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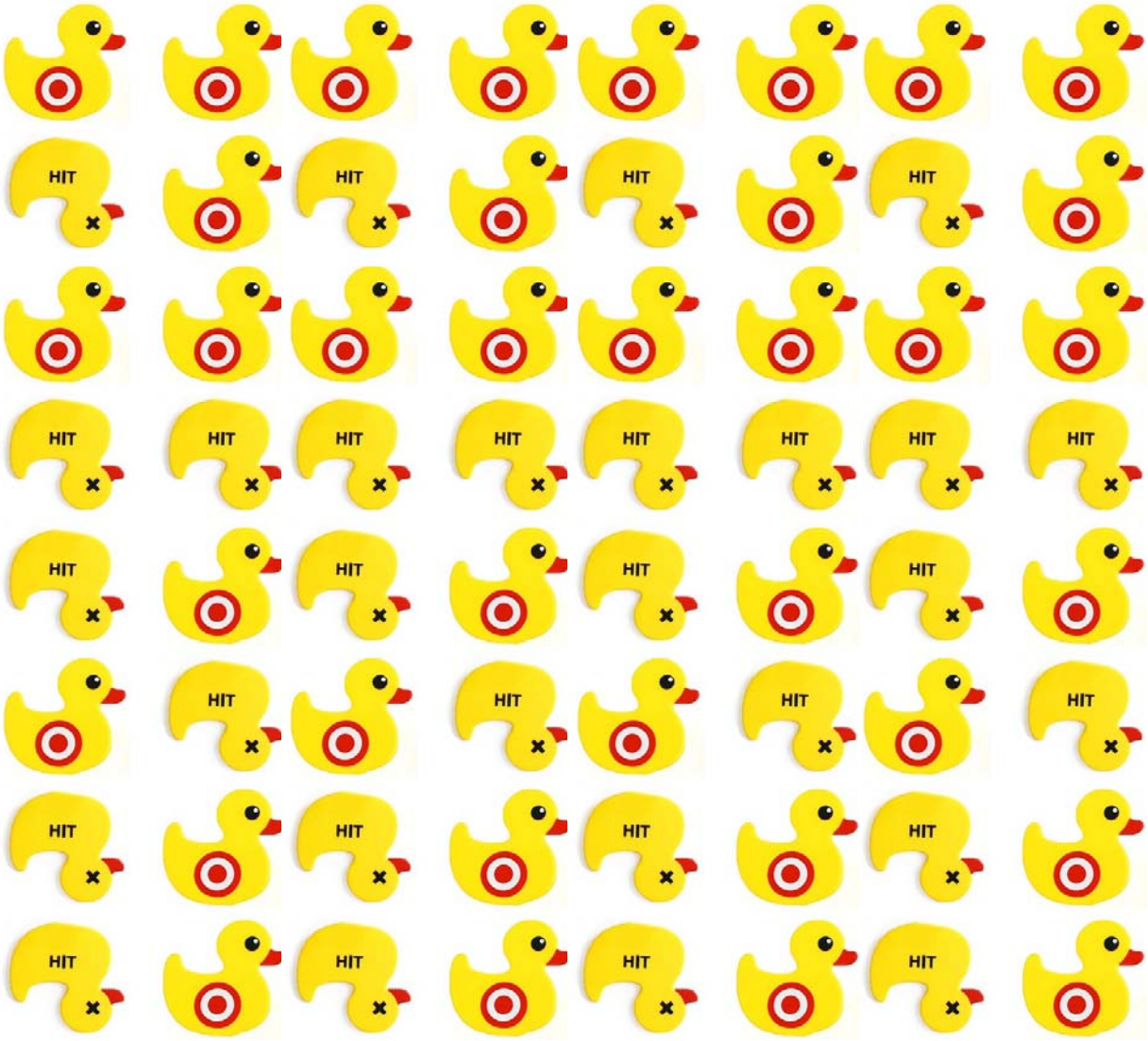

Automotive ecosystem

Sitting ducks

Sector report, September 2017

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Automotive ecosystem

Sitting ducks

Technology

29 September 2017

Transport is likely to be the next industry to be digitised and almost all vehicle makers are unprepared. Electric vehicles (EVs) and autonomy could reduce overall US transport spending by 65%, which needs to be supplemented with digital services by players wishing to survive. Edison thinks that sensor data is the one area where vehicle makers have an edge and hence is critical to their future. They must control this asset or face becoming sitting ducks for those that would reduce them to handsets on wheels.

- **Digital differentiation**. Transport is ripe for disruption. Furthermore, there is a real possibility that demand for vehicle shipments falls substantially over the next 10-15 years. Edison thinks that embracing digital, controlling sensor data combined with a completely new way of thinking is required by vehicle makers wishing to survive for the long term.
- **Sensor data** will be the new vehicular currency. Edison thinks that Digital Life services from smartphones will become ubiquitous and unlikely to offer value for vehicle makers. However, sensor data is unique, required for autonomy and, critically, they still have a lock on access to it. Edison sees sensor data as the opportunity for vehicle makers to avoid severe disruption.
- **The infotainment unit** could become the most important part of the vehicle as it is where all the sensor data can be accessed in one place. Furthermore, it is the main digital interface with the user meaning that the digital user experience will be defined here.
- **The gatekeepers**. Despite the threat of disruption, Edison believes that the fact that OEMs are the gatekeepers to sensor data will give them a seat at the table as well as the opportunity to differentiate. How they execute on this is likely to define who survives and who does not.
- **Monetisation**. Edison calculates that Digital Life (smartphone only) in the vehicle could be worth $112 per user per year in US or $32.1bn in revenues. The use of sensor data could drive that figure higher. Potential substantial falls in both the radio advertising ($17.7bn) market and transportation ($2.6tn) markets provide a plentiful source for spending on new digital services.
- **EVs and autonomy** have the capacity to cause substantial declines in both vehicle shipments and transport spending as a whole. Edison calculates that manual EVs could reduce cost per mile to $0.40 from $0.88 where it is today. Autonomy promises to reduce this still further to $0.29 per mile. There is a huge economic incentive for consumers to switch to EVs, which, together with autonomy, Edison estimates could cause a 44% reduction in US vehicle shipments.
- **Sitting ducks**. While vehicle makers are aware of the threat, many are in denial and few have any real idea how to address it. Most are easy targets for digital ecosystems that could easily reduce them to handsets on wheels.

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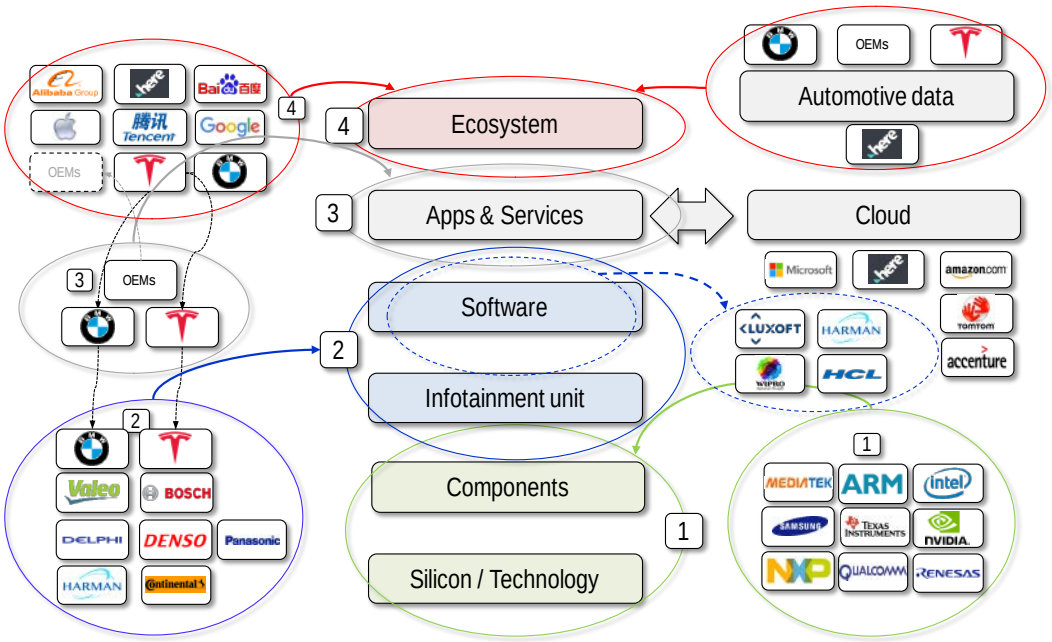
Digital services in the vehicle

Today most users will buy a vehicle based on looks, comfort, safety, performance and price, with very little value being attached to how well the vehicle performs when it comes to digital services. However, this is beginning to change. As users spend more and more time on their smartphones, they also want to be able to have access to their Digital Life when they are behind the wheel of a car. To create as much value as possible two issues need to be addressed:

- **First,** the user experience has to be very different to that on a smartphone or tablet as the driver's eyes and attention need to remain on the road.
- **Second,** the circumstance of being on a journey needs to be taken into account to create value-added services for which users will pay.

With all of the data that the vehicle generates integrated with Digital Life, experiences and services that are specific to both the user and to the journey that they are making can be created. Edison thinks that whoever addresses these issues the most effectively will be the entity to which the value being generated by the digitisation of the vehicle will accrue.

Exhibit 1: Infotainment unit technology stack, Q217



Source: Edison Investment Research

In a similar vein to the mobile and PC industries, value in the digital vehicle looks likely to accrue to the two ends of the value chain (Exhibit 1). This is because it is at these two ends where players will be able to generate the differentiation that users are willing to pay for. Edison has long believed that the prime driver of margin in the consumer electronics industry is purchasing preference. When it comes to driving differentiation through digital features in the automobile, we think that this market will be no different. **Hence, it looks like profitability will be found in those companies that enable the technology in the vehicle through silicon, components, software or intellectual property or by those that bring the digital services together in the vehicle in an easy and fun to use way (Exhibit 1).**

The vehicle makers would clearly love to become ecosystems in their own right, but it is obvious that they are not well set up to do so as they do not have the right management teams or the

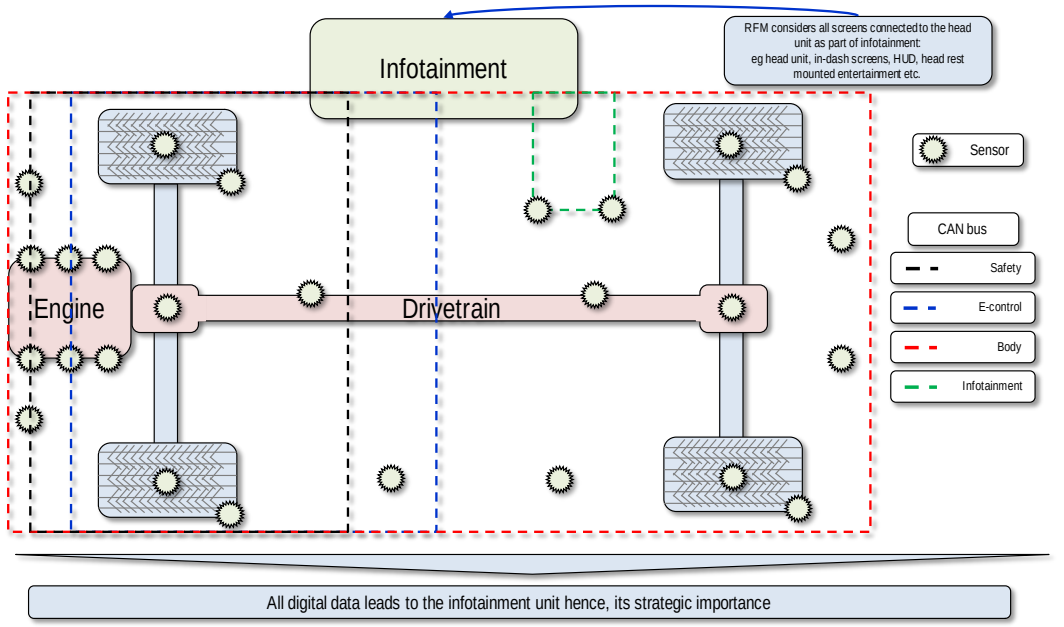
experience. However, what they do have is control of the sensor data that is generated from the sensors in the vehicle (Exhibit 3). **Edison thinks that this data is essential to evolving the digital experience in the vehicle from simply projecting smartphone apps onto the infotainment unit into something transformational.** It is this data that will enable a smartphone mapping app to become more in tune with the vehicle. For example, by taking fuel level, tyre wear, exhaust condition and brake wear information and combining it with the user's calendar, the most convenient and cost-effective replacement, maintenance or refuelling can take place with very little input from the user.

This is how a smartphone app can become far richer and more applicable to the use case in the vehicle, but it requires timely and up-to-date information from the vehicle's sensors to work properly. **This is the edge that the vehicle makers have, as, currently, they are the gatekeepers to this data, meaning that the digital ecosystems cannot yet simply bypass the vehicle makers.** Edison thinks that this is their one chance to remain relevant in the digital vehicle, which is why the infotainment unit has become the most strategically important part of the automobile.

The digital vehicle

The digital vehicle is made up of three main components: infotainment, controller area networks (CAN bus) and sensors (Exhibit 2). Modern vehicles have sensors everywhere and almost all aspects of the running of a vehicle can be monitored as well as collecting highly accurate data with regard to the vehicle's surroundings. This data is gathered by the sensors and is communicated via four CAN bus networks: 1) safety, 2) e-control (engine and systems management), 3) body (windows, doors, cameras, etc) and 4) infotainment. A CAN bus operates very much like a computer network and cuts down on wiring required while still allowing communication between different parts of the vehicle. The infotainment unit is where it all comes together as this is the one place where all four networks are physically present and can be bridged by a single unit. This combined with the fact that this unit is the main driver interface with the machine and the point where smartphone information is projected makes it the ideal place for the "brains" of the vehicle to reside.

Exhibit 2: Map of the digital car, Q217

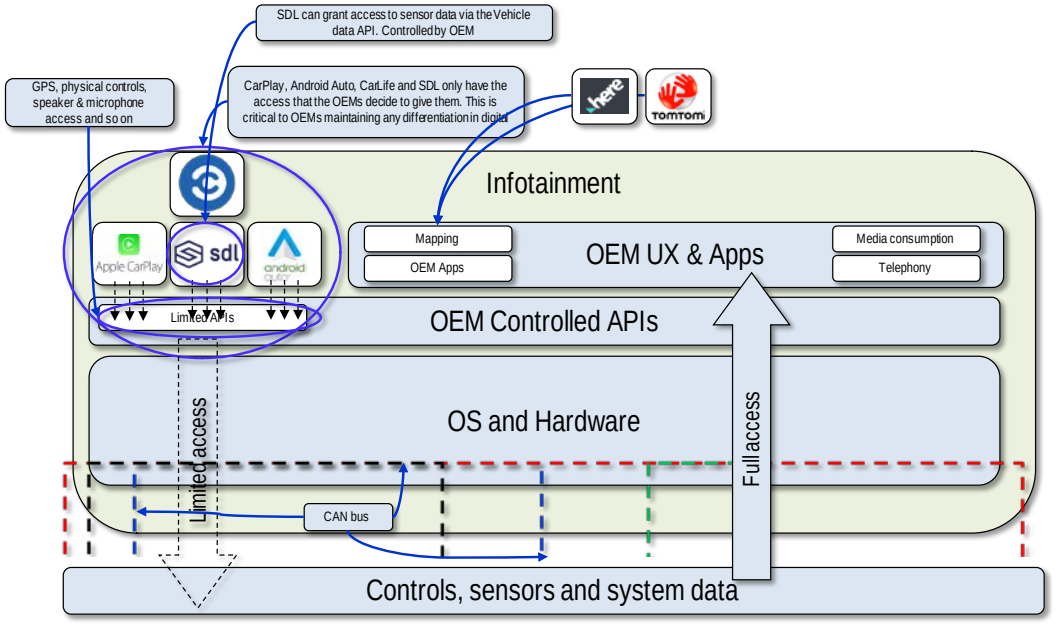


Source: Edison Investment Research

There are many players all vying for the driver's attention, but in the lead at the moment are the current digital ecosystems that seem to have a much better idea about how to delight users in the

vehicle than the vehicle makers do. **To put it simply, the best infotainment unit today is the one in the driver's pocket.** However, it is far too early to rule the vehicle makers out of having a position in digital as they are the gatekeepers of the essential sensor data that can turn a smartphone app running on a vehicle screen into something far more useful.

Exhibit 3: Map of the infotainment unit, Q217



Source: Edison Investment Research

This is why the design of the infotainment unit is so important. How the infotainment unit is structured determines who has access to which data as well as defining the limitations and functionalities of services and applications. The structure is not dissimilar to a smartphone or a tablet, with a user experience sitting on top of an operating system with access to the core functions and data of the vehicle being determined by the APIs that sit between the OS and the application layer.

The third-party experiences that allow smartphone apps to appear on the infotainment unit are all similar in their structure. Essentially, they take an application running on a connected smartphone and project it into the infotainment unit screen in a way that is applicable for usage in the vehicle. For example, this would include the ability to control the app with voice as well as with any buttons and knobs present on the vehicle that are not on the smartphone. The app appears on the screen of the infotainment unit but it is running on the smartphone. This is a key distinction as in this configuration, the apps have no access to the vehicle beyond that specified by the OEM, leaving it in complete control access to the sensor data (Exhibit 3). **Edison views these services (CarPlay, Android Auto, SDL and CarLife) simply as projectors of smartphone apps and services, and not an integrated piece of the digital vehicle itself.**

The exception to this are third parties that are embedded into the vehicle makers' software, as these potentially have full access to the sensor data. The two most well-known are HERE and TomTom, both of which provide the map upon which the OEM navigation offering is based. Clearly, this is a business that is rapidly changing as maps now need to be constantly updated and integrated with other data to make them at least as useful as offerings coming from smartphones. These players are not seen as a threat as they are well known suppliers to the industry. Furthermore, HERE is increasingly being seen as the focal point for all those players with an interest of keeping Google out of their businesses. These include both rival digital ecosystems and vehicle manufacturers, which Edison thinks, beyond the mirroring of smartphone apps onto the infotainment unit, are right to be very cautious.

Consequently, Edison views the infotainment unit as the place where the battle for the digital vehicle will be fought in the coming years. While the ecosystem companies have the advantage in terms of user loyalty and usage on smartphones, the vehicle makers hold the key to making those services relevant, useful and sticky in the setting of the vehicle. **It is critical to their long-term outlook that they do not give away these keys needlessly.**

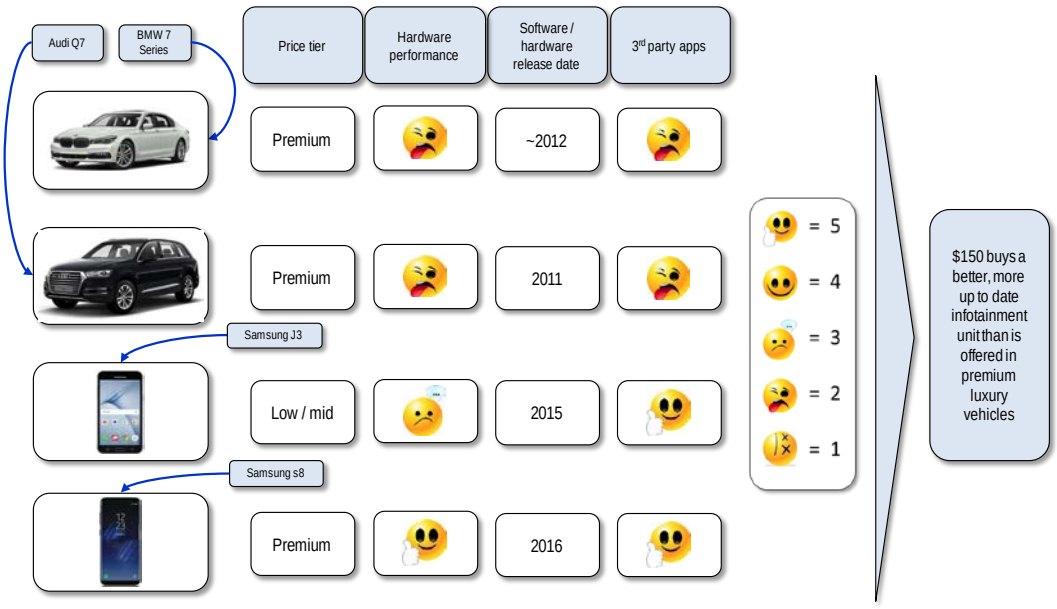
The infotainment unit does not immediately leap to mind as a computer, but demand from consumers for digital services is rapidly pushing it in that direction. The infotainment unit is rapidly becoming the brains of the vehicle, but it also needs to able to communicate with the user in an easy and fun to use way (Edison Law of Robotics No. 1. Furthermore, if vehicle companies want to see their vehicles really become hotbeds of innovation, they need to encourage third parties to create services to run on their vehicles (Edison Law of Robotics No. 4). Currently, most users prefer to use their smartphone services in the vehicle because what is on offer from the vehicle makers simply cannot live up to this requirement. Edison thinks that in many ways, the state of development of the infotainment unit is exactly where smartphones were before the emergence of the iPhone. There are a number of reasons for this.

1. Technological pace

The infotainment unit is currently embedded into the vehicle. This combined with regulatory requirements means that the specification of the infotainment is locked down three to five years before the vehicle comes to market. This means that by that time, the hardware specification is way behind what even the cheapest and worst performing handsets are capable of. For example, Audi's infotainment system in its top of the line Q7 currently uses the NVIDIA Tegra 3 chipset, which was released in 2011 and was used in high-end Android devices in 2012. The most recent chip that Edison has found in an automotive infotainment unit in the market today is the TI OMAP 5, which was released in 2013.

In practice, this means that a mid-range smartphone costing around $150 has more processing power, more recent software and far more third-party apps than the infotainment system included in a premium luxury vehicle (Exhibit 4). Against this backdrop, it does not come as a big surprise that consumers would rather use digital services on a smartphone than on the infotainment unit.

Exhibit 4: Premium infotainment units vs. smartphones, Q217



Source: BMW, Audi, Samsung, Edison Investment Research

2. Endemic fragmentation

Each OEM has its own software that is completely incompatible with the software from any other manufacturer. It is also not uncommon for one manufacturer to have more than one software version that is used in different models. This is almost an exact replica of the situation in the handset industry before the 2007 smartphone revolution. Most vehicle makers base their software on BlackBerry's QNX with one or two using Microsoft's embedded automotive offering, or the tier 1 suppliers do it all themselves using Linux using their own proprietary software.

The end result is that every user experience is very different. As long as they all aim to emulate the user experience on the smartphone, what results is usually something that is very difficult to use and one that most users cannot be bothered to learn. While they have an easier to use solution in their pockets, the smartphone remains their preferred choice. **The vehicle makers are unlikely to make any headway at all for as long as the best infotainment unit remains the one in the pocket.**

This also creates a nightmare for developers ensuring that only those companies whose existence would be threatened by not being present in the infotainment unit have enough incentive to develop apps for these units. The two best examples of this are Sirius XM and **Pandora, the latter of which has developed at least 20 different versions of its app in order to ensure widespread presence in the vehicle.** The vast majority of developers will simply refuse to develop for any automotive infotainment units while this situation persists.

Edison thinks that the answer for the vehicle makers lies not in trying to copy the smartphone (an experience that does not work very well in the car), but in developing a user experience that makes the most of both being present in the vehicle as well as the data that the vehicle generates to make digital services that are more useful and fun to use in that setting.

3. Business model

Edison thinks that the OEM approach to monetising the infotainment unit is antiquated and needs to change. Currently, vehicle makers charge large amounts of money for services that digital ecosystems give away for free. The simplest example is map updates, which are often free for three years after purchasing the vehicle but only if the user subscribes to a service offered by the OEM that in many cases offers very little. For example, the Audi Connect internet service costs $33 per month and for that the user gets the free updates for the three years, software updates, traffic as well as vehicle tracking and remote unlocking. The attitude of the Audi towards its customers is made clear in that the vehicle can connect to Wi-Fi in the user's home but will not update the maps without this overpriced service. Even HERE's business model of charging for updates looks dated, as Google's map is always up to date and is free for anyone who can download the app.

In effect, the vehicle makers are asking customers to pay high prices for lower quality services than they can get for free on smartphones. Unless this changes, users are likely to continue to use their smartphones rather than the infotainment unit, thereby ensuring their digital commoditisation. **Edison thinks that for the automakers to survive, these sorts of business models need to be discarded as soon as possible. Failure to do this is likely to ensure that someone else will provide a great digital experience (eg Google), resulting in little or no usage of their services and digital commoditisation.**

The most precious commodity will be the data that users generate, which, combined with insights drawn from the sensor data of the vehicle, could allow the vehicle makers to create must-have services thus ensuring their digital differentiation. Edison believes that this could generate far more value for the vehicle makers in terms of insight and loyalty than the revenue generated by their current substandard subscription services. Offering free services in return for access to data as well as permission to update software in the infotainment unit over the air is likely to result in vehicle

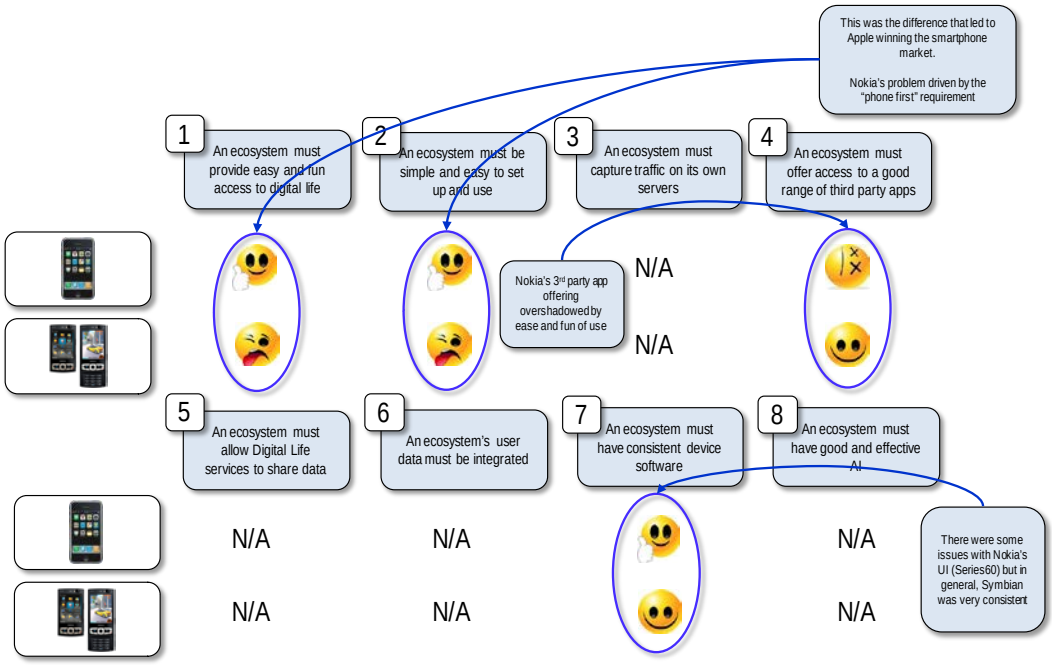
makers having much higher-quality services. **This in turn would lead to happier customers who are more likely to stick with their brands the next time they buy a vehicle.**

Digital user experience

Edison thinks that the infotainment unit today is where the handset industry was in 2006. Then the idea of a mobile device that could do more than voice and text had been around for a very long time but no one had really been able to make anything of it. There was a smartphone market, but penetration was low and limited mostly to the more technologically literate segment of the market. Despite their literacy, usage was almost completely dominated by voice and text as there was not much else other than games that could be easily done with the devices. It was not until Apple forced the industry to throw away the shackles of legacy and embrace the new and unknown that the smartphone was able to come of age. We think that something very similar will happen in vehicles, which remain mired in the notion that the experience in the vehicle has to be the same as it is on the phone.

When Apple launched the iPhone, it took a huge risk in departing from the tried and tested method of ensuring that a smartphone was a phone first and a computer second. This meant that every device had to have a physical keyboard and had to be able to be operated with one hand. This was the hard and fast rule and until Apple turned the market on its head, it held absolutely true and every smartphone that launched without these features failed miserably.

Exhibit 5: iPhone vs Nokia 95: 8 Laws of Robotics, 2007



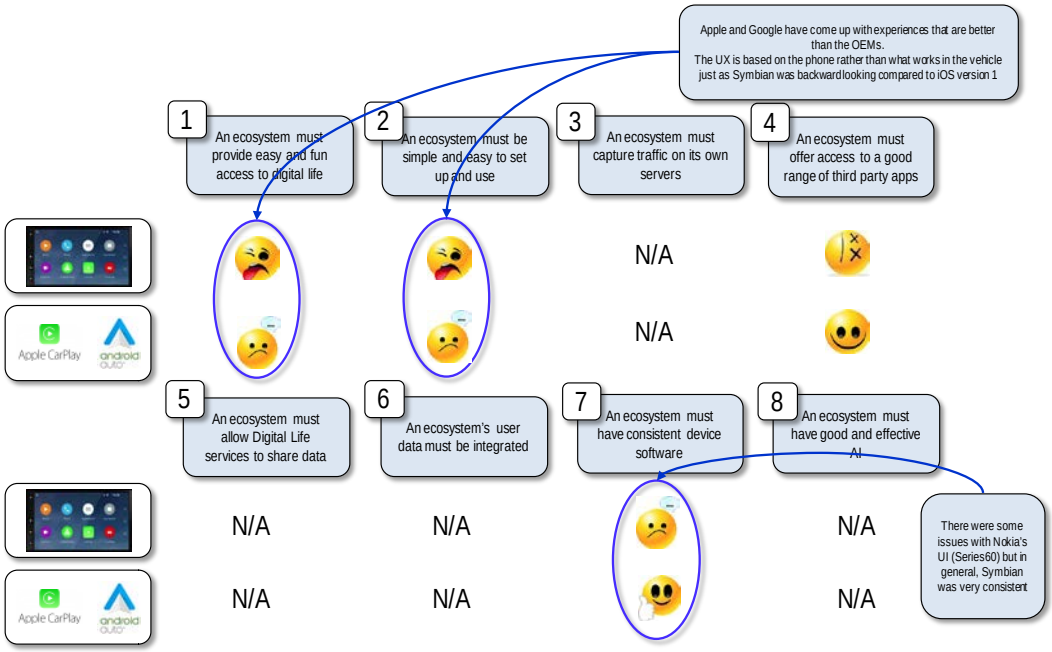
Source: Edison Investment Research, Nokia, Apple

Consequently, Edison thinks that an assessment of what made the iPhone successful can be used as a parallel for what needs to happen with the digital experience in the vehicle. When comparing the iPhone against Nokia's most successful smartphone (n95) (Exhibit 5), Edison has used the eight Laws of Robotics. In this analysis, it quickly becomes clear that the only place where the n95 fell drastically short was on the user experience, as the n95 had a better offering of third-party apps and Symbian did not suffer from meaningful software fragmentation. We note that in 2007 laws 3, 5, 6 and 8 were not relevant, and hence no assessment has been made of them.

In the automobile industry, we see a very similar pattern where the current state of digital in the vehicle is similar to where Symbian (and Microsoft) smartphones were in 2006. In the automobile,

the primary digital interface is the infotainment unit. Edison considers instrument clusters and other screens to be secondary to the infotainment as they often display the same information in the same way as dictated by the main unit.

Exhibit 6: Vehicle makers, CarPlay and Android Auto – eight Laws of Robotics



Source: Edison Investment Research

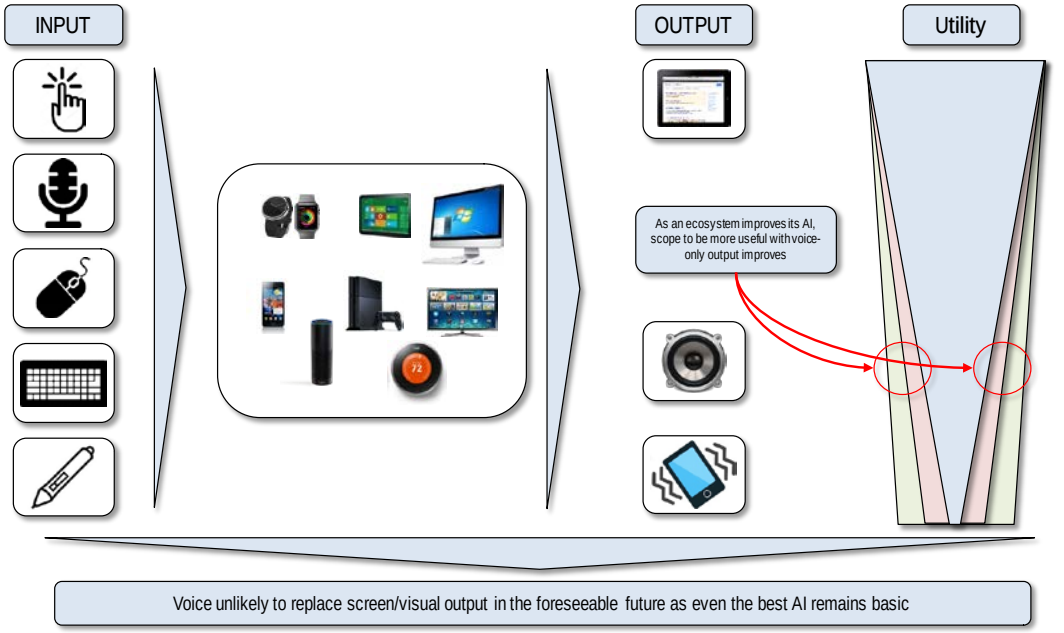
Comparing the OEM to Apple's and Google's user experiences against the same laws shows a similar pattern to that seen with Nokia in 2007. (Note: CarPlay, Android Auto have individually been given a full appraisal on the eight Laws of Robotics starting on page 34.) **The problem is that the user experience of all infotainment units appears to have been designed on the rules that apply to the smartphone and not to those of the car.** Edison thinks that neither the vehicle makers nor the digital ecosystems have a clear idea of the best way for the driver to interact with Digital Life services in the automobile and as a result have assumed that replicating the smartphone will be good enough.

Clearly, it is not, as the circumstances in the vehicle are very different. The distance between the user and the screen is much greater and for most of the time, the user's eyes are required to be on the road. Hence, this user experience does not work well in the automobile, which is why the adoption of new services remains extremely slow. For example, in the US the vast majority of all media consumption in the automobile remains analogue radio built into the dashboard (Exhibit 17). This is despite extremely high penetration of the driving population with Digital Life services via their smartphones. Edison thinks that a different approach to interacting with the driver is required. Of the current contenders out there, the most promising is voice, but this is also beset with plenty of problems.

Voice

While humans remain responsible for driving, huge limitations are placed upon the man machine interface as the driver's attention has to remain on the road. The primary sense required for the road is sight meaning that the leading contender for interaction with Digital Life services remains voice and audio. However, voice is not without limitations. In the vehicle, it is an ideal method for interaction but its utility is still very limited when compared to using a screen and touch for communicating with the user (Exhibit 7).

Exhibit 7: Ins and outs of the man machine interface

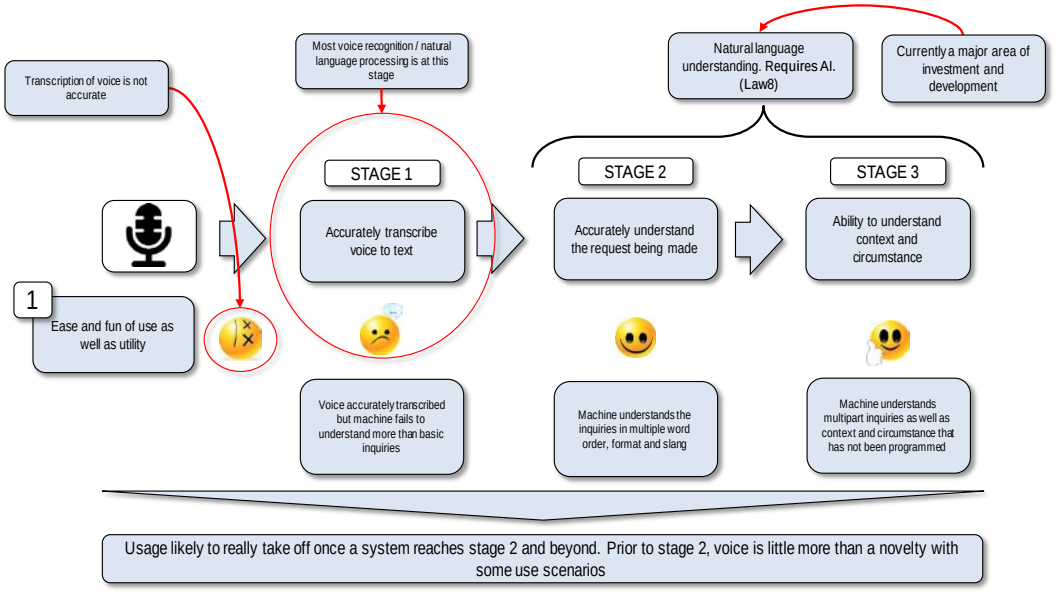


Source: Edison Investment Research

This is because the medium of sound is far more limited in the information that it can relay compared to the information that can be conveyed visually. The old saying that a picture is worth a thousand words accurately illustrates the problems of limiting the communication between man and machine to audio only. **However, it is worth noting that it is possible to convey vast amounts of information between humans through the medium of conversation and this is clearly what is missing when using voice to interact with machines.**

Improvements in voice recognition and natural language processing have meant that in terms of being able convert speech into text, machines have recently become extremely accurate. Previously, machines would have difficulty in recognising the actual words spoken let alone be able to derive any meaning from them. Hence, voice interaction with a machine was a slow and frustrating experience which meant that most users would try it once and then revert to a keyboard. With much more accurate voice recognition, this is beginning to change as voice is now a reliable and easy to use method of text input into a machine.

Exhibit 8: Stages of voice recognition in the ecosystem



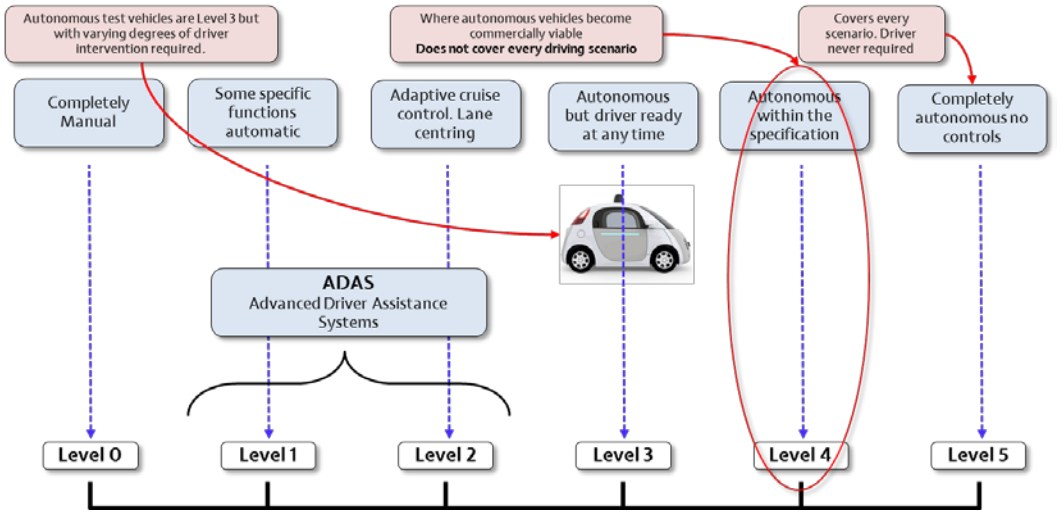
Source: Edison Investment Research

Unfortunately, to meaningfully enhance the man-machine interface in the automobile, voice recognition needs to improve significantly beyond mere recognition and evolve into understanding (stage 2 and 3 (Exhibit 8)). **This is where artificial intelligence (AI) comes in because to be really useful, the machine has to be able to understand and respond as if the user was talking to another human.** Today this is very far from the case and even the best digital assistants are extremely limited in terms of what they can understand, even though they can accurately identify almost every word spoken. Once this has been conquered, there will be scope for substantial usage of voice in the automobile. At present, this is the lead contender to drive usage in the vehicle but it is quite possible that autonomy (see below) may come first which would negate all efforts in this direction.

Autonomous vehicles

Of all the trends around the digitisation of the vehicle, none have attracted more attention than autonomous driving. The idea that vehicles could soon be driving themselves promises to revolutionise the transport industry, improve productivity, cut down on traffic jams and provide independence to those that are unable to drive themselves. Furthermore, vehicles that drive themselves have the potential to change the automobile industry radically with ownership moving from individuals to large corporations that provide them on demand as a service. This could radically change how consumers purchase transport as those that subscribe to a service are unlikely to care very much about, or be willing to pay for styling, leather seats, on the road performance or great sound systems. **Edison thinks that these are the main differentiators for the vehicle makers today meaning that a utopian future of clean and quiet cars, always available with no traffic jams could be a dystopian future for the automobile industry.** Furthermore, electric vehicles (EVs) and autonomy could have a materially negative impact on automobile demand. This is why all the vehicle makers are scrambling to come up with a solution for autonomy before the technology industry reduces them to makers of commoditised boxes on wheels.

Exhibit 9: Levels of autonomy in the automotive industry

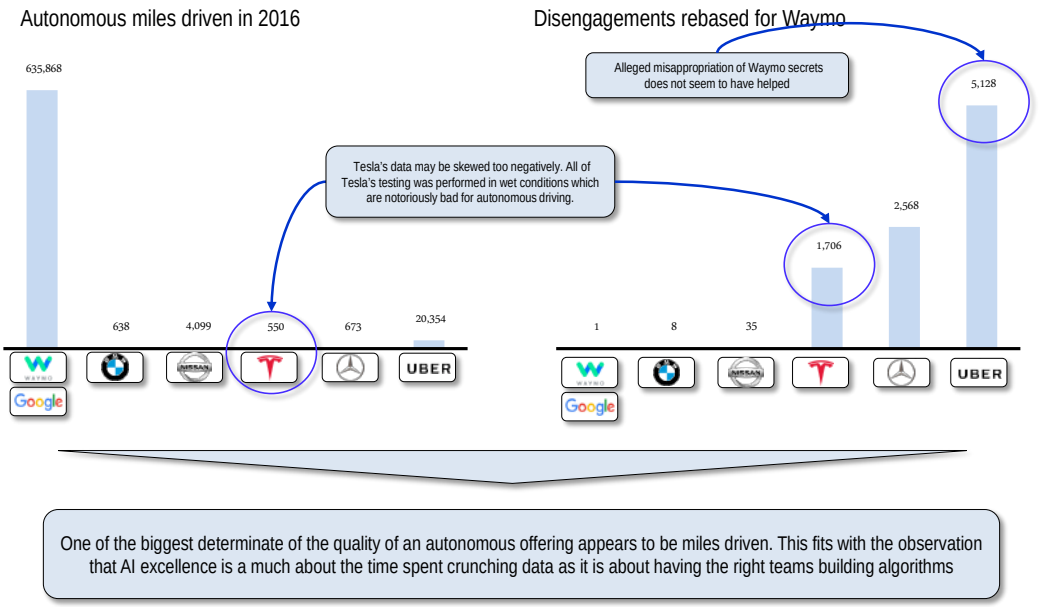


Source: Society of Automotive Engineers

The progression towards autonomous vehicles involves a steady increase in automation that is already underway with Advanced Driver Assistance Systems (ADAS). This covers Level 1 and 2 and involves automation of specific systems such as cruise control or steering. Level 1 is single systems being automated like simple cruise control, while Level 2 involves systems beginning to work together to provide functions like adaptive cruise control, lane centring or automated parking. Level 2 is the most advanced that is properly available today commercially, but work is well underway on systems to provide Level 4 autonomy. In our view, Level 4 is the point at which autonomous cars become a commercial reality because at this point the occupant of the vehicle no longer has to be ready to take over the vehicle at any moment. This is the main difference between Level 3 (where test cars are today with varying levels of ability) and Level 4. Level 4 for most practical purposes is full autonomy but there will be circumstances such as off road that the vehicle may not be able to handle. Consequently, in a Level 4 vehicle, Edison would still expect to find all the controls necessary for full manual control of the vehicle. Level 5 is where autonomy has reached a stage where manual control is superfluous and so no controls would be present. There is a possibility that the industry will move straight to Level 5 from Level 3. The case for skipping Level 4 is created by liability which if taken by the vehicle manufacturer or the fleet owner, will mean that the fleet owner will require absolute control of the vehicle such that it cannot be interfered with in any way by the passenger.

For all practical purposes, Edison thinks that commercial autonomy will be reached at Level 4 (or 5 if 4 is skipped) which is the target all the players are aiming for.

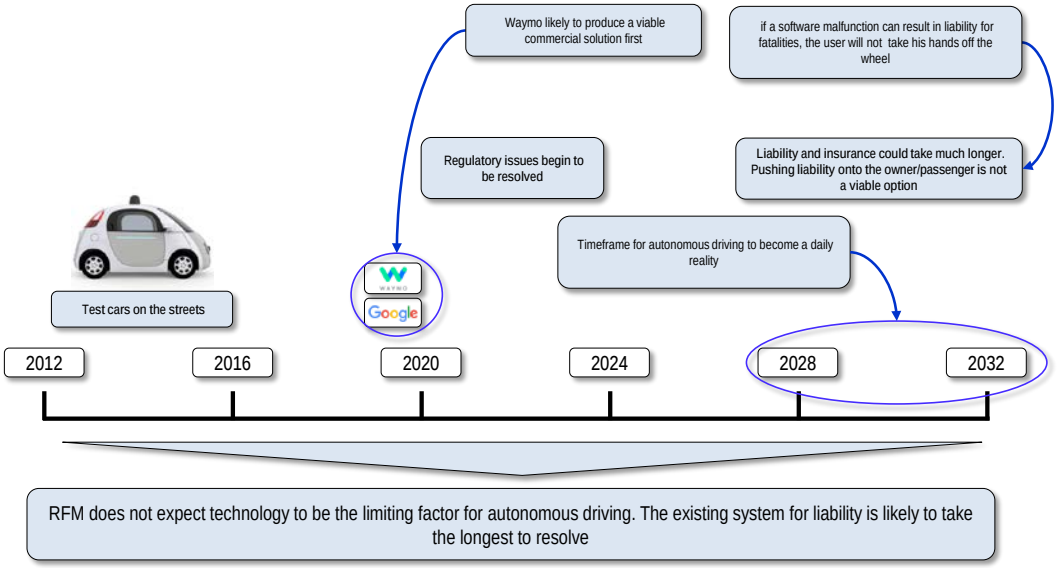
Exhibit 10: Autonomous driving performance by the major players, 2016a



Source: California department of motor vehicles

We believe that Level 4 autonomy will be achieved long before the market is ready to receive it. This is because regulation and liability are currently based on a human driving the vehicle. With all vehicles being piloted by humans, each vehicle has a single sentient place where liability can be placed. With machines driving, this becomes much more complex as in order to be acceptable to the passenger, liability has to be carried elsewhere. **A user who may be blamed for a software glitch causing a fatality is unlikely to take his hands off the wheel,** thereby obviating the entire use case for an autonomous vehicle. The current default position is to push all liability onto the person sitting in the driving seat whether or not he has his hands on the wheel. This has to change for autonomy to be a market reality meaning that the whole insurance industry needs to be uprooted and changed. This will take time which, combined with regulators also needing to adjust their schemes to incorporate the autonomous use case, leads Edison to forecast that autonomous cars will not be widespread and commonplace much before 2030 (Exhibit 11).

Exhibit 11: Timeline for roll-out of autonomous vehicles



Source: Edison Investment Research

Market impact of electric vehicles and autonomy

There are two issues approaching the automotive industry which threaten to fundamentally reduce the amount of money spent on vehicular transportation by consumers. A large part of this reduction is likely to be borne by the vehicle makers meaning that only the fittest are likely to survive. These are:

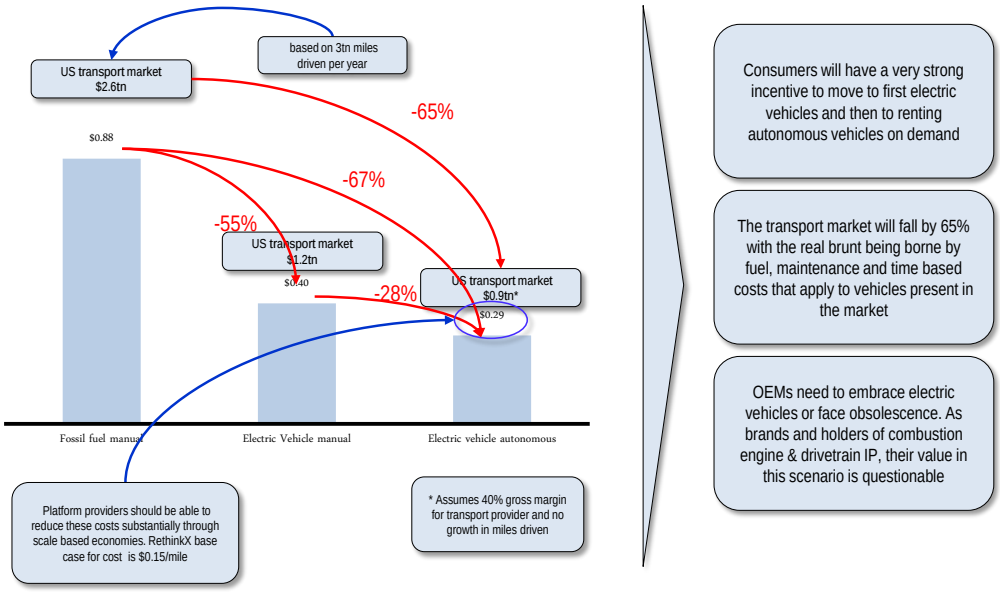
- Electric vehicles will be much cheaper to run and last much longer than internal combustion engine vehicles making them much more attractive to almost all buyers.
- Autonomous electric vehicles could cause demand for vehicles to decline substantially as less vehicles are needed on the road to fulfil demand for transportation.

Together, Edison thinks that these two issues have the potential to reduce the total amount of money spent on transportation by up to 65% and to reduce the demand for vehicle sales by up to 44%. This means that revenues will no longer be sufficient to support the industry size that exists today. The weaker and slower players are likely to face an existential threat as these issues make themselves felt.

We think that most vehicle companies today are brands, form factor designers, system integrators and holders of intellectual property on combustion engines and drivetrain (Exhibit 26). Furthermore, almost all journeys made today are utilitarian in that the driver of the vehicle is making the journey to fulfil a specific purpose. This has substantial and positive ramifications for the value of the data being generated, which is why the vehicle makers must maintain control of the data at all costs. All of this means that the vehicle will increasingly become secondary to the journey meaning that the characteristics that are used to sell cars today will become less and less relevant.

We have attempted to gauge the potential economic impact in conjunction with a study carried out by think tank RethinkX (https://www.rethinkx.com/transportation). We agree with RethinkX in that the single most important measure when considering the economics of shifting from individual ownership to a rental model is cost per mile. After examining the study, we have made some rough calculations based on the report and other sources, to try and gauge the impact that electric vehicles (EV) and autonomy might have on the economics to the end user (Exhibit 12).

Exhibit 12: Cost comparison of vehicle transport per mile in the US, 2016a



Source: RethinkX, US Bureau of Labour Statistics, Tesla, Edison Investment Research

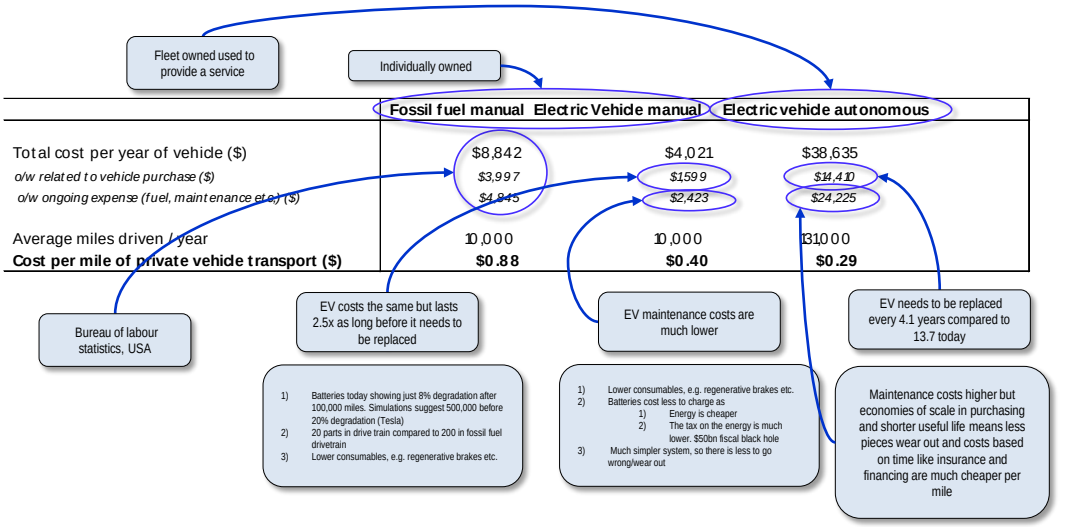
We think that by far the biggest impact will be moving from internal combustion engine powered manually driven vehicles to electric manually driven vehicles. This is primarily because EVs have a much simpler mechanical propulsion system allowing them to last much longer and to become

cheaper to maintain. RethinkX thinks it possible that EVs could end up lasting five times longer (1m miles) than existing vehicles (200,000 miles). Simulations from Tesla indicate that the vehicle could travel 500,000 miles before the battery reaches 20% degradation which is likely to be the biggest factor driving replacement of the vehicle. Consequently, we assume an average lifetime of 500,000 miles for EV which is c 2.5x longer than the 200,000 experienced by most internal combustion engine vehicles today.

Taking the longer lifetime into consideration means that the cost of purchasing the vehicle (Exhibit 13) is spread over 2.5 times as many miles creating a meaningful decline in total cost per mile. (Edison has assumed that an EV costs the same as an internal combustion vehicle in the same category.) Furthermore, the simpler system, current tax breaks and charging as compared to fuel also have a significant effect. **Overall, Edison estimates that moving from an internal combustion engine vehicle to an EV reduces the cost per mile by 55% from $0.88 per mile to $0.40 per mile for the owner of the vehicle.** Given that almost all of the drives made are done so for a purpose, we think that the economics of EVs are likely to vastly outweigh any lingering preferences for the old style of vehicles resulting in an almost complete conversion of the market once EVs hit economic scale and the right infrastructure is in place.

A move towards EVs has significant implications for the oil, gas and electricity generation industries. Around 45% of oil demand is created through demand for fuel for passenger vehicles which in the US could be replaced with a corresponding 18% increase in demand (RethinkX) for electricity as EVs are much more energy efficient. RethinkX's study suggests that because electricity capacity is built to meet peak demand, EVs could be charged at times of low demand in order to minimise the requirement for more infrastructure meaning a minimal impact on capex although electricity generation overall would still need to rise.

Exhibit 13: Cost of autonomous electric vs manual fossil fuel, US, 2015a



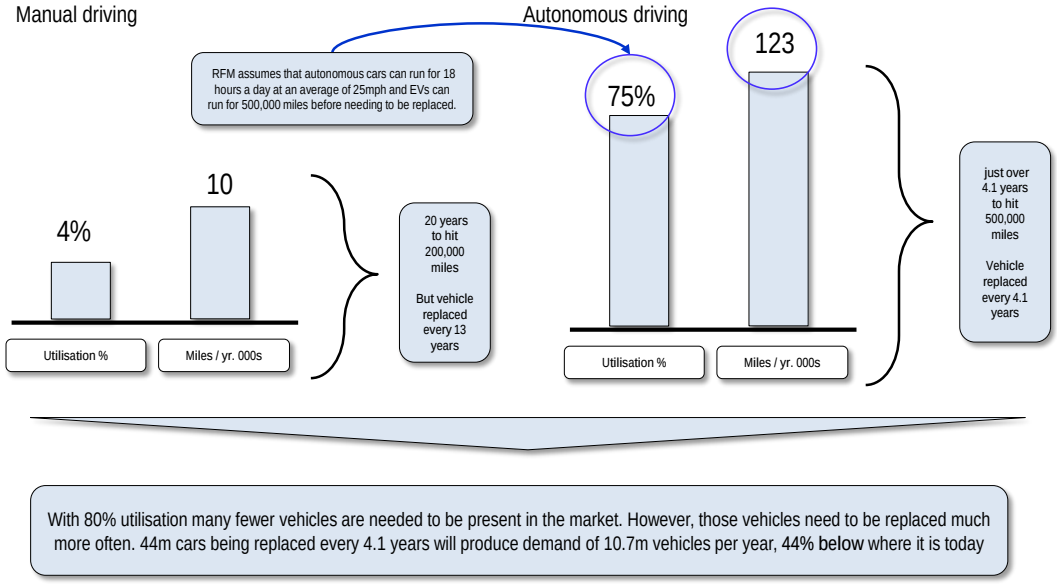
Source: RethinkX, US Bureau of Labour Statistics, Tesla, Edison Investment Research

Migrating from manual EVs to autonomous reduces the cost to the end user even further. This creates another incentive for consumers to migrate away from vehicle ownership as autonomy matures. A move to autonomy has scope to significantly increase the total numbers of miles driven as being able to drive would no longer be a limiting factor when it comes to being mobile. **However, for the simplicity of this analysis, Edison has assumed that total miles driven in the US remains unchanged at around 3.08tn miles per year.**

Most vehicles today spend around 96% of the time doing nothing but with autonomy this could change significantly. Edison estimates that an autonomous vehicle could run for 18 hours a day (leaving 8 hours for charging) which at an average speed of 25mph gives a total capacity of

164,500 miles per year. Mathematically, this would translate into a requirement for 18.7m vehicles to be present in the market to provide the capacity to drive 3.08tn miles. However, demand is unlikely to be constant meaning that more vehicles will be needed to be able to meet peak demand. Analysis by RethinkX estimates that having 44m vehicles present in the market would be sufficient taking into account demographics, geography and demand patterns**. This represents an 82% decline from the 250m vehicles that are currently on the road in the US but the total fleet would need to be replaced much more frequently.** Most cars are driven to destruction meaning that on average in the US, vehicles are replaced every 13.7 years. With autonomous EVs driving 123,000 miles per year, these would need to be replaced every 4.1 years giving **total demand in the US for 10.7m vehicles** (Exhibit 14). **This is 44% below where it is today, raising the likelihood that the majority of vehicle makers today would not be viable in their current form.** Edison sees the possibility for huge downsizing and consolidation among the vehicle makers over the next 15-30 years.

Exhibit 14: Market impact of autonomous vehicles in the US



Source: RethinkX, Edison Investment Research

Ride hailing

The big assumption being made about autonomous driving is that the usage of vehicles will move from being a single person or family to shared ownership. The main reason why automobiles today experience 4% utilisation is because only their owners use them meaning that they spend most of the time waiting to be used again by the same person. Edison thinks that the real promise of autonomous autos is about making much more efficient use of both vehicles and roads.

In order to increase vehicle capacity utilisation, the vehicle has to be used by different people. Either the owner as an individual can rent it out when he is not using it or it can be owned by a third party that offers an on-demand service. This is the likely future for all ride hailing companies that exist today as marketplaces between drivers and passengers. When the driver disappears, the current ride hailing marketplace will evaporate meaning that the ride hailing services will need to evolve or go out of business.

Edison believes that when the driver disappears, the ride hailing companies will be forced into becoming providers of transport services either by owning the vehicles themselves or by renting the

downtime from individual vehicle owners. This is why autonomous driving is so important, as without it, their businesses will become obsolete as vehicles begin to pilot themselves.

The best-known ride hailing service is Uber but its development of autonomous driving is not going well (Exhibit 10). Edison's analysis indicates that Uber is very far behind even some of the automakers and miles behind Google. Edison sees nothing to stop Mercedes Benz or Renault from offering a service directly to owners of its vehicles that allows them to rent out their vehicles as part of an autonomous fleet when not in use. Hence, to hold onto the customer loyalty that it already had in the US and Western Europe, Uber has to come up with a better autonomous solution than all of its competitors and peers including Google.

With a better solution, it will have a very good chance of remaining the go to place to hail an autonomous vehicle as it will still have the relationship with passengers despite the loss of the drivers. Google has abandoned its plan to build its own autonomous vehicle and is now concentrating on forming partnerships with automakers in order to get its self-driving technology in the hands of users. Edison's analysis indicated that Google's self-driving capability is miles ahead of Uber in terms of performance (Exhibit 10), creating substantial pressure for Uber to improve. If Google, in conjunction with the automakers can offer a superior autonomous solution compared to the existing ride hailing companies, then they will become obsolete and follow the internal combustion engine into the graveyard of history.

Digital Life

The Edison Digital Life pie (Exhibits 16 and 18) remains central to our analysis of the digital ecosystem. It measures how users spend their time engaged with digital services on their devices. (Edison excludes voice, text and e-commerce). Analysing each ecosystem on this basis gives a very good idea about how well developed its strategy is and how much more work or investment is needed to assemble the right assets to provide a complete offering for the user's Digital Life. It also gives a good assessment of how big the monetisation opportunity is. An assessment of the impact of Digital Life on the monetisation opportunity is discussed in detail on page 3 of Mobile Ecosystems, 24 February 2017.

To date, Edison has assessed a Digital Life pie for usage based on smartphones and tablets only. This is because while some of the same Digital Life services can be used on other devices such as wearables, consoles and TVs, there is no evidence that the experience on those devices has any effect on their choice with regard to where they live their digital lives. Consequently, Edison continues to believe that they are irrelevant when considering what drives consumers to choose one ecosystem for another.

Currently, almost all purchasing decisions for an automobile are based on physical attributes such as form factor, safety, performance, economy and so on but digital is starting to have an impact. Increasingly, users want to know about how their digital lives will be delivered to them when they are in the vehicle. The more important this becomes, the greater the threat to the vehicle makers. Edison sees the Digital Life pie for the automobile being relevant today for two reasons:

- **Brand preservation for the vehicle makers:** If digital services become part of the purchase decision in the automobile and every vehicle were to run only Android Auto or Apple CarPlay there would be no differentiation for the vehicle makers in this area, laying them more exposed to commoditisation. This is why Edison sees all vehicle makers feverishly working away to differentiate themselves in digital services and how to keep Apple and Google from reducing them to handsets on wheels.
- **Automotive digitisation:** The automobile is emerging as the next major device to be digitised and given that it registers a very high level of usage in terms of time (Exhibit 17), may soon

become relevant in the user's decision with regard to which ecosystem he decides to use to live his digital life.

The automobile is also unique in that in terms of time spent, it is not close to the smartphone but it is substantial. Surveys have shown that smartphone usage in the US can be up to 300 minutes per day while the average driver spends 101 minutes in the vehicle every day. While it is much more difficult to monetise that time given that the user's attention is focused elsewhere, the added variables of location and movement over large distances offer potential for monetisation that other devices types do not. Furthermore, in order for a vehicle to become autonomous, it needs to be fully digitised meaning that vehicles are going to become digitised sooner rather than later.

This is why the major ecosystems are all very keen to have their Digital Life services present in the vehicle. Four out of six of the top ecosystems already have their own solution for digital services in the infotainment unit with the promise of several more to come (Exhibit 15). From the ecosystem perspective, the vehicle is just another device across the digital spectrum through which they can deliver Digital Life services.

Exhibit 15: Ecosystems across different device types, Q217

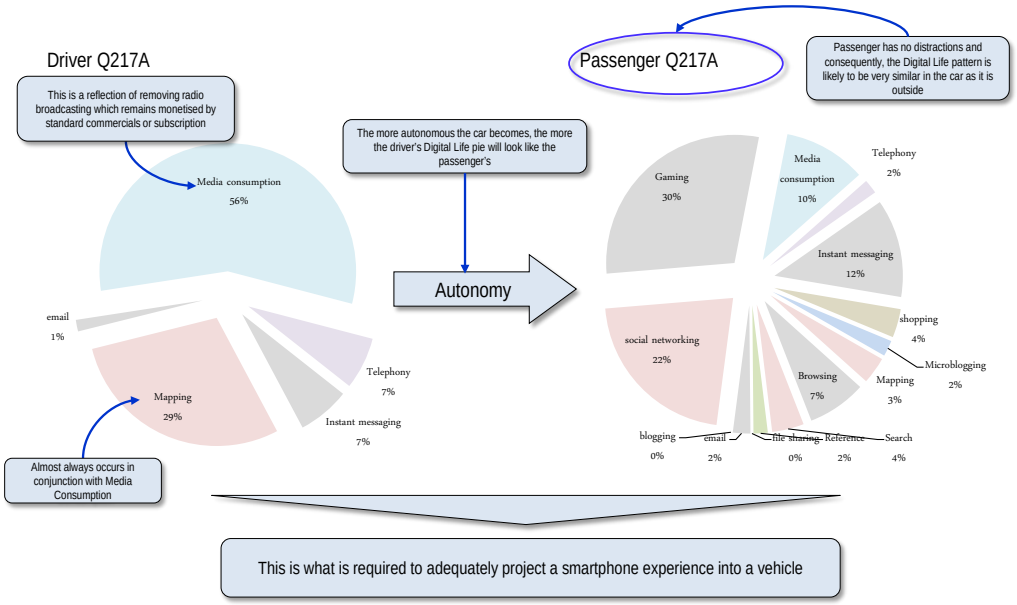
Source: Edison Investment Research, Company data

This is why it is relevant to consider the automobile in the context of all the other devices (Exhibit 15) and here it is clear how important the opportunity of the digital ecosystem in the vehicle is to the ecosystem companies. Of the top six ecosystems, only Facebook and Tencent have no real presence in the automobile, but this is something that may change as the vehicle becomes increasingly important. Edison thinks that currently, Facebook and Tencent intend to address the vehicle through their apps rather than creating a full experience for the infotainment unit. This makes some sense as of the top ecosystems, these two are the most driven by apps currently, although Facebook's strategy is to expand into a fully-fledged ecosystem over time.

Digital Life in the vehicle

There are two Digital Life scenarios that exist within the car: the driver (Exhibit 16: LHS) and the passenger (Exhibit 16: RHS). As the driver always must have the vast majority of his attention on the road, his capacity to consume Digital Life services will be very different to a passenger. Many services such as social networking and gaming are simply not relevant in this scenario. Hence, they are not represented in the Digital Life pie of the driver (Exhibit 16).

Exhibit 16: Edison Automotive Digital Life pies, Q217



Source: Edison Research, Triton, Arbiton, Scarborough Research, Edison Investment Research, Nielsen, Google, Pewinternert.org, comScore, NetMarketShare

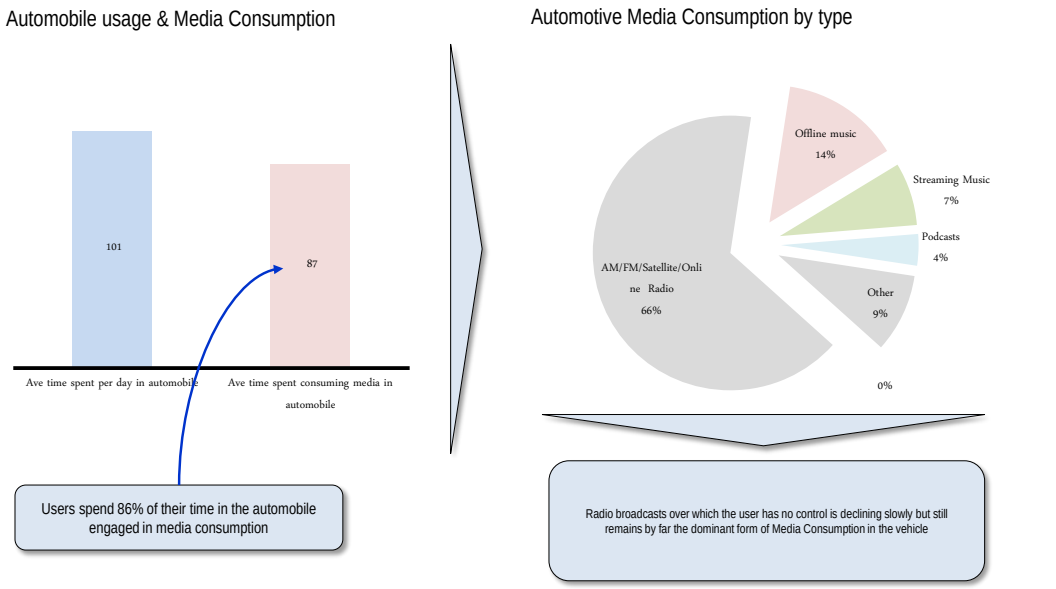
Unsurprisingly, media consumption (audio only) and mapping are the two biggest segments, with communication-related services making up the rest. This fits exactly with how Apple and Google have structured their offerings for the vehicle with their efforts being focused on audio, messaging and navigation. Due to the lack of distractions, Edison thinks that the Digital Life pie for the passenger is exactly the same as it is for users at home, at work, in the street, or on public transport. There has been no indication that the Digital Life pie in these scenarios is much different from the average which is why Edison thinks that there are no meaningful insights to be gained by breaking them out.

We have identified two problems with the analysis of the Digital Life pie for the driver.

- A large proportion of the two main Digital Life services occur at the same time in that while navigating, the driver will also listen to media. Consequently, in terms of time spent, total usage adds up to more time than the driver spends in the vehicle.
- The vast majority of media consumption in the vehicle is not interactive digital but analogue or digital radio broadcasting which renders the user completely passive, other than to select which channel to listen to.

Consequently, Edison has adjusted the time allocation to media consumption to reflect both the fact that a large part of it is not digital as well as the fact that much of it occurs at the same time as navigation. **This is why media consumption accounts for 56% of the pie (Exhibit 18) rather than the 86% that one would normally calculate (87 minutes out of a total of 101 minutes per day spent in the car).**

Exhibit 17: Media consumption in the vehicle, Q217



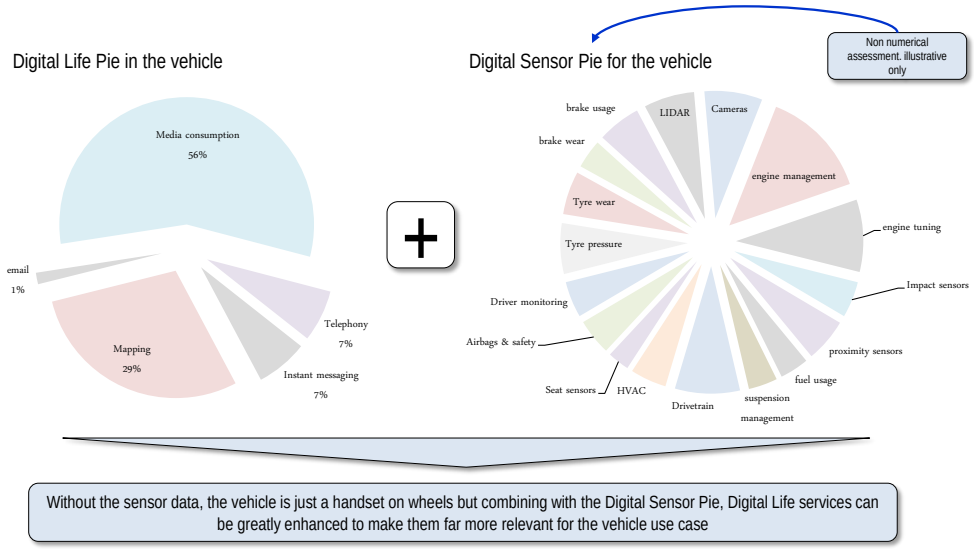
Source: Edison Investment Research

Sensor data

Unlike consumer electronic devices, Edison thinks that Digital Life in the vehicle is only part of the story. The Digital Life pie deals with the use of services normally used in a smartphone in the context of the car, but it does not address the unique use case of the vehicle itself. A modern vehicle has a large array of sensors (Exhibit 2) which collect and relay information about how the machine is running and its surroundings to the infotainment unit. The information is aggregated and then used to run the vehicle and/or is presented to the user. **Edison thinks that this information is the key ingredient to taking the services that are being used on smartphones and deepening and enriching them to make them applicable and much more valuable to the occupants of the vehicle.** The data are also essential in autonomous driving as any company wishing to work in the space must either have a vehicle of its own (or re-fit an existing model) or have access to the data through a relationship with a vehicle maker.

Edison believes that sensor data will be essential to enabling a whole series of new and intuitive digital services that will help differentiate the offering from one manufacturer to the next. The sorts of services enabled could be smart scheduling that recommends the right time and best price to refuel the car, insurance discounts for safe driving practices monitored through engine, steering and braking data or interactive parking and traffic services. **However, our view is that digital data generated by the smartphone in the vehicle is not differentiating**. This is because Apple and Google will already be present in almost every vehicle (Android Auto is now available on phones so it can be used in any vehicle and is portable from one vehicle to another). Edison thinks that it is when data from the smartphone are combined with the information from the vehicle that the real opportunity occurs. This is why the sensor data are so important and need to be taken into account when considering Digital Life in the vehicle. Furthermore, sensor data also represent a monetisation opportunity that could be used to partially or fully offset declining revenues from vehicle sales.

Exhibit 18: The full picture of Digital Life in the vehicle, Q217

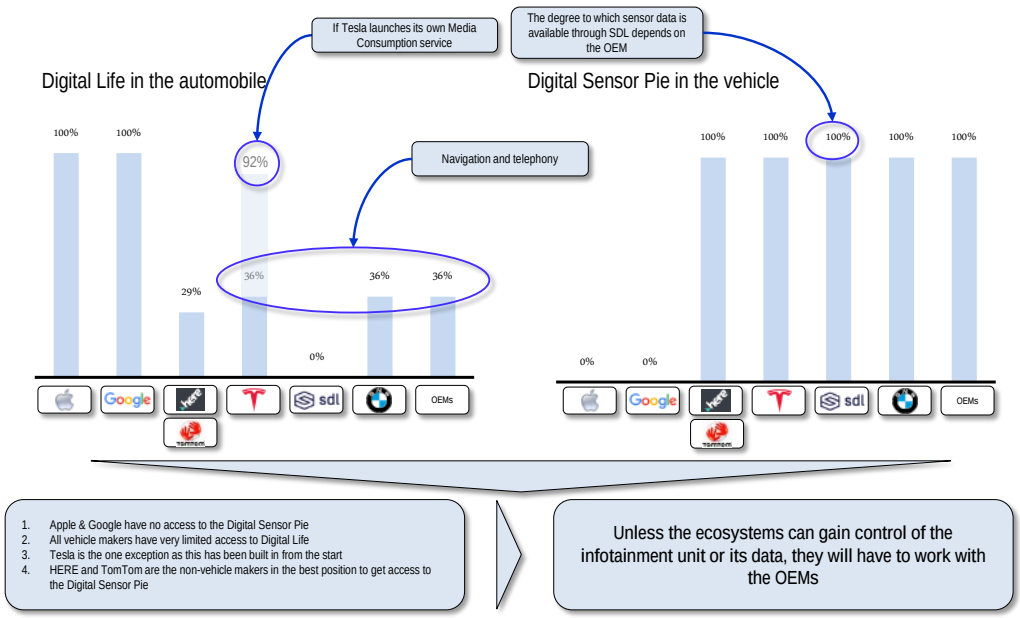


Source: Edison Research, Triton, Arbiton, Scarborough Research, Edison Investment Research, Nielsen, Google, Pewinternert.org, comScore, NetMarketShare

Edison thinks that due to the importance of sensor data, the real opportunity for digital services in the automobile are best assessed by looking at coverage of both pies. With the sensor data pie, it is an all or nothing segment in that the digital service provider or ecosystem either has access to the Can Bus networks in the vehicle or it does not. This is why the coverage of this pie is either 100% or 0% with nothing in between for the companies under analysis (Exhibit 19).

Although the vehicle makers often give the impression of being behind or out of touch with digital services, Edison thinks that it is the vehicle makers that currently have the greatest opportunity. This is because they have access to the sensor data that are capable of providing differentiation in the automobile in contrast to the digital ecosystems which do not. This is why Edison thinks that Google in particular is seeking ways to be more deeply integrated into the infotainment unit.

Exhibit 19: Coverage of both automotive Digital Life pies, Q217



Source: Edison Research, Triton, Arbiton, Scarborough Research, Edison Investment Research, Nielsen, Google, Pewinternert.org, comScore, NetMarketShare

Edison has selected seven players in the digital automotive ecosystem for deeper analysis. One of these six is represented by the vehicle makers that have been put together as one group. This has been done as the vast majority of automakers are very similar in terms of what they are doing in digital services and how they are faring and so it makes no sense to us to separate them.

Edison thinks that the two exceptions amongst the auto makers are BMW and Tesla. **First:** they have clearly identified what they are trying to achieve in the digital vehicle; and **second,** they are writing their own code. In Edison's opinion this sets them apart from the other automakers and warrants analysing them individually.

Apple, Google and SDL are all delivering systems that allow Digital Life services to be presented on the infotainment unit while still running on the device that has been brought into the vehicle. Edison thinks that Apple and Google (particularly) have ambitions to move beyond this and to gain deeper access to the vehicle through an expansion of their automotive offerings. Clearly this has a potentially substantial impact on the entire industry given how strongly entrenched with the consumer they have become. The last category is the two map providers HERE and TomTom. These two companies are by far the leaders in the provision of automotive maps and have ambitions to move beyond that into the provision of value added digital vehicular services. To achieve this they need access to sensor data and given their existing relationships with the vehicle makers and the fact that they are already embedded in the infotainment unit (Exhibit 2), they may be able to gain some traction.

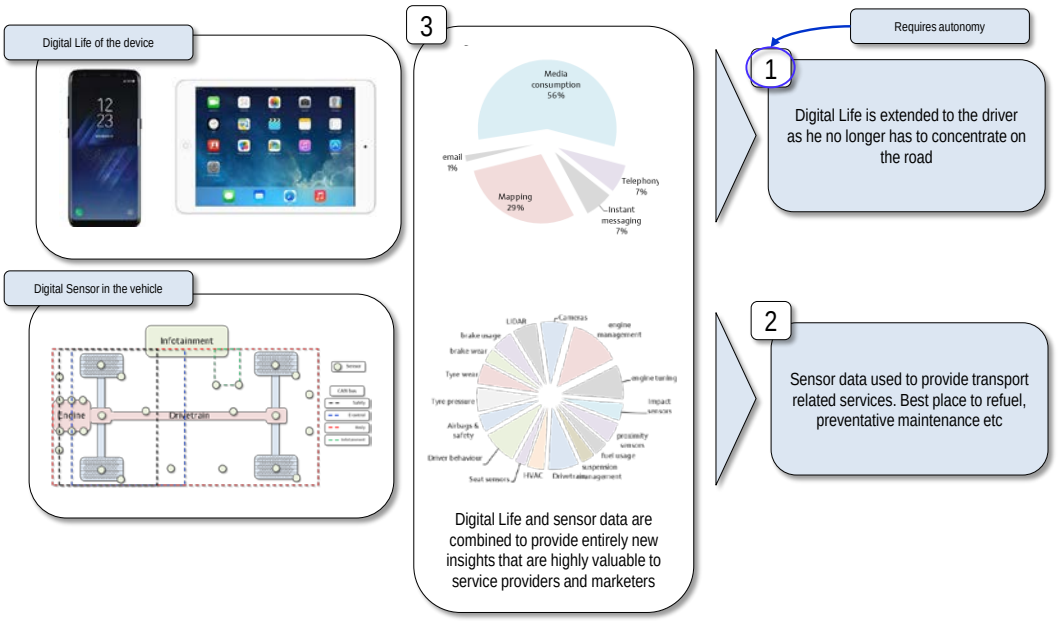
Assessing the seven offerings against the Digital Life pie and the Digital Sensor pie shows the following:

1. Despite dominating Digital Life, Apple and Google currently have no access to the Digital Sensor Pie. This leaves them with the monetisation opportunity for Digital Life only.
2. All vehicle makers (including BMW and Tesla) have very limited access to Digital Life (navigation and telephony) but excellent coverage of the Digital Sensor pie. Although they have coverage of telephony, Edison doubts they are able to collect data from the services on their infotainment units as almost all of them are simply Bluetooth speakers. **In reality, Edison sees vehicle makers currently collecting data from navigation and the Digital Sensor pie only.**
3. Tesla is the one exception as understanding of users has been built into Tesla products from the ground up. Furthermore, should Tesla launch its own media consumption service, this would take its coverage of the Digital Life pie to 92% giving it the best coverage of any player in the space. This has yet to be announced and Edison thinks that the momentum of Apple Music and Spotify is already great enough to make it unlikely that a venture of this nature would succeed.
4. Of the non-vehicle makers, we believe HERE and TomTom are in the best position to get access to the Digital Sensor pie. This is because their maps are deeply embedded within the infotainment unit and there are long standing and trusted relationships between these companies and the vehicle makers. HERE is now mostly owned by the automotive industry further enhancing its ability to get access to the Digital Sensor pie.

Monetisation of the digital vehicle

Edison sees three methods by which the digital vehicle can be monetised. The first is through the data generated by the device that the user brings with him into the vehicle and the second is through the use of the sensor data generated by the vehicle. The third, and most powerful, is when the data from the device with regards to the user's Digital Life is combined with the sensor data in the vehicle to provide insights that can be of high value to service providers and marketers. In our view this is why the digital ecosystems are all very keen to win access to the data to combine it with Digital Life insights that they already have.

Exhibit 20: Monetisation of the digital vehicle



Source: Edison Investment Research

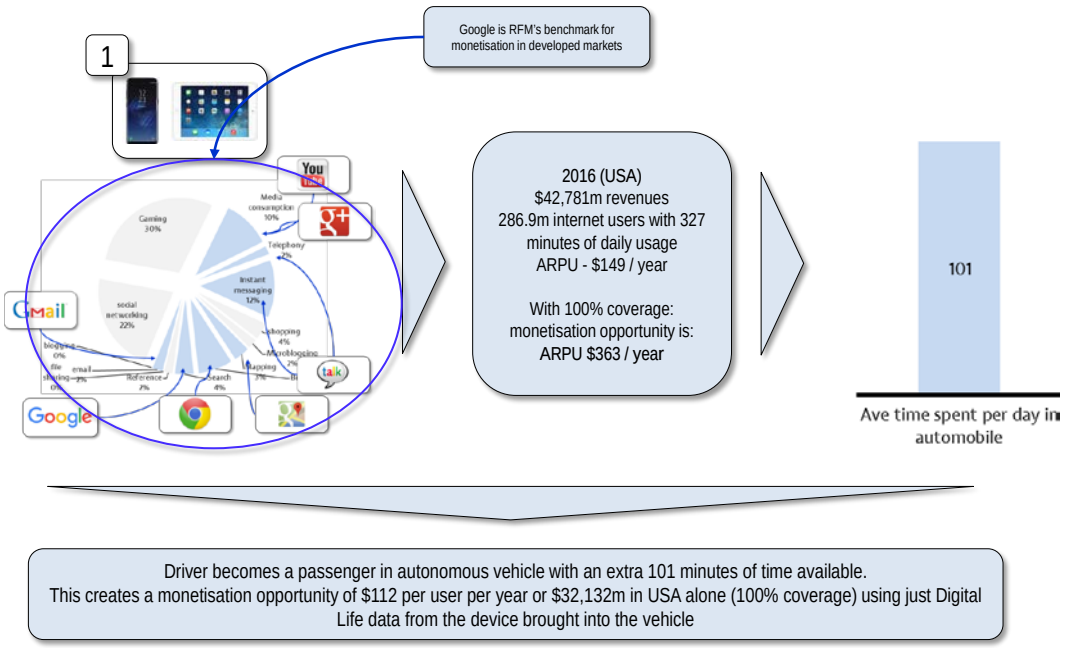
Device generated monetisation

Edison believes that this opportunity will occur when vehicles start to pilot themselves. At this point the issue of driver distraction would be resolved as the driver becomes a passenger and can direct all of his attention to a digital device. It is at this point that the Digital Life of the driver disappears leaving just the Digital Life of the passenger (Exhibit 16).

On this basis, it is possible to estimate the monetisation opportunity using Google's 2016 data from the US as a benchmark. This is the same rationale that is used to estimate the monetisation opportunity for any Digital Life service or ecosystem. In 2016, Google generated total revenues of $42,781m in the US which translates into $149 per user per year (ARPU). Google manages to generate this revenue despite having just 41% coverage of the Digital Life pie (Exhibit 21) implying that an ecosystem with 100% share should be able to generate around $363 in ARPU. Using Flurry as a data point, Edison estimates that these users spend 327 minutes a day engaged with Digital Life.

Drivers in the US spend on average 101 minutes per day in the vehicle (Exhibit 17) and when the vehicles drive themselves, this time becomes available for other activities. Assuming that time in the vehicle remains unchanged this could meaningfully increase time spent engaged with Digital Life thereby increasing the monetisation opportunity. Edison calculates that this could **increase monetisation by $112 per user per year or a total market opportunity (with 100% coverage of the Digital Life pie) of $32,132m per year in the US alone.**

Exhibit 21: In vehicle monetisation of Digital Life from the device, 2016



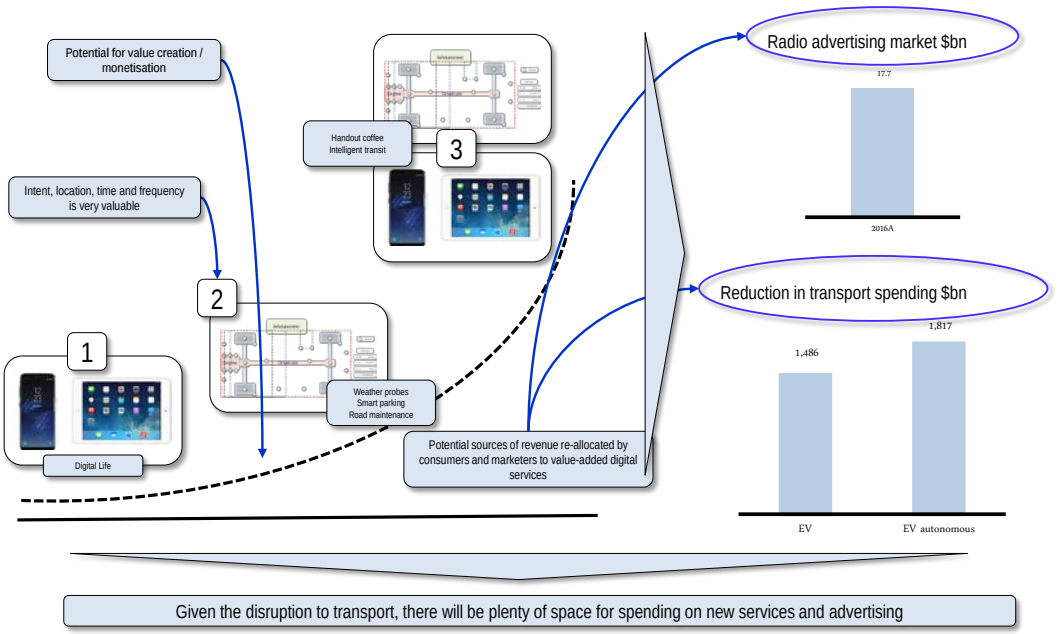
Source: Edison Research, Google, Edison Investment Research

Sensor data generated monetisation

The second and third methods of monetisation involve the use of the sensor data generated by the vehicle. These data are unique to the vehicle that generates them and, at the moment, it is the vehicle manufacturer that controls access. **Edison strongly believes that this is the one area where the vehicle manufacturers have an edge**. In many other areas, such as the arrival of electric, digital and autonomous vehicles, vehicle makers are at risk of being reduced to handsets on wheels. Edison also believes that the infotainment unit is the most important part of the digital vehicle because this is where the four Can Bus networks meet making it the one place in the vehicle where every single piece of data can be present.

Edison thinks that sensor data are potentially extremely valuable as almost every journey is made for a reason (aka an intent drive). For example, instead of rolling out weather stations to help predict the weather, hurricanes, floods and so on, the meteorological service could buy the weather-related data that vehicles generate via the vehicle manufacturer to the meteorological service. Another example could be parking providers, knowing where the driver is going and hence being able to accurately price and offer their parking spaces to drivers in real time and then guiding them into the bay. A third example could be the Department of Transport buying suspension derived sensor data to assess the quality of the roads and pre-emptively and more cheaply fix places where the road is wearing out. **These are the kind of services that could be enabled simply by making use of the sensor data that vehicles generate.** Because of the knowledge of location, time and frequency and the potential cost savings that would result, Edison thinks that data could easily be more valuable than the $112 per user per year calculated as the opportunity for simply using Digital Life data generated by the device brought into the vehicle.

Exhibit 22: In vehicle monetisation of Digital Life and sensor data



Source: RethinkX, Edison Investment Research, e-marketer

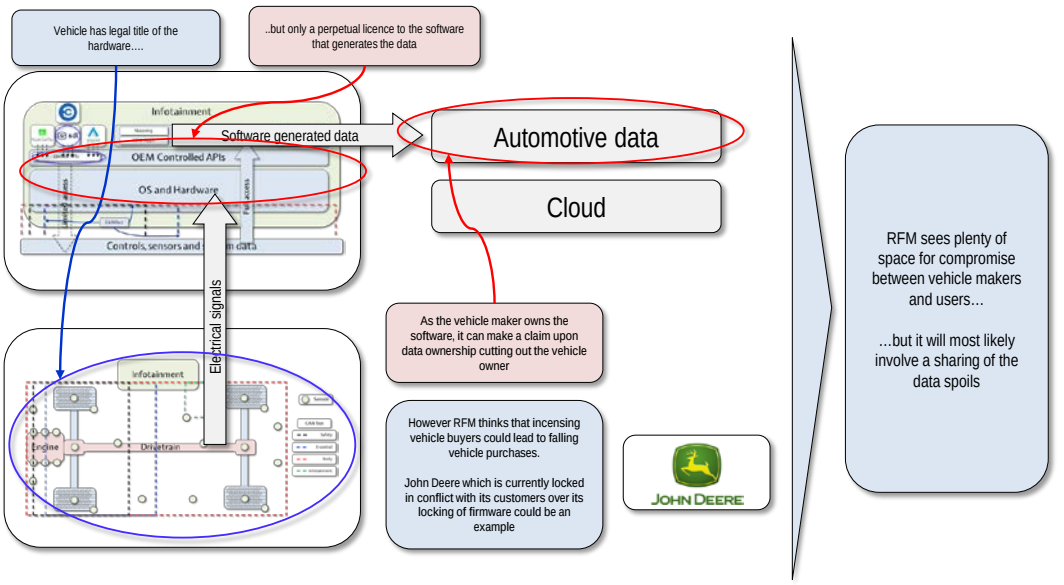
The third method (Exhibit 22) is to use the sensor data in conjunction with Digital Life data on the device as this will give a much better understanding of the driver or passenger in any given context. Digital Life holds far more personal data than is likely to accrue on the vehicle which combined with the sensor data can make for much greater depth of insight. A good example of this is a coffee shop knows that the driver likes a certain type of coffee and will pass the store within 15 minutes. The coffee shop can make the driver an offer and if he accepts, simply hand him his coffee as he drives past. Another example could be a transport service that can suggest driving and parking, ride hailing, bicycle or public transport as the best method or even the best combination thereof for both time and cost effectiveness.

Edison research has indicated that when it comes to data, the whole is much greater than the sum of the parts. In digital ecosystems, when more of the Digital Life pie the ecosystem is covered by an ecosystem, there is an upward and non -linear increase in the potential value that can be created. The more the ecosystem understands its user, the more tailored its services can be and the more accurate the advertising that it sells giving an increase in price. The more the pie is covered, the more potential there is for the user to spend more time within that ecosystem and so the volume opportunity increases. It is these two factors together that give the non-linear improvement in monetisation opportunity. Edison thinks a similar improvement is possible through the addition of sensor data to Digital Life data (Exhibit 22). **Hence, as long as the vehicle manufacturers can hold onto their ownership of the sensor data, they will at least have a seat at the table**. Unfortunately, even here Edison sees problems.

Sensor data ownership

When it comes to the monetisation of sensor data, there is no clear position in terms of ownership of the data. The potential conflict is clear to see when one considers a company that owns a fleet of vehicles. This company will consider that, as it owns the vehicles it will also own the data that they generate.

Exhibit 23: Sensor data ownership



Source: Edison Investment Research, John Ellis Associates, Extreme Tech

When there is little or no data or little monetary value, this is not an issue but when it can make a meaningful difference to the bottom line, it becomes extremely important. Edison thinks that the same will be true for consumers as surveys have found that over 90% of consumers believe that they own the data that their vehicles generate.

The position of the vehicle manufacturers seems to be that they are also laying claim to this data on the basis of software. The information is being generated mostly by software that interprets the signals from sensors and turns it into meaningful numbers (Exhibit 23). However, while the owner of the vehicle owns the vehicle itself, he does not own the software within it. The vehicle manufacturer grants the user a licence into perpetuity to use the software. There is a reasonable legal argument that goes along the lines of: because the user does not own the software that generates the data, he does not own the data itself.

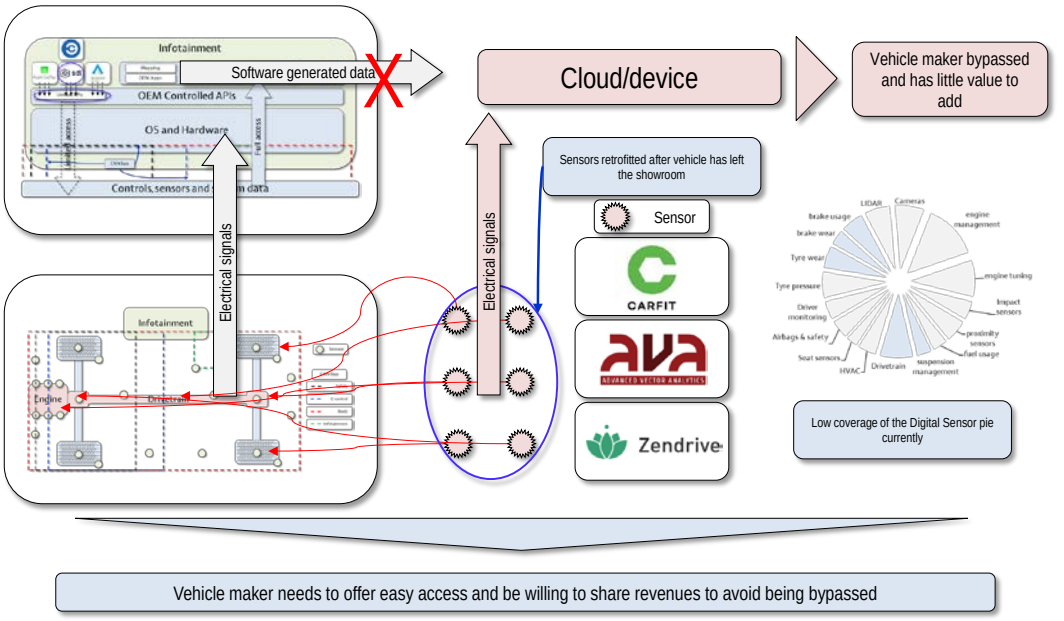
Regardless of the legal ownership, it is likely to incense vehicle buyers so much that once they become aware of this issue, it could prevent them from buying the vehicle in the first place. A good example of this is the ongoing fight between John Deere and farmers who own its tractors. Effectively John Deere has locked the vehicles such that any repair or maintenance, no matter how trivial, can only be done by an approved technician costing $150 per hour plus the callout charge. This also means that John Deere can determine the end of life for the vehicle simply by ending its repair service to that model. The net result is that incensed farmers are purchasing cracked copies of the John Deere software from Eastern Europe to perform the maintenance themselves. The farmers have been granted a copyright exemption that allows them to circumvent the locked down software but the legality of doing so with cracked software is uncertain. **The end game here is that John Deere gets such a bad reputation that farmers stop buying its tractors creating an opportunity for a rival with a more farmer friendly attitude to pick up market share.**

Consequently, Edison believes that even if the vehicle makers do legally own the data, depriving users of access to and control of their data is likely to incense vehicle buyers and be viewed very dimly by regulators and data privacy advocates**. Faced with the potential loss of vehicle sales, Edison thinks that the vehicle manufacturers should be open to sharing at least some of the spoils of their new data bonanza with their customers.**

Over the top (OTT) sensors

Edison believes that OTT sensors represent one of the biggest risks to the vehicle manufacturers. OTT sensors are where sensors outside of the control of the vehicle manufacturer are used to monitor the performance of the vehicle itself. These can be the accelerometers in a mobile phone (Zendrive) or a simple device that is added to the vehicle that is capable of detecting how the vehicle is functioning (CARFIT & Advanced Vector Analytics).

Exhibit 24: Advent of retrofitted over-the-top (OTT) sensors



Source: Edison Investment Research, company data

Currently, this is almost exclusively carried out by interpreting vibrations using sophisticated software, but it seems other means of measurement are likely to be forthcoming. CARFIT, with one small hockey puck stuck on the dashboard, claims to be able to monitor the condition of tires, wheels, brakes, shock absorbers and the steering column. It also claims that it can have a view on the overall state of the vehicle. Advanced Vector Analytics claims that it can use six sensors to replace the 150 currently present on a helicopter and that this could easily be applied to the automotive market.

The danger for the vehicle makers is clear (Exhibit 24). This research has identified that in the long term, the vehicle data may be one of the few things that these companies have left with which to differentiate their product. **If the vehicle makers are slow or restrictive in terms of dealing with customers and service providers, they will be encouraging the growth of these sorts of solutions. Given the scope for value creation using vehicle data, there is the potential to generate incremental revenue.** The current risk is very low as these solutions are fragmented and each only cover a small segment of the Digital Sensor pie but as time progresses and the opportunity remains, we believe the risk is very likely to grow rapidly.

Eight Laws of Robotics

While the Digital Life analysis assesses ecosystems on the degree to which they are addressing the opportunity, it makes no assessment of how well they offer their services. This is where the eight Laws of Robotics come in. These are eight simple tests designed to appraise the quality of the ecosystem and how likely it is to succeed. Combined with the Digital Life pie, these laws form the basis of the opinion that Edison holds on the strategy, success and outlook of any one ecosystem. These laws are also highly relevant to those planning on offering digital services in the vehicle and hence it makes sense to assess the ecosystems and the vehicle manufacturers and other players based in that context.

The eight laws are divided into two groups. The first four are the fundamental assessment of how well an ecosystem currently caters to the requirements of its users. This is an assessment of how well an ecosystem should be able to generate user loyalty and a return on investment based on where it is today. **Laws 1-4 (Exhibit 25) are:**

1. **Easy and fun:** An ecosystem must provide easy and fun access to digital life
2. **Set up:** An ecosystem must be simple and easy to set up and use
3. **Traffic capture:** An ecosystem must capture traffic on its own servers
4. **App. equivalency:** An ecosystem must offer access to a good range of third party apps

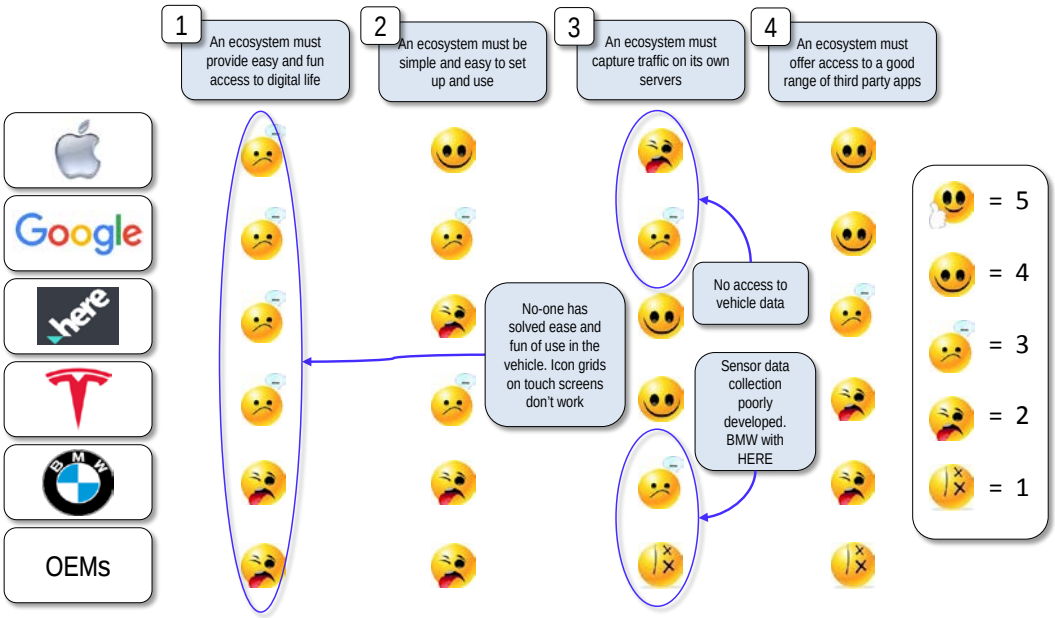
Laws 4-8 are an assessment of how well an ecosystem is set up to compete in the longer term. These are more subtle and assess the internal systems of the ecosystem in order to ascertain how well it can improve its services and make its offering deeper and richer for the user. Edison argues that a good score on laws 5-8 is required to be able to fend off the increasing competition that will inevitably materialise as the growth slows and competition increases. **Laws 5-8 (Exhibit 26) are:**

5. **Data sharing:** An ecosystem must allow Digital Life services to share data
6. **Data integration:** An ecosystem's user data must be integrated
7. **Software consistency:** An ecosystem must have consistent device software
8. **Artificial intelligence:** An ecosystem must have good and effective artificial intelligence

Edison has analysed six of the chosen players active in the digital automotive segment and tested them against the eight Laws of Robotics to see how they perform and where the strengths and weaknesses of each offering is to be found. This analysis is detailed in Exhibits 25 and 26.

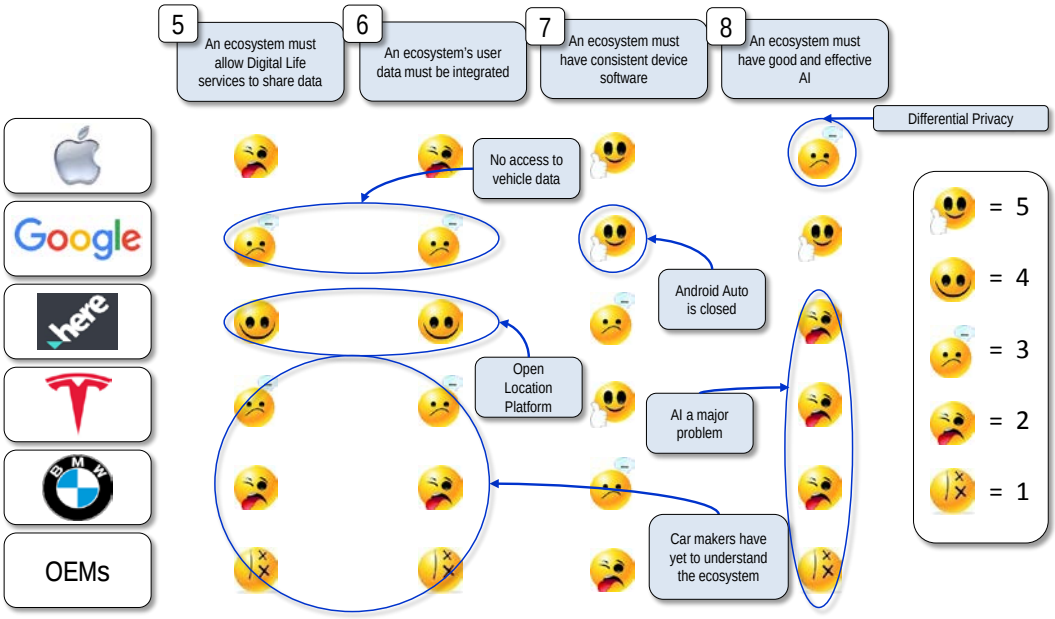
1. No one has come close to getting the user experience in the vehicle correct. This is discussed in more detail on page 9.
2. Capturing and understanding vehicle data remains a big problem. Apple and Google do not have access to the data while vehicle makers except Tesla are struggling to get up and running. HERE's Open Location Platform has promise but it is very early days.
3. Android's endemic fragmentation that it suffers in smartphones and tablets is not replicated in the vehicle as Android Auto is closed and proprietary to Google.
4. HERE has understood the importance of putting together different data sets to deliver greater insight into user behaviour. However, we think that there is a long way to go before this translates into services that can generate meaningful revenues or differentiation for HERE and its owners.
5. AI remains a big issue for all of the automotive players except Google. Edison suspects that there will be plenty of third-party vendors that will emerge over time to help the vehicle makers plug this gap in competence that they can never really hope to fill.

Exhibit 25: Laws of Robotics 1-4 in the automotive context



Source: Edison Investment Research

Exhibit 26: Laws of Robotics 5-8 in the automotive context



Source: Edison Investment Research

Automotive ecosystems

Vehicle makers

The vehicle manufacturers are under assault from all sides and while the situation might appear hopeless, Edison thinks that there is something that can be done about it.

Most vehicle manufacturers have very similar characteristics and challenges which is why Edison is assessing them as a group (except Tesla and BMW) rather than individually. These characteristics include:

1. The core assets are their brands and intellectual property that they have developed on combustion engines and transmission.
2. They are essentially system integrators who design a product and write detailed specifications for systems that are put out to tender to their suppliers. Once they receive the systems from their suppliers they integrate them to produce the final product.
3. Once their products leave the factory they are quickly forgotten.
4. They neither write nor understand software.
5. The product cycle is four to five years whereas technology is running on an 18-month cycle
6. Their products are differentiated by form factor, safety, performance and cost of ownership and not the digital experience in the vehicle.

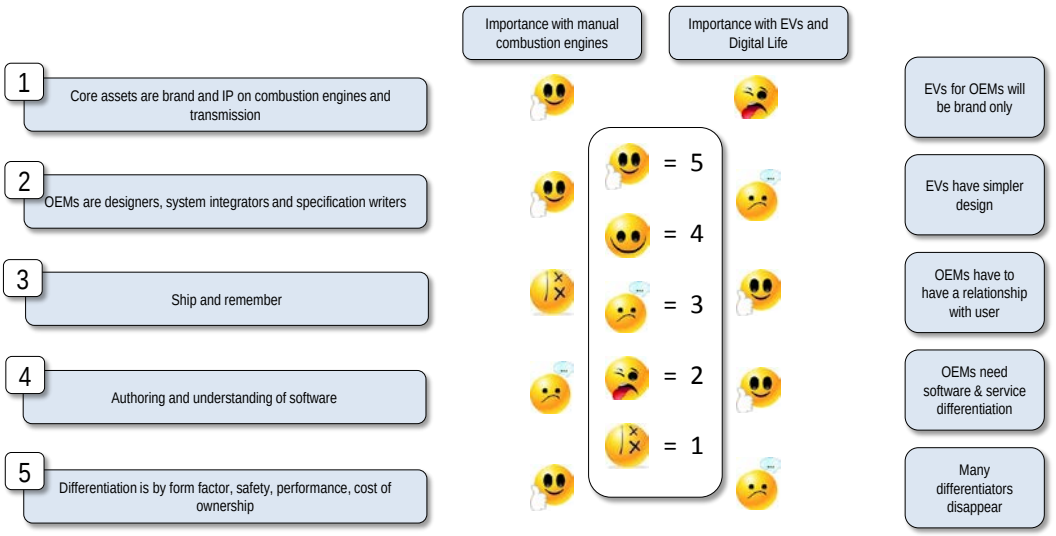
In the current market where 90m vehicles are sold every year, there is no problem as electric vehicles are but a tiny fraction of the total and autonomy is still years away from being a commercial reality. The problem begins when one considers what is likely to happen over the next 10 to 15 years.

If our analysis is even vaguely correct, then electric cars in volume will be a much cheaper form of transport. The lower maintenance cost and much longer life time could more than halve the cost per mile for a consumer to travel from point A to point B. Given almost every single journey is made with intent and that the vast majority of the current market is for utility vehicles, it is not difficult to see how the entire market could quite quickly transition to electric vehicles. In addition, digital services are now a very important part of many drivers' lives and they increasingly want to bring that into the vehicle with them. Consequently, the vehicle purchase decision will be increasingly influenced by the user's experience of digital services in the vehicle. If Google and Apple get their way then digital experiences will be all Google or all Apple meaning that the opportunity for digital differentiation on the part of the vehicle makers will have been lost. There is also a significant risk that this scenario would also mean the loss of control over sensor data (see below).

In a world where electric vehicles are the norm and where digital services are an important driver of the vehicle purchase decision, vehicle manufacturers in the current form would seem to have very little to offer as:

1. Their core IP will have become obsolete
2. The core skill of systems integration will have become much simpler
3. It will be important to maintain a relationship with the vehicle owner in order to offer value added digital services
4. Software will have become an essential skill
5. Differentiation will come down to cost per mile, digital experience and to some degree form factor

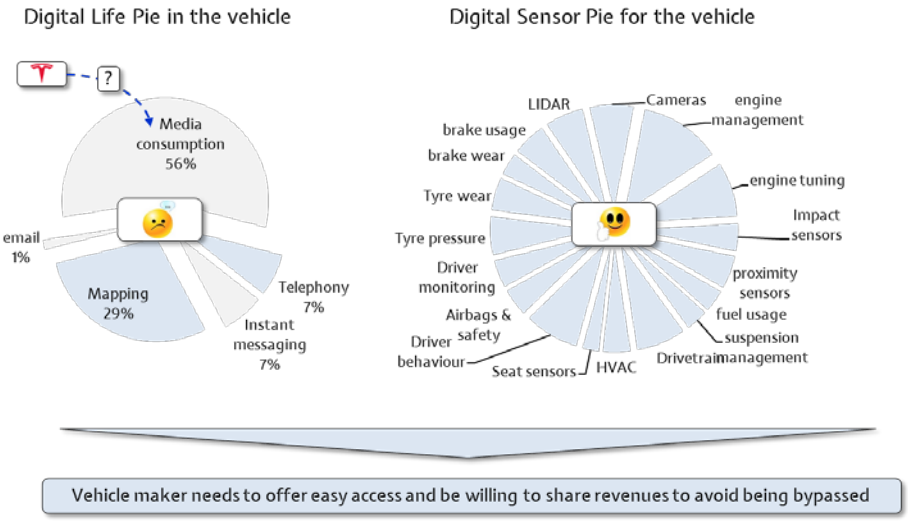
Exhibit 27: OEM characteristics with combustion and EVs, Q217



Source: Edison Investment Research

Edison thinks that it is very clear that the vehicle manufacturers have to become radically different companies in 10-15 years or be faced with an existential crisis. This is particularly the case if the market for vehicles is going to take on a large and downward correction. Most of the assets that are considered core to their current value are likely to diminish greatly in value and may even become substantial liabilities. **However, it is not all doom and gloom as the vehicle makers currently have a lock on what could easily turn out to be the most valuable asset in the future: the Digital Sensor pie (Exhibit 18)**.

Exhibit 28: Vehicle makers in the Digital Life of the vehicle, Q217



Source: Edison Research, Triton, Arbiton, Scarborough Research, Edison Investment Research, Nielsen, Google, Pewinternert.org, comScore, NetMarketShare

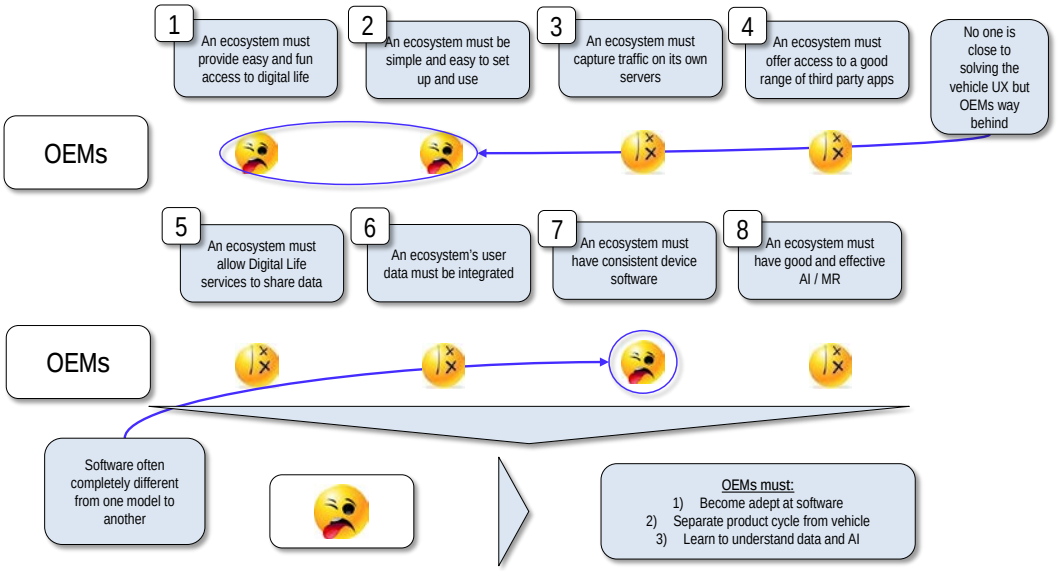
Although vehicle makers are weak in the Digital Life pie, they are the gatekeepers to the sensor data that the vehicle generates (Exhibit 3) and may even be able to claim ownership of that data (Exhibit 23). Edison thinks that providing access to the Digital Life pie in the context of the vehicle, will quite quickly become a commodity as far as the vehicle manufacturers are concerned. This is because the vast majority of their users will be using either an Apple or a Google ecosystem device. Almost all manufacturers are likely to offer Apple's CarPlay which is exactly the same experience

from one manufacturer to the next. Furthermore, Android Auto is now available on Android devices independently of the vehicle meaning that it can be “retro-fitted” to almost any vehicle.

Hence, the availability of an Apple or Google Digital Life user experience is likely to spread quite quickly through the vehicles providing no differentiation at all for the vehicle makers. Consequently, they have to come up with a compelling reason for the user to leave the Apple and Google experience and return to their own environments.

The ace in the hole that all the vehicle makers have is their control of vehicle sensor data. They have 100% coverage of the Digital Sensor pie (Exhibit 18) meaning that only they are able to offer the services that can be created through the capture and understanding of this data. This gives them an edge in digital differentiation **but they will also have to craft well designed services and an experience that scores well against the eight Laws of Robotics. This is where the real work needs to be done (Exhibits 29, 25 and 26).**

Exhibit 29: Vehicle makers against the eight Laws of Robotics



Source: Edison Investment Research

Almost all OEM-designed infotainment user interfaces offer a very poor user experience. Edison thinks that the experience is currently so poor that should innovative digital services be added, there would be a good chance that the majority of users would never know that there were there. This is why Edison thinks that the vehicle makers must:

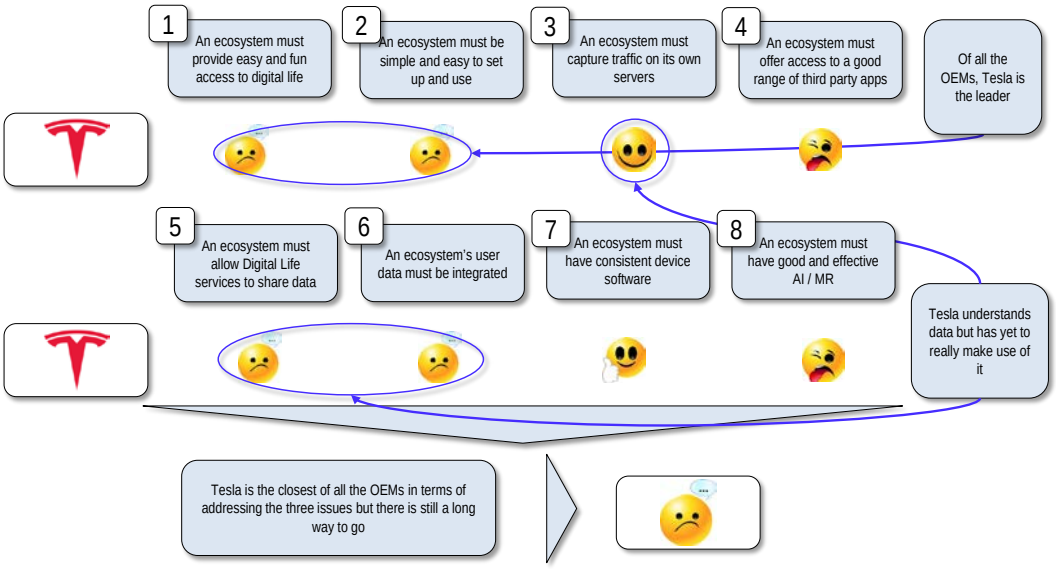
- Become adept at software and ensure the infotainment units have consistent software and are over-the-air (OTA) updateable
- Separate the infotainment unit product cycle from the vehicle so that it can be independently upgraded with both hardware and software
- Understand the importance of data collection, analysis, sharing and integration and work internally or with third parties to obtain the AI required to draw insightful conclusions from the sensor data

Vehicle makers that can improve their digital offerings in the vehicle have a good chance to survive the heavy consolidation that is almost certain to occur should demand for vehicles begin to decline as the transition to EVs and then again to autonomy begins to occur. This is how the vehicle makers can maintain the one real asset they are likely to have left, their brands. So far, only Tesla and BMW are showing any sign of understanding the importance of this which is why we outline them below.

Tesla

Tesla is often described as the Apple of the vehicle industry but Edison thinks this view applies mostly to its hardware design and the physical experience rather than a maniacal focus on software. With respect to the transforming automotive industry, Tesla remains in the same position as Apple and Google in that it has not yet been able to solve the issue of digital services in the car. Its infotainment unit has the largest screen and has worked out (like Volvo) that portrait screens work better in vehicles than landscape but it has not yet solved the thorny issue of delivering digital services to the driver in a ground-breaking way.

Exhibit 30: Tesla against the eight Laws of Robotics, Q217



Source: Edison Investment Research

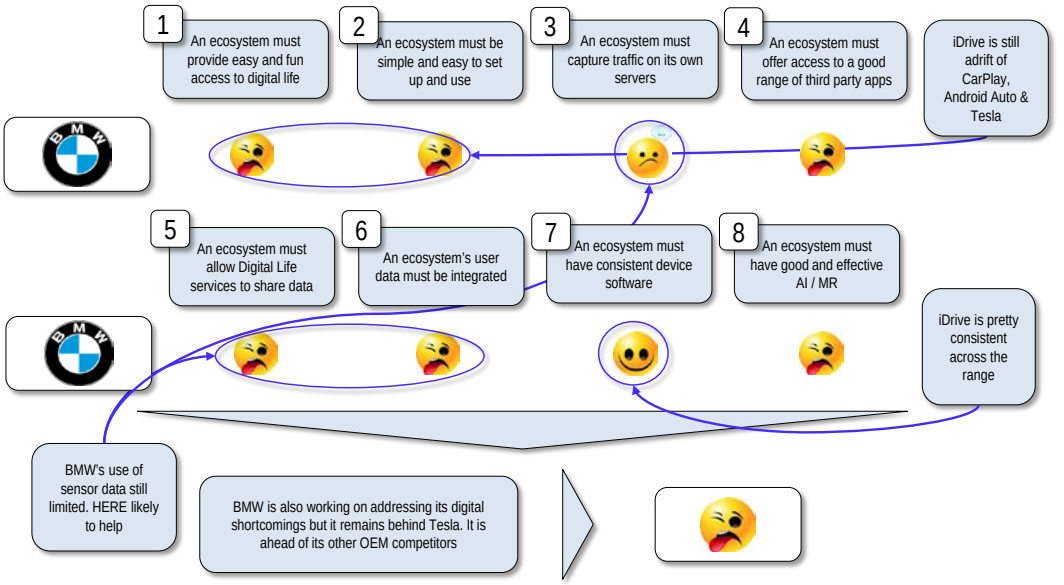
Instead its focus appears to have been on how to make the vehicle drive itself such that the driver can focus all his attention on the screen but even there, there is still a lot of work to do (Exhibit 10). Waymo (Google), Nissan and BMW all seem to have more effective autonomous solutions although there are some discrepancies with the data. Furthermore, Tesla's sales volumes compared to those of its traditional rivals are tiny meaning that its market impact is still very limited despite the disproportionate amount of attention that it receives.

As a result of its low volumes, its data set will be extremely limited in terms of both quantity and segmentation as only a certain segment of the vehicle buying market is purchasing its vehicles. Tesla (along with Google) has woken up the automotive industry from its torpor, and it remains comfortably ahead in terms of the transition to electric vehicles. As a smaller player, Tesla badly needs to get digital and sensor data spot on or it is at risk of being side-lined should one of the larger players suddenly get it right.

BMW

BMW has many of the hallmarks of a regular vehicle maker with one significant exception ie it has been early to recognise the importance of software and services and the threat that Google represents to its long-term ability to differentiate. We think that BMW does not offer Android Auto in its vehicles due to its concerns around allowing Google free access to its sensor data. However, we suspect this might change as Android Auto remains locked out from being able to access any sensor data controlled by the OEM. Consequently, we believe that the threat of being disintermediated now really rests with running full Android on the infotainment unit (Exhibit 33) rather than Android Auto. Full Android on the infotainment unit would in all probability, grant Google unfettered access to sensor data.

Exhibit 31: BMW against the eight Laws of Robotics, Q217



Source: Edison Investment Research

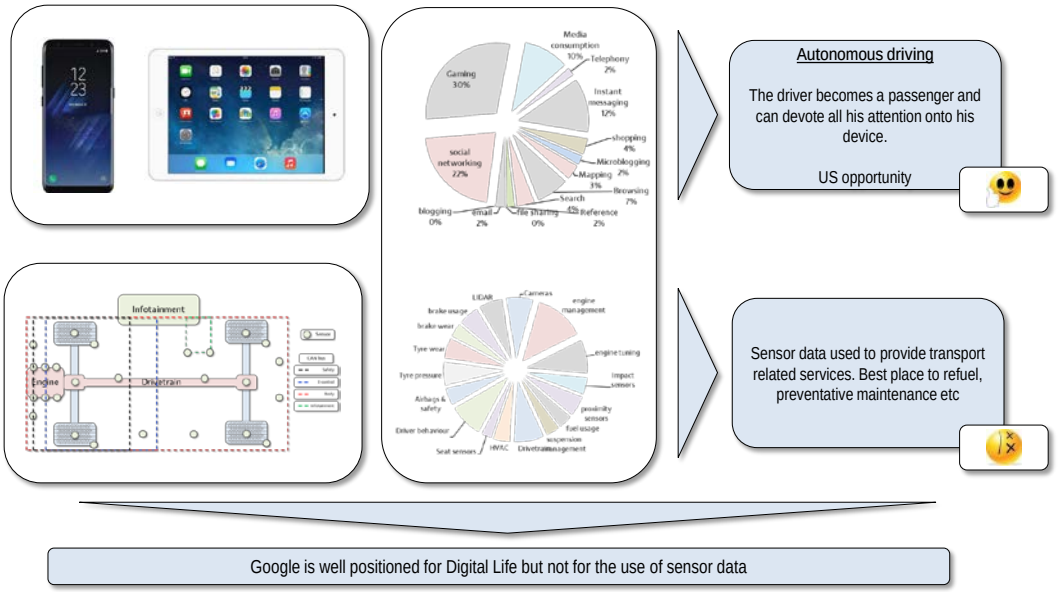
This understanding of the importance of software and services has also led BMW to invest in software expertise giving it the ability to write some of its code in-house. This is the main reason why BMW fares a little better than the other vehicle makers when it comes to Laws of Robotics 3,4,5,6,7 and 8 (Exhibits 25 and 26).

BMW's overall score is not that high because although it is laying the groundwork for digital services, it still has an awful lot of work to do. For example, its user experience on iDrive is still woefully behind what CarPlay, Android Auto and Tesla offer. Although BMW has realised that data is important, Edison thinks that it has not yet really yet worked out what to do with it. Furthermore, it is quite far away from having enough data to be able to create meaningful services using that data. Its ownership and collaboration with HERE could provide a means for BMW to make the most of the data that it is generating but HERE is also at an early stage of its development.

Google

Google's existence is focused around the categorisation of all Internet data and drawing conclusions from that data to sell targeted advertising. In that context, its success is determined by two factors. **First, how well it understands its users.** The better it understands its users the more accurately it can target advertisements making those advertisements of much higher value. **Second, time**. The longer its users spend within its services, the greater opportunity it has to place advertisements in front of them and therefore the greater its addressable market. Once this has been understood, almost everything Google does makes complete sense which includes its strategy within the vehicle.

Exhibit 32: Opportunities for Google in the vehicle



Source: Edison Investment Research

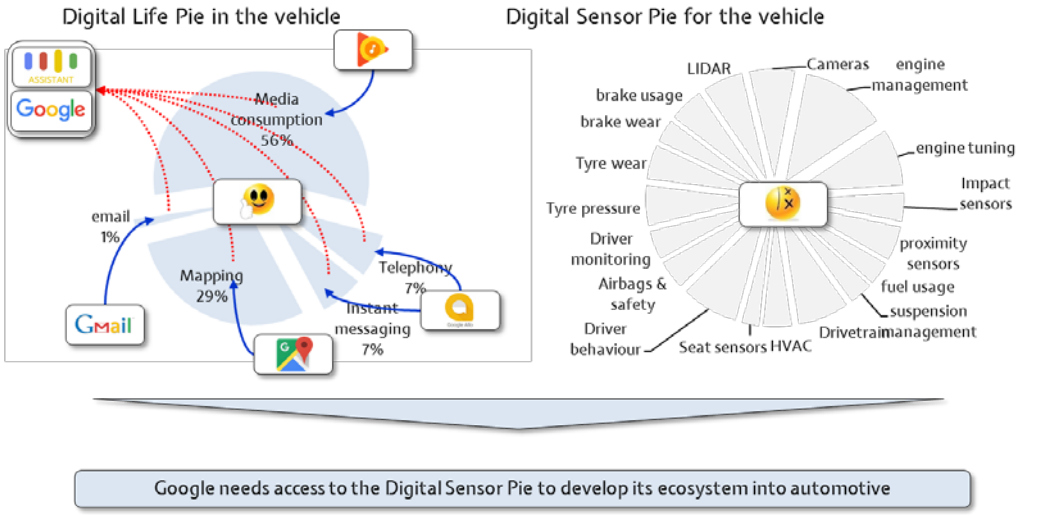
Edison has identified two opportunities for Google in the vehicle (Exhibit 32).

First: More time with Digital Life. As vehicles become more autonomous, the driver (now a passenger) no longer has to look at the road but instead can concentrate on the device in front of him. Here, Google is well positioned as it has pretty good coverage of the Digital Life pie and already generates substantial revenues from it. This is purely an incremental increase in total time spent engaged with a device. Edison has calculated that freeing up the driver could create an incremental monetisation opportunity for Google of $13,174m in US revenues (Exhibit 21) (or $32,132m for an ecosystem with 100% coverage of Digital Life in the US).

Second: Greater insight with sensor data. Edison has identified that the monetisation opportunity in the vehicle using sensor data is likely to be much greater than that offered by Digital Life on its own (Exhibit 22). The first opportunity is to use just the sensor data to enhance the vehicle experience but the real opportunity comes when both are used together. This is because almost all journeys are made with a specific purpose in mind which raises a large range of possible marketing opportunities that were not previously available. It is also likely to increase the conversion rate if the intent is understood in great detail. This is made possible by understanding both the data from the vehicle as well as the user's own Digital Life patterns.

Furthermore, in order to make the vehicle autonomous, we expect that the provider of the autonomous function will require full access to sensor data. **Consequently, Edison believes that Google is highly incentivised to gain access to vehicle sensor data as it is required for both of the opportunities outlined above to become a reality.**

Exhibit 33: Google in the Digital Life of the vehicle, Q217

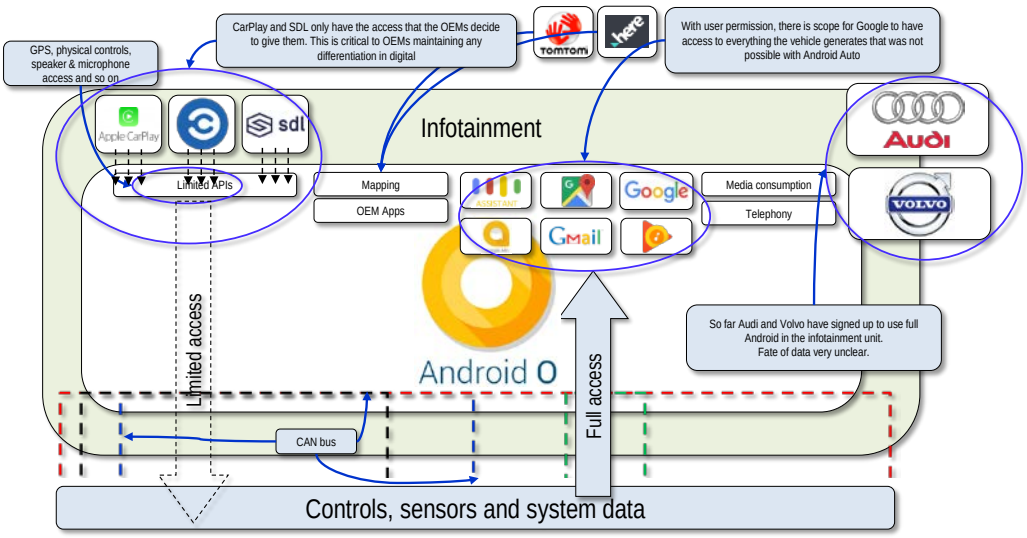


Source: Edison Research, Triton, Arbiton, Scarborough Research, Edison Investment Research, Nielsen, Google, Pewinternert.org, comScore, NetMarketShare

This is where the problems begin because as of today, **Google has no access to the sensor data of the vehicle (Exhibit 33)**. Through its existing Google Mobile Services (GMS), Google has 100% coverage of the automotive Digital Life pie in the vehicle meaning that many drivers will use a mobile device rather than the infotainment unit for the core digital services when driving. This is all very well for Google, but in Edison's opinion it does not advance its monetisation opportunity meaningfully as for this Google needs access to the sensor data. Edison believes that Android Auto could have access to sensor data should the vehicle makers allow it but to date no one seems to have done so. **The net result is that Android Auto provides a useful way to use Google services when driving but very little more for as long as it has no access to sensor data.**

This is why we believe that Google has moved to make Android rather than Android Auto available to run the entire infotainment unit rather than just as an extension of apps from the smartphone. This involves the replacement of the proprietary software on the infotainment unit with a full version of Android. This means that Android would be directly interfacing with the Can bus networks and that Google's apps such as the assistant and maps would be resident and running on the infotainment unit. This has the effect of deeply integrating Google services into the vehicle and in all likelihood, gives Google access to all of the sensor data that the vehicle generates (Exhibit 34).

Exhibit 34: Map of infotainment unit powered by Android



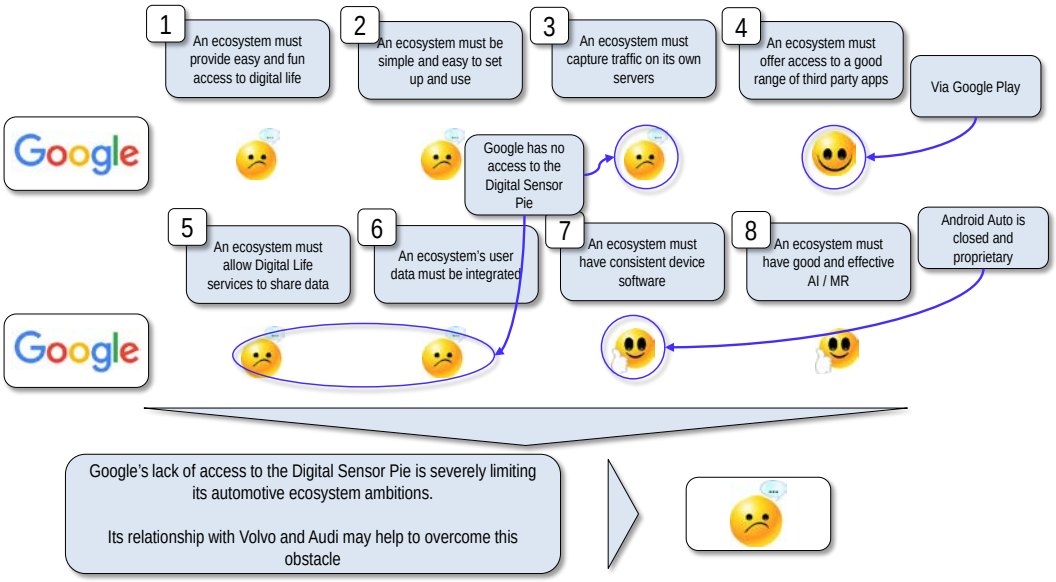
Source: Edison Investment Research, Google

To date, only Audi and Volvo have signed up to use Android as a replacement for their proprietary infotainment unit software and its implications are very uncertain. Google has referred to this version of Android as "manufacturer-tweaked" which could mean anything from the addition of extensions to control things like windows and the air-conditioning to a complete fork of the code that closes it down completely. In the initial versions Android will only be controlling things like heating, cooling and windows and will not run some of the critical functions like engine management and the brakes. **However, Edison thinks that while it may not control these functions, Android in the vehicle will have access to the data that they generate.** Edison thinks that this is all Google will care about as Google only needs the data from these systems to realise its goals in the vehicle.

The key question is how much access to sensor data have Audi and Volvo given to Google in return for free access to its software and services? Given that Google's vehicle ambitions can only be properly achieved through access to sensor data, we suspect that Volvo and Audi will have had to have given some access but the degree is unclear. What is also unclear is the ownership of this data of which Edison thinks that Google and vehicle makers have very different views. Google wins access to much of the data that powers its intelligence by asking users whether they would like Google to make their services better. The yes response grants Google access to the data and the services become more personalised and better at predicting requirements. Edison sees the same possibility in the vehicle where the driver is asked at set up whether he would like Google to make its services better. A positive response could then result in all of the vehicular data being uploaded to Google's services either through the phone or the vehicle's own modem. **Edison thinks that this is a very good example of why having software expertise in-house is becoming critical for a vehicle manufacturer.** Not understanding software means putting a black-box into the heart of one's product with little to no idea or control of how it will behave under certain circumstances.

We have identified that in a world of EVs and digital services, the only real edge that the vehicle makers have will be their exclusive access to the Digital Sensor pie (Exhibit 3). Consequently, we believe that sharing this data with Google is dangerous because Google will become empowered to cement its relationship with the end user to the detriment of the vehicle maker. This is exactly what has happened to Android handset makers and to some degree mobile operators where Google has been able to drain the majority of the Android industry of its profitability. A similar future awaits vehicle makers who are not extremely wary of Google's long-term intentions with regard to their customers. **This is one characteristic that sets BMW apart from other vehicle makers: it is very wary of the impact Google will have on its long-term digital differentiation.**

Exhibit 35: Google against the eight Laws of Robotics (automotive)



Source: Edison Investment Research

Of all the potential players in the digital vehicle, Google is one of the leaders. It has not yet solved the user experience problem but if this is solved by voice, then it already has a substantial lead with Google Assistant. Furthermore, Google is by far the global leader in understanding the importance of data integration which combined with the AI to draw insightful conclusions, puts it way ahead of even its digital competitors. Edison thinks that obtaining access to the Digital Sensor pie (Exhibits 33 and 34) would meaningfully improve its score against the eight Laws of Robotics (laws 3, 5 and 6) in the automotive context. This would make its services deeper, richer and more intuitive than all of its competitors meaning that users could predominantly choose Google and demand its full integration into their vehicles.

However, to achieve this, Google has to work with or around the vehicle makers who are the gatekeepers to the critical sensor data. How its relationship with Audi and Volvo evolves will be key to determining its success in this area. Edison also sees the possibility for Google to invest in OTT sensor strategies which would allow it to completely bypass the vehicle makers. At the moment, the sensor data available by using these methods is limited but it is unlikely to remain this way for long.

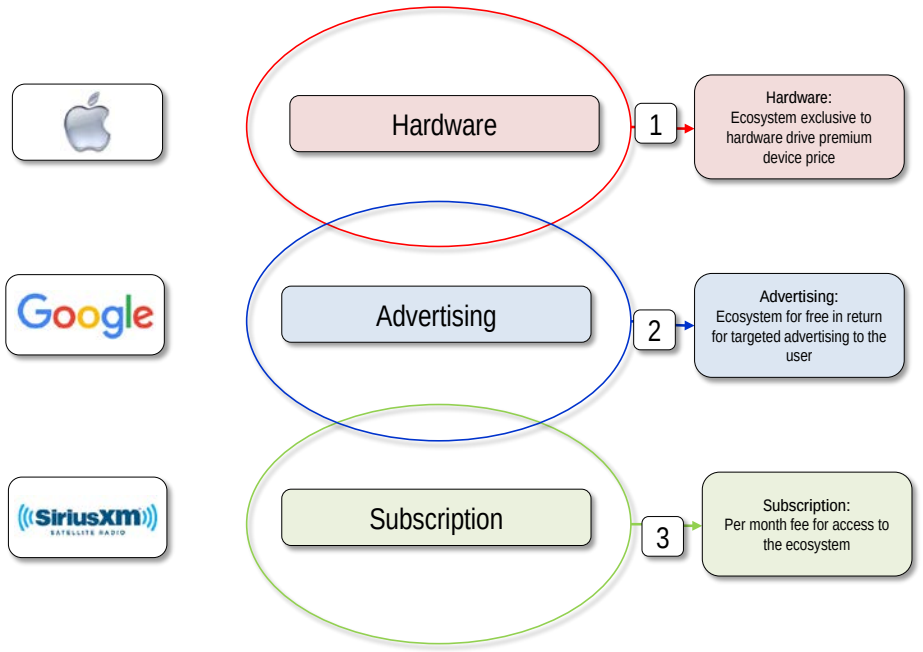
Apple

Apple is often mentioned in the same breath as Google when discussing digital automotive potential but Edison thinks that its strategy in this segment is completely different. This is because of the huge difference between Apple and Google when it comes to monetisation of the ecosystem. **Edison's position has long been that in smartphones, Apple and Google do exactly the same thing, it is just that they go about it in different ways.**

Our view remains that there are three methods of ecosystem monetisation (Exhibit 36), of which the vehicle is a natural extension. These are:

1) Monetisation through hardware. This involves keeping the ecosystem exclusive to devices from select manufacturers and earning a return on it through premium device pricing. If the ecosystem is desirable, then users will be willing to pay a premium to access it.

Exhibit 36: Three models of monetisation



Source: Edison Investment Research

2) Monetisation through advertising. The ecosystem is effectively given away for free but monetisation occurs through the targeting of users for marketing campaigns sold to advertisers.

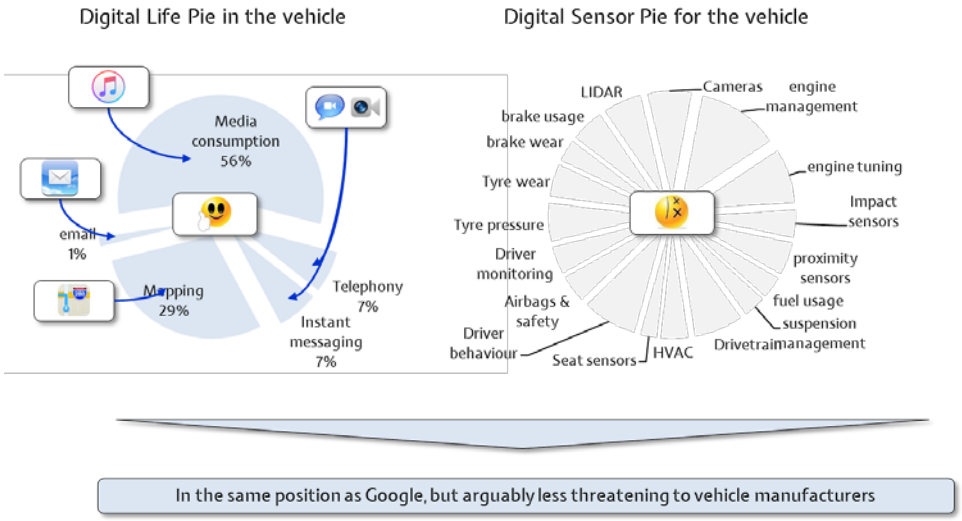
3) Monetisation through subscription. Here, monetisation is achieved by selling access to the ecosystem for a fixed subscription paid either monthly or annually. It is the least developed of all of the business models, but Edison can see this becoming more popular as users become fed up with being constantly bombarded by advertising. Sirius XM is an automotive example of this form of monetisation.

When Edison examines monetisation from this perspective it becomes clear that Apple and Google do the same thing but it in different ways. **Consequently, in order to enter the automobile segment, Apple would need to sell a premium hardware product of some description. This would take the form of either a vehicle or an infotainment system that one would plug into a vehicle.** Edison believes that this was the purpose of Project Titan which, for a time, attempted to design an electric vehicle but has since been scaled back to something far more realistic. Apple is a company that is known to insist on 40% gross margins or more on the products and services it sells. The problem with a vehicle is that it would be very difficult to make 40% gross margins on pressed steel, brake pads, wheels and so on. This would mean that either Apple would take a gross margin hit by producing such a product or that the product would have to be so expensive that no one would buy it. However, Edison believes that it would be possible to make 40% gross margin on an infotainment unit (if Apple could persuade any vehicle maker to leave a gaping hole where its most strategic component is supposed to go), or an autonomous driving system.

Apple has admitted that it is working on an autonomous driving system and has been awarded a permit to retrofit three Lexus SUVs and to test them on road in California. Edison thinks that Apple has a very long way to go to catch up with Google or even the vehicle makers when it comes to autonomous driving and three SUVs is unlikely to be enough to gather the experience necessary to create a competitive system. Apple has described autonomous driving as the “mother of all AI problems” which underlines its challenge given that Edison does not place Apple in the top 5 players in AI (see Mobile Ecosystems – Men and boys, 16 December 2016).

Consequently, Edison thinks that for the foreseeable future, Apple's presence in the automotive market will be limited to CarPlay. CarPlay is very like Android Auto and SDL (Exhibit 3) in that it takes apps and services running on the smartphone and projects them into the infotainment unit allowing access to the buttons, speakers and microphones present in the vehicle. In terms of coverage of Digital Life in the vehicle, Apple scores 100% as it has services that cover all likely uses of digital services while driving (Exhibit 37).

Exhibit 37: Apple in the Digital Life of the vehicle



Source: Edison Research, Triton, Arbiton, Scarborough Research, Edison Investment Research, Nielsen, Google, Pewinternert.org, comScore, NetMarketShare

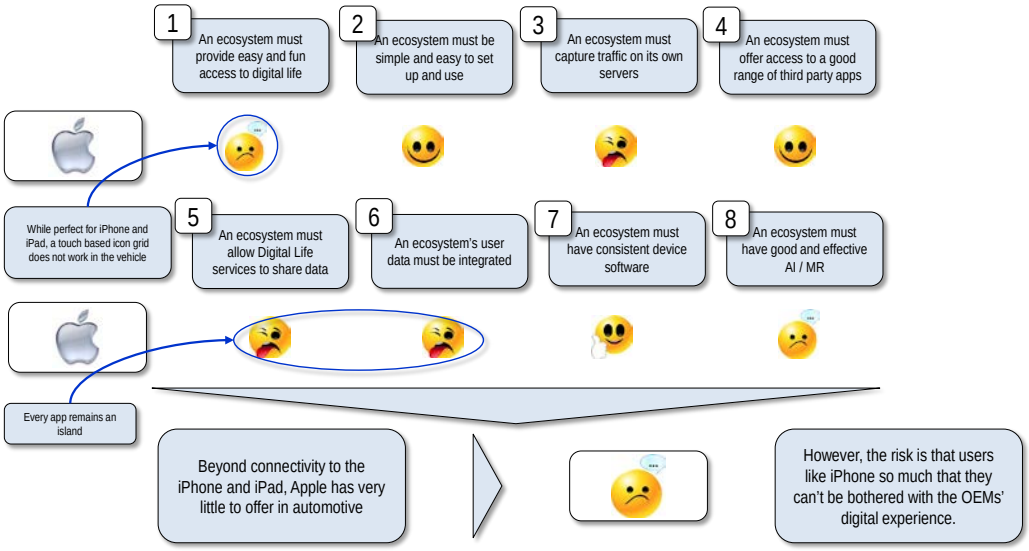
However, when it comes to sensor data, Apple comes up short for exactly the same reason as Google as CarPlay exists outside of the manufacturer's infotainment software environment (Exhibit 3) and has no access to sensor data.

Edison believes that this is much less of a problem for Apple as its business model is not dependent on winning access to data in order to make money. **Edison believes that Apple uses CarPlay to increase loyalty and stickiness to the iOS ecosystem such that when the user comes to buy another iPhone, he will still be willing to pay a higher price for it partially based on how well it works with his vehicle.** This is not threatening to the vehicle makers in the same way as Google is. The only real threat that Apple offers in this scenario is one where users use their iPhones in the vehicle all the time and ignore the vehicle makers' own digital experience.

This remains a significant risk because the experience that Apple offers users in the vehicle remains far superior than that offered by the vehicle makers themselves. This is clearly shown when Apple's automotive offering is assessed against the eight Laws of Robotics (Exhibit 38). While Apple (like everyone else) has yet to solve the issue of user experience in the vehicle, it provides a far better experience than the automakers. Furthermore, it has a vibrant developer ecosystem creating the possibility of a large number of third-party apps becoming available for CarPlay as well as very consistent software from one vehicle to another.

Consequently, the main activities of Media consumption and navigation are easier in almost all cases than using the infotainment unit. If digital preference in the vehicle moves to an iPhone, then the vehicle makers are in trouble as a piece of differentiation that they hope to benefit from in the future will no longer be available to them. Furthermore, any innovations that they create by using sensor data may end up going unnoticed by users unwilling to use the infotainment units in their vehicles. **All of this plays to Apple's advantage as the more users do with Apple devices, the more loyal they are likely to become to the iOS ecosystem, thereby preserving Apple's ability to charge premium prices**.

Exhibit 38: Apple against the eight Laws of Robotics (automotive)



Source: Edison Investment Research

HERE

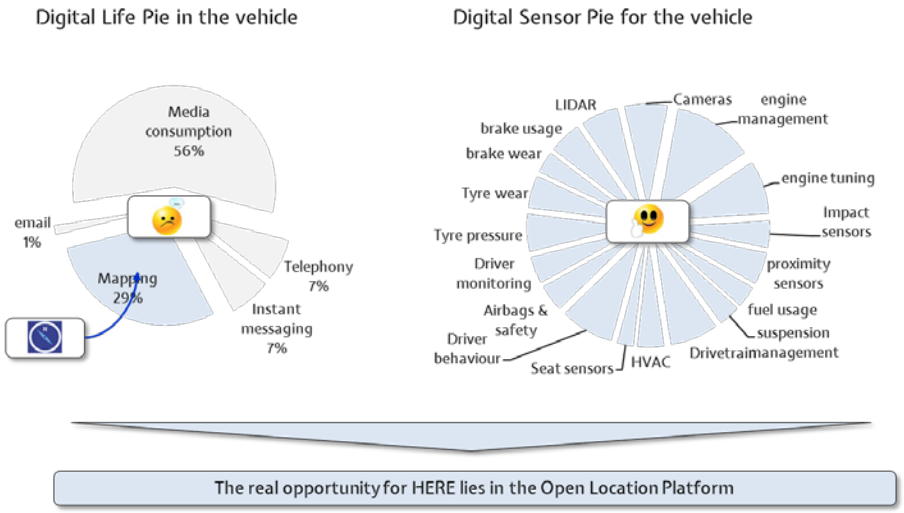
HERE started life as a map provider called Navteq which was purchased by Nokia in 2007 and then sold onto BMW, Daimler and VW in 2015. It was rebranded HERE by Nokia in 2012 which signalled its move away from simply providing maps to becoming a provider of location-based services. Nokia's fall from grace in the smartphone market significantly held up its transition to location based services but with new ownership and management, its strategy is moving quickly ahead.

Its shareholder base is also expanding; Tencent and Intel have become important strategic investors and it has deepened its relationships with Facebook, Amazon and Microsoft who are all committed to using HERE and its platform to power their requirements for location. For the provision of location (maps are a subset), there are only two players capable of providing location on a global basis. HERE is one and Google is the other.

Edison thinks that it is this position as the only credible alternative to Google for location that has allowed HERE to become a focal point for all of Google's competitors. This is why Facebook, Amazon, Microsoft and Tencent have all made commitments to HERE as using Google for location is a strategic impossibility. Edison believes that this has had a substantial positive impact on HERE's credibility giving it an excellent chance of making a success of its strategy to become a global leader in the provision of location.

HERE also has an entrenched position with the vehicle manufacturers thanks to its owners and the fact that it has around 80% market share in the provision of maps for vehicles. Maps for vehicles need to work fully when offline and are also required to offer a high level of detail even in areas which are less well travelled. This is where Google Maps falls short as its offline capability is severely restricted and outside of urban areas its quality falls short of that demanded by the vehicle manufacturers.

Exhibit 39: HERE in the Digital Life of the vehicle, Q217

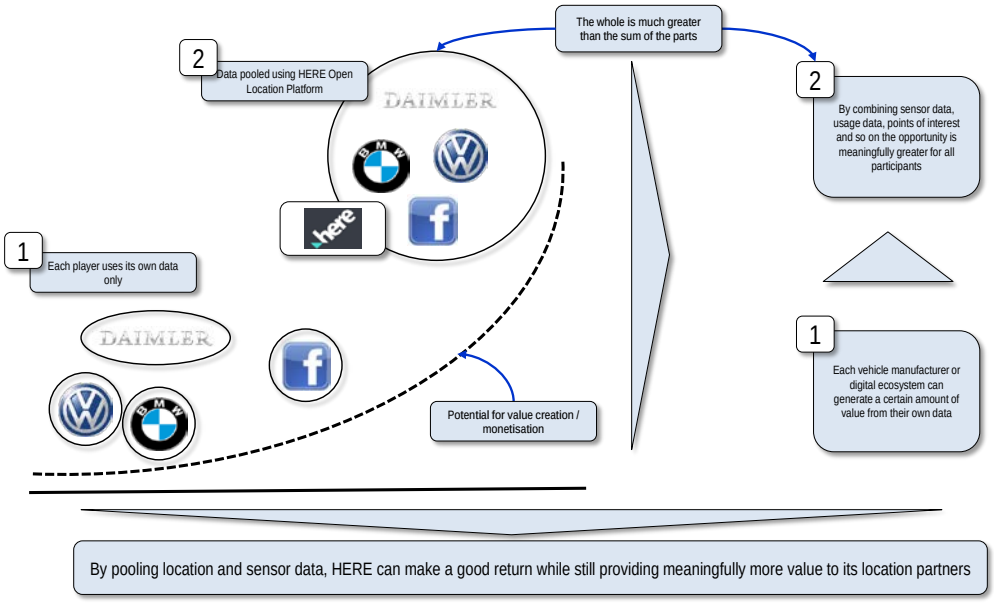


Source: Edison Research, Triton, Arbiton, Scarborough Research, Edison Investment Research, Nielsen, Google, Pewinternert.org, comScore, NetMarketShare

Furthermore, because HERE is a trusted supplier to the automotive industry, its products (maps at the moment) are already embedded within the vehicle's infotainment unit, opening a potential route to a complete access to the Digital Sensor pie. To achieve this, it needs to do much more than just maps. HERE has already achieved this with Jaguar Land Rover (JLR), where JLR has based its inControl Touch Pro Infotainment system entirely upon HERE's auto platform. Currently, there is no data relationship between HERE and JLR that Edison is aware of (like there is with BMW, VW and Daimler (see below)), but that can now be very easily enabled.

Edison thinks that the trusted relationship between HERE and the vehicle makers puts HERE in a very good position to get access to sensor data from multiple sources including digital ecosystems, network probes, smart cities and infrastructure and vehicle manufacturers. HERE's strategy is simply to create a place in the cloud (open location platform (OLP)) where data can be pooled, integrated and analysed to create a real-time picture of what is happening in the real world.

Exhibit 40: Potential value creation by the Open Location Platform

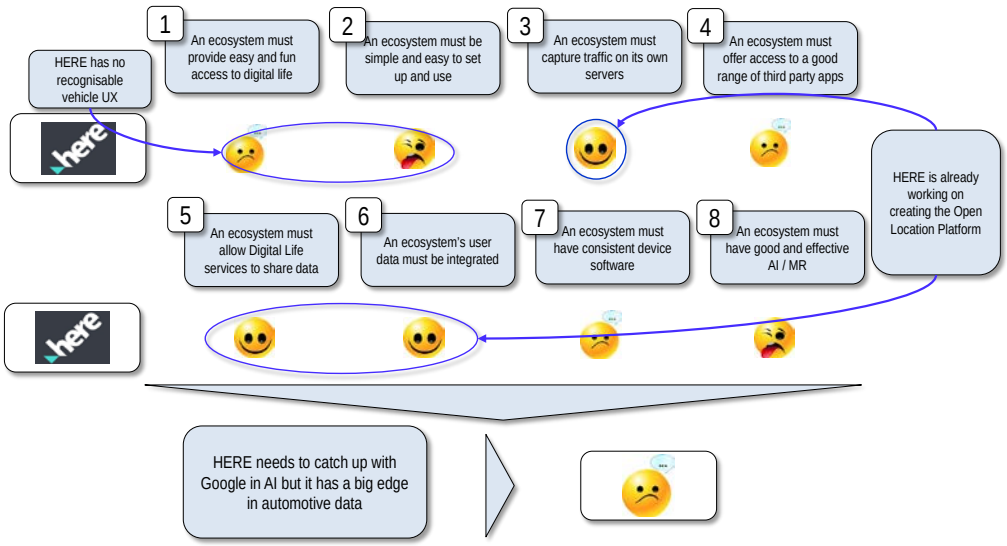


Source: Edison Investment Research, HERE

The idea is that HERE's partners contribute their data to the OLP and HERE uses AI to work out real-time events based on the combination of inputs and to then pass those insights back to the individual partners. In a very similar manner to the combination of the Digital Life pie and the Digital Sensor pie , the combination of all of this data can yield far more meaningful results than the data from individual partners can on their own (Exhibit 40). Consequently, the whole is so much greater than the sum-of-the-parts that Edison thinks that HERE can make a healthy profit as well as offering its partners the ability to make a higher return on their data-related investments than they could on their own.

This strategy is very straightforward in its conception but Edison thinks that there will be significant hurdles to overcome when it comes to execution. **First,** all of the different partners will have different data sets that are generated in different formats. HERE will have to figure out how to put that data together and work out what it all means, which Edison suspects will be much more easily said than done.

Exhibit 41: HERE against the eight Laws of Robotics



Source: Edison Investment Research

In order to make sense of the data being contributed, HERE will need to ramp up its AI expertise. Edison has identified that excellence in AI to date has been driven more by the amount of time spent working on these problems than the brains that one has on the bench. HERE is a relative newcomer to this space and although it will be receiving a lot of data, it has a big hill to climb to integrate and make sense of it all. Once it has done this it will need more AI to work out what the data means and most importantly of all, what its partners can do with it. This is why HERE receives a weak score on AI (Exhibit 41) although its good score on laws 3,5 and 6 indicate that it is well aware of what needs to be done and is actively working on making it so.

Second, a lot of the insights that the platform hopes to generate will be required to be provided in as close to real time as possible. This will place significant processing and storage constraints upon the OLP that will need to be addressed from day 1. Edison thinks that HERE is ahead of all of its peers when it comes to a platform of this nature and the traction that it has won to date is extremely encouraging.

However, there remains a very long way to go and a lot of work is required before the promised value creation will be accruing to its partners in real time. HERE is one of the most promising players in the Digital Sensor pie and Edison expects that many more vehicle makers will end up contributing their data as the opportunity unfolds.

Conclusion

The transport industry is in the cross hairs of the disrupters and because it is so large, so old and (in many cases) so slow to move, it is a soft target. Edison has identified that the vehicle makers have an opportunity to play in the new digitised industry as **they are the gatekeepers to the data set that is required for the disruption to happen in the first place.** It is essential that they find a way to monetise this data, as the move to EVs and then autonomous vehicles could easily cause the transport industry to halve in size. Most vehicle makers will be unable to survive a collapse of that degree without a radical shake-up and the development of new revenue streams. These revenue streams will be maximised using the combination of Digital Life data from the smartphone and the sensor data generated by the vehicle.

Although the vehicle manufacturers are the gatekeepers, there is plenty of research being conducted that aims to independently extract the sensor data from the vehicle and to create services around that. This is why the vehicle makers have to act quickly to make this data available while still maintaining control of it as without control of this data set, they will become very little more than handsets on wheels.

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