Sensing in ADAS & Autonomous Vehicles: What's Winning & Why?

Edge AI & Vision Alliance Webinar – Jan 2025

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Agenda

- What's Happening with ADAS?
- How About Autonomous?
- What about Architecture Change?
- Conclusions
- Q&A

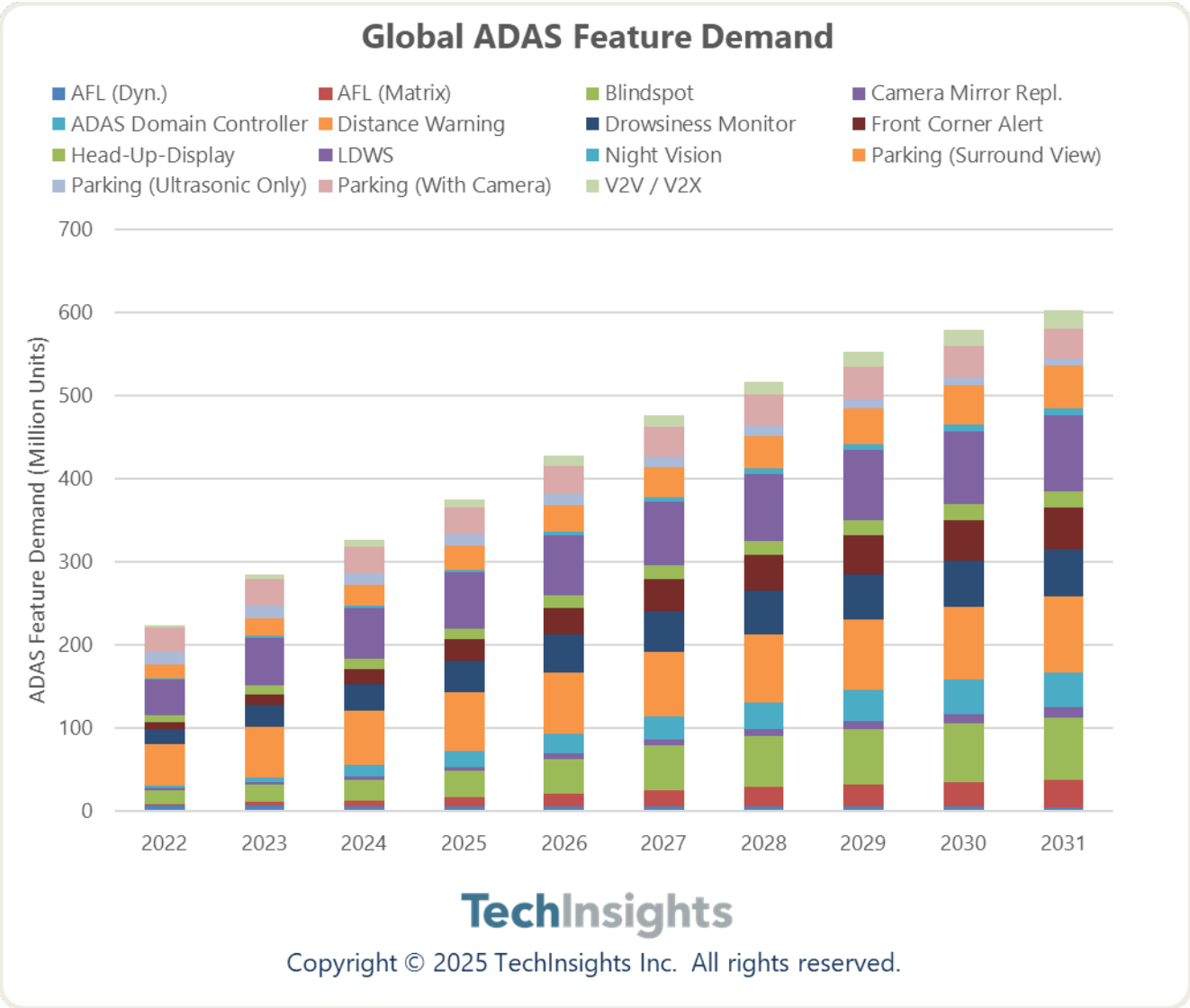
What's Happening with ADAS?

OEM ADAS split into Safety and Convenience Applications

- NCAP Mandate/ “soft mandate” 5-star requirements drive low-end ADAS
  - Large volumes but incredibly strong cost pressure from OEMs
- Consumers expect safety systems as standard equipment
- Governments mandating what was “Advanced” a few years ago (AEB, LDWS/LKA)

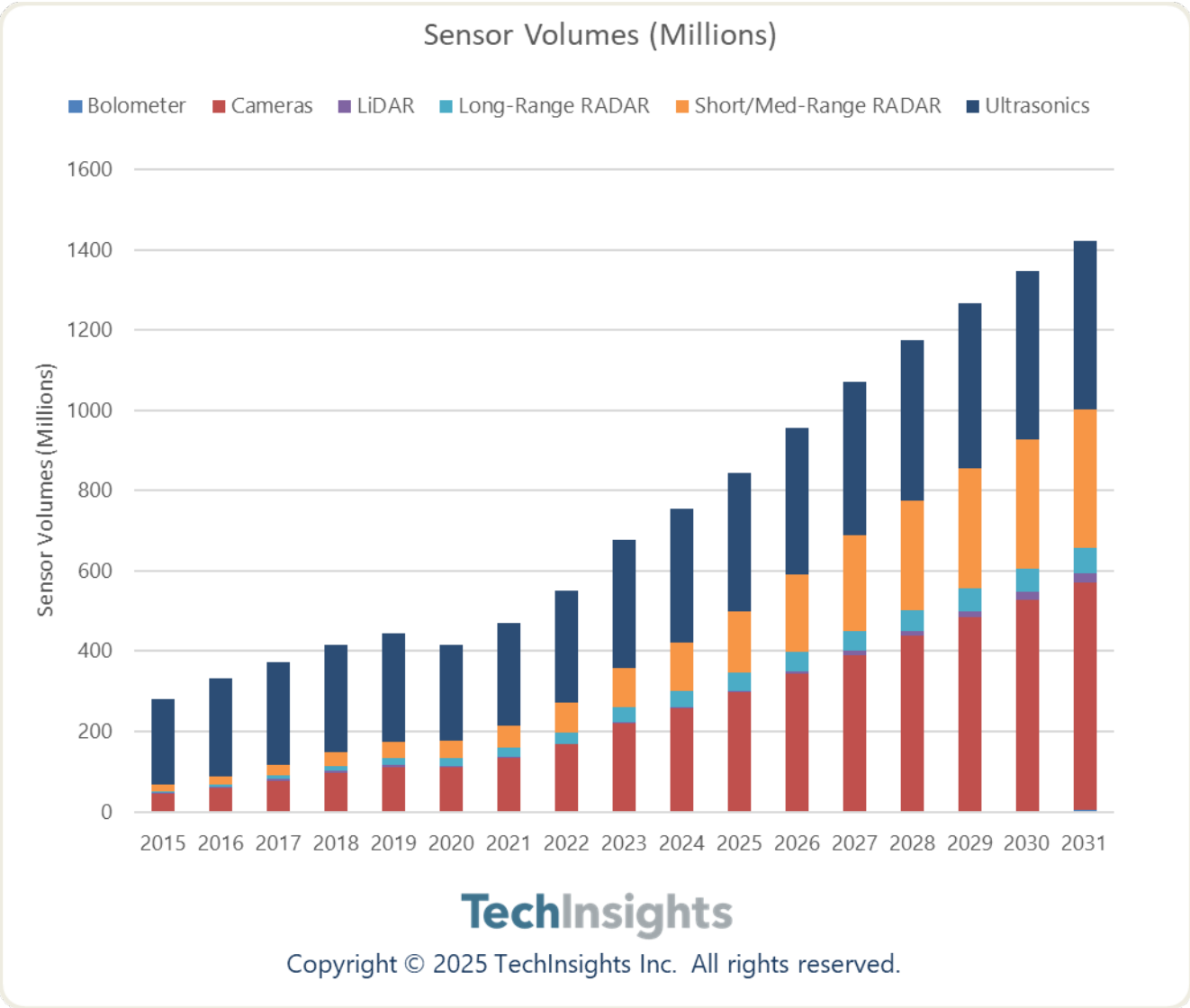
- ADAS features that can be sold as an option or option/subscription
  - Recurring subscription revenue a goal of many OEMs
- This is where so-called L2+ systems and L3 systems are today
  - Ford, GM, NIO, Tesla and Volvo charge a subscription fee for L2+ solutions

Global ADAS Demand for 600M Features by 2031



- Feature count still growing…but…
  - Many features starting to hit saturation point towards end of forecast
- Over 2024 to 2029, fastest growing features are:
  - AFS Matrix Lighting
  - Camera-based DMS
  - ADAS Domain Controller

> 1 Billion ADAS Sensors Globally by 2027 – 1.4 Billion by 2031

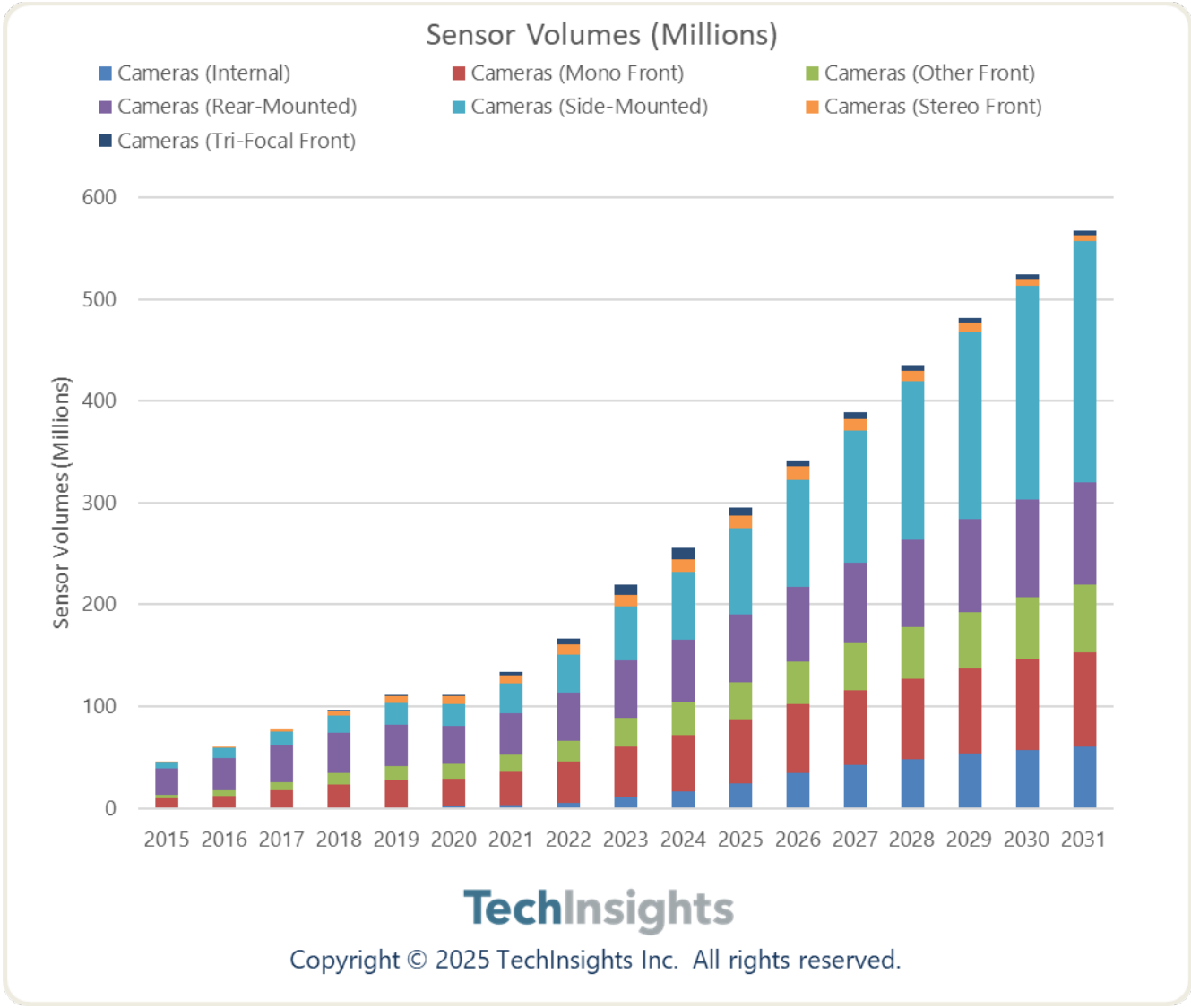


Click the chart to see the data in the Online Data Report

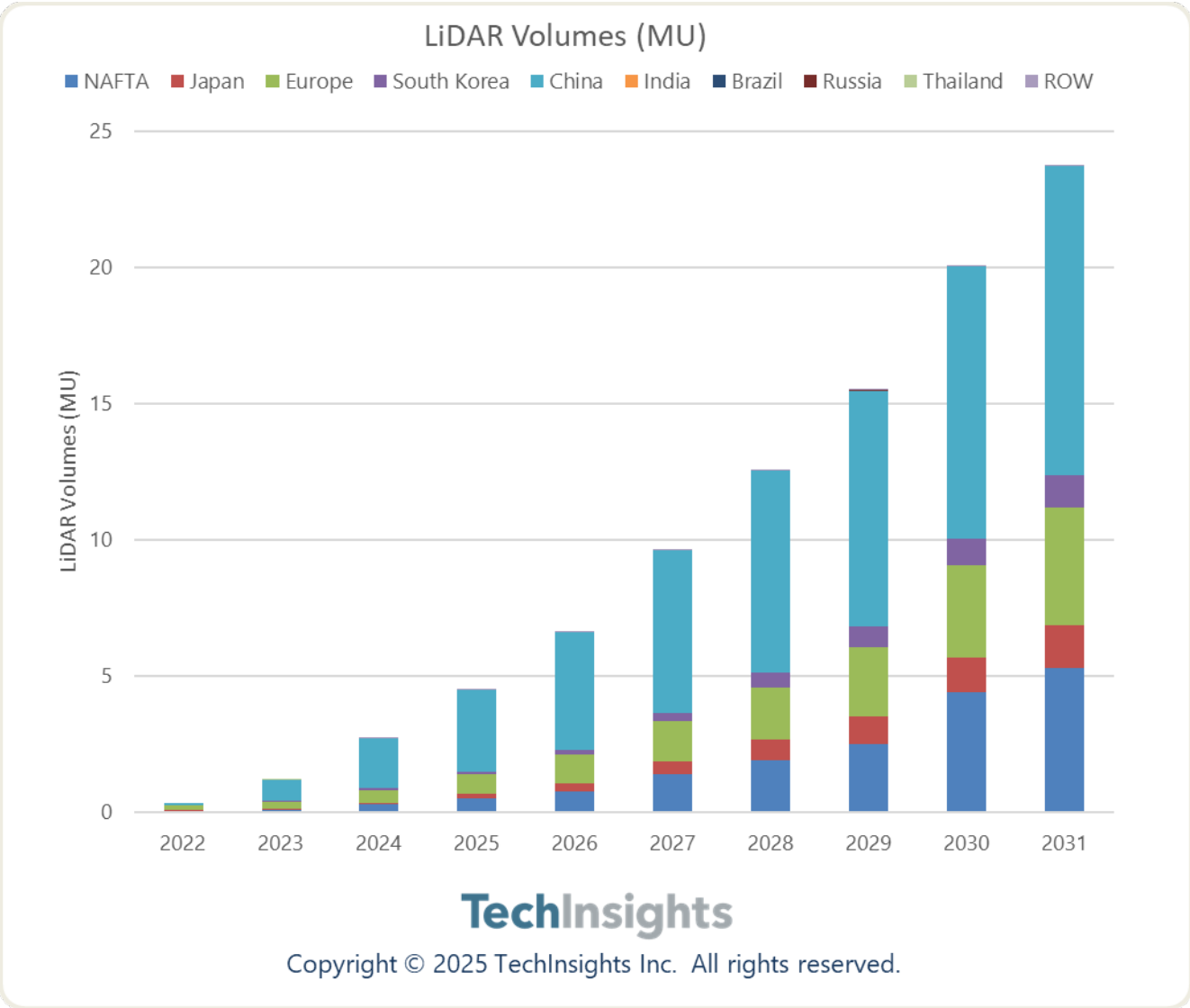
- Growth for almost all sensor types
- Fastest growth in cameras is for internal units for DMS/OMS
- Fastest RADAR growth is also for internal units
- LiDAR and bolometer markets still expected to be very small in unit terms relative to other sensors
  - Bolometer market has significant upside **IF** it becomes 100% required to meet NCAP VRU / poor light requirements
  - LiDAR volumes in 2031 around 24 million, dominated by fitment to L2/L3 vehicles. China will be the largest market

Detailed Camera Demand Shifts

- 2015
  - Almost 80% of camera demand from parking / surround view
- 2022
  - Front windshield cameras hit peak share of 34% of total camera demand
- 2031
  - Side mounted cameras by far the single most common type of camera
- 2024-29 fastest growth camera is for internal usage



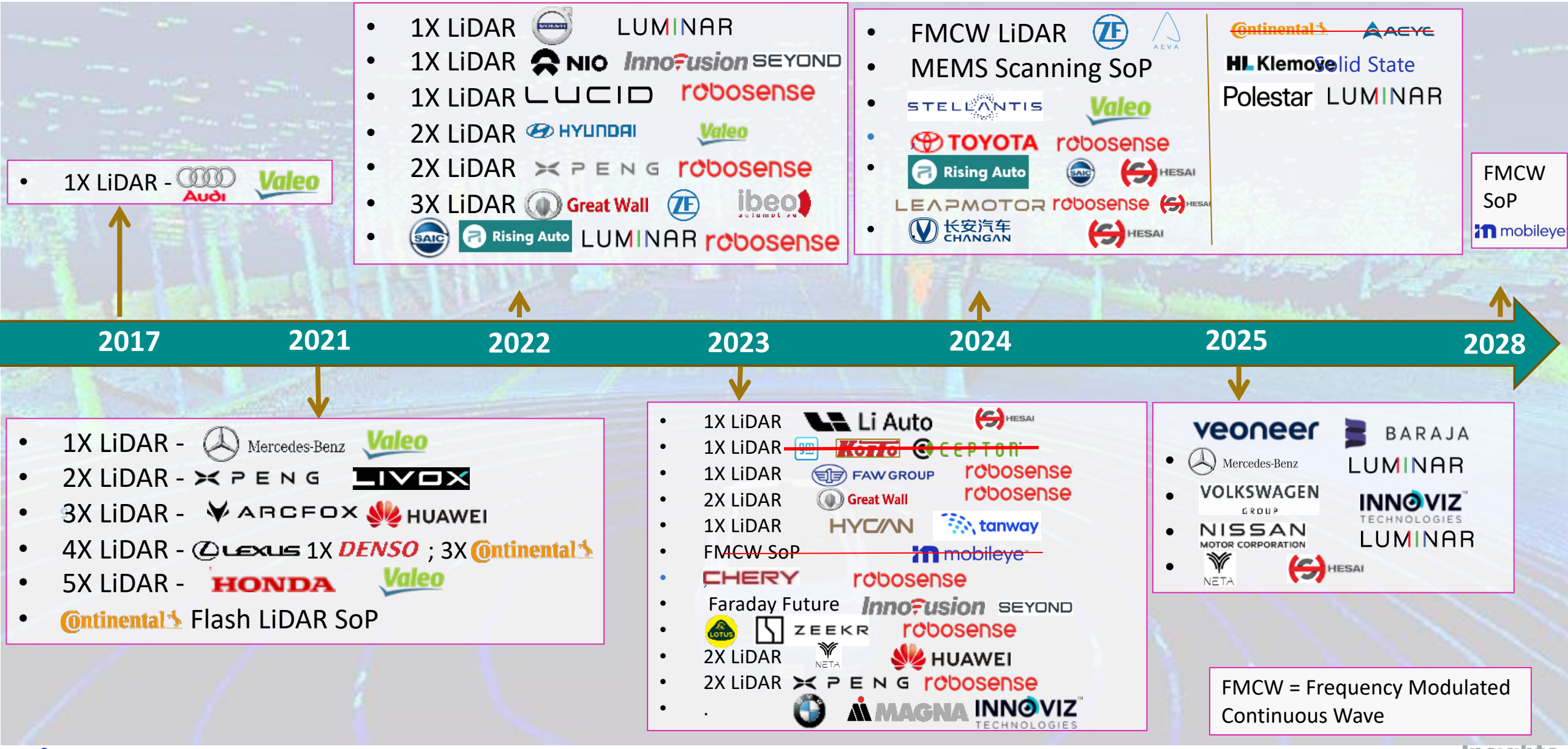
Vehicles Made in China Largest LiDAR Market



Click the chart to see the data in the Online Data Report

- In 2022, European-made vehicles were the largest Hi-res LiDAR market
  - Mainly Valeo Scala units on German luxury models
- Vehicles made in China expected to account for >50% of market for most of the forecast period

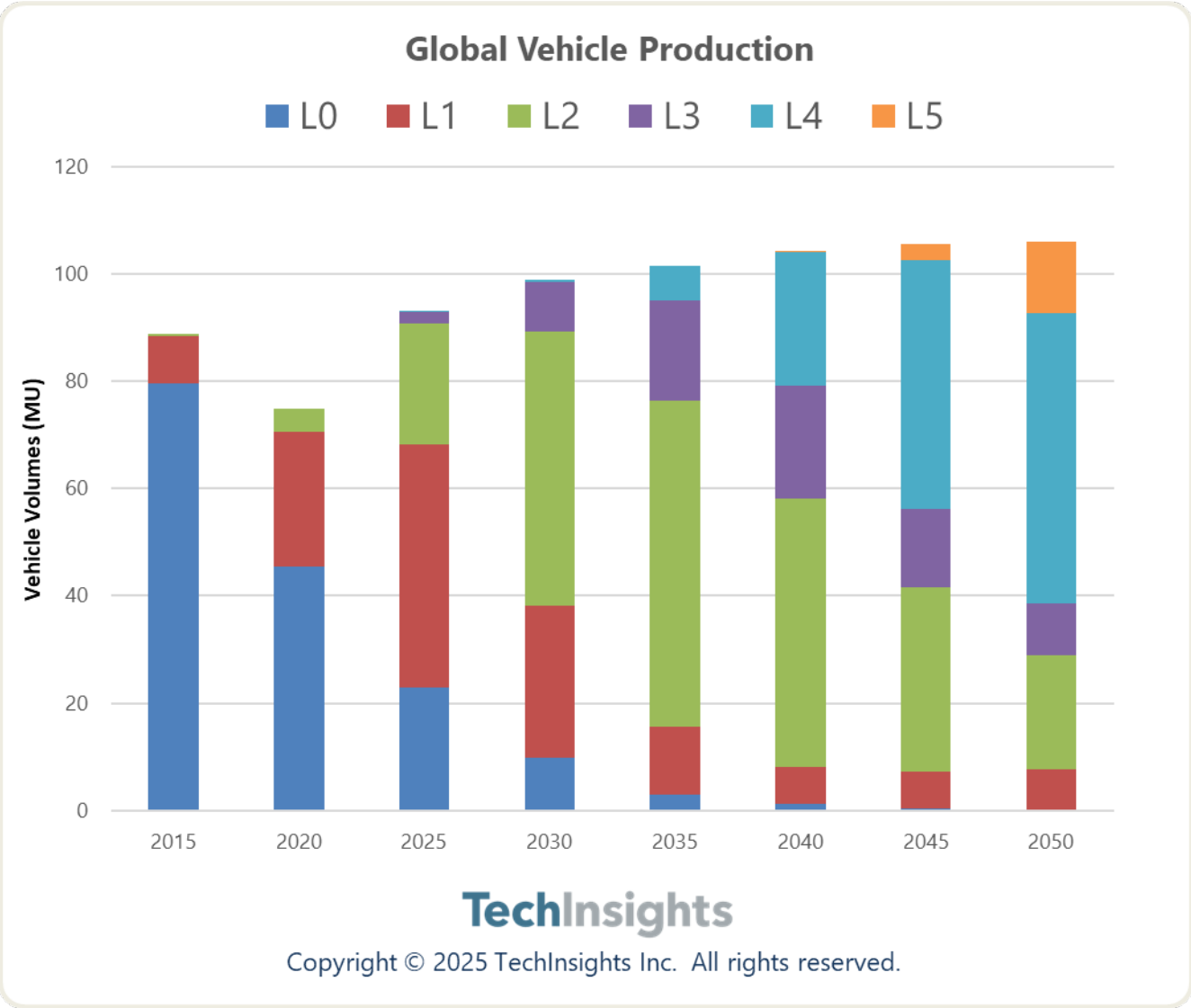
LiDAR – Chinese Suppliers leading adoption



FMCW = Frequency Modulated Continuous Wave

How About Autonomous?

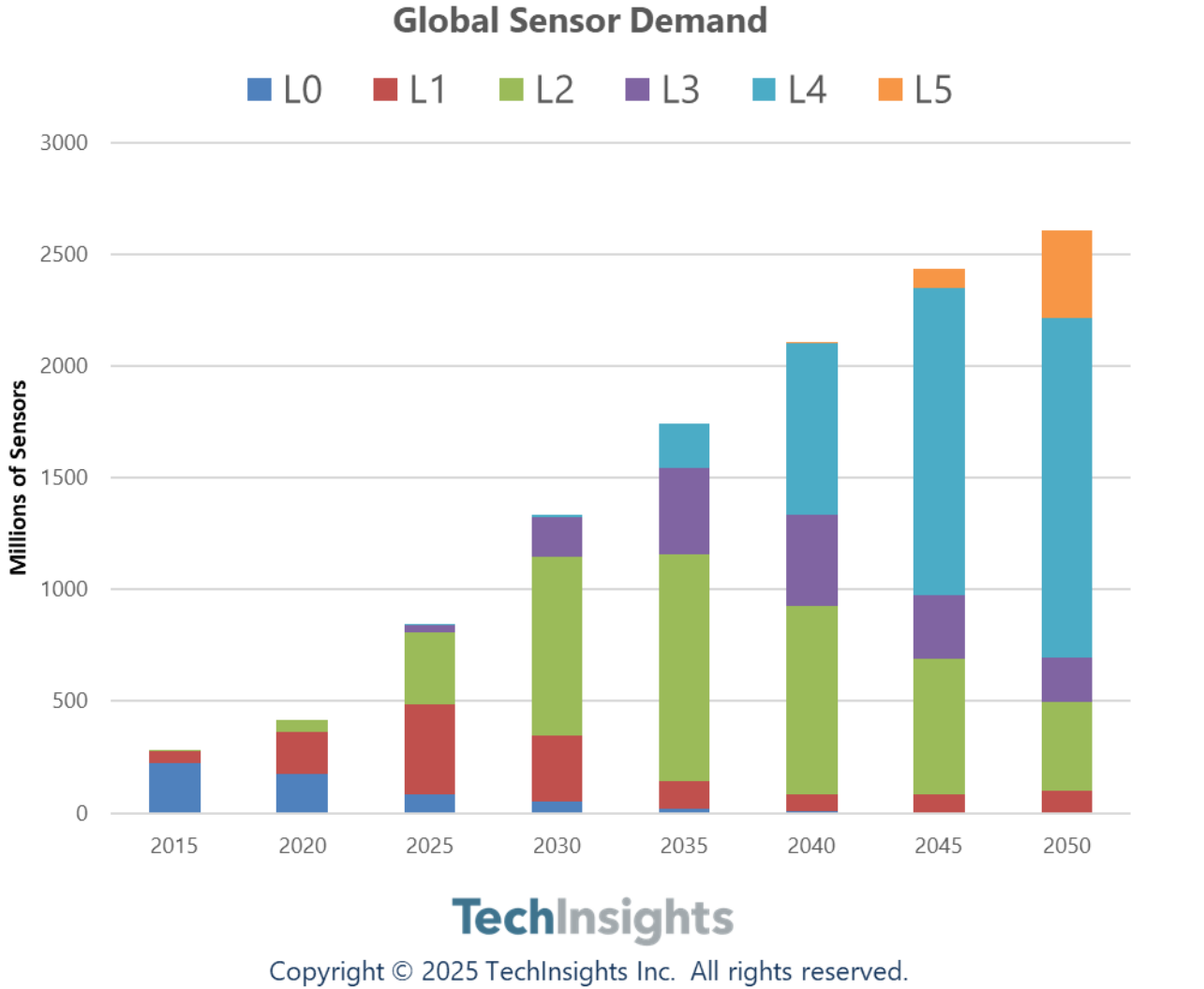
Global Large-Scale Deployment of L4 AV Still YEARS Away



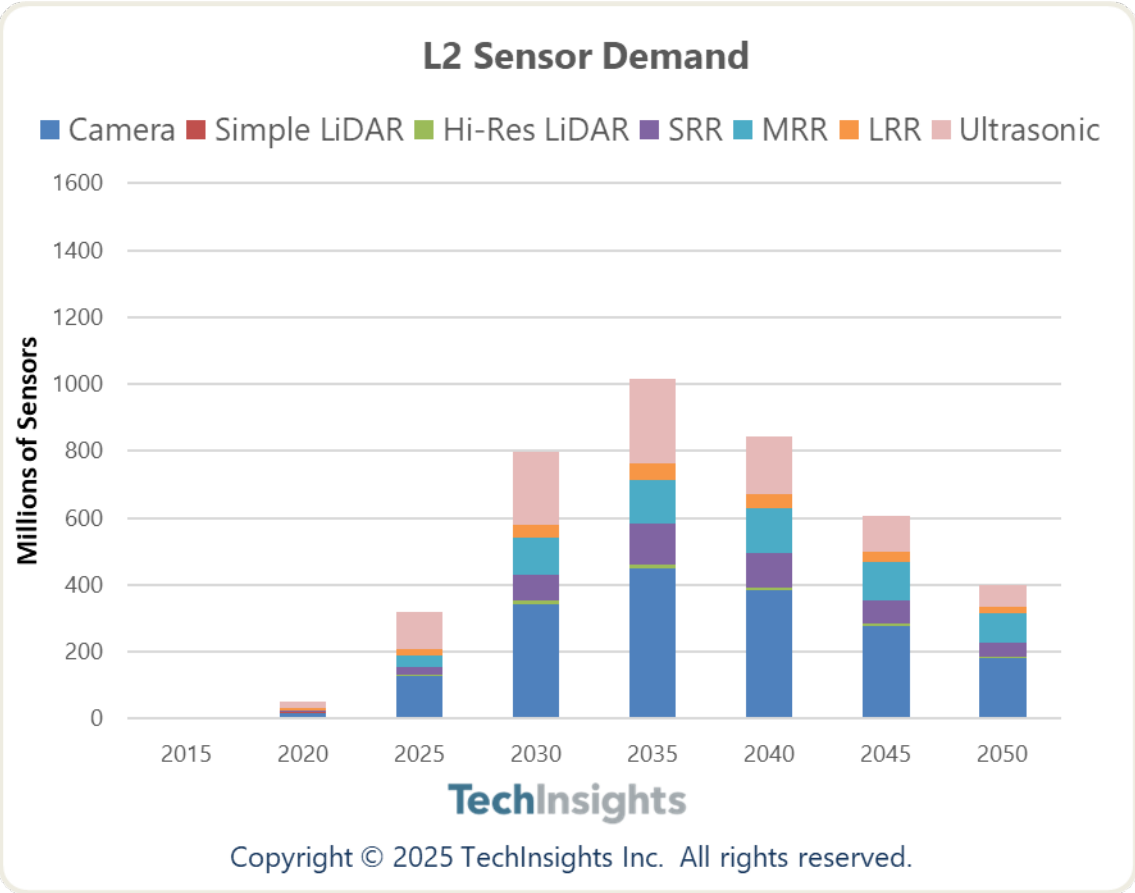
- Much ADAS (e.g. AEB) is classified as L0
- L1 demand driven mainly by LKA function (now offered by almost all LDWS solutions)
- L2 ACC and auto-park systems to grow strongly during the 2020s
- L3 now emerging – but still expected by TechInsights to be "stop-gap" solution on the path to L4
  - L3 has been boosted in recent update
- L4 demand has been delayed – many automakers pulling back

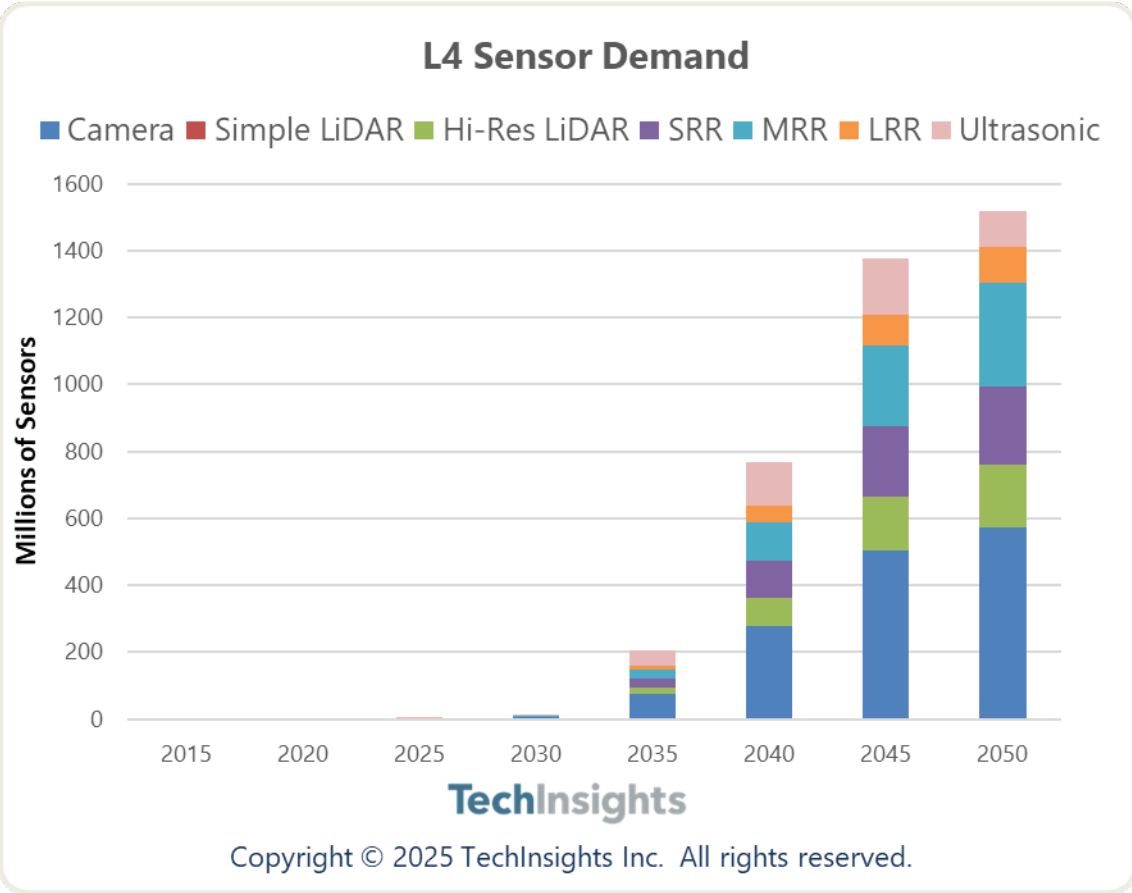
Short/medium-Term Sensor Demand NOT L4 Driven

- 2025 sensor demand dominated by L1 and L2 solutions
- 2030 sees strong shift to L2
- 2035 sees first significant L4-based sensor demand
- 2040s until L4-based demand starts to dominate?



Comparing L2 & L4





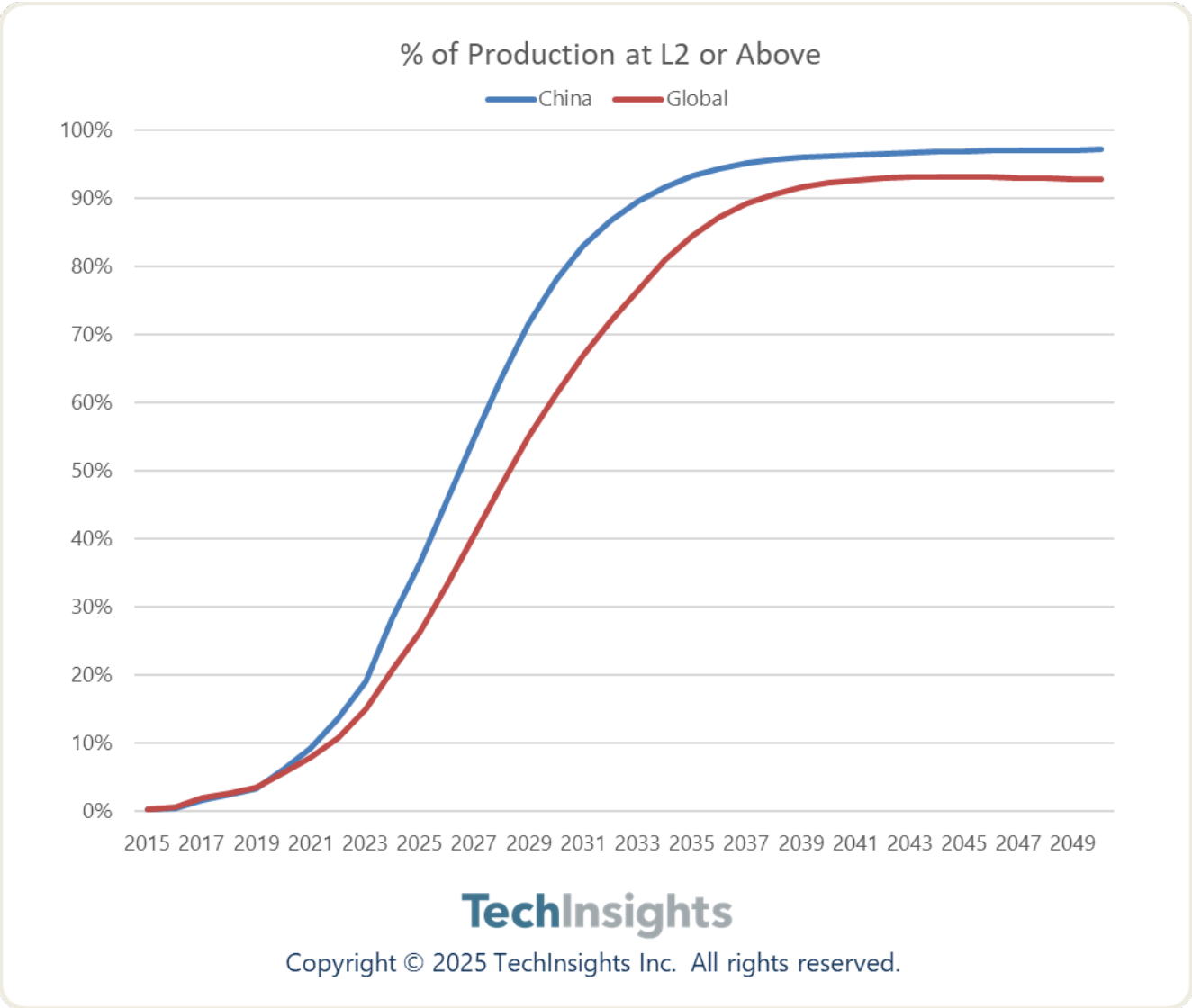
- Cameras the dominant sensor type
- Hardly any LiDAR

- Proportionally **FAR** more usage of LiDAR and RADAR

China Leads in L2 and above Deployment

- China to lead in L2 and above vehicle production
- In 2030, 78% of production in China is expected to be at L2 or above
  - 60% at L2
  - 17% at L3
  - 1% at L4
- Globally, only 61% of production will be at L2 or above:
  - 52% at L2
  - 9% at L3
  - 0% at L4

- **BUT!** China also has more L0 vehicles proportionally in 2030
  - 13% L0 in China in 2030
  - 10% L0 globally in 2030



Hurdles to AV over next 3-5 years

- **AV Deployment** Expanding Operational Design Domain (ODD) difficult and expensive!
  - The last 2% of edge case ODD is proving to be very difficult including: glare, social norms, outdated mapping detail, toll booths, water-filled potholes, overhanging vegetation, downed power lines, icing, uncooperative people, falling objects, delivery robots and common human rule-breaking (Source SAE).
- **AV Scalability** – Waymo fleet is still in the hundreds rather than the tens of thousands of vehicles announced a few years ago;
  - Rolling out fleets of robotaxis will be WAY more capital intensive than rolling out ride-hailing as Uber & Lyft did
- **Public Acceptance** – some early uneasiness with Robotaxis; Uber and Cruise – Lawyers at the ready
- **Potential Legislation Hurdles** – typically lags behind technology
- **Complex Ecosystem**
  - A huge amount of duplication of effort.
- **Goldrush of Funding has Ended** – investors need to be in for the long haul

Viable Routes to L4?

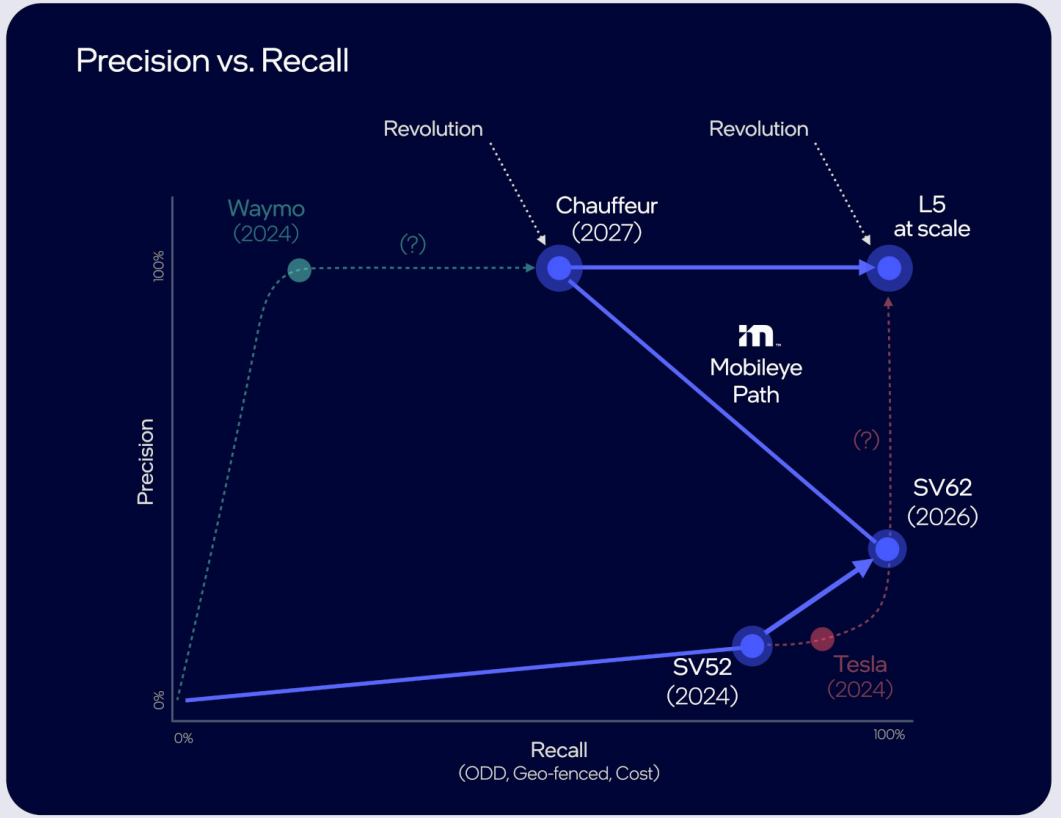
Precision and Recall in Autonomous Driving Systems

Precision (safety)

- Mean-Time-Between-Failures (MTBF)
- Sufficient MTBF for eyes-off / no driver

Recall (availability)

- **ODD:** Conditions where an autonomous vehicle can operate; broader ODDs lead to higher recall
- **Geographical scalability:** How good is out-of-the-box performance in a new location
- **Cost:** Lower cost (system, maintenance) leads to higher recall



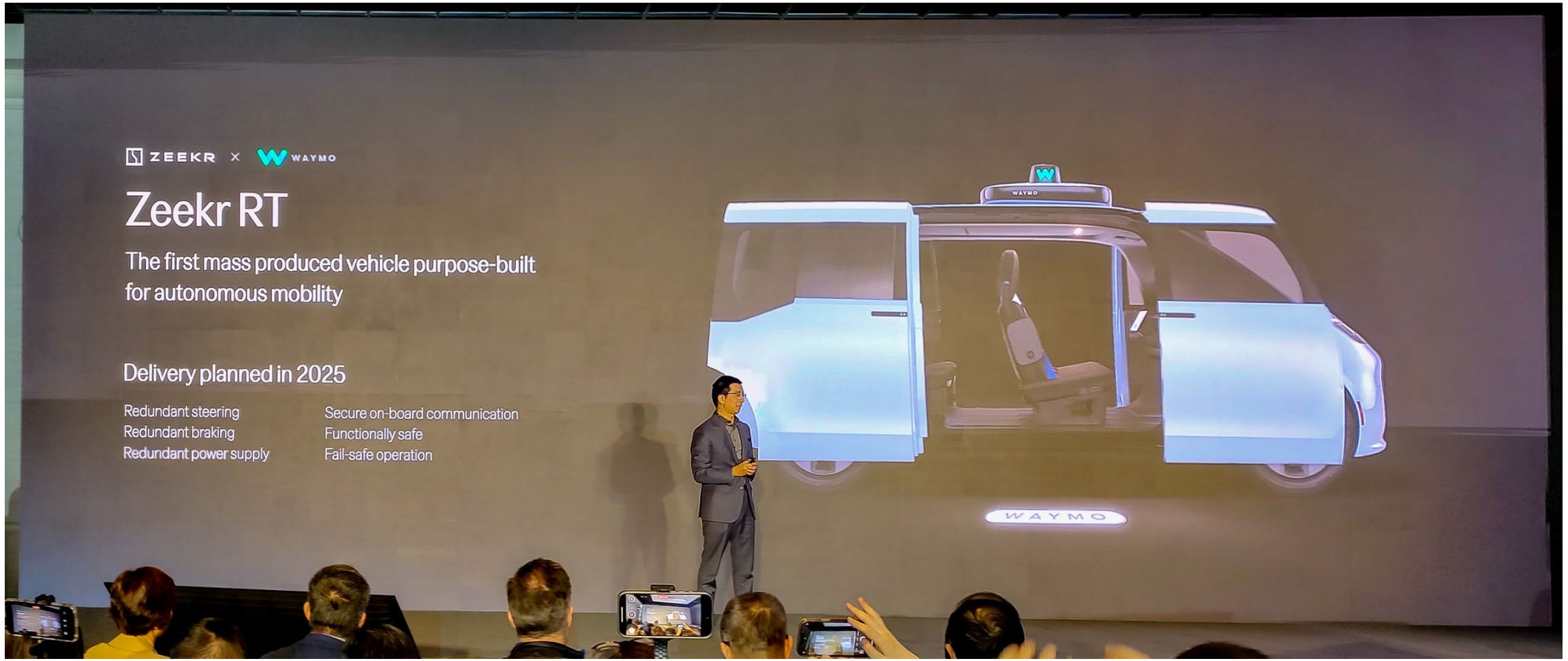
*Dates provided are estimates only

- Mobileye sees vision alone as sufficient for L2-style "Supervision" driving
- Adds RADAR/LiDAR for L4 in Chauffeur

Source: Mobileye CES 2025

What About Robotaxis?

Source: TechInsights at ZEEKR Press Conference, CES 2025

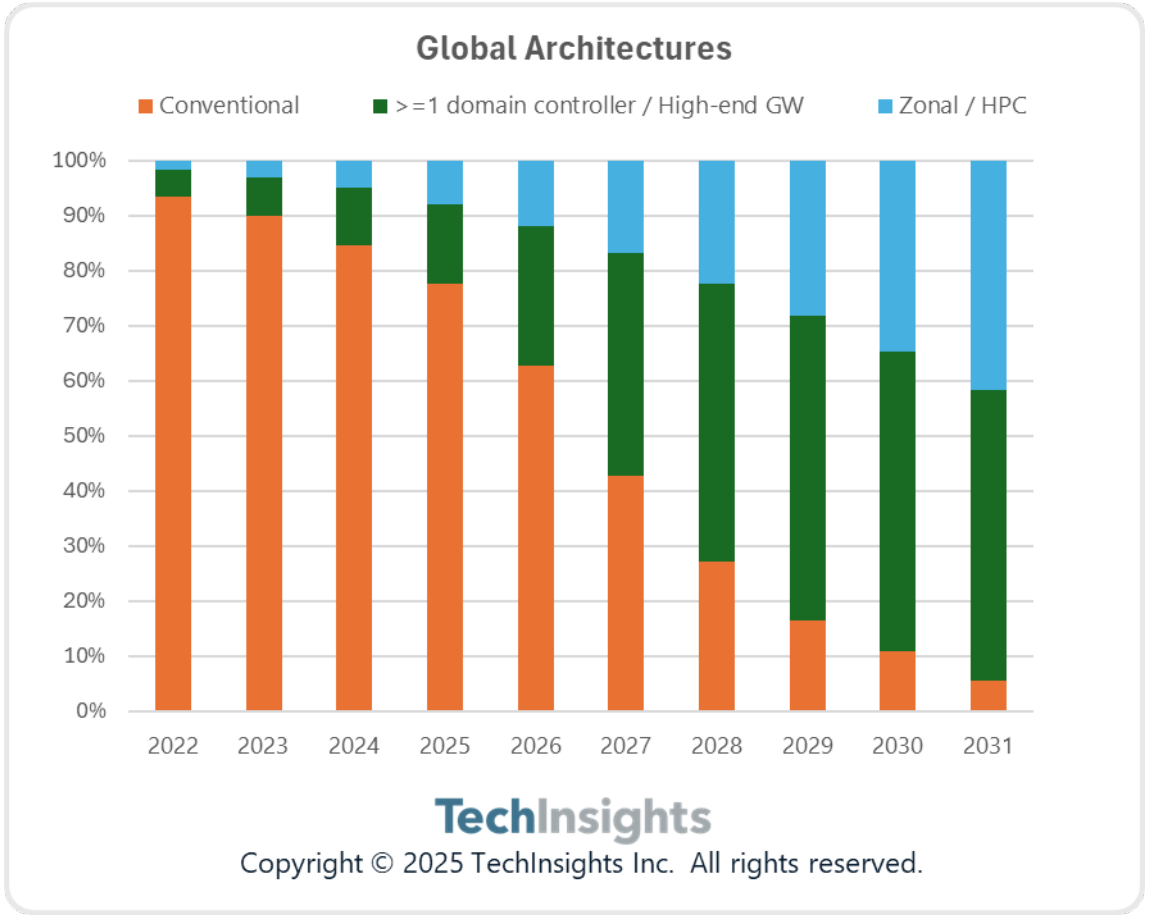


- LOTs of robotaxi and CES 2025…but...
- TechInsights sees big questions remaining on scalability and speed of roll-out

What about Architecture Change?

Days of the Standalone “Smart” Camera are Limited

- By 2030, the vast, vast majority of vehicles will be being built using some form of more centralized vehicle architecture
- Implications for sensors are:
  - Less need for on-sensor data processing
  - More need for high-bandwidth links to connect sensors



Conclusions

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- Discrete ADAS feature demand continues to grow, but demand is starting to saturate for some features
- Sensor demand will keep growing, as more complex features require more sensors
- Overall, cameras will become the most numerous sensor type
  - Camera alone widely seen as sufficient for up to and including L2 type systems
- Overall sensor demand out to 2030 largely drive by L1 and L2 type technologies
- L4 only starts to scale from 2030

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