PART 1: PROGRESS UPDATE WP 5
(TERMINAL OPERATIONAL SIMULATIONS)

PART 2: DEMO
(MELZO TERMINAL)

PART 3: PROGRESS UPDATE WP 7
(NETWORK SIMULATIONS)

Macomi - Corné Versteegt

PART 1
PROGRESS UPDATE WP 5

Terminal Operational Simulations

Build a *simulation-based Decision Support Environment* to support optimizing the design and operations of intermodal terminals

- Layout
  - get the layout ‘right’ before construction and operations start: changes are costly or....even impossible
  - holistic integrated approach (civil / equipment / IT / operations / financial / hinterland)
- Container Handling Equipment
  - Selection of the ‘right’ equipment
  - Right numbers of equipment

WORK DONE

Deliverable	M	Important to notice
D5.1 - Data model **FINISHED and SUBMITTED**	6	Two parts: • Data requirements • Data model Work on feedback EU
D5.2 Ontology **FINISHED and SUBMITTED**	9	Two parts: • Ontology • Conceptual models Work on feedback EU
D5.4 - Coupling of simulation library to overall architecture	17	Delays in • Late delivery of layout of Melzo Interface BIM -> SIM is finished Interface SIM -> BIM starts after case study Melzo
D5.1 and D5.2 are the basis for D5.3 (library of simulation components) and D5.4 (coupling to overall architecture)		

WORK DONE

Deliverable	M	Risks / Important to notice

D5.3 Developing a simulation component library	17	Current status
		• Arrival and volume generator finished
		• Simulation library partly finished:
		  • Basic components:
		  • Equipment (RS, RC, TT)
		  • Trains and rail network
		  • Trucks and gate
		  • Stack and containers
		  • User interface SIM
		  • Selected set of KPIs
		
		• Demo Melzo ready for this meeting (MS9)

IMMEDIATE OBJECTIVES (NEXT 6 MONTHS)

Deliverable	M	Risks / Important to notice

D5.3 Developing a simulation component library	17	**1. Connection SIM -> BIM (D5.4)**
		2. Melzo terminal
		• Further testing and refinement model
		• Check model by Melzo staff
		3. La Spezia terminal
		• Implementing layout of La Spezia
		• New components
		  • WS operations (vessels and STS)
		  • Improving TOS
		4. Connection to traffic simulation
		Terminal simulation to provide inputs (logs) on:
		• Truck gate arrival/departure time
		• Truck cargo size (TEU)
		• Used gate
		5. KPIs
		• Link to KPI WP
		• Dashboard of KPI
		
		Work will continue after month 18
		• Improving existing simulation components

DEVELOPED SIMULATION COMPONENTS

Equipment

- Gantry cranes
  - Rail crane and RTG
  - Connection to areas, e.g. buffer
- External trucks
  - Moving container to/from the terminal
- Terminal tractors
  - Horizontal transportation
  - Single box only
- Reach stackers
  - All-purpose CHE
  - Operates within set number of container blocks
- Trains
  - Locomotives
  - Railcars

Infrastructure

- Container blocks
- Container spots
  - 20, 40, 45 feet
  - GP, MT, reefer, tank, bulk, IMO
- Road network
  - Roads, crossings
  - Parking lots and lanes
- Rail network
  - Tracks
  - Rail yard
  - Shunting yard
- Gates
  - In/Out lanes
  - Queuing and processing

DEVELOPED SIMULATION COMPONENTS

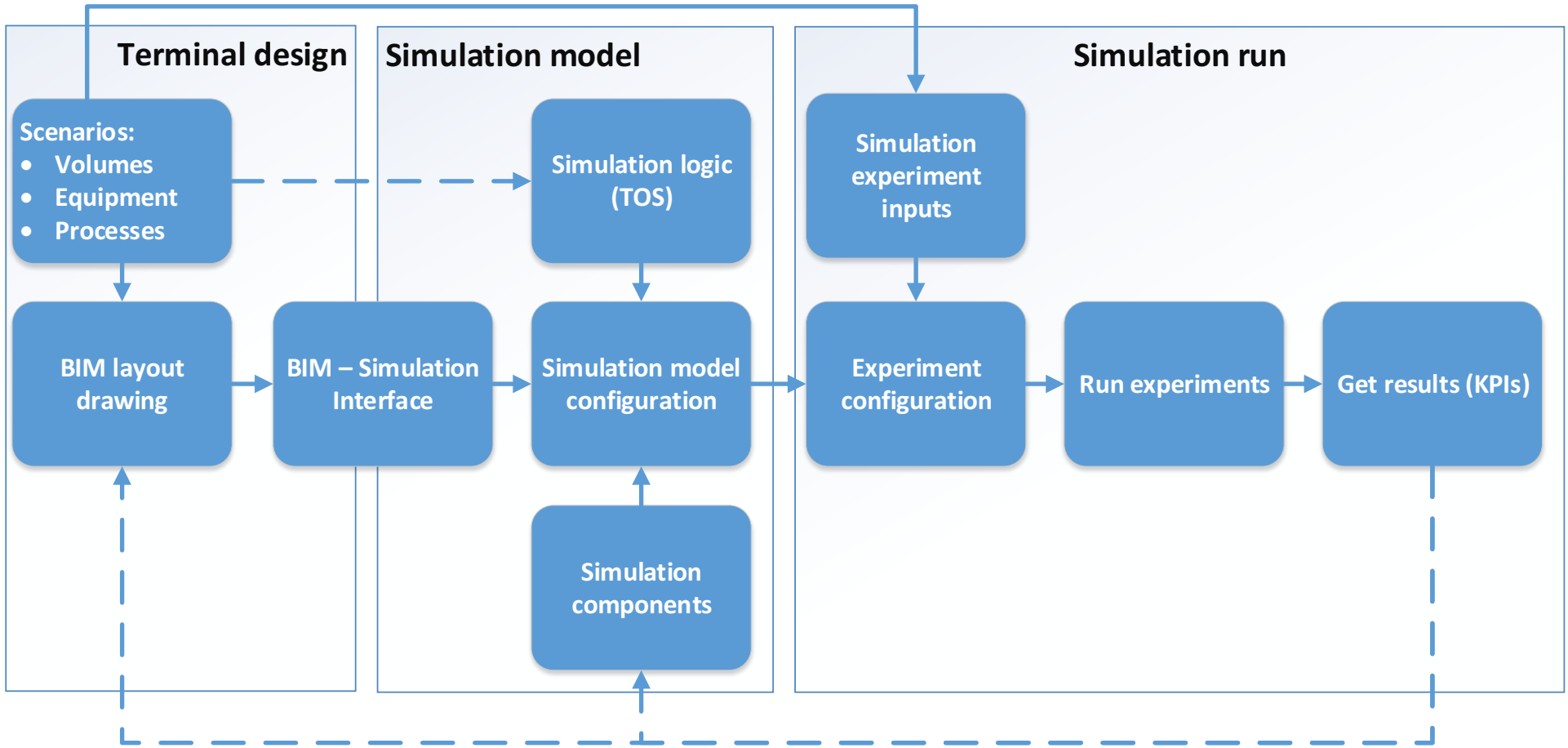
Control

- Job creation and coordination
  - Identify containers to pick
  - Execute digging
  - Identify drop off location
  - Initiate operations
  - Resolve conflicts
  - Coordinate interactions (e.g. CHE with transporters)
- Routing
  - Stopping positions
  - Traffic rules
  - Shunting
  - Parking
- Recording KPI's

Volumes

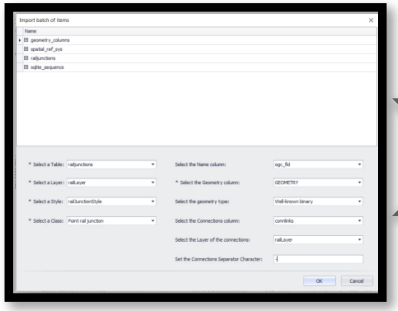
- Train arrivals
  - Weekly and single-time services
  - Box number, types and sizes
  - Number of arriving and departing boxes on train
  - Train sizes and compositions
- Truck arrivals
  - Box number, types and sizes
  - Number of arriving/departing boxes on truck
  - Weekly and hourly arrival patterns
- Initial stack composition
  - Box number, types and sizes
  - Initial locations

SIMULATION ELEMENTS



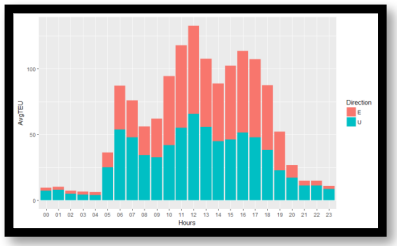
BIM ←→ SIMULATION COUPLING

BIM layout



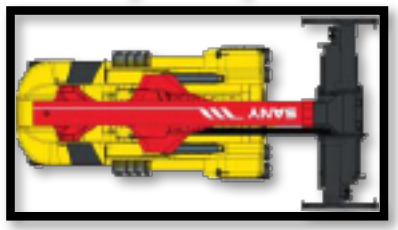
Layer conversion

Simulation layout

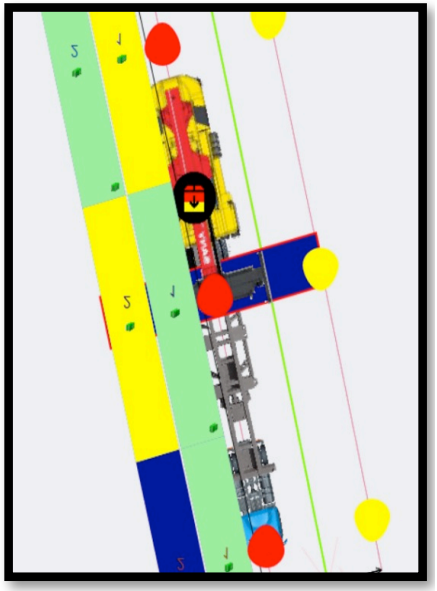


Arrival volumes

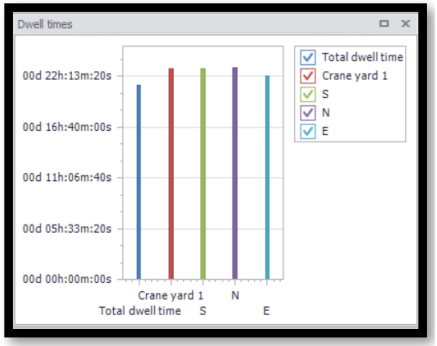
Simulation run



Equipment settings



Simulation animation



Simulation KPIs

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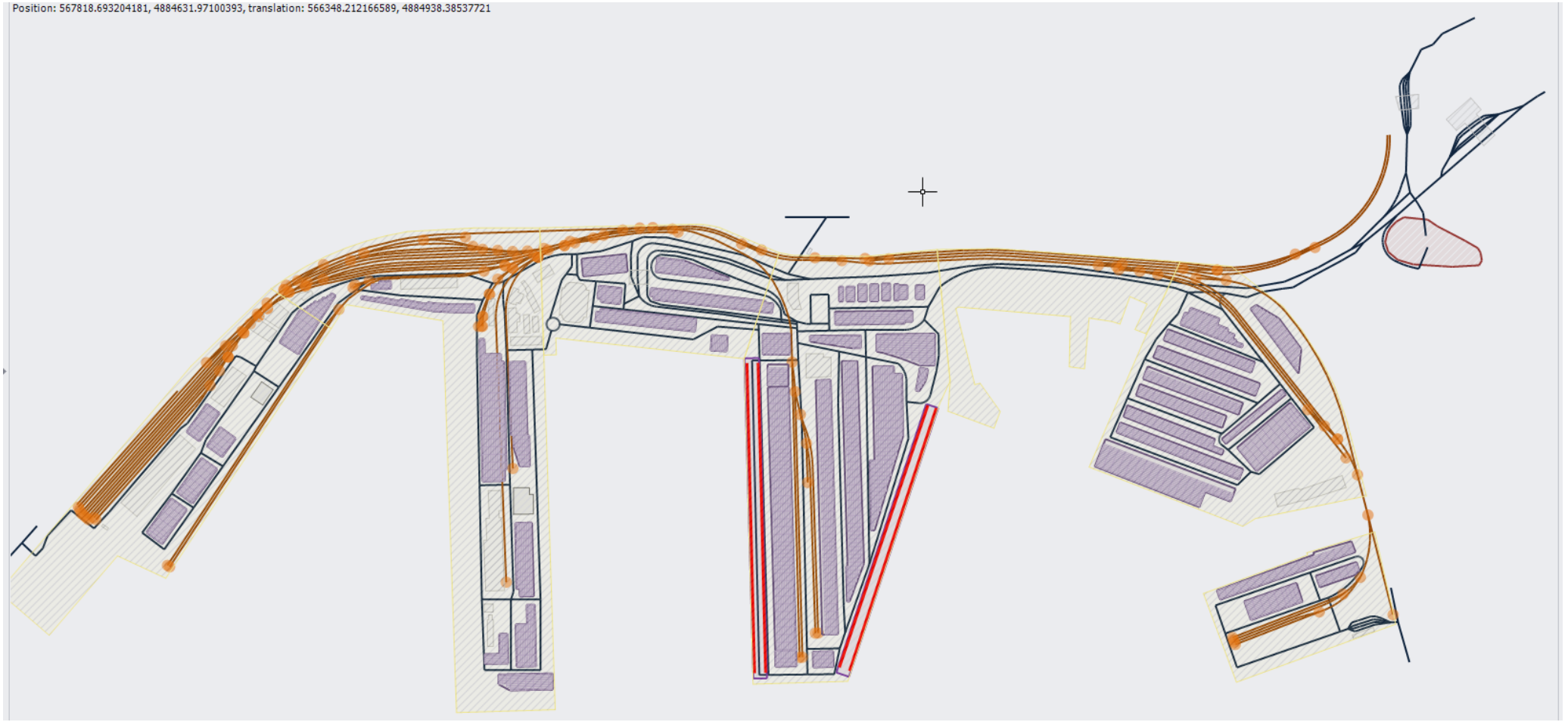
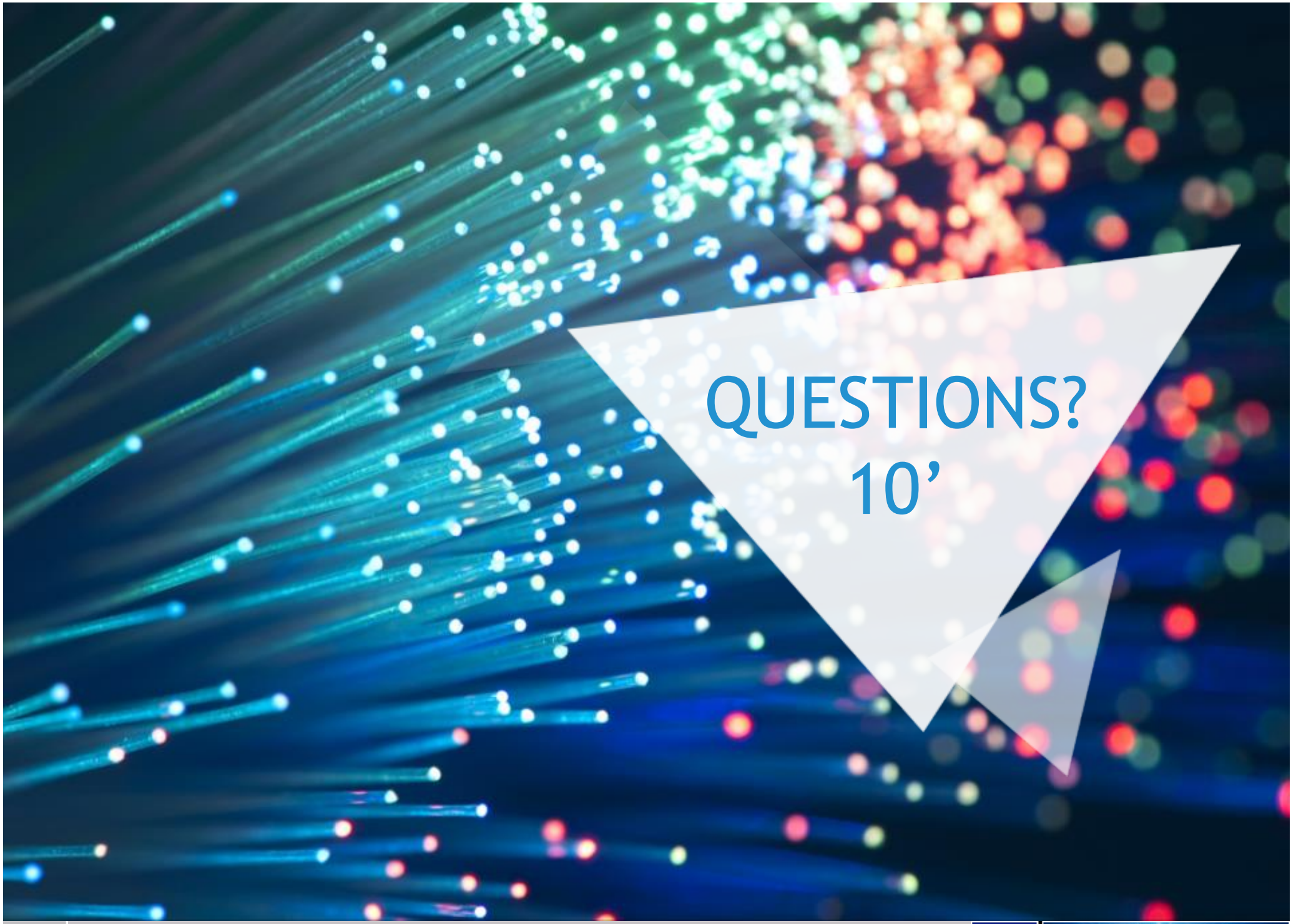
- Risks
  - Layout
    - Late delivery of Melzo layout
    - Iterations IDP-Macomi took longer
  - Lack of data
    - We have received little (or just enough) information from Melzo/La Spezia
    - More information will lead to better results
  - Computational time needs to improve
- Opportunities
  - High reusability potential
  - Automating layout conversion

LA SPEZIA LAYOUT – FIRST DRAFT




QUESTIONS?
10’

PART 2
DEMO MELZO TERMINAL

Terminal Operational Simulations

Goal of demo

1. Show project team status of simulation library
2. Familiarise the project team with the simulation library
3. Discuss next steps and future direction

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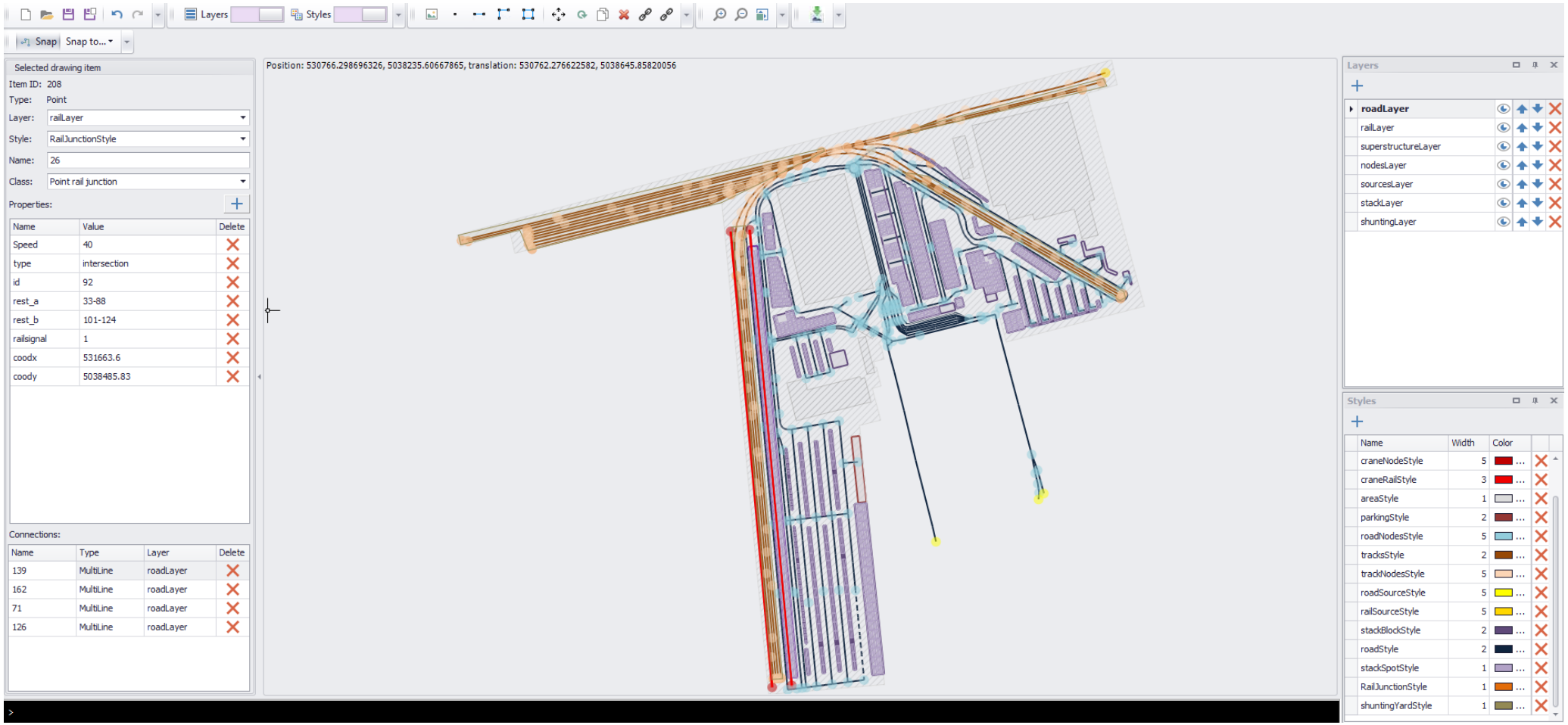
We use the following steps in simulation projects on terminals:

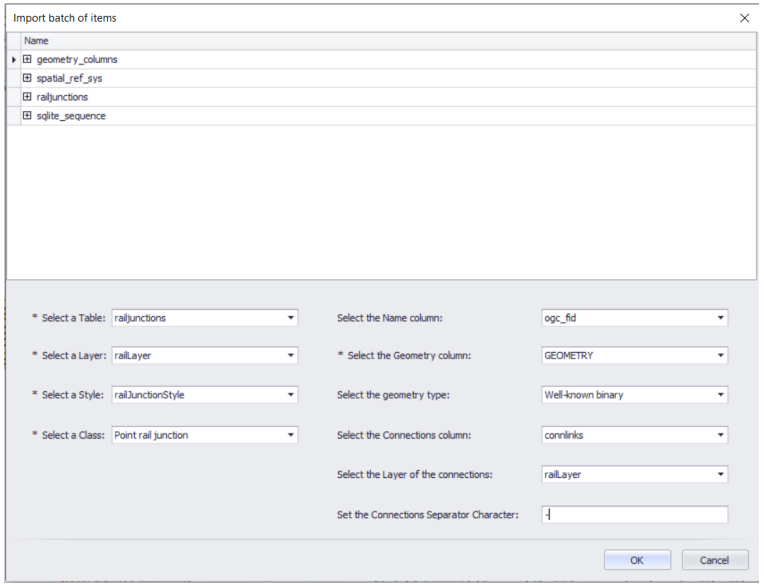
- Step 1: layout from BIM to simulation
- Step 2: volume and terminal parameters
- Step 3: run simulation experiments
- Step 4: results (KPI and animation)

STEP 1: BIM → SIMULATION INTERFACE



STEP 1: BIM → SIMULATION INTERFACE

- Create a new drawing
- Sequentially import .sqlite files to appropriate layers
- Distinguished classes:
  - Road traffic track (road link)
  - Road traffic source
  - Road traffic sink
  - Rail track
  - Point rail junction
  - Rail source
  - Rail sink
  - Rail location (for grouping sidings)
  - Crane rail (leading or secondary)
  - Stack block
  - Stack spot
- Inspect the drawing, introduce minor changes



STEP 2: MELZO VOLUME DATA (2016)

Type	Number of boxes	TEU	Average dwell time [h]	% total number
General Purpose (GP)	105988	200668.75	54.0	57.05
Empty (MT)	56415	98635.75	342.5	30.37
Tank	10300	11777.80	41.7	5.54
OOG	7487	13924.50	136.4	4.03
Bulk	4216	6337.5	267.0	2.27
Reefer	1369	2967	132.6	0.74
Total	**185775**	**334311.3**		

Train data

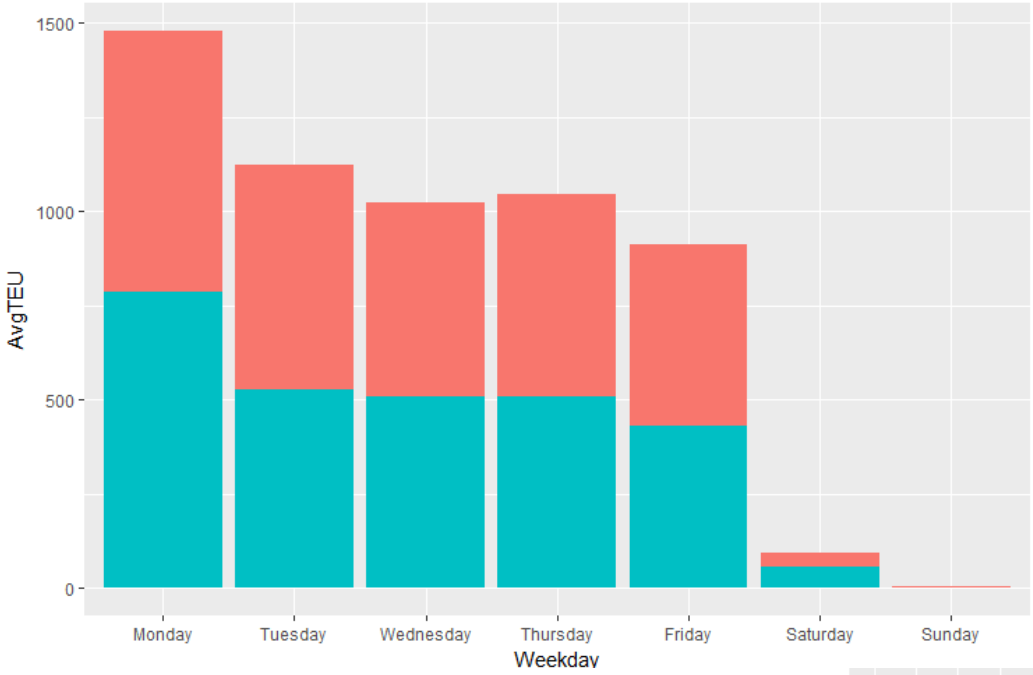
	Trains	Number of boxes	TEU
Arrival	352	87208	160347.1
Departure	344	80871	148711.8

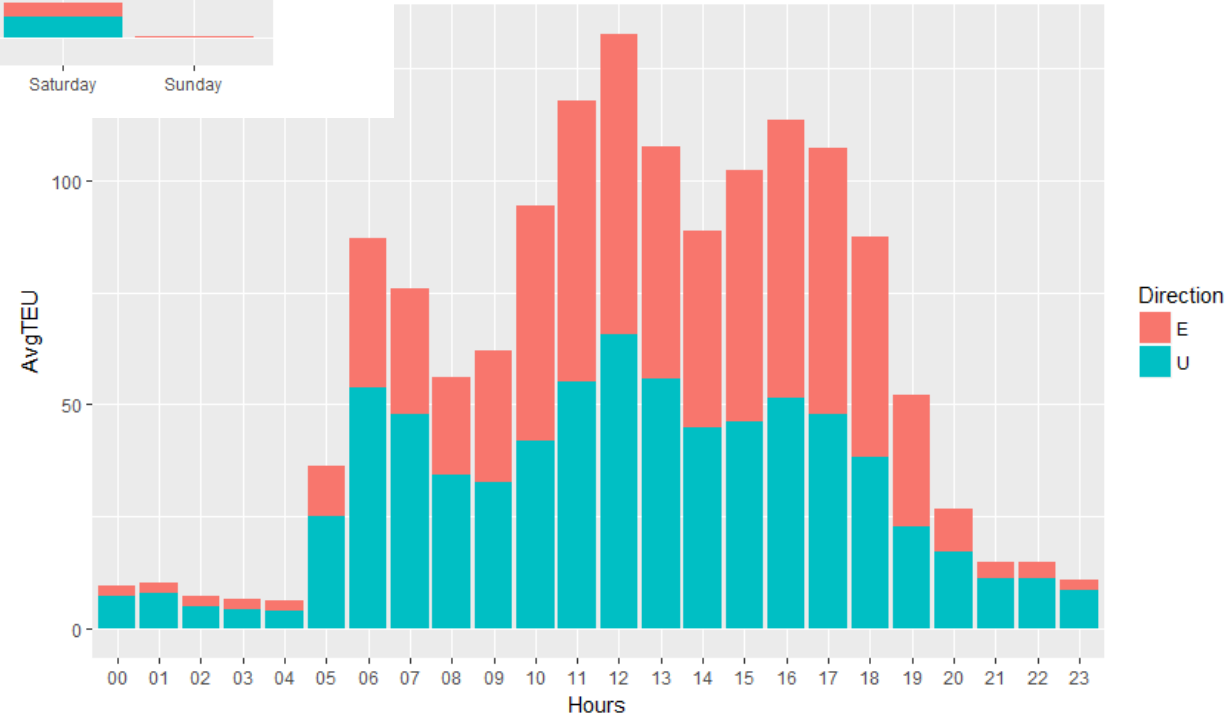
Truck data

	Trucks	Number of boxes	TEU
Arrival	?	98567	173953.2
Departure	?	104904	185588.5

Truck numbers are to be estimated based on percentage split of arriving and departing cargo. Will be difficult to validate though.

STEP 2: MELZO VOLUME DATA – TRUCK ARRIVALS (2016)





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STEP 2: VOLUME GENERATION

- Volume generation is based on actual Melzo train and truck arrivals and total volume
- Step 1: weekly and one-off train arrivals creation
  - Timing, capacity, dropped and picked boxes - user input
  - Randomisation (numbers, arrival time)
  - Boxes split per size and type
- Step 2: remaining volume is transported on trucks
  - Arrival weekly and hourly patters, and composition (number of boxes) – user input
  - Matching types, sizes of boxes and the TEU factor
  - Account for truck limitations (max TEU transported)
  - Exponential arrivals within the hour
- Step 3: create arrival list with trains and trucks

Volumes

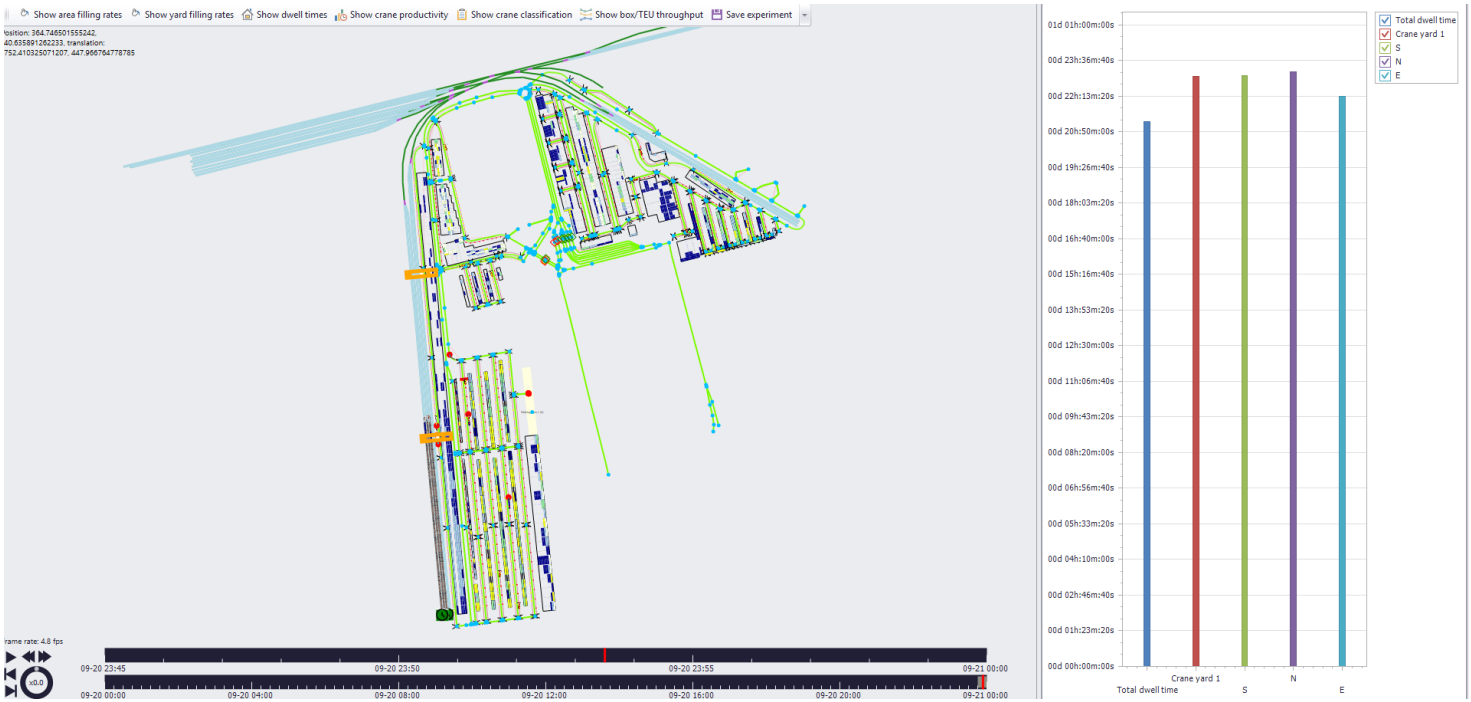
- Initial 3055 boxes
- 433 Trucks
- 14 Trains
- Daily throughput of almost 600 containers
- GP, MT, reefers, bulk and tank containers of 20, 40 or 45 feet (restricted by type)

Terminal

- Reach stackers – 13
  - Constrained to areas
- Rail cranes - 2
- Terminal tractors – 20
  - Single container capacity

STEP 3: RUN SIMULATION EXPERIMENTS

- DEMO WP5 Melzo Terminal



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STEP 4: RESULTS (KPI'S AND ANIMATION)

Developed KPI's

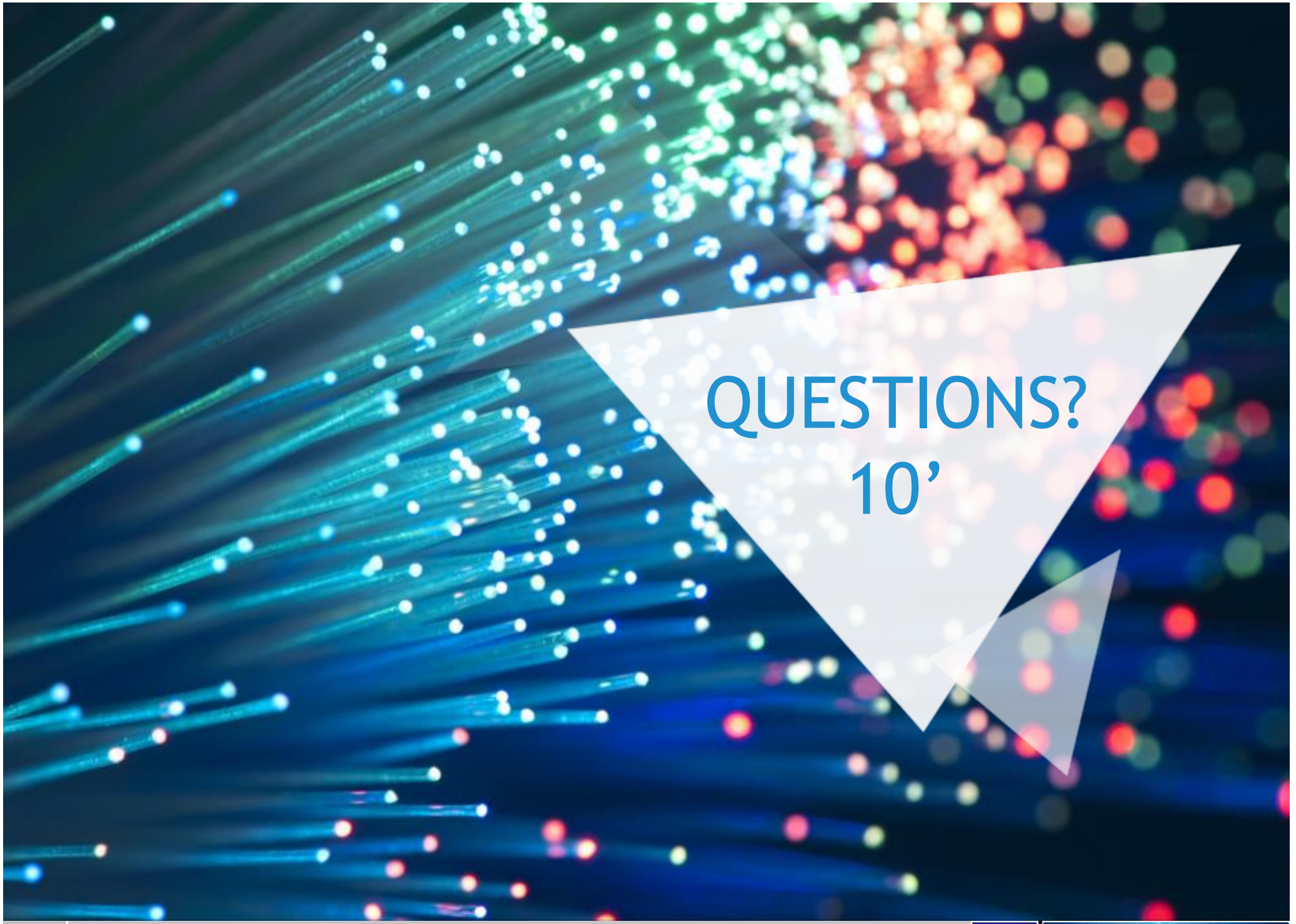
- Filling rates over time for stack blocks and areas
- Dwell time of containers per area
- Productivity of gantry cranes and reach stackers
  - Productive, unproductive moves
  - Average productivity per hour
  - Percentage split of time when productive, digging and idle
- Throughput per area
  - In boxes/TEU
  - Averages per day
- Internal transporters percentage split of time when transporting, going to pickup, idle and waiting
  - Average numbers and per vehicle
- External truck arrival log
  - Turnaround times, gate queues, delays

Other KPIs are in progress

IMMEDIATE OBJECTIVES (NEXT 6 MONTHS)

Deliverable	M	Risks / Important to notice

D5.3 Developing a simulation component library	17	**1. Connection SIM -> BIM (D5.4)**
		2. Melzo terminal
		• Further testing and refinement model
		• Check model by Melzo staff
		3. La Spezia terminal
		• Finalize layout of La Spezia
		• Get more data from La Spezia
		• New components
		  • WS operations (vessels and STS)
		  • Improving TOS
		4. Connection to traffic simulation
		Terminal simulation to provide inputs (logs) on:
		• Truck gate arrival/departure time
		• Truck cargo size (TEU)
		• Used gate
		5. KPIs
		• Link to KPI WP
		• Dashboard of KPI
		
		Work will continue after month 18
		• Improving existing simulation components



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PART 3
PROGRESS UPDATE WP 7

Network Simulations

OBJECTIVES AND DELIVERABLES

Create a simulation based Decision Support Environment to

- Asses the interconnectivity between terminals
- Align the design of terminals and network

The DSE should help us to *identify potentials for optimizing network capacity and network resilience (minimize tardiness). The DSE should support in locating potential bottlenecks and test new logistic (bundling) concepts.*

Major activities

- Build simulation based Decision Support Environment
- Pilot test case

DELIVERABLES AND MILESTONES LIST

Deliverable	Month	Risks / Important to notice
D7.1 Rail interconnection simulator	24	The interaction between terminal simulation and network simulation Risk • Which level of detail of abstraction?
D7.2 Assessment in pilot cases	30	Selection of pilot study • Corridor Le Spezia/Melzo – Rotterdam Risk • Availability of data and other traffic
D7.3 Assessment of the interconnection resilience	32	Definition of resilience and recovery Risk • Collection of operational data required

PILOT CASE (SETUP)

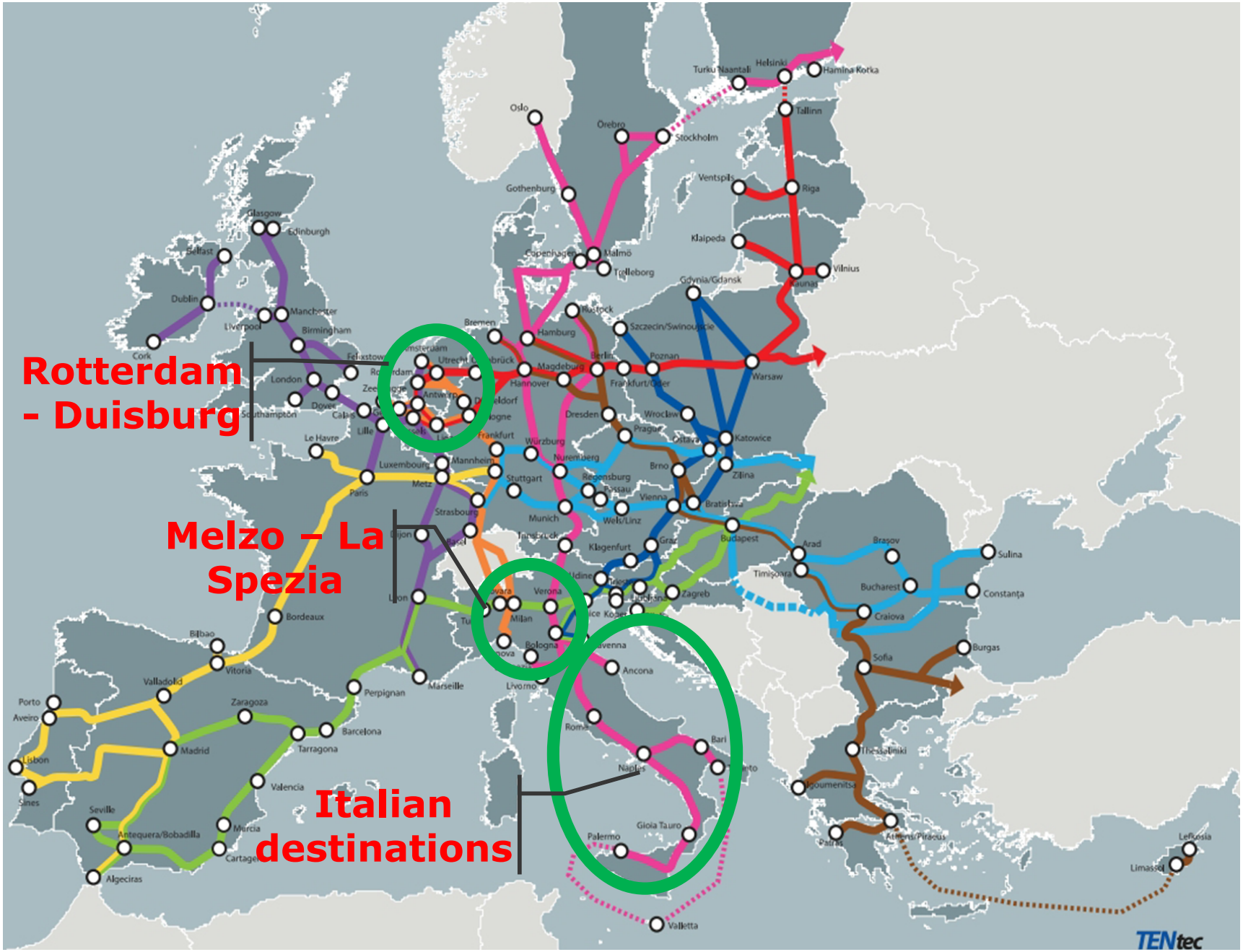
Goal

- Identify and evaluate logistic concepts to improve the network capacity and train utilization in the corridor between
  - Rotterdam (intermodal terminals and shunting yard)
  - Duisburg (intermodal terminal)
  - Melzo/La Spezia (intermodal terminal)

Test identified logistic concepts in the DSE

1. *Port shuttle trains*
   - Schedule new separate train services in port areas to bundle and combine cargo from low volume destination from several terminals to one collecting terminal
2. *Virtual port shuttle trains*
   - Use underutilised or left-over capacity of existing train service
3. *Transhipment hubs (common rail terminal)*
   - A new kind of rail terminal that is open for all customers that don't have a rail connection/terminal
4. *Virtual transhipment hubs (common rail terminal)*
   - Part of the capacity existing terminals is dedicated to be used by other customers
5. *Cargo bundling (mixed/coloured trains)*
   - Combine cargo destinations for several destinations onto one train and transhipment at other locations

NETWORK: RHINE-ALPINE CORRIDOR



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HORIZON 2020

NETWORK: TRAIN DESTINATION DATA FOR MELZO (2016)

	Arriving			Departing		
Destination	Trains	Boxes	TEU	Trains	Boxes	TEU
Bari Scalo Ferruccio (IT)	211	6261	10279.45	211	6690	10754.85
Dinazzano (IT)	-	-	-	34	1220	1246.00
Duisburg (DE)	135	3877	7746.90	133	3287	6373.60
Frenkendorf (CH)	91	2437	4179.25	91	2789	4676.25
Frosinone (IT)	76	1353	2242.05	76	1358	2243.50
Genova Voltri (IT)	303	7773	12496.00	292	9631	15062.00
La Spezia (IT)	731	24480	40036.75	330	10398	16733.50
Nola (IT)	73	660	1381.10	73	625	1246.25
Ospitaletto-Travagliato (IT)	-	-	-	14	444	679.00
Padova (IT)	269	8151	17346.50	269	6684	14601.25
Padova Interporto T.I. (IT)	14	83	139.25	232	3397	6295.55
Ravenna (IT)	92	2660	4064.00	93	2741	4087.00
Rotterdam RSC (NL)	39	164	212.40	-	-	-
Rotterdam GTS (NL)	140	4155	8675.05	142	4383	9191.85
Rotterdam Samskip (NL)	266	9608	20859.60	264	9936	21555.90
Rotterdam Waalhaven (NL)	246	7538	14307.55	243	8473	15578.80
Trieste (IT)	82	2526	3602.65	82	2023	3417.75
Venlo (NL)	224	7235	15666.25	223	7252	15662.00
Zeebrugge (BE)	6	231	346.50	8	302	483.00

PILOT CASE (SETUP)

Inputs

- Terminal
  - Number of tracks
  - Number of rail cranes
  - Productivity of trains
  - Opening times
- Network
  - Number of tracks
  - Travel distances
- Volumes
  - Arrival patterns
  - Due dates
  - Destinations
- Trains
  - Length
  - Speed
- Special constructs
  - Shunting yards
  - Border impact (handovers)
  - Other traffic impact

Outputs

- Timetable
  - Routes and trips
- Cargo throughput
  - Terminals
  - Route
- Delays per
  - Containers
  - Routes
  - Infrastructure
- Number of trips
- Utilisation of
  - Infrastructure
  - terminal equipment
- Peak factors
- Logistical concepts KPIs

- Already trying out on smaller cases

- Initial impressions:
  - A complex planning problem…
    - Complex planning/scheduling algorithms
    - Longer computation times (and we have fast computers….)
    - Difficult for optimization (we use genetic algorithms)
  - The more scattered the network, the bigger delays

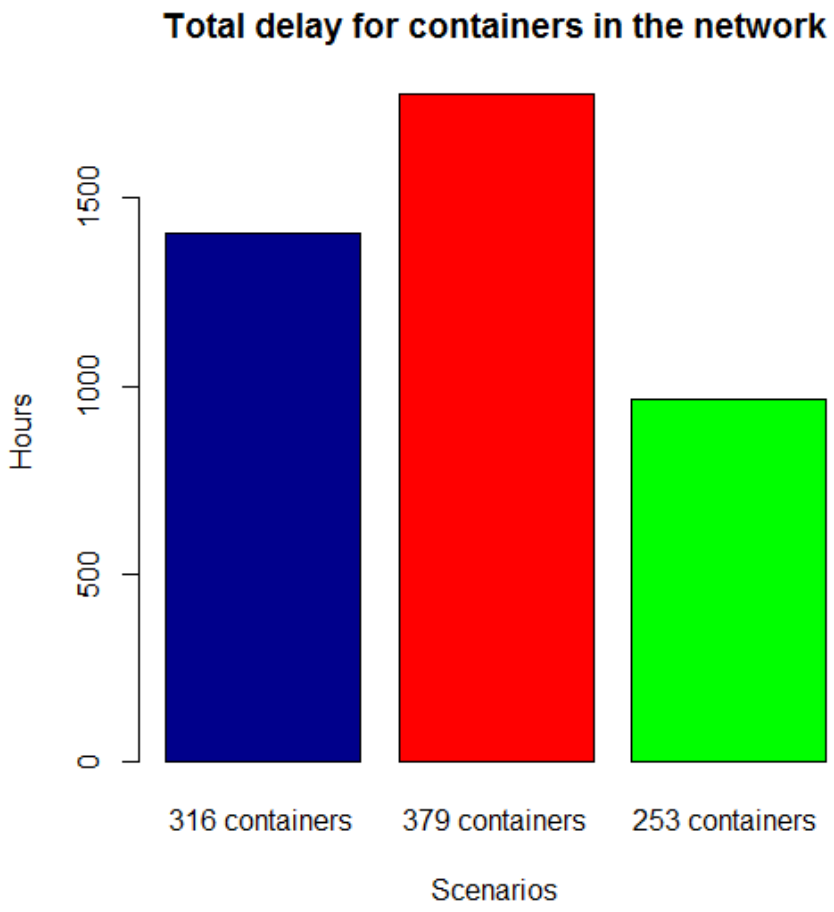
Network

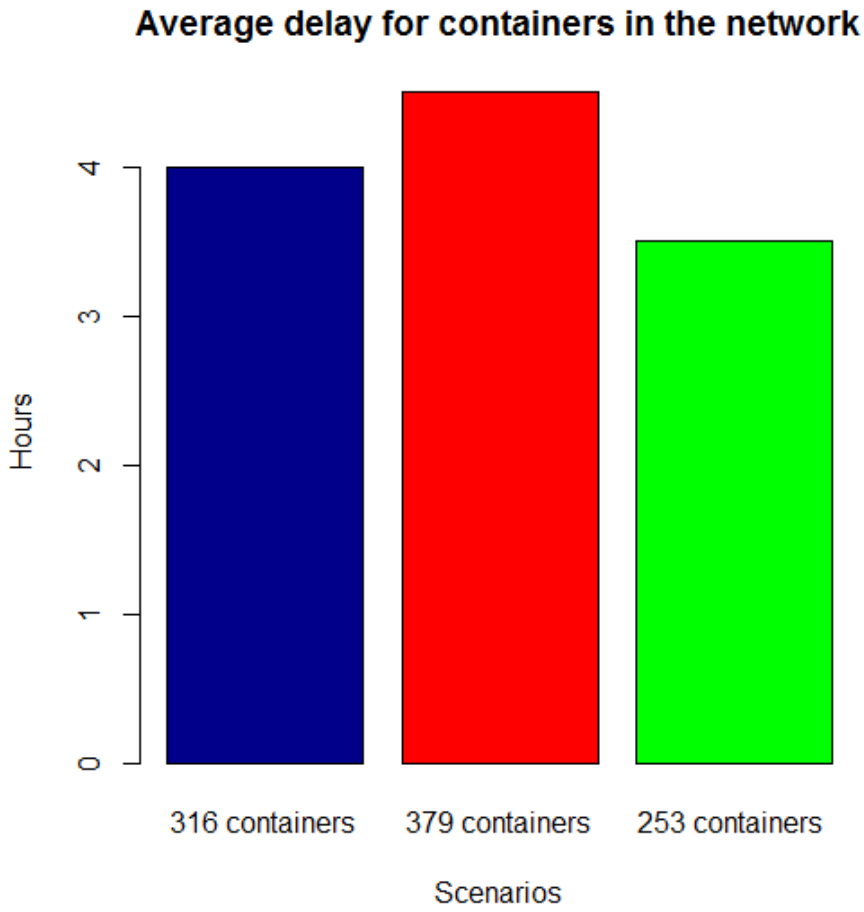
- 6 terminals, in each
  - 2 cranes
  - 10 boxes/hour crane productivity
  - Single rail siding
- Single rail terminal connections
- 24 hour run

3 Scenarios

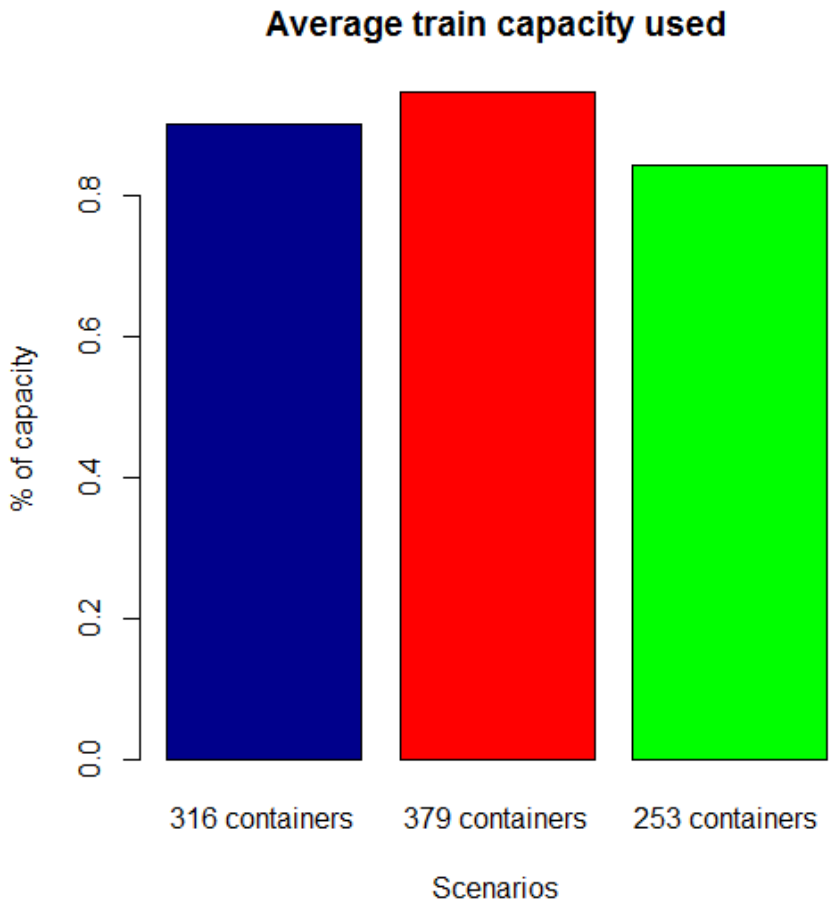
- Default (316)
- Increased demand by 20% (379)
- Decreased demand by 20% (253)

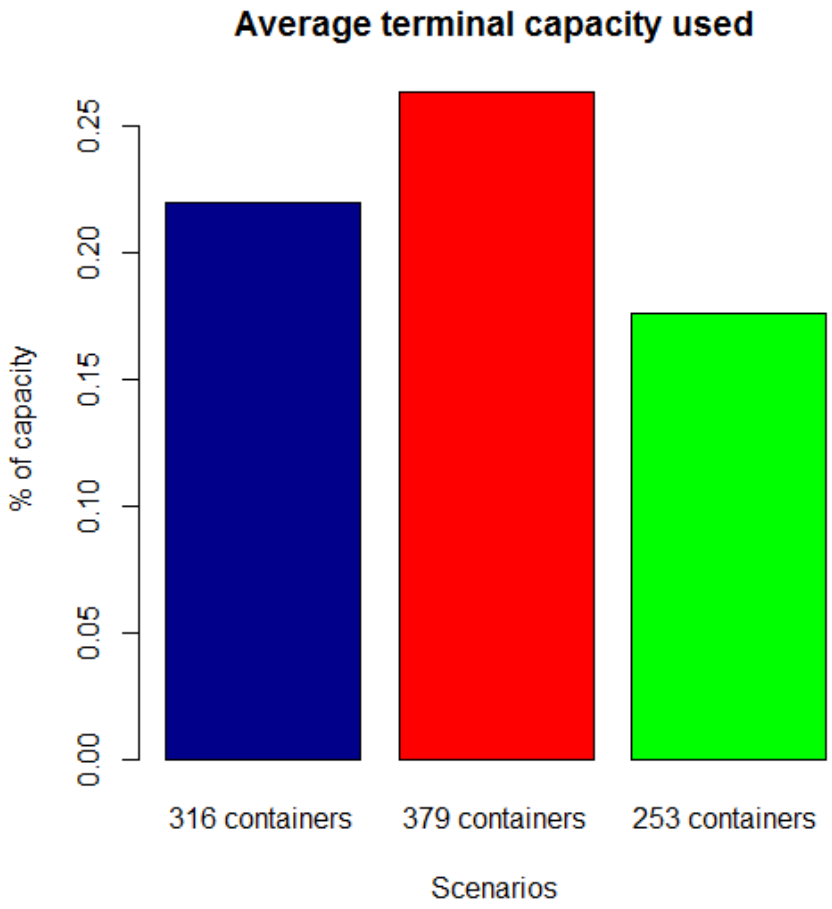
Delays in the network





Resource utilisation

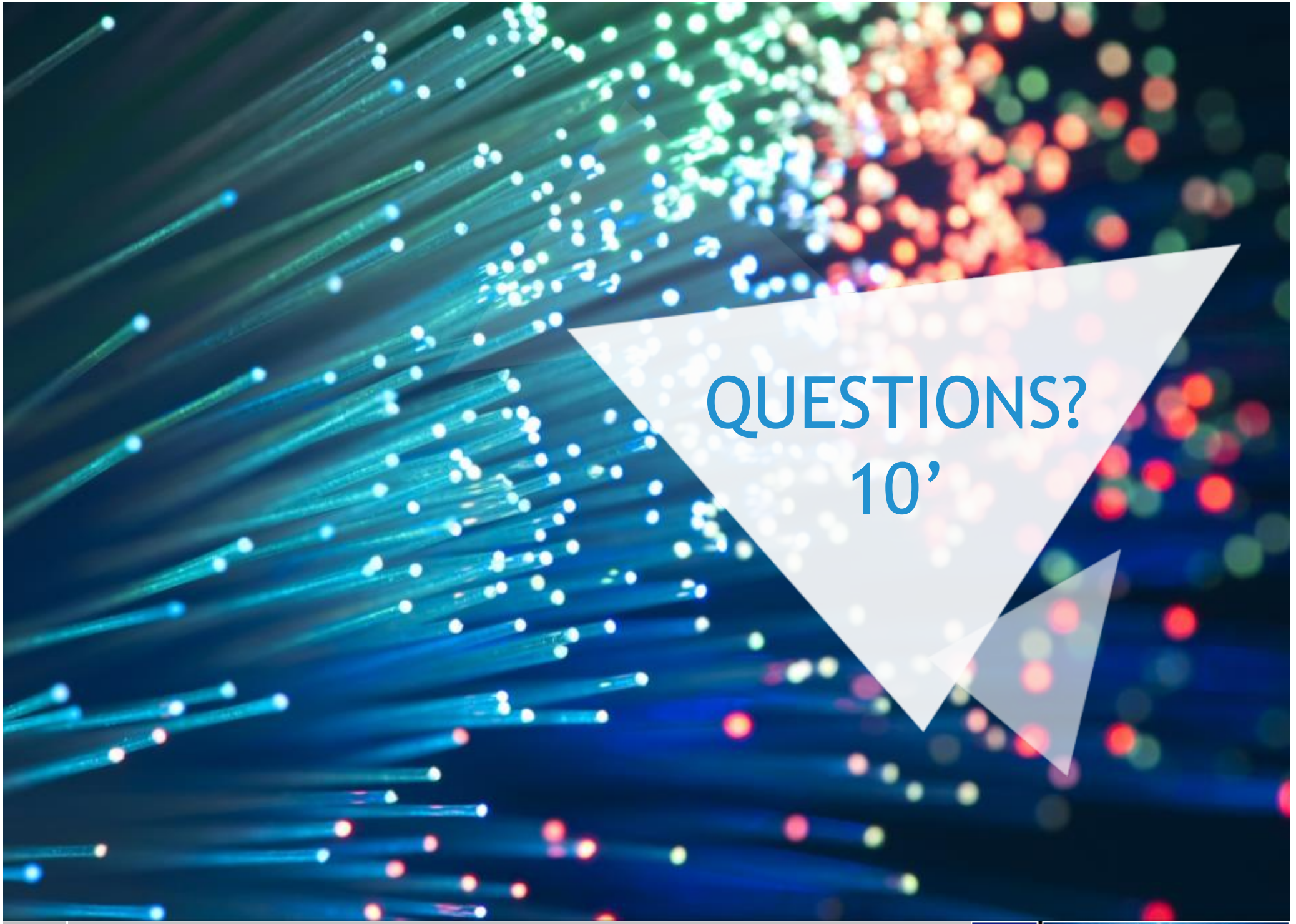




UNCERTAINTIES

- Data on terminals, volumes and network scattered and not always available/reliable
- Difficult to assess network usage by other (not investigated) trains
- Difficult to constrain the network due to terminal interlinking
  - High network complexity requires a lot of data and might hinder computational time

- Level of abstraction
  - Link WP5/7…..mixing detailed terminal simulation and network simulations
  - Or separate tool?
- Data/layout on network
  - Where do we get this information?
  - Integration with other train services?


QUESTIONS?
10’

THANKS!

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