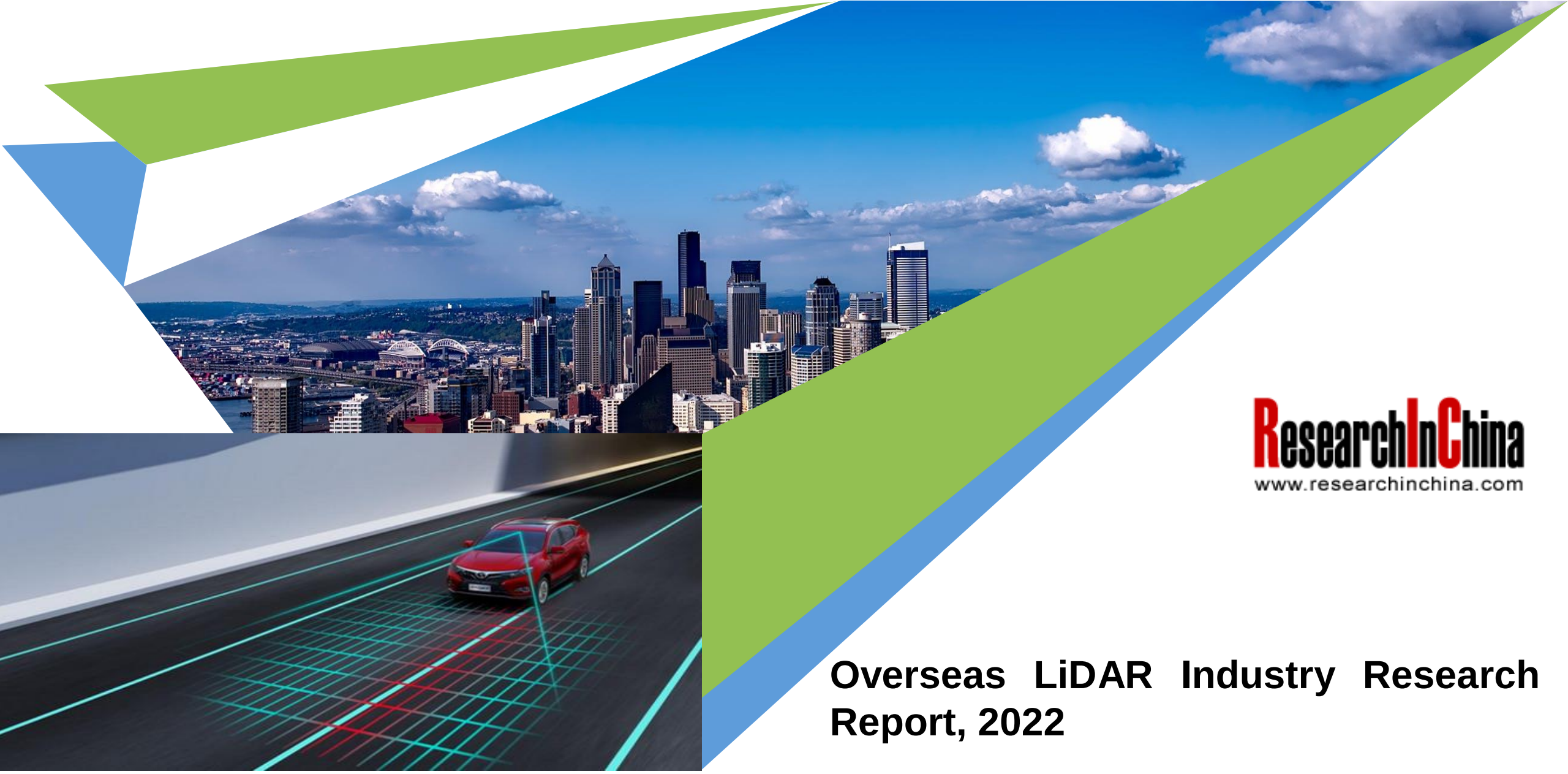

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Overseas LiDAR Industry Research Report, 2022

Aug. 2022

Amid a variety of technology routes in parallel, rotating mirror and flash solutions are adopted most widely during OEM mass production.

LiDAR technology routes include mechanical, MEMS, rotating mirror/prism, OPA, flash, etc. On the whole, LiDAR evolves from mechanical type to solid-state type, with multiple technology routes existing in parallel (for example, Velodyne has developed mechanical and solid-state solutions simultaneously since Velarray debuted at the 2017 Frankfurt Auto Show). Flash is the most popular solution in the layout of foreign vendors, followed by FMCW and MEMS.

Technology Route Layout of Foreign LiDAR Vendors

Enterprise	Mechanical	MEMS	Rotating mirror	OPA	Flash	FMCW	Others
Velodyne	√						√ (solid state)
Luminar			√				
Innoviz		√					
Aeva						√	
Ouster	√				√		
Ibeo					√		
Valeo		√	√		√		
LeddarTech					√		
AEye		√					
Quanergy	√			√			
Cepton							√ (MMT technology)
Blickfeld		√					
Insight LiDAR						√	
Sense Photonics					√		
Waymo	√						
Mobileye						√	
Aurora						√ (acquisition of Blackmore and OURS)	
Bosch		√ (speculated)					
Continental		√ (investment in AEye)			√ (acquisition of Advanced Scientific Concepts)		
Aptiv		√ (investment in Innoviz)		√ (investment in Quanergy)	√ (investment in Leddartech)		
Veoneer	√ (in collaboration with Velodyne)						√ (in cooperation with Baraja; acquisition of Fotonic)
Xenomatix					√		
Opsys					√ (microflash)		
Infoworks						√	
Baraja							√ (spectrum-Scan technology)
SiLC						√	
Cruise						√ (acquisition of Strobe)	
ZF					√ (acquisition of 40% shares of Ibeo)	√ (in collaboration with Aeva)	

Source: ResearchInChina

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Amid a variety of technology routes in parallel, rotating mirror and flash solutions are adopted most widely during OEM mass production.

As per OEM mass production, rotating mirror and flash solutions are adopted most widely. Valeo is a typical vendor leveraging the rotating mirror solution, and it produces LiDAR at the Wemding factory in Bavaria, Germany. As of 2021, its Scala LiDAR shipments had exceeded 160,000 units, with a single unit costing less than $1,000. Ibeo is known for its flash LiDAR. The ibeoNEXT LiDAR system produced by ZF features the detection range of more than 250 meters, the horizontal angular resolution of 0.04°, and the vertical angular resolution of 0.07°. It can recognize guardrails, road signs, cars, bicycles and pedestrians, along with their respective positions and movement directions. It has been installed on Great Wall WEY Mocha.

OEM Mass Production of Foreign Automotive LiDAR

Brand	Model	Selling price	LiDAR supplier	Technology	Number of vehicles installed with LiDAR	Installation location	Mass production time
Ford	Ostosan	-	Velodyne	Mechanical	Velarray H800/Alpha Prime	-	-
Great Wall	WEY Mocha	RMB175,800-218,800	Ibeo	Flash	3 (A long-range LiDAR + 2 medium-range LiDARs)	Front bumper + fog lamp	May 2022
SAIC	Rising Auto R7	RMB350,000 (expected)	Luminar	Rotating mirror	1*Iris	Roof	To be delivered in August 2022
SAIC R	ES33	RMB210,000-270,000	Luminar	Rotating mirror	1*Iris	Roof	H2 2022
Polestar	Polestar 3	RMB350,000-500,000	Luminar	Rotating mirror	1*Iris	Above the front bumper	To be launched in October 2022
Volvo	Volvo XC90 (battery-electric version)	RMB340,000+	Luminar	Rotating mirror	1*Iris	Roof	2023
Honda	LEGEND EX	About RMB660,000	Valeo	Rotating mirror	5*SCALA 1	Front and rear bumpers	Launched in the form of lease in March 2021
Benz	New S-Class	RMB910,000-1,840,000	Valeo	Rotating mirror	1*SCALA 2	Grille	Delivered in selected countries in 2021
Audi	e-tron (experimental version)	-	Aeva	FMCW	1*Aeries	Roof	2019
Volkswagen	ID BUZZ	-	Aeva	FMCW	5*Aeries	Roof, front bumper edge, front edge	2023
Toyota	Mirai	JPY8.6 million (approximately RMB515,000) (Japanese market)	Denso/ Continental	-/Flash	Denso's sixth-generation LiDAR/2*HFL-110	The front LiDAR is provided by DENSO, and the LiDARs at rear/both sides are provided by Continental	April 2021
BMW	7 Series	About RMB1.349 million	Innoviz	Solid state	Innoviz One	Inside the front grille	2023
Volvo	XC40 (battery-electric version)	-	Luminar	Rotating mirror	-	-	2022
Audi	A8	RMB720,000-1.8 million	Valeo	Rotating mirror	1*SCALA 1	Grille	2017
Benz	EQS	RMB660,000-810,000	Valeo	Rotating mirror	1*SCALA 2	Grille	2021
Lexus	LS500H	JPY17.94 million (approximately RMB1.075 million) (Japanese market)	Denso/ Continental	-/Flash	Denso's sixth-generation LiDAR/2*HFL-110	The front LiDAR is provided by DENSO, and the LiDARs at rear/both sides are provided by Continental	April 2021

Source: ResearchInChina

Perception algorithms become the layout focus of foreign vendors

The quality of perception algorithm determines perception accuracy and distance. Therefore, LiDAR vendors not only upgrade their own hardware, but also develop perception software, so as to form the closed loop of perception fusion and system-level supply. Foreign LiDAR vendors mainly leverage self-research, acquisition and cooperation with software companies to deploy perception algorithms.

Perception Software Layout of Foreign Automotive LiDAR Vendors

LiDAR vendor	Layout mode		
	Independent R&D	Cooperation	Acquisition/investment
LeddarTech	In June 2022, LeddarTech announced the official grand opening of LeddarTech's Sensor Fusion and Perception Development Center in Tel Aviv, Israel.		In July 2020, LeddarTech acquired VayaVision to accelerate the delivery of its comprehensive and open sensor fusion and perception platform for the automotive and mobility market. In September 2020, the acquisition of Phantom Intelligence provided LeddarTech access to specific LiDAR designs, software, and associated customer and partner projects.
Luminar	In May 2022, Christopher "CJ" Moore, who served as director of Autopilot software at Tesla (ticker: TSLA) and more recently a director of autonomous systems at Apple, joined Luminar to lead the company's global software development team.	In March 2021, Luminar partnered closely with Zenseact, a newly-formed 550-person software company owned by Volvo Cars, to deliver autonomous software for series production vehicles. They will serve SAIC with complete LiDAR hardware and components of Luminar's Sentinel.	In July 2022, Luminar invested in ECARX to accelerate deployment of its long-range LiDAR and software in the Chinese and global markets.
Quanergy	Qortex is a core, proprietary perception software platform compatible with Quanergy's full suite of LiDAR sensors.		
Velodyne	In July 2021, Velodyne release Vella ADAS software algorithm and the Vella Development Kit (VDK).	In April 2021, Velodyne and Ansys teamed up to develop software models of next-generation automotive LiDAR sensors to provide substantially improved hazard identification capabilities for highly advanced AVs.	In 2019, Velodyne acquired mapping and localization software as well as intellectual property assets from Mapper.ai to accelerate development of Vella™, breakthrough software that establishes its directional view Velarray™ LiDAR sensor.
Valeo	Scala 3 is powered by predictive algorithms that predict the trajectory of surrounding vehicles and trigger necessary actions accordingly.		
Innoviz	In April 2021, Innoviz launched the perception platform, Innoviz APP.		
Ouster	In May 2021, the latest Python SDK was released.	Ouster has boasted over 40 software and integration partners worldwide. In November 2021, Ouster provided a dedicated NVIDIA DriveWorks plugin based on NVIDIA DRIVE.	
Ibeo	Ibeo has over 20 years of experience in perception software development.		
Blickfeld	In March 2022, Doychin Tsanev, head of LiDAR perception development at Hyundai Mobis, became Blickfeld's new AI perception lead. In January 2022, Blickfeld launched its own perception software, Percept.		

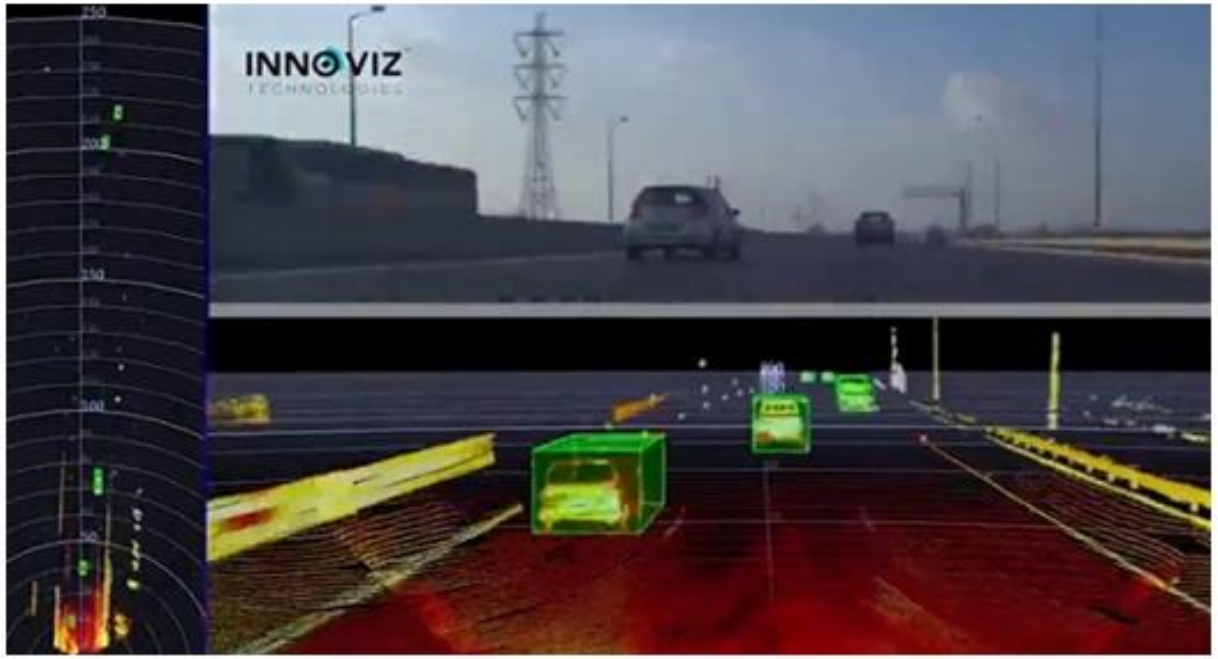
Source: ResearchInChina

Innoviz Perception Software

LeddarTech mainly makes its layout through acquisitions. LeddarTech acquired sensor fusion and perception software companies VayaVision and Phantom Intelligence in 2020. LeddarTech's open platform based on its full-waveform digital signal processing technology combined with VayaVision's raw data sensor fusion and perception software stack will deliver the most accurate environmental model, enabling the volume deployment of ADAS and AD applications. In September 2020, the acquisition of Phantom Intelligence provided LeddarTech access to specific LiDAR designs, software, and associated customer and partner projects.

Innoviz mainly develops its own perception algorithm. In April 2021, Innoviz launched embedded automotive perception platform "Innoviz APP". Innoviz APP can accurately detect and classify objects in any 3D driving scenario up to 250 meters away, including cars, trucks, motorcycles, pedestrians, and more. It also executes perception algorithms in real time, detecting and classifying pixels as collision relevant or non-collision relevant. At the same time, it can also be integrated on chips as an embedded software IP. Innoviz's software leverages the massive data from LiDAR and proprietary AI algorithms to provide excellent scenario awareness as well as an automatically upgradable ASIL B(D) solution.

Innoviz's Perception Software Detects and Classifies Cars in 3D Scenarios up to 250 Meters Away



Source: Innoviz

Luminar Sentinel Alpha

Luminar makes its layout through cooperation, investment and independent R&D. In March 2021, Luminar cooperated with Volvo's self-driving software subsidiary Zenseact to create a "holistic autonomous vehicle stack" made for production vehicles. The stack is called Sentinel, which will integrate Zenseact's OnePilot autonomous driving software solution alongside Luminar's Iris LiDAR, perception software, and other components as a foundation. The system is designed to handle highway autonomy and a number of safety measures to proactively avoid collisions with evasive maneuvers, reducing accident rates by up to seven times. Luminar completed development of the alpha version of Sentinel in 2021 and plans to accomplish the beta version in 2022. In addition, Luminar will serve SAIC's production vehicles with complete LiDAR hardware and components of Luminar's Sentinel.

Luminar Showcased Sentinel Alpha for Active Safety and Expressway Autopilot at CES 2022

Source: Luminar

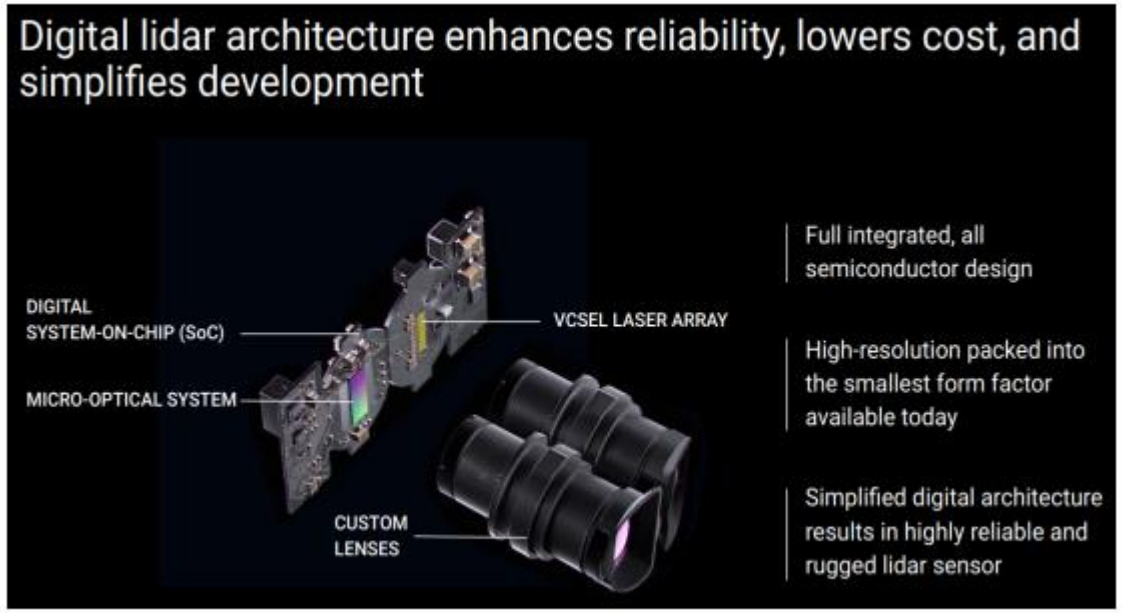
Chip-based LiDAR development is vital for mass production and cost reduction

Chip-based LiDAR development is vital for mass production and cost reduction

Inside LiDAR, there are hundreds of discrete devices with high costs in materials and optical assembly, which pose a major obstacle to mass production. Chip-based LiDAR can integrate hundreds of discrete devices into one chip, effectively reducing the product size and costs while facilitating mass production.

For example, all of Ouster's digital LiDAR sensors share the same core architecture. The architecture consists of two chips and a patented micro-optical system, replacing hundreds of discrete components inside traditional analog LiDAR, improving reliability and reducing price (the ES2 debuts with an expected price of $600 for series production -- and Ouster's digital LiDAR technology provides a clear roadmap that will allow future models to break the $100 price barrier).

All of Ouster's Digital Lidar Sensors Share the Same Core Architecture

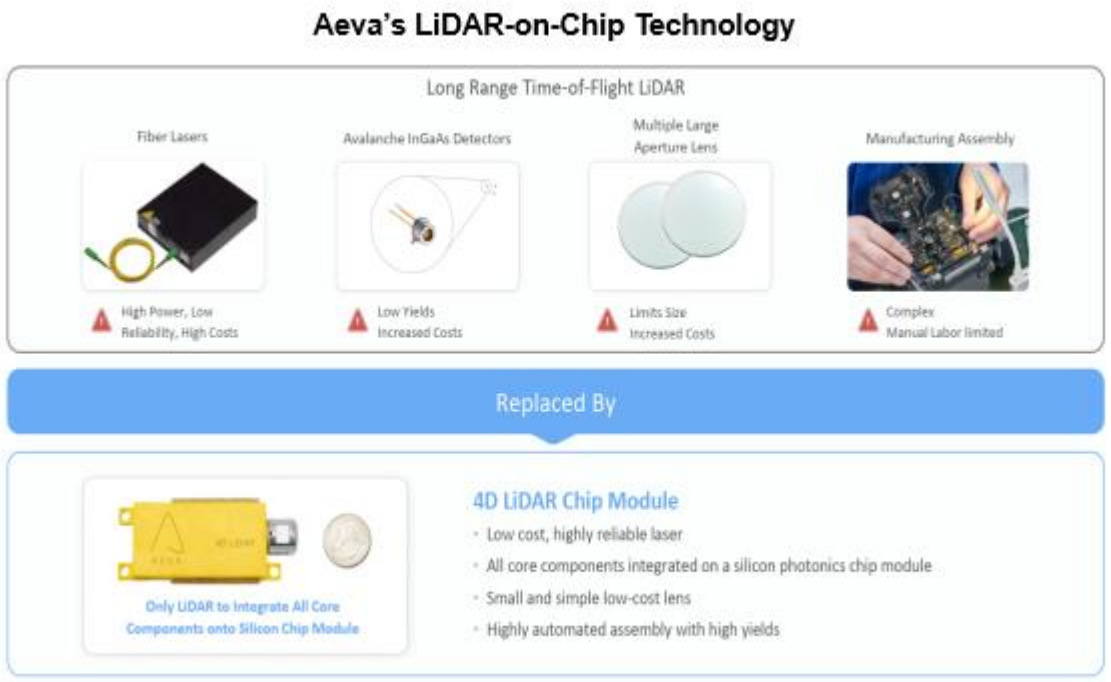


Source: Ouster

As shown above, in Ouster's LiDAR core architecture, a vertical cavity surface emitting laser ("VCSEL") array integrates all lasers on a single chip. The custom SoC integrates single photon avalanche diode ("SPAD") detectors and a proprietary digital signal processing system to handle all commands and control logic of LiDAR. The patented micro-optical system guides light through LiDAR to improve the detector efficiency exponentially.

Aeva’s LiDAR-on-Chip Technology

Aeva is also working on a chip-based layout. In February 2022, Aeva unveiled Aeries? II, a 4D LiDAR? sensor leveraging Aeva’s unique Frequency Modulated Continuous Wave (FMCW) technology and the world’s first LiDAR-on-chip module design which places all key components including transmitters, receivers and optics onto a silicon photonics chip in a compact module. The compact design is 75% smaller than the previous generation. Mass production is expected in 2023.



Source: Aeva

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