Delivery Sortation System

PASS

PASS Lite & DSS

Total Planned Deployment – 22,150
SCHEMELESS SORATION

End of FY13

7,100 Systems
Covering 90% of Packages Delivered
Dynamic Routing Model

- PTS
- SSF
- POS
- NMATS
- Mail.Dat
- PRLM
- Local
- ENTR

TRP
Transactional Record Processor

DRT
Dynamic Routing Tool

PASS / DSS Unit

Audio/Visual Dynamic Routes

PASS Website

GPX to Device
Load diagram
Turn by turn map

Routes
1. SAT1
2. SAT2
3. SAT3

Routing Reports
Testing Dynamic Routing in Washington DC
• Provides real-time communications and GPS

• Wireless tether for existing IMD to minimize cost

• Reduce posting of data from 5 hours to 20 minutes
DYNAMIC DELIVERY IN THE LAST MILE: Future State

- Dynamic Routing
- Geo-Fencing
- Real-Time Scan
- MyPost
- Delivery Analytics
- Timestamp
- Pass

Dynamic Delivery in the Last Mile: Future State
United States Postal Service
CIO Dynamic Routing Strategy
Statement of Objectives

January 18, 2013
# Table of Contents

Section I. Purpose .................................................................................. 3  
Section II. Background ...................................................................... 3  
Section III. Scope ............................................................................. 4  
Section IV. Objectives ....................................................................... 5  
Section V. Summary ........................................................................... 6
SECTION 1 - PURPOSE

The Postal Service is currently engaged in various efforts and studies centered on the dynamic routing of package mail, Express Mail, and Priority Mail. Changes in delivery standards for these types of mail, as the result of possible new product initiatives and with the possibility of Congress allowing the Postal Service to enact Five Day Delivery require rapid and organized delivery approaches. These new approaches also require changes in current operational procedures at the plant and post office levels. The purpose of dynamic routing is to provide web-based, national desktop tools to the plants, post offices, and management that will facilitate expeditious, sequenced delivery of certain mail types with clear turn by turn instructions to delivery personnel.

Although several groups within the Postal Service are presently engaged in dynamic routing studies and activities, it is important that a single corporate solution be achieved. Presently there are known COTS (commercial off the shelf) solutions available, and the USPS is also experimenting with custom built solutions for dynamic routing. Flexibility is very important to the USPS regarding dynamic routing. The USPS is seeking a more flexible means to deliver mail given the potential changes in the present rigid delivery structure. A more flexible delivery model, and supporting national desktop platform applications, will assist the USPS in reaching our restructuring goals.

This statement of objectives will outline the need for a dynamic routing solution and the elements that must be considered to achieve a corporate wide solution.

SECTION II. BACKGROUND

The Postal Service must provide a newly realigned delivery network that transforms today's delivery into a more streamlined and efficient service that still addresses the needs of mailers and customers to deliver products and services on the street over 300 days a year. Carrier work must move from the current practices of AM office work and AM/PM street work to an environment of all street delivery throughout the business day. This leverages our core strength of delivering product to every residence and business in the nation. What the conveyance is between letter carrier and customer is central to the efficient delivery of product, yet must still remain viable to mailers and customers.

Dynamic routing will play a key role in the overall success in the transformation of the USPS delivery operations model. As the USPS moves quickly to explore and launch new initiatives such as Same Day Delivery, and including pick-ups at retail locations, it is imperative that the USPS acquire the appropriate methods and national desktop tools (no site-by-site roll-outs) to support this, and other, new public offerings successfully. Additionally, if the USPS is allowed to enact Five Day Delivery by Congress it will be critical that a dynamic routing solution is available quickly. That dynamic routing solution will need to be designed to assist delivery personnel who are striving to meet service standards for Express Mail, Priority Mail, and packages that are delivered on Saturdays and Sundays.
SECTION III. SCOPE

The following section will provide the scope of dynamic routing for the USPS. This includes, but is not limited to, an evaluation of dynamic routing COTS products that are both customizable and configurable. Custom applications may also be entertained, but the overall expectation is to meet a corporate wide need for dynamic routing.

Current in-house dynamic routing applications may warrant a more robust solution that could be scaled up and architected into USPS production under USPS Information Technology rules and standards. A short term solution will be needed in support of Five Day Delivery (FDD). Presently the USPS is asking Congress for permission to move to a five day delivery operation model. If approved, the Post Master General has mandated that FDD be operational within 90 days. The Delivery Post Office Operations strategy to manage and deliver Express Mail will consist of delivery from a hub location, not at the post office level. The “Express Mail hub” approach is only for FDD, but could be utilized for other mail classes and products. No decision beyond FDD has been made at this time however. Personnel at the newly created hub locations will need a dynamic routing tool that provides turn-by-turn instructions, as well as more in depth capabilities such as quantity of route selection, route length in time, and other parameters that will facilitate the most efficient delivery of Express Mail given the resources available. This tool may also be used to initially plot the pickup of Express Mail items from locations such as small offices and Express Mail collection boxes.

Additionally, as the USPS realizes more and more dynamic routing needs in the coming months and years it is critical from a cost and infrastructure perspective that a corporate wide solution be achieved as early as possible. The scope of such a national desktop platform solution should support, but not be limited to; advanced scalability, maximum configurability, up-to-date GIS, ease of use, and IT compliance.
SECTION IV. OBJECTIVES

Objectives for USPS dynamic routing are comprehensive. The USPS seeks a system that is supported nationally and has flexible support for multiple initiatives. The dynamic routing system shall be able to handle input from more than one source and process data based on functions. The capability for passive and manual input into the system is required so that local site personnel can administer and adjust data inputs and outputs. As stated earlier, a web-based functionality via a national desktop platform and a tablet (or similar device) are desirable. The USPS will also need to see the usage, hosting, and balancing recommendations of the solution. The system must be capable of national deployment within one year of selection.

Product Features

- Workload balancing tools
- Vehicle usage based on package size and load balancing
- Alerts and real-time communications
- Web-based
- Passive and manual input capability (insertion of a pick-up piece with adjustment to dynamic route)
- Interface with USPS backend applications
- State of the art GIS based mapping and routing
- Process => 3,000 inputs in <= 10 minutes (performed simultaneously in multiple cities in every US time zones)
- Ability to scale up to route 11 million packages (within 6 hours)
- Schedule multiple packages and drop-offs
- Predictive modeling
- Optimization of associated workforce
- Turn-by-turn directions (print capability)
- Full reporting (including financial metrics and constraints)
- Traffic reporting and speed limit variables
- Administrator tools for carrier management
- System shall retain route history and line of travel data, including latitudes and longitudes.
- Capability to route across ZIP Code boundaries (including uniquely defined boundaries based on one or more, or partial Zip Codes)
- Route length, number of routes, mileage, and fuel management
- Ability to import and export data
- Number of stops on route, amount of route time, types of destinations (i.e. high rise versus houses, and other)
- Parcel volumes (quantity of parcels input into system, quantity of parcels delivered)
- Handle boundary routes and out-of-boundary routes
- Integrate communications, routes, and data with cellular and GPS navigation devices.
- Real time exception reporting
- Optimize one route across multiple service areas where pickups are done in multiple service areas (intermediate routes).
• Allow customized delivery deadlines for select packages (for example, Express Mail by noon, all other packages when possible)
• Customized "service times" based on address attributes
• Delivery to Collection box location instead of physical home for certain types and size of packages.
• Customized start, end, last delivery, break, and lunch times for routes when factoring historical traffic.
• Route restrictions based on road-type
• Time penalties for turns (left turns and u-turns)
• Local application view limited to service area's information
• Area application view for summary and details of offices within the area
• National application view for summary only
• Predefined service areas
• Locate 95% of street addresses including highway contract, rural route and newly added addresses or ability to accept latitudes/longitudes and retain for future routing use.
• Vehicle usage based on package size and load balancing
• Predictive analytics
• Ability to capture and validate delivery points and related data
• Capability to capture volume reporting
• Ability to add customized events and associated time parameters that can be adjusted based on geography and time.

It is critical that the USPS be provided with an understanding of how quickly a solution can be implemented. A no-cost proof of concept is desirable, as well as clear disclosure as to the total ramp-up timeline.

SECTION V. SUMMARY

This statement of objectives has outlined information regarding present and planned dynamic routing activities. The core strategy for dynamic routing should be of the nature to facilitate and include other dynamic routing needs that may come up as necessary to the Postal Service, and be able to synthesize those needs into a single corporate-wide solution.

The desire of the USPS is to proceed with a collective effort for a single dynamic routing solution. The solution shall not be limited to solving a delivery problem within a segment of the USPS process chain, rather it should address, as appropriate, the total cycle of mail acceptance through final delivery -- from first to last mile.

For the purpose of responding to this statement of objectives vendors are asked to provide the following:

• Complete product overview
• Full description of capabilities and supporting technical requirements
• Product data sheets
• List of current product users
• All input and output variables
Dynamic Routing

UPS solves this type of problem every day, for every driver using an in-house built system called ORION.

55,000 UPS “Brown Trucks.”

UPS saves **85 million** miles per year and billions of dollars through analytics.

By comparison, the Postal Service has **212,530** delivery vehicles! Just imagine how much they could save through a similar solution.

**15 trillion trillion**—The number of possible routes a driver with just 25 packages to deliver can choose from.
Postal Service to Make Sunday Deliveries for Amazon

By RON NIXON
Published: November 11, 2013

WASHINGTON — The cash-short United States Postal Service, which has failed to win congressional approval to stop delivering mail on Saturdays to save money, has struck a deal with the online retailer Amazon.com to deliver the company’s packages on Sundays — a first for both, with obvious advantages for each.

For the Postal Service, which lost nearly $16 billion last year, first-class mail delivery, particularly on Saturdays, is often a money loser, whereas package delivery is profitable.

The deal, announced on Sunday and taking effect immediately, in time for the holiday shopping season, gives the
Current Dynamic Routing Model

- USPS currently uses a dynamic routing solution, called RouteSmart, on a limited, but expanding basis.
- RouteSmart provides directions to drivers for 400 addresses in 5 minutes.
- The Postal Service has expressed interest in developing an internal solution to lower costs.
Project Summary

**USPS Background**
- Dynamic routing saves other delivery companies billions of dollars annually.
- USPS considering package only delivery on Sat. and just contracted with Amazon for Sunday package delivery.
- Currently using an expensive dynamic routing solution called Routesmart.

**Objectives**
1. Formulate an algorithm to minimize the time/cost to deliver parcels given a daily delivery list.
2. Assess implementation strategies and cost effectiveness of implementing dynamic delivery solutions

**Problem Statement**
- Desires an internal long-term solution to dynamic routing.
- Seeking to gain efficiencies in delivery methods and is specifically interested in the potential of dynamic delivery solutions.
- Wants to better understand the requirements and process for implementing a dynamic delivery solution.

**Scope**
- A limited set of random addresses comparable to data sets currently run through the RouteSmart system.
- One depot at a time.
- Arlington County Zip Codes.
- Package delivery only – Saturday or Amazon.
Concept of Operations

USPS Address Management System

Data Management

Core Processing (Model)

Carrier Interface

External Factors

DRT Interface

System Administration
- Work Load Balancing
- Routing Constraints

Real Time Traffic Data
- Road Construction Data

Geocoding Software

Data Archiving

Database (Package Info)

Dynamic Routing System

USPS Dynamic Routing Tool

Dynamic Routing Tool

Interface

Data Management

Core Processing (Model)

Carrier Interface

External Factors

DRT Interface

System Administration
- Work Load Balancing
- Routing Constraints

Real Time Traffic Data
- Road Construction Data

Geocoding Software

Data Archiving

Database (Package Info)
Requirements Development Objectives

✓ Identify, understand and document the needs of the USPS.

✓ Create a High Level System Requirements Specification (SyRS)
  ✓ Decompose the problem
  ✓ Provide basis for future Systems Engineering activities, including requirements development and analysis.
  ✓ Provide a template by which the USPS can determine suitability of potential solutions.

✓ Allocate requirements to the modeling activities
  ✓ Ensure the model meets the requirements set and highlight areas were it does not.
The GMU DRS shall accept as an input a maximum and minimum route length constraint.

- For the purposes of this project and model testing this constraint was a maximum of 5 hours and a minimum of 2 hours.

The GMU DRS shall take as an input delivery time needed for each delivery location and use this information in determining total route time.

- For the purposes of model testing this constraint was set to 2.5 minutes per parcel, based on average delivery time as provided by USPS.

The GMU DRS shall process at least 400 delivery locations simultaneously and formulate, optimize and report dynamic routes within >10 minutes of receiving a start request.

The GMU DRS shall formulate and optimize routes so that delivery locations are visited once on a given route and for a delivery location set.

The GMU DRS shall output a sequential list of delivery locations and parcel pickups for each route produced.

The GMU DRS shall output total mileage for each route produced by the DRS on a given system run.

The GMU DRS shall output total number of routes produced by the DRS on a given system run.
Model Overview

- Address List
- Geocode*
- Calculate Travel Times**
  - Cluster Algorithm
  - Dynamic Routing Model

SAS Code

Display Output

*Uses MapPoint and Excel
**Uses PCMiler
Clustering Approach

1. Create clusters based on least squares distance.

2. Heuristically estimate total delivery times for each cluster.

3. If delivery times are acceptable, then done. Otherwise, create new clusters with different min and max size.

Solutions with fewer clusters are preferred.
Model Formulation

For each cluster:

- Solve as a single driver Traveling Salesman Problem
- Seek to minimize the time required for all deliveries
- Determine time and mileage of route

- Modeled with SAS OR tools.
- First solves as an LP, then dynamically adds cuts until an acceptable solution is reached.
Model Performance

- Successfully delivers to all addresses for models of 400 and 2,000 deliveries
- Five iterations of 400 addresses completed in average of < 9 minutes*

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*OptSolver time could be improved by using multiple machines.
Model Outputs

1. Number of drivers required
2. Ordered delivery list for each driver
   - Can inform facility which packages to load onto each truck.
   - Informs driver of the efficient route to deliver packages.
The GMU DRS shall accept as an input a maximum and minimum route length constraint.

- For the purposes of this project and model testing this constraint was a maximum of 5 hours and a minimum of 2 hours.

Each model test run produced routes that were on average 2.9 hours long. No routes were more than 5 hours or less than 2 hours.

The GMU DRS shall take as an input delivery time needed for each delivery location and use this information in determining total route time.

- For the purposes of model testing this constraint was set to 2.5 minutes per parcel, based on average delivery time as provided by USPS.

Each model test run produced an output file specifying the number of deliveries made per location and the delivery time associated as a multiple of 2.5 minutes.

The GMU DRS shall process at least 400 delivery locations simultaneously and formulate, optimize and report dynamic routes within >10 minutes of receiving a start request.

- As discussed in in the Model Performance, each delivery location set processed on average in less than 9 minutes. One data set took approximately 16 minutes to process.
The GMU DRS shall formulate and optimize routes so that delivery locations are visited once on a given route and for a delivery location set.

- Each model run output was analyzed and it was verified that no redundant route stops were present.

- The GMU DRS shall output a sequential list of delivery locations and parcel pickups for each route produced.

- Each model run produced an output file specifying an ordered delivery list for each route.

- The GMU DRS shall output total mileage for each route produced by the DRS on a given system run.

- Each model run produced an output file specifying the total mileage for each route produced.

- The GMU DRS shall output total number of routes produced by the DRS on a given system run.

- As specified in the Model Performance, each model run produced a metric specifying the number of routes produced.
Model to Maps

Generating the mapped model output:
✧ Each Route produced by model was converted to a .csv file.
✧ Executed a Java program to convert .csv to a Keyhole Markup Language (KML) file.
✧ Imported KML to Google Maps
✧ Leveraged Google’s’s interpolation algorithm to make route stops follow roads.
  ▪ Google Maps can also be used to determine turn-by-turn directions between each route stop.
The Green, Orange, and Maroon routes are grouped closely together but there is little overlap.

The Green route comes south to deliver to 2 delivery points that are passed by the Blue, Teal, and Red routes.
The Purple, Green, Red, Pink, and Blue routes have significant overlap.

The Green route travels to both ends of Arlington County.

The Purple route has 2 delivery areas on opposite ends of Arlington.

The Red route contains only 15 deliveries.
Comparison with RouteSmart

- Our solution
  - 95.4 miles
  - 1,400 minutes
- RouteSmart (run by Postal Service)
  - 87.9 miles
  - 1,295 minutes

Our solution was within 7% of the RouteSmart solution.

Our solution still has significant room for improvement.

1) Clustering
2) Multiple CPUs
3) Other Algorithms
Recommendations and Roadmap

- Fully automate the process and data links.
- Improve clustering algorithm to improve workload balancing and time constraints.
- Explore additional heuristics to improve the speed of the model.
- Explore alternative solvers such as CPLEX and GUROBI.
- Obtain sufficient SAS licensing.
- Explore cloud computing services to host processing
- Fully integrate model output with GIS system
- Fully integrate model with GPS devices
Impacts

- Developed a prototype to demonstrate dynamic routing capability.
- Able to produce results similar to an industry dynamic routing solution.
- A fully developed dynamic routing solution will enable USPS to implement new services like Saturday and Sunday package delivery.
Acknowledgements

- Dr. Karla Hoffman
- Angela Lawson – USPS, Dynamic Delivery support
- Marc McCreery – USPS, IT Manager
- Tom Stewart – USPS, Created RFI
- David Yacobucci – USPS OIG
Lifecycle of a Package

The dynamic routing decision will take place at the Destination Processing Plant right before packages are loaded onto trucks.
Background

- The United States Postal Service (USPS) historically delivers mail and packages through over 200,000 nationwide static delivery routes. These routes are the same everyday.
- Recently, the USPS issued a ‘Request for Information’ regarding dynamic routing solutions. Dynamic routing is a routing technique that changes drivers’ routes daily based on the deliveries they need to make for that day. Dynamic routing would allow the Postal Service to consider ideas including:
  - Delivering only packages on Saturday - debated in proposed legislation
  - Same day delivery of mail or packages – a hot product in pilot phases
  - Separating package delivery from mail delivery – a potentially different business model
- Other delivery companies have saved billions of dollars every year through their adoption of dynamic routing solutions.
Problem Statement

• Facing a potential budget reduction, USPS is seeking to gain efficiencies in delivery methods and is specifically interested in the potential of dynamic delivery solutions. USPS is seeking more efficient delivery routing methods and wants to better understand the requirements and process for implementing an internal dynamic delivery solution.
Objectives

- Formulate an algorithm to minimize the time/cost to deliver parcels given a daily delivery list.
- Develop a System Requirement Specification
- Assess potential solutions and implementation strategies for nation wide dynamic routing.
- Develop a Concept of Operations
- Develop a System Prototype
Assumptions

- Drivers depart and return to the same office.
- Full-time drivers must work 8 hours/day.
- Part-time drivers hours are flexible.
- Travel time calculator assumes standard traffic conditions.
- Cost factors as provided by USPS.