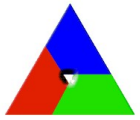
POEM

Management and Optimization

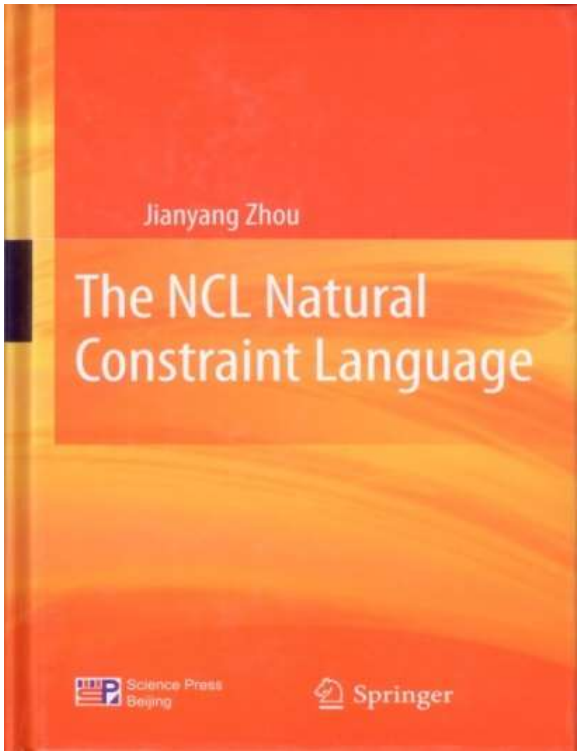


Jianyang Zhou

Mathematical Language

- Mathematics Recognition + Operations Research

$$
\begin{aligned}
&Ti1 \in [150.0, 240.0], \quad To1 \in [250.0, 490.0], \quad Ti2 \in [150.0, 190.0],\\
&To2 \in [210.0, 340.0], \quad FE1 \in [2.941, 10.0], \quad FE2 \in [3.158, 10.0],\\
&Fi1 \geq 0.0, Fi2 \geq 0.0, \quad FB12 \geq 0.0, FB21 \geq 0.0, \quad Fo1 \geq 0.0, Fo2 \geq 0.0,\\
&\\
&T11 = 500.0 - To1, \quad T12 = 250.0 - Ti1, \quad T21 = 350.0 - To2,\\
&T22 = 200.0 - Ti2, \quad Fi1 + Fi2 = 10.0, \quad Fo2 + FB12 = FE2,\\
&Fo1 + FB21 = FE1, \quad Fi1 + FB12 = FE1, \quad Fi2 + FB21 = FE2,\\
&\\
&FE2 \times (To2 - Ti2) = 600.0, \quad 150.0 \times Fi1 + To2 \times FB12 - Ti1 \times FE1 = 0.0,\\
&FE1 \times (To1 - Ti1) = 1000.0, \quad 150.0 \times Fi2 + To1 \times FB21 - Ti2 \times FE2 = 0.0,\\
&\\
&\min \quad 1300 \times \exp\left(0.6 \times \log\left(20000 \times 6 \,/\, \left(4 \times \sqrt{T11 \times T12} + (T11 + T12)\right)\right)\right) +\\
&\qquad 1300 \times \exp\left(0.6 \times \log\left(12000 \times 6 \,/\, \left(4 \times \sqrt{T21 \times T22} + (T21 + T22)\right)\right)\right).
\end{aligned}
$$



- Publications

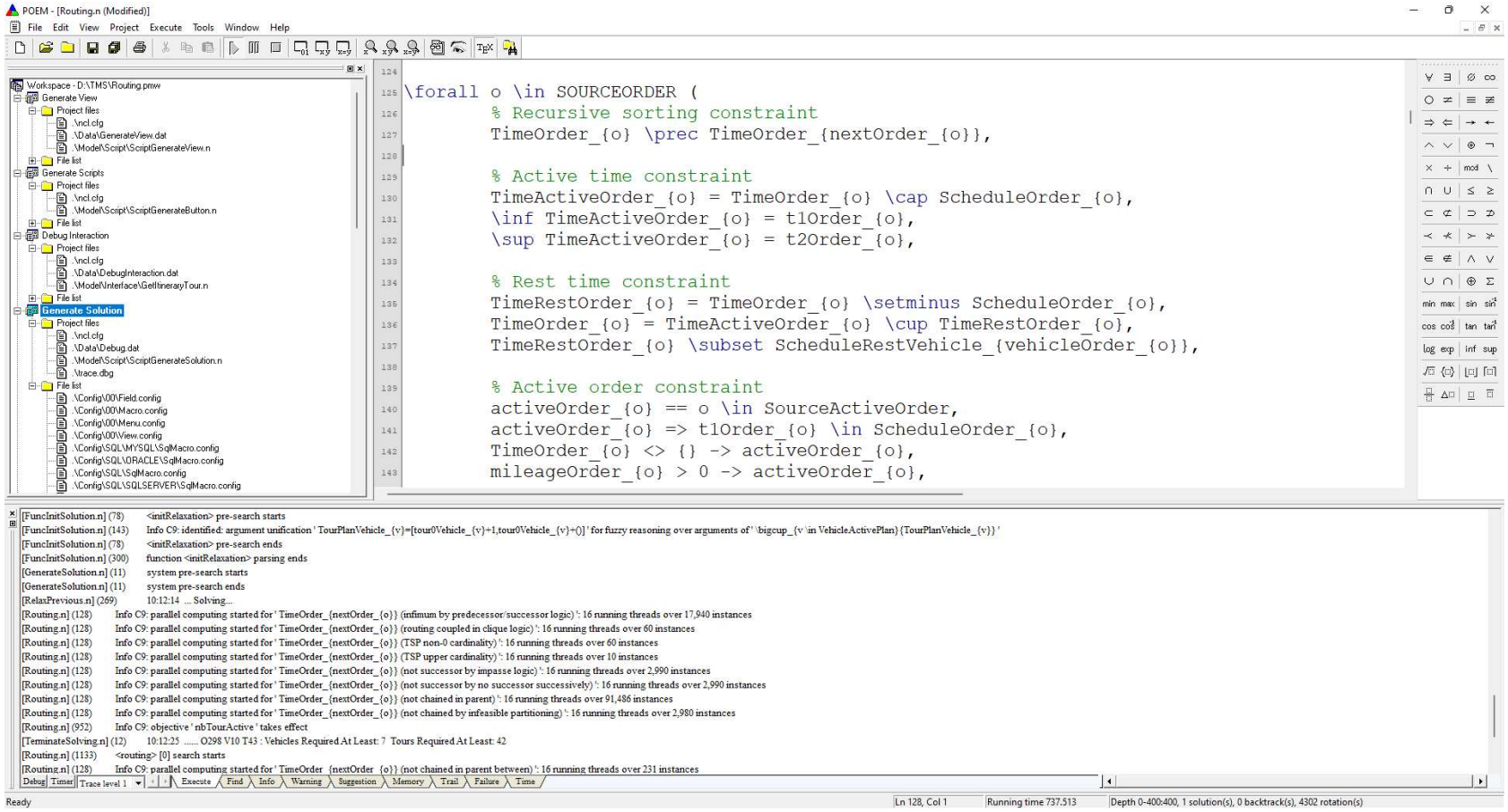
J. Zhou: The NCL Natural Constraint Language. Springer, ISBN 978-3-642-23844-4 (2012)

J. Zhou: Introduction to the constraint language NCL - Journal of Logic Programming. 45 (1-3): 71-103 (2000)

The POEM Platform

- POEM : Development Tool for The NCL Language

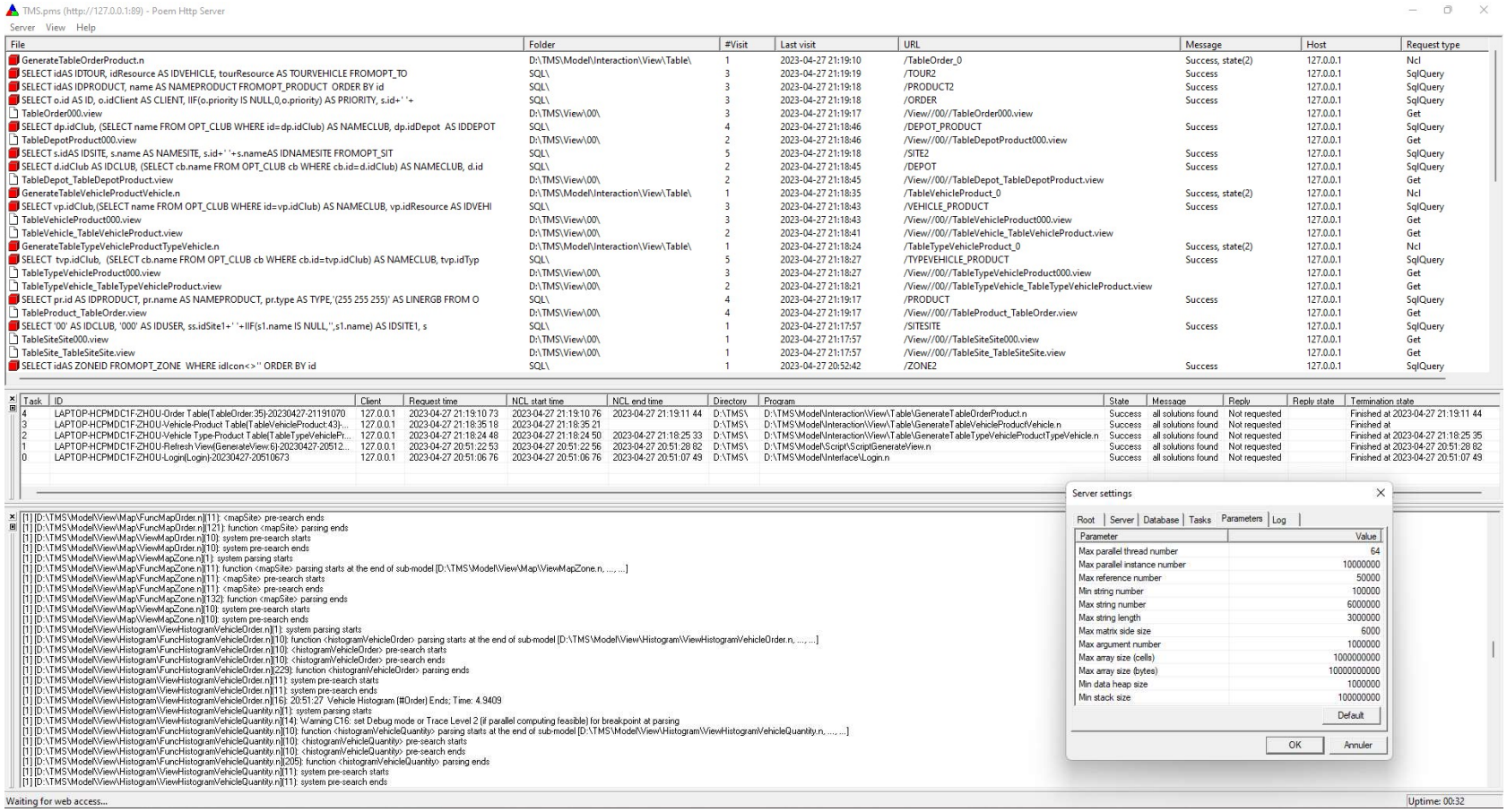
Products



The POEM Platform

- PoemServer : Multi-Task Server / Parallelism for Each Task

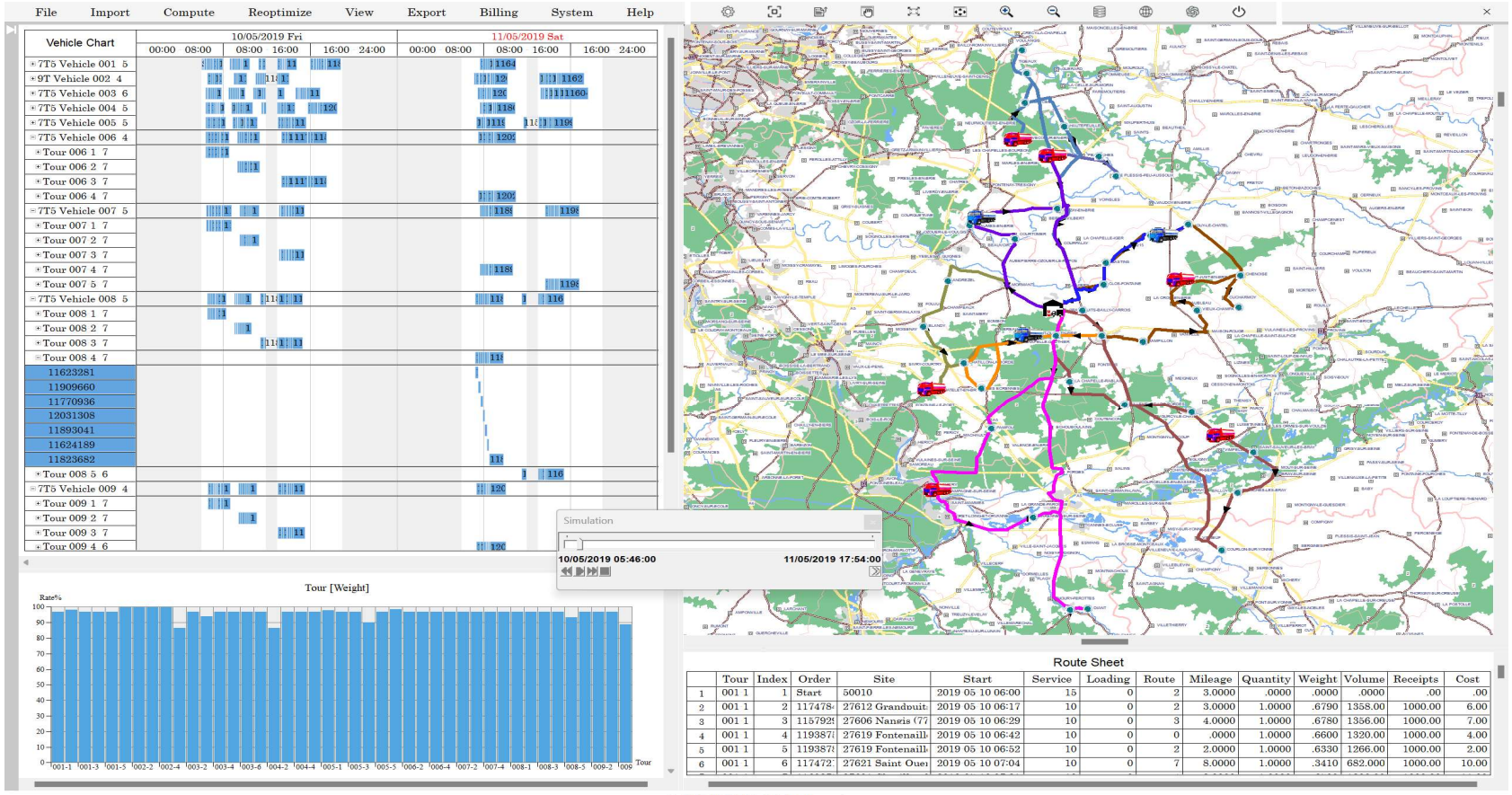
Products



The POEM Platform

- PoemView : Visualization Component

Products

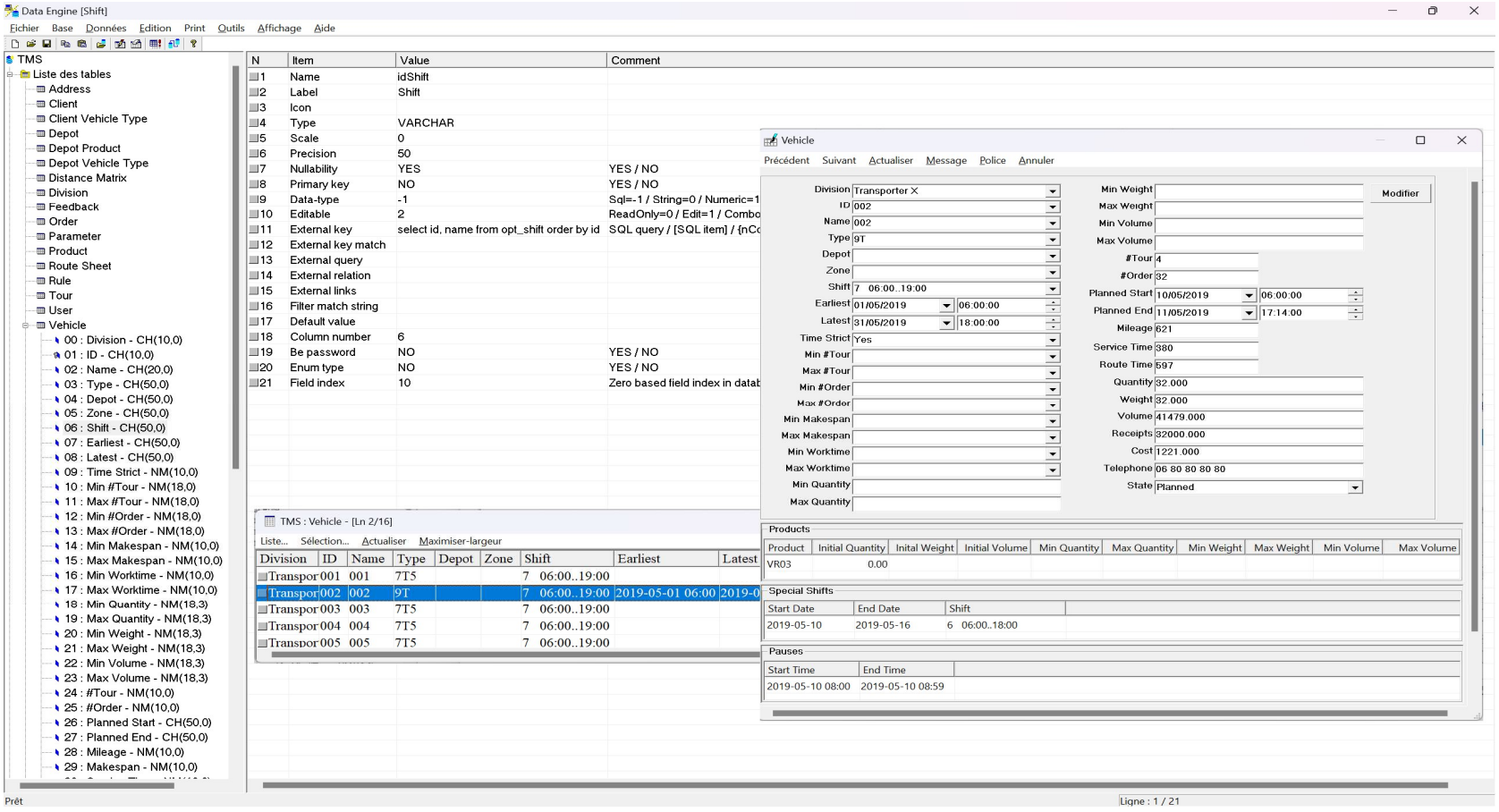


	Tour	Index	Order	Site	Start	Service	Loading	Route	Mileage	Quantity	Weight	Volume	Receipts	Cost
1	001 1	1	Start	50010	2019 05 10 06:00	15	0	2	3.0000	.0000	.0000	.0000	.00	.00
2	001 1	2	117478	27612 Grandpuit	2019 05 10 06:17	10	0	2	3.0000	1.0000	.6790	1358.00	1000.00	6.00
3	001 1	3	115792	27606 Nangis (77	2019 05 10 06:29	10	0	3	4.0000	1.0000	.6780	1356.00	1000.00	7.00
4	001 1	4	119387	27619 Fontenaill	2019 05 10 06:42	10	0	0	.0000	1.0000	.6600	1320.00	1000.00	4.00
5	001 1	5	119387	27619 Fontenaill	2019 05 10 06:52	10	0	2	2.0000	1.0000	.6330	1266.00	1000.00	2.00
6	001 1	6	117472	27621 Saint Oue	2019 05 10 07:04	10	0	7	8.0000	1.0000	.3410	682.000	1000.00	10.00

The POEM Platform

- PoemData : Modeling, Diagnosing and Managing Data

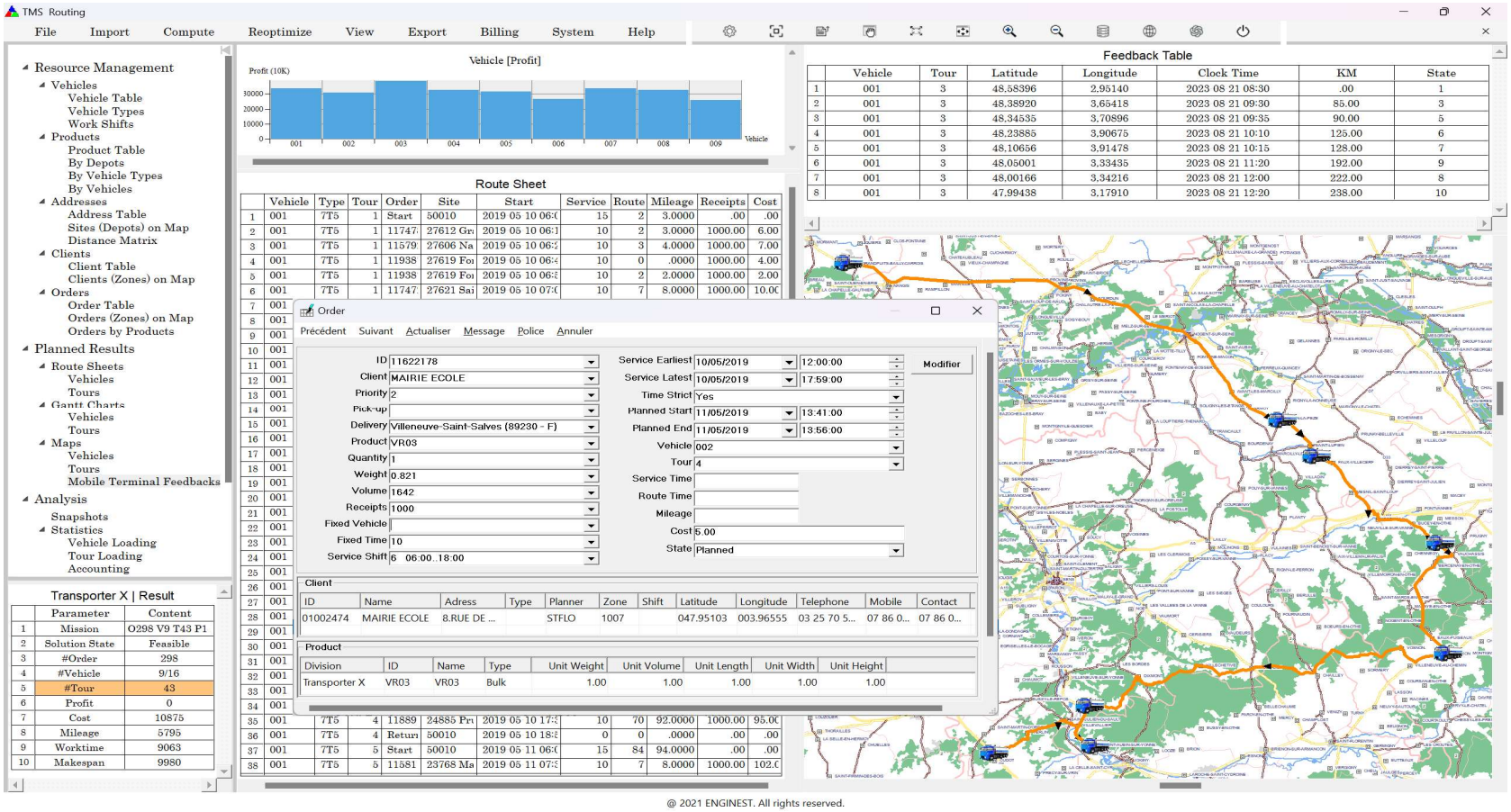
Products



The POEM Platform

Products

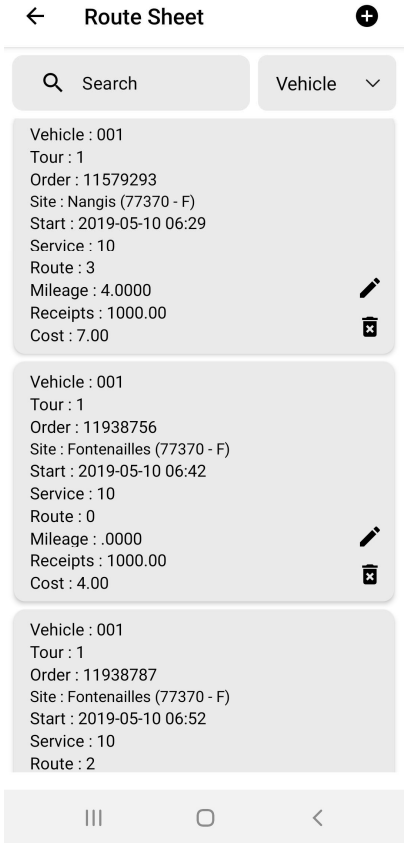
- PoemClient : Client Terminal for The Server

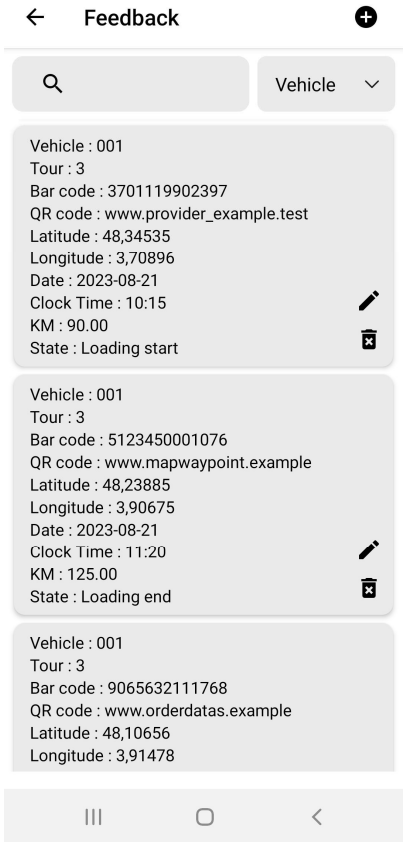


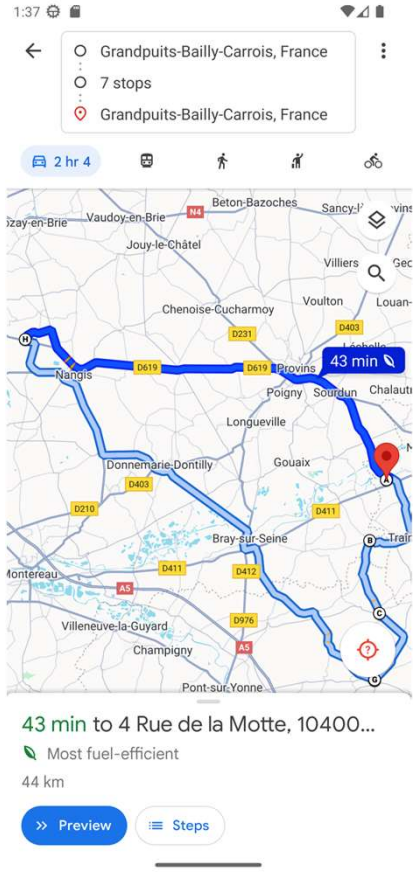
The POEM Platform

PoemMobile : Mobile Terminal for The Server

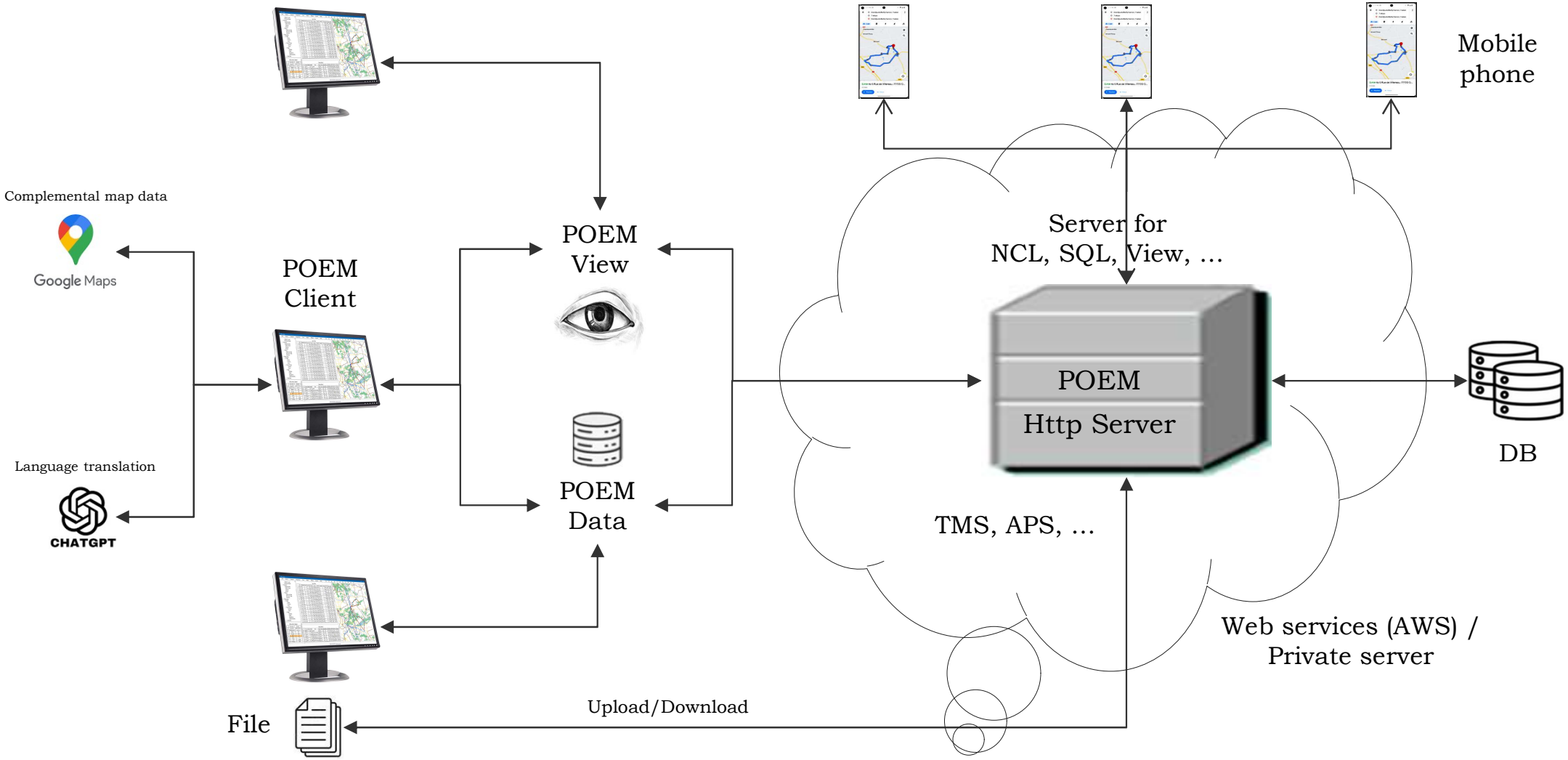
Products







Deployment SaaS



TMS : Transport Management System

Logistics Management	Transport Planning	Economic Zone Planning

▶ TMS Logistics : Logistics Management

- Objective: Optimize the plan of supply.
- Management: Sales (quotation/order), supply, stock, vehicle fleet and accounting (invoice/balance sheet).
- Constraints: stock capacity, demand (quantity/volume/weight), etc.

▶ TMS Routing : Route Optimization

- Generic: Multi-agency, multi-user, multi-depot, multi-product, multi-vehicle, multi-day, multi-tour, short or long trip.
- Objective: Number of vehicles/tours, mileage, duration/working time, cost and profit.
- Constraints: Vehicle capacity (quantity/volume/weight), work regulations, route distance (time/mileage) and customer time windows, etc.

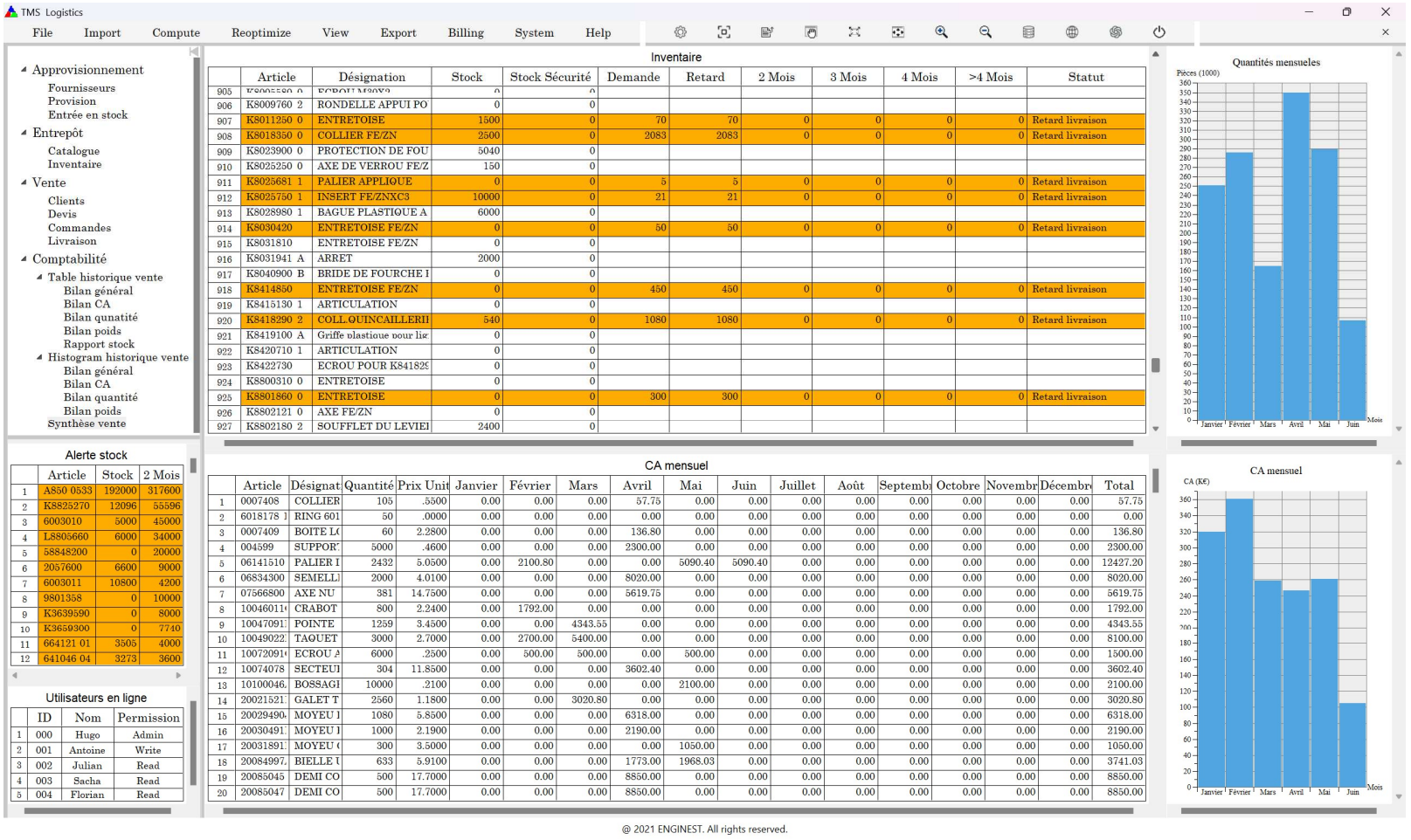
▶ TMS Depot : Economic Zone Optimization

- Objective: Minimize overall cost of depots over a period by defining their locations and economic zones.
- Constraints: Types (primary and secondary) and capacities (minimum and maximum monthly tonnage) of depots, products (types and prices), vehicles (types, capacities and costs), mileage between depots and customers, etc.

TMS : Transport Management System

- Logistics Module : Logistics Management

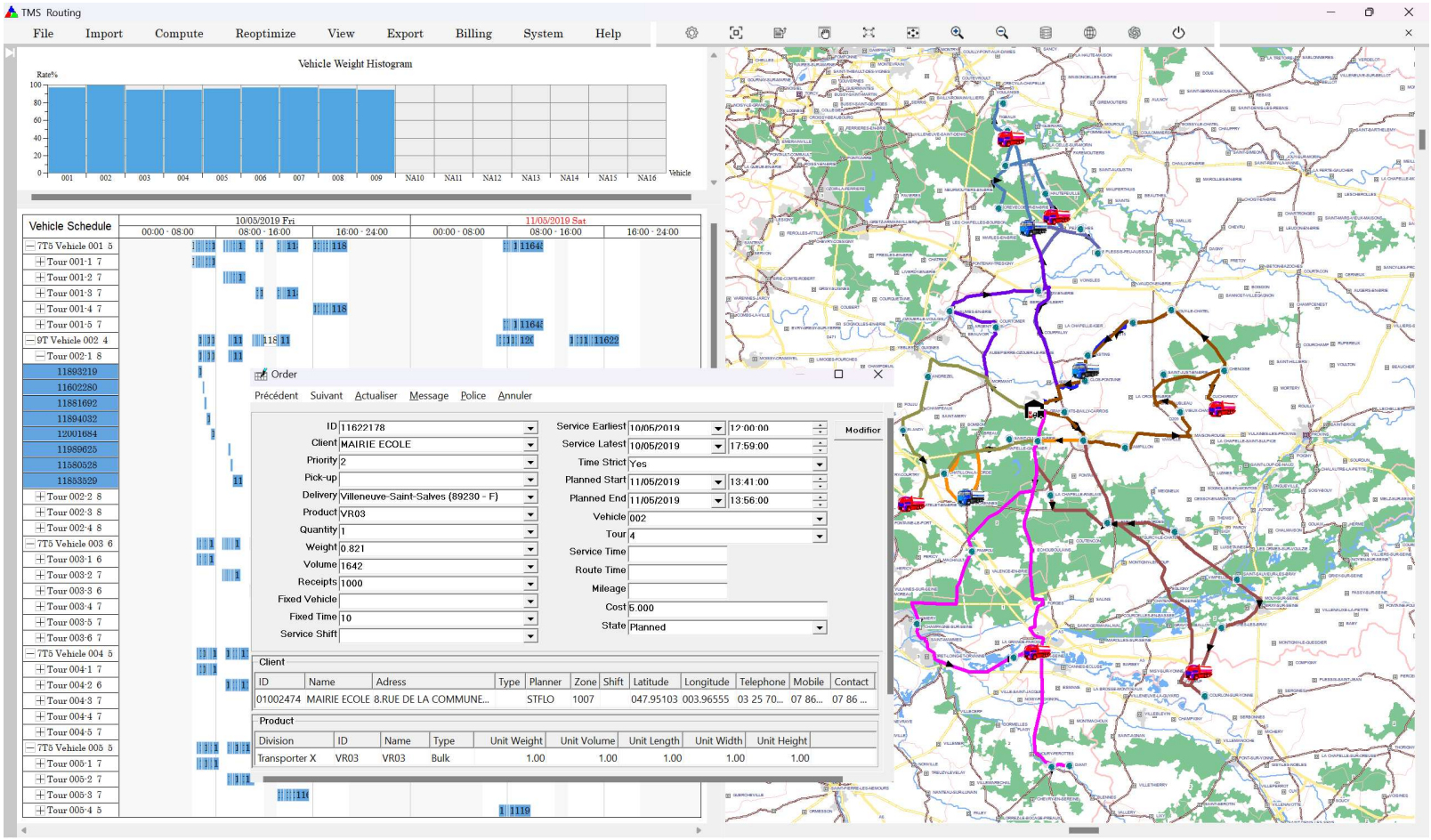
Applications



TMS : Transport Management System

Applications

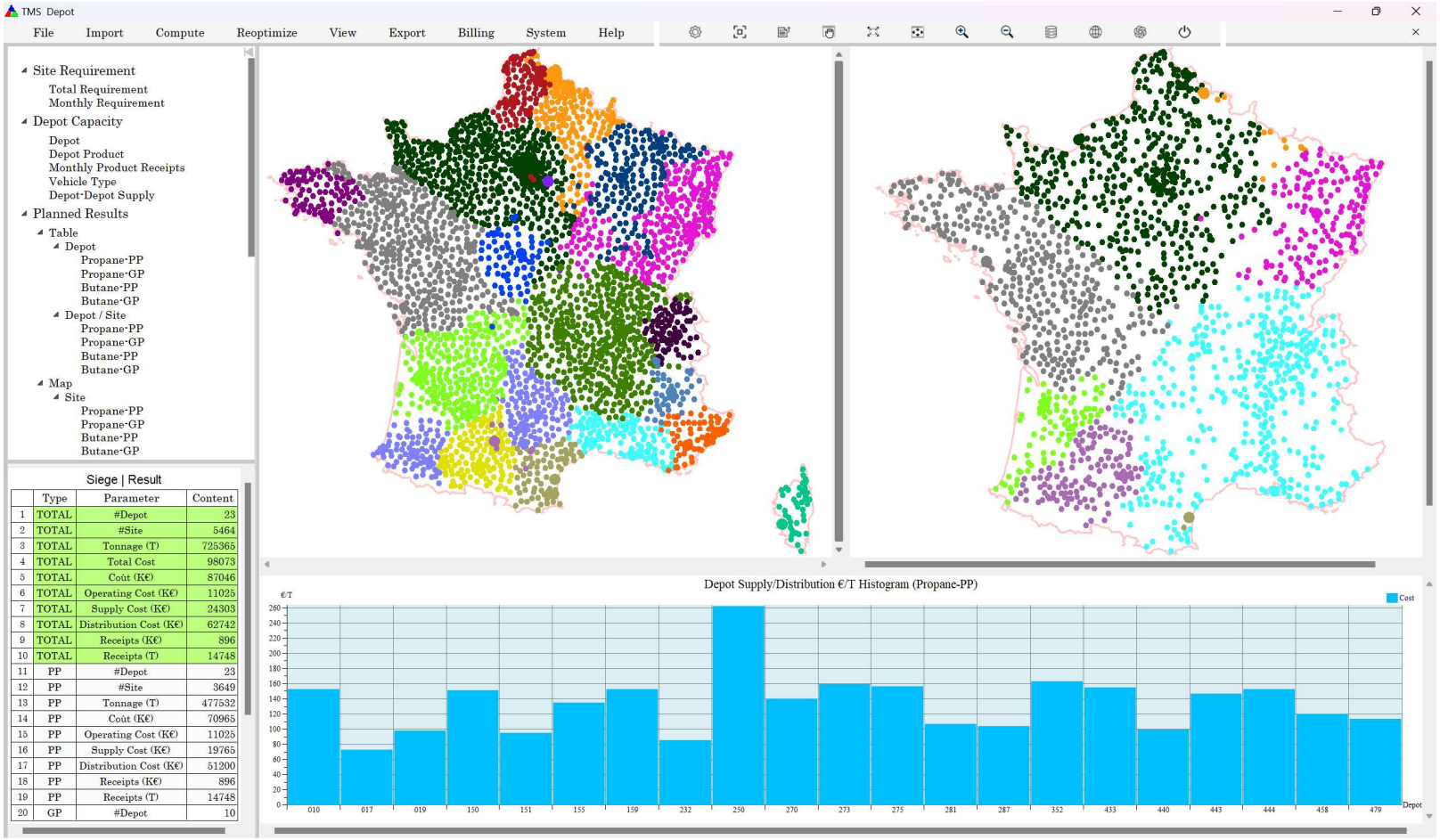
- Routing Module : Route Optimization



TMS : Transport Management System

Applications

- Depot Module : Economic Zone Optimization



	Type	Parameter	Content
1	TOTAL	#Depot	23
2	TOTAL	#Site	5464
3	TOTAL	Tonnage (T)	725365
4	TOTAL	Total Cost	98073
5	TOTAL	Coût (K€)	87046
6	TOTAL	Operating Cost (K€)	11025
7	TOTAL	Supply Cost (K€)	24303
8	TOTAL	Distribution Cost (K€)	62742
9	TOTAL	Receipts (K€)	896
10	TOTAL	Receipts (T)	14748
11	PP	#Depot	23
12	PP	#Site	3649
13	PP	Tonnage (T)	477532
14	PP	Coût (K€)	70965
15	PP	Operating Cost (K€)	11025
16	PP	Supply Cost (K€)	19765
17	PP	Distribution Cost (K€)	51200
18	PP	Receipts (K€)	896
19	PP	Receipts (T)	14748
20	GP	#Depot	10

APS : Advanced Planning and Scheduling

▶ Planning/scheduling tasks over resources

- Human or material, static or mobile
- Uni-capacitated or multi-capacitated or no capacity limit
- Time precision: day, hour, minute or second

▶ Respecting simultaneously more than 100 types of constraints

- The task structure of a project and its operation process
- Time constraints on projects
- The organization of work teams and the cooperation of teams across agencies
- The structural demand for resources by a task
- The working time, earliest start and latest end, of a task
- The division in time or quantity of a task over resources
- The constraints of coordinating tasks according to multiple resources
- Distance constraints between different tasks based on mobile resources
- Mobility and parallel/sequential capacities of a resource
- The work calendar and daily shifts of a resource
- Resource allocation and mobilization to work sites, ...

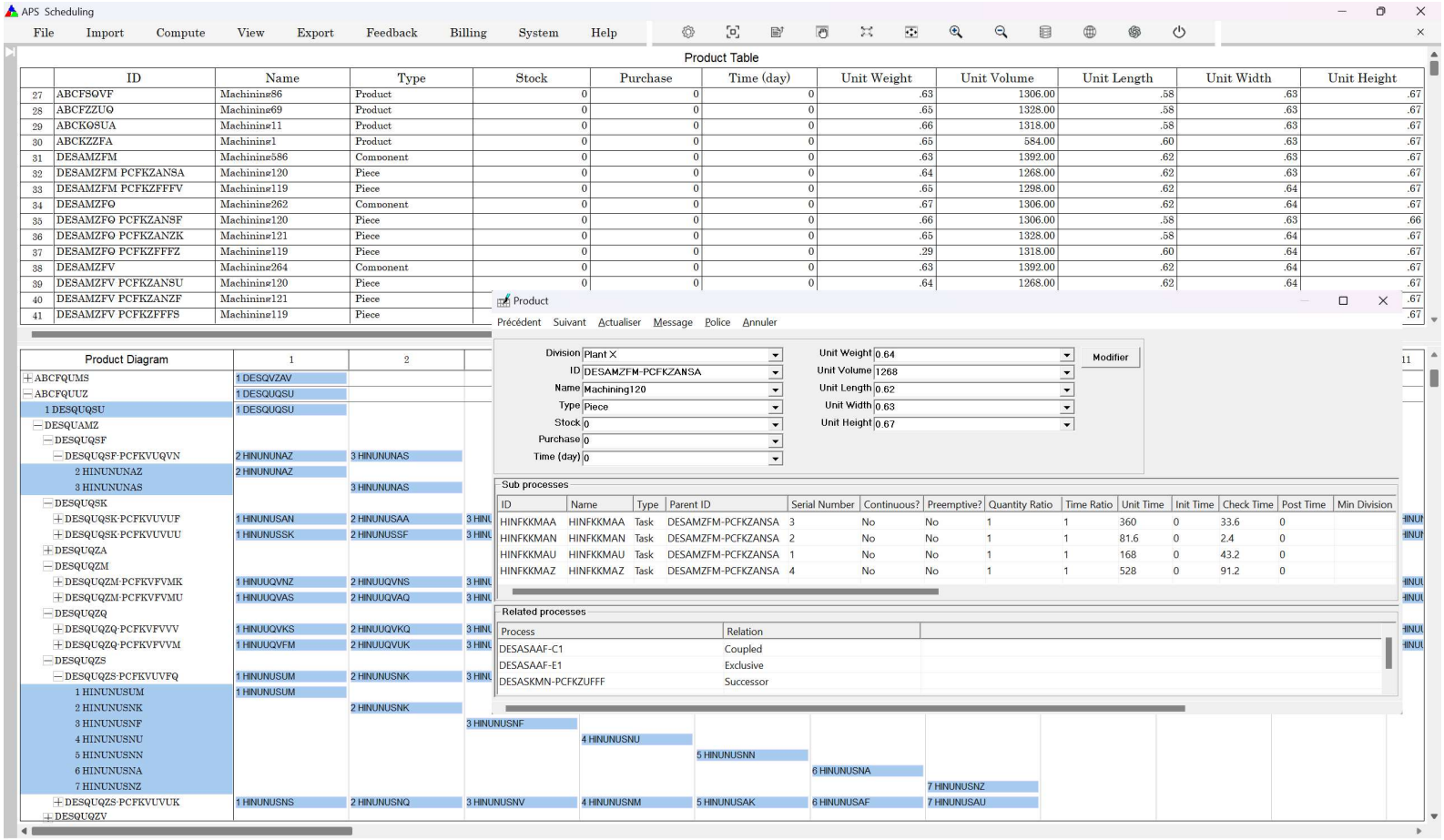
▶ Optimizing with multiple objectives

- Delay of projects, duration of projects, number of resources, cost, profit, ...

APS : Advanced Planning and Scheduling

- APS : Modeling and Managing Data Logically

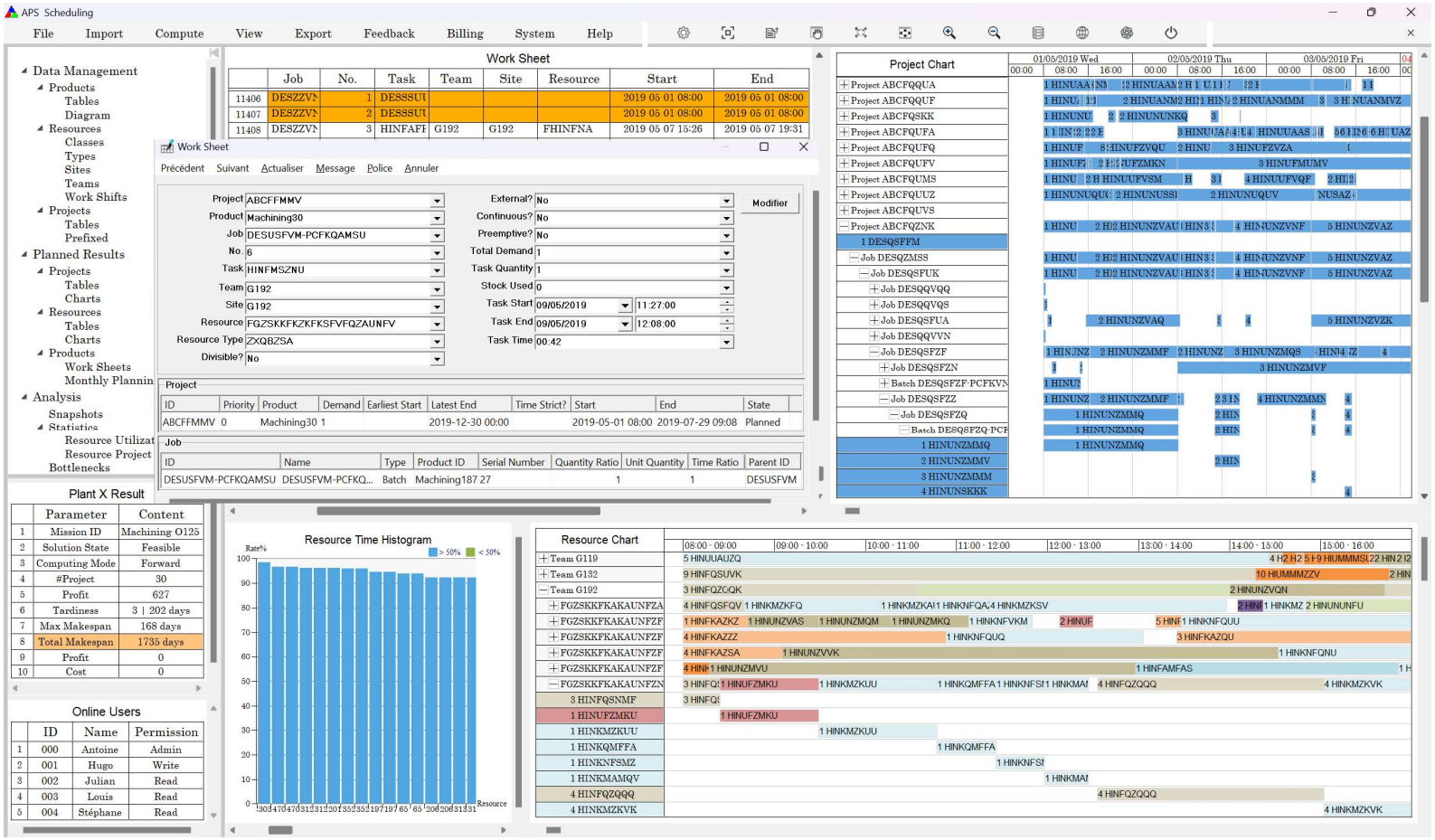
Applications



APS : Advanced Planning and Scheduling

- Scheduling Module : Operational Scheduling (Precision: hour/minute/second)

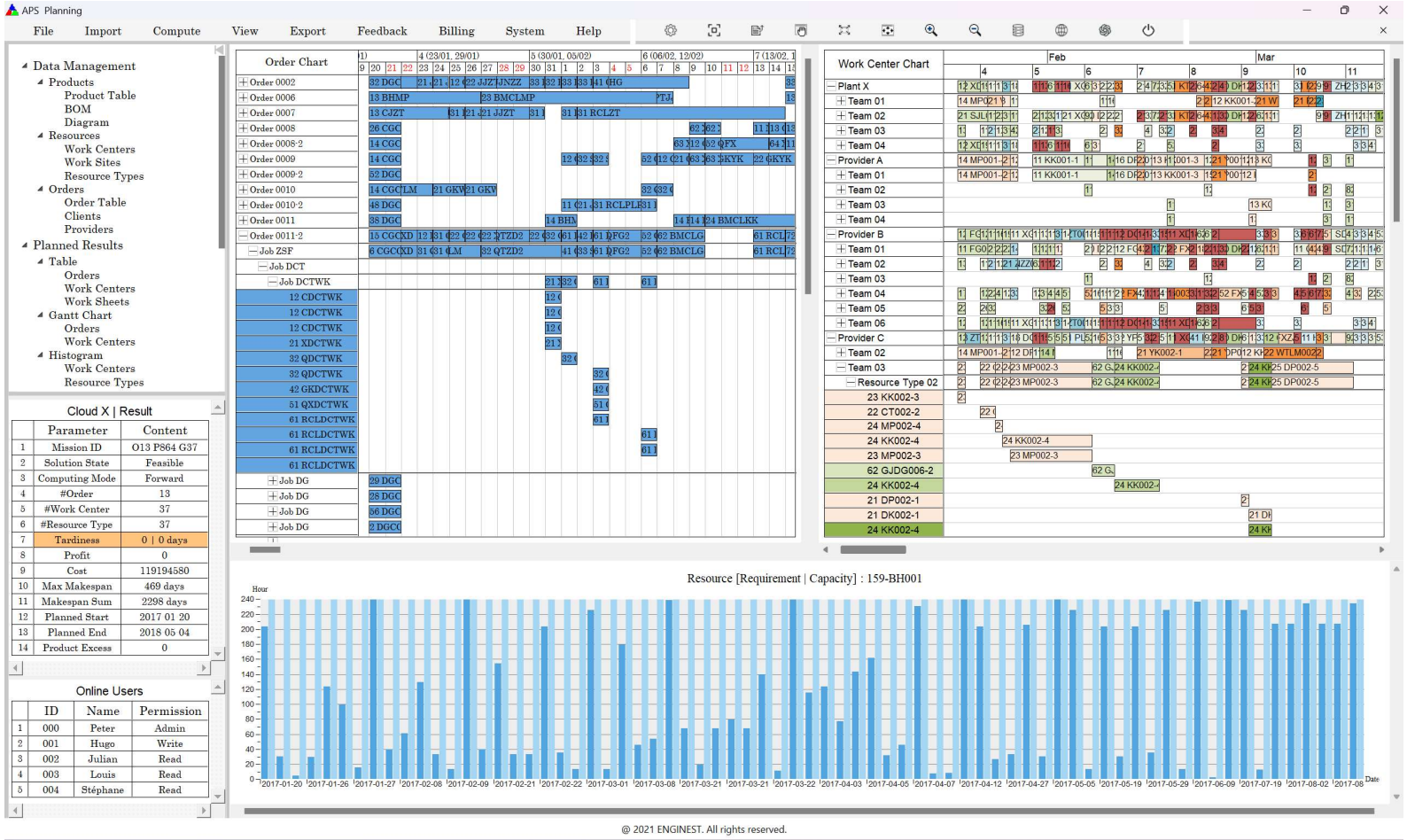
Applications



APS : Advanced Planning and Scheduling

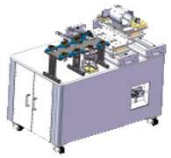
- Planning Module : Project Management and Personnel Planning

Applications



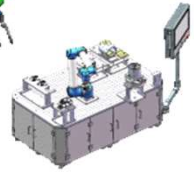
APS : A Generic Model

- Generalized through around fifteen different types of projects :
- Production planning/scheduling (machining/shaping, coating, heat treatment, assembly, integration)
- Project planning and human resource optimization, etc.
- Complex context: synchronization of mobile (AGV/robot) and static (machine/tool) resources



Optional tasks:
AGV can transport materials
at the platform or warehouse on the line side

Division of a task
in quantity on resources



Parallel capacity of a resource:
Parallel tasks on the platform

Multi-resource tasks:
synchronization of AGV / robotic arm

Mobile resources (AGV, robot):
Distance constraint between tasks

Sequential capacity of a resource:
splitting an AGV job into multiple batches

Advantages

▶ NCL : Turing-Complete Mathematical Language

- Artificial Intelligence : Mathematical parser and debugger
- Operations Research : Set programming
- Inference Engine : Reasoning based on first-order logic
- Exact Method + Parallelism : Significantly increased performance

▶ The POEM Platform: Open Architecture

- Flexible: Parameterizable NCL models; configurable terminal interfaces
- Complete: Data management, visualization/interaction and optimization

▶ Agile Applications: Project Cost Minimized / Solution Optimized

- Generic : Easy to deploy, train, maintain and duplicate; project cost minimized
- Optimal : Optimized Mathematical solution; operating cost minimized

Thanks

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