Freight Fluidity Measurement Program: Implementation Options

White Paper

Prepared for
Transportation Research Board

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Summary

Information on how transportation supply chains perform from the perspectives of shippers, carriers and receivers is critical to knowing if supply chains are working or failing, and that information is, in turn, critical to determining if and where public investment or changes in policy and regulation might improve freight system performance and support economic competitiveness and growth.

This white paper outlines options for implementing a freight fluidity measurement program—a program that measures the general performance of representative transportation supply chains and their networks over time. It builds on the findings and conclusions of three companion papers that examined potential users and benefits, geographic scales, and data needs and availability for a freight fluidity measurement program. The key conclusions were:

- There are three potential markets for freight fluidity information:
  - Agencies and firms focused on international import/export trade;
  - Agencies and firms focused on domestic and North American (NAFTA) transportation supply chain performance; and
  - Agencies and firms focused on local and regional transportation supply chain performance.

- Three sets of data are available about supply chain performance:
  - Data on travel time, travel-time reliability and cost for freight movement by domestic truck, rail and barge are available, accessible and affordable.
  - Data on travel time, travel-time reliability and cost for freight movement through ports are available, but not readily accessible.
  - Data on supply-chain safety and risk are available, but generally not accessible.

- Consideration of the potential markets and the availability of data suggests that the order of priority for developing a freight fluidity measurement program should be as follows:
  - National/North American supply chain performance, focusing on travel time, travel time reliability and cost for truck, rail and barge moves;
  - Megaregion/metropolitan supply chain performance; and
  - Global supply chain performance.

- Finally, a freight fluidity measurement program must:
  - Be capable of measuring supply chains of different lengths, using different combinations of freight transportation modes and serving different industries;
  - Be applicable at different geographic scales;
  - Use measures and metrics that are common across transportation supply chains; and
  - Report trends in the high-level performance of the supply chains.
This paper outlines three options for implementing a freight fluidity measurement program:

- **Federal program lead**, focusing on measuring supply chain performance and network fluidity at the **national and megaregion** scales with subsequent expansion to support a North American system;

- **State and local lead**, focusing initially on supply chain performance and network fluidity at the **metropolitan-, state- and freight-corridor levels** with subsequent expansion to the megaregion and national scales; and

- **Private sector lead**, focusing on supply chain performance at the **national and megaregion levels** and serving public sector clients at these or other scales as demand warrants.
1.0 Introduction

This white paper outlines options for implementing a freight fluidity measurement program—a program that measures the general performance of representative transportation supply chains and their networks over time.

A transportation supply chain is an end-to-end path of freight moves. A supply chain may be a trip accomplished by a single truck move or a trip accomplished by a combination of truck, rail, ship, airplane or pipeline freight moves. A supply chain may be a short trip within a single metropolitan area, state, or region or a long trip spanning regions and continents.

Information on supply chain performance is needed to fill a gap in public sector transportation and economic development planning and investment. The public sector is accustomed to looking at freight transportation system performance in terms of network and corridor capacity, infrastructure condition and safety. As a consequence, transportation planners and engineers tend to focus on the average condition and performance of a system or facility, not on the performance of an individual trip or shipment moving through the network. Moreover, because their jurisdiction is often limited to a single state or metropolitan area, it is difficult for public sector planners and engineers to assess the end-to-end performance of supply chains, many of which extend across state and national boundaries. As a result, the public sector is often not as effective as it could be in making strategic investments in the freight transportation system that directly improve supply chain performance. The result is a less cost-effective freight transportation system, less competitive industries and lost economic opportunity.

Information on how transportation supply chains perform from the perspectives of shippers, carriers and receivers is critical to knowing if supply chains are working or failing, and that information is, in turn, critical to determining if and where public investment or changes in policy and regulation might improve freight system performance and support economic competitiveness and growth.

Information on transportation supply chain performance is also needed to support national freight system planning and reporting. In MAP-21 (Moving Ahead for Progress in the 21st Century Act), Congress declared that "It is the policy of the United States to improve the condition and performance of the national freight network to ensure that the national freight network provides the foundation for the United States to compete in the global economy...." Congress called for development of a national freight strategic plan, designation of a national freight network, preparation of a national freight network condition and performance report,
and establishment of performance measures for states to use to assess freight movement on the Interstate system. Congress specified that all four actions were to be informed by performance measures.

A freight fluidity measurement program (or transportation supply chain performance monitoring system) would provide the middle of the three levels of information necessary for an effective Freight Performance Monitoring System. The three levels, illustrated in Figure 1.1, are: information about the economy and the demand for freight transportation; information about supply chains—the paths along which freight shipments move—and end-to-end trip performance; and information about the condition and performance of the highway, rail and other networks and facilities that carry freight trips.

**Figure 1.1 Freight Performance Monitoring System (FPMS)**

- **Economy/Markets**
  - **Freight Analysis Framework (FAF)**
    *Economic output and growth by industry and region; commodity flows between regions by mode*

- **Logistics/Operations**
  - **Supply Chain Performance Monitoring System (SCPMS)**
    *
    Travel time, travel-time reliability, and cost of representative supply chain freight trips*

- **Networks/Flows and Infrastructure**
  - **Highway Performance Monitoring System (HPMS)**
    *Condition and performance of the freight highway network*
  - **National Performance Measurement Research Data Set (NPMRDS)**
    *
    Vehicle speeds and travel times over the freight highway network*
  - **Rail Carload Waybill Sample (CWS)**
    *
    Volume of freight flows over the freight rail network*
The U.S. Department of Transportation (U.S. DOT) and the Federal Highway Administration (FHWA) have successfully developed information for the top level—information about the economy and freight demand. The Freight Analysis Framework (FAF) describes and forecasts economic output by region and industry and the resultant commodity flows over the highway and rail networks. They have also successfully developed information on the condition and performance of the highway network for the bottom level. The Highway Performance Monitoring System (HPMS) provides detailed information on truck volumes and pavement conditions by roadway segment. The new National Performance Measurement Research Data Set (NPMRDS) complements the HPMS by providing information about truck travel speeds and travel times over the National Highway System (NHS) roadway segments. The Rail Carload Waybill Sample (CWS) provides information on the types and tonnage of commodities hauled over the major rail lines.

What is missing is a sustained program at the middle level to describe and measure the performance of transportation supply chains—to understand how well the highway, rail and other networks support the timely and cost-effective completion of freight trips and whether those trips satisfy the needs of business and industry to compete and grow in national and global markets.

This white paper outlines options for implementing a freight fluidity measurement system— a Supply Chain Performance Monitoring System (SCPMS)—that will provide information on the travel time, travel-time reliability and cost of freight trips over representative supply chains.

2.0 Guidance from White Papers 1, 2 And 3

This White Paper is one of four papers commissioned to explore the feasibility of setting up a program to measure the fluidity of transportation supply chains and their freight networks.

- White Paper #1 explored “who” and “why”—the potential users and benefits of a freight fluidity performance measurement system. It discussed the ways in which information about transportation supply chain performance might be applied and how that information might impact transportation planning, policy, regulation and investment.

- White Paper #2 discussed “what” is to be measured—the scale and geography of a freight fluidity measurement program. What industries supply chains should be followed? How many? At the local, regional, megaregion, national or North American levels? How should freight trip performance be monitored along corridors, at gateways or across national borders?

- White Paper #3 described “how”—the data needed and available to support fluidity measurement. Are valid, reliable and affordable data available from public and private sources and how might the data be obtained and analyzed cost-effectively?

White Paper #4 builds on the findings and conclusions of Papers #1, #2 and #3. The key conclusions of those papers were as follow:
There are three potential markets for freight fluidity information:

- Agencies and firms focused on **international import/export trade**; examples would include the Department of Commerce, the Department of Agriculture (USDA), and private-sector shippers/receivers;

- Agencies and firms focused on **domestic and North American (NAFTA) transportation supply chain performance**; examples would include FHWA, state DOTs, regional freight coalitions and private-sector shippers/receivers; and

- Agencies and firms focused on **local and regional transportation supply chain performance**; examples would include regional coalitions, state DOTs, metropolitan planning organizations (MPOs) and private-sector shippers/receivers.

Table 2.1 illustrates how the markets are differentiated by arraying potential users against the geography/scale of the supply chains of central interest to each.

### Table 2.1 Potential Users and Scale of Application of Supply Chain Performance Measures

<table>
<thead>
<tr>
<th></th>
<th>Global</th>
<th>NAFTA</th>
<th>US</th>
<th>Mega-Region</th>
<th>State</th>
<th>Metro</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>USDOC</strong></td>
<td>B</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td><strong>USDA</strong></td>
<td>B</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td><strong>Private Firm</strong></td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td><strong>FHWA</strong></td>
<td>C</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td><strong>Coalition</strong></td>
<td>C</td>
<td>B*</td>
<td>B</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td><strong>State DOT</strong></td>
<td>C</td>
<td>C*</td>
<td>B</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td><strong>MPO</strong></td>
<td>C</td>
<td>C*</td>
<td>C</td>
<td>B</td>
<td>A</td>
<td>A</td>
</tr>
</tbody>
</table>

A = primary interest, B = secondary interest, C = tertiary interest
* May be A if on major border crossing/trade lane

Examples of potential users are shown in the rows. The geographic scale of transportation supply chains is shown in the columns. The letter entries in the cells indicate the expected level of interest in supply chain performance measurement by user and scale, where A = primary interest, B = secondary interest, and C = tertiary interest. For public agencies, the
level of interest reflects their mandate and jurisdiction. The market clusters are indicated by
the red ovals, but should be read as broad generalizations. In practice, there will be
considerable overlap and variation in the level of interest across users.

**Three sets of data are available about supply chain performance:**

- Data on travel time, travel-time reliability and cost for freight movement by domestic truck,
  rail and barge are available, accessible and affordable. Truck data are available from public
  and private sources. Rail data are available primarily from private sources. "Some
  assembly is required" in all cases.

- Data on travel time, travel-time reliability and cost for freight movement through ports are
  available, but not readily accessible. The accessibility of data on the movement of
  shipments through a port varies widely by port and terminal, reflecting differences in
  ownership and competitive position. Data on travel time, travel-time reliability and cost for
  freight movement by ocean-going vessels are available, but also not readily accessible.

- Data on supply-chain safety and risk are available, but generally not accessible. Truck,
  rail, barge, port and ship safety data available from state and federal sources, but must be
  allocated to specific routes and then apportioned to representative supply chains, which is
  time-consuming, expensive and statistically challenging. Many shippers develop estimates
  of supply-chain risk, but those estimates are at least partially subjective and generally
  treated as confidential business information.

Table 2.2 summarizes the availability of performance measurement data and the approximate
cost of acquiring the data by the type of measure (travel time, travel-time reliability, cost,
safety and risk) and mode of freight transportation. The freight modes are shown in the rows;
the trip performance measures in the columns. The letter entries (A, B…) in the upper left of
each cell indicate the availability of data today. The dollar signs ($$) in lower right of cell
indicate the anticipated cost to obtain and analyze the data. The ovals define the three sets of
data as differentiated by availability and cost.
Table 2.2  Availability and Cost of Supply Chain Performance Measures

<table>
<thead>
<tr>
<th></th>
<th>Travel/ Dwell Time</th>
<th>Travel-Time Reliability</th>
<th>Cost</th>
<th>Safety</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>$</td>
<td>$</td>
<td>$$</td>
<td>$$$</td>
<td>$$$</td>
</tr>
<tr>
<td>Rail</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>$$</td>
<td>$$</td>
<td>$$</td>
<td>?</td>
<td>$$$</td>
</tr>
<tr>
<td>Barge</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>$$</td>
<td>$$</td>
<td>?</td>
<td>?</td>
<td>$$$</td>
</tr>
<tr>
<td>Port</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>C</td>
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<tr>
<td></td>
<td>$$</td>
<td>$$</td>
<td>$$</td>
<td>?</td>
<td>$$$</td>
</tr>
<tr>
<td>Ship</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>C?</td>
<td>C?</td>
</tr>
<tr>
<td></td>
<td>$</td>
<td>$</td>
<td>$$</td>
<td>$</td>
<td>$$$</td>
</tr>
</tbody>
</table>

\(A = \text{readily available}, \ B = \text{somewhat available}, \ C = \text{less available}\)

Consideration of the potential markets and the availability of data suggest that the order of priority for developing a freight fluidity measurement program should be as follows:

1) National/North American supply chain performance, focusing on travel time, travel time reliability and cost for truck, rail and barge moves;

2) Megaregion/metropolitan supply chain performance; and

3) Global supply chain performance.

Finally, the papers conclude that a freight fluidity measurement program must be:

- **Capable of measuring supply chains of different lengths**, using different combinations of freight transportation modes and serving different industries;

- **Applicable at different geographic scales**—multistate/megaregion, corridor, state and metropolitan—and be logically consistent with Canadian and Mexican freight fluidity measurement programs;
• **Use measures and metrics that are common across transportation supply chains** and can be readily scaled to different geographies, modes and networks; and

• At a minimum, be able to **report trends in the high-level performance of the supply chains** along the public and quasi-public freight transportation system links and nodes, that is, along highways and rail lines and through ports, which are the focus of most public sector policy, planning, regulatory and investment programs.

A freight fluidity measurement program should not duplicate the day-by-day and hour-by-hour performance tracking done by the shippers, carriers and receivers. That level of detail—usually treated as confidential business information—is not required to support most public sector decisions. The program also need not capture detail on the time that freight shipments spend within private-sector warehouses and distribution centers. The time that shipments spend within warehouses and distribution centers affects the overall time required to move freight along a supply chain, but the dwell time within these facilities is determined and controlled by private-sector business decisions and market conditions. The public sector will usually not have access to this information.

### 3.0 IMPLEMENTATION OPTIONS

Considering potential users and benefits, geographic scales, and data needs and availability, three options for implementing a freight fluidity measurement program are offered for initial discussion:

• **Federal program lead**, focusing on measuring supply chain performance and network fluidity at the **national and megaregion** scales with subsequent expansion to support a North American system.

The program would cover two dozen representative industries and supply chains, track their performance at the national and mega-region scales, and report on their performance quarterly or annually. Subsequent phases could add major North American trade routes and corridors and expand regional and state coverage through on-going planning grants to regional coalitions, states and MPOs.

The program would be designed primarily to inform federal policy and investment priorities in freight transportation and meet MAP-21 mandates. Responsibility for the program would be lodged with the FHWA Freight Office, which would assign two to three staff to the effort. The staff would be responsible for management of the program; procurement of data collection, interview and processing services; and web-based dissemination of information to stakeholders. Once established, the FHWA could consider migrating the program to the Bureau of Transportation Statistics to ensure long-term consistency in data collection and reporting. For initial planning purposes, the program is assumed to be of similar scale and cost to the Freight Analysis Framework program.
• **State and local lead**, focusing initially on supply chain performance and network fluidity at the metropolitan-, state- and freight-corridor levels with subsequent expansion to the megaregion and national scales.

The program would track performance at the metropolitan-, state- and freight-corridor levels, initially covering a dozen representative industries and supply chains in each of six megaregions (out of the approximately 12 U.S. megaregions). The objective would be to rapidly deploy a program that would build an atlas of information on upwards of 70-80 supply chains. Subsequent phases could expand coverage to other megaregions and focus on linking megaregions to provide national coverage.

The primary focus of the program would be to inform state and local freight policy and investment priorities and support local economic development. Lead responsibility for development of the program could be assigned to multistate coalitions or state DOT planning/freight offices in the larger state DOTs that have sufficient staff capacity. These groups would serve as program centers, with one to two staff in each center responsible for management of the program; procurement of data collection, interview and processing services; and web-based dissemination of information to stakeholders.

To ensure consistency across the program centers, a FHWA Freight Office liaison would be charged with coordinating the efforts of the centers. The development of data procurement, analysis and reporting methods and protocols could be accelerated through a TRB program, modeled after the SHRP programs, and by leveraging University Transportation Center (UTC) research grants. Again, for initial planning purposes, the program is assumed to be of similar scale to the Freight Analysis Framework program, with the U.S. DOT funding the major share of the cost of the coalition- and state-operated centers.

• **Private sector lead**, focusing on supply chain performance at the national and megaregion levels and serving public sector clients at these or other scales as demand warrants.

The third option is to outsource the program to one or more private-sector firms (or consortia of firms). The private sector firms would track and report the performance of specific transportation supply chains as requested by their clients. The supply chains could range from local to global in scale and reporting could range from weekly to annually, depending on the jurisdiction and interest of the client.

Initially, U.S. DOT would be the primary client. Over time, it is expected that half of the clients would be federal agencies, including U.S. DOT, the Department of Commerce and the Department of Agriculture; a quarter would be a mix of regional coalitions, state DOTs and economic development agencies, and MPOs; and the remaining quarter would be private clients using the data for market research, benchmarking and investment planning. Each firm would likely dedicate five to eight staff to the effort. Coverage and continuity would be determined by client demand and the profitability of the service over time.
Table 3.1 summarizes these options. The program leads are shown in the column headings and the program elements are shown in the row headings. The elements used to define each option are:

- **Market/Mandate.** What is covered (types of industries and supply chains)? When (time period/s)? Where (geographic scale)? Why (benefits of using transportation supply chain performance information)?

- **Organization.** Who implements the program (allocation of roles and responsibilities)? How is the work done (data acquisition, analysis methods and dissemination procedures)?

- **Resources.** How much money is needed to develop and sustain the program (capital and operating budgets)? What staffing is required (number of people and skills)? What technology is required (specialized equipment, etc.)?
# Table 3.1 Implementation Options

<table>
<thead>
<tr>
<th>Market/ Mandate</th>
<th><strong>What, When, Where</strong></th>
<th><strong>Why</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEDERAL LEAD</strong></td>
<td>Initial Phase</td>
<td>Subsequent Phases</td>
</tr>
<tr>
<td>Initial Phase</td>
<td>Track performance at the national and megaregion scales.</td>
<td>Add regional and state coverage through grants or on-going planning funds to regional coalitions, states and MPOs. Add major North American trade routes and corridors.</td>
</tr>
<tr>
<td>Subsequent Phases</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>STATE AND LOCAL LEAD</strong></td>
<td>Initial Phase</td>
<td>Subsequent Phases</td>
</tr>
<tr>
<td>Initial Phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsequent Phases</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PRIVATE SECTOR LEAD</strong></td>
<td>Initial Phase</td>
<td>Subsequent Phases</td>
</tr>
<tr>
<td>Initial Phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsequent Phases</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Why</strong></td>
<td>Inform federal policy and investment priorities in freight transportation. Meet MAP-21 mandates.</td>
<td>Inform state and local policy and investment priorities in freight transportation. Support local economic development.</td>
</tr>
<tr>
<td>Organization By Whom</td>
<td>FEDERAL LEAD</td>
<td>STATE AND LOCAL LEAD</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------</td>
<td>---------------------</td>
</tr>
<tr>
<td></td>
<td>Initial Phase</td>
<td>Subsequent Phases</td>
</tr>
<tr>
<td>Organization By Whom</td>
<td>FHWA Freight Office</td>
<td>Migrate to BTS? Establish research program within TRB (SHRP X?) to develop methods, etc.?</td>
</tr>
<tr>
<td>How (process)</td>
<td>FHWA direction; contracted data collection, interview and processing services.</td>
<td>Contracted data collection, interview and processing services. FHWA liaison to coordinate programs.</td>
</tr>
<tr>
<td>Resources How Much (funding)</td>
<td>$___M/year (comparable to FAF program?)</td>
<td>$___M/year</td>
</tr>
<tr>
<td>Staff and Skills</td>
<td>2-3 responsible for management, procurement and dissemination.</td>
<td>1-2 per coalition or state responsible for management, procurement and dissemination.</td>
</tr>
<tr>
<td>Technology</td>
<td>Data storage and web-based dissemination to stakeholders</td>
<td>Data storage and web-based dissemination to stakeholders</td>
</tr>
</tbody>
</table>