OPTIYARD PROJECT SPECIFICATIONS

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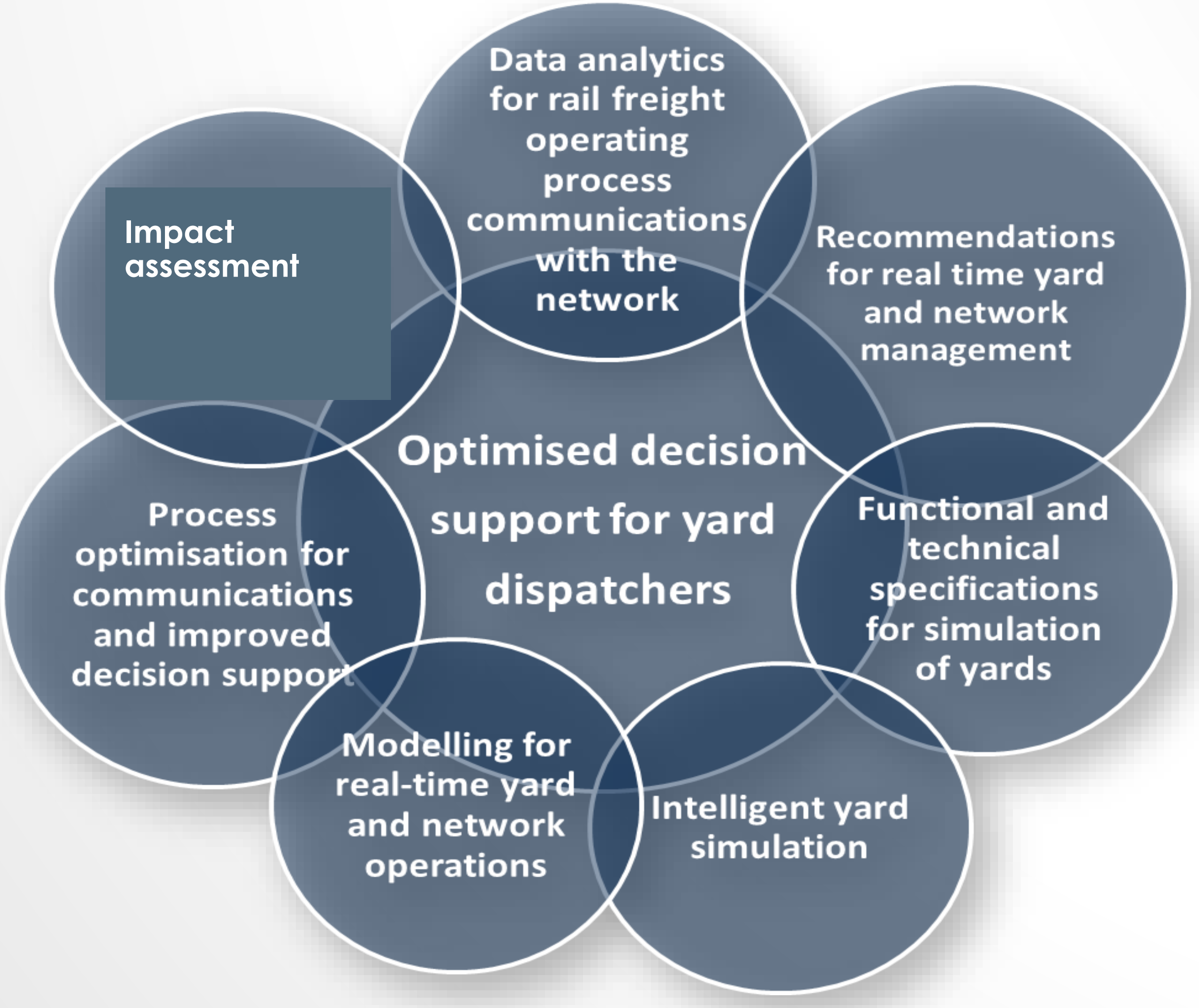
SOME KEY OVERALL AIMS OF OPTIYARD

- **OptiYard** aims to provide decision support tools to Yard Managers that better consider the surrounding network, with a view to ensuring smooth and efficient yard operations that are essential for the global efficiency of the transport chain
- This is done via a three-pronged approach to develop an optimised decision support system for yard dispatchers which aims to:
  - Provide enhanced, more automated yard management by analysing existing processes and operations and developing appropriate optimisation algorithms to improve operations for both single wagon load and block train traffic;
  - Improve information and communications processes between the Yard Management System, the RUs and the Network (IM) by analysing data feeds and modelling an enhanced communications environment;
  - Enhance real-time interaction with the surrounding network, giving the yard dispatcher better visibility of any perturbations and disruptions to the yard operation schedule.

OPTIYARD INNOVATION ACTIVITIES



KEY CHALLENGES

- Successful real-time yard management lies in understanding, designing, implementing and managing the real-time information exchange between the yard and the relevant eco-system, and managing the interactions between yard management and network management
- The essential nature of this has been set out in WP3 of the project, where we have specified the simulation of yard operations and the co-ordination of this simulation with the relevant network eco-system
- This was tackled in stages through four Tasks;

TASKS TO MEET THE OBJECTIVES

Requirements for the general applicability of the simulation environment

- Specification of the OptiYard eco-system, to provide understanding of how to design a suitable simulation environment to assess the OptiYard developments

The Functional Specification

- Specification of the functions required to present the key elements of the eco-system, their roles and actions in the eco-system, the processes involved in real-time yard operations and the interactions between yard operations and real-time network management

The Technical Specification

- Setting out out the technical specifications to ensure flexibility and computational efficiency

Specification for data management interface

- Providing the specifications for real-time data management and information exchange within the OptiYard eco-system, and between the OptiYard eco-system and the wider railway network.

THE FUNCTIONAL SPECIFICATION

- A description of all the business processes involved in yard operation and network management, and specification of the functions that simulation must perform
- A full listing and understanding of the sequence of events relevant to yard operations
- Development of a high-level design incorporating all functions and modules within an overall view of they interact and fit together

FUNCTIONAL SPECIFICATION: INFRASTRUCTURE

- **Yard facilities**
  - Type of the yard: hump yard, flat yard, gravity yard
  - Infrastructure layout (receiving yard, classification yard, departure yard, hump, maintenance track, repair track, sorting bowl, etc.)
  - Track characteristics (running direction, speed limit, gradient, curvature, signal, electrification, etc.)
  - Assets (shunting and line locomotives)
  - Personnel
- **Intermodal terminal facilities**
  - Infrastructure layout, track characteristics, equipment (type, capacity, etc.), cost for loading/unloading
- **Surrounding network**
  - Infrastructure layout, signalling system, track characteristics

FUNCTIONAL SPECIFICATION: VEHICLES

- **Wagons**
  - ID, owner, length, weight, number of axles, maximum speed, braking characteristics, net weight of cargo
  - Trip plan
  - Preferred arrival time at the destination terminal and the penalty for late arrival
- **Common data for freight and passenger trains**
  - ID, Type and priority
  - Maximum speed, characteristics of traction, braking and running resistance
  - Train control system on board: fixed-block, ETCS (and level), etc.
  - Train route and schedule
- **Extra data for freight trains**
  - Composition: block train or single wagon load (for SWL trains, Wagon ID and ordering)
  - Wagon content
  - Status: incoming, waiting to be decoupled, waiting to be coupled, ready-to-depart
  - ETA time at the yard or ETD time from the yard

REPRESENTATIVE TYPES OF YARDS

- **SORTING/MARSHALLING YARDS** (e.g. hump yards)
  - Typically catering for wagon-load rail freight
  - Rail mode only
  - Complex rail operations
  - Efficient operation and reliability is important

Our example:
Ceska Trebova

- **YARDS SERVING INDUSTRIAL AREAS** (e.g. port areas)
  - Smaller, with less complex operations
  - Block trainloads as well as wagon-load
  - Often relatively high capacity utilisation

Our example:
Trieste

- **CUSTOMER TERMINALS/INTERMODAL TERMINALS**
  - Often relatively small, capacity may be an issue
  - Block trainloads as well as wagon-load
  - Other modes operating on site
- **OTHER TYPES OF RAIL SITE OPERATIONS POTENTIALLY RELEVANT;**

  e.g. locomotive depots, rolling-stock maintenance sites?

FUNCTIONAL SPECIFICATION: NETWORK SIMULATION AND OPTIMISATION

- The **network simulation** model should
  - Simulate the movement of passenger and freight trains in the network, according to the schedule
  - Plan the speed profile for each train according to the schedule
  - Estimate the Time of Arrival at yards
  - Provide the train location, speed and ETA to yards on request
  - Simulate the random delays occurring when trains are running on the line and/or dwelling at stations
- The **network management and optimisation** model should
  - Decide the train priority when two or more trains request to access the same resource at the same time
  - Conduct ad-hoc rescheduling and rerouting
  - Determine the path for a waiting-to-depart freight train and the associated schedule

THE TECHNICAL SPECIFICATION

THE YARD SIMULATION MODEL

- The Villon rail simulation tool has been adopted as the basis for the yard simulation model
- This is a well-established and tested tool which provides the functionality we need, operates at an appropriate level of detail, and has manageable data requirements
- The tool, its application to the project, its technical specifications and data needs and hardware requirements are set out in the relevant OPTIYARD deliverables
- Was demonstrated at the mid-term conference last year

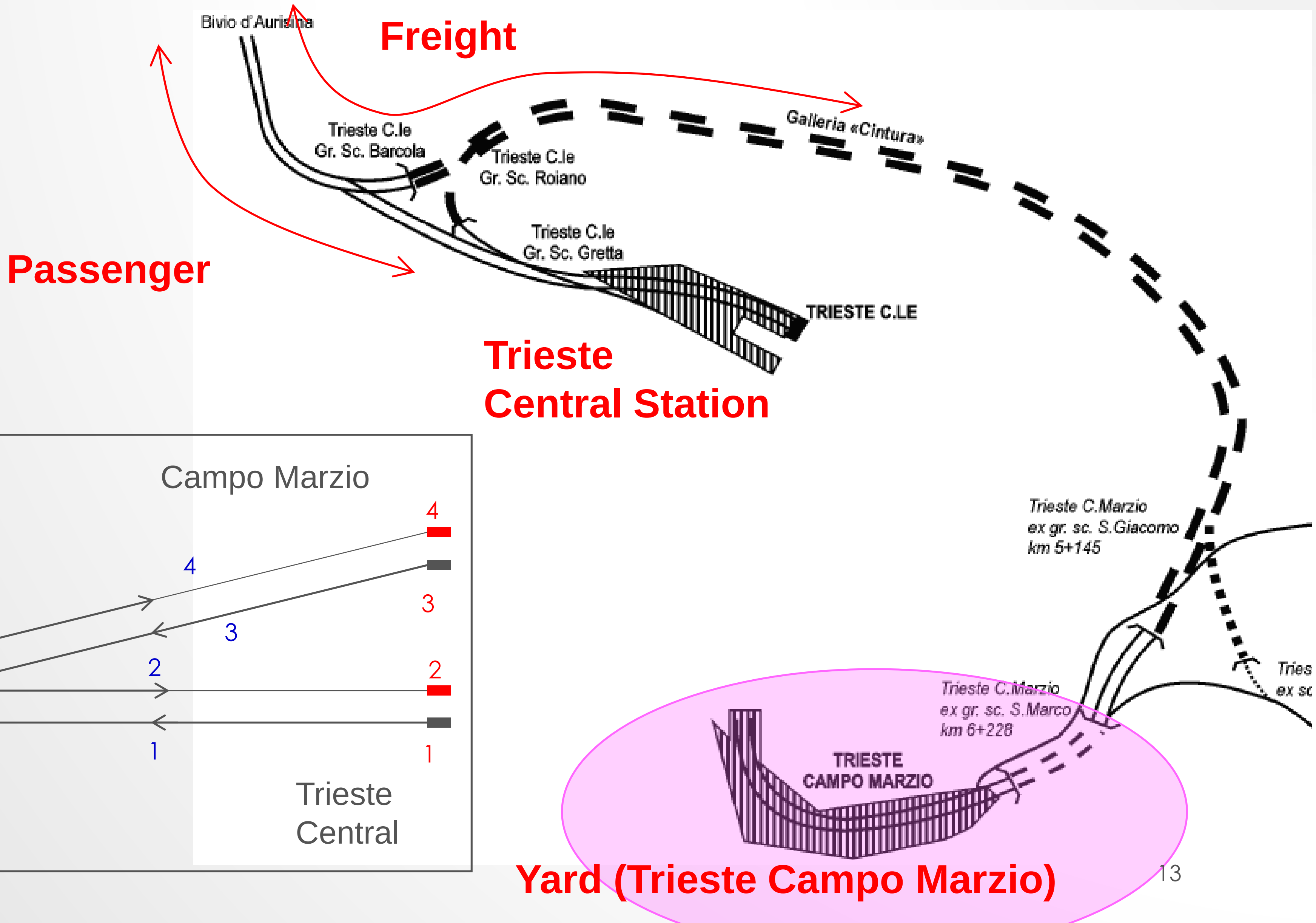
THE TECHNICAL SPECIFICATION

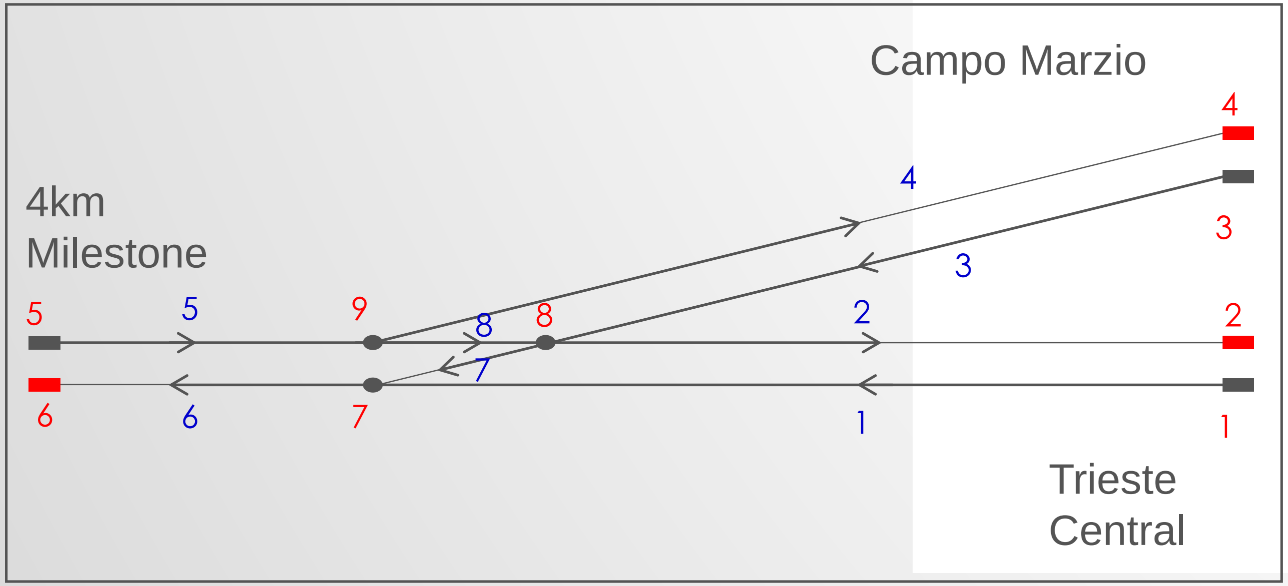
THE NETWORK MODEL

- A development of **TrackULA** (Track Unified simuLation Algorithms)
- A ***Network*** simulation tool:
- ***Microscopic***: the rail infrastructure is modelled, and individual train & train driver behaviour can be modelled
- ***Dynamic*** and ***stochastic***:
  - Simulating explicitly the trains’ space-time movements
  - Modelling variations in train/driver behaviour
  - Modelling variations in line/network conditions
- ***Flexibility***: new rules can be readily incorporated and tested
- Embedding the function of ***speed profile optimisation***

EXAMPLE ILLUSTRATION: NETWORK SIMULATION

- Trieste, Italy





DATA MANAGEMENT REQUIREMENTS

- The need to manage and process data in a way that provides rapid response to yard and traffic control personnel
- Speed, accuracy and flexibility to produce reports in formats suitable for user needs, e.g. Graphing
- Ability to produce output data to calculate relevant KPIs
- High IT security to ISO standards
- Access and administrative rights need to be agreed
- Documentation needs to be produced and maintained
- Suitable common data structures for efficient data exchange between different applications
- Compatibility with emerging rail industry data formats eg RailML

SIMULATION AND OPTIMISATION

- Later Work Packages have developed the required methodologies for application to our case studies;
  - Yard Simulation
  - Yard Optimisation
  - Interactions, communications and data-sharing between Yard Simulation and Yard Optimisation
  - Strategy for Network Integration and co-ordination between yard and network
  - Impact assessment/appraisal
- These will be presented later today

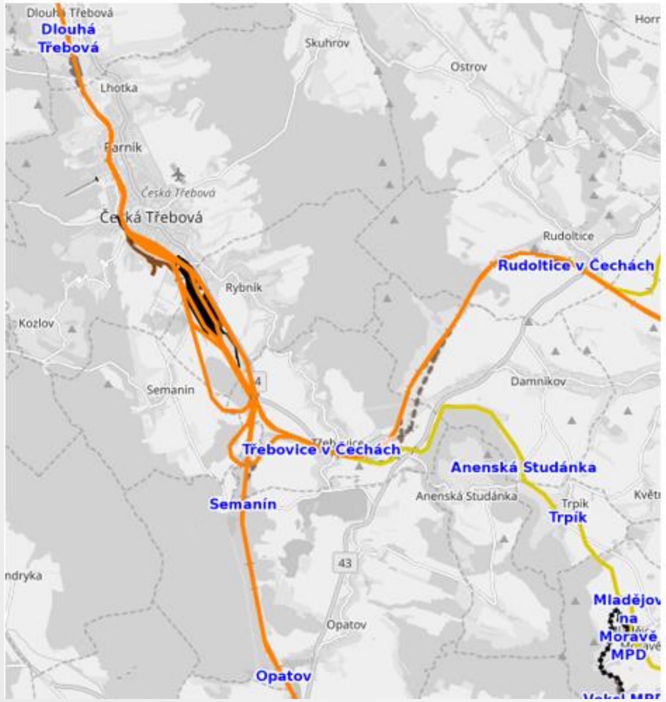
YARD AND NETWORK INTERACTION

- Valuable collaborations with the FR8HUB project have led to development of a consistent view relating to this aspect;
- Key improved interactions required;
  - More informed and timely estimate of ETAs to yards
  - More effective interactions between yards and network regarding determination of departure slots from yards onto the network
- These are especially important when there are perturbations to pre-determined schedules
- With current rail information systems, it is only realistic to consider localised networks, rather than wider areas or the entire network
- Essentially, the local network between the yard and the nearest ‘staging post’ (e.g. loop tracks, holding sidings) before or after the yard

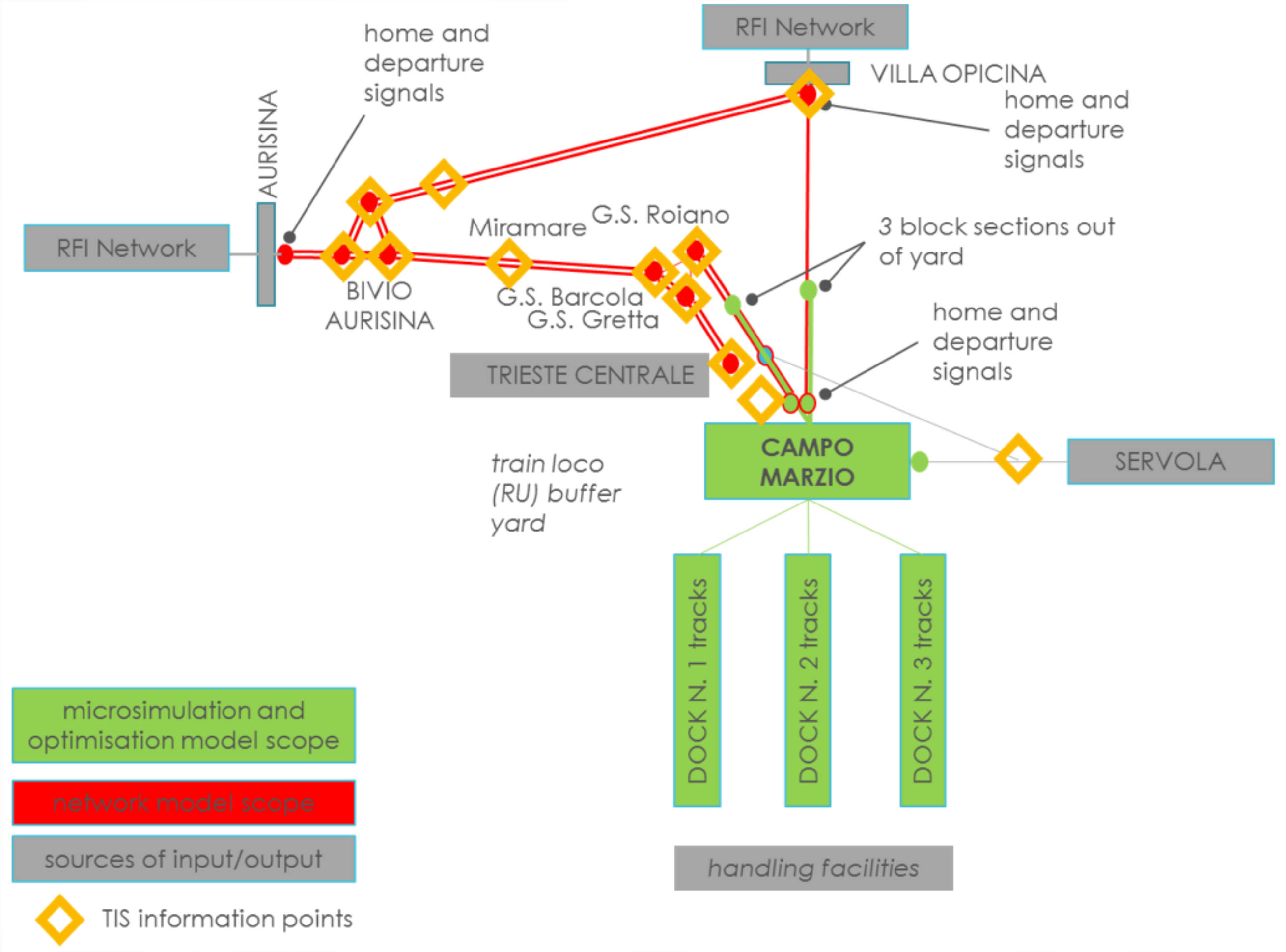
SUMMARY

- OptiYard has been working on the development of simulation and optimisation tools for better real-time operation and management of railway yards and networks
- The functional specification identifies:
  - All necessary information and characteristics of yards, terminals, surrounding networks, wagons and trains for simulation
  - activities and behaviours in yards, terminals and surrounding networks that need to be simulated
- The yard optimization approach is more original, specifically for the project
- The technical specifications of the simulation tools are largely based on existing systems but these have been adapted to the precise needs. They have been designed to be interfaced together and to facilitate compatibility with rail information systems as these continue to develop

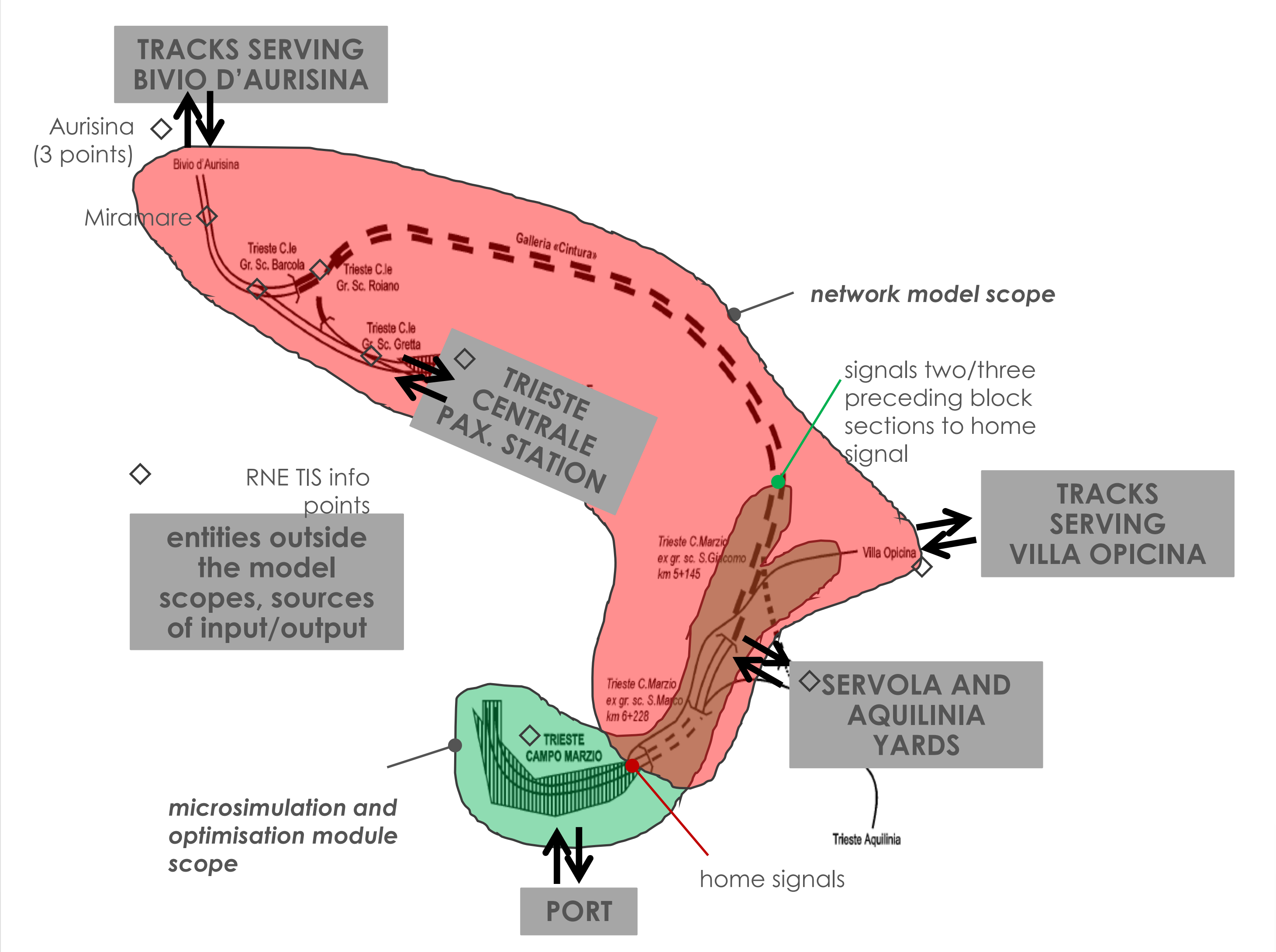
THE OPTIYARD CASE STUDIES



MODEL SCOPE, TRIESTE (1)



MODEL SCOPE, TRIESTE (2)



Thank you!

INTEGRATION WITH THE NETWORK

OptiYard final event, 25th September 2019

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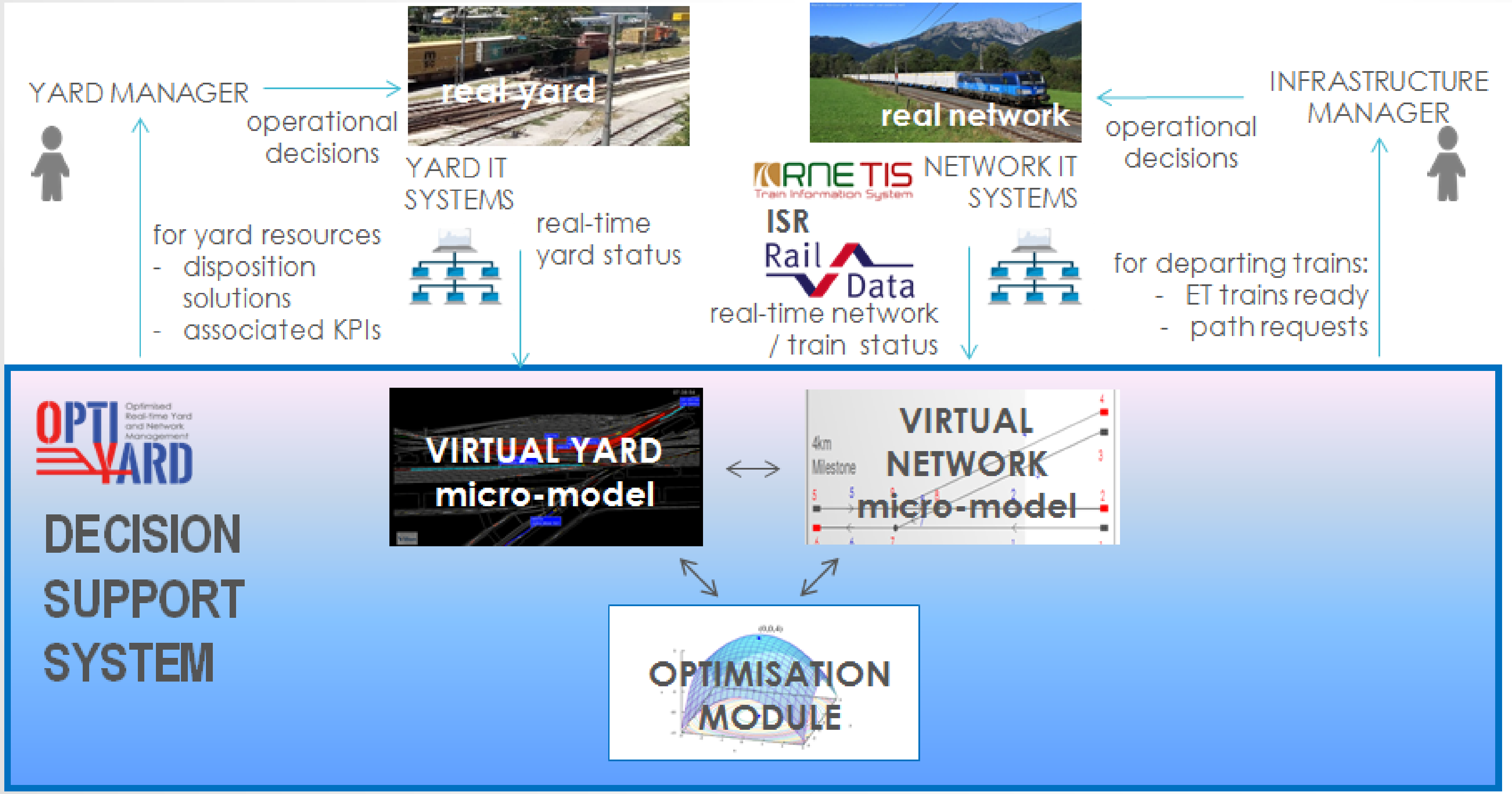
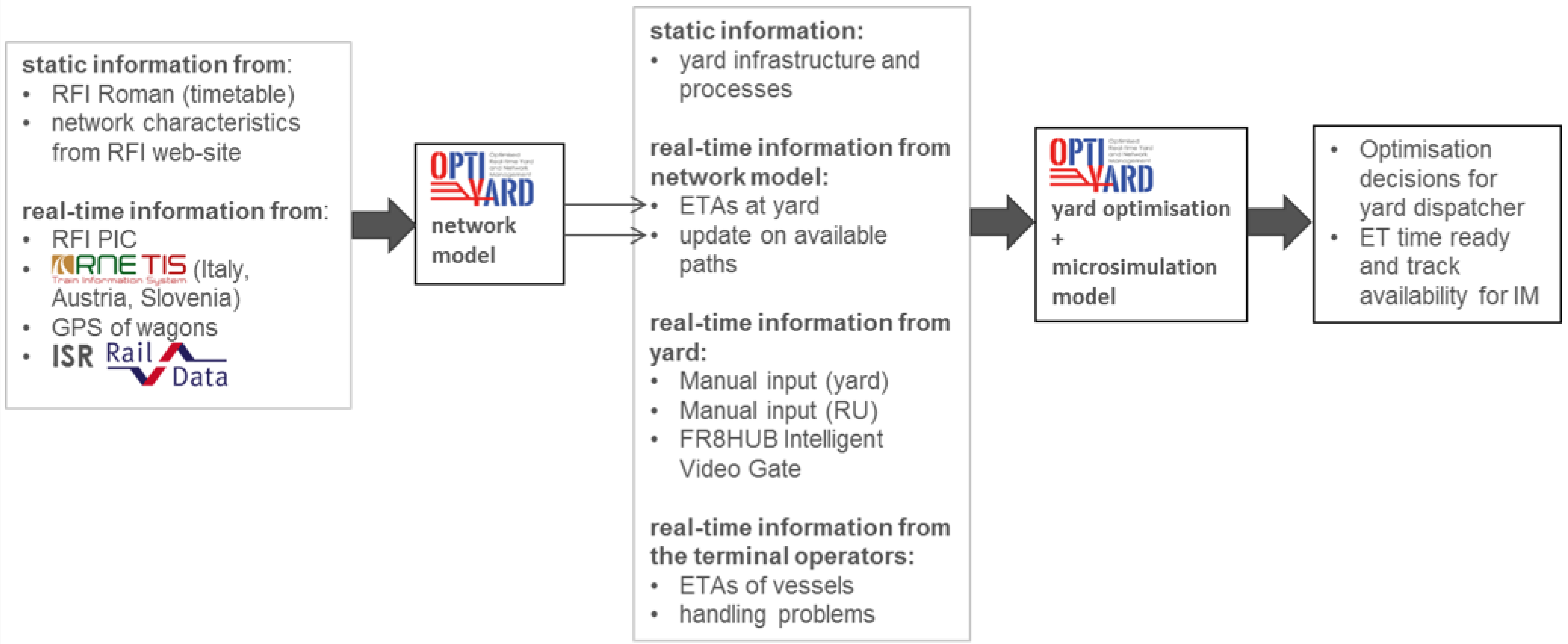
MODEL INTERACTIONS, OVERVIEW



OUTSIDE INPUTS FOR THE OPTIYARD ENVIRONMENT



INPUT-OUTPUT WITH IM AND RU SYSTEMS