



# Collaborative optimization model to solve horizontal collaboration among stakeholders using VRP

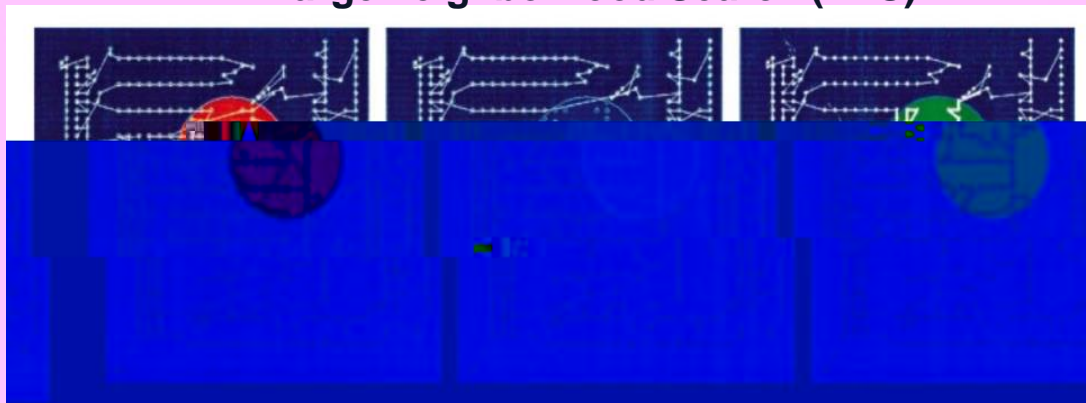
LOGISTAR - Enhanced data management techniques  
for real time logistics planning and scheduling

# LOGISTAR: Global optimization

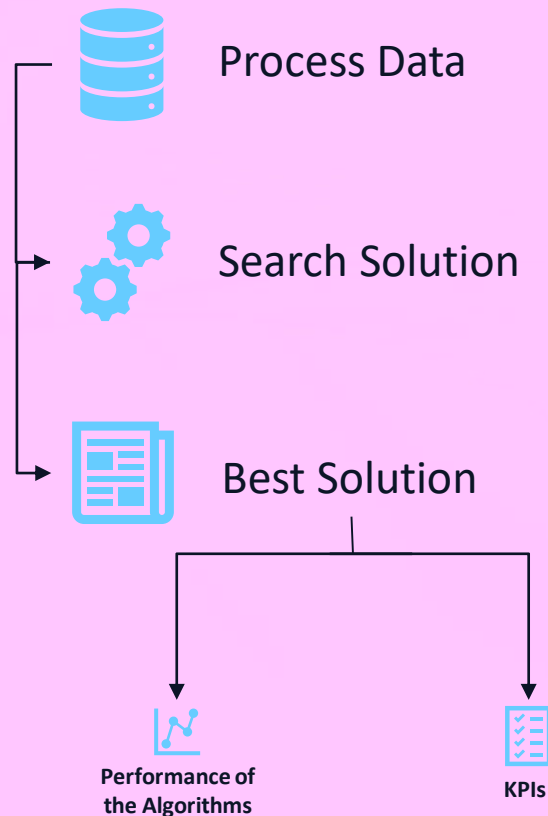
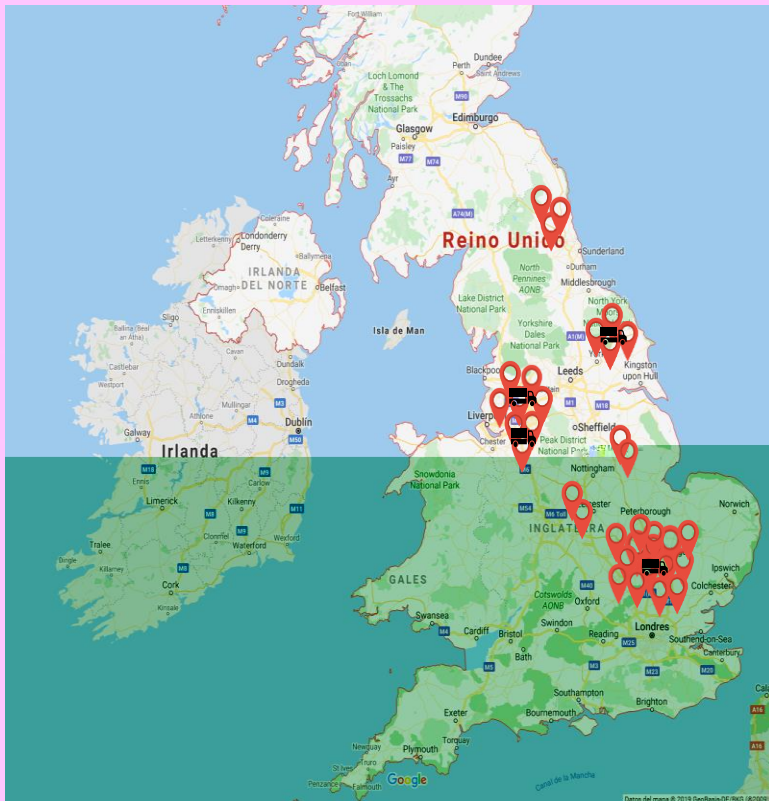
The LOGISTAR project focuses on optimizing distinct multi-point route VRP problems:

- Capacity and type of good restricted
- Co-loading, pickup and delivery restricted
- Multi-depot, backhauling and time-dependent

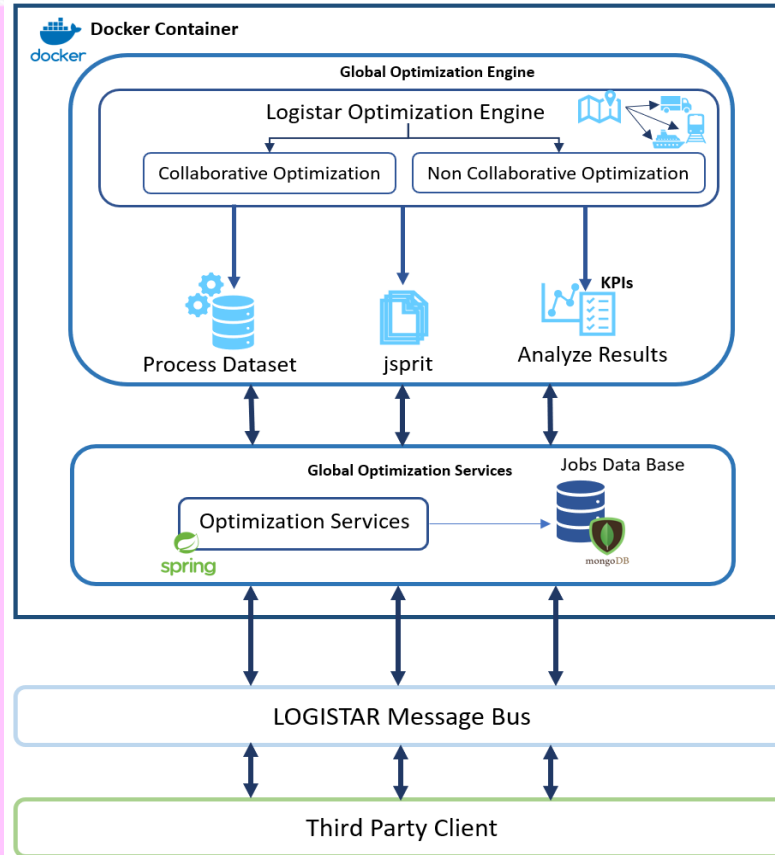
## Large neighborhood Search (LNS)



# LOGISTAR: Global optimization



# LOGISTAR: Global Optimization Module Architecture



# LOGISTAR: Global Optimization Module Architecture

Selected JSprit framework as the optimization engine

- <https://jsprit.github.io/>
- Java-based lightweight and flexible framework based on LNS
- Scales well to distinct VRP variants

Implementation of the model

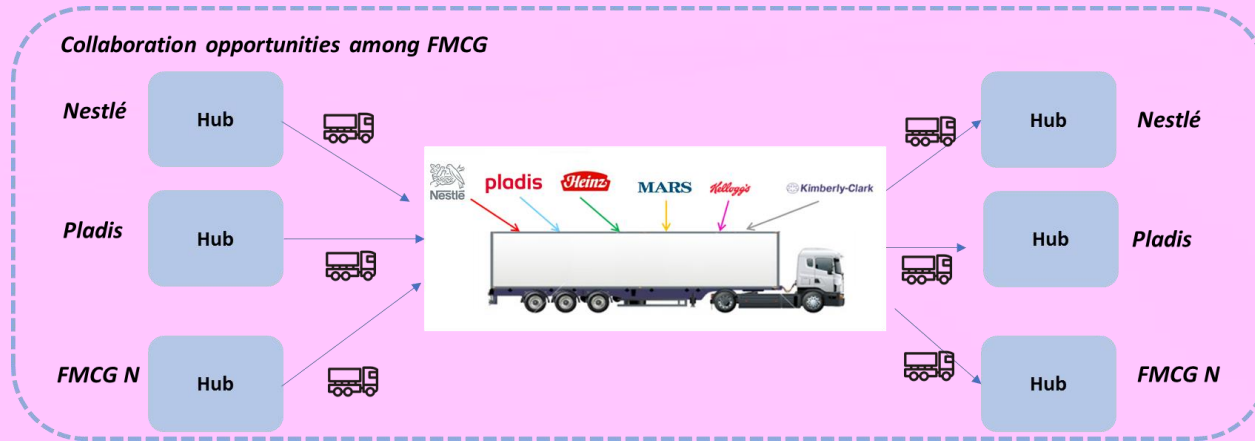
- Selection of routing engine
- Implementation of cost function
- Implementation of new restrictions
- Evaluation on data provided by stakeholders



- Living Labs
  - **Backhauling and Co-loading**
    - Process of **various information** coming from the different companies
      - schedules, resources, constraints, truck, positions... empty return legs...
    - The operators will have an **overall overview of the status** of the operations through the real-time dashboards and the real-time information on road transport system.
  - **Synchromodality**
    - Real time **re-planning due to a disrupting event**: corrective and preventive
      - Planning of synchromodal routes basing on real time events.
      - Dynamic assignation of freight transport networks.
    - Real time **status on goods movements**: position of vehicles, arrival time of cargo fleets.

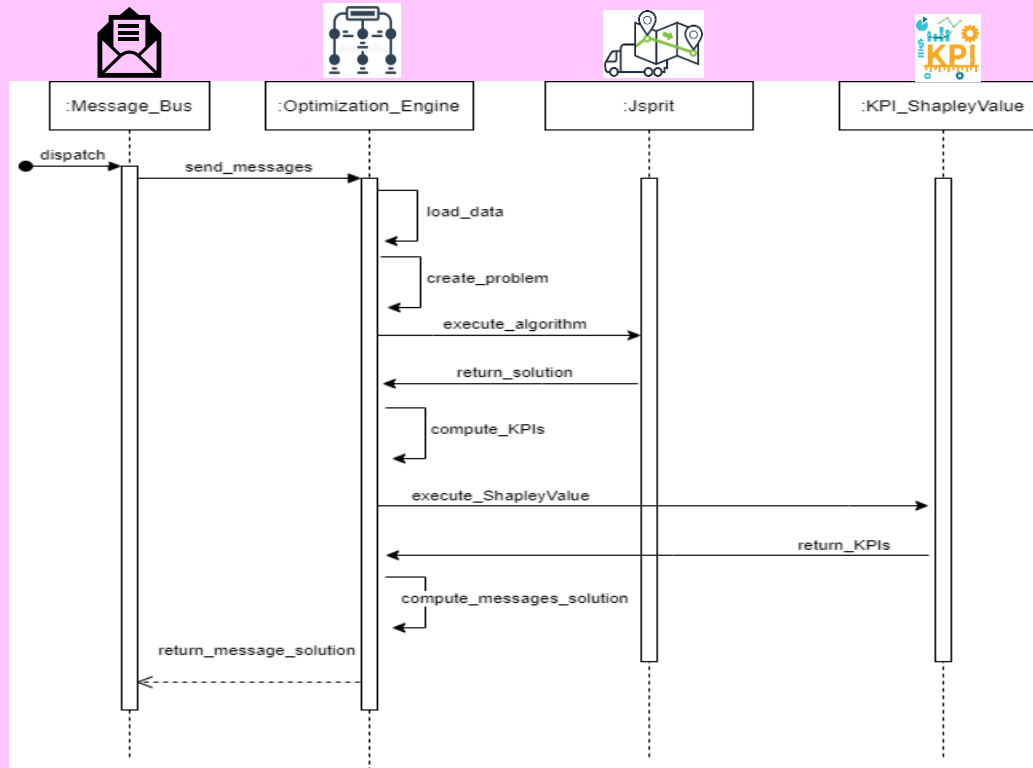
## Backhauling and Co-loading

To improve backhauling management  
Overall overview of the status of the operations





## Optimization process flow





## Input Data

```
{
  "livingLab": "LL1",
  "day": "2021-04-22",
  "orderList": {
    "vehicleFleet": {
      "vehicleFleet": {
        "identifier": "NE-TR-1",
        "stakeholderIdentifier": "nestle",
        "type": "Truck",
        "maxAllowedWeight": {
          "numericValue": "26000.0",
          "unit": "kg"
        },
        "capacity": {
          "numericValue": "2600.0",
          "unit": "q"
        },
        "capacityFootprint": {
          "numericValue": "5200.0",
          "unit": "q"
        }
      },
      "orderList": {
        "identifier": "f1cb1c33-32b8-3511-ab33-b8767e0777ac",
        "referenceId": "nestle80865078485",
        "issued": "2021-04-25T09:10:49+01:00",
        "messageStatus": "UPDATE",
        "stakeholderIdentifier": "nestle",
        "loadNumber": "R245753",
        "shipmentNumber": "TXN78833",
        "deliveryNumber": "0065078485",
        "pickupLocation": {
          "lat": "52.5243186419391",
          "long": "-1.70110855054996",
          "prefLabel": "RN2",
          "address": {
            "addressLocality": "COLESHILL",
            "streetAddress": "HORN HALL DISTRIBUTION PARK",
            "postalCode": "B46 1AD"
          }
        },
        "dropOffLocation": {
          "lat": "53.547617797852",
          "long": "-2.65866208076477",
          "prefLabel": "W13",
          "address": {
            "addressLocality": "WHEATLE END EST",
            "streetAddress": "WINCATON DC (JOLLIES)",
            "postalCode": "WN3 6BB"
          }
        },
        "loadInterval": {},
        "deliveryInterval": {
          "hasBeginning": "2021-04-22T10:00:00+01:00",
          "hasEnd": "2021-04-22T10:00:00+01:00"
        },
        "deliveryArrivalTime": "2021-04-22T09:30:00+01:00",
        "totalWeight": {
          "numericValue": "5925.7",
          "unit": "kg"
        },
        "palletUtilization": {

```

## Output Data

```
{
  "Total_Drops" : 40,
  "Empty_Running" : 2813.08,
  "DistanceKm" : 5968.34,
  "TimeH" : 173.43,
  "Solution_Cost" : 25220.43,
  "Total_Routes" : 22
  "Data_Struct" : [ { {
    "Company" : "Pladis",
    "Vehicle_FRw_Weight" : 0.51,
    "DistanceKM" : 52.87,
    "Vehicle_FRm_Weight" : 0.03,
    "Vehicle_FRm" : 0.06,
    "TimeH" : 2.98,
    "Vehicle_Id" : "Pladis Truck 1-C",
    "Vehicle_FRw_Footprints" : 0.51,
    "Vehicle_FRm_Pallets" : 0.06,
    "Coordinate_Star_and_End" : "[x=-1.459583][y=52.7687",
    "Empty_Running" : 26.57,
    "Depot" : "LE65 1PF",
    "Vehicle_FRw_Pallets" : 0.49,
    "Vehicle_FRm_Footprints" : 0.04,
    "Vehicle_FRw" : 0.51
  }, {
    "Zip_Code_From" : "LE65 1PF",
    "End_Time" : 420.46714814845257,
    "Arr_Time" : 420,
    "Shipment" : "Drive",
    "From" : "[x=-1.459583][y=52.7687",
    "To" : "[x=-1.4608][y=52.76516]",
    "Zip_Code_To" : "GBLE65.1",
    "Distance" : 420.4333336072918
  }, {
    "Order" : 1,
    "Time_Window_End" : 539,
    "Coordinate_Location" : "[x=-1.46",
    "End_Time" : 480.46714814845257,
    "Arr_Time" : 420.46714814845257,
    "Foot_Prints" : 0,
    "Number_Pallets" : 1,
    "Shipment" : "PickupShipment",
    "Time_Window_Start" : 0,
    "ID" : "P-9-CUST86193615",
    "Weight" : 0.227
  }
  ]
}
```

## Results of a test case where a collaborative solution is created

01:00 - 02:00	[x=-1.4][y=5.7]	Pickup		(1p 0fp 0.23w - 01:00 h) - TW:(00:00-08:59) FILL:(1p - 0fp)
01:00 - 02:00	[x=-1.4][y=5.7]	Pickup		(2p 1fp 0.64w - 01:00 h) - TW:(00:00-08:59) FILL:(3p - 1fp)
02:00 - 02:42	GBLE65.1	Drive	B46 1AL	(38 km - 00:42 h)
02:42 - 03:42	[x=-1.7][y=5.5]	Pickup		(18p 9fp 9.98w - 01:00 h) - TW:(00:00-06:45) FILL:(21p - 10fp)
02:42 - 03:42	[x=-1.7][y=5.5]	Pickup		(14p 7fp 7.53w - 01:00 h) - TW:(00:00-06:45) FILL:(35p - 17fp)
02:42 - 03:42	[x=-1.7][y=5.5]	Pickup		(13p 6fp 6.66w - 01:00 h) - TW:(00:00-06:15) FILL:(48p - 23fp)
03:42 - 05:45	B46 1AL	Drive	S80 3EG	(111 km - 02:03 h)
05:45 - 06:45	[x=-1.0][y=5.2]	Delivery		(13p 6fp 6.66w - 01:00 h) - TW:(05:45-06:45) FILL:(35p - 17fp)
05:45 - 06:45	[x=-1.0][y=5.2]	Delivery		(14p 7fp 7.53w - 01:00 h) - TW:(06:15-07:15) FILL:(21p - 10fp)
05:45 - 06:45	[x=-1.0][y=5.2]	Delivery		(18p 9fp 9.98w - 01:00 h) - TW:(06:15-07:15) FILL:(3p - 1fp)
06:45 - 07:53	S80 3EG	Drive	GBLE11.5	(60 km - 01:07 h)
07:53 - 08:59	[x=-1.2][y=5.7]	Delivery		(2p 1fp 0.64w - 01:05 h) - TW:(08:59-09:30) FILL:(1p - 0fp)
07:59 - 08:59	[x=-1.2][y=5.7]	Delivery		(1p 0fp 0.23w - 01:00 h) - TW:(08:59-09:30) FILL:(0p - 0fp)
08:59 - 09:28	GBLE11.5	Drive	LE65 1PF	(26 km - 00:29 h)

## Motivation for intermodality

- Growing transport volumes call for a shift in transport modes
  - Congestion, climate change and air pollution
- Move transportation volume from road-centered towards other alternatives
  - Improve the characteristics of logistic chains

## Intermodality

Aims to integrate transport volumes and modes

- bundling of flows, switching the transport mode
- requires close cooperation between actors
- In line with EU transportation policy objectives, to foster a shift from road to rail
  - Reduce dependence on imported oil
  - Cutting carbon emissions by 60%

## Intermodal containers

To enable intermodality we rely on intermodal containers

- Without handling the freight itself during changes of modes
  - There is no reloading nor unloading
- It enables efficient and effective solutions to share costs
  - Based on cooperation and integration
- Containers are used to transport materials across intermodal hubs

## Optimization process

The approach is based on the optimization of a 3-way process

- Pre-haul (pickup process)
- Long-haul (door-to-door transit of containers)
- End-haul (delivery process)
  - Pre-haul and end-haul are usually road-based, while long-haul is considered for intermodal optimization
  - Objective is to select intermodal routes and determine container flow so that a performance measure is optimized
  - Non trivial process

## Optimization heuristic

Backtrack algorithm is widely used in transportation optimization as a general algorithm

- Some modifications to the general algorithm
- Branching factor is not static for all means of transport
- End-haul (delivery process)





# Contact details



[www.logistar-project.eu](http://www.logistar-project.eu)



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