# *How close are we to self-driving?*

## State of the Art 2020

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# 4 years to highly automated driving, still…

*in 2016*

*”highly automated driving in 2020, nearly fully automated driving in 2025”* [1]

*later*

GM: Cruise CEO Daniel Ammann, *“When you’re working on the large-scale deployment of mission critical safety systems, the mindset of ‘move fast and break things certainly doesn’t cut it.”* [2]

Ford CEO Jim Hackett *“We overestimated the arrival of autonomous vehicles.” [3]*

Gill Pratt (CEO Toyota Research Institute) : *“none of us in the automobile or IT industries are close to achieving true Level 5 autonomy.” [4]*

*[1] „The Self-Driving Car Timeline – Predictions from the Top 11 Global Automakers“, https://emerj.com/ai-adoption-timelines/self-driving-car-timeline-themselves-top-11-automakers/*
*[2] e.g. https://www.asiaone.com/digital/its-almost-2020-where-are-all-driverless-cars?page=1*
*[3] e.g. https://www.engadget.com/2019/04/10/ford-ceo-says-the-company-overestimated-self-driving-cars/*
*[4] e.g. https://www.cargroup.org/wp-content/uploads/2017/08/Eustice.pdf*

“We are not as close as we thought we are…”

So where are we now in 2020?

AD Levels revisited / consolidated:

# *practically* only SAE-L2 & SAE-L4 are of interest


not interesting (done)

**e.g. TESLA Autopilot**

*Sensor setup: Cam, Usonics, Radar, IMU, GPS*

***on the market, personally owned car***

e.g. AUDI A8, but skipped by many OEMs, difficulties in handover

practically not feasible

**e.g. WAYMO, Uber**

*Sensor setup: LIDAR and HD Maps*

*Cam, Usonics, Radars, IMU, GPS*

***in research & in public transport***

Intermediate conclusion:

*"L2 is there,*
*L4 in development"*

"So, we are close! are we?"

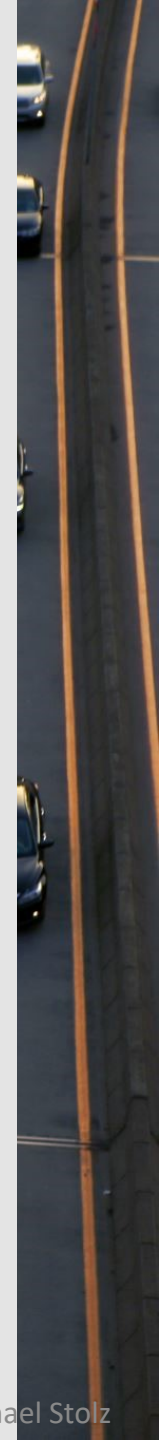
*"Not really,*
*since the last step to L4*
*is the most difficult one."*

*"Why don't we have self-driving cars yet?*

*(SAE L4 to buy)*

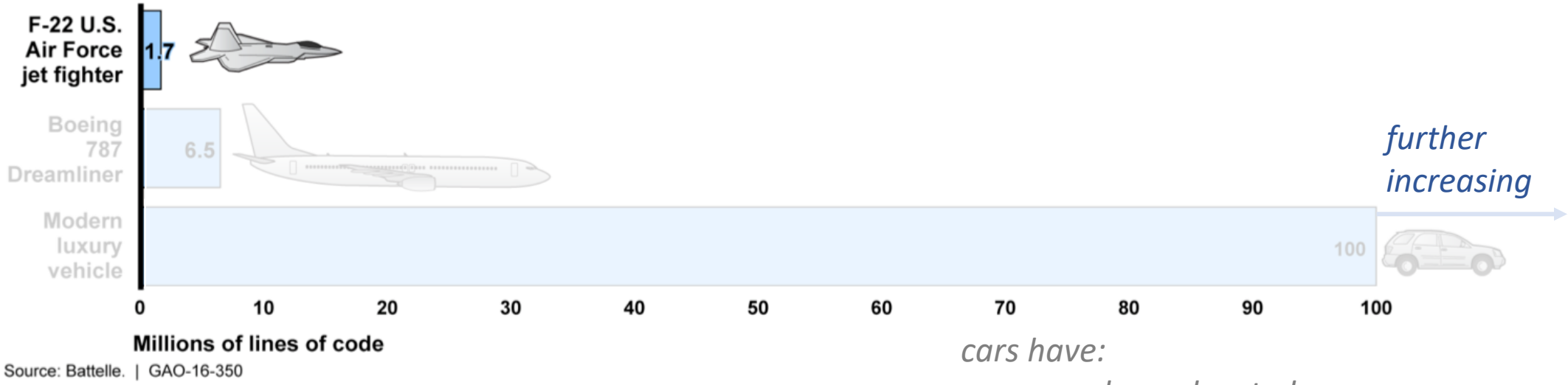
Future


...loading



# *Software is always late…*
# *…and we have a lot of software*

**Figure 2: Average Lines of Software Code in Modern Luxury Vehicle Compared to Types of Aircraft**




Source: Battelle. | GAO-16-350

*further increasing*

*cars have:*

*less educated users*
*more variants*
*shorter dev. cycle*
*shorter prod. lifetime*
*…*

*Source: Vehicle Cybersecurity: DOT and Industry Have Efforts Under Way, but DOT Needs to Define Its Role in Responding to a Real-world Attack, General Accounting Office (www.gao.gov); at [https://www.gao.gov/assets/680/676064.pdf](https://www.gao.gov/assets/680/676064.pdf)*

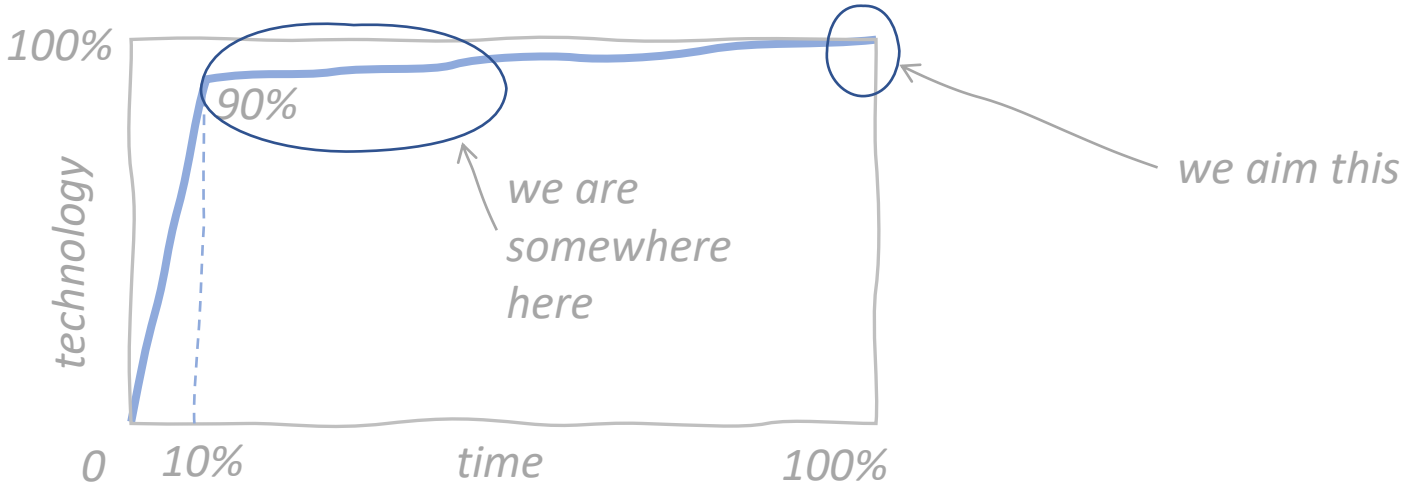
# *Why SW is late? …the 90-90 rule*

***"When you're 90% done*, you still have 90% to go**,"***

Mr. S. Arnoud (Waymo Director of Engineering) during a MIT lecture recently

* technology
** time

*The first "90% of the technology takes 10% of the time."*




The (90-90) rule is attributed to Tom Cargill of Bell Labs, and was made popular by Jon Bentley's September 1985 "Programming Pearls" column in Communications of the ACM, (www.wikipedia.org)

# *What do we aim for ?*
# *100% or is 98% enough?*

*“We aim to be better than average human drivers."*

*This is a fatality rate less than* ***f = 1.09***
*fatalities per 100 million miles*

this is a reliability
of 99.9999989%

R[%]= (1- 1.09E-8)*100

Source: https://www.rand.org/pubs/research_reports/RR1478.html


*“So L4 to buy will need time,*
*What comes next ?*
*and When?”*
Dr. Michael Stolz

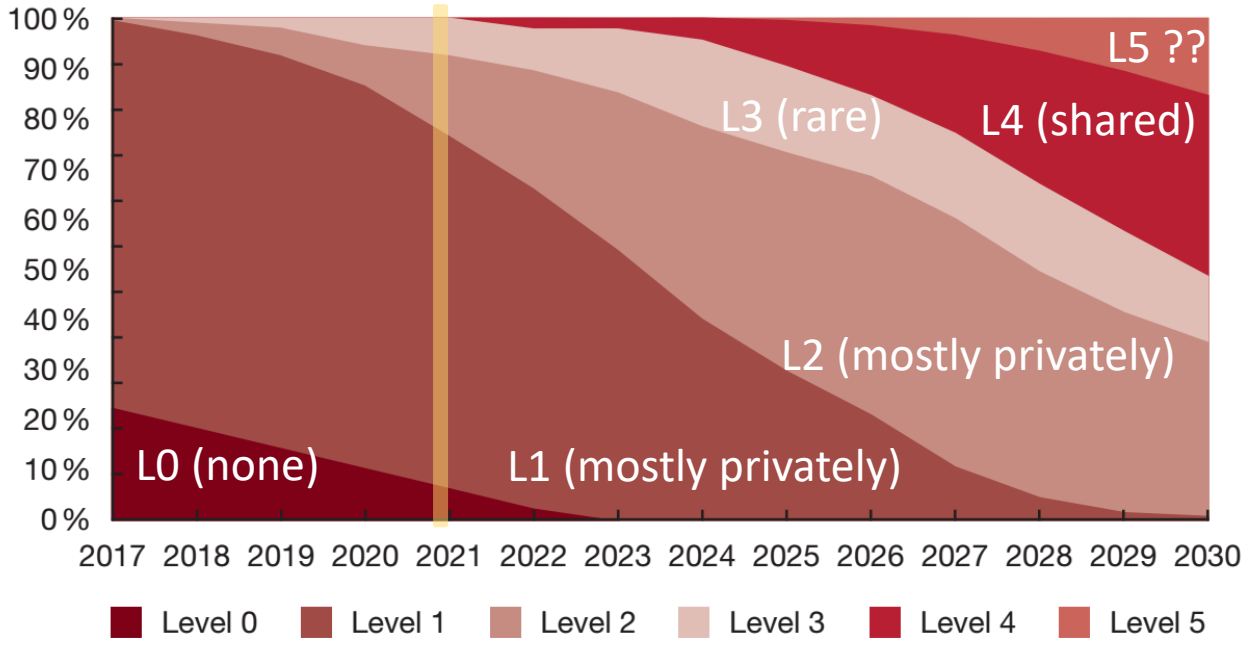
# AD Prognosis from Consultants

*"Will so many people buy L1 & L2?"*

*…Chances are high that everyone does…*

*…because it will be mandatory and nearly for free…*

**Fig. 26 Europe: Development of automation levels (2017–2030)**




*Source: Felix Kuhnert, Christoph Stürmer and Alex Koster, "Five trends transforming the Automotive Industry", **PricewaterhouseCoopers GmbH** Wirtschaftsprüfungsgesellschaft, 2018, www.pwc.com/auto*

# *Future implementation plans (EU)*

**Table 5: List of mandatory safety measures in PO3**

| Measure | Description | Applicable vehicle categories | | | |
|---|---|---|---|---|---|
| | | Passenger cars | Light commercial vehicles | Buses | Trucks and trailers |
| | | $M_1$ | $N_1$ | $M_2$ & $M_3$ | $N_2$ & $N_3$ |
| **AEB-VEH** | Autonomous emergency braking for driving and still-standing vehicles ahead | 9/2021 | 9/2021 | | |
| **AEB-PCD** | Autonomous emergency braking for pedestrians and cyclists | 9/2023 | 9/2023 | | |
| **ALC** | Alcohol interlock installation facilitation | 9/2021 | 9/2021 | 9/2021 | 9/2021 |
| **DDR-DAD** | Drowsiness and attention detection | 9/2021 | 9/2021 | 9/2021 | 9/2021 |
| **DDR-ADR** | Distraction recognition | 9/2023 | 9/2023 | 9/2023 | 9/2023 |
| **EDR** | Event (accident) data recorder | 9/2021 | 9/2021 | | |
| **ESS** | Emergency stop signal | 9/2021 | 9/2021 | 9/2021 | 9/2021 |
| **FFW-137** | Full-width frontal occupant protection crash test | 9/2021 | 9/2021 | | |
| **FFW-THO** | Full-width frontal occupant protection crash test with advanced measuring dummy and lower appropriate injury criteria thresholds to encourage adaptive restraints | 9/2021 | 9/2021 | | |
| **HED-MGI** | Head impact zone enlargement for pedestrian and cyclist protection (to include the windscreen area) | 9/2023 | 9/2023 | | |
| **ISA-VOL** | Intelligent speed assistance (through non-intrusive haptic feedback) | 9/2021 | 9/2021 | 9/2021 | 9/2021 |
| **LKA-ELK** | Lane keeping assist (emergency lane keeping system that intervenes only in case of an imminent threat such as leaving the road, or leaving the lane with oncoming traffic) | 9/2021 | 9/2021 | | |
| **PSI** | Pole side impact occupant protection | 9/2021 | 9/2021 | | |
| **REV** | Reversing camera or detection system | 9/2021 | 9/2021 | 9/2021 | 9/2021 |
| **TPM** | Tyre pressure monitoring system | | 9/2021 | 9/2021 | 9/2021 |
| **VIS-DET** | Vulnerable road user detection and warning on front and side of vehicle | | | 9/2021 | 9/2021 |
| **VIS-DIV** | Vulnerable road user improved direct vision from driver's position | | | 9/2025 | 9/2025 |
| | **Benefit-to-cost ratio** | 1.39 | 0.53 | 2.11 | 1.03 |
| | **Total cost per vehicle** | € 516 | € 521 | € 970 | € 1,013 |
| | **Fatalities prevented** | 21 337 | 1 283 | 227 | 1 947 |
| | **Severe injuries prevented** | 126 390 | 6 917 | 2 410 | 5 023 |
| | **Slight injuries prevented** | 470 747 | 23 486 | 8 174 | 13 274 |

Source https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SWD:2018:0190:FIN:EN:PDF

Shift from **voluntary** (NCAP) to **mandatory** features (homologation)

Safety (will come) first (and **soon**)!

# *“What comes next ?”*

***Some answers:***

*Soon:* *Mandatory Active Safety Functions*

*next 1-2 year(s)*

*Mid-term:* *some L3 features for attention*

*next 2-4 years*

*Long-term:* *L4 features w. extending ODDs*

*next 3+ years ☺*

# Thank you!

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The Future of Automated Vehicles is


still loading....