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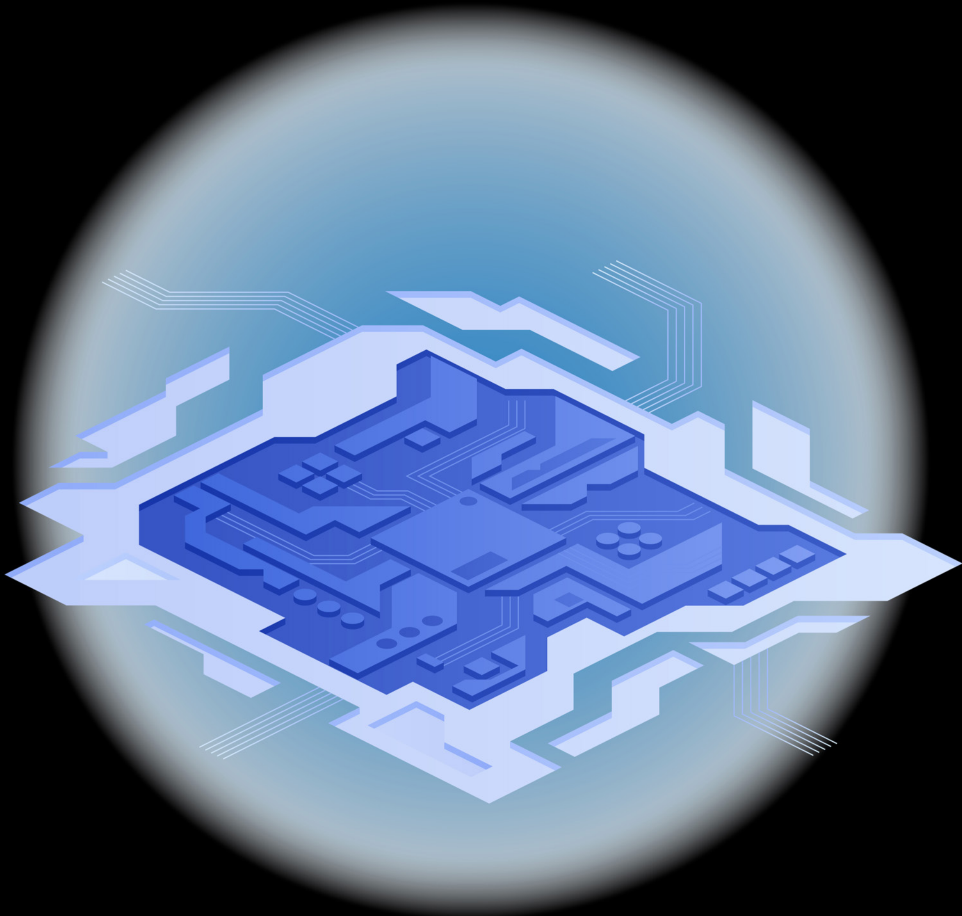

Reimagining the auto manufacturing supply network

Using the semiconductor crisis to effect positive change for the future

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Sometimes the smallest thing can bring an entire ecosystem to its knees. Whether it's a microscopic virus or the common computer chip, we're learning the hard lessons of underestimating risk. We're also being forced to acknowledge that some problems don't have a quick fix. If we're going to avoid catastrophe in the future, we should challenge some of the foundational systems and processes we've taken for granted.

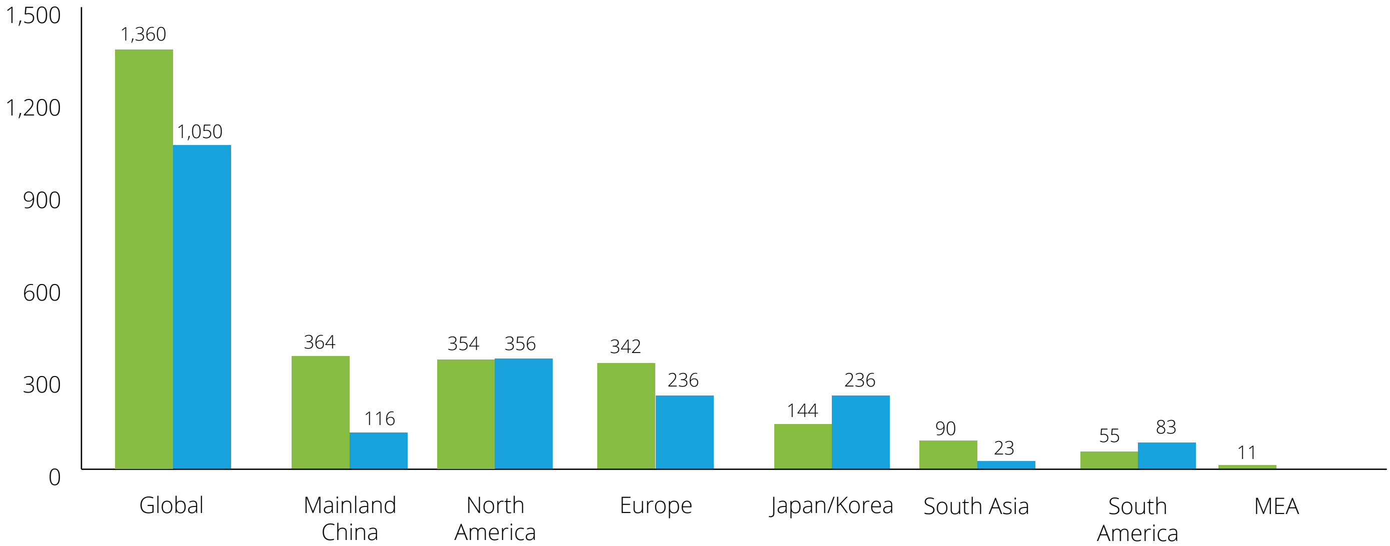
The global semiconductor shortage is driving companies across several industries, including automotive original equipment manufacturers (OEMs), to make large production cuts that may persist into next year.[1] Along with significant near-term financial pressures, this situation has been a call to action for stakeholders to identify and manage risks through advanced collaboration, multitier visibility, and predictive threat response. In fact, many companies are beginning to recognize that rebuilding supply networks around the core principles of efficiency and resiliency is not only possible, but long overdue and imperative to remain viable in a rapidly transforming global automotive sector.

How did we end up here?

The semiconductor shortage hit the automotive sector right at the point when it was trying to mount a sustained recovery from the COVID-19 pandemic. A shortage of wafer and substrate production capacity has forced many OEMs to shutter production facilities around the world. According to a recent IHS Markit report, the global unit volume loss attributed to the pandemic in the Q1 2021 totaled more than 1.3 million vehicles. [2] Some volume recovery is expected to begin later this year as manufacturers look to implement strategies such as shortening the traditional summer shutdown period.[3] The unit volume loss in China, North America, and Europe was very similar, with each region dropping about 350,000 vehicles in the first three months of 2021. Going forward, Q2 volume losses are expected to be somewhat lower, but still significant at a combined 1 million units globally.[4]

"...this situation has been a call to action for stakeholders to identify and manage risks through advanced collaboration, multitier visibility, and predictive threat response."

Figure 1. Impact of semiconductor shortage on global light vehicle production (Q1 versus Q2 2021, thousands)



Source: IHS Markit (as of April 23, 2021).

At the heart of this crisis lies a mismatch in supply and demand for semiconductors:

Powering down vehicle assembly

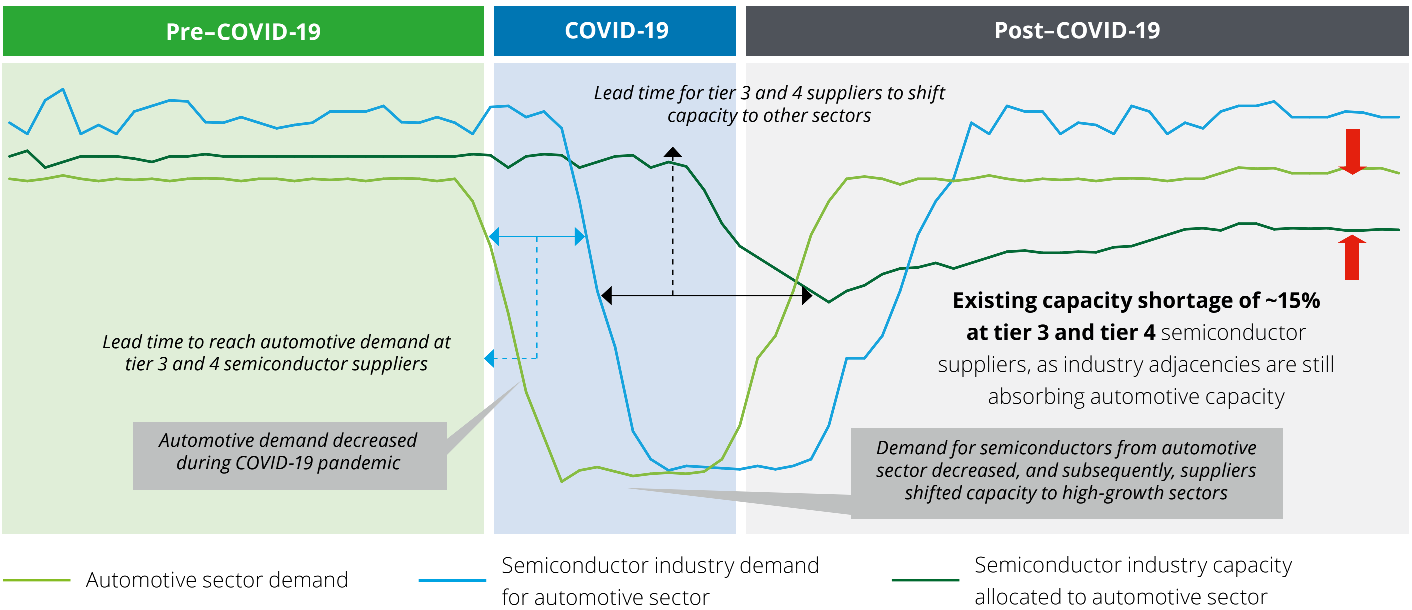
The COVID-19 pandemic had a swift and severe impact on the globally integrated automotive industry. As a result, manufacturers drastically reduced their forecast projections to suppliers. Months later, as OEMs restarted operations, sales rebounded in the second half of 2020, with high growth led by pent-up consumer demand. The strength of the rebound in demand caught the industry largely by surprise, and the need for semiconductors returned. These components form the basis of the electronic subassemblies which now account for about 40% of the cost of a vehicle, up from 18% in 2002.[5]

Restarting semiconductor supply is easier said than done

In response to the vehicle assembly plant shutdowns in early 2020, tier 3 and 4 semiconductor wafer and substrate manufacturers shifted their production to higher-demand sectors such as consumer electronics. Restarting the automotive supply channel remains hampered by the reality of semiconductor manufacturing lead times, which can be three, four, or even six months for advanced chips. There is also a knock-on effect of one to two months to restart electronic module production at the tier 1 and 2 supplier level. In addition, exogenous factors such as US-China trade tensions, implications of the recent severe weather in Texas, and the unfortunate fire at the Renesas factory in Japan have exacerbated the situation. Finally, in a highly specialized, capital-intensive industry, the limited number of players with semiconductor manufacturing expertise will likely keep supply constrained.

> "We need to develop dual sourcing strategies from different geographies for critical commodities."
>
> **Chief procurement officer, global OEM**

Figure 2. Illustrative gap in semiconductor demand and supply for automotive sector



Source: Deloitte analysis.

You can't avoid what you can't see coming

At the heart of this crisis is a lack of visibility up and down the value chain that prevented OEMs from identifying potential risks associated with their decision to shutter vehicle assembly operations in spring 2020. Traditionally, it has been very difficult to create a line of sight through an entire automotive supply chain for a variety of reasons, including a lack of trust and communication between stakeholders, reliance on poor volume forecasts, and outmoded data management systems. The result is an unknown number of potentially disastrous threat vectors that remain buried until it's too late to avoid them.

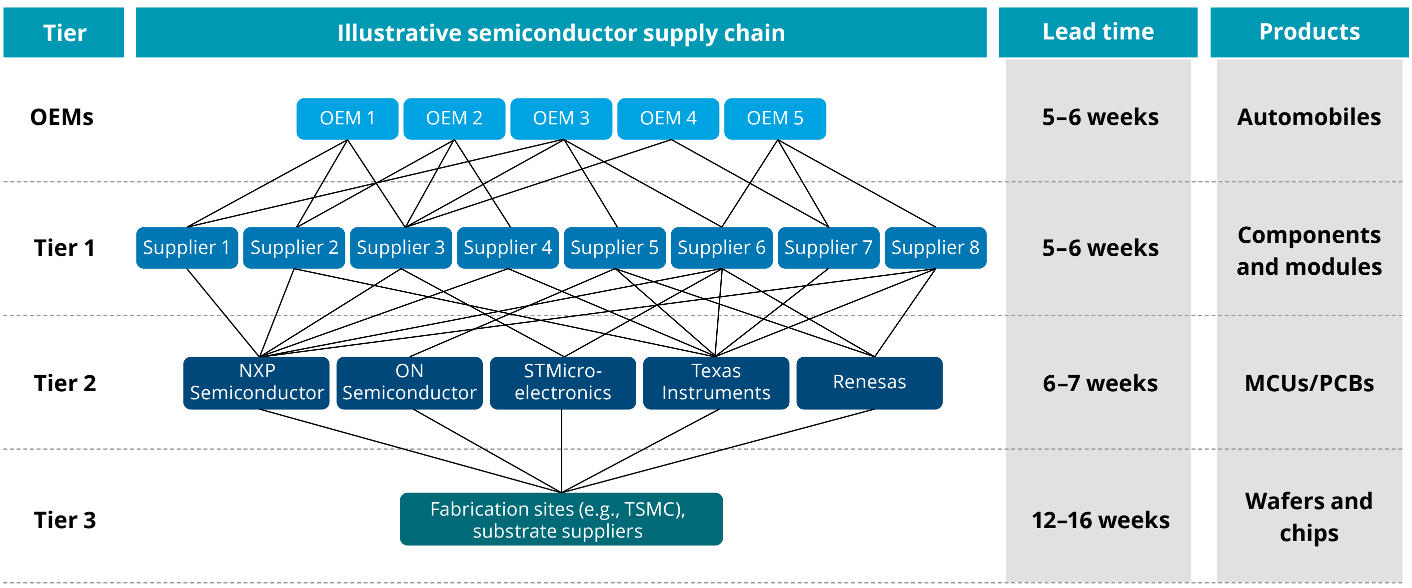
It should be noted that the industry has faced similar challenges many times in the past. For example, an explosion at a chemical plant in Germany back in 2012 caused a shortage in a key component required to produce nylon resin, which is used to manufacture a broad range of products, including vehicle fuel and brake lines.[6] At the time, two companies controlled half the global supply of nylon resin, which proved to be a serious challenge for OEMs trying to maintain vehicle production volumes. Another example emerged in the aftermath of the Great Tohoku earthquake and tsunami that devastated Japan back in 2011. Several automakers faced a shortage of a specialty pigment used in automotive paint products because the only plant in the world that made it was located near the Fukushima nuclear power plant that was heavily damaged in the disaster.[7]

Obviously, these "black swan" events highlight the need for multitier supply chain visibility as OEMs look to integrate their networks globally.[8] Automotive OEMs' visibility is primarily limited to their tier 1 suppliers as dictated by existing contractual obligations. Beyond that, there is often surprisingly little information shared in terms of who suppliers are in subsequent tiers, what components they provide, and how their operational parameters could potentially destabilize the entire network.

This lack of visibility is also insufficient to uncover structural bottlenecks that exist at subtier levels of supply. For example, the global semiconductor supply chain is governed by a consolidated and cost-effective, but ultimately brittle "diamond-shaped" structure (see figure 3). The relatively large number of tier 1 component integrators are reliant on a small number of global semiconductor providers which, in turn, rely on a handful of tier 3 wafer manufacturers, which are subject to long lead times (12–26 weeks) at their fabrication sites.

> "Generally, 99% of [semiconductor] manufacturing foundries have no visibility where the part is going."
>
> **Former SVP, global semiconductor manufacturer**

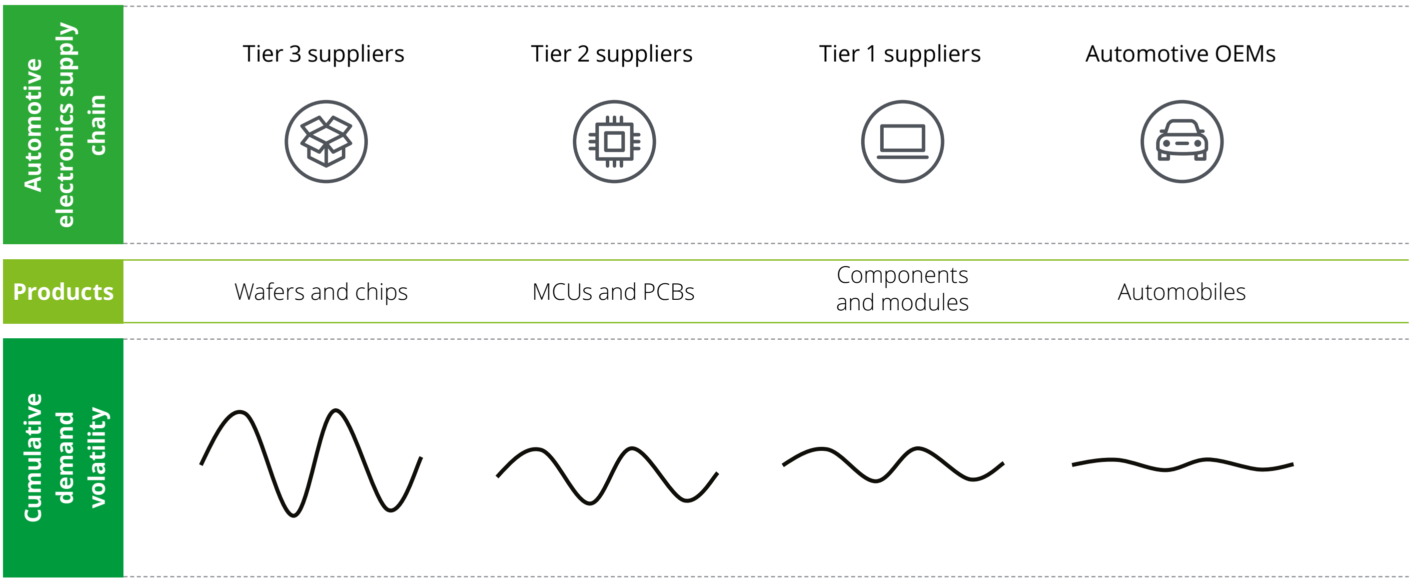
Figure 3. Description of "diamond-shaped" supply chains affecting the automotive sector



Source: Deloitte analysis.

In addition, most OEMs have not adopted systems or processes to enable a real-time exchange of information with their suppliers. Hence, large fluctuations in production planning volumes happen at sub-tier levels in response to even small shifts in customer demand. This is typically known as a "bullwhip effect" where delayed communication between stakeholders at each tier in the supply chain are often amplified by judgements placed on the demand signals received.

Figure 4. Illustrating the "bullwhip effect"



Source: Deloitte analysis.

How are OEMs navigating through the crisis?

Continuous exchange of information between OEMs and suppliers through shared IT capabilities has been critical to manage the ongoing crisis. OEMs are now directly engaging with tier 2 and tier 3 suppliers in the semiconductor network to secure the capacity they need while defining new rules of engagement going forward.

The impact of the semiconductor crisis is expected to last at least through the end of this year, given the long lead times and constrained supply that is intrinsic to each tier. To their credit, every OEM has responded by employing a variety of tactics to minimize both near- and long-term damage, including shifting assembly to more in-demand products,[9] bypassing the installation of some modules until a later date, and securing alternate sources of semiconductor supply.

In order to gain a deeper understanding of the various strategies OEMs are implementing to deal with the crisis, we conducted a series of executive interviews with key stakeholders. Here are some specific actions that industry players are taking:

- Forming crisis response teams to work closely with their tier 1 partners to secure supply commitments and adjust production plans. These teams are also built with a broader response perspective to handle holistic disruption scenarios, as opposed to localized events.
- Flexing the production of vehicle models and feature mixes in each market to maximize profitability.
- Working with suppliers to understand where components are coming from and how much risk these companies represent going forward.
- Approaching wafer and chip suppliers to establish direct commercial agreements.
- Sharing 18- to 24-month forecasts with all of their tier 1 suppliers twice a year in an attempt to improve the quality of planning information and get early allocation of capacity.
- Lobbying efforts by North American OEMs to get preferred supply considerations for the automotive sector. Other countries, including Japan, have lobbied Taipei to help ease the shortage.
- Exploring other options, such as prebuilt wafer banks[i] and the use of proxy panels,[ii] to reduce lead times to manufacture required volumes. Other industries with near-field communication applications are already utilizing these options.
- Semiconductor industry experts have also identified the possibility of leveraging third parties with "burn-in" testing process[iii] support to alleviate some of the capacity limitations.

It should be noted that one of the largest global OEMs has been able to avoid the worst of the crisis by setting up contractual obligations with critical multitier suppliers to stockpile two to six months of chips on its behalf.[10] While this appears to run counter to the long-held paradigm of just-in-time (JIT) manufacturing, it was successful in insulating the OEM against the initial disruption. The US government is also actively looking to review the current-state supply chain for semiconductors in order to identify policy recommendations and investments to improve resiliency moving forward.[11] One of the likely outcomes of the review process will be to encourage semiconductor providers to shift their manufacturing footprint to better align with high-demand regions so greater flexibility can be achieved in sourcing critical components while removing geopolitical barriers.

i. Wafer banks provide storage for finished or semifinished wafers. By storing these work in process wafers prior to final assembly, test, and configuration, manufacturers can reduce overall lead time to supply and enable product postponement operations. Suppliers can maintain wafer banks at one or more factories that can be used for immediate demand.

ii. Proxy panels are fully manufactured six-layer wafer products. This is a new packaging technique not currently in production mode. Automotive OEMs are testing their feasibility.

iii. Burn-in (also called "infant mortality") is a semiconductor testing process where a component is exercised under elevated operating conditions to test its reliability and filter out those components that fail early.

Here are four critical business capabilities management should consider to address a similar crisis in the future:

1. Supplier risk management organization to monitor supply risks and proactively identify disruptions

Industry-leading OEMs have centralized five to 10 dedicated global supplier risk management resources within purchasing and supply chain functions. Their focus is combining greater visibility into financial and geopolitical risks with supplier performance metrics to enable better sourcing decisions. Some have a 24/7 event monitoring capability to identify supplier and geopolitical events that can immediately disrupt the supply chain. Aided by tools such as artificial intelligence and machine learning, the ability to identify risks by industry, commodity, and even supplier as early as possible should continue to improve. Having said that, there is still a long way to go in terms of effectively identifying supplier risks on a real-time basis. Most OEMs remain dependent on their tier 1 suppliers for information on supply disruptions, which significantly lowers their ability to proactively manage risk.

2. Multitier visibility to identify "bottleneck" suppliers

Multitier supply chain mapping is critical to understanding the operating parameters that influence the performance at each supplier node within an integrated network. Recent executive interview results indicate a wide disparity among OEMs when it comes to these mapping exercises. For example, some OEMs report having only achieved a 10% to 20% visibility rate, while higher-performing OEMs have more than 70% visibility down to the tier 2 level. At the core of this issue is a recognition among OEMs that it is difficult to automate end-to-end mapping at all levels. The most effective approach can be to prioritize critical value streams and drill through the individual multitier supplier connections to the right level of detail. If OEMs are able to successfully map subtier relationships, it can enable them to identify critical, high-risk commodities and proactively engage affected stakeholders to manage their overall risk profile while reducing the cost of crisis management.

"Full visibility would mean getting down to the tier 2 level and would only include information like location and part specifications for critical items."

Former purchasing director, global OEM

3. Supplier collaboration approach

All supply chains operate according to a particular "drumbeat." For example, the semiconductor industry has been notoriously cyclical, vacillating between periods of growth and contraction over the past 50 years. The underlying causes for these pendulum swings are twofold: (1) the long manufacturing lead times involved, and (2) the capital- and equipment-intensive nature of the industry. On the one hand, semiconductor manufacturers typically require a minimum of three to six months to fill net-new orders. Aligning on production changes typically happens in a monthly S&OP process. On the other hand, when a semiconductor manufacturer wishes to increase its production capacity, purchasing and installing additional machinery can take four to six months if all goes well and can easily stretch to 12 to 18 months for more advanced equipment.

A few OEMs have dedicated programs to engage with tier 1 suppliers and understand these embedded rhythms on a case-by-case basis. Some OEMs are sharing both short- and long-term forecasts with suppliers to help them model their capacity and identify constraints early. More importantly, they are trying to ensure that the entire supply chain for a given set of commodities is operating off the same synchronized demand signals in an attempt to reduce the bullwhip effect. In return, they get visibility into critical operational metrics such as cycle times, shifts, capacities, and lead times. The intent is to try to stabilize any demand variability from OEMs and better manage the daily and weekly supply needs. Some are even deploying IT capabilities to enable a two-way exchange of information with suppliers. However, there seems to be limited success in achieving a continuous exchange of information with real-time visibility into supply constraints. Perhaps, the automotive sector could take a lesson from other industries, such as retail, aerospace and/or consumer electronics, on the use of collaborative planning, forecasting, and replenishment (CPFR) techniques to build more robust lines of communication.

4. Crisis response management to mitigate negative impacts

In case of a supply crisis, OEMs deploy cross-functional teams (CFTs) to identify potential impacts and plan mitigation steps. CFTs have experts from multiple functions, such as planning, engineering, purchasing, legal, supplier risk management, and supply chain management. Some OEMs have created "war rooms" where the CFT, led by the supplier risk management function, manages the company's crisis response. CFTs conduct frequent supplier visits to identify issues at ground level. This team can also provide financial liquidity and manufacturing expertise to help bolster supplier operations. One of the OEMs interviewed for this research identified 500 priority commodities after the 2011 Fukushima earthquake and tsunami in Japan. The disaster prompted the creation of comprehensive business continuity plans at all levels of the supply chain, including agreements to stockpile two to six months of inventory on behalf of the OEM.

Our research also reveals that it is critical to understand the total cost of a component at each stage of the supply chain. From the semiconductor supply chain point of view, the standard process is for electronics companies to establish specifications, source, and negotiate pricing on high-cost components, including specialized chips. This leaves their contract manufacturers to procure the less expensive commodity chips. Limited visibility into these transactions may increase warranty costs associated with semiconductor reliability issues. A push to create more visibility could allow OEMs to directly engage with chip suppliers for the purpose of managing costs by "designing in" performance requirements and thus improving the quality and reliability of the resulting semiconductors.

From the study results, it is evident that most OEMs have strong capabilities and knowledge within their own organizations. But they are often hampered by existing contractual obligations, functional silos, limited technology investments, and conventional ways of working, which allows embedded supply chain risks to go unnoticed.

Making supply chains "resilient"

Building cost-effective, resilient supply networks is a strategic imperative that can be accelerated by advancements in technologies, business readiness, and an OEM's overall ability to manage and rapidly respond to information. Looking at collaboration, OEMs should evaluate where their suppliers are located and how to connect with them to gather information and utilize the knowledge gained to measure associated risks. This end-to-end collaboration and real-time sharing of information between OEMs and suppliers can be enabled by targeting three elements (see figure 5).

Figure 5. Elements for success in creating end-to-end collaboration

Organization and talent

Talent is a critical enabler for supplier risk management functions to succeed. Knowledge of critical commodities and their extended supply chain beyond tier 1 can be a differentiator. Another imperative is to have talent with expertise in risk analytics and predictive modeling to best leverage data (internal and third-party) and digital technologies. Last but not least is knowledge management, as every crisis teaches us something.

Process and governance

Supplier collaboration requires clear, mutually agreed-to, and measurable objectives, supported by a robust governance structure. OEMs must establish policies, monitoring, and control mechanisms to build efficient collaboration programs. They need to establish supplier onboarding programs with a defined set of expectations and communication protocols to initiate and build on supplier relationships further to continuously exchange information.

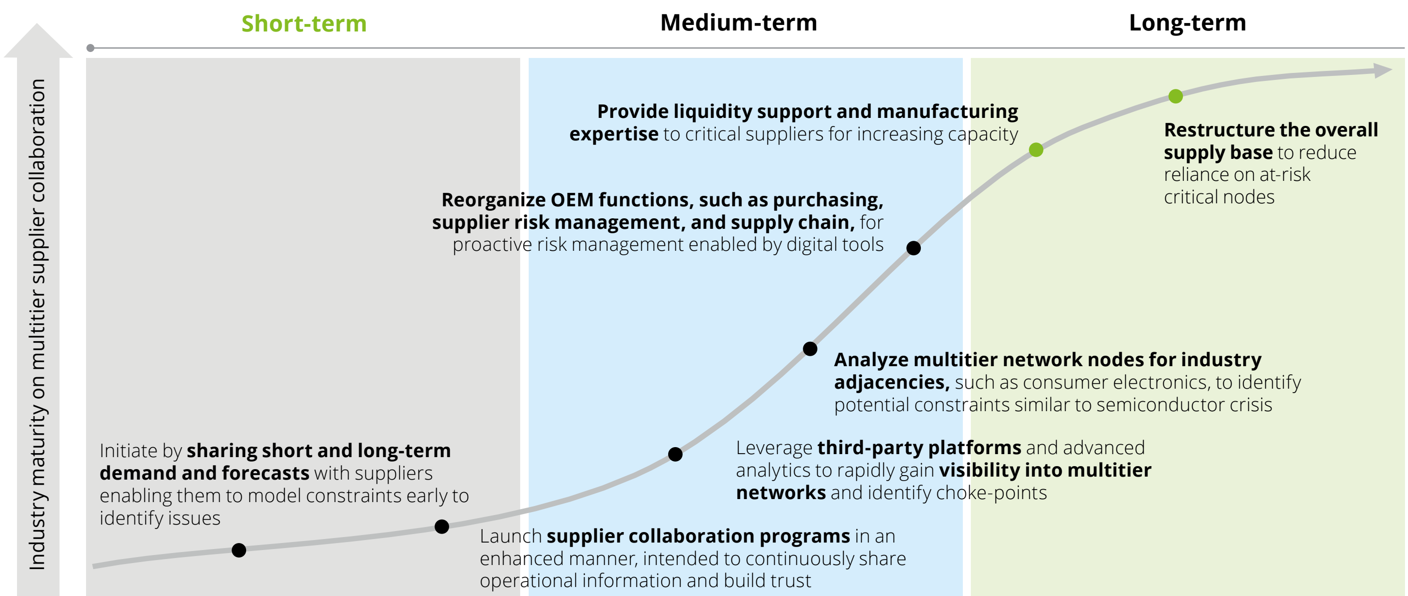
Data, analytics, and technology

Creating a digital ecosystem can lower collaboration barriers inside and beyond an organization. OEMs must invest in third-party platforms to build multitier visibility and enable continuous exchange of information with suppliers. To build a resilient supply chain, OEMs will also require advanced analytics such as risk monitoring to identify at-risk critical nodes in the supply chains and work with suppliers to reduce network reliance on these nodes.

Source: Deloitte analysis.

Building up the capabilities that underpin these three elements depends on an OEM's responsiveness to shifting conditions in the supply chain and its willingness to make required investments. Given the nature of this challenge, it may take a number of years for OEMs to drive fundamental change in the way they engage with their supply base. However, the current crisis can act as a catalyst for forward-looking OEMs to finally address long-standing supply chain issues and establish a road map for resilience (see figure 6).

Figure 6. Road map to resilience



Source: Deloitte analysis.

Conclusion

The semiconductor shortage has already caused a great deal of damage to the global automotive sector over the past few months and, with no quick fix in sight, the road to recovery could be quite long. It has caused every OEM to rethink its global supply network in terms of where critical risks might still be buried. It has resurfaced the need to create direct contracting relationships with suppliers much further upstream. It has also reinforced the need for better, more timely data rather than relying on a disjointed patchwork of information that is often inaccurate and out of date. Aligning to the "drumbeat" of long lead times required to restart component production will likely also be more of a factor in assessing the implications of shuttering vehicle assembly plants in the future.

The current crisis also represents a unique opportunity for automakers to rewrite the rules of engagement to increase the amount of visibility they have across their entire supply base. It may also mean pulling back from some long-held manufacturing tenets like just-in-time manufacturing in favor of carrying more inventory of strategic components and raw materials as a buffer against potentially catastrophic disruption.[12] Simply put, working to create a more collaborative value chain built on trust among stakeholders is a critical imperative for OEMs and suppliers going forward. It is abundantly clear that inaction is not an option. Otherwise, we risk history repeating itself (once again).

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