Route optimisation, without the bullshit

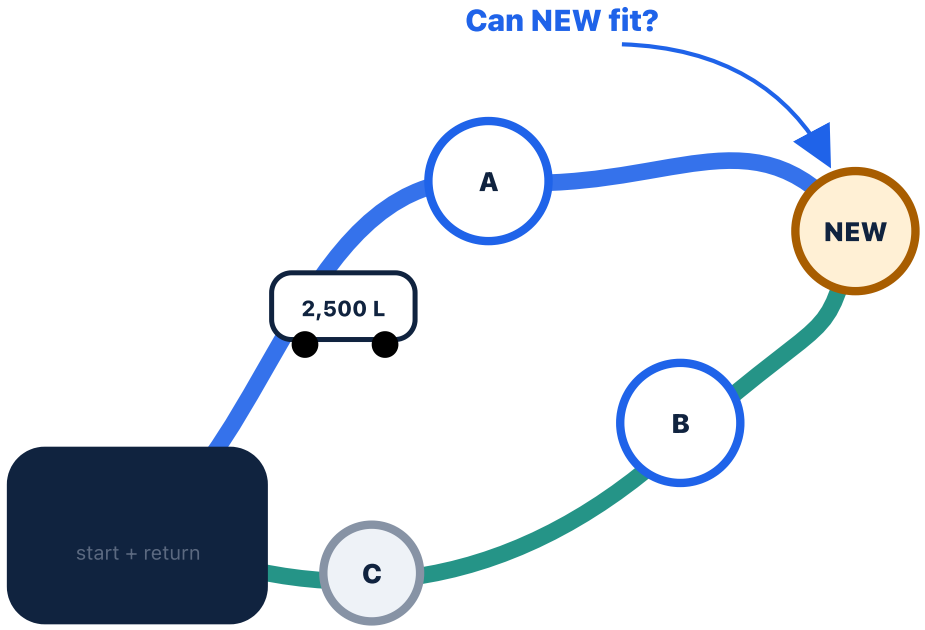
A visual coaching guide for thinking clearly about planning, constraints, solvers and real-world execution.

The map is the easy part.

The hard part is deciding **who should visit which stops, in what order, at what time, with which vehicle**—while reality keeps changing.

Milk collection example | VRP made intuitive | Industry patterns | FleetRobo lens

Use this guide to: ask better customer questions, challenge vague "AI" claims, reason with engineering, and recognise where product differentiation actually lives.



Five problems people lazily call “routing”

Separate them first. Otherwise product conversations become a soup of maps, GPS and algorithms.

1 Routing

Which road path connects known points?

A → B using truck-safe roads

2 Sequencing

In what order should stops be visited?

Depot → C → A → B

3 Allocation

Which vehicle or driver owns each stop?

Truck 7 serves A, C, F

4 Scheduling

When should each visit and shift occur?

Reach A between 06:00–06:30

5 Optimisation

Search across all four decisions for the best feasible plan.

Minimise cost without breaking reality

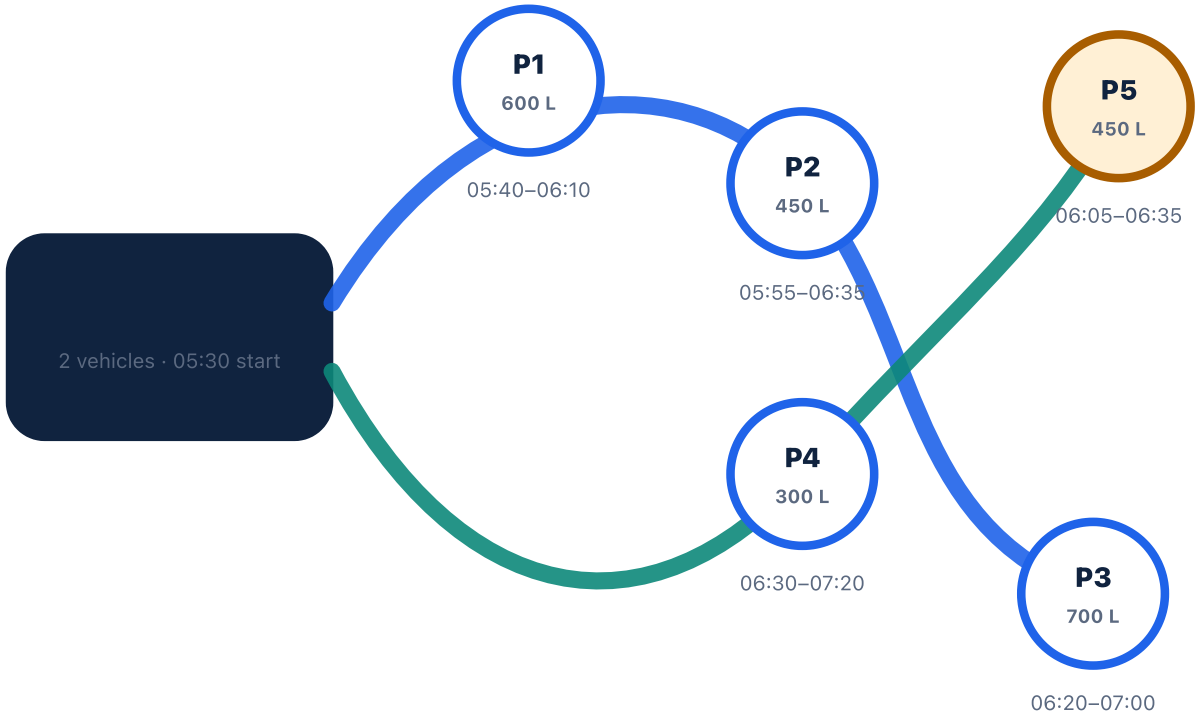
Route optimisation mental model

FleetRobo Order → Plan → Execute abstraction

Tracking is different again: it observes what actually happened after the plan was committed. Planning produces intent; GPS produces

A milk run is a Vehicle Routing Problem with personality

The generic skeleton is familiar. Dairy adds freshness, variable collection quantities and sometimes product-separation rules.



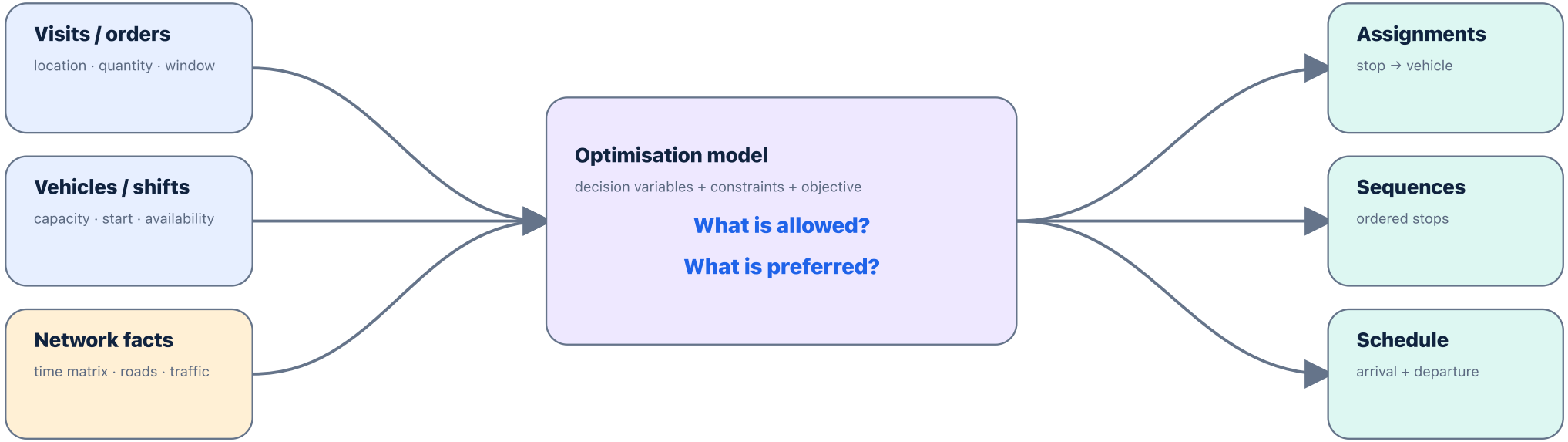
What the planner is really deciding

- ✓ **Assignment:** which truck collects each point?
- ✓ **Sequence:** in what order?
- ✓ **Timing:** can every collection window be met?
- ✓ **Load:** does cumulative milk stay within capacity?
- ✓ **Return:** can the truck reach the chilling centre before quality or shift limits?
- ✓ **Stability:** should today's familiar route be preserved even if another plan is 2 km shorter?

Important: "Shortest route" is usually the wrong problem statement.

Optimisers do not consume “business requirements”

They consume structured entities, constraints, costs and an objective. Bad modelling in means confidently wrong plans out.



Coordinates are not addresses.

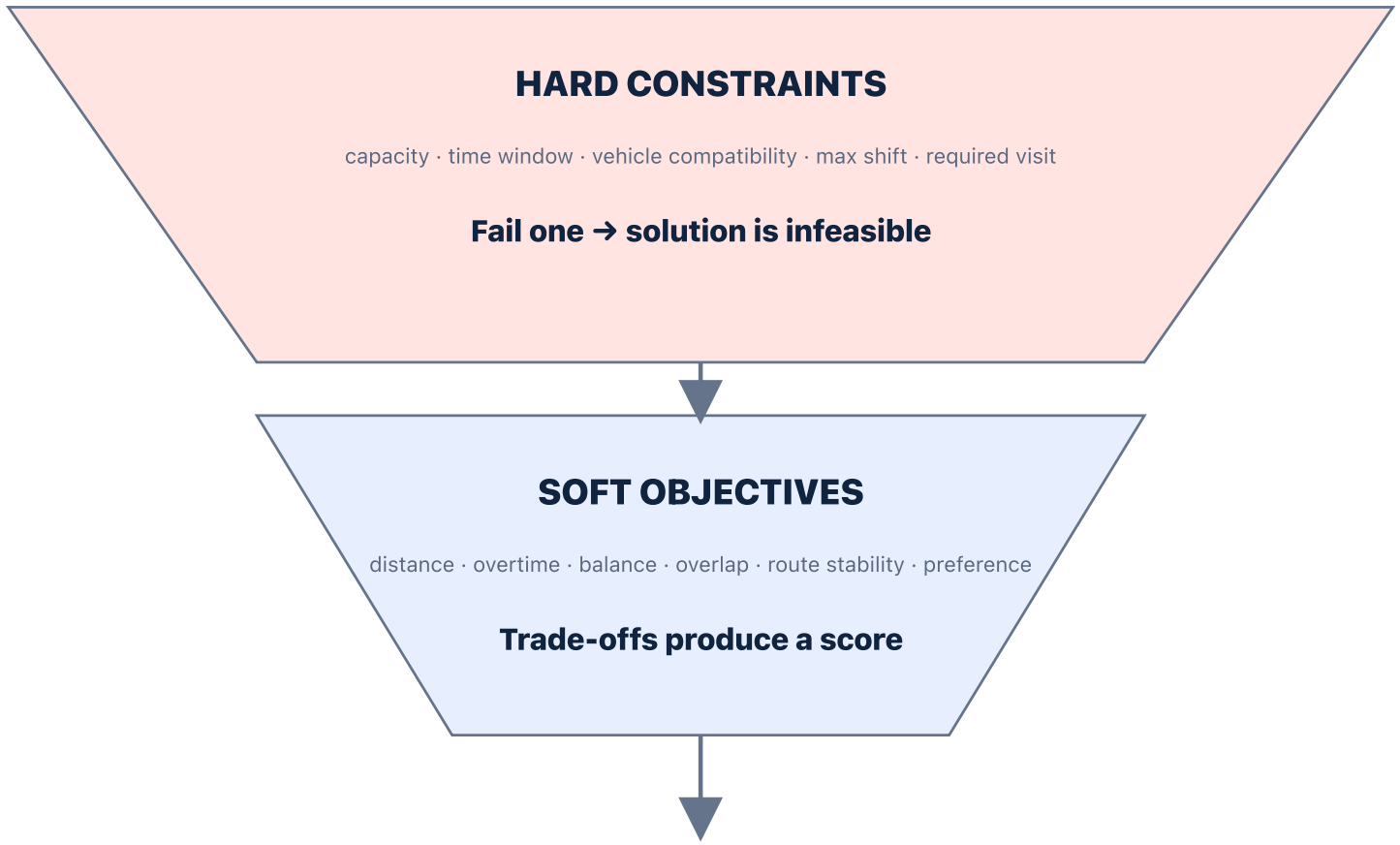
Capacity may be weight, volume, compartments or product compatibility.

Travel time is not straight-line distance.

Google Route Optimization shipment/vehicle model; OR-Tools dimensions

Hard constraints gate. Soft objectives rank.

This distinction is the single most useful concept for product conversations.



Candidate routes

Option B 92
feasible · stable · +4 km

Option A 74
feasible · +8 km · more delay

Option C —
infeasible · misses window

Never hide infeasibility behind a mysterious low score. Explain the broken rule.

Can a new pickup fit an existing route?

Test every sensible insertion position, reject broken constraints, then compare the survivors.

Existing Route R1

D 12m A 14m B 18m C 22m D

Load 1,900 / 2,500 L · all windows currently pass

NEW P5

450 L

window 06:05–06:35

service 8 min

A D → A → P5 → B → C → D

+8 km

✗ C becomes 18 min late

B D → A → B → P5 → C → D

+4 km

✓ capacity, windows and shift pass

C D → A → B → C → P5 → D

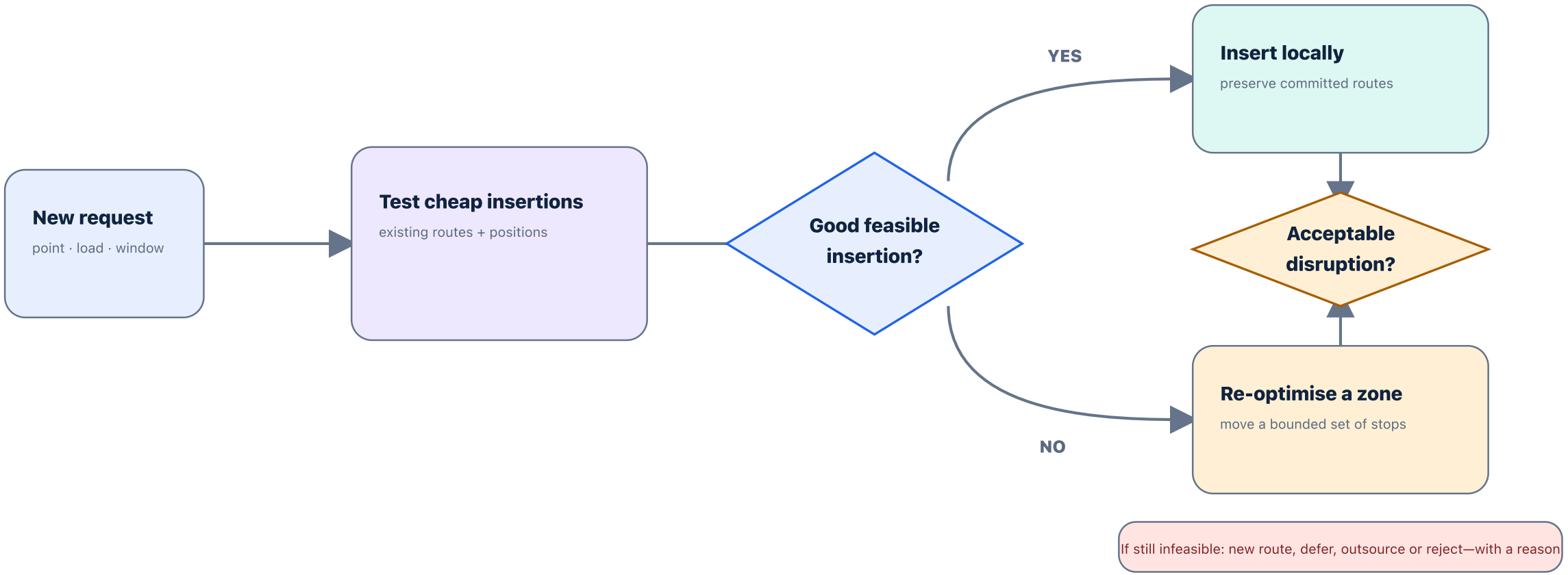
+11 km

✗ P5 reached after 06:35

Recommendation **Insert P5 after B** because it is the lowest-cost feasible change—not merely the geometrically nearest point.

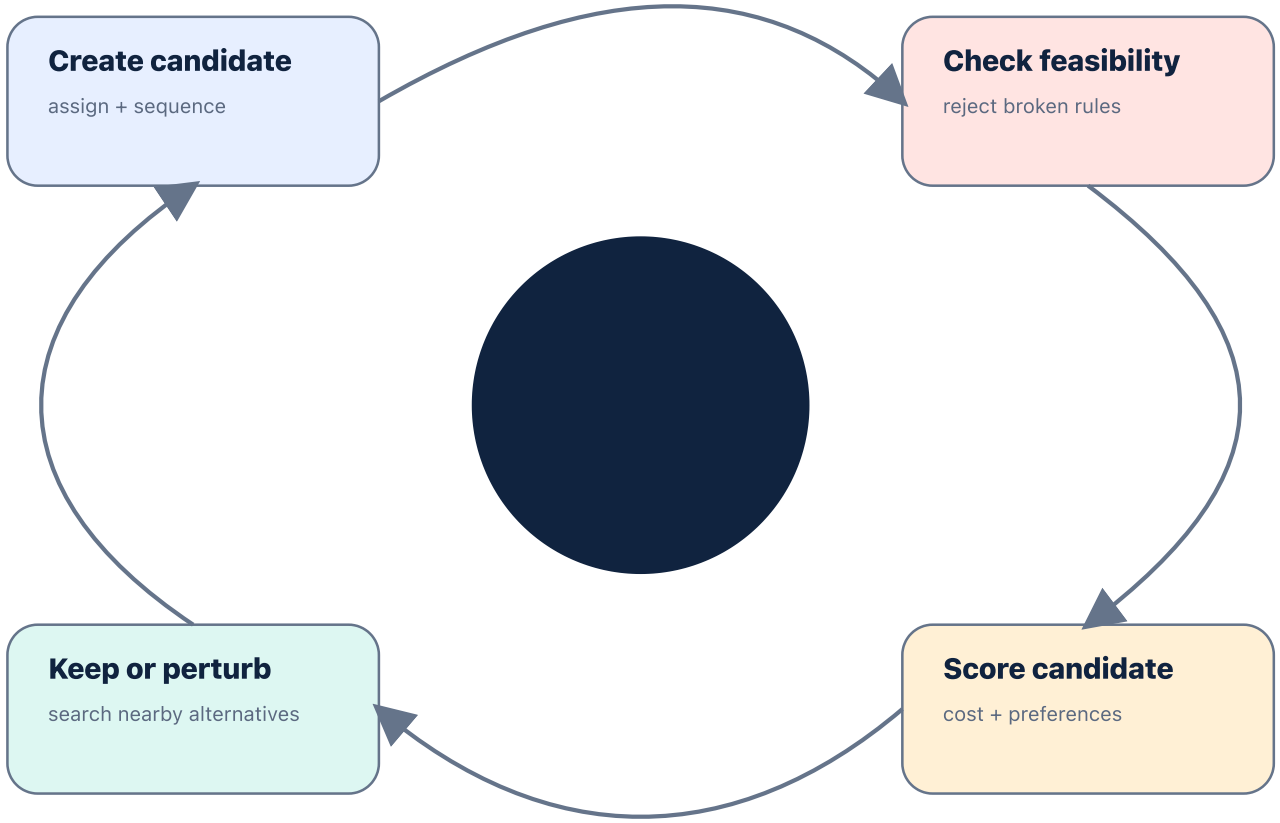
Insertion, local repair or full re-optimisation?

The smartest planner is not the one that constantly redraws everything. Operational stability has value.



The solver searches. It does not “understand logistics”.

Your team supplies the model and trade-offs; the engine explores combinations faster than humans can.



Exact methods

Can prove optimality, but often become slow as problem size and constraints grow.

Heuristics / metaheuristics

Find good solutions quickly; may not prove they are globally best.

Time limit

Real products frequently ask for “best answer in 2–30 seconds,” not theoretical perfection.

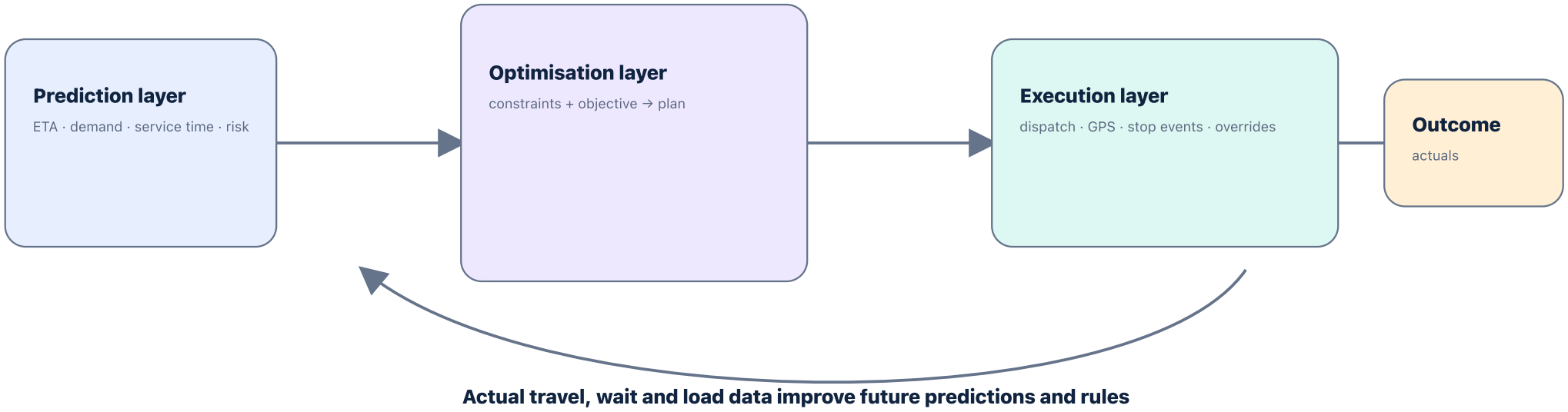
Product implication

Show solution quality, unresolved visits and trade-offs —not a magical “Optimised” badge.

OR-Tools: VRPs are computationally hard and may return good, non-optimal solutions

Optimisation chooses. Machine learning predicts.

They can work together, but calling the whole thing “AI” hides important engineering and product decisions.



Rule of thumb: If the task is “choose the best feasible combination,” think operations research. If it is “estimate an unknown future value,” think machine learning.

How others package the same underlying problem

The market differs less in the mathematics than in control, integration, explainability and operational workflow.

BUILD

Solver toolkit

Google OR-Tools

You own the data model, distance matrix, constraints, search configuration, scaling and UX.

Best when optimisation logic is strategic IP and you have OR engineering depth.

API

Managed optimiser

Google / HERE

Send vehicles, visits, windows and costs; receive assigned routes, metrics and unresolved work.

Fastest path when roads, traffic and industrial solving are infrastructure—not differentiation.

PLATFORM

Constraint platform

Timefold

Model hard and soft constraints, score solutions, support real-time planning and expose useful visualisations.

Useful when constraint flexibility and explainability matter more than owning the solver.

BUY

Operations SaaS

OptimoRoute

Import orders, plan, manually adjust, dispatch to drivers, track progress and analyse actual performance.

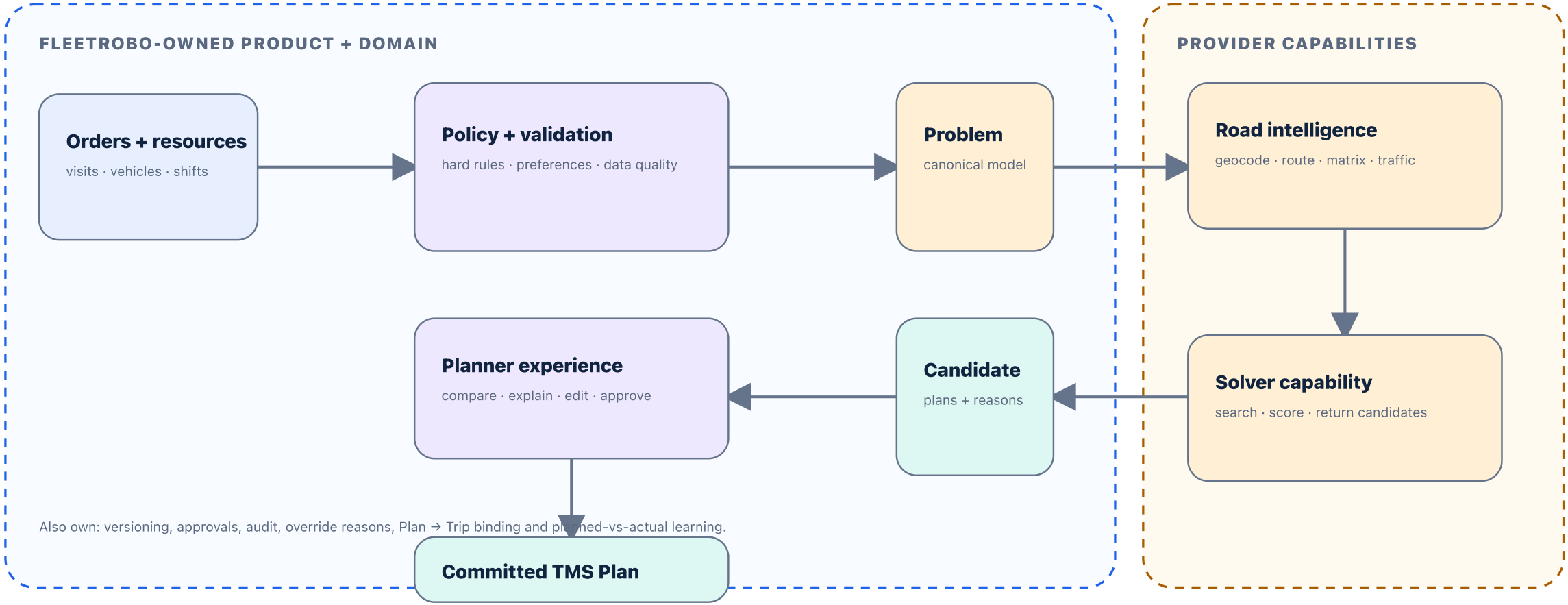
Shows the complete user workflow—but offers less control over your TMS product experience.

GraphHopper illustrates another modular pattern: separate geocoding, routing, matrix and optimisation APIs so each layer can be swapped or owned independently.

Official Google, HERE, GraphHopper, Timefold and OptimoRoute documentation

What FleetRobo should own—and what it can rent

Own the operational truth and decision experience. Treat road intelligence and solver machinery as replaceable capabilities until proven otherwise.



A trustworthy planner is a decision cockpit, not a “Generate Route” button

Humans need to see the plan, understand compromises and stay in control when the model meets messy operations.

1 Prepare
Validate visits, fleet, windows and missing data

2 Configure
Choose objective, frozen routes and allowed disruption

3 Generate
Produce candidates plus infeasible/unassigned work

4 Compare
Map + vehicle timeline + visit view + metrics

5 Explain
Why assigned, why skipped, which constraint binds

6 Adjust
Drag, lock, override and re-run locally

7 Commit
Approve versioned Plan and dispatch

8 Observe
Track actuals, exceptions and route adherence

9 Learn
Calibrate ETAs, service times and business rules

Map spatial shape + overlaps

Vehicle timeline shift, wait, breaks, lateness

Visit table assignment, window, reason, status

Route optimisation mental model

Timefold visualisation workflow; OptimoRoute planner workflow

Route planning happens at three different horizons

The users, decisions, data freshness and tolerance for change are different at each horizon. Treating them as one screen creates chaos.

MONTHLY / WEEKLY **1**

Network and route design

Define the stable operating shape before daily demand arrives.

- Depots, collection zones and route templates
- Service days and standard collection windows
- Vehicle types, capacities and transporter pools
- Policies: maximum distance, duration and mixing rules

Owner: Operations manager + route designer

DAY-BEFORE / SHIFT START **2**

Daily planning

Turn today's work and available fleet into committed Plans.

- Import today's quantities, additions and cancellations
- Confirm vehicles, drivers, shifts and unavailable assets
- Insert visits, create routes and compare alternatives
- Review, adjust, approve and dispatch

Owner: Route planner / dispatcher

SAME DAY / LIVE **3**

Exception and replanning

Repair only what must change after commitment or movement.

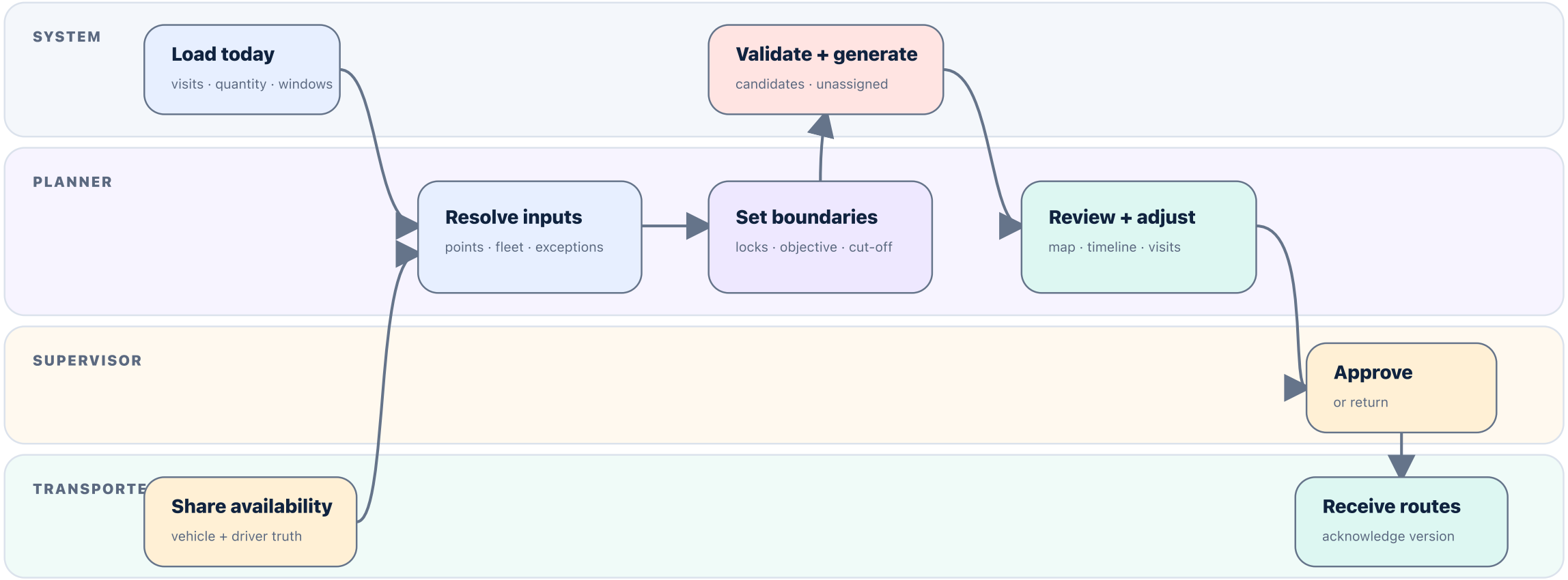
- New pickup, quantity spike, delay or breakdown
- Protect completed and frozen work
- Repair locally before re-optimising a wider zone
- Approve, notify and preserve a new Plan version

Owner: Dispatcher + supervisor + live ops

Reality: planners rarely start from a blank map. They begin with yesterday's routes, today's changes and a limited permission to disturb what drivers already know.

How a route planner builds and commits the day

A practical swimlane: what the system prepares, what the planner decides, what the supervisor governs and what the transporter receives.

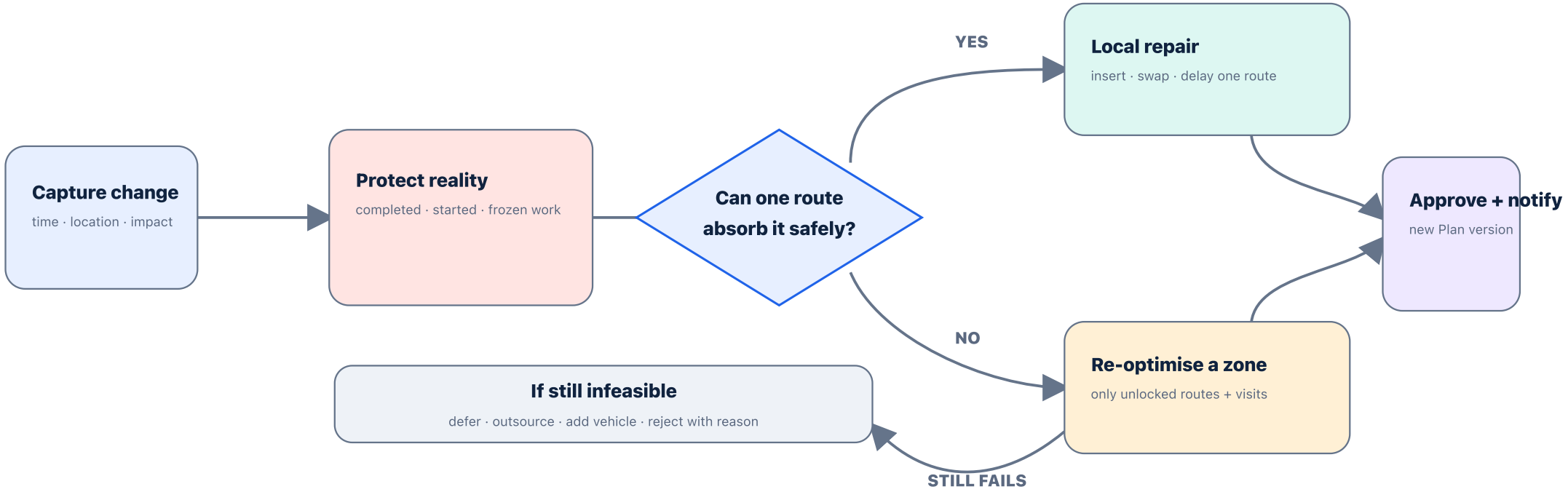


Output: a versioned, auditable Plan—not merely a polyline. Unassigned visits remain visible with reasons.

When reality changes, repair the smallest safe part of the plan

Same-day replanning is governed change management. The goal is not to continuously redraw every route.

New pickup · Quantity spike · Vehicle unavailable · Road delay · Missed collection



Driver communication: never silently alter a dispatched route.

Versioning: keep original, changed and actual sequence.

Success metric: service recovered with minimum disruption.

Most route-optimisation failures are product failures before they are algorithm failures

The solver is an excellent scapegoat for missing data, contradictory rules and ignored operational behaviour.

Garbage coordinates

Pins fall on the wrong road, village or entrance.

Validate and let users correct map points.

Fantasy travel times

Rural roads, loading queues and seasonal conditions are absent.

Calibrate matrix estimates with actual trip data.

Constraint explosion

Every stakeholder marks preferences as mandatory.

Force hard-versus-soft classification and ownership.

Plan instability

Minor changes reshuffle every driver and stop.

Freeze committed work and penalise disruption.

Silent infeasibility

Visits vanish because no route can legally serve them.

Show unassigned work and exact reason codes.

Manual override blindness

Drivers know local reality but overrides disappear.

Capture reason, outcome and repeat patterns.

Optimise the wrong KPI

Distance falls while overtime, spoilage or service failure rises.

Use a balanced scorecard tied to business outcome.

Tracking ≠ planning

GPS dots are mistaken for route intelligence.

Keep Plan intent and Trip evidence as separate layers.

Questions that reveal the real problem

Ask these before discussing vendors, algorithms, screens or “AI”.

Business

1. What does “better” mean: distance, vehicles, freshness, on-time rate, stability or cost?
2. What is the cost of leaving one pickup unserved?
3. Which decisions are strategic, daily and real-time?
4. What can a planner override, and who approves it?

Constraints

1. Which rules are truly impossible to break?
2. Which rules are preferences with penalties?
3. Are quantities known, forecast or confirmed only at pickup?
4. Do milk grades, compartments or cleaning rules restrict mixing?

Operations

1. When are routes frozen?
2. How frequently do new points or quantity changes arrive?
3. What causes planners and drivers to ignore generated routes?
4. How are waiting, failed visits and road exceptions recorded?

Technology

1. Where do geocodes, traffic and GPS come from?
2. What response time is acceptable for planning and replanning?
3. Must the result be reproducible and auditable?
4. What happens when provider APIs or GPS are degraded?

What you should learn—in the right order

You do not need to become an operations-research scientist. You need enough depth to frame the problem, challenge assumptions and lead product decisions.

01 Vocabulary

TSP, VRP, CVRP, VRPTW, pickup-delivery, depot, matrix, hard/soft constraints.

Outcome: translate customer language into a known problem family.

02 Model a tiny case

Use 1 depot, 2 vehicles and 8 visits on paper. Mark capacity and windows.

Outcome: feel why nearest-neighbour logic fails.

03 Run a solver

Complete the OR-Tools VRP and time-window tutorials; alter one constraint at a time.

Outcome: understand inputs, search limits and infeasibility.

04 Compare providers

Send the same small dataset to one managed optimiser and compare its model/output.

Outcome: separate provider capability from FleetRobo product value.

05 Shadow reality

Observe planners for two route-planning cycles and capture every manual exception.

Outcome: discover hidden constraints no workshop will surface.

06 Design the cockpit

Prototype map + timeline + visit table + reason explanations, not just route lines.

Outcome: test whether humans trust and can repair the plan.

07 Measure the loop

Compare planned vs actual distance, time, stops, load and overrides.

Outcome: improve estimates, rules and adoption continuously.

The mental model to carry into Universal TMS

Do not jump to features yet. Preserve these product truths when we eventually design the planning capability.

1

Plan is a commitment

Optimisation proposes a versioned Plan. GPS and Trip events later prove what happened.

2

Patterns stay generic

Milk collection maps to Multi-Stop or Consolidated Plans; dairy rules belong in configuration.

3

Explainability is product

Why this vehicle, why this sequence, why this stop is unassigned and what changed must be visible.

4

Human control is not failure

Locks, edits and overrides are first-class operational inputs —not embarrassing exceptions.

5

Providers remain replaceable

FleetRobo owns the canonical model, policy, workflow, audit and execution feedback loop.

6

Optimise outcomes

Distance is one metric. Reliability, capacity, freshness, workload, stability and service matter too.

Your next useful question is no longer “Can we build route optimisation?” It is: **“What decisions, constraints and outcomes must our planning product own?”**

A compact glossary and source map

Keep this page nearby when the acronyms start breeding.

TSP

One vehicle, visit all locations, choose sequence.

VRP

Multiple vehicles, assignments and routes.

CVRP

VRP with vehicle capacity.

VRPTW

VRP with visit or shift time windows.

PDP

Pickup and delivery pairs with precedence.

Matrix

Travel time/distance between every relevant pair.

Objective

What the solver tries to minimise or maximise.

Penalty

Cost of a soft-rule violation or dropped visit.

Heuristic

A method that finds good solutions quickly.

Re-optimisation

Solve again after data or operations change.

Study next

Foundations: Google OR-Tools Vehicle Routing, VRP and VRPTW guides.

Managed API model: Google Maps Route Optimization request/response and time-window concepts.

Constraint product: Timefold introduction, visualisations and metrics.

Operations workflow: OptimoRoute planning and planning-settings guides.

Dairy depth: milk collection centre VRP, raw-milk routing and blending research.

Full URLs: included in the companion `SOURCES.md`.

> **Coaching rule:** learn through one evolving dataset. Changing the example every time hides the effect of each constraint.