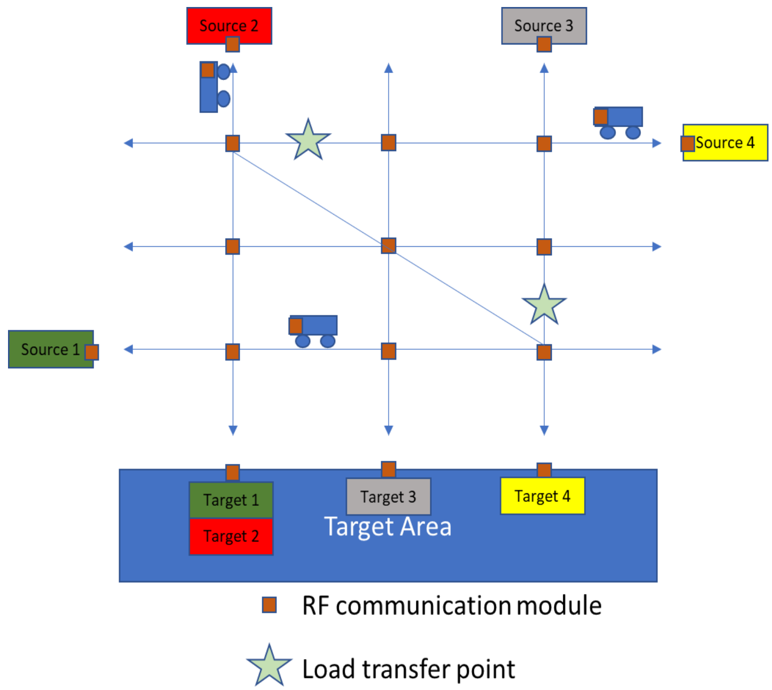
Smart Logistics System

In this project, the objective is to design and implement a logistics system where vehicles transport "loads" from designated sources to specific targets in an efficient fashion while adhering to the movement rules and minimizing delays. The system operates within a predefined area, where sources, vehicles, and targets are equipped with displays that show real-time load information. Movement and load transfers are tracked and logged in real-time on a remote computer via wireless communication, with the goal of maximizing the score based on the type of load and the time taken for delivery.



- The "load" is not a physical object but rather a digital entity that the vehicles must retrieve from the sources and transport to the targets. There is a fixed placement of loads distributed over sources in the beginning. When delivered, the four different types of load result in fixed, linear, or exponential scores which are described in Appendix SLS-1.
- Vehicles travel along predefined lines within the designated area to reach the sources where they receive the digital loads and then transport them to the target areas. These lines allow the vehicles to move vertically, horizontally, and diagonally.
- Loads can be transferred between vehicles at specific locations, allowing for strategic coordination to optimize delivery times and the total score.
- There are three types of vehicles which have different load capacities and transfer restrictions. Descriptions are given in Appendix SLS-1.
- The vehicles, resources, and targets communicate wirelessly with the remote computer to ensure accurate tracking and logging of all activities.
- The system operates in time slots, during which all vehicle movements toward their planned destinations occur simultaneously. The time-slot duration is determined based on system design and is common for all the vehicles in the system. This slot-based operation is intended to alleviate mechanical difficulties and streamline coordination.
- Once the system is started, vehicles should start their movements in at most 30 seconds.

The system must ensure that vehicles do not collide during operation. To prevent collisions, vehicles must follow predetermined movement rules, coordinating their routes to avoid each other, especially at intersections and during load transfers.

It is recommended that students simulate the problem using a suitable programming environment to ensure the system functions as intended before implementation.

Extra features:

- Vehicle movement, load transport, and load prioritization decisions can be optimized using AI algorithms. This is an optional feature that can enhance the system's performance by allowing it to make smarter decisions based on the current situation and goals.
- Loads may be continuously generated at the sources according to predetermined stochastic models. . Each group can use multiple different models, but it is required that at least one model be the same across all groups for performance comparison.

Appendix SLS-1

Scoring of Loads

Score Calculation for Load 1

Scoring Formula:

$\text{Score}_1 = \{X, if\ T\_transport\ \leq\ N\ slots\ 0, if\ T\_transport\ >\ N\ slots$

- X: Points received for Load 1.
- N: Maximum number of slots required to transport Load 1.
- T_transport: Transport time for Load 1 (number of slots).

Score Calculation for Load 2

Scoring Formula:

$\text{Score}_2 = \{Y, if\ T\_transport\ \leq\ M\ slots\ 0, if\ T\_transport\ >\ N\ slots$

- Y: Points received for Load 2.
- M: Maximum number of slots required to transport Load 2.
- T_transport: Transport time for Load 2 (number of slots).

Score Calculation for Load 3

Scoring Formula:

Score = X_3 - k × T_elapsed time

- X_3: Initial maximum score.
- k: Point loss coefficient (fixed rate).
- T_elapsed time: Time elapsed after the creation of the load.

Score Calculation for Load 4

Scoring Formula:

Score = X_4 × e^(-k × T_elapsed time)

- X_4: Initial maximum score.
- k: Point loss coefficient (fixed rate).
- T_elapsed time: Time elapsed after the creation of the load.

Total Score Calculation

The Total Score is calculated by summing up the points received from all types of loads.

Vehicle Type Descriptions

Type A vehicle: Can pick up loads from the source and deliver them to the destination. It can also transfer loads to another vehicle if necessary.

Type B vehicle: Can pick up loads from the source but cannot deliver them to the destination. It must transfer the load to a Type A or Type C vehicle at a transfer point.

Type C vehicle: Cannot pick up loads from the source but can deliver loads to the destination after receiving them from a Type A or Type B vehicle.