Improving Railroad Network Routing
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The BNSF Network
The Car Routing Puzzle

BNSF Stations

Hump Yards
One Routing Solution

Hump Yards
Maintaining the Routing Rules
A Local Perspective

Traditional System

- Block from Memphis
- Block to Kansas City
- General Merchandise
- Includes
  - Thornton, Delpaso, Plegrove, Marysvill, Mounkes, Craig, Rocklin, Newcastle, Bowman, Colfax, Caphorn, Golrun, Dutflat, Alta, Towle, Midas, Blucanon, Emigap, Cisco, Troy, Norden, Truckee, Oroville, Elsey, Poe, Pulga, Merlin, Camrodger, Belden, Virgilia, Paxton, Spargarden, Quijet, Sloat, Blairsden, Portola, Hawley, Floriston, Verdi, Mogul, Lawton, Chilecot, Renjet, Scotts, Doyle, Redhouse, Reno, Sparks, Vista, Hated, Patrick, Herlong, Flanigan, Sanpass, Sano, Reynard, Wunotoo, Clark, Thisbe ...

- Total of 1823 Stations in this block
Maintaining the Routing Rules
A Network Perspective
Creating a New Paradigm
Using A Shortest Path Algorithm

 Traditional Blocking
   Design manager must completely specify routing manually; computer adheres to specified routing
   Routing preferences hard coded into rules
   Routing changes, even minor local ones, may require network-wide revision of rules

 Algorithmic Blocking
   Design manager manually specifies routing options using skeletal block definitions; computer logic selects routes
   Routing preferences reflected in “impedances”
   Routing changes of any size may be implemented quickly and their impacts predicted with models
Setting Up Algorithmic Blocking

Block Definition
• From Kansas City
• To E Leavenworth
• Any Traffic

Block Definition
• From Kansas City
• To Waldron
• Any Traffic

E Leavenworth
Waldron
Kansas City
Changing Routes with Algorithmic Blocking

Set “Valves” (impedances) to Route Traffic as Desired
Rule Maintenance Simplification with Algorithmic Blocking

<table>
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<th>Stations Covered</th>
<th>Table Entries</th>
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<td>&lt; 70</td>
<td>550,000 +</td>
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Traditional

Algorithmic Blocking
Real-Life Rerouting Problem
1996 Atlanta Olympics

Normal Operating Plan for All Traffic To Macon
Real-Life Rerouting Problem
1996 Atlanta Olympics

Olympics required rerouting of hazardous material Atlanta - Macon
Real-Life Rerouting Problem
1996 Atlanta Olympics

Manual Diversion (CSX)
6 months to install, then 1 month to restore
Real-Life Rerouting Problem
1996 Atlanta Olympics

ABC Diversion (NS)
1 person-day to plan and install

Linwood

Chattanooga

Atlanta

Sheffield

Knoxville

Macon

Birmingham

Olympics

X

ABC Diversion (NS)
1 person-day to plan and install
Real-Life Rerouting Problem
1996 Atlanta Olympics

ABC Diversion (NS)
1 person-hour to remove
The Fundamentals of Algorithmic Blocking

Find blocks which can carry traffic (feasible blocks)
Feasible blocks -- AB, AC, BD, CD
Infeasible blocks -- AD (weight restriction)

Find “lowest impedance” route over feasible blocks
Impedance $ABD = $ Yard A Impedance + Line AB Impedance + Yard B Impedance + Line BD Impedance
Impedance $ACD = $ Yard A Impedance + Line AC Impedance + Yard C Impedance + Line CD Impedance
Lower impedance route is chosen

If a route is blocked, Algorithmic Blocking will find another, if one is available
Limitations of Algorithmic Blocking

- Routes across a sequence of blocks
  - No consideration of trains and train connections
  - No consideration of time

- No ability to consider capacity constraints
  - Blocks do not have capacity constraints – trains do
  - Capacity is a function of time, so failure to consider time prevents capacity planning

- Some traffic should be routed to minimize costs, others to minimize transit time
A Look at a Terminal
Cars At Yard A

Algorithmic Blocking

Arrival Yard
Class Bowl
Departure Yard
A Look at a Terminal
Cars At Yard A

Time-Space Solution

Arrival Yard
Class Bowl
Departure Yard

This AM
This PM

Dpt 1200 Today
Dpt 1800 Today
Dpt 1200 Next Day
Another Look at the Network

AB Alone

Time-Space

Next PM

This AM

This PM

Next AM

Next PM
Convergence of Terminal and System Views

Arrival Yard  Class Bowl  Departure Yard
Convergence of Terminal and System Views
Some form of algorithmic blocking in place or being implemented at four North American railroads.

BNSF has a form of time-space algorithm without algorithmic blocking.

Much work within and between railroads will be needed if railroads are to become more scheduled and their service more predictable.