



I. Overview

The main sector that the technology industry will have to tackle in 2018 is data privacy. With Europe's General Data Protection Regulation of 2018 coming into effect in May, every single organization in the world that collects any sort of data will be impacted. Simultaneously, we are seeing sustained growth in Cloud Computing, Urban Mobility, VR/AR, AI/ML, and IoT, while the more established fields of smartphones and blockchain are seeing a cooldown.

There is a lot of speculation and overvaluation in the industry, however. For example, Netflix has been valued with multipliers that led to valuations greater than Disney. It is possible that a bubble could burst some time in the near future leading to potential risks.

The following document has been written to provide CBE analysts, case team leaders, and managing directors with a basic overview of the technology industry in the United States. It is by no means complete.

II. Technology Trends by Field

A. GDPR/Privacy

In a nutshell, GDPR requires all data collected to be “opt-in” rather than “opt-out”, which means that users must explicitly allow the company to collect the data. The data must also be well-encrypted, up to date, and accurate. And, finally, users must be able to delete all of their data, to completely erase themselves. [1] The penalties for a violation of any of these rules are severe and proportional to the size of the company, which means that organizations are prioritizing GDPR compliance and dedicating a great amount of resources towards doing so. This intensely important legislation will shape data collection for the future, with major companies choosing to eschew cloud-based data analytics for more local data mining techniques. This brings Federated Learning research to the forefront, a technique which allows models to be trained locally and updated from the cloud, rather than sending user data to the cloud, effectively decentralizing machine learning. [2]

B. Cloud Computing

Nevertheless, cloud computing is still the future. There are two main types of customers for cloud computing: startups and large enterprise customers, but both categories witness the same benefits. Cloud computing is cheaper as it allows you to pay only for what you use, removing any overhead. The computing is decentralized, which means that load balancing and data backups are easier and more efficient. Further, cloud computing allows for simplified data analytics as providers have built-in, optimized techniques that integrate with SQL/No-SQL storage mechanisms.

This leads us to the fundamental benefit of cloud computing: specialization. Amazon, Google, and Microsoft have hundreds if not thousands of employees solely dedicated to building strong support systems for their cloud computing mechanisms. With AWS dominating in market share and Azure and Google Cloud constructing a ecosystems that are growing at rates above 100% YoY (Oracle and IBM are also major players), the technological development in the field is at an ever-accelerating pace, with Kubernetes and Spark being fantastic examples. This means



stronger security protocols and optimization in every way. Google may lead in ease-of-use, while AWS leads in the number of offerings, and Microsoft leads in integration with legacy products. [3]

C. Urban Mobility

Self-driving ride-sharing, dockless bike-sharing, dockless scooter-sharing. Cities are changing, and the way we move around them is changing too. Technology is driving new forms of transit, driven by electric vehicles and sharing. Bonzer, a startup in Cambridge, MA expects to deliver car-sharing to suburbs with small, three-seater vehicles. [4] Uber, Lyft, and Via are, of course, growing rapidly and partnering with transit organizations to provide last-mile connectivity, [5] along with exploring self-driving taxis, such as Waymo's experiment in Phoenix, even after the accident. [6] Dockless bikes and scooters from companies like Lime and Bird are causing headaches for regulators who aren't sure whether these will just be a fad or not. [7] All of these technologies are only possible due to strong 4G and soon 5G connectivity around the US, allowing for app-based rental and GPS tracking. Cities and streets are being redesigned behind these paradigms and only time will tell which technologies are fads and which are built-to-last.

Self-driving cars will likely lead to more car-sharing and reduced car-ownership, reducing the need for parking and wide-streets. This could, in the very long-term, yield improved walkability and density in cities. All of these technologies will also bring environmental benefits as mobility services move towards electric power. Finally, as the platform of Mobility as a Service grows, housing will likely have to be redesigned to accommodate denser populations. This could lead to a taller, denser San Francisco, for example, where NIMBYism may be hampering growth.

D. Smartphones/Laptops

The field of smartphones, dominated by Apple in the US and Android worldwide, with Samsung, Huawei, and Xiami being the primary Android manufacturers, has seen a plateauing of global demand in recent years, with a YoY drop of 2%. [8] The low-margin market has been hampered by a lack of innovation and intense competition from Chinese manufacturers. Smartphones are no longer the hot new market and are not seeing much growth, especially in the US. This will likely continue until there is some new technological breakthrough, and, until then, we will likely only see incremental iterations of phones similar to the iPhone X and Pixel series. Along the same lines, there is not a whole lot happening in the laptop/personal computer market, although Apple has been slow to update its computers, while Microsoft has been busy building a solid ecosystem with its Surface line.

E. Wearables

Wearables are seeing a great amount of growth, potentially jumping to a \$100 billion market in 2021. [9] Smartwatches account for 15-20% of that market, dominated by the Apple Watch. But, the primary use-case comes from sports/fitness, such as Fitbit. Another potential market is AR enabled eyewear. Although the Google Glass failed in the consumer market due to privacy concerns, it is making a comeback along with the Microsoft HoloLens in the B2B markets, primarily for manufacturing and education. About 50% of factories in the US are already utilizing some sort of AR/VR headset technology. [10]



F. Virtual Reality/Augmented Reality

Segueing, Virtual Reality and Augmented Reality will likely be the next big disruptor in several industries including medicine, retail, and manufacturing. VR is already huge for gaming with organizations such as Facebook (Oculus), HTC, and Sony investing heavily in these applications. VR is also heavily useful for training purposes and in medicine, with applications to prevent behavioral or eye diseases. [11]

Augmented and Mixed Reality will likely have a larger impact, with Google, Microsoft, and Apple making big strides. Google and Microsoft have existing wearables that have seen heavy experimentation, and Apple has been speedily developing AR platforms with ARKit and is reportedly even working on an AR enabled wearable. AR has been making strides in gaming as well, with Pokemon Go the prime example. AR also has redefined tourism, retail, and manufacturing experiences. In tourism, AR-enabled tours have allowed phones to replace tour guides. In retail, AR has allowed users to try on clothes and see how furniture fits in their homes. Finally, in manufacturing, AR has allowed engineers to go hands-free and view detailed information as they work. The field is ripe for further innovation and it'll be exciting to see where it goes.

G. Artificial Intelligence/Machine Learning

AI and ML techniques have become increasingly easier to use for even untrained developers. Packages like Keras and TensorFlow and cloud services primarily from Azure and Google Cloud Platform have allowed developers to create and use neural networks and statistical models for large data analytics. This has led to an explosion in the use and training of effective machine learning models as even small, bootstrapped companies can access these techniques without large overhead costs. [12] This opening up of ML techniques has allowed for major strides in the use of ML in healthcare for driving down drug development costs, in finance for effective market predictions, and in security for predicting cyber-attacks and image identification. The data deluge has allowed for input data availability to grow dramatically, also contributing to smarter models. On the research side, as discussed earlier, federated learning is bringing huge privacy improvements to model development and new networking techniques are bringing greater efficiency to distributed neural networks.

H. IoT/5G

5G networks are expected to deploy later this year, as the 5G standard was approved earlier this year. Carriers are expected to launch 5G networks by the end of the year and 5G enabled phones are expected to launch simultaneously. 5G networks will bring theoretical speeds of up to 2 Gbps, miles ahead of the current 4G LTE standard. This will lead to the enablement of true Internet of Things technologies, with large networks of products everywhere. This means connected cars, connected streetlights, connected doorbells, connected mailboxes, etc. [13]

Many will run on Apple's HomeKit protocol or Google's Home ecosystem, which will bring a real purpose to those other than turning your Apple TV on and off. This will also bring a real purpose for digital assistants like Cortana, Alexa, and Google Assistant other than turning Spotify on and off.



Embedded sensors will gather and deliver data about every mundane aspect of our lives. This brings up privacy concerns, especially as, in their current form, IoT devices are not powerful enough to run data calculations on their own so they have to offload their data. IoT has an adoption problem in its current form as it still is expensive and only for the more tech-savvy consumers. But, as the prices fall and availability rises, the technology will become highly commonplace and useful.

I. Blockchain

Since its zenith in December 2017, Bitcoin and other cryptocurrencies have crashed and the market has been either plateauing or falling, depending on what regulators have been feeling. This also goes for the hype around the blockchain technology. Few, if any, practical applications of blockchain have taken off, although many companies have experimented with it. Blockchain is extremely expensive to run, not just because of the electricity and computing power required, but also because of gas costs for every transaction, especially on larger blockchains. This makes prototyping prohibitively expensive and actual deployment and customer acquisition expensive as well, let alone retainment. The other issue is that, while decentralization has significant benefits for security, many of those benefits can be achieved in alternative ways and may be just as effective.

J. Cybersecurity

Cybersecurity remains what should be the most major important concern that any company that collects any data should have, other than privacy. After a series of major breaches in 2017, including the infamous Equifax breach and the Intel security flaws, companies are hiking investments in data protection and hardware protection. There are huge risks and breaches just waiting to happen. AI/ML based techniques will allow experts to identify trends in past attacks and notify experts should such trends repeat, but hackers can also use the same techniques to identify holes, reducing the amount of manual labor involved in hacking. Ransomware attacks may expand to IoT devices, holding entire ecosystems hostage. And, worse, state-sponsored attacks may ramp up in this tough political climate. [14,15]

III. CBE's Role

At Harvard Undergraduate CBE, we are committed to helping the technology economy shift further towards innovation, growth, and a sustainable future. In the past, we have worked with numerous players in the industry, including GE, Nference, and Boeing. We recognize that the technology industry moves fast and therefore push to ensure that we remain up to date and enthusiastic about all the new fields that technology opens up.

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