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MAIL PROCESSING NETWORK RATIONALIZATION SERVICE CHANGES, 2012

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REBUTTAL TESTIMONY OF

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OF DECISION/ANALYSIS PARTNERS

ON BEHALF OF

AMERICAN POSTAL WORKERS UNION, AFL-CIO

APWU-RT-3

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1 Autobiographical Sketch

My name is Pierre Kacha. I am the director of the Postal Practice at decision/analysis partners LLC, a management and technology consulting firm based in Fairfax, VA, specializing in logistics and operations management with emphasis on the postal, mailing, and shipping sectors.

I hold a PhD and MS in Industrial Engineering from Purdue University and a BS in Mechanical Engineering from the George Washington University. I have worked as a management and technology consultant for the past 24 years, the majority in the postal sector for public postal operators and private companies. I joined decision/analysis partners in 2003. My postal consulting assignments included product development, market research, operations analysis and reengineering, and technology requirement specification. I have directed the development of many postal decision-support tools, such as network simulation models and postal facility planning tools that have provided my clients with insights into their business objectives.

Over the past four years, I have led my company's support of Canada Post's Postal Transformation program, a comprehensive effort at modernizing and streamlining operations at Canada Post.

2 Purpose of Testimony

The purpose of my testimony is to present partial results of a study performed under my direction by my company, decision/analysis partners LLC (d/ap) of Fairfax, VA on behalf of the American Postal Workers Union, AFL-CIO. The study uses a detailed network simulation model originally developed for the USPS Office of Inspector General to compute service performance and costs of the Postal Service's processing and distribution network under alternative scenarios. I will provide a detailed description of the network simulation model, the scenarios modeled, and results obtained to-date.

3 Library References

The following supporting APWU library references are filed:

APWU-LR-N2012-1/NP1 Input Data Set

APWU-LR-N2012-1/NP2 Baseline Validation Worksheet

APWU-LR-N2012-1/NP3 Circuity Analysis

APWU-LR-N2012-1/NP4 Cost and Productivity Calculations

APWU-LR-N2012-1/NP5 Model Sample Output Data

APWU-LR-N2012-1/NP6 Scenario Files

APWU-LR-N2012-1/NP7 Network Simulation Model

APWU-LR-N2012-1/NP8 Decision/Analysis Partners Presentation at the May 1, 2012 Technical Conference

4 Introduction and Executive Summary

In 2010, decision/analysis partners LLC (d/ap) developed a network simulation model as part of a project for the USPS OIG. The network simulation model assumed a greenfield approach to the USPS network, and the results were presented as part of the USPS OIG white paper entitled "A Strategy for a Future Mail Processing & Transportation Network" (RARC-WP-11-006). In January 2012, we were retained by the APWU to enhance this network simulation model to conduct a study designed to evaluate a number of scenarios against current existing service standards, based on accurate depiction of USPS operating conditions and origin/destination mail volumes. The model computes total network service performance and costs for each scenario by aggregating the processing and distribution service and cost of each origin-destination pair for First Class Mail and Standard Mail across shapes and presort levels.

The initial OIG network simulation model was enhanced for this 2012 study to simulate mail routing logic that approximates USPS practices as closely as possible. This simulation logic includes distribution rules, detailed processing plant processes, facility capacity and productivity, and transport mode, capacity, speed, and frequency for each origin/destination and mail product combination. The network simulation model uses data provided by the Postal Service to the greatest extent possible, using a number of sources as detailed in the Appendix, including ODIS mail volumes by mail types, service performance standards, facility capacity, and mail processing equipment and productivity. The network simulation model uses average daily mail volumes. A baseline run using the current Postal Service network configuration shows that the network simulation model accurately replicates facility volumes as reported in MODS and total operating costs.

Table 1 shows network service performance for a baseline configuration that reflects USPS FY2010 operating conditions and an initial series of seven scenarios (explained in the body of the testimony). It is also represented graphically in Figure 1.These scenarios use different numbers of mail processing facilities causing some mail to use different paths through the simulated network, traveling longer distances or encountering capacity bottlenecks.

		On-Time Service Performance (%)					
			Overnight Mail				
Scenario Name	# of Facilities	Overall	Intra-SCF Turnaround (Origin ZIP = Destin ZIP)	Intra-SCF Non-Turnaround (Origin ZIP <> Destin ZIP)	Inter-SCF D+1	Inter-SCF D+2	Inter-SCF D+3
Baseline	477	92.5%	96.3%	95.4%	69.3%	96.2%	97.5%
Top Three Quartiles	410	91.9%	95.1%	94.4%	69.2%	95.0%	97.1%
Shoot For 400	400	91.9%	94.7%	93.6%	70.1%	94.6%	97.4%
Shoot For 350	350	91.3%	92.5%	92.4%	71.0%	93.3%	97.6%
Top Half	342	91.3%	92.9%	93.1%	70.4%	93.7%	97.1%
Shoot For 300	300	88.7%	86.9%	88.0%	70.4%	89.7%	96.8%
Top Quartile	276	87.9%	86.0%	87.8%	70.1%	88.5%	96.0%
ShootFor250	250	86.0%	81.7%	82.1%	71.6%	86.0%	95.8%

Table 1: Network Simulation Model Service Performance Results by Scenario

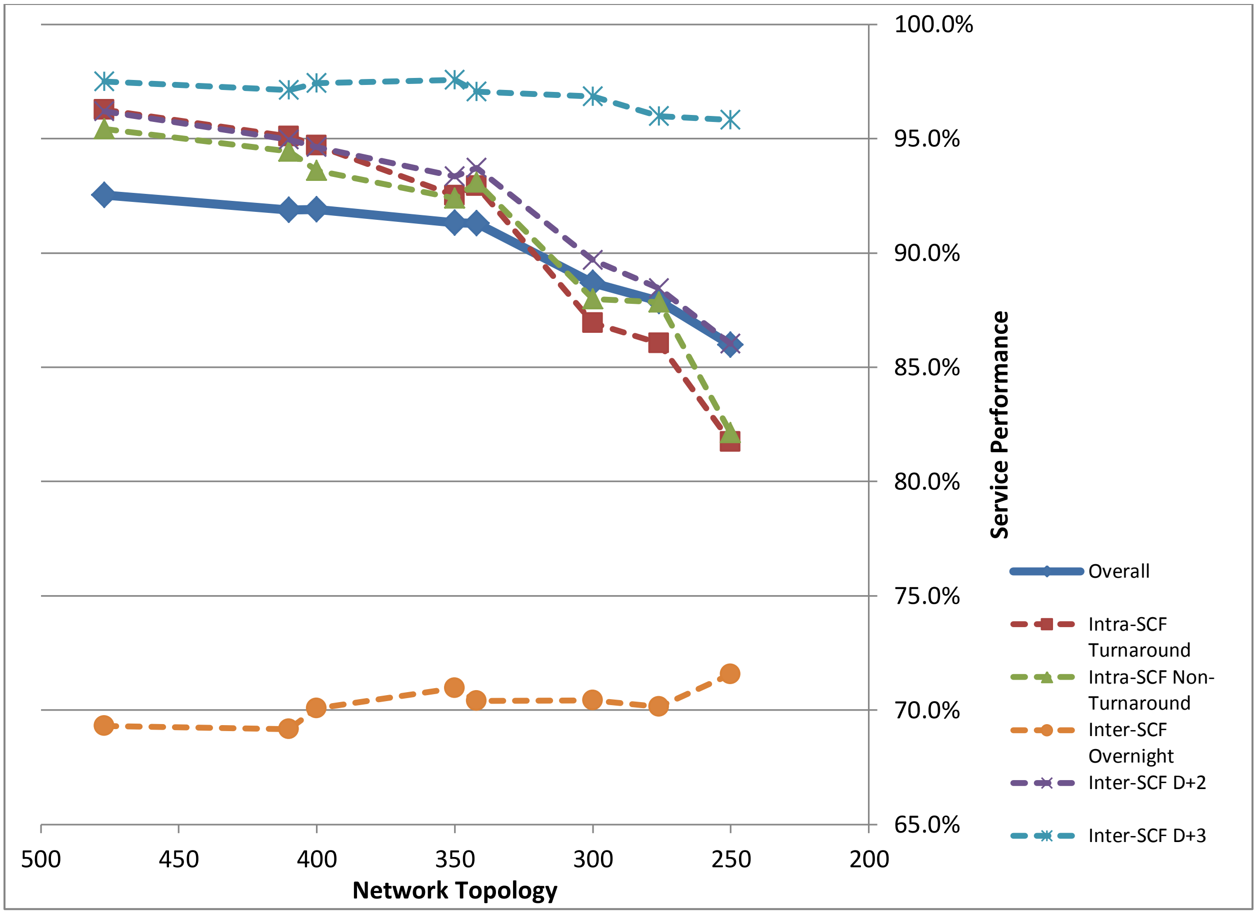

Figure 1 – Service Performance for FMC Letters and Flats

These service performance results are idealized because they do not reflect the inherent variability of the mail processing and distribution environment – variability which is caused by a host of factors including the unpredictability of labor-intensive operations, fluctuations in machine throughput and/or downtimes, labor shortages, unpredictable variation in demand, variation in time in transit, etc. Moreover, many processes are not represented (e.g., yard and dock operations, opening unit operations, bulk mail acceptance, etc.) each of which contributing to the overall service performance.

Due to lack of time, we did not test the effects of more stringent, but quite plausible, operating conditions. These additional conditions, which we intend to analyze include:

- Evaluating service performance under peak processing volumes, based on FY2010 data

- Adding a ‘tail of mail’ for originating outgoing mail to depart the originating ZIP3 at 8pm (in the reported results, the second and final dispatch departs the originating ZIP at 6pm)
- Considering a 7am target entry time at the destination ZIP3 (in the reported results, the cutoff time is set to 8am)

The costs associated to the scenarios tested are presented below; these are explained in the body of the testimony.

		Letters & Flats Processing Costs + Overhead Costs (millions of $)								
Scenario Name	# Plants	Fixed Processing Costs		Variable Processing Costs			Overhead Costs		Total	
				Letters	Flats					
		Costs	% of Baseline	Costs		% of Baseline	Costs	% of Baseline	Costs	% of Baseline
Baseline	477	$1,133	--	$1,650	$717	--	$7,236	--	$10,736	--
Top 3 Quartiles	410	$1,113	98.3%	$1,649	$712	99.7%	$7,070	97.7%	$10,545	98.2%
Shoot For 400	400	$1,112	98.1%	$1,650	$708	99.6%	$7,050	97.4%	$10,520	98.0%
Shoot For 350	350	$1,103	97.4%	$1,648	$697	99.1%	$6,895	95.3%	$10,343	96.3%
Top Half	342	$1,102	97.2%	$1,648	$700	99.2%	$6,917	95.6%	$10,367	96.6%
Shoot For 300	300	$1,095	96.6%	$1,635	$686	98.1%	$6,528	90.2%	$9,944	92.6%
Top Quartile	276	$1,091	96.3%	$1,632	$688	98.0%	$6,448	89.1%	$9,859	91.8%
Shoot For 250	250	$1,062	93.7%	$1,615	$668	96.5%	$6,014	83.1%	$9,359	87.2%

Table 2: Network Simulation Model Cost Results by Scenario

5 Study Background & Objective

The USPS processing and distribution (P&D) network is configured to process many products of varying demand, each following separate operating procedures and subjected to different service commitments. The performance of a particular mail P&D network can be measured by a number of key indicators, mainly: the ability to meet service performance, and overall costs (RT production processing costs and overhead costs[1]). A sound network simulation model of the P&D network can provide an understanding of how service performance and costs change under various scenarios

[1] Costs include variable and fixed RT production processing costs and overhead costs, as defined in the Definition of Terms and other sections.

or configurations, becoming a decision-aid to stakeholders for making strategic, business, or operational choices.

To provide sound results, the network simulation model must use reliable data, closely replicate reality, and also be calibrated against known operational conditions. USPS-provided FY2010 operational data and parameters as well as operating conditions, are faithfully represented to evaluate different network configurations in terms of their effect on service performance and costs. A subset of the Postal Service's products is represented (letters, flats across classes and presort levels).

6 Definitions

The following terms are used in the remainder of this testimony:

Term	Definition
Baseline Network Configuration	The set of mail processing facilities assigned by USPS in FY2010 to sort and distribute the average daily volume of letter and flat mail. The Baseline network characterizes the mail processing capacity available to each facility, the prevailing distribution assignments established (see definition below), and the distribution rules between each mail processing facility (see definition below).
Distribution Assignments	The assignment of ZIP3s to mail processing facilities for originating and incoming sort.
Distribution Rules	The instructions that determine the routing of mail between two mail processing facilities based on the origin and destination ZIPs of the mail.
Network Configuration	In this context, the assignment of mail processing facilities within the 48 contiguous states to process letter and flat mail. A network configuration distinguishes itself from the USPS FY2010 baseline network of facilities (the Baseline) by consolidating some facilities (losing facilities) into other existing facilities (gaining facilities). If the processing capacity in gaining facilities is modified with respect to the Baseline, this is considered a distinct network configuration.
Costs	The sum of the variable and fixed RT processing labor costs and

Term	Definition
	transportation costs. Labor costs are computed using data and analysis in USPS-N2012-1/NP2, 15, and 46. Transportation costs are computed by estimating travel distance and transportation modes between origin to destination point, using USPS-N2012-1/65 data.
Overhead Costs	The sum of admin/other and maintenance labor costs, plus supply, fixed opening, and fixed operating non-labor costs. Based on data and analysis in USPS-LR-N2012-1/14, 15, and 43.
Service Performance	The portion of First Class letter and flat mail delivered to a ZIP3 centroid by 8AM of its due day. The due day is derived from the published service standards for the OD pair of each Mail Unit (see definition below) entering the
Product	A general descriptor used to reference mail of the same Shape and Class. In addition to its Shape and Class, a Product is represented by a number of additional attributes (see section below on 'Mail Products and Attributes').
Shape	A dimensional characteristic of the Product. The Shape can be a letter, a flat, or a parcel.
Class	A descriptor of 'service standard', whereby service standard is defined as the time to flow a Mail Unit (see definition in this section) from its Origin ZIP3 to its Destination ZIP3. The service standard is measured in days.
Mail Unit	The smallest logical grouping of mail pieces represented in the network simulation model. A Mail Unit's attributes include: • Its Product, • Its Sort Level, • Its Origin ZIP3, • Its Destination ZIP3, • Its Induction Date, and • Its Piece Count.

Term	Definition
	Any simulated Mail Unit that displays different attribute values is treated as a distinct Mail Unit. This enables the network simulation model to maintain the traceability of each simulated Mail Unit. This construct allows the flow of individual Mail Units to be represented efficiently and tracked from end-to-end as they are processed and transported through the network. Some of the attributes for a Mail Unit are static over its entire "life" (Product, Origin ZIP3, Destination ZIP3, and Induction Date), while other attributes (Sort Level and Piece Count) change to reflect the Mail Unit's current state as it flows through the network, undergoes processing operations, or is aggregated with other Mail Units.
Mail Processing Facility	A mail processing facility sorts Mail Units by flowing them through mail processing operations that are determined by process flow instructions (see further below). The attributes associated with a facility include: • Facility Name • Location (latitude/longitude and time-zone) • Equipment set (the number and type of each processing machine present, see below) Mail Unit types processed by mail processing facilities depend on the equipment type available at the facility.
Sort Level	The level or depth to which a particular Mail Unit is sorted at any point through the flow of the Mail Unit from induction point to destination. A Mail Unit's Sort Level will vary from an initial level (e.g., presorted, single piece) to its final Sort Level (walk sequenced), and will evolve based on the mail processing operation it undergoes. The network simulation modeled Sort Level possibilities are: • No Sort Level • ZIP3 • ZIP5 • Carrier Route, and • DPS

Term	Definition
Mail Bin	A logical grouping of multiple Mail Units used when they need to be aggregated together but still retain their individual attributes, such as when Mail Units are staged for a mail processing operation, or when Mail Units are loaded together for transport.
Equipment Set	The number and type of each processing machine assigned to a mail processing facility. Equipment Sets were obtained from USPS Library Reference N2012-1/17.

7 Network Simulation Model Overview

7.1 Scope

The network simulation model is designed to flow letter and flat mail (FCM and Standard) from origin ZIP3 to destination ZIP3, through pre-assigned outgoing facilities, ADC/AADCs, and incoming facilities. Average daily FY2010 mail volumes and distribution rules are used for the baseline network configuration as well as the other scenarios presented here. The information sources for FY2010 volume data and distribution rules are presented in the Appendix. The process by which these volumes are attributed across Origin-Destination ZIP3s pairs is explained further below.

7.2 Mail Products and Attributes

The table below shows the USPS Products used in the network simulation model with their attributes.[2]

[2] A future version of the network simulation model will incorporate remaining Product shapes (parcels) and classes (Priority).

Shape	Class	Lbs Per Piece	Cubic Feet Per Piece	Pre-sorted	USPS Constituent Mail Categories	Avg Daily Non-CR, Non-DDU Volume
Letters	First Class	0.03922	0.00225	N	1C Single Piece Letters/Cards	94,734,962
				Y	1C Non-carrier Route Letters/Cards	153,064,193
	Standard	0.05991	0.00276	Y	Standard Letters, Non-ECR	159,887,665
Flats	First Class	0.20961	0.00922	N	1C Single Piece Flats	6,237,122
	Standard	0.25160	0.00773	Y	1C Non-carrier Route Flats	2,220,237
				Y	Standard Flats, Non-ECR	23,321,959
	Periodicals	0.38520	0.01390	Y	In/Outside County Periodicals	9,170,597
	Package	1.37230	0.05850	Y	Package Services BPM Flats	454,400

Table 3 – Modeled Products and Model-Relevant Product Attributes

The single Lbs/Piece and Cu.Ft/Piece values for each Product were computed based on the volume-weighted average of the Lbs/Piece and Cu.Ft./Piece values for the Product's constituent USPS mail categories. These size and weight factors are used for transportation cost calculations within the network simulation model.

A complete list of data sources is also provided in the Appendix.

7.3 Facility Attributes

The baseline network simulation model contains a representation of each mail processing facility in the network[3]. The attributes of each facility are specified as inputs to the simulation, including:

- Facility Name
- Location (latitude/longitude)

[3] Source: USPS-LR-N2012-1/15, 17, and 34

- Equipment set (the number and type of each processing machine present, see below)

7.4 Facility Equipment

Each facility in the simulation network simulation model has an assigned equipment set used for automated processing operations. This equipment set consists of the number and type of each machine at the facility. The attributes associated with each type of machine include:

- Machine Type
- Throughput (pieces/hour)[4]
- List of shape-based processing operations the machine may perform (e.g., L-OGP, F-INP, etc.)

All machines of the same type are assumed to be equal in terms of their capabilities.

7.5 Model Design Guidelines

Average daily mal volumes. Mail flows through the network simulation model use average origin/destination weekday FY2010 daily volumes. The effects of weekend days, holidays, Christmas, etc. are not considered in the network simulation model. A “priming period” of four simulated-days is run with identical daily input volumes to allow the network simulation model to reach a steady state. All metrics are collected starting on the fifth simulated-day, again with the same input average daily volumes.

ZIP3. Three-digit ZIP codes are the ‘organizing’ structure in the model:

- Average daily mail volumes are organized by Origin-Destination ZIP3 pairs.
- Mail processing facilities are assigned to a ZIP3. Thus, each ZIP 3 is assigned the following categories of mail processing facilities:
- Outgoing processing facility – for letters and flats; First Class and Standard
- Incoming processing facility – for letters and flats; First Class and Standard
- Area distribution centers (AADCs) – for letters; First Class

[4] Source: Figure 1 Model Equipment Throughput – Direct Testimony of Emily R. Rosenberg on behalf of US Postal Service (USPS-T-3).

- Area distribution centers (ADCs) – for flats and periodicals; First Class
- Area distribution centers (ADCs) – for flats and bound printed matter; Standard

Mail Units. A Mail Unit represents the smallest grouping of mail pieces in the network simulation model. Each Mail Unit carries attributes that characterize it. Some of the attributes are static over the Mail Unit's entire "life" (Product, Origin ZIP3, Destination ZIP3, and Induction Date). Other attributes (Sort Level and Piece Count) change to reflect the Mail Unit's current state as it flows through the network, undergoes processing operations, or is aggregated with other Mail Units.

Any simulated Mail Unit that displays different attribute values is treated as a distinct Mail Unit. This enables the network simulation model to maintain the traceability of each simulated Mail Unit from creation to removal.

Transportation capacity. Transportation capacity (air and surface) is assumed to be unconstrained. Transportation departures occur based on a fixed daily operating schedule outlined in a subsequent section.

Manual operations. Manual operations are not modeled. Consequently, mail processing facilities that do not have automated processing equipment in the baseline FY2010 conditions[5] have been assigned a single machine. Specifically, mail processing facilities that do not have cancellation equipment have been assigned a single NEC/MARK machine; facilities with no DBCS have been assigned a single DBCS; facilities with no Flat Sorters or AFSM100 machines have been assigned a single Flat Sorter machine.

7.6 Modeling Environment

The design objective is to provide a transparent, reusable, and scalable model of USPS's P&D network processes. To fulfill these objectives, the underlying simulation core is provided by MASON[6] (Multi-Agent Simulator Of Networks). MASON is an open-

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[5] Source: USPS-LR-N2012-1/17 17_ZipAssignment_LocalInsight.xls, Summary Worksheet
[6] http://cs.gmu.edu/~eclab/projects/mason/

source, extendable, discrete-event multi-agent simulation toolkit designed to serve as the basis for a wide range of simulation tasks. All software is implemented in Java.

8 Model Description

A 'baseline' network simulation model is first built to emulate the USPS network in effect in FY2010, with all pertinent operating conditions. The baseline network simulation model serves as a benchmark to evaluate the alternative scenarios in terms of their effect on service performance and costs. The baseline and the scenarios adhere to the same design described in this section.

8.1 Mail Units Induction

Mail Unit volumes are inducted into the network in one of two ways:

- as origin-entered mail through an origin ZIP3, or
- as presorted drop-shipped mail at either a DSCF or DNDC.

The subsections below describe how mail induction is modeled for origin-entered and facility-entered (drop-shipped) Mail Units.

8.1.1 Origin-Entered Mail Units

For each origin ZIP3, new origin-entered Mail Units are "created" at two discrete times, 4pm and 6pm local time, with the average daily volume split 30% for the 4pm induction, and 70% for the 6pm induction[7].

The Mail Unit's attributes (Product, Sort-Level, Origin ZIP3, Destination ZIP3) are set based on input volume tables generated through a process described in Section 8.3.2. The Piece Count attribute is subsequently set to the estimated Average Daily Volume multiplied by 30% or 70% accordingly, and the Induction Date is set to the current simulated day.

[7] The final 6pm induction privileges early acceptance of First Class Mail into the originating processing facility, thus clearing the CANC and/or OGP operations comfortably before their clear time. A final dispatch of 8pm would be a more realistic representation of the tail of the collection process, and would likely incur higher risks of plan failure (i.e., risks of not clearing by cutoff time).

The newly-created origin-entered Mail Units are then simulated being transported by truck from the centroid of each origin ZIP3 to the outgoing facility assigned to serve that ZIP. The transportation time is computed as a Product of the distance from origin ZIP3 centroid to outgoing facility at an average truck speed of 46.5 mph. A circuity factor of 1.28 is utilized (See Transportation discussion below).

8.1.2 Facility-Entered (Drop-shipped) Mail Units

Facility-entered Mail Units are modeled as entering the network at DSCFs and DNDCs[8] at a constant rate between 8am and 4pm. During that time window, drop-shipped volumes are created as new Mail Units at 30-minute intervals with attributes set according to the values estimated in the network simulation model input volume tables generated using the process described in Section 8.3.2. The piece count associated with each facility-entered Mail Unit is set such that the Average Daily Volume is uniformly distributed over the 8am-4pm drop-ship time window.

8.1.3 Mail Unit Removal

Each destination facility is assigned an incoming transport “Mail Bin” for each of its served ZIP3 code destinations. Mail Bins accumulate incoming Mail Units to be transported to that destination ZIP3.

At the dispatch time of 6:30am, the Mail Bins are emptied and the Mail Units are transported from the facility to the centroids of their destination ZIP3 codes.

The transport time and associated transport cost are computed in a manner similar to transport from origin ZIP3 to outgoing facility.

Mail Units exit the system when they reach the centroid of their destination ZIP3. At that point, final exit statistics are computed, and the mail is removed from the network simulation model.

[8] Standard mail and Bound Printed Matter is cross-docked through NDCs.

8.2 Modeling Mail Units through the Network

Mail Units flow through the simulated P&D network according to distribution rules[9]; they flow within processing facilities based on process flow routing rules. This section describes distribution and process flow rules represented in the network simulation model.

8.2.1 Distribution Routing

Each ZIP3 is assigned a facility for each of the following designations:

- Cancellation/Letters & Flats Outgoing (CANC/L-F OUTG)
- Letters & Flats Incoming (L-F-INC)
- AADC
- ADC for First Class and Periodical Flats (ADC-FCM)
- ADC for Standard and BPM Flats (ADC-STD)
- NDC

These facility assignments are organized in a lookup table structured as shown below.

ZIP3	CANC/L-F-OUTG Facility	L-F-INC Facility	AADC Facility	ADC-FCM Facility	ADC-STD Facility	NDC Facility

Table 4 – ZIP3 Facility Assignment Table Structure

For the baseline, the assignment of facilities to operations is derived from the USPS-LR-N2012-1/NP2. Archived June 2010 labeling lists are also used to obtain the AADC, ADC, and NDC assignments[10].

The facility assignment table is used to determine how to route Mail Units as they move through the network. Mail Units inducted at an origin ZIP3 are first transported to the assigned outgoing facility for mail of that shape. From an outgoing facility, a mail piece's next stop is influenced by its published service standard[11]:

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[9] Source:USPS-LR-N2102-1/NP2 operation assignments, and published labeling lists.
[10]Source:L004,L801,L601:
http://pe.usps.com/Archive/HTML/DMMArchive20100607/labeling_lists.htm
[11] Source: https://ribbs.usps.gov/index.cfm?page=modernservice

- Mail Units with a 1-day or 2-day service standard are transported directly to the assigned Incoming facility.
- Mail Units with a 3+ day service standard are transported to the destination AADC or ADC facility.
- Letter Mail is transported to destination AADCs
- FCM and Periodical class flat Mail Units are transported to the destination ADC for FCM and Periodicals, and
- Standard and BPM flat Mail Units are transported to the destination ADC for Standard and BPM flats.

Refer to the section below for a description of the transportation analysis.

8.2.2 Process Flow Routing

Each Mail Unit has an associated Sort Level attribute that changes based on the processing operations performed as the Mail Unit advances through the network. Each processing operation results in a different Sort Level assigned to the Mail Unit, and a Mail Unit's location and Sort Level determine which processing operation or facility to be sent to next.

The table below shows the Sort Levels applied to each shape after being processed through a particular operation.

	RESULTING SORT LEVEL TRANSITIONS		
OPERATION	Letters	Flats	Parcels
Cancellation	None	N/A	N/A
Outgoing Primary	None→ZIP3	None→ZIP3	None→ZIP3
Incoming Primary	ZIP3→ZIP5	ZIP3→ZIP5	ZIP3→Carrier Route
Incoming Secondary	ZIP5→DPS	ZIP5→Carrier Route	N/A

Table 5 – Processing Operations and their Resulting Sort Level Transitions

The sort level transitions above are applied in the general cases. Some exceptions are applied in selected circumstances to account for turnaround mail, Managed Mail, and other situations that require special treatment. These special cases are described below.

Prioritization Logic – The network simulation model prioritizes First Class Mail over Standard Mail when Mail Units of both classes compete for mail processing resources. Moreover, the network simulation model prioritizes mail on the basis of its due date; accordingly, First Class Mail with the nearest due date is processed first (i.e., overnight FCM is processed before D+2 FCM, which has precedence over D+3 FCM). Special considerations are also applied to First-Class Turnaround Mail (see next).

First-Class Turnaround Mail - Special logic is applied to First Class Mail that originates and destinates at the same facility (turnaround mail). A portion of such mail is assumed to be sorted to ZIP5 during Outgoing Primary, and could thus skip the incoming primary operation (INP) and proceed straight to Incoming Secondary (INS) The fraction of First Class turnaround mail allowed to skip INP is determined as follows:

For letters, 30 DBCS bins are set aside during L-OGP for high-density 5-digit ZIP codes. For flats, the number of set aside bins is 4. For each facility, its 30 highest-population 5-digit ZIP codes (or 4 highest 5-digit ZIP codes for flats) by 2010 census population are determined; these are assumed to represent "high-density zones." The use of 30 and 4 set-aside bins for letters and flats respectively was an approximation based on subject matter expert opinion.

For each ZIP3 code for which the facility performs INP, the fraction of that ZIP3's population that falls within the high-density zones is computed. That fraction becomes the "INP bypass fraction" for that ZIP3 code. When the facility is processing a First-Class turnaround Mail Unit destined for a particular ZIP3 code, the network simulation model finds the INP bypass fraction for that ZIP3 code and that fraction of the pieces skip INP and are assigned straight to the queue for INS.

The network simulation model does not use site-specific bypass flow rates, but uses this generic methodology to better approximate mail processing choices.

Managed Mail - AADC and ADC facilities serve a unique role in the simulation model by performing a fraction of INP sortation on behalf of downstream facilities. For flats, that fraction is assumed to be 100%. Thus, any non-local ZIP3-sorted flats at an ADC facility would receive INP sortation to ZIP5-level before being transported on to the destination Incoming facility.

For non-local letters at an AADC, the fraction to receive INP sortation is less than 100%. A similar logic is used as for First Class Turnaround Mail described above: 30 bins are set-aside for the top-30 highest-population downstream 5-digit ZIP codes for which the facility serves as an AADC. Then for each non-local ZIP3 code for which the facility serves as an AADC, the fraction of that ZIP3 code's population that falls within the top-30 high-population 5-digit ZIP codes is computed. That fraction becomes the “managed INP fraction" for that ZIP3, so any ZIP3-sorted Mail Unit destined for a non-local 3-digit ZIP code would have the corresponding fraction of its pieces split off into a new Mail Unit and receive INP sortation to ZIP5-level before being transported to the destination Incoming facility.

Destination INP Re-handling – A portion of all letters and flats is assumed to need re-handling at the destination incoming facility after receiving a Managed Mail sortation at an upstream AADC or ADC:

- 35% of ZIP5-sorted letters and 70% of ZIP5-sorted flats are given an INP sortation at the destination incoming facility after being received from an upstream facility AADC or ADC.

In reality, each facility would exhibit site-specific re-handling characteristics, so the generic re-handling percentages utilized in the network simulation model are just rough approximations based on subject matter expertise.

Mail Units Skipping 2nd DPS Pass – 10% of all letter Mail Units are assumed to skip the 2nd DPS pass (L-INS2) after completing the first pass (L-INS1). This reflects machine rejects and re-handling at L-INS1.

8.2.3 Operating Schedules

The assumptions associated with the timing of mail arrival, processing, and transportation activities are summarized below (all times are in the local-time of the facility or ZIP code):[12]

ALL SHAPES		
Start Time	End Time	Event or Time Window
06:30	N/A	Incoming dispatch time from incoming facility to destination ZIP3.
00:30	N/A	Outgoing dispatch time to downstream ADC/AADC or facility.
LETTERS - FCM		
Start Time	End Time	Event or Time Window
16:00	N/A	30% of origin-entered mail inducted
18:00	N/A	70% of origin-entered mail inducted
16:00	23:00	Cancellation processing window
16:00	00:00	Outgoing processing window
14:00	02:00	Incoming primary processing window
23:00	02:30	DPS 1-st pass processing window
02:30	06:30	DPS 2nd pass processing window
LETTERS – STD		
Start Time	End Time	Event or Time Window
08:00	16:00	Destination drop-ship time window
08:00	20:00	Incoming primary processing window
23:00	02:30	DPS 1-st pass processing window
02:30	06:30	DPS 2nd pass processing window
FLATS - FCM AND PERIODICALS		
Start Time	End Time	Event or Time Window
16:00	N/A	30% of origin-entered mail inducted
18:00	N/A	70% of origin-entered mail inducted
16:00	00:00	Outgoing processing window
14:00	02:00	Incoming primary processing window
00:00	06:30	INS (Carrier Route sort) processing window
FLATS - STD/PACKAGE		
08:00	16:00	Destination drop-ship time window
07:00	18:00	Incoming primary processing window
08:00	00:00	INS (Carrier Route sort) processing window

Table 6 – Operating Windows for Modeled Mail Processing Operations

[12] Alternative standard operating windows ("Current Operating Plan of a Typical Plant") can be found in N2012-1 USPS-T-4 testimony by Neri (Filing ID 78328).

8.3 Input and Output Data

8.3.1 Presort Levels and Network Entry Points

Each Product's volume is broken down by presort level and entry point as shown below. Three levels of Presort are modeled - ZIP5, ZIP3, and 'less-than-ZIP3'. Three possible network entry points are considered: DSCF, DNDC, and Origin.

			DSCF-Entered		DNDC-Entered			Origin-Entered		
Shape	Class	Pre-sorted	ZIP5 Presort	ZIP3 Presort	ZIP5 Presort	ZIP3 Presort	<ZIP3 Presort	ZIP5 Presort	ZIP3 Presort	<ZIP3 Presort
Letters	FCM	N	0%	0%	0%	0%	0%	0%	0%	100%
		Y	0%	0%	0%	0%	0%	48.24%	35.37%	16.39%
	Std	Y	38.5%	13.85%	8.07%	14.11%	2.19%	4.87%	8.41%	10.0%
Flats	FCM	N	0%	0%	0%	0%	0%	0%	0%	100%
		Y	0%	0%	0%	0%	0%	25.13%	43.26%	31.60%
	Std	Y	38.21%	5.35%	18.93%	8.86%	0.15%	10.33%	13.70%	4.48%
	Period.	Y	2.84%	1.75%	0%	0%	0%	63.37%	24.83%	7.21%
	Package	Y	0%	59.76%	0%	18.31%	0%	0%	19.24%	2.69%

Table 7 – Presort Levels and Network Entry Points for Modeled Products

The entry-point and drop-ship percentages above were derived from the PRC Docket ACR2010 Library Reference 14, "Mail Characteristics Study." They are used in the estimation of ZIP-to-ZIP and drop-ship volumes, described in the following section.

8.3.2 Input Data: Product-Level ZIP-to-ZIP Estimation of Mail Unit Volumes

All ZIP-level NP2 MODS volumes must be allocated to Products by allocating origin-entered Products to origin-destination ZIP3 pairs, and allocating facility-entered Products to destination ZIPs. A detailed description of the approach used is provided in the Appendix; it is reflected in LR: Input Data Set: (worksheets "LetterVolumesForModel" and "FlatVolumesForModel" in the "ConsolidatedInputData").

8.3.3 Output Data

The network simulation model generates numerous output files used to provide a granular level view of the progression of Mail Unit flows over the simulated period, and to collect the performance metrics necessary for evaluating the effects of varying scenarios.

8.4 Performance Metrics

The network simulation model provides the necessary data to compute and analyze service performance and costs. These metrics are computed at the network-level, but also accrued at the level of individual ZIP3 O-D pairs, to allow for further drill-down analysis if necessary.

Service performance is measured as the “on-time” portion of First Class Mail for each O-D pair, based on the published service standards for that O-D pair. “On-time” is defined as the acceptance of Mail Units to a destination ZIP3 centroid on or before 8 am on the day specified by their service standard (i.e., day of induction + service standard for the O-D pair).

For each Mail Unit accepted at a destination ZIP3, the network simulation model distinguishes between (i) the portion of volume that is on-time and (ii) the portion of volume that is late i.e., arrived after 8am on the due date determined by its service standard).

Late arrival can be caused by lengthy transportation times, or by failure of Mail Units to clear processing operations by the end of scheduled processing windows. Mail Units that fail to clear a processing operation by the end of that operation’s processing window get held over until the operation resumes the following day. Any such held-over Mail Units are processed when the processing window reopens.

Thus, service performance is computed as follows:

$$Ontime\ Service\ Performance = \frac{Volume\ accepted\ Day\ N - Volume\ accepted\ Day\ N\ but\ late}{Volume\ accepted\ Day\ N}$$

Note that, because data is collected only when the model reaches steady state, the volume accepted on Day N is equal to the volume *expected* to be exchanged between the O-D ZIP3 pair (i.e., volume accepted at a destination ZIP3 = volume inducted at the corresponding origin ZIP3)

8.5 Computing Facility Costs and Productivity Factors

(Refer to "APWU-LR-N2012-1/NP4 Cost and Productivity Calculations" for this discussion).

Productivity equals processing workload divided by workload cost. To measure it, we first compute total processing demand workload and workload cost by facility using the workbooks from Library References USPS-LR-N2012-1/NP2, 15 and 46. USPS Library Reference NP2 provides formulas used to compute total demand workloads by shape. USPS-LR-N2012-1/15 provides the variable RT unit demand costs and the facility square footage values, while USPS-LR-N2012-1/46 provides the fixed RT unit costs. The unit demand costs times the total demand workloads equal the total variable RT production processing costs. The fixed RT unit costs times the facility square feet equal total fixed RT costs. We add to these costs the overhead costs calculated by multiplying the facility square feet by unit overhead costs derived from regression equations reported in USPS-LR-N2012-1/14 'Overhead Regression' worksheet. This sum of RT production costs and overhead costs, expressed per square foot, equals total unit costs, the inverse of which are the productivities.

8.5.1 Computing Demand Workload

Columns AA-AC in worksheet 'Model MODS' of USPS-LR-N2012-1/NP2 workbook "NP2_FY2010 Workload Volume by Operation Type.xlk" define processing workload by converting MODS letter, flat , and parcel piece handlings into what are called LTTR, FLAT, and PRCL demand units. These conversions of MODS pieces into demand workload units account for the higher workload content of a parcel versus a flat, and of a flat versus a letter. One (1) MODS PRCL piece handling converts into a larger demand unit than does 1 MODS FLAT piece handling. The FLAT demand unit in turn exceeds the LTTR demand unit from a single MODS LTTR piece handling.

To simplify the computation of these NP2 column AA-AC demand workloads for purposes of our later analysis, we developed an extended version of NP2 called "NP2_FY2010 Workload Volumes from Conversion Factors.xls". The 'Model MODS' sheet in this new workbook applies these conversion factors to compute the same demand workloads columns AA-AC in the USPS-LR-N2012-1/NP2 'Model MODS' sheet report. The details of this computation are as follows.

LTTR Demand Workloads. LTTR workloads equal the sum of AFCS and DBCS demand workloads. Column BJ of sheet 'Model MODS' in "NP2_FY2010 Workload Volumes from Conversion Factors.xls" shows that for each 3-Digit ZIP, AFCS demand units equal MODS AFCS volumes times a constant 0.0153 conversion factor. Column BK shows that the DBCS demand units equal the sum of the L-OGP, L-INP, L-INS1, and L-INS2 demand workloads where:

- L-OGP Demand = L-OGP MODS volume * 0.0081;
- L-INP Demand =L-INP MODS volume * 0.0064;
- L-INS1 Demand =L-INS1 MODS volume * 0.0061; and
- L-INS2 Demand =L-INS2 MODS volume * 0.0061.

These 0.0153, 0.0081, 0.0064, and 0.0061 factors are calculated in the formulas added at the top of sheet 'Model MODS'. For example, cell AJ24 calculates 0.00081 for L-OGP as a function of the DBCS machine footprint, the DBCS throughput rate, and the L-OGP operating window time period.

PRCL Demand Workloads. For each 3-Digit ZIP:

PRCL demand workload = 0.4283*Total Parcel MODS volume

= 0.4283*(Sum of P-OGP, P-INP, PRI-O, and PRI-I Parcel MODS Volumes),

where:

0.4283 is calculated in cell AA24 as a function of the SPBS footprint and throughput rate and the sum of the outgoing primary and incoming primary parcel sorting operating windows.

FLAT Demand Workloads. The 3-Digit ZIP FLAT demand workloads are computed according to the formula:

FLAT demand workload = MAX (F-OGP workload, F-INP workload, F-INS workload), where:

- F-OGP workload =F-OGP MODS Volume *0.2531;
- F-INP workload = F-INP MODS Volume*0.0905;
- F-INS workload F-INS MODS Volume* 0.0628;

and where the 0.2531, 0.0905, 0.0628 conversion factors are derived in cells AA26, AR26, BJ26, as functions of the AFSM footprint and throughput rate and the F-OGP, F-INP, and F-INS operating time windows.

8.5.2 Unit Demand Costs

Column N of worksheet 'ProductionInfo' in the USPS-LR15 workbook "15_LogicNet Model.xls" reports "RT Production" costs per demand unit by combination of Plant ID, Line, Line Option, and Product, with the latter consisting of LTTR, FLAT, and PRCL. These LTTR, FLAT, and PRCL RT unit costs multiplied by the their corresponding total demand workloads produce the total LTTR, FLAT, and PRCL workload costs.

To derive one set of LTTR, FLAT, and PRCL RT unit costs for each Plant ID, I developed an extended version of USPS-LR15 workbook "15_LogicNetModel.xls called "15_LogicNetModel_Unit Demand Costs by Shape_Revised.xls." This new workbook uses the 'ProductionInfo' worksheet to produce the pivot table 'PlantIDProdctCounts' and the worksheet "RTUnitCostbyPlantIDPrdct." Columns were then added to the 'Demand' worksheet in order to use the unit RT costs in column G of 'RTUnitCostsbyPlantIDPrdct' to compute total Demand Costs, which are reported in column O of worksheet 'Demand.'

These unit RT Production costs are also known as unit variable RT Production costs, or unit variable processing costs, because they vary with processing volumes. A second set of unit costs are fixed with respect to volumes. As reported in USPS-LR-N2012-1/46, three sets of fixed costs are computed for three facility groups, with each group defined based on processing floor space:

- Group 1 facilities have 210,000 square feet of space or less, and are each assigned an average daily fixed cost of $466.
- Group 2 facilities have more than 210,000 and up to 450,000 square feet of space, and are each assigned a $22,991 average daily fixed cost.
- Group 3 facilities have more than 450,000 square feet, and are each assigned a $107,726 average daily cost.

The unit fixed RT costs are defined as these average daily fixed costs divided by the respective processing square feet.

The total demand workloads are expressed as floor space equivalents. Therefore, the variable RT workload processing costs per unit are costs per square foot, and can be added to the fixed RT unit costs to compute total variable plus fixed RT production unit costs.

8.5.3 Total RT Production Variable Demand and Fixed Processing Costs

The LTTR, FLAT, and PRCL demand workloads are multiplied by the corresponding unit costs in the workbook “Cost and Productivity Estimates_Revised.xls” to derive total variable RT demand costs. Column F in this workbook inputs the MODS CANC pieces that column H converts into AFCS demand workloads. Moreover, column F obtains these CANC pieces not from “NP2_FY2010 Workload Volumes from Conversion Factors.xls”, but from the Network Simulation Model input worksheets. Columns I, L, O, and R in “Cost and Productivity Estimates_Revised.xls” likewise input the Simulation Model L-OGP through L-INS2 MODS volumes, which columns K, N, Q, and T convert into DBCS workloads. These workloads plus the AFCS workloads equal the column-V total LTTR demand workloads. Corresponding MODS inputs and conversions into demand workloads for flats and parcels produce total FLAT and PRCL demand workloads in columns AF and AI.

These LTTR, FLAT, and PRCL demand workloads are multiplied by their respective variable RT unit demand costs in columns AJ-AL to compute the total LTTR, FLAT, and PRCL workload costs. The latter sum to the total variable RT production costs in AP. The corresponding fixed RT costs in column AR equal the column-AQ unit fixed costs times the column-E processing square feet. Total RT variable plus fixed production costs are reported in AS.

8.5.4 Overhead Costs

In addition to the variable and fixed RT processing costs, the Postal Service computes other/admin labor, fixed opening, supplies, maintenance labor, and fixed operating overhead costs. Columns AT, AV, and AW calculate the other/admin labor, supplies, and maintenance labor overhead costs using the formulas presented in sheet 'Overhead Regression' of the USPS-LR14 workbook "14_Mail Processing Window Scoring Tool.xls". Columns AU and AX obtain the fixed opening and fixed operating costs from the 'PlantDetails' worksheet of USPS-LR15.

For other/admin labor, supplies, and maintenance labor, LR14 defines three sets of formulas for three facility groups - again defined according to processing floor space. For group 1 facilities having 21,264 square feet or less, other/admin labor, supply, and maintenance labor costs are set at annual totals of $647,641, $52,132, and $800,218 (or $1,774, $143, and $2,192 per day), respectively. For facilities having between 21,265 and 550,000 square feet, other/admin, supply, and maintenance costs are computed based on regression equations that define costs as quadratic functions of floor space. For facilities having more than 550,000 square feet, costs are computed based on regression equations that define costs as linear functions of space.

8.5.5 Total Costs and Productivities

The sum of the column AT-AX overhead costs and column AS variable plus fixed RT production costs in "Cost and Productivity Estimates_Revised.xls" equal the column-AY grand total facility costs. Note that these costs do not include what Professor Bradley in USPS-T-10 and USPS Library Reference N2012-1/20 refers to as indirect costs, which are costs accounted for by multiplicative factors, such as the service wide ratio, the miscellaneous ratio, and other piggyback factors. AZ equals the total variable plus fixed RT production unit costs, which as noted are costs per square foot, plus the total overhead costs per square foot. The inverse of these total unit facility costs equals the column-BA facility productivities.

8.5.6 Comparison of Baseline Facility Datasets

This "Cost and Productivity Estimates_Revised.xls" file computes costs and productivities for 466 baseline facilities. These 466 are all the facilities – excluding 7 located outside the contiguous 48 states – that USPS-LR-N2012-1/NP2 reports as having conducted letter, flat, or parcel sorting during FY 2010. The 466 include 10 facilities (4 of which are NDCs) that are not on the USPS-LR15 list of 476 baseline facilities, but that USPS-NP2 reports as having conducted parcel sorting during FY 2010. The USPS-LR15 list includes 20 facilities not on the 466 list. These 20 are the 7 non-contiguous facilities, plus 13 others that NP2 indicates did not conduct letter, flat, or parcel sorting during FY 2010.

8.6 Transportation

Transportation statistics are accrued for all movement of mail from one mail processing facility to another, and between mail processing facilities and origin/destination ZIP codes (transportation segments within ZIP3s are not modeled; e.g., to the ZIP5 level). The network simulation model reports the following transportation segments:

- Local originating transportation, from origin ZIP3 centroid to outgoing facility; reported in truck-miles
- Local destinating transportation, from destinating facility to destination ZIP3 centroid; reported in truck-miles
- Inter-SCF surface transportation; reported in truck-miles
- Air transport as specified in USPS-LR-N2012-1/64; reported in lbs-miles

The required transportation space (measured as the number of cubic feet being transported) is computed by multiplying the piece counts transported by the per-piece cubic feet factor for the corresponding Product (see Table 3), and aggregating the cubic feet across all Mail Units. The result is converted to a number of required trucks (rounded up) based on an assumed usable truck capacity of 1500 cubic feet[13]. The network simulation model assumes the same truck capacity for local and inter-SCF transportation.

Surface mileage is estimated as the great-circle distance between the starting and ending points[14] multiplied by a factor to adjust for road network circuity. Comparison of the site distances used in USPS-LR-N2012-1/15 versus their great circle distance counterparts result in a median circuity factor of 1.28, and past transportation research has also found circuity factors near 1.28 to be appropriate[15], so that is the circuity factor used for this analysis. (Refer to the companion DVD for circuity factor analysis).

For each air transport segment, the total weight of the shipment is computed using per-piece weight factors (see Table 3) multiplied by the number of items of each mail type included in the shipment. The number of lb-miles is then obtained by multiplying the total weigh by the great-circle distance between the start and end points.

Air transport is used only for First Class Mail if it was the transport mode specified in USPS-LR-N2012-1/64. For facility-to-facility links for which no transport mode is specified in USPS-LR64, a distance threshold of 1,000mi is used to select between surface and air transport. The 1,000mi threshold is selected based on analysis of the USPS-LR64 transport mode assignments and facility-to-facility distances.

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[13] Truck capacity is based data provided the Direct Testimony of E. Rosenberg, USPS-T-3 which states that 302,400 letters fill half of a 53ft truck, thus a full truck would contain 602,800 letters; the average letter size being 0.0025 ft^3, the computed truck capacity is 1,512 ft^3 (rounded off to 1,500ft^3)

[14] The Great Circle Distance is given by the equation $D = 2R_E \sin^{-1}\sqrt{\sin^2\left(\frac{\Delta\phi}{2}\right) + \cos\phi_s \cos\phi_f \sin^2\left(\frac{\Delta\lambda}{2}\right)}$, where R_E is the radius of the Earth and (φ_s, λ_s) and (φ_f, λ_f) are the latitude and longitude of the target and proposed gaining facility, respectively. Δ indicates a difference, e.g. $\Delta\varphi$ is $\varphi_f - \varphi_s$. Source: http://en.wikipedia.org/wiki/Great-circle_distance

[15] Newell, G. (1980). Traffic flow on transportation networks. Cambridge Massachusetts: MIT Press.

Travel times are computed as a product of the distance between facilities and an assumed transport speed of 46.5 mph for surface transport, or 450 mph for air transport.

9 Model Validation

Model calibration is prerequisite to gain confidence in the response of the network simulation model and the insights that it helps draw. Calibration must be established against a known benchmark.

In this case, we have established USPS's reported FY2010 operating conditions as the benchmark. As such, sources of pertinent information that characterize USPS's FY2010 operating conditions were drawn from library references and non-public documents filed under PRC Docket N2012-1. When appropriate, we have also used other official sources of data, such as PRC Docket ACR2010 and USPS RIBBS website. All data sources are documented in the Appendix.

This section presents the network simulation model validation results. For a better understanding of the process, it is recommended to refer to the companion DVD, folder APWU-LR-N2012-1/NP2 "Baseline Validation Worksheet" (here after referred to as LR "Baseline Validation Worksheet").

9.1 Baseline Facility Set

A set of 477 facilities is used in the baseline network simulation model. This set is obtained by including the 466 facilities defined as all of the facilities which USPS-LR-N2012-1/NP2 reports as having conducted some combination of letter flat, or parcel sorting during FY2010 (the 466 excludes 7 facilities located outside the contiguous 48 states; on the other hand, it includes 4 NDCs of the 21 NDCs).

The list of 466 facilities includes 6 non-NDCs that NP2 reports as having conducted strictly parcel processing during FY2010. Moreover, these facilities are not on LR15. They are thus excluded from the baseline facility set since the focus is on letter and flats processing.

The baseline set is then augmented with 17 NDCs to represent all 21 NDCs in the baseline model as hub facilities that conduct strictly cross docking operations.

This results in a net addition of 12 facilities which increases the final baseline set total to 477 (466-6+17). The list of facilities can be found in the companion DVD in the APWU Library Reference "APWU-LR-N2012-1/NP1Input Data Set" hereafter referred to as "Input Data Set" (The list of facilities is found in worksheets Baseline and Post AMP Facilities and Routing Tables" of the APWU Library Reference) .

9.2 Description of Validation Tests

The MODS volumes reported in the N2012 filings[16] serve as the benchmark to ensure that the Baseline model is representing FY2010 USPS P&D network operations with fidelity, and that the logic of the network simulation model, as described in Section 8, replicates processing and distribution operations on the ground.

The validation process consists thus of flowing FY2010 Mail Units volumes by OD pair according to USPS-defined distribution assignments and distribution rules (see definition) that were in effect in FY2010. Mail volumes are collected at each modeled mail processing operation[17] and of comparing the network simulation modeled volumes by operation to the volumes reported in N2012-1 filings.

The table below provides national level aggregates:

[16] These volumes can be obtained in the USPS-LR-N2012-1/NP2 filing (NP2_FY2010 Workload Volume by Operation Type.xls) or its public equivalent, USPS-LR-N2012-1/13.
[17] Same operations as reported in USPS-LR-N2012-1/13, NP2

National-Level Comparison: Model vs. FY10 NP2 MODS Average Daily Volumes								
	CANC	L-OGP	L-INP	L-INS1	L-INS2	F-OGP	F-INP	F-INS
Model Raw ADV Piece-count	**74,432,888**	**136,276,377**	**225,013,922**	**367,345,384**	**330,637,933**	**10,034,728**	**26,624,942**	**41,330,485**
NDC OGP Volumes, not in NP2		(3,501,932)				(34,391)		
Model Adjusted ADV	**74,432,888**	**132,774,445**	**225,013,922**	**367,345,384**	**330,637,933**	**10,000,337**	**26,624,942**	**41,330,485**
NP2 FY10 MODS ADV	**74,434,482**	**132,782,282**	**226,298,001**	**364,229,929**	**327,854,915**	**10,027,938**	**26,861,471**	**41,364,235**
Model vs. NP2 MODS Comparison	**100%**	**100%**	**99%**	**101%**	**101%**	**100%**	**99%**	**100%**

Table 8 - National-Level Comparison: Model vs. FY10 NP2 MODS ADVs

Plant-level volume comparisons reflect a very strong fidelity of the network simulation model with respect to the MODS volumes reported in the N2012-1 references. For each mail processing operation the % difference is contrasted between model-generated volumes and NP2 MODS provided volumes ("%vs." column). All results are presented in the companion DVD, LR "Baseline Validation Worksheet".

Minor differences are noted between model-computed volumes (for each operation within each modeled mail processing facility) and the MODS-reported volumes. This confirms the proper calibration of the network simulation model, thus giving confidence in its response as network configurations are modified during the scenario analysis.

10 Scenario Analysis

10.1 Scenario Overview

Scenarios are generated by reassigning the processing of ZIP3s' mail to new facilities (the 'gaining' facilities), while preventing the facilities formerly assigned to those ZIP3s from performing processing functions (the 'losing' facilities).

Whereas USPS's Area Mail Processing (AMP) consolidation process may selectively reassign the outgoing <u>or</u> the incoming mail processing functions for a ZIP3 to a gaining facility, the network configuration approach is more naïve in that it reassigns <u>both</u>

outgoing and incoming processing for a ZIP3 to a gaining facility. More precisely, it reassigns in unison all ZIP3s that were formerly assigned to a losing facility to a single gaining facility. (A detailed description of the algorithm we use to develop the scenarios is provided in the Appendix.)

To isolate the effects on service performance and costs of changing scenarios, the scenarios ‘freeze’ certain conditions to keep them identical to the baseline model. Specifically:

- ADC and AADC assignments to ZIP3s remain unchanged between the baseline conditions and any hypothesized network configuration.
- The operating conditions remain unchanged with respect to baseline. This includes operating windows, dispatch times for local and inter-SCF transport, and processing capacities at the gaining facilities.
- No new mail processing facilities are added to any of the scenarios configured.

10.2 Scenario Structure

Each scenario consists of unique set of *initial conditions* used to create *input data,* which is processed by the network simulation model to produce *output data* that is then subjected to analysis.

- Initial Conditions: rules used to produce the input data. For instance: “consolidate up to 100 facilities of below-average productivity, provided each consolidation does not span more than 150 miles.”
- Scenario Input Data: the set of **scenario-specific** files fed into the network simulation model to produce output data.
- Facility List: defines each facility’s location and equipment.
- Assignment Table: defines the facilities assigned to handle processing operations for each 3-digit ZIP code.
- Other inputs that remain constant across scenarios (e.g. volumes for O/D pairs, locations of 3-digit ZIP centroids) are stored in a separate Common Input Data folder.
- Scenario Output Data: the set of raw files produced by the network simulation model after processing the Input Data.

10.3 Algorithm for Creating Scenarios

An algorithm has been developed to produce scenarios; it is discussed further in the Appendix. The algorithm enables to vary network configurations in each scenario by modifying the following parameters:

- Productivity Threshold – set the upper bound for the productivity factor of the facilities being assigned as losing facilities. All facilities with a productivity factor lower than this threshold are considered for closure by the algorithm and are assigned to a facility of equal or higher productivity factor.
- The productivity factors are computed to range between 0.23 and 0.64. Refer to Section 8.5 for a description of the computational approach for facility productivity factors.
- ADCs and AADCs are prevented from closure by assigning them an artificially high productivity factor of 99 (this avoids distribution from changing with respect to the baseline conditions)
- Maximum number of losing facilities – this sets an upper bound on the number of losing facilities. If not set, the algorithm closes all facilities until it hits the productivity threshold limit.
- Distance Threshold – the maximum distance allowed between a facility considered for closure and the nearest facility to which it is reassigned. If no potential gaining facility is closer than this distance to the facility considered for closure, the facility is considered too remote and remains therefore open.

These parameters were varied as presented in the table below to generate a set of 'stock' scenarios for analyses purposes (see next section for the results).

Scenario Name	Productivity Threshold	Max # of Losing Facilities	Distance Threshold (miles)
Top Three Quartiles	0.311406278	N/A	150
ShootFor400	0.381225608	77	150
ShootFor350	9	127	150
Top Half	9	N/A	150
ShootFor300	9	177	150
Top Quartile	9	N/A	150
ShootFor250	0.293554018	227	150

Table 9 – Parameters Used for Hypothesized Network Configuration Scenarios

10.4 Scenarios Tested

Referring to the above table, the scenarios labeled “Top Three Quartiles”, “Top Half”, and “Top Quartile” assign a value to the productivity threshold so as to maintain facilities in the network configuration that fall respectively in top three productivity quartiles, the top two productivity quartiles, and the top quartile. Additionally, in these scenarios, no facility closure is allowed if it is reassigned to a facility beyond the 150 miles distance threshold. No limit is set for the maximum number of losing facilities, as this is dictated by the productivity threshold.

The scenarios labeled “Shoot for 400”, “Shoot for 350”, “Shoot for 250” aim to generate a network configuration with a fixed set of mail processing facilities. It does so by setting an artificially high productivity threshold so that all facilities are considered for closure provided the total number of mail processing facilities is respected and the distance threshold is not violated.

Because the algorithm assign a candidate losing facility to a facility of productivity factor equal or higher to the threshold assigned, it tends to promote the reassignment of losing facilities into ADCs or AADCs which, as indicated above, are prevented from closure.

The resulting scenario configurations can be found in the companion DVD.

10.5 Post AMP Network Scenario

A separate scenario is also analyzed to account for AMP consolidations that were planned by USPS prior to presenting its proposal for service standards modification (PRC Docket N2012-1). This scenario consists of representing the resulting network configuration, had the proposed AMP studies been implemented by USPS.

The resulting hypothetical network configuration (hereafter referred to as 'PostAMP') identifies 51 full facility closures with respect to the FY2010 baseline list of 477 facilities; these 51 facilities are thus removed from consideration in the PostAMP scenario. Additionally, selected ZIP3s are reassigned to 62 other facilities, thus constituting 'partially gaining' facilities. Moreover, 80 facilities show a lower incidence of ZIP3 assignments, thus constituting 'partially losing facilities'.

A review of pertinent sources of information was conducted to prescribe this resulting network configuration; the sources of data and the methodology used to organize the information are found in the Appendix. The PostAMP scenario results are presented below.

11 Results

11.1 Organization of the results

The network simulation model's output data files are post-processed in Excel to provide summary results. These are organized as follows:

Service performance tables. These display volume accepted by 8am at destination ZIP3, and the portion of that volume characterized as late in order to compute service performance (see definition of Service Performance above). The on-time percentages are computed for each O-D pair of First Class Mail by shape (letters, flats).[18] The on-time percentages are split into the following service standard subsets:

- Intra-SCF Turnaround; defined as overnight mail originating and destinating in the same ZIP3
- Intra-SCF non-turnaround; defined as overnight mail originating in a ZIP3 and destinating in another ZIP3 in the same SCF
- Inter-SCF D+1; defined as overnight mail between O-D ZIP3 pairs assigned to separated mail processing facilities
- Inter-SCF D+2 and D+3; defined as second- and third-day standards

Cost tables report RT production mail-processing costs (fixed and variable) and overhead costs attributable to letters and flats.

[18] On-time performance of Standard Mail is excluded because of the arbitrary assignment that would need to be done to the due day as a function of the day of induction. Standard Mail is still modeled in order to determine the effect that it may have on mail processing capacity requirements.

11.2 Service Performance Results

The table summarizes service performance results for FCM under seven conditions:

- The baseline conditions; reported in the Validation section
- The seven hypothesized network configuration scenarios

		On-Time Service Performance (%)					
			Overnight Mail				
Scenario Name	# of Facilities	Overall	Intra-SCF Turnaround (Origin ZIP = Destin ZIP)	Intra-SCF Non-Turnaround (Origin ZIP <> Destin ZIP)	Inter-SCF D+1	Inter-SCF D+2	Inter-SCF D+3
Baseline	477	92.5%	96.3%	95.4%	69.3%	96.2%	97.5%
Top Three Quartiles	410	91.9%	95.1%	94.4%	69.2%	95.0%	97.1%
Shoot For 400	400	91.9%	94.7%	93.6%	70.1%	94.6%	97.4%
Shoot For 350	350	91.3%	92.5%	92.4%	71.0%	93.3%	97.6%
Top Half	342	91.3%	92.9%	93.1%	70.4%	93.7%	97.1%
Shoot For 300	300	88.7%	86.9%	88.0%	70.4%	89.7%	96.8%
Top Quartile	278	87.9%	86.0%	87.8%	70.1%	88.5%	96.0%
ShootFor250	250	86.0%	81.7%	82.1%	71.6%	86.0%	95.8%

Table 10 – Service Performance Results for Algorithmically Generated Scenarios

The PostAMP scenario results are presented below. We do not present them with the above scenarios because the choice of facilities for closure and the ZIP3 assignments to the gaining facilities for outgoing and incoming processing, are based on local decisions made by USPS personnel in the process of the AMP reviews. The PostAMP scenario thus follows a unique rationale for facility closure.

		On-Time Service Performance (%)					
			Overnight Mail				
Scenario Name	# of Facilities	Overall	Intra-SCF Turnaround (Origin ZIP = Destin ZIP)	Intra-SCF Non-Turnaround (Origin ZIP <> Destin ZIP)	Inter-SCF D+1	Inter-SCF D+2	Inter-SCF D+3
Post AMP	427	91.9%	94.3%	94.1%	68.3%	95.4%	97.6%

Table 11 –Service Performance Results for Proposed AMPs

11.3 Cost Results

The table below summarizes the labor and facility costs attributable to each scenario. The costs computations are described in a previous section.

		Letters & Flats Processing Costs + Overhead Costs (millions of $)								
Scenario Name	# Plants	Fixed Processing Costs		Variable Processing Costs			Overhead Costs		Total	
				Letters	Flats					
		Costs	% of Baseline	Costs		% of Baseline	Costs	% of Baseline	Costs	% of Baseline
Baseline	477	$1,133	--	$1,650	$717	--	$7,236	--	$10,736	--
Top 3 Quartiles	410	$1,113	98.3%	$1,649	$712	99.7%	$7,070	97.7%	$10,545	98.2%
Shoot For 400	400	$1,112	98.1%	$1,650	$708	99.6%	$7,050	97.4%	$10,520	98.0%
Shoot For 350	350	$1,103	97.4%	$1,648	$697	99.1%	$6,895	95.3%	$10,343	96.3%
Top Half	342	$1,102	97.2%	$1,648	$700	99.2%	$6,917	95.6%	$10,367	96.6%
Shoot For 300	300	$1,095	96.6%	$1,635	$686	98.1%	$6,528	90.2%	$9,944	92.6%
Top Quartile	276	$1,091	96.3%	$1,632	$688	98.0%	$6,448	89.1%	$9,859	91.8%
Shoot For 250	250	$1,062	93.7%	$1,615	$668	96.5%	$6,014	83.1%	$9,359	87.2%

Table 12 – Costs Results

Overhead costs consist of variable overhead costs, fixed opening costs, and fixed operating costs. A given facility's opening and operating costs do not change unless the facility is removed from consideration. Rosenberg's testimony (USPS-T-3) and USPS-LR-N2012-1/15 define fixed opening cost as a proxy for either the rental cost of a leased facility, or the calculated "opportunity cost" of an owned facility. USPS-T-3 and USPS-LR15 define fixed operating cost as a proxy for utility and heating fuel costs.

The reason facility consolidations reduce total variable RT production costs by much less than they reduce the fixed RT production plus overhead costs is that variable RT unit costs remain constant with respect to processing floor space as this space increases over a wide range of total square feet. For example, variable RT unit letter demand cost equals a constant $0.6524 for all facilities containing square feet ranging from 0 to 210,000. It doesn't matter if the space is 2,000 square feet or 210,000, the cost stays at $0.6524. It only falls to the next level, $0.5452, for floor space greater than 210,000, and remains at $0.5452 up to 450,000 square feet. It falls only one more time – to $0.3568 – at space exceeding 450,000. Since total variable RT letter production cost can only fall when unit variable letter cost falls, only a facility consolidation that transfers workload from a $0.6524-unit-cost closing facility to a $0.5452 or $0.3568-cost gaining facility, or from a $0.5452 to a $0.3568-cost facility will reduce total variable RT letter costs.

In contrast, facility consolidations always reduce fixed RT production and overhead costs. These fixed production and overhead costs are fixed with respect to volume demand workload. Thus, the total cost at a losing facility that is saved when this facility closes is not matched by any increase at all in fixed production and overhead cost at the gaining facility. The gaining facility's fixed production/overhead costs instead remain constant, despite the transfer of volume-demand workload from the losing facility; because the gaining facility's total floor space stays constant.

11.4 Transportation Results

Total truck miles for intra-SCF (daily local truck miles) and inter-SCF (daily long-haul truck miles) are presented below. These are computed as described in a previous section and are not representative of prevailing surface transportation contract agreements which may include multiple stops per route.

The results are useful to gain insights on the relative changes in inter-SCF and intra-SCF across scenarios, suggesting that inter-SCF transportation diminishes as the number of facilities are reduced, but that this reduction is to be offset to a degree by intra-SCF transportation.

Scenario Name	# Facilities	Daily Local Truck-Miles	Daily Long Haul Truck-Miles	Total Daily Truck-Miles
Baseline	477	92,566	106,402,700	106,495,266
TopThreeQuarters	410	101,368	97,465,535	97,566,903
ShootFor400	400	103,222	94,605,186	94,708,408
ShootFor350	350	115,474	82,802,611	82,918,085
TopHalf	342	115,311	82,570,454	82,685,765
ShootFor300	300	136,089	63,920,240	64,056,329
TopQuarter	278	139,662	58,685,970	58,825,632
ShootFor250	250	157,321	45,330,054	45,487,375

Table 13 – Model Computed Ground Transportation Truck Miles

12 Conclusions

The network simulation model was rigorously calibrated against NP2 MODS reported volumes to provide the confidence needed in analyzing the effects of various network configuration scenarios on service performance and costs.

As a decision-support tool, this network simulation model can help evaluate a host of alternative scenarios, some algorithmically defined as described in this testimony, and others based on actual decisions taken in the field, as presented in the PostAMP scenario.

The fact that we designed the network simulation model to be ZIP3 centered (see design guidelines), enables us to test any network configuration scenario against ZIP3-to-ZIP3 service standards and their corresponding volumes. Moreover, the network simulation model is designed with flexibility to scale average daily volumes, modify mail processing capacity at the facility level, or change distribution rules –conditions that we did not vary in this reported testimony. Consequently, as explained in the executive summary, the results we present reflect only a subset of scenarios that could be evaluated. Some of these scenarios will be tested soon to understand, in particular, the effects on service performance and costs of more stringent but quite plausible operating conditions.

Appendix A – Sources of data files

Volume data

The following sources were use to determine mail volumes:

Data Set	Source
Average Daily Non-CR, Non-DDU Volume	• FY2010 RPW Report • PRC Docket ACR2010 USPS-LR-14, RPW_by_Shape_and_Indicia.zip/Shape Indicia FY 2010 PublicV.xls Summary Worksheet • PRC Docket ACR2010 USPS-LR-14, RPW_by_Shape_and_Indicia.zip/Shape Indicia FY 2010 PublicV.xls Various Worksheets • PRC Docket ACR2010 USPS-LR-36, "mailcode.public.fy10.txt"
Average Daily Volume ODIS	• ODIS FY2010 Summary
Average % 1C FCM requiring Canceling	• PRC Docket ACR2010 USPS-LR-14, RPW_by_Shape_and_Indicia.zip/First Class and Standard Mail WGTI 2010.xls "FCM and STD Indicia Summary" Worksheet
FY2010 annual distribution of mail volumes by presort level for FCM and Standard	• PRC Docket ACR2010 Library Reference USPS-LR-14, RPW_by_Shape_and_Indicia.zip/Shape Indicia FY 2010 PublicV.xls Summary Worksheet
FY2010 volumes by presort and entry point	• PRC Docket ACR2010 Library Reference USPS-LR-14, RPW_by_Shape_and_Indicia.zip/Shape Indicia FY 2010 PublicV.xls Periodicals Worksheet • PRC Docket ACR2010 Library Reference USPS-LR-14, RPW_by_Shape_and_Indicia.zip/Shape Indicia FY 2010 PublicV.xls Package Services Worksheet

Distribution Rules

Source of data for representing the FY2010 distribution rules:

- AADC, ADC, NDC assignments from June 7, 2010 USPS Labeling Lists L801, L004, and L601
- USPS-LR-N2012-1/NP2 operations worksheets

FY2010 Baseline Facility List and Facility Definition

Sources of data used:

- USPS-LR-N2012-1/15, 17, and 34
- USPS-LR-N2012-1/15 (15_LogicNet Model.xls, PlantDetails Worksheet) for: LogicNetID, LogicNetName, LogicNetActive, Latitude, Longitude.
- USPS-LR-N2012-1/34 (LR.USPS.34.xls, USPS Modeling Facility List Worksheet) for: Finance#, Open, MODS Site
- USPS-LR-N2012-1/17(17_ZipAssignment_LocalInsight.xls,Summary Worksheet) for SqFt and Machine Counts
- USPS-LR-N2012-1/NP2 (NP2_FY2010 Workload Volume by Operation Type, "FY2010 Workload" Worksheet) for MODSName
- N2012-1 DFC/USPS-T4-5 - Response of U.S. Postal Service Witness Neri to Douglas F. Carlson Interrogatories for NDC machine counts
- Also used USPS-LR-N2012-1/68 to reconcile differences and fill missing finance #'s

Machine Throughput by Type

- Figure 1 Model Equipment Throughput – Direct Testimony of Emily R. Rosenberg on behalf of US Postal Service – USPS-T-3

Entry Point Percentages and Drop-Ship Percentages

- Entry-point and drop-ship percentages are derived from the PRC Docket ACR2010 Library Reference 14, "Mail Characteristics Study."

AADC, ADC, NDC assignments to ZIP3

- http://pe.usps.com/Archive/HTML/DMMArchive20100607/labeling_lists.htm: L004, L801, L601

Published Service Standards

- https://ribbs.usps.gov/index.cfm?page=modernservice

Transport Modes between O-D pairs

- Library Reference USPS-LR-N2012-1/64

Source of AMP Studies Reviewed for Scenario Network Configuration

- AMP studies and PIR reports as posted to the "Latest Consolidation List" page on the APWU website (http://www.apwu.org/issues-consolidation/consolidation-latest_list.htm) or in USPS NP12's list of AMP decisions
- USPS OIG Report Number CI-AR-12-003: "US Postal Service Past Network Optimization Initiatives."

Appendix B – Product-Level ZIP-to-ZIP Estimation of Model Inputs

This section describes the approach used; it is fully shown in the accompanying worksheets "LetterVolumesForModel" and "FlatVolumesForModel" in the "ConsolidatedInputData" Excel file found in the Companion DVD. This description refers explicitly to the LetterVolumesForModel worksheet as an example, but the basic approach is the same for FlatVolumesForModel.

NP2 MODS Letters Disaggregation into Product Level ZIP-to-ZIP for CANC & OGP. Using the LetterVolumesForModel worksheet as an example, the process is described following from left to right across the worksheet.

Beginning with the originating ZIP-level MODS CANC and OGP volumes from USPS-LR-N2012-1/NP2 (hereafter referred to as simply "NP2"), these operation-level volumes are decomposed into estimated Product-level volumes for Products that would undergo the CANC and OGP operations, specifically, those that were Single Piece or presorted to less-than-ZIP3 level[19].

The operation-level to Product-level decomposition is performed, in general, by assuming that the distribution of Products is equal to the national-level Product percentages derived from the ACR2010 "Mail Characteristics Study" (hereafter, and in the worksheets, referred to as "RPW"). The details of how these percentages are derived are shown in accompanying worksheets "Volumes-Source2" and "Volumes-Source6" in the "ConsolidatedInputData" Excel file. The ADV of First Class single-piece stamped letters was assumed to be equal to the NP2 MODS CANC ADV, and the remaining L-OGP ADV was allocated to Products proportionally based on their RPW national-level percentages.

[19] DNDC-entered volumes are not included here, however, because NP2 did not include NDC facilities for letters and flats.

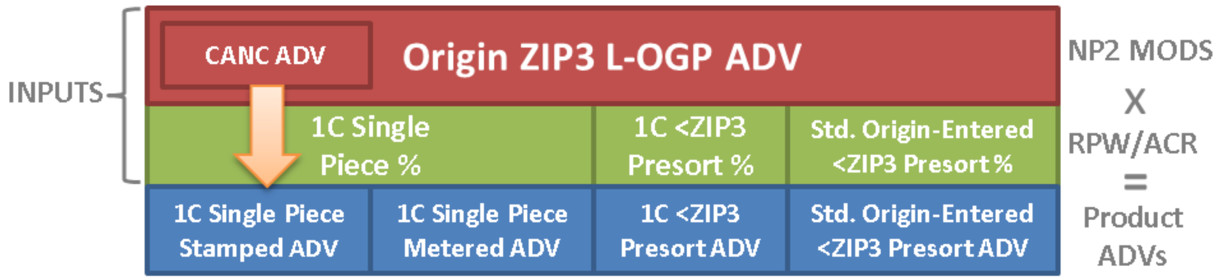


Figure 2 - Decomposition of NP2 MODS L-OGP ADV into Product-level ADVs using RPW Product Volume Percentages

Decomposing the MODS CANC and OGP volumes into Product-level volumes yields the volumes originating from each ZIP3 of each Product constituent of CANC and OGP. We then allocate these originating volumes to destination ZIP3s using origin-to-destination percentages derived from ODIS. The ODIS percentages are obtained by computing the percentage of each origin ZIP3's First Class letters sent to each destination[20]. These percentages are then used to allocate each origin ZIP3's originating volumes to destination ZIP3s.

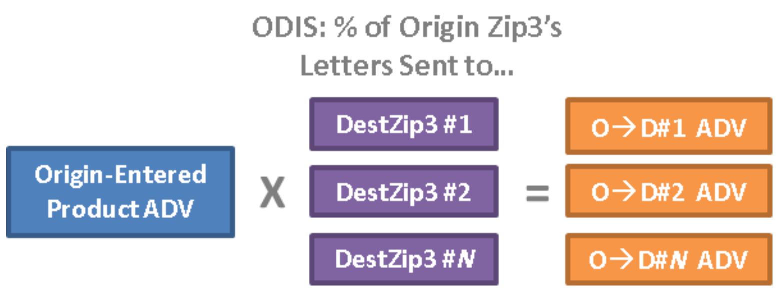


Figure 3 - Decomposition of Origin-Entered Product ADV into O-D ADVs using ODIS-derived Percentages

This completes the volume estimation for the CANC/OGP-constituent Products, allowing us to next address the volume constituents of INP.

NP2 MODS Letters Disaggregation into Product Level ZIP-to-ZIP for INP. The starting point is the destination ZIP-level MODS INP volumes from NP2. Since the

[20] This step is based on the FY2010 ODIS dataset and is done outside of the spreadsheet. To avoid time-consuming recalculation, the relevant formulas for this step are provided at the top of the worksheet for reference.

CANC/OGP-constituent Products also contribute to the MODS INP volumes, they must be subtracted so that the volumes of these Products are not double-counted.

However, the remaining INP volumes do not represent volumes purely attributable to Products that entered the network presorted to ZIP3 level. This is due to several reasons:

- Some pieces, such as high-density turnaround mail, skip INP.
- Some pieces get counted twice as part of INP if they receive an upstream Managed Mail sort and then get re-handled through INP at the DSCF.
- For pieces that receive a Managed Mail sort, which counts toward INP, the ZIP where they receive that Managed Mail sort is not their actual destination ZIP.

These confounding factors make it questionable to directly decompose the remaining INP volumes into Product-level volumes, as was done previously for CANC and OGP. Instead, we use the RPW Product volumes as the starting point and disaggregate them to destination ZIPs proportionally based on the remaining INP volumes. This approximation step introduces some uncertainty into the volume estimation of ZIP3-presorted Products, but is the best alternative given the data available and the confounding factors above. The equations below express the decomposition of NP2 MODS L-INP volumes into product-level destination ADVs algebraically.

$$L_z = \max(0, M_z - C_z)$$

Where: M_z = NP2 MODS L-INP of destination ZIP3 *z*

Cz = Destination ADV for ZIP3 z already counted as part of L-OGP

L_z = NP2 MODS L-INP of destination ZIP3 *z* remaining to be allocated after subtracting C_z

$$R_z = \frac{L_z}{\sum_z (M_z - C_z)}$$

Where: R_z = % of national RPW product volumes to allocate to destination ZIP3 *z.*

$$X_{pz} = N_p * R_z$$

Where: N_p = National RPW Product ADV of product *p*

X_{pz} = Destination ZIP3 z ADV of product *p*

At this point, the ZIP3-presorted drop-shipped Products are assigned to a destination and are thus complete. The origin-entered Products are allocated to origin ZIP3s using destination-from-origin percentages derived from ODIS. These ODIS percentages are obtained by computing the percentage of each destination ZIP3's First Class letters sent to that destination from each origin[21]. Lastly, we consider INS.

NP2 MODS Letters Disaggregation into Product Level ZIP-to-ZIP for INS. Beginning with the Destination ZIP-level MODS INS volumes from NP2, we subtract from each destination's INS the destinating volumes that have already been counted as part of OGP or INP, again to prevent double-counting of those volumes. The estimation of INS-constituent volumes is less ambiguous than for INP because virtually all pieces must go through INS at their destination, so we could assume a one-to-one relationship between the INS volumes and Product volumes being estimated. Thus, we decompose the remaining NP2 MODS INS volumes into estimated Product-level volumes for Products that were presorted to ZIP5 level. This is done, as before, using RPW-derived Product percentages.

[21] Again, this step is based on the FY2010 ODIS dataset and is done outside of the spreadsheet.

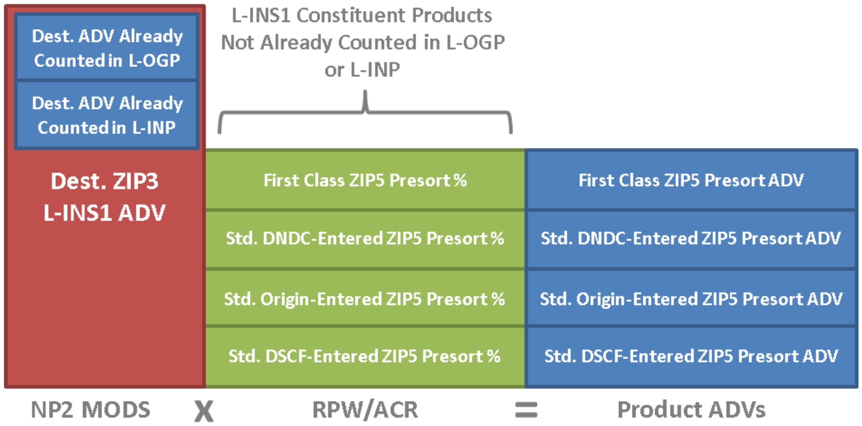


Figure 4 - Decomposition of NP2 MODS L-INS1 into Product-level ADVs using RPW Product Volume Percentages

At this point the drop-shipped Products are complete (the origin-entered Products are allocated to origin ZIP3s by once again using destination-from-origin percentages derived from ODIS).

The final estimated volumes are collected into a single final summary table at the far right of the worksheet “LetterVolumesForModel” (and “FlatVolumesForModel”) in the “ConsolidatedInputData” Excel file.

Appendix C – Description of Output Data Files

The following output files are generated by the network simulation model. Sample files can be found in the accompanying APWU-LR-N2012-1/NP5 “Model Sample Output Data”.

File Name	Description
dailyDeliveryMetrics_day5	Primary file used to analyze service performance (see below). This file provides, for each ZIP-to-ZIP pair, the number of pieces of each product "Delivered" and the number of those that were "Late" on the simulated day shown in Column A. The abbreviations used in product names are: L = Letters, F = Flats, P = Parcels, FC = First Class, STD = Standard Class, PER = Periodicals Class, PKG = Package Class
dailNetworkMetrics	This file contains various daily, network-level transportation metrics, e.g., total numbers of pieces transported by surface/air, by product, by leg (originating/inter-facility/destinating), etc.
dailyFacilityQueueMetrics	This file represents a snapshot of the processing queue sizes in each facility at noon each simulated day. The queue sizes are broken down by product and by operation, e.g., CANC (Cancellation), L_OGP (Letters Outgoing Primary), etc., and by product. Facilities queue sizes that grow larger from one day to the next indicate that the facility doesn’t have enough processing capacity to process all of the previous day's mail during its processing window.
dailyFacilityWorkloadMetrics	The file represents a snapshot of the volume processed in each facility by noon of each simulated day. The workload sizes are broken down by product and by operation, e.g., CANC (Cancellation), L_OGP (Letters Outgoing Primary), etc., and by product.
dailyFacilityValidationMetrics	This file shows the total daily number of pieces of each product processed through each operation for each facility. This is file is used as the input for the "Validation" analysis (see “BaselineValidationVsMODS-ODIS.xlsx “ in the LR “Baseline Validation Worksheet” of the companion DVD).
dailyFacilityInAndOutMetrics	The file shows the volume, by Product, that are entering and exiting each facility, and the origin and destination of these volumes, e.g., origin-entered locally, drop-shipped to the facility, sent/received from one facility to another, dispatched for local delivery, etc. Note: values for simulated day #4 represent the total of all days up to and including day 4, then for subsequent days the values are just the daily totals.

File Name	Description
intradayFacilityMetrics	This file contains the same information as in the other "Facility" files above, but at half-hour intervals. It provides ‘counters’ that are incremented as time progresses. In other words, to find the number of Standard Letters drop-shipped to a facility between 10:00 and 12:00 it would be the value of "DropshippedMailReceived_L_STD" at 12:00 minus the value at 10:00. The "_queue" metrics differ, however; and are a snapshot: they indicate the actual size of the processing queue at that moment in time.
intradayFacilityDeltaMetrics	Same data as above but shows volume fluctuations in 30 minute increments

Table 14 – Description of Model Output Files

Appendix D – Description of Facility Reassignment Algorithm

This section describes the process to develop a method for programmatically:

- determining which facilities may hypothetically be viable candidates for consolidation,
- determining which facilities are likely to take over mail processing responsibilities for the facilities targeted for consolidation, and
- populating a "Processing Assignment table" reflecting the originating and destinating mail processing assignments (at the ZIP3 level) after all such hypothetical consolidations are implemented.

Setup for Reassignment Algorithm

Productivity factors are assigned to each facility.

$$Facility\ Productivity = \frac{Demand\ Workload}{Workload\ Cost}$$

(Refer to the testimony for a description of the computation of Demand Workload and Workload Cost).

These productivity factors are included in the baseline facility list which is formatted and prepared to serve as an input to the reassignment algorithm. Preparing the baseline list includes the following actions:

Modifications to the facility list were made to prevent certain facilities from being affected by the reassignment algorithm in one of two ways:

- Facilities that handle ADC/AADC processing in the processing assignment table were manually assigned productivity factors of 99, effectively removing them from consideration as losing facilities while allowing them to remain as possible gaining facilities, ensuring that the ADC/AADC network and routing rules were not affected by the consolidations.
- If needed, some facilities could temporarily be removed from the facility list, while remaining in the processing assignment table. This would prevent the algorithm from considering the facilities as gaining or losing facilities and would ensure that their processing assignments do not change. As the facilities do remain in use, they are added back to the list following the execution of this algorithm for use by the network simulation model.

The list was then sorted by productivity factor in ascending order, ensuring that the lowest-productivity facilities were the first to be considered for consolidation. The first (and therefore lowest-productivity) facility in the list was designated as a "target" facility. In addition, two columns were added to the facility list:

- Great Circle Distance – the shortest-path distance on the surface of the (assumed spherical) Earth from each facility to the designated "target" facility. This field is recalculated when the target facility is changed.[22]
- Notes – Comments on the facility. Before running the algorithm, the notes were only used to designate the "special" facilities that were given artificially inflated productivity factors. During its operation, the algorithm populates this field with additional information as appropriate, such as the reason for skipping the consolidation of a facility.

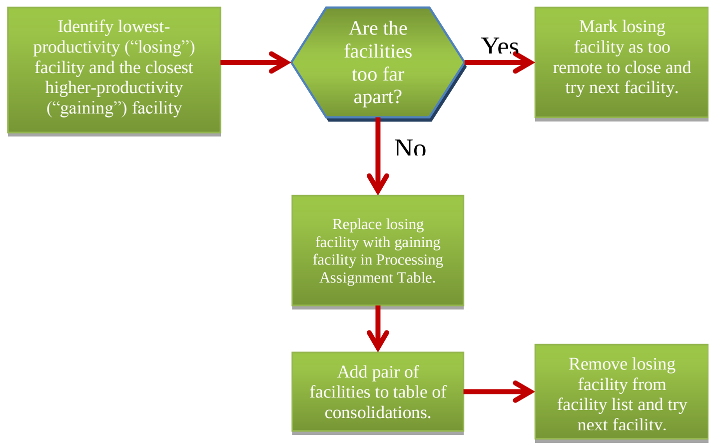
In addition, a blank Facility Closures list was created to track the target and gaining facility pairs identified by the algorithm. It contained the following columns:

- Losing Facility – characteristics of the facility closed by the algorithm, including its MODS name (if any exists), StandardizedName, latitude, longitude, nearest 3-digit ZIP code, and productivity factor.
- Gaining Facility – characteristics of the facility to which the algorithm assigned the processing responsibilities of the losing facility. Identical fields and usage to the losing facility.
- Great Circle Distance – the shortest-path distance on the surface of the (assumed spherical) Earth from the losing to the gaining facility.
- Number Reassigned – the number of changes made to the Processing Assignment table by the algorithm to reflect the transfer of processing assignments from the losing to the gaining facility.

[22] See formula in the body of the document. Source: http://en.wikipedia.org/wiki/Great-circle_distance

Reassignment Algorithm Methodology

An overview of the algorithm as a flow diagram follows:



Before running the algorithm, additional values were set:

- <u>Productivity Threshold</u> – the cutoff for a facility to be considered for closure by the algorithm. All facilities with a productivity factor **lower** than this threshold were considered for closure.
- <u>Distance Threshold</u> – the cutoff for distance between a facility pair considered for closure. If no facility is closer than this distance to a target facility considered for closure, the target facility will be deemed too remote to close and will therefore remain open.
- <u>Maximum facilities to close</u> – this value may optionally be set to prevent the algorithm from closing more than the specified number of facilities. If not set, the algorithm will run until it hits the productivity threshold.

Once those fields are set, the algorithm repeats the following process:

- Identify the facility targeted for closure. Also, using the Great Circle Distance field, identify a potential gaining facility: the closest facility to the target that has a productivity factor greater than or equal to the threshold.
- If the distance of the potential gaining facility from the target facility is greater than the distance threshold, flag that facility as having been skipped by adding "too remote" to its Notes field, set the next facility as the new target, and restart this loop from the beginning.
- If the two facilities are close enough to be consolidated, replace each instance of the target facility in the Processing Assignment Table with the gaining facility, i.e. reassign all processing conducted by the target facility to the gaining facility. Count each change made to record the impact of this consolidation.

- Add the consolidation pair as a record to the list of facility closures, along with the distance between them and the number of changes made to the Processing Assignment table to reflect the consolidation.
- Delete the record of the target facility from the Facility List, and set the next facility in the newly updated facility list as the new target.

This loop repeats itself until all the facilities with productivity values below the threshold have either been closed or skipped, or until it closes the optional maximum number of facilities.

Appendix E – Description of Post AMP Assignment Process

This effort consists of generating a list that identifies all mail processing facilities assignments (for originating and destinating processing, by ZIP3) which are the result of proposed AMP consolidations that were intended to occur prior to the Network Rationalization Operational Consolidation filed by USPS in USPS-LR-N2012-1/73.

The Post AMP network configuration (referred to as 'PostAMP' the reported results) would consist of updating the initial 477-facility network configuration (used in the baseline model) to reflect consolidations that would have resulted from the proposed AMPs.

Sources

The key sources of data used were:

- **Baseline Processing Assignments and Facility List** – This is the list used in the baseline model. It consists of a table of the facilities handling different categories of mail as of FY2010. It is compiled from USPS NP2's "FY2010 Workload Volume by Operation Type" workbook, sheets CANC through PRI. The list of unique facility names in the assignment table comprises the facility list. This list is found in the companion DVD in the Library Reference "Input Data Set (Worksheets "Baseline and Post AMP Facilities and Routing Tables")
- **2010 ZIP Code Data** – list of ZIP3s and names for Continental U.S. along with location and population information. Sourced from LR15, /15_LogicNetModel Workbooks/15_LogicNet Model.xls, CustomerDetails worksheet.
- Mail processing facility consolidation information
- AMP studies and PIR reports as posted to the "Latest Consolidation List" page on the APWU website (http://www.apwu.org/issues-consolidation/consolidation-latest_list.htm) or in USPS NP12's list of AMP decisions
- USPS OIG Report Number CI-AR-12-003: "US Postal Service Past Network Optimization Initiatives."

Cataloging known AMP decisions

To develop the Updated Processing Assignment list, the mail processing facilities that were candidates for AMP consolidation had to be inventoried, and the corresponding

ZIP3 reassignments had to be made to the "Baseline Processing Assignments and Facility List" (see 'Sources'), thus resulting in modified processing assignments.

Beginning with the 2010 ZIP Code Data list from LR15, which included ZIP3 and location name fields, columns were added to describe any documentation found pertaining to changes, either past or future, to originating or destinating mail processing assignments for each ZIP3. A typical record follows:

		Losing Plant		First Gaining Plant					
ZIP3	Name	Name	Type	Name	Type	Source	Miles	AMP Type	Implementation Date
039	039 - PORTSMOUTH NH	Portsmouth NH	P&DF	Manchester NH	P&DC	Final PIR 2011.05.19	45.1	Originating	10/1/2009

Second Gaining Plant (if applicable)					
Name	Type	Source	Miles	AMP Type	Implementation Date
Southern Maine ME	P&DC	AMP Decision 2011.08.05		Destinating	

Confirmed	Implemented	Comment
Yes	Yes	APWU says destinating done too

The added fields are defined as follows:

<u>Losing Plant</u> – **If an AMP consolidation has affected, or is planned to affect, processing at this plant**, 'Losing Plant' represents the facility at which mail was/is handled **before** the consolidation.

- Name: Facility name, e.g. Long Beach CA
- Type: Facility type, e.g. P&DC

<u>First Gaining Plant</u> – The facility at which mail processing **occurs or would occur** as a result of an AMP decision**, regardless** of AMP status (e.g., completed, planned).

- Name: Facility name, e.g. Santa Ana CA
- Type: Facility type, e.g. P&DC
- Source: Document containing facility information, e.g. Final PIR 2011.05.17
- Miles: Distance in miles of this facility from the losing facility.
- AMP Type: Processing operations reassigned according to the AMP, i.e. Originating, Destinating or both (Orig/Dest).

- Implementation Date: date at which the consolidation was completed or was scheduled to be completed.

In cases where the mail processing assignments to a ZIP3 were remaining unchanged, some AMP-related fields were not populated – these are: the Miles, AMP Type, and Implementation Date.

Second Gaining Plant – In cases ZIP3 processing was assigned, or was intended to be assigned, to two facilities (e.g., due to multiple AMP consolidations), the 'Second Gaining Plant' represents this additional facility. The Second Gaining Plant has the same fields and usage as the First Gaining Plant.

Implemented – This field assumes the following values:

- "Yes" if the consolidation appears in "Appendix C: AMPs Implemented Between FY 2004 – FY 2011" of the Jan. 9 OIG "U.S. Postal Service Past Network Optimization Initiative" report, or if the APWU business agent for the relevant plant has indicated that the consolidation is complete.
- "Half" if the ZIP3 has been affected by multiple consolidations, only one of which has been implemented, and should be explained further in the comments.

Comment – other circumstances surrounding a consolidation, e.g. reason for an omission or "half" status; data conflict; or specific categories of mail processing to be moved (e.g. letter mail only).

After reviewing the "Consolidation Information" (see 'Sources' above), only about 120 consolidations were recognized. USPS OIG Report CI-AR-12-003, by contrast, has stated that 418 AMP studies were initiated as part of this round of consolidations, of which only 66 were halted by the time their study was conducted. A complete list of AMP studies and their statuses could not be found.

Creating the Updated Processing Assignment table

The AMP summary discussed in the previous section was filtered to display only ZIP3s with associated "losing" facilities, i.e. only the facilities for which mail processing had been affected by one of the inventoried AMPs.

An ‘Updated Processing Assignments’ file was created in which the facilities associated to these ZIP3s were changed to reflect the state of processing after an AMP was to have occurred. The following distinctions were made:

- For Originating AMPs, the gaining facility was identified to be the recipient of originating letters and flats, so the ORIGIN_LTTR_FLAT field was updated to the new facility.
- For Destinating AMPs, the gaining facility was identified to be the recipient of destinating letters, flats, and SPBS processing, so the DEST_LTTR and DEST_FLAT values were updated to the new facility. If the DEST_SPBS field had previously held the same value as DEST_LTTR and DEST_FLAT, the DEST_SPBS value was updated to the new facility as well.
- For AMPs of both Originating and Destinating mail processing, both sets of changes were made.
- The NDC and ASF fields remained unchanged. Unless explicitly mentioned in an AMP report, the AADC and ADC values were left unchanged as well (this only affected ZIP3s 415 and 416).

In addition, three new columns were added:

- <u>AMPd?</u> - Used to indicate whether or not an AMP report or PIR affecting mail processing in the ZIP3 was found.
- <u>Change?</u> – Used to indicate whether or not changes were made to values for the ZIP3 to reflect the AMP. Note that ZIP3s whose records were not changed appear to overwhelmingly, if not exclusively, be associated with AMP consolidations, if any, that occurred before FY2010, the cutoff for the “Baseline Processing Assignments and Facility List” (see ‘Sources’).
- <u>Comments</u> – Any additional information that makes the record stand out.

Counting Facility Closures

Fifty one (51) mail processing facilities that were listed in the “Baseline Processing Assignments and Facility List” no longer appeared in the Updated Processing Assignment list, and therefore, for the purposes of the network simulation model, were considered to be closed.

A further analysis of the Updated Processing Assignment list indicates that 62 facilities have a higher incidence of ZIP3 assignments and can thus be considered “gaining” facilities; whereas 80 facilities have a lower incidence of ZIP3 assignments often and can be considered as “losing” facilities (these include the 51 fully closed facilities).

Appendix F – Organization of Input and Output data files

This appendix describes the content and file organization of the companion DVD.

Analysis and Baseline Folders

The Library Reference APWU-LR-N2012-1/NP1 “Input Data Set” folder contains ConsolidatedInputData.xlsx, a complete index of the data used in model design and operation. This data comes from multiple sources, attributed in each sheet. In addition, the folder contains three subfolders. “Baseline Model Input” contains CSV files describing the name, location and equipment configuration of each USPS mail processing facility, as well as a table assigning facilities to processing operations for each 3-digit ZIP3 modeled. These files are formatted as required to be used as model input. The “PostAMP Model Input” folder, similarly, contains the same files, modified to reflect the postal processing network as determined from research into implemented and approved AMP consolidations. A “Common Model Input” folder contains any model inputs that do not vary across network scenarios, such as ZIP-to-ZIP volumes or rules to determine transportation modes.

The APWU-LR-N2012-1/NP2 “Baseline Validation Worksheet” contains a single Excel workbook used to compare model-computed mail processing volumes to USPS MODS-provided volumes for the purpose of validating the model’s accuracy.

APWU-LR-N2012-1/NP3 “Circuity Analysis” contains a workbook used to determine the circuity factor used in the model to better represent the actual travel distance between facilities.

The APWU-LR-N2012-1/NP4 “Cost and Productivity Calculations” folder contains three workbooks that together describe how RT production mail-processing costs and overhead costs were calculated for each facility and across the postal network.

APWU-LR-N2012-1/NP5 “Model Sample Output Data” contains a set of sample model output files used to demonstrate the format of the CSV files created by the Network Simulation Model.

APWU-LR-N2012-1/NP7 "Network Simulation Model" contains the actual model executable JAR file, a sample configuration file set up to run the baseline analysis, and a readme file with the syntax for running the model. It also includes the Excel workbooks, BulkReassigner_v4.xlsx and BulkScenarioAnalyzer_v4.xlsx, that contain macros for programmatically generating and analyzing input and output data for the model.

Structure of the APWU-LR-N2012-1/NP6 "Scenario Files"

Background. Each scenario consists of unique set of *initial conditions* used to create *input data,* which is processed by the network simulation model to produce *output data* that is then subjected to *analysis*.

- Scenario Initial Conditions: rules used to produce the input data. For instance: "consolidate up to 100 facilities of below-average productivity, provided each consolidation does not span more than 150 miles."
- Scenario Input Data: the set of **scenario-specific** files fed into the network simulation model to produce output data.
    - Facility List: defines each facility's location and equipment.
    - Assignment Table: defines the facilities assigned to handle processing operations for each 3-digit ZIP code.
    - Other inputs that remain constant across scenarios (e.g. volumes for O/D pairs, locations of 3-digit ZIP centroids) are stored in a separate Common Input Data folder.

- Scenario Output Data: the set of raw files produced by the network simulation model after processing the Input Data.

- Scenario Analysis: The set of processed files produced during the review of the Output Data.
    - O/D pair tables produced displaying delivered and late volumes and percentages for each mail type in each O/D pair, split into service standard

subsets (Turnaround, other Intra-SCF, and second- and third-day standards)

- Facility performance tables displaying the percentage of different mail types failing to clear each operation in each facility by the operation's cutoff time.
- Processing cost tables showing the RT mail-processing costs and overhead costs incurred by each facility.
- Network metrics tables showing the cost and mileage of mail transportation through the network.

Data Naming and Storage Conventions. The Scenarios folder contains an index of scenarios describing the size of the network that each represents, a description of how the scenario was generated, and some key statistics. Each scenario described by the index has its own folder, which contains all the files relevant to the scenario: model inputs, model outputs and analysis.

Within each scenario folder are three subfolders. The InputData folder contains the inputs specific to that scenario: the facility list and processing assignment table. If the scenario was generated through algorithmic consolidations, a summary table of the consolidations performed will also be present.

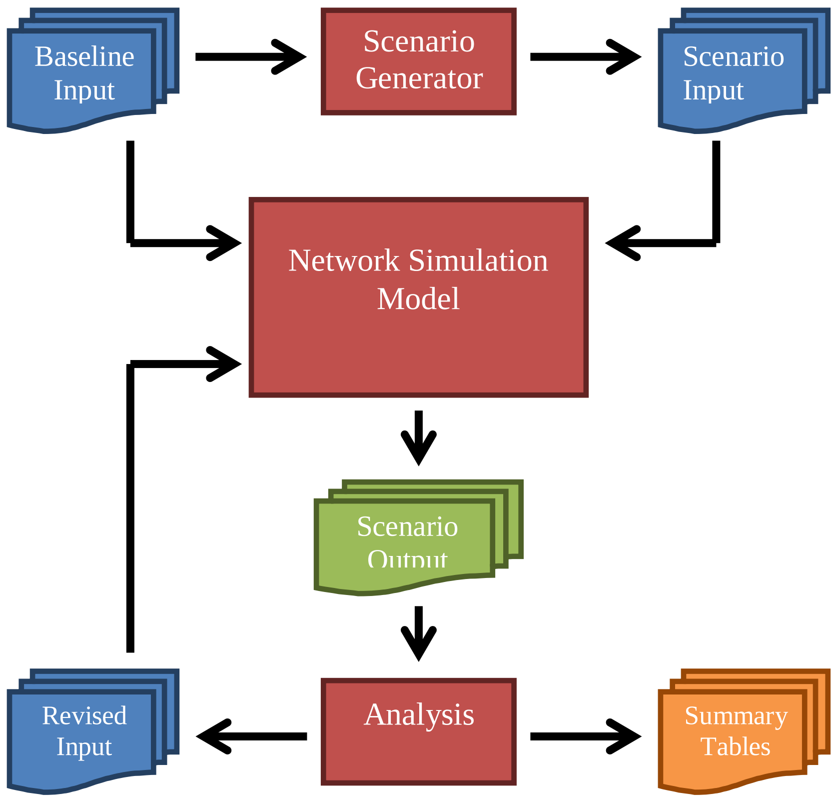
The OutputData folder contains all the raw files produced by the network simulation model for that scenario, including network transportation metrics, facility processing volumes and O/D pair delivery volumes. The Analysis folder contains the analysis files described above: modified versions of output files used to analyze the scenario, including service performance, processing performance, transportation metrics and cost assessment.

Example Scenario File Structure

TopThreeQuarters/

- TopThreeQuarters_InputData/
  - TopThreeQuarters_AssignmentTable.csv
  - TopThreeQuarters_Facilities.csv
  - TopThreeQuarters.xlsm
- TopThreeQuarters_OutputData/
  - dailyDeliveryMetrics.csv
  - intradayFacilityMetrics.csv
  - …etc
- TopThreeQuarters_Analysis/
  - TopThreeQuarters_FacilityPerformance.xlsm
  - TopThreeQuarters_ODPairTables.xlsm
  - TopThreeQuarters_Processingcosts.xlsm
  - TopThreeQuarters_RevisedNetworkMetrics.xlsm

Appendix G – Description of Key System Components



The Scenario Generator is an Excel workbook, BulkReassigner_v4.xlsm, that contains a copy of the FY2010 baseline assignment table and facility list along with each facility's productivity factor, calculated as described above. After creating a list of scenario names and initial conditions (productivity threshold, distance threshold and maximum number to close), a macro is run that simulates each set of facility closures. The Generator creates and saves the Network simulation model-compatible input (CSV) and configuration (XML) files for each listed scenario. For instance, the Generator would create a Example_InputData folder containing Example_Facilities.csv and Example_AssignmentTable.csv, as well as a config.Example.xml file, for a scenario named Scenario.

Each scenario's generated InputData folder is then moved into the Network simulation model's InputData folder, and the configuration XML files are moved into the root alongside the network simulation model JAR file. The network simulation model can then be run from the command line, selecting the proper configuration file each time to run each scenario. Within its OutputData folder, the network simulation model creates a folder unique to a scenario (e.g. Example_OutputData) containing a set of output (CSV) files for each scenario.

If the input and output folders for each scenario are then copied into a folder named for that scenario, such that the structure of the input and output files for each scenario matches that described above, a Scenario Analyzer can be used to quickly generate summaries of the network simulation model results for each scenario. The Analyzer, like the Generator, is an Excel workbook, BulkScenarioAnalyzer_v4.xlsm. It contains a table of service standards by O/D pair and a table of processing unit costs by facility, as well as code used to process the output files. The After listing the scenario names as in the Generator, a macro is run that identifies subsets of O/D pairs by service standard and facility assignments and compiles service and processing performance statistics, processing costs and transportation metrics, then arranges them into a table for easy comparison. Any files created in the process are saved into a newly created scenario analysis folder, e.g. Example_Analysis, within the scenario folder. It can also be used to generate new facility lists that reflect the addition of equipment to facilities accommodate any capacity constraints. These lists will be added back to the scenario's InputData folder, renamed, for instance, Example_Upgraded_Facilities.csv.

Appendix H – Hardware and software configuration

The network simulation model consists of an executable JAR file, which can be run on any computer with the latest Java Runtime Environment installed (Version 6, Update 31 at the time of this writing). The network simulation model requires at least 8 GB of RAM.

For this study, the network simulation model was run on an Intel Core i5 computer with 32 GB of memory and with Windows 7 Professional x64 SP1 installed.