

AUTOMOTIVE 4.0

Sensing the road ahead for tier 1 suppliers



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	INTRODUCTION	4
 01	AUTOPILOT By 2024, an estimated 25-35% of all cars sold will have self-driving capabilities.	6
 02	CONNECTIVITY Forecasts show that 100% of cars shipped in Japan, North America and Western Europe will feature in-vehicle connectivity by 2027.	12
 03	POWERTRAIN ELECTRIFICATION Improvements in battery technology and increasing environmental pressure drive the adoption of electrical vehicles.	22
 04	NEW ENTRANTS Tesla, Google, Apple and Chinese players are entering the global automotive stage.	28
 05	SUPPLY CHAIN DIGITISATION Increasing complexity in the product portfolio, systems and parts require OEMs to further integrate and digitise supply chain processes.	33
 06	COST & GLOBALISATION Continuous cost pressure and globalisation efforts remain on the daily agenda of tier 1 suppliers.	38
	CONCLUSION	46
	DEEP DIVE: KEY ENABLER 'IT'	50

INTRODUCTION

The automotive industry undoubtedly finds itself in a phase of major change. There are technological mega forces like autopilot cars, connectivity or powertrain electrification as well as general mega forces like new entrants, digitisation of the supply chain and cost pressure and globalisation which are carving the shape of the future auto ecosystem.

The vision of Automotive 4.0¹ describes the evolution of the automobile from the origins of Karl Benz or the Ford Model T over to the post WWII cars and the respective development of the Automotive 2.0 and nowadays the move towards Automotive 2.5 as a connected car. Automotive 3.0 portrays the mid-term vision of the “car as a digital app” combined with pervasive electric charging networks, autonomous driving capabilities and urban on-demand services. Automotive 4.0 will take this even one step further and will feature the definitive change in redefining the industry as one of “mobility” as opposed to “automobiles”. Within 20 years, there will be tens of millions of autonomous vehicles. The ability to call for a vehicle (with or without driver) on demand may create a new model of shared ownership or access to vehicles and services that take the current utilisation of cars from 5-10% to 75% of the hours in a day. In order to stay relevant, tier 1 suppliers will have to

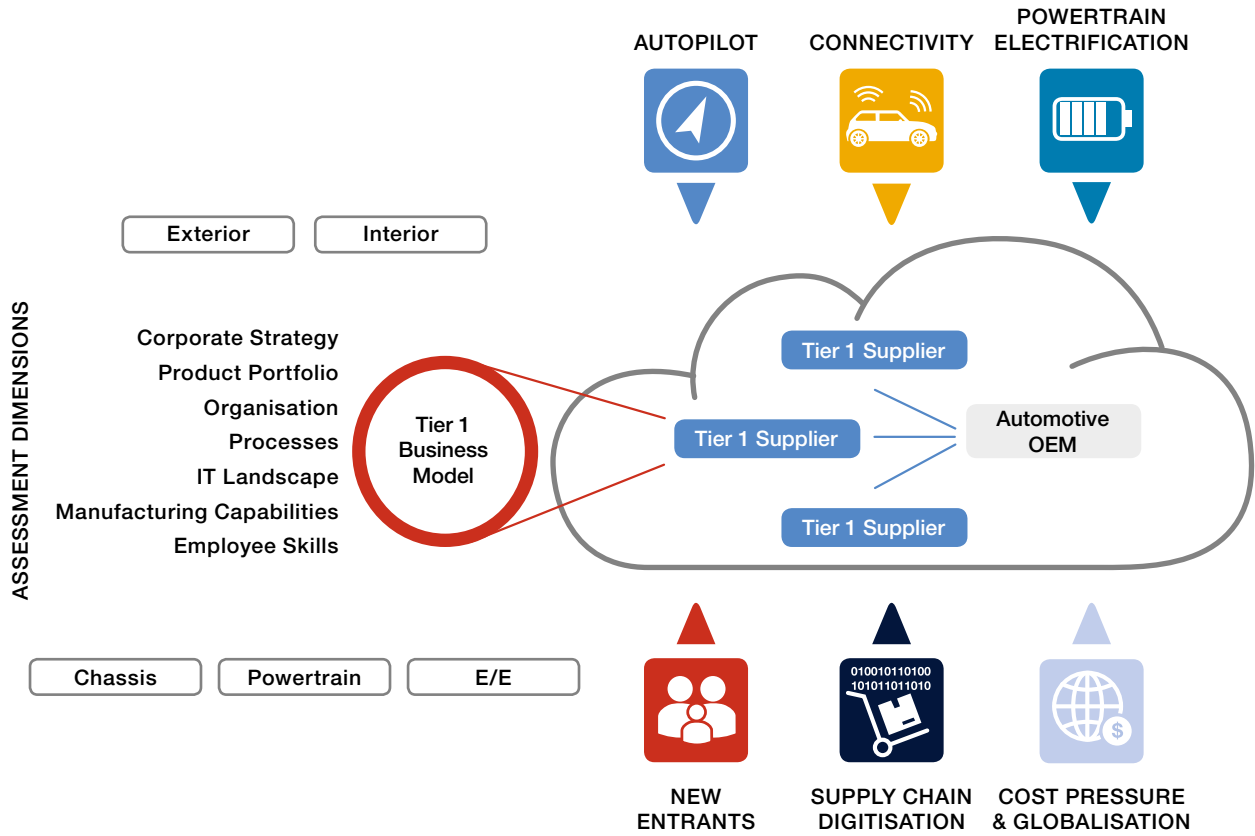
align with this evolutionary process and will have to develop an enhanced set of core traits resulting in what we believe will be the “automotive 4.0 supplier”.

While it is beyond dispute that the main constituents of this change are the car manufacturers, it is often neglected that these forces will drive a bull-whip effect throughout the entire value chain. The next ones to be hit upstream are the tier 1 suppliers. These players not only account for a high share of automotive innovation but even more so they are the hidden enablers of ecosystem change. The playing field of the tier 1 suppliers comprises a plethora of categories and covers the full spectrum of components and modules which go inside a car: exterior, interior, chassis, powertrain and electrics / electronics (E/E). We are clustering and evaluating the automotive suppliers based on these five primary market segments.



This study will analyse the implications of the transformational forces, identify the burning platforms and it will provide recommendations for the future positioning of automotive suppliers with regard to their primary market segment. Each mega trend will be explored considering its effect on the tier 1's corporate strategy, product portfolio, organisation, processes, IT landscape, manufacturing capabilities and employee skills.

Transformation of the retail landscape including direct, digital sales channels or the evolution of new transportation models driven by generation Y preferences are further trends impacting the industry. Due to only limited direct impact on the automotive supplier landscape – yet certainly on OEMs and their downstream value chain – we are not including the latter mega forces in this point-of-view and focus on such trends which have significance for automotive tier 1s.



Automotive 4.0 mega forces and analysis scope



01 AUTOPILOT

Once a hobby of nerdy students, the pursuit of self-driving cars has become a very serious undertaking of most global automotive OEMs and new players like Google and purportedly Apple. Since they started research back in 2009 with the Toyota Prius, Google has self-driven over 1 million miles on the streets of Mountain View and Austin. In December 2014, Google has revealed the first real build of their prototype vehicle with the friendly face.

Mercedes Benz' S 500 Intelligent Drive – nick-named Bertha - uses sensor technologies that are already used in traffic today and has successfully been test-driven on the German A8 autobahn and on the streets of Sunnyvale where the Californian research centre of Daimler is located. Daimler is furthermore working on autonomous trucks to hit the roads very soon. A further example is Baidu – the Chinese search engine giant – who is partnering with BMW to launch self-driving prototypes in the race with Google. The list could go on and on, but the point is clear: self-driving cars will be a big thing for OEMs and for tier 1s. Many OEMs have ambitions to bring self-driving cars to market by 2020 and market research indicates around 25 to 35% of cars sold by 2024 will be self-driving.

In order to assess the impact of this revolution on the tier 1s, it is imperative to understand the technological components at play. While the setup may differ from maker to maker, the autonomous systems most likely

“The technology is accelerating so fast that I can't tell you if it's going to be 2020 or 2025 before we get full automation. But it's coming, no matter what.”

Dr. Bjorn Giesler,
Audi's piloted driving expert

will include devices to sense the car's environment like Lidar – a laser range finder that creates 3D images of surrounding objects -, GPS, inertial navigation system, radars, ultrasonic sensors, cameras, altimeters, gyroscopes and tachymeters. The CAN bus or FlexRay will collect the environmental information from those sensors and will provide it to a central ADAS (Advanced Driver Assistance Systems) unit which is analysing the data utilising special software.

The software will then make decisions on how to manoeuvre the car and send appropriate commands to the braking, acceleration or steering system. Many of these components are already in use today but a few critical items will be new and will present incremental opportunity for the market participants.



Component	Purpose	Supplier examples	Incremental opportunity for suppliers	Qualitative growth expectation
Lidar	Lidar is a laser range finder. With its array of 32 or 64 laser beams, it creates 3D images of objects in the surrounding and therefore helps the car to identify hazards on the road.	Bosch, Continental, Velodyne, Ibeo	Equip self-driving cars with this new technological component. Today's cost is starting at approx. \$30k – this will have to come down in order to reach broad market adoption. Some OEMs are not using Lidar so it is not a must-have technology in terms of market opportunity.	Medium to high
Radar	Radars are usually mounted on the front and rear bumpers to enable the car to be aware of vehicles in front of it and behind it. This technology is already used by adaptive cruise control systems.	TRW, InnoSenT	Today, radars are mostly used in premium cars. Suppliers can grow sales numbers along with the growth of self-driving car market.	Medium
Ultra-sonic sensors	Ultra-sonic sensors are mounted at the rear wheels and are activated when the car is in reverse gear. These sensors identify objects close to the car and are used by parking assist systems.	Bosch, Valeo	Ultra-sonic sensors are quite common today and used by parking assist systems. Incremental opportunity for suppliers may only be low to medium.	Low to medium
Cameras	This camera is mounted on the windshield and helps to identify objects in front of the car. These objects include pedestrians, other motorists, road signs or traffic lights.	TRW, Magna	Today, cameras are mostly used in premium cars. Suppliers can grow sales numbers along with the growth of self-driving car market.	Medium
GPS sensors, inertial navigation system	The GPS sensors receive information about the location of the car and together with the inertial navigation unit it can determine highly accurate estimates of the exact location of the car.	iMAR	GPS is pretty common in cars based on the prevalence of built-in navigation devices. Inertial navigation system presents an incremental opportunity for suppliers since these are mostly used in premium cars today.	Medium
Altimeters, gyroscopes, tachymeters (MEMS)	Altimeters, gyroscopes, and tachymeters also help to determine the precise location of the car.	Bosch, STMicro-electronics	Mostly used in premium cars. Suppliers can grow sales numbers along with the growth of self-driving car market.	Medium

Component	Purpose	Supplier examples	Incremental opportunity for suppliers	Qualitative growth expectation
FlexRay, CAN-bus, LIN-bus	Collects the data from various sources (Electronic Control Units (ECUs)) in the car	Bosch, Dräxlmaier, Leoni	Already in use today. No additional opportunity expected.	Low
Central ADAS unit (Advanced Driver Assistance Systems)	Main recipient of all sensor data. Runs analytical software to determine the next best action	Delphi, TTTech, Mobileye	Only used in prototype cars today; will be the key component in self-driving cars. Major incremental opportunity exists for hardware suppliers.	High
Analytical Software	Uses the sensor data to calculate next best action and car behaviour in specific driving situations, e.g. emergency brake or turning around an obstacle on the street or simply to follow the course of the street. The software needs to be able to set priorities to specific situations, i.e. reaction to an emergency needs to happen within milliseconds while overtaking on the autobahn can be planned longer in advance.	AdasWorks, Ottomatik	Only used in prototype cars today; will be the key component in self-driving cars. Major incremental opportunity exists for software suppliers.	High
Braking, acceleration, steering system		Thyssen-Krupp Presta Steering, Brembo	Already in use today. No additional opportunity expected.	Low

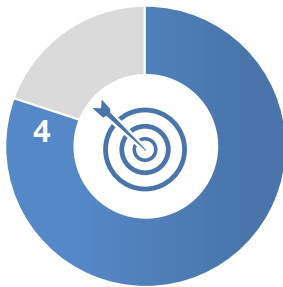
Insurance Business and Extended Liabilities

Not only will the introduction of self-driving cars have an impact on tier 1 suppliers, but also on various other participants in the wider auto ecosystem, for example on insurance companies. Assuming a widespread adoption of proven self-driving technologies in the market, it is fair to say, that the overall cost of crashes will likely be reduced because traffic will be safer than today. This will lead to lower average insurance cost by car which in turn could have a positive effect on the car market. In today's legislation, the driver is the main party at fault for a crash. In the future, with

little or even no control of the car by the driver, this responsibility may gradually shift to car technology and ultimately to the car manufacturer. For OEMs this will likely increase their overall cost of liabilities which will either be priced into the car or cascaded backwards in the supply chain hitting again the tier 1 supplier. As OEMs have a long-standing track record of successfully negotiating prices and favourable T&Cs with their suppliers, it can be assumed that the tier 1s will at least have to absorb a fair amount of those increased liability cost.



Impact of Autopilot on Tier 1 Supplier



Corporate strategy

Driverless taxi service may evolve (e.g. Uber). Extended liability for components supplied to the OEM: in case of an accident less responsibility for the driver and more for the OEM who may shift this liability to the tier 1.



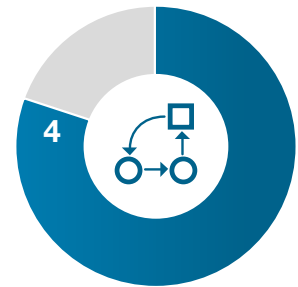
Product portfolio

Traditional E/E suppliers may see an extension to the current product portfolio, e.g. for Lidars, CPU or analytical SW.



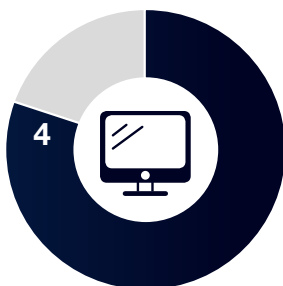
Organisation

Re-organisations may be required within R&D, product management or sales function to align with the new product.



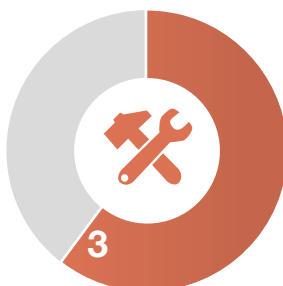
Processes

New players like Google or Apple may require expedited development processes that meet the pace of their own activities (start-up culture). Suppliers are historically used to slightly longer cycles in line with OEM portfolio strategy.



IT landscape

In line with software development capabilities additional / new tools may be required, e.g. also including systems engineering tools.



Manufacturing capabilities

Lidars and potentially other sensors may require additional manufacturing equipment. CPUs should not mean a major change for current ECU suppliers.



Employee skills

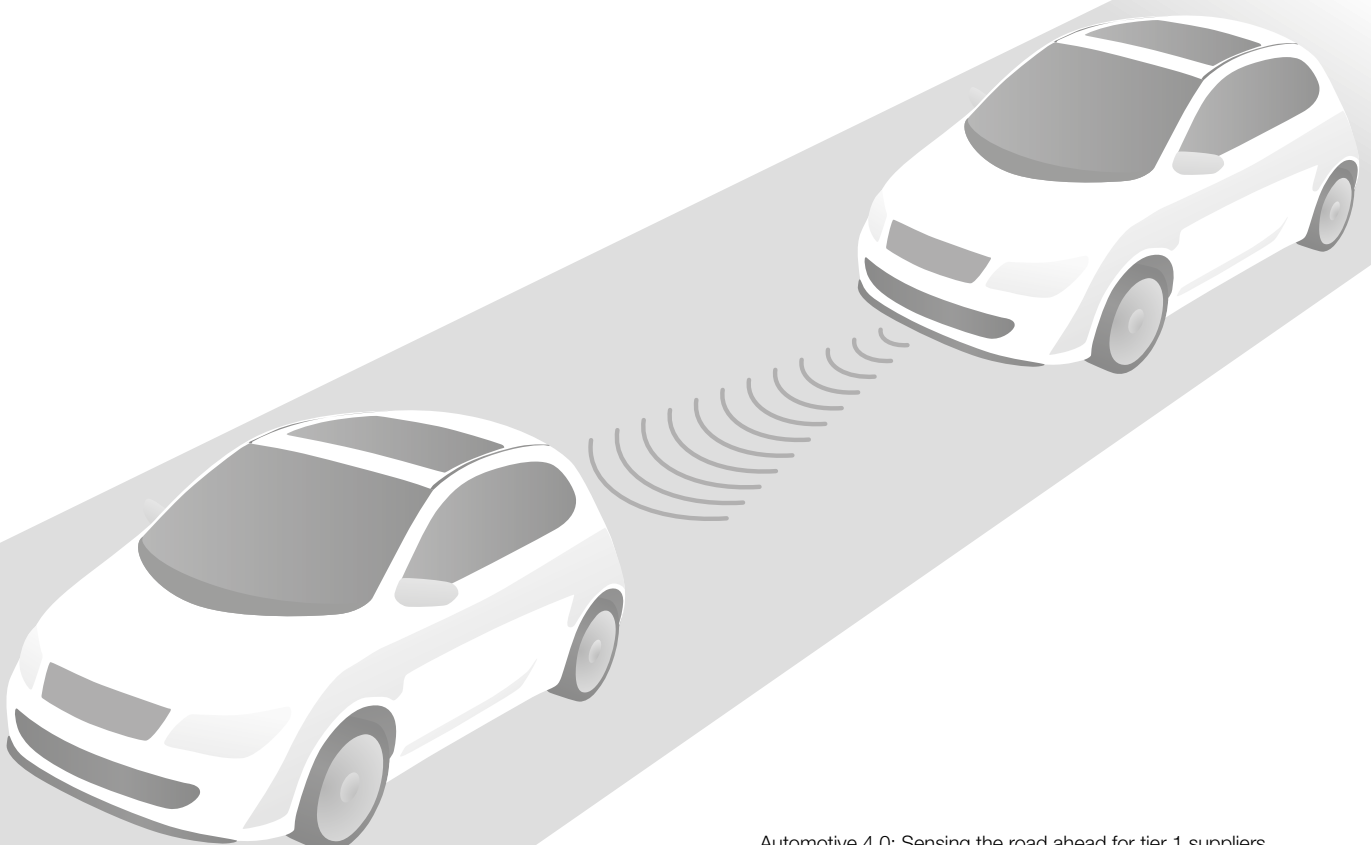
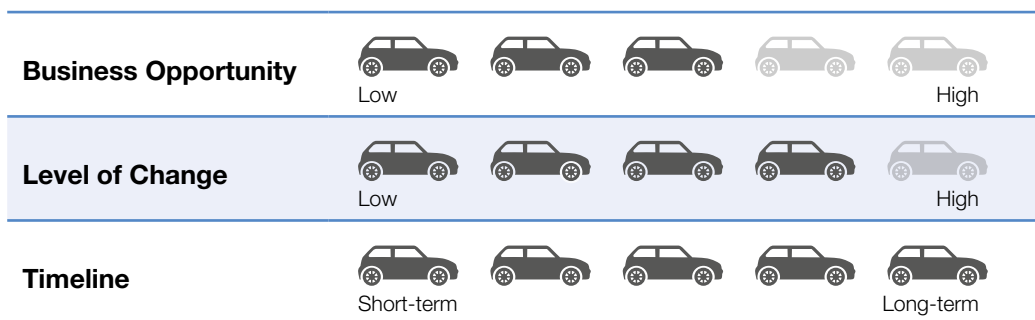
Software development and analytical capabilities will mean a major change to current potential tier 1 suppliers.

Score: 1 = low to 5 = very high | Source: NTT DATA assessment

Summary

First models of cars with full self-driving capabilities will be ready for market in 2020. Question is if politics and legislation in the target markets will keep up with the technological pace and - in the best meaning of the word - pave the way for self-driving vehicles on our streets. New sensor technology, central processing units and analytical software creates incremental business opportunities for tier 1 suppliers. Packaging all those components in one integrated 'autopilot' system will reduce the integration efforts for the OEMs and will help

tier 1s to differentiate from competition. Standards will become vital to ensure seamless interaction with other systems in the car. New players like Google or Apple may require expedited development processes and a start-up like mind set. Software development and analytical capabilities will pose a challenge to tier 1 suppliers. Increased liability expectations from the OEM towards the tier 1 will arise due to shift in responsibility from the driver to the car and its technology.





"We will only be able to have self-driving vehicles on the highway in 2020 with highly accurate maps."

Dirk Hocheisel,
General Manager, Bosch

"Just the sensors necessary for autonomous driving on their own should account for a market volume worth ten billion Euros in 2020,"

according to Continental's
CEO Degenhart.

"We want to be one of the leading suppliers for all products in order to meet the demands of the new mega-trends. Naturally, we also want to become one of the leading innovators in the areas of autonomous driving and driver assistance systems and are therefore investing heavily."

Stefan Sommer, CEO, ZF Friedrichshafen AG



02 CONNECTIVITY

While for most premium manufacturers, connectivity or connected car services are entering the mature stage, it still remains a subject of improvement for many mass market OEMs and thus for tier1s.

For example, BMW's ConnectedDrive presents the driver with services like real-time traffic information, intelligent emergency call, tele services, online entertainment or remote control parking. Mercedes connect me, Volkswagen's Car-Net or Land Rover's InControl and many others offer a reasonably comparable portfolio of services, each of course with 'differentiating' bells and whistles. A further hot working item is the seamless integration between drivers' smartphones and the in-car infotainment system, for example based on Apple's CarPlay or Google's Android Auto. It seems the race for in-car operating systems has just begun and more consumer electronics will make it into the car. Using consumer technology in the car was once frowned upon by the automotive industry with its ultra-high standards, but now this is increasingly being accepted.

In terms of market outlook, analysts predict that the connected car market and hence the opportunity for tier 1 suppliers will grow at a compound annual growth rate of 40-50% and that by 2020, 70-80% of the cars shipped globally will come with built-in internet connectivity. By 2027, it is even forecasted that 100% of cars shipped in Japan, North America and Western Europe will feature in-vehicle connectivity. This will be different in low-cost, mass markets like India or China.

Let's also not overlook the automotive aftermarket which may present additional opportunity for tier 1 suppliers to provide connectivity devices plugged into the on-board diagnostics port of the car. While these may not give your car the full range of connected car services that come with built-in functionality, they 'at least' can provide telematics data to a smartphone app or a web portal.

„Our goal is to disrupt ourselves, and own the customer relationship beyond the car.“

Mary Barra,
Chief Executive Officer,
General Motors

The opportunity for tier 1 suppliers related to connected cars primarily sits within the technological components used to create the end-to-end connectivity experience and requires components inside and outside the actual vehicle. The components inside the car encompass the head-unit or infotainment system,

a communication module, the CAN bus, various electronic control units, a cyber-security 'solution' or an aftermarket connectivity device. Components outside the car include the mobile network (3G, 4G), physical infrastructure (e.g. traffic lights, parking garages) and a vehicle backbone (connected car service delivery platform). The vehicle backbone serves as the central hub to receive and send data from and to the cars and to provide the desired services; in many cases these services may also include an OEM app store.



Technology Required Inside The Car

Car component	Component purpose	Supplier examples	Incremental opportunity for suppliers	Qualitative growth expectation
Infotainment system / head-unit with (embedded) software	Provides the user interface for the driver to choose certain functions	Alpine, Continental, Harman,	Provide substantially improved user experience through new in-car operating systems (players like Apple, Google, Microsoft, etc.)	Medium to high
Communication module (GSM / WLAN)	Transfers data between the car and its environment / connect to the mobile network or to physical infrastructure or other vehicles using 3G or LTE	Harman, Peiker	Existing suppliers to grow volumes with increasing number of connected cars	High
Electronic control units	Provide data about or control the state of the specific functions of the car, e.g. location, trip data, battery / fuel status, driving behaviour, windows / doors status, etc. Head-unit will send commands received online to the respective ECU, e.g. lock doors.	Various, e.g. Bosch,	In general this will be business as usual with some modifications or product refreshes.	Low to medium
Cyber-security	Blocks unwanted access to the car / identify errant messages from external	Entire ecosystem of OEMs, tier 1s, IT players	Rising opportunity to provide car security software; could be existing security software providers from the IT space, existing in-car OS providers, completely new SW dev players or new business unit within existing tier 1, or semiconductor suppliers with built-in security software	High
Aftermarket connectivity device plugged into OBD	Enables originally „disconnected“ cars to become „connected“	Mojio, Vodafone	Additional opportunity by selling aftermarket connectivity devices for cars which do not originally have such a capability	Medium

Digital Vehicle Security

Hackers recently hacked a Jeep Cherokee and remote controlled the car. Other hackers did stop a Tesla Model S and yet others identified a major flaw in GM's OnStar. All this shows that the automotive industry is behind the curve when it comes to ensuring cyber security in their car models. Over-the-air software updates in the car – as already practiced by Tesla – will find its way to the mass market and will even exponentiate the challenge to ensure digital security in the car. IT history has proven that whatever can be hacked, will be hacked. In contrast to traditional cyber security in IT systems where a hole mostly means loss of data or financial damage, a bug in the digital vehicle security can immediately threaten human lives. What vulnerabilities exist inside and outside of the car? What security frameworks and models are required? What standards need to be developed? What kind of collaboration is needed? What will the connected car ecosystem look like? All those questions and probably many more need to be addressed in order to tackle the problem as a whole and not only piece of it. OEMs and tier 1s need to acknowledge the issue and start working in a collaborative way across traditional company

borders to fix it. The problem will not be fixed by one company on its own but only through a holistic effort that considers the requirements of such a complex system of system in its solutioning approach. Further, the main challenge for most automotive companies is that software development has not been a core competency. And this issue needs a speedy solution so neither OEMs nor tier 1s can afford to grow this capability organically and be bound to the traditional long-term automotive development cycles. They need to learn from cyber security experts outside the traditional automotive landscape with a strong background in Information Technology and apply proven IT approaches to tackle this challenge. Vehicle security needs to make its way into the regular development process of the car, e.g. for ECUs or the head-unit. This opens room for new players with specialised solutions to enter the automotive market and ultimately become a potential take-over target. Players like Tesla, Google or Apple are genetically much better suited to develop computer on wheels rather than most OEMs and tier 1s. This can certainly add an increased level of dynamic to the auto ecosystem.



Technology Outside The Car

Car component	Component purpose	Supplier examples	Incremental opportunity for suppliers	Qualitative growth expectation
Mobile network (3G, 4G)	Transmits data to and from the car to a vehicle backend system („connected car cloud“)	Mobile network operators, e.g. T-Mobile, AT&T	Existing network operators to scale data volumes with number of connected car	Medium
Physical infrastructure	Provide status information from speed signs, road signs, traffic lights or parking garages	Mostly in research phase	Equip the physical infrastructure with sensors, actuators and communication capability	Medium to high
Connected car service delivery platform	Main recipient of car and infrastructure data; provides the interface to remote control of the car through mobile apps or web-browser; analyses (big) data and provides next-best action recommendations, e.g. predictive maintenance, break-down service, accident emergency support; also often includes an app store; will deliver over-the-air software updates to the car	IT system integrators, e.g. NTT DATA	Implement a vehicle backbone / connected car cloud, integrate with other backend systems and operate it long-term	High

Connected Vehicle Service Delivery Platform

The other new software component is the connected vehicle service delivery platform, also called connected car cloud or vehicle backbone. It serves as the central integration platform and creates a direct channel to the car and to its driver and passengers. This platform allows the integration with the vehicle of various players like the OEM (of course), a service desk, dealers and repair shops, insurance companies, emergency rescue services, media and content providers, utility companies (in case of electric vehicles), fleet operators, infrastructure operators, or mobile network providers. Thereby it enables the creation of completely new business models, may increase brand loyalty and opens new revenue streams.

Such a platform needs to be highly secure, scalable, flexible and reliable to cater for the requirements given by the various parties involved. Simply spoken this is a piece of software – quite a complex one. And again, software development is not a core competency of the OEMs and also not of many tier 1s. Exceptions prove the rule. Given the strong market outlook for connected cars, the OEM will either have its own platform developed or will use a pre-developed platform by a third party provider. Not having such a platform in the future is not a realistic option. In terms of own development, OEMs typically work together with external consultants and system integration firms. In terms of third party, such platforms are either provided by large, innovation-driven tier 1 suppliers with a strong affinity towards software or by network operators / network equipment providers that have tweaked their existing mobile service delivery platform and flavour it automotive.

Since an increasing number of OEMs have established or are in the process of establishing a platform, the window of opportunity for tier 1s is narrow and shifting to higher gears is required. Once in the game, it may not only present the opportunity for one-time revenues but also to operate such a platform on an on-going basis with continuous revenue streams down the road. Acquiring the necessary software and IT skills in such a high speed race is not an easy task but feasible with the right partnering approach.

Besides building and operating such a platform, is there any revenue potential for the tier 1 with regards to connected car business models? Our analysis shows that we expect only low to medium potential for tier 1 suppliers to benefit from the incremental revenue streams coming through connected car business models. We see potential in navigation and traffic information services, car-locating and geo-fencing, parking, battery charging, predictive maintenance or remote diagnostics services. In order to leverage the latter two, tier 1 suppliers need to be directly in the communication loop when a car is sending information about a critical component which is about to break down or has broken down already. The tier 1 supplier could then provide an expedited spare parts management process and closely collaborate with the repair shop to minimize waiting times and hassle for the driver. Of course such a model would need the strong support of the OEM which is unlikely to happen since OEMs are still trying to figure out their way how to monetise connected car services. Tier 1s may be more successful in approaching large fleet operators and providing their value-added services directly to them.



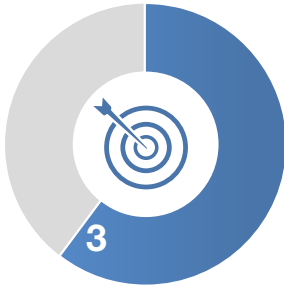
Service category	Connected car business model	Expected revenue model	Main competitors for tier 1 suppliers	Estimated service opportunity for tier 1 suppliers
Infotainment	Music, video, TV streaming	Flat rate or per usage	Content providers (e.g. Spotify, iTunes, Apple Music, Google)	Low
	Weather & news	Free	Information brokers, websites	Low
	Internet surfing	Free	Websites	Low
	Social media	Free	E.g. Facebook, Twitter, LinkedIn	Low
	Ticketing and reservation	Per usage	E.g. ticket brokers, travel agencies, cinemas	Low
	App downloads	Per usage	App store provider, developers	Low
Location-based services	Navigation and traffic information services	Flat rate, free	Navigation service providers, e.g. TomTom, Google Maps, Here	Low to medium
	Points of interest search	Mostly free	Navigation service providers, e.g. TomTom, Google Maps, Here	Low
	Car locator, geo-fencing	Flat rate, per usage, free	OEM	Medium
	Parking	Per usage	Parking infrastructure operators	Medium
	Gas stations, fuel prices	Free	Fuel price portals	Low
	Battery charging stations			Medium
Assistance services	eCall (emergency call)	Free	Emergency rescue services	Low
	bCall (break-down call)	Flat rate, per usage, free	OEM, dealer, repair shop, automobile clubs	Low
	Predictive maintenance	Flat rate	OEM, dealer, repair shop, tier 1 supplier	Low to medium
	Over-the-air software updates	Flat rate, per usage, free	OEM	Low
	Remote diagnostics	Free, flat rate	OEM, dealer, repair shop, tier 1 supplier	Low to medium
	Services appointments	Free, per usage	Dealer, repair shop	Low

Service category	Connected car business model	Expected revenue model	Main competitors for tier 1 suppliers	Estimated service opportunity for tier 1 suppliers
Remote control services	Climate, heating	Free	OEM	Low
	Battery status and management	Free	OEM	Low
	Vehicle usage data, driving behaviour	Free	Primary: OEM, secondary: insurance companies for driving behaviour based pricing	Low
	Door lock	Free	OEM	Low

Source: NTT DATA assessment



Impact of Connectivity on Tier 1 Suppliers



Corporate strategy

Tier 1 suppliers will face a very strong competition from OEMs in building new business models. Suppliers will have to balance such an approach with their „usual“ OEM customer relationship.



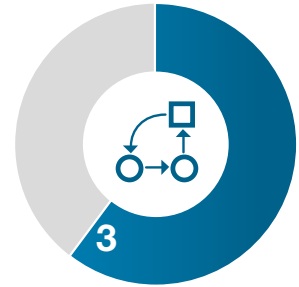
Product portfolio

Broader portfolio will be required in line with components required inside / outside of the car.



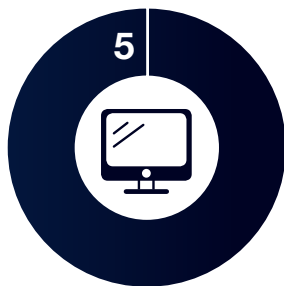
Organisation

Adjustments in development and sales functions / roles to cover this new market segment.



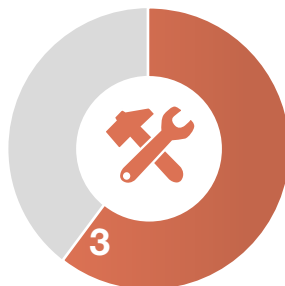
Processes

Adjustments of development processes for the delivery of new components and services. New processes for the delivery of connected services.



IT landscape

Extended (embedded) software development capabilities and need for systems engineering. Setup of a connected car cloud-based platform.



Manufacturing capabilities

Adjustment in manufacturing capabilities in line with extended portfolio.



Employee skills

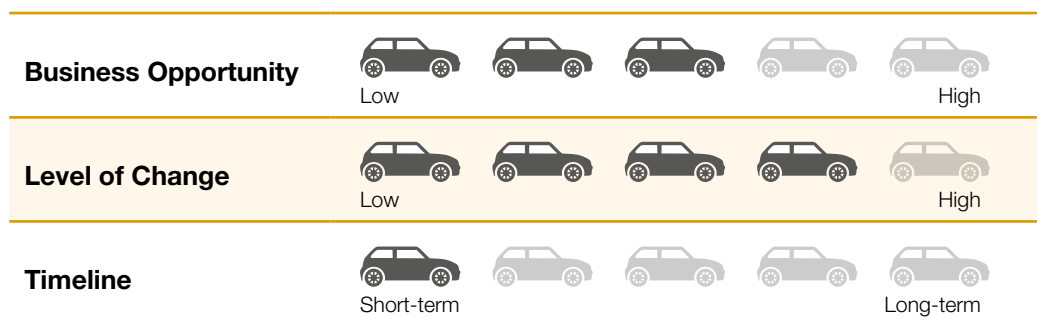
Extended hardware and software development skills required.

Score: 1 = low to 5 = very high | Source: NTT DATA assessment

Summary

Connected vehicles probably represent the most near-term area of opportunity for OEMs and consequently for automotive tier 1 suppliers. Market analysts predict that by 2020 70-80% of cars shipped globally will come with built-in internet connectivity. The opportunity for tier 1 suppliers is mainly centred on the components inside and outside the vehicle. With the exception of very few large tier 1 suppliers, we do not foresee any major opportunity related to

new services business models for tier 1s. In most cases, the OEM would have to accept their tier 1 suppliers to take a different, more end customer centric role than before. Developing and building components for the connected vehicle will require even more software skills than ever before from the tier 1 supplier and agile development methods will become the pre-dominant way of working between the supplier and the OEM.





“Furthermore, the vehicle will become part of the internet. Who can access which data should be the vehicle owner’s decision.”

Dr Elmar Degenhart,
CEO, Continental AG



“Electronics and software are more important to the automotive industry than ever before.”

Sachin Lawande, CEO, Visteon



03 POWERTRAIN ELECTRIFICATION

The electrification of the powertrain has been a topic of hype for quite a while but it seems disenchantment has taken the place instead. There were just above 400 000 electric vehicles officially registered in 2014 in contrast to 100 000 units in 2012. The global sales forecast for 2015 is expected to break through the 1 million barrier.

By 2020, the market is forecasted to reach 8 million registered electrical cars – compared to an installed base of approx. 1,3 billion cars this correlates to a share of 0,6%. So this must be a long-term play and OEMs as well as tier 1 suppliers will require a lot of stamina in the wait for electrical vehicles (EV) to become a source of major revenue and profit. For quarterly-driven tier 1 suppliers such long-term investments (+10 years ahead) may pose additional challenges. For privately-owned suppliers this may be their perfect playground.

Tesla, for instance, has built its business model solely on EVs. BMW - with its i-branded cars - has established a whole new product line along with

“We believe that Tesla, other companies making electric cars and the world would all benefit from a common, rapidly-evolving technology platform.”

Elon Musk,
CEO, Tesla Motors

will certainly be a key factor in achieving broad market penetration. Bosch estimates that by 2020 an EV will be 45% more expensive than a comparable traditional model. In anticipation of a growing demand for EVs most tier 1 suppliers have aligned their product portfolios with the new technology. In doing so, they aim to position themselves as the prime partner for OEMs.

An electrical vehicle has a much lower amount of moving parts than a traditional car. This will dramatically reduce its overall complexity and improve serviceability. While the industry has made good progress, the battery is the most costly single part of an EV, and the cost per kWh is expected to be approximately \$170 to \$200 by 2025. For a Tesla Model S 70D which assumingly has a total battery capacity of 70 kWh, this translates to a cost of \$11.900 to \$14.000 - almost 17% of today's sales price. For a market of 16 million EVs sold in 2025 and an average battery capacity of 30 kWh, this could result in a revenue opportunity of \$82 to \$95 billion for EV battery manufacturers. Bosch's recent acquisition of the Silicon Valley start-up and venture capital backed Seeo illustrates the hot competitive situation characterising this space.

The market opportunity for traction motors – the engine that powers an EV – is estimated to reach over \$25 billion in 2025. The design of these motors along with their position in the vehicle and how they are integrated is changing rapidly. There is an increasing trend to have more than one motor near the wheels, in the wheels or inside the transmission. As EV technology matures, it is possible for tier 1 suppliers to distinguish themselves from their competition by developing components which are highly price-competitive, flexible in their way of integration, very reliable and light-weight. Weight will be a differentiating factor for EVs as it has a direct impact on the distance a vehicle can travel with its given battery charge. This opens the space for tier 1s regarding new materials research, changes in product design and enhanced manufacturing methods, processes and tools.



Charging Infrastructure

In its attempt to become a leader in electrical mobility, the German government has recently announced plans to install more than 400 fast-charging stations all over Germany – on average every 30 kilometres. These stations allow recharging within 20 minutes and will be implemented in partnership with one of the largest providers of roadhouses in the country. However, this number is still light-years behind the number of regular petrol stations in Germany (2015: 14 209) and so highlights the enormous potential for providers of EV charging stations. The potential lies not

only in the physical hardware infrastructure but also in the operations of those stations via the utilisation of a suitable software platform e.g. for reservation, rating, payment or clearing purposes. Again this requires a lot of IT know-how and a potentially cloud-based service and represents a new field for historically hardware-oriented players. Naturally, these services are often provided by large utility companies and tier 1s do not seem to have ambitions in entering this space. However, it could form a very logical horizontal diversification of their existing business model.

Estimated market opportunity for EV batteries and traction motors

EV component	Supplier examples	Expected market size in 2025	Opportunity for tier 1 suppliers
Battery	<ul style="list-style-type: none"> ■ Panasonic: e.g. Tesla, VW ■ AESC: e.g. Nissan ■ LG Chem: e.g. GM, VW, Daimler, Ford or Renault ■ BYD: BYD ■ Samsung SDI (acquired Magna battery business): e.g. Audi 	\$82 to \$95 billion	High
Traction motors	Bosch, Remy International, ZF, Siemens, Continental	\$25 to \$30 billion	High

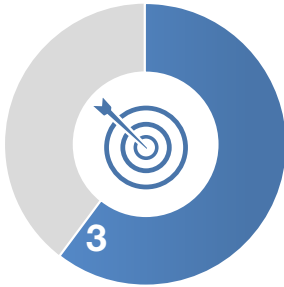
EVs May Threaten The Current Supply Base

While there is opportunity for tier 1 suppliers to grow their business in line with the growth of the EV market, there is also a threat for suppliers that earn their money today with the traditional combustion engine and associated powertrain components. These components include amongst others pistons, camshafts, spark plugs, injection pumps, turbochargers, fuel tanks, alternators, oil pumps, motor oils or manual and automatic gear boxes. For many of these components, there are highly specialised suppliers that have based their business model on a single product group and are therefore dependent on a single source of revenue. Suppliers with such a model are at high risk of disappearing in a 100% EV market scenario. Just picture the complex automotive landscape in Germany around Daimler in Stuttgart, BMW in Munich or VW in Wolfsburg. What tidal wave would the EV market evolution bring to these suppliers, to the cities they operate in, to their employees and families, to schools and universities and so on?

Yet fortunately, the market development for EVs is sluggish enough and hence grants such companies sufficient time to establish a second leg and align their business model and product portfolio accordingly. In many cases it will require a large amount of creativity, intelligence and risk-taking to make your company fit for the future, e.g. what do you do if you are a supplier of motor oils or pistons or fuel tanks today? What is the logical credible expansion of your business model? How do you grow new capabilities (organically, non-organically)? Some of the traditional suppliers may ultimately disappear. New players will emerge. Value add will shift between regions, countries and continents.



Impact of Powertrain Electrification on Tier 1 Suppliers



Corporate strategy

Battery charging and replacement may present additional room for opportunity and would require changes to the business model.



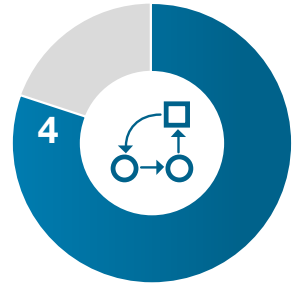
Product portfolio

Transition to EVs will be a long-term process so the portfolio can be adjusted over time accordingly; however compared to today the portfolio required for EVs is significantly different.



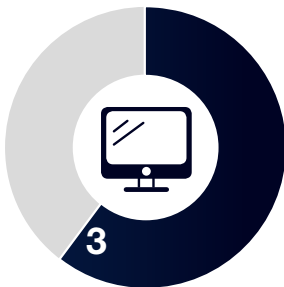
Organisation

Potentially dedicated EV business units will be established.



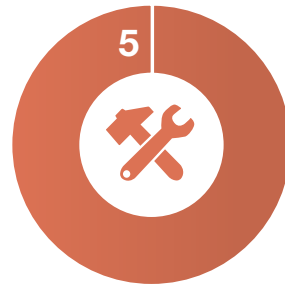
Processes

Minor adjustments in core R&D processes expected. Battery replacements and operations of charging stations.



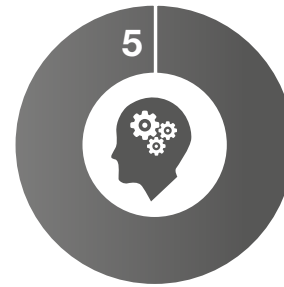
IT landscape

Minor adjustments in core IT landscape expected. If new business models like charging infrastructure will be operated, then IT needs to change.



Manufacturing capabilities

New manufacturing methods and equipments will be required, e.g. for the production of traction motors or battery systems.



Employee skills

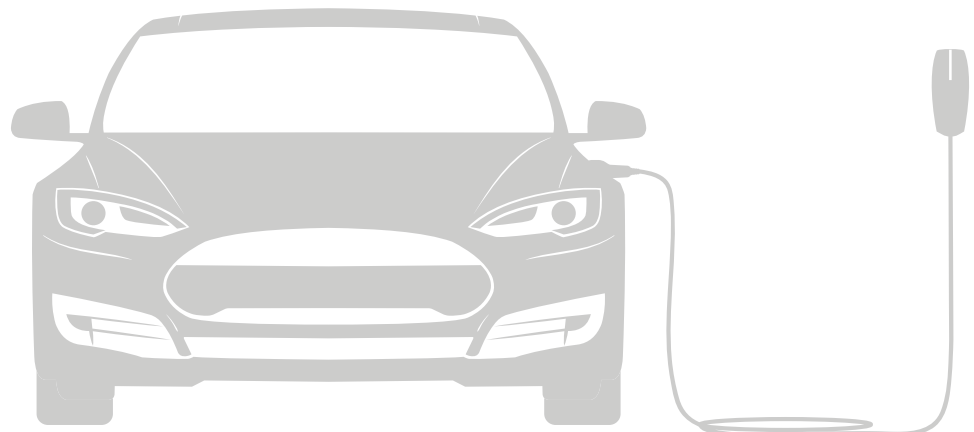
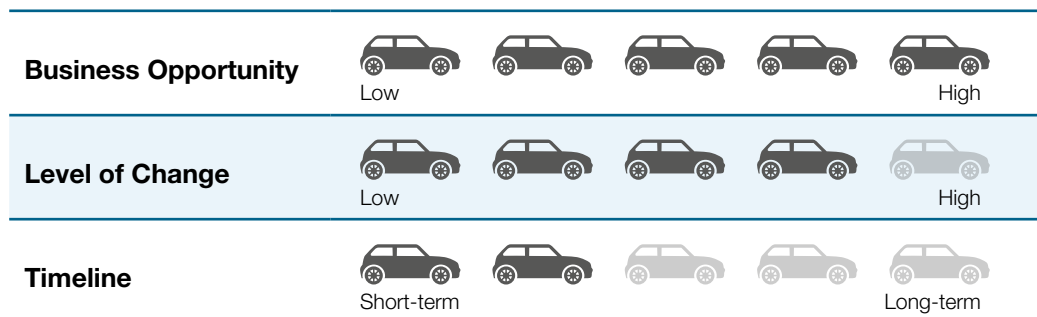
Significant change to skills, especially in R&D, product management and sales.

Score: 1 = low to 5 = very high | Source: NTT DATA assessment

Summary

The transition from traditional combustion engines over to hybrids and finally to electrical vehicles will be a long-term roadmap which gives the OEMs and the suppliers enough lead-time to transform their business model accordingly. However, the seeds need to be planted today. In an EV-only extreme scenario, it would have a dramatic effect on the incumbent supplier landscape. Suppliers that are highly specialised in mechanical or electro-mechanical components such as pistons, camshafts or spark plugs will become an endangered species as EVs will simply not need these parts anymore. Such suppliers need to adjust their portfolio now and identify credible extensions to their current primary market segments. As EVs will feature much

less complexity in its overall powertrain there is a certain risk that commodity players with low-cost manufacturing capabilities will win over players that are highly specialised and operate out of high-cost nations. It already appears that battery technology will be dominated by Asian players such as Panasonic or LG Chem in the future even though European players are pushing forwards. See, for example, Bosch and its acquisition of Seeo or Tesla's gigafactory that is planned to go live in 2017. Ultimately, this will be a 'cost per X' battle, comparable to what happened in the photovoltaics industry with manufacturing capacities mostly shifting from Europe to China.





“Increasing hybridisation, including 48-volt technology, will pave the way for electro mobility. Hybridisation encourages sensible value for money and makes it possible for drivers to gain initial experience with electro mobility.”

José Avila, member of the Executive Board at Continental and Business Director of the Powertrain Division

“I am positive that we will make huge progress within the field of battery technology. By 2020 we aim to have halved the costs and doubled energy density. To this I am committed.”

Volkmar Denner, CEO, Bosch



04 NEW ENTRANTS

If you were to look at a Porter's Five Forces analysis for the automotive industry from a few years ago and check the details in the "Threat of new entrants" quadrant, you would easily notice that the stereotype answer is "low" because of 'high initial capital investments', 'very intense competition dominated by established companies' or because 'well-known brands have a rock-solid market position'.

Now, a few years later, we all know that this is certainly not the case anymore. Companies like Tesla, Google and Apple all have the potential to significantly change the appearance of the automotive landscape for the next years coming. So what has changed since then? The most obvious answer is probably 'cash'. Apple has approximately \$200 billion in cash on hand - this is almost equal to the gross domestic product of Greece or Qatar. Google's cash reserves are predicted to hit \$100 billion in 2016. This is more than a cushy base for these two giants to spend some of those reserves in new business opportunities. Tesla's situation, however, is a little bit different. Funded in the Series A round mostly by Elon Musk, who personally invested \$7,5 million, it has been Tesla's strategy to enter the market with a premium roadster and then broaden the business into more mainstream vehicles that include sedans and affordable compacts. The profits from the preceding model should then cover the investments required to build the next vehicle and hence expand the product portfolio and revenue basis, step by step.

Apple's project "Titan" is rumoured to be undergoing research and development of an electric car. While there is a lot of speculation about this project, there are some indications that Apple in fact could be entering the automotive market. For example, Apple is hiring automotive managers and engineers away from traditional OEMs, discussing renting space on an old Naval base to test-drive cars or meeting with top-ranking BMW officials at the Leipzig plant to discuss the re-use of the i3 as a platform. Whether project "Titan" is related to an actual vehicle or limited to technology required for self-driving cars or if it even exists at all cannot be confirmed at this point in time. Apple often ventures into new spaces but, given its requirements for design and truly disruptive products, not too many of these really make it to market.

"The car is the ultimate mobile device, isn't it?"

Jeff Williams, Senior Vice President of Operation, Apple

In contrast, the "self-driving car project" by Google X is much more known to the public and includes different types of prototype vehicles like the Toyota Prius, Audi TT or the Lexus RX450h. Google is said to use equipment from Bosch, ZF, LG and Continental in their robot cars. The technology packed into these cars is worth \$150 000 and includes a \$70 000 Lidar system supplied by Velodyne. The latest version of the car is assembled by Roush Industries Inc. - a specialty manufacturer that is known for its Ford Mustang models. Google is also said to be working on a premium robot taxi service in order to enter the market of new transportation modes and take away market share from Uber.

Taking a look over the Pacific Ocean, many things have happened since Chinese cars - like the Landwind X6 - miserably failed the EuroNCAP crash test a few years back. Automotive makers such as Chang'an, Xindayang, BYD or GAC have the potential to enter the global sales stage. In particular Chang'an takes a special position in the vast number of Chinese manufacturers and has recently received an award for its global potential. Amongst 33 cars that have been tested in a 2013 EuroNCAP crash test, the Chinese model Qoros 3 has achieved the best results. In a strive for excellence, Chinese manufacturers have hired experienced designers and engineers from European and US OEMs. Consequently, a much improved level of product quality and design can be expected from Chinese cars.

Having the right supply base plays a key role in the future success of these new entrants. Whether you are looking at Google, Apple, Tesla or Chinese OEMs, all of them understand very well that working with established tier 1 suppliers who have mature and innovative technologies is a key ingredient on the road to automotive industry disruption. For example, Tesla has selected Dräxlmaier - a German headquartered supplier of interior systems,



cockpits, wiring harness and electrical management systems. Schaeffler – a supplier of high precision components for engine and powertrain applications – has received top supplier awards from Chang’an and BYD. Magna has received customer excellence awards from GAC and Chang’an. Bosch is supplying Google’s test fleet with the electrical traction motor, power electronics, sensors and electrical steering. Hannover-based Conti is Google’s supplier of choice for braking systems, tires, electronic control units and wheel rotation speed sensors. After reviewing

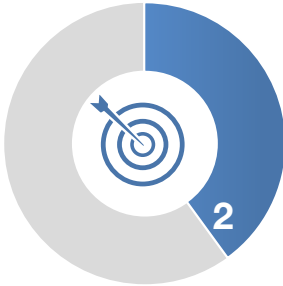
the financials of the top 10 automotive suppliers with headquarters in Europe and North America, it turns out that they generate between 18% to 28% of revenues in Asia and hence with OEMs active in this market. The share of employees in Asia typically follows this distribution, with only a few exceptions. This trend – largely driven by the automotive market growth – will continue as suppliers need to sell their products to local Asian OEMs (in particular China) and also to foreign OEMs with manufacturing sites in Asia.

So what does this all mean for tier 1 suppliers?

In general we do not anticipate new entrants to expand the automotive market size beyond the current trajectory as such. The strategy of new entrants will be about eating away market shares from incumbents. However, for tier 1 suppliers that are able to make quick and sound decisions in working new entrants, it may pose an additional revenue opportunity. Some suppliers may even face internal reluctance or sloppiness when approached by new players. Reluctance in that tier 1 decision makers may be concerned about jeopardizing existing OEM relationships once it becomes public that the supplier works with - what some OEMs may perceive as - the “new enemy”. Sloppiness in the form of tier 1 executives, who may not comprehend the full potential of new entrants when approached to deliver

initial small lot sizes and ‘digest’ development cost in more unusual ways. New entrants – in particular the ones with a strong software background – will require a much different (higher) pace than most traditional OEMs require from their tier 1 supply base. Agile development will be a new phrase that suppliers need to add to their daily process and project vocabulary. Furthermore, new entrants will demand a more pragmatic approach to the entire business relationship, which is not bound to working along a formal milestone and gateway plan that spans 3 to 5 years. All this poses a major change to the established business philosophy of tier 1s and requires new mind set, from the top level of the organisation down to the shop floor workers.

Impact of New Entrants on Tier 1 Suppliers



Corporate strategy

Working with new entrants may require slightly adjusted terms & conditions but no major change to the current business model expected.



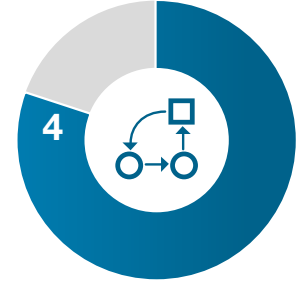
Product portfolio

Only adaptations of the portfolio to fit the requirements of the new entrant. Requirements related to autopilot resp. connectivity are treated in separate chapters as part of this study.



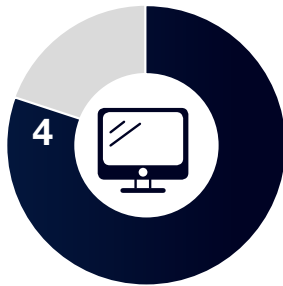
Organisation

New sales organisation (centrally and locally) may be required.



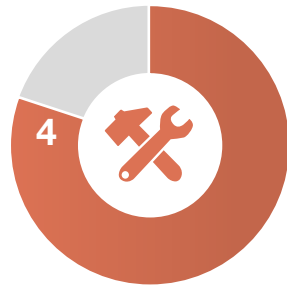
Processes

Expedited and very pragmatic development, manufacturing and sales processes may be required to match the speed of the new entrants which typically have a start-up culture.



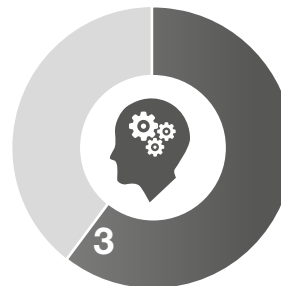
IT landscape

A modular, component-based architecture will support the pursuit of new customers, markets and products and enable expedited processes. Software development and systems engineering will gain importance.



Manufacturing capabilities

Rapid prototyping and use of 3D printing technologies will help to get modules and components out faster to the new entrant.



Employee skills

Speediness, a start-up like mind set and intercultural skills (esp. Chinese) in working with new car makers will be required.

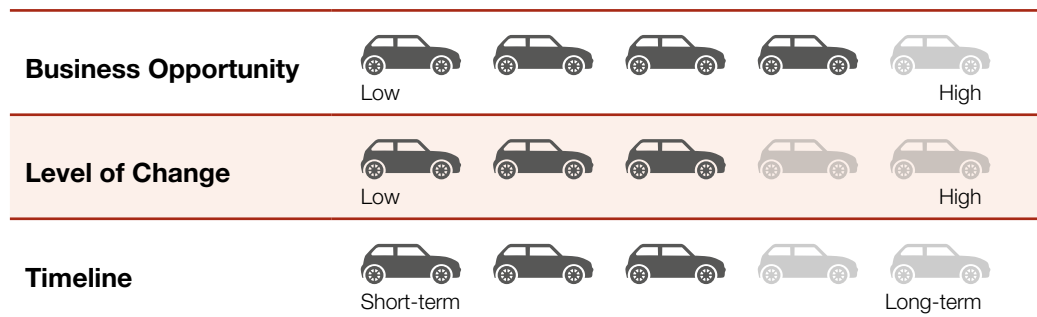
Score: 1 = low to 5 = very high | Source: NTT DATA assessment



Summary

Google, Tesla, Chinese OEMs and purportedly Apple will be bringing change to the once so settled automotive landscape. Even it cannot currently be reliably stated how the centres of gravity and market shares will shift, it is foreseeable that traditional OEMs will need to update their view on their competitive landscape. The rise and fall of companies in other industries substantiate the conclusion that powers in an ecosystem can change, e. g. the story of Nokia and Apple in the

mobile phones business. New players will be a good thing for the automotive market as this will drive up innovation and drive down costs for end customers. For suppliers who liaise with these players in good time, this may mean increased market opportunity. Working with these new players, however, will be different than working with traditional OEMs in terms of the increased emphasis on speed, flexibility, innovative capacity, risk taking and pragmatism.



“Asia is now a priority region for Faurecia ... Faurecia has also begun forging strategic alliances with Chinese automakers such as Geely (which now owns Volvo), the Xuyang Group and, more recently, Chang’An.”

Faurecia Website

“Chinese manufacturers are fully intending to enter the global market.”

Dr. Rolf Gall, Head of the ZF Engineering Center Shanghai

“Magna International Inc. would be an ideal partner to manufacture vehicles for Apple Inc., Google Inc., or other new entrants that might decide to jump into the automotive business.”

Donald Walker, CEO,
Magna International





05 SUPPLY CHAIN DIGITISATION



Supply chain management is to the automotive industry what a river is to a water mill. From the invention of the barcode in the 1950s, over to the introduction of just-in-time as part of Toyota’s production system in the 60/70s, the development of the theory of constraints by Goldratt and Cox in the early 80s, or the appearance of Enterprise Resource Planning applications in the 1990s, supply chain management is undergoing a constant, evolutionary process. What will the supply chain world look like in 2020? We believe the answer lies in autonomy and self-regulating mechanisms that take the burden from today’s still very labour-intensive processes.

The ever increasing complexity of products, systems and parts is pushing many OEMs to the limit of their current processes and IT applications. Only seven to eight years ago an average car had around ten to fifteen networked electronic control units. In today’s premium cars this number is going up to ninety ECUs and more. The product portfolio has also dramatically increased: In the mid-1990s Mercedes-Benz had eight models (Baureihen) whereas today they have twenty-two. The complexity rises if you look at the increase in the number of production sites spread across the continents due to OEMs’ on-going globalisation efforts. All this drives the need for a higher level of transparency and automation in today’s ultra-complex global supply chain networks.

Many OEMs have sensed the urgency and have initiated large-scale internal transformation programmes in order to achieve cross-functional integrated supply chain planning and execution. These initiatives are aiming at a highly sophisticated forecasting of primary demands from end customers across markets, models and features, the conversion of those forecasts into secondary demands (i.e. modules, parts) and the calibration with internal production capacities and external supplier capacities. This can only be achieved by transforming given supply chain processes and their related planning and execution applications – inside and outside of company borders. In addition, the increasing requirement for real-time information and effective communication across the supply network is critical for managing and optimising the supply chain in a flexible way.

The buy-in and active involvement of the OEMs’ supplier network is critical in order to make it all happen. However, there is a fair amount of complication in this endeavour. Firstly, most suppliers are working with

a fair number of OEMs and therefore need to adapt to individual requirements and standards. This typically exceeds the level of effort and investment they are able to commit. Secondly, transparency of capacities may be a very good thing for the OEM but in contrast it may limit the flexibility of the supplier in reacting to various, fast-changing OEM demands. Obviously, the

OEM has the contractual relationship with the tier 1 supplier but how does he ensure the participation of tier 2 or tier 3 in this end-to-end pursuit?

Transparency should not stop at the tier 1 but has to go upstream all the way to the first grain of sand. Otherwise the OEM will never be able to identify bottlenecks in the supply chain that will then drive a bullwhip effect downstream.

Implementing new processes and applications will not solve the problem alone. Technology is not a hurdle anymore: IT applications have matured and companies have much improved the introduction of new systems. Big data volumes can be handled by in-memory databases and interpreted in real-time by advanced analytical software running on a hardware / cloud infrastructure that is more powerful than ever before. Sensors and actuators as part of cyber-physical systems are also entering the phase of maturity; internet-connected devices are becoming ubiquitous and wireless networks have reached broad geographical coverage at high data speeds.

„It is no more and no less the question of the complete digitisation of the entire value-added chain – spanning across research and development to production and, finally, to sales and distribution.“

Dieter Zetsche, CEO, Daimler AG

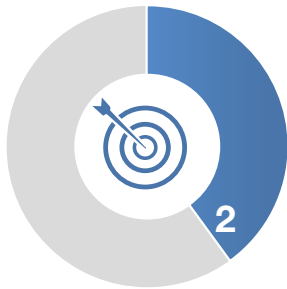
3D printing technology opens up completely new manufacturing and inventory methods: do you have to store a spare part for the next 20 years or do you print it once you actually need it? The synchronisation of the collaboration between developers, suppliers, OEMs, 3rd party logistics providers, dealers and customers will be very much coined by the use of those new technologies in the future.

Many of these so called “Industry 4.0”, “Internet of Things” or “Digitisation” initiatives aim at automating formerly highly manual supply chain and manufacturing processes and create truly autonomous entities. In the future, value add processes will be managed and controlled by the production resources in real-time. Products themselves will become intelligent. Decision-making will be decentralised and planning cycles will become much shorter than they used to be.

Besides technology, this undertaking needs an active change management effort alongside a robust business case for all parties involved to successfully implement such a large-scale transformation. With all OEM style individualism and competitive edge thinking, the industry would have to agree on functional and technical standards to ease the way of integration between companies. If every OEM tries to push through its own ‘standards’ this will fail before it has actually started. Tier x suppliers will simply not be able to afford it. Suppliers also need to be able to retain a certain flexibility in balancing demands coming from different OEMs. Taking away this flexibility will also kill the thing itself.



Impact of Supply Chain Digitisation on Tier 1 Suppliers



Corporate strategy

Autonomous entities in the supply chain may mean a change to the business model. Since less manual work needs to be carried out, resources may be freed up for higher value add.



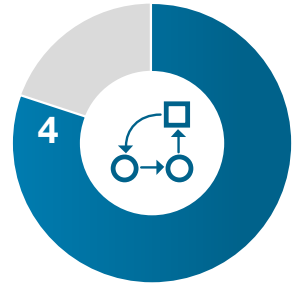
Product portfolio

No major change expected.



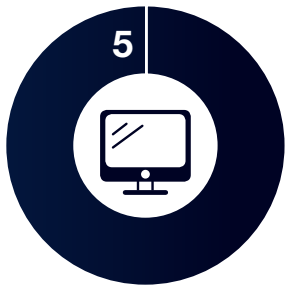
Organisation

Adjustment in roles and planning / execution functions can be expected.



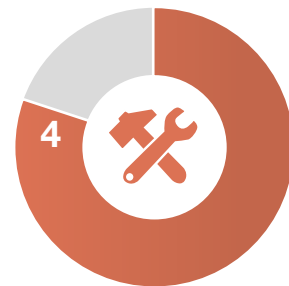
Processes

Changes to supply chain planning and execution processes expected (including inbound and outbound processes for real-time logistics tracking and optimisation).



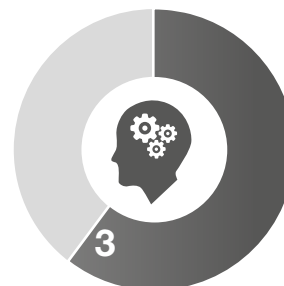
IT landscape

IT landscape needs to be adjusted in accordance with enhanced processes. Former infrastructure may not suffice anymore since new bus architectures will be required.



Manufacturing capabilities

Digitisation of manufacturing equipment as part of „Internet of Things“ or „Industrie 4.0“ initiatives.



Employee skills

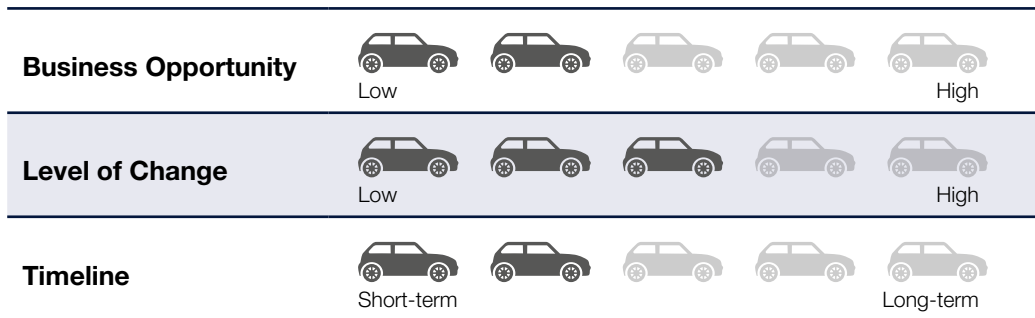
Employee skills need to be aligned with new supply chain planning and execution processes.

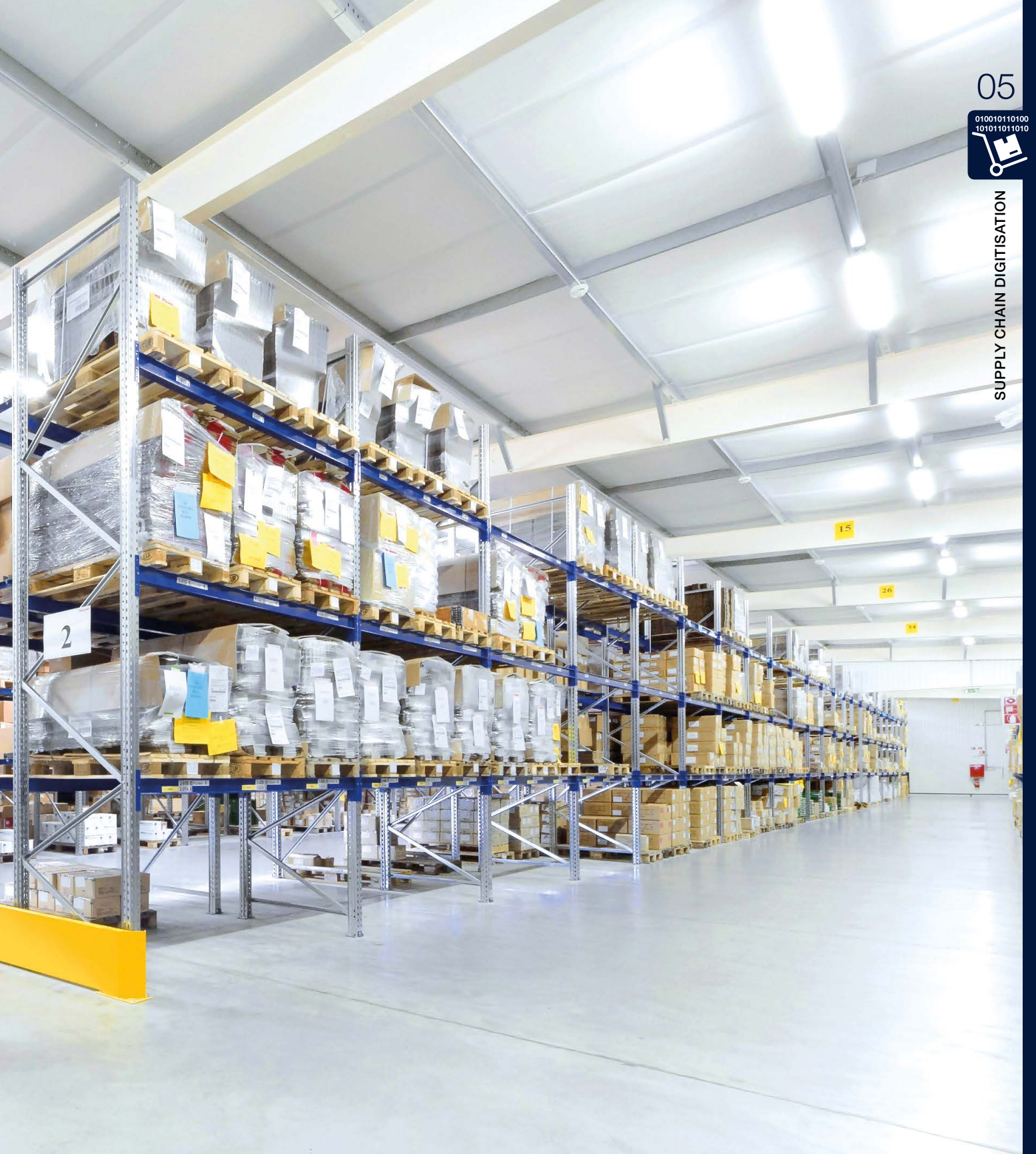
Score: 1 = low to 5 = very high | Source: NTT DATA assessment

Summary

Automotive OEMs are confronted with ever increasing complexities in markets, product lines, products, options, parts, manufacturing sites and suppliers. While spreadsheets ruled the business many years ago, this no longer suffices in today's high-paced environment. This complexity drives the need for a higher level of transparency and automation in today's ultra-complex global supply chain networks. OEMs and suppliers need to achieve an even tighter integration of processes

and application across company borders. Industry-wide frameworks and standards will help to make such a large-scale transformation affordable in particular for the tier 1 to tier n suppliers. Solo attempts from OEMs within "their" supply chain are bound to fail due to lack of a positive business case and consequently a lack of buy-in from the suppliers as they have to work with a multitude of OEMs.





“Alongside innovative, high-quality products, the capabilities of the ZF supply chain are becoming an ever more unique selling point within the space of international competition.”

ZF Friedrichshafen, core purchasing strategy



06 COST & GLOBALISATION

It seems that cost and globalisation have already been on the daily agenda of automotive OEMs and hence also on the to-do list for tier 1 suppliers for centuries. Comparing profit margins of OEMs and suppliers is a common practice for OEM sourcing teams in order to prepare for suppliers negotiations – a practice in which automakers regularly excel.

Taking a detailed look at the margins of the Top 50 automotive suppliers in 2014 shows an average pre-tax margin of approximately 6,8%. In recent years, OEMs have traditionally operated 1 to 1,5% points lower than their supply base.

Total supplier revenues have grown 6,8% from 2013 to 2014 while profits in the same time frame grew even by 13,3%. Europe including the UK accounts for 42% of the total revenues base, with Asia following at 35% and North America including Mexico trailing at 23%. When analysing the profitability geographically it is evident that Europe also leads here with an average pre-tax margin of 7,3%, followed by North America at 6,6% and Asia at 6,4%. European suppliers also seem to have a slightly broader product portfolio when compared to American and Asian suppliers. Whether this is the reason for their leadership in terms of revenue and profitability cannot be substantiated. Breaking out the German supply base from the analysis shows above average performance: share of revenue of 27%, 2013/14 revenue growth of 9,1%, margin of 7,6%, 2013/14 margin growth of 18,4% and a broader than average portfolio breadth. The top 10 suppliers alone have generated more than 50% of top 50 revenues and profits, demonstrating the dominance of a few large players.

Looking at 2016, the dominance of the large players will receive even more momentum with recent M&A activity in the automotive supplier market. ZF's acquisition of TRW will result in a combined revenue of approx. \$40b or Continental's purchase of Elektrobit will further strengthen its software capabilities, which are vital for growing segments like connected cars, autonomous driving or electrical vehicles. Magna's take-over of the German transmission specialist Getrag is another recent proof of automotive supplier consolidation. The supplier landscape has traditionally been in greater flux than the OEM field, which demonstrates the constant urge of tier 1s to optimise portfolios, structures and bottom-line results.

There is clearly more room for supplier consolidation in the market but is it the only lever companies can write down on their corporate strategy charts? How can they escape the cost trap?

In terms of product innovation, quality, supply chain excellence, global proximity and cost, OEMs will keep on pushing their suppliers to the limit as much as they can. Therefore suppliers are under constant pressure to fulfill all dimensions of the scorecard, which ultimately results in strategic decisions to acquire or sell parts of the business. See for example Johnson Controls' divestiture of the automotive electronics unit.

Over the years, OEMs have done their share of breeding a supply base which is bound to working in a reactive way by fulfilling pre-defined specifications through new products and delivering it to the OEM in a Just in Time / Just in Sequence fashion. Exceptions prove the rule. In such an approach, suppliers will never be able to escape the cost trap which in particular applies to tier 1s in a highly commoditised segment, e.g. seating or tires. The good side of the story is the before described mega forces hold enough potential to convert the former customer-supplier relationship into a partner relationship model.

The secret lies in how quickly suppliers can gain an advantage in the evolving Car IT and software innovations spaced over the OEMs. The competitive advantage and differentiation in the future will not reside in further refining mechanical or electro-mechanical but in software, respectively embedded software and leading-edge electronics. Since OEMs themselves are facing challenges in creating the required Car IT (keywords: advanced driver assistant systems and digital vehicle security) and software capabilities (keyword: new business models), suppliers may have a real chance to strengthen their position.



In addition to the constant pressure on prices, OEMs are requiring suppliers to follow their globalisation footprint and establish parts production plants in proximity to their vehicle assembly locations in emerging markets such as China, India or Brazil. This creates further challenges to an already stretched supply base. Moreover, these markets have a set of roadblocks to overcome, e.g. increasing labour cost,

immature infrastructures and immature tier x networks as well as currency fluctuations. Globalisation for suppliers will not only mean expanding their production footprint but also leveraging the local expertise in terms of research & development and sourcing. A successful tier 1 supplier will need to leverage those global capabilities and be where their OEM customers are.

General SWOT analysis of automotive tier 1 suppliers

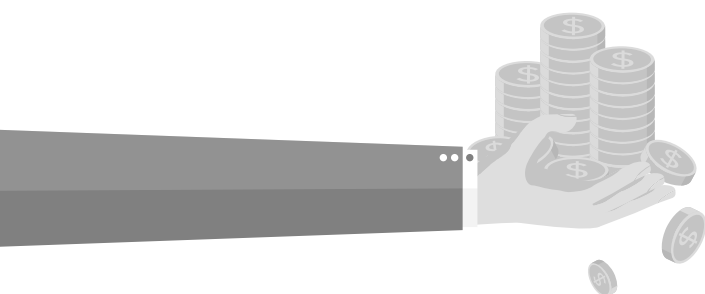
Strengths	Weaknesses
<ul style="list-style-type: none"> ■ In average, a sound financial position with better than average OEM performance ■ Long-standing OEM relationships and typically strong integration in OEMs' product roadmap ■ Deep technological expertise across virtually all automotive component and module domains ■ Used to operate in a multi-national site context incl. R&D, production and sales 	<ul style="list-style-type: none"> ■ Reactive go-to-market approach mostly limited to existing relationships and OEM requests ■ Suppliers too often let OEMs drive their development by a 'black box' specification approach ■ Lack of out-of-the-box partnership models and limited re-use of assets and good practices outside the automotive industry
Opportunities	Threats
<ul style="list-style-type: none"> ■ Expand global footprint to be in proximity with OEMs and counter leverage global cost potentials ■ Actively push innovations into OEMs and switch to a pro-active go-to-market and development model ■ Leverage rapidly evolving new technologies (e.g. CarIT, battery technology) to differentiate products and services ■ Engage with new OEMs which are evolving or unaddressed as of today 	<ul style="list-style-type: none"> ■ Commoditisation of technologies enables evolution of new, low-cost supply base from Asia-Pacific ■ Continuing supply base consolidation carries the risk of becoming irrelevant for smaller suppliers and/or being under increased cost pressure ■ New OEMs requiring a more agile approach for development and production which may be in strong contrast to suppliers' status quo due to a certain resistance to change

Geographical Analysis of Automotive Suppliers' Financials

Geography (# suppliers)	Revenue 2014	Share 2014	Margin 2014	Breadth of portfolio	Revenue Growth 13/14	Profit Growth 13/14
Europe incl. UK (18)	277	42%	7,3%	1,97	7,9%	16,2%
thereof Germany (10)	178	27%	7,6%	1,80	9,1%	18,4%
Asia (11)	229	35%	6,4%	1,60	5,2%	20,1%
North America incl. Mexico (21)	153	23%	6,6%	1,64	7,3%	0,0%
Total (50)	659	100%	6,8%	1,74	6,8%	13,3%

Figures in USD billion

Source: NTT DATA analysis of financial reports





Top 10 Ranking of Automotive Suppliers (By 2014 Revenue)

#	Company	Country of HQ	Automotive related revenue 2014	Automotive related EBIT 2014	Revenue growth 2013/14	EBIT margin 2014	EBIT growth 2013/14
1	Continental AG	Germany	45.868,4	4.446,2	3,6%	9,7%	2,6%
2	Robert Bosch GmbH	Germany	44.627,3	3.193,0	9,4%	7,2%	1,9%
3	Denso Corp.	Japan	38.327,8	3.534,3	6,7%	9,2%	34,3%
4	Magna International Inc.*	Canada	36.641,0	2.632,0	5,2%	7,2%	27,5%
5	Hyundai Mobis	Korea	32.566,5	2.763,5	5,8%	8,5%	5,0%
6	Johnson Controls Inc.	USA	28.664,0	1.947,0	6,9%	6,8%	14,4%
7	Aisin Seiki Co.	Japan	26.810,9	1.625,5	3,9%	6,1%	7,1%
8	Faurecia	France	25.029,3	895,0	4,5%	3,6%	25,2%
9	ZF Friedrichshafen AG	Germany	21.671,6	1.292,1	9,3%	6,0%	36,1%
10	Lear Corp.	USA	17.727,3	787,4	9,2%	4,4%	29,1%

Figures in USD million

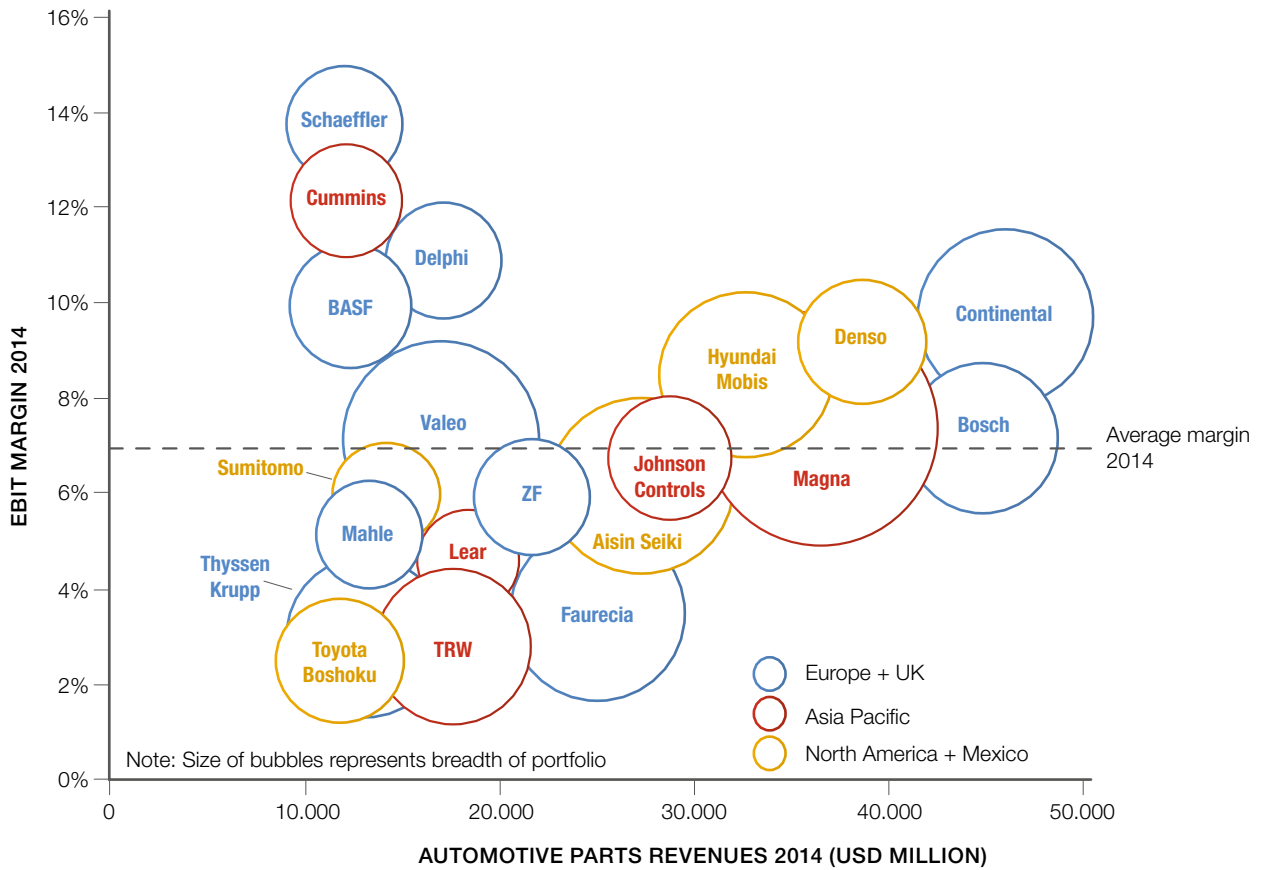
Source: NTT DATA analysis of financial reports

Remarks for all above financial data:

- All data stated was extracted from companies' annual reports, earnings calls or presentations as provided on the individual companies' websites.
- All non-USD values stated have been converted into USD by using the corresponding average exchange rates for 2014 and 2013 according to oanda.com.
- Because of missing or incomplete data the companies Yazaki Corp., Yanfeng Automotive Trim Systems Co., Brose Fahrzeugteile GmbH, IAC Group, Mando Corp. And Flex-N-Gate Corp. have not been included in this analysis.
- In case no EBIT was explicitly declared - comparable values (e.g. operating income) are stated
- In case automotive parts business was not clearly separated in the company's reporting, assumptions were made based on total revenue and earnings and pro-rated accordingly.
- Figures for Continental AG also includes rubber revenues of approx. \$17,9b.

4D Analysis of Top 20 Automotive Suppliers

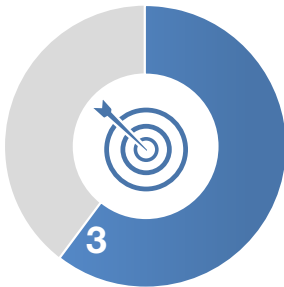
(Revenue, profitability, geography and breadth of portfolio)



Source: NTT DATA analysis of top 20 automotive supplier financial reports



Impact of Cost & Globalisation on Tier 1 Suppliers



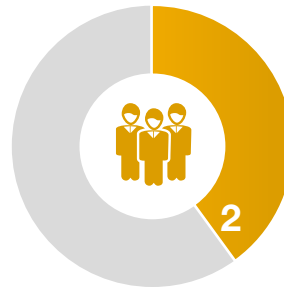
Corporate strategy

To escape the cost & commoditisation trap, suppliers will have to look for new business models on an on-going basis.



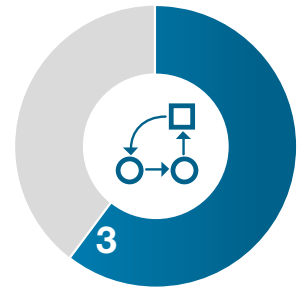
Product portfolio

Product portfolio will be subject to regular lifecycles and cost optimisation exercises.



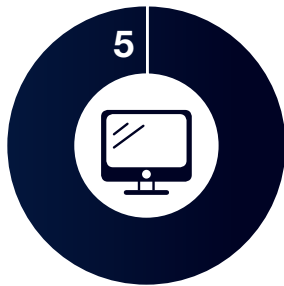
Organisation

Continuous organisational optimisation in light of globalised operations as well as use of shared service centers.



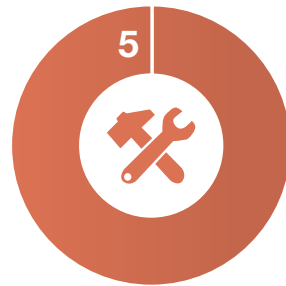
Processes

Need for continuous improvement (efficiency), workflows and level of integration of business processes across all domains of the enterprise.



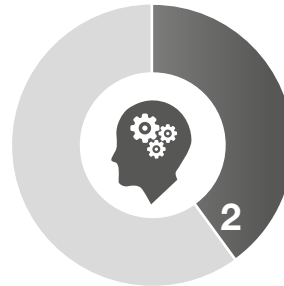
IT landscape

IT will be viewed as the key lever to reduce cost of doing business and to globalise operations.



Manufacturing capabilities

Increasing levels of automation and use of Internet of Things architectures and practices.



Employee skills

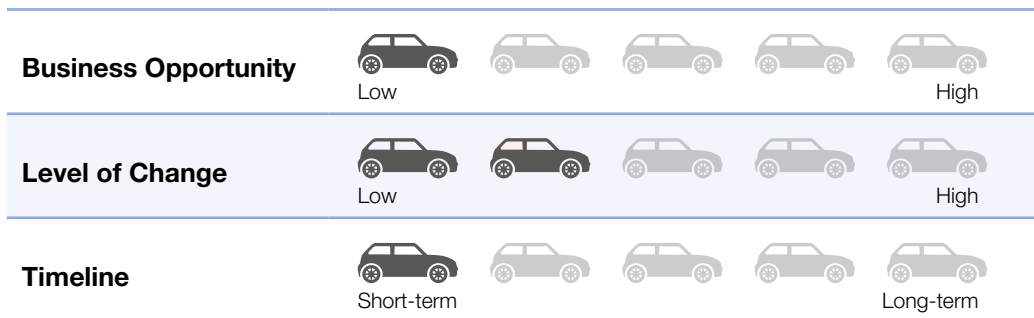
Continuous skill development and life-long learning to improve methods and approaches.

Score: 1 = low to 5 = very high | Source: NTT DATA assessment

Summary

Due to on-going reduction of OEMs' value add activities, the overall automotive supplier market has seen a healthy growth over recent years. In average, margins are trading in the mid-single digit percent range for both suppliers and their OEMs and are therefore still not in line with expectations of the investor community. European players are able to manage their bottom-line slightly higher than their peers in Asia and North-America. There are no signs of a slow-down in supplier consolidation; it even appears as an effective means to strengthen the product portfolio and support globalisation activities. Nowadays, with increasing emphasis on

CarIT and electronics, suppliers have the opportunity to convert the traditional OEM relationship model into a partnership. This is assuming they are able to implement the relevant skills, methods, organisation, processes and, ultimately, a business model in a way that they become an indispensable player for the OEM on the journey towards autopilot, connectivity and electrical powertrain. Only through this will suppliers be able to escape the cost and commoditisation trap and further improve company financials.





“We need to offer the same level of engineering, capacity and quality everywhere. To do this, you need to be a large supplier.”

Faurecia, Yann Delabriere, CEO



CONCLUSION

The automotive 4.0 mega forces will have a major impact on most tier 1s. Suppliers need to adapt to this tidal wave of changes in order to stay relevant in a highly competitive marketplace. Our research indicates that suppliers in the E/E segment are the ones to be impacted most by the automotive 4.0 mega forces – impacted in the best meaning of opportunities and challenges. Electronics and embedded software will play an ever increasing role in nearly all of the analysed mega forces. Premium models will feature 100 million lines of code and more than 90 electronic control units. In terms of impact, E/E suppliers are closely followed by powertrain and interior suppliers. We are seeing the least impact on chassis and exterior suppliers.

Even though most suppliers may be aware of the mega forces in the automotive market place, the major challenge lies in adapting the entire business model in all its complexity and dimensions to these mega forces in a timely manner. Certain sluggishness is immanent to most human beings as well as to most corporate organisations. How do you overcome

this and enable change within the organisation to stay ahead of the curve? This is not the time for procrastinators. This is the time for companies to take calculated risk and place bets on the future. In all of its impressive history, the automotive industry has not seen this level of change before.

Impact of Mega Forces By Tier 1 Segment

	Exterior	Interior	Chassis	Powertrain	Electrics / Electronics	
						1 Low 2 Low – Med 3 Medium 4 Med – High 5 High
Autopilot	2	4	2	2	5	<ul style="list-style-type: none"> Additional sensors may require adjustments to the exterior Components like steering wheel or pedals may disappear Adjustments to steering, acceleration, braking systems expected New sensors, central ADAS unit, software will be required
Connectivity	1	5	1	2	5	<ul style="list-style-type: none"> Major impact on head unit / HMI expected Connected services, e.g. for battery management or charging infrastructure will become relevant ECUs and communication devices will see significant impact
Powertrain Electrification	1	2	4	5	3	<ul style="list-style-type: none"> Impact on head unit / HMI expected Chassis to be adjusted to electrical powertrain and new space may become available (no transmission tunnel) Main impact will be on current providers of powertrains Adjustments of ECUs to electrical powertrain incl. battery management
New Entrants	3	3	3	4	5	<ul style="list-style-type: none"> In general, additional potential through new entrants for tier 1s that are quick in engaging with new entrants New entrants will most likely feature electrical powertrain E/E will play a major role for new entrants like Google, Tesla or Apple
Supply Chain Digitisation	4	4	4	4	4	<ul style="list-style-type: none"> Supply chain digitisation will impact all tier 1 segments almost equally
Cost & Globalisation	3	3	3	3	3	<ul style="list-style-type: none"> Tier 1s are going through this cycle since many years and have mostly adjusted themselves Cost & globalisation will impact all tier 1 segments almost equally
Total Impact Score (max. 30)	14 47%	21 70%	17 57%	20 57%	25 83%	

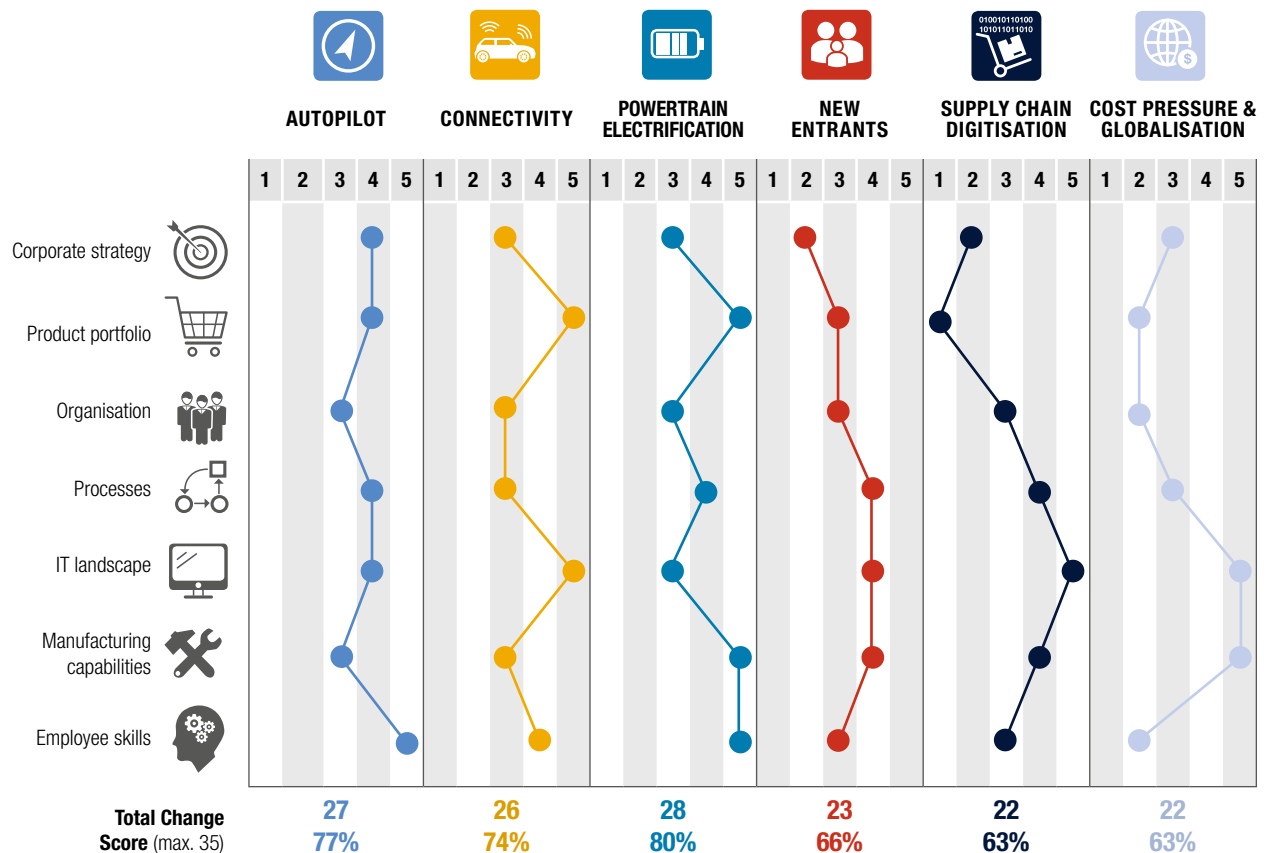
Source: NTT DATA assessment

Level of Change

In addition to the preceding automotive segment impact analysis, it is furthermore important to understand how the mega forces will impact the different dimensions of the suppliers' business model. Based on our analysis we believe that powertrain electrification will have the most significant impact on all dimensions of the tier 1 suppliers' enterprises. EVs are closely followed by autopilot cars, connectivity, new entrants and supply chain digitisation head to head with cost & globalisation. All those mega forces will put a strong emphasis on the capabilities of the IT landscape which will be a key enabler and even more so IT needs to assume the role of the driver

to successfully manage the required transformation of the enterprise. But also manufacturing capabilities, employee skills and business processes will be high on the boardroom agenda and will require high a level of change. Each mega force portrays its own transformation profile and will require attention in specific enterprise dimensions. Tier 1s will need to prioritise the mega forces with a close look at their corporate strategy, identify their own positioning against those dimensions and develop an appropriate transformation roadmap in order to get from the "as-is" to the "to-be".

Level of Change Analysis



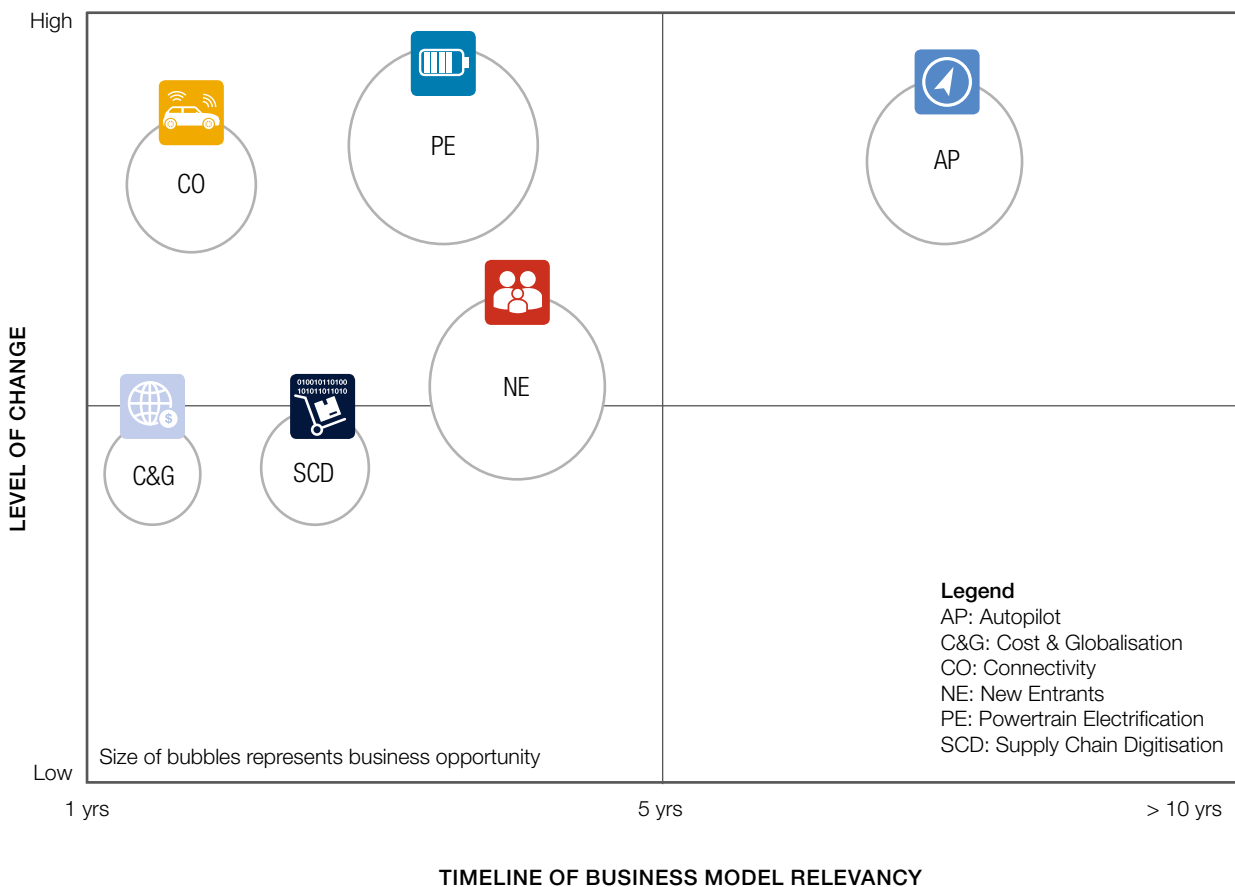
Source: NTT DATA assessment

Automotive 4.0 Roadmap Development For Tier 1 Suppliers

The prioritisation of the mega forces and the development of a transformation roadmap need to consider the individual business opportunity, the level of change and the timeline of the relevancy for the company's business model. The low hanging fruits will feature a low level of change, a strong business opportunity and a short to mid-term timeline until they sustainably contribute to the corporate financials. Our portfolio analysis shows that 5 out of 6 mega forces

are already relevant and will become relevant within only the next few years, which will exert a major stress on tier 1 organisation. However, not all mega forces are equally important to individual tier 1 segments such as exterior, interior, chassis, powertrain or E/E. A tier 1s individual roadmap has to consider all of these dimensions in light of its own business model, capabilities and strategic priorities going forward.

Strategic Mega Force Portfolio Analysis



Source: NTT DATA analysis

Core Traits Of The Automotive Supplier 4.0

The level of change is unprecedented in the entire automotive history and requires an expanded set of core traits, including in particular software capabilities, agile development practices, customer flexibility, a sensing attitude, an adaptive business model, a change in agent mind set and being or becoming a true global player. All of these traits will present suppliers with their own challenges and individual way of implementation. In most of the identified mega forces, e.g. connectivity or autopilot, software will play an increasing role and suppliers need to transform from a pure hardware to an integrated hardware and software provider. The integration of mechanical, electro-mechanical, E/E and software alongside the growing number of more complex components enforces the need of leveraging systems engineering approaches to ensure functionality and reliability. New entrants are pushing the accelerator pedal relatively

hard in terms of shortening product innovation cycles as they are used to a different pace than most traditional automotive companies. In addition, new entrants are representing a new target group. This will require flexibility of the suppliers as they may have strong ties with other automotive OEMs. Not upsetting their existing customers while engaging with new players may pose unfamiliar challenges. Being ahead of the crowd in terms of business model and product or service innovation needs a strong sense of market and an environment that stimulates risk-taking. All of these trends require an adaptive business model that extensively utilises IT best practices as well as a change in method to ensure transformation really happens. Global proximity to existing and evolving customers with R&D, sales, production or sourcing functions along with diversified teams will be vital in light of market consolidation.

Car IT and SW capabilities

- Understands the growing importance of Car IT / (embedded) software and advanced architectures and identifies adjacent business opportunities
- Implements practices for systems engineering and systems lifecycle management
- Partners extensively or acquires required skills to fill own SW deficiencies

Sensing attitude

- Passionate about discovery of new trends in the automotive marketplace
- Anticipates innovations, creates incubator spaces and promotes risk-taking
- Actively drives new technologies and (mobility) business models to move from a commodity supplier to a market shaper

Global player

- Globalises functions like R&D, sales, production or sourcing and creates diversified teams
- Moves close to its (new) customer base and evolving automotive markets



Digital adaptive business

- Aligns business model, organisation and business processes with new market realities to avoid strategic drifts
- Utilises best-practice IT approaches to digitise the business horizontally and vertically

Agile development

- Drives to significantly reduce long-term automotive development cycles
- Applies agile development methods for hardware and software components

Change agent

- Appreciates the importance of 'soft' factors as part of transformational activities
- Applies change methods in relevant projects

Customer flexibility

- Considers new entrants as a great opportunity
- Adjusts sales approach and product portfolio to meet the needs of new clients

Source: NTT DATA analysis

DEEP DIVE: KEY ENABLER 'IT'

IT is the success factor to make change happen ²

Previous chapters of this study substantiate how automotive mega forces will impact the landscape for OEMs and in particular for tier 1 suppliers. The level of change will be profound in nature and requires suppliers not only to adapt to this new reality but to become a market shaper who considers change as an opportunity. IT will play a fundamental role in many aspects of the anticipated change:

1. Car IT and embedded software to enable new features, functions and services in the car as the final product
2. Engineering IT to support the efficient research & development of the product including Car IT and embedded software
3. Business IT to facilitate new business models, post-merger integrations and more efficient business processes across all domains of the corporation

At NTT DATA, we believe that the current model used to manage the traditional IT needs to evolve incrementally and needs to be delivered iteratively. The model should be inclusive of all aspects of the business while also being targeted and selective in its focus, we call this model agile IT.

Agile IT is a model for managing IT that is built for purpose to address the specific challenge at hand and is adaptive and extensible to meet the evolving IT needs of digital businesses. This model is informed by customer needs, influenced by business priorities and integrated into the fabric of the business by effectively utilising the people and underlying culture of any enterprise. Agile IT uses systems thinking to address the skills, process, technology, systems, ecosystem and organisational dynamics that are the underpinning of today's digital businesses. The main objective of agile IT is to enable businesses to think smarter, act faster and flex the business within the context of current market opportunities and broader prevailing culture and trends in the market place. The current model for IT, which is built around delivering IT faster, better and

cheaper, is not adequate to deal with the increased volume, velocity and variety of change driven by the rapidly evolving digital landscape. In order to support digital businesses, the current model needs to be extended to support innovation, agility and value. To do this IT needs to go beyond today's point solutions such as agile software development, DevOps, and continuous delivery to a more holistic model that can deliver sustainable results and is highly adaptable to change.

Our model for agile IT is built on over fifteen years of managing large scale IT organisations, observing some of the best IT departments across the globe, engaging with some of the most innovative startups and working with well-established offshore development factories in Asia and Eastern Europe. It focuses on managing IT professionally (IT as a business) to deliver competitive differentiation and value to today's digital businesses and their customers.

Agile IT starts with a change in the mind set and skill set of IT leaders. This model requires CIOs and IT leaders to model three primary leadership behaviours:

- Understand how IT enables the business - Recognise and understand how the business model of any enterprise is implemented in practice.
- Run IT as a business - Understand the business model, operational processes and metrics that measure the effectiveness of IT in an enterprise.
- Be the change leader - CIOs should model and demonstrate the change they want to see in an agile IT organisation.

The agile IT organisation aims to deliver business agility as a core competency. This requires five core capabilities that will help IT move beyond playing defence and "keeping the lights on" to a key stakeholder in the business that plays an effective offence that adds value to the enterprise.

"IT is also an integral building block within enterprises. Only with stable and efficient IT is it possible to implement change within the company."

Klaus Straub, CIO, BMW AG

1. Adaptive Enterprise Architecture

Over the past two decades there has been a lot of focus on enterprise architectures (EA) and enterprise data architectures. Many IT organisations have invested millions of dollars and countless hours in their quest to map the businesses they support in a set of models and documents. However, these efforts have at best been met with mixed results. The most successful efforts have been able to capture a snapshot of the IT industrial complex in any organisation at a particular point in time. The challenge is that enterprises are dynamic organisations that change and evolve on a daily basis and these large and complex EA efforts turn into legacy systems very quickly. Today's digital business and agile IT require the ability to move quickly and adapt to rapid and constant changes in underlying technologies and the ecosystem in which these businesses operate and compete on a daily basis.

2. Digital Portfolio Management

Digital Portfolio Management (DPM) is the capability of an organisation to provide better understanding and insights of the key experiences that any business uses to deliver value to its main stakeholders (customers, employees and partners). These digital experiences span multiple channels and cut across organisational silos and boundaries of IT applications and infrastructure. In other words, these experiences are a collection of activities and interaction that, when orchestrated well and executed consistently, helps provide a meaningful and value-added experience that is hard to replicate and brings competitive differentiation into the market place.

DPM is an effective mix of art and science that focuses on prioritising and making business IT decisions, determining investment policy and mix, matching investments to business priorities, and allocating resources to enable expected business outcomes. DPM treats the key experiences and the IT industrial complex (infrastructure, applications, people, etc.) as an investment and applies professional portfolio management techniques to this investment. It helps define the intrinsic value and underlying risk of

“IT lays the foundation for Hella’s success and its role will only grow. An average of 91% of those responsible for their respective areas value IT as being extremely relevant for the company.”

Gerd Niehage, CIO, Hella

these experiences and identifies how IT assets and people contribute to the core value chain of activities that enable the experience. Finally, DPM helps a business implement a targeted investment strategy that is aligned with the enterprise’s digital strategy that focuses on enhancing, improving, substituting or outsourcing each experience or category of experiences in the digital portfolio. Our DPM approach includes a set of tools and techniques such as the digital experience Matrix that helps us understand and prioritise what needs to be done to accelerate the journey towards becoming a digital business.

3. Innovation and Customer Centricity

In order to drive the evolution to a digital business, IT needs to build and sustain a mindset of innovation and customer centricity. One of the approaches to introduce customer centricity is the approach to user-centred design (UCD) pioneered by the ground breaking consultancy firm IDEO. This approach explores the creative tension and tradeoffs between the feasibility of the solution (can it be built) against the viability (can we make money off the solution) and the desirability (will people want it). Truly customer-centric companies have learnt to strike an effective balance to user-centred design to consistently deliver successful products and services to the market place. In our experience, becoming an agile IT organisation that is customer-centric requires starting the design process with the desirability of a concept before moving to the feasibility and viability of any proposed solution. Approaching UCD in this sequence enables IT to identify solutions that resonate with their customers. However, this is only one part of the solution, the second part is building the organisational skills for divergent thinking.



4. Platform Thinking and Multi-Sided Platforms for IT

The first three capabilities we discussed focused on identifying ideas, experiences and opportunities for differentiation. The fourth capability, platform thinking focuses on how to implement many of these ideas in a faster and less capital intensive manner that allows us to start small and fail early or scale fast. Today's de-facto model for delivering IT solutions is based on a proven playbook that focuses on eliminating variability and IT sprawl. It does so through ruthless standardisation, implementing command and control based management structures and centralised teams that are designed to drive economies of scale and optimise unit costs. This model also depends on the availability of large numbers of skilled resources that are always in short supply around the world. This "Industrialised IT" model was effective in solving problems such as Y2K conversions, large multi-year ERP implementations and repeatable/recurring problems. Additionally, this model has several unintended consequences such as increasing time to market, reducing flexibility and stifling innovation. The result is that these businesses have inflexible and expensive IT and a workforce that has lost its ability to innovate for the business, costs too much and is slow to react to the changing needs of the marketplace.

Platform thinking provides the ability to achieve minimum efficient scale in any process or solution without requiring the volume, size and scale that was required to drive efficiency in the industrialised IT model. Platform thinking focuses on creating more throughput and output for IT without resorting to traditional approaches to achieving scale. For

example, consider how Apple's recently announced ResearchKit turns any willing user of an iPhone into a participant in a global research effort. This platform allows researchers across the globe to get access to global participants and gives them the ability to scale without actually having to recruit people for these studies.

For agile IT organisations it is critical to identify and architect solutions that use multi-sided platforms (MSP) for IT in emerging areas such as cloud, security, analytics, IoT etc. in order to rapidly scale capabilities without having to add a lot of headcount and retool a lot of their existing talent.

5. Horizontal IT Teams

Horizontal IT teams (HIT) are one of the most critical components of the agile IT. This approach to building IT organisations abandons the tried and trusted way or organising IT around business and technology towers that was used in the industrialised IT model. Building a truly agile IT organisation requires HIT teams that are tuned to deliver and improve a specific experience(s). These teams can be dynamically configured to drive innovation and increase the throughput of the experience that they are focused on. These HIT teams start off by radically rethinking how to deliver the experience using 21st Century approaches and rebuild teams that are dynamic, built for purpose and flexible enough to morph themselves to adapt to changing requirements. This approach combines proven techniques in a unique and innovative way to address the opportunities presented by today's digital businesses.

ABOUT THE AUTHOR

Christian Seider

Christian is a Vice President Automotive at NTT DATA in Germany where he is in charge of the automotive supplier business. He has over 15 years of experience in the consulting and IT services industry.

Before joining NTT DATA, Christian was an Associate Partner at IBM Global Business Services where he was responsible for consulting sales and delivery for a German automotive OEM for more than four years. His focus is on business model innovation, process excellence and IT system implementation for automotive tier 1s and OEMs. He is a certified consultant and has published several articles and whitepapers on market trends and innovation plays in the automotive and high-tech industry. Christian studied Business Engineering at the University of Karlsruhe and enjoyed an executive education on Strategic Risk and Decision Management from Stanford University. He is passionate about his family, cars, electronic gadgets and travelling.

He can be reached at: christian.seider@nttdata.com.

Acknowledgements

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REFERENCES

Autopilot

- Audi: <http://www.news.com.au/technology/innovation/first-car-that-can-drive-itself-the-next-generation-audi-a8-limousine-on-the-road-in-2017/story-fnjwucvh-1227368047823>
- Bosch: <http://www.wsj.com/articles/bosch-tomtom-join-forces-to-develop-digital-maps-for-self-driving-cars-1437461646>
- ZF: <http://www.automobil-produktion.de/2015/08/zf-chef-sommer-will-auf-augenhoehe-mit-bosch-und-conti-ziehen/>
- Conti: <http://www.welt.de/wirtschaft/article145015200/Warum-selbstfahrende-Autos-so-teuer-sein-werden.html>

New entrants

- Apple: <http://www.businessinsider.com/apple-jeff-williams-the-car-is-the-ultimate-mobile-device-2015-5?IR=T>
- Faurecia: <http://www.faurecia.com/en/about-us>
- ZF: http://www.zf.com/china/en_cn/corporate/news_events_corporate/magazine_and_news/chinese_market/chinese_market_1.html
- Magna: <http://www.theglobeandmail.com/report-on-business/international-business/us-business/magna-in-good-position-to-build-apple-google-cars-says-ceo/article24320885/>

Connectivity

- GM: <http://www.reuters.com/article/2015/09/29/us-gm-ceo-idUSKCN0RS2K420150929>
- Conti: <http://www.mittelbayerische.de/wirtschaft-nachrichten/der-conti-chef-glaubt-an-die-e-mobilitaet-21840-art1269081.html>
- Visteon: <http://www.autonews.com/article/20150622/OEM10/306229993/visteon-affirms-software-shift>

Electrical powertrain

- Tesla: <http://www.teslamotors.com/blog/all-our-patent-are-belong-you>
- Bosch: <http://www.electrive.net/2015/07/28/volkmar-denner-philipp-schroeder-andrae-rupprechter/>
- Conti: http://www.continental-corporation.com/www/presseportal_com_de/themen/pressemitteilungen/1_topics/verschiedenes/pr_2014_12_30_mobilitaetsstudie_de.html

Supply chain digitisation

- Daimler: <http://media.daimler.com/dcme-dia/0-921-614233-49-1847484-1-0-1-0-0-0-0-0-0-1-0-0-0-0.html>
- ZF: http://www.zf.com/media/media/de/document/corporate_2/company_4/purchasing_and_logistics/purchasing_strategy/Kernstrategie_EK.pdf

Cost & globalisation

- Faurecia: <http://europe.autonews.com/article/20141209/ANE/141209948/faurecia-expects-to-gain-from-megasupplier-trend>

Deep Dive: Key Enabler IT

- BMW: <http://www.automotiveit.eu/bmw-cio-straub-it-hat-beamtenmentalitaet/news/id-0048891>
- Hella: <http://www.automotiveit.eu/wir-springen-nicht-auf-jeden-it-trend/top-interviews/id-0050199>

General

- Where market figures have been stated, these have been taken from reliable analyst sources and in some case enhanced with own judgement
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¹ Based on NTT i3, „The automotive industry as a digital business“, Rainer Mehl and Srinu Koushik

² Taken from NTT i3, „Agile IT“, Srinu Koushik



ABOUT NTT DATA

NTT DATA is your innovation partner anywhere in the world. Headquartered in Tokyo, we have business operations in over 40 countries. Our emphasis is on long-term commitment, and combining global reach with local intimacy to provide premier professional services from consulting and systems development to outsourcing.

NTT DATA combines local flexibility and agility with centrally coordinated access to global resources. NTT DATA's long-standing customer relationships are a testament to its ability to combine the best of both worlds: the scale and resources of a globally operating group, combined with local teams possessing deep market insight and expertise. This has allowed NTT DATA to meet customer needs all over the world, consistently exceeding their expectations for quality, timeliness, and local knowledge.