

# End-to-End Supply Chain Visualization

A Sourcemap™ White Paper

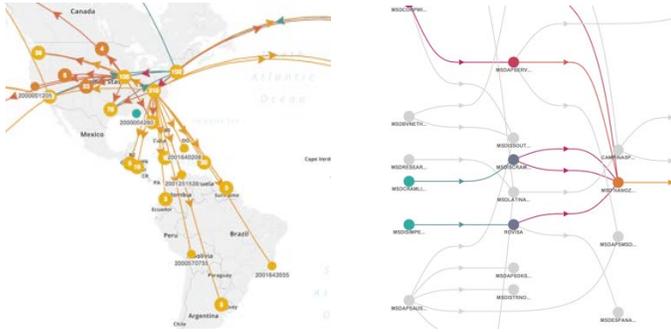


Figure 1. Two types of end-to-end supply chain visualization: geographic (left) and network (right)

## Introduction

Supply chain visibility is a key business challenge: in a recent [survey](#) of business continuity professionals, nearly 75% reported a lack of visibility into their supply chains. The problem is even more pronounced for extended supply chains: most companies have little to no information on second- and third-tier suppliers. End-to-end supply chain visualization models the flow of products from raw materials to finished goods, enabling new kinds of analytics for operations, risk and sustainability. Originally developed by MIT engineers in 2009, this technology was spun off by MIT startup Sourcemap Inc. in 2011.

*75% of business continuity professionals report a lack of visibility into their supply chains.*

End-to-end supply chain visualizations can be used to create effective reports, but their greatest value is analytic: they enable users to quickly surface insights on risks and opportunities across the global operations of an organization. End-to-end supply chain

visualizations support collaboration and decision-making by groups of experts and non-experts alike. They also help to make sense of extremely complex datasets containing thousands of data points, which is often the case in multi-tiered supply chains. And because of recent developments in data mining, end-to-end supply chain visualizations can now be generated automatically from enterprise databases (ERP, DRP, TMS, etc...) as well as third-party sources such as supplier surveys and shipment tracking updates.

This paper describes implementations of automated, end-to-end supply chain visualization across industries, including food, pharmaceuticals, forestry, apparel, electronics and consumer packaged goods. The benefits of end-to-end visualization include supply streamlining operations, reducing risk, improving data quality and facilitating reporting.

## How it Works

Traditional data visualizations – pie charts, bar graphs and the like – are designed to highlight simple quantitative relationships. Today's advanced visualizations make it possible to uncover the patterns and relationships behind big, multi-dimensional datasets. A typical end-to-end supply chain includes hundreds of shipping links connecting thousands of vendors, manufacturers, distributors and customers. Modeling such complex networks relies on techniques that were originally developed to visualize the millions of users in a social network. Unlike traditional business charts and graphs, these network diagrams need to be interactive so that it is easy to instantly search and sort the supply chain by individual products, shipments, and key performance indicators.

The best way to generate supply chain visualizations is by mining the data in enterprise databases, including vendors, purchase orders, shipments, and inventory. Additional visibility can be gained from third-party

sources: supplier surveys, audit reports, and bills of lading, for example.

Once extracted, supply chain data is automatically stitched together into an an interactive visualization of the end-to-end network in a matter of seconds (See Fig. 1). The supply chain visualization dashboard can be shared across the enterprise for anyone to search, filter, analyze, export and re-model.

## Benefits

Based on how much data you collect; the benefits of end-to-end supply chain visualization include:

- Data Validation
- Chain-of-Custody Reporting
- Supplier Benchmarking
- Supply chain planning and optimization
- Risk heat maps and alerts
- Emergency response
- Control tower-like visibility

## Data Validation

**OBJECTIVE:** A supply chain map showing accurate, up-to-date location information for use in planning logistics or responding to disruptions

**DATA REQUIREMENTS:** Purchase orders, audit databases, shipping lane databases and/or buyers' own spreadsheets

When severe weather threatens to disrupt your supply chain, how do you ensure that no critical sites or shipments are at risk? In two deployments of geo-visualization for CPG manufacturers, Sourcemap found that more than 50% of the addresses on file in purchasing databases are billing addresses – not the manufacturing locations critical to planning and risk management. In a separate implementation of end-to-end supply chain mapping for a top-10 global pharmaceutical manufacturer, the most readily available information on product distribution networks was only updated once a year.

Data validation is a critical step for supply chain management, allowing you to achieve everything from

inventory optimization to audit compliance – and it's especially crucial for responding to critical events in a timely manner.

*More than 50% of addresses on file in purchasing systems are billing addresses, not actual manufacturing locations.*

There is continuous turnover of products, vendors and customers in any supply chain. One of the immediate benefits of visualizing supply chain data is to quickly find and fix problems within master data – whether it's because the data is missing, out-of-date, or inconsistent.



Figure 2. Supplier's billing address (left) and actual manufacturing location (right)

End-to-end visualizations quickly and effectively revealed the gaps in data in the CPG and pharma implementations. Identifying irrelevant addresses was achieved by batch-visualizing the purchase orders on a map (geo-visualization) and sharing the resulting supply chain map with buyers familiar with the supply chain (See Fig. 2). In many cases, they could identify the wrong addresses at a glance (for example, a Japanese supplier was located at its US sales office). In other cases, they zoomed into a site on a satellite map to see whether it pointed to an office or an industrial building.

Actual manufacturing addresses were found in buyers' own spreadsheets or sourced from audit databases.

Mapping up-to-date distribution networks was accomplished by mining ERP data to uncover the active lanes connecting products through various stages of manufacturing, packaging and distribution. The visualizations are displayed as a network (see Fig. 3) enabling key stakeholders from each tier in the distribution chain to quickly access and report on the data.

## Chain-of-Custody Reporting

**OBJECTIVE:** Chain-of-custody reports reflecting timely data at any scale (corporate/product family/SKU/bath/serial number)

**DATA REQUIREMENTS:** Shipment history files, vendor master, product family, bill of materials

Controlled products are subject to strict supply chain reporting requirements, including documenting the product's chain of custody for every jurisdiction where it's sold. During implementations with a top-5 global pharmaceutical and a top-10 US biotech manufacturer, end-to-end supply chain visualization provided an automated interface to report on the distribution networks of flagship products.

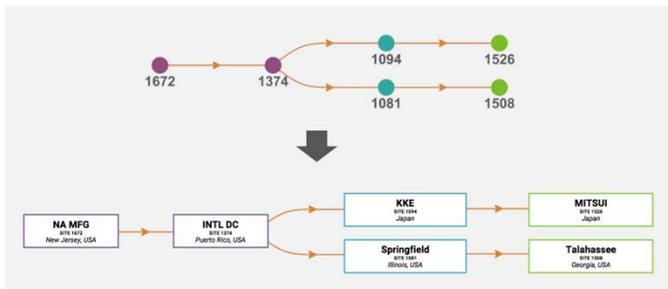


Figure 3. Print-ready chain-of-custody reports generated automatically from end-to-end supply chain visualization

An end-to-end supply chain visualization system was configured to generate these chain-of-custody reports automatically from shipment history data. Users select the product, date range, and customer region and the software renders a print-ready visualization of all

possible paths to reach customers. In addition to streamlining the research required to report on product chain-of-custody, these reports were useful as a shared decision-making tool when planning expansion into new markets (see Planning and Optimization).

## Supplier Benchmarking

**OBJECTIVE:** supplier benchmarking dashboard to compare and report on supplier performance across multiple criteria

**DATA REQUIREMENTS:** vendor master, audit results, survey responses

How do you benchmark a supply chain with thousands of suppliers? A top-20 global apparel retailer uses interactive supply chain visualization to quickly sort and rank suppliers according to performance attributes (on-time delivery, quality) and compliance (environmental impact, social audits), all weighted by purchasing volumes and contract length. The results are used to prioritize suppliers for audits, engagement and preferential contract terms.

A top-5 US food manufacturer uses interactive supply chain visualization to benchmark suppliers and generate reports that suppliers themselves can access to see their performance compared with peers. The data is collected through automated online surveys. The responses are automatically tallied and visualized through a combination of business intelligence dashboards and supply chain mapping, which is especially useful to compare supplier performance according to geography.

In both cases the entire supplier base can be analyzed on one screen. Users narrow the list down by filtering by acceptable ranges for each attribute and exporting a tiered ranking report – all within minutes.

## Supply Chain Planning and Optimization

**OBJECTIVE:** Improve overall supply chain performance (cost/lead time/service level)

**DATA REQUIREMENTS:** Supply network, alternates, costs, lead times, inventory and demand

End-to-end supply chain visualization provides a complete model of the flow of goods to customers so you never make a decision without knowing its impact across the business. It works by comparing multiple versions of the supply chain network to find an overall win-win-win on landed cost, lead time, and service level.

In implementations with electronics, apparel and automotive manufacturers, supply chain managers were able to automatically calculate the lead time and landed costs to make decisions in a matter of hours on problems including:

- Make vs. buy analysis (out-source vs. in-source)
- Inventory optimization
- Supplier selection
- Omni-channel distribution
- Finding synergies in M&A
- Product launches



Figure 4. One example of end-to-end supply chain visualization for optimization: landed lead time in days overlaid on a supply chain map (left) and network model (right)

End-to-end network visualization has a number of advantages for supply chain optimization because of its ability to include multiple tiers in a single analytic dashboard. Savings in one part of a supply chain are automatically tallied up with costs incurred in another: for example, a cheaper raw material might require additional inventory or higher shipping lead times. It's easy to focus on a critical product path (a sequence of steps that raises the overall cost or lead time significantly) while disregarding already efficient portions of the supply chain where improvements will not impact the whole (See Fig. 4).

End-to-end supply chain optimization is based on data on existing nodes and links, combined with costs (shipping, labor, materials) and times (shipping, lead, and process). Users upload one or more scenarios and

the software automatically calculates the landed cost and lead time as part of the visualization.

## Risk Heat Maps and Alerts

**OBJECTIVE:** capture risk probability across the supply chain and/or respond in case of potential disruptions

**DATA REQUIREMENTS:** supply network, revenue, sole-sourcing, sole-shipping, inventory, and supplier criticality

How can you stay one step ahead of the risks facing your supply chain? End-to-end visualization makes it possible to see all of the biggest vulnerabilities at once, and understand how they impact the overall flow of goods.

The first step in visualizing supply chain risk is to create a comprehensive map of key supply, manufacturing, distribution and customer sites, and shipping lanes, including key waypoints such as ports, canals and major highways that could act as transport bottlenecks. This mapping reveals risks inherent in the structure of the network, especially geographic concentrations of suppliers and sole-sourcing.

Sites and shipping lanes should be ranked in terms of criticality, either manually (for example on a scale of 1-5) or using an automated risk exposure calculation (expressing the risk of each node and link in terms of potential impact to revenue).

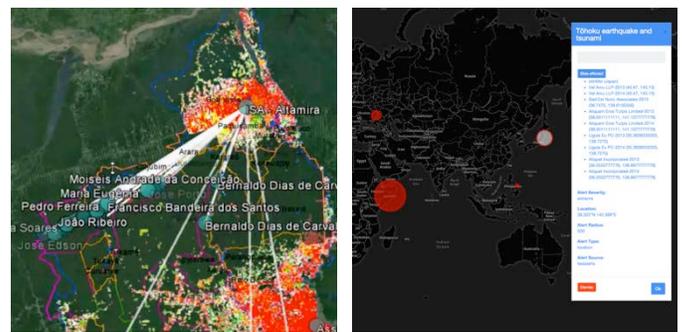


Figure 5. Risk heat maps showing deforestation (left) and real-time disruption alerts (right)

The supply chain risk map guides decision in two ways: through static risk probability heat maps and real-time disruption alerts. Risk heat maps overlaid on a supply

chain provide a snapshot of the probability of major risks. Commonly available heat maps include:

- Business: Economic Growth, Ease of Doing Business, Corruption
- Social: Per capita GDP, Unemployment, Age Distribution, Labor issues, Trafficking
- Environment: Water, Deforestation, Contamination, Climate Change

Sourcemap can overlay the supply chain visualization with these heat maps to automatically generate a risk score for each node and shipping lane. The risks are compounded into a tiered list which can be exported to guide business continuity planning.

An end-to-end supply chain map also serves as an always-on disruption alert service. When an event is detected, the geo-visualization engine checks for nearby supply chain nodes and shipping waypoints and flags any overlap based on the criticality of the site and the severity of the event. Email and SMS alerts are sent to all subscribing stakeholders. The alerts contain information on the affected sites, the products that flow through them, and contact information for site managers. Even minor disruptions can be quickly tied to revenue streams, and managers can be the first to reach out and make sure that the supply chain stays healthy.

## Control Tower

**OBJECTIVE:** locate raw materials, intermediate and finished goods at sites and in transit in near-real-time

**DATA REQUIREMENTS:** 3PM data feeds, inventory, purchase orders

In today's omni-channel supply chains, it should be possible to ship to customers from anywhere products are available – not just from the nearest distribution center. How do you know where all active inventory is situated, across manufacturing sites, distribution warehouses, on the road or in the air?

A control tower provides a near-real-time view of the overall end-to-end supply chain complete with continuous updates on shipment locations, delays and

exceptions, and inventory as it shifts location. In implementations of control towers for a top-5 global food company, a top-10 us biotech company and a top-3 Brazilian forestry certifier, the technology relied on real-time web connections between transactional databases and the end-to-end visualization software. Feeds were configured with key reference data (company name, site name, product name) and updated through on-site apps and data feeds via JSON API. Tracking numbers are used to follow each shipment from site to site.



Figure 6. Visualizing inventory in dollars across the suppliers of a CPG supply chain

Shipment transit data is available from major 3PL and shipping companies such as Fedex and UPS, giving the user just-in-time alerts when shipments are delayed in transit or at customs. Should a new shipment be needed, the user can quickly dial up an inventory view and search by SKU to find real-time product availability (see Fig. 6). The supply chain control tower provides industry-leading control and streamlines omni-channel distribution so that it can be managed cross-functionally across all company users. The supply chain control tower is poised to move from aerospace and military applications to becoming a commonplace feature of all business intelligence platforms.

## Conclusion

The applications of end-to-end supply chain visualization are endless. This paper presented just a few of the advantages available to companies willing to visualize their global operations from data they already have access to. Making this data actionable stands to vastly improve supply chain efficiency and reduce risks, leading to an on-demand, on-time distribution network you can configure on the fly.