Longer Term Investments

Enabling technologies

Chief Investment Office WM | 21 May 2018 7:04 pm BST
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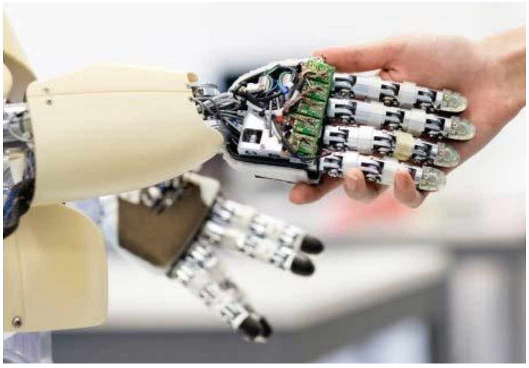
- Tech devices and advances have disrupted every aspect of our lives, and spending on the underlying enabling technologies that enable their development and production should remain high over the next decade as both disrupting and incumbent companies continue to invest to grab or defend market share.
- We have identified five mainstream enabling technologies – artificial intelligence (AI), augmented reality/virtual reality (AR/VR), big data, cloud computing and 5G – that are set to transform many industries over the next decade. We expect them to grow in aggregate by an average 12.8% annually, from USD 420bn in 2017 to USD 1.1trn in 2025.
- Hence, we believe enabling technologies offer solid long-term growth as technological disruption is an irreversible trend. Investors can take part in this by investing in a diversified way in our theme of enabling technologies, with leading software and semiconductor companies emerging as winners.

Our view

Disruptive innovation is a term coined by Harvard University professor Clayton Christensen. It refers to processes in which a product or service takes initial root in simple applications at the bottom end of a market before moving relentlessly up the value chain and eventually displacing established competitors. Trends like e-commerce, fintech and automation have demonstrated how technology can dislocate markets in a short time span. Incumbents now realize that disruption is an irreversible trend and are adapting to the new normal according to the long-standing principle "if you can't beat them, join them."

As a result, interest from technology disruptors and incumbents alike in investing in enabling technologies (ETs) that drive innovation is increasing. The five mainstream ETs we have identified as likely to create significant economic value over the next few years include AI, AR/VR, big data, cloud and 5G. For example, an AI chatbot can help a bank and a tech disruptor both to improve their fintech offering, while AR/VR can aid a retailer and a tech company in bettering their e-commerce offerings. We expect these five ET industries to grow by an average 12.8% annually, from USD 420bn last year to USD 1.1trn in 2025.

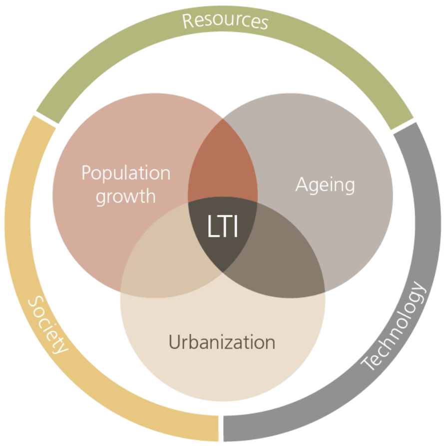
We see enabling technologies as one of the best ways to invest in technological advances and expect a double-digit rate of earnings growth. Investors, in our view, will be best rewarded by taking diversified exposure to companies involved in ETs. Software and semiconductor companies with superior pricing power and high entry barriers should fare particularly well, in our view.



Source: UBS

Introduction to the Longer Term Investments (LTI) series

- **The Longer Term Investments (LTI)** series contains thematic investment ideas based on long term structural developments.
- Secular trends such as population growth, ageing, and increased urbanization create a variety of longer term investment opportunities.
- These investment opportunities are influenced by the interplay of technological advancement, resource scarcity, and the societal changes.
- Investors willing to invest over multiple business cycles can benefit from potential mispricings created by the typically shorter term focus of stock markets.



Key drivers

Demand for enabling technologies will be strong over the next decade, in our view, thanks to three key factors:

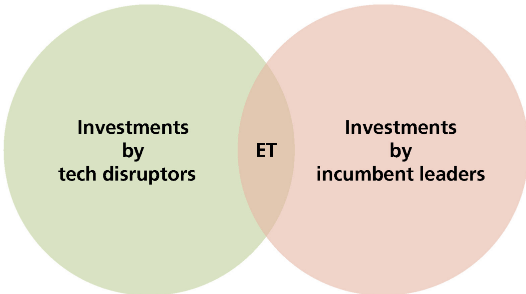
Technological advances: Technology has become so ubiquitous in our lives that it has redefined the meaning of everyday English. "Cloud" now refers to computing delivered through a network; "tablet" means a smart device used to browse; and "to stream" equates with playing videos on the internet. In our report "The economics behind long-term themes" published on 20 February, we highlighted how technological disruption has only begun.

Despite the strong growth, penetration ratios of key technological trends are only in the early stages. For example, e-commerce penetration has just crossed 10% in a few markets, whereas fintech penetration based on our recent report is still in low-single digits. Against this backdrop, we think major technology companies will continue to focus on investing in the enabling technologies that power these disruptive trends. Meanwhile, incumbents are not being left behind because they are realizing the benefits of technology. In our fintech theme, we highlighted how traditional banks enjoy higher return on equity (RoE) and lower cost-to-income when they invest in fintech technology. We also discussed how traditional retailers that embrace e-commerce are benefiting from above-average growth. As a result, we see enabling technologies companies occupying a sweet spot as they benefit from the spending of both tech disruptors and incumbents. For instance, investing in cloud helps a tech disruptor launch a fintech service through an app that lowers its time-to-market, while for a incumbent bank it can help reduce its data center costs and streamline processes, thus leveling the playing field. Similar examples can be shared across industries like retail, ride-sharing, leisure, etc.

Fig. 1: Tech disruption has only just begun
The many forces of technology disruption and enabling technologies

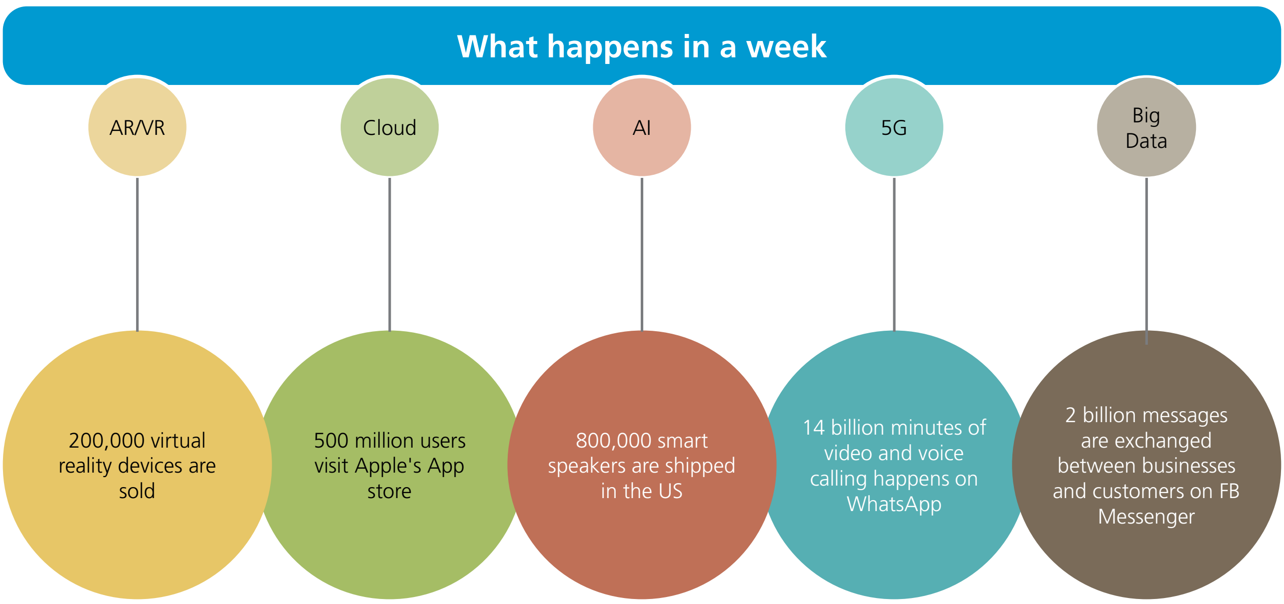
Source: UBS, as of May 2018

Fig. 2: Enabling technologies (ET) is in a sweet spot



Source: UBS, as of May 2018

Fig. 3: An average week in the life of enabling technologies
Activities across industries



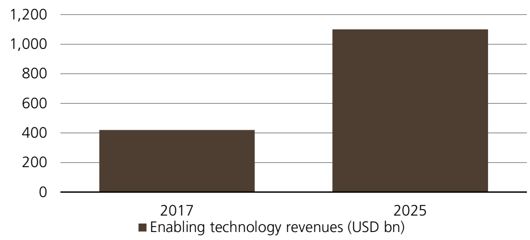
Source: Company reports, Facebook, Apple, eMarketer, IDC, Bloomberg Intelligence, UBS, as of May 2018

Changing consumer lifestyles: Millennials, who make up 27% of the global population today, are digital natives who are changing consumer lifestyles. Driven by a desire to stay connected at all times and the need to efficiently multitask throughout a busy day, most of us have become digital omnivores. In an average week, two billion messages are exchanged between businesses and customers on Facebook Messenger (big data), according to Facebook; 14 billion minutes of video and voice calls take place on Whatsapp (5G), according to Facebook; 800,000 smart speakers (AI) are shipped in the US, and 500 million users visit app stores (cloud), according to Apple; and 200,000 virtual reality devices are sold, according to IDC and Bloomberg Intelligence. This increasing consumerization trend will lead, in our view, to greater demand for the enabling technologies that support the megatrends.

Need to drive further enterprise productivity: Technology has boosted economic growth via productivity improvements (personal computers, office automation, etc.) in a low-growth environment, and the need to raise productivity further has only increased. As a result, an incremental shift is occurring in the nature of enterprise spending away from merely maintaining legacy technologies to introducing emerging technologies, with cloud, big data and AI as the key beneficiaries. Thanks to the disruptive nature of many of these enabling technologies, we see significant economic value being added globally over the next few years through efficiency gains.

Fig. 4: Enabling technologies expected to post CAGR of 12.8% during 2017-25

Industry revenues in USD bn



Source: UBS, as of May 2018

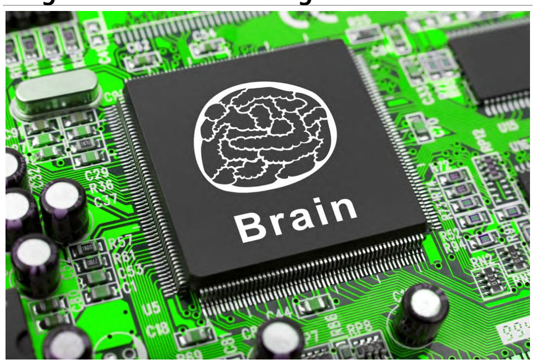
How big is the addressable market?

The five enabling technologies that we think will transform the global economy over the next decade account today for only mid-teens of global IT spending. Thanks to their widespread adoption by disruptors and incumbent companies alike, they represent one of the fastest growing areas within the domain of IT expenditures, and we expect the amount devoted to them to rise from USD 420bn last year to USD 1.1trn in 2025, an average annual growth rate of 12.8%, three times faster than that for overall global IT spending. In the next few sections, we provide explain why we believe the five enabling technologies are set to transform many industries.

Artificial intelligence

AI is commonly defined as "the theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages." More practically, we think of AI as a set of tools and programs that makes software "smarter" so that an outside observer thinks the output is generated by a human. This is how Alan Turing first described it in his 1951 paper "Computing Machinery and Intelligence." In practice, Turing's definition of AI can be broadly applied to computers performing tasks previously done by human beings at a comparable or higher level.

Fig. 5: With AI, machine intelligence will converge with human intelligence



Source: Dreamstime, UBS

An overnight sensation, 67 years in the making

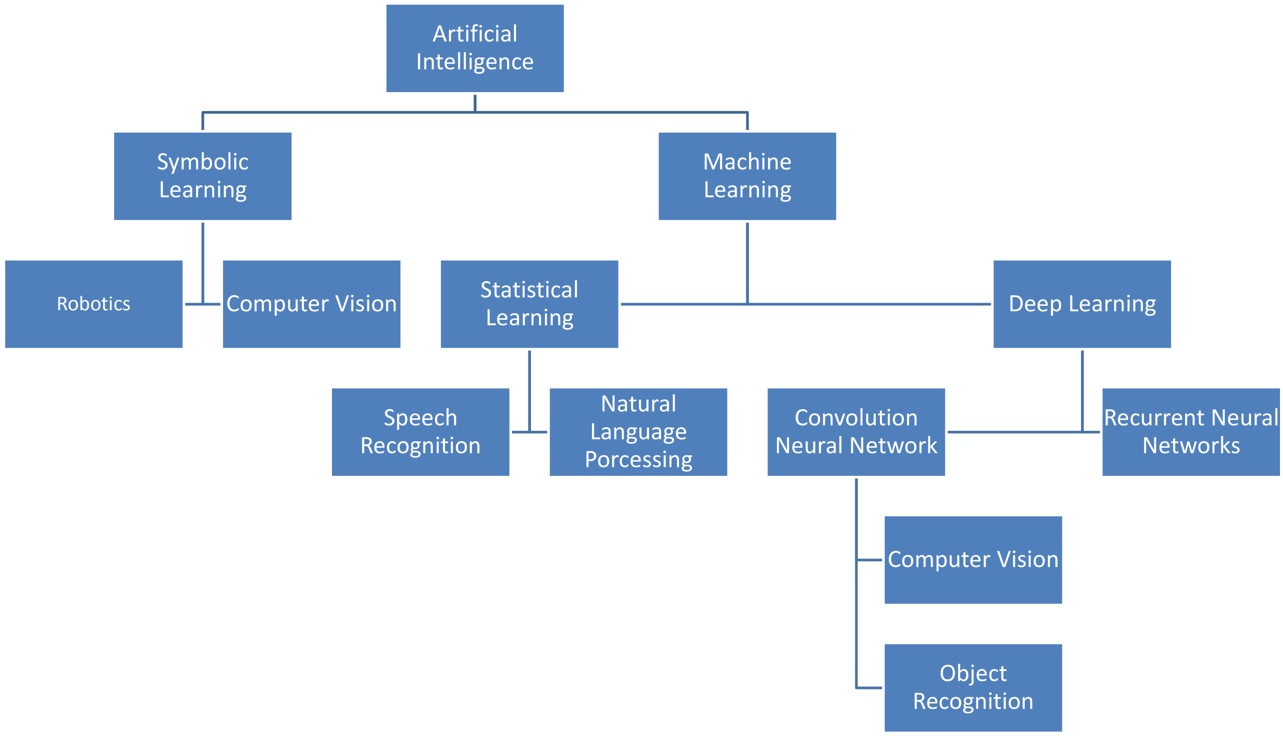
Almost seven decades after Turing's paper, AI is finally about to realize its potential, we believe, thanks to the huge strides made in computing power, storage, networking and software platforms. In the longer term, AI will likely function as a broad horizontal technology platform with the potential to fundamentally change how many industries operate. Its initial beneficiaries will likely be the companies that provide the underlying technologies and products that underpin it.

AI – what it is and what it isn't
AI is typically used as a blanket term to describe what are actually three very different forms of the technology – narrow AI, artificial general intelligence (AGI) and artificial super intelligence (ASI) – that have very different applications, effects and adoption timelines. Similarly, many equate machine learning, neural nets and deep learning with AI, while they are actually individual technologies and techniques among other AI components. Lastly, AI is not a panacea that solves problems autonomously, but instead requires significant human guidance in terms of designing, implementing and directing component systems.

Symbolic learning systems use data based on human-readable/understandable problems, essentially trying to replicate human reason and intuition. This branch of AI was the focus of most research and development efforts in the 1990s. But the rapid decline in the cost of computing power and the explosion of data have resulted in a surge of machine learning.

Machine learning can be thought of as the ability of an AI system to automatically learn and improve a solution without being explicitly programmed to do so. To "learn automatically" is not the same as to "learn autonomously," as most machine learning systems require some human direction regarding data and desired outcome.

Fig. 6: A hierarchy of artificial intelligence



Source: UBS, as of May 2018

We all experience machine learning (ML) in some form today. For instance, Google Maps and Waze use it to help us navigate traffic using real-time data. Ride sharing company Uber uses ML to determine car availability and pricing in real time. Social media platforms use ML to identify and automatically tag friends and family in pictures, and are rapidly investing in it (and other AI tools) to fight "fake news" and objectionable content. E-commerce companies use ML for product suggestions, customization and fraud detection. And, of course, our mobile devices all use ML in offering personal assistance.

Weak AI is already at work in our everyday lives

In the near term, a relatively wide and rapid adoption of narrow or weak AI appears likely. Narrow AI typically focuses on a single task within relatively narrow parameters. It tends to rely on statistical analysis to help it identify patterns and correlations in very large sets of data. It is currently used in many consumer and business applications.

For instance, many emerging cyber-security products and services depend on it to identify anomalies in network traffic, user behavior and application performance that may indicate a security breach. Online customer support increasingly uses "chatbots," or computer programs, based on narrow AI that aim to replicate and even improve the customer experience. Retailers increasingly call on it to suggest products to consumers or drive purchases with well-timed, well-placed promotional offers. Banks also use AI in their fraud detection efforts ranging from anomaly detection to voice-printing.

While all of these developments are interesting, the real long-term promise is in the advance toward AGI and, ultimately, ASI.

Narrow AI can have wide-ranging impact

The everyday instances of AI that affect us fall into the narrow AI category. While AGI and ASI may sound more exciting (and perhaps a bit scary), they are beyond our time frame for investment for now. But narrow AI not only plays an important role in our lives already, it can drive significant value.

In the near term, industry analyst Gartner believes narrow AI solutions will focus on three efforts: improving the customer experience, reducing the cost of existing products and services through new-found efficiencies, and increasing revenue from new opportunities.

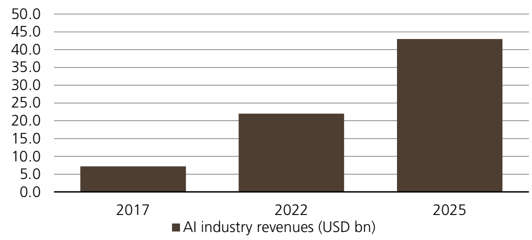
While these areas may seem pedestrian compared to the popular media's presentation of AI, Gartner sees significant potential for AI to influence economies and markets over the longer term, and expects it to produce business value of USD 3.9trn by 2022.

AI spending likely to grow 5x global IT spending

UBS expects AI industry revenues to grow from USD 7.2bn in 2017 to USD 43bn in 2025, an average annual growth rate of 25%. While that represents more than five times the average global IT spending growth, we still believe our estimates are conservative: AI improvements in terms of computing power, machine learning and deep learning capabilities, availability of talent and enterprise adoption could surprise to the upside.

Fig. 7: AI revenue expected to post CAGR of 25%during 2017-25

Industry revenues in USD bn



Source: UBS, as of May 2018

Augmented reality and virtual reality

AR/VR applications are still in their infancy but are set to transform many industries over the next decade as the technology matures. AR overlays digital imagery onto the real world, while VR refers to an artificial environment normally generated by a computer that can be experienced by the user in a seemingly real or physical way. An example of AR is using a clear headset like Google Glasses or a smartphone camera in the game Pokémon Go to overlay information. VR uses opaque headsets like the one in Fig. 8 to immerse the user in a virtual world.

AR/VR holds promise in three major areas – entertainment, gaming/simulation and retail. As the gaming industry is already an early adopter of motion-sensing technologies, we consider it low-hanging fruit. Simulation is also an important growth market as AR/VR can be used in military or healthcare anatomy simulations. Meanwhile, the entertainment industry should get a big boost from AR/VR due to its wide reach. For example, live sports events currently suffer from limited seating, but with VR the problem is solved to some extent: users can enjoy an almost-live experience with the VR device. While the retail sector has already been disrupted by e-commerce, AR/VR is likely to take disruption to another level. For instance, in apparel shopping or home furnishing, consumers can leverage it to experience in advance how clothes or furniture look before buying them.

As such, we see wide use cases for AR and VR emerging in the next few years across many industries like banking, retail, media, etc. Interestingly, research is currently underway on converging both AR and VR into mixed reality where virtual renderings interact with the real world. We believe significant advances in sensor and graphics technologies should accelerate innovation and explode the use cases.

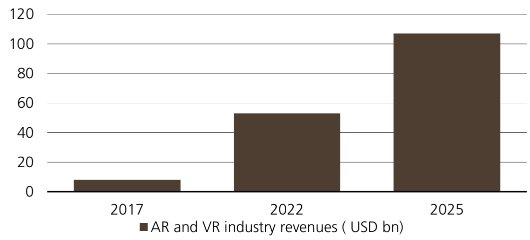
The combined size of AR and VR industry stood at USD 8bn last year. Based on industry estimates (Goldman Sachs) it is expected to reach USD 107bn in 2025. While most of today's sales are hardware, the mix of both AR and VR software should rise significantly, in our view, as devices become cheaper and the availability of software content rises. Also, while the industry will likely be driven by VR in the near term, AR structurally holds more promise due to its user-friendly features and potential for scalability.

Fig. 8: Virtual reality device

Source: Dreamstime, UBS

Fig. 9: AR/VR revenues expected to grow 13.3x during 2017-25

Industry revenues in USD bn



Source: Goldman Sachs, UBS, as of April 2018

Big data

Thanks to rapid urbanization in emerging markets, we expect the global internet user base to increase by 2bn from last year to 2027, and for internet penetration to reach 75%. This trend, the proliferation of connected devices and solid enterprise data trends should lead to an exponential increase in consumer data. According to IDC, EMC and Bloomberg Intelligence, the annual size of the data universe is expected to reach 44 zettabytes by 2020, more than 50 times what it was in 2010. As seen in Fig. 10, we anticipate the global data universe to expand by a factor of more than 10 from 2020 to 2030, reaching 456 zettabytes – **equivalent to 840 iPhones (64 GB) per person.**

Despite what these figures suggest, we think only a tiny fraction of digital data is being fully exploited – i.e. data that, if analyzed properly, could save either costs or maximize revenue for companies. Examples of such applications include a public utility analyzing power use patterns to make electricity distribution more effective, or correlations being identified in scientific data from independent studies.

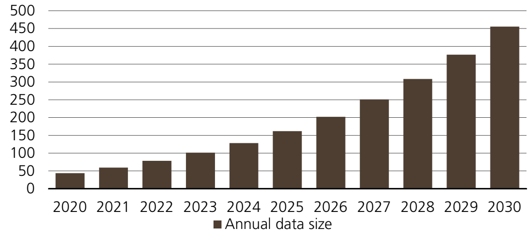
Still, we see promise in big data technology as a solution to data analysis problems. Big data technology, which should not be confused with the big growth in data, refers to analytics used to extract value from large and untapped pools of data that are generally too complex to manipulate with standard methods or tools. As most generated data is unstructured, non-traditional technologies like big data, which mainly include standards like Hadoop, NoSQL and MapReduce, are employed to analyze data and add value to business.

On the enterprise side, big data analytics tools are widely used by retailers like Walmart and e-commerce companies like Amazon and Alibaba to generate more business. Other corporations have started to raise spending on big data tools to try to reduce costs and generate revenue from new sources. Big data analytics can help online retailers make product recommendations based on what other customers with a similar profile have bought and provide instant coupons to effect the purchase. And they can enable utilities and manufacturers to translate the huge amount of data generated by their operations into actionable insights that improve supply/demand management and predictive maintenance.

According to IDC and Bloomberg Intelligence, revenue for the global big data market stood at USD 143bn last year. We expect it to grow by 8% CAGR from 2017 to 2025, or twice the average growth in enterprise IT spending. Our estimates are conservative as we believe greater adoption by emerging market companies could provide an upside surprise. As a result, we expect big data market revenues to reach USD 285bn in 2025 and represent the second-largest addressable market within enabling technologies.

Fig. 10: More than 10x growth expected in data from 2020 to 2030

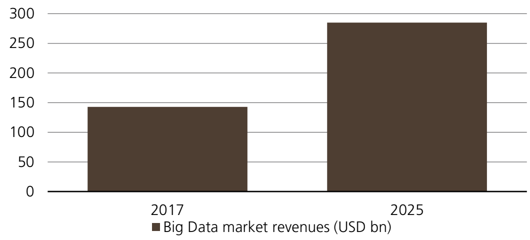
Digital universe in zettabytes



Source: IDC, EMC, Bloomberg Intelligence, UBS, as of April 2018

Fig. 11: Big data market revenues expected to grow by CAGR of 8% during 2017-25

Industry revenues in USD bn



Source: IDC and Bloomberg Intelligence, UBS, as of May 2018

Cloud computing

IT architectures are evolving rapidly. The gains in computing power, storage capacity and networking speeds over the past decade have been breathtaking. The emergence of mobile, the increased focus on data and analytics, and a constant need to provide better solutions at lower costs are driving chief information officers (CIOs) and chief technology officers (CTOs) to reconsider the fundamental nature of IT. No wonder cloud computing is the topic *du jour* in technology.

The democratization of IT
In the past, a significant divide existed between the technology used by large enterprises and that used by small and medium-sized businesses. But cloud alters the economic landscape of IT for businesses. We believe the rise of cloud technology is democratizing IT as it enables small and medium-sized businesses to use enterprise-class applications. This is best exemplified by the growing success of software-as-a-service (SaaS). Over time, SaaS will enable firms of all sizes to develop innovative applications in areas such as big data analytics and AI without making significant up-front capital investments by leveraging the advanced services available from cloud providers.

Cloud changes the delivery model and economics of IT
The financial media and tech industry analysts often discuss "the cloud" without precisely defining the term, instead using it as a generic catch-all. But investors need to understand cloud both as a service delivery model and an ownership one. The two are related but not interchangeable, and understanding the difference is crucial when evaluating opportunities in the rapidly changing tech world.

In a traditional IT environment, teams of IT professionals provide and support physical assets, including servers, storage and networking. Above this layer, other teams provide support and develop IT solutions that include operating systems, databases that applications run on and tools used by application developers. Applications are at the highest level and are used by employees to ultimately drive business outcomes for either internal or external customers. Security is also a critical function whose importance is only now being recognized. Unfortunately, security professionals face an increasingly complex environment.

Cloud changes IT delivery by virtualizing many of the services currently being delivered as discrete offerings. This is done by virtualizing the underlying IT resources. Virtualization utilizes a layer of software that is then used to present the underlying individual elements as a pool of resources. These pooled resources are accessible to users as on-demand resources.

Cloud is on-demand, pooled computing
This model of an on-demand, pooled-resource contrasts starkly with traditional IT architectures. For example, an application developer rolling out a new app in a traditional IT architecture would need to have servers, storage and networking hardware provisioned by the respective hardware teams. The developer would also likely need to acquire the rights to use an operating system and middleware from another team, provision databases from a fourth team and have the entire project secured by yet another team.

Fig. 12: Cloud computing image

Source: Dreamstime, UBS

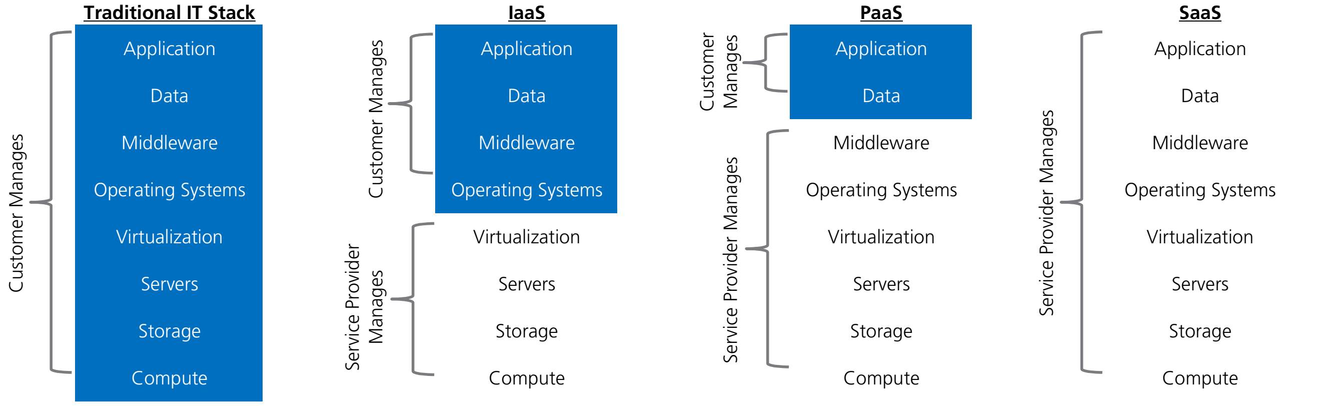
Paas, Iaas, SaaS – IT anyway you like it

In a cloud-based world, the software developer could simply go to a cloud service provider, provide a credit card number and instantly have access to all the necessary tools to develop and roll out an application. This is done through infrastructure-as-a-service (IaaS) or platform-as-a-service (PaaS), with the main difference between them being the level of service offered; PaaS offerings typically include the hardware resources but not the software (operating systems, middleware, databases, etc.), while IaaS typically includes all the tools and infrastructure needed. Regardless of the cloud flavor, this model of computing allows IT to be accessed and consumed in any preferred manner.

Whatever the delivery method or service, cloud computing has five key characteristics:

1. Cloud is on-demand IT allowing for automated provisioning of computing, storing, networking and software from a service provider (such as Amazon or Microsoft). It contrasts with traditional IT, which is hierarchical and typically requires significant human intervention to provision and deliver services.
2. Cloud is a network-based service that can be delivered and consumed across multiple platforms (PCs, thin clients, laptops, smartphones, tablets) and over multiple networks (private, public Internet).
3. The cloud model depends on the sharing of pooled IT resources across users, typically referred to as " multitenancy". In this case, "users" either can be employees within an organization sharing IT assets in a private cloud in a company-owned data center or multiple companies sharing IT assets owned and managed by a cloud service provider.
4. Cloud computing is elastic. Customers can scale up or scale down computing, storage and network resources as needed. No infrastructure is required.
5. Cloud is billed ratably, like a utility and unlike traditional IT, which requires large capital investment upfront for computing, storing, networking and applications. In addition to upfront capital costs, IT organizations also bear operating costs, including personnel, building, power and cooling. These costs can be significant, with some industry analysts suggesting that operating costs can be 75% of the total cost of the data center.

Fig. 13: Comparison of traditional IT and cloud IT stacks



Source: UBS, as of May 2018

Private, public and hybrid – choose your economics

In addition to defining cloud across IaaS, PaaS and SaaS, cloud computing is also defined by its ownership model. Most people are familiar with the public cloud model as offered by Amazon AWS, Microsoft Azure and Google Cloud Platform. In these services, the underlying IT architecture is owned and maintained by the cloud service provider.

At the opposite end of the spectrum, some larger corporations have private clouds, or IT environments that satisfy all five criteria discussed above but are owned and maintained by the corporation rather than a third-party service provider. Private clouds aim to offer the same services (IaaS, PaaS and SaaS) and benefits (automation, scalability, multitenancy and utility-like billing) as public cloud providers, but often at lower cost since owning the assets is often cheaper than "renting" them over the long term.

Hybrid cloud operates in the middle ground, in which applications running in a private cloud environment "burst" into a public cloud for excess or flexible capacity as needed. It can also refer to an application that has some components running "on premise" in a private cloud while others run in a public cloud service.

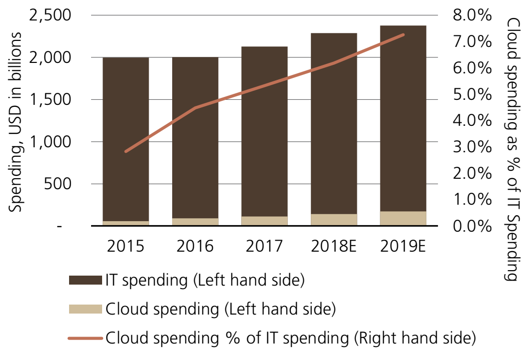
Of the three cloud computing models, hybrid cloud will ultimately be adopted fastest, in our view. It offers the flexibility and agility of public cloud along with the economics of private cloud, especially for larger IT organizations. Also, hybrid cloud brings the potential for IT departments to "insource" mission critical workloads and "outsource" less critical applications.

Significant scope for growth

Cloud as an investment theme has almost led to fatigue, in our view. But data from industry research firm Gartner and Bloomberg Intelligence suggests it is still in the early days of its growth.

Fig. 14 shows that spending on public cloud services (i.e. spending with Amazon AWS, Microsoft Azure, Google Cloud, etc.) was only 5% of total IT spending last year, and is only expected to account for 7% next year. Estimates of the market sizes of private and hybrid cloud are not available, but, based on Gartner and Bloomberg Intelligence, the size of the total cloud market was USD 260bn in 2017. We expect the market to grow by 9% CAGR and reach USD 520bn by 2025, and comprise close to mid-high teens of overall IT spending. We consider our estimate reasonable given the increased

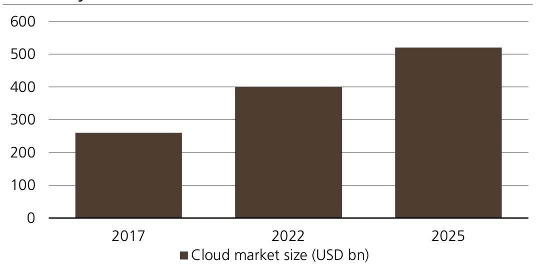
Fig. 14: Public cloud spending vs. global IT spending



Source: Gartner, UBS, as of May 2018

Fig. 15: Cloud market expected to grow by CAGR of 9% during 2017-25

Industry revenues in USD bn



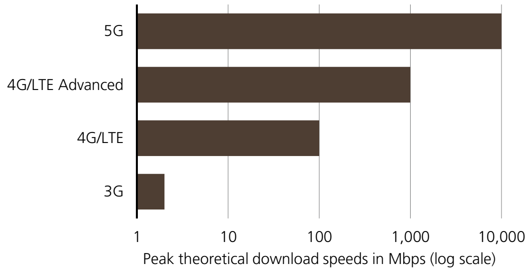
Source: Gartner and Bloomberg Intelligence, UBS, as of May 2018 market share gains for cloud companies fueled by increased enterprise adoption.

Regardless of how one sizes the market, it appears clear to us that there is a significant multiyear growth opportunity ahead for companies exposed to cloud computing. These opportunities span hardware, software and services across the entire IT spending landscape.

5G

5G is the next phase in the evolution of wireless technology. As with previous generations, it will boost wireless broadband speeds and lower costs. Importantly, when fully implemented, it is expected to enable autonomous driving, massive internet of things (IoT) and telemedicine, among other applications. In the intermediate term, 5G will be deployed as an alternative broadband access technology, with this "third pipe" of fixed wireless access potentially spurring new competition.

Fig. 16: Theoretical peak download speeds



Source: GSM Association, UBS, as of May 2018

A unified network that enables new applications

We believe 5G's importance will be measured more by the applications it enables rather than the underlying technological advancement. Industry association 5G Americas sees five major ones:

- Fixed wireless access (FWA) will provide high-speed broadband to consumers wirelessly and open up new opportunities for wireless carriers, which will be able to compete with incumbent wireline and cable providers globally. FWA is on track to be the first commercially deployed 5G service, with initial deployments planned for this year.
- Enhanced mobile broadband (EMB) will provide exceptionally high bandwidth (up to 10Gbps peak) to large numbers of users in difficult networking environments (e.g., concert-goers in a large stadium and passengers on high-speed transportation).
- Enhanced multimedia applications will enable 4K and 8K video transmission across a variety of conditions for applications including entertainment, manufacturing and public safety.
- Connected vehicles will use 5G standards for vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I) and vehicle-to-pedestrian (V2P) communications that will support the safety requirements of autonomous driving.
- Massive IoT will enable the deployment of large numbers of low power sensors in areas such as agriculture, smart cities, industrial/manufacturing, and utilities.

Standards still evolving

5G is now defined more as a set of requirements than technologies, which has left its proponents open to criticism that this next generation of wireless is simply an industry marketing tool. While there may be some truth to this, the reality, in our view, is that marketing hype always arrives before the technology, and 5G is no different. We believe the current open-ended definition of 5G reflects the view that this next generation of wireless is seen by proponents as a platform rather than just another "G."

5G changes much more than just the radio network
One of the common criticisms of 5G is that, unlike previous generations of wireless, it does not significantly change the radio access network in terms of technology or efficiency. But we think this criticism misses the mark.

In the wireless portion of the network, existing technologies such as MIMO (multiple input, multiple output) antenna and QAM (quadratrure amplitude modulation) are further refined to markedly boost capacity and transmission speeds.

Widespread deployment of 5G will require widespread availability of new spectrum. Current wireless networks typically use low band spectrum, which offers relatively long-distance transmission but at relatively slow speeds. 5G networks will utilize more mid- and high-band spectrum that offers greater speeds at the expense of reach.

Most importantly, the underlying network will evolve and require that new technologies be developed across each key piece of the wireless network, including radio access, transport and the core network.

5G will depend less on traditional macro base stations and more on small cells, or miniaturized base stations, that will be deployed in greater numbers to offset the lack of reach in higher bandwidth spectrum. Small cells are much cheaper than macro stations, and will also likely be managed remotely.

A platform approach
We think 5G will be defined as much by what it does as by what it is. As discussed above, its networks will be tasked with supporting multiple applications and services with varying needs and network requirements. For instance, autonomous driving may utilize cloud-based decision making based on real-time telemetry data, which would require extremely low latency. (As noted, leading vendors have suggested latency of 1 millisecond, or the same time it takes a human to react to something in front of her eyes.) But beyond latency in the RAN, autonomous driving will require fast backhaul and the processing of real-time information in data centers.

A large battery-powered sensor network might require the cell to operate at extremely low power to preserve battery life. This may be achieved by having low-power small cells. Finally, a massive IoT deployment may have to operate under narrow-band IoT standards that will require a cell site to manage a large number of cells. This would require a network that can provide extremely high capacity connections to manage a large number of small cells.

Existing 4G technology could support these examples, but each use case would require a dedicated network, leaving carriers with high capital costs and operational complexity. But 5G as a flexible platform is expected to serve each very different use case due to its highly virtualized nature. Rather than dedicated equipment that performs discrete tasks, 5G networks will have a greater mix of software control running on commodity servers.

This increased level of virtualization will permit flexibility and agility that will cause carrier systems to look more like modern cloud service provider networks rather than traditional wireless networks. For example, a core feature of 5G will be network slicing, a software based application that creates "virtual" networks that can be optimized for a given application. A virtual network can be "spun up" or "spun down" as needed, and the entire network can operate at higher capacity and thereby lower costs. In this example, 5G will look remarkably like IaaS and PaaS offerings.

5G is the infrastructure that carriers have always wanted but couldn't have (until now)

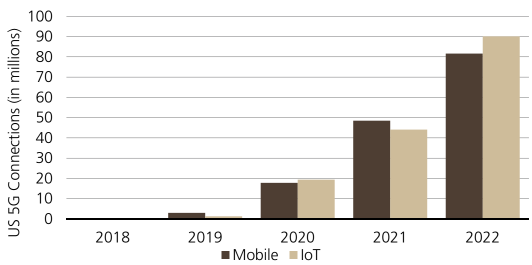
The industry view is that 5G networks should deliver unparalleled scale, flexible control and extremely low costs. This scale and flexibility in particular contrasts with prior wireless network generations that were generally purpose built for a narrow range of applications (1G/2G were voice-centric, 3G/4G focused on broadband data) and that scale linear relative to traffic. Some of the expected 5G requirements and the associated benefits include:

1. Low latency: It is expected to be only 1 millisecond, or the same amount of time it takes the human eye to respond, which will be critical for autonomous driving. A car traveling 50 mph will have a 36.5ft delay when braking if there is 0.5 second latency. At the targeted 1 millisecond, the brake can be engaged in less than a foot of travel.
2. Higher speeds: A draft report released on 22 February 2017 by the International Telecommunications Union specifies that a 5G cell should be capable of providing 20Gbps service. While service to individual users will be lower, 5G download speed is expected to be 20x that of 4G, and the effective speed should be higher due to implementation of beam forming and massive MIMO.
3. Higher capacity: 5G networks should support unprecedented capacity as measured in device numbers. Ericsson envisions 5G networks providing connectivity for up to 1 million low-power sensors per square kilometer. The same network should also provide as much as 20Mbps service on demand at sporting events.
4. Flexibility: 1G through 4G wireless standards were essentially built for purpose, evolving from simple voice to broadband connectivity. 5G is anticipated to be a platform that will enable numerous applications, from autonomous driving and fixed wireless access to telemedicine, smart cities and VR/AR. 5G networks will serve as a flexible platform that can use different services as needed.

It is this platform approach that will allow 5G to enable multiple applications on the same infrastructure. As seen in Fig. 17, IDC and Bloomberg Intelligence expect 5G IoT connections to outpace mobile connections in the US by 2022.

Based on the major public announcements by major global telecom operators, the addressable market for 5G equipment market is still at the nascent stage, with revenues of around USD 2bn. We expect it to grow by 75x from 2017 to 2025, with total 5G equipment revenue reaching USD 150bn by 2025.

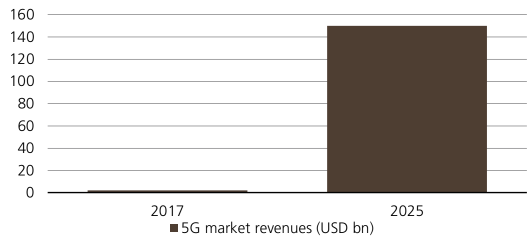
Fig. 17: 5G connections - mobile vs. IoT



Source: IDC, Bloomberg Intelligence, UBS, as of May 2018

Fig. 18: 5G market revenues expected to grow by 75x during 2017-25

Industry revenues in USD bn



Source: UBS, as of May 2018

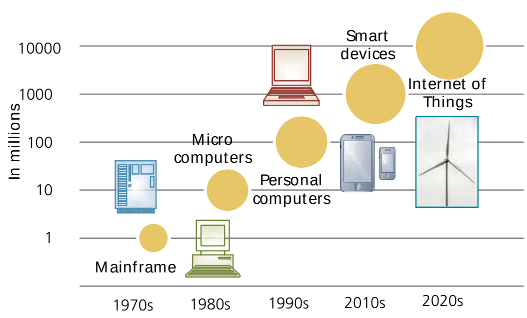
The only constant in enabling technologies is change

As the saying goes, the only constant in technology is change. The scope of our enabling technologies theme will continue to expand as more powerful technology trends emerge. Take the evolution of the computing cycle: it has progressed in such a way that every cycle has lasted for at least 10–15 years and expanded the addressable market by a factor of almost 10. The annual addressable market for mainframes was only 1m units; microcomputers upped the addressable market to 50m units yearly in the 1980s. This was followed by an explosion during the PC era, when annual PC shipments expanded to more than 100m units. Smart devices, which include both smartphones and tablet PCs, revolutionized the consumer user experience with touchscreens and apps, resulting in over 1bn units shipped per year. The IoT marked the fifth computing cycle a few years ago and is gathering momentum as it lives up to the previous cycles' evolution of further miniaturization and 10x industry growth. During each cycle, different enabling technologies powered the computing cycles, so understanding and identifying "the next big thing" is imperative due to the evolving nature of technology.

For instance, blockchain is an enabling technology that holds significant promise. The addressable market may be limited at this stage, but the distributed ledger nature of the technology makes putting it on the radar worthwhile, in our view. We have identified six industries where its impact will be primarily felt: financials, manufacturing, healthcare, public services, utilities and the sharing economy. While the use cases in financials, like trade finance and issuing tokens, are well documented, in other industries it can solve key problems; for instance, in healthcare it can help by providing anonymized clinical data as part of a distributed ledger and permitting inspection agencies like the US Food and Drug Administration (FDA) or research institutes to access only relevant information while maintaining patient confidentiality. In the sharing economy, blockchain's identity management solutions fit well by helping build trust and making networks more secure by managing the integrity of user reviews.

Other potential enabling technologies range from quantum computing to foldable displays. Most are in the early stage of their development, and significant research needs to be done before they become mainstream. That said, investors should have a dynamic approach and monitor developments as a significant breakthrough may accelerate their adoption.

Fig. 19: The evolution of computing cycles

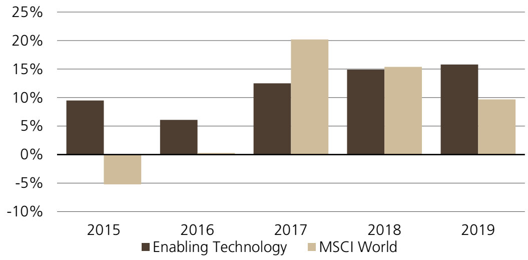


Source: UBS, as of May 2017

Investment implications

With technology advances set to continue, demand for enabling technologies should remain strong. Based on our analysis, the combined addressable market for the five major enabling technologies discussed in this report should grow from USD 420bn last year to USD 1.1trn in 2025, or at an average annual growth rate of 12.8%. Given their software and semiconductor mix, we expect margins for enabling technologies to expand moderately, resulting in a low-double-digit rate of earnings growth over the next decade. Fig. 20 shows the earnings growth potential of our theme, which should be one of the fastest-growing ones globally over the next decade. Investors, in our view, will be best rewarded by taking a diversified exposure to it, focusing on software and semiconductor companies that have superior pricing power and high barriers to entry.

Fig. 20: Strong earnings growth expected to continue for enabling technology companies (in %)



Source : UBS, as of May 2018

Risks

Key negative risks include, but are not limited to:

a) Tighter regulations around emerging disruptive trends that could slow industry growth. Favorable or limited regulations are a key growth driver for the industry, which results in increased demand for many technologies like AI and cloud, so more regulation could brake adoption rates.

b) Data privacy and consumer protection concerns. Data is the fuel that powers many enabling technologies. Companies leverage it to provide a wide range of disruptive services, Any potential data breach or cyber crime is a risk. Still, our other Longer Term Investment theme "Security and safety" highlights opportunities from the broader trend of rising spending on cyber security. Additionally, lower consumer protection compared to traditional products can also slow adoption.

c) While enabling technologies continue to gain market share within IT spending, a weaker-than-expected global IT spending environment due to persistent and significant business uncertainty may weigh on overall industry growth prospects.

d) The emerging nature of enabling technologies means the potential list of winners will likely be more dynamic and should continue to evolve. So investors need to pursue a diversified approach when investing in the theme.

Key positive risks are industry consolidation, including more M&A transactions, which would boost industry valuations, and more favorable regulations that would increase demand for enabling technologies.

Table 1: Enabling technologies - part 1
This is not a list of recommendations, nor is it comprehensive.

Company Name	ISIN	M' Cap in bn USD	Company focus	Exposure to enabling technology	Country	Currency	Price in local currency
ASML Holding NV	NL0010273215	82.6	AI	25%	NETHERLANDS	EURO	160.0
Blue Prism Group plc	GB00BYQ0HV16	1.3	AI	75%	BRITAIN	British Pound	1412.0
Global Unichip Corp	TW0003443008	1.2	AI	33%	TAIWAN	Taiwan Dollar	259.0
Hangzhou Hikvision Digital Technology Co Ltd	CNE100000PM8	57.1	AI	33%	CHINA	Chinese Renminbi	39.3
NVIDIA Corp	US67066G1040	137.4	AI	25%	UNITED STATES	US Dollar	226.3
Taiwan Semiconductor Manufacturing Co Ltd	TW0002330008	192.4	AI	25%	TAIWAN	Taiwan Dollar	220.5
Activision Blizzard Inc	US00507V1098	52.1	AR/VR	25%	UNITED STATES	US Dollar	68.4
ams AG	AT0000A18XM4	7.5	AR/VR	33%	AUSTRIA	Swiss franc	88.5
DeNA Co Ltd	JP3548610009	2.9	AR/VR	25%	JAPAN	Japanese Yen	2126.0
Electronic Arts Inc	US2855121099	36.5	AR/VR	25%	UNITED STATES	US Dollar	118.9
Gree Inc	JP3274070006	1.4	AR/VR	25%	JAPAN	Japanese Yen	645.0
Himax Technologies Inc	US43289P1066	1.2	AR/VR	25%	TAIWAN	US Dollar	7.2
HTC Corp	TW0002498003	1.6	AR/VR	33%	TAIWAN	Taiwan Dollar	58.1
Largan Precision Co Ltd	TW0003008009	16.6	AR/VR	25%	TAIWAN	Taiwan Dollar	3685.0
Logitech International SA	CH0025751329	6.9	AR/VR	25%	SWITZERLAND	Swiss franc	40.0
NCSoft Corp	KR7036570000	7.2	AR/VR	20%	SOUTH KOREA	South Korean Won	355000.0
NetEase Inc	US64110W1027	33.5	AR/VR	25%	CHINA	US Dollar	254.8
Nintendo Co Ltd	JP3756600007	59.7	AR/VR	33%	JAPAN	Japanese Yen	46180.0
Razer Inc	KYG7397A1067	3.1	AR/VR	25%	SINGAPORE	Hong Kong Dollar	2.7
Rovio Entertainment Oyj	FI4000266804	0.5	AR/VR	25%	FINLAND	EURO	4.9
Sony Corp	JP3435000009	58.7	AR/VR	33%	JAPAN	Japanese Yen	5083.0
Sunny Optical Technology Group Co Ltd	KYG8586D1097	18.6	AR/VR	33%	CHINA	Hong Kong Dollar	133.0
Take-Two Interactive Software Inc	US8740541094	12.0	AR/VR	25%	UNITED STATES	US Dollar	104.9
Ubisoft Entertainment SA	FR0000054470	11.0	AR/VR	25%	FRANCE	EURO	82.1
Zynga Inc	US98986T1088	3.2	AR/VR	25%	UNITED STATES	US Dollar	3.6
Accenture PLC	IE00B4BNMY34	101.0	Big Data	25%	IRELAND	US Dollar	150.7
Amadeus IT Group SA	ES0109067019	33.0	Big Data	25%	SPAIN	EURO	62.8
Amdocs Ltd	GB0022569080	9.6	Big Data	33%	UNITED STATES	US Dollar	66.7
Amkor Technology Inc	US0316521006	2.0	Big Data	25%	UNITED STATES	US Dollar	8.5
Analog Devices Inc	US0326541051	32.7	Big Data	25%	UNITED STATES	US Dollar	88.3
Applied Materials Inc	US0382221051	53.1	Big Data	25%	UNITED STATES	US Dollar	50.5
ASE Industrial Holding Co Ltd	TW0003711008	10.9	Big Data	25%	TAIWAN	Taiwan Dollar	75.1
CA Inc	US12673P1057	14.2	Big Data	25%	UNITED STATES	US Dollar	34.0
Capgemini SE	FR0000125338	23.2	Big Data	25%	FRANCE	EURO	114.8
EPAM Systems Inc	US29414B1044	6.1	Big Data	33%	UNITED STATES	US Dollar	114.5
Fair Isaac Corp	US3032501047	5.1	Big Data	33%	UNITED STATES	US Dollar	171.3
Globalwafers Co Ltd	TW0006488000	7.2	Big Data	25%	TAIWAN	Taiwan Dollar	491.0
Hewlett Packard Enterprise Co	US42824C1099	26.6	Big Data	33%	UNITED STATES	US Dollar	17.1

Source: Bloomberg, UBS estimates, as of 3 May 2018

Important note: This is a company reference list, with the most enabling technologies stocks globally exposed to industries like AI, AR/VR, big data, cloud and 5G and also based on sales/ profits/investment exposure larger than 20% and market capitalization of more than USD 0.2bn. Please note that this list is only for reference and is not a recommendation list.

Table 1: Enabling technologies - part 2
This is not a list of recommendations, nor is it comprehensive.

Company Name	ISIN	M' Cap in bn USD	Company focus	Exposure to enabling technology	Country	Currency	Price in local currency
Infosys Ltd	INE009A01021	39.2	Big Data	25%	INDIA	Indian Rupee	1194.2
International Business Machines Corp	US4592001014	130.8	Big Data	33%	UNITED STATES	US Dollar	142.5
KLA-Tencor Corp	US4824801009	15.9	Big Data	25%	UNITED STATES	US Dollar	102.2
Lam Research Corp	US5128071082	31.1	Big Data	25%	UNITED STATES	US Dollar	189.5
Micron Technology Inc	US5951121038	53.2	Big Data	75%	UNITED STATES	US Dollar	45.9
Nanya Technology Corp	TW0002408002	9.1	Big Data	75%	TAIWAN	Taiwan Dollar	89.9
NetApp Inc	US64110D1046	18.1	Big Data	50%	UNITED STATES	US Dollar	67.4
Nuance Communications Inc	US67020Y1001	4.3	Big Data	75%	UNITED STATES	US Dollar	14.6
NuFlare Technology Inc	JP3756350009	0.8	Big Data	25%	JAPAN	Japanese Yen	7110.0
Open Text Corp	CA6837151068	9.7	Big Data	25%	CANADA	Canadian Dollar	46.5
Partron Co Ltd	KR7091700005	0.4	Big Data	50%	SOUTH KOREA	South Korean Won	8270.0
Pegatron Corp	TW0004938006	6.2	Big Data	25%	TAIWAN	Taiwan Dollar	70.7
Phison Electronics Corp	TW0008299009	1.7	Big Data	50%	TAIWAN	Taiwan Dollar	261.0
Realtek Semiconductor Corp	TW0002379005	1.9	Big Data	50%	TAIWAN	Taiwan Dollar	112.0
Sabre Corp	US78573M1045	6.4	Big Data	25%	UNITED STATES	US Dollar	23.3
Samsung Electronics Co Ltd	KR7005930003	316.4	Big Data	33%	SOUTH KOREA	South Korean Won	2650000.0
Seagate Technology PLC	IE00B58JVZ52	15.7	Big Data	75%	UNITED STATES	US Dollar	54.7
SK Hynix Inc	KR7000660001	56.1	Big Data	50%	SOUTH KOREA	South Korean Won	82900.0
Splunk Inc	US8486371045	14.9	Big Data	50%	UNITED STATES	US Dollar	103.0
STMicroelectronics NV	NL0000226223	20.6	Big Data	25%	SWITZERLAND	EURO	18.9
Tableau Software Inc	US87336U1051	6.9	Big Data	75%	UNITED STATES	US Dollar	85.2
Tata Consultancy Services Ltd	INE467B01029	100.8	Big Data	25%	INDIA	Indian Rupee	3506.2
Teradyne Inc	US8807701029	6.7	Big Data	25%	UNITED STATES	US Dollar	34.3
Texas Instruments Inc	US8825081040	101.2	Big Data	25%	UNITED STATES	US Dollar	103.0
Tokyo Electron Ltd	JP3571400005	31.2	Big Data	25%	JAPAN	Japanese Yen	20740.0
Transcend Information Inc	TW0002451002	1.2	Big Data	33%	TAIWAN	Taiwan Dollar	83.4
Verisk Analytics Inc	US92345Y1064	16.5	Big Data	33%	UNITED STATES	US Dollar	100.0
Western Digital Corp	US9581021055	22.8	Big Data	50%	UNITED STATES	US Dollar	76.8
Win Semiconductors Corp	TW0003105003	3.3	Big Data	25%	TAIWAN	Taiwan Dollar	232.0
Wipro Ltd	INE075A01022	18.5	Big Data	25%	INDIA	Indian Rupee	271.7
WONIK IPS Co Ltd	KR7240810002	1.2	Big Data	25%	SOUTH KOREA	South Korean Won	32350.0

Source: Bloomberg, UBS estimates, as of 3 May 2018

Important note: This is a company reference list, with the most enabling technologies stocks globally exposed to industries like AI, AR/VR, big data, cloud and 5G and also based on sales/ profits/investment exposure larger than 20% and market capitalization of more than USD 0.2bn. Please note that this list is only for reference and is not a recommendation list.

Table 1: Enabling technologies - part 3
This is not a list of recommendations, nor is it comprehensive.

Company Name	ISIN	M' Cap in bn USD	Company focus	Exposure to enabling technology	Country	Currency	Price in local currency
Advanced Micro Devices Inc	US0079031078	10.6	Cloud	25%	UNITED STATES	US Dollar	11.0
Akamai Technologies Inc	US00971T1016	12.2	Cloud	75%	UNITED STATES	US Dollar	71.7
Box Inc	US10316T1043	3.2	Cloud	75%	UNITED STATES	US Dollar	23.6
Broadcom Inc	US11135F1012	94.0	Cloud	33%	UNITED STATES	US Dollar	228.7
Citrix Systems Inc	US1773761002	14.3	Cloud	33%	UNITED STATES	US Dollar	104.4
Cloudera Inc	US18914U1007	2.2	Cloud	33%	UNITED STATES	US Dollar	14.7
Cognizant Technology Solutions Corp	US1924461023	47.7	Cloud	25%	UNITED STATES	US Dollar	81.4
F5 Networks Inc	US3156161024	10.1	Cloud	33%	UNITED STATES	US Dollar	165.7
Fujitsu Ltd	JP3818000006	12.7	Cloud	33%	JAPAN	Japanese Yen	673.7
HCL Technologies Ltd	INE860A01027	19.5	Cloud	25%	INDIA	Indian Rupee	931.1
Intel Corp	US4581401001	243.8	Cloud	33%	UNITED STATES	US Dollar	52.3
Microsoft Corp	US5949181045	718.5	Cloud	33%	UNITED STATES	US Dollar	93.5
Oracle Corp	US68389X1054	185.8	Cloud	25%	UNITED STATES	US Dollar	45.5
Palo Alto Networks Inc	US6974351057	18.1	Cloud	33%	UNITED STATES	US Dollar	196.7
Quanta Computer Inc	TW0002382009	6.8	Cloud	33%	TAIWAN	Taiwan Dollar	52.7
Red Hat Inc	US7565771026	28.9	Cloud	50%	UNITED STATES	US Dollar	162.6
ServiceNow Inc	US81762P1021	29.2	Cloud	50%	UNITED STATES	US Dollar	165.5
VMware Inc	US9285634021	53.7	Cloud	75%	UNITED STATES	US Dollar	132.5
ADTRAN Inc	US00738A1060	0.7	5G	25%	UNITED STATES	US Dollar	14.9
Arista Networks Inc	US0404131064	19.7	5G	25%	UNITED STATES	US Dollar	265.5
Cavium Inc	US14964U1088	5.3	5G	25%	UNITED STATES	US Dollar	75.1
Ciena Corp	US1717793095	3.7	5G	25%	UNITED STATES	US Dollar	25.9
Cisco Systems Inc	US17275R1023	211.3	5G	50%	UNITED STATES	US Dollar	43.9
Corning Inc	US2193501051	22.2	5G	25%	UNITED STATES	US Dollar	26.7
Finisar Corp	US31787A5074	1.9	5G	25%	UNITED STATES	US Dollar	16.3
Juniper Networks Inc	US48203R1041	8.7	5G	50%	UNITED STATES	US Dollar	24.9
Motorola Solutions Inc	US6200763075	17.4	5G	50%	UNITED STATES	US Dollar	107.6
Nokia OYJ	FI0009000681	33.0	5G	33%	FINLAND	EURO	4.9
Skyworks Solutions Inc	US83088M1027	16.6	5G	33%	UNITED STATES	US Dollar	91.4
Telefonaktiebolaget LM Ericsson	SE0000108656	24.9	5G	75%	SWEDEN	SEK	66.4
Xilinx Inc	US9839191015	16.6	5G	75%	UNITED STATES	US Dollar	65.1
ZTE Corp	CNE000000TK5	19.4	5G	50%	CHINA	Chinese Renminbi	31.3

Source: Bloomberg, UBS estimates, as of 3 May 2018

Important note: This is a company reference list, with the most enabling technologies stocks globally exposed to industries like AI, AR/VR, big data, cloud and 5G and also based on sales/ profits/investment exposure larger than 20% and market capitalization of more than USD 0.2bn. Please note that this list is only for reference and is not a recommendation list.

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Appendix

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21. UBS is acting a lead Financial Adviser and Corporate Broker regarding the proposed combination of J Sainsbury PLC and ASDA Group Ltd

Appendix

UBS CIO WM equity selection system (for US sector Equity Preferences)
US equity sector strategists provide two equity selections: Most Preferred (MP) and Least Preferred (LP).

Most Preferred*

We expect the stock to outperform the benchmark in the next 12 months.

Least Preferred*

We expect the stock to underperform the benchmark in the next 12 months.

*A stock cannot be selected as Most Preferred if UBS Research rates it a Sell, while a UBS Research Buy rated stock cannot be selected as Least Preferred.

Restricted: Issuing of research on a company by CIO WM can be restricted due to legal, regulatory, contractual or best business practice obligations which are normally caused by UBS Investment Bank's involvement in an investment banking transaction in regard to the concerned company.

Equity selection: An assessment relative to a benchmark

Equity selections in Equity Preferences lists (EPLs) are relative assessments versus a sector/industry, country/regional or thematic benchmark. The chosen benchmark is disclosed on the front page of each EPL.

Stocks can be selected for several EPLs. To keep consistency, a stock can only be selected as either Most Preferred or Least Preferred, but not both simultaneously. As benchmarks differ between lists, stocks need not be included on every list to which they could theoretically be added.

The country EPL is a list of Most Preferred recommended stocks that our US Equity Sector Strategy team feels are best positioned within their respective sector coverage to outperform their respective sector benchmark over a 12-month investment horizon. These selections should not be viewed as a portfolio as they represent a current snapshot of our views. In the event that a recommended stock is no longer Most Preferred, the list will be updated in the next monthly publication. As such, these recommendations are only valid as of the date of the report and performance for this list will not be calculated. For updates to the views on these names, please consult the most recent Equity Preferences List (EPL) for the relevant sector, which may be obtained from your client advisor.

Securities in the US versions of the Equity Preference List have been removed from distribution outside the US if the security is not rated as Most Preferred or Least Preferred or if UBS Research doesn't cover the security or if the sector is covered by an analyst outside of the US.

Current UBS global rating distribution (as of last month-end)	
Buy	47.81% (25.49%*)
Neutral	36.61% (22.56%*)
Sell	13.57% (13.49%*)
Suspended	1.83% (65.85%*)
Discontinued	0.18% (0.00%*)

Appendix

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