MIRAE ASSET
Building on principles

Autonomous driving

Age of ADAS: Invest in sensor market

Autonomous driving/Auto parts (Maintain)
Industry Report
June 8, 2017

Mirae Asset Daewoo Co., Ltd.

[Autonomous driving/Auto parts]

Inwoo Park
+822-3774-3763
inwoo.park@miraeasset.com

We believe that an increasing focus on social concerns and corporate competition over the commercialization of relevant technology will inevitably bring on the era of autonomous cars. In addition to the greater focus on social concerns, an increasing focus on environmental issues is also helping accelerate the development of autonomous driving technology. While responding to such trends, automakers and parts suppliers are additionally motivated to commercialize advanced driver assistance systems (ADAS) in an effort to generate additional profits, with consumers adopting and purchasing the new technology at a faster-than-expected pace.

However, the advent of the era of autonomous cars, in which most of the cars on roads offer limited (Level 3) or full (Level 4) automation features, will likely take a long time (one estimate is that it will not arrive until around 2050). Considering the mass production schedules of relevant technology and vehicle replacement cycles, we expect limited- or fully-autonomous cars to account for more than half of all new car sales by 2030 and more than half of all registered cars by 2040. Instead of a sudden shift of the industry, the adoption of new technologies into traditional cars should continue at a steady pace in the near term. We expect to see the gradual adoption of vehicle automation Level 1-2 ADAS features into cars continue over at least the next 10 years. The global market for ADAS technology will likely grow at 18% per annum from US$16bn in 2016 to US$37bn by 2021.

Within the ADAS market, we recommend focusing on the sensor value chain, which accounts for the largest portion of the ADAS market and is expected to enjoy 23% growth per annum from US$7.4bn in 2016 to US$20.8bn by 2021. Over the same period, the market for auto-use camera, radar, and LiDAR should each grow by 24%, 21%, and 61%, respectively, per annum.

Based on our analysis of the auto-use sensor value chain, we highlight six stocks (Table 1) that we believe warrant attention. ON Semiconductor (ON US, US$16.65) current market leader in camera image sensing chips, and continues to expand its market share each year. STMicroelectronics (STM IM, EUR15.48) is likely to grow alongside Mobileye (MBLY, US$62.15) as the hardware partner for the camera signal processing EyeQ chips. STMicroelectronics also holds the second largest market share in radar sensing and processing chips. Infineon (IFX GR, EUR20.28) is the current market leader in radar sensing and processing chips, and has recently acquired the LiDAR MEMS mirror market leader, Innoluce (NR). Continental (CON GR, EUR198.95) holds the largest market share in radar modules and maintains a competitive edge among system suppliers, with proprietary technology secured for all major sensor modules. Delphi (DLPH US, US$86.03) is seen as an alternative investment option in the LiDAR sector, as the equity investor and technology partner of major 3D scanning LiDAR module maker Quanergy(NR). Finally, among domestic companies, Halla Holding's subsidiary Mando-Hella Electronics should continue to post rapid growth from the supply of ADAS cameras and radars to Mando (204320 KS, TP: W290,000, CP: W247,000).

C O N T E N T S

I. Executive Summary

Futurists assert that the era of autonomous driving is imminent, and automakers, parts suppliers, and ICT companies continue to make visible progress on technological advances toward autonomous cars. However, some continue to question the need for autonomous cars. When - and to what extent - will the era of autonomous driving cars affect our everyday lives?

We believe that an increasing focus on social concerns and corporate competition over the commercialization of relevant technology will inevitably bring on the era of autonomous cars. In addition to the greater focus on social concerns, an increasing focus on environmental issues is also helping accelerate the development of autonomous driving technology. While responding to such trends, automakers and parts suppliers are additionally motivated to commercialize advanced driver assistance systems (ADAS) in an effort to generate additional profits, with consumers adopting and purchasing the new technology at a faster-than-expected pace.

However, the advent of the era of autonomous cars, in which most of the cars on roads offer limited (Level 3) or full (Level 4) automation features, will likely take a long time (we estimate that it will not arrive until around 2050). Considering the mass production schedules of relevant technology and vehicle replacement cycles, we expect limited- or fully-autonomous cars to account for more than half of all new car sales by 2030 and more than half of all registered cars by 2040. Instead of a sudden shift of the industry, the adoption of new technologies into traditional cars should continue at a steady pace in the near term. We expect to see the gradual adoption of vehicle automation Level 1-2 ADAS features into cars continue over at least the next 10 years. The global market for ADAS technology will likely grow at 18% per annum from US$16bn in 2016 to US$37bn by 2021.

Within the ADAS market, we recommend focusing on the sensor value chain, which accounts for the largest portion of the ADAS market and is expected to enjoy 23% growth per annum from US$7.4bn in 2016 to US$20.8bn by 2021. Over the same period, the market for auto-use camera, radar, and LiDAR should each grow by 24%, 21%, and 61%, respectively, per annum.

Based on our analysis of the auto-use sensor value chain, we highlight six stocks (Table 1) that we believe warrant attention. ON Semiconductor is the current market leader in camera image sensing chips, and continues to expand its market share each year. STMicroelectronics is likely to grow alongside Mobileye as the hardware partner for the camera signal processing EyeQ chips. STMicroelectronics also holds the second largest market share in radar sensing and processing chips. Infineon is the current market leader in radar sensing and processing chips, and has recently acquired the LiDAR MEMS mirror market leader, Innoluce. Continental holds the largest market share in radar modules and maintains a competitive edge among system suppliers, with proprietary technology secured for all major sensor modules. Delphi is seen as an alternative investment option in the LiDAR sector, as the equity investor and technology partner of major 3D scanning LiDAR module maker Quanergy. Finally, among domestic companies, Halla Holding's subsidiary Mando-Hella Electronics should continue to post rapid growth from the supply of ADAS cameras and radars to Mando.

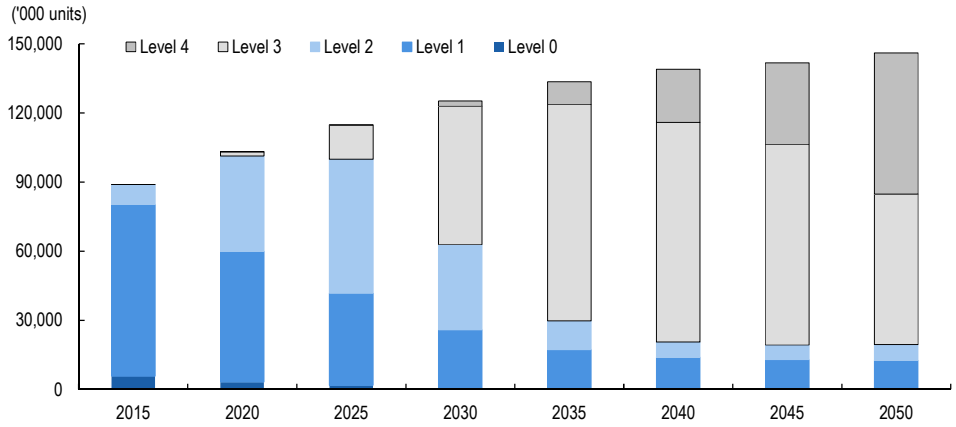
Table 1. Notable ADAS/autonomous driving sensor value chain companies

Company	Country	Ticker	P/E (x)			Investment points
			17F	18F	19F	
ON Semiconductor	US	ON US	12.6	10.8	9.1	Holds largest market share in camera image sensing chips; currently expanding into software market
STMicroelectronics	Europe	STM IM	22.5	17.9	16.8	Hardware partner for Mobileye's EyeQ chips; holds second largest market share in radar sensing and processing chips
Infineon Technologies	Germany	IFX GR	23.6	20.8	18.6	Holds largest market share in radar sensing and processing chips; recently acquired LiDAR MEMS mirror market leader, Innoluce
Continental	Germany	CON GR	12.2	11.1	10.4	Holds largest market share in radar modules; system supplier, with proprietary technology secured for all major sensor modules
Delphi	US	DLPH US	13.3	12.2	11.1	Equity investor and technology partner of major 3D scanning LiDAR module maker Quanergy
Halla Holdings	Korea	060980 KS	7.0	7.8	7.5	Subsidiary Mando-Hella Electronics posting rapid growth in sales of ADAS cameras and radars

Note: P/E based on June 7th 2017 close. Source: Bloomberg, Mirae Asset Daewoo Research

Key charts

Figure 1. Sales outlook by vehicle automation level



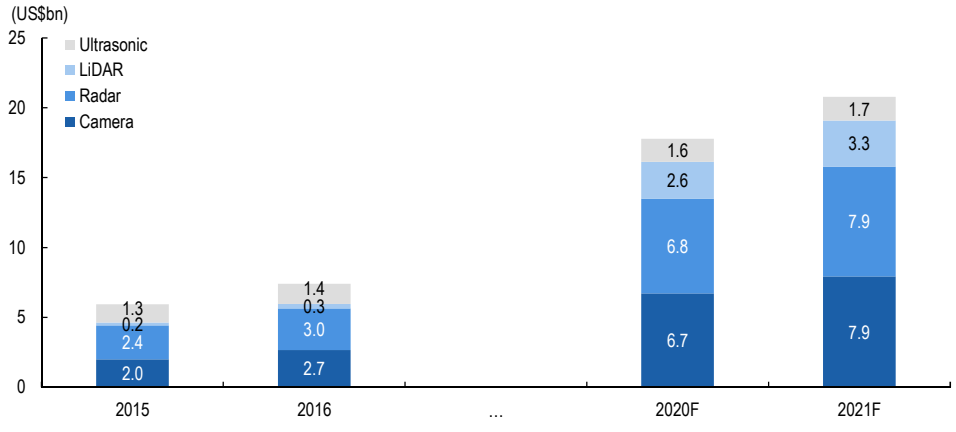
Source: Strategy Analytics, LMC Automotive, Mirae Asset Daewoo Research

Table 2. ADAS market outlook: US$16bn in 2016 → US$37bn in 2021 (CAGR 18%) (US$bn, %)

	2015	2016	2017F	2018F	2019F	2020F	2021F	2016-2021 CAGR
Adaptive front lighting	2.2	2.3	2.4	2.4	2.5	2.4	2.4	1%
Blind spot	1.2	1.4	1.6	1.7	1.8	1.8	1.8	5%
Camera mirror replacement	0.0	0.0	0.0	0.0	0.1	0.3	0.5	-
Central ADAS processor	0.0	0.0	0.0	0.1	0.1	0.2	0.2	193%
Distance warning	**2.4**	**3.4**	**5.0**	**6.7**	**8.5**	**10.1**	**11.1**	**27%**
Drowsiness monitor	0.6	0.7	0.7	0.8	0.9	1.0	1.2	12%
E-call telematics	**1.7**	**2.4**	**3.2**	**4.2**	**5.1**	**5.9**	**6.4**	**21%**
Front corner alert	0.0	0.0	0.0	0.0	0.3	0.6	0.9	-
Head-up-display	0.4	0.6	0.8	0.9	1.0	1.1	1.2	17%
LDWS	**1.4**	**1.8**	**2.4**	**3.1**	**3.8**	**4.5**	**5.1**	**22%**
Night vision	0.1	0.1	0.2	0.3	0.4	0.5	0.7	41%
Parking	2.7	3.2	3.5	3.9	4.3	4.7	5.1	10%
V2V / V2X	0.0	0.0	0.0	0.1	0.1	0.2	0.3	58%
Total	**12.6**	**16.0**	**19.8**	**24.1**	**28.9**	**33.4**	**37.0**	**18%**

Source: Strategy Analytics, Mirae Asset Daewoo Research

Figure 2. Auto-use sensor market outlook: US$7.4bn in 2016 → US$20.8bn in 2021 (CAGR 23%)



Source: Strategy Analytics, Mirae Asset Daewoo Research

II. How will era of autonomous driving begin?

Advent of autonomous driving era seen as inevitable

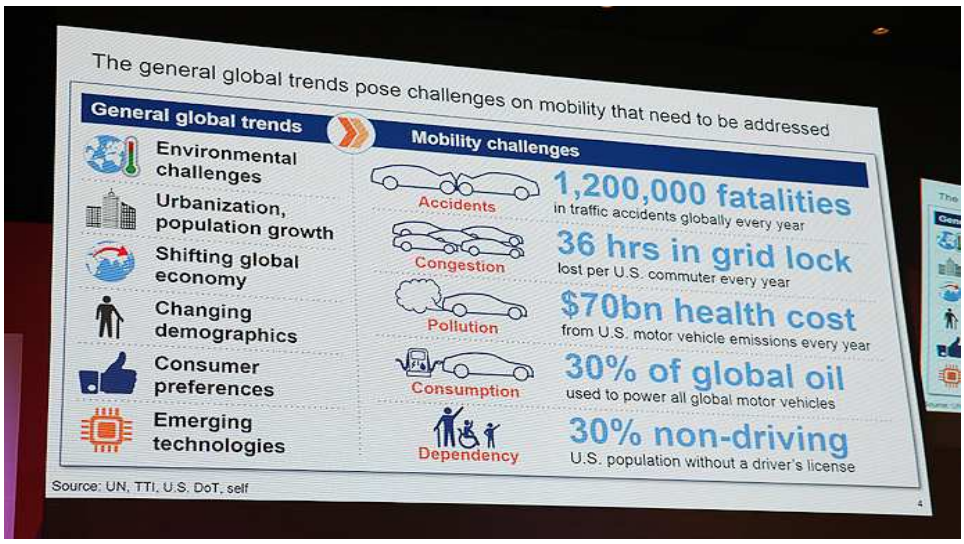
The Fourth Industrial Revolution is rising as a key issue for industries, with autonomous cars frequently emerging as a major example of this revolution. Futurists assert that the era of autonomous driving is imminent, and automakers, parts suppliers and ICT companies continue to make visible progress on technological advances toward autonomous cars. With these developments, it seems that the era of autonomous cars is actually unfolding in front of our eyes.

However, some continue to question the need for autonomous cars and why the market for relevant technology needs to grow. Some assert that most people enjoy driving and that autonomous driving technology does not add substantial value. In addition, several surveys carried out on the issue show that concerns remain over placing complete trust in the technology.

Based on the review of facts, we present two answers for such questions. First, an increasing focus on social concerns, as well as corporate competition over the commercialization of relevant technology, will inevitably bring on an era of autonomous cars. Second, as it will likely take several decades for autonomous cars to become mainstream, the near-term focus should remain on adapting new technologies into traditional cars. Full self-driving automation (Level 4 from the five levels of vehicle automation defined by the National Highway Traffic Safety Administration, or NHTSA) should be available from 2020-2025, but it will likely take a long time for the technology to advance from being available to becoming mainstream.

Elaborating on our first answer, we point out that one factor helping to accelerate the advent of autonomous driving is the move towards stricter safety regulations. With most of the world's 1.2mn annual deaths from car accidents linked to careless driving, governments are seeking to regulate or provide incentives for the adoption of certain autonomous safety features on automobiles. A key example is the adoption of autonomous emergency brake (AEB) systems. With the technology helping to notably reduce rear-impact and pedestrian accidents, the adoption of AEB systems gains additional points on the Euro New Car Assessment Program (NCAP) in Europe and will become a mandatory feature on all new cars offered in the US by 2022. Meanwhile, additional regulations announced in the US in early 2017 include the mandatory adoption of vehicle-to-vehicle (V2V) communication systems on all new cars by 2023. V2V communication aims at reducing blind spot related accidents.

Figure 3. Global challenges to bring on new mobility era (autonomous/connected/eco-friendly cars and car-sharing)



Source: Global Auto News (excerpt from Prof. Sven A. Beiker's keynote speech at the 2017 Seoul Motor Show Conference)

In addition to strengthening safety regulations, increasing focus on environmental issues is accelerating the development of autonomous driving technology. Further advancement of autonomous driving technology is expected to prompt wider adoption of car/ride sharing and help to optimize driving distance and time, notably contributing toward energy saving and CO2 reduction. Meanwhile, autonomous driving technology can also help improve convenience for groups such as the elderly and the disabled.

Meanwhile, automakers and parts suppliers are actively working on the automation of vehicle control features and commercialization of ADAS in order to meet strengthening safety regulations and reinforce selling points. ADAS commercialization efforts are fueled further by the generation of actual profits, unlike eco-friendly features struggling to gain traction on production and sales, due to limits in securing visible profits.

Hyundai Motor (005380 KS, TP: W178,000, CP: W160,000) is currently offering the Smart Sense package for its IG Grandeur model (offers NHTSA vehicle automation Level 1) in the domestic market at W1.6mn, and the adoption rate of the optional package is reaching near 30%. For the Smart Sense packages offered for the Genesis G80 and EQ900 models (vehicle automation Level 2; combination of ADAS functions offer control over the vehicle, including features, such as highway cruise-assist systems) at W2.5-3.0mn, adoption rates currently reach 50% and 80% levels, respectively. With consumers adopting autonomous driving technology at a faster-than-expected pace and the cost of the Smart Sense packages estimated at half the level of consumer prices, we believe companies are already started to secure profits from autonomous driving features.

Meanwhile, in October 2016, Tesla (TSLA US, US$359.01) released the prices of autonomous driving features for its automobiles at US$5,000 for limited self-driving automation (Level 3) and US$8,000 for full self-driving automation (Level 4). Although steep at present, the price of autonomous driving features should fall below US$4,000 levels by the time mass production of Level 3 and Level 4 autonomous cars starts in earnest (around 2020 and 2025, respectively), with the cost of key components and technology expected to decline naturally. In all, for consumers, we expect the added price of purchasing an autonomous car to fall visibly below the added price of selecting an eco-friendly car.

In sum, social demand, corporate competition on the commercialization of relevant technology, and decline in prices to levels acceptable by consumers should bring on the era of autonomous cars.

Figure 4. Regulations on safety-related ADAS features in major countries (mandatory adoption or NCAP incentives)

Country/Region	NCAP/Mandate	System	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
China	NCAP Proposal	AEBS												5*+ (****)		5*+ (****)					
China	NCAP Proposal	ESC												5*+ (****)		5*+ (****)					
European Union	Mandate	ABS																			
European Union	Mandate	ESC																			
European Union	Mandate	*AEBS (HCV)*																			
European Union	Mandate	*LDWS (HCV)*																			
European Union	NCAP	AEBS								5*		Pedestrian		Bicycle		Crossing, Junction & Head-On					
European Union	NCAP	LDWS								5*		Lane Keeping		Road Edge & Evasive Steering							
European Union	NCAP	BSD																			
European Union	NCAP	Speed Alert-TSR																			
European Union	Mandate	*ABS (Motorcycles)*																			
Japan	Mandate	ESC																			
Japan	Mandate	*AEBS (HCV)*																			
Japan	Mandate	*LDWS (HCV)*																			
Japan	NCAP	AEBS										5*		Update							
Japan	NCAP	LDWS										5*									
South Korea	Mandate	ESC																			
South Korea	NCAP	AEBS										5*		Update							
South Korea	NCAP	LDWS										5*									
USA	NCAP	AEBS												5* (**)							
USA	NCAP	AHB												5* (**)							
USA	NCAP	BSD												5* (**)							
USA	NCAP	FCW					Recommend only														
USA	NCAP	LDWS					Recommend only							5* (**)							
USA	Mandate	ESC																			
USA	Mandate	Backup Camera										New Models		All Models							
USA	Mandate Proposal	FCW																			
USA	NHTSA Agreement	AEBS																(***)			

Note: Based on the Euro New Car Assessment Program (NCAP)
Source: Strategy Analytics, Mirae Asset Daewoo Research

However, autonomous cars are decades away from full deployment

Autonomous cars are coming, with the only questions being how soon and how fast. Level 1 to 2 vehicles (vehicles with ADAS-enabled safety features) are entering the mass production stage. However, strictly speaking, vehicles are not truly autonomous until Level 3 (Limited Self-driving Automation: The vehicle controls all safety functions under challenging driving environments. The driver must be ready to take back control in case of emergency) and Level 4 (Full Self-driving Automation: The vehicle will be in full control end to end on the trip). As such, we project the deployment of autonomous technologies based on Level 3 and 4 vehicles.

Table 3. Levels of autonomous driving

Level	Definition	Specifications
Level 0	No Automation	- The driver is in complete and sole control of the primary vehicle controls at all times
Level 1	Function-specific Automation	- Certain functions are automated to enhance the driver's safety - e.g.) ESC (electronic stability control), SCC (smart cruise control), AEB (autonomous emergency braking system), and LKAS (lane-keeping assist system) - Specific control functions are collectively referred to as ADAS (Advanced Driver Assistance System)
Level 2	Combined Function Automation	- Automation at this level involves one or more specific control functions designed to work in unison to take control over the vehicle - e.g.) SCC+LKAS, SCC+LKAS+AEB - Vehicles are capable of autonomous highway driving - The driver is liable for an accident
Level 3	Limited Self-driving Automation	- The vehicle controls all safety functions under certain traffic and environmental conditions - However, the system may signal the driver to reengage in the driving task at some points, providing the driver with an appropriate amount of transition time to safely regain manual control - The driver is expected to be behind the wheel; a car accident may lead to disputes over who is legally responsible for the accident
Level 4	Full Self-driving Automation	- The vehicle is designed to perform all safety-critical driving functions for an entire trip - The driver provides destination or navigation input, but the vehicle will be in control end to end on the trip - No one has to be in the driver's seat; the vehicle is held responsible for any accidents

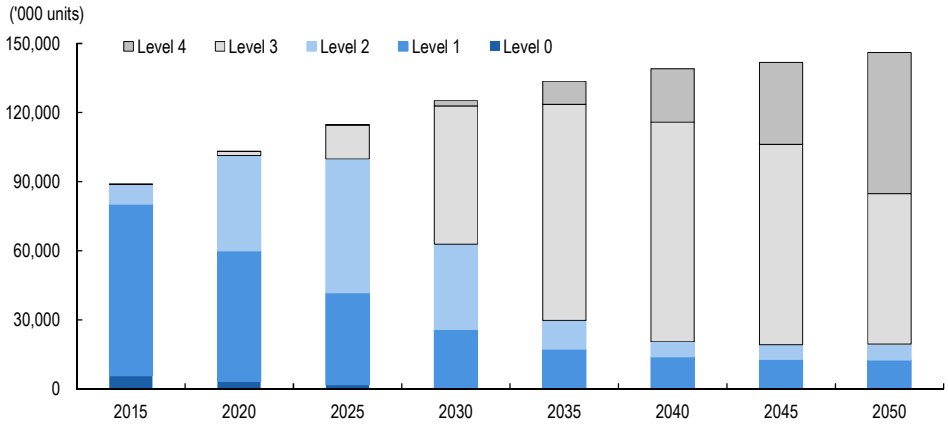
Source: NHTSA, Mirae Asset Daewoo Research

[Mass-production timeline]

Given that major automakers have already developed technologies for Level 3 autonomous driving capabilities, and demonstration vehicles are being showcased at various trade shows, we expect full-fledged mass-production of Level 3 vehicles to begin from 2020. According to Strategy Analytics, Level 3 vehicles will account for 2% (1.75m units) of new car sales in 2020. This estimate is in line with projections by other market researchers. The penetration of Level 3 vehicles is expected to accelerate afterwards. Strategy Analytics predicts that Level 3 vehicles will account for 13% (15m units) of new car sales in 2025 and 48% (60m units) in 2030.

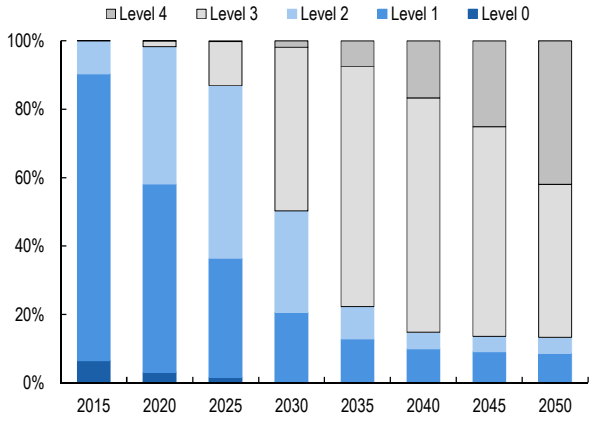
Despite varying degrees of technology development, most market players set their commercialization targets for Level 4 vehicles sometime between 2020 and 2030. The prevailing view in the market is that Level 4 vehicles will be available for test-driving during 2020 and 2025 and scheduled for mass-production sometime between 2025 and 2030. Strategy Analytics projects that Level 4 vehicles will account for 2% (2.3mn units) of new car sales in 2030 and exceed 50% after 2050.

Figure 5. Global new car market outlook by level of autonomous driving (in terms of sales volume)



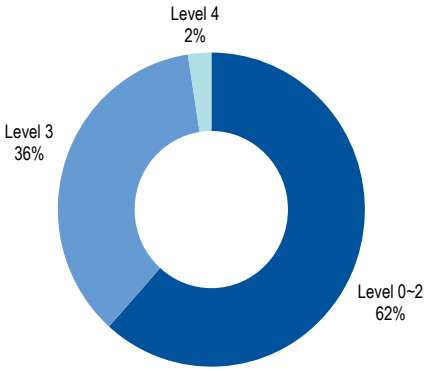
Source: Strategy Analytics, LMC Automotive, Mirae Asset Daewoo Research

Figure 6. Global new car market outlook by level of autonomous driving (in terms revenue share)



Source: Strategy Analytics, LMC Automotive, Mirae Asset Daewoo Research

Figure 7. Level 3 & 4 vehicles, as % of car registrations (2035)



Note: Based on IEA estimates of registered cars (1.7bn units)
Source: Strategy Analytics, International Energy Agency, Mirae Asset Daewoo Research

[Mainstream]

The average replacement cycle for vehicles is over 10 years. Even if mass-production were to begin in earnest, autonomous vehicles will not be going mainstream anytime soon. According to Strategy Analytics, Level 3 and 4 vehicles will account for 70% and 7% of new cars sales, respectively, by 2035, which implies that ordinary driver-controlled cars will likely continue to dominate the roads. The International Energy Agency (IEA) predicts that the number of vehicles on the road worldwide will double to 1.7bn by 2035. Considering cumulative sales volumes and car replacement cycles, we estimate Level 3 and 4 vehicles will account for 36% and 2%, respectively, of vehicles on the road in 2035, and together exceed 50% of car registrations by 2040.

As such, we expect it will be around 2050 before Level 3 and 4 vehicles make up the majority of the traffic, and it will be at least another decade later that fully autonomous cars become the norm. As such, we expect the automotive industry to take an evolutionary path, through the continuous incorporation of new technologies, rather than undergoing drastic changes.

ADAS to drive market over next 10 years

As aforementioned, Level 3 and 4 vehicles are expected to account for more than 50% of new car sales by 2030 and car registrations by 2040. As such, we expect Level 1-2 vehicles **(**vehicles with ADAS safety features) will go mainstream over the next decade.

Our view is supported by a bright outlook for the ADAS market. According to Strategy Analytics, the global market for ADAS is forecast to grow at an impressive CAGR of 18%, from US$16bn in 2016 to US$37bn in 2021**.**

Specifically, we note three key ADAS functions, in terms of the market's size and growth rates, including: 1) Distance Warning (which helps drivers control the distance between themselves and the vehicle in front; e.g., SCC and AEB); 2) E-Call Telematics (which automatically calls the nearest emergency center in case of an accident); and 3) LDWS (which prevents inadvertent lane changes; including LKAS). These specific control functions are related to regulations over automated safety features.

Table 4. ADAS market outlook: US$16bn in 2016 → US$37bn in 2021 (18% CAGR) (US$bn, %)

	2015	2016	2017F	2018F	2019F	2020F	2021F	2016-2021 CAGR
Adaptive front lighting	2.2	2.3	2.4	2.4	2.5	2.4	2.4	1%
Blind spot detection	1.2	1.4	1.6	1.7	1.8	1.8	1.8	5%
Camera mirror replacement	0.0	0.0	0.0	0.0	0.1	0.3	0.5	-
Central ADAS processor	0.0	0.0	0.0	0.1	0.1	0.2	0.2	193%
Distance warning	**2.4**	**3.4**	**5.0**	**6.7**	**8.5**	**10.1**	**11.1**	**27%**
Drowsiness monitor	0.6	0.7	0.7	0.8	0.9	1.0	1.2	12%
E-Call telematics	**1.7**	**2.4**	**3.2**	**4.2**	**5.1**	**5.9**	**6.4**	**21%**
Front corner alert	0.0	0.0	0.0	0.0	0.3	0.6	0.9	-
Head-up-display	0.4	0.6	0.8	0.9	1.0	1.1	1.2	17%
LDWS	**1.4**	**1.8**	**2.4**	**3.1**	**3.8**	**4.5**	**5.1**	**22%**
Night vision	0.1	0.1	0.2	0.3	0.4	0.5	0.7	41%
Parking	2.7	3.2	3.5	3.9	4.3	4.7	5.1	10%
V2V / V2X	0.0	0.0	0.0	0.1	0.1	0.2	0.3	58%
Total	**12.6**	**16.0**	**19.8**	**24.1**	**28.9**	**33.4**	**37.0**	**18%**

Source: Strategy Analytics, Mirae Asset Daewoo Research

Looking at the market from an investment perspective, there are many ways to invest in the megatrend toward autonomous driving, although risk-return expectations may differ by investor. However, the most efficient way to yield a stable return with lower risks is via autonomous vehicle companies with a proven record of steady earnings growth. From a long term perspective, it is possible to invest in potential leaders in technology standards for Level 3-4 autonomous driving capabilities; however, this would be as risky as investments in a biotech company.

In sum, from a medium-risk, medium-return perspective, the best way to invest in the autonomous driving trend is investing in the ADAS segment, a major growth driver over the next decade, and related players. We divided the ADAS segment's value chain into recognition (sensor)-decision (software + ECU/DCU)-control (actuators) stages. We recommend focusing on the recognition (sensor) value chain, which accounts for the fastest-growing (and largest) share of the ADAS market.

Sensor value chain looks most attractive

As discussed above, the value chain of the ADAS market can be broken down into recognition-decision-control segments by technology. The recognition segment includes sensor technologies, such as cameras, radar, and LiDAR, which perceive external data, such as obstacles, road signs, and traffic signals. The decision segment includes software algorithm and ECU/DCU technologies, which efficiently process data needed to make driving decisions. The control segment includes actuator technologies, which control steering, acceleration, and deceleration, based on computed results.

By segment, Strategy Analytics estimates the sensor value chain, excluding signal-processing software and chips, will expand from US$4.6bn in 2016 to US$11bn in 2021. However, software and chips should be included to analyze the actual market for the entire sensor value chain. Factoring in the software and chip markets (Table 5), we estimate that the total ADAS sensor market will post a CAGR of 23% from US$7.4bn in 2016 to US$20.8bn in 2021.

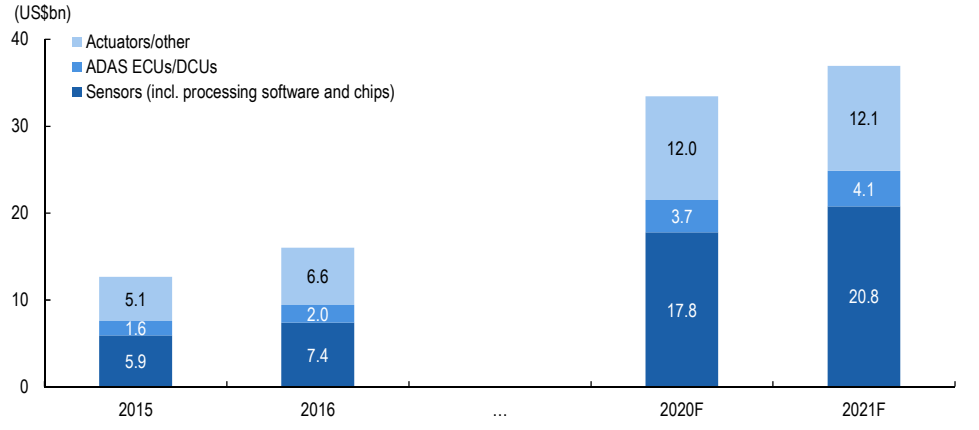
Of the decision segment, Gartner estimates the market for ADAS-use processors (ECU/DCU) will report a CAGR of 15% from US$2bn in 2016 to US$4.1bn in 2021. The value of actuator and other segments can be derived by deducting the sensor and processor markets from estimates for the entire ADAS market. In conclusion, the sensor value chain accounts for as much as 46% of the entire ADAS market in 2016, and the figure will likely increase to 56% in 2021, posting a faster CAGR of 23%, compared with other segments. As such, we recommend focusing on the sensor value chain from an investment point of view.

Table 5. ADAS sensor market outlook: US$7.4bn in 2016 → US$20.8bn in 2021 (CAGR 23%) (US$bn)

	2016				2021F			
	Market excl. SW	SW price (US$)	Units (m)	**Total market**	**Market excl. SW**	SW price (US$)	Units (m)	**Total market**
Camera	1.80	45	19.3	2.67	4.59	45	74.4	7.94
Short/Medium-distance radar	1.09	50	19.8	2.08	2.79	40	69.1	5.55
Long-distance radar	0.60	50	6.0	0.90	1.39	40	23.0	2.31
LiDAR	0.16	50	2.9	0.31	1.18	160	13.2	3.29
Ultrasound	0.97	2	241.6	1.45	1.07	2	308.4	1.69
Total sensor market	**4.62**			**7.40**	**11.02**			**20.77**
Entire ADAS system				15.99				36.95
Share of sensor value chain				46%				56%

Note 1: As Strategy Analytics excluded software and chips from sensor market estimates, we added our software market estimates to derive the total ADAS sensor market value.
Note 2: Camera software counts are based on front cameras, as Mobileye's EyeQ chip is only used for main front cameras.
Note 3: We assumed that LiDAR software prices will rise to US$160 by 2021, given increasing adoption of high-end products, but assumed a decline in radar software prices.
Source: Strategy Analytics, Mirae Asset Daewoo Research

Figure 8. ADAS market outlook by value chain: Sensor value chain accounts for largest and fastest-growing share of market

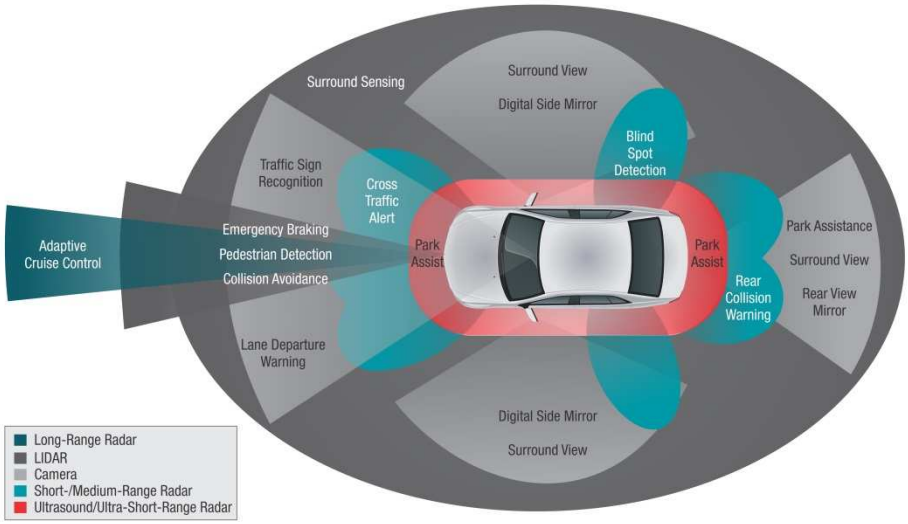


Source: Strategy Analytics, Gartner, Mirae Asset Daewoo Research

III. Market analysis by sensor and investment strategy

Autonomous cars use a variety of sensors, including cameras, radar, LIDAR, and ultrasound sensors, to detect the driving environment (see Figure 9). So far, a combination of individual sensors has been used, depending on the ADAS features that automakers intend to implement. Recently, however, auto parts makers are striving to develop an integrated sensor that is cheaper and can compensate for the weaknesses of individual sensors.

Figure 9. Types of autonomous driving sensors and their applications



Source: Texas Instruments

1) Cameras

Cameras are the most essential sensor for ADAS and autonomous driving. Although radar or LIDAR can identify the exact distance and special information of a variety of objects, this is not useful for detecting information regarding the shapes of such things as traffic lanes, lights, signs, or pedestrians. Notably, stereo cameras that can even obtain distance information have recently been introduced.

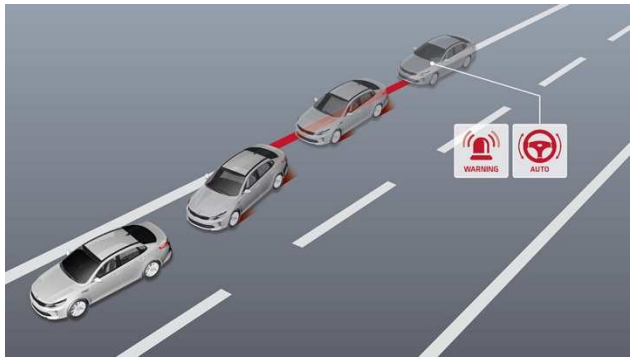
Major ADAS features that cameras offer include lane departure warning systems (LDWS) and lane keeping assistance systems (LKAS). These systems are designed to warn the driver when the vehicle begins to move out of its lane and, if no action is taken, automatically take steps to ensure the vehicle stays in its lane. Cameras also play an important role in autonomous emergency braking (AEB) systems, which automatically stop the vehicle in instances where objects, such as pedestrians or another vehicle, suddenly appear. In the past, a combination of cameras and radars were used to provide AEB features. Recently, however, auto parts makers have been offering AEB features via cameras or radar alone.

While the above mentioned ADAS features are based on relatively expensive front-facing cameras, an around-the-view monitor or parking assistant system (PAS) can be applied via relatively cheap rear-/side-facing cameras.

Figure 10. Front-facing camera for ADAS

Source: ZF TRW

Figure 11. LDWS and LKAS

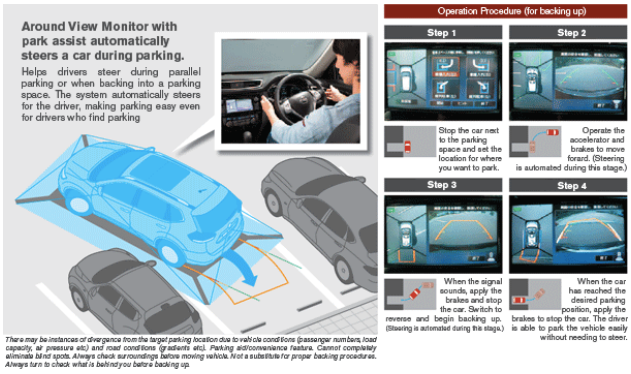


Source: Kia Motors

Figure 12. AEB: Cameras are the major sensor

Source: Euro NCAP

Figure 13. Around-the-view monitor and PAS



Source: Nissan

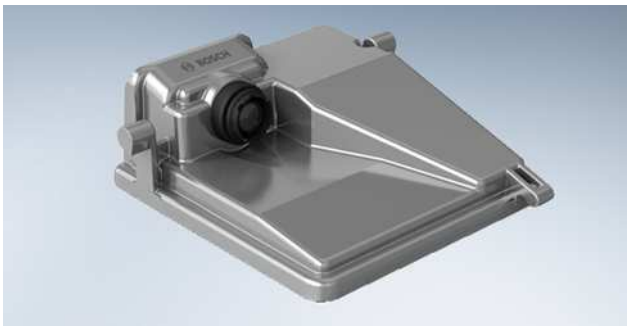
For ADAS/autonomous driving cameras, the most recent technological trend is a shift from mono to stereo cameras. The virtue of stereo cameras is that they can recognize objects in 3D, using visual differences between lenses. Stereo cameras can obtain distance information, in addition to shape information, and are likely to be more expensive than conventional cameras.

Of note, as cameras-based ADAS/autonomous driving techniques become more commonplace, cameras that can perform multiple functions simultaneously are increasingly being developed. To perform multiple functions simultaneously, it is necessary to increase image-processing speeds significantly. As such, the application of much faster chips and more efficient software algorithms are assuming greater importance.

Figure 14. Denso's stereo camera

Source: Denso

Figure 15. Bosch's multi-function camera



Source: Bosch

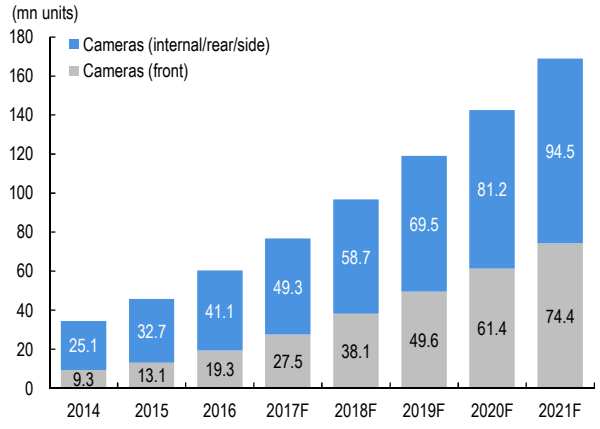
Figure 16. Mobileye's image processing chip & evolution of EyeQ series

Source: Mobileye

Demand for automotive cameras is surging, as the ADAS market has been growing rapidly on: 1) increasing focus on driver/pedestrian safety; 2) competition over the commercialization of ADAS technology; and 3) declining prices of ADAS components. Demand for automotive cameras expanded at a CAGR of 32% from 34.5mn units in 2014 to 60.4mn units in 2016. We expect this trend to persist for the time being. Strategy Analytics, a market research firm, also projects automotive camera demand to grow to 168.9mn units by 2021 (CAGR of 23%). Specifically, demand for front-facing cameras, which are becoming more important, will likely expand at a CAGR of 31%, while demand for internal and rear-/side-facing cameras should grow at a CAGR of 18%. Meanwhile, the ASP of automotive cameras (sensing chip + housing), which stood at around US$31 in 2016, will likely fall to around US$27 in 2021.

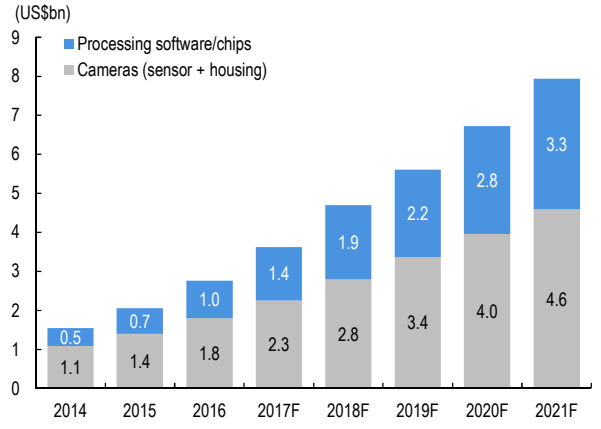
We estimated the market for automotive camera modules (sensing chip + housing + image processing chip/software) by adding the value of the automotive camera market (ASP multiplied by expected demand) and that of the image processing chip/software market (Mobileye's EyeQ chip ASP of US$45 multiplied by front-facing camera demand). As such, we expect the automotive camera module market to expand at a CAGR of 24% from US$2.7bn in 2016 to US$7.9bn in 2021.

Figure 17. Automotive camera demand forecast (volume)



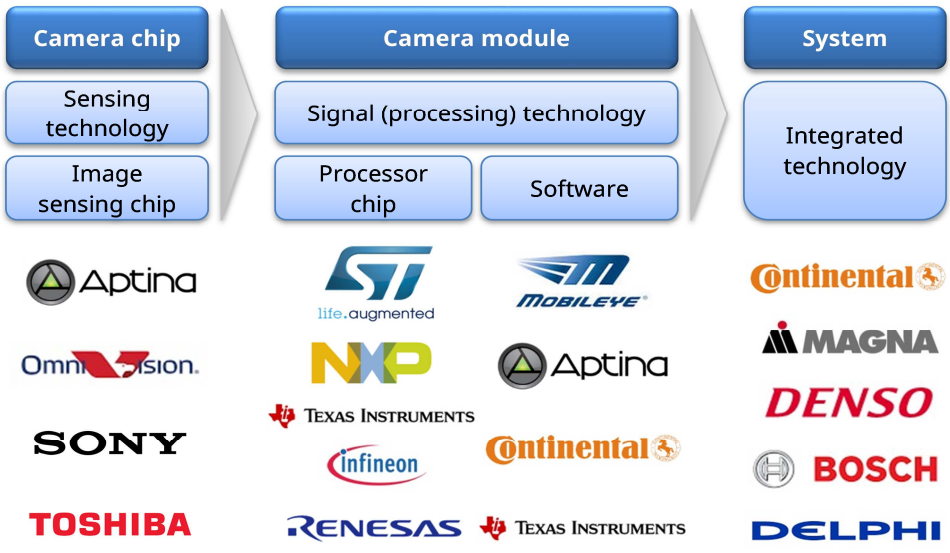
Source: Strategy Analytics, Mirae Asset Daewoo Research

Figure 18. Automotive camera module market forecast (value)



Source: Strategy Analytics, Mirae Asset Daewoo Research

Figure 19. Automotive camera module value chain



Note: Aptina was acquired by ON Semiconductor in 2014
Source: Mirae Asset Daewoo Research

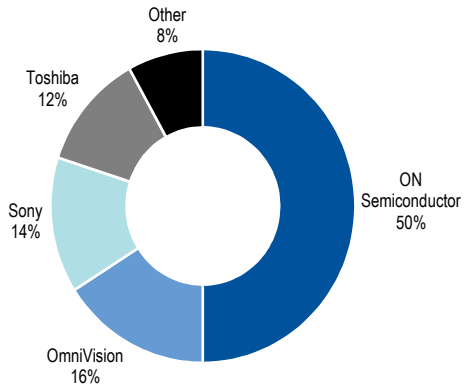
The camera module value chain consist of: 1) chipmakers that supply image-sensing chips to module makers; 2) module makers that develop/install the software algorithm needed to obtain shape information by processing/analyzing image signals; and 3) system makers that implement ADAS features based on camera modules.

In the automotive image sensing chip market, ON Semiconductor, which acquired Aptina (NR) in 2014, ranks first, with its market share expanding to 50% in 2016, followed by OmniVision (NR), Sony (6758 JP, JPY4050), and Toshiba (6502 JP, JPY324.4). The combined market share of the top four companies stands at 92%.

Among module makers, Mobileye (software) and STMicroelectronics (hardware) are dominant. Although Mobileye claims that its EyeQ series controls 80% of the market, we believe its actual market share stands at 50-60%. As the module business creates high added value, sensing chip manufacturers and system makers - including ON Semiconductor, Texas Instruments (TXN US, US$84.34), and Continental - are striving to expand into the module business. Among Korean makers, Nextchip (092600 KS, W12050) is currently developing an image processing chip, aiming to win orders in 2017 and start commercial production in 2018.

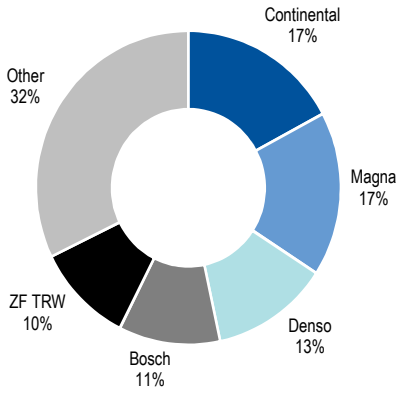
In the system value chain segment, most auto parts makers are competing, with no single players having yet to gain market dominance. As of 2015, Continental, Magna (MGA US, US$45.39), Denso (6902 JP, JPY 4818), Bosch (NR), and ZF-TRW (NR) gained the upper hand in LDWS.

Figure 20. Automotive image sensing chip M/S (2016)



Source: On Semiconductor, Mirae Asset Daewoo Research

Figure 21. LDWS M/S (2015)



Source: Strategy Analytics, Mirae Asset Daewoo Research

Among companies in the camera module value chain that we believe warrant attention are ON Semiconductor, among chipmakers, and STMicroelectronics among module makers.

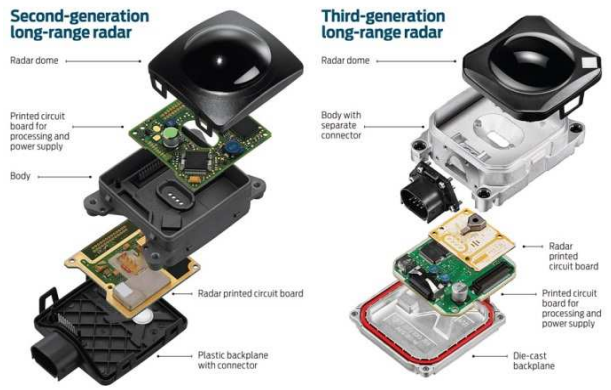
STMicroelectronics - a supplier of chips to Mobileye – is a potential beneficiary of robust sales growth for the EyeQ series. ON Semiconductor, which boasts a high - and steadily-climbing - market share, supplies more than 50% of automotive image sensing chips, similar to the combined share of Aptina (NR) and OmniVision five years ago. Furthermore, the company is competing to win orders in the module value chain segment, backed by its in-house developed processors.

2) Radar sensors

A radar sensor measures the distance to an object, as well as its speed, by detecting the difference in time and frequency between the radio waves that are emitted to the object and those received back by the sensor. Unlike cameras, radar sensors cannot detect images of an object, but can operate effectively both day and night and in all weather conditions, as they use radio waves. They can also measure the distances of moving objects.

Radar sensor-based ADAS include smart cruise control (SCC), autonomous emergency braking (AEB), and blind spot detection (BSD) systems. As radar sensors usually find it difficult to increase the measurement of both distance and scan angles, they come in long-range and medium/short-range types. Long-range radar sensors are used in the smart (adaptive) cruise control system, an intelligent form of cruise control that automatically adjusts vehicle speed to maintain a safe distance from vehicles ahead, while short/medium-range radar sensors are adopted in AEB and BSD systems.

Figure 22. Bosch's 2nd and 3rd long-range radar sensors



Source: Bosch

Figure 23. Smart cruise control systems

Source: Daimler Benz

Figure 24. Radar sensors are used in urban/city AEB systems

Source: Mirae Asset Daewoo Research

Figure 25. Blind spot detection (BSD)

Source: Mirae Asset Daewoo Research

In line with recent technology trends for most automotive sensors, companies have been endeavoring to develop lightweight, smaller-sized, and lower-priced automotive radar sensors. Indeed, Bosch's recent long-range radar models, the LRR3 and LRR4, weigh less than 300g, compared with 600g for its 2000 model, the LRR1. Recent models also display marked improvements, in terms of measurement range (150m → 250m) and opening angle (8 degrees → 30 degrees for the LRR3 and 40 degrees for the LRR4).

Efforts are also underway to develop automotive radar sensors that use higher-frequency bandwidths. The higher the frequency of the bandwidth, the higher the range resolution. While BSD-use short-range radar sensors have so far been based on the 24GHz technology, companies are now developing 77-79GHz radar sensors.

While different chips have so far been used for different ADAS features, automotive sensor makers are now seeking to integrate a variety of ADAS features into a single integrated radar chip. They are also developing an integrated radar system, which offers both long-range and short/medium-range detection capabilities.

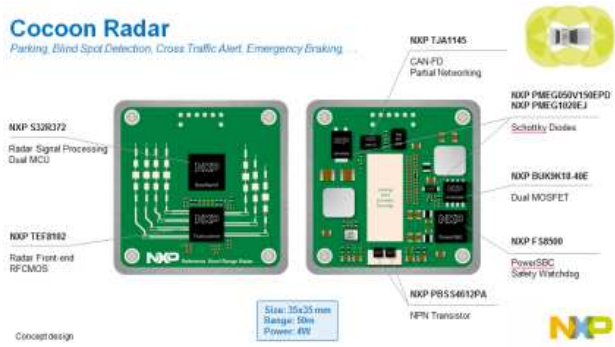
Figure 26. Bosch's radar sensor evolution, in terms of weight and measurement distance/angle

Source: Bosch

Figure 27. Efforts are underway to develop higher-bandwidth automotive radar systems

Source: Imec

Figure 28. NXP Semiconductors' latest integrated short-range radar model

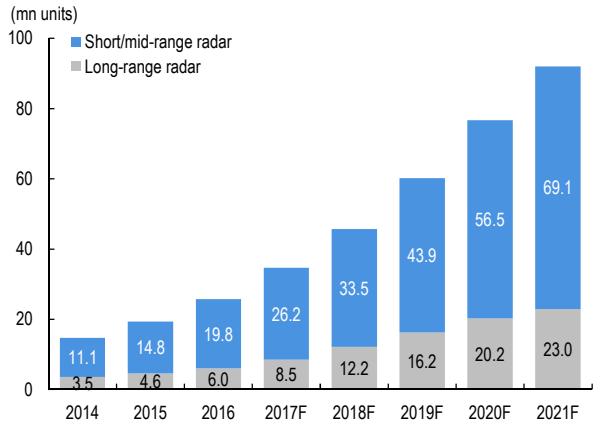


Source: NXP Semiconductors

Amid the rapid growth of the ADAS market, annual demand for automotive radar sensors has expanded at a 33% CAGR, from 14.7mn units in 2014 to 25.8mn units in 2016. Given that the ADAS market is now in the early rapid-growth phase, fast-paced growth in automotive radar demand should also continue for some time. Strategy Analytics estimates that automotive radar sensor demand will increase at a 29% CAGR through 2021 (reaching 92mn units in 2021), with long-range and short/medium-range radar sensors posting a CAGR of 31% and 28%, respectively, during the same period.

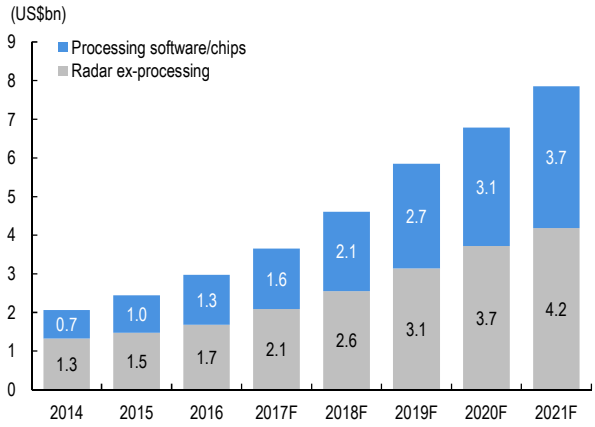
The ASP of automotive radar sensors stood at US$65 (US$100 for long ranges and US$55 for short/medium ranges) in 2016 and is projected to decline to US$45 by end-2021. We calculate the value of the automotive radar module market by summing up the values of the automotive radar and image processing chip/software markets. Assuming the ASP of radar processors at US$50 for 2016 and US$40 for 2021, we forecast the value of the automotive radar module market will increase at a 21% CAGR from US$3bn in 2016 to US$7.9bn in 2021.

Figure 29. Automotive radar demand forecast (volume)



Source: Strategy Analytics, Mirae Asset Daewoo Research

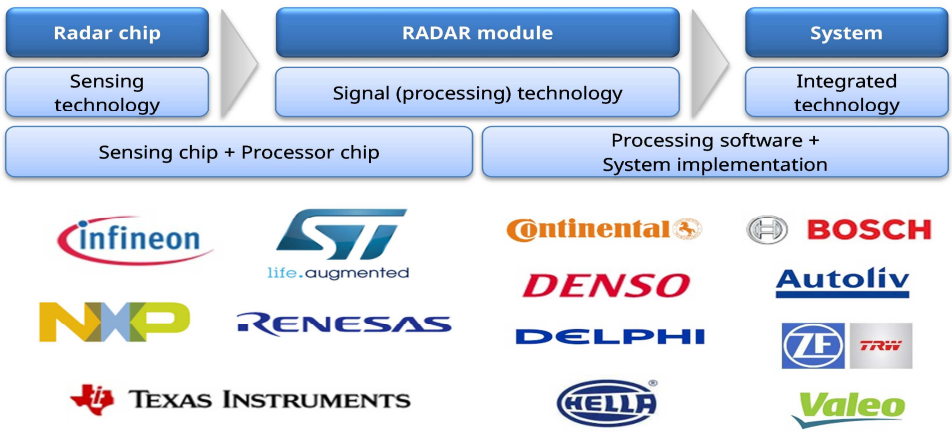
Figure 30. Automotive radar module market forecast (value)



Source: Strategy Analytics, Mirae Asset Daewoo Research

Companies in the radar sensor module value chain include chipmakers, module makers, and system makers. Actually, however, these can be divided into just two groups: 1) makers of sensing and processor chips (used to analyze electronic signals received from module chains); and 2) ADAS makers (mostly automotive parts makers that are now developing processing software in house).

Figure 31. Automotive radar module value chain



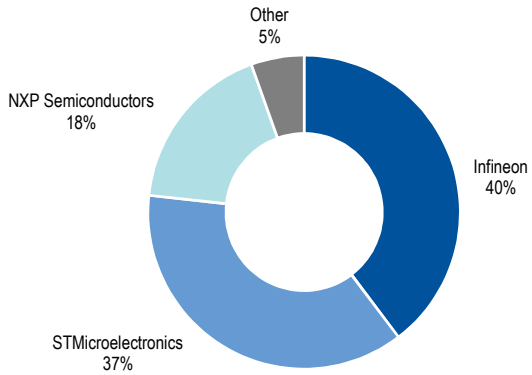
Source: Mirae Asset Daewoo Research

Regarding the first group, the market for radar sensing/processor chips has been dominated by a few chipmakers; due mainly to limited market demand and sizable development costs, only those specializing in electronic control units (ECU) have had the resources to invest in such chips. Germany-based Infineon Technologies (IFX GR, EUR20.28), the market leader in radar sensing/processor chips (market share of 40% as of 2015), supplies both long- and short-range radar chips for system makers. STMicroelectronics, which holds the second largest market share, focuses on the production of short-range radar chips, while NXP Semiconductors (NXP US, US$108.22), which has acquired Freescale and has the third largest market share, provides mainly long-range radar chips.

In the market for radar module-based ADAS system chains, Continental and Autoliv (ALV US, US$112.86) are taking the lead. Both firms have acquired technologies for both long-range and short-range radars through M&As, and hold sizable shares of both the smart cruise control (SCC) and BSD system markets. Bosch and Denso (6902 JP, JPY4818) have garnered significant market shares in SCC systems (in which long-range radars are mainly used), while Hella (HLE GR, EUR45.44) and Valeo (FR FP, EUR61.67) now hold the largest and second largest market share in BSD systems (based mainly on short-range radars), respectively.

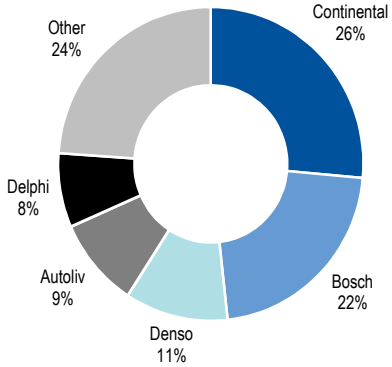
In the automotive radar-related market as a whole, we think it is worth keeping an eye on Infineon Technologies (IFX GR), and Continental, leading players in their respective radar chip and module/system markets, in light of the strong growth potential of the markets.

Figure 32. Automotive radar chip market breakdown by supplier (2015)



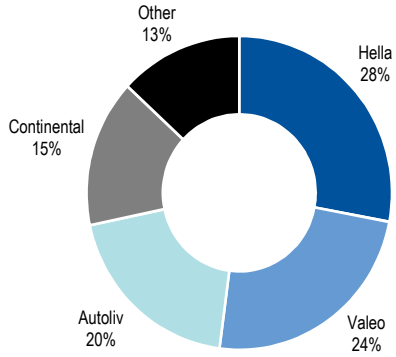
Source: Infineon Technologies, Mirae Asset Daewoo Research

Figure 33. SCC system (based mainly on long-range radars) market breakdown (2015)



Source: Strategic Analytics, Mirae Asset Daewoo Research

Figure 34. BSD system (based mainly on short-range radars) market breakdown (2015)



Source: Strategic Analytics, Mirae Asset Daewoo Research

3) LiDAR

LiDAR works on the similar principles as radar, but it measures the distance to a target by emitting a pulsed laser, instead of radio waves. Automotive LiDAR systems usually transmit laser beams with a wavelength of 905nm, which can precisely locate targets, thanks to its much narrower beam divergence, compared with radar. Currently, LiDAR systems are provided for 2D and 3D scanning, with 3D scanning systems being more expensive, due to greater technical challenges for development.

In 2016, LiDAR system demand was estimated at just 2.9mn units (mostly for 2D scanning); meanwhile, radar system demand reached 198mn units for short/medium-range and 6mn units for long-range sensors in 2016, as radar systems boast higher measurement stability, with performance and prices that are similar to 2D scanning LiDAR systems. The strength of the LiDAR system can be better appreciated when it is applied to 3D scanning. To accelerate penetration, LiDAR system companies are focusing on lowering prices and reducing sizes for 3D scanning systems.

Figure 35. Continental's 2D scanning LiDAR SRL 1

Source: Continental

Figure 36. Velodyne's 3D scanning LiDAR systems

Source: Velodyne

The new products of Velodyne (NR) and Quanergy well illustrate the latest 3D scanning LiDAR technology trends. Velodyne, a US-based firm that mass-produces and sells the most advanced LiDAR systems, recently introduced products that measure the environment in 360 degrees by spinning multiple laser light sources with motors. Despite exhibiting outstanding performance, the company's products did not achieve great success in the market, due to high prices. In an effort to bring down prices, the company reduced the number of light sources from 64 to 16, adopted solid state sensors, and integrated sensors and processors onto a single chip, which resulted in the price tag falling from US$75,000 to US$8,000. Nevertheless, they are still expensive for finished car manufacturers. Currently, automakers prefer LiDAR sensors with simpler structures and lower prices, despite their limited horizontal field of view (FoV). To meet such demand, Velodyne unveiled a new low-end model, the Velarray, with a horizontal FoV of 120° and announced plans for mass-production of the model starting in 2018.

Quanergy, which was invested in by Samsung Electronics (005930 KS, TP: W2,500,000, CP: W2,305,000) and Delphi, and also cooperates with HMC (005380 KS, TP: W178,000, CP: W160,000), is believed to have the most cost competitive product lineup. In particular, the company entered the spotlight when it launched the Mark VIII (eight light sources and 360° FoV) for under US$1,000. In addition, the company began producing the S3 model (solid state and a horizontal FoV of 120°) in early-2017, targeting to provide the model for US$250 or less, once it reaches mass-production.

Figure 37. Specifications of major LiDAR sensor products

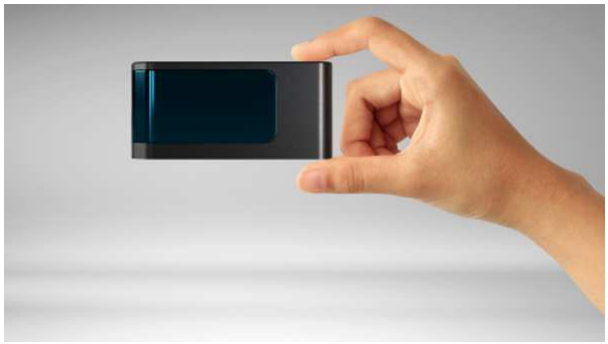
	Unit	Velodyne (HDL-64E)	Quanergy (Mark-VIII)	IBEO (ScaLa B2)	SICK (LD-MRS)
Laser Wavelength	nm	905	905	905	905
Operating Range	m	120(R~0.8)	300(R~0.8)	150	0.5~250
Range(@R=0.1)	m	50	100	50	50
Horizontal FoV	degree	360	360	145	85
Angular Resolution(Horizontal)	degree	0.09	0.1	0.25	0.125/0.25/0.5
Vertical FoV	degree	+2~-24.8	+3~-17	3.2	3.2
Angular Resolution(Vertical)	degree	0.4	2.5	0.8	0.8
Spin Rate	Hz	5~15	10~30	25	12.5~50
Point per Second	-	>1.333M	>288,000	1,743	>34,000
Operating Voltage	VDC	15±1.5(@4A)	9~32	-	9~27
Power Consumption	W	<60	-	7	8
Weight	kg	13(29 lbs.)	1	0.51	1
Dimension	mm	254(h)×203.2(r)	76.2(h)×88.9(r)	105(w)×100(d)×60(h)	164.5(w)×93.2(d)×88(h)
Operating temp.	℃	-10~50	-40~85	-40~85	-40~70

Source: KEIT, Mirae Asset Daewoo Research

Figure 38. Specifications of Velodyne's VLP-16

Note: Horizontal FoV of 360°, maximum range of 100m, 16 channels, US$7,999
Source: Velodyne

Figure 39. Velodyne's latest LiDAR system (targeted for mass production starting in 2018)



Note: Horizontal FoV of 120°, maximum range of 200m
Source: Velodyne

Figure 40. Quanergy's development of LiDAR sensors

Note: For the S3, horizontal FoV of 120°, maximum range of 150m, and distance accuracy of +/-5cm
Source: Quanergy

Figure 41. Innoviz-Magna's LiDAR (targeted for mass production starting in 2018)

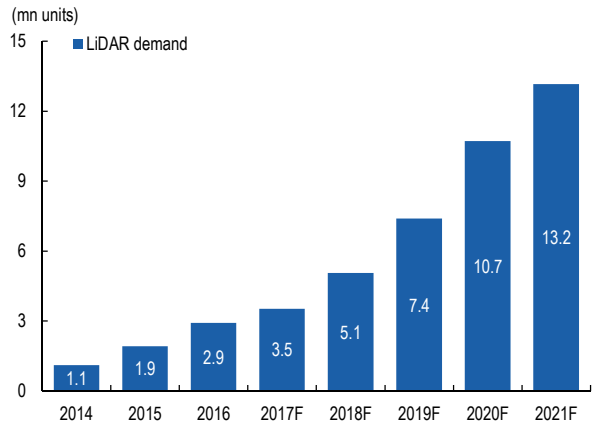
Note: For the S3, horizontal FoV of 100°, maximum range of 200m, and distance accuracy of <10cm
Source: Innoviz

The Scala, which was developed via the partnership between Germany's Ibeo (NR) and France's Valeo, also features solid state sensors with a horizontal FoV of 145°. At this year's CES, HMC (005380 KS, TP: W178,000, CP: W160,000) demonstrated its autonomous driving technology with the Scala system. Innoviz (NR), an Israeli startup, is also developing its LiDAR sensor system InnovizOne (solid state and a horizontal FoV of 100°) in cooperation with Magna. The company targets a mass-production price of US$100.

As such, companies are focusing on the development of lower-priced and smaller-sized systems. Accordingly, recent products tend to adopt solid state sensors and feature limited horizontal FoVs. The prices of 3D scanning systems are projected to fall below US$300 by 2020.

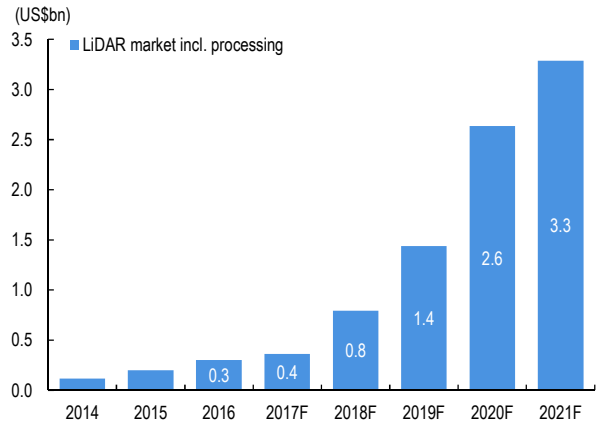
Demand for automotive LiDAR systems is expected to grow sharply starting in 2018, with a pickup in the mass-production of 3D scanning systems. Strategy Analytics projects that automotive LiDAR system demand will increase at a CAGR of 35%, rising from 2.9mn (mostly 2D scanners) to 13.2mn (mostly 3D scanners) by 2021. The ASP of automotive LiDAR systems, including signal processors, is estimated at just US$104 in 2016, as most of the systems sold last year were 2D scanners. As the ASP of automotive LiDAR system is expected to rise to US$250 in 2021 in line with the increasing demand for 3D scanning systems, the global automotive LiDAR module market, including signal processors, is projected to expand from US$300mn in 2016 to US$3.3bn in 2021 (a CAGR of 61%).

Figure 42. Automotive LiDAR demand outlook (volume)



Source: Strategy Analytics, Daewoo Securities Research

Figure 43. Automotive LiDAR module market outlook (value)



Note: Based on the assumptions that 3D scanning LiDAR systems will be mass-produced starting in 2018 and become mainstream technology in 2020
Source: Strategy Analytics, Mirae Asset Daewoo Research

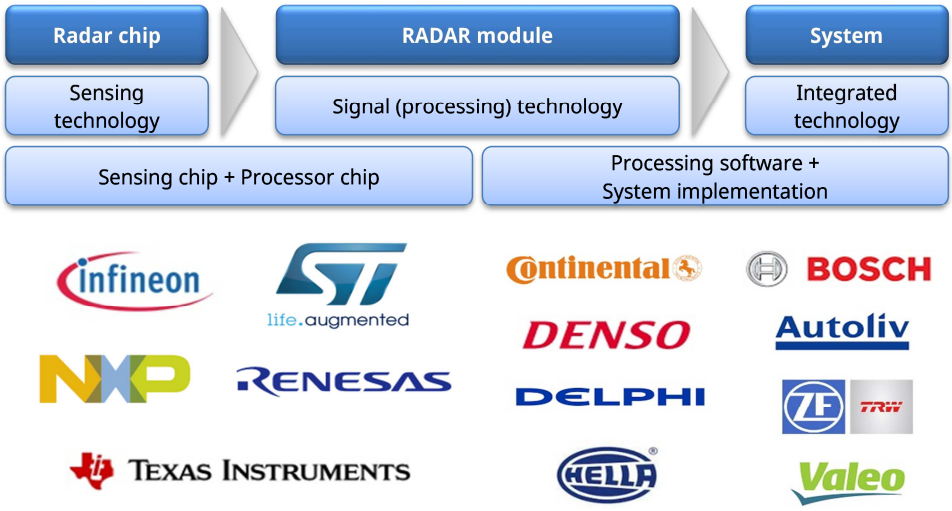
The LiDAR module value chain consists of chipmakers, module makers, and system makers. The value chain of chips for LiDAR systems is more segmented than for radar systems. Semiconductor firms like Germany-based Osram Opto Semiconductors (NR) and US-based Trilumina (NR) are making efforts to carve out footholds ahead of rivals in the laser diode (a source of laser beam) market. Trilumina attracted investments worth US$9.16mn from Denso (6902 JP, JPY4818) in 2014. The production of LiDAR sensors also requires optical chips, such as MEMS mirrors, and receiver chips. Innoluce of the Netherlands is the world's leading MEMS mirror producer, while US-based Maxim Integrated (MXIM US, US$49.41) claims the largest share in the global receiver chip market. Innoluce was acquired by Infineon of Germany in 2016.

The aforementioned LiDAR system producers, including the US' Velodyne and Quanergy , Germany's Ibeo, and Israel's Innoviz, are all major global module makers. They design the structure of the entire LiDAR system modules, and develop/install software algorithms that measure distance based on input signals. Although Continental, which mass-produces and sells 2D scanning LiDAR systems, is currently leading the LiDAR module market, new players should take the lead in the soon-to-be-flourishing 3D scanning system market.

We advise investors to take two factors into consideration in making investments in companies related to automotive LiDAR module systems. First, there is no company that mass-produces automotive LiDAR modules in Korea. Second, module makers are using customized application-specific integrated circuit chips (ASIC) to produce signal processing chips.

Looking at the value chain of ADAS and autonomous driving system based on LiDAR modules, Continental is ahead of other players in the 2D scanning LiDAR-based system market. However, Valeo of France and Delphi of the US are gaining prominence in the 3D scanning LiDAR system market. While Valeo developed LiDAR modules jointly with Ibeo, Delphi has invested in Quanergy and cooperates with the company for technology development. Other auto parts makers are also cooperating actively, with Denso (6902 JP, JPY 4818) investing in Trilumina last year and Magna jointly developing LiDAR modules with Innoviz.

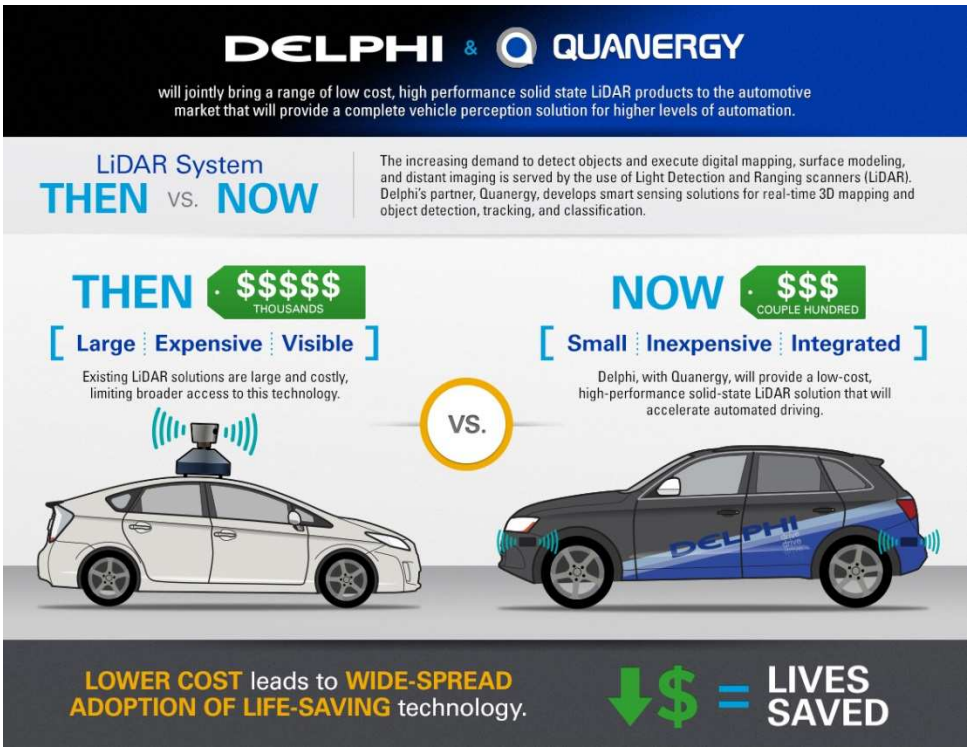
Figure 44. Value chain in the automotive LiDAR module industry



Source: Mirae Asset Daewoo Research

Despite the stellar growth potential of the automotive LiDAR system market, it does not present attractive investment opportunities, as most of the major chip and module makers are unlisted. Maxim Integrated (MXIM US, US$49.41) is the only listed chipmaker in the world, and no module maker has yet been listed.

Figure 45. Delphi's partnership with Quanergy



Source: Delphi

Halla Holdings (060980 KS)

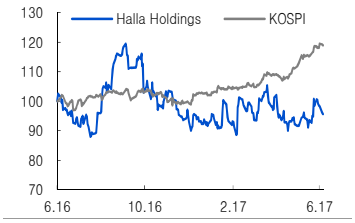
Focus on fast-growing subsidiary, Mando-Hella Electronics

Auto

(Maintain)	Buy
Target Price (12M, W)	83,000
Share Price (06/07/17, W)	62,800
Expected Return	32%

OP (17F, Wbn)	121
Consensus OP (17F, Wbn)	120
EPS Growth (17F, %)	78.0
Market EPS Growth (17F, %)	36.3
P/E (17F, x)	5.1
Market P/E (17F, x)	10.1
KOSPI	2,360.14
Market Cap (Wbn)	678
Shares Outstanding (mn)	11
Free Float (%)	70.4
Foreign Ownership (%)	10.6
Beta (12M)	0.42
52-Week Low	57,800
52-Week High	78,500

(%)	1M	6M	12M
Absolute	4.3	4.3	-5.6
Relative	-0.9	-12.0	-19.5



Mando-Hella Electronics beneficiary of fast-growing ADAS sensor market

Mando-Hella Electronics (MHE) is a 50-50 joint venture between Halla Holdings and Hella (HLE GR, EUR45.44). Given that Hella is a German automotive supplier specializing in automotive engine control units (ECUs) and sensors, we think the joint venture has enabled Halla Holdings to produce in-house: 1) ECUs for both brake and steering systems; 2) general sensors (e.g., Yaw & G, torque, wheel speed); and 3) advanced driver assistance system (ADAS) sensors (e.g. ultrasonic sensors, camera sensors, radar sensors). The ADAS sensor division, which relies on a single customer, Mando (204320 KS, TP: W290,000, CP: W247,000), accounted for 12% of overall revenue in 1Q17.

As aforementioned, the ADAS sensor market is forecast to expand at a CAGR of 23% through 2021, driven by stricter automobile safety regulations in developed markets and intensifying technological competition among global automakers. Accordingly, we estimate MHE's revenue from ADAS sensors will report a CAGR of over 20% through 2020.

We expect the ECU business to display stable revenue growth, given rapidly growing demand for braking/steering ECUs mainly in EMs (e.g. China and India), fueled by the increasing adoption of electronic chassis (e.g. brake/steering systems). Notably, MHE is set to start a new plant in India from 2H17 to meet Indian market demand. We project that MHE's revenue will increase at a CAGR of 11% from 2016 through 2020, on the back of global technology trends and the diversification of customers and products.

Reiterate Buy and TP of W83,000; solid earnings

The in-house distribution/logistics division saw revenue contraction from 2013 and 2015 due to efforts to shed its less-profitable businesses, but displayed top- and bottom-line growth from 2016, led by the CKD logistics business. Indeed, Halla Holdings delivered above-consensus earnings in 1Q17, thanks to the in-house distribution/logistics division, where revenue and operating profit jumped 27% and 57% YoY, respectively. Halla Holdings stands to benefit from Mando's strong revenue growth, in the form of brand royalties, and is delivering healthy earnings, with Halla Corp recognized under the equity-method from 1Q17.

Despite its earnings stability and growth potential, we believe Halla Holdings is undervalued, with the company's current market cap falling below the value of its Mando stake. Given that Hyundai Motor Group's (HMG) sluggish Chinese sales are weighing on the Korean auto parts sector, and the Chinese automotive industry is facing structural margin downtrends, we expect Halla Holdings' earnings stability to be highlighted going forward. We maintain our Buy rating and target price of W83,000 (based on NAV valuation).

FY (12)	12/14	12/15	12/16	12/17F	12/18F	12/19F
Revenue (Wbn)	919	892	1,001	981	1,018	1,055
OP (Wbn)	50	96	116	121	130	138
OP Margin (%)	5.4	10.8	11.6	12.3	12.8	13.1
NP (Wbn)	1,079	75	75	134	83	90
EPS (W)	72,030	6,959	6,975	12,415	7,723	8,359
ROE (%)	84.0	8.2	8.2	13.7	7.8	7.9
P/E (x)	1.0	9.3	8.7	5.1	8.1	7.5
P/B (x)	0.8	0.8	0.7	0.6	0.6	0.6
Dividend Yield (%)	0.7	1.9	2.1	2.1	2.1	2.2

Note: All figures are based on consolidated K-IFRS; NP refers to net profit attributable to controlling interests
Source: Company data, Mirae Asset Daewoo Research estimates

MHE enjoying rapid growth in sales of ADAS sensors

Mando-Hella Electronics (MHE) was established in November 2008 as a 50:50 joint venture (JV) between Mando and Hella, a German auto parts company. During the transition of the Halla Group into a holding company structure, MHE became a direct subsidiary of Halla Holdings, instead of Mando.

With Hella specializing in electronic control units (ECUs) and sensors used in automobiles, the JV allowed Mando to internalize the production of: 1) ECUs for brake and steering control; 2) sensors for such things as yaw & G, torque, and wheel speed; and 3) ADAS sensors (ultrasonic, camera, and short/long-range radar). As of 1Q17, ECUs for brake and steering control accounted for 64% of total revenue, sensors 24%, and ADAS sensors 12%, with roughly 95% of MHE's revenue generated from Mando.

Figure 46. MHE's major products

Source: MHE, Mirae Asset Daewoo Research

MHE highly attractive, in terms of growth potential

The company's revenue reached W570bn in 2016, after growing at a CAGR of 19% from W340bn in 2013. The rapid growth was driven by two main factors: 1) the shift toward electric parts for chassis systems (brake and steering control) in emerging markets, such as China and India, drove sharp growth in demand for ECUs for brake and steering control; and 2) tougher safety regulations in developed markets, alongside rising competition in the commercialization of relevant technology, which boosted the adoption of ADAS features on automobiles and led to steep growth in demand for ADAS sensors.

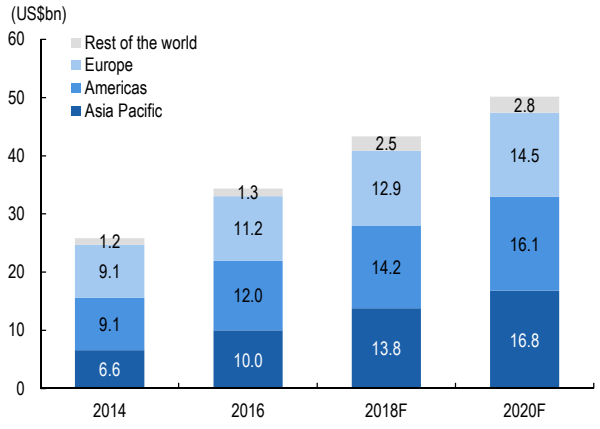
The shift toward electric parts for chassis systems in emerging markets is expected to continue in the near term. In Figure 47, we show that the market for electric power steering (EPS) is expected to grow at a CAGR of 10% from 2016 through 2020, with emerging markets in Asia-Pacific and other regions likely to drive most of the two regions' respective CAGRs of 14% and 20%.

Meanwhile, the adoption of ADAS in developed markets is seen as an even stronger trend, as covered in our industry analysis. We expect the market for automobile-use sensors to grow at a CAGR of 23% from US$7.4bn in 2016 to US$20.8bn by 2021. As a result, MHE should see ADAS sensor revenue grow at a CAGR above 20% through 2020.

Favorable industry trends, the addition of a plant in India (scheduled to ramp-up production in 2H17), and product/customer diversification efforts should drive rapid growth of MHE's total revenue through 2020 (2016~2020F CAGR 11%). Assuming growth in revenue from ECUs for brake/steering control and sensors at a CAGR of 10% and ADAS sensors at a CAGR of 21%, we estimate MHE's total revenue at W880bn levels for 2020.

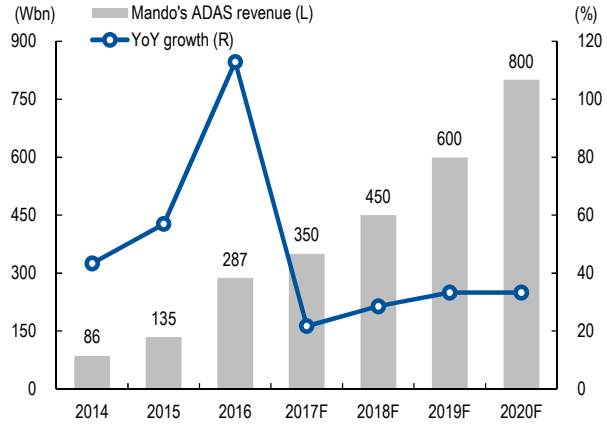
MHE's OP margin improved from 5.1% in 2013 to 8.2% in 2016. With revenue growing at a rapid pace, the company should be able to keep its OP margin around 8% levels on average, despite fluctuations likely caused by the addition of new plants going forward.

Figure 47. EPS market by region: EM posting rapid growth



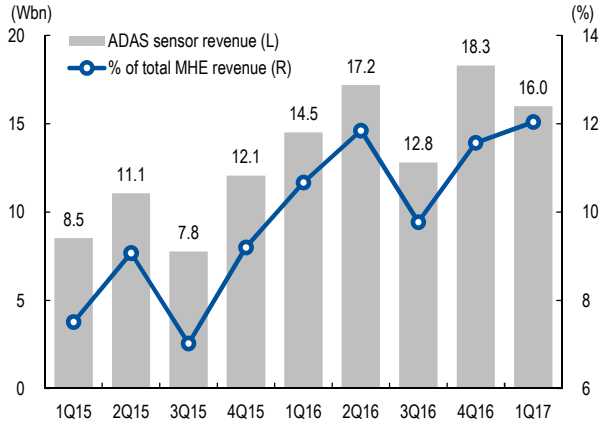
Note: Electric power steering (EPS), emerging markets (EM)
Source: Industry data, Mirae Asset Daewoo Research

Figure 48. Mando's ADAS sales to grow at 29% CAGR to 2020



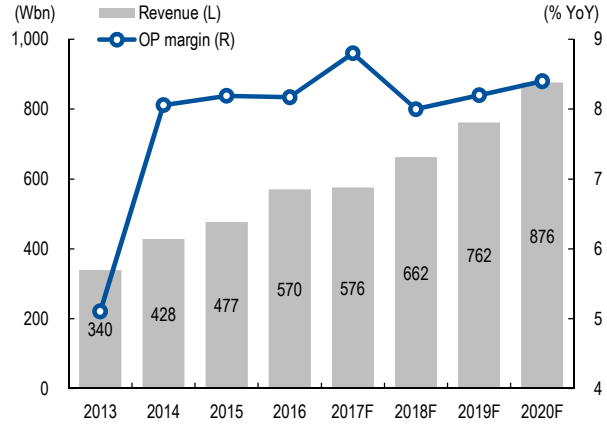
Source: Mando, Mirae Asset Daewoo Research

Figure 49. MHE's ADAS sensor sales



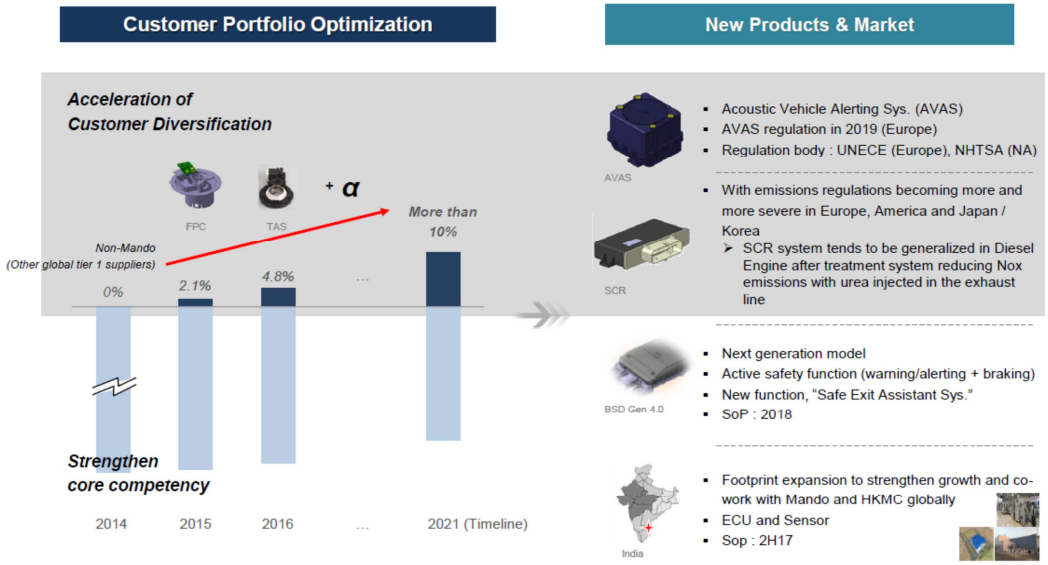
Source: Halla Holdings, Mirae Asset Daewoo Research

Figure 50. MHE's sales and OPM trend



Source: Halla Holdings, Mirae Asset Daewoo Research

Figure 51. MHE's customer/product diversification efforts



Source: Halla Holdings

Table 6. Quarterly earnings trends and forecasts (Wbn, %)

	1Q16	2Q16	3Q16	4Q16	2016	1Q17	2Q17F	3Q17F	4Q17F	2017F	2018F
Revenue	**219**	**249**	**253**	**280**	**1,001**	**229**	**239**	**250**	**263**	**981**	**1,018**
Pure holdings	25	29	27	40	121	31	35	38	46	149	161
Distribution/logistics	155	179	187	195	715	196	202	210	214	823	847
Automobile sintering	39	39	36	43	158						
Other businesses		2	2	3	7	2	2	2	3	9	10
Operating profit	**24**	**30**	**25**	**37**	**116**	**25**	**30**	**30**	**35**	**121**	**130**
Pure holdings	14	18	15	25	72	19	21	23	29	91	97
Distribution/logistics	5	9	7	6	27	7	10	8	7	33	36
Automobile sintering	5	6	5	7	22						
Other businesses		(2)	(2)	(1)	(5)	(1)	(1)	(1)	(1)	(3)	(3)
Other income	(0)	11	(3)	1	9	(3)	74	0	1	72	4
Financial income	(5)	(7)	(9)	(5)	(25)	(8)	(7)	(5)	(4)	(24)	(21)
Pretax profit	**19**	**35**	**13**	**33**	**100**	**14**	**98**	**26**	**32**	**169**	**113**
Net profit	**13**	**26**	**9**	**28**	**75**	**14**	**78**	**19**	**23**	**134**	**83**
YoY growth											
Revenue	2.8	12.5	2.6	32.6	12.2	4.3	(3.8)	(1.1)	(6.2)	(2.0)	3.8
Pure holdings	70.0	95.5	6.3	127.5	66.7	21.4	20.7	40.1	14.8	23.2	7.7
Distribution/logistics	(4.7)	5.6	1.2	25.3	6.5	26.7	13.2	12.1	10.2	15.0	3.0
Automobile sintering	9.0	5.8	1.7	10.9	6.9						
Other business							8.8	2.4	(5.8)	27.3	12.6
Operating profit	16.1	26.2	(13.7)	62.3	20.8	4.4	(0.4)	23.4	(5.2)	4.1	7.8
Pure holdings	15.3	35.6	(34.6)	70.0	14.3	32.4	17.9	52.5	14.6	26.8	6.2
Distribution/logistics	12.2	43.5	536.2	99.1	85.3	56.7	13.7	16.0	15.6	22.0	10.7
Automobile sintering	21.8	16.2	4.5	37.0	20.2						
Other businesses							RR	RR	RR	RR	RR
Other income	(27.0)	86.4	(44.9)	39.8	8.4	(26.3)	181.9	93.1	(5.8)	68.3	(33.2)
Financial income	(38.7)	112.5	(55.1)	21.1	0.2	8.3	198.1	118.1	(16.3)	78.0	(37.8)
Margins											
OP margin	10.9	12.2	9.7	13.2	11.6	10.9	12.7	12.1	13.3	12.3	12.8
Pure holdings	55.8	61.4	54.9	62.8	59.2	60.9	60.0	59.7	62.7	60.9	60.1
Distribution/logistics	3.0	5.0	3.9	3.2	3.8	3.7	5.0	4.0	3.4	4.0	4.3
Automobile sintering	13.4	14.2	13.0	15.8	14.2						
Other businesses		(99.9)	(119.4)	(32.2)	(74.5)	(44.8)	(40.0)	(40.0)	(26.7)	(36.5)	(30.0)
Pretax margin	8.6	13.9	5.3	11.9	10.0	6.1	40.8	10.3	12.0	17.2	11.1
Net margin	5.8	10.6	3.4	9.9	7.5	6.0	32.8	7.5	8.9	13.7	8.2

Source: Company data, Mirae Asset Daewoo Research estimates

Halla Holdings (060980 KS/Buy/TP: W83,000)

Comprehensive Income Statement (Summarized)

(Wbn)	12/16	12/17F	12/18F	12/19F
Revenue	**1,001**	**981**	**1,018**	**1,055**
Cost of Sales	**792**	**770**	**794**	**820**
Gross Profit	**209**	**211**	**224**	**235**
SG&A Expenses	**93**	**90**	**94**	**97**
Operating Profit (Adj)	**116**	**121**	**130**	**138**
Operating Profit	**116**	**121**	**130**	**138**
Non-Operating Profit	**-16**	**48**	**-17**	**-16**
Net Financial Income	-25	-23	-21	-20
Net Gain from Inv in Associates	0	0	0	0
Pretax Profit	100	169	113	122
Income Tax	20	39	26	28
Profit from Continuing Operations	80	130	87	94
Profit from Discontinued Operations	0	7	0	0
Net Profit	**80**	**137**	**87**	**94**
Controlling Interests	75	134	83	90
Non-Controlling Interests	5	3	3	3
Total Comprehensive Profit	**138**	**137**	**87**	**94**
Controlling Interests	133	134	83	90
Non-Controlling Interests	5	3	3	3
EBITDA	132	137	147	155
FCF (Free Cash Flow)	73	124	82	89
EBITDA Margin (%)	13.2	14.0	14.4	14.7
Operating Profit Margin (%)	11.6	12.3	12.8	13.1
Net Profit Margin (%)	7.5	13.7	8.2	8.5

Statement of Financial Condition (Summarized)

(Wbn)	12/16	12/17F	12/18F	12/19F
Current Assets	**416**	**444**	**429**	**415**
Cash and Cash Equivalents	104	147	120	96
AR & Other Receivables	201	185	192	198
Inventories	88	90	93	97
Other Current Assets	23	22	24	24
Non-Current Assets	**1,498**	**1,546**	**1,621**	**1,701**
Investments in Associates	926	968	1,035	1,108
Property, Plant and Equipment	337	343	350	356
Intangible Assets	49	49	49	49
Total Assets	**1,914**	**1,990**	**2,050**	**2,116**
Current Liabilities	**372**	**340**	**337**	**333**
AP & Other Payables	180	158	164	170
Short-Term Financial Liabilities	167	158	148	137
Other Current Liabilities	25	24	25	26
Non-Current Liabilities	**586**	**570**	**560**	**551**
Long-Term Financial Liabilities	518	504	491	479
Other Non-Current Liabilities	68	66	69	72
Total Liabilities	**958**	**910**	**896**	**884**
Controlling Interests	**919**	**1,040**	**1,110**	**1,186**
Capital Stock	55	55	55	55
Capital Surplus	265	265	265	265
Retained Earnings	659	779	849	925
Non-Controlling Interests	**37**	**40**	**43**	**47**
Stockholders' Equity	**956**	**1,080**	**1,153**	**1,233**

Cash Flows (Summarized)

(Wbn)	12/16	12/17F	12/18F	12/19F
Cash Flows from Op Activities	86	144	102	109
Net Profit	80	137	87	94
Non-Cash Income and Expense	-31	61	45	46
Depreciation	13	13	14	14
Amortization	3	3	3	3
Others	-47	45	28	29
Chg in Working Capital	30	-9	-1	-1
Chg in AR & Other Receivables	-24	15	-7	-6
Chg in Inventories	14	-2	-3	-3
Chg in AP & Other Payables	38	-21	5	5
Income Tax Paid	**-13**	**-41**	**-26**	**-28**
Cash Flows from Inv Activities	-10	-22	-24	-24
Chg in PP&E	-13	-20	-20	-20
Chg in Intangible Assets	-2	-3	-3	-3
Chg in Financial Assets	259	1	-1	-1
Others	**-254**	**0**	**0**	**0**
Cash Flows from Fin Activities	-121	-37	-37	-36
Chg in Financial Liabilities	197	-24	-23	-22
Chg in Equity	0	0	0	0
Dividends Paid	-14	-13	-14	-14
Others	**-304**	**0**	**0**	**0**
Increase (Decrease) in Cash	-45	43	-27	-24
Beginning Balance	150	104	147	120
Ending Balance	**104**	**147**	**120**	**96**

Forecasts/Valuations (Summarized)

	12/16	12/17F	12/18F	12/19F
P/E (x)	8.7	5.1	8.1	7.5
P/CF (x)	13.3	3.4	5.2	4.9
P/B (x)	0.7	0.6	0.6	0.6
EV/EBITDA (x)	9.6	8.9	8.4	8.0
EPS (W)	6,975	12,415	7,723	8,359
CFPS (W)	4,546	18,376	12,148	12,931
BPS (W)	85,822	97,002	103,441	110,466
DPS (W)	1,250	1,300	1,350	1,400
Payout ratio (%)	16.6	10.1	16.6	15.9
Dividend Yield (%)	2.1	2.1	2.1	2.2
Revenue Growth (%)	12.2	-2.0	3.8	3.6
EBITDA Growth (%)	21.1	3.8	7.3	5.4
Operating Profit Growth (%)	20.8	4.3	7.4	6.2
EPS Growth (%)	0.2	78.0	-37.8	8.2
Accounts Receivable Turnover (x)	5.7	5.5	5.8	5.8
Inventory Turnover (x)	10.9	11.1	11.1	11.1
Accounts Payable Turnover (x)	5.7	5.2	5.7	5.7
ROA (%)	4.6	7.0	4.3	4.5
ROE (%)	8.2	13.7	7.8	7.9
ROIC (%)	22.8	18.6	19.9	20.6
Liability to Equity Ratio (%)	100.1	84.2	77.7	71.7
Current Ratio (%)	112.0	130.7	127.3	124.7
Net Debt to Equity Ratio (%)	59.4	46.4	43.8	41.1
Interest Coverage Ratio (x)	4.2	4.5	5.0	5.5

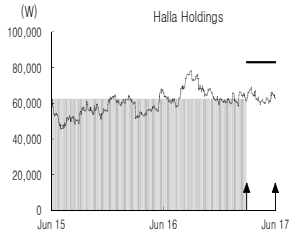
Source: Company data, Mirae Asset Daewoo Research estimates

APPENDIX 1

Important Disclosures & Disclaimers

2-Year Rating and Target Price History

Company (Code)	Date	Rating	Target Price	Company (Code)	Date	Rating	Target Price
Halla Holdings(060980)	03/06/2017	Buy	83,000			No Coverage	



Stock Ratings		Industry Ratings	
Buy	: Relative performance of 20% or greater	Overweight	: Fundamentals are favorable or improving
Trading Buy	: Relative performance of 10% or greater, but with volatility	Neutral	: Fundamentals are steady without any material changes
Hold	: Relative performance of -10% and 10%	Underweight	: Fundamentals are unfavorable or worsening
Sell	: Relative performance of -10%		

Ratings and Target Price History (Share price (—), Target price (▬), Not covered (■), Buy (▲), Trading Buy (■), Hold (●), Sell (◆))

* Our investment rating is a guide to the relative return of the stock versus the market over the next 12 months.
* Although it is not part of the official ratings at Mirae Asset Daewoo Co., Ltd., we may call a trading opportunity in case there is a technical or short-term material development.
* The target price was determined by the research analyst through valuation methods discussed in this report, in part based on the analyst's estimate of future earnings.
* The achievement of the target price may be impeded by risks related to the subject securities and companies, as well as general market and economic conditions.

Equity Ratings Distribution

Buy	Trading Buy	Hold	Sell
72.86%	15.58%	11.56%	0.00%

* Based on recommendations in the last 12-months (as of March 31, 2017)

Disclosures

As of the publication date, Mirae Asset Daewoo Co., Ltd. and/or its affiliates do not have any special interest with the subject company and do not own 1% or more of the subject company's shares outstanding.

Analyst Certification

The research analysts who prepared this report (the "Analysts") are registered with the Korea Financial Investment Association and are subject to Korean securities regulations. They are neither registered as research analysts in any other jurisdiction nor subject to the laws and regulations thereof. Opinions expressed in this publication about the subject securities and companies accurately reflect the personal views of the Analysts primarily responsible for this report. Mirae Asset Daewoo Co., Ltd. ("Mirae Asset Daewoo") policy prohibits its Analysts and members of their households from owning securities of any company in the Analyst's area of coverage, and the Analysts do not serve as an officer, director or advisory board member of the subject companies. Except as otherwise specified herein, the Analysts have not received any compensation or any other benefits from the subject companies in the past 12 months and have not been promised the same in connection with this report. No part of the compensation of the Analysts was, is, or will be directly or indirectly related to the specific recommendations or views contained in this report but, like all employees of Mirae Asset Daewoo, the Analysts receive compensation that is determined by overall firm profitability, which includes revenues from, among other business units, the institutional equities, investment banking, proprietary trading and private client division. At the time of publication of this report, the Analysts do not know or have reason to know of any actual, material conflict of interest of the Analyst or Mirae Asset Daewoo except as otherwise stated herein.

Disclaimers

This report is published by Mirae Asset Daewoo, a broker-dealer registered in the Republic of Korea and a member of the Korea Exchange. Information and opinions contained herein have been compiled in good faith and from sources believed to be reliable, but such information has not been independently verified and Mirae Asset Daewoo makes no guarantee, representation or warranty, express or implied, as to the fairness, accuracy, completeness or correctness of the information and opinions contained herein or of any translation into English from the Korean language. In case of an English translation of a report prepared in the Korean language, the original Korean language report may have been made available to investors in advance of this report.

The intended recipients of this report are sophisticated institutional investors who have substantial knowledge of the local business environment, its common practices, laws and accounting principles and no person whose receipt or use of this report would violate any laws and regulations or subject Mirae Asset Daewoo and its affiliates to registration or licensing requirements in any jurisdiction shall receive or make any use hereof.

This report is for general information purposes only and it is not and shall not be construed as an offer or a solicitation of an offer to effect transactions in any securities or other financial instruments. The report does not constitute investment advice to any person and such person shall not be treated as a client of Mirae Asset Daewoo by virtue of receiving this report. This report does not take into account the particular investment objectives, financial situations, or needs of individual clients. The report is not to be relied upon in substitution for the exercise of independent judgment. Information and opinions contained herein are as of the date hereof and are subject to change without notice. The price and value of

the investments referred to in this report and the income from them may depreciate or appreciate, and investors may incur losses on investments. Past performance is not a guide to future performance. Future returns are not guaranteed, and a loss of original capital may occur. Mirae Asset Daewoo, its affiliates and their directors, officers, employees and agents do not accept any liability for any loss arising out of the use hereof.
Mirae Asset Daewoo may have issued other reports that are inconsistent with, and reach different conclusions from, the opinions presented in this report. The reports may reflect different assumptions, views and analytical methods of the analysts who prepared them. Mirae Asset Daewoo may make investment decisions that are inconsistent with the opinions and views expressed in this research report. Mirae Asset Daewoo, its affiliates and their directors, officers, employees and agents may have long or short positions in any of the subject securities at any time and may make a purchase or sale, or offer to make a purchase or sale, of any such securities or other financial instruments from time to time in the open market or otherwise, in each case either as principals or agents. Mirae Asset Daewoo and its affiliates may have had, or may be expecting to enter into, business relationships with the subject companies to provide investment banking, market-making or other financial services as are permitted under applicable laws and regulations.

Distribution
United Kingdom: This report is being distributed by Mirae Asset Securities (UK) Ltd. in the United Kingdom only to (i) investment professionals falling within Article 19(5) of the Financial Services and Markets Act 2000 (Financial Promotion) Order 2005 (the "Order"), and (ii) high net worth companies and other persons to whom it may lawfully be communicated, falling within Article 49(2)(A) to (E) of the Order (all such persons together being referred to as "Relevant Persons"). This report is directed only at Relevant Persons. Any person who is not a Relevant Person should not act or rely on this report or any of its contents.
United States: This report is distributed in the U.S. by Mirae Asset Securities (USA) Inc., a member of FINRA/SIPC, and is only intended for major institutional investors as defined in Rule 15a-6(b)(4) under the U.S. Securities Exchange Act of 1934. All U.S. persons that receive this document by their acceptance thereof represent and warrant that they are a major institutional investor and have not received this report under any express or implied understanding that they will direct commission income to Mirae Asset Daewoo or its affiliates. Any U.S. recipient of this document wishing to effect a transaction in any securities discussed herein should contact and place orders with Mirae Asset Securities (USA) Inc., which accepts responsibility for the contents of this report in the U.S. The securities described in this report may not have been registered under the U.S. Securities Act of 1933, as amended, and, in such case, may not be offered or sold in the U.S. or to U.S. persons absent registration or an applicable exemption from the registration requirements.
Hong Kong: This document has been approved for distribution in Hong Kong by Mirae Asset Securities (HK) Ltd., which is regulated by the Hong Kong Securities and Futures Commission. The contents of this report have not been reviewed by any regulatory authority in Hong Kong. This report is for distribution only to professional investors within the meaning of Part I of Schedule 1 to the Securities and Futures Ordinance of Hong Kong (Cap. 571, Laws of Hong Kong) and any rules made thereunder and may not be redistributed in whole or in part in Hong Kong to any person.
All Other Jurisdictions: Customers in all other countries who wish to effect a transaction in any securities referenced in this report should contact Mirae Asset Daewoo or its affiliates only if distribution to or use by such customer of this report would not violate applicable laws and regulations and not subject Mirae Asset Daewoo and its affiliates to any registration or licensing requirement within such jurisdiction.

Mirae Asset Daewoo International Network

Mirae Asset Daewoo Co., Ltd. (Seoul)
Global Equity Sales Team
Mirae Asset Center 1 Building
26 Eulji-ro 5-gil, Jung-gu, Seoul 04539
Korea

Tel: 82-2-3774-2124

Mirae Asset Securities (HK) Ltd.
Suites 1109-1114, 11th Floor
Two International Finance Centre
8 Finance Street, Central
Hong Kong
China
Tel: 852-2845-6332

Mirae Asset Securities (UK) Ltd.
41st Floor, Tower 42
25 Old Broad Street,
London EC2N 1HQ
United Kingdom

Tel: 44-20-7982-8000

Mirae Asset Securities (USA) Inc.
810 Seventh Avenue, 37th Floor
New York, NY 10019
USA

Tel: 1-212-407-1000

Mirae Asset Wealth Management (USA) Inc.
555 S. Flower Street, Suite 4410,
Los Angeles, California 90071
USA

Tel: 1-213-262-3807

Mirae Asset Wealth Management (Brazil) CCTVM
Rua Funchal, 418, 18th Floor, E-Tower Building
Vila Olimpia
Sao Paulo - SP
04551-060
Brasil
Tel: 55-11-2789-2100

PT. Mirae Asset Sekuritas Indonesia
Equity Tower Building Lt. 50
Sudirman Central Business District
Jl. Jend. Sudirman, Kav. 52-53 Jakarta Selatan 12190
Indonesia
Tel: 62-21-515-3281

Mirae Asset Securities (Singapore) Pte. Ltd.
6 Battery Road, #11-01
Singapore 049909
Republic of Singapore

Tel: 65-6671-9845

Mirae Asset Securities (Vietnam) LLC
7F, Saigon Royal Building
91 Pasteur St.
District 1, Ben Nghe Ward, Ho Chi Minh City
Vietnam

Tel: 84-8-3911-0633 (ext.110)

Mirae Asset Securities Mongolia UTsK LLC
#406, Blue Sky Tower, Peace Avenue 17
1 Khoroo, Sukhbaatar District
Ulaanbaatar 14240
Mongolia

Tel: 976-7011-0806

Mirae Asset Investment Advisory (Beijing) Co., Ltd
2401B, 24th Floor, East Tower, Twin Towers
B12 Jianguomenwai Avenue, Chaoyang District
Beijing 100022
China

Tel: 86-10-6567-9699

Beijing Representative Office
2401A, 24th Floor, East Tower, Twin Towers
B12 Jianguomenwai Avenue, Chaoyang District
Beijing 100022
China

Tel: 86-10-6567-9699 (ext. 3300)

Shanghai Representative Office
38T31, 38F, Shanghai World Financial Center
100 Century Avenue, Pudong New Area
Shanghai 200120
China

Tel: 86-21-5013-6392

Ho Chi Minh Representative Office
7F, Saigon Royal Building
91 Pasteur St.
District 1, Ben Nghe Ward, Ho Chi Minh City
Vietnam

Tel: 84-8-3910-7715