Advanced Modeling for Operations

ASSIGNMENT - PART 1

POLITECNICO
MILANO 1863

DIPARTIMENTO DI
INGEGNERIA GESTIONALE

Assignment
Problem description

Design of a factory logistics system with autonomous tugger trains

Warehousing and transportation of raw materials, components, and finished products within the factory

Storage and picking of raw materials and components

Transportation of raw materials and components to the production lines

Production of finished goods

Transportation of finished goods to the warehouse

Storage, picking and shipment of finished goods

Assignment
Problem description

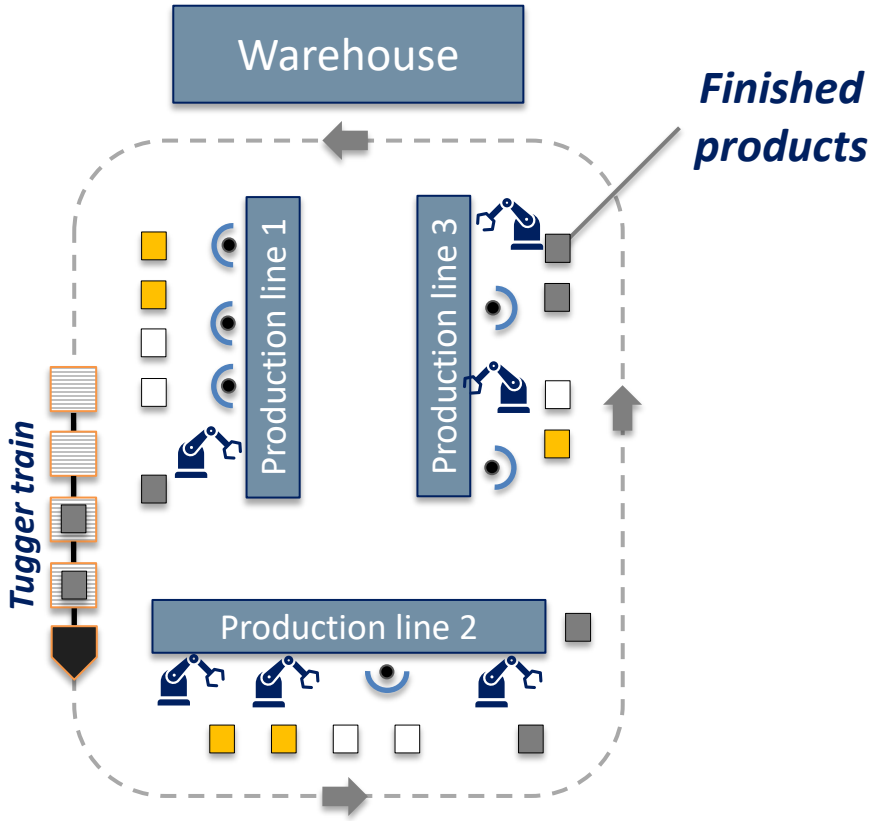
Design of a factory logistics system with autonomous tugger trains

Warehousing and transportation of raw materials, components, and finished products within the factory

Focus of the assignment

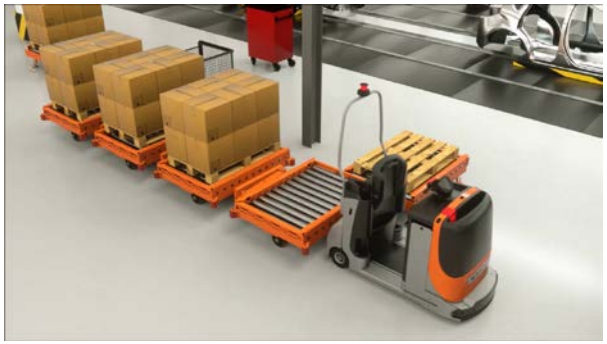
Assignment
Problem description

Design of a factory logistics system with autonomous tugger trains



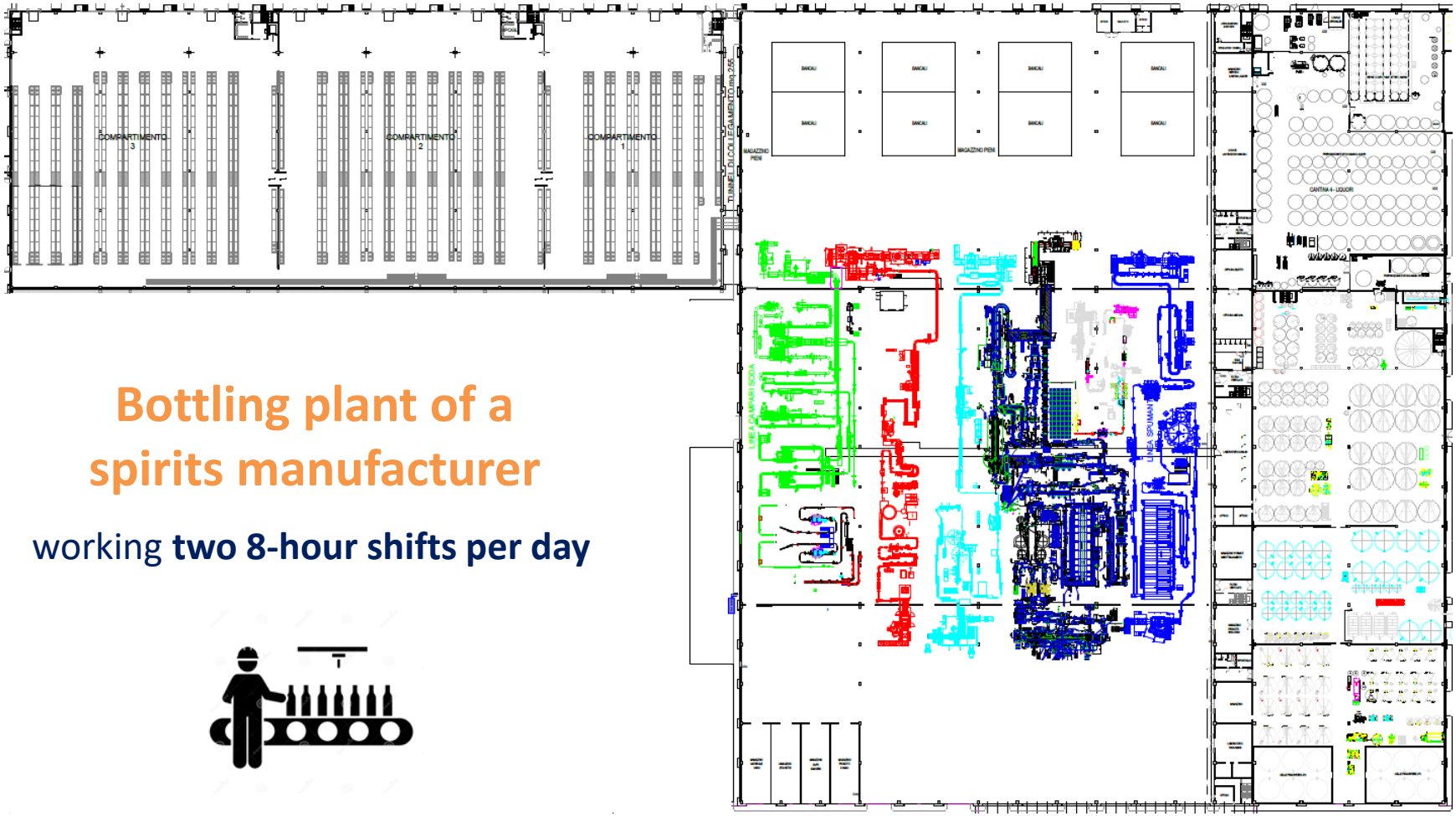
Tugger train

Design of a factory logistics system with autonomous tugger trains



- Each tugger train consists of **1 tugger vehicle and 4 wagons**
- The tugger vehicle is **automated** (**no driver** is needed)
- Tugger trains have a maximum **loading capacity**:
  - 4 unit loads
  - 2 tons (overall weight of the transported unit loads)
- Tugger vehicles are **electric vehicles**. Energy is stored in a **battery**, that needs to be periodically recharged at a **charging station**

Assignment
Problem description: factory layout



Bottling plant of a spirits manufacturer

working **two 8-hour shifts per day**

Assignment
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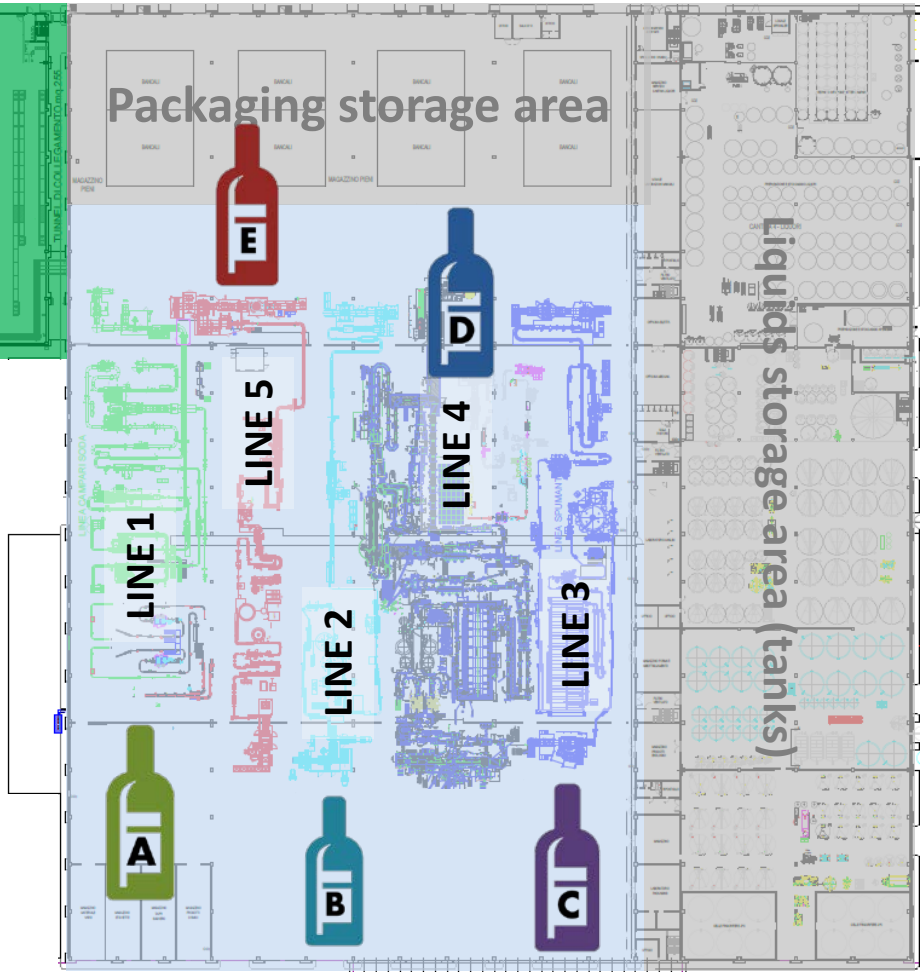

5 production lines (bottling lines)
making **different products**:

Line ID	Product ID
1	A
2	B
3	C
4	D
5	E

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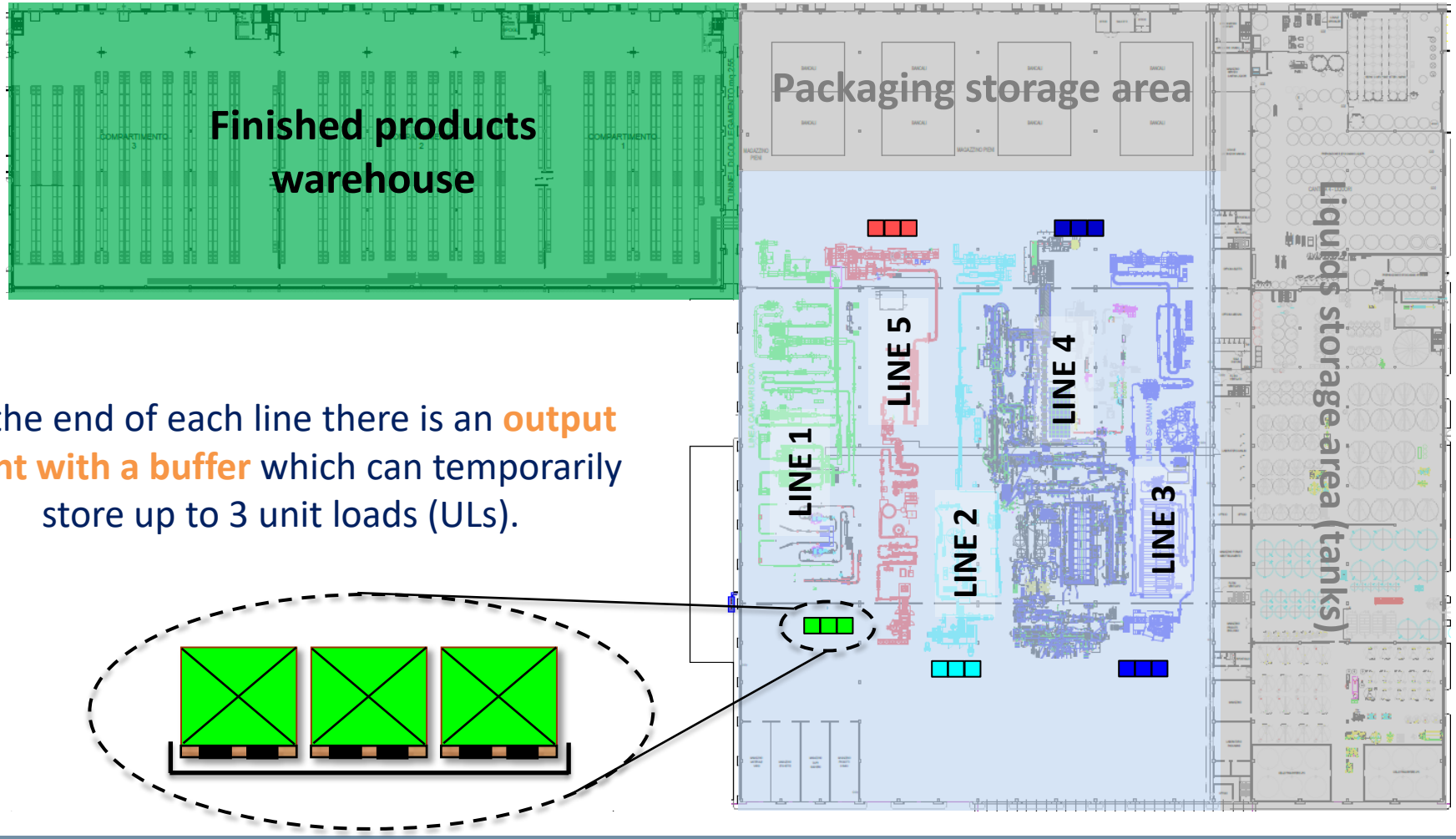

At the end of each line there is an **output point with a buffer** which can temporarily store up to 3 unit loads (ULs).

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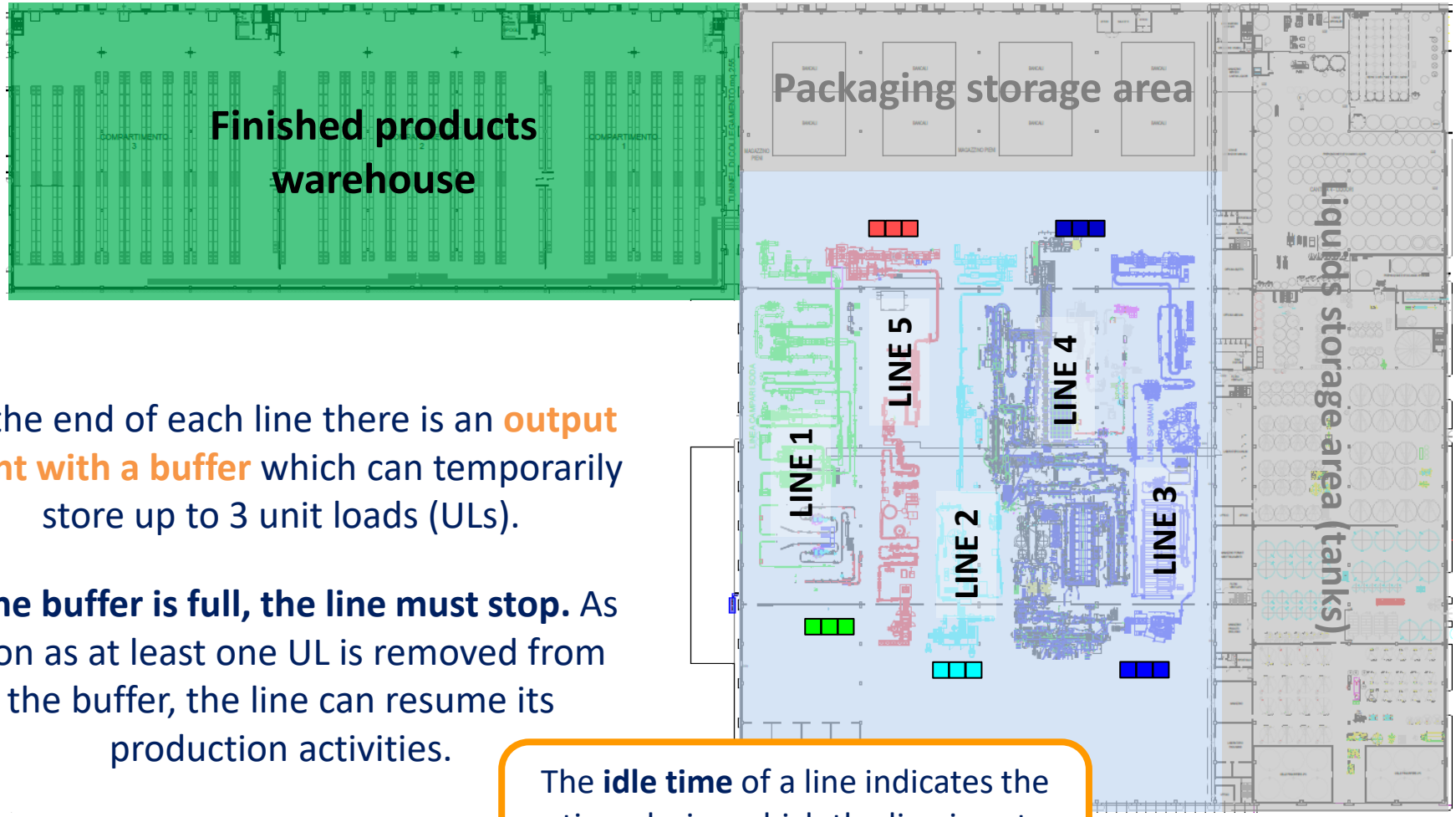

At the end of each line there is an **output point with a buffer** which can temporarily store up to 3 unit loads (ULs).

If the buffer is full, the line must stop. As soon as at least one UL is removed from the buffer, the line can resume its production activities.

The **idle time** of a line indicates the time during which the line is not producing (since the buffer is full)

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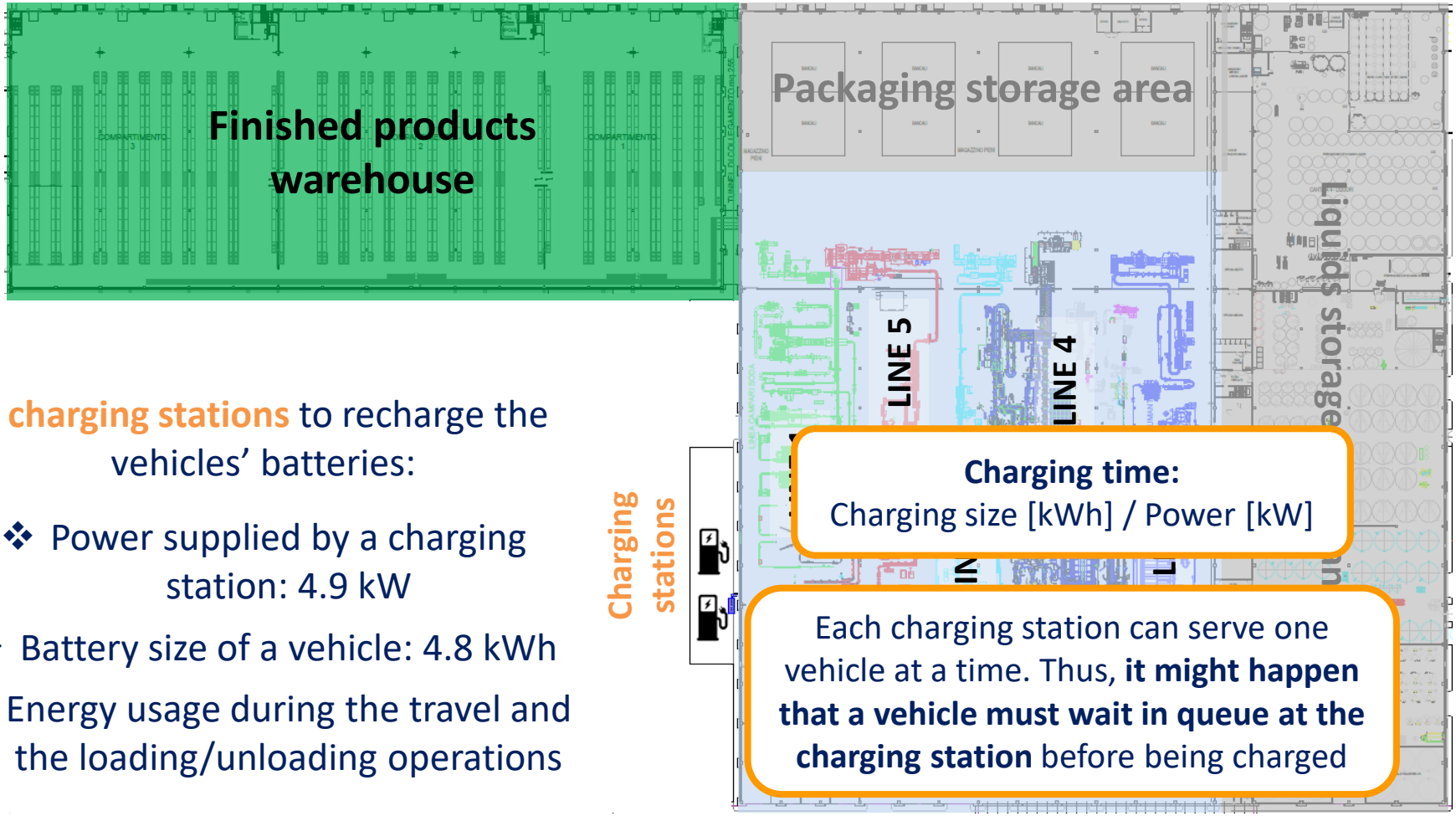
Problem description: factory layout



2 **charging stations** to recharge the vehicles' batteries:

- Power supplied by a charging station: 4.9 kW
- Battery size of a vehicle: 4.8 kWh
- Energy usage during the travel and the loading/unloading operations

Charging time:
Charging size [kWh] / Power [kW]

Each charging station can serve one vehicle at a time. Thus, **it might happen that a vehicle must wait in queue at the charging station** before being charged

Assignment
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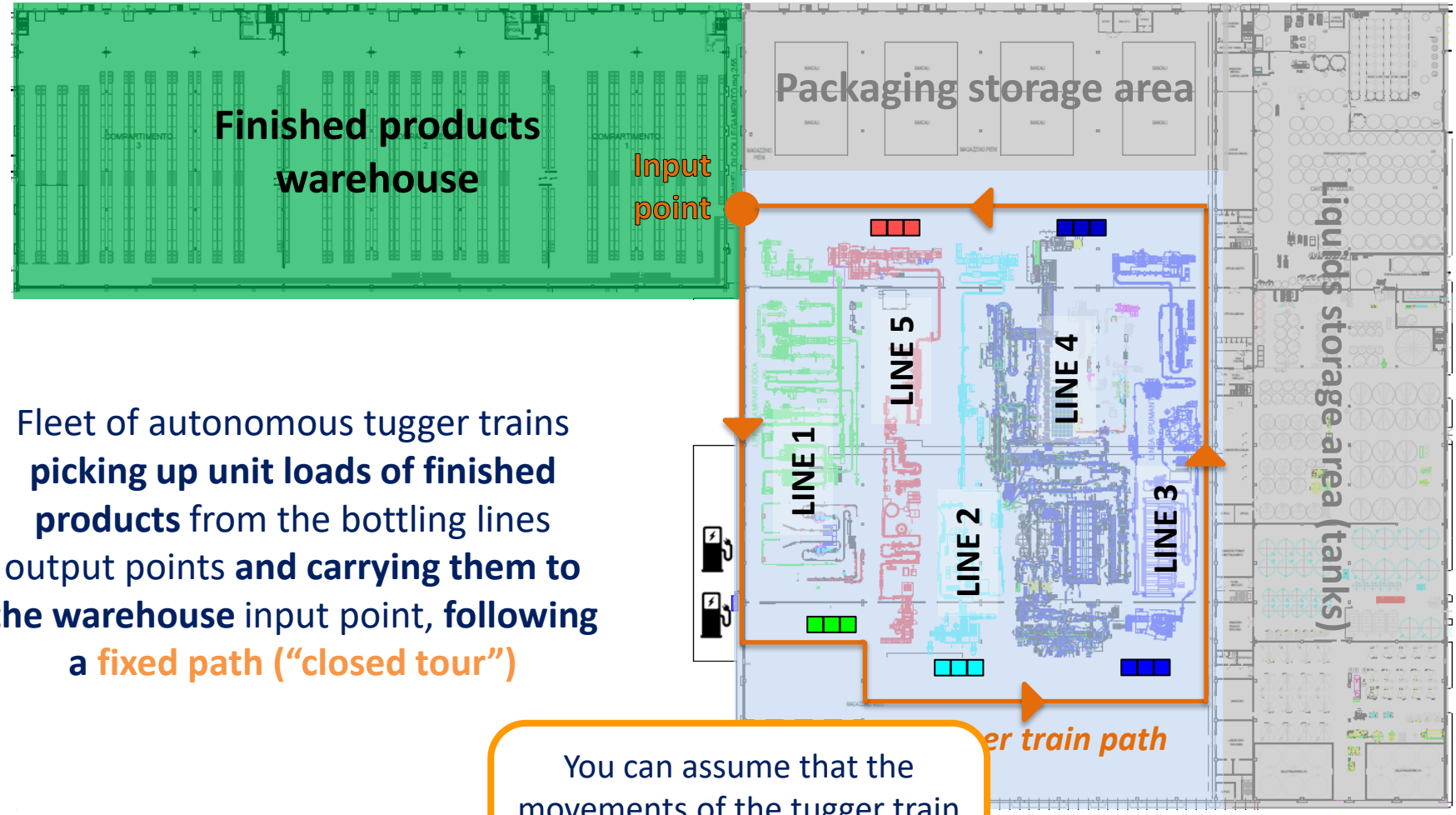


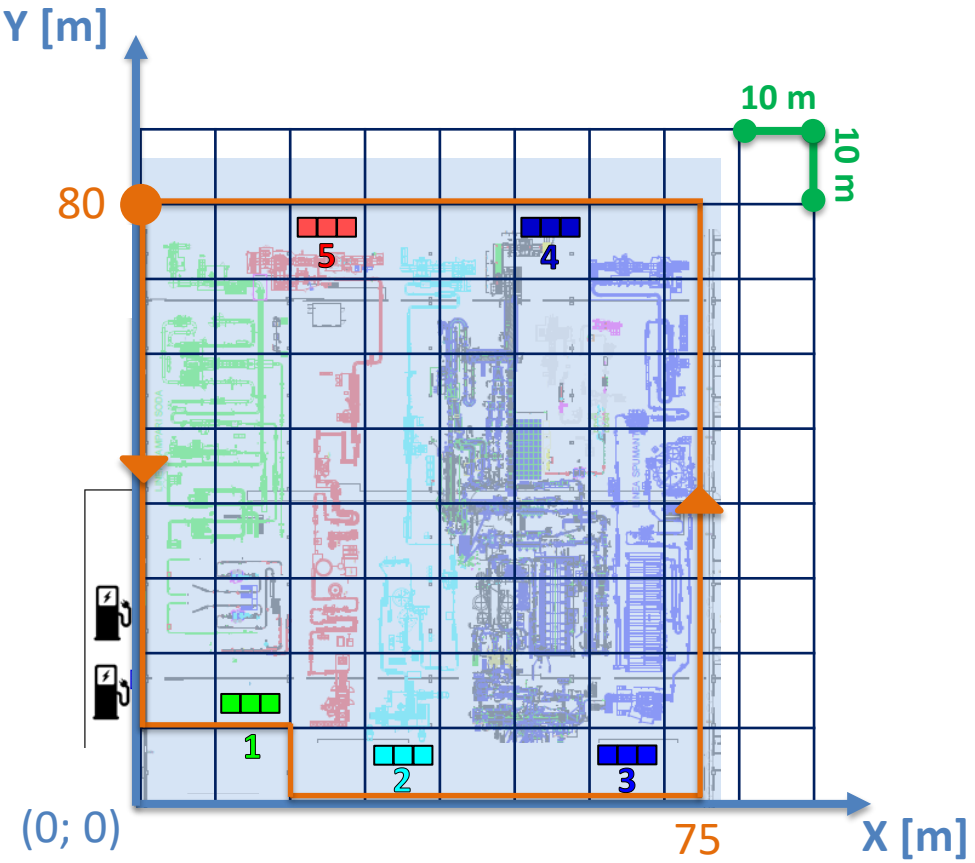
Fleet of autonomous tugger trains **picking up unit loads of finished products** from the bottling lines output points **and carrying them to the warehouse** input point, **following a fixed path ("closed tour")**

You can assume that the movements of the tugger train along the path are rectilinear
→ **Rectilinear distances**

Assignment
Problem description: factory layout

Each tugger train follows a **fixed path ("closed tour")**:

1. It starts at the **warehouse input point**
2. (It goes to a **charging station**, if needed)
3. It passes by all the **lines output points**, checking if there are ULs to be picked up. If so, and if the train still has some capacity left, it picks up one or more ULs
4. It goes back to the **warehouse input point**, where it unloads the ULs



The coordinates of the lines output points, together with the cycle times, are reported in the file "lines_info.csv"

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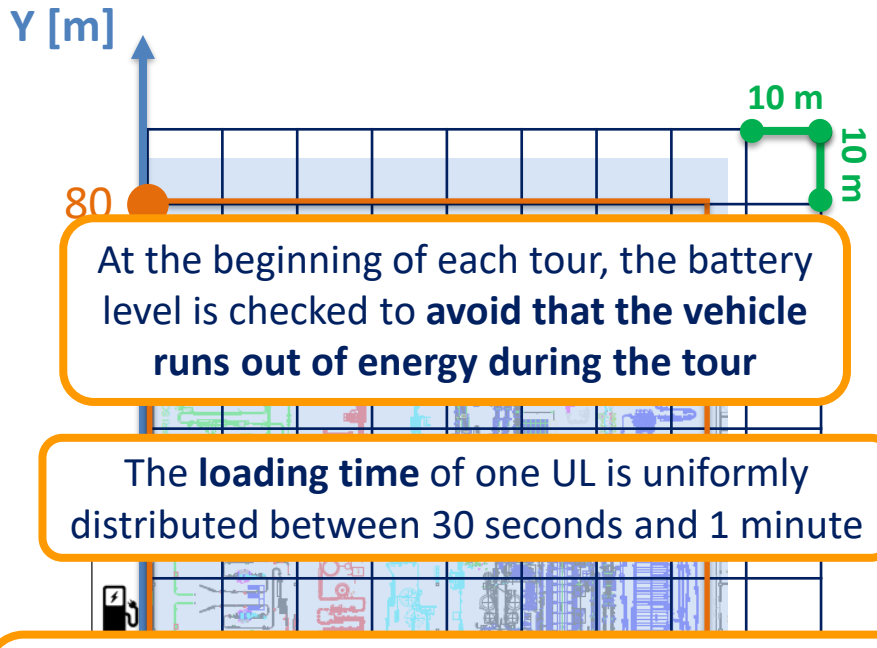

At the beginning of each tour, the battery level is checked to **avoid that the vehicle runs out of energy during the tour**

The **loading time** of one UL is uniformly distributed between 30 seconds and 1 minute

The **unloading time** of ULs at the warehouse input point has a fixed component (30 seconds to stop the vehicle in the right position) and a variable component (uniformly distributed between 30 s and 1 min per UL)

The coordinates of the lines output points, together with the cycle times, are reported in the file "lines_info.csv"