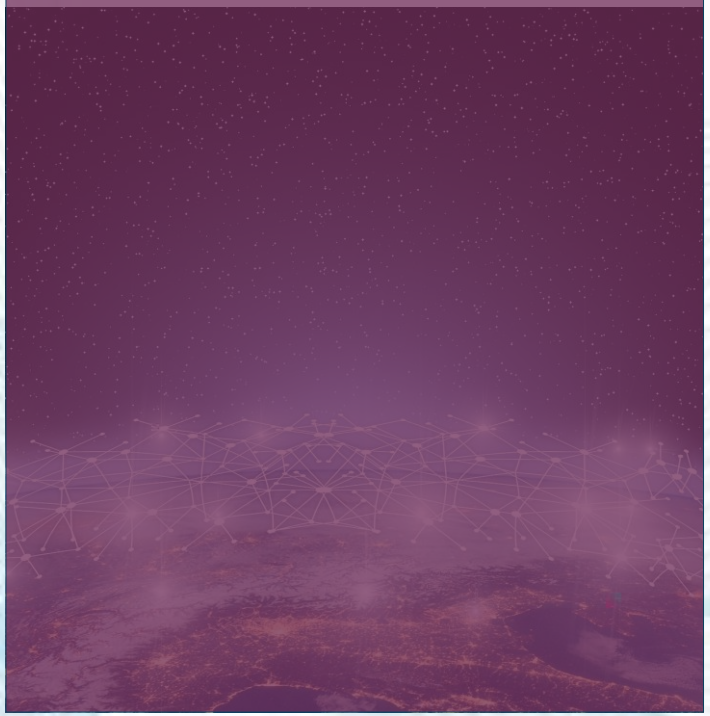
ABM SIMULATION TESTING

Importance of the Agent-based Model

Validation of Routing & Optimization Algorithms



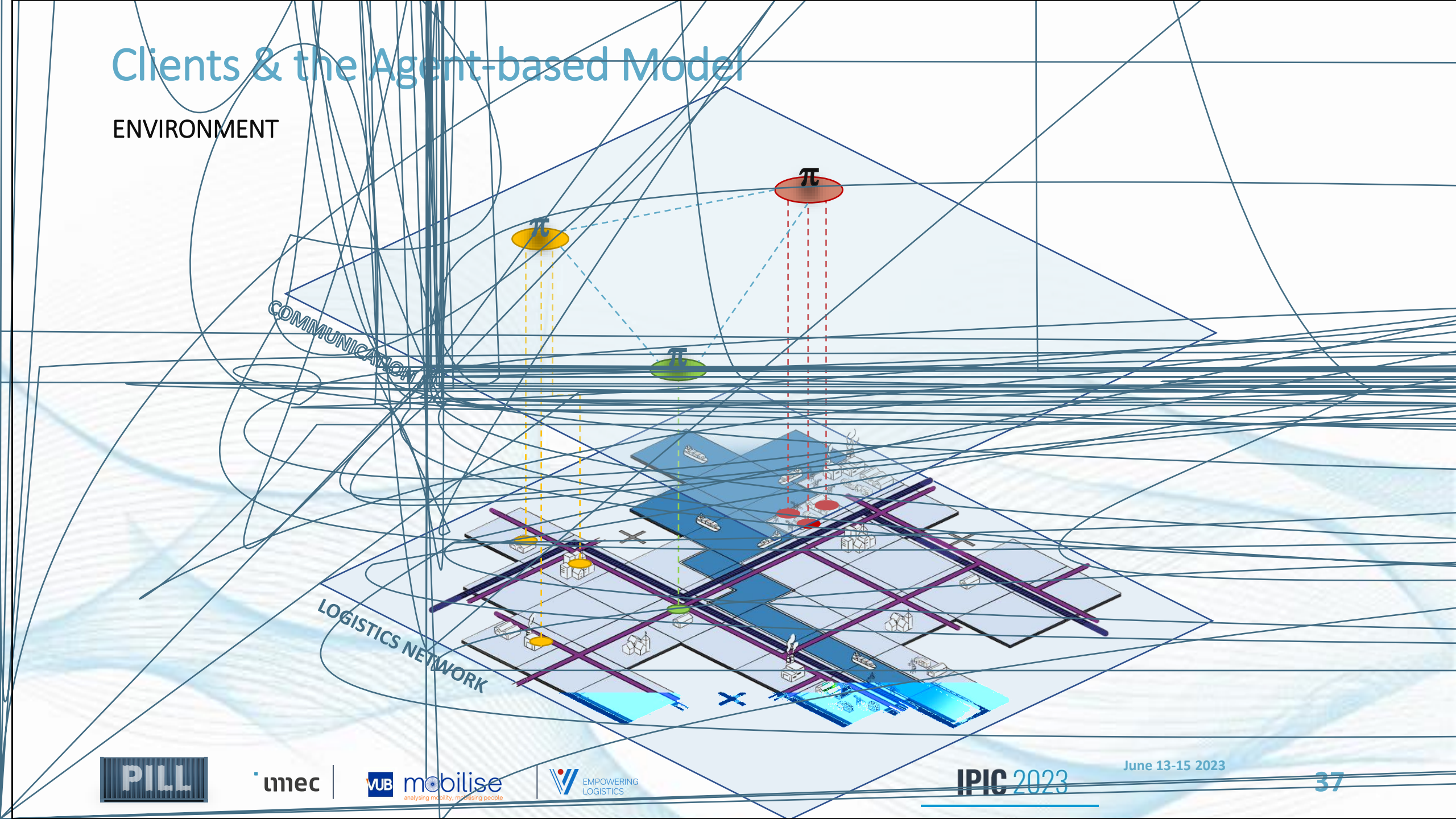
Scalability Testing

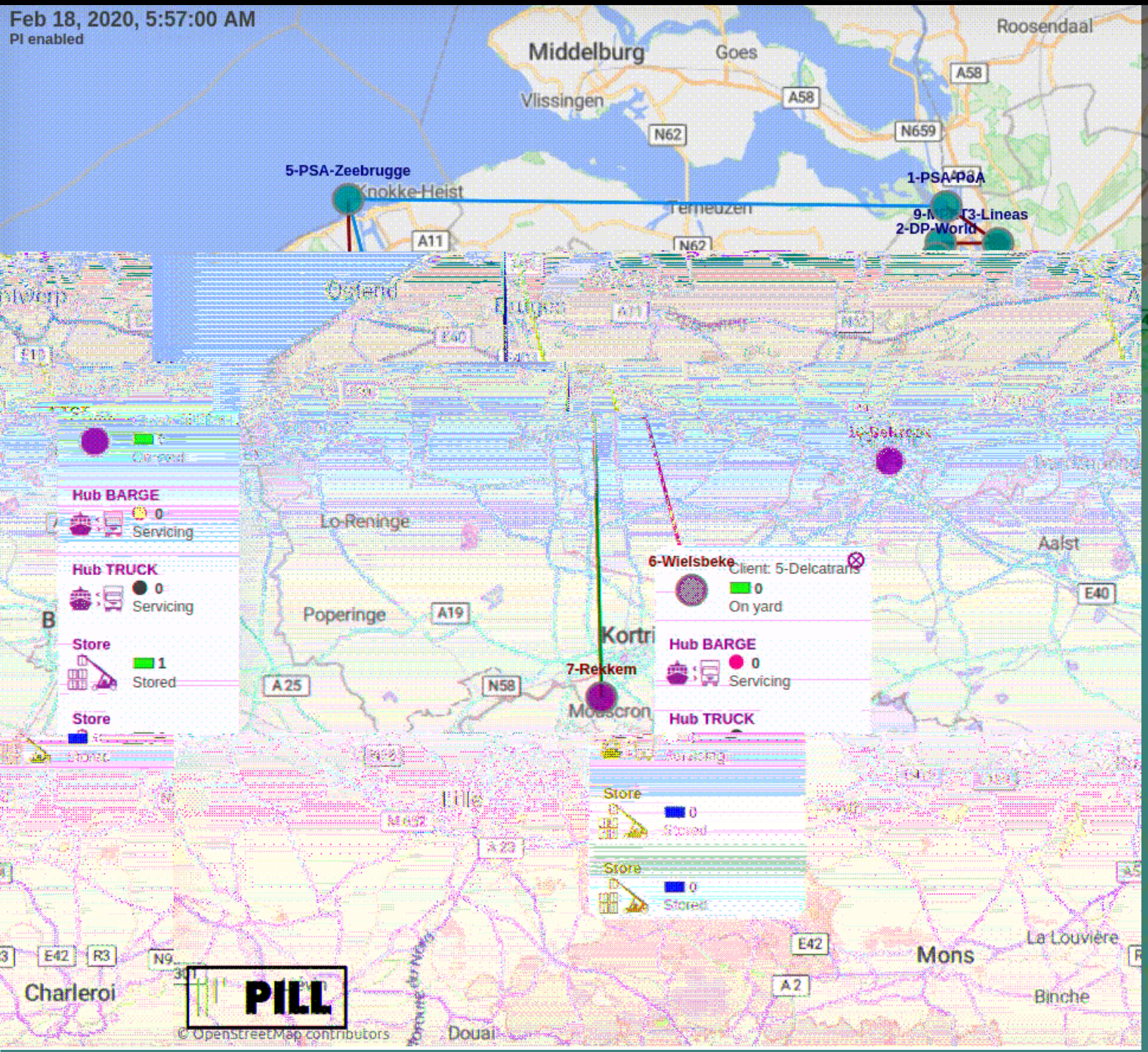


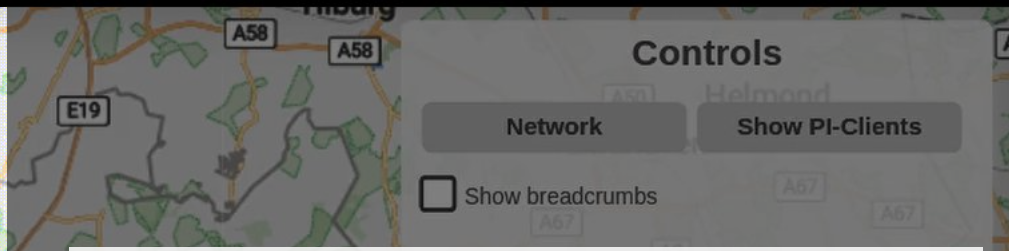
Predictive Analysis

Clients & the Agent-based Model

ENVIRONMENT







Client

- An active PI-Client
- Planning, booking and reservation

Node

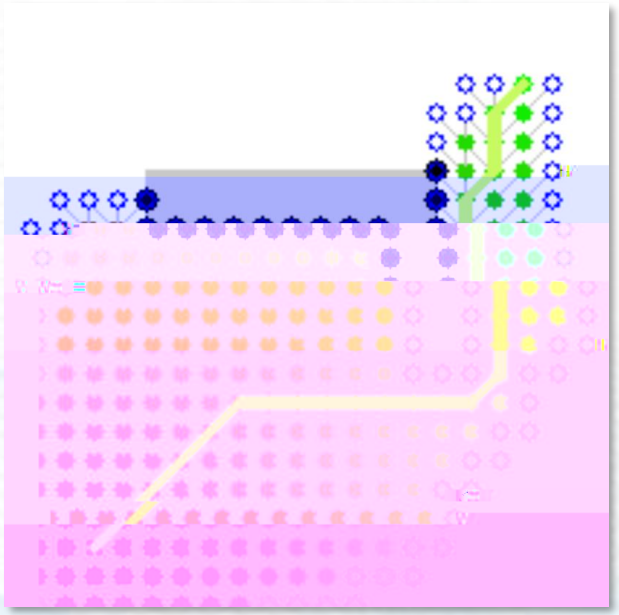
- A physical location
- Characterised by capabilities for routing

Mover

- Trucks, trains and barges
- Flexible and scheduled
- Depart from the base (owner's node)

Routing algorithms

PIA* – SNAPSHOT PLANNING

- 

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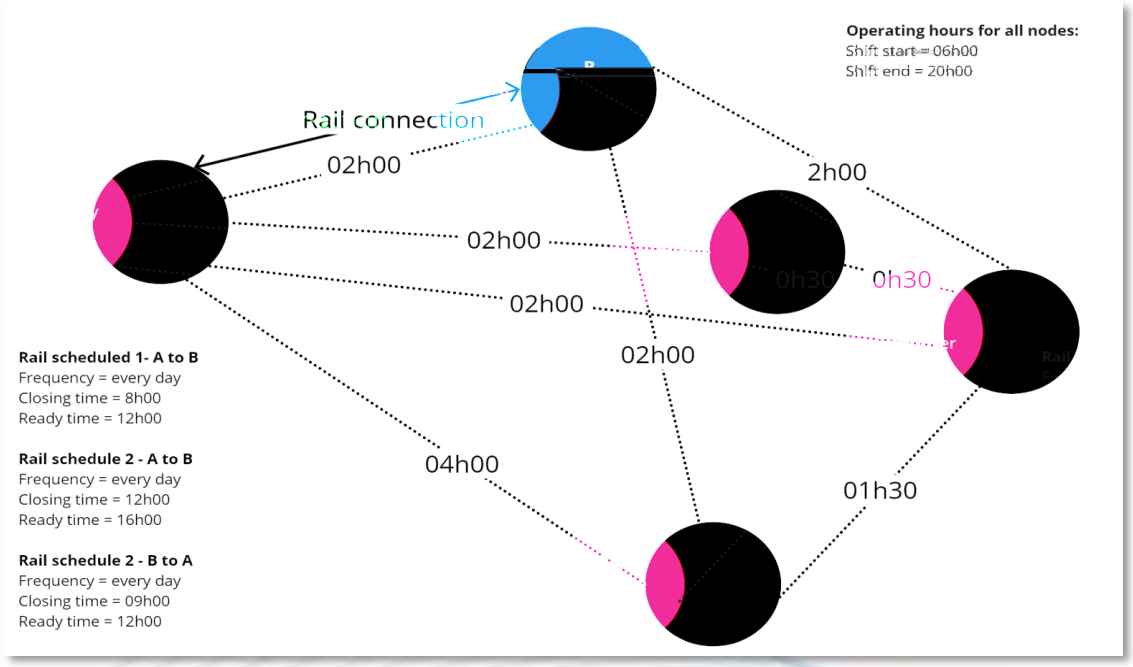
time

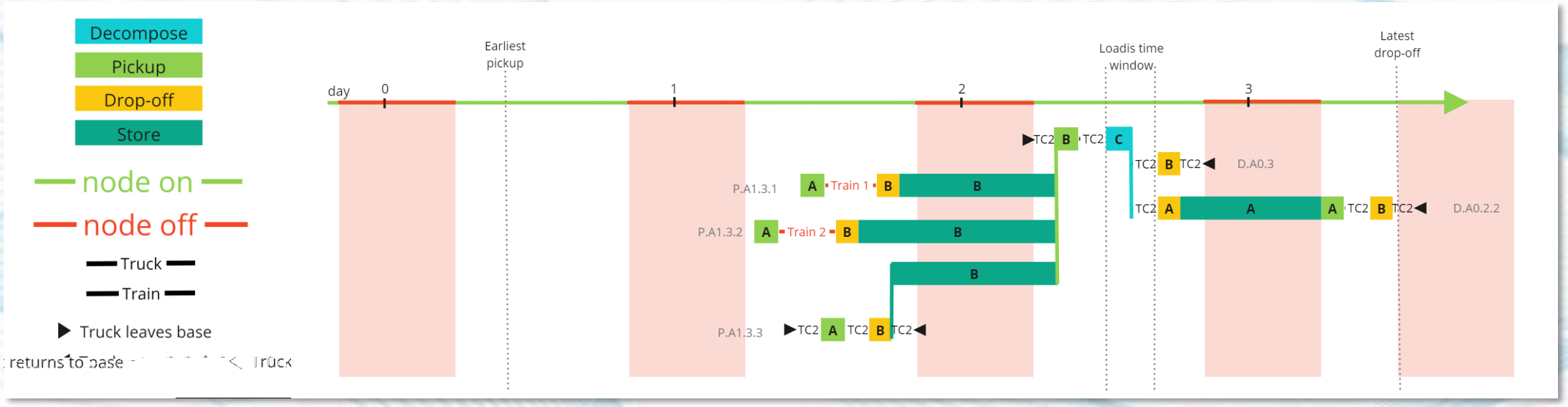
Routing algorithms

PIA* – SNAPSHOT PLANNING

Export

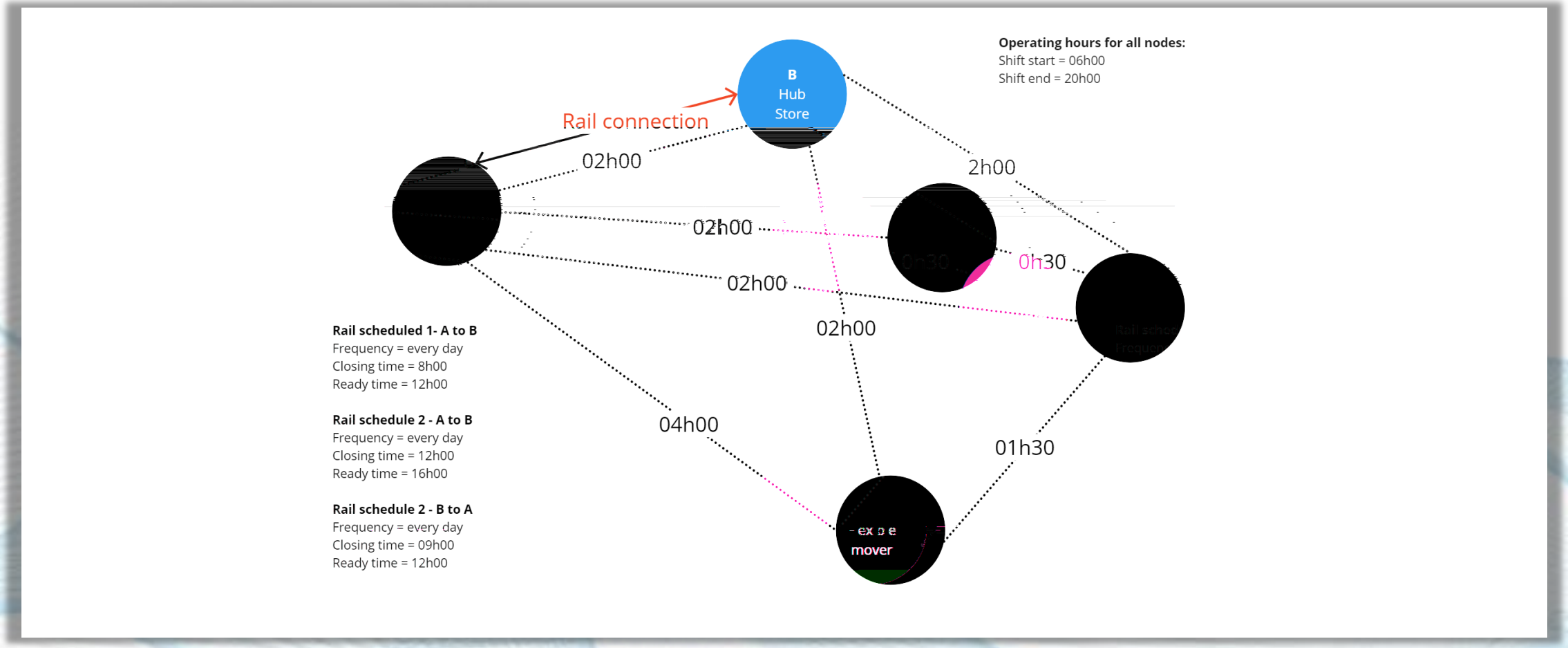
- Back tracking: empty container from A to C
- Forward tracking: loaded container from C to A





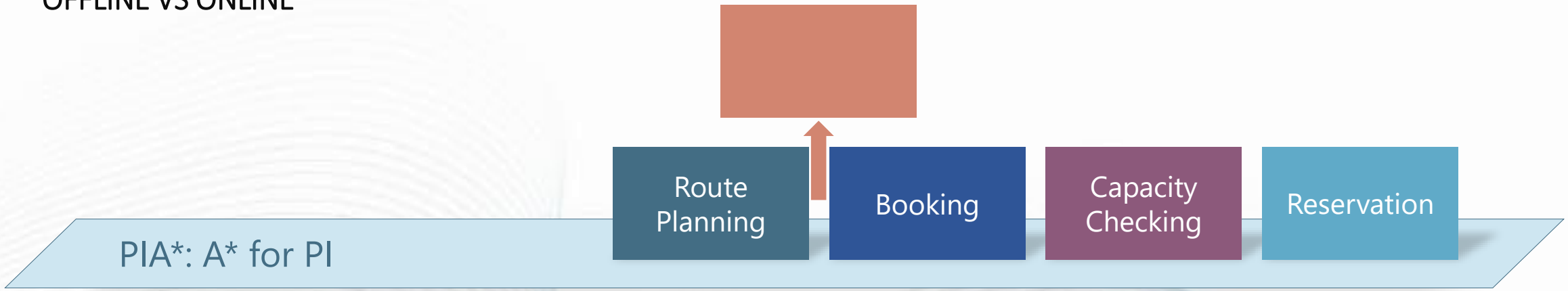
Routing algorithms

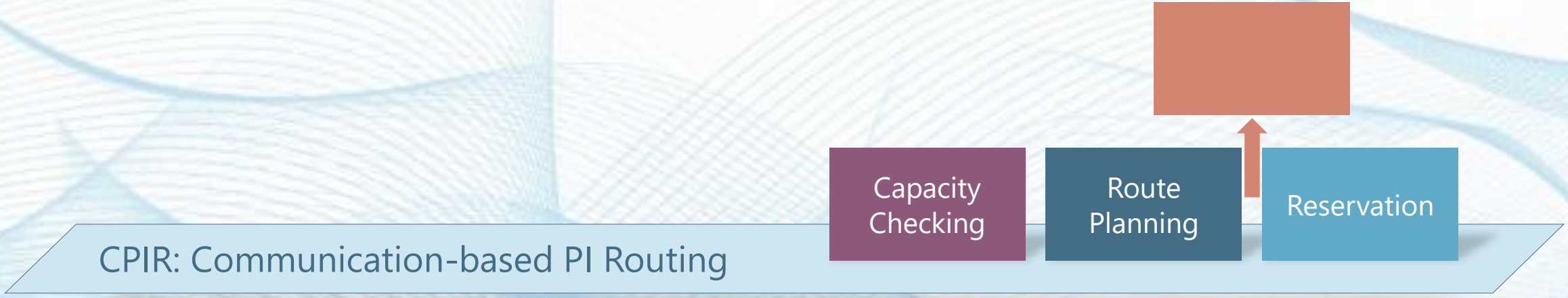
CPIR – ON-DEMAND PLANNING



Routing algorithms

OFFLINE VS ONLINE





Importance of the Agent Based Model

Validation of Routing & Optimization Algorithms

- Routing optimality
- Privacy
- Disruptions treatment

Scalability Testing

- More nodes
- More constraints
- More capabilities

Predictive Analysis

- Towards Digital Twin
- What if…
- Risk management

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KEY TAKE-AWAY #1

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> The PILL solution has proven to answer several logistics challenges

KEY TAKE-AWAY #2

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> Trust and control are driving factors to build a data sharing network

KEY TAKE-AWAY #3

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> Achieving a critical mass is crucial to the value proposition of PI

KEY TAKE-AWAY #4

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> Data standards are the basis for a PI network

KEY TAKE-AWAY #5

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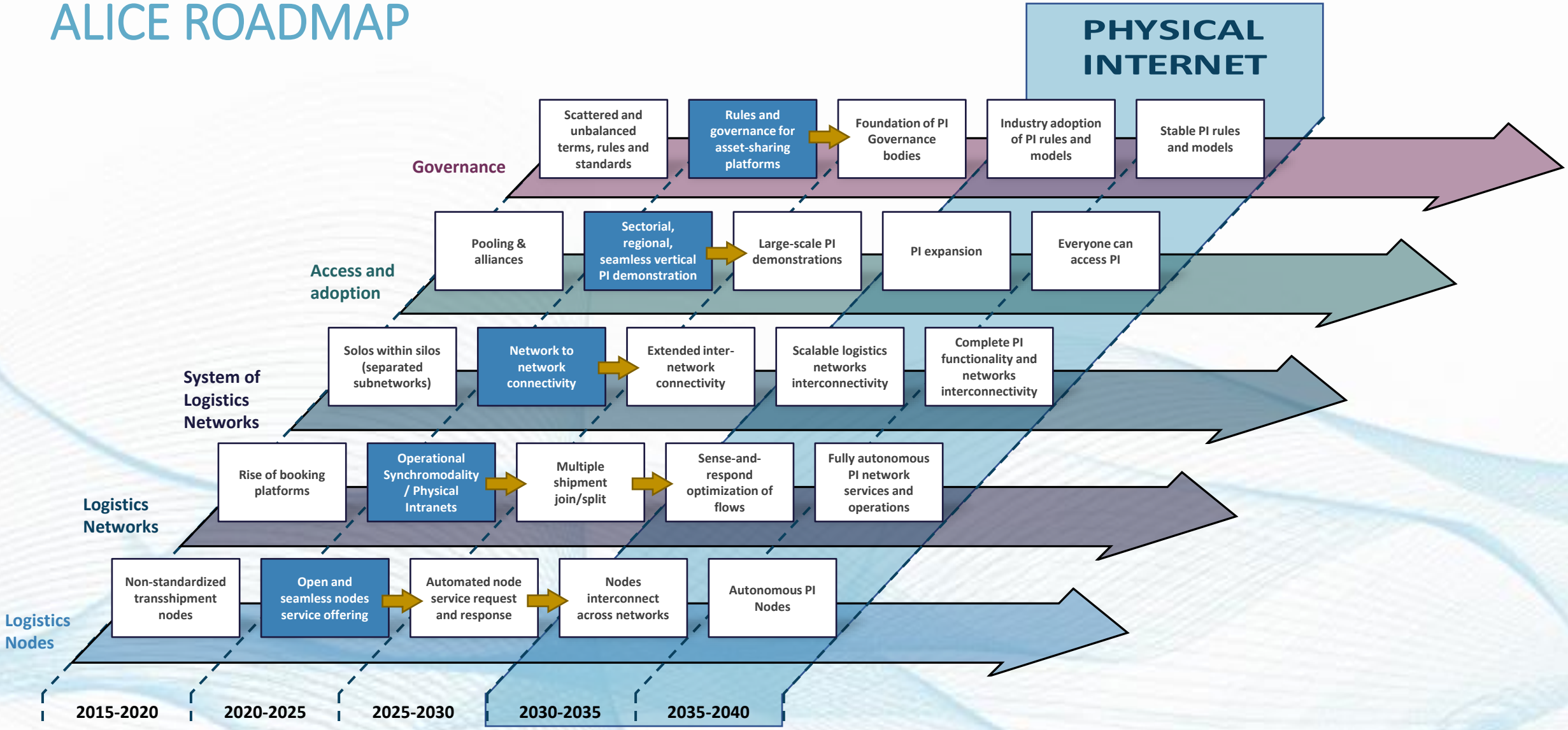
> The revolution of PI will be enabled by the emergence of new digital services

ALICE ROADMAP

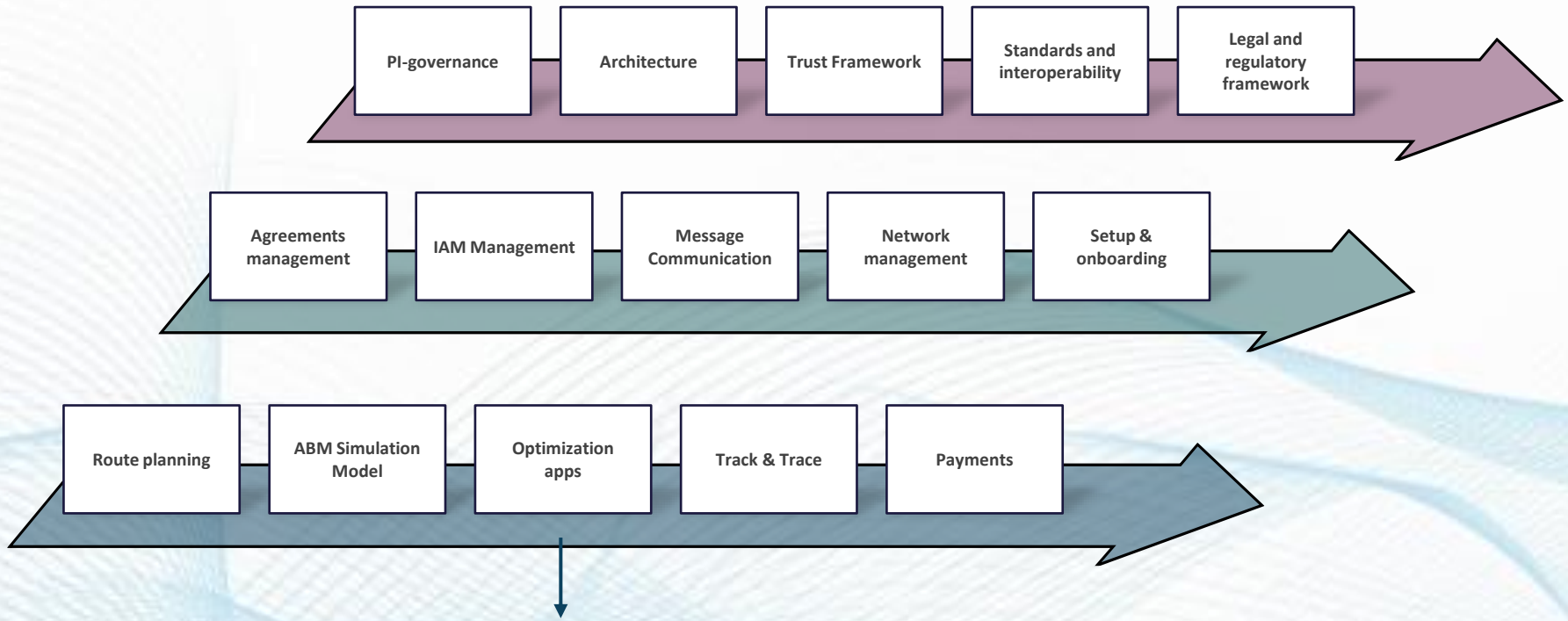


PILL ROADMAP

PI-Client Framework

Collaborative components

Physical Internet App Marketplace



PILL synergies

PIONEERS

DISCO

SYTADEL

FLEMISH SMART DATA SPACE

We are looking for project partners to further build the PI roadmap!

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9th Internation

Physical Internet Co

June 13-15, 20

Athens, Greece

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