

Product Description «Way.Pro auto»

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Company information

Smart Machines LLC is a software developer for the integrated optimization of automobile and railway logistics¹.

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product Nam:	Way.Pro auto

In the field of automotive logistics: we create intelligent solutions that cover the entire supply chain, from planning and distributing goods in a warehouse to optimizing routes and arranging goods in the back.

General description of the product and its modules

The IT product «**Way.Pro auto**» is a software for automatically generating optimal automobile routes based on specified parameters (restrictions). The implementation can be performed in two variations:

- «box solution»;
- separate service for calculating optimal routes.

«Box solution» Includes the integration of the optimal route calculation service with an IT platform that has the necessary functionality to automate the main logistics processes:

- user authorization and role system;
- dling requests for transportation;

¹ В данном документе будет сделан упор именно на решении для автомобильной логистики.

- accounting for hired and own transport, specifying the type of car;
- analytical module and consumption of telematics metrics;
- cartographic service;
- user-friendly and intuitive interface (UI) for the user, etc.

This option is optimal when it is necessary to build an automation system for logistics processes «from scratch», without using current information systems for accounting and control of logistics processes. If you only need to integrate the optimal route calculation service using the REST API, then the option of quickly integrating a separate calculation service using a clear contract is preferable.

Taking into account the extensive field of automobile logistics and the many nuances in the product **«Way.Pro auto»** highlights 4 main modules:

- «[The First mile](#)»;
- «[Trunk lines](#)»;
- «[The Last Mile](#)»;
- «[Courier delivery](#)».

«[The First mile](#)» module generates optimal routes from any point of initial departure (for example, supplier warehouses, stores, or terminals) to a warehouse consolidating a given volume of goods.

«[Trunk lines](#)» module calculates optimal routes for transportation between any warehouses directly or using cascade² routes.

«[The Last Mile](#)» module generates optimal routes from the warehouse to the delivery points, which can be order pick-up points, shops or terminals.

«[Courier delivery](#)» generates optimal routes from warehouses, pick-up points, or stores to end customers (individuals or legal entities) by foot couriers, couriers using cars or other means of transport (bicycles, scooters).

These modules cover all the main contours of automobile logistics, contain many parameters, and quickly adapt to the customer's business requirements. The IT product **«Way.Pro auto»** is intended for managers of the logistics division of transport companies who solve the following tasks:

- creating of multiple logistics routes manually or using various information systems;
- consideration of a variety of dynamic factors and constraints;
- reduced logistics costs due to more efficient routes and usage tools;
- prompt updating, verification of delivery scenarios and regular recalculation as a result of changing conditions;
- creating a relationship between customers, warehouse and transport logistics;
- creation of transportation efficiency analytics with indication of growth steps.

² «Cascade routes» provides for the possibility of unloading/reloading goods at an intermediate warehouse and further shipment to the destination warehouse.

Additional services

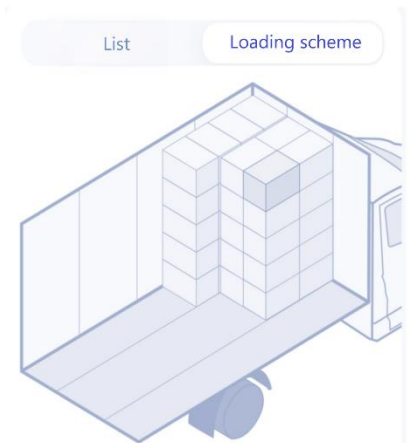
In addition to the direct function of calculating optimal routes (generating data on route numbers and point sequences), the product «Way.Pro auto» contains a number of additional services that may be important to the customer:

- cargo placement service in the back of the car;
- analytics service;
- service for generating standard (KPI) speeds;
- auto - order service;
- clusterization service.

[Cargo placement service in the back of the car](#) allows you to determine the order of loading and unloading of each product, as well as visualize its location in the body of the car.

The service allows you to flexibly customize the loading algorithm, taking into account the type of cargo and its limitations, for example, loading combined cargo, fragile or oversized cargo, the possibility of stacking cargo on top of each other or, conversely, prohibiting such a layout.

This service allows you to load and unload goods as quickly and efficiently as possible in the warehouse, as well as at each loading and unloading point, saving time at each point.



The [analytics service](#) provides users with the ability to automatically generate key transportation indicators, display positive and negative metrics, and visualize data in a convenient form in the form of dashboards. An example of calculated indicators for «[The Last Mile](#)» and «[Trunk lines](#)» is presented below:

Analysis of the calculation of last-mile routes

General indicators

Calculation details

General indicators

Field name:	Value	Unit
Number of selected points:	272	unit
Number of routes generated:	274	unit
Number of units product per day:	27 425	unit per day
Number of units product per 1 point:	100	unit per point

Сравнительный анализ:

Field name:	Was	Became	Difference	Unit.
Total distance:	8 582	7 783	- 799	km
Average route distance:	536	563	+ 27	unit
Departure frequency:	0,9	0,7	+ 0,2	per day
Density of points:	15,2	14,8	- 0,4	km
Units of goods per 1 km:	3,4	3,6	+ 0,2	per km
Waiting time:	03:40	03:19	-00:21	hh:mm

Close

Analysis of the calculation of mainline routes				
Comparative analysis:				
Indicator	Metric	Calculation 1	Calculation 2	Difference
Pallets	Number of pallets (units)	151 776	115 270	-36 497
	Number of pallets (units/km)	6,6	7,5	+0,9
Streams, routes	Number of unique routes (units)	3 385	3 344	-41
	Number of unique routes (units)	1 222	1 125	-97
	Share of direct routes (%)	29	23	-6
	Share of transit routes (%)	71	77	+6
Distance	Distance of unique routes (km)	995 677	859 308	-136 369
	Average shoulder distance (km)	815	764	-51
	Average route distance (km)	1 665	1 579	-86
Time	Time on unique routes (hour)	5 933	5 209	-724
	Average time on routes (hour)	5,5	6,5	+1,0

[Service for generating standard \(KPI\) speeds](#) automatically calculates the standard speed between logistics facilities to monitor order fulfillment and work with its own or attracted transport. This solution is most popular for long-haul transportation, where order fulfillment is monitored and the financial motivation of drivers is determined.

The formation of standard speeds is based on ML models, taking into account several factors:

- traffic and estimated time on the route;

- telematics data received from transport;
- the actual indicators of other participants on this route.

Example of a table with automatic calculation of standard speeds³:

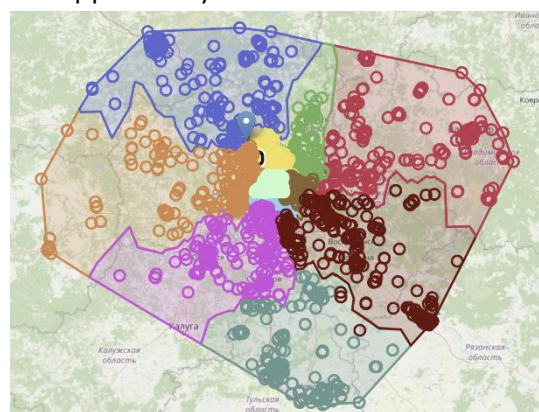
Departure warehouse	Destination warehouse	Actual routes for 7 days, units.	% own transport	Distance, km.	Date of the last normative speed	Last normative speed, km/hour	Actual speed, km/hour	Proposed normative speed, km/hour
Warehouse 1	Warehouse 2	224	95,2%	445	13.05.2025	44,1	50,2	48,2

When calculating the optimal routes, taking into account the specified number and type of vehicles, the **auto order service** informs the user about the need for additional transport orders, which will reduce the overall logistical costs of transportation. This algorithm takes into account the function of minimizing transportation costs and the cost of attracting transport.

Clusterization service (zoning) provides users with the opportunity to form clusters according to the necessary parameters, such as:

- Uniform zones for delivery to customers based on statistics and current orders;
- warehouse capacity and the load on the gates from which goods are shipped to certain logistics routes;
- the agreed tariff policy for the delivery of goods..

This service generates a final solution with the coordinates of all zone boundaries, and visualization on the map is also possible.



Functional features

The main functionality of the IT product **«Way.Pro auto»** is related to the calculation of the final routes with a sequence of points based on the received data on transportation (applications), as well as the specified parameters (restrictions).

The necessary data for the calculation of the four main directions are presented in the table below:

	The First mile	Mainline routes	The Last Mile	Courier delivery
Data for the calculation	<ul style="list-style-type: none"> • warehouse coordinates; • coordinates of the destination points; • volume (or mass) products for each point; • type of transport. 	<ul style="list-style-type: none"> • coordinates of the departure warehouse; • coordinates of the destination warehouse; • volume (or mass) of the product; • type of transport. 	<ul style="list-style-type: none"> • warehouse coordinates; • coordinates of the destination points; • volume (or mass) products for each point; • type of transport. 	<ul style="list-style-type: none"> • warehouse coordinates; • coordinates of the destination points; • volume (or mass) products for each point; • type of transport.
Calculated data	<ul style="list-style-type: none"> • route number; • the sequence number of the point; • volume (or mass) products for each point; • type of transport. 	<ul style="list-style-type: none"> • departure warehouse; • destination warehouse; • volume (or mass) of the product; • type of transport. 	<ul style="list-style-type: none"> • route number; • the sequence number of the point; • volume (or mass) products for each point; • type of transport. 	<ul style="list-style-type: none"> • route number; • the sequence number of the point; • volume (or mass) products for each point; • type of transport.

³ By taking into account the formula for calculating logistics costs, taking into account the delivery time parameter, it is possible to convert operational efficiency (speed change) into a monetary estimate.

The presented data are minimal but enough data sets (fields or attributes) necessary to perform the calculation of building an effective route, all additional parameters will be described separately. The calculated data can be provided in tabular form with the ability to display routes on a map.

The basic calculation of the route and the sequence of points is based on the choice of various parameters for each type of logistics. Parameter setting can be implemented systematically, when immutable restrictions are set, as well as in a custom version, where the user can change the set parameter value and recalculate the optimal routes.

The list of main parameters for the directions «The First mile», «Trunk lines», «The Last Mile» and «Courier delivery»⁴ is presented in the table below:

Parameters	The First mile	Mainline routes	The Last Mile	Courier delivery
• minimum or maximum allowable route distance	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• route duration	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• transport capacity and tonnage	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• the type of cargo to account for its layout in the body and capacity	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• traffic, toll roads, truck roads	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• time windows (work schedule) of logistics facilities	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• cargo type - cartons, pallets, H*W*D	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• loading and unloading time, the volume of the cargo and its type	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• VIP clients (priority of delivery)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• target function (cost reduction, speed increase, its combination)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• number of loading or unloading points in the route	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• storage capacity for incoming routes	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
• separating points from warehouses for recalculation	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
• the number of edges and the presence of cascade routes		<input checked="" type="checkbox"/>		
• warehouse capabilities to account for incoming and processed routes		<input checked="" type="checkbox"/>		
• the number and location of own and hired transport		<input checked="" type="checkbox"/>		

The list of implemented parameters is constantly expanding, and it is also necessary to clarify that many specific customer requirements are implemented point-by-point for business requirements and the final calculation model will contain all the necessary conditions and restrictions.

⁴ In this case, car courier delivery is assumed. For courier delivery options using other means of transport, there are similar parameters and settings.



The user's work with the service is intuitive and simple – you need to select the main parameters, upload the calculation data and get the calculated result. The steps of working with the service using the example of «The Last Mile» module are presented below:

The final solution is presented in several versions – in tabular form, on a map, as well as in the form of analytical indicators with a convenient way to compare planned and actual indicators of logistics routes.

Technical features

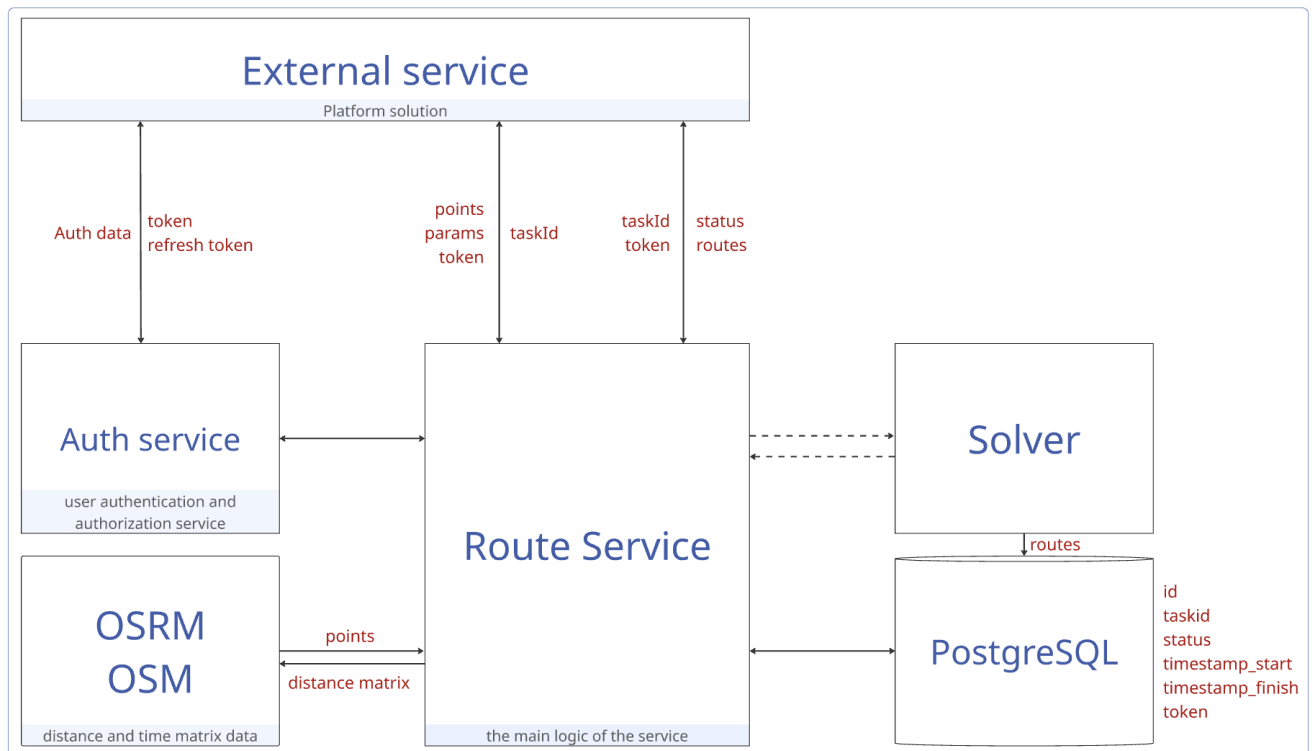
The current solution is implemented using a micro-service architecture, in which the main software modules are combined using the API:

- services (clusterization, sequence calculation);
- mathematical algorithms and libraries;
- optimization tools (solvers) for linear and integer programming problems.

The main technological parameters of the product are shown in the table below:

Product stack	Solution
• programming language	services: Golang; math modules - Python; solvers - C++.
• database	DBMS PostgreSQL
• OSRM	Open Street Map, Google Maps
• authorization	JSON Web Token (JWT)
• containers	Docker
• queue broker	Apache Kafka
• API	REST API
• operating system	Debian
• web-server	Nginx
• CI/CD	GitLab

The top-level architecture of all four product modules is shown in the figure below, which shows the main components, as well as the relationships between them:



This architecture assumes compliance with key quality parameters of the product: horizontal and vertical scaling, operational communication between services and their isolation, speed of deployment and dependency management, testing on a separate DEV circuit, ensuring security through authentication and authorization.

Mathematical features

In the process of implementing the software product «**Way.Pro auto**» math teams have changed and improved mathematical solutions and modules many times, making them optimal for applied tasks, taking into account a variety of parameters (constraints) and large data size.

The algorithms used for «**The First mile**», «**The Last Mile**» and «**Courier delivery**» modules are:

- at the first stage, the clustering method "Minimal connected Tree" (MST) is used;
- at the second stage, the "Large Neighborhood Search" (LNS) method is used;
- at the third stage, a stochastic optimization algorithm is used – the "Simulated Annealing Method".

This approach is heuristic and provides a solution that is close to ideal. Even with huge amounts of input data and a wide range of parameters, the calculation time does not exceed ten minutes.

The algorithm used for the «**Mainline routes**» module is:

- integer linear programming (ILP).

This approach is precise, so it provides an absolutely optimal solution as an answer. With really large amounts of input data, the calculation time can take several hours.

An extremely important advantage of these models is their variability, the ability to account for parameters, as well as their flexible adaptation to new requirements.

Product advantages

The main advantages of the proposed IT product «**Way.Pro auto**»:

- coverage of the entire logistics contour - transport logistics, optimization of work in the warehouse (preparation of goods, accumulation and optimization of gate load), as well as work with applications;
- a large number of ready - to- use parameters and wide calculation settings;
- a proven solution in the largest companies with a strong logistics unit (cumulatively more than 1,000 warehouses, more than 500,000 last-mile routes, more than 200,000 trunk lines, more than 1 million courier routes per month);
- operation with BigData, synchronous and operational asynchronous calculation;
- flexible integration with any system using the REST API;
- integration with cartographic services and consumption of traffic data;
- Proven effectiveness of reducing logistics costs by up to 11%, reducing the waiting time for goods by up to 12%, positive feedback from logistics specialists;
- a powerful mathematical tool optimized for real business tasks;
- highly qualified specialists in the team with more than 10 years of experience in automobile logistics (including business analytics and mathematics).

The Company's top priority is to provide a tool to the customer that will actually save ~10% of costs, as well as significantly improve the operational performance of logistics processes.

To quickly start working with the Customer and flexibly configure the solution, the Company's policy provides for the allocation of part of the team to the Customer at the integration stage and the creation of a pilot project (data analyst, system analyst, architect, etc.).

Contacts

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