

**MIDLANDS
ENGINE**

Observatory

**DISCONTINUOUS INNOVATION IN
THE MIDLANDS ENGINE (DIME)**

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Brought to you by



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Objectives

The objectives of the DIME research programme were to develop a scanning exercise, including desk-based research and new primary source evidence to enable the region to better understand the nature of our current competitive advantage; the gap between both where we are now with current global best practice and where global best practice will be in the future.

This study was designed to bring together existing knowledge and new insight from regional and national leaders in digital connectivity and technology. The project intended to develop relationships with 'unusual suspects' to generate a series of different viewpoints resulting in a range of perspectives – which will form the basis for future phases of research or design and development of future policy initiatives. A key driver for this programme has been the discovery of previously unknown opportunities, and to set out how the engine might enable these to become more commonplace – to be known.

The aim is that an ultimate outcome of DIME will be an unrivalled and real time evidence base for the region, establishing improved linkages for the Midland Engine to those at the leading edge of digital innovation across a range of industry sectors.

Multiple Possible Futures

Looking back.

It arrived with names like Yahoo! and Lycos.

Google came later.

Yahoo! turned down the chance to buy them.

But also, Blockbuster shareholders did not see the point of buying Netflix and Kodak executives anticipated that the digital image would never take off.

Even though they had invented it.

In 2004, the celebrated economists Levy and Murnane forecast that the digital economy would have its limits because a computer could never drive a truck through an intersection.

In 2018, Waymo put Level 4 autonomy on the road in Phoenix, Arizona. Level 4 means that the car looks after all driving decisions within a geographical area and certain weather parameters.

Level 5 means no human intervention at all, anywhere.

Every km moved by a Tesla car is a km more learned by the machine.

Digitalization has not been linear.

Facebook started, more or less, as a joke.

AirBnb because its founders wanted to raise some cash by renting off an airbed that they kept under their sofa.

Nobody knows who Satoshi Nakamoto really is.

If 10% of Facebook's users adopt the Diem currency, that will be a cryptocurrency with 270,000,000 users.

On January 1st, 2020, DeepMind, part of the Alphabet empire, reported that in a trial of 87,000 women, its Artificial Intelligence had consistently out-performed human expertise in breast cancer detection, both in terms of false negatives and false positives.

That machine will continue to learn.

Scenario Planning

The concept and phrase “multiple possible futures” comes from the techniques of Scenario Planning. It conveys that although the future is unknown, it is possible to reliably isolate alternative possibilities and the variables that determine them.

The term distinguishes Scenario Planning from forecasting. A forecast is what we expect to happen e.g., next year’s sales forecast by a clothing store. “Multiple Possible Futures” reports that there are alternative possibilities but that it is possible to reason about them and to note relevant data and drivers.

A Scan

This report has adopted some of the techniques of Scenario Planning but it is not the outcome of a full exercise. Instead, it is just a scan, a horizon scanning report, based on fifteen interviews. This is not a full-scale study.

The study asked experts what they think *will* happen in the future. It also asked them what *might* happen in the future, but which is less likely.

Something that *will* happen in the future is classified as a trailblazer and might be a firm or a technology.

Those things that *might* happen in the future are classified as wildcards.

In order to look at both trailblazers and wildcards and to interpret the relationship between them, a larger narrative has been imposed across them. This sees trailblazers as forming part of a superstar economy. This adopts modern research in Economics that identifies how a limited number of very high capability firms now dominate the digital economy (and indeed the argument holds for the economy more widely). These very high capability firms are called superstars. In other words, where we find a trailblazer technology, it is typically because a superstar is working to develop it. If it is not a superstar directly, then it is a subsidiary or supplier of a superstar.

We can start to make assertions about a possible future that remains in the control of superstars.

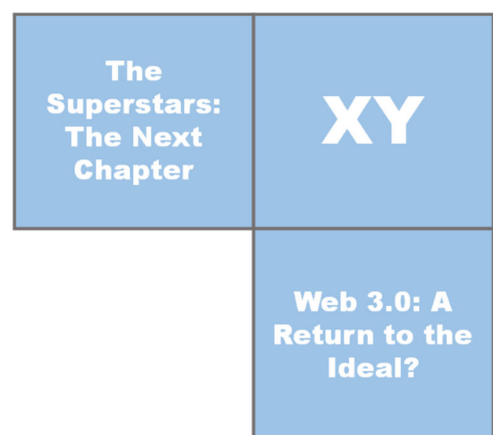
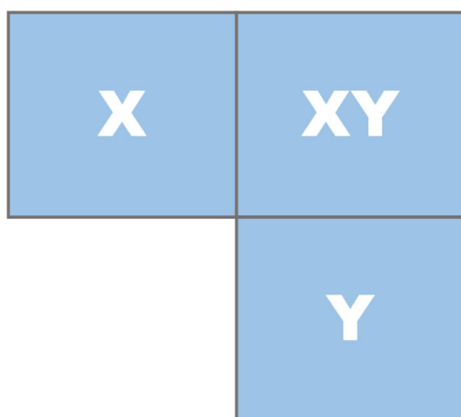
Wildcards come from another hinterland, one which might one day, somehow, challenge the superstars, at least to some degree. This is termed “A Return to the Ideal?” because the technologies are associated with decentralization. Tim Berners-Lee originally foresaw a decentralized world emanating from the web. He did not anticipate that superstars might control it. Hence, the idea of *return*.

The technological constellation of Web 3.0 is the wildcard featured in this scan. The core technology of Web 3.0 is blockchain which is also taken up and developed by superstars. Yet, in the form of a Web 3.0 architecture it is used to support decentralized, local and low-cost structures that scale up around blockchain systems, providing contracts, finance and anything that can be programmed in a full Turing capability programming language. Fundamentally, Web 3.0 is very significant because of the adoption of foundation status by the inventors of Ethereum. The alternative was to develop Ethereum as a private company, effectively a potential acquisition for a superstar. That decision to set up a foundation meant that some significant technology developments were retained outside of the ecosystems of superstars, and that new technologies could build upon them, including for-profit technologies and firms.

By definition, the trailblazer technologies of the superstars represent a more likely future than a decentralized, wildcard economy of Web 3.0. Yet that decentralized, wildcard economy *might* happen.

Or in the discontinuous future, there might be some sort of rough accommodation between them.

In the figures below, X is a scenario. Y is a scenario. X and Y are alternatives and are in some ways oppositional. If they were not oppositional, they would not be alternative scenarios. XY is the accommodation that might emerge between them.



Superstar Firms: The Next Chapter

The big firms are already selected, more or less, and within reason, we can predict the technology that they are focused upon.

Introduction

Broadly, the idea of “superstar firms” conveys that in the 21st Century, a small number of firms have supernormal influence. Associated to this, increasingly, key technology markets are highly concentrated and described as “winner takes all” or “winner takes most” - analysts typically point to a top decile of firms that reaps most of or all the rewards. Most prominent among top decile firms are technology firms.

These top technology firms also make inroads into other markets that were hitherto not considered as characterized by digital technology. This is an increasingly significant phenomenon. The implication of this is that the superstar firm moves beyond the “tech” sector into more traditional sectors. The media industry is classic example, as is retail, but the development of Booking.com and AirBnB in travel markets provides another example of how markets can be occupied by technology firms. Finance, healthcare, logistics and automotive provide further examples of this still gestating phenomenon.

The most obvious superstar firms are Alphabet, Amazon, Apple, Facebook and Microsoft. Such firms typically have extremely high valuations, and within this, high intangible value that is significantly associated with elevated spending on research and development (R&D). It follows that major research advances are likely to be developed in-house by these superstar firms, or within their open innovation ecosystems, or else they might be obtained by a superstar through acquisition of an early-stage firm or technology. This is an important feature of superstar markets – such firms are likely to be either the source or the acquirer of future technology breakthroughs. It then follows that an obvious way of understanding the next technology developments of the 21st Century is by analyzing the R&D and acquisitions of superstars.

Understanding Superstars

Authors define superstar firms in different ways that are less or more encompassing. Yet they agree on their significance in modern markets pointing to them as “winner takes all” or “winner takes most” outcomes. The extent of domination by superstars is outside of historical norms.

A useful approximation is to focus on top decile firms with a particular emphasis on digital technology firms.

Of particular note, is that superstars increasingly dominate innovation in their markets, either directly through their development activities, through their ecosystem of suppliers and partners, or then through acquisitions. In addition, superstars are associated with particularly strong characteristics in terms of productivity, revenue, intangible value, market-share, profit and long-term growth.

For reference to the phenomenon of superstar firms, refer sources below:

- Ayyagari, M., Demircuc-Kunt, A., and Maksimovic, V. (2018). Who are America's Star Firms? Available at <https://ssrn.com/abstract=3230154>
- Criscuolo, C. (2015). Productivity Is Soaring at Top Firms and Sluggish Everywhere Else. Available at <https://hbr.org/2015/08/productivity-is-soaring-at-top-firms-and-sluggish-everywhere-else>
- Manyika, J., Ramaswamy, S., Bughin, J., Woetzel, J., Birshan, M. and Nagpal, Z., (2018). “Superstars: The dynamics of firms, sectors, and cities leading the global economy”. McKinsey Global Institute (MGI) Discussion Paper, October 25 [Online]. Available at: <https://www.mckinsey.com/mgi/overview/in-the-news/whats-driving-superstar-companies-industries-and-cities>
- Shivakumar, R. (2017). “The market power of superstar companies is growing”. *Chicago Booth Review*, October 26 [Online]. Available at: <http://review.chicagobooth.edu/economics/2017/article/market-power-superstar-companies-growing>
- Van Reenan, J. (2018). Increasing Differences Between Firms: Market Power and the Macro-Economy. Centre for Economic Performance Discussion Paper, No.1576. Available at <http://cep.lse.ac.uk/pubs/download/dp1576.pdf>

The Next Chapter

The idea of “the Next Chapter” is to say that this superstar phenomenon will continue and that the leading technology firms that are known today are likely to be the leading firms that dominate tomorrow. They will be kept in place by their high spending in R&D and by their acquisitions. Moreover, they will be protected by the fact that they already have extensive, positive network effects that make them difficult to challenge, and have established platforms that make them very convenient for consumers and other customers through low-transaction costs.

Leading firms that were cited as exemplars in the DIME research are ARM, Ericsson, Microsoft, Nvidia, and Qualcomm, but this is not to the exclusion of other dominant firms in the 21st Century.

Network Effects and Transaction Costs – Why Are They Important?

The difference between the traditional economy of the 20th century and the Digital Economy of the 21st century is best accounted for through the prevalence of network effects. In simple terms, a positive network effect denotes the situation where the increased size of a network is associated with greater value. A good example is an online social network. The more potential alliances there are in any given social network, the more valuable it is to someone who joins it. This dynamic relation between size and value is a network effect. This phenomenon is native to digital industries but not to most traditional business areas such as FMCG, the pre-digital automotive industry or the retail industry before e-commerce.

There are two main types of network effect. A *direct* effect describes the most obvious situation, e.g., if x’s family and friends are located on a social network y, then x gains directly from joining that network y. An *indirect* network effect is related to the development of complementary products e.g., if x adopts the most popular operating system, then it is likely that a lot of other firms will have made complementary apps and devices for that operating system, thereby making x’s choice still better. Both direct and indirect network effects confer the greatest advantage to the biggest networks, hence monopoly or oligopoly follows in markets that are characterized by network effects. From this, naturally follows the phenomenon of the superstar firm, although it can be further elaborated through other concepts including that of transaction costs.

The concept of transaction costs describes the overall cost of acquiring something. By overall cost is meant all relevant expenditure including the price, but also the cost of finding out about something, making comparisons with alternatives, delivery costs and other relevant parts of the transaction. Digitization is associated with diminished transaction costs e.g., the overall cost of an e-commerce purchase is typically lower than a traditional retail purchase, or the transaction costs of maintaining a bank account are typically lower when using an app than the same maintenance activities through the traditional banking network (transferring funds, checking balances, depositing funds etc.). It follows that where digital firms can deploy new software and systems in order to lower transaction costs, they will typically be able to build

new markets e.g., the costs of maintaining one's wellbeing might diminish with the development of new lifestyle, healthcare, dietary and monitoring apps. The costs associated with making journeys diminish with taxi apps and might diminish further with greater autonomy in cars.

Modern phenomena such as platforms (e.g., Amazon, Booking.com, Netflix) and operating systems (e.g., Android, iOS) reduce transaction costs and have been deployed by digital firms to move into new markets and to challenge and undermine traditional firms. As noted, as well as reducing transaction costs, platforms and operating systems also generate positive network effects. Where firms have advantages in both network effects and transaction costs, they will have a synergistic set of strategic benefits that enable them to proceed towards oligopoly or even monopoly.

Application Areas

A framework developed by Deloitte organizes digital technologies into three application areas or layers. Utilizing this, the aim here is to identify leading technologies that are likely to characterize the next chapter of the development of the superstars.

The original framework has three layers, as described below:

- Interaction: The software, hardware, and content with which consumers interact.
- Computation: The logic that enables the interaction.
- Information: The data and structure that allow computational functions to be completed accurately, efficiently, and securely.

The technologies reported in the study are as follows:

Interaction:

Platform technologies are akin to operating systems that are applied to different areas of commerce and social life. They provide a set of related services that enable different groups to interact together. Platforms are made up of global hardware networks. These networks are controlled by software systems that optimize the performance of applications that are used by consumers and groups. Platforms are not static but are dynamically updated many times a day through processes of experimentation and innovation. The established platforms of today can be considered as unrivalled because of the way that this technological innovation combines with highly positive network effects and low transaction costs. Yet, niche technological developments that assist in their functioning (e.g., new apps or network devices) can be highly valuable and provide small firms with a way into the ecosystems of the superstar companies that run platforms.

The idea of a platform encompasses different levels of service from cloud hosting (e.g., Amazon Web Services), through open platforms (e.g., Google Play for Android), to full-service platforms (e.g. Amazon.com).

- XR¹ (Extended Reality) encompassing streaming virtual reality (VR), augmented reality (AR), and mixed reality (MR) content from any application on a remote server. Extending this to take in sensor input and edge computation to provide high value experiences through a constantly aware ‘network compute fabric².’
- Digital Twins enable business productivity by improving workflow, through AR and VR technologies. This affects the economics around complex physical objects, allowing knowledge-sharing and also more precise and valuable supply of engineering interventions. Co-operation and collaboration can be achieved on a global basis. Though the use of sensors and digital mapping of the physical world, it is feasible that eventually there will be a digital twin of every significant object in every place, just as now everybody’s house is on Google Maps. Such types of digital information will allow complex reasoning and will input to further product development. Companies such as Nvidia and BMW have partnered to demonstrate the use of digital twins in manufacturing. Their demonstration brings a full suite of Nvidia technologies to simulate all the elements of the factory model to create AI- enabled use cases such as virtual factory planning, autonomous robots, predictive maintenance, and big data analytics. The result of these innovations is to reduce planning times as well as improving flexibility and precision. Digital twins are also predicted to be applicable to other areas such as healthcare where surgeons can guide teams through operating on the digital twin of the patient’s heart.

Digital Twins

An IBM definition of a digital twin is a virtual representation of an object or system that spans its lifecycle, is updated from real-time data, and uses simulation, machine learning and reasoning to help decision-making.

It is creating a highly complex virtual model that is the exact counterpart (or twin) of a physical thing. The ‘thing’ could be any complex object such as a car, a building, a bridge, or a jet engine. Connected sensors on the physical asset collect data that can be mapped onto the virtual model. Anyone looking at the digital twin can see crucial information about how the physical thing is operating in the real world.

- RegTech – regulatory technology – applications that allow firms to gather, utilize and share complex information related to new reporting environments associated with sustainability and wellbeing agendas. Potentially there is a new class of business-oriented

¹ A term typically used by Nvidia.

² A term typically used by Ericsson.

application here that supports firms, from the smallest to the largest, with the intelligence needed to meet essential reporting beyond the financial, which is also incorporated into day-to-day management through sensors and edge computing.

- Haptic technology – Ancient Greek, ἅπτω (háptō) – technology that involves or conveys touch which might be used in a low-latency environment for transferring skills so that a remotely positioned expert manipulates a machine or the hands/limbs of a less-able human. Haptic technology conceptually overlaps manual dexterity and robotics. It enables an internet of skills³. Through this, the web advances beyond its current manifestation as a means of the transfer of information to become also a technology of the transfer of skills, e.g., using haptic gloves to share or teach dextrous skills such as playing a musical instrument, manipulating an engineered product or performing surgery.

Democratizing Skills

“The potential global impact of this creation would be phenomenal and instrumental in conquering some of the world’s biggest challenges. The Internet of Skills can enable important disaster operation applications such as remote monitoring/surgery of people in need (e.g. applicable in Ebola hit areas); it can enable remote education (e.g. a child in Gaza is taught painting); it can enable industrial remote decommissioning and servicing capabilities (e.g. remote repair of a broken car in Africa); among other important applications.”⁴ Mischa Dohler, Ericsson 5G Testbed, King’s College London.

Core technology enablers for the Internet of Skills are:

- 5G and beyond, low latency networks.
- Artificial Intelligence.
- Standardized Haptic Codecs

Computation

- Artificial Intelligence is an emerging technology widely predicted to revolutionise diverse application areas across business and society. A key feature of AI is that it is a ‘general purpose technology’ (GPT) which means that it has multiple, highly consequential applications. Expertise in a GPT like AI allows firms to grow their scope of operations, again enabling established superstar firms with high R&D expenditure to further develop their dominance. Today, AI is already widespread through Machine Learning, a term which describes constantly optimizing, statistical prediction. Machine Learning is known

³ A term associated with Ericsson and King’s College London.

⁴ [Innovation lessons from the Internet of Skills - Ericsson](#)

to consumers through applications including personalised advertising, voice recognition, facial recognition, spell-checkers, search engines, recommendation engines and payment fraud detection. Machine Learning has many other highly-advanced application areas including providing the basis for autonomy in cars, other robotic applications, and healthcare diagnosis. Machine Learning also impacts upon the value-chain of digital industries through the tendency to associate the highest value with the best data. What this means is that it is not necessarily the best algorithms that determine the highest value, but rather it is increasingly it is having access to the best data that determines the highest value.

- Bandwidth has a fundamental effect on what can be done and where. The rollout of 5G remains important before 6G takes over. Localised 5G solutions and coverage are possible and provide an immediate opportunity for firms while deployment by the network operators continues. With 5G, there is an increased trend of open architectures and commoditisation of hardware such as is seen in Open RAN, federation through introduction of edge clouds, atomisation through introduction of microservices and automation through the increased use of artificial intelligence. These trends mean that innovation can happen rapidly where new features and capabilities can be introduced in a few months/years rather than a decade.⁵
- The development of XR, sensor-rich environments and edge computing means that leading chip manufacturers are in a race to develop low-power semiconductors and to provide evidence of their value through new applications. XR presents a powerful tool in the way enterprise works. Alongside AI and machine learning, it could be possible for teams to work on new products and prototypes in a virtual environment through the creation of digital twins, thereby saving resources. It could also be excellent for the digital transformation of employee training by erasing distance between team members as a result of low latency networks. Areas under development include autonomous machines, healthcare, energy and power, and exascale (10^{18} floating point operations per second) computing.

Information Layer:

- Blockchain is noted as a core technology for providing trust in transactions and the monetisation of digital or certificate assets. It is important to note that can be deployed in highly automated processes and provide an immutable record (a ledger). It follows from this that blockchain can be understood to lower the transaction costs of validating things (e.g., a commercial agreement, the movement of a consignment). It has already facilitated the development of FinTech solutions, especially through the development of Decentralised Finance (DeFi), and is associated with innovations in the precious stones

⁵ [From 5G to 6G Governance](#)

industry (e.g., De Beers diamond certification) and port logistics (Maersk). It follows that blockchain can be considered as a technology that supports existing platforms in the superstar economy (e.g., Microsoft Azure) but also separately as a decentralising technology in a wider Web 3.0 architecture (see Web 3.0 – A Return to the Ideal?).

- Access to valuable data sources allows firms to develop a value-chain across (1) data creation and collection, (2) data storage, (3) data processing (cleaning etc.), (4) analytics, (5) consumption and monetization through a business model⁶. The logic of this stepwise process is that making money from data is a specialist skill that requires access to high quality data resources. Many of the most notable superstar firms have access to vast data resources, often personal data of consumers, and have developed markets for data products (e.g., personalized advertising). Note that techniques of data analysis are standard and shared, and that many of the best algorithms are open-source, hence access to good data is proportionately more of a differentiator than skills in analysis. Herein there are implications for firms and public authorities that might want to do deals over data with superstar firms.

⁶ This 5-step value chain is proposed by Visconti, R.M., Larocca, A. and Marconi, M., 2017. Big data-driven value chains and digital platforms: From value co-creation to monetization. *SSRN Electronic Journal*.

Implications

Prompts.

The Ecosystem of Superstars

What are the valuable new technologies and applications that the superstars will want?

Next Version Interaction

Which are the XR applications and technologies that will generate high, positive network effects and low transaction costs?

The Green Firms and the Pioneers of Wellbeing

In the Midlands, a place famous for alternative and ethical capitalism, what are the educational, leadership and PR opportunities of Regtech?

21st Century Skills of the Midlands

In the Midlands, a place historically famous for skills, what are the educational, leadership and PR opportunities of haptic technology? Could the Midlands be the world's engine of haptic skills? Could the Midlands provide labs for the Internet of Skills?

Deals Over Data: Sources for Artificial Intelligence

As value is increasingly determined by having the access to the best data, rather than having the best algorithm, which firms, agencies and communities already have key data that might be used in existing or future AI applications? How can this data be turned into value?

Private Network Deployment

5G and 6G rollouts are vital, but firms (or clusters of firms) also have the option of equivalent private network capability. This is expected to be the preferred option for many firms⁷.

The Sensor-Rich Environment

What are the applications (service, industrial and agricultural) that can lower cost and/or build new markets through a sensor-rich environment? Can new services piloted here be offered globally?

Automating and Disintermediating Through Blockchain

What are the application areas where blockchain can enhance productivity? Can it be used to significantly lower the costs of starting a business? What are the global trade deals that might be managed through blockchain systems that benefit firms and agencies in the Midlands?

⁷<https://www2.deloitte.com/us/en/insights/industry/technology/technology-media-and-telecom-predictions/2020/private-5g-networks.html>

Web 3.0: A Return to the Ideal?

"The Web as I envisaged it, we have not seen it yet. The future is still so much bigger than the past."
Tim Berners-Lee.

"By the technical – albeit contested – definition of the sector, blockchain is a pure creative industry (mislabelled as fintech). It is a designed, creative product, made of software. Furthermore, it came from the deepest, purest sources of open-source software culture, and spread through the internet, largely through amateur, outsider and hacker channels."

"It would be remiss of us not to point out that blockchain is itself a creative industry, the most newly formed protean landmass to erupt from the deep digital oceans of the internet." Jason Potts and Ellie Rennie, RMIT, Melbourne.

Introduction

The wildcard scenario is Web 3.0. The first iteration of the web brought websites. This has since been given the shorthand web 1.0. Firms and individuals responded to the new technology by putting information online. The web was something like an electronic version of a catalogue or a brochure. The second iteration of the web is the architecture we use now. This is web 2.0. The major difference between web 1.0 and web 2.0 is that the former was read-only, while now we have read/write interfaces so that social media, comments sections, chat bots, video uploads and so forth have turned the web into an arena for billions of conversations, narrowcasts and broadcasts. Without doubt, our 21st century society publishes and utilizes more information than any previous society. There is a power-law difference between the way we publish and utilize information today and that of the turn of the century. Underpinning this are the superstar platforms and underpinning them, for the most part, is an advertising business model.

The terminology is difficult and might change, but the concept of Web 3.0 is widely understood to refer to *Web 2.0 + trust*. That is, it is the read/write web that we have now plus apps that allow contracts to be written among us and sealed in an immutable blockchain. This lowers the transaction costs of making contracts. The web moves from being an arena in which trust is difficult to establish to one where it can be reliably established through setting up identities, verifying them, and holding their histories in a blockchain architecture. These identities can then strike agreements and trade with 'Smart Contracts.' An implication of this is that it is realistic to expect many new opportunities to be created because people can advertise, seek and contract very cheaply. It also means that, potentially, the advertising business model that underpins the superstar platforms will be challenged. This is because it becomes feasible that people write contracts to deal with their own data, either individually or in communities.

Through Web 3.0, power will become more decentralized because people can become economically active and contract on their own, with their friends or with new associates. The phrase 'The Return of the Ideal' seeks to capture this, because this is to return closer to the ideal version of the web that was envisaged by Tim Berners-Lee and other pioneers.

The main reason why Web 3.0 has emerged as a realistic prospect is the work completed by the Ethereum Foundation to develop blockchain systems, standards, cryptocurrency, smart contracts, a Turing-complete programming language (Solidity), and system architectures that then support the development of further solutions that might be commercial or non-commercial. In other words, it provides a complete set of tools that allow further development of Web 3.0 architectures, systems and apps without relying on the work of (most of) the superstars. This work of the Ethereum Foundation is the difference between blockchain as mentioned here, in the 'Return of the Ideal', and the same technology in 'The Next Chapter'. It can be thought of as embodying a complete architecture that is decentralized. To illustrate how this might work, under Web 3.0 one might have a choice of different blockchain providers to support a given transaction (e.g., the sale of a valuable item, or an investment in a start-up business), as well as a choice of different apps (or Dapps, with the 'D' designating 'decentralized') to handle personal or business finance through what is known as 'DeFi' (Decentralized Finance). Such a flexible world of tools is negotiated without reliance on dominant platforms, traditional brokerages or banks.

In a Web 3.0 architecture, cryptocurrency is used to pay for blockchain transactions. This is important because blockchain is expensive in terms of the computer power that is needed. Ether is the most prominent example of a cryptocurrency being used in this way. It is the native currency of the Ethereum network and is used to pay for records made in the Ethereum blockchain. The cryptocurrency has a fixed supply and its value will fluctuate according to demand for transactions on the blockchain to which it applies. Logically, this is something like a share-price. In conventional public businesses, commentators expect share-prices to rise with increased demand for that business's products or services (assuming profit increases). As a share-price rises, the firm might increase capacity or diversify. With a cryptocurrency, its value (against a given fiat currency) should increase with increasing demand for the service of its associated blockchain. Assuming that the actual price of making a record in a blockchain remains fixed, an increased value of the cryptocurrency implies more potential transactions in the system i.e., it will increase capacity. Hence, higher cryptocurrency values equate to a more powerful 'economy' for the given blockchain system. Hereby, Web 3.0 is also an architecture that is characterized by positive network effects with all the implications that are implied by that but whilst maintaining the decentralization of the economic agents themselves.

Note here the difference between a currency like Ether that pays for a designated blockchain system and Bitcoin which has no designation. The former is both a product of the blockchain (through cryptography) and a means of paying for transactions on it. Bitcoin differs in that it has no core application to which its value is linked. Therefore, the value of Bitcoin is not like a share-price but instead works as a global investment network, characterized by some unusual

dynamics. With Bitcoin, the positive network effects have a binary implication. Synchronically, positive network effects encourage new adopters into Bitcoin, as each new adopter drives up the value, but also encourages existing adopters to leave for the same reason.

Ethereum should therefore be understood as an example of a complete Web 3.0 architecture that includes a cryptocurrency. Bitcoin is a cryptocurrency alone. Furthermore, as well as providing technologies for implementation, Ethereum functions as a set of standards that can be deployed by other providers, both commercial and non-commercial. Other systems built on Ethereum standards include Cordano, Internet Computer, PolkaDot and Solana. Each offers a new architecture and tries to solve the issues of speed and sustainability (power usage) that currently affect Web 3.0 systems. Interoperability between the systems will ensure that competitors can come to the market and users can choose different contracting systems for different purposes.

Non-Fungible Tokens and Smart Contracts

A new application of Web 3.0 is the Non-Fungible Token (NFT). This concept has gathered interest in news media, mainly through its application to arts and creative media. The NFT can be thought of as the simplest form of contract and as such should be understood only as a reduced expression of the potential usefulness of Web 3.0.

NFTs constitute a new market whereby stakeholders can purchase the right to own a single token that is associated with an artwork, item of media or other informational record. No other rights are conferred, but because ownership is exclusive and the supply of NFTs is limited there is a potential market and, with that, anticipation of rising or falling prices for any given token. To date, NFTs associated with creative and media products have attracted most coverage. In July 2021, Warner Bros., announced a collection of 91,000 limited-edition NFTs associated to the new film "Space Jam: A New Legacy." The NFTs are related to the film's star LeBron James as well as featuring characters in the film including Bugs Bunny, Tweety and Porky Pig.

Artworks are readily associated with NFTs and form a kind of secondary market around the work itself e.g., if the Picasso family issued a NFT for Guernica, or Yoko Ono issued a NFT for Imagine, what would the prices be? As well as art and media, there are applications related to wider industries, quests and achievements too. In June 2021, Sir Tim Berners-Lee sold a NFT associated with the source code of the web for \$5.4m. Also in June 2021, the University of California Berkeley created a NFT that is associated with Nobel prize-winning cancer research on immunotherapy. This NFT was bought by alumni of the institution for \$54,360 through a Decentralized Autonomous Organization (DAO), which is a Web 3.0 structure for handling a collection of related Smart Contracts. The sale of this NFT raised \$50,000 for further cancer research at the university. Another example of the NFT comes with pioneering projects in animal and wilderness conservation. This consists of a NFT that designates ownership of land and allows stakeholders to buy the rights to land (either as individuals or as groups) with

restrictive clauses imposed that protect that land. The owners receive a share in the legal rights of ownership, just like any other landowner, but might never set foot on the land nor ever need to interact with a lawyer to complete a purchase or sale.

Smart Contracts provide more functionality. They are executable sequences of logic. Examples from creative and media artworks provide, again, ready examples of the potential. Artists might, for example, directly issue contracts on the use of their works with the minimal involvement of intermediaries. A musical artist could, for example, license a new recording to fans according to some conditions (e.g., payment, duration, plays etc.). An author of a textual work might do similarly, e.g., license a copy of a new book according to conditions of payment and duration. As contracts are 'smart', artists will be able to vary pricing and conditions according to many factors (e.g., whether the purchaser is a commercial entity) without having to administer the system or ever make a call to a publisher.

How Wild is the Wildcard?

This is nascent technology affected by many challenges but there are numerous sources of evidence that testify to its growing significance. In the UK Parliament on May 18th, 2021, the potential of Web 3.0 was raised by Tom Tugendhat, M.P., who accompanied his speech with a Tweet, saying:

"We need to think about the contracts and currencies that will shape future trade and risk sharing. We're seeing the flipping⁸ from #Bitcoin to #Ether and we need @hmtreasury to help create space for UK innovation and our legal system to learn what's needed in a new economy"

Back in 2015, the Government Office for Science proposed:

"Government could support the creation of distributed ledger demonstrators for local government that will bring together all the elements necessary to test the technology and its application. A demonstrator at a city level could provide important opportunities for trialling and implementing distributed ledger technologies.... "

On the potential of NFTs for the creative and media industries, Scott Belsky, Chief Product Officer of Adobe, said in 2021:

"This NFT world is likely the greatest unlock of artist opportunity in 100+ years. This isn't a sub-optimal or fringe version of the real world art economy, it is a vastly improved one."

Ark Investments (a technology fund of over \$50bn) and Square (the payments app) have proposed cryptocurrency (Bitcoin) as a complementary product to sustainable energy production through solar and wind. This is because cryptocurrency can function as an energy user at peak

⁸ The term refers to the prospect of the market capitalisation of Ether exceeding that of Bitcoin.

times when otherwise supply outstrips demand. As a captive consumer, cryptocurrency guarantees sale of excess energy thereby making sustainable energy more affordable overall.

Separately but again on the topic of cryptocurrency, Ark Investments has this statement:

“Since the emergence of Bitcoin, we have witnessed the rise of a global battle among monetary systems, both sovereign and non-sovereign. ARK believes cryptocurrencies governed by neutral, open-source networks have the potential to win this battle. By unlocking a new mechanism to store and transfer value, cryptocurrencies have the opportunity to create an open foundation of strong assurances in wealth and monetary integrity.”

In June 2021, it was announced that Andreessen Horowitz, one of Silicon Valley’s most prominent venture capital firms, has launched an investment unit dedicated to cryptocurrency and Web 3.0, backed by \$2.2bn. The announcement brought Andreessen Horowitz’s total commitment to Web 3.0 to above \$3 billion.

In October 2020, IDEO Colab Ventures announced a \$21m early-stage fund for investment in crypto technologies and Web 3.0. The PR statement recorded: *“The venture capital fund sees crypto and blockchain as a key driver of societal change.”*

On this issue of societal change, the famed economist Hernando de Soto claims that blockchain is one of humanity’s most important tools in the fight against poverty. This is because it can be used to release “dead capital”. What this means is that small-scale landowners and farmers across the world can feasibly register land-ownership rights on blockchain, taking these rights out of the jurisdiction of corrupt governments that might change land records, making the rights of the poor immutable. This will then make them suitable for investment either through bank loans or micro-investments made by contributors across the globe. It is feasible to argue that one day, many of us will support and invest in the farms and factories of the poor, perhaps through Decentralized Autonomous Organizations (DAOs) that handle multiple Smart Contracts across different legal frameworks.

Another indication of uptake and market development is that Web 3.0 speeds are increasing exponentially. This solves a longstanding problem of cryptocurrency transactions being too slow for practical use in many circumstances (e.g., at point-of-sale). Today, the Solana blockchain has a transaction speed of 65,000 transactions per second which is 2.5 times faster than Visa. It is therefore realistic to consider its use at point-of-sale or in any other setting. Solana is a new benchmark. Both Bitcoin and Ethereum are much slower than Solana in their current versions (10,000 times slower and 4,000 times slower, respectively).

Against these indications of positive potential are stacked some issues that remain very difficult. The association of Bitcoin and other cryptocurrencies with ransomware attacks is a significant issue for regulators. The issue arises where criminals have been able to establish user-accounts under fake or untraceable identities, typically in countries with ambiguous relationships to

Bitcoin. This means that even though all the movements of the Bitcoin are tracked, and therefore should support the tracing of illegal transactions, there remain opportunities for unknown recipients of Bitcoin to convert it into fiat currency, usually through a second deception. Further to this, sustainability is a fundamental problem because of power generation requirements, and the new proof-of-stake architectures that are designed to tackle this are in many cases still only conceptual, as are the advanced proposals described above to make cryptocurrency a captive consumer of sustainable energy. This is an important hurdle to wide adoption.

From here, three variables can be identified that are likely to significantly determine the fate of the 'Return to the Ideal' wildcard scenario:

1. Increased regulatory confidence.
2. Wide adoption of high-speed blockchain solutions similar to that pioneered by Solana.
3. Solutions to the problem of sustainability.

Implications

Prompts.

The Communities

What are the community causes that will benefit through adoption of Web 3.0? What can be done for vulnerable groups or by vulnerable groups to develop safer web environments?

The Universities

Could universities in the Midlands build the best Web 3.0 courses in the world? What about Web 3.0 research?

The Courses

What about public courses? Start-up meetings?

The Pilots

Could there be public-sector pilots? Could these be in association with pioneering Web 3.0 firms? Might they originate in the Midlands through university or college projects, communities, firms?

The Cities

The world's best city for Web 3.0: What does this mean? Is there a strategy that could be developed around it? Would there be value in inviting existing firms and start-ups into test-bed partnerships?

Web 3.0 is not the only Wildcard.

There are other potential wildcards i.e., technologies that might very significantly affect the future. Those gathered in this scan are as follows:

- Deep Learning,
- Computational developments through Hyper Computing (extending the boundaries of mathematical problem solving), Exascale Computing (at least 10^{18} operations per second) or later, and still much faster, Quantum Computing.
- Level 4 and Level 5 autonomy in automotive transport.
- Breakthrough chip designs, especially for low power usage.
- A shift to machine diagnostics in healthcare (as this implies very large datasets and significant reorganization).
- Integration of new digital technology (e.g., new chip designs) with new developments in energy grids (e.g., smart grids, graphene, new forms of solar).

Trailblazers versus Wildcards: the Alternative Scenarios

“Whereas most technologies tend to automate workers on the periphery doing menial tasks, blockchains automate away the center. Instead of putting the taxi driver out of a job, blockchain puts Uber out of a job and lets the taxi drivers work with the customer directly.”

Vitalik Buterin, Founder & Inventor at Ethereum Foundation.

Carpe diem – seize the day.

Opposition and Accommodation

The alternative scenarios are in opposition for the following reasons:

- Ethereum is a foundation.
- Success of Web 3.0 will tend to undermine the economic basis of some key superstars. This occurs because Web 3.0 potentially offers equivalent functionality on a more decentralized basis that will potentially lower transaction costs still further. The quote from Vitalik Buterin above vividly illustrates this. Further beyond this, substantial parts of the superstar economy are built on advertising fees (Alphabet and Facebook are obvious examples), and Web 3.0 architectures will undermine this by retaining personal data with individuals and giving them tools to allow them to contract over it. The issue of privacy is therefore a key fault-line between Superstar and Web 3.0 economies.
- Cryptocurrencies such as Ether are potentially of global reach and the principles of network effects will apply to them to the point at which they take on greater numbers of uses (e.g., every taxi-driver in every city in the world starts to use Ether) and become tightly enmeshed with the global economy, providing a new epoch and mechanism in global interconnectedness.

Nonetheless, there are points of accommodation or compromise between the superstar economy and Web 3.0.

- Not all superstars would be undermined by a Web 3.0 economy (e.g., chip manufacturers) and some might benefit (e.g., cloud hosting).
- Technologies are common across both superstars and Web 3.0, but are utilized through different business models e.g., blockchains are available through firms including Amazon, IBM and Microsoft. There are also other blockchains that target adoption by enterprises such as VeChain.

- Superstars are making key strategic adjustments to prepare for and take advantage of a Web 3.0 world. Facebook is a pioneering example here with proposals for its new Diem cryptocurrency (Latin, *carpe diem* – *seize the day*). This will potentially be a historic innovation as it will allow Facebook users to contract utilizing a cryptocurrency. Diem will come with advanced governance features to ensure its stability and that major governments accept it. These governments are likely to be very concerned if Facebook is unable to offer verified accounts. Assuming Diem is initiated as planned and that it satisfies regulators, Facebook users could contract with each other (e.g., a money transfer, or to buy a product) through the platform. A myriad of financial transactions would be possible. This will diminish transaction costs of commercial exchange, globally and also locally, and take advantage of Facebook's colossal network effects (2.7bn monthly active users in 2020).

Implications

Important To All Scenarios

The following proposals are potentially valuable to both 'Superstars: The Next Chapter' (trailblazers) and to 'Web 3.0; A Return to the Ideal?' (wildcard):

- Tech-Hubs, Incubators and Accelerators are all widely recognized and remain very important. Networking within these environments remains key to the development of communities and opportunities. There is arguably additional potential benefit to be gained by taking this further so that networks spread through the Midlands and also beyond to the North-West, North-East, Northern Ireland and Scotland. Contact across networks that encompasses big cities like Manchester, Newcastle, Edinburgh and Belfast is likely to be of enhanced value just by virtue of generating greater opportunity for knowledge exchange, testing, and the development of contacts. Developing towards the north might also help counterbalance the dominance of the South-East and London, and capitalize on current trends towards better lifestyles.
- Access to funders and funding is obviously vital and should include both traditional and non-traditional sources (Venture Capitalists, Research Grants, Incentives).
- The role of the public-sector in entrepreneurial activity is important. This might start with research projects (e.g., with universities) or by convening entrepreneurial activity in the ways described here. Providing pilot sites for new technologies is potentially a significant contribution (e.g., Internet of Skills, blockchain). Training too is important, perhaps associated with cutting-edge technologies so that people from less advantaged social groups do not just catch-up but also overtake.

- There are examples to learn from, including Media City in Salford where building space is available with subsidised rents and a strong front of house image. At Salford, the environment also includes a Tech Hub with VR Lab, and 3D Printing etc. Involvement of the Digital Catapult has enabled access to equipment meaning that companies have been able to develop solutions without having to incur large expenditure. In this way, it is possible to show the right facilities and mechanisms help new firms to develop to a stage where they can engage with multinationals.

A Golden Triangle of Impact Universities?

In the UK, universities across Cambridge, London and Oxford are said to constitute “the Golden Triangle.” These are Cambridge University, Imperial College London, King’s College London, London School of Economics, Oxford University, and University College London.

Globally, universities with high technological capability have come to dominate reputational rankings e.g., Massachusetts Institute of Technology, California Institute of Technology (Caltech), Stanford University, and the Swiss Federal Institute of Technology (ETH Zurich).

Is there a new golden triangle, a kind of golden network, to be built in the Midlands? What would this mean? Would this be universities with high competence in technological projects, very high capability in invention, very strong partnerships in product development, high connectivity to superstars and their eco-systems, high connectivity to grant funding and venture funding, major facilitation of community start-ups, and a world-leading capability to generate leading spin-out companies? Could there be a golden triangle of impact?

- University collaboration could be a key advantage both in terms of access to research and also through development of talent with the key focus being the key areas highlighted in this report. Universities are assessed for their “Impact” and have long and deep cultural commitments to social development. If universities could give time for academics to both share knowledge with start-ups, but also learn from those start-ups and other academics, then these universities are very likely to be rewarded in the achievement of these goals.
- Information sharing and curating can make an important contribution, especially to busy entrepreneurs or those who are considering their first-steps e.g., regular sharing and synopsis of Deloitte Tech Trends reports. If the public sector and universities can convene events that are both nationally significant and locally useful, fame and capability will spread: technology provider events, honest takes from consultancy organizations, white papers, journals, local networking and international trade visits.

- Lifestyle has emerged as a key opportunity. Given the crisis of Covid-19, there is more awareness of the importance of lifestyle to wellbeing and greater interest in access to better housing, green spaces and culture and other social factors. Reputation through marketing and branding (e.g., “Silicon Glen” in Scotland) is important in encouraging firms and entrepreneurs to consider new options.
- Consistent with what has been said about top firms (Superstars), top-decile firms and their partners in the region could be encouraged to act as tutors and brokers for the start-up community, providing solutions for industrial, business and public sector leaders to address critically important “pain points”.

Conclusion

The Midlands Engine has the potential to make decisions that set its strategy apart from other regions and which cultivate an internationally-leading digital identity. Within this scanning exercise the role of superstar companies has been identified and is obviously key. It makes sense in the modern economy to associate with superstars and the firms that are, or could be, in their ecosystems. The names ARM, Ericsson, Microsoft, Nvidia, and Qualcomm have been highlighted within the scope of this scan. There are obviously others too; famous and dominant firms in technology markets. Associated are key technological developments including XR, Digital Twins, RegTech, Haptic Technology and Artificial Intelligence. Developing projects and capabilities in these technologies might have significant multiplier effects of many types across the regional economy.

Finally, Web 3.0 represents a potential discontinuity of some magnitude. There are regulatory and sustainability barriers to its development, but also plans to address them. It is not too early to start some sorts of projects in Web 3.0, perhaps at a community level. Prominent firms and funds are already associating with Web 3.0 and a significant amount of progress has been accomplished. There is a realistic possibility of building new decentralized economic ties that span the region and the globe.

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