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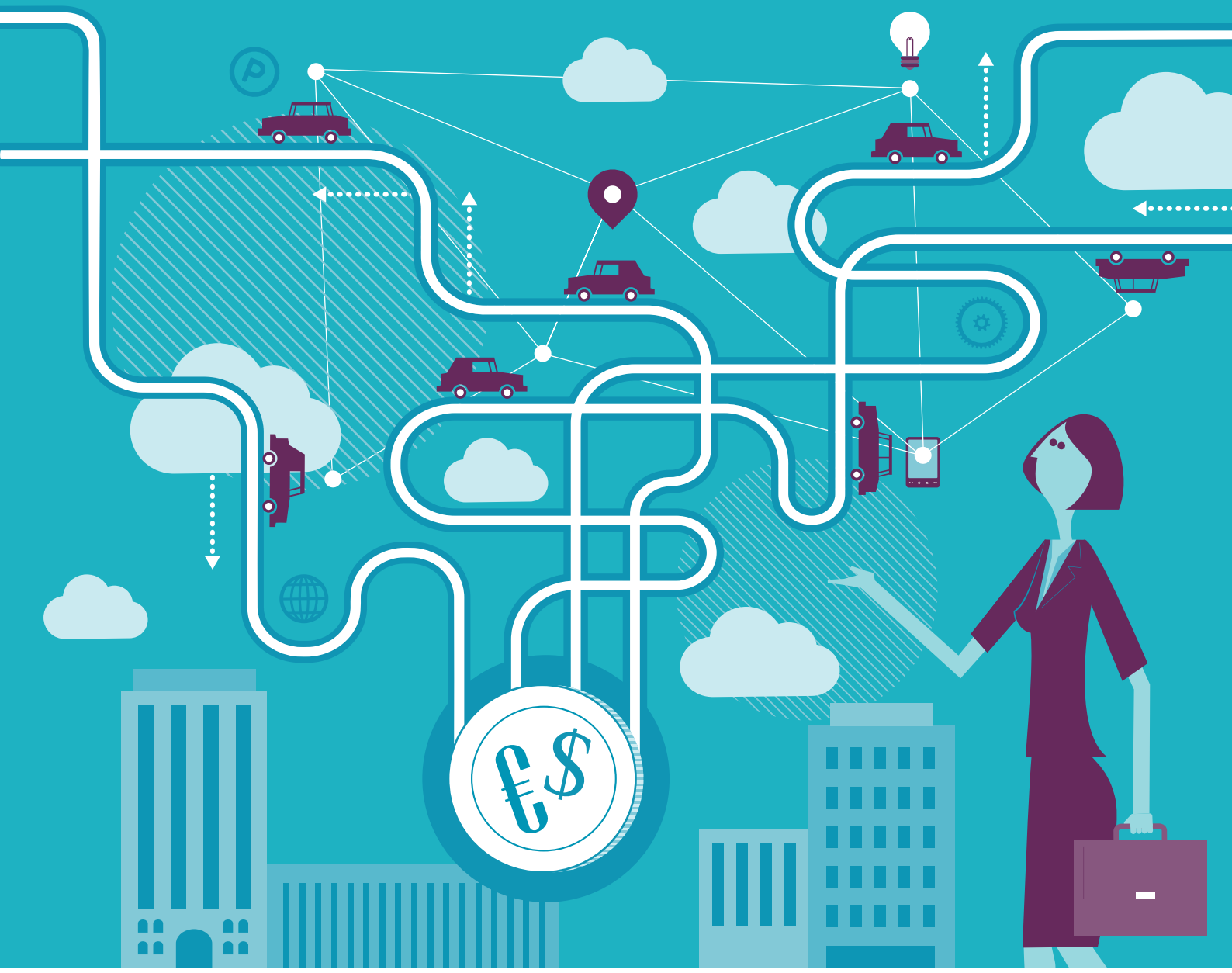
Rigorous empirical research on intellectual property



The Value of Connectivity in the Automotive Sector – A First Look

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Summary

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The Value of Connectivity in the Automotive Sector – *A First Look*

Prof. Bowman Heiden[1]

Executive Summary

This study looks at the actual value that connectivity in vehicles can bring to society and the different sectors affected, Connectivity is one of the four critical megatrends facing the automotive industry. These trends are autonomous driving, shared mobility and electrification, yet connectivity is both separate and integrated to these other megatrends. The importance of connectivity is therefore fundamental to the future evolution of the industry. The vehicle is emerging as the next digital platform which may be analogous to the evolution of the smartphone and the opportunities that connectivity provides have incentivized automakers to increasingly install embedded connectivity to capture the value from this new ecosystem. Such vehicles are often termed connected vehicles. One estimate from McKinsey Advance Industries (2016) predicts that on-demand mobility and data-driven services from such vehicles could account for approximately $2 trillion (or approximately 30%) of the automotive revenue pool by 2030, with data connectivity services accounting for between $450-$750 billion per year. This growth is built upon advanced mobile telecommunication standards, in particular, cellular standards, which provide the enabling infrastructure for new connectivity-based products and services to emerge in the automotive/mobility sector.

This study looks at the value of connectivity in the automotive sector by linking the concept of the connected vehicle to concepts of economic value and providing initial valuation models and measurements of the market revenue from several connected vehicle applications. First, the concept of the connected vehicle is discussed through a brief history of its development, emphasizing the emerging battle between the vehicle ecosystem and the mobile ecosystem for dominance of the platform for connected vehicle services. Figure 1 below displays the dynamism of the future evolution of the connected vehicle environment to include direct and indirect communication with infrastructure (V2I); pedestrians (V2P); other vehicles (V2V); and the broader network (V2N) in what is collectively termed Vehicle-to-Everything (V2X). As V2X and autonomous functionality grow, so will the value that connectivity brings to mobility.

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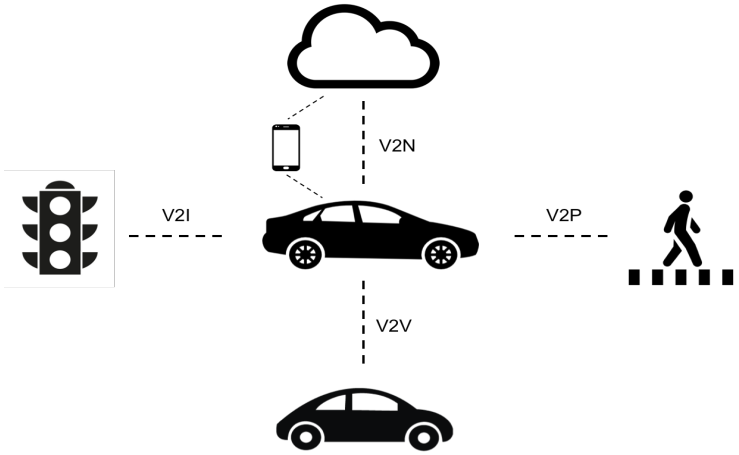

Figure 1. Overview of future vehicle-to-everything (V2X) environmental interfaces.

Second, the fundamental concepts of economic value are explored, including (1) the distribution of value among producers, consumers, and society; (2) value logics and models for the valuation of technology; and (3) an overview of valuation methods for technology-based products and services. This section emphasizes the importance of understanding the *total economic value*, including total market revenue, consumer surplus, and relevant externalities when addressing the value of a market. See figure 2 below for a simple economic model of value distribution in a market. In addition, the concepts of fundamental value logics (improvements vs. new solutions) are related to core value models (direct vs. indirect value creation) and applied to the use of specific valuation methods (hedonic pricing, conjoint analysis, and the income-based DCF method) to provide a foundation for the measurement of value in the connected vehicle context.

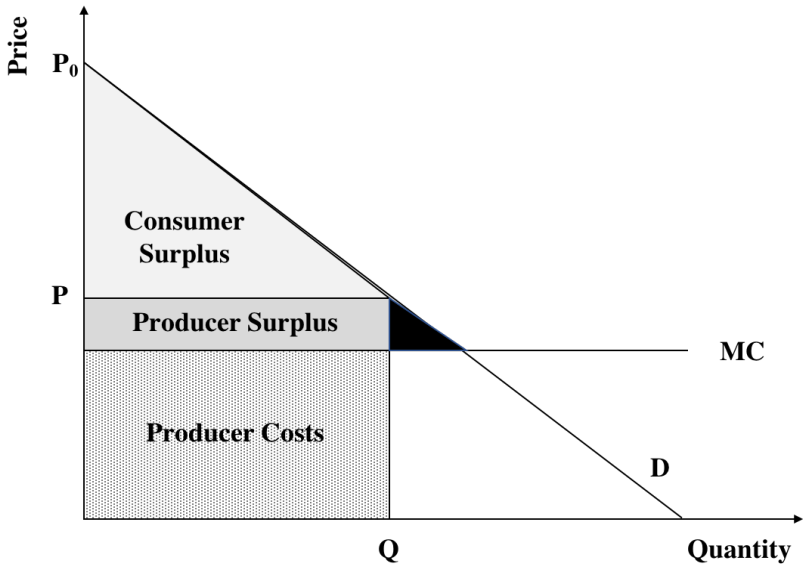

Figure 2. An economic model of value distribution in a market.

Third, the nature of the connected vehicle market is explored, including specific applications and their associated value attributes and models concerning the competing vehicle and mobile

ecosystems. Of the over 40 connected vehicle applications identified in the research, a subset of eight applications/use cases were analyzed in relation to their primary ecosystem (vehicle vs. mobile), actor focus (i.e. consumer, producer, commercial), value proposition (e.g. convenience, safety, entertainment, cost savings, risk reduction, loyalty), and value model (revenue, cost, and indirect). The applications exemplified include advanced navigation, breakdown assistance (bCall), emergency assistance (eCall), fleet management, In-vehicle WiFi, remote diagnostics/maintenance, ride-sharing, and usage-based insurance.

Fourth, the quantification of the value of automotive connectivity is based primarily on publicly available data from several perspectives, including the entire automotive connectivity value stack, the total market revenue, the vehicle ecosystem, and specific automotive applications. The main focus is on value generated by automotive products and services that are enabled by cellular connectivity or similar technology standards. The goal of this section is to exemplify key valuation concepts and models across different types of automotive connectivity, using available quantifiable data and growth forecasts in order to better understand the nature of these emerging markets.

Figure 3 below presents a simple model of the automotive connectivity value stack, which includes key revenue pools in the value chain that are priced in the market, in addition to the consumer surplus and externalities (that are not priced but still deliver significant socio-economic value). The bottom layers of this automotive stack (i.e. the communication value chain) creates value that is shared with the mobile industry, in particular, the core communication technologies, the communication infrastructure, and operator connectivity access, and the automotive connectivity system, where the latter can be enabled through an embedded device, a tethered device, or a smartphone.

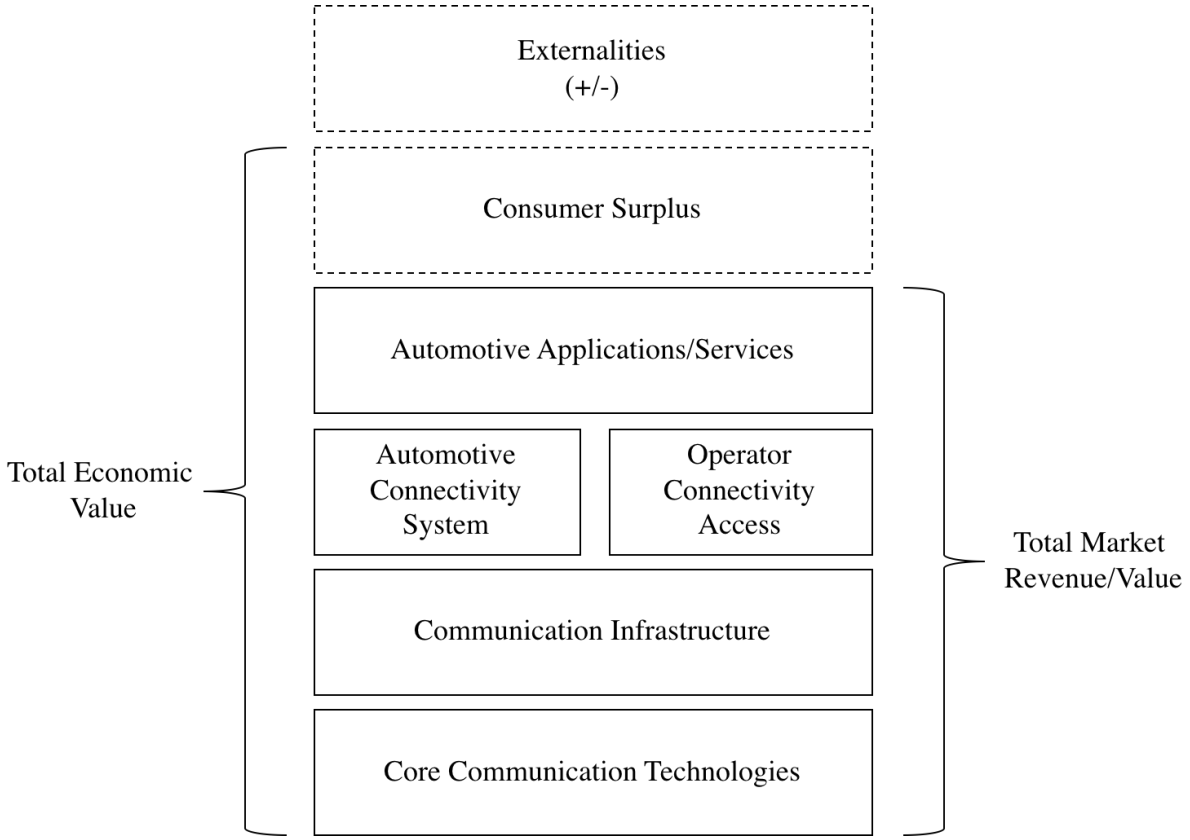

Figure 3. Automotive connectivity value stack. Adapted from BCG (2014)

The application layer, built primarily on software and data, provides customized automotive services, as discussed above. The layers from core communication technologies to automotive applications constitute different revenue pools in the total automotive connectivity market. Table 1 below provides information on a subset of the revenue pool explicitly related to the automotive connectivity and applications layers. The total from these revenue pools is estimated at $225.5 billion in 2018 and forecasted to be $483 billion in 2023 on a global basis.

Revenue pool	**2018**	**2023**
Vehicle hardware	17,511	27,901
Vehicle services	885	2,335
Infotainment services	346	1,284
Usage-Based Insurance (UBI)	15,620	65,342
Smart parking	17,800	35,800
Fleet management services	16,756	31,636
Ride-hailing	153,591	318,765

Total	**222,509**	**483,063**

Table 1. Current and forecasted revenues for the automotive connectivity market (millions$). All forecasts are global. Source: Statista

The study also provides quantitative estimates of the value of connectivity in the automotive sector from the following perspectives:

- **Consumer's willingness-to-pay (WTP) and Producer willingness-to-sell (WTS)**
  The results from previous research show a broad range of average WTP estimates from $201-$1,215 at the point of sale for a connected vehicle. In addition, a study of the cumulative prices for premium connectivity services offered by 15 global automakers in 2019 showed a broad range from $330-$22,645 with a mean of approximately $3,900 and a median of $2,800 per vehicle over its lifetime.

- **Total revenue per connected vehicle in the vehicle ecosystem**
  The calculation of the increase in vehicle revenue due to connectivity at point of sale was found to be $537 per connected vehicle, and the net present value of the total service revenue amounted to $56 per connected vehicle in 2018. These combined for total revenue per connected vehicle based on the worldwide market in 2018 is estimated at $593. A similar calculation of the US market yielded an estimate of $670.

- **Total revenue per 4G-enabled vehicle in the GM Onstar ecosystem**
  The total service revenue (excluding connectivity hardware) based on 2016 forecasts of income for the period 2016-2018 by the GM CFO was calculated as $1,522 in the US and $634 worldwide per vehicle. IHS forecasts for Onstar in the same period produced calculated estimates between $1,113-$1,909 in the US and $795 worldwide per vehicle.

- **Total revenue for specific connected vehicle applications**

  1. **Advanced Navigation**
     The Advanced Navigation value model is based on revenue generation, typically through a subscription model, although advertising-based models are also applicable. For example, GM Onstar's Connected Navigation provides advanced features through its embedded 4G connection, including real-time traffic updates, enhanced voice recognition, real-time points of interest, and predictive navigation. In 2019, Connected (Advanced) Navigation is available from Onstar as part of their Unlimited Access subscription ranging from $39.99-59.99 per month. For the 6-year period 2018-2023, an average total service revenue of $464 is calculated based on the NPV of the service revenue per subscription over the time period. Moving from revenue per subscription to

total connected vehicles, a total service revenue of $17 per connected vehicle worldwide is calculated.

2. **Over-the-Air (OTA) updates**
   Due to increased automotive connectivity, the use of over-the-air (OTA) software updates, also known as SOTA (software-over-the-air), are now technically possible. Vehicle recalls are both expensive for automakers as well as for customers, due to loss of time and convenience, which in turn affects brand loyalty. This creates the opportunity for hybrid business models that both provide OTA updates as a revenue-generating value proposition to the customer as well as an investment in cost reduction technology for the automaker. In turn, this can generate higher customer satisfaction leading to a greater likelihood of further service relations and the repurchase of the same brand. Using publicly available data from 2017, a potential OTA cost savings of $177 was calculated per connected vehicle. In 2015, IHS Automotive estimated that cost savings due to OTA updates would grow from the present size of $2.7 billion to $35 billion by 2022, focused primarily on telematics and infotainment updates, resulting in forecasted total OTA cost savings per connected vehicle of $1,038 over a connected vehicle's lifetime.

A comprehensive evaluation of the impact of connectivity in the automotive sector would need to incorporate all layers in the value stack, including all connected vehicle applications, the associated consumer surplus from these applications, and the reduction in negative externalities, such as reduced carbon emissions and reduced accidents resulting in fewer injuries and deaths.

Key Highlights

- Connectivity is a megatrend that is transforming the automotive industry towards a new mobility sector. In the near future, most new vehicles will be increasingly equipped with embedded connectivity capabilities due to safety regulations, development of V2X functionality, and the potential service revenue.

- The growing value of connectivity in the automotive sector is predicated on the development of high performance, open telecommunication standards, such as advanced cellular technology (e.g. 4/5G).

- The vehicle is becoming the next big digital platform, generating competition between the existing mobile/smartphone ecosystem and the emerging vehicle ecosystems for control of the value of automotive/mobility services.

- Connected vehicle applications are still small but are growing. Current estimates of the revenue from the vehicle ecosystem to automakers were calculated at $670 (US) and $593 (WW) per connected vehicle, based on a subset of existing applications in 2018.

- The total revenue from connectivity-enabled products and services in the automotive sector was calculated to grow from $223 billion to $483 billion from 2018-2023 for a subset of existing revenue pools, with forecasts predicting as much as $2 trillion by 2030.

- Market revenues do not provide the whole picture, especially when multi-sided business models are deployed. Therefore, the total economic value, including consumer surplus and relevant externalities, is important to bear in mind when determining the value of connectivity in the automotive sector or regulation of the sector.