

Introductory Benchmark Instances Specification

Reference Documentation: Test Instance (Sanity Check) & Small Easy Instance · Mathematical Topology, Matrices, Fleet Economics, and Hand-Verified Baseline Calculations.

Vehicle Type & Echelon	Capacity	Fixed Cost (\$F_k\$)	Var Cost (\$c_k\$)	Max Duration	Service Scope
Echelon 1: Heavy Truck	350 pkgs	€280.00 / truck	€1.75 / km	600 min (10 h)	Primary Depot (DP) → Secondary Hubs (DS) → DP
Echelon 2: Delivery Van	65 pkgs	€85.00 / van	€0.80 / km	480 min (8 h)	Secondary Hub (DS) → Customer Points (PL) → DS

1. Instance 1: Test Toy Instance (instance_toy_2pl.json)

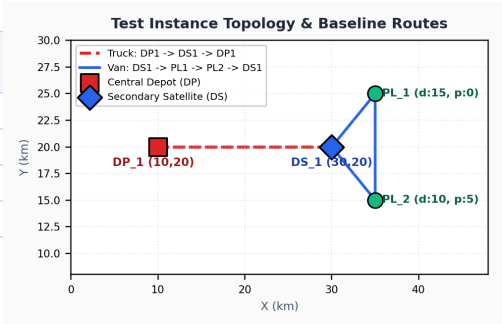
Designed for rapid sanity checks and step-by-step hand calculation verification. Features **4 nodes** (1 DP, 1 DS, 2 PL).

ID	Type	Description	Coords (X, Y)	Deliv (\$d_i\$)	Pick (\$p_i\$)	Time Window (min & HH:MM)	Service
DP_1	DP	Main Central Warehouse	(10.0, 20.0)	0	0	[360, 1200] (06:00 - 20:00)	30 min
DS_1	DS	Urban Secondary Hub	(30.0, 20.0)	0	0	[420, 1140] (07:00 - 19:00)	25 min
PL_1	PL	Customer Alpha	(35.0, 25.0)	15	0	[480, 720] (08:00 - 12:00)	15 min
PL_2	PL	Customer Beta	(35.0, 15.0)	10	5	[510, 750] (08:30 - 12:30)	15 min

Duration Matrix (min)	DP_1	DS_1	PL_1	PL_2
DP_1	0 min	25 min	35 min	35 min
DS_1	25 min	0 min	12 min	12 min
PL_1	35 min	12 min	0 min	15 min
PL_2	35 min	12 min	15 min	0 min

Distance Note

Distances are computed directly from (X, Y) coordinates via Euclidean distance: $d(u,v) = \sqrt{(x_u-x_v)^2 + (y_u-y_v)^2}$.



Route & Vehicle	Sequence & Detailed Schedule	Dist	Fixed	Variable	Total Cost
Echelon 1 (Truck)	DP_1 (dep 06:00/360) → DS_1 (arr 06:25, serv 25m, dep 06:50) → DP_1 (arr 07:15)	40.00 km	€280.00	$40 \times 1.75 = €70.00$	€350.00
Echelon 2 (Van)	DS_1 (dep 08:00/480) → PL_1 (arr 08:12, serv 15m) → PL_2 (arr 08:42, serv 15m) → DS_1 (arr 09:09)	24.14 km	€85.00	$24.14 \times 0.80 = €19.31$	€104.31
OFFICIAL TEST COST	Hub Synchronization: Truck departs DS1 @ 06:50 < Van departs DS1 @ 08:00 (Valid)	64.14 km	€365.00	€89.31	€454.31

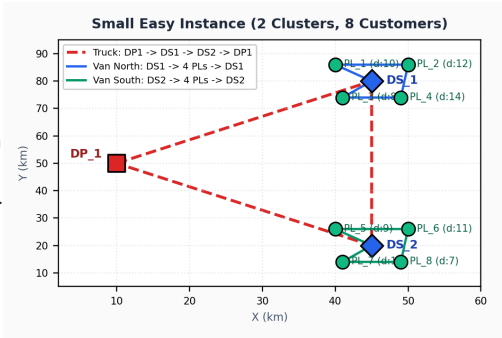
2. Instance 2: Small Easy Instance (instance_small_easy_8pl.json)

A clustered benchmark with **11 nodes** (1 DP, 2 DS, 8 PL) partitioned into two geographic regions (North & South). Engineered with **full-day 12-hour time windows (07:00–19:00)** and generous vehicle capacity margins so standard heuristics (Nearest Neighbor, Savings) find clean feasible solutions.

ID	Type	Region / Description	Coords (X, Y)	Deliv (\$d_i\$)	Pick (\$p_i\$)	Time Window (HH:MM)	Serv
DP_1	DP	Main Central Warehouse	(10.0, 50.0)	0	0	[360, 1200] (06:00 - 20:00)	30m
DS_1	DS	Northern Secondary Hub	(45.0, 80.0)	0	0	[420, 1140] (07:00 - 19:00)	25m
DS_2	DS	Southern Secondary Hub	(45.0, 20.0)	0	0	[420, 1140] (07:00 - 19:00)	25m
PL_1	PL	Customer North Alpha	(40.0, 86.0)	10	0	[420, 1140] (07:00 - 19:00)	10m
PL_2	PL	Customer North Beta	(50.0, 86.0)	12	4	[420, 1140] (07:00 - 19:00)	10m
PL_3	PL	Customer North Gamma	(41.0, 74.0)	8	0	[420, 1140] (07:00 - 19:00)	10m
PL_4	PL	Customer North Delta	(49.0, 74.0)	14	2	[420, 1140] (07:00 - 19:00)	10m
PL_5	PL	Customer South Alpha	(40.0, 26.0)	9	0	[420, 1140] (07:00 - 19:00)	10m
PL_6	PL	Customer South Beta	(50.0, 26.0)	11	3	[420, 1140] (07:00 - 19:00)	10m
PL_7	PL	Customer South Gamma	(41.0, 14.0)	13	0	[420, 1140] (07:00 - 19:00)	10m
PL_8	PL	Customer South Delta	(49.0, 14.0)	7	5	[420, 1140] (07:00 - 19:00)	10m

Cluster Architecture & Demands:

- **North Cluster (DS_1):** Customers PL_1..PL_4. Total delivery demand = **44 pkgs** (Van limit = 65). Total pickup = 6 pkgs.
- **South Cluster (DS_2):** Customers PL_5..PL_8. Total delivery demand = **40 pkgs** (Van limit = 65). Total pickup = 8 pkgs.
- **Truck Trunk Route:** 1 Heavy Truck visits DS_1 then DS_2 carrying 84 / 350 packages.
- **Synchronization Schedule:**
 - Truck departs DS_1 at 07:26 → Van 1 departs DS_1 at 07:30 (Valid)
 - Truck departs DS_2 at 09:11 → Van 2 departs DS_2 at 09:20 (Valid)



Route / Vehicle	Tour Sequence & Detailed Schedule	Dist	Fixed	Variable	Total Cost
Heavy_Truck_1	DP_1 (dep 06:00/360) → DS_1 (arr 07:01, serv 25m, dep 07:26) → DS_2 (arr 08:46, serv 25m, dep 09:11) → DP_1 (arr 10:12)	152.20 km	€280.00	$152.2 \times 1.75 = €266.35$	€546.35
Delivery_Van_1 (N)	DS_1 (dep 07:30/450) → PL_1 (arr 07:40) → PL_2 (arr 08:03) → PL_4 (arr 08:29) → PL_3 (arr 08:50) → DS_1 (arr 09:10)	35.06 km	€85.00	$35.06 \times 0.80 = €28.05$	€113.05
Delivery_Van_2 (S)	DS_2 (dep 09:20/560) → PL_5 (arr 09:30) → PL_6 (arr 09:53) → PL_8 (arr 10:19) → PL_7 (arr 10:40) → DS_2 (arr 11:00)	36.31 km	€85.00	$36.31 \times 0.80 = €29.05$	€114.05
OFFICIAL EASY COST	3 Vehicles Activated — Fully Feasible Schedule — 0 Violations	223.57 km	€450.00	€338.45	€788.45

3. REST API Benchmark & Submission Reference

The submission evaluator accepts solutions formatted as a single unified list of routes. The echelon of each route is automatically inferred by the API (DP-origin routes are Echelon 1; DS-origin routes are Echelon 2).

Team Name	Bearer API Key Token	HTTP Authentication Header
team1	sk-team1-8f3a9e2c4b	Authorization: Bearer sk-team1-8f3a9e2c4b
team2	sk-team2-7d1e5c3a8f	Authorization: Bearer sk-team2-7d1e5c3a8f
team3	sk-team3-4b9a2e6f1c	Authorization: Bearer sk-team3-4b9a2e6f1c
team4	sk-team4-3c8f1a5e9d	Authorization: Bearer sk-team4-3c8f1a5e9d
team5	sk-team5-1a7c5e9d3f	Authorization: Bearer sk-team5-1a7c5e9d3f

JSON Submission Payload Example (Test Instance Solution)

```
{ "team_name": "team1", "api_key": "sk-team1-8f3a9e2c4b", "instance_id": "instance_toy_2pl", "claimed_cost": 454.31,
"routes": [ { "route": ["DP_1", "DS_1", "DP_1"], "departure_time": 360 }, { "route": ["DS_1", "PL_1", "PL_2", "DS_1"],
"departure_time": 480 } ] }
```

Validation Protocol & Error Response Specifications

Validation Check	Failure Reason / Error Response	HTTP Status
Authentication	Team name does not match the provided API Key token.	401 Unauthorized
Instance Matching	Instance ID in payload does not exist on server.	404 Not Found
Customer Coverage	One or more customer delivery points (PL) are omitted or visited multiple times.	422 Unprocessable
Capacity & Pickups	Load exceeds vehicle capacity at departure or during cumulative pickup steps.	422 Unprocessable
Hub Synchronization	Delivery van departs secondary satellite (DS) before the trunk truck has arrived and unloaded.	422 Unprocessable
Time Windows	Vehicle arrives at a customer after tw_close.	422 Unprocessable
Cost Verification	The claimed_cost deviates from the server-computed exact cost by > 0.05 €.	422 Unprocessable