

Could 5G be the Great Enabler of Level 5 Autonomy?

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EasyMile

- Founded in June 2014
- Our main product: the EZ-10 fully autonomous electric shuttle
- 150+ employees
- Offices in 5 different countries: FR, SG, US, DE, AU
- Clients: Largest transport operators in the world
- 200+ deployments around the globe
- 80+ vehicles produced as of 2018-06

What are the Different Levels of Autonomy

SAE Autonomy Levels (simplified for mere mortals like me):

- L0: No automation at all
- L1: Driver assistance — either steering or acceleration/deceleration
- L2: Partial Automation — hands off, but eyes on to continuously monitor the system
- L3: Conditional Automation — eyes off, but ready to take over
- L4: High Automation — fully autonomous under limited conditions
- L5: Full Autonomation — fully autonomous under all conditions

Different Roads to Full Autonomy

- Iteratively, over time, move from Level 0 to Level 5, with incremental improvements

OR

- Start from a blank slate, and build a Level 4 system from the ground up

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“The electric light did not come from the continuous improvement of candles.”

- Oren Harari

EasyMile's EZ-10

Designed to be fully autonomous from the ground up

No steering wheel, no pedals, no wing mirrors

Symmetrical

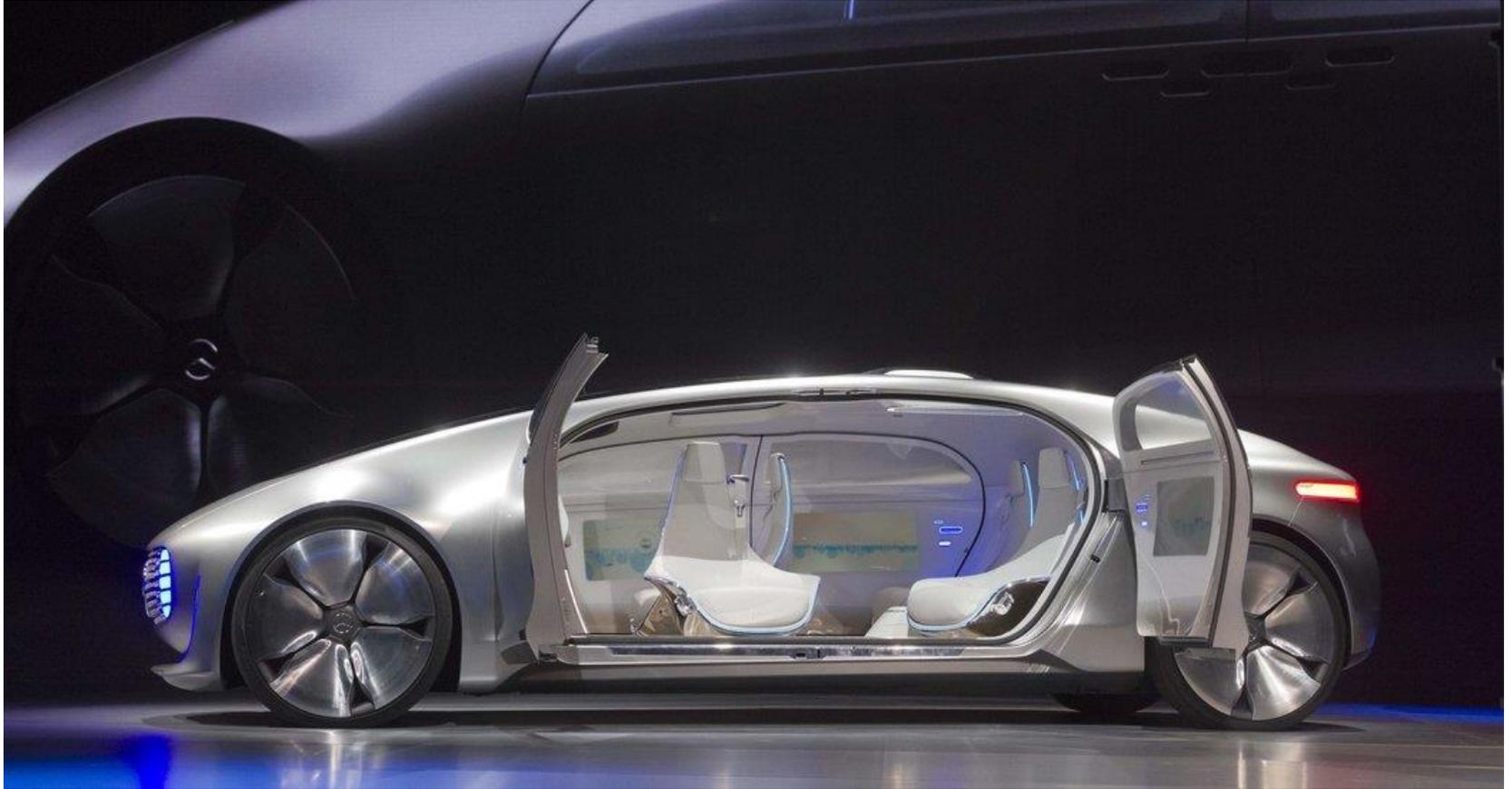
Fully electric



Why Do We Need 5G?

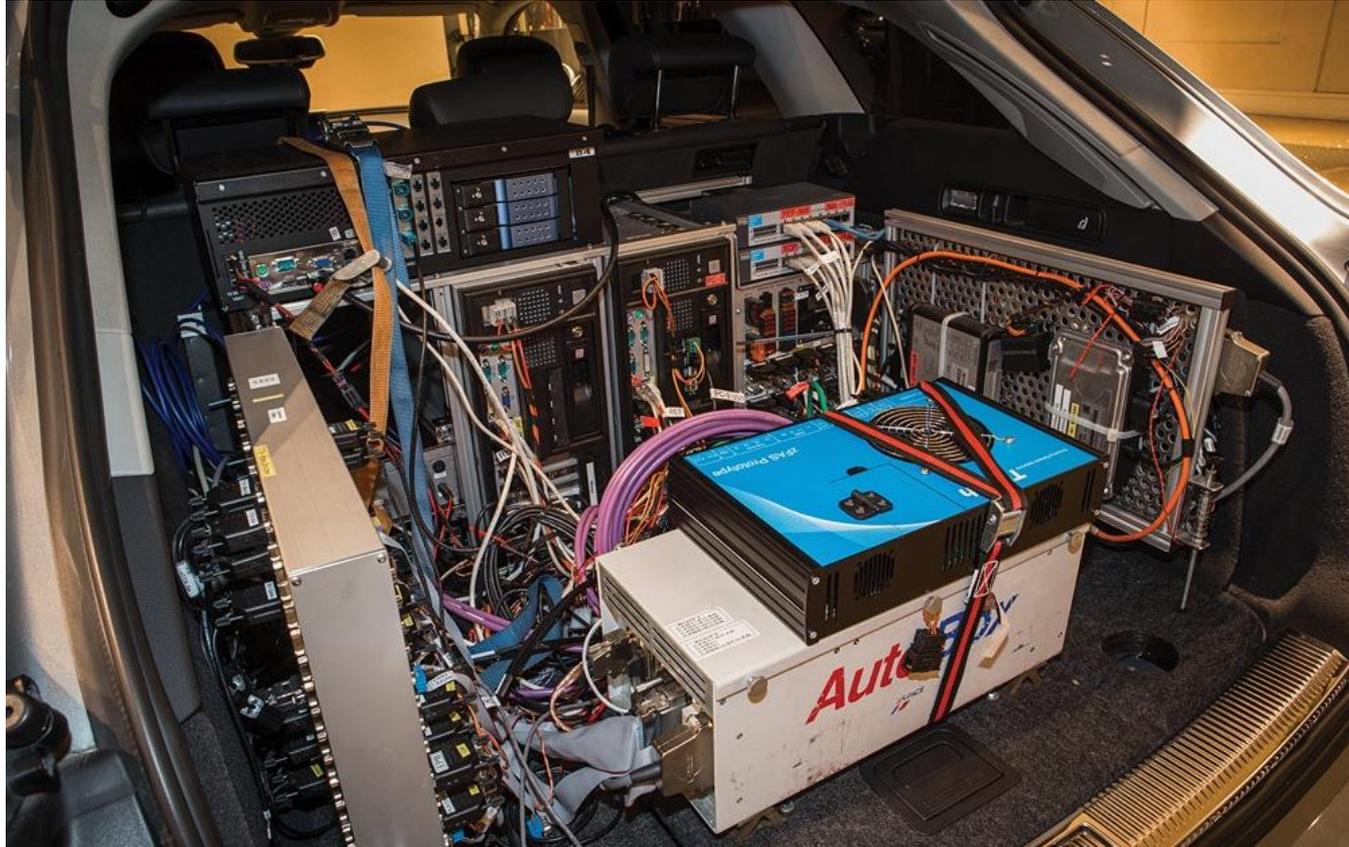
Why Do We Need 5G?

1- The Vision of Autonomous Cars



Why Do We Need 5G?

2- The Reality Today



Thank You!
Questions?

How do our vehicles perceive and localise themselves?

Typical set of sensors

- GPS + RTK
- Camera
- LIDAR
- Radar
- IMU
- Odometer



To achieve centimeter accuracy localisation precision.

LIDARs by different manufacturers:
CeptonTech, Ouster, Velodyne

But why is it so hard to build an autonomous vehicle?

The short answer?

For the same reasons that it is so fun and exciting: it's the bleeding edge of technology and research, and at the crossroads of so many fields.

But why is it so hard to build an autonomous vehicle?

Challenges and opportunities:

- **Perception has to improve dramatically**
- Norms are still being discussed and defined (i.e. ISO 26262)
- **Embedded, certified, processing power is currently extremely limited**
- **Energy consumption/autonomy will be a key factor**
- Real-time safety critical programming (and certifications)
- The legal/regulatory framework is being discussed
- **In many fields, the state of the art is still way behind the level required for production vehicles (ex: Deep Learning)**

How Could 5G Help Solve Some of these Challenges?

- QoS will enable safer, more robust autonomous systems
- Live streaming of HD Maps will become much more reliable and achievable
- High-density and low latency will enable V2I in dense urban areas

Typical LiDAR today



Data generated: ~ 50 Mbps



Channels:

64



Field of View:

Vertical: +11.25° to -11.25°
(22.5°)
Horizontal: 360°



Resolution:

64 × 2048 (10 Hz)



Beam Divergence:

0.13° full angle



Range:

>200m



Laser Class:

Class 1 Eye-Safe



Precision/Accuracy:

± 3 cm / Zero bias



Sampling Rate:

1,310,720 points per second



Rotation Rate:

10–20 Hz



Output Per Channel:

Distance
Intensity
Ambient near-IR
Reflectivity
Angle
Time stamp

Sensor Data Production

Today:

- 4 FullHD Cameras: 4x 22 Mbps ~ 100 Mbps
- Low Def Surround Cameras + Interior Cameras: ~ 50 Mbps
- 2 64-beam LiDARs: 2x 50Mbps ~ 100 Mbps
- Add another 100Mbps for a radars, other more basic sensors, low def safety LiDARs
- Total: ~ 450 Mbps => 180 GB per hour, or a 2-4TB per day (12-24 hours)

Tomorrow:

- Higher Definition Cameras
- 128-beam, higher frequency LiDARS could easy lead to 1 Gbps
- HD Radars
- Total: ~ 2 Gbps very realistic within 2 years

How Could 5G Help Solve Some of these Challenges?

How we could leverage 20Gbps downlink and 10Gbps uplink, 1ms latency:

- Upload in real time all the sensors data
 - Safety / Regulatory
 - Cost Savings
 - R&D
- Offload processing to the Edge and to the Cloud
 - Tap into much cheaper and much more powerful compute resources
- Enable features difficult to implement on 4G
 - Teleoperation for example

Thank You!
Questions?

<https://github.com/easymile>

We're always hiring. Apply here: jobs@easymile.com