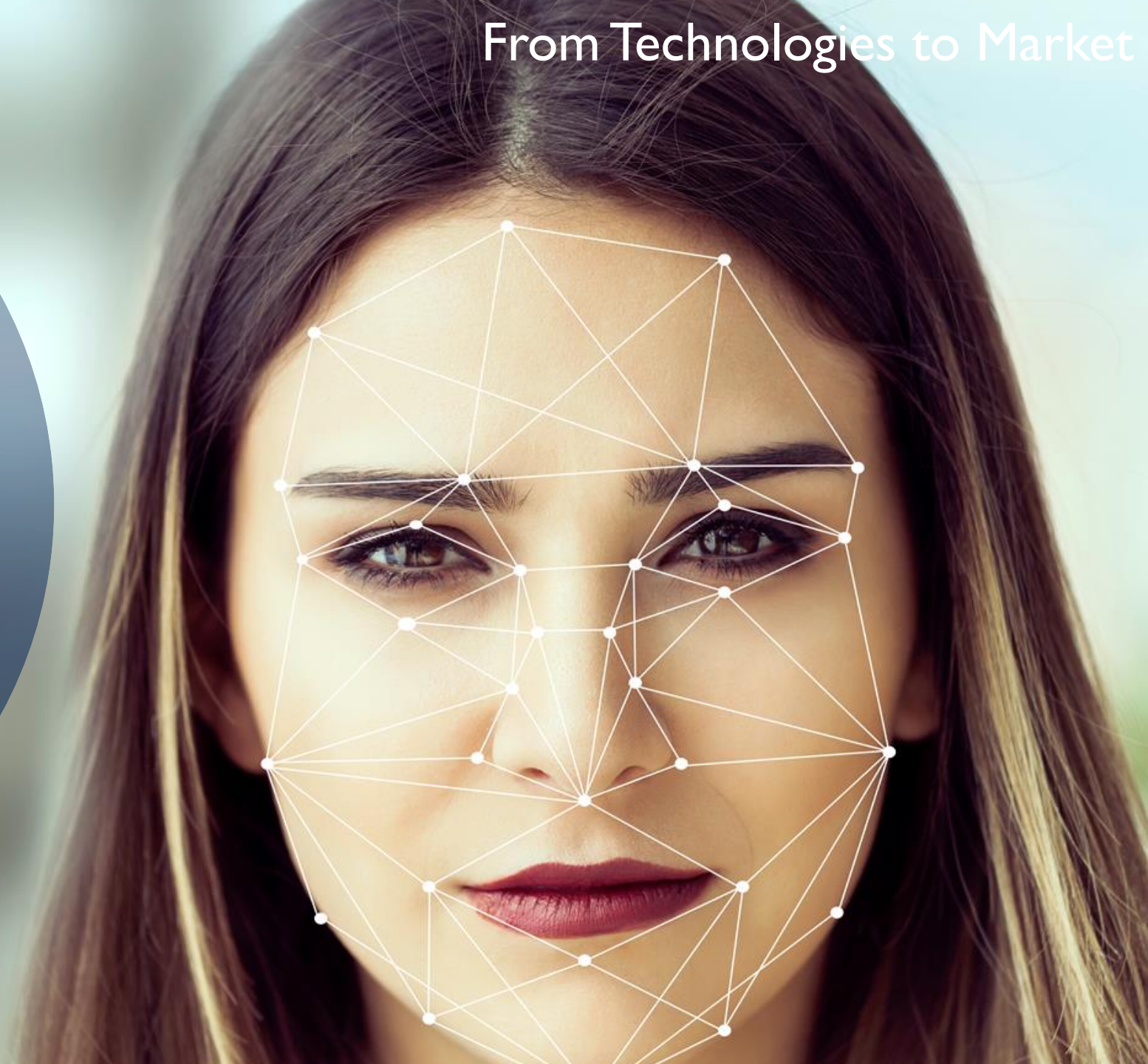
VCSEL – A market fueled by smartphone applications. But not only…

EPIC meeting on VCSELs Technology and Applications



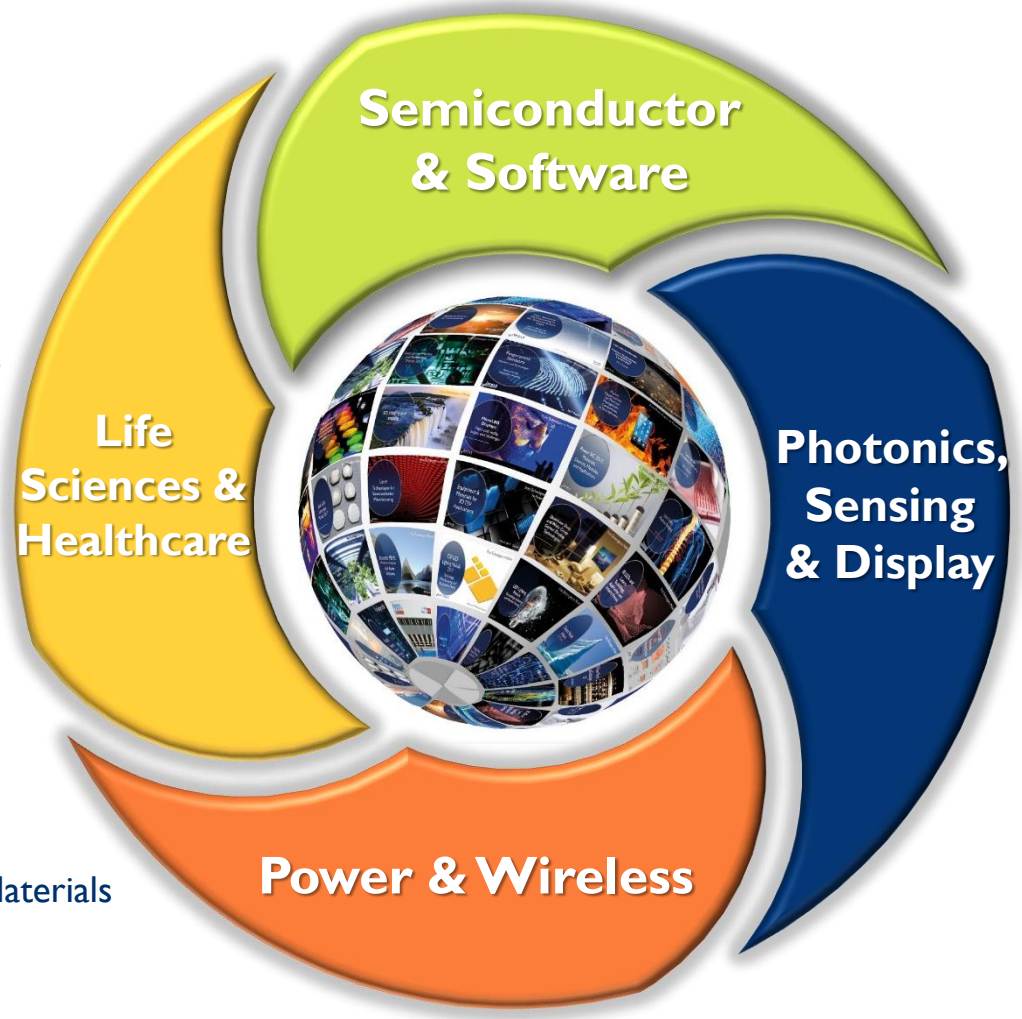
YOLE Développement

INTRODUCTION TO YOLE DEVELOPPEMENT – 4 DIVISIONS

Market research and consulting
30+ analysts in the following areas:

Life Sciences & Healthcare

- Microfluidic
- BioMEMS
- Inkjet Printing
- Solid-State Medical Imaging & BioPhotonics
- Bio Technologies



Semiconductor & Software

- Package & Assembly & Substrates
- Semiconductor Manufacturing
- Memory
- Software & Computing

Power & Wireless

- RF Devices & Technology
- Compound Semiconductors & Emerging Materials
- Power Electronics
- Batteries & Energy Management

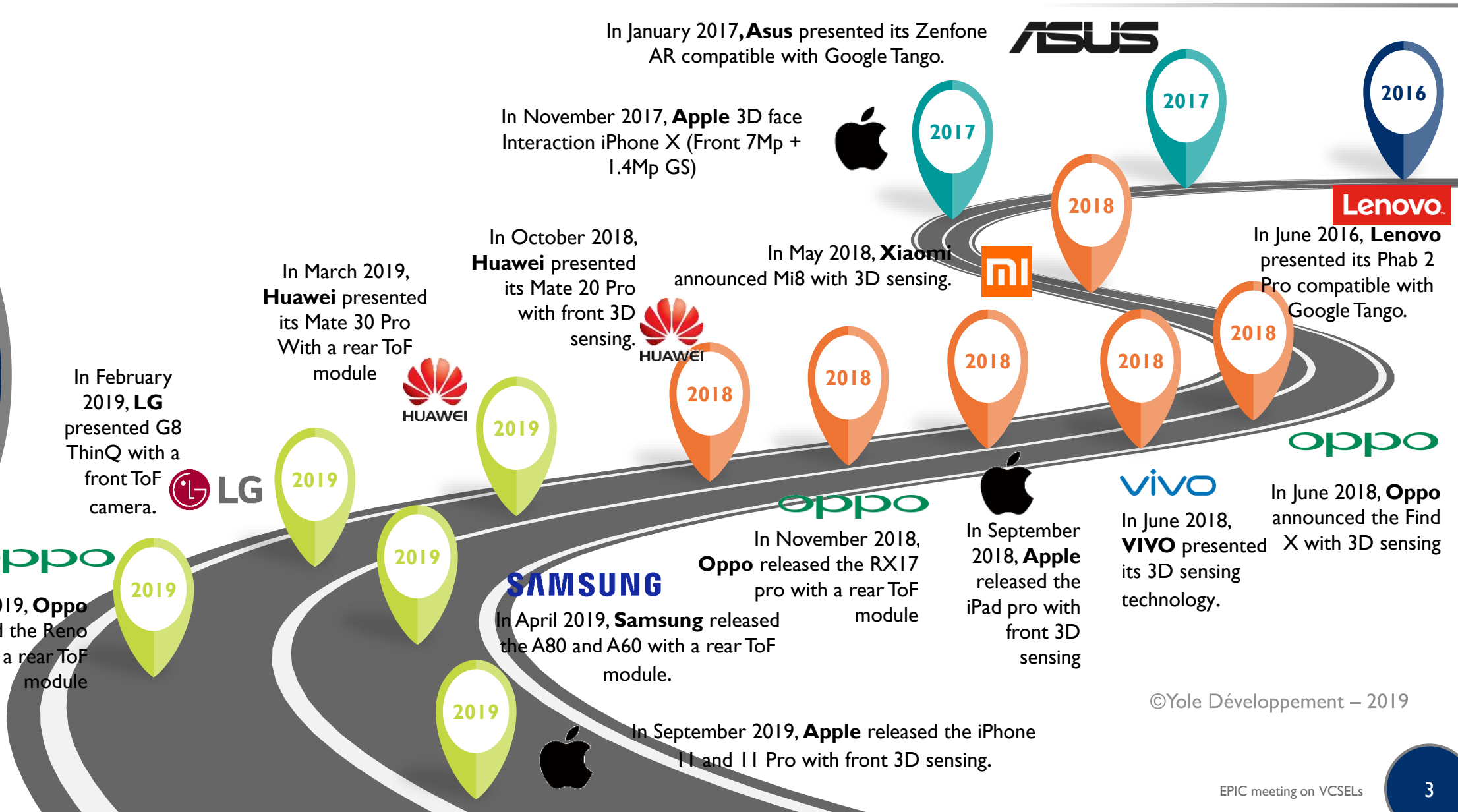
Photonics, Sensing & Display

- Solid-State Lighting & Display
- MEMS, Sensors & Actuators
- Imaging
- Photonics & Optoelectronics

VCSEL INDUSTRY

Apple vs. Android ecosystem - Trends

During 2018, six new smartphones have been released with 3D sensing modules. As of Q2-2019, six new smartphones have already been released and it is likely to continue.



VCSEL INDUSTRY

Smartphone 3D sensing roadmap – Front side

As of today, only high-end smartphones are implementing front 3D sensing module for facial recognition but stereo vision, less expensive, could be implemented in middle-end smartphones in the coming years.

2017

iPhone X

Front 3D camera
structured light
VCSELs: flood illuminator + dot projector (30k dots)
Luxury smartphones

2019

Vivo Nex
Dual Display

Front 3D camera
Indirect time of flight
VCSEL: flood illuminator
High-end smartphones

2020

Front 3D camera
Structured light
VCSEL: flood illuminator + dot projector (30k dots)
Luxury smartphones

2020

Front 3D camera
Direct time of flight
VCSEL: flood illuminator
High-end smartphones

Structured light approach could be replaced by a time of flight and/or a stereo vision approach.

2020

Front 3D camera
Stereo vision
VCSEL: dot projector (3k dots)
Middle-end smartphones

VCSEL INDUSTRY

Smartphone 3D sensing roadmap – Rear side

Rear side applications are expected to evolve from photography to augmented reality.

2015

LG G4

Rear camera
direct time of flight SPAD
Range: few meters

Used for autofocus

2018

Oppo RX17 Pro

Rear 3D camera
indirect time of flight
Range: few meters

Used for computational photography

+

Used for augmented reality

2020

Rear 3D camera
direct time of flight SPAD arrays
Range: up to 5-6m

2022

Rear 3D camera
direct time of flight with SPAD array
Range: up to 10m?

VCSEL INDUSTRY

Qualification status of VCSEL manufacturers for 3D sensing

Three main suppliers for smartphone are emerging. Leading VCSEL manufacturers are already qualified by OEMs with ams having many design wins.

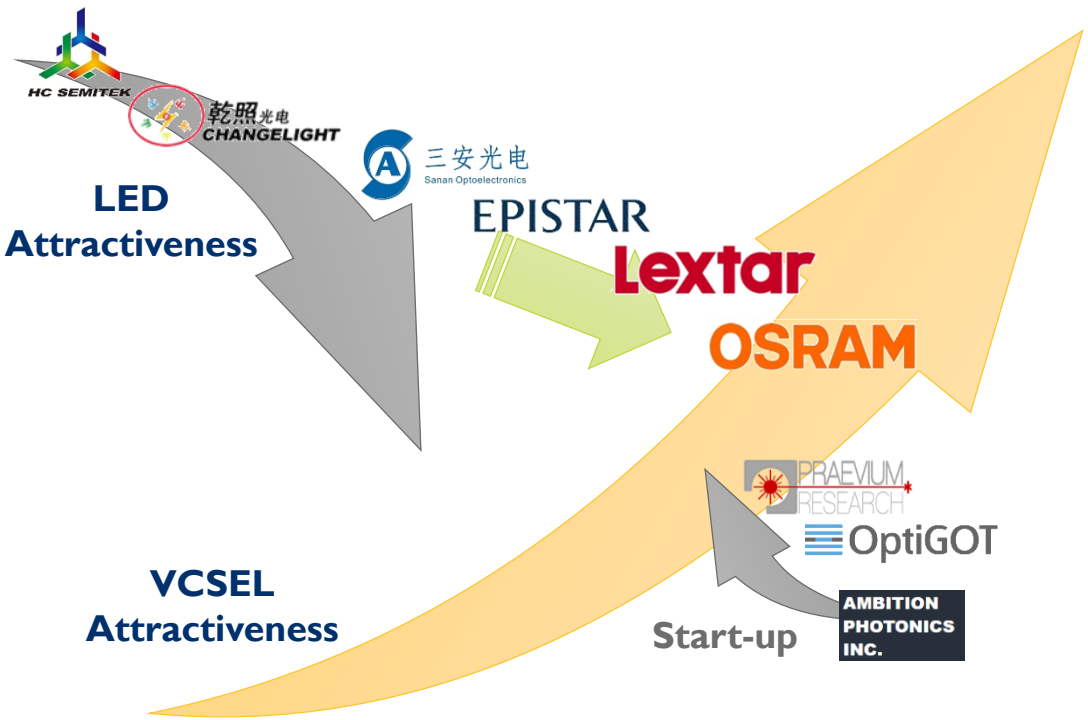
R&D	Qualification	Mass production	What for?	Customer
Lumentum			Dot projector Flood illuminator	Apple, oppo
HLJ			Proximity (Headsets)	Apple
Trumpf			Proximity Flood illuminator	Apple, Huawei
Princeton Optronics / ams			Dot projector Flood illuminator	Xiaomi, Huawei, LG ?
TrueLight Corporation			Proximity (Headsets)	Xiaomi, Huawei, oppo
II-VI / Finisar			Flood illuminator	Apple
Sanan				
Osram				
Lextar				
Epistar				

Who is supplying Honor and Samsung?

VCSEL INDUSTRY

Positioning of new entrants

New entrants will mostly position themselves as VCSEL designers, except for the ones already having epitaxy capacity (i.e.: MOCVD reactor) and know-how and able to qualify their process.



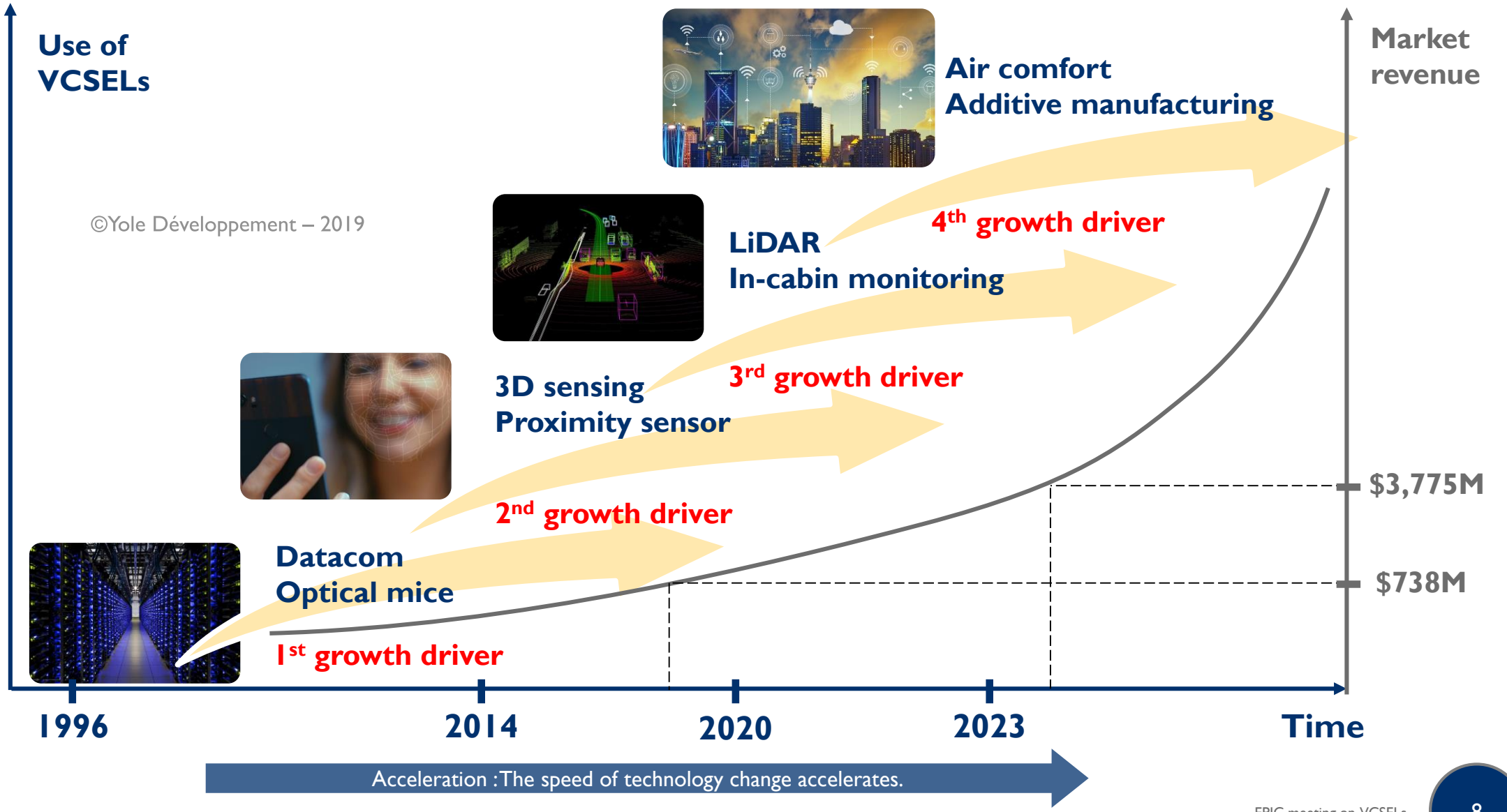
Attractiveness of VCSEL business

- With bright business prospects, the VCSEL business is attracting several new entrants coming from the LED industry and start-ups eyeing VCSEL potential.
- LED players want to use their knowledge on MOCVD epitaxy and their reactors for internal VCSEL manufacturing.
  - This might be a difficult task as traditional VCSEL players are already struggling with manufacturing yields and qualification process.
- Identified start-ups are positioned at VCSEL design level or at VCSEL module/system level and use their expertise related to epitaxy and chip manufacturing as well as specific IP and knowledge at different levels of the supply chain.
  - These players will compete directly with historical VCSEL giants and large new entrants coming from the LED industry, both with internal manufacturing capability.
  - They will need strong know-how, intellectual property and expertise to differentiate from other players.

VCSEL MARKET

Market growth drivers

Datacom was the first mass application for VCSELs. Today, consumer applications are increasing the demand for such devices. In the next few years, automotive and industrial applications should generate even more demand and volume.



VCSEL MARKET

New opportunities for VCSELs – Focus on automotive applications

Some opportunities in the automotive field…

Automotive - Interior

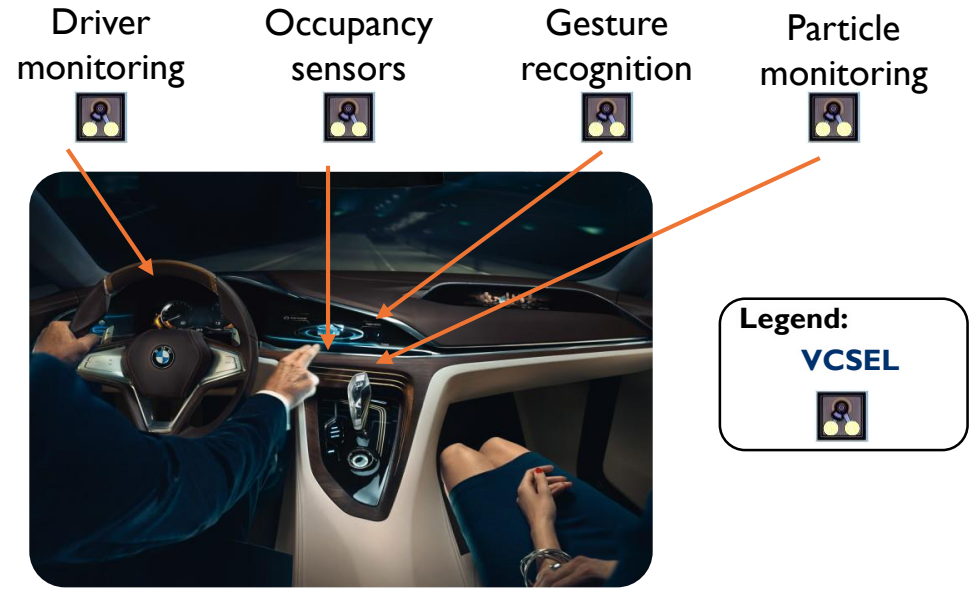
Short-term

- Gesture recognition
- Driver monitoring systems

Long-term

- Occupancy detectors
- Particle monitoring

ams TRILUMINA Advancing Illumination to Sense Your World™ eyeSight



Automotive - Exterior

Long range

Short- / Mid-range

XENOMATIX Automotive Vision Solutions fastree 3D ibeo automotive OUSTER

VCSEL MARKET

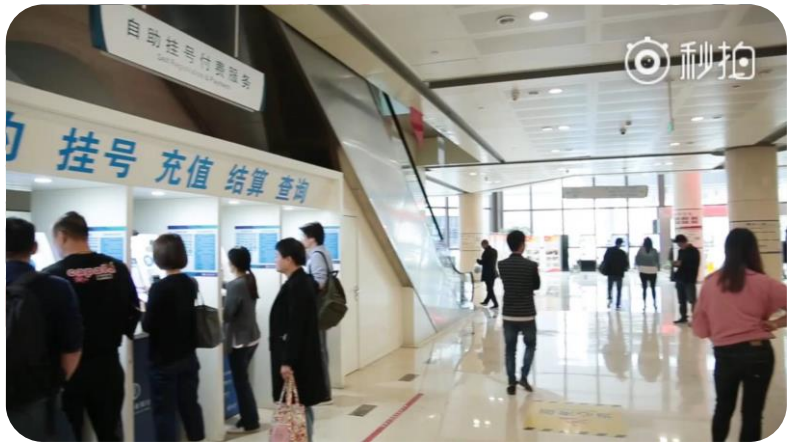
New opportunities for VCSELs

…but not only.

Face payment

MEGVII 旷视 · 蚂蚁金服 ANT FINANCIAL · KFC

Identity verification



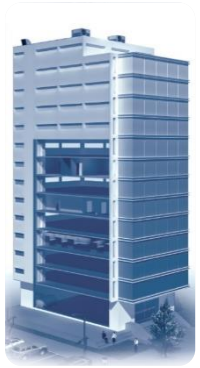
Medical systems

File creation
Registration
…

Access control

Business building
Government offices
Subways…

Air comfort



Transportation

paragon · BOSCH

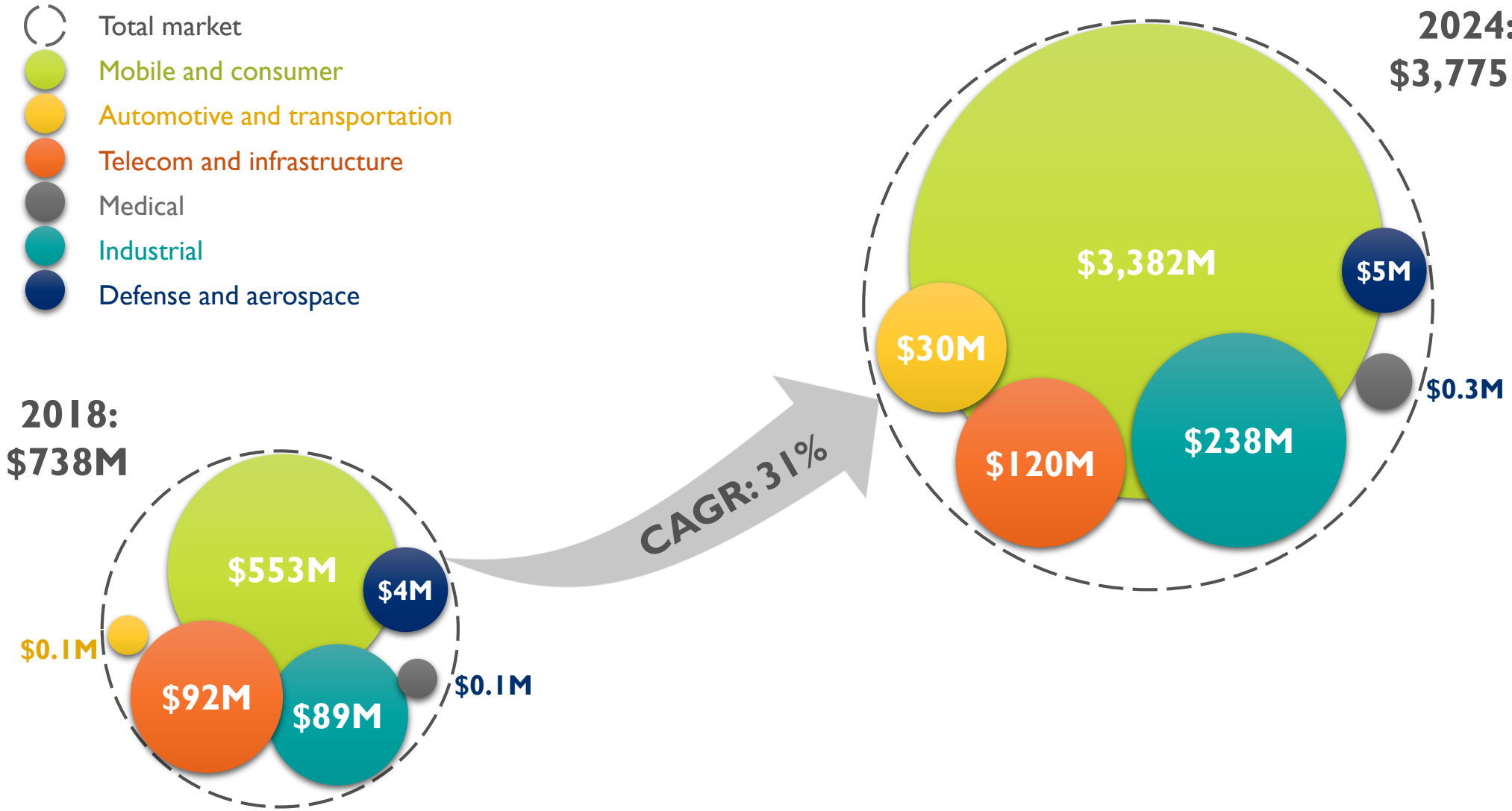
Smart building / Building automation

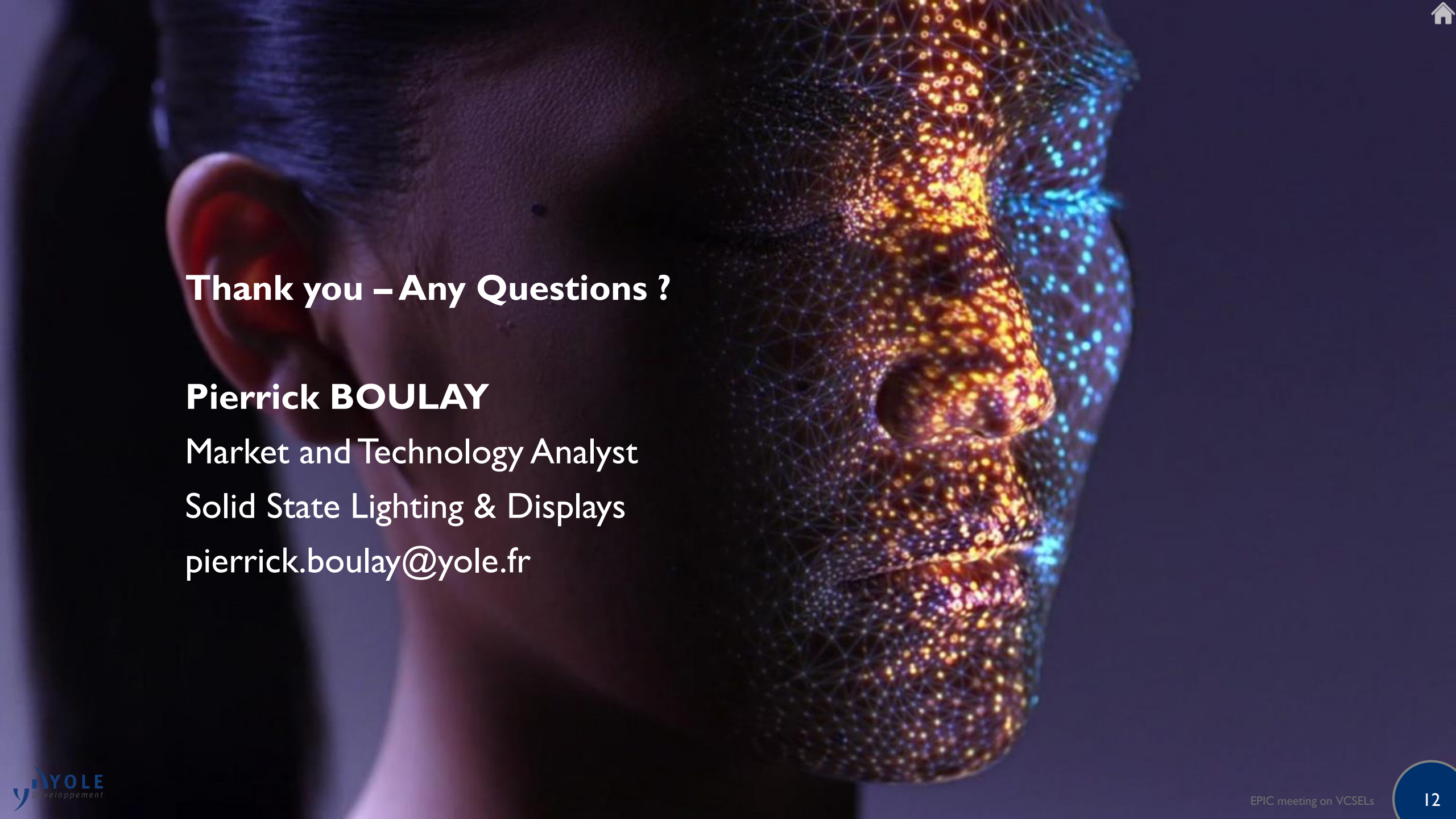
PLANTOWER 攀藤科技 · SHARP · SHINYEI TECHNOLOGY

VCSEL MARKET

2018 – 2024 VCSEL market forecast

A 31% CAGR is expected in the next 6 years with mobile and consumer applications driving the market.





Thank you – Any Questions ?

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