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Modernizing FRA's Rail Freight Routing and Analysis Tools

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Outline

- **Background**
- **Waybill Sample**
- **Toolkit Overview**
- **Methodology**
- **Examples**

Background

- **Partnership between the Surface Transportation board (STB) & Federal railroad Administration (FRA)**
- **Carload Waybill Sample Data is an annual database that provides the only source of railroad commodity flow data**
- **Railroads that terminate over 4,500 cars in the U.S. per year are required to file a sample of waybills with the STB for regulatory oversight**
- **The Carload Waybill Sample is Confidential; the rules for release of waybill data are codified at 49 CFR 1244.9.**

Waybill Sample

- FRA uses the data to support safety and security by analyzing the related movement of hazardous materials
- The data contains rail shipments of origin, destination, type of commodity, number of cars, tons, revenue, length of haul, participating railroads, interchange locations, and etc.
- 2014 there were 666,394 records

Country	Carloads	Tonnage
Canada	1,355,251	81,139,164
Mexico	100,524	2,241,004
U.S.	35,240,295	2,063,078,050

- <https://www.stb.gov/stb/docs/Waybill/2014%20STB%20Waybill%20Reference%20Guide.pdf>

Waybill Sample

Standard Transportation Commodity Code (STCC)

- STCC is a 7 digit code
- 2 digit is the broadest classification
 - 01: Farm Products (Agriculture)
 - 01131: Barley
- 39 Classifications of STCC
- Examples of most used STCC codes
 - 01: Farm Products
 - 11: Coal
 - 13: Crude Petroleum, Natural Gas or Gasoline
 - 28: Chemicals
 - 37: Transportation Equipment

- Intermodal is flagged within the database

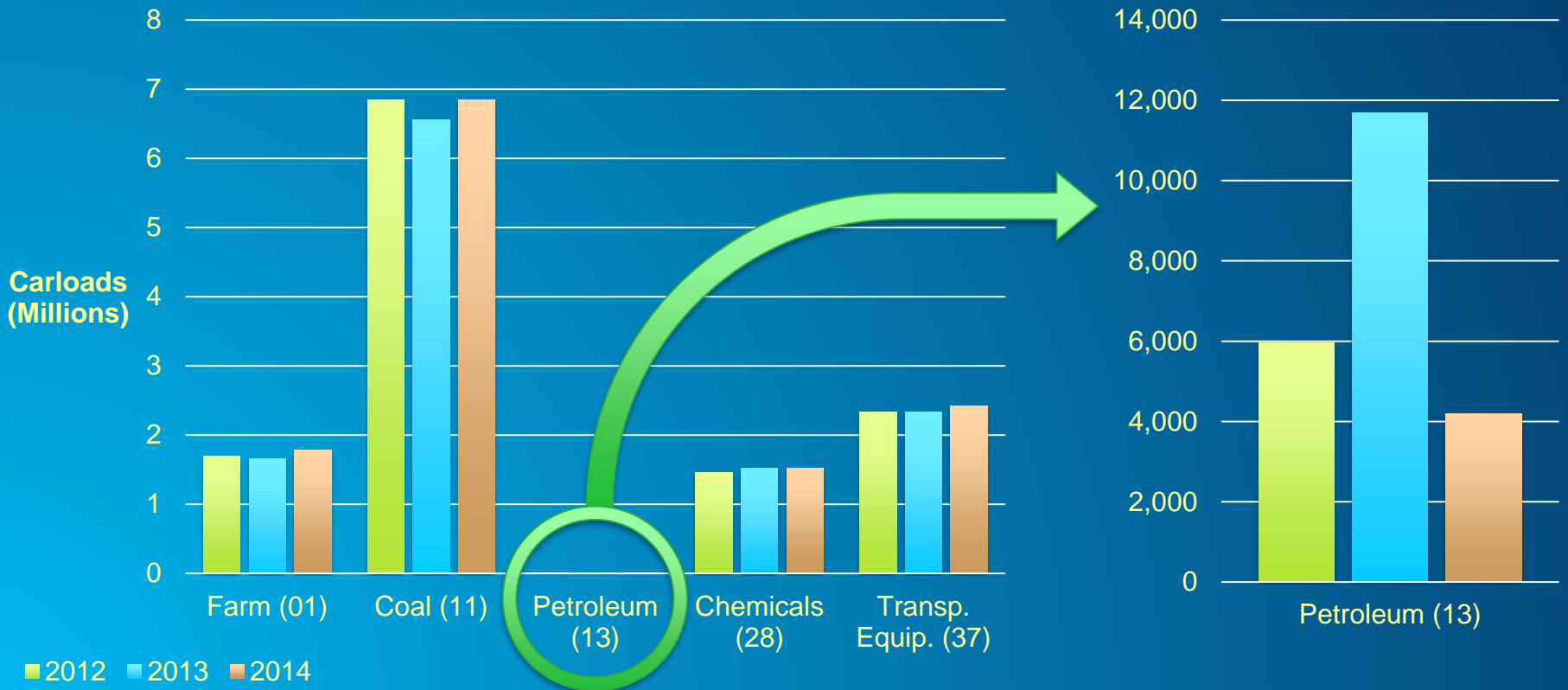
Statistics by STCC

Commodity Group	2 Digit STCC	Waybill Samples	Carloads		Revenue		Tonnage	
					\$M US		Millions	
Farm Products	1	19,145	1,780,067	(4.9%)	6,636	(6.90%)	156.37	(7.3%)
Coal	11	27,651	6,844,464	(18.7%)	17,623	(18.40%)	767.16	(35.7%)
Petroleum	13	61	4,189	(0%)	16	(0%)	0.39	(0%)
Chemicals	28	33,154	1,519,078	(4.1%)	6,931	(7.20%)	131.03	(6.1%)
Transportation Equipment	37	58,366	2,424,647	(6.6%)	8,697	(9.10%)	50.47	(2.4%)

* Data is from the STB Public Use file

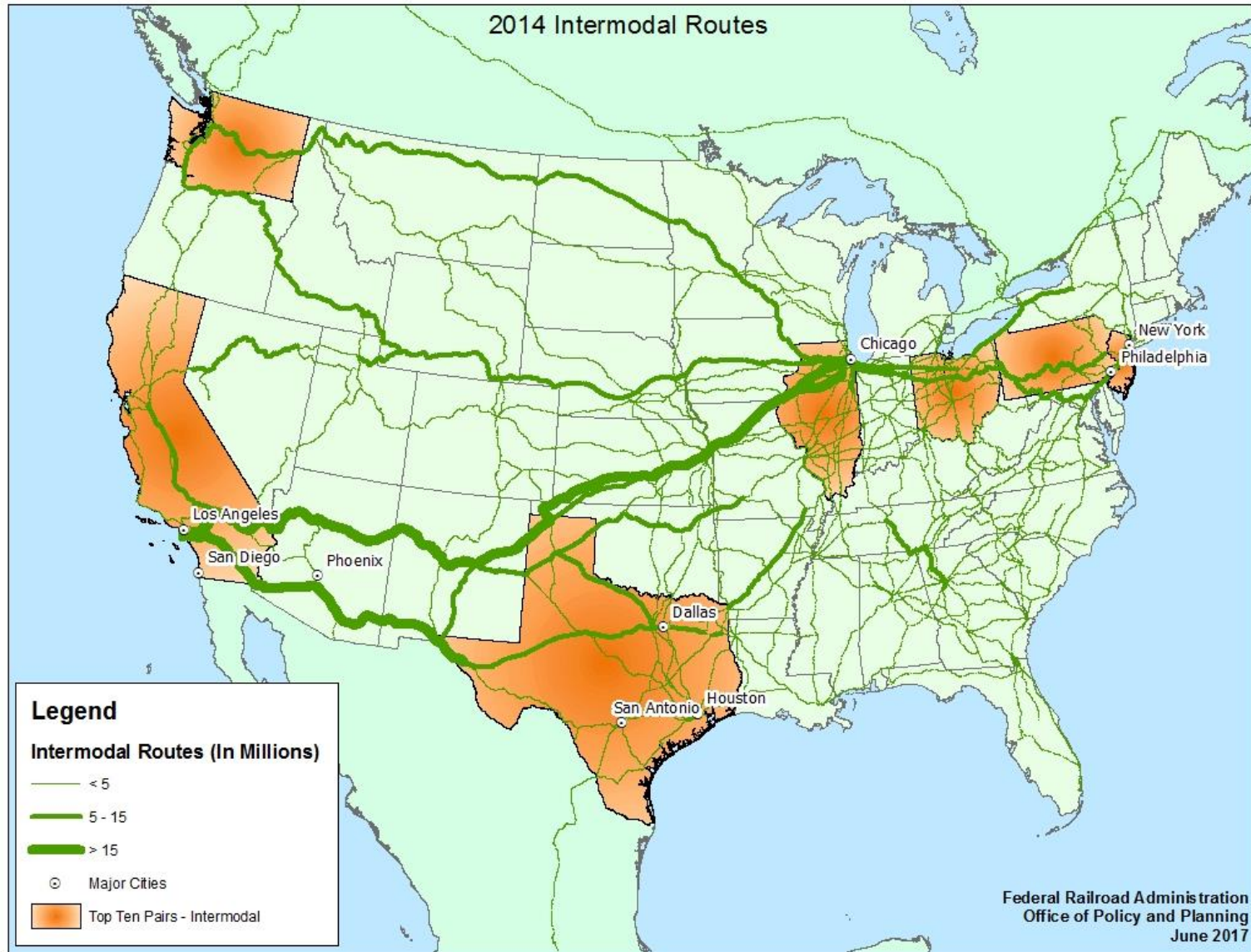
Trends Over Time

Commodity Group	Carloads		
	2012	2013	2014
Farm (01)	1,690,428	1,661,383	1,780,067
Coal (11)	6,842,782	6,559,225	6,844,464
Petroleum (13)	5,949	11,697	4,189
Chemicals (28)	1,464,618	1,519,737	1,519,078
Transp. Equip. (37)	2,325,891	2,328,492	2,424,647



Top Ten Intermodal Pairs (2014 Data)

- IL - CA
- CA - IL
- CA - TX
- TX - CA
- WA - IL
- IL - TX
- IL - PA
- NJ - IL
- IL - OH
- IL - WA



Key Attributes in the Waybill Sample

Attribute	Description
STCC	Standard Transportation Commodity Code
Origin FSAC	Origin Freight Station Accounting Code
Interchange (1-7)	Interchange Junction Abbreviation
Termination FSAC	Termination Freight Station Accounting Code
Origin SPLC	Origin Standard Point Location Code
Termination SPLC	Termination Standard Point Location Code
Origin Railroad	Origin Standard Carrier Alpha Code – RR Code
Interchange Railroad	Interchange Standard Carrier Alpha Code – RR Code
Termination Railroad	Termination Standard Carrier Alpha Code – RR Code
Expanded Carloads	Number of Carloads; multiplied by the expansion factor
Expanded Tons	Billed Weight in Net Tons; multiplied by the expansion factor

Why Create a Toolkit?

- We want to understand WHO is moving WHAT and WHERE
 - Which carriers?
 - Which commodities?
 - Where are the major routes and supporting alternatives?

This is available through the Waybill but...

- With so much data, we need an *automated* way to produce statistics and maps

Other Key Data Sets

- **North American Rail Network (NARN)**
 - Geodatabase of rail links and nodes for all of North America (not just USA)
 - Includes attributes regarding track ownership and trackage (usage) rights
 - Density

- **Centralized Station Master (CSM)**
 - Maintained by Railinc
 - List of all rail carrier stations in North America (and other international areas)

Key Attributes in the Rail Network

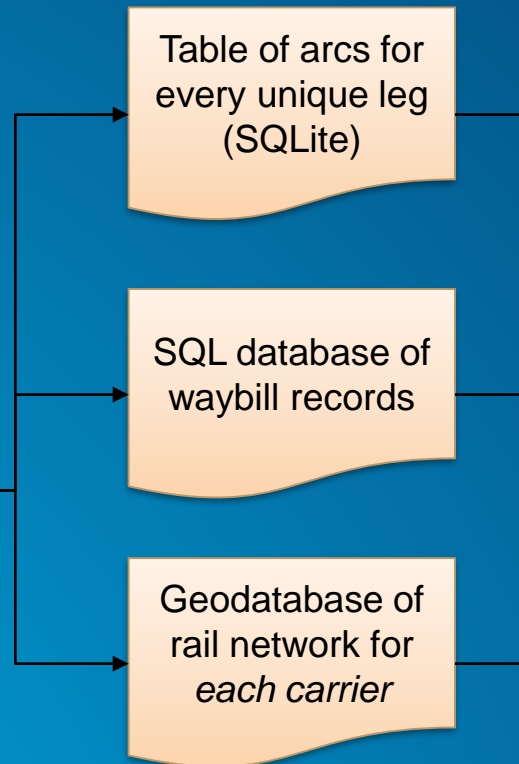
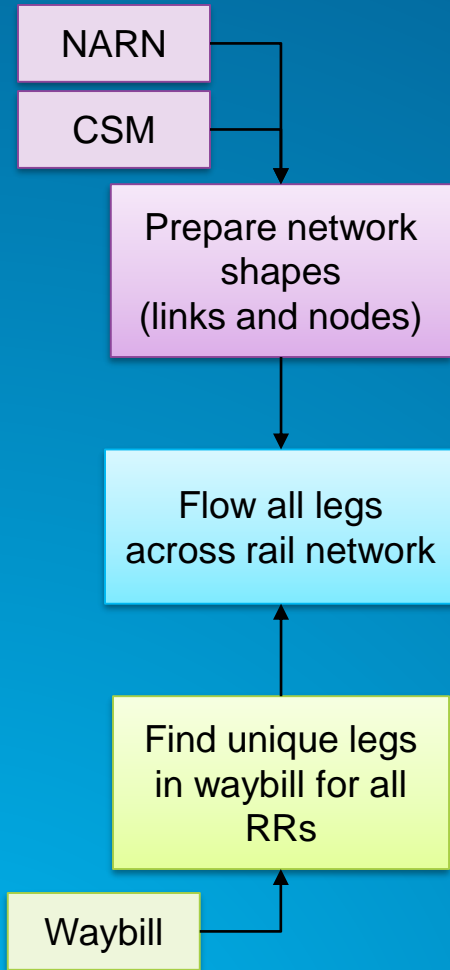
Attribute	Description
RR Owner (1-3)	Owner(s) of the rail line
Trackage Rights (1-9)	Railroads which have trackage rights
FRFRANODE	From node
TOFRANODE	To node
NET	Type of track (Mainline, industrial, siding, etc.)
IMPEDANCE	Miles / (1 + Density)
SCAC	Standard Carrier Alpha Code – Railroad ID
FSAC	Freight Station Accounting Code
RULE 260	Interchange Junction Abbreviation
SPLC	Standard Point Location Code

Toolkit Description

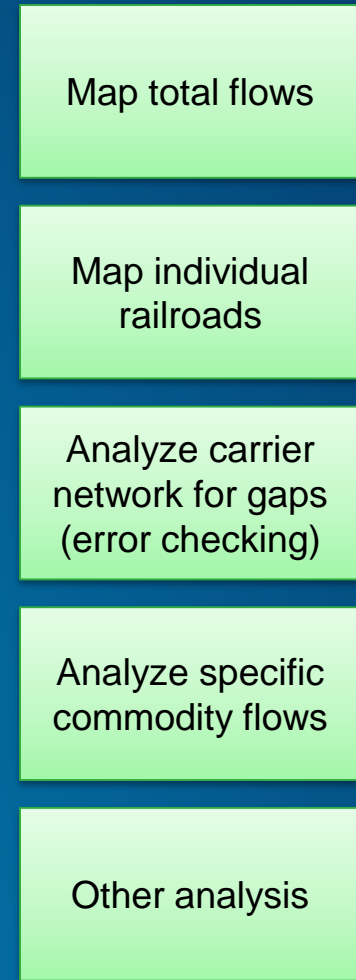
- **Python-based GIS tools which:**
 - **Prepare Waybill and network data**
 - **Assess shipment 'legs' – station-to-station pairs within the Waybill**
 - **Flow across the network and store route information**
 - **Compile and analyze Waybill data**
- **ArcGIS and arcpy package integrate spatial analysis capabilities, including routing and visualization**
- **Microsoft SQL Server database used for most data handling**
- **SQLite used to store routing tables**

Concept of Flow

Do Once

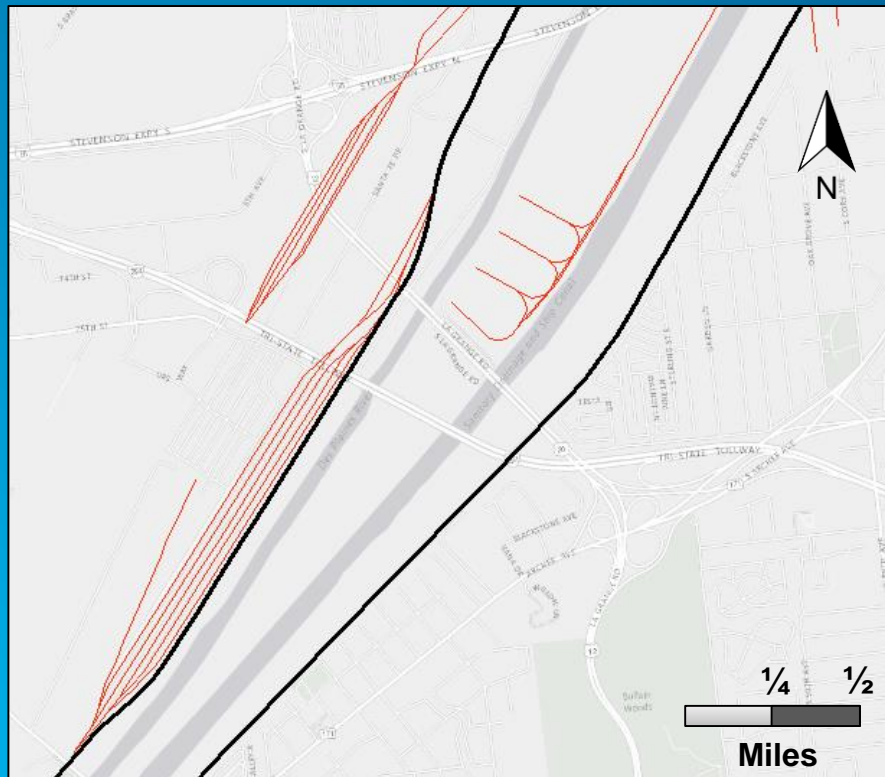


Do Iteratively/On Demand



Setup the Network

- Load entire NARN network (links and nodes)
- Select only main and industrial portions of the network
 - Sidings are ignored since the tool is only interested in aggregated flow, and not specific handling of congestion on the rail network



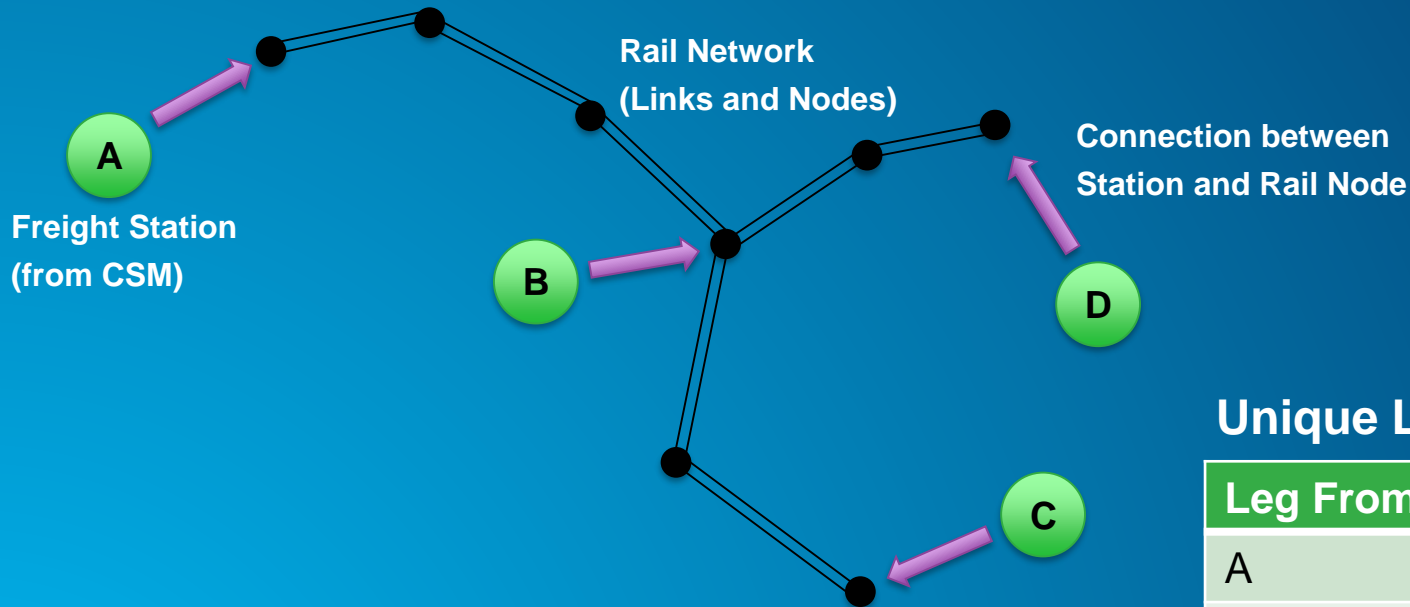
- Main and Industrial
- Non-Main/Industrial (Sidings, etc.)

Create Legs and Relate to Stations

- **Waybill specifies up to 6 interchange points between origin and destination – these are broken out into ‘legs’**
- **A unique list of all legs in the waybill data is assembled and stored in the database**
- **Approximately 58,000 unique legs in the current waybill sample dataset**
- **Each origin/destination station is also connected to the NARN by proximity to nearby rail nodes**

Example - Create Legs and Relate to Stations

Waybill Record ID	From Station	Intermediate Station	To Station	Tonnage
1	A	B	C	10
2	A	-	D	5



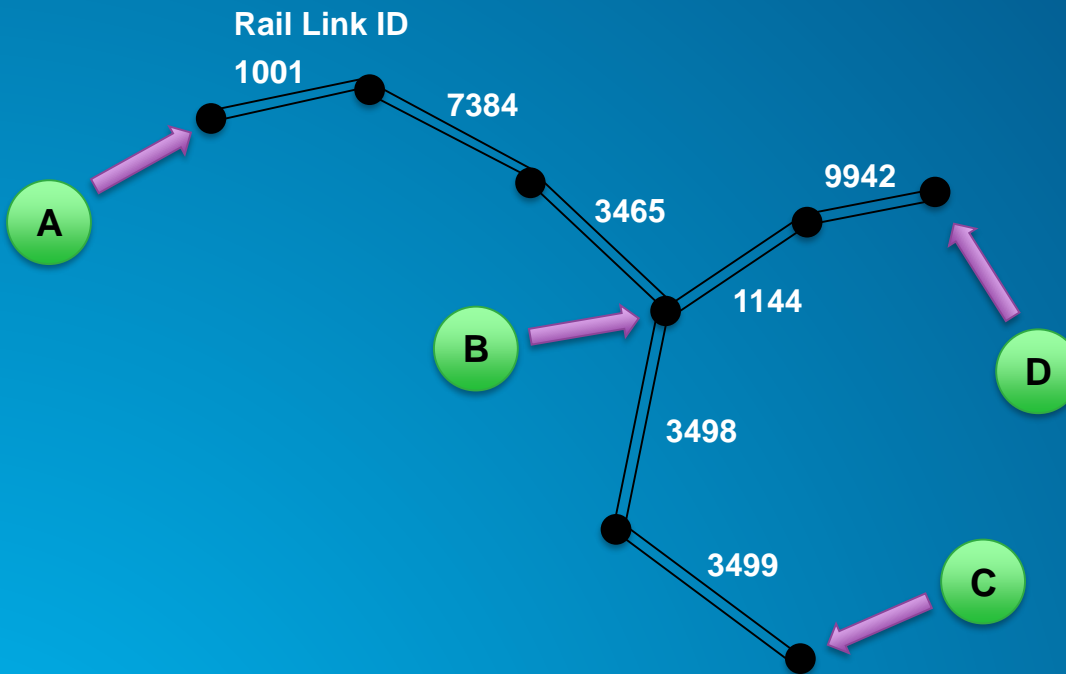
Unique Legs

Leg From	Leg To
A	B
B	C
A	D

Flow Railroads

- **Analyze each selected carrier individually**
- **For each leg from the waybill for the identified carrier, flow between origin and destination stations**
 - **Legs which do NOT flow are tracked**
- **Store routing results to SQLite database**

Example - Flowing Legs



Unique Legs

Leg From	Leg To
A	B
B	C
A	D

Flow Results

Leg From	Leg To	Link ID
A	B	1001
A	B	7384
A	B	3465
B	C	3498
...

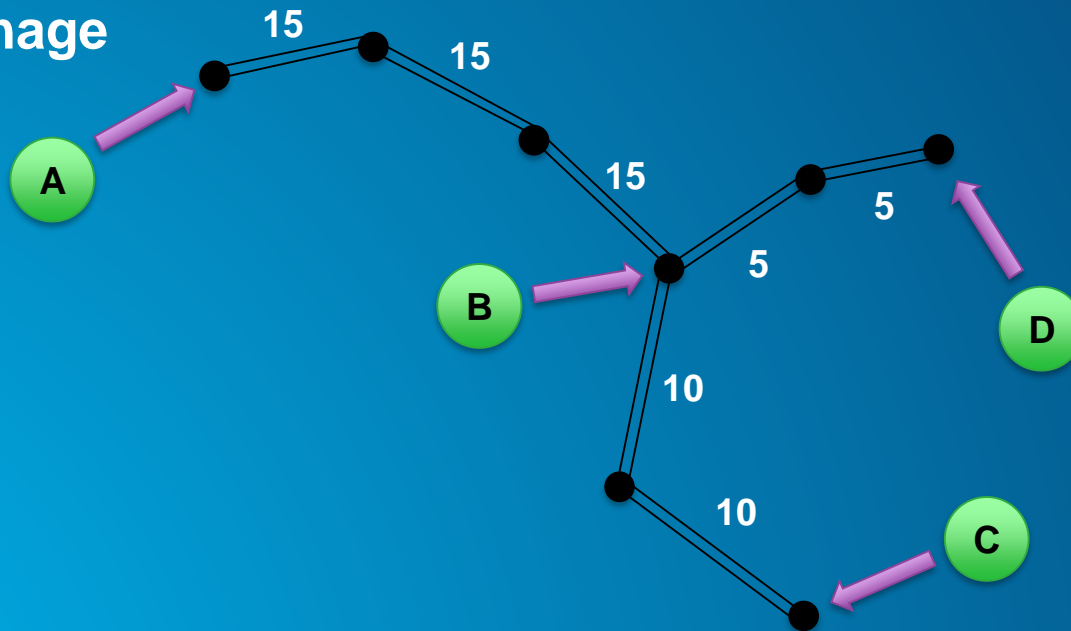
Analysis and Mapping

- By separating analysis and routing, all unique waybill legs must only be flowed once
- The waybill can be reanalyzed to compute:
 - Tonnage
 - Carloads
 - Specific Commodity
 - Specific Railroad
- Results can then be linked to the network quickly using the stored flow results

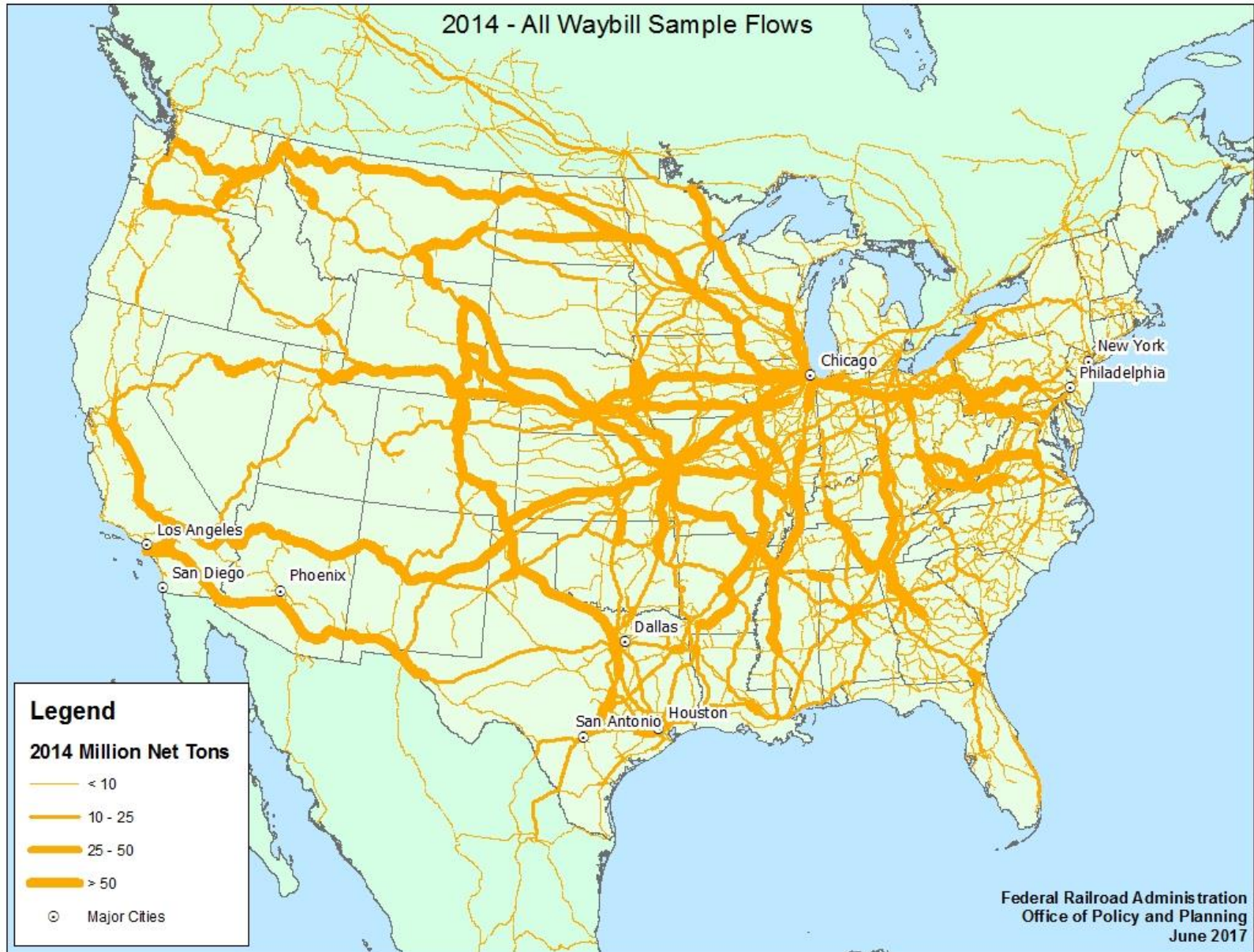
Example – Compiling Results

Waybill Record ID	From Station	Intermediate Station	To Station	Tonnage
1	A	B	C	10
2	A	-	D	5

Total Tonnage



Example Map (2014 Data)



Current Development & Next Steps

- **Add more analysis tools**
 - Network connectivity error testing
 - 'Reality checking' Waybill distance versus flowed distance
- **Move to ArcGIS Professional**

Thank you!

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