Freight Advanced Traveler Information System (FRATIS)

OPTIMIZATION OVERVIEW

Dr. Sam Fayez
FRATIS Solution

- Freight Advanced Traveler Information System (FRATIS) Applications:

  - Freight-Specific Dynamic Travel Planning and Performance
    - Enhances traveler information systems to address specific freight needs
    - Integrates data on wait times at intermodal facilities (e.g. ports), traffic conditions, incident alerts, road closures, work zones, routing restrictions (hazmat, oversize/overweight)
    - Adaptive Communication between Drayage Company, Drivers, and Intermodal Facilities
    - Real-time Information and Dynamic Routing for Drivers

  - Drayage and Truck Routing Optimization
    - Optimize truck/load movements between freight facilities, balancing early and late arrivals.
    - Individual trucks are assigned best time windows for pick-up or drop-off.
    - Utilizes travel information and information on port terminal conditions to optimize operations.
FRATIS Modules

Planning  Execution  Monitoring
FRATIS Architecture

- Mapping Services
- Traffic Services
- Construction Data
- etc.

Planning Module
- Optimization Algorithm Customized for each site

Operational Constraints
- Truck routes
- Distance between stops
- Appointment time window at each stop
- Travel time between stops
- Traffic delays by time of day & day of the week
- Weather condition and expected delays
- Construction schedules on routes
- Stop time for each job
- Waiting time at each stop by time of day & day of the week
- Drivers Hours of Service/Duty
- Equipment related constraints
- Special requirements (e.g. Hazmat)

Execution & Monitoring Module

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Planning

- Receive and Enter jobs into FRATIS
  - Pickup Freight
  - Drop-off Freight
  - Live Load/Unload Freight

- Run the optimization algorithm
  - FRATIS inherits a sophisticated optimization algorithm that evaluates all the possible combinations of moving freight between locations
  - The optimization engine is on the cloud and will recommend the best combination in seconds
  - The optimization will recommend the most efficient, productive, and cost effective execution sequence and timing for each driver/truck at the same time satisfying all the operational and transportation constraints
Planning

Capture Drayage Operation Constraints

- Truck routes
- Distance between stops
- Appointment time window at each stop
- Travel time between stops
- Traffic delays by time of day & day of the week
- Weather condition and expected delays
- Construction schedules on routes
- Stop time for each job
- Waiting time at each stop by time of day & day of the week
- Drivers Hours of Service/Duty
- Equipment related constraints
- Special requirements (e.g. Hazmat)
Optimization Algorithm Development Cycle

Version 1
- Develop initial version of Optimization Algorithm
  - Objective: Minimize total traveling time
  - Constraints: Customers’ location
- Test over TSP Benchmark Problems
  - Compare output to the Best Known Solution

Version 2
- Modify Optimization Algorithm
- Develop next version of Optimization Algorithm
  - Objective: Minimize total traveling time, Minimize number of trucks
  - Constraints: Customers’ location, Customers’ time window, Service time, Capacity (Truck)
- Test over VRPTW Benchmark Problems
  - Compare output to the Best Known Solution

Version 3
- Modify Optimization Algorithm
- Develop final version of Optimization Algorithm
  - Objective: Minimize total traveling time, Minimize number of trucks, Minimize logistical traveling time, Maximize loaded moves, Maximize truck productivity
  - Constraints: Consider customers’ location, Customers’ time windows, Delivery/RRY time windows, Shop Time (Service + Waiting), Driving and Duty Hour Limits, Load Match, Container Unload, Steam Ship Line
- Test over Drainage Benchmark Problems
  - Compare output to the Best Known Solution

Version 4
- Enhance Optimization Algorithm
- Develop final version of Optimization Algorithm
  - Objective: Minimize total traveling time, Minimize number of trucks, Minimize logistical traveling time, Maximize loaded moves, Maximize truck productivity
  - Constraints: Consider customers’ location, Customers’ time windows, Delivery/RRY time windows, Shop Time (Service + Waiting), Driving and Duty Hour Limits, Load Match, Container Unload, Steam Ship Line
- Test and Evaluate on Memphis Test Site
  - Evaluate Algorithm and Compare output to Manual Plan

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Optimization Algorithm Development Cycle

**Version 4**
- Develop final version of Optimization Algorithm
- Test and Evaluate on Memphis Test Site
- Evaluate Algorithm and Compare Output to Manual Plan
- Enhance Optimization Algorithm

**Objective**
- Minimize total traveling time
- Minimize number of trucks
- Minimize bobtail traveling time
- Maximize loaded moves
- Maximize truck productivity

**Constraints**
- Consider customers’ location
- Customers’ time windows
- Depots/RYY time windows
- Stop Time (Service + Waiting)
- Driving and Duty Hour Limits
- Load Match
- Container Reload
- Steam Ship Line

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## Optimization Algorithm Development Cycle

<table>
<thead>
<tr>
<th>Version 5: FRATIS LA</th>
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<tbody>
<tr>
<td>Added Constraints</td>
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<tr>
<td>Waiting Times at Marine Terminal</td>
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<tr>
<td>Real Time Traffic provided by Navteq</td>
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<table>
<thead>
<tr>
<th>Version 6: FRATIS South Florida</th>
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<tbody>
<tr>
<td>Added Constraints</td>
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<tr>
<td>Customized based on integration with TMW Order</td>
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<td>Management System</td>
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<table>
<thead>
<tr>
<th>Version 7: FRATIS Central Florida</th>
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<tbody>
<tr>
<td>Added Constraints</td>
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<tr>
<td>Network Traffic Patterns</td>
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<tr>
<td>Real Traveling Time provided by INRIX and TMC</td>
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<tr>
<td>Receiving Docks Schedules</td>
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<table>
<thead>
<tr>
<th>Version 8: FRATIS TEXAS</th>
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<tbody>
<tr>
<td>Added Constraints</td>
</tr>
<tr>
<td>Integration with I-35 Traveler Information System</td>
</tr>
<tr>
<td>developed by TTI</td>
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</table>
Planning

Generate optimal plan

The optimization algorithm recommends the best feasible plan that maximizes operational efficiency of freight pickups and deliveries of all the trucks in a given fleet, specifically the plan that will:

- Maximizes value added moves
- Minimizes non-value added moves
- Maximizes load matching & backhauls
- Minimizes travel time and traffic delays
- Minimizes waiting time
- Minimizes required fleet size
- Maximizes the drivers productivity
- Maximizes customer service level
Generated Optimal Plan

Optimized Solution (User-Modifiable)

Plan Performance Measures

<table>
<thead>
<tr>
<th>Modified Plan</th>
<th>$5,115.27</th>
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<tbody>
<tr>
<td>Orders:</td>
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<td>Total Time:</td>
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<tr>
<td>Total Miles:</td>
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<tr>
<td>Total Bobtail Miles:</td>
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<tr>
<td>Total Time:</td>
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<tr>
<td>Driving Time:</td>
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<tr>
<td>Stop Time:</td>
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<tr>
<td>Waiting Time:</td>
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<table>
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<th>$5,115.27</th>
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</tr>
<tr>
<td>Waiting Time:</td>
<td>00:53</td>
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</tbody>
</table>

Drivers Itinerary

- Francisco Anas: 31.00 mi, Jobs 1123816, 11232184, 1125971, 1126847, 11238476
- Aram Boyadjian: 177.00 mi, Jobs 1125182, 11268241
- Dillon Bruno: 97.00 mi, Jobs 1125647, 1126981, 1126961E, 1125628, 1126909
- Cesar Cabezales: 156.00 mi, Jobs 1126549, 1126546, 1126720, 1125720E
- Suren Khachatrian: 106.00 mi, Jobs 1125545, 1125583, 1125944
- Ruben Lamas: 153.00 mi, Jobs 1125544, 1125415E, 1125604E, 1125054, 1125056E
- Jesus Gutierrez: 85.00 mi, Jobs 1125030
- Bert Hernandez: 173.00 mi, Jobs 1125133, 1125144
- Sergio Mendez: 201.00 mi, Jobs 1124728, 1125358, 1125542
- New Driver: 0.00 mi

Drivers with Assignments: 9

Accept Plan and Send to WebFleet
Manually Modified Plan

Optimized Solution (User-Modifiable)

Plan Performance Measures

**Modified Plan**  
- Orders: 30
- Total Time: 125.22
- Total Miles: 1260.00
- Total Bobtail Miles: 588.00
- Total Time: 125.22
- Driving Time: 29:07
- Stop Time: 64:00
- Waiting Time: 01:25

Cost: $5,641.83

**Optimum Plan**
- Orders: 30
- Total Time: 113.40
- Total Miles: 1240.00
- Total Bobtail Miles: 588.00
- Total Time: 113.40
- Driving Time: 28:12
- Stop Time: 64:00
- Waiting Time: 00:53

Cost: $5,115.27

Drivers Itinerary

<table>
<thead>
<tr>
<th>Driver</th>
<th>Distance</th>
<th>Joles</th>
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<tbody>
<tr>
<td>Francisco Arias</td>
<td>26.00 mi</td>
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<tr>
<td>Aram Boyadjian</td>
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</tr>
<tr>
<td>Dillon Bruno</td>
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<td>Cesar Cabanyales</td>
<td>168.00 mi</td>
<td>11229847</td>
</tr>
<tr>
<td>Suren Khochatryan</td>
<td>184.00 mi</td>
<td>1125828.4</td>
</tr>
<tr>
<td>Ruben Lemos</td>
<td>151.00 mi</td>
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<tr>
<td>New Driver</td>
<td>0.00 mi</td>
<td></td>
</tr>
</tbody>
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Accept Plan and Send to WebFleet
Planning

- **Review the optimal plan and approve**
  - The optimal plan will be displayed to the dispatcher including:
    - Plan details for each driver, truck, and shipment
    - Plan summary statistics including miles, time, cost, status miles, utilization, fleet size, etc.
  - The dispatcher will review the generated plan to ensure that the plan can be executed based on the operational constraints of drivers, fleet, and specifics of the pickups and deliveries. Also the dispatcher past experience.
  - The dispatcher will be able to make any changes to the plan. The system will update the plan summary statistics and provide a comparison between the dispatcher modified plan and the system generated optimal plan.
Planning

- Communicate the plan details
  - Confirm jobs with drivers
  - Send jobs to drivers
  - Send notification to intermodal facilities/customers with plan specifics including the estimated time of arrival (ETA) to each stop location.
Execution

- **Drivers receive and execute Jobs**
  - Drivers receive the jobs including stop locations, sequence and timing on their smartphones or navigation device.
  - The smartphone or navigation device will identify the best route between current driver location and the next stop location, the best route is determined based on:
    - Specific truck routes
    - Historical traffic information
    - Current traffic conditions
    - Construction schedules
    - Other constraints e.g. Hazmat Shipment, Over size, weather conditions, etc.
  - Estimated time of arrival will be updated and communicated in real time.
  - The smartphone or navigation device will identify alternate routes between stops in case of delays/incidents in the current route (dynamic routing).
Drayage Fleet Operators (DO’s)

- Truck ETA message is sent from DO to MTO one day before a container is to be picked up off at MT, ETA is based on traffic historical data.

- Container information message is sent from DO to MTO once order information entered in the order management system.

- Container availability message is sent from MTO to DO once the container is cleared from customs and become ready for pickup.

Marine Terminal Operators (MTO’s)

- Truck ETA message is sent from DO to MTO once the truck start heading to the MT, ETA is based on real time traffic data.

- MTO uses truck ETA information to support estimation of labor and equipment orders; and stacking preparation.
Dispatcher receives same day jobs

- Dispatchers will review the new job and enter into the system and update constraints
- The dispatcher will have several options to add the job to the current plan:
  - Locate the closest truck(s) using GPS
  - Enter the job into the system and run the optimization with the new job and the current unexecuted jobs
  - Review the workload of the driver or the output of the optimization
  - Dispatch and send jobs to drivers
Monitor the daily operations

- Dispatchers monitor the execution of all the jobs in real time and ensure proper execution, including:
  - Tracking trucks
  - Traffic conditions, construction, and congestion
  - Arrival times to each location
  - Stop times at each location
  - Waiting times at each location
  - Drivers hours of service
  - Weather condition

- Dispatcher through FRATIS have access to live information and they can provide information to drivers in real-time
Monitoring

Drivers’ availability (available drivers, maximum duty hours, maximum driving hours)

Estimated traffic conditions (travel times under traffic conditions)
Monitoring

- Improve plan robustness and execution
  - FRATIS has built in comparison modules to compare:
    - Plans vs. Execution
    - Optimal Plans vs. dispatcher modified plans
  - The comparison modules will measure the deviations and will update the planning modules in order to generate more robust optimal plans.
Discussion