

Sorter Simulation Model in Visual Components



Problem Statement

Introduction

We want to evaluate the design of an efficient sorting system to handle mixed flow of products from multiple sources. The goal is to ensure each conveyor line leaving the sorter only contains one type of product.

System Overview :

Sources :

- 4 sources producing 4 different product types : Product A, B, C & D.
- Each source generates a random mixture of all 4 products.
- Each source produces all the product types with 25% probability.

System Overview :

Product distribution :

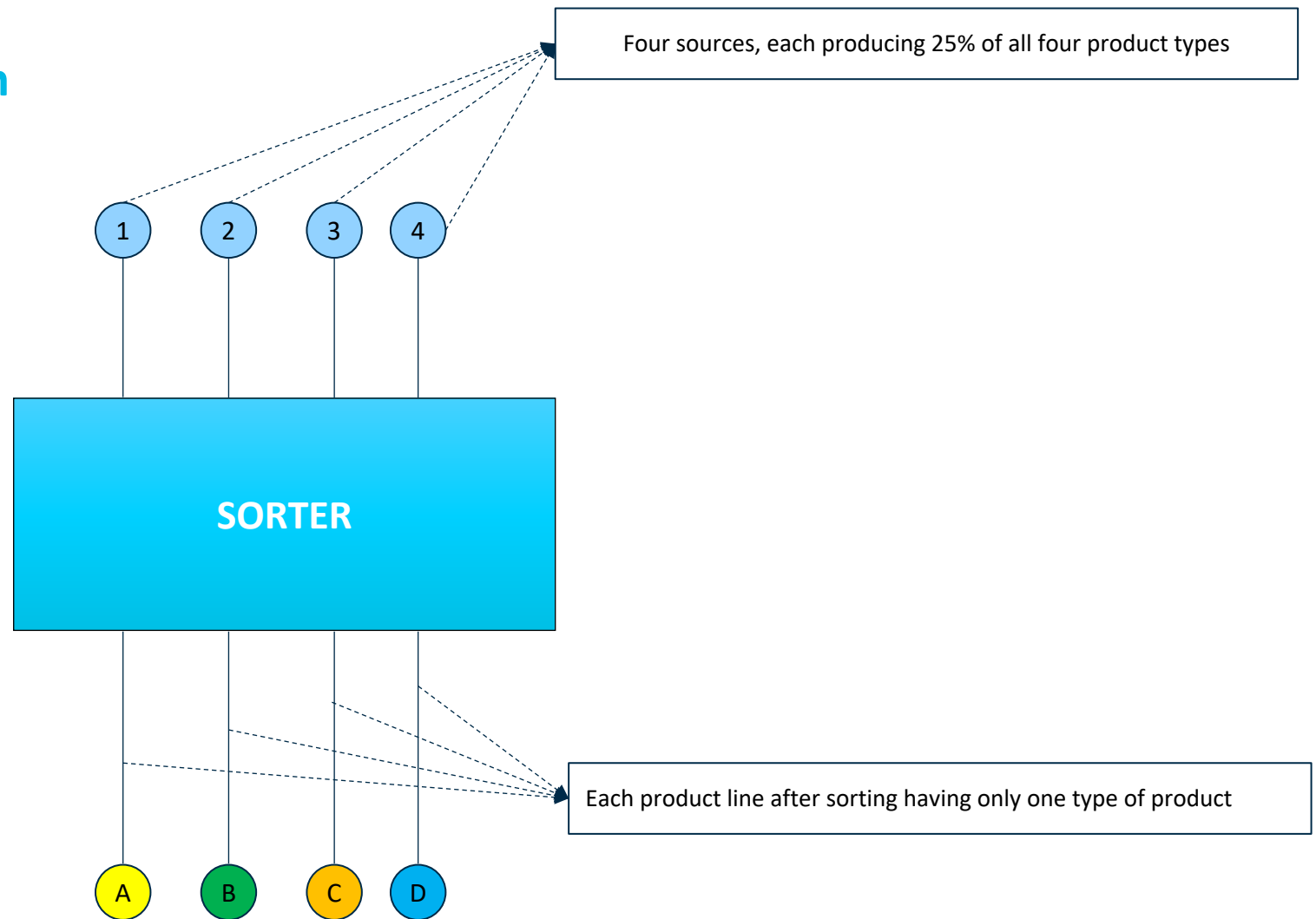
- Product A : 25% each from Source 1,2,3,4
 - Product B : 25% each from Source 1,2,3,4
 - Product C : 25% each from Source 1,2,3,4
 - Product D : 25% each from Source 1,2,3,4
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- The product type arrival at each source is random and follows no particular pattern.

System Overview :

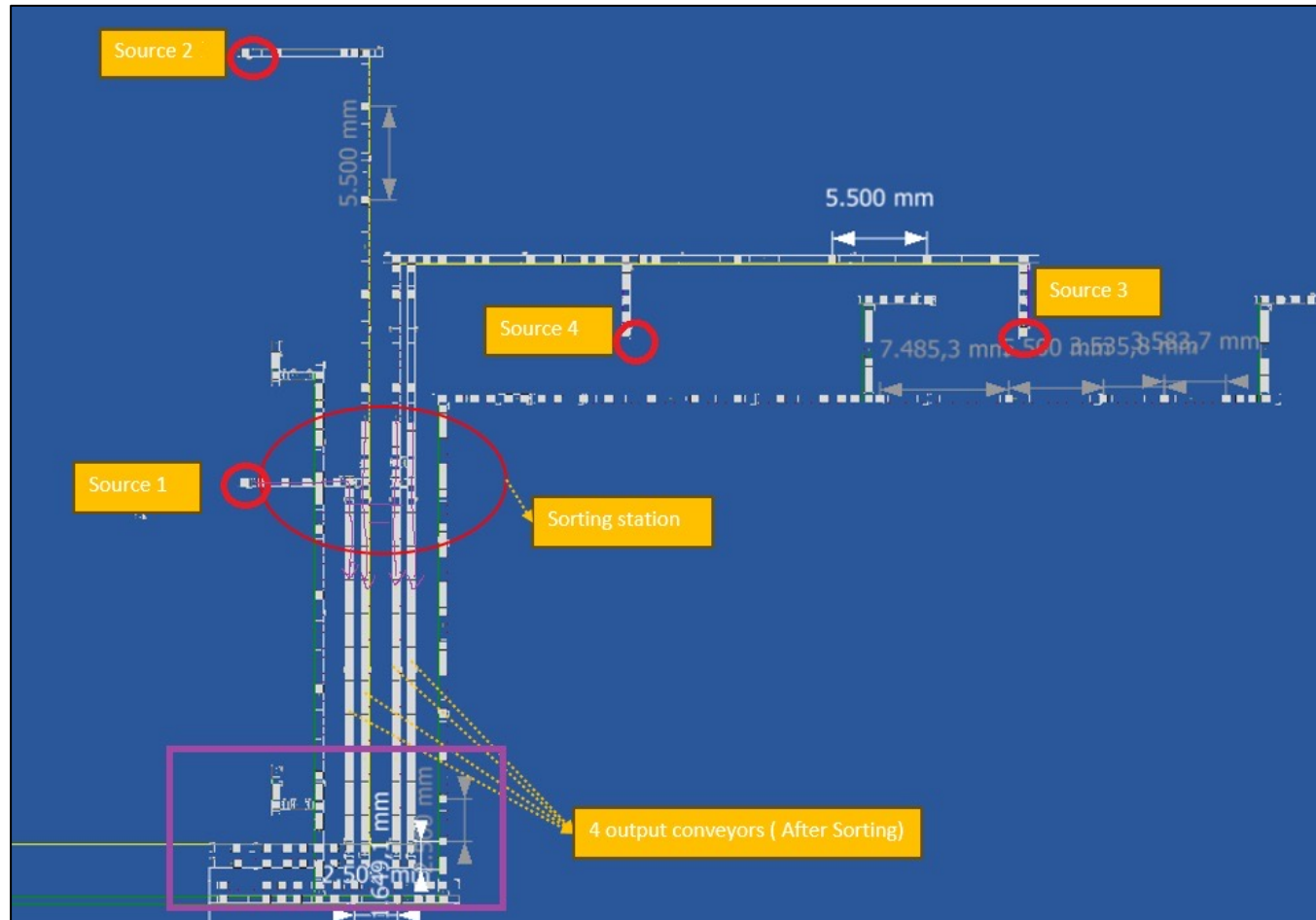
Conveying System:

- Input : Mixed products are conveyed one by one in 4 conveyor lines from sources to a central sorting station.
- Output: After sorting each of the 4 conveyor will only have one type of product in it.

Schematic representation



MTPro Layout:



Design Challenge

- Design and model an efficient sorting system in Visual Components keeping the **cycle time (performance constraint)** and **costs (design constraint)** in mind.
- Modelling sources that produces random product mix with the required distributions.

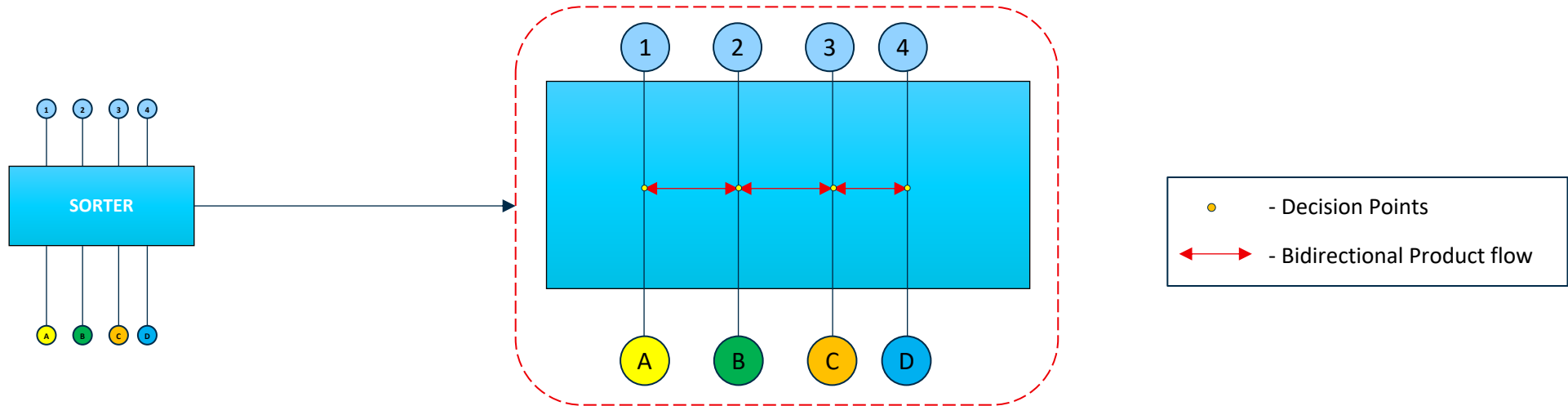
Sorting Strategy development

- Develop a sorting strategy to efficiently separate the products into distinct product types.
- In each of the conveying lines in the sorting area, there are **decision points** where sorting decisions can be executed.
- The system can be improved by systematically **increasing the no. of decision points**, thereby enhancing overall **flexibility**.
- **Increasing the no. of decision points** enhances overall system flexibility and reduces queue formation at sorting points, at the expense of **increased cost** and **complexity**.
- This **trade-off** between **cost** and **cycle time** must be carefully considered in the system design.

General Design Concepts

1. Horizontal Conveyors

- The basic configuration of this approach is to have horizontal conveying lines connecting all four conveyors.

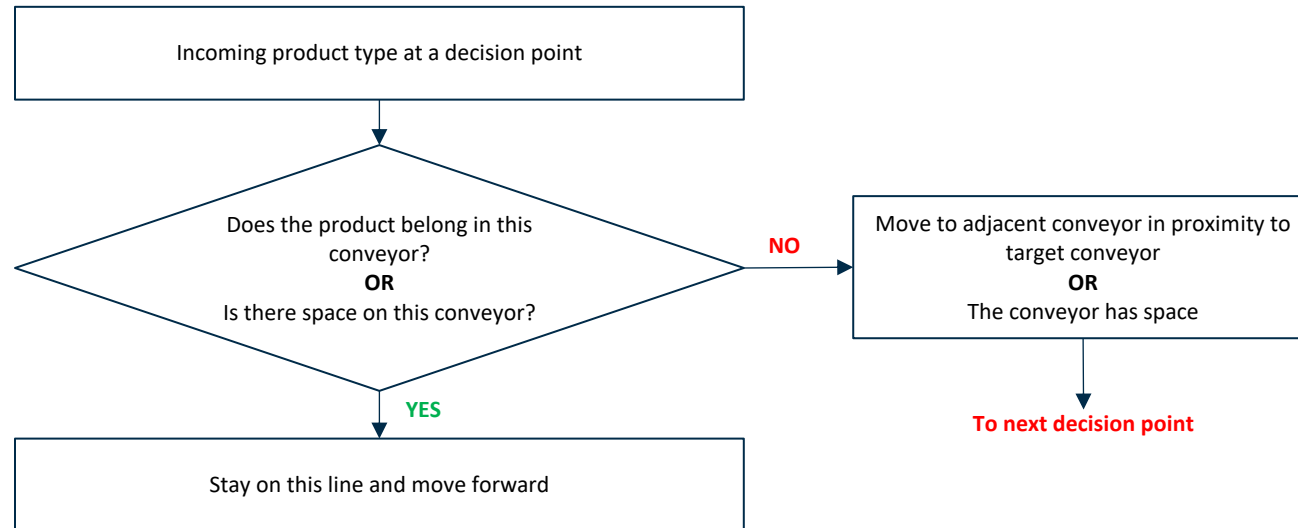


- The product will be sorted based on the sorting logic at each **decision points**.
- Although very simple and cost efficient, the system will have a poor performance due to large queues at different decision points.

General Design Concepts

1. Horizontal Conveyors

- Sorting logic defines the performance of the system. At each decision point, the basic **sorting logic** is as follows:

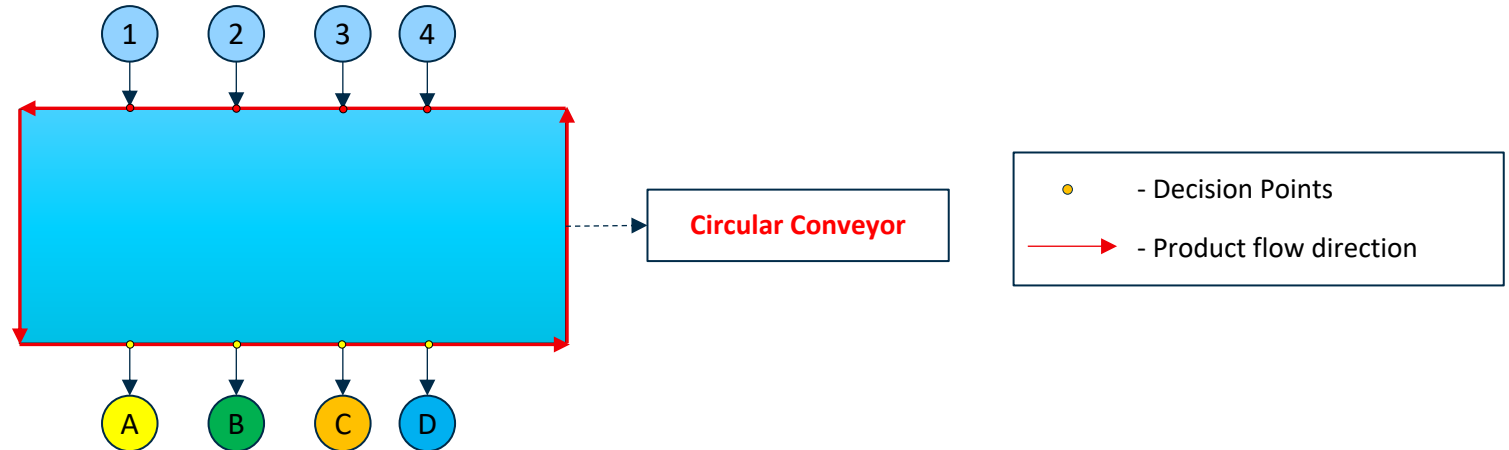


- Decision points are connected to horizontal conveyors, which transfers the product to the intended conveyor.

General Design Concepts

2. Circular Conveyors

- The basic configuration of this approach is to connect all four sources to the circular conveyor.

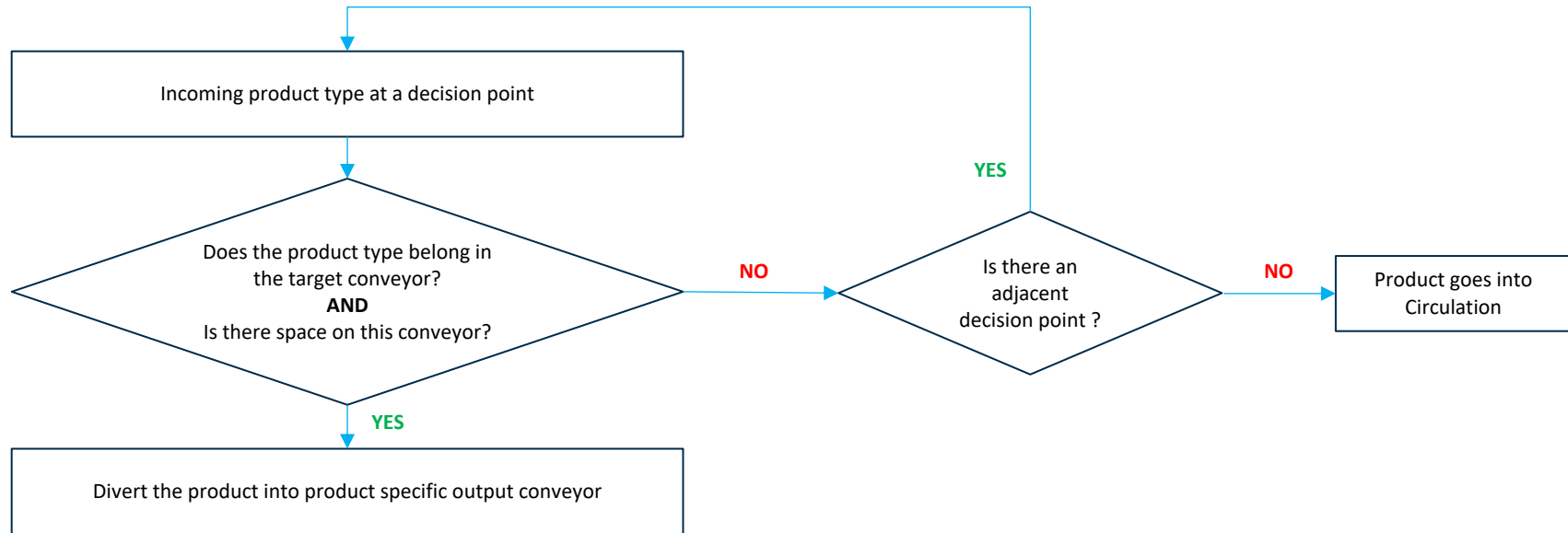


- Circular conveyor can accumulate, circulate and distribute the products to output conveyors.

General Design Concepts

2. Circular Conveyors

- At each decision point at the output, the basic sorting logic is as follows:

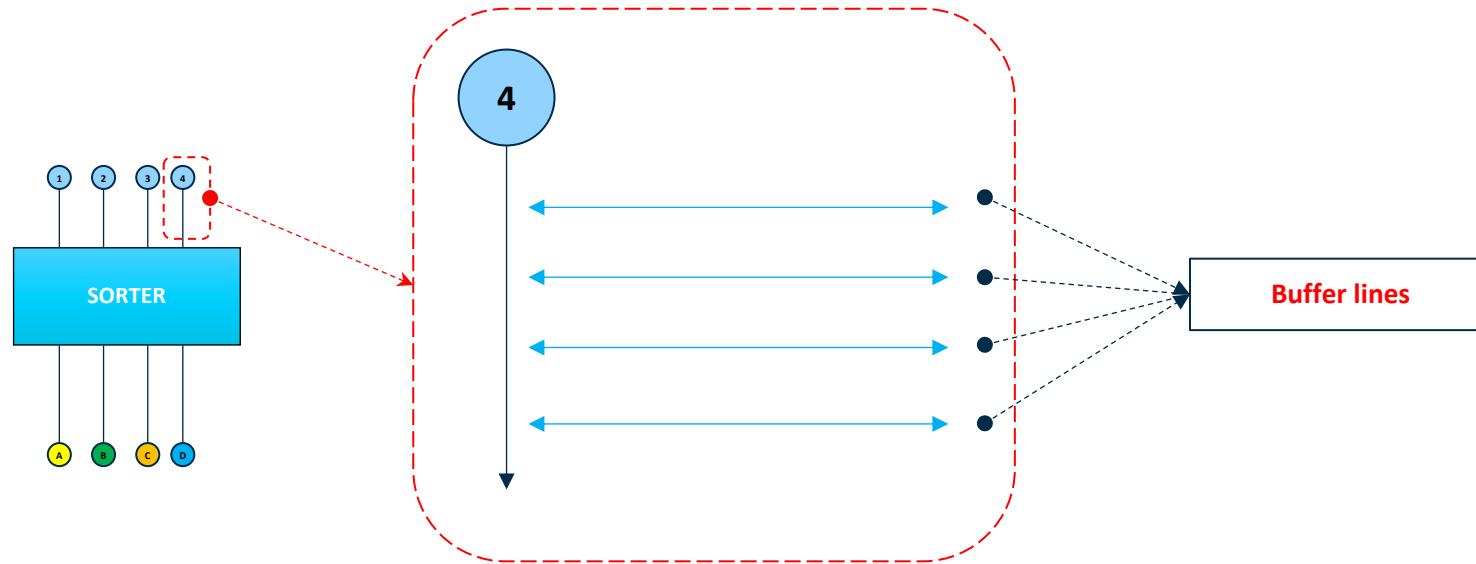


- Advantages:** Continuous flow of products into output conveyors
- Challenges:** Susceptibility to operational issues when processing large batches of identical products.

General Design Concepts

3. Dead-end buffers

- These buffer lines can temporarily store and distribute products to the output line when required.



- These lines can be used for pre-sorting the product types before transferring them back when required.

Design of Sorting Area

The design concepts mentioned previously, or a combination thereof, can be utilized to design the simulation model of the sorting area.

Approach 1 : Horizontal Conveyors

- Utilize **decision points** and **horizontal conveyors** for sorting the products to target conveyors.
- Analyze material flow to **pinpoint potential blockages** or **queues** within the system.
- Implement changes to sorter configuration by repositioning horizontal transfer conveyors to counter the blockages and queues.
- Heuristic decomposition by breaking down sorting tasks into smaller, manageable chunks i.e., products types from sources 3 and 4 can be **pre-sorted** into conveying lines in proximity to the target conveyor.

Design of Sorting Area

- In contrast to a single horizontal line connecting all four conveyors, a waterfall sorting configuration, which includes **multiple horizontal conveyors at different levels** along the vertical conveyor length, can be implemented.

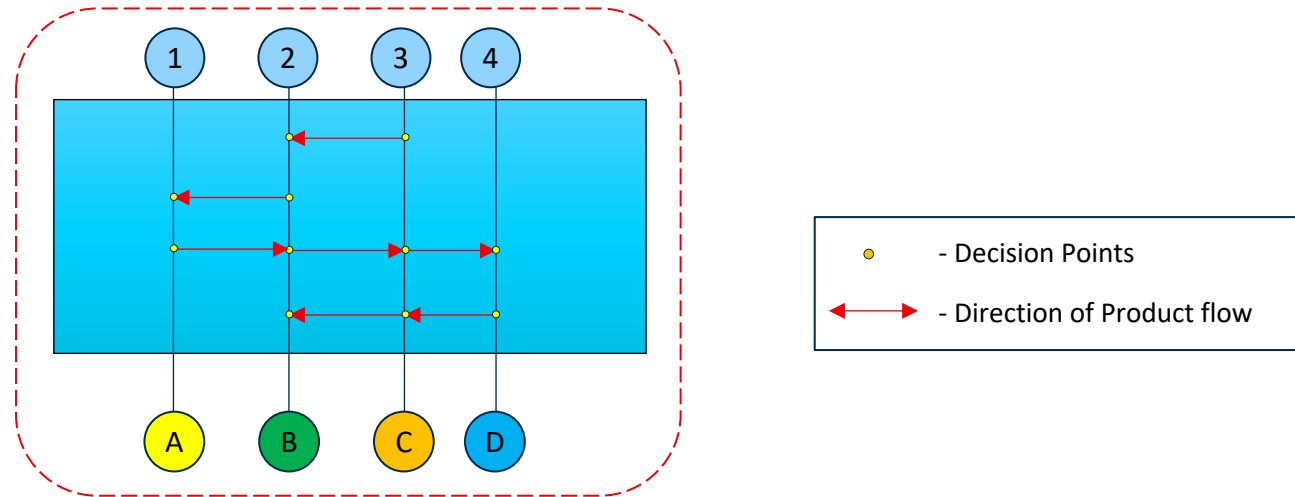


Fig. : Schematic representation of sorting area (Approach 1)

Design of Sorting Area

Approach 2 : Circular conveyors

- Another approach to this sorting problem is by implementing a **circular conveyor** replacing the horizontal conveyors.
- The circular conveyors can **accumulate** and **circulate** the different product types from all 4 sources and finally distribute to the products to the output conveyor.
- The entrance from sources to circular conveyor is based on **capacity controller** logic, which is a simple **fill level control** for input and output.
- The transfer to target is governed by decision points at the entrance of output conveyors.
- The product is then transferred to the target product specific conveyor depending on its availability.
- If the target conveyor capacity is exceeded, products are circulated along the circular conveyor.

Design of Sorting Area

- In addition, **bypass lines** connecting the sources directly to their target conveyor of a product type can be utilized.

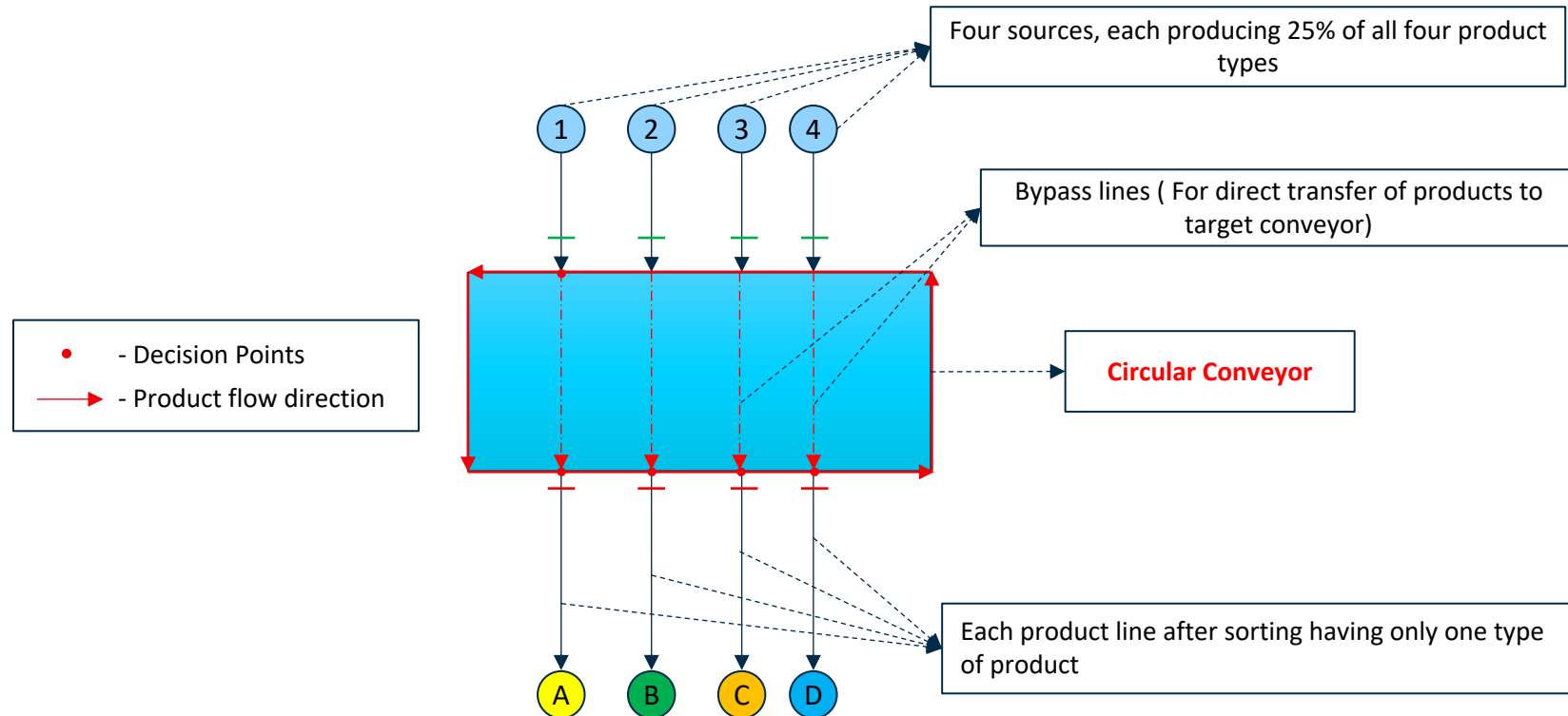


Fig. : Schematic representation of sorting area (Approach 2)

Design of Sorting Area

- The fill level control ensures only the specified number of products between the entry and exit points enter the circular conveyor.
- The system can push the sorted products into output conveyors and can circulate them if the conveyor capacity is exceeded.
- This eliminates the blockage at these decision points allowing latter materials to be sorted instead of waiting in the queue.

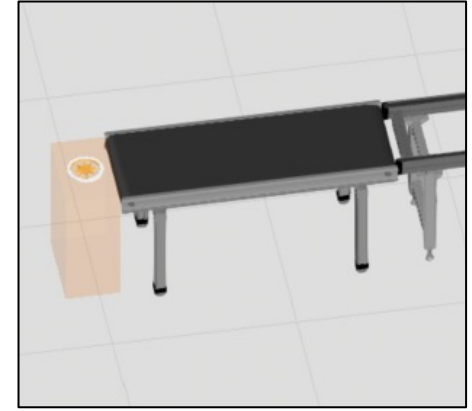
System Modelling

Source :

- Four source feeders producing products with `FeedMode` : Distribution
- Interval : 22 sec (Given)
- Probability of each product type 25%

Conveying Units :

- Conveyor used : Bosch Rexroth TS2- Conveyor Unit.
- Modelled based on MTpro layout (Given).



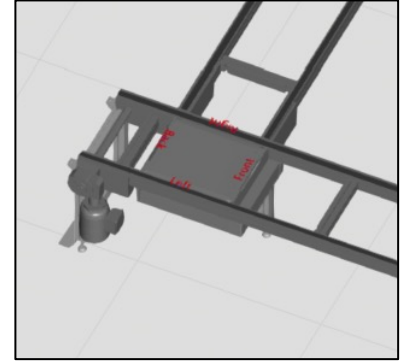
System Modelling

Decision points:

- Lift transverse units based on routing rule.

Sorter (Approach 1):

- Combination of conveyor units, Belt Sections and Lift transverse units.
- **Decision points** : Lift transverse unit routing to desired output conveyor based on product type routing rule.



System Modelling

Sorter (Approach 2):

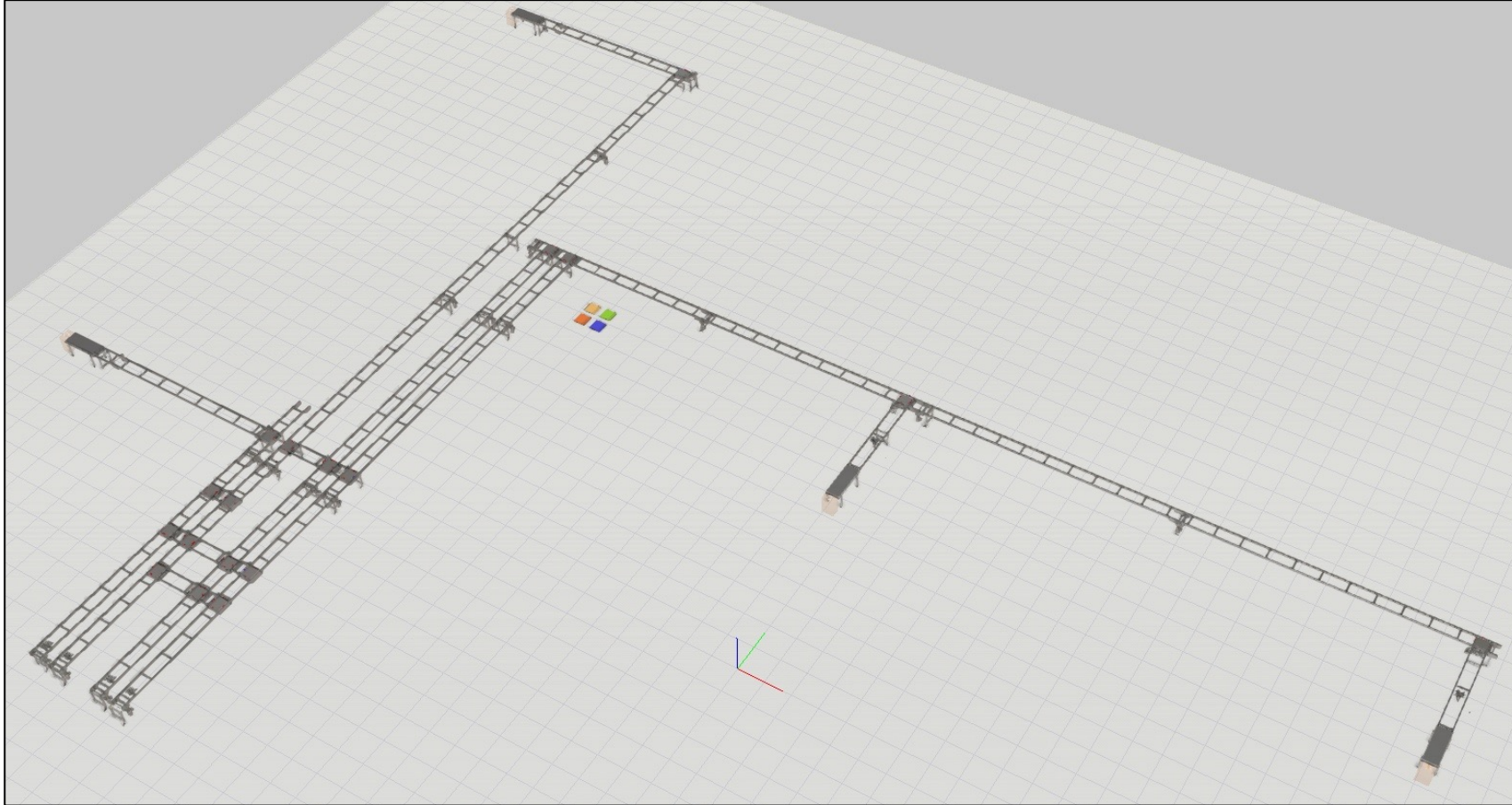
- Combination of conveyor units to form a circular conveyor system.
- **Decision points** : Lift transverse unit routing to desired output conveyor based on **product type** and **capacity routing rule**.
- **Capacity Control nodes** at entry/ exit of circular conveyor, to control capacity between entry and exit points.

Processing stations:

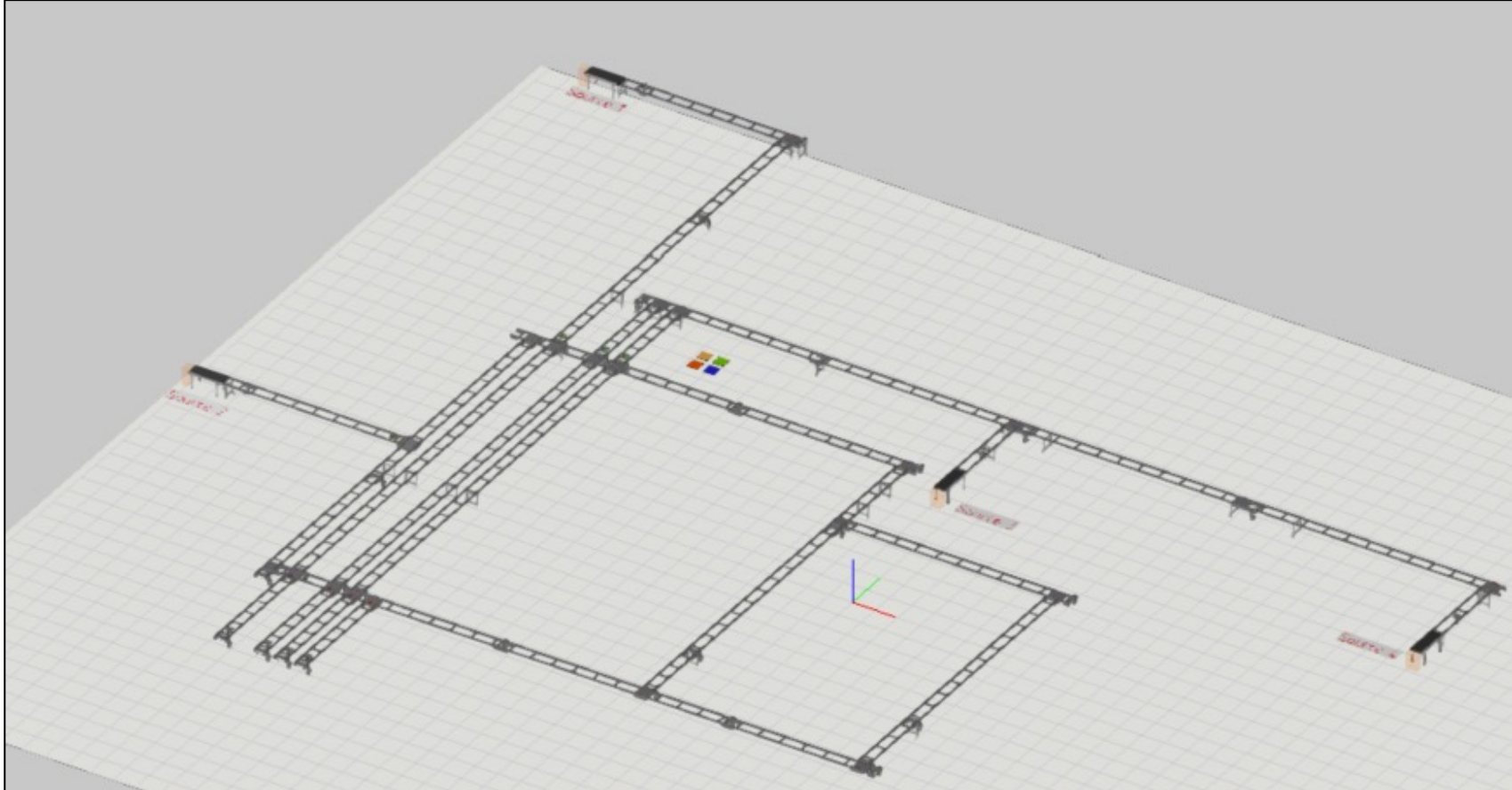
- Position units at the end of each output conveyors with a process time of 16s.



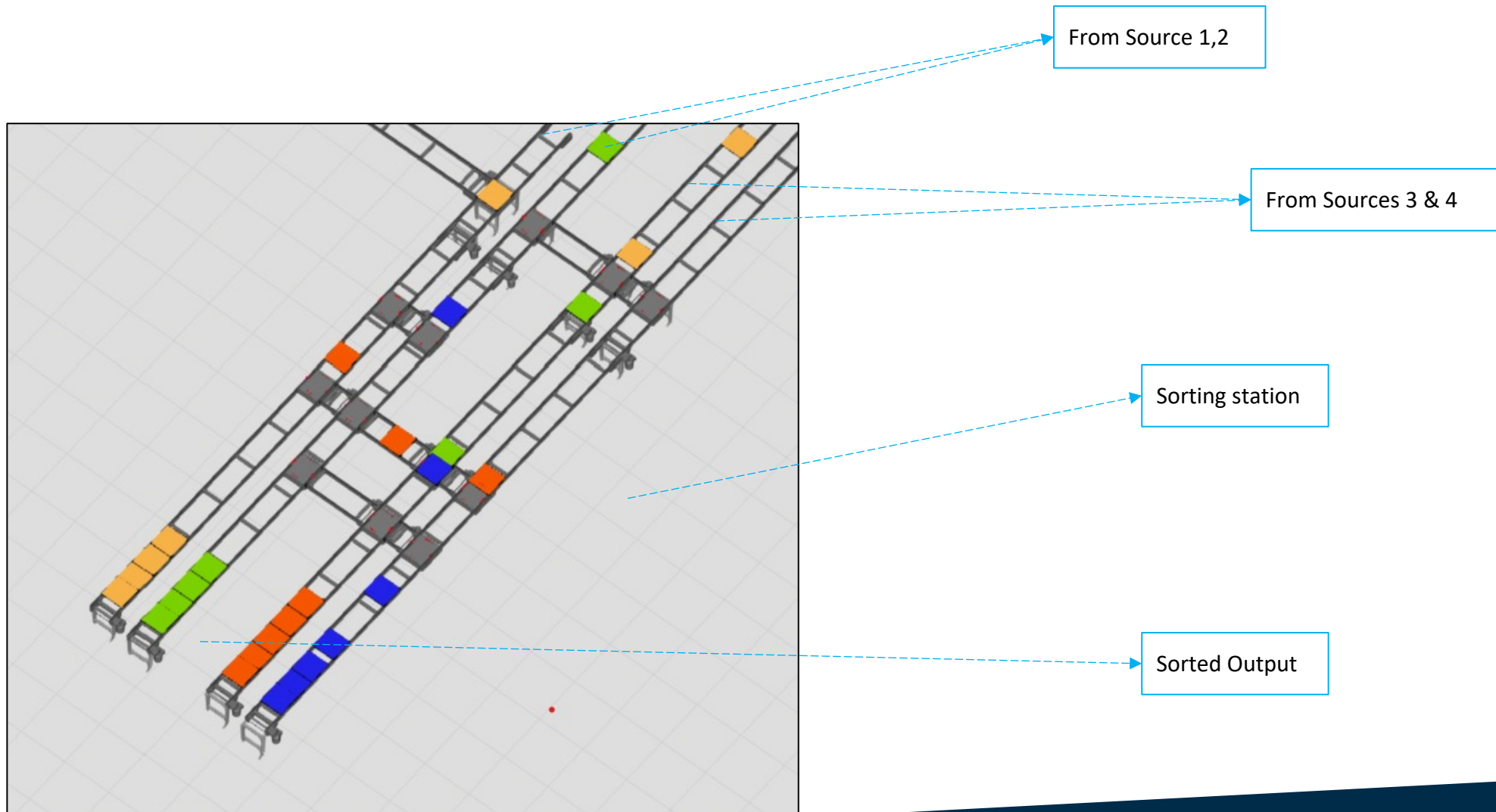
System Modelling (Approach 1)



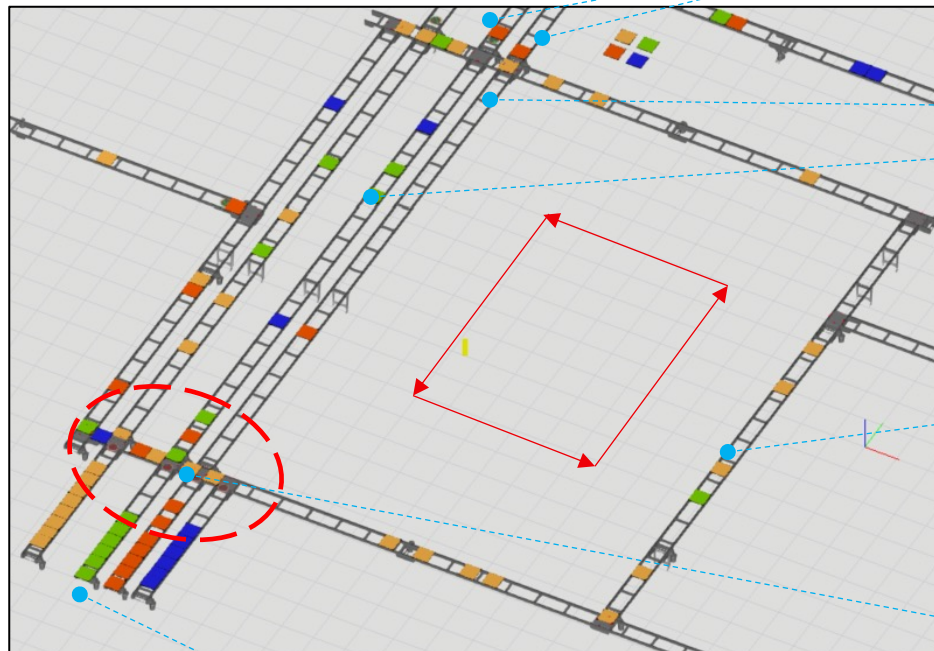
System Modelling (Approach 2)



Sorter Configuration (Approach 1)



Sorter Configuration (Approach 2)



From Sources

Bypass Lines

Circular Conveyor

Decision Points

Sorted Output

Observations & Results