



Delivering value in



**With Operations
Research**

October 30, 2012

NETWORK MAP & FACT SHEET



BNSF Facts

Length of network: 32,000 route miles

States in network: 28

Canadian provinces in network: 2

Employees: 38,000

Headquarters: Fort Worth, Texas

Ports served: 40+

Intermodal facilities: 31

Locomotives: 6,000

Average annual capital investment (2000-2010): **\$2.6 billion**

Signal locations: 12,400

Bridges: 13,100

Tunnels: 87

Tunnel miles: 34

Highway-railroad grade crossings: 25,800

Packages shipped on time during typical holiday season: 50 million

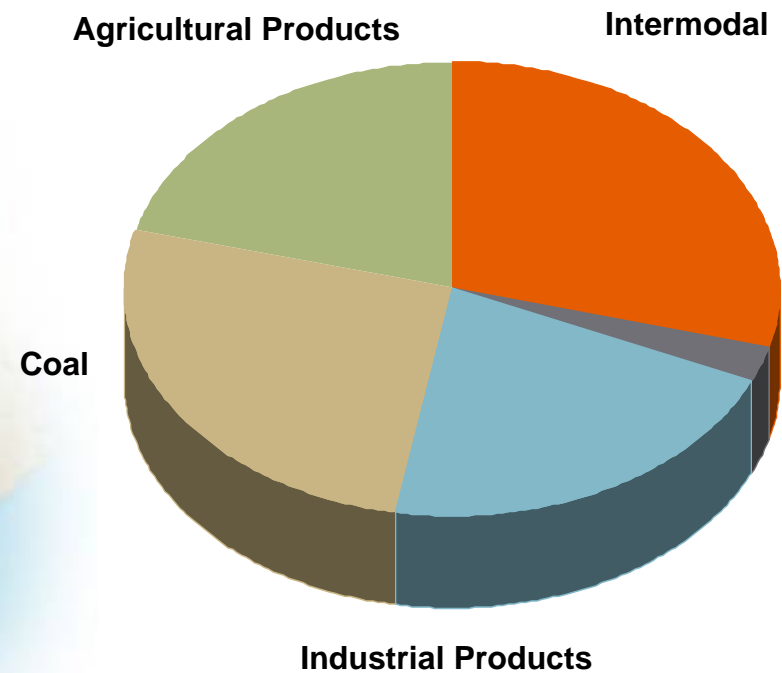
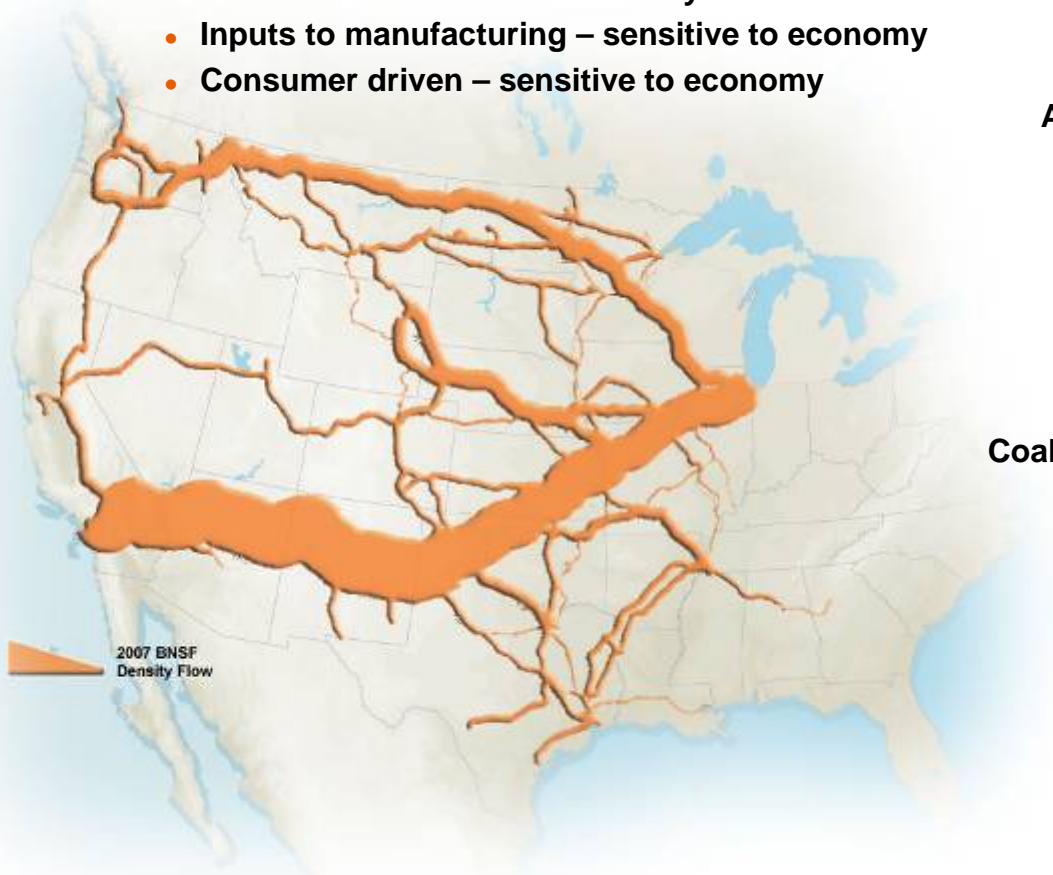
Carloads shipped in 2010: **9.2 million**

Distance BNSF hauls 1 ton of freight on 1 gallon of diesel fuel: 495 miles

BNSF Franchise

BNSF Network

- **Balanced revenue base (recession resistant)**
 - **Bulk – less sensitive to economy**
 - **Inputs to manufacturing – sensitive to economy**
 - **Consumer driven – sensitive to economy**



BNSF 2011 Revenues: \$19,548 Millions

Major Customers & Beneficial Owners

10,000+ Customers and 21,000+ Bene-Owners



WHO ARE WE

- **A group that provides analytical consulting and decision support tools throughout BNSF Railway**
- **Part of Capacity Planning and Operations Research**
- **~17 full-time/interns with advanced degrees in Operations Research or Industrial Engineering**
- **OR started after the BNSF merger in mid 90's**
 - **Strategic Studies**
 - **Technology Services**
 - **Service Design**
 - **Capacity Planning and Operations Research**

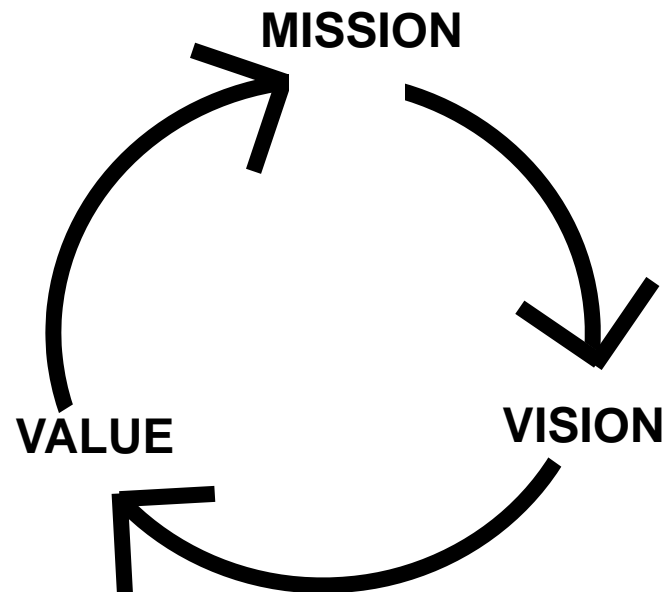
MISSION, VISION & VALUE

Build BNSF competitiveness

- Increase efficiency
- Identify opportunities

Improve efficiency

- Reduced costs
- Improved productivity
- Faster cycle time
- Balanced Network



Improve Decision Support tools

- Block network
- Train schedule
- Coal sets
- Empty equipments
- Crew planning
- Power planning
- Etc...

SAMPLE OR APPLICATIONS in OPERATIONS



Crew



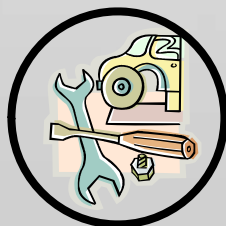
Track Infrastructure



Locomotive



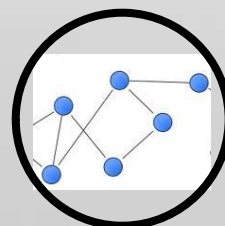
Maintenance



Equipment



Service Design



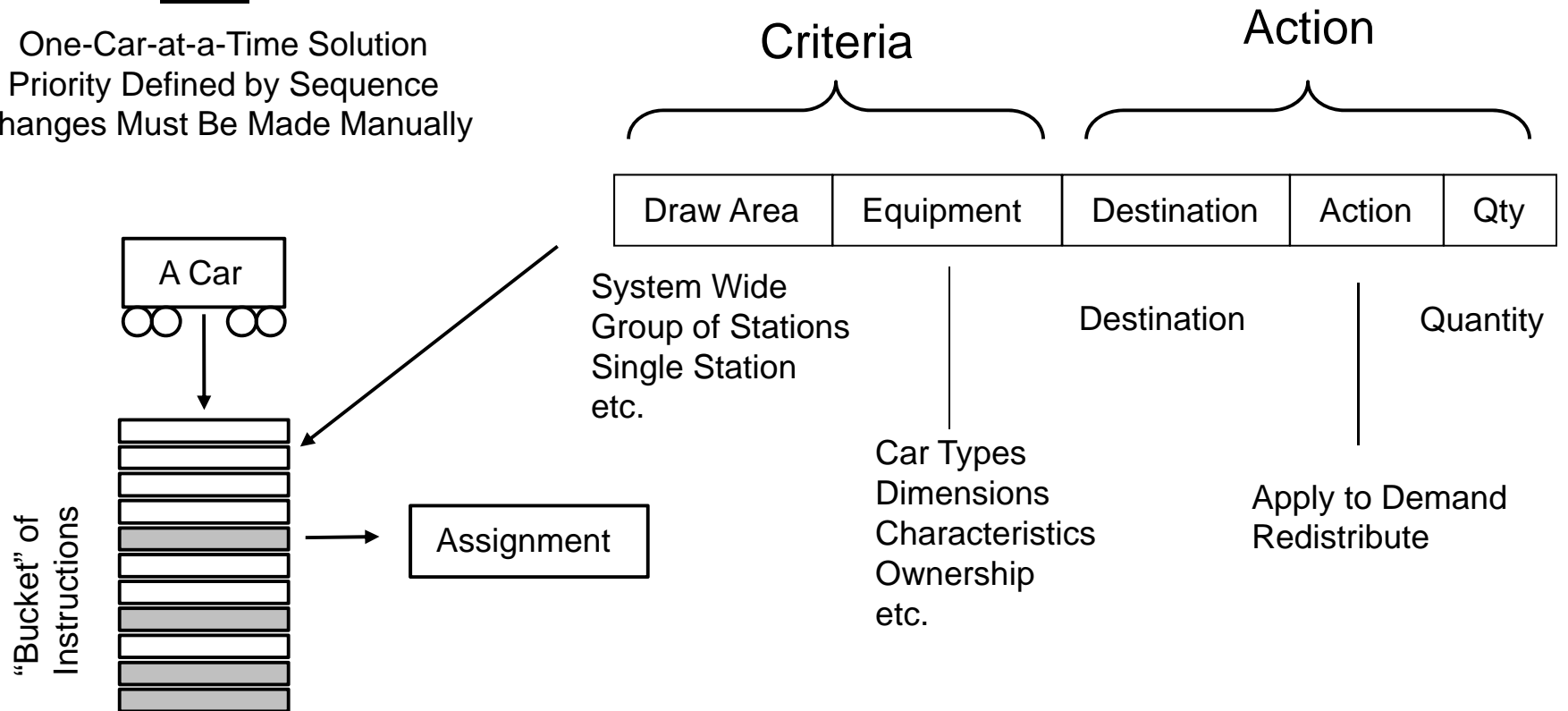
Equipment Distribution

- **Railroads own many of the railcars used by their customers.**
 - **Railcars come in a variety of types and sizes with a number of distinguishing characteristics.**
 - **Customers have varying requirements for railcars.**
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- **The Problem: Once a railcar is unloaded, where should it be sent for its next load?**

Equipment Distribution (the old way)

ED

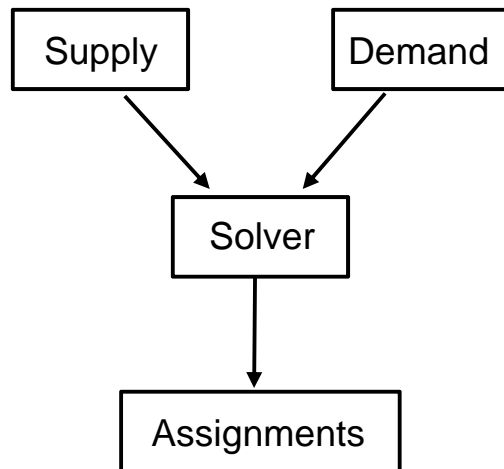
One-Car-at-a-Time Solution
 Priority Defined by Sequence
 Changes Must Be Made Manually



Equipment Distribution Optimization

EDO

System-Wide, Optimal Solution
Solutions Automatically Revisited



Supply

Empties (at next available location)
Loads (future empties at unloading location)
Empty cars expected to be received in interchange

All Supply Defined by Equipment Types (ETs)

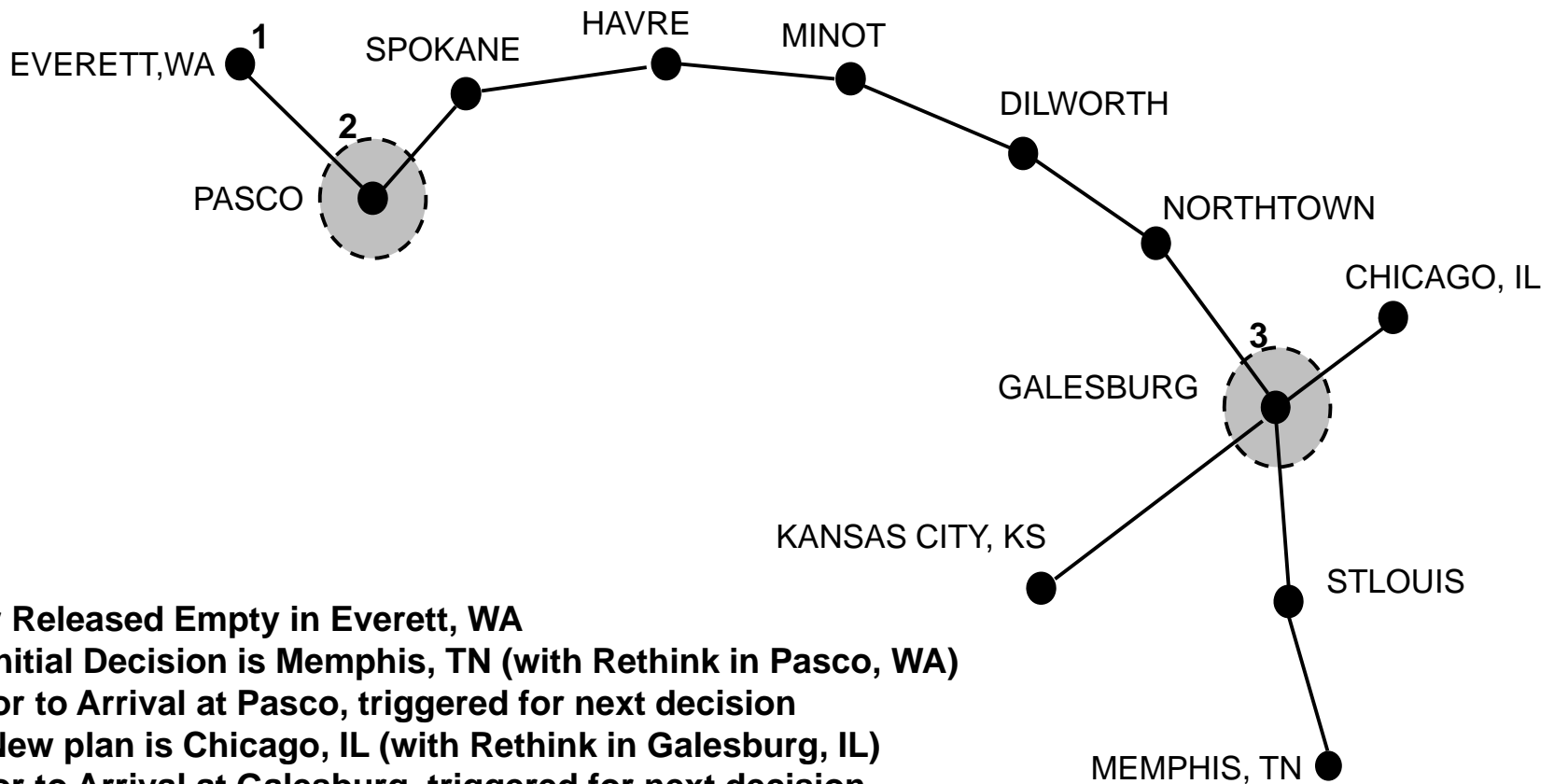
Demand

Customer Demands
Non-Customer Demands

Solving

- Identify all possible assignments of supply to demand -- equipment match and able to arrive “in time”
- Calculate a “value” for each possible assignment
- Find the group of assignments that result in the greatest overall “value”
- Re-solve every fifteen minutes -- taking into consideration updates to supply and demand since the last solve and rethink opportunities along the way.

EDO Rethinks



- 1. Car Released Empty in Everett, WA**
Initial Decision is Memphis, TN (with Rethink in Pasco, WA)
- 2. Prior to Arrival at Pasco, triggered for next decision**
New plan is Chicago, IL (with Rethink in Galesburg, IL)
- 3. Prior to Arrival at Galesburg, triggered for next decision**
New plan is Kansas City, KS (with no Rethinks)
Car “locked” to Kansas City, KS demand and removed from supply

STOCHASTIC EMPTY CAR DISTRIBUTION

- **Problem Description**

- Given

- Demand: customer demands to load cars, timing, location and car characteristics
- Supply: Empty car supply, timing, location and car characteristics
- Transit time: Probable transit times from supply to demand points

- Task: Assign empty cars to customer requests

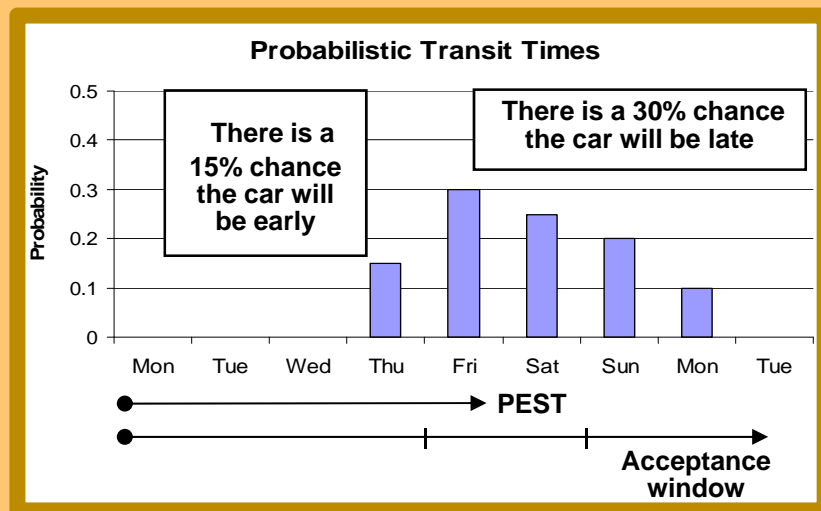
- **Benefits/Current Status**

- More efficient and reliable assignments of cars to customer demands

STOCHASTIC EMPTY CAR DISTRIBUTION

• Example

- Assume a demand with acceptance window between Friday and Saturday.
- A car becomes available on Monday, and matches the customer's equipment requirements.
- PEST indicates that if car is assigned, it will be at the customer's facility on Friday.



- PESTs are a point estimates of transit time.
- PESTs do not capture the stochastic component of the problem.
- Probability distributions give a more general picture, and allow to explicitly include expected early or late costs in the process of assigning value to candidates for the solver.
- Probability distributions are estimated using observed (historical) transit times.

Status

- **EDO has been in production since 2000.**
- **EDO currently handles empty distribution for the following carload equipment fleets – box cars, covered hoppers, gondolas, flat cars, open top hoppers, ag singles, and woodchips.**
- **Probable transit times were added to EDO in 2007/2008.**
- **CSXT EDO application is a finalist for this year's Edelman Award**

Where is Analytics used?

- Identifying Opportunity- Data Analytics
- Decision Support tools – Advanced Analytics
- Support Roll-out
 - Track usage
 - Run-times
 - Follow up on Failures
 - Quantify impact
- Identify opportunities

