BLOCKCHAIN INNOVATION IN EUROPE

A thematic report prepared by

THE EUROPEAN UNION BLOCKCHAIN OBSERVATORY & FORUM

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Observatory and Forum

An initiative of the

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About this report

The European Union Blockchain Observatory and Forum has set as one of its objectives the analysis of and reporting on a wide range of important blockchain themes, driven by the priorities of the European Commission, and based on input from its Working Groups and other stakeholders. As part of this, it will publish a series of thematic reports on selected blockchain-related themes. The objective of these thematic reports is to provide a concise, easily readable overview and exploration of each theme suitable for the general public. The input of a number of different stakeholders and sources are considered for each report. These may include:

- Members of the Observatory and Forum's Working Groups.
- An academic research paper on the theme prepared by one of the Observatory's academic partners.
- Input from participants at the relevant EU Blockchain Observatory and Forum workshop.
- Input from the Secretariat of the EU Blockchain Observatory & Forum (which includes members of the DG CONNECT of the European Commission, and members of ConsenSys AG).
- Desk research by the Secretariat (as needed).

CREDITS

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Introduction

Blockchain[1] is one of the major breakthroughs of the past decade.

A technology that allows large groups of people and organizations to reach agreement on and permanently record information without a central authority, it has been recognized as an important tool for creating trust online, potentially providing the infrastructure for a fair, inclusive, secure and democratic digital economy.[2] This has significant implications for how we think about many of our economic, social and political institutions.

As a key component of the next generation World Wide Web, often referred to as Web 3.0,[3] blockchain is also expected to become an important industry in its own right. By providing trust in information without using third parties, blockchain can greatly facilitate peer-to-peer transaction platforms, potentially catalysing new, decentralised and highly automated digital markets that will create new businesses and be an ongoing source of innovation and economic growth.[4]

That makes it an important development for Europe. Europe has responded with a number of major initiatives designed to explore and support the nascent blockchain industry. This includes the European Union Blockchain Observatory & Forum, under whose aegis this paper has been written.

Our goal at the Observatory and Forum is to get a clear picture of blockchain's current possibilities and future potential, to understand the questions it raises and to evaluate the EU's best options to foster innovation within the space, allowing its citizens and industries to benefit from blockchain applications and ensuring the region plays a leading role in blockchain both today and in the future.

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1   For the sake of convenience, we are using the term "blockchain" to refer to distributed ledger technology generally. Strictly speaking, a blockchain is a kind of distributed ledger. See What's the difference between blockchain and DLT?, Max Thake, Medium, 8 February 2018.

2   The trust machine, The Economist, 31 October 2015.

3   Why the Web 3.0 Matters and you should know about it, Matteo Gianpietro Zago, Medium, 31 January 2018.

4   See Antonis Polemitis of the University of Nicosia in In the world of cryptocurrency buzz, blockchain is the real winner, CNBC, 11 January 2018. "This is an industry that we think that over several decades will be as revolutionary as the internet. We're going to have several million people working in this industry, if not tens of millions."

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As Mariya Gabriel, Commissioner for the Digital Economy and Society, has said:

> *"I see blockchain as a game changer and I want Europe to be at the forefront of its development. We need to establish the right enabling environment — a Digital Single Market for blockchain so that all citizens can benefit, instead of a patchwork of initiatives. The EU Blockchain Observatory and Forum is an important step in that direction."*

In this paper we aim to set the scene for the Observatory and Forum's work by examining the state of blockchain innovation in Europe today, looking at both Europe's strengths and weaknesses vis-à-vis this technology, and making some recommendations on where we think Europe should set its priorities in the future[1].

To do so we have relied on a wide variety of sources.

We reviewed the existing literature, including research papers, reports and press articles. We interviewed a number of blockchain thought leaders and practitioners (you will find their quotes sprinkled throughout the text) to get their views. We also consulted the thought leaders in our two working groups,[2] as well as those who attended our Blockchain Innovation Workshop in Vienna on 22 May 2018.[3]

Last, but certainly not least, we relied on the many insights from the broader European blockchain community and general public which we receive through our online platform at eublockchain.mobilize.io.

We have produced what we hope is a comprehensive yet easy-to-read *tour d'horizon* of the state of blockchain in Europe today. While it is beyond our scope to explain in detail how blockchain works,[4] for the sake of this overview it can be good to keep in mind certain aspects of how it is used.

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1   European Commission launches the EU Blockchain Observatory and Forum, 1 February 2018.
2   EU Blockchain Observatory and Forum working groups
3   EU Blockchain Observatory and Forum, workshop and report, Blockchain Innovation in Europe, Rathaus Vienna, 22 May 2018
4   EU Blockchain Forum FAQs, Blockchain in the EU and Western-Europe in 2018-2021: initiatives and forecasts

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First, blockchain is not just one thing. Originally invented in 2009 as the technology enabling Bitcoin, over the last ten years it has evolved in many directions, taking on myriad shapes and flavours and addressing a seemingly endless list of use cases. There are however some useful distinctions.

One has to do with who can access and interact with the blockchain. Bitcoin is an example of a 'permissionless' blockchain: anyone can read the data and become part of the network or act as a validator. Permissionless blockchains represent the most decentralised form of blockchains, but blockchains can also be useful with a more limited set of actors, which is the case in permissioned implementations of blockchains. 'Permissioned' means that access is restricted in some way, for instance only to a certain set of registered participants or validators.

Second, blockchain is important because it has the potential to disrupt or transform fundamental economic, social and political institutions and structures through the mechanism of decentralisation.

Take money and commerce. As the success of Bitcoin and other crypto assets shows, blockchain offers a relatively easy technological means for individuals or organisations to issue their own tokens,[5] thereby challenging the traditional authority of governments to assume this role. Blockchains allow for viable, direct transactions between parties, challenging the authority of banks who today hold a virtual monopoly in the safeguarding and exchange of value.

Blockchains also make it possible to build large, direct, peer-to-peer marketplaces for products, services or information, challenging many of the middlemen – today often technology companies – who have built empires as market infrastructure providers and arbiters. Through the mechanism of the token launch (often referred to as an Initial Coin Offering or ICO), companies can now raise money by selling 'tokens' directly to investors, bypassing the venture capitalists and investment bankers who have traditionally been the conduits of startup or corporate financing.

The token launch provides a good example of how blockchain touches on many important legal questions too. As we will see below, there is intense debate in the legal and regulatory community about what these tokens

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5   As of this writing, CoinMarketCap is tracking over 1,600 cryptocurrencies.

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actually represent, and what rules should govern their issuance and use. The outcome of this debate will be fundamental to how the blockchain industry develops.

By adding full programming capabilities to blockchain, as Ethereum was the first to do, individuals can program smart contracts – self-executing agreements directly between parties. These can in theory replace many of the functions carried out by the legal and judicial institutions that have developed over centuries, including writing, adjudicating on and enforcing commercial and other contracts. In practice, smart contracts raise many thorny questions, like to what extent code can really be considered law, or who can be held liable for a smart contract gone wrong. The outcome of these debates will also fundamentally shape blockchain's future.

There are many other issues at stake as well, and we hope to touch on as many as we can in the pages below. Before doing so, one little disclaimer.

To give our picture life, we have tried to provide concrete examples where we could, and in doing so we have had to make choices. For almost any illustrative project or initiative we mention, we could have easily found ten others.

These mentions are not meant to be indications nor endorsements. Instead, they serve to give a taste of what is out there. We encourage any and all who are interested to explore blockchain in Europe on their own and discover this vibrant community and all the activity it has spawned. Hopefully this paper can serve a useful purpose as an initial guide.

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Blockchain innovation inside the European Union

WHEN IT COMES TO BLOCKCHAIN, EUROPEAN INSTITUTIONS ARE HEEDING THE CALL

There is no doubt that blockchain technology has captured the attention of Europeans.

From governments to enterprises, from academic institutions to startups to the vibrant and constantly growing blockchain community, people are discussing what this technology could mean for European society and its economy, and – more importantly – taking active measures to foster innovation and start building the platforms and applications to make this vision a reality.

This is certainly the case with many of Europe's governments and important institutions. As Alexandre Stachtchenko, President of La Chaintech and co-founder of the startup Blockchain Partner, points out:

> "Despite the sometimes persistent image of scams, crime and terrorism, the institutions' look on blockchain has recently evolved, and real business models are starting to be understood."

The European Union Blockchain Observatory and Forum, mentioned above, is one of the more visible Europe-wide efforts to foster blockchain in the Union. It is by far not the only one. Other developments of note include the EUR 5 million Blockchains for Social Good prize;[1] the recently announced Fintech Action Plan,[2] which calls for "a comprehensive strategy on distributed ledger technology and blockchain addressing all sectors of the economy"; and the recent resolution of the Industry, Research and Energy Committee of the European Parliament recognising the role blockchain can play in enhancing innovation in Europe and around the world.[3]

The recently constituted European Blockchain Partnership, an effort by national governments in Europe to boost blockchain innovation and support the creation of blockchain applications for governmental and public services,[4] underscores the importance of this technology for individual European governments as well. There are other examples too.

France has positioned itself at the forefront of blockchain innovation by regulating in 2017 the use of blockchain for the exchange of securities, starting back in 2016 with mini-bonds.[5] The country will also be one of the first

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1 EU Officials Reveal €5 Million 'Blockchains for Social Good' Contest, Coindesk, 10 November 2017.

2 FinTech: Commission takes action for a more competitive and innovative financial market, 8 March 2018.

3 European Parliament passes a blockchain resolution, Open Access Government, 18 May 2018.

4 European countries join Blockchain Partnership, 10 April 2018.

5 New "blockchain" regulation related to ownership and transfer of securities: the upcoming end of printed securities registers for French companies, Lexology, 8 February 2018.

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in Europe to offer a legal framework for token launches with the forthcoming PACTE bill[6] and was with Germany at the origin of discussions engaged during the G20.

In its current Coalition Agreement, the German government explicitly stated that it wanted to develop a comprehensive blockchain strategy and supported an appropriate legal framework for cryptoasset and token trading in Europe and globally.[7] Austria is supporting blockchain research projects through an EUR 8 million research fund.[8] The central bank of Lithuania is creating a blockchain 'sandbox' for Fintech companies,[9] has indicated its intention to create a Digital Collector Coin (DCC)[10] and, in cooperation with the Lithuanian Ministry of Finance and the country's tax authorities, has issued ICO guidelines.[11]

Estonia has become famous for its e-Estonia program, a pioneering effort to support its citizens in the fields of digital identity and blockchain-controlled health records, among other things.[12] In Spain the Alastria project is being held up as a model for how to build national and European-wide blockchain platforms.[13] In the Netherlands, the Dutch government is working with the private sector to bring blockchain innovation forward through the Dutch Blockchain Coalition, which has already developed more

than 40 blockchain proofs of concept.[14] In Luxembourg, Infrachain is a government-supported effort which "aims at introducing governance mechanisms that would facilitate development, deployment and adoption of blockchain applications, for various sectors including banking, FinTech and financial services in the current regulatory environment."[15] The Benelux countries have also signed a memorandum of understanding to cooperate with each other in blockchain development.[16] And, while not an EU member state, Switzerland's Crypto Valley has built a global reputation as one of the world's most vibrant and important blockchain ecosystems.[17]

The European academic community has heeded the call as well. In 2015 the University of Nicosia became the first in the world to offer a Masters Degree in blockchain.[18] Other institutions to offer blockchain courses include Oxford University,[19] the University of Edinburgh,[20] Cambridge University, University College London, the University of Northampton,[21] and the IT University of Copenhagen.[22]

Europe is also becoming quite active in blockchain research and development. To date the European Commission has granted approximately EUR 80 million to EU projects dealing with blockchain in many sectors and has announced plans to increase funding by up to EUR 300 million

6   Report: France to Have Bespoke ICO Regulations in Place by 2019, Crowdfund Insider, 5 June 2018.
7   German Coalition Agreement (Koalitionsvertrag zwischen CDU, CSU und SPD, 19. Legislaturperiode).
8   Austrian Government Backs New Blockchain Research Institute, Coindesk, 7 December, 2017.
9   Lithuania's Central Bank Unveils Blockchain Startup Sandbox, Coindesk, 15 January 2018.
10   Coin Enthusiasts Can Go Crypto With World's First Collectable, Bloomberg, 6 March 2018.
11   Lithuanian Gov't Releases ICO Guidelines That Aim to Create 'Certainty and Transparency', Cointelegraph, 11 June 2018.
12   E-Estonia
13   Large Spanish companies form the Alastria consortium to develop the blockchain ecosystem in Spain, BBVA, 17 October, 2017.

14   Dutchdigitaldelta.nl, Dutch Blockchain Coalition.
15   Blockchain Governance Framework in Luxembourg: More Opportunities for Financial Innovation, Luxembourg Bankers Association, 18 May 2018.
16   Benelux countries sign blockchain collaboration MoU, Forbes, 21 February 2018.
17   Cryptovalley.swiss.
18   University of Nicosia Launches Free, Open MOOC Led By Bitcoin Experts, University of Nicosia, 2 April 2014.
19   Oxford Blockchain Strategy Programme.
20   Universities add blockchain to course list, Financial Times, 18 June 2018.
21   The Best Universities to Study Blockchain Technology, Trustnodes, 9 June 2017.
22   10 Universities That Offer Blockchain Courses, Coinify, 6 July 2017.

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by 2020, notably through its EU research and innovation programme, Horizon 2020.[23]

This work is taking place at institutions across the Union. Among these are the Observatory and Forum's academic partners, the University of Southampton, the Knowledge Media Institute of the Open University, the Centre for Research and Technology Healls (Information Technologies Institute), the Lucerne University of Applied Sciences, and University College London, all of which have been contributing to the Observatory and Forum's work.

Other research efforts of note include the University of Copenhagen's Blockchain Research Center,[24] the University of Oslo's Blockchain Research Fellowship[25] and the Blockchain Center at the Frankfurt School of Finance and Management.[26] They are by no means the only ones.

Nor are just a large number of institutions involved. Europe's researchers are also delving into a wide variety of blockchain topics, with themes ranging from scalability to identity management, supply chain, government services, finance, IoT, healthcare, media, smart cities, energy, and legal aspects. Europe is also strong in important fields related to blockchain, like cryptography,[27] the science of which underpins how many blockchains work, or artificial intelligence, which is seen as an important adjunct technology for many use cases.[28]

BUSINESSES ARE ACTIVELY EXPLORING THE SPACE

Blockchain has also captured the attention of Europe's entrepreneurs and businesses, catalysing a great deal of activity 'on the ground' in Europe as well.

This is particularly evident in Europe's extremely vibrant blockchain startup scene. While it is not always an easy task to determine a project's exact location, especially as its official registration place can differ from the team members' actual working location and nationality,[1] a look at the available data shows that a wide variety of EU-based projects are emerging in various fields.

According to one site which tracks blockchain startups, about a quarter are based in the EU (among which the UK has the biggest share by far).[2] Blockchain startups globally are working in a wide variety of industries, from supply chain and logistics to entertainment and gaming, with (perhaps unsurprisingly), infrastructure, exchanges, payments and financial services among those attracting the most attention.

Blockchain is not just about startups, of course. According to one study, close to 60% of large corporates globally are either actively considering or are in the process of deploying blockchain technology.[3] Among companies who have reached the proof of concept stage, the majority expect blockchain to be integrated into their systems by the end of 2018.

23   Boost for blockchain research as EU increases funding four-fold, Irish Times, 8 February 2018.
24   European Blockchain Center.
25   PHD Research Fellowship in Blockchain, Universitetet i Oslo.
26   Frankfurt School of Finance and Management.
27   Bitcoin is known as a 'cryptocurrency' because cryptography plays a critical role in the functioning of the Bitcoin blockchain, as it does for many other blockchains.
28   Artificial Intelligence And Blockchain: 3 Major Benefits Of Combining These Two Mega-Trends, Forbes, 2 March 2018.

1   The Observatory is currently working on a comprehensive, crowdsourced mapping of projects in the European Union. It is available at www.eublockchain-forum.eu/initiative-map.
2   Outlier Ventures Startup Tracker
3   Nearly 6 in 10 large corporations considering blockchain deployment

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Here too activity is spread across a wide variety of industries, as enterprises look to blockchain to develop new business models, improve existing processes, and allow better, smoother and safer ways to collaborate with other actors.[4]

This is certainly true in banking, as financial services has been among the first sectors to understand the potential use cases and new markets implied by the technology.[5] One consultancy reported that 90% of the international banking executives worldwide it interviewed confirmed their bank was "currently exploring the use of blockchain/distributed ledger technology in payments."[6]

Blockchain has captured the imagination of the developer community too. Blockchain-related GitHub repositories[7] grew globally from zero in 2009 to over 85,000 towards the end of 2017. London (2nd place) and Paris (6th) were among the top 10 cities for blockchain development

based on the number of projects started.[8] Developers from the UK and Germany are among the most active in the blockchain field on GitHub (around 3,000 developers together), with strong developer activity in such other European locations as France, the Netherlands, Spain and Switzerland.[9]

As we look at in more detail below, Europe can also boast of a large number of vibrant blockchain "communities" in many cities and regions. This too is a reflection of the technology's wide appeal.

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4   Several large European companies such as Airbus, Bosch or Orange, have expressed their interest in distributed ledger technologies and are currently researching this field.

5   For instance, Deutsche Bank, Commerzbank and Intesa Sanpaolo have joined R3, the banking consortium focusing on advancing blockchain and distributed ledger technologies for the banking and finance sector, while French national bank Banque de France is currently leading an interbank blockchain experiment. The UK also shows interest: as quoted by the Financial Times in October 2017. In Italy, ABI Lab - a banking research and innovation centre run by the Italian Banking Association - is building a DLT proof of concept (PoC) with the participation of 14 Italian banks.

6   Blockchain Technology - How banks are building a real-time global payment network, Accenture Mobility

7   GitHub is the world most active website and absolute reference to host code repositories and allow collective work, whether private or open-source.

8   Evolution of blockchain technology Insights from the GitHub platform, Deloitte Insights, 6 November, 2017.

9   Deep Tech, The State of European Tech 2017.

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The European Union's blockchain strengths and competitive advantages

EUROPE CAN RELY ON STRONG BLOCKCHAIN COMMUNITIES

Our short tour above of the state of blockchain in Europe today is, perhaps unsurprisingly, a good guide to the strengths and competitive advantages that Europe should be able to count on to maintain a leading role in this technology tomorrow.

We noted that Europe's blockchain developers are already playing a key role in developing blockchain technology. With its large and highly educated overall community of engineers and developers, what ARK's CTO François-Xavier Thoorens calls "a big pool of development capacity," Europe has a good base to build up these numbers. This is a distinct advantage at a time when there is an acute shortage of trained blockchain talent.

We noted the vibrant blockchain entrepreneurial scene in Europe as well. This too comes out of a much larger community of entrepreneurial-minded individuals across the Union. As more and more of them discover blockchain and begin to understand its potential for new businesses, we can expect entrepreneurial activity to continue to increase. That will spur innovation and the growth of the industry.

Europe's many local blockchain communities, which among other things facilitate the

exchange of ideas and experience, should also continue to be fertile ground for blockchain innovation. As Carlos Kuchkovsky at BBVA puts it:

> *"There are good universities, corporations, underground groups… The communities are different from one city to another, but are generally quite mature and do a good job."*

Because of its size, Europe may have an advantage over other regions in terms of the diversity of its communities, with different areas having – often for historical reasons – a different focus.

Illustrating the point, Stachtchenko talks about the difference between the blockchain scenes in London and Berlin. The English capital is characterised by large number of former bankers that have or are in the process of launching their own financial-services-related blockchain projects. The German capital, for its part, is more developer oriented, with a big Ethereum hub and a notable grassroots blockchain community.[1]

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1   Berlin is also home to the IOTA Foundation, the first crypto-asset funded non-profit foundation ever to be headquartered within a European Union Member State.

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Europe also has an advantage in the number and quality of its blockchain events, which among other things provide a chance for the different local communities to get together and cross-pollinate ideas and experience.

The list is impressive. Notable blockchain conferences on the 2018 calendar include Blockchain Expo Europe in Amsterdam, Blockchain Expo London, the ICO Festival and Unchain in Germany, MoneyConf in Dublin, the Crypto Asset Summit in Vienna, the Blockchain Bitcoin Conference in Prague, Building on Bitcoin Lisbon 2018, and the Crypto Valley Conference on Blockchain Technology in Zug, Switzerland.[2] Blockchaingers, the biggest blockchain hackathon in the world, takes place in the digital city of Groningen in the Netherlands.

Nor is it just large events. A spot check in April found over 300 blockchain-related meetups scheduled in the European Union over a period of a few weeks, with some three-quarters of them taking place in the UK, Germany, Spain, France and the Netherlands.[3]

Less formal but more frequent than conferences, meetups have become one of the means of choice for the blockchain community to get together in relaxed settings and talk about ideas, present projects, or just get inspiration. Today they play, and can be expected to continue play, a central role in the ongoing development of this young industry. Their influence should certainly not be underestimated.

GOVERNMENTS ARE SUPPORTING THE DEVELOPMENT OF THE TECHNOLOGY

If community represents the more grassroots, bottom-up development of blockchain, government policy, regulation and the law can play a positive role in a more top-down fashion. Here, too, Europe can count on a number of strengths.

As we saw above, European governments have taken notice of and decided to support this technology on both an EU and national government level. Such support is extremely important in catalysing sustainable innovation in any field, and blockchain is no different.

While European governments are hardly the only ones to put national resources into blockchain, Europe can also count on a great wealth of experience managing complex policy and regulatory issues across borders. This can be an important advantage in blockchain, which is an inherently cross-border technology and which tends to raise thorny issues of international law.

Europe also always has had a strong penchant for collaboration between governments, corporates, startups, academics and the general public. As efforts like Alastria or the Dutch Blockchain Coalition (both mentioned above) attest, this tradition is being carried on in the blockchain space. This too will likely be a plus for collaboration and innovation.

Any significant new technology is likely to raise legal and regulatory questions, and require a clear legal and regulatory framework if it is to

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2   Top 10 Blockchain Events and Conferences 2018, Jorgi Modi, Hacker Noon, 26 March 2018.
3   Numbers based on the amount of meetups planned in EU countries in the next five weeks, registered on meetup.com (April 2018).

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succeed on a large scale. This is certainly the case with blockchain.

While we are far from such clarity today, Europe does have the advantage of an extremely well-developed legal and regulatory framework in general, and it is used to incorporating new technological developments into this framework as they arise. This experience will be useful when it comes to dealing with blockchain.

As François-Xavier Thoorens explains,

> *"blockchain is not just about crypto-assets, it is a whole ecosystem, and Europe provides an already existing legal and social ecosystem to integrate with."*

No one knows for sure how this will all play out, of course. There is a principle of EU law according to which legislation should not be technology specific. With this in mind, we should not expect any blockchain-specific law on the EU level. Considering the socio-political implications of blockchain-driven decentralisation, however, we can expect questions around how to apply existing laws and regulations to blockchain's new realities. We are already seeing this, for example, in Malta's recently enacted regulatory framework for blockchain, cryptocurrencies and distributed ledgers.[1]

Whatever the ultimate outcome, there is no reason to expect that Europe's lawmakers and regulators won't continue to put blockchain high on their agenda of priorities, and work to both realize its potential and protect Europeans from its risks.

The European Securities and Markets Authority (ESMA),[2] whose mandate is to promote the stability of financial markets and protect investors, provides a good example of this happening today. ESMA has been closely monitoring developments in the blockchain space for quite a while, having published an important report in 2016,[3] and through workshops and other efforts continues to look at regulatory and legal issues around blockchain-based digital assets, and to make recommendations.

Will this be enough to ensure Europe a leading role in the global blockchain industry? That too remains to be seen. For along with its advantages, blockchain in Europe faces a number of hurdles too. These we examine in our next section.

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1   Maltese Parliament Passes Laws That Set Regulatory Framework For Blockchain, Cryptocurrency And DLT, Forbes, 5 July 2018.

2   European Securities and Markets Authority.
3   ESMA assesses usefulness of distributed ledger technologies.

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Key challenges and barriers for blockchain in the European Union

As we have stated repeatedly, few technologies have as wide a variety of potential use cases, or ambitions to disrupt and rethink so many fundamental economic, social and even political structures, as blockchain. Considering its relative youth and open-source roots, blockchain is also still quite pliable. People can – and do – experiment with it, change it, adapt it. That means it is evolving very rapidly.

Keeping up with all of this is a challenge anywhere work is being done with this technology, and Europe is no exception. Below we set out some of the most important areas where hurdles will have to be overcome. A number of these are inherent to the technology and applicable wherever it is employed. Others are specific to the European context. All are fundamental to the future shape of this new industry.

INNOVATION NEEDS LEGAL AND REGULATORY CLARIFICATION

While Europe can count its well-developed legal and regulatory environment as an advantage in developing a suitable framework for blockchain technology over the long term, today there are fundamental areas that this technology touches on in which there is no or little legal and regulatory clarity or unity.

Such lack of clarity can put a chill on innovation. Entrepreneurs understandably fear investing heavily in products only to find that what they have done is not compliant, potentially exposing them to financial or even criminal penalties. This is a serious issue. While it is possible in certain cases to get rulings from the authorities ahead of time, the process is often slow and cumbersome, slowing down businesses. Nor is it always clear if a ruling in one country or region is binding/legal in others.

As Marius Jurgilas of the Bank of Lithuania points out,

> *"There is some level of legal harmonisation, but many points are of national competence. There is no problem at the national level, but if the EU are pushing for something pan-European, there are many differences between countries, for example with regards to medical records."*

When it comes to creating clarity, the most pressing need is probably in the area of token classification. Whether a token is regarded as a security, a financial instrument or a means of payment is central to how it is regulated, and of keen interest not just for token issuers, but also for any enterprise dealing on a commercial

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basis with tokens (like exchanges, financial advisors and brokers).

Other issues are thorny too. For instance, the tax and accounting treatment of cryptoassets is still very unclear. In many cases, so too is the legal status of smart contracts, which among other things can be used to enshrine contractual agreements between parties in computer code. Such smart contracts have the advantage of being transparent and self-executing: once deployed in the blockchain, they cannot be stopped. But can code really be law, as advocates of smart contracts often maintain? How can we enforce the stipulations of a smart contract on a blockchain with its real-life counterparts? How do we handle litigation and appeals for automated, self-executing agreements? What if there is a flaw in the code, as famously happened with the Ethereum DAO?[1]

While smart contracts are a good example of the difficulties in applying laws and regulations developed for conventional, centralised platforms and businesses to the decentralised blockchain paradigm, they are not the only one.

Because of their decentralised nature, many blockchain projects, especially public, permissionless blockchains, are more like public infrastructure projects than private, profit-oriented endeavours. Should rules for private companies apply to them? Public, permissionless blockchain platforms like Bitcoin or Ethereum are maintained by their communities and are, in theory, not owned by anyone. Who then can be made responsible or considered liable if something goes wrong? And what jurisdiction would hold sway?

GDPR AND BLOCKCHAIN

All of the above are questions raised by blockchain in general. They will need to be addressed, not just in Europe, but everywhere this technology takes hold.

But there is also a very Europe-specific regulatory issue with huge implications for blockchain in the Union: the problem of reconciling Europe's new General Data Protection Regulation (GDPR) with blockchain.

GDPR is a comprehensive update to Europe's data protection regulations with the dual objective of protecting the data rights of individuals and facilitating the free movement of personal data in the EU.

The law was conceived and written before blockchain technology was widely known, and so was fashioned with an implicit assumption that a database is a centralised mechanism for collecting, storing and processing data. As has since become clear, many of GDPR's stipulations seem to clash with blockchain's decentralised approach.

The most obvious and oft-cited point of tension comes from the fact that blockchains are, generally speaking, constantly growing, append-only databases, to which information can only be added, not removed. GDPR, on the other hand, explicitly gives individuals the right to have their data amended to ensure it remains accurate or (with certain exceptions) erased when no longer needed.

There are other areas of tension as well.

In an open, permissionless blockchain, where all full nodes on the network process the

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1   Decentralized Autonomous Organization (DAO), Wikipedia.

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information, it can be difficult to identify what GDPR calls the 'data controller', the person or entity with ultimate responsibility for how the data is used. Yet identifying such an entity is a key requirement of the law.

GDPR stipulates that data can only be transferred to third parties outside the EU if the location in question offers equivalent levels of protection as those found in Europe. In many permissionless blockchains, which are open to anyone regardless of location and in which a full copy of the database is replicated on all the full nodes participating in the network, it is not possible to selectively limit where the data goes.

This replication of the full data set throughout the network also seemingly clashes with GDPR's stipulation that applications and businesses only process as much data as needed for a specific transaction. So too do the protections GDPR gives individuals from having their personal data automatically processed. Blockchains generally, and smart contracts in particular, automatically process information by design.

Many see these tensions as irreconcilable, and conclude that a large number of blockchain projects are likely incompatible with GDPR. Some have even argued that blockchain technology is a threat to data protection.[1]

Reconciling GDPR and blockchain will not only be a challenge for lawmakers. As long as the legal framework around personal data and blockchain remains unclear, entrepreneurs and those designing and building blockchain-based platforms and applications in Europe

face massive uncertainty. That can put a brake on innovation.

Michèle Finck, one of the leading scholars on GDPR and blockchain,[2] calls the lack of legal certainty with respect to certain aspects of the GDPR "one of the biggest challenges," adding:

> *"Most actors seek to build something that is compliant, but they don't know what that means, and their lawyers, when they can afford some, don't know either."*

But there is cause for optimism as well. Both GDPR and blockchain at heart share the objective of data sovereignty, so blockchain could become a tool to achieve this objective. Blockchain is also still an immature technology. As it evolves, it may be possible to find ways to make the technology GDPR compliant. Blockchain could in theory make it easier for platforms and applications to have this compliance 'baked in' to the code, supporting data protection by design, one of the law's primary objectives.

Here too only time will tell. As Finck puts it:

> *"GDPR is not anti-innovation. It does some very good things for innovation. But we have to be aware that whatever it does, it touches virtually every blockchain."*

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1   Blockchain technology is on a collision course with EU privacy law, IAPP, 27 February 2018.

2   Michèle Finck, Blockchains and Data Protection in the European Union (30 November 2017), Max Planck Institute for Innovation & Competition Research Paper No. 18-01. Available at SSRN: https://ssrn.com/abstract=3080322 or http://dx.doi.org/10.2139/ssrn.3080322.

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BUSINESSES FACE CHALLENGES TOO

European blockchain businesses face a number of other challenges as well. The most acute is probably the fact that it is exceedingly difficult for companies that have raised funds in cryptoassets to get a traditional bank account. Part of the problem lies with the projects themselves. Particularly in the early days of fundraising via token launches, many projects did not perform adequate know-your-customer or anti-money laundering checks, either out of naiveté or because of lack of clear rules for how to do so in the crypto world. Banks, however, are generally required to know the source of the funds they accept. And while there are some smaller banks in European jurisdictions like Latvia[1] or Liechtenstein that are more open to blockchain projects,[2] this remains a huge hurdle for many.

But the source of funds is only part of the problem. Due to general regulatory uncertainty, European banks seem hesitant to touch crypto assets of any kind. Many are still influenced by the recommendation issued by the European Banking Authority in 2014 in which "the EBA recommends that national supervisory authorities discourage credit institutions, payment institutions and e-money institutions from buying, holding or selling virtual currencies."[3]

For blockchain projects that either do not want to, or for some reason cannot, raise funds directly through ICOs, it can be hard to find funding via other means. Compared to regions like the US, it has, for instance, traditionally been considered harder for startups in Europe

to find early-stage seed funding.[4] Blockchain startups are unfortunately no exception.

Like in the early days of the Internet, much of the work in blockchain today is about building the basic platforms upon which businesses will then produce products and services. So another challenge for blockchain businesses in Europe – albeit one largely under their control – is how to build and govern blockchain consortia with stakeholders in corporate-government and citizens. As we have seen above, many are already rising to the occasion.

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1   Investments in Cryptocurrency, Blue Orange Bank.
2   Liechtenstein Bank Frick offering cryptocurrency investments and cold storage, Adam James, Bitcoinist, 3 March, 2018
3   EBA Opinion on 'virtual currencies', 4 July 2014.
4   The difference between raising early-stage capital in the US vs. Europe, Medium, 25 June 2015.

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GETTING TECHNOLOGY AND RESEARCH RIGHT

Any discussion of issues facing the nascent blockchain industry would not be complete without mention of the many technical challenges that need to be solved before blockchain can reach its potential.

Among the most pressing in the permissionless blockchain space is scalability (both Bitcoin and Ethereum today can only process a fraction of the amount of transactions per second as private systems like Visa). Public blockchains that use proof-of-work consensus algorithms of the type introduced by the Bitcoin blockchain also consume a tremendous amount of energy (indeed, that is what proof-of-work is designed to do). As these networks grow, that energy consumption becomes increasingly unsustainable.[1] This has spurred great efforts in the blockchain community to find more environmentally friendly alternatives, for instance proof-of-stake.[2]

Security is another issue. Blockchains rely on sophisticated cryptography to encrypt data and maintain the integrity of the ledger. The advent of quantum computing may make the encryption algorithms that underlie many of today's blockchains vulnerable to attack, making it possible, for instance, to break the elliptic curve signature scheme and calculate the private key based on the public key. However, it is quite possible that by the time quantum computing becomes mainstream, many blockchains will have switched to quantum-resistant solutions.

At the moment blockchain is in its early, experimental phase, with technologists regularly developing new approaches and techniques. For blockchain to become a global phenomenon, the community will eventually have to agree on basic technical standards.

This is an important step for any emerging technology, as standards facilitate communication, interaction, innovation, compliance and interoperability.[3] With the plethora of blockchain projects coming online, interoperability is particularly important, and there are several significant projects underway to allow blockchains to easily interact with each other and share information.[4] This will have a positive impact on the technology as a whole.

These, of course, are not Europe-specific issues, but Europe could – some would say must – play a key role in solving them. To do so, it needs to know how. That means funding for research. While Europe has generally been good about making such funds available, as Alexander Denzler from the Lucerne University of Applied Sciences and Arts puts it, there is always room for more:

> *"The more money you put into research and education, the more chance you have to win this competition and be a leader."*

Nor is funding the only issue. Ledger co-founder and CTO Nicolas Bacca insists on the need for collaborative research between the

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1   [Proof of work, or proof of waste?](#), Medium, 14 December 2017.
2   [Proof of Work vs Proof of Stake: Basic Mining Guide](#), BlockGeeks.

3   [The Importance of Standards](#), CENELEC.
4   [Blockchain Interoperability Cosmos vs. Polkadot](#), Medium, Dave Kajpust, 27 June 2018.

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various actors:

> *"The European Union must create a dense, pan-European and collaborative network of all the active and dynamic entities: European institutions, national governments, universities and researchers, startups and entrepreneurs, big groups and companies, banks, open-source communities and underground groups."*

To turn this knowledge into concrete results, Europe will also need to grow blockchain-savvy engineers and developers. The problem is acute.[5] As Denzler points out, "maybe 2,000 people worldwide can build a blockchain from scratch." That is hardly enough to meet demand.

The talent shortage of course is an issue facing the blockchain industry globally. The challenge – and opportunity – for Europe is to take a leading role in solving it. Nor is it just tech talent. Business people will also have to learn more about how blockchain works, where its promising use cases lie, and what new business models it implies. As Philippe Genestier from Orange Labs explains:

> *"At this early stage, large companies have not yet reached the point of deploying applications, they are still trying to understand and discover what they can do with the blockchain."*

Since blockchain, as we have said, touches on many fundamental economic, social and

political issues, economists, social scientists, political scientists, and even philosophers will increasingly need to understand what blockchain is. Only then can they help the rest of us better understand what it could mean.

The general public will need to be educated as well. As any lay person who has tried to set up their own wallet will likely tell you, blockchain technology today is still complex and hard to use. Of course it is mostly up to blockchain developers to build better user experiences. But end users will need to be educated on how blockchains work. Those of us old enough to remember the early days of the Internet, when concepts like e-mail and web browsing were new and strange, will understand what this entails.

As many of the people we spoke to when preparing this paper told us, the technology also suffers from an unfortunate image problem. There is a general confusion between blockchain and Bitcoin, and between projects aiming to improve people's lives and society and the unfortunate but inevitable abuses of blockchain such as ICO scams or money laundering. While there is certainly criminal activity in the crypto world, it is not more prominent than elsewhere.[6] Yet the 'Wild West' perception remains.

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5   [Blockchain engineers are in demand](#), TechCrunch, 15 February 2018.

6   [Research Concludes that Laundering of Illicit Funds Constitutes Less than 1% of Bitcoin Transactions](#), Bitcoin.com, 15 July 2018.

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GREAT DEBATES: THE SOCIETAL CHALLENGES OF DECENTRALISATION

Blockchain is not just a new technology; it is a new mindset. As it takes hold, it may be worth mentioning some of the societal debates that either are – or can be expected to be – raised by it.

The core premise behind blockchain technology is decentralisation: the replacement of top-down, centralised platforms, products and services, with bottom-up, decentralised ones. In the vast number of cases, this means replacing middlemen with a peer-to-peer alternative in which people interact directly among themselves.

Whether or not such radical eradication of trusted third parties is desirable *per se* is however open to debate. In many cases, third-parties perform important functions. Instead of full decentralisation, it is possible that blockchain will catalyse a re-thinking of the role of middlemen in many industries and contexts, forcing a re-pricing of their services.

Such debates will likely take place in the political realm as well.

Many, for instance, believe blockchain can be used to transform and strengthen democratic processes within countries, among other things by building trustworthy, corruption-resistant, transparent, real-time voting systems while maintaining voter anonymity.

As Denzler points out, this could "help rethink the democratic process: a president is currently elected for 5, 6, 7 years, but we could now make public decisions more horizontal instead of always delegating our decision power to a representative. Blockchain could lead to a generalisation of an e-voting process."

Ubiquitous, real-time e-voting could also greatly facilitate direct democracy, in which all citizens constantly vote on all important issues. Yet while direct democracy can be an excellent check against the tyranny of the powerful, it can also lead to a tyranny of the masses. That is why modern democracies have introduced checks and balances. It also remains to be seen to what extent the general public will accept e-voting. While those who understand blockchain understand how it can create trust in information, for the average person the technology remains a black box, as easily subject to suspicion as any other technology.[1]

Blockchain can also be used for e-government. As in other industries, there is much promise here: blockchain could be an excellent means to improve government administration, the sharing of public data, the traceability of decisions and services, transparency in government expenditure, and the provision of public services.

Blockchain could be used to radically automate many government processes, bringing down costs and increasing efficiency in areas as diverse as identity[2] (electronic IDs and e-voting), verification and notarisation (for instance, cross-border proofs that a certain person has earned a certain academic degree or signed a

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1   German court rules e-voting unconstitutional, DW, 3 March 2009.
2   See for example Europe's eIDAS regulation.

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document) or property (blockchain-based land registries).[3]

There is, at least in theory, practically no limit to such automation. Many in blockchain are working on projects to support decentralised autonomous organisations (DAOs),[4] where human governance is completely replaced by algorithms. While generally applied to businesses or associations, there is no reason why the concept couldn't work at the country level as well.

This would mark a profound shift and, for many, a welcome one, supporting transparency and accountability in government and fighting corruption. But to what extent do we want public services to be digital? To what extent do we want an automated government? As such things become technically possible, we are likely to see increasingly heated debate.

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3   Estonia says that 99% of its governments services are digital (not just blockchain), saving it "800 years" of working time" annually. See Estonia Solutions E-Governance.

4   A DAO (Decentralised Autonomous Organisation) can be seen as the most complex form of a smart contract, where the bylaws of the decentralised organisation are embedded into the code of the smart contract, using complex token governance rules. For more details refer to: What is a DAO? Blockchain Hub.

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Emerging priorities for blockchain in the European Union

So where does Europe go from here when it comes to blockchain? Based on our analysis and workshop discussions, there are a number of areas where it should set its priorities.

First and foremost, Europe needs to clarify the legal and regulatory framework. Top of the list is resolving the tensions between GDPR and blockchain. The legal, fiscal and accounting status of tokens must be clarified as well, along with the rules surrounding the exchange of cryptoassets and fiat money.

Ensuring that legitimate blockchain projects can get bank accounts is a high priority too for Europe's entrepreneur community, which needs reassurance that its investments in innovation are not at risk on compliance grounds. In doing this, Europe will need to decide to what extent current laws and regulations can be applied or adapted to blockchain and crypto assets.[1]

One way regulators can foster innovation is by implementing regulatory 'sandboxes' in which projects can experiment with new products and services under the eye of the regulator, and without fear of costly compliance breaches. Many countries have adopted such practices, which are generally welcomed by the community. However, sandboxes are limited and do not offer the same level of certainty as actual legal and regulatory changes.

Europe should also work with lawmakers and regulators in other parts of the world to share best practices, with an eye to agreeing on global norms.

Second, Europe needs to continue to focus on education and research. While we have identified research as an advantage for Europe, other regions such as North America or Asia are not standing still. If the European Union wants to take this role, it needs to "compete with the US and take it to the next level," says Kuchkovsky, who believes research is a must if Europe wants to maintain parity with other regions and stay competitive on the global blockchain scene.

Blockchain education should be a priority for Europe too.

That means finding ways to tackle the blockchain talent shortage, first and foremost among developers, but also in related fields. Europe's entrepreneurs and executives need accessible means by which they can learn about blockchain's potential and use cases, and so be inspired to build the new platforms and business models that blockchain can engender. Europe should look to support blockchain education for other stakeholders

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1   To take one European example: the Finance Working Group of Blockchain Bundesverband (German blockchain association) suggests to regard tokens as security, if they are comparable to conventional instruments set out in Art. 4 (1) (44) MiFID, especially to conventional tradable debt and equity instruments, while tokens that are supposed to convey some functional utility to token holders other than/in addition to payment for goods or services, in the form of access to a product or service offered or at least intended to being enabled or created, rather form an economic good and no financial product. Statement on token regulation with a focus on token sales, Finance Working Group, Blockchain Bundesverband.

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as well, for instance journalists and the general public.

This naturally counts for its own representatives too. Whether regulators or administrators, European Union and national government officials have already shown a great interest in better understanding blockchain in order to better administer it. This should be supported.

Third, Europe should continue to drive the adoption of blockchain technology by the public and private sectors. The pursuit of flagship projects that provide real benefits to users and demonstrate the value-add of the technology, will have the dual effect of creating a domestic market for innovative entrepreneurs, and encouraging investors to fund more local projects.

The European Union already has some experience in the sustained promotion of innovation and new technology adoption, for example with the Horizon 2020 program, the biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over 7 years (2014 to 2020).

Fourth, Europe should continue to promote collaboration in the blockchain space. Certain areas in particular could be positively impacted by a closer collaboration between the governments and companies. As Denzler points out:

> *"In order to create e-voting solutions, you need to have identity management, so the government's support in this is very important.."*

Identity, in fact, is a crucial component to many blockchain applications and pan-European identity standards for blockchain could play a very important role in the uptake of this technology. Europe should therefore work to design and implement them. It should also, where it can, support the development of technical and other standards applicable to blockchain technology. This is a prerequisite for any emerging technology to take off on a large scale.

Fifth, Europe could also foster blockchain innovation by continuing to study the

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ecosystem and providing data on its growth and condition, as it is doing with the EU Blockchain Observatory and Forum and other initiatives.

By gathering and sharing such information with entrepreneurs and developers, as well as other blockchain stakeholders, Europe could go a long way to stoking the flames of innovation that have already lit up its burgeoning blockchain community. That would be in the interest of all parties.