2020 embedded VISION summit®

Market Trends in Automotive Perception: From Insect-Like to Human-Like Intelligence

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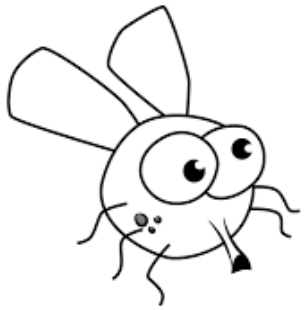
REMOVING THE HURDLES

The goal in automotive is to reach autonomy. Critical questions: when, where and how?

"The fly has the CPU of a toaster nonetheless it can do quite a lot"

Bruno Maisonnier
Anotherbrain CEO



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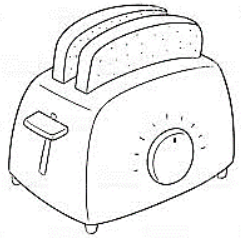

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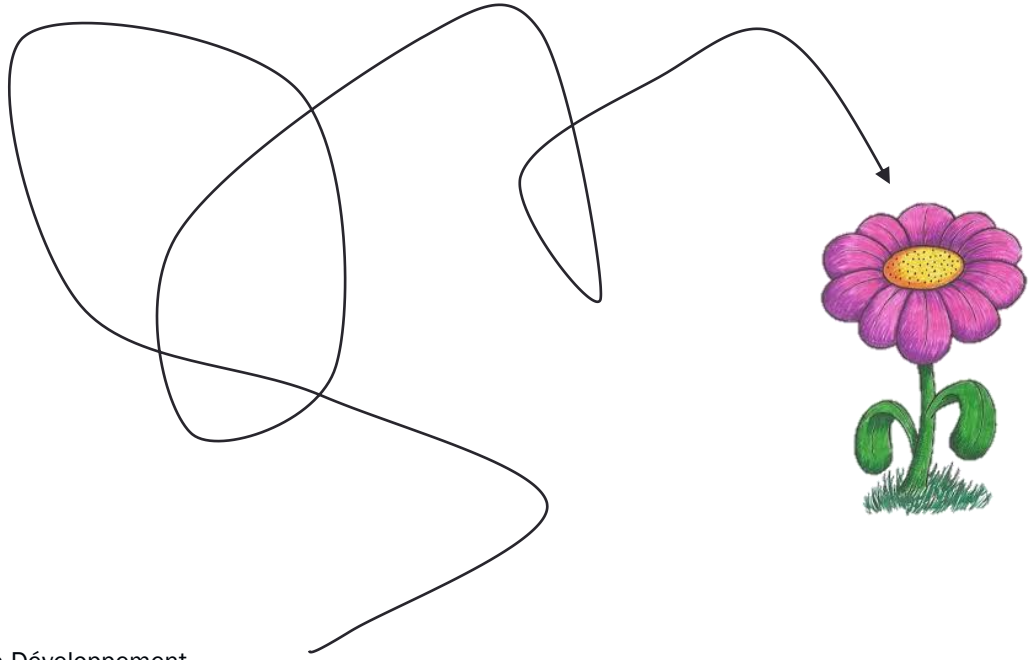
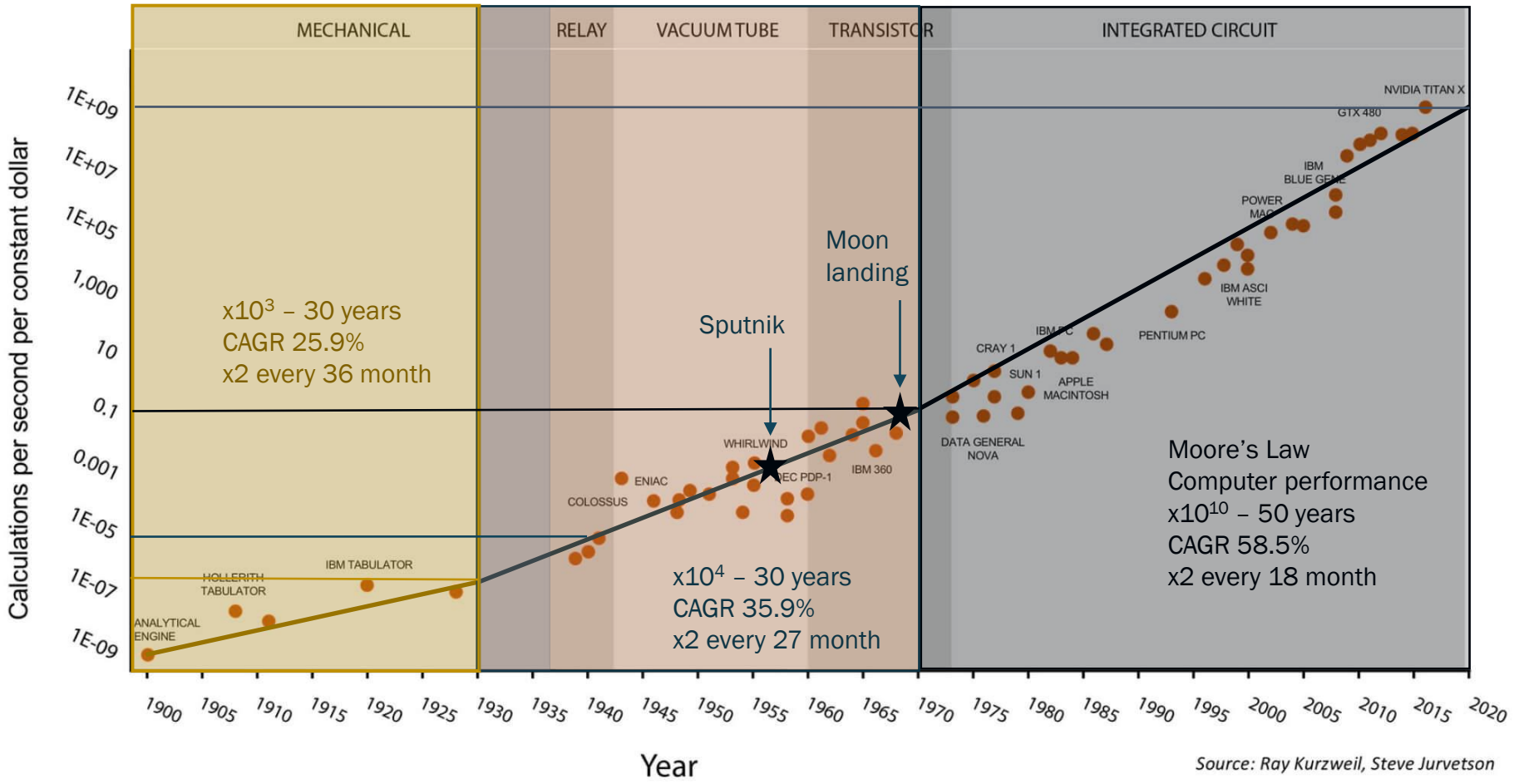


MOORE'S LAW FOR THE MARKETING MANAGER

Processing power per $ is (was) doubling every 18 months



Advancements in digital electronics are strongly linked to Moore's law : microprocessor prices, memory capacity, sensor performance …

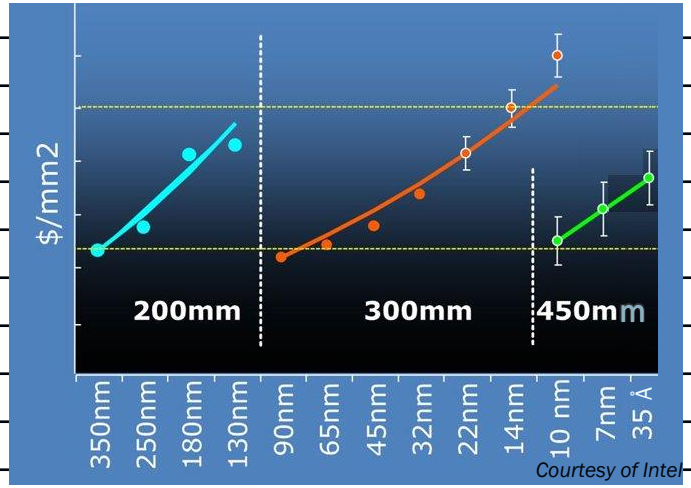
Digital electronics has contributed to world economic growth in the late 20th and early 21st centuries.

Moore's law describes a driving force of technological and social change, productivity, and economic growth.

SEMICONDUCTOR PLAYERS INTO THE SCALING ROADMAP

The end of Moore's Law economics?

Altis						
DB Hitek	DB Hitek					
Freescale	Freescale					
Fujitsu	Fujitsu					
Global Foundries	Global Foundries					
Grace	Grace					
IBM	IBM					
Infineon	Infineon	Fujitsu				
Intel	Intel	Global Foundries				
Panasonic	Panasonic	HLMC				
Renesas	Renesas	IBM				
Samsung	Samsung	Intel				
Seiko	Seiko	Panasonic				
SMIC	SMIC	Renesas	Global Foundries			
Sony	Sony	Samsung	HLMC			
ST Microelectronics	ST Microelectronics	SMIC	IBM			
Texas Instruments	Texas Instruments	ST Microelectronics	Intel	Global Foundries		
Toshiba	Toshiba	Toshiba	Samsung	Intel	Intel	
TSMC	TSMC	TSMC	ST Microelectronics	Samsung	Samsung	
UMC	UMC	UMC	TSMC	TSMC	TSMC	?
180nm	90nm	45nm	28nm	14nm	7nm	35Å
2002	2006	2010	2014	2018	2022	
	4 years	4 years	4 years	4 years	4 years	



Courtesy of Intel

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MOORE'S LAW FOR THE MORE THAN MOORE PARADIGM?

"Moore's Law" supported the growth of markets and technology in the semiconductor space for 50 years

It is now challenged from the technology standpoint but also the economics

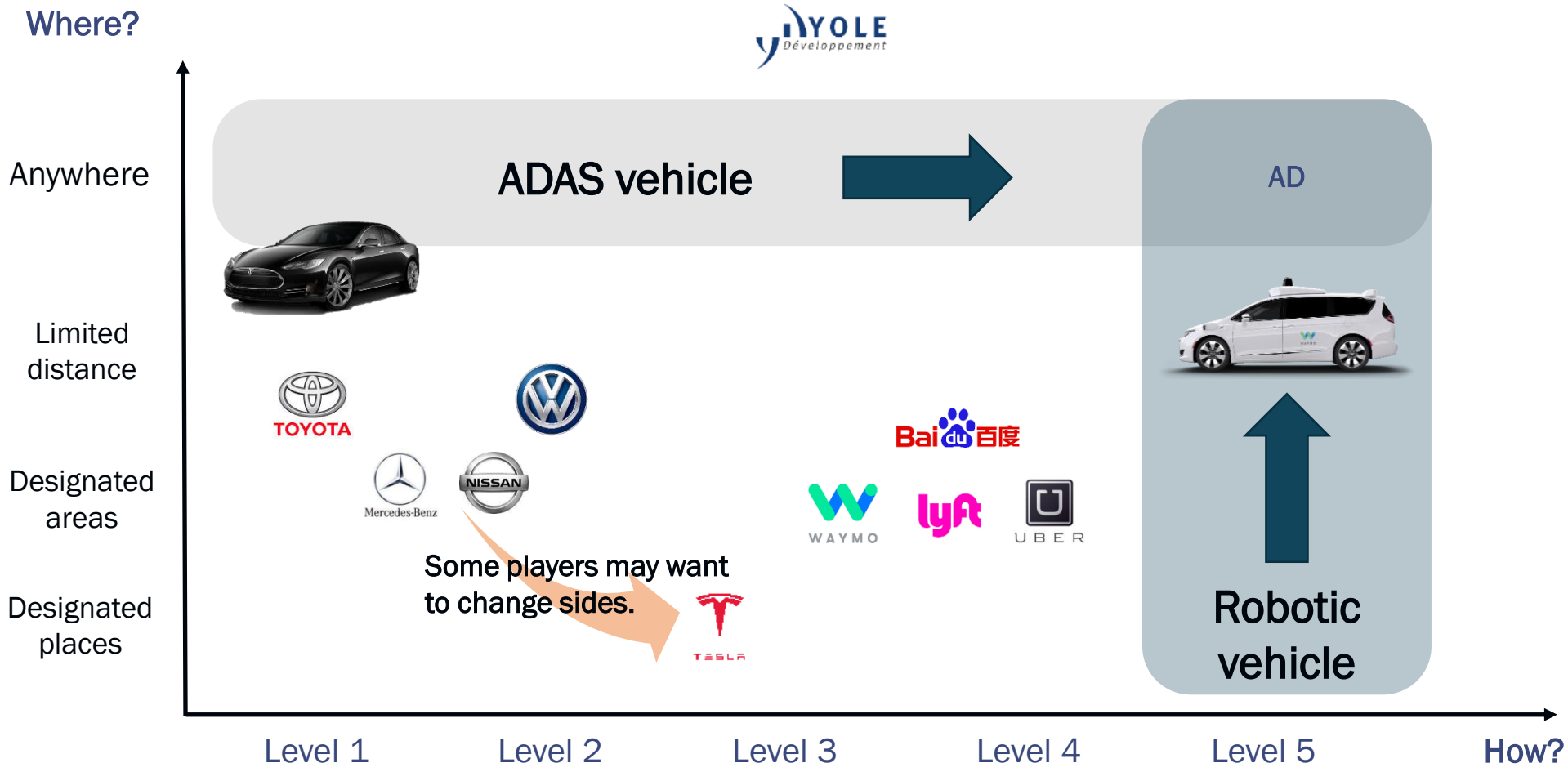
This presentation is looking into some similar "law" that could be seen in the "More than Moore" paradigm, i.e. image sensors and cameras

Automotive is the first "sensing" market for image sensors, where cameras are used in combination with computing chips for automotive ADAS, but also in some robotic vehicle applications for autonomous driving (AD)

AUTONOMOUS VEHICLES — THE ROBOTIC DISRUPTION CASE

There are two distinct paths toward autonomous vehicles

Both strategies lead to the same goal.



AUTOMOTIVE (ADAS) VS ROBOTIC CARS (AD)

Robotic cars use a different set of technologies than conventional cars

2018
Automotive
ADAS Level 1-2-2+

23M cameras for 94 cars
mass market technology
standard production
1.3Mp 3.75um 1/3'' RS

Application : Car ownership
personal mobility

Main Players :

TOYOTA, VW, GM, Mercedes, Ford, NISSAN, Peugeot, Nio, TESLA, Audi, HONDA, HYUNDAI, VOLVO, BMW, Mazda, Lynk & Co

Mainly Camera & Radar

High diversity of sensors

2018
Industrial
AD Robotic cars

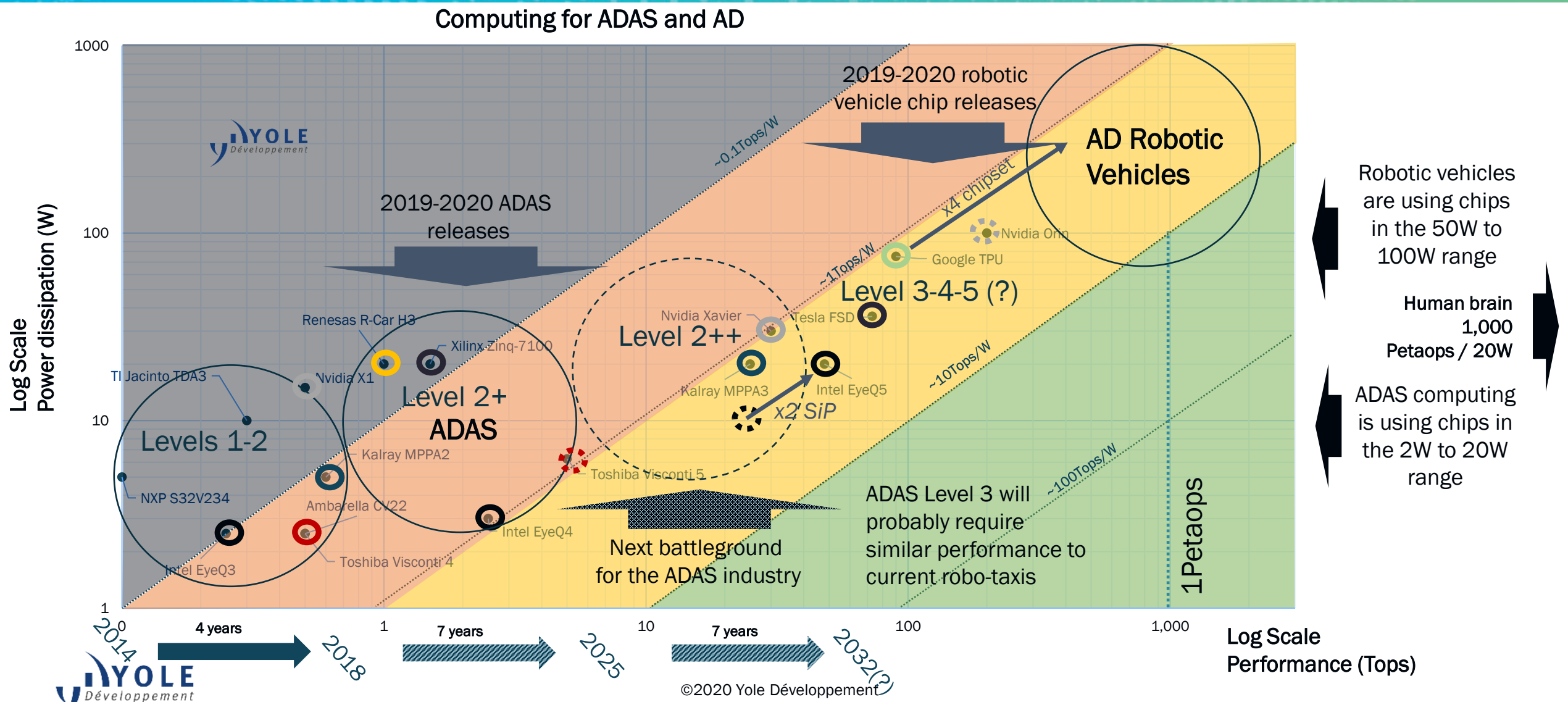
30k cameras for 4k cars
industrial grade technology
add-on retrofit approach
5.2Mp 3.45um 2/3'' GS

Application :
Fleet ownership
Mobility as a Service (Maas)

Main Players :

WAYMO, UBER, cruise, lyft, Baidu 百度, ZOOX

AUTOMOTIVE (ADAS) VS ROBOTIC CARS (AD)



Robotic vehicles are using chips in the 50W to 100W range

Human brain 1,000 Petaops / 20W

ADAS computing is using chips in the 2W to 20W range

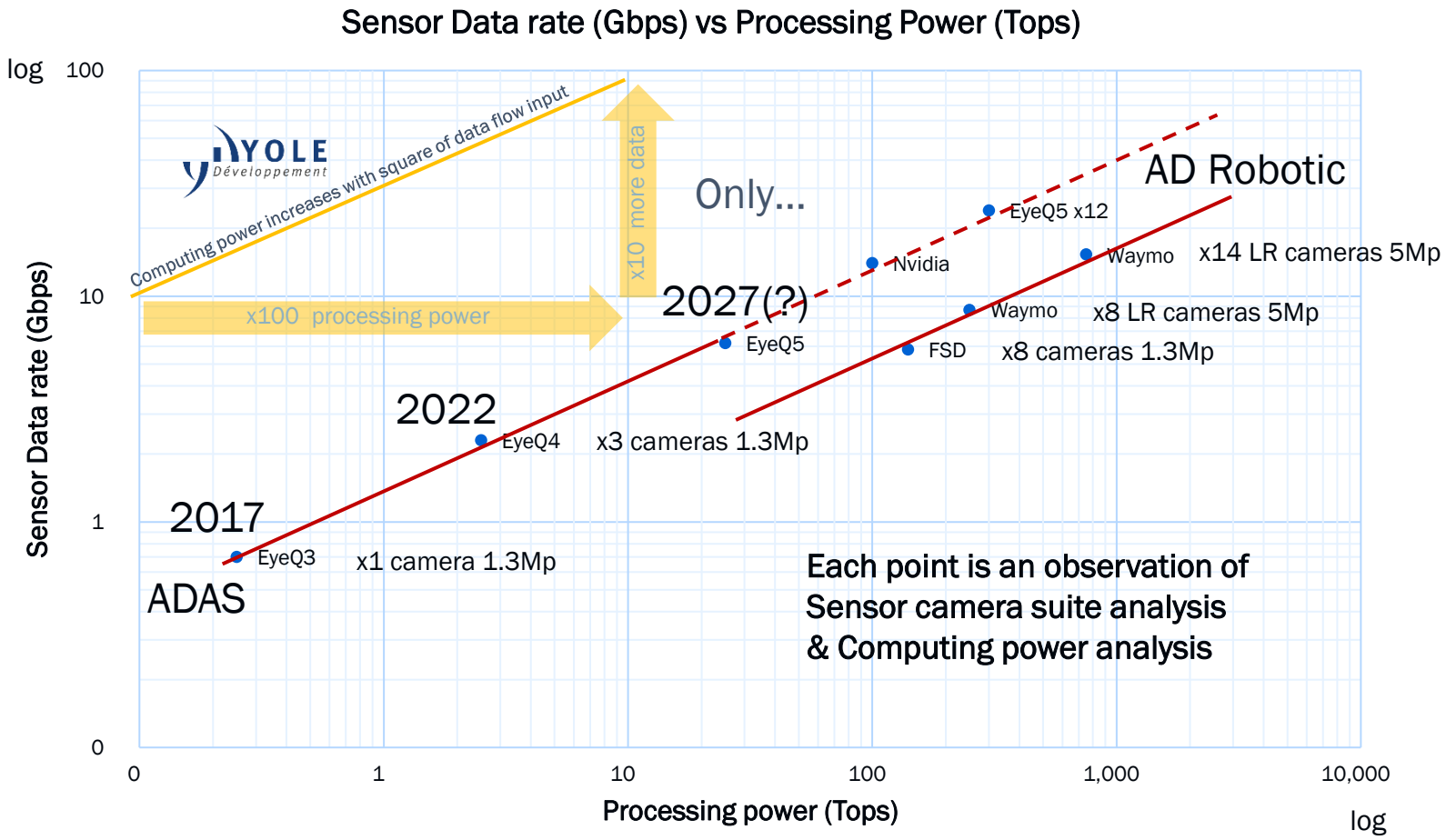
“MORE THAN MOORE” LAW

For these two applications every technical choice is a tradeoff

Due to Moore’s Law, players like Mobileye and Waymo were able to increase the processing power of their solutions by x2 every 24 months (at constant price)

From observation, the flux of camera data increases x2 only every 48 months

The flux of data fed to the AD system doubles every 48 months*



* The “More than Moore” law is twice slower than the Moore’s law

AUTOMOTIVE MARKET TREND — ADAS TO AD

How many cameras for what processing power?

Flux of Processed data and processing power are correlated

From 10 years of market analysis, seems like a “More than Moore law”:

Computing power requirement increases with the square of data

Current AD system design will be heavily limited by the ability to increase processing power

- Computing performance improvement will be in great demand (architecture, memory, GAAfet…)
- Sensing performance improvement (resolution, dynamics, frame rate) will have slower pull
- New sensing and computing approaches, improving “quality” vs. “quantity” of data is needed (Lidar, Thermal, SWIR,…)

AUTONOMOUS VEHICLES — SENSING AND COMPUTING

There are three innovation scenarios

3 innovation scenarios for the future of automotive sensing & computing

More of the same computing

New computing

Brute force computing

2,500Tops

2039

Video based automomy

250Tops

2032

Level 3-4-5

25Tops

2025

Level 2++

2.5Tops

2018

Today ADAS

Today AD Robotic

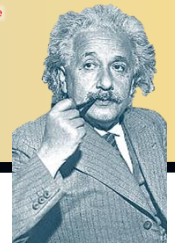
Addition of Lidar / Thermal / Swir...?

Quantum ? Neuromorphic ?

Tomorrow AD Robotic

Disruption?

Robotic autonomy using "better" data coming from new sensors



More of the same sensors

New sensors

WRAP UP

The goal is to reach autonomy. Question: when, where and how?

- There are currently 2 path toward autonomy: ADAS automotive or AD robotic
- Both paths follow a newly defined "More than Moore Law": computing power requirement increases with the square of the data being processed
- The consequence is that in today's innovation scenario in automotive, we are mainly waiting for Moore's Law to act to improve current ADAS application, using "same sensor" and "same computing" approach
- The other innovation scenario currently being used is looking into new technologies for better sensing, (lidar, thermal infrared, time gating, SWIR,…) knowing the computing power available. This approach is used by the AD robotic camp and could eventually bring L2++ to automotive sooner
- Disruption in this space would be the 3rd path to innovation: New technologies are emerging which could disrupt the roadmap, new sensing approaches combined with a new computing paradigm could accelerate history — neuromorphic, quantum technologies (else?) are highly needed

Thank you

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