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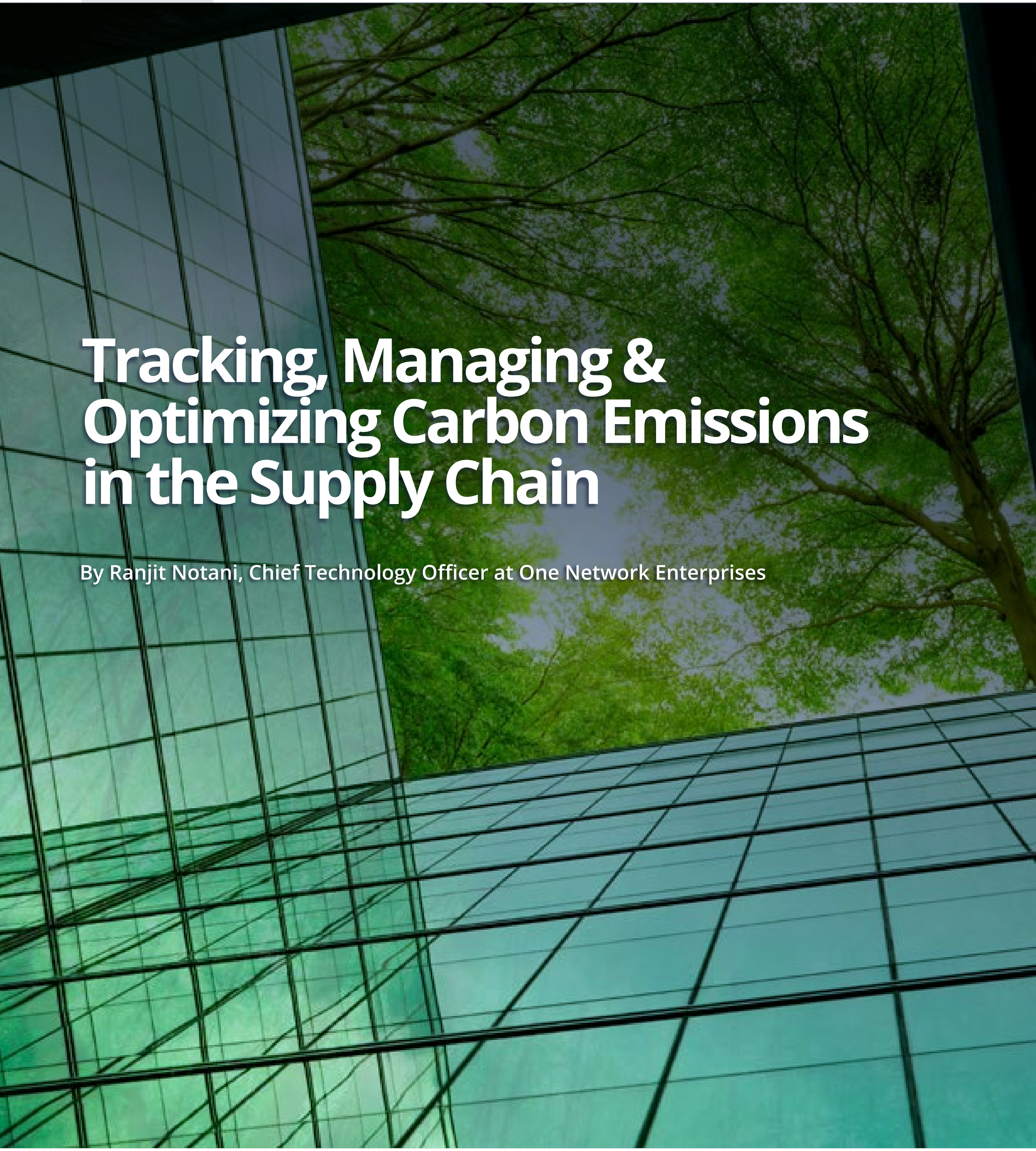

Tracking, Managing & Optimizing Carbon Emissions in the Supply Chain

By Ranjit Notani, Chief Technology Officer at One Network Enterprises

In recent years there has been an increased emphasis on Environmental, Social, and Governance (ESG) concerns. Just to highlight a couple of prominent examples, investors are considering ESG factors in their investment decisions, and supply chain buyers are considering (or would like to consider) ESG factors in their sourcing and purchasing decisions.

The "E" (or Environmental) portion of ESG is the main topic of this paper. And more specifically tracking, management, and optimization of carbon dioxide (CO_2) emissions in the context of supply chain.

CHALLENGES IN EMISSIONS TRACKING IN THE SUPPLY CHAIN

The first step in controlling or optimizing anything, and CO_2 is no exception, is to track or measure it. While there are numerous initiatives to measure CO_2 emissions at the enterprise level, a holistic supply chain view is critical. Without this view, companies are mis-incentivized to divest the CO_2 emissions-intensive parts of their business. While this improves their metrics, it merely shifts the problem around. A digital supply chain network is a natural place to both gather this data as well as perform subsequent analysis and optimization around it.

Tracking CO_2 in a supply chain is currently a difficult undertaking. One major reason for this is that, while calculating a company's total carbon footprint is (relatively) straightforward, it is of limited use (say) to buyers in the supply chain, because the total carbon footprint of their vendors is not directly actionable. Even if two vendors produce the same item, one may only do final assembly, whereas the other may have a more vertically integrated supply chain for that item, resulting in higher emissions. As a result, the total carbon footprint of (say) a vendor is only a marginally useful metric.

A FOUNDATION FOR MAPPING & TRACKING EMISSIONS

Before proceeding any further, it will be helpful to define a few terms.

Carbon Footprint (of an Activity): The "carbon footprint" of an activity is the amount of greenhouse gases (primarily carbon dioxide or CO_2) emitted in the performance of that activity.

Cumulative Carbon Footprint (for a series of Activities): The "cumulative carbon footprint" is defined for a series of activities as the sum of all the individual-activity carbon footprints of those activities.

Embodied Carbon Footprint (of an item): is the cumulative carbon footprint of that item from the most upstream raw materials to the current state of the item. The embodied carbon footprint, if it were available, is the pinnacle of carbon tracking in the supply chain as it allows every node in the supply chain to make decisions based on this quantity. Unfortunately, this is difficult to calculate currently. Still, it is useful as a mental construct as it helps clarify our thinking about carbon in the supply chain.

To tackle this problem, it is useful to subdivide supply chain activities into two categories, viz. transportation and "the rest". The reason for this is that calculating carbon footprints for transportation activities (i.e., "movements") (such as a full truckload movement or a rail movement, or an air movement) is the most amenable to reasonably accurate measurements and there are numerous calculators, data sources and formulas to do this.

However, just having a movement-level carbon footprint is not sufficient. This carbon footprint needs to be "allocated" to items to be maximally actionable. Unlike traditional allocation, which is often done based on value, here, it makes much more sense to allocate based on weight and/or volume. Fortunately, the data to do this is present in the supply chain Network.

Movement-level carbon footprint can be allocated to the shipments on the movement, which in turn can be allocated to the shipment lines, which in turn can be allocated to the order schedules. Once the order schedule allocated carbon footprint is known, then this can be used for fine-grained tracking of per-item carbon footprint due to transportation.

Additionally, this order schedule carbon footprint can be used to predict the item-lane carbon footprint. These predictions can use traditional forecasting or machine learning to predict item-lane carbon footprint running on the history of order schedule or shipment line movement-allocated carbon footprint.

Similarly, this can be used to predict lane-mode carbon footprint or lane-mode-carrier carbon footprint. Viewed purely from the transportation subset of the supply chain, this can be used for a variety of analytics on low-cost carbon carriers on a lane as well as sourcing of substantially similar items from different vendors and locations.

For the latter, the buyer can make the simplifying assumption that the embodied carbon footprint of two substantially similar items is similar, except for the inbound movement, which in turn can influence the procurement decision.

The most natural way to influence the procurement decision is to introduce a carbon term into the multi-factor objective function which weighs not only factors like price, but also factors like item-lane carbon footprint. The weights on such objective function factors can be set by the buying organization.

Eventually, if either carbon taxes or other approaches such as cap and trade take off, then, in theory, all aspects of the carbon footprint are baked into the price and thus multi-factor objective functions (at least due to carbon footprint) would not be required. However, it is not clear if either of these two approaches will prevail.

A FRAMEWORK FOR TRACKING & OPTIMIZING CO2 EMISSIONS

To incorporate these into a comprehensive framework, the idea of item-specific carbon-incorporated pricing is introduced. Essentially, for the subset of items whose price already incorporates the economic externality cost of carbon, they will not contribute to the carbon term component of the multi-factor objective function.

The next step is to broaden the analysis and functionality from transportation-only to "the rest" of the supply chain. Before we do this, it is helpful to divide supply chain items into two categories. In the first category are serialized and "lot-instanced" items. (At One Network, we refer to these sorts of items in the Digital Supply Chain Network™ as "singletons".) The second category is "normal" and lot-based items. The reason to categorize this way is that different mechanisms can be used for carbon calculations for these two categories.

The singleton items, unlike normal items, carry an identity that persists through the multi-enterprise, multi-echelon, supply chain network. This identity can persist through multiple echelons of the supply chain, all the way to customers, and even through returns and subsequent re-introduction.

For these sorts of items, a Singleton-Operation Carbon Footprint (SOCF), can directly associate a carbon footprint with every operation on the singleton. Thus, if all the SOCFs are recorded by different parties on a singleton, then the embodied carbon footprint of the singleton is easily calculated.

A classic example would be vehicles, which become singletons when they get a VIN number. Since most vehicles get a VIN number at a similar stage in their production cycle, vehicles can become comparable in their post-VIN stage. This post-VIN stage can span from OEMs to logistics providers to dealers to customers. Furthermore, as automotive companies move to the notion of a "subscription car," this same singleton, which is so useful for that business model, also supports a full lifespan (post-VIN) cumulative carbon footprint calculation.

Calculating the post-VIN cumulative carbon footprint can allow for a true carbon accounting cost of that vehicle, not just limited to the number of miles driven. For example, it can account for elements like the incremental carbon footprint from the embodied carbon of spare parts. So, two vehicles, driven the same number of miles, may have very different embodied carbon footprints due to one requiring spares with very different embodied carbon footprints.

For non-singleton items (i.e., "normal" and lot-based items), the operation carbon footprint cannot be directly associated with the item. Instead, there needs to be an allocation process.

For both singleton and non-singleton items, there is the question of how a company's total carbon footprint is converted to an item-operation carbon footprint. In some ways, this problem has many similarities to activity-based costing.

The best way to approach this is to divide a company's total carbon footprint (derived from the electricity bill, water consumption, hydrocarbon consumption, etc.) into a direct component that can be directly associated with a production resource (such as an assembly line), and an indirect component which cannot be so associated.

For the direct component, since we already know the loading (as well as the predicted loading) of a resource with an item, this can be used to allocate the resource's carbon footprint to an item work order. This is similar to how the movement's carbon footprint could be allocated to order schedules.

Since we can calculate the predicted item-operation carbon footprint this can be used in Sales & Operations Planning (S&OP) to make longer-term operational decisions that factor in these predicted carbon footprints.

For the indirect carbon footprint, for example, the carbon footprint from the electricity consumption of the corporate headquarters, the total indirect carbon footprint would be allocated to all the items being produced cumulatively. This would be similar to how indirect costs are allocated in activity-based costing.

Once this allocation is done a company can calculate the cumulative carbon footprint of all its items from raw materials to finished goods. This information can be posted to the network. This information would be associated with the distributed bill of materials in the network.

As more and more companies post this information to the network, the embodied carbon footprint for an item across multiple echelons of companies starts to emerge. Even if there are gaps in the total embodied carbon footprints, for the purpose of decision making, the network can fill in cumulative carbon footprints from like items in the network as a stopgap. This starts advancing the network towards having information on the embodied carbon footprint of more and more items over time.

Also, One Network's Digital Supply Chain Network™ has a patented permissions framework, that enables highly targeted access to information, based on organization and role. Thus, any carbon information such as cumulative carbon footprint or embodied carbon footprint can be shared with just those parties that need to know, including customers, regulators, partners, and other third parties.

BEYOND ESG

Besides calculating numerically oriented information such as cumulative carbon footprint, movement-allocated carbon footprint, operation-allocated carbon footprint, etc., there are all sorts of useful qualitative information that can be required of vendors to post to the network.

The Digital Supply Chain Network™ includes the NEO Databot. It is designed for large-scale custom data gathering of qualitative and quantitative information in a multi-enterprise, multi-echelon supply chain. This opens opportunities to gather, track, analyze, and optimize factors that go beyond emissions and ESG.

Companies must plan ahead and ensure that their supply chain technology can handle the complexity and challenges of ESG reporting. Key components include a flexible framework, a digital supply chain network, and network-enabled AI/ML. In the near future, this qualitative information will be as important for decision-making as quantitative data.

About the Author

Ranjit Notani is chief technology officer and leads overall product direction for One Network. He brings to the company over 20 years of experience conceptualizing and architecting enterprise solutions, and holds over 30 patents. Previously, Notani was co-founder and CTO of Transcend Systems, and spent several years at i2 Technologies where he held various key architecture positions, playing an integral part in product strategy as a Fellow. Notani holds a Master of Science from Purdue University and a Bachelor of Technology from the Indian Institute of Technology, Bombay.

ABOUT ONE NETWORK

One Network is the leader in intelligent control towers for autonomous supply chain management. From inbound supply to outbound order fulfilment and logistics, this multi-tier, multiparty digital platform helps optimize and automate planning and execution across the entire supply network and every trading partner. Powered by NEO, One Network's machine learning and intelligent agent technology, real time predictive and prescriptive analytics enable industry-leading performance for the highest services levels and product quality at the lowest possible cost. It's the industry's only solution with a fully integrated data model from the consumer to suppliers and all logistics partners, providing a network-wide, real-time single version of the truth. Leading global organizations have joined One Network, transforming industries like Retail, Food Service, Consumer Goods, Automotive, Healthcare, Public Sector, Telecom, Defense, and Logistics. Headquartered in Dallas, One Network has offices across the Americas, Europe, and APAC. For more information, please visit www.onenetwork.com

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