Fleet Innovations

Continually Advancing State-of-the-Art Solutions

Fleet Innovation

Innovation has been central to the evolution of Descartes' routing, mobile and telematics solutions. Never before has there been a convergence of so many technological advancements available to accelerate their transformation. Descartes is combining these advancements with the deep domain expertise gained over many years in the market to deliver the next generation of solutions that make a difference to your business. Here are a number of the many ways Descartes is leveraging advanced technologies.

1. **Artificial Intelligence**
2. **Machine Learning**
3. **Robotic Process Automation**
4. **Strategic Route Optimization**
5. **Same-day Optimization**
6. **Digital Twin**
7. **Cloud Elasticity**

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Artificial Intelligence

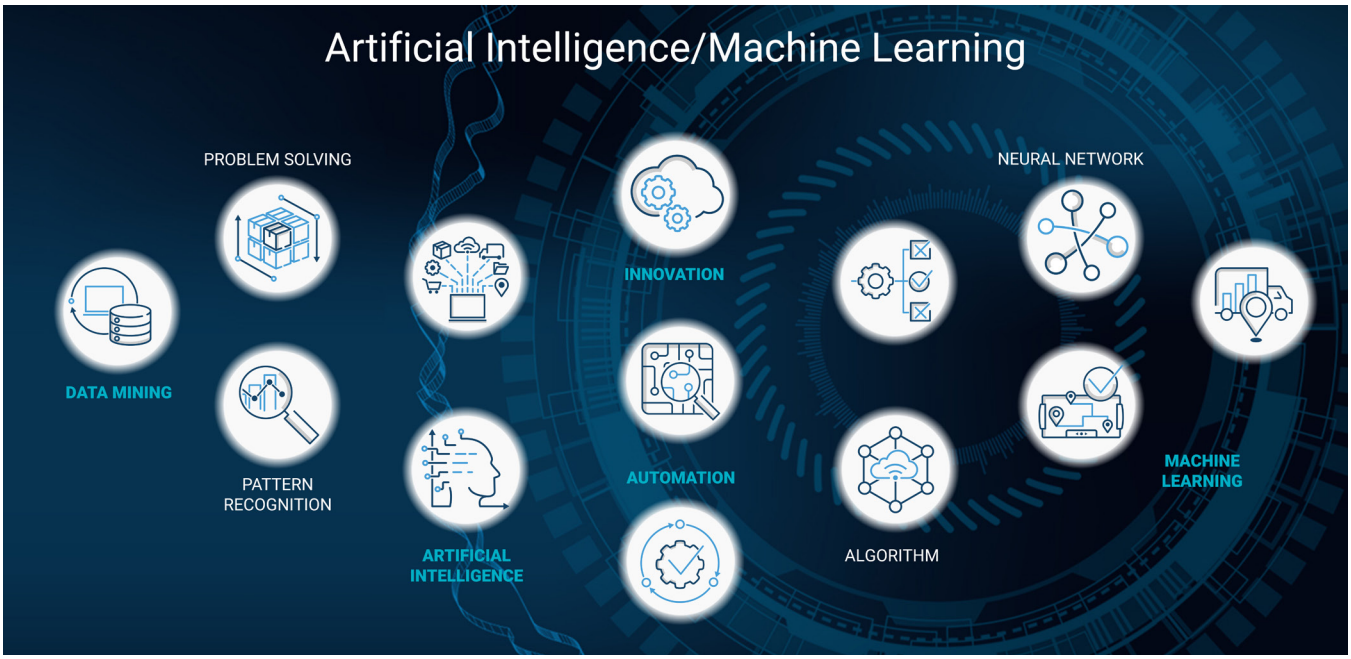
Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. The term may also be applied to any machine that exhibits traits associated with a human mind such as learning and problem-solving. The ideal characteristic of artificial intelligence is its ability to rationalize and take actions that have the best chance of achieving a specific goal. There are specific classes of artificial intelligence such as rules-based expert systems and machine learning that are used to solve logistics and supply chain problems.

Source: Investopedia *and Descartes*

AI-Based Optimization Configuration

Powerful route planning algorithms can produce dramatic improvements in route productivity and customer service. However, because these algorithms are highly flexible, they can be complex, require a deep understanding of how they work and the parameters that are used. In addition, data, and business goals, and constraints also impact the configuration. Descartes Route Planner AI Advisor uses machine learning to leverage the power of Descartes' sophisticated optimization algorithm to, simplify the configuration process and get the desired results.

Descartes Route Planner AI Advisor provides configuration guidance based on a series of business questions that can be easily answered by the user in the context of the data that needs to be optimized. The solution then analyzes the problem set based on those answers and the data provided. After the automated analysis is concluded, Descartes Route Planner AI Advisor returns a proposed configuration that best achieves the business goals specified by the user. Multiple business scenarios can be executed and the proposed configuration with the best performance can be easily applied to production environment.



The Benefits of AI-based Configuration are:

1. Configuration unique to the customer
2. Streamlines configuration process
3. Eliminates guesswork from the configuration process
4. Domain expertise is "built-in"
5. Evaluate the impact of multiple business scenarios

Machine Learning

Machine Learning (ML) is the study of computer algorithms that improve automatically through experience.[1][2] It is seen as a subset of artificial intelligence. Machine learning algorithms build a mathematical model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of applications, such as email filtering and computer vision, where it is difficult or infeasible to develop conventional algorithms to perform the needed tasks.

Source: Wikipedia

Machine Learning for ETA Calculation

Estimated-time-of-arrival (ETA) calculations are critical to help companies manage the execution of routes and keep customers informed of status of their deliveries. A lot of information goes into the ETA calculation – road network, planned and actual delivery times, traffic patterns, etc. However, other factors such as driver capability, asset type, geography, customer location and weather can also significantly impact ETA calculations. Descartes Route Planner uses machine learning to take these factors into account in real-time to create the best ETA predictions for the remaining stops and continues to update the ETA based upon changing conditions. More accurate ETAs allows customers to better plan for the delivery making adjustments to resources, inventory and unloading and loading times.

The Benefits of ML-aided ETA Calculation are:

1. More accurate arrival predictions
2. Improved customer experience
3. Automated calibration

Machine Language-Based Performance Tuning

Good route planners keep their system performing at its best by regularly adjusting the parameters to reflect real-world conditions. Using machine learning, Descartes Route Planner can help tune operational parameters because it uses historic planned and executed route data to suggest modifications to the data to make planning results more realistic. Other factors such as locations, service durations, transit times and time windows can be modified to further improve route fidelity and create more efficient routes. For example, Descartes Route Planner has the ability of identify geocoding corrections based on actual GPS latitude and longitude data received by drivers executing a planned stop. The corrected location allows for more accurate route planning which can result in a reduction of miles, time and failed delivers as a result of bad geocodes.

Machine Learning (cont'd)

ML-based performance tuning can be highly granular because route performance can vary by a number of factors including truck type, driver, territory and time of the day. Descartes Route Planner uses the same ML techniques to improve route planning performance in the following areas:

1. Service Duration and Transit Times (planned and ETA) by:

a. Driver – some drivers are more effective than others and new drivers are on a learning curve…
b. Truck Type – truck size and configuration impact driving speeds and loading and unloading times…
c. Territory – geography impacts driving speeds and the time to unload and load vehicles…

2. Time Windows by:

a. Location or customer type – location can impact how long it takes to load and unload vehicles and customers can be more or less efficient during the loading and unloading process…

b. Territory – time window size can vary depending upon the geography as certain territories are faster to access than others

The Benefits of ML-based Performance Tuning include:

1. Help ensure the most accurate route plans
2. Help maximize route plan results
3. Address uniqueness of drivers, vehicles, territories, etc.
4. Reduce planning system configuration maintenance

Robotic Process Automation

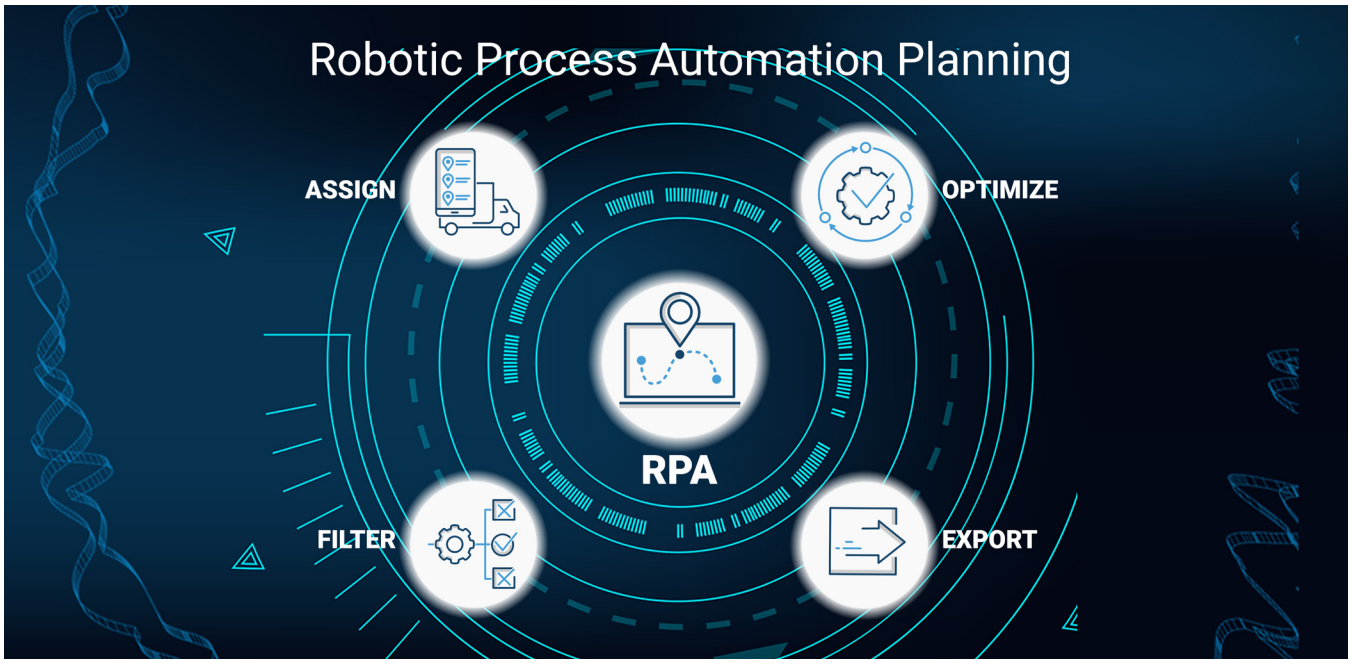
Robotic Process Automation (RPA) is an application of technology, governed by business logic and structured inputs, aimed at automating business processes. Using RPA tools, a company can configure software, or a "robot," to capture and interpret applications for processing a transaction, manipulating data, triggering responses and communicating with other digital systems. RPA scenarios range from something as simple as generating an automatic response to an email to deploying thousands of bots, each programmed to automate jobs in an ERP system.

Source: CIO Magazine

Robotic Process Automation (RPA) – Based Planning

The route planning process is not a simple as "hitting the optimization button". Good planners apply a number of techniques besides optimization to arrive at the best results and it is critical to standardize the planning process across planners to ensure consistency. As part of Descartes Route Planner, Descartes Background Optimizer (BGO) uses RPA to make every planner as good as the best planner. Its bot structure allows planners to configure complex planning and coordination tasks across multiple planning schedules. For example, BGO can be configured to filter data, run specific optimization strategies (e.g. swapping and selective optimization) that are time sensitive and automatically move plans from planning to execution without any intervention. Multiple BGOs can be configured across large planning schedules to continually optimize and execute multi-phase plans. There can be multiple types of BGOs configured to solve specific planning and execution tasks. These BGOs can be invoked in real-time depending upon the incoming data or other events.

Robotic Process Automation (cont'd)



The Benefits of Robotic Process Automation:

- Build complex planning scenarios
- Automate complex planning tasks
  - Ensure planning consistency
  - Deliver best results
  - Minimize planning resources
  - Reduce planning latency
- 24X7 availability
- Streamline delivery planning and execution processes
- Scale for large planning problems

Strategic Route Planning

Strategic route planning is a technology-enabled route planning process that determines the optimal combination and location of resources (e.g. distribution centers, fleet size and drivers) to meet customer service and financial targets while considering service policies and operational practices.

Source: Descartes

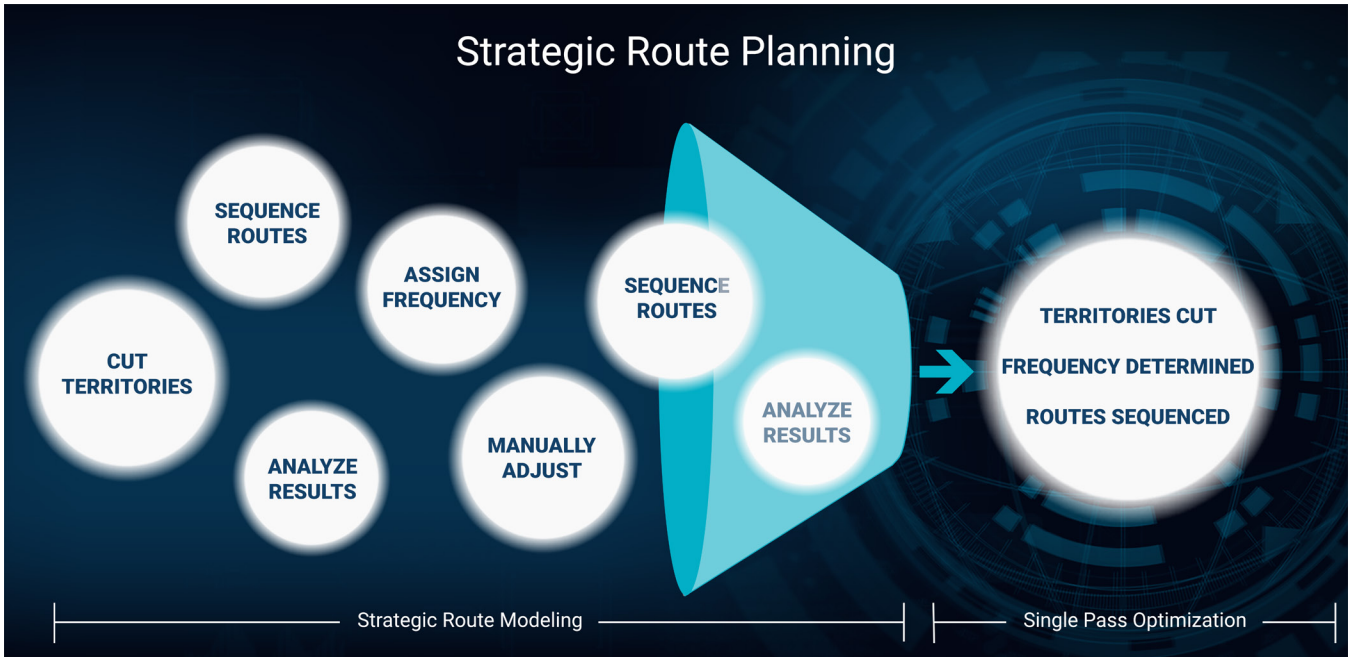
Strategic Route Planning for Fleets

Distribution networks are in constant change whether it is order volume and mix, customers, customer service policies, business strategies, etc. As a result, distribution networks can quickly get out of balance and do not run optimally or cost-effectively. In addition, fleet operators need a way to model and evaluate the impact of potential changes to their distribution network before they are implemented.

Strategic Route Planning (cont'd)

Descartes strategic route planning was designed to optimize distribution networks. It is different than daily route planning and has the potential to deliver even greater productivity and service improvements because strategic route plans address more fundamental change. In daily route planning, the strategies, policies and even the territories, frequencies and routes are already defined. The goal of daily route planning is to do the best with those restrictions already in place. With strategic route planning customers, volumes, service policies, asset types and operational constraints can be treated as variables. Policies, practices, capacity etc. can be flexed to see what new or changed routing strategies and tactics will best address changes in demand or new business goals.

Strategic route planning applies to not only those fleets that run static or master routes, but also to dynamic routes because strategic route planning helps model the policies and practices that dictate the daily routing parameters. Strategic route planning is an important in understanding the best approaches to enter new markets or consolidate acquisitions. because, as demand changes and distribution organizations look at new markets, they will need to use the solution to help predict the costs and capacity required to move forward.



The Benefits of Strategic Route Planning:

- Reduce fleet costs
- Improve customer service
- Balance work across resources
- Determine best delivery frequency and day
- Determine impact of new service policies
- Evaluate new customers, markets and mergers

Same-Day Optimization

Same-day optimization is the dynamic delivery appointment booking and execution of intra-day ad-hoc orders through intelligent automated selection of the most cost-effective resource while using time-definite delivery windows.

Source: Descartes

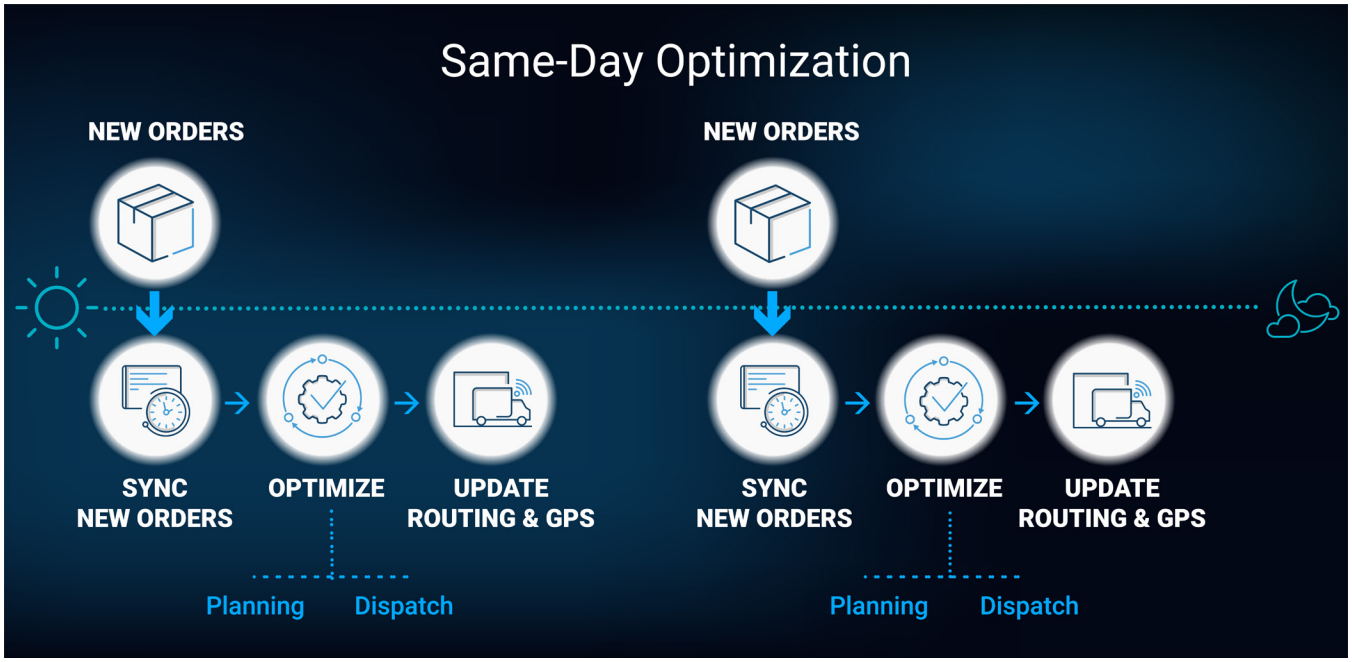
Same-Day Optimization for Fleets

Same-day optimization combines dynamic delivery appointment scheduling with the real-time GPS-based status of vehicles in the field. It allows customers to take in new orders during the day, and automatically dispatch them for delivery or service that same day. Same-Day Optimization dynamically schedules appointments on the plan or live dispatch schedule, using GPS-based location and other real-time information to optimize the fleet utilization in conjunction with the customer delivery window requirements.

Real-time data that is included in the optimization include:

- Fleet capacity, order picking time, planned routes, product attributes, equipment type, driver
- Actual vehicle location
- Actual route status – which routes are running on time, which are behind, product availability on truck
- Multiple order pick-up options
- Traffic history
- Service times at planned stops
- Delivery windows
- Overtime and surge resource options

Same-Day Optimization intelligently manages changes to routes so that new orders don't cause disruptive changes such as redirecting the driver to a new stop when they are about to deliver to an already planned delivery. Same-Day Optimization provides options to control how many stops ahead are shared with the driver and how many stops ahead are locked to minimize driver disruptions All the updates and changes to the route, stops, and service activities are available real time to the drivers on their handheld device.



The Benefits of Same-Day Optimization:

- Offer time-definite same-day delivery
- Improve same-day delivery productivity
- Reduce delivery costs
- Take orders with later cut-off times
- Provide more dynamic or premium delivery service options
- Make delivery a competitive weapon

Digital Twin Technology

A digital twin is a virtual model of a process, product or service. This pairing of the virtual and physical worlds allows analysis of data and monitoring of systems to head off problems before they even occur, prevent downtime, develop new opportunities and even plan for the future by using simulations.

Digital Fleet Twin

Digital twin, the creation of a virtual, but dynamic, representation of fleet operations is a powerful approach to better understand how it works today or could work in the future. With a digital twin, an organization can monitor performance, predict the impact of changes, identify areas for improved productivity or customer service and evaluate new operating models. Descartes Route Planner addresses the 5 key components that are needed to create digital twin of your fleet.

Real-world modelling. The real-world of fleet operations is inexact and messy and there are a lot of complex trade-offs between service and cost. The ability to deal with hard and soft constraints for vehicles, products, customers, etc. is critical to creating an accurate operational model of the fleet. Descartes Route Planner uses location-based services (i.e., digital map technology) where roads are modelled more accurately and there is a wealth of historical, predictive and real-time traffic information. Machine learning adjusts drive, location and stop times to improve model accuracy. In addition, business rules, operational constraints and physical limitations can also be modelled.

Digital Twin Technology (cont'd)

Continuous optimization. Digital twins operate in real-time, making or taking decisions that improve operational performance. The notion of planning and dispatching blurs as the optimization engine needs to take in real-time updates to make predictive recommendations on what best to do because of changes to orders, vehicle and driver status, road congestion, etc. New orders can be evaluated for best delivery options and time-definite delivery including placing those orders or the live dispatch schedule. Descartes Route Planner uses continuous optimization, machine learning, or other forms of artificial intelligence in powerful ways to provide real-time insight such as dynamically calculated ETAs and facilitate autonomous decision-making.

Integrated real-time data. The degree of integration of real-time data sources — mobile, telematics, traffic, etc. — with the continuous optimization technology is critical to the ability of the digital twin to make accurate and timely predictions and decisions. The breadth and depth of data and the sophistication of the interaction goes well beyond capturing regular GPS updates. In addition, the integration needs to be bidirectional and event-driven to take in order and delivery status changes as they occur and coordinate drivers' actions on the road.

Scenario management. The ability to test and validate the impact of proposed operational changes or new business models is one of the most powerful capabilities of the digital twin. Most fleet operators want to be more agile but are slowed by the validation process. With a digital twin, the ability to clone, tweak and run enhanced models against operational data allows organizations to more quickly and accurately assess the cost, service, and other operation impacts of proposed changes. Descartes uses an AI-based technology that provides configuration options that take into account scenario-based business objectives and operational data.

Analytics. Not every improvement opportunity happens in real-time. Part of the power of the digital twin is to collect large amounts of data over time to analyze trends. For example, we had a customer who was collecting 4 billion data points annually and used that information to simplify and rewrite its stop time model to improve time forecasting and route productivity. Analytics technology is another area where the improvement in sophistication, ease-of-use and cost has also improved dramatically in the last several years to make it more widely adopted and part of the digital twin strategy.

The Benefits of a Digital Fleet Twin (DFT)

- Proactive alerting of operational issues
- Model fleet operations to predict performance
- Assess impact of operational, asset or policy changes

Cloud Elasticity

In cloud computing, elasticity is defined as "the degree to which a system is able to adapt to workload changes by provisioning and de-provisioning resources in an autonomic manner, such that at each point in time the available resources match the current demand as closely as possible.

Source: Wikipedia

Cloud Elasticity and Route Optimization

Large scale route planning operations that operate in real-time require tremendous amounts of computing resources. The cloud is the perfect place to run large scale route planning problems because it offers almost unlimited capacity. However, not all route optimization technologies were designed to automatically scale to take advantage of cloud computing. In addition, during "quiet" periods, optimization computing resources should be minimized to reduce cloud operating costs. Descartes Background Optimizer's (BGO) elastic cloud optimization uses robotic process automation (RPA) to efficiently deploy cloud resources according to their transaction volume and optimization demands. The BGO automatically spins up new optimization processes and has more parallel resources working on the same problem set. This results in reduced optimization time, higher quality results and reduced cloud costs. No IT resources are required beyond initial configuration.

The Benefits of Cloud Elasticity and Route Optimization:

- Quickly solve large scale optimization problems
- Minimize cloud computing costs
- Minimize IT resource involvement

About Descartes Systems Group

Descartes (Nasdaq:DSGX) (TSX:DSG) is the global leader in providing on-demand, software-as-a-service solutions focused on improving the productivity, performance and security of logistics-intensive businesses. Customers use our modular, software-as-a-service solutions to route, schedule, track and measure delivery resources; plan, allocate and execute shipments; rate, audit and pay transportation invoices; access global trade data; file customs and security documents for imports and exports; and complete numerous other logistics processes by participating in the world's largest, collaborative multimodal logistics community. Our headquarters are in Waterloo, Ontario, Canada and we have offices and partners around the world.

Learn more at www.descartes.com and connect with us on LinkedIn and Twitter.

Uniting the People & Technology That Move the World.

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