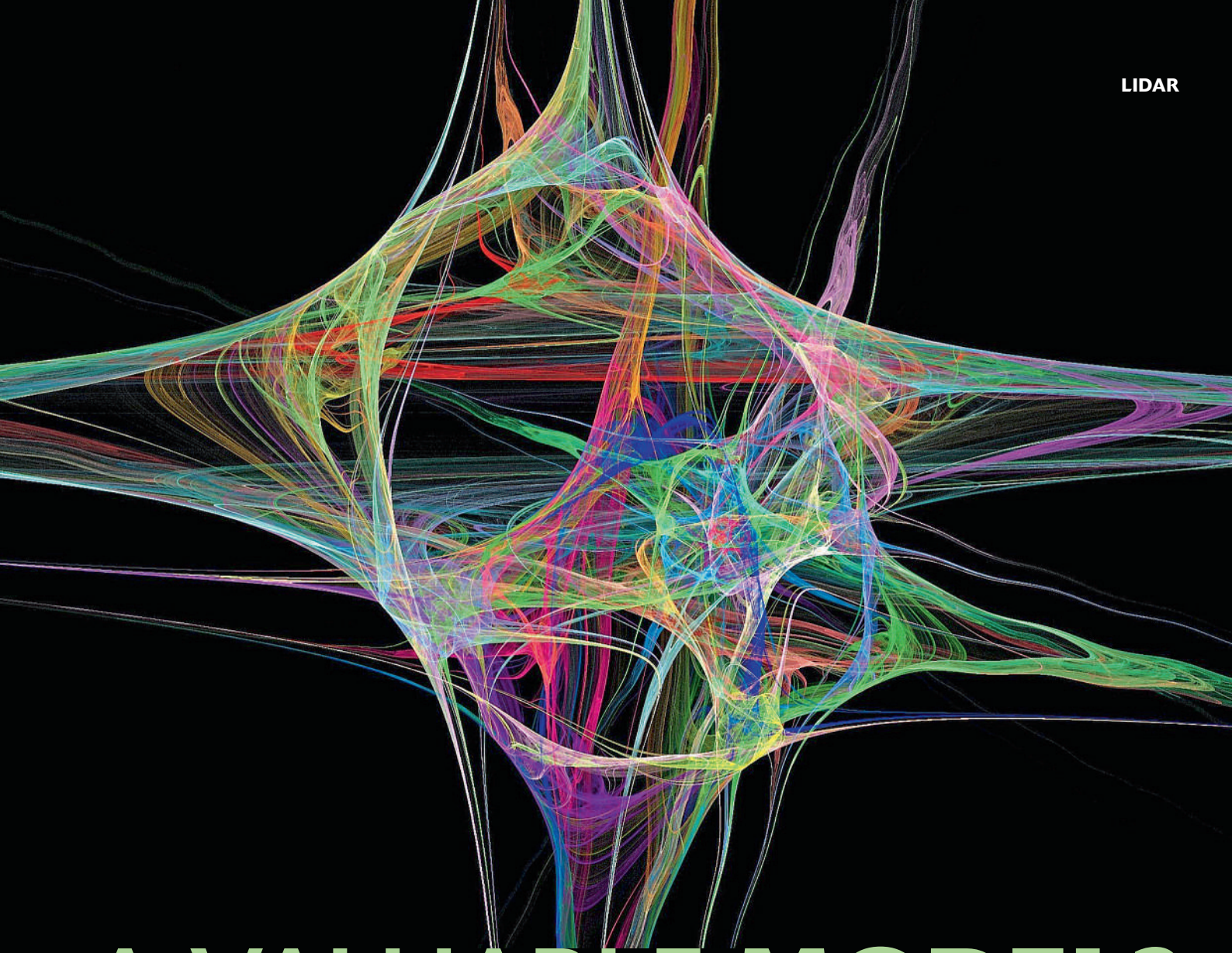


A VALUABLE **MODEL?**

WILL THE TOPOGRAPHIC INDUSTRY BE A MODEL FOR THE LIDAR INDUSTRY? THE INVENTION OF THE 3D REAL-TIME LIDAR 15 YEARS AGO HAS DISRUPTED THE LIDAR INDUSTRY AND INTERACTIONS WITH THE TOPOGRAPHIC DOMAIN HAVE EMERGED. **ALEXIS DEBRAY** AND **DIMITRIOS DAMIANOS** LOOK AT HOW ONE SECTOR COULD FOLLOW THE OTHER

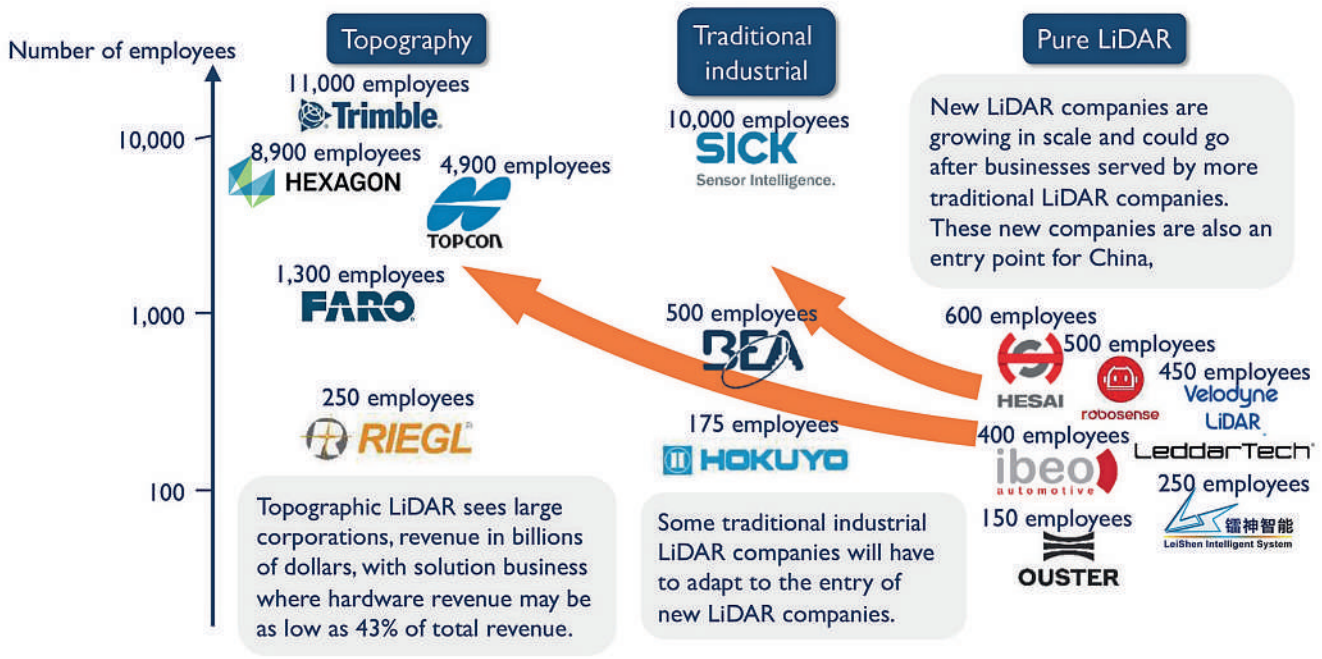
The LiDAR industry is living a revolution. About a hundred companies are involved in the development of new LiDAR aiming at applications in automotive, robotic cars, mining, logistics, factory automation, security, and farming. Considering the whole supply chain, hundreds of companies are involved. As a consequence, the LiDAR market for automotive and industrial applications is expected to grow from US$1.6bn in 2019 to US$3.8bn in 2025. Along with new applications, numerous new LiDAR technologies are being developed. MEMS micro-scanners, optical-phased array, Risley prisms, liquid crystals, wavelength shifting, and sequential flash are new technologies for image formation. These technologies allow for more robust and more compact systems, as well as easy mass-production when compared with traditional scanning systems based on turntables or Galvano scanners.

The revolution is also evident in ranging methods. LiDAR traditionally relies on direct time of flight (dToF) in which the time that it takes photons to travel to an object and back is used to evaluate the distance. Frequency-modulation continuous-wave (FMCW) is a ranging technique well known in radar but is new to LiDAR. FMCW has the potential to increase the sensitivity by a factor of 10 to 100 thanks to coherent detection. Usually operating at 1,550nm, this wavelength is much less damaging to the eye than 905nm. Therefore, it allows the use of more powerful lasers reaching longer distances. Finally, FMCW can leverage the technical blocks of silicon photonics to build reliable and compact systems using semiconductor technologies. Consequently, FMCW could lead to much more performant LiDAR in the future.

The changes are not only at the system level but also at the component level. Single-photon avalanche diodes (SPAD), vertical-cavity surface-emitting lasers (VCSEL), and silicon photomultipliers (SiPM) are making their way into LiDAR systems. SPAD and VCSEL are relatively new photonic components used for photodetection and light emission, respectively. They have found wide application in the consumer market.

LiDAR companies by business model and workforce

(Source: LiDAR for Automotive and Industrial applications report, Yole Développement, 2020)



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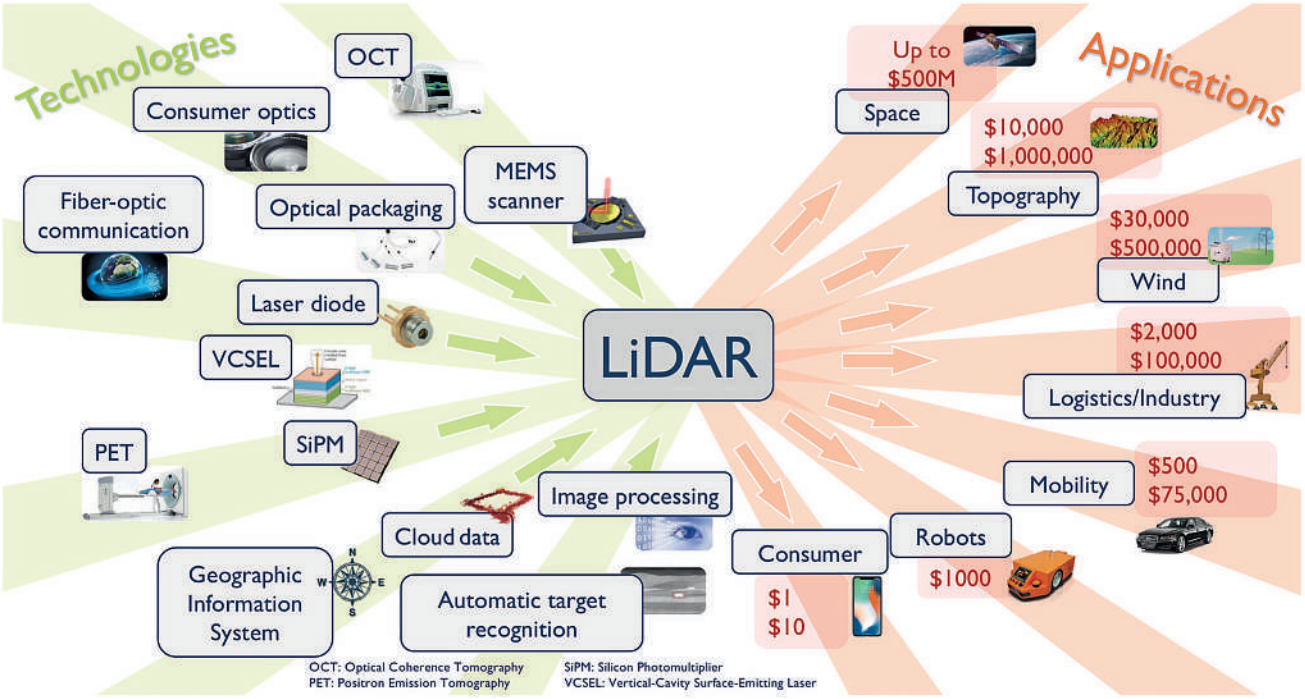
LiDAR: from technologies to applications

(Source: LiDAR for Automotive and Industrial applications report, Yole Développement, 2020)



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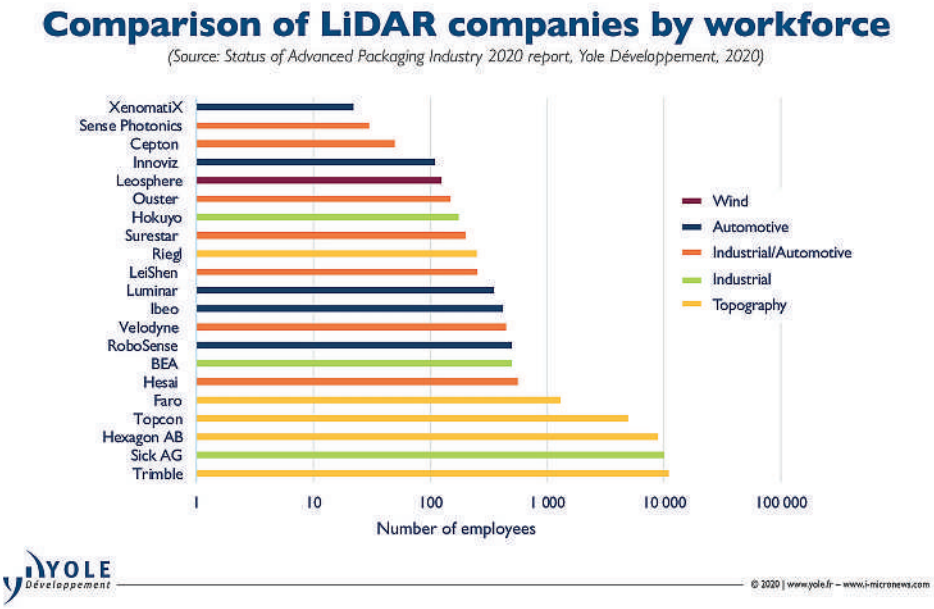

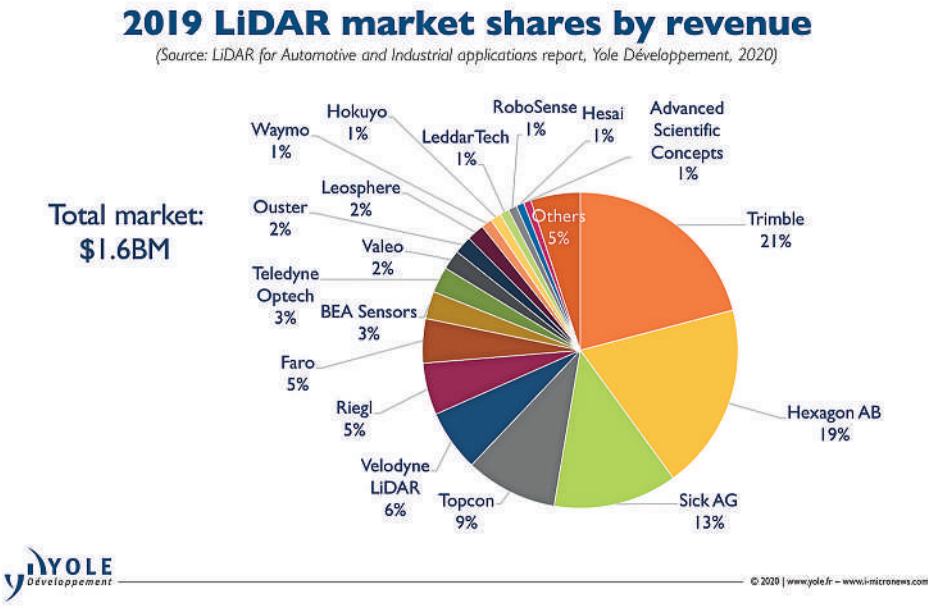

example, they are used for proximity sensing and 3D face identification in smartphones. These semiconductor devices can bring reliability to LiDAR systems. SiPM originated from medical imaging and are extremely sensitive photodetectors which can bring new improved performance to LiDAR systems. According to public sources, more than US$2.2bn has been invested in LiDAR companies since 2013. These investments are driving many technical innovations in the field.

A mature industry

Topographic LiDAR dates back to the 1970s. George D Hickman flew the first bathymetric LiDAR in 1968. Johannes Riegl founded the Riegl company in 1978. Riegl is a well-known provider of topographic LiDAR based in Austria, mainly specialised in airborne LiDAR. Topographic LiDAR are complex systems integrating several sensors, such as GNSS receivers and inertial measurement units (IMU) needed for very accurate positioning. Their minimum unit price is US$100k while automotive LiDAR is targeting unit prices below US$1k for long-range LiDAR and US$100 for short range. Topographic LiDAR has become a well-established business with applications in construction, infrastructure, and buildings. The main players are Trimble, Hexagon AB, and Topcon which are large corporations with annual revenues amounting to several billion dollars and a workforce of several thousand employees.

What is interesting about these companies is the evolution of their business models, evolving from selling hardware to selling services, where they are now using the data from the sensors they are selling to manage entire fleets of trucks, agriculture, and construction equipment. Concerning the LiDAR business, they are now not only providing hardware but also using the 3D data acquired by the LiDAR to provide construction plans as well as to organise and manage construction equipment which is monitored by GNSS receivers. The business of these companies has shifted so much from hardware to services that the hardware revenue for Trimble represents only 43% of its total revenues.

Two LiDAR worlds

How these two worlds will interact in the future is a difficult yet interesting question. In mapping, Velodyne, the inventor of 3D real-time LiDAR, is providing LiDAR to GeoSLAM for handheld systems which make for a new, simpler, and cheaper offering in the topographic domain. Phoenix LIDAR Systems, among others, is developing UAV-based LiDAR for mapping. DJI is also providing UAVs equipped with LiDAR which are coming from Livox, a Chinese company which targets also the automotive and industrial segments. UAVs equipped with LiDAR are a new proposition for topographic and industrial applications.

Handheld LiDAR and UAV LiDAR are the two main segments benefiting from lighter and less expensive LiDAR. For example, the unit price of a Livox LiDAR is around US$800. Topographic LiDAR companies are also interested in the new applications which have been released by new LiDAR companies in the past 10 years. Leica Geosystems, part of Hexagon AB, has recently introduced the BLK247, a LiDAR targeting security applications. Autonomous Stuff, also part of Hexagon AB, is providing various systems, including LiDAR from Velodyne, for the development of autonomous vehicles although they are not developing their own LiDAR for automotive applications.

Although the wandering of one world (topography) into another (automotive) is still modest, it will surely develop in the future, both profiting from each other's particularities and experience. However, it is unlikely that new LiDAR companies will take on the more traditional topographic LiDAR companies. The annual volumes for these last, estimated at 15,000 units for 2019, are much smaller than the several million units expected for the automotive market in the next years. Moreover, the business models are different with topographic companies emphasising services, software, and data management. Nevertheless, these traditional topographic LiDAR companies could serve as a model for the new LiDAR ones, evolving from solely hardware providers to include more software and services in their offerings. The LIDAR market is indeed transforming, with many exciting markets and technology developments ongoing on different fronts. One question remains: who will cross over and who will fall into the chasm?

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