



ArcLogistics™: The Routing and Scheduling Solution for Fleet Management

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ArcLogistics: The Routing and Scheduling Solution for Fleet Management

An ESRI White Paper

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ArcLogistics: The Routing and Scheduling Solution for Fleet Management

Introduction ESRI® ArcLogistics™ software is a complete solution for complex routing and scheduling problems and helps you minimize costs, maximize productivity, and improve customer service. Offering a quick and significant return on investment, ArcLogistics lends itself to fleet management across all organizations including food and beverage, manufacturing and delivery, local governments, school districts, courier and messenger, and utilities and telecommunications.

Key Features Use ArcLogistics to determine which vehicle should serve each customer location and the best stop sequence to accommodate your customers' time windows while minimizing travel distance and time. ArcLogistics offers intelligent routing by taking into account actual network drive times, distances, street network restrictions, vehicle characteristics, customer characteristics, and more. After solving a routing problem, you can export routes and schedules back to a database using GIS-based applications or print routes with driving directions.

- Ability to use your own street data including any network restrictions and parameters
- Option to purchase high-quality street data for either Europe or the USA and Canada
- Builds routes based on network drive times, distances, and restrictions, not straight-line distances
- Takes into account specialties of vehicles and orders
- Imports customer orders from any Open Database Connectivity-compliant database
- Geocodes customer addresses
- Ability to use your own geographic data
- Outputs route summary reports, detailed and overview maps, street-level directions, driver manifests, and more
- Outputs routes and schedules to other GIS-based applications
- Integrates with automatic vehicle location (AVL), vehicle navigation, enterprise resource planning, customer relationship management, warehouse management, accounting, and route accounting systems, as well as other enterprise technologies

With ArcLogistics, you can realize savings of 10 to 30 percent in terms of mileage, overtime, time spent routing, and vehicles used. Increased efficiency means that each vehicle may be able to visit more customer locations in less time. This technology typically pays for itself within a few months.

ArcLogistics is a fully interactive desktop routing and scheduling software application that helps organizations deliver goods and services more efficiently, reduce costs, and improve customer service. ArcLogistics features advanced solver functionality, street data options, and application framework environments.

Advanced Solver Functionality

ArcLogistics solver functionality includes an advanced routing and scheduling algorithm that has proven itself in deployments across numerous industries. The benefits of ArcLogistics extend beyond calculating routes and being able to accommodate normal situations. Fleet management operations are seldom routine, and the assurance of having a robust and tested solver functionality will save time and money and conserve resources when demands are high. The ArcLogistics solver functionality accommodates a wide range of routing and scheduling problems. These are described below.

Priorities

Orders can be assigned high or normal priorities to designate how they should be assigned in the route. The ability to assign priority allows the best allocation of vehicles when more orders exist than resources will allow. ArcLogistics is able to ensure that high-priority orders are filled before normal orders when constraints and limitations arise. This translates not only into keeping delivery/service appointments but also better accountability and reliability in an organization's fleet management.

Capacities

You can set up to five capacities for your vehicles: Weight, Volume, Custom, Custom 2, and Maximum Orders. Volume, Weight, Custom, and Custom 2 are the maximum volume, weight, and custom capacity the vehicle can carry. Custom and Custom 2 provide an option to specify any other capacity that affects how much your vehicles can carry (e.g., pallets, cases, wheelchairs). Volume, Weight, Custom, and Custom 2 can be in any measurement, such as cubic feet, pounds, pallets, cases, or just the number of items, as long as they are consistent. Use the same units you'll use to specify the weight, volume, and custom value of individual orders—for example, if you'll be using cubic feet and pounds for orders, use cubic feet and pounds for your vehicles.

Maximum Orders is the number of orders a vehicle can handle. If your vehicles don't have a maximum number of orders that they can handle, set maximum orders to a high number such as the maximum number of orders your fleet handles in a day. ArcLogistics never exceeds these capacities when assigning orders to routes.

Zones

Zones are geographic map features that are associated with a vehicle in order to send that vehicle into a preferred area. Zones are very useful when your operation has fixed routes with distinct geographies or when you want to tailor routes to specific areas based on your own business logic.

Costs

ArcLogistics builds routes that attempt to minimize costs while meeting order time windows. There are four vehicle costs you can specify.

Fixed cost is what you pay each time you use the vehicle such as a daily rental fee. But if you pay a daily rental fee regardless of whether or not you use the vehicle, do not specify

it as a fixed cost. If you have vehicles that are less preferable to operate, you can set a higher fixed cost so that ArcLogistics is less likely to use them.

Per Mile or Per Kilometer cost can include the cost of fuel; maintenance; depreciation; and mileage-based wages, fees, or taxes.

Per Hour cost can include the hourly wage of the driver, the cost per hour of operating the vehicle, or both. The cost per hour must be greater than zero.

Per Hour OT is the per-hour cost of operating the vehicle once overtime begins. This cost can include the hourly wage of the driver, the cost per hour of operating the vehicle, or both. The overtime cost per hour must be greater than or equal to the per-hour cost.

Specialties

With ArcLogistics, you can set up an unlimited number of specialty codes. From this list, you can give vehicles and orders as many specialties as needed. ArcLogistics will only assign an order to a route that has all its specialties. If no route has all of an order's specialty codes, ArcLogistics will not assign the order. If an order has no specialty codes, ArcLogistics can assign it to any route including routes with specialties.

Vehicle Workday Rules

ArcLogistics contains many workday rules that the solver considers when calculating routes and schedules. You can set the start range to control when routes can begin. Per-hour cost begins accumulating for the route no later than the end of the start range.

Earliest Start is the earliest time that you want to allow the vehicle to begin its route. ArcLogistics never schedules a route to begin before this time.

Latest Start is the latest time that you want to allow the vehicle to begin its route. The larger the range between the earliest and latest start times, the more flexibility ArcLogistics has to vary the start time of your routes so that unproductive time can be reduced.

Maximum Travel Distance is the maximum distance of a route. The vehicle must return to its end location within this distance.

Maximum Travel Duration is the maximum number of hours that a route can be driven. The vehicle must return to its end location within this time frame.

Maximum Total Duration is the maximum duration of a route including travel time, lunch, order service time, wait time, and time at the start and end of the route. The vehicle must return to its end location within this time frame.

Time Before OT is the number of hours into a route before the overtime hourly rate applies.

Lunch Break Length is the length of the lunch break in minutes. The time at lunch is included in the cost of the route.

Locations

Start and End are the locations where the vehicle begins and completes routes. You can click the drop-down arrow and choose a location from the list. If you have not already set up a location, you can click the Locations option and add it.

Time at Start is the average amount of compensated time spent at the beginning of the route, for example, preparing or loading a vehicle.

Time at End is the average amount of compensated time spent at the end of the route, for example, servicing the vehicle or preparing it for the next day.

Renewal Locations are optional. A renewal location is a location where a driver can reload (or unload) a product midroute when vehicle capacities are either reached or depleted. If a vehicle delivers products, you can set the vehicle's renewal location(s) to where the vehicle can reload—for example, if a vehicle delivers propane, when that vehicle is empty, it returns to the filling station (its renewal location) to refill and then continues its route for the day. If a vehicle picks up products, you can set the vehicle's renewal location(s) to where the vehicle can unload—for example, if a vehicle empties dumpsters, when the vehicle is full, it goes to the landfill (its renewal location) to unload and then continues its route for the day.

Time at Renewal is the average amount of time spent reloading or unloading the vehicle while at a renewal location.

Time Windows

Order Time Windows are the time ranges that the order should be serviced. An order can have two time windows.

Treat Time Windows as Hard means that an order cannot be serviced (late) after the latest time window.

Max. Violation Time is the number of minutes an order can be serviced after the time window ends, if not using hard time windows.

Service Time

Service time is the number of minutes it takes to service the order. Service time can be in decimal minutes.

Priority

Orders can have high or normal priority. ArcLogistics always tries to route all orders, but in situations where this can't be done, high-priority orders will get routed at the expense of normal-priority orders.

Curb Approach

You can set Curb Approach to specify from which side of the street a vehicle must approach the order. This is particularly important when there is a center divider in the street that restricts the approach to an order to one direction or for paratransit-type operations where people must be picked up curbside.

Delivery Type

The delivery type can be either Pickup or Delivery. Route capacities are tracked throughout the route if the orders are a mix of both pickups and deliveries.

Paired Orders

If orders are paired, one order has a delivery type of Pickup, its pair has a delivery type of Delivery, and both orders must have the same order number. Maximum Time on Vehicle is only available for paired orders and restricts the time between the pickup and delivery. Paired orders can only have one time window. Paired orders are used in paratransit-type operations and for courier-type work.

Barriers

Barriers are geographic features that completely block the traversability of the street segments they cover. Barriers can be drawn directly in ArcLogistics using a drawing tool, or they can be imported as a shapefile or a geodatabase. Barriers offer a simple and realistic way to manage roadworks, accidents, closed roads, flooded areas, restricted areas, and other conditions that temporarily block roads.

U-turn Policy

Some routing problems require special consideration of U-turns depending on the performance capabilities of the fleet. The three settings related to U-turns are Everywhere, Nowhere, and Only at dead ends. If you set the U-turn policy to Nowhere, you may find that some orders could be technically unreachable, for example, if an order was at the end of a cul-de-sac.

Rating the Importance of Meeting Time Windows

ArcLogistics offers three settings to rate the level of importance in meeting time commitments: High, Medium, and Low. High means that the complete solution may cost more in distance driven, time taken, and/or routes utilized to complete the routes, but there should be fewer time window violations of orders compared to a solution that uses the Low setting.

Rating the Importance of Reducing Excess Transit Time for Paired Orders

Excess transit time for a paired order is the amount of additional travel time above the minimum direct travel time between the two addresses of the paired order. If it is important in your routing strategy to minimize the excess transit, then you may want to set this to High.

Departing within Time Windows

If your routes must depart from a stop before the time window closes, you can check this option. If your routes can arrive at a stop before the time window closes and continue to service the order after the time window closes, then you can leave this option unchecked.

Dynamic Point Zones

ArcLogistics can create routes that minimize route crossover and form natural geographic clusters. These routes may be more expensive to operate or may miss some time window commitments but are more likely to be geographically distinct.

Street Data Options

ArcLogistics consumes street data in the form of a network dataset to calculate routes and schedules. The network dataset can be in any of the following formats: Smart Data Compression (SDC), shapefile, or geodatabase. In addition, the street data requires an address locator for geocoding purposes.

SDC Street Data Purchased with ArcLogistics

The street data that you can purchase with ArcLogistics is in a compressed format known as Smart Data Compression. This compressed data contains all the streets for the entire United States and Canada on two DVDs or all the streets for Europe on another two DVDs. The data contains all the information needed to use ArcLogistics for both routing and geocoding, so it is ready to use.

The SDC street data supplied with ArcLogistics cannot be edited and is licensed to ArcLogistics, meaning other applications cannot use it. Managing speeds associated with SDC street data is done using parameters in either individual routing folders or routing project properties.

<i>Using Your Own Street Data</i>	You may opt to use ArcLogistics with your own street data or with street data from another source; however, there are four requirements the street data must meet.
ArcGIS® Network Dataset	The network dataset must contain a drive-time attribute with Usage Type of Cost and Units in a time domain. It should have Use By Default set to true. It must also contain a distance network attribute with a Usage Type of Cost and Units in a distance domain. It should have Use By Default set to true. The network dataset must also have a hierarchy network attribute with Usage Type of Hierarchy. It should have Use By Default set to true.
ArcMap™ Map Document	The ArcMap map document (.mxd) will contain the cartographic layers, such as streets, major roads, parks, counties, provinces, rivers, and points of interest, that you will see in the map view. Any scale-dependent drawing rules need to be set up in ArcMap before being used in ArcLogistics. If the network dataset is added to the map document, it will be used by default, and you will not have to browse for it in the New Project window.
Address Locator	You will typically need an address locator with address, city, state, and postal code. For fallback geocoding, you will also typically want to include a postal code locator. These locators should be in the same workspace as your network dataset so that they are used by default. In some international and localized situations, your address locator may contain limited street address information.
Spatial Reference	The street data feature classes should have a spatial reference defined. In ArcMap, when you check View Data Frame Properties and the Coordinate System tab, the Current Coordinate System should not be Unknown. When data is prepared for use in ArcLogistics as described above, you will just need to pick the map document in the ArcLogistics New Project window and the network dataset and locator(s) will be chosen for you by default. In other words, you should not have to browse for them or otherwise understand what these things are.
Application Framework	The ArcLogistics application framework is the underlying technology that allows processing data and integrating with other systems, providing a complete routing system.
<i>Geocoding and Order Import</i>	<p>ArcLogistics includes a geocoding tool that is used to find the position of orders and locations on the street network. Geocoding is determined by the address locator being used in the routing project, and the geocoding and geocoding preferences dialog box will reflect the address locator being used.</p> <p>You have control over the automatic matching process using the geocoding preferences dialog box. The match ranges that you set include Auto Geocode, Leave Ungeocoded, and Fallback. The Auto Geocode range tells ArcLogistics to automatically match orders if the highest scoring candidate generated by the input address falls in the Auto Geocode range. The minimum Auto Geocode score is 30. If the best candidate generated by the input address has a score that falls in the Leave Ungeocoded range, that order will remain ungeocoded. If, however, the best candidate generated by the input address has a score that falls in the Fallback range, then ArcLogistics will attempt to match the order using the fallback locator(s) in the routing project. If the best two candidates receive equal scores, ArcLogistics will by default leave them ungeocoded. This often happens when there are slight inaccuracies in the input address such as a missing street directional prefix.</p>

If the x,y coordinates of an order are known, you have the option to import the coordinates along with other relevant order information that is used for routing. If the Import XY is near a street, then the order will match without even investigating the input address candidates.

Manual Geocoding

You can manually geocode orders that were not automatically matched during order import. In the Geocode Address dialog box, the name and the customer number of the current order are displayed, and you can move backward or forward between a group of orders using the navigation arrows on the main toolbar. You can also choose to show or hide the map view by clicking the Show/Hide tool or geocode an order to the selected candidate by clicking the Geocode tool.

Grouping

The available Group By options include None, All, Customer No, and Address. Since the orders are not grouped initially, None is the default setting. If you want to geocode all the orders to the same place, you can group by All. Similarly, you can geocode all orders that share the same customer number or the same address by grouping by Customer No or Address, respectively.

Filtering

The default is set to show all candidates. However, you may choose to limit the number of candidates shown in the Candidates List View and Candidates Map View by selecting a filter option in the pull-down menu. ArcLogistics can show either the best candidates or all candidates above the chosen cutoff score.

Candidates List View

The Candidates List View displays all candidates generated by the current input address as well as the User Pick, Import XY, and Fallback XY if applicable. The input address candidates are scored from 0 to 100, with 100 being the closest match. Scores are determined by the address locator being used in the routing project.

Candidates Map View

The map tools at the top of the Candidates Map View are standard with a few additions:

- A User Pick tool (a red pushpin) for adding/moving the user pick. Please note that only one user pick may be added. If a user pick does not exist, the User Pick tool adds it. Otherwise, it will move it.
- A User Pick By XY tool allows manual typing in of the x,y coordinates of an order.
- A Zoom To Candidate tool (green circle button) zooms the map in to the current candidate.
- A Zoom To Geocoded tool (blue square) zooms to a currently matched coordinate.
- A convenient scale bar directly above the map changes as the user zooms in for a closer look at the streets.
- An On/Off Table of Contents (TOC) tool allows the map view table of contents to be displayed or hidden.

Immediately below the map view, the address and coordinates that the cursor is pointing to are displayed.

Exporting Routing Files

From the Export Routing Folders dialog box, ArcLogistics enables you to export to text files and pick the fields you want exported. After specifying the folder to export into, you can choose either Routes (.txt or .csv) or Orders (.txt or .csv) in addition to the Access database files (.mdb) and line and point shapefiles (.shp). In addition to being able to pick the fields you want to export, you can also save multiple export profiles.

Duplicating Routing Folders

The duplicate routing folder feature can be used to evaluate alternate routing scenarios and is particularly helpful for users who service more or less the same set of orders and want to evaluate the effects of different ArcLogistics settings.

Interactive Map View

The ArcLogistics map view is interactive, allowing you to add and remove geographic data, hide data layers, and change symbology of layers and orders. It also includes map controls and options to change the display of routing information.

Map View Controls

The map view contains a set of standard map controls that are used to move around the map and to visualize your routing data.

These controls are

- Select
- Zoom to Full Extent
- Zoom In
- Zoom Out
- Zoom to Selected
- Zoom to Previous Extent
- Zoom to Next Extent
- Pan
- Refresh Map
- Control Map Display
- Print Map
- Add Layer
- On/Off TOC

Adding Map View Data

You can add the following data layers to the map view:

- Points (.shp, .lyr, .gdb)
- Lines (.shp, .lyr, .gdb)
- Polygons (.shp, .lyr, .gdb)
- Raster
- Web services

Changing the Display of Routing Information

The Control Map Display option offers you the ability to change how routes, orders, and other routing information are presented in the map view.

- Show Scale Bar displays the map scale bar.
- Show Leading Stem Time displays the route on the map from the route start location to the first stop. In large operations, this is sometimes left unchecked to avoid clutter in the map view.
- Show Trailing Stem Time displays the route on the map from the final stop to the route end location. In large operations with dozens of vehicles, this is sometimes left unchecked to avoid clutter in the map view.
- Show Arrows displays arrows along the route pointing in the direction of travel.
- Label Sequence displays all stops with their sequence number within the route.

- Show Zones displays zones (if there are any) in the map. Zones will be colored to match the routes with which they are associated.
- Label Zones places a label on any zones displayed in the map.
- Show Barriers displays barriers in the map. Barriers are displayed as red hashed polygons or a red X for point barriers.
- Show Unassigned Orders displays unassigned orders within a routing folder in the map.
- Map Tips Field allows you to select a field from the drop-down menu to be included in the map tips shown when you hover on orders.
- Straight Lines displays routes as straight lines in the map.
- Follow Streets displays routes using the actual geometry of the routes as they follow the street segments. This display takes longer to render in the map view than Straight Lines does.
- The Orders tab allows you to change the symbology of orders based on a field you select.

Reports

ArcLogistics includes Crystal Reports® Viewer from Business Objects™. This allows you to view the template reports included in ArcLogistics.

Localization

ArcLogistics will use the regional settings on your computer to format common settings for number formats, time, currency, and date/time format.

Address formats on forms conform to the locator being used.

User interface labels can be changed for the following fields using File/Options/Labels:

- | | |
|------------|-----------------|
| ■ Volume | ■ Comments 2 |
| ■ Weight | ■ Description |
| ■ Custom | ■ Description 2 |
| ■ Custom 2 | ■ Phone (H) |
| ■ Comments | ■ Phone (W) |

Complete application localization for international markets is available using the ArcLogistics Localization Toolkit available from ESRI international distributors.

ArcLogistics Plug-ins

Plug-ins allow you to customize ArcLogistics by adding special features to support workflows it does not do out of the box. A typical example is adding a button that performs an import or export of routing information to or from your internal systems. You can also add custom behavior to certain events such as before or after building routes. Any developer tool and language that can create a COM component can be used to create plug-ins. You implement the IALCommand interface with a component in the appropriate category (similar to adding a command to ArcMap).

The ArcLogistics API itself reflects exactly what you see in the application. If you know how to work with routing folders, orders, and so forth, in the user interface, then using the API to automate things will be straightforward. Most plug-ins automate repetitive tasks just with these objects.

ArcLogistics plug-ins run within ArcLogistics. You can also use the COM API to modify projects (i.e., add orders) from an external application.

You have full access to the underlying ArcObjects™ classes. For example, you can convert a routing folder to a Network Analyst VRP Layer (INALayer) and export it. Route lines are returned as an ArcObjects IGeometry interface pointer, and so forth.

Sample plug-ins and code are included on the ArcLogistics installation CD including an object model diagram and a tutorial.

Minimum System Requirements

For the latest information on system requirements and recommended system aspects, visit <http://support.esri.com>.

CPU Speed	1.6 GHz recommended or higher
Processor	Intel® Core™ Duo, Intel Pentium®, or Intel Xeon® processors
Operating System	<ul style="list-style-type: none"> ■ Microsoft® Windows® 2000 Professional with Service Pack 3 or higher ■ Microsoft Windows Server® 2003 ■ Microsoft XP Home Edition with Service Pack 1 or higher ■ Microsoft XP Professional Edition with Service Pack 1 or higher ■ Microsoft Windows Vista®
.NET	Microsoft .NET Framework 2.0
Windows Installer	3.1
Display	Screen resolution 1024 x 768 recommended or higher, greater than 256 color depth
RAM	1 GB minimum, 2 GB recommended or higher (More orders and vehicles [larger operations] will require more RAM.)
Disk Space—ArcLogistics	Destination drive—At least 10 MB of free disk space for the ArcLogistics application (Depending on the number of orders, routes, routing folders, and projects you will use, plan on at least 1–2 GB of free disk space for these.)
Disk Space—ArcGIS Engine	Destination drive—500 MB of free space for ArcGIS Engine and Tutorial Projects
Disk Space—Street Data	10 GB of disk space for installation of the ESRI Street Data DVD(s)



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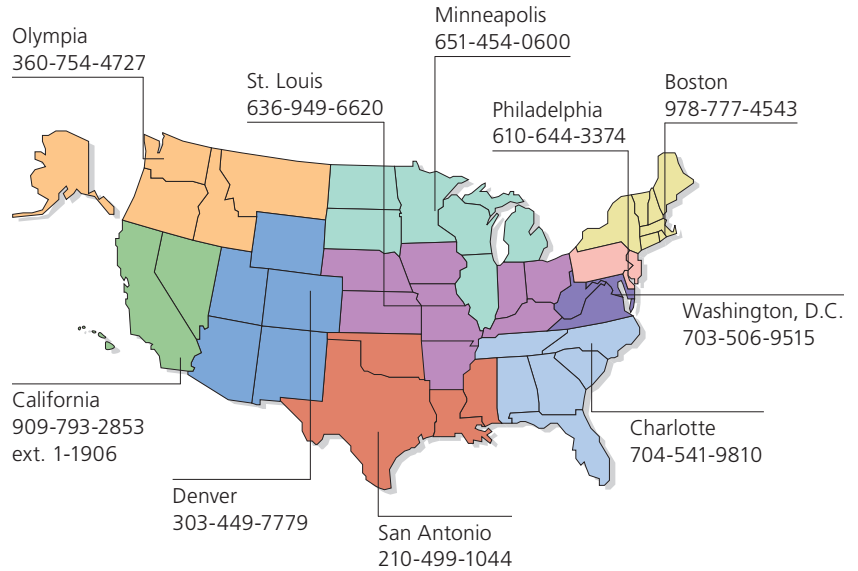
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