

SONY

Advanced Imaging and Sensing Technologies in ADAS Systems

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11/14/2024

Sony Semiconductor Solutions Group

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Sense the Wonder

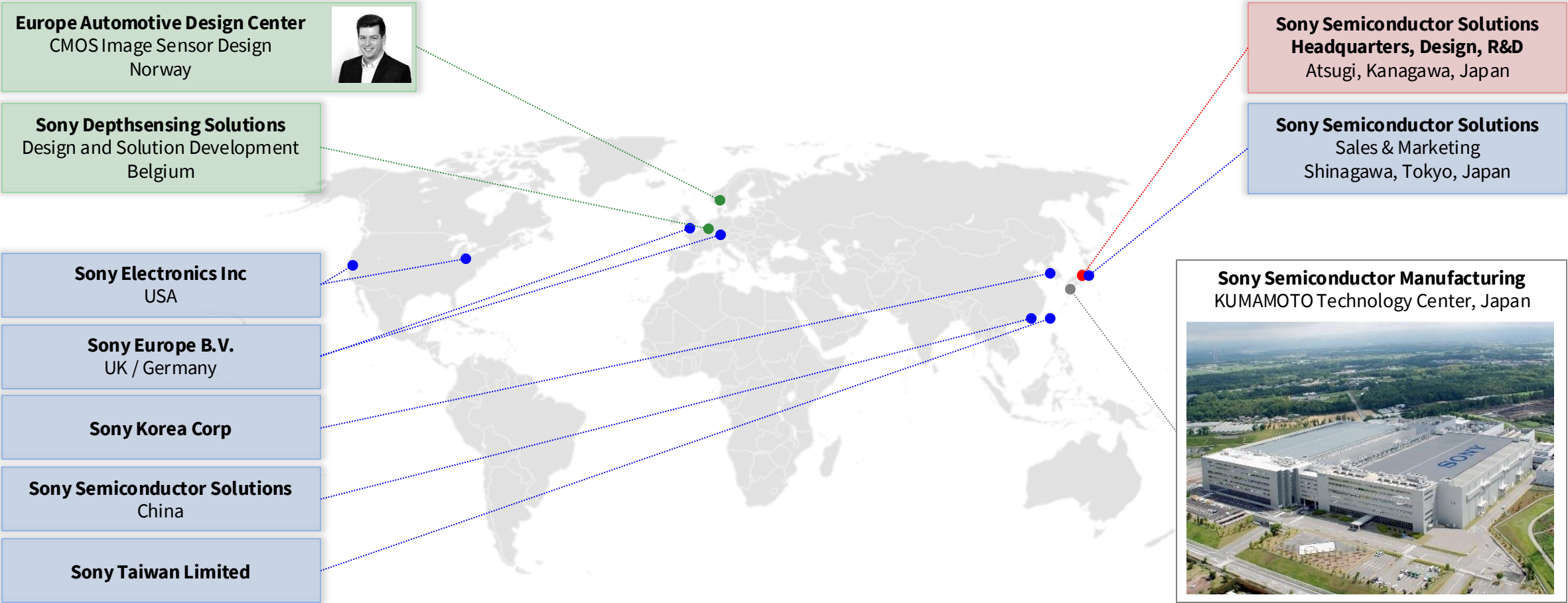
- ❑ **Introduction**
- ❑ **CMOS image sensors for ADAS**
- ❑ **SPAD for LiDAR external sensing**
- ❑ **Summary and conclusion**

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Introduction | Sony Semiconductor Solutions

- Key Automotive Locations -

- Headquarters, Design, R&D
- Design / Solution Development
- Sales / Marketing / Support



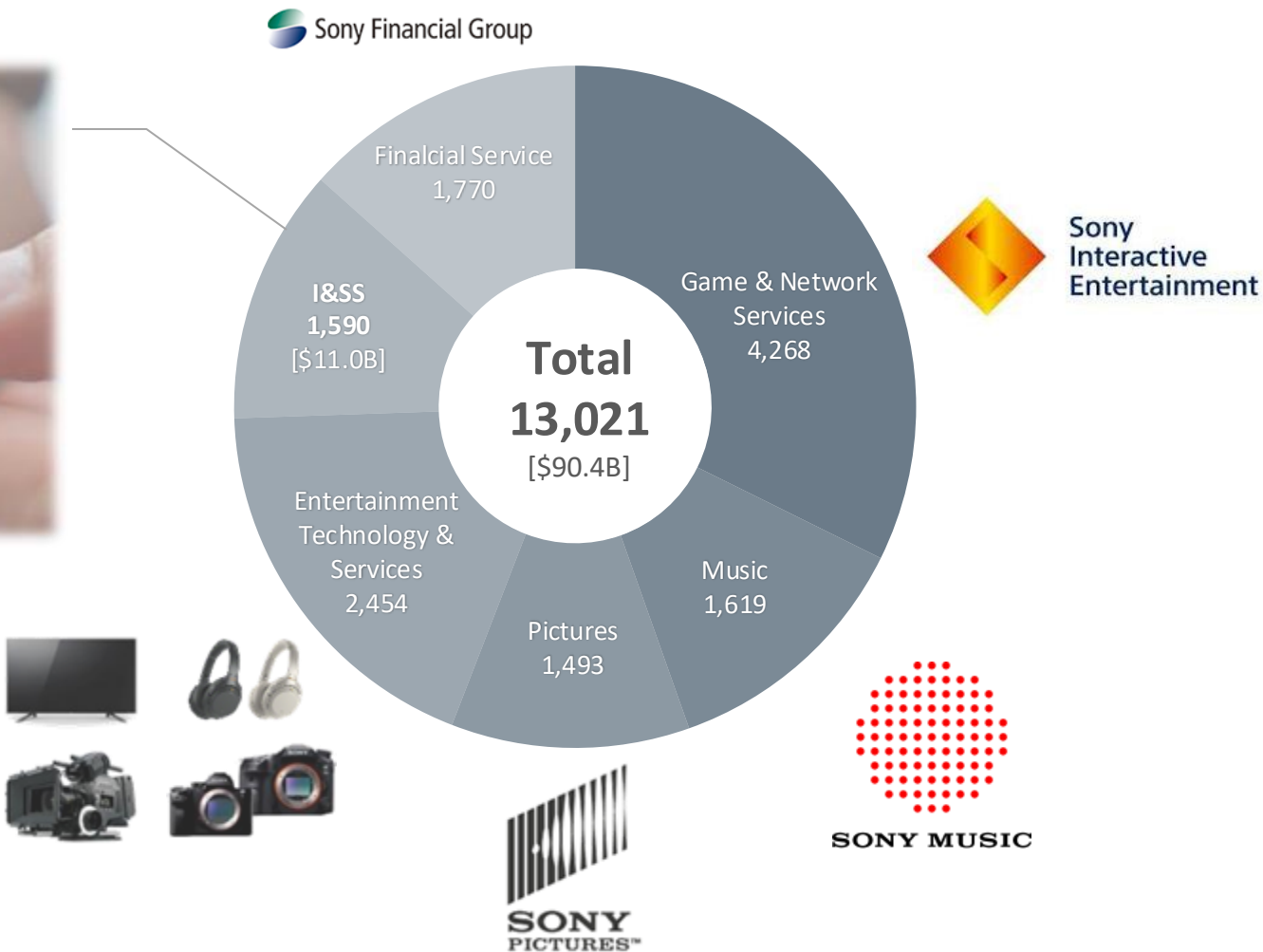
Introduction | Sony Group Corporation

- FY23 Sony Consolidated Financial Announcement on 14th May 2024 (Billion Japanese Yen) -



Sony Semiconductor Solutions

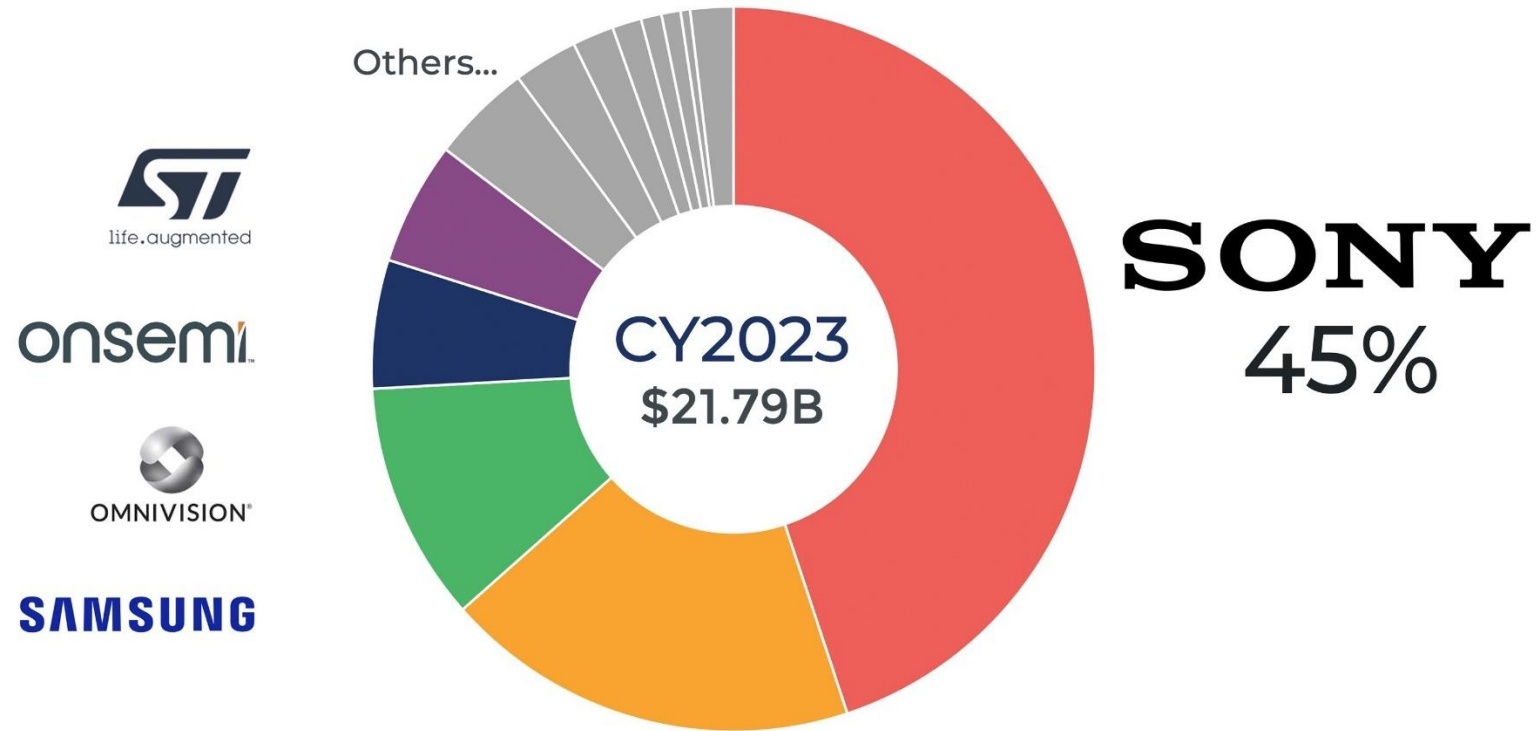
as Imaging & Sensing Solutions



Introduction | Sony Semiconductor Solutions

- Image Sensor Market Share -

Source: Status of the CMOS Image Sensor Industry report, Yole Intelligence, 2024

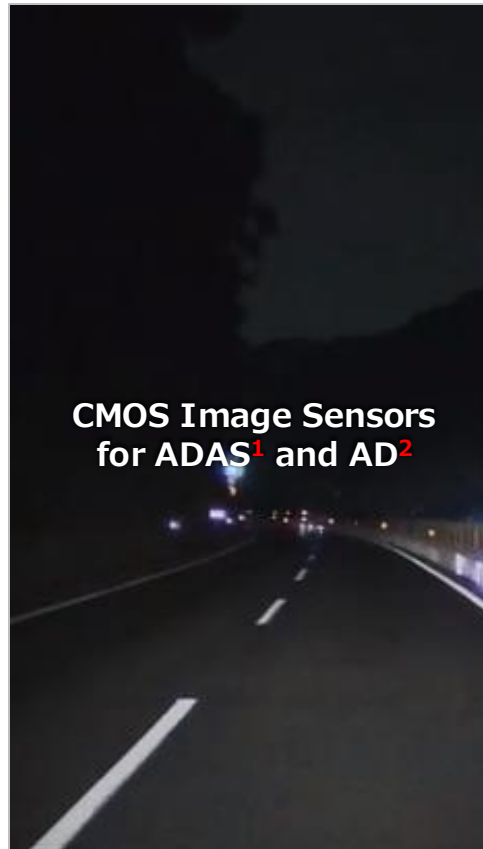


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Introduction | Sony Semiconductor Solutions

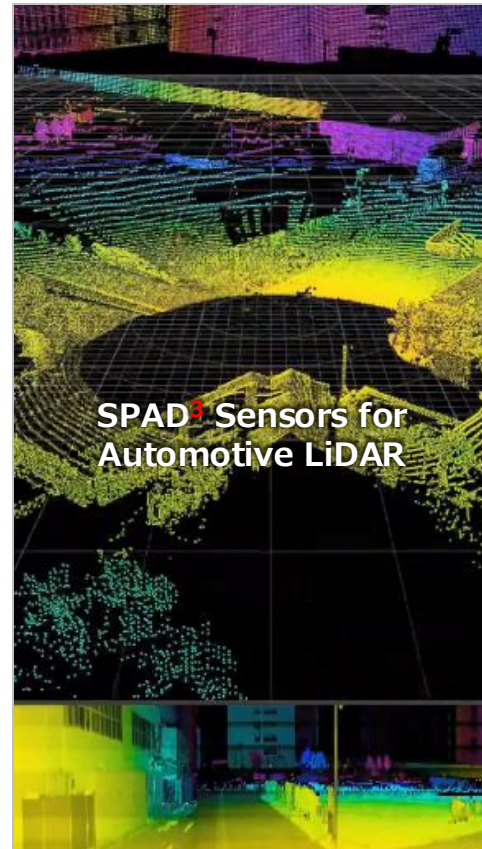
- Key Activities in Automotive -

Four technologies to create safe, secure and comfortable mobility for the future:



CMOS Image Sensors
for ADAS¹ and AD²

¹: Advanced Driver Assistance Systems
²: Automated or Autonomous Driving

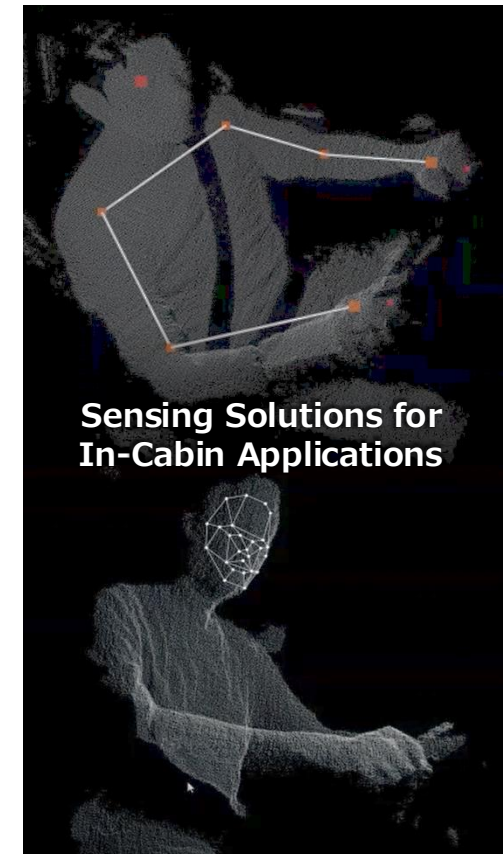


SPAD³ Sensors for
Automotive LiDAR

³: Single Single-Photon Avalanche Diode



Sensor Fusion and
Software Solutions

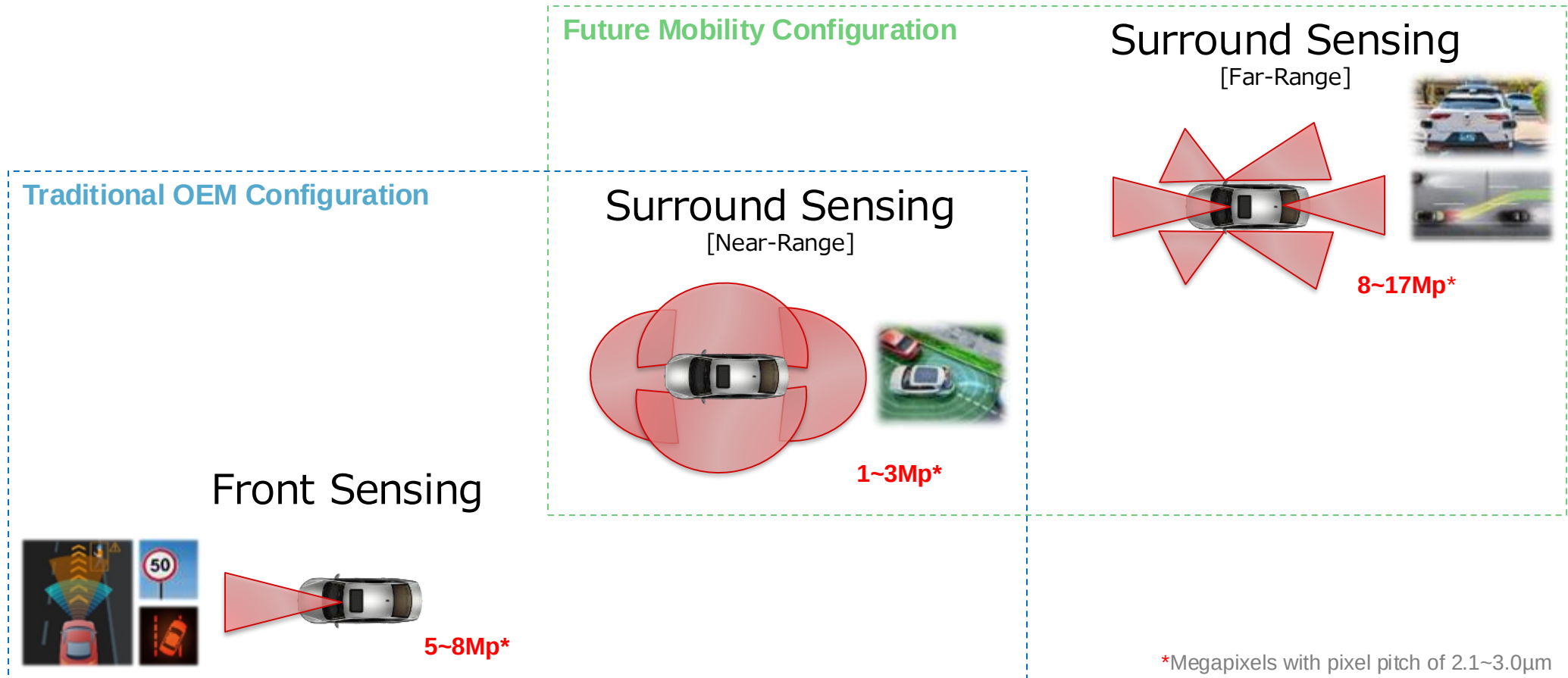


Sensing Solutions for
In-Cabin Applications

- ❑ Introduction
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CMOS image sensors for ADAS | Market Trend

- Major Camera Applications -



CMOS image sensors for ADAS | Customer Expectations

- Essential Requirements for Automotive Image Sensors -



High Dynamic Range (HDR)

No HDR

Single capture ~65dB



With HDR

Multiple captures merged up to 120dB



LED Flicker Mitigation (LFM)

LED missed

Exposure Time <10ms



LED captured

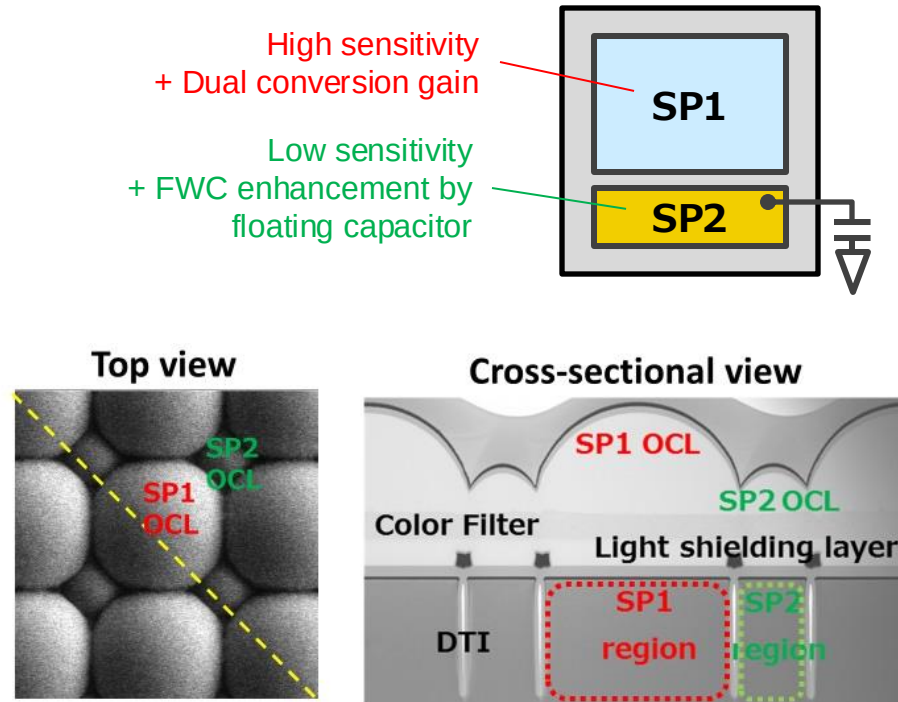
Exposure Time >10ms



How to solve all this in a CMOS image sensor?

CMOS image sensors for ADAS | Introducing Sony's Subpixel Technology

- State-of-the-Art Characteristics Achieved -



FWC = Full Well Capacity | DTI = Deep Trench Isolation | OCL = On-Chip Lens

High sensitivity
+ Dual conversion gain

Low sensitivity
+ FWC enhancement by
floating capacitor

Subpixel:
120dB HDR
with LFM

SP1H

SP1L

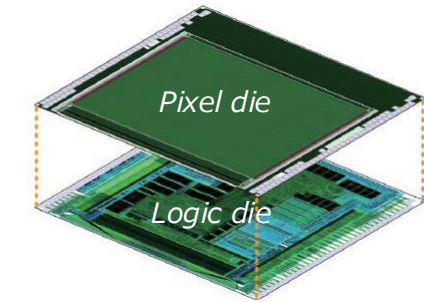
SP2

SP2+FC

>10ms



Sony's Subpixel
Technology is offered as
Stacked CMOS Image
Sensor



Sony's subpixel provides the best overall performance to meet customer expectations.



- ❑ Scalable across automotive image sensors in pixel pitch of 3.0 and 2.1 μ m.
- ❑ Mass-production ready for multiple products from 1.3 up to 17.4 megapixels.

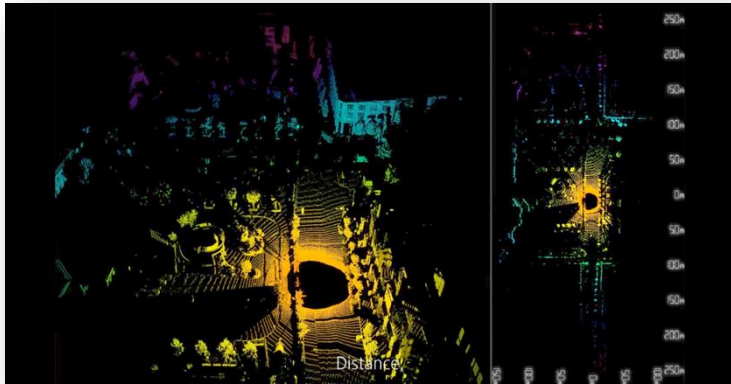
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SPAD for LiDAR external sensing | Why LiDAR in Automotive?

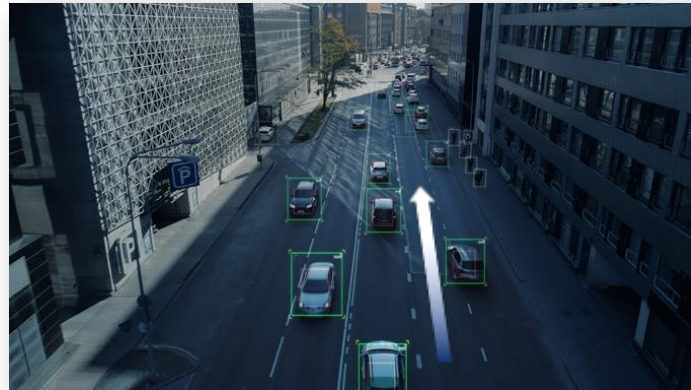
- LiDAR Applications -

LiDAR: Light Detection and Ranging

❑ A system to create a high-resolution, real-time 3D image of the surroundings, for navigation and obstacle detection.



Real-time 3D Digital Map



Free Space Recognition

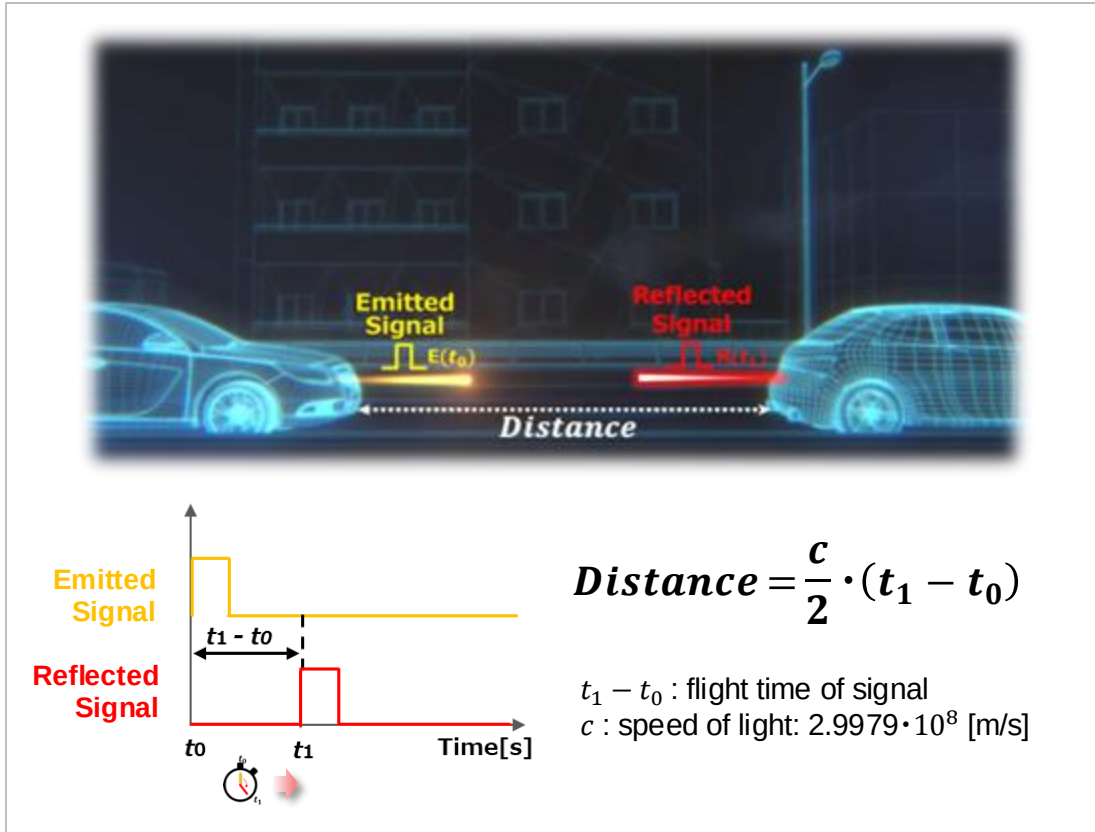


Improved Object Detection

SPAD for LiDAR external sensing | How does a ToF LiDAR work?

- LiDAR Basics -

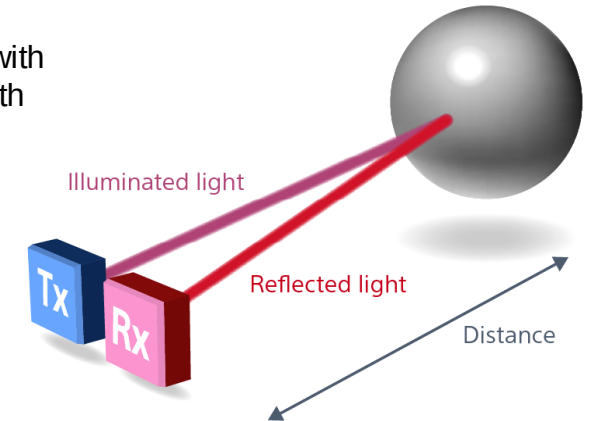
Principle of Time of Flight (ToF):



Typical ToF LiDAR concept:

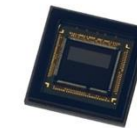
TX technology:

- Laser (VCSEL or EEL) with 905 or 940nm wavelength
- Beam steering either mechanical or MEMS



RX technology:

- SPAD - Single-Photon Avalanche Diode



IMX459*

10μm pixel pitch
597 (H) x 168 (V)

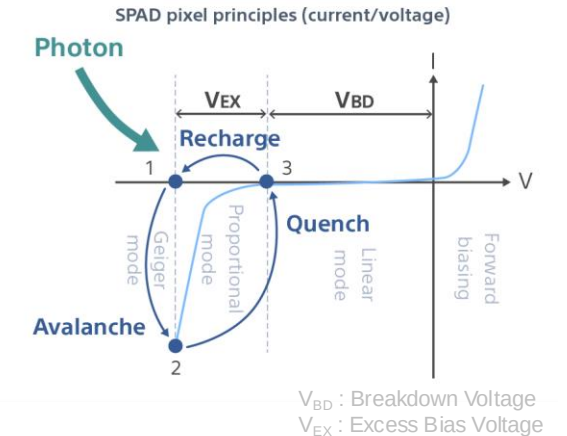
*Sony to Release a Stacked SPAD Depth Sensor for Automotive LiDAR Applications, an Industry First.
(As of announcement September 6, 2021.)

SPAD for LiDAR external sensing | How does a SPAD work?

- SPAD Basics -

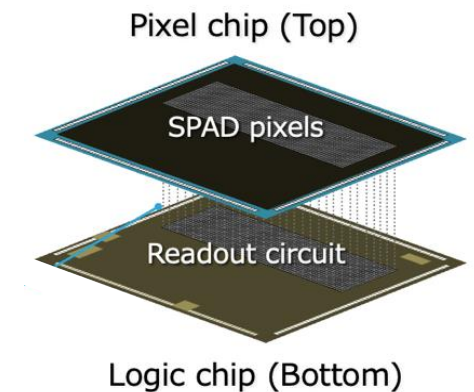
Simplified working principle:

- 1. Photon Detection:** When a single photon hits the SPAD, it creates an electron that triggers an avalanche which amplifies the signal allowing it to be detected.
- 2. Pulse Generation:** The avalanche creates a small pulse, a digital signal that indicates a photon was detected. This signal is then counted by the device.
- 3. Quenching and Reset:** After each detection, the SPAD “quenches” or stops the avalanche. It then resets itself so it’s ready to detect the next photon.



Key Benefits:

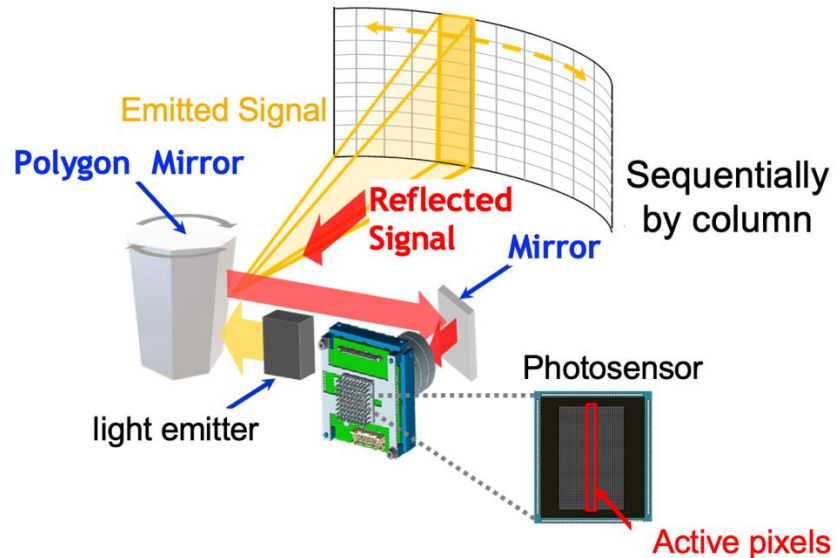
- ☐ **Extreme Sensitivity:** Single photons can be detected.
- ☐ **Precise Timing:** Exact time of arrival for each photon can be recorded.



SPAD for LiDAR external sensing | Technical Trend

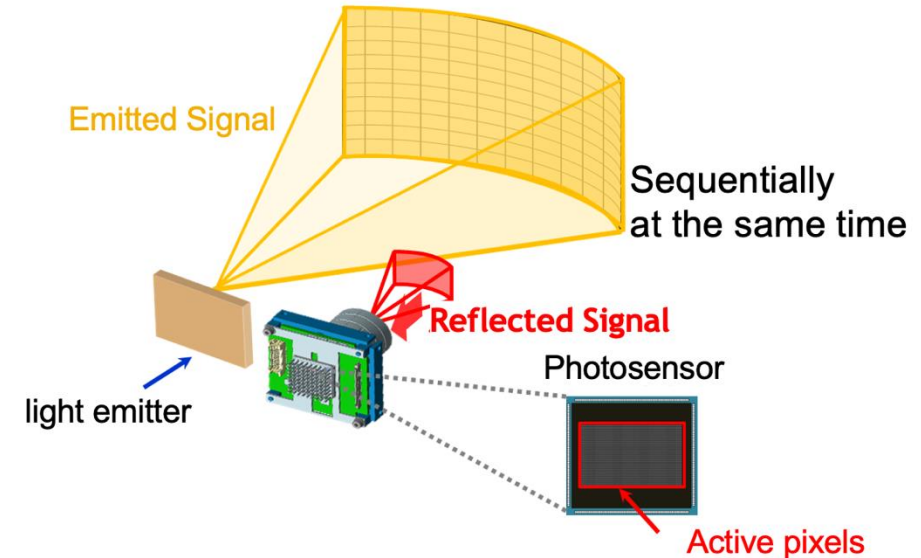
- Enabling Solid State LiDAR -

Mechanical LiDAR



- ❑ High-definition, for long-range
- ❑ Difficult to reduce size and weight
- ❑ High system BOM cost
- ❑ Reliability concern, due to moving parts

Solid State LiDAR



- ❑ Targeted for short- to mid-range sensing
- ❑ Smaller and lighter system configuration
- ❑ Lower system BOM cost
- ❑ High reliability, no moving parts

The challenge is to find the balance between performance and commercial targets.

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- ❑ **Sony's subpixel architecture provides the best overall performance** for CMOS image sensors to meet customer expectations in ADAS and AD applications.
- ❑ **Subpixel technology is scalable** across automotive image sensors, offered in pixel pitch of 3.0 to 2.1 μ m and mass-production ready for products from 1.3 up to 17.4 megapixels.
- ❑ **LiDAR is indispensable for higher-levels of autonomy** and to enable safety critical applications while in most cases augmenting existing camera sensing solutions.
- ❑ **Sony's SPAD sensors are a sensing solution for LiDAR** which could make Solid-State systems smaller and more cost-effective to achieve higher adoption rates.

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