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Preface

BOND project (Blockchains Boosting Finnish Industry) started to research Blockchain technology usage for non-cryptocurrency Use Cases in Q4/2016. One part of the project was to create an overview of the European level Blockchain research. This report, European Blockchain analysis, presents EU Horizon 2020 programme funding opportunities, granted projects and the status of national and international Blockchain standardization. Additionally examples of various established Blockchain forums and associations are briefly introduced.

Contents

1. Introduction

BOND-project, Blockchains Boosting Finnish Industry has been researching Blockchain use in non-cryptocurrency Use Cases. Objective of the project is to form an understanding of Blockchain tools, technologies, solutions and business possibilities in different domain areas, first focusing on Finnish business environment. Although the first focus is in Finland, status of European level Blockchain research is important to know in order to get connected to the European Blockchain ecosystems.

Therefore, we have created this report, which collects an overview of the status of the Blockchain research in Europe. Document includes an overview of the European Commission research calls and funded Blockchain research projects, introduction of some Blockchain forums and associations and information concerning Blockchain standardization internationally, in Europe and nationally in Finland. Some recent European Commission and Parliament Blockchain events have also been introduced.

When our project started in Q4 2016, Blockchain technology research and piloting had just started to gain space and in the European Commission open research calls there were not very many Blockchain specific calls open. However it was already visible that end of 2016 and especially in 2017 many research consortiums were creating project proposals, which contained suggestions to apply Blockchain technologies as one of their solution to many research topics as the hype cycle of Blockchain was gaining momentum.

2. European level Blockchain research

European Commission and European Parliament have taken many actions concerning Blockchain and Distributed Ledger Technologies during the last year (H2/2017 - H1/2018) and the speed is increasing. In several declarations, European Commission has announced that it will invest potentially up to 340 million Euros in projects supporting the use of Blockchain in various technical and societal areas through the programme Horizon 2020.

At the end of the year 2017, European commission published a short 2-page fact sheet about Blockchain and plans of the year 2018 objectives. Beside above mentioned funding plans, European Commission will actively participate in the international standardization, test Blockchain solutions through proof of concepts and piloting projects. Target is also to broaden EU financing of pilot projects in other areas of public interest like eGovernment, eHealth, or transport. Commission will also work on Governance and interoperability frameworks and assess the need for an EU Blockchain infrastructure. (European Commission. 2017).

European Commission promotes that it will explore 2018 and beyond the potential of Blockchain to improve cross-border European services for example in

- VAT reporting;
- Taxation;
- Customs;
- Title and business registries;
- Environmental, financial and company reporting,
- Health records management, clinical trials reporting, medicines registration, identity management.

2.1 European commission research calls

Blockchain technologies are still considered to be in a maturation phase and there is a need for more innovation, research, development, piloting and proof of concepts in order to facilitate uptake. Blockchain is a technology, which can be applied across domains and industries, so the European Commission is encouraging the applicants to propose Blockchain technology solutions, where it is applicable in the proposer's plans. In the earlier calls Blockchain technology was rarely mentioned and in the current calls several calls mention Blockchain in the call text, some not. In the following Table 1 we have collected a list of appropriate research calls, forthcoming, currently open, or already ended calls for this theme.

2.1.1 Seaching new forthcoming European Commission H2020 calls

In the future more European Commission funding opportunities available can be searched by checking the newsroom, that lists all open calls for Proposals and calls for Tender relevant to the Digital Single Market from the link: https://ec.europa.eu/digital-single-market/en/newsroom/funding-opportunities/all

Another source searching for new open and forthcoming H2020 Calls is to search through the European Commission participant portal from the link: https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/master_calls.html

Table 1 European Commission research calls related to Blockchain.

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
EU Horizon 2020	RIA Research and Innovation action IA Innovation action CSA Coordination and support action	**ICT-12-2016** TOPIC : Net Innovation Initiative b. Research and Innovation actions … The goal is to provide SMEs, social enterprises, industries, researchers, communities and individuals with a new development platform, which is intrinsically protective of the digital sovereignty of European citizens. The key characteristic of such a platform is to be fully distributed (e.g. using decentralised algorithms based on Blockchains), in order to be more resilient, intrinsically resistant to malware and hacking, preventing any possible centralisation of data storage or data management, and able to provide federated identity management.	12 April 2016	

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		Proposals are expected to design, develop and demonstrate an architecture for such a platform, with the involvement of relevant technological actors (P2P and open source developers, open hardware manufacturers, experts in security, encryption, anonymity, Blockchains and linked data) as well as of civil society organisations (citizens' organisations, digital rights advocacies, artists, social scientists) and interested developers of the overlying social applications and systems (creative industries, SMEs, social entrepreneurs, software developers).		
EU Horizon 2020	European Open Science Cloud for Research	H2020-INFRADEV-2016-2017	22 June 2016	http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/infradev-04-2016.html
EU Horizon 2020	EINFRA-12-2017: Data and Distributed Computing e-infrastructures for Open Science	European Research Infrastructures (including e-Infrastructures), H2020-EINFRA-2016-2017	29 March 2017	http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/calls/h2020-einfra-2016-2017.html#c,topics=callIdentifier/t/H2020-EINFRA-2016-2017/1/1/1/default-

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
				group&callStatus/t/Forthcoming/1/1/0/default-group&callStatus/t/Open/1/1/0/default-group&callStatus/t/Closed/1/1/0/default-group&+identifier/desc More about e-infrastructure activities: https://ec.europa.eu/programmes/horizon2020/en/h2020-section/e-infrastructures
EU Horizon 2020	Innovation Action	ICT-15-2016-2017: Big Data PPP: Large Scale Pilot actions in sectors best benefitting from data-driven innovation (IA)	25 April 2017	https://ec.europa.eu/research/participants/portal4/desktop/en/opportunities/h2020/topics/ict-15-2016-2017.html
EU Horizon 2020	HERCULE-AG Hercule III Action Grant	**HERCULE-TC-2017-02** Scope: The dissemination of knowledge and best practices during conferences, workshops or seminars ("Conferences") for staff employed by eligible bodies listed in Article 6 of Regulation 250/2014 as well as independent experts and academics active in the protection of the financial interests of the Union, and covering the following topics:	09 August 2017	

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		identification of risk and vulnerabilities the financial interests of the Union are exposed to: new fraud schemes or transgressions perpetrated against the financial interests of the Union, including the impact of the deployment of new technologies, such as virtual currencies (Blockchain); awareness raising on specific fraud indicators ("red flags") that might characterize transgressions against the financial interests of the Union.		
EU Horizon 2018-2020	Leadership in enabling and industrial technologies Information and Communication Technologies (LEIT-ICT)	**ICT-13-[2019]: Digital advances for local/urban manufacturing** Specific challenge: … The evolving industrial internet, CPS, IoT, big data technologies and emerging enablers such as Blockchain enable or promise easier connected digital value chains.	2019	
EU Horizon 2018-2020	Leadership in enabling and industrial technologies	**ICT-35-[2019]: Internet of Things** Scope: A) Research and innovation actions: Semantic interoperability to	2019	

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
	Information and Communication Technologies (LEIT-ICT)	cope with the increased complexity of connecting vast number of heterogeneous devices with increasing demands for contractual arrangements (e.g. Blockchains) for secure interaction.		
EU Horizon 2018-2020	Leadership in enabling and industrial technologies Information and Communication Technologies (LEIT-ICT)	**ICT-36-[2018]: Future Hyper-connected Sociality**: Scope: A) Veracity and digital companions for social media. … information veracity e.g. through use of advanced approaches such as the Blockchain protocol, and mechanisms for "bubble-busting".	2018	
EU Horizon 2018-2020	Leadership in enabling and industrial technologies Information and Communication Technologies (LEIT-ICT)	**ICT-38-[2018]: A multilingual, inclusive Next Generation Internet:** Scope: Block 2: Inclusive and personalised learning Expected Impact: B) Innovation action – Trusted digital learning identities: Develop and pilot solutions based on open compo-	2019	

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		nents for Blockchain-based certificates that enable the recognition of learning achievements, accomplished in formal and informal learning contexts. Expected Impact: - Emergence of new business model for Blockchain-based certificates		
EU Horizon 2018-2020	Leadership in enabling and industrial technologies Information and Communication Technologies (LEIT-ICT)	**ICT-42-[2018]: Fintech: Support to experimentation frameworks and regulatory** Scope: - Envisage possible actions and (technical) solutions to evaluate the impact of regulation and facilitate regulatory compliance in financial areas. This could concern in particular DTL/Blockchain based or algorithmic regulation based initiatives.	2018	
EU Horizon 2018	CSA Coordination and support action	**Blockchain and distributed ledger technologies for SMEs - INNO-SUP-03-2018**	15 May 2018	http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/innosup-03-2018.html

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		Scope: - The Action will be a piloting scheme for the uptake of DLTs by SMEs. It will aim at testing in real conditions the opportunities, challenges, risks and necessary conditions associated with DLTs in different context and sectors. Thereby it will stimulate (i) the uptake of DLTs by SMEs and inspire others to follow, and equally (ii) it will sensitize intermediaries to develop their expertise in this respect and (iii) it will help draw lessons for policy makers and regulators. - It will include and make use of financial support to third parties to allow for 20-30 SMEs to test concrete applications of DLTs in their respective field with technology suppliers (budget for each third party not exceeding EUR 50,000). The selection of entities involved in the pilots, the matchmaking process, the monitoring of each case as well as the management		

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		of the financial support to third parties will be ensured by the co-ordinator. At least 50% of the total proposed budget shall be allocated to financial support to third parties (please refer to the grant conditions for this topic). - The Commission considers that proposals requesting a contribution from the EU of up to EUR 1.5 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts. Expected Impact: · More SMEs take advantage of the opportunities offered by DLTs. · More intermediaries are familiar with DLTs and equipped to assist SMEs in this field. · Improved framework conditions for the uptake of		

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		DLTs and the mitigation of related risks.		
EU Horizon 2018-2020	RIA Research and Innovation action IA Innovation action CSA Coordination and support action	**Future Hyper-connected Sociality - ICT-28-2018** Specific Challenge: - Future social networks, media and platforms will become the way our societies operate for communication, exchange, business, creation, learning and knowledge acquisition. The challenge is to mobilise a positive vision as to the role that Social Media will increasingly play in all these areas, and to overcome today's critical issues about trust and governance through democratic reputation mechanisms, and user experience. Scope: - Analysing and building the foundation of next generation Social Media platforms towards a "Global Social Sphere", based on peer-to-peer/decentralised, community approaches and free/open	17 April 2018	http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/ict-28-2018.html

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		source principles. This foundation shall enhance the role of prosumers, communities and small businesses, mastering technological barriers, introducing innovative and participatory forms of quality journalism, and using various data in a secure manner. These activities should contribute to overcome the current accumulation of power by central intermediaries often located outside Europe.		
EU Horizon 2018-2020	RIA Research and Innovation action	**InCo Flagship on Integrated multi-modal, low-emission freight transport systems and logistics - MG-2-9-2019** Specific Challenge: - Global as well as regional and local freight transport is massively changing due to accelerating technological changes, the establishment of new players in global trade, the rise of protectionism, and the slowing down of economic growth of important partners such as China. New logistics	16 January 2019	http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/mg-2-9-2019.html

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		concepts (such as the Physical Internet) and new disruptive technologies, such as Blockchain, Industry 4.0, vehicle automation and truck platooning or new business models, like 'crowdshipping' and the circular economy models will have an impact on global freight transport, its optimisation and its environmental footprint that needs to be better understood and assessed. Furthermore new trade routes from and to Europe will probably change the traditional pattern of freight movement and will need new connections with European corridors and hubs at a time of budget limitation on investment for transport infrastructure. - Sustainable integrated multimodal freight transport is particularly important for the development of countries in special situations – least developed countries, landlocked developing countries, and small island states and outermost regions - which face common		

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		problems resulting from the under-resourcing of transport infrastructure and services, traffic-related air pollution and high accident levels, but also diverse geopolitical and trade situations. These countries/regions also have an enormous potential for sustainable development. International cooperation can support their economies both domestically and globally for a global benefit and ensuring better integration of these regions into the world economic landscape. Scope: - Proposals should address one or more of the following aspects: · Understanding how new concepts in logistics, in combination with new national strategies to organize freight flows in ports and airports have an impact on global freight transport, and on related greenhouse gas emissions. Multimodal transfer zones from ports and airports		

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		from long-haul to last mile logistics need to be better analysed in order to find appropriate measures and for ensuring seamless door-to-door transport, exploiting the full potential of modularization and other innovative logistics concepts. International cooperation with major trade partner countries is essential to ensure the smooth transfer at all levels of the transport chain. Proposals should also address solutions that enable peripheral regions and landlocked developing countries to have proper accessibility to international trade. · Speed up the process and transition towards the Physical Internet paradigm, demonstrating how different technologies, business cases and standards come together in real-world applications, and are able to deliver added value to the users and have positive impacts in terms of emissions and energy consumption. Priority partners		

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		should be USA, Canada, China, Japan. Demonstrations of satellite-based applications using EGNOS and Galileo are also suggested. · Research the range of new issues and questions emerging with the new trade routes to and from Europe, such as the Northern Sea Route (across an ice-free Arctic in summer months) or the new Silk Road routes and the Chinese One Belt One Road strategy; the effect of the development of these new routes on trans-continental freight modal split; the additional interfaces needed between the new overland routes and the EU internal transport networks / corridors. Priority partners are those along the routes. The geopolitical and trade aspects of these developments, in particular on countries affected by these developments, should be considered.		

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		· Understand new disruptive trends emerging as on-demand logistics solutions such as crowd-sourcing of deliveries (or 'crowdshipping') which have the potential to be a logistics 'game-changer', evidencing different impacts in both emerging and industrialized countries, including the possible integration of passengers and freight flows. Research on the crowd-sourcing of logistics would benefit from international collaboration, partly to compare the development of the phenomenon in different markets, but also to explore whether it can be extended to long-haul / cross border freight delivery, taking in consideration economic, regulatory and security constraints. · Assess the impact of emerging technologies in other sectors than freight transport (e.g. Blockchain, Industry 4.0, 5G, 3D printing, unmanned aerial vehicles (UAV's)) on the logistics operational system, and		

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		identify the potential development paths that lead to the optimal exploitation of their positive effect. · Collect best-case models and develop decision support systems aimed at helping public authorities and private companies to determine the most likely scenarios and to promote a higher level of collaboration between the different stakeholders, including new emerging ones. · Consideration of aspects of governance, privacy and cybersecurity of and with regard to cargo.		
EU Horizon 2018-2020	RIA Research and Innovation action	**Next Generation Internet - An Open Internet Initiative - ICT-24-2018-2019** Specific Challenge: - This initiative aims at developing a more human-centric Internet supporting values of openness, cooperation across borders, decentralisation, inclusiveness and	17 April 2018 28 March 2019	http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/ict-24-2018-2019.html

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		protection of privacy; giving the control back to the users in order to increase trust in the Internet. It should provide more transparent services, more intelligence, greater involvement and participation, leading towards an Internet that is more open, robust and dependable, more interoperable and more supportive of social innovation. Scope: - Involving today's best Internet innovators to address technological opportunities arising from cross-links and advances in various research fields ranging from network infrastructures to platforms, from application domains to social innovation. Beyond research, the scope includes validation and testing of market traction with minimum viable products and services, of new economic, mobility and social models, and involves users and market actors at an		

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		early stage. Multi-disciplinary approaches are encouraged when relevant. Eventually this initiative should influence Internet governance and related policies. Research and Innovation Actions - Each Research and Innovation Action (R&I Action) will focus on a given research domain supporting the objective of a human-centric Internet. It will build a European ecosystem of researchers, innovators and technology developers by selecting and providing financial support to the best projects submitted by third parties in a competitive manner. - Through an agile and flexible process, 'R&I Actions' will focus their support on third party projects from outstanding academic research groups, hi-tech start-ups and SMEs, so that multiple third parties will be funded in parallel contributing to the same research area, using short research cycles		

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		targeting the most promising ideas. Each of the selected third parties projects will pursue its own objectives, while the 'R&I Action' will provide the programme logic and vision, the necessary technical support, as well as coaching and mentoring, in order that the collection of third party projects contributes towards a significant advancement and impact in the research domain. The focus will be on advanced research that is linked to relevant use cases and that can be brought quickly to the market; apps and services that innovate without a research component are not covered by this model. - Beneficiaries shall make explicit the intervention logic for their specific research domain, their capacity to attract top Internet talents, to deliver a solid value-adding services package to the third party projects, as well as their expertise and capacity in managing the full life cycle of the open calls		

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		transparently. They should explore synergies with other research and innovation actions, supported at regional, national or European level, to increase the overall impact. - For grants awarded under this topic for Research and Innovation actions beneficiaries may provide support to third parties as described in part K of the General Annexes of the Work Programme. The support to third parties can only be provided in the form of grants. The respective options of Article 15.1 and Article 15.3 of the Model Grant Agreement will be applied. - For the call closing in 2018 'R&I Actions' in the following three sub-topics will be called for. Proposals should address only one of these sub-topics. · Privacy and trust enhancing technologies: as		

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		sensors, objects, devices, AI-based algorithms, etc., are incorporated in our digital environment, develop robust and easy to use technologies to help users increase trust and achieve greater control when sharing their personal data, attributes and information. · Decentralized data governance: leveraging on distributed open hardware and software ecosystems based on Blockchains, distributed ledger technology, open data and peer-to-peer technologies. Attention should be paid to ethical, legal and privacy issues, as well as to the concepts of autonomy, data sovereignty and ownership, values and regulations.		

Program	Funding scheme	Call name + information about the call	Deadline / Timeframe	Further information
		· Discovery and identification technologies: to search and access large heterogeneous data sources, services, objects and sensors, devices, multi-media content, etc. and which may include aspects of numbering; providing contextual querying, personalised information retrieval and increased quality of experience.		

2.1.2 Research calls raised up in the European Commission Info day

Below we are presenting more links of the Blockchain / DLTs Horizon 2020 Work Programme 2018-2020 for further details. These calls were promoted in the European Commission's Blockchain info day in December 2017 (European Commission 2017b). Few of the next calls were presented in the earlier Table 1.

SME call and EU Horizon Prize
Blockchain and distributed ledger technologies for SMEs (INNOSUP-03-2018): http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/innosup-03-2018.html

EIC Horizon Prize on Blockchains for Social Good: http://ec.europa.eu/research/eic/index.cfm?pg=prizes_Blockchains

Next generation Internet
Future Hyper-connected Sociality (ICT-28-2018): http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/ict-28-2018.html

Next Generation Internet - An Open Internet Initiative (ICT-24-2018-2019): http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/ict-24-2018-2019.html

An empowering, inclusive Next Generation Internet (ICT-30-2019-2020): http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/ict-30-2019-2020.html

Smart Mobility and Living
Interoperable and smart homes and grids (DT-ICT-10-2018-19): http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/dt-ict-10-2018-19.html

Advanced technologies (Security/Cloud/IoT/BigData) for a hyper-connected society in the context of Smart City (EUJ-01-2018): http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/euj-01-2018.html

Transport
InCo Flagship on Integrated multimodal, low-emission freight transport systems and logistics (MG-2-9-2019): http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/mg-2-9-2019.html

Energy

TSO – DSO – Consumer: Large-scale demonstrations of innovative grid services through demand response, storage and small-scale (RES) generation (LC-SC3-ES-5-2018-2020): http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/lc-sc3-es-5-2018-2020.html

The role of consumers in changing the market through informed decision and collective actions (LC-SC3-EC-1-2018-2019-2020): http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/lc-sc3-ec-1-2018-2019-2020.html

eGovernment

Transformative impact of disruptive technologies in public services (H2020-SC6-TRANSFORMATIONS-2018-2019-2020): http://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-societies_en.pdf

eHealth

Digital health and care services (SC1-DTH-10-2019-2020): http://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-health_en.pdf

Prototyping a European interoperable Electronic Health Record (EHR) exchange (SC1-DTH-08-2018): https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/sc1-dth-08-2018.html

Trusted Digital Solutions and Cybersecurity in health and care (H2020-SC1-FA-DTS-2018-2020): https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/calls/h2020-sc1-fa-dts-2018-2020.html#c,topics=callIdentifier/t/H2020-SC1-FA-DTS-2018-2020/1/1/1/default-group&callStatus/t/Forthcoming/1/1/0/default-group&callStatus/t/Open/1/1/0/default-group&callStatus/t/Closed/1/1/0/default-group&+identifier/desc

Toolkit for assessing and reducing cyber risks in hospitals and care centres to protect privacy/data/infrastructures (SU-TDS-02-2018): http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/su-tds-02-2018.html

Raising awareness and developing training schemes on cybersecurity in hospitals (SU-TDS-03-2018): http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/su-tds-03-2018.html

Internet of Things (ICT-27-2018-2020): http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/ict-27-2018-2020.html

FinTech
Support to experimentation frameworks and regulatory compliance (ICT- 35): http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/ict-35-2018.html

2.2 European commission funded Blockchain projects

In this section, we present some funded example projects from the Horizon 2020 programs. European Commission has announced that it has allocated about 83 million Euros to Blockchain related projects. Earlier it was already mentioned that potentially up to 340 million could be committed to Blockchain projects by the European Commission from 2018 to 2020.

Seventeen (17) projects have been mentioned in a European Commission presentation as examples of granted Horizon 2020 projects concerning Blockchain technology. Projects with their webpages and short descriptions taken from their websites are:

- D-CENT (social money for democratic societies)/EU-funding ended in May 2016- https://dcentproject.eu/
  - A Europe-wide project developing the next generation of open source, distributed, and privacy-aware tools for direct democracy and economic empowerment.
- DECODE (decentralised management architecture)- https://www.decodeproject.eu/
  - DECODE provides tools that put individuals in control of whether they keep their personal information private or share it for the public good.
- MyHealthMyData (Blockchain for health and patient-centric system)- http://www.myhealthmydata.eu/
  - MyHealthMyData (MHMD) is a Horizon 2020 Research and Innovation Action which aims at fundamentally changing the way sensitive data are shared. MHMD is poised to be the first open biomedical information network centred on the connection between organisations and individuals, encouraging hospitals to start making anonymised data available for open research, while prompting citizens to become the ultimate owners and controllers of their health data. MHMD is intended to become a true information marketplace, based on new mechanisms of trust and direct, value-based relationships between EU citizens, hospitals, research centres and businesses.
- Bloomend (Blockchains for social media)- http://cordis.europa.eu/project/rcn/211092_en.html

- The main goal of the Bloomen proposal is to extend the use of the Blockchain technology to handle different online user transactions, provide an innovative way of content creation, sharing, personalized consumption, monetization and copyrighting. In particular within the Bloomen project, Blockchains will be used as a distributed database for media copyright information, for fast micropayments of media content, and for transparency in copyright management and monetization.

· SUnFISH- http://www.sunfishproject.eu
  - The overall problem that SUNFISH has looked into is the lack of infrastructure and technology allowing Public Sector players to federate their clouds. Cloud computing is drawing wide attention in the Public Sector. Nowadays main bodies rely on their own private clouds, leading to a multitude of secluded, not-interoperable cloud centres. The lack of reliable cross-cloud infrastructure hinders effective and practicable exploitation of clouds in the Public sector. SUNFISH has built upon this need by providing a software platform that via the principled usage of a Blockchain infrastructure offers decentralised, democratic and secure federation of private and public clouds.
· Symbiote- https://www.symbiote-h2020.eu
  - The main goal of symbIoTe (symbiosis of smart objects across IoT environments) is to foster a simplified IoT application and service development process over interworking IoT platforms. symbIoTe is built around the concept of virtual IoT environments provisioned over various cloud-based IoT platforms. Virtual IoT environments are an abstraction composed of virtual representations of actual sensors and actuators being exposed by their host platforms to third parties.
· GHOST- http://cordis.europa.eu/project/rcn/210233_en.html
  - Safe-Guarding Home IoT Environments with Personalised Real-time Risk Control (GHOST) objective is to effectively respond to the multitude & complexity of cybersecurity challenges in smart-homes GHOST deploys a pioneering software-enabled ‘usable security’ solution. The project brings professional level security to the European citizens and to this end it: (a) increases the automation level & effectiveness of existing security services; (b) opens up the cybersecurity ‘blackbox’ to consumers, creates understanding and builds trust through effortless decision support & advanced ‘usable transparency’; (c) enhances the system’s self-defence by safeguarding critical security-related data using Blockchain technology.
· BlockchainKYC (Iceland)- http://cordis.europa.eu/project/rcn/211172_en.html

- Authenteq has developed a smartphone-based 100% automated and tamper-proof online identity verification service (Authenteq ID) that uses multifactor biometric authentication, fitting the needs of online/mobile marketplaces, as well as other websites that require or benefit from ID verification such as betting, gaming or dating sites. This system aims to eliminate user anonymity in online transactions (and therefore drastically reduce identify fraud), while maintaining the highest level of privacy for consumers. Authenteq ID uniquely combines [1] a smartphone app, where the end-user creates its certified ID by scanning its passport and taking a selfie, [2] backend proprietary services that perform face match recognition, image analysis of ID security elements and third-party security checks, and [3] Blockchain data storage for validation purposes (impossible to reverse-engineer and hack). Personal details and images are hashed and files deleted from the server and app.

· Signaturit (Spain)- http://cordis.europa.eu/project/rcn/205049_en.html
  - Signaturit - The smartest e-Signature solution to send and sign documents on the go. Signature is a service that allows to the user handwriting signature of documents through any mobile device in a digitized format. It allows the receiver to sign an attached document received by email. After the session logout, the service automatically converts the attachments to a PDF document that is signed with an electronic signature, sealed and with time stamping.
· Billon (Poland)- http://cordis.europa.eu/project/rcn/212243_en.html
  - Disrupting the economy – FinTech Blockchain solution revolutionises direct payments. Secure, low-cost and simple bank-free payments for everyone. Our value proposition is Billon - a distributed ledger technology for creating free current accounts enabling making ultra-low cost payments with real currencies (EUR, GBP, PLN) in a regulated manner. The disruptiveness of Billon arises from:(1) distributed architecture developed on Blockchain by our specialists, (2) compliance with the EU regulations upon the agreements with banks and ongoing FCA Regulatory Sandbox in the UK.
· BROS- http://cordis.europa.eu/project/rcn/209037_en.html
  - Blockchain: a new framework for swarm RObotic Systems. Using a novel combination of Blockchain technology and swarm robotics systems, BROS will generate new models to address three fundamental issues by using the robots as nodes in a network and encapsulating their transactions in blocks: First, new security models and methods can be implemented in order to give data confidentiality and entity validation to robot

swarms, therefore making them suitable for trust-sensitive applications. Second, distributed decision-making and collaborative missions can be easily designed, implemented, and carried out by using special transactions in the Blockchain, which enable robotic agents to vote and reach agreements. Third, robots may be able to function in diverse and changing environments without any change in their control algorithm, if their operation corresponds to different Blockchains that use different parameters.

- DLInnociate- http://cordis.europa.eu/project/rcn/209748_en.html
  - Innovation Associate knowledgeable in Blockchain technology for real time economy platform business development. DLI Ltd operates right now in a synergetic business landscape where the development of national information society and the client assignments collide in a manner profitable for the company. DLI Ltd need to complement its expertise with knowledge in Blockchain technology for secured Real Time Economy in cloud, both in general for providing applications to any client and for piloting the DEEP, Digital Enterprise Ecosystem Platform business plan on open innovation with a client in the FinTech. The plan targets to leverage the business plan further within the client's global organization, one of the world's largest settlement system for domestic and international securities transactions.
- DEFENDER- http://cordis.europa.eu/project/rcn/210231_en.html
  - Defending the European Energy Infrastructures. Critical Energy infrastructures (CEI) protection and security are becoming of utmost importance in our everyday life. DEFENDER framework will combine a range of devices/technologies for situational awareness (fixed sensors like PMUs, mobile devices like drones and advanced video surveillance) (ii) intelligent processing for cyber-physical threat detection with (iii) a toolbox for incident mitigation and emergency response and (iv) Human-In-The-Loop for managing people interaction with CEI, while leveraging on Blockchain technology for peer-to-peer trustworthiness.
- TITANIUM- http://cordis.europa.eu/project/rcn/209948_en.html
  - Tools for the Investigation of Transactions in Underground Markets. TITANIUM will develop novel methods and technical solutions for investigating and mitigating illegitimate activities (relating to either crime or terrorism) involving virtual currencies and/or underground market transactions.
- INTERLACE- http://cordis.europa.eu/project/rcn/209089_en.html
  - Interacting Decentralized Transactional and Ledger Architecture for Mutual Credit. The objective of INTERLACE is to use

the Abstract State Interaction Machines framework (CoreASIM) open source output of the FP7 FET project BIOMICS to develop a decentralized transactional and ledger architecture demonstrator for B2B mutual credit.

- STOP-IT- http://cordis.europa.eu/project/rcn/210216_en.html
  - Strategic, Tactical, Operational Protection of water Infrastructure against cyber-physical Threats. Water critical infrastructures (CIs) are essential for human society, life and health and they can be endangered by physical/cyber threats with severe societal consequences. STOP-IT solutions are based on: a) mature technologies improved via their combination and embedment (incl. public warning systems, smart locks) and b) novel technologies whose TRL will be increased (incl. cyber threat incident services, secure wireless sensor communications modules, context-aware anomaly detection technologies; fault-tolerant control strategies for SCADA integrated sensors, high-volume real-time sensor data protection via Blockchain schemes; authorization engines; irregular human detection using new computer vision methods and WiFi and efficient water contamination detection algorithms).
- CHARIOT- http://cordis.europa.eu/project/rcn/212490_en.html
  - Cognitive Heterogeneous Architecture for Industrial IoT. CHARIOT will provide a design method and cognitive computing platform supporting a unified approach towards Privacy, Security and Safety (PSS) of IoT Systems including among others the following innovations: 1) A Privacy and security protection method building on state of the art Public Key Infrastructure (PKI) technologies to enable the coupling of a preprogrammed private key deployed to IoT devices with a corresponding private key on Blockchain system. 2) A Blockchain ledger in which categories of IoT physical, operational and functional changes are both recorded and affirmed/approved by a combination of a cognitive engine and private key hashing between the cognitive engine and IoT devices to authorise change and, likewise, invalidating any and all other changes be they malicious or otherwise. 3) A fog-based decentralised infrastructure for Firmware Security integrity checking that leverages a Blockchain ledger to enhance physical, operational and functional security of IoT systems, including actuation and deactivation.

- #Blockchain4EU: Blockchain for Industrial Transformations, https://blogs.ec.europa.eu/eupolicylab/portfolios/Blockchain4eu/
    - The European Commission's Joint Research Centre (JRC) and Directorate-General for Internal Market, Industry, Entrepreneurship & SMEs (DG GROW) have launched the project #Blockchain4EU: Blockchain for Industrial Transformations, running until February 2018. The project was a forward-looking exploration of existing, emerging and potential applications based on Blockchain and other Distributed Ledger Technologies (DLTs) for non-financial / industry sectors. Final event of the project will be held on the 24th of May 2018. Project has also published a final report describing the project and its results with the title: Blockchain4EU: Blockchain for Industrial Transformations (Nascimento S. & al. 2018).

3. Blockchain forums and advisory groups

Several international and national associations and organizations are promoting and involved with Blockchain technology and many Blockchain forums have been emerging in the recent time. National Blockchain associations and organizations have been established in most of the member countries. We have collected in this section few examples of pure Blockchain forums and some other noteworthy organisations and forums, which are dealing with the Blockchain. Many of the nationally established Blockchain associations are networking and connecting themselves with neighbour country Blockchain associations to achieve international networking and cooperation.

Intention is not to try to create an all-inclusive list of forums and associations, but to give an overview that lot is happening in this field. This introduction gives also some starting points, where a person can start connecting to the Blockchain world. It should be also noted that as in our BOND-project we have been researching Blockchain use in non-cryptocurrency Use Cases, our list of forums and groups concerns general Blockchain forums and we have not searched pure cryptocurrency forums. In the FinTech area Blockchain development is also progressing rapidly and there are lot of Fintech related Forums established.

3.1 European Blockchain observatory and forum

European Commission launched in the 1st of February 2018 the EU Blockchain Observatory and Forum (European Commission 2018b). Some of the main objectives of the observatory are:

- map key existing initiatives in Europe and beyond;
- monitor developments analyse trends and address emerging issues;
- become a knowledge hub on Blockchain;
- promote European actors and reinforce European engagement with multiple stakeholders;
- represent a major communication opportunity for Europe to set out its vision and ambition on the international scene;
- inspire common actions based on specific use-cases of European interest.

These objectives makes this forum a very good source to follow what is happening in the Blockchain area in Europe and internationally. The work has just begun, but the community is growing rapidly. Observatory has Internet pages, which can be found from:

https://www.euBlockchainforum.eu/

Observatory has also community pages, where several channels and discussion is ongoing (registration needed):

https://euBlockchain.mobilize.io/

Currently there are channels for seven interest groups in the EU Blockchain Forum and Observatory:

- EU Blockchain Observatory & Forum (general announcements)
- Community
- Blockchain innovation in Europe
- GDPR, data policy and compliance
- Government services and digital identity
- Scalability, interoperability and sustainability
- Tokens and ICOs

Observatory is also working on the Fintech area of distributed ledgers and it will report on the challenges and opportunities of crypto assets later in 2018 and is working on a comprehensive strategy on distributed ledger technology and Blockchain addressing all sectors of the economy. (European Commission. 2018e).

Observatory opened a call of experts for two working groups, the “Blockchain Policy and Framework Conditions Working Group” and the “Use Cases and Transition Scenarios Working Group”. 30 members for both of the groups were selected from over 350 applicants and they are expected to support and contribute to the Observatory Blockchain work for the next two (2) years. Selected experts and more detailed descriptions of the working groups’ objectives can be found from the observatory’s Internet pages (EU Blockchain. 2018a).

3.2 EIT Digital

EIT digital, (http://www.eitdigital.eu/) seeks to generate significant innovations from top European research results. The objective is incubation, market uptake and rapid growth of these innovations. They focus their investments on a limited number of innovation areas that have been selected with respect to European relevance and leadership potential - the Innovation Action Lines. These action lines are as follows: Digital Industry, Digital Cities, Digital Wellbeing and Digital Infrastructure.

EIT Digital has recognized the emerging Blockchain and in October 2017 EIT Digital opened an innovation space in Amsterdam to boost FinTech. This new line is called Digital Finance. According to Patrick Essers node-director of EIT Digital in the Netherlands. "With this location we intend, together with our partners, to develop new financial products and services based on technologies as Blockchain, Artificial Intelligence and Cybersecurity. In addition, we will help European FinTech

scaleups, including the Dutch, to expand their markets and to attract international capital. Our new co-location fits in the mission of EIT Digital to make Europe a key player in the digital world economy." (EIT. 2018a)

3.3 The Organisation for Economic Co-operation and Development (OECD)

The Organisation for Economic Co-operation and Development (OECD), https://www.oecd.org/, mission is to promote policies that will improve the economic and social well-being of people around the world. The OECD provides a forum in which governments can work together to share experiences and seek solutions to common problems.

OECD has taken a role concerning Blockchain and they have been working with statements and recommendations and events. In his presentation, Greg Medcraft, Director, Financial and Enterprise Affairs, OECD concluded his presentation saying: “Blockchain is transformative, and will touch many parts of the economy. Governments need to develop the right policy environment to help Blockchain innovations and applications flourish. And the OECD has a role to play in getting this right.” (Medcraft G. 2018.)

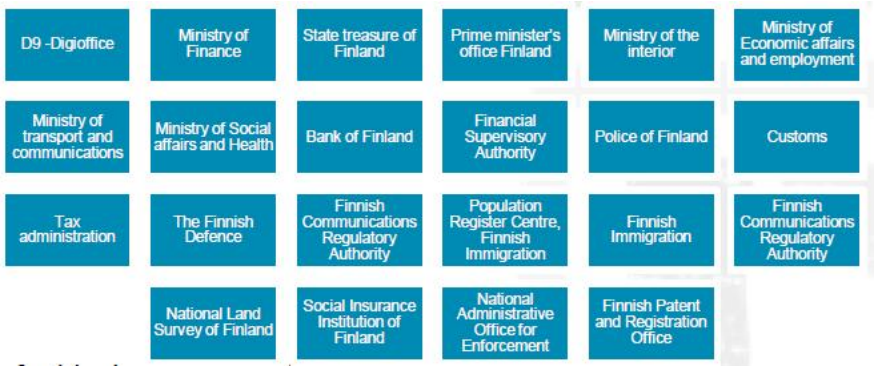
OECD’s Observatory of Public Sector Innovation (OPSI) was seeking in spring 2018 comments and edits on a draft working paper titled: "Blockchains Unchained: The Implications of Blockchain Technologies for the Public Sector" (OECD. 2018a.). Comments were asked in public call and the document was circulated through direct channels in the member countries.

OECD organizes also event concerning Blockchain, e.g. in June 2018 there will be an event “Blockchain and competition policy” and prior to the event, OECD has published an issues paper: “Blockchain Technology and Competition Policy - Issues paper by the Secretariat” (OECD. 2018b).

3.4 Finland: Public administration’s Blockchain technology network - D9

Finnish public administrations Blockhain technology network was initiated by the State Treasury of Finland and the Ministry of Finance in June 2017. Purpose of the network is to develop Finnish public administration knowhow about Blockchain, help to figure out the opportunities of Blockchain and bring together different actors working with Blockchain technology. Figure 1 shows the different actors of various administration areas (situation December 2017) in the network.

Figure 1 Public administration sectors in network (source Janne Pulkkinen/State Treasury)



Players in the network have strong interest to understand and collect information about Blockchain and Distributed Ledger Technologies. Network is cooperating with the public and private sector companies and research community via workshops and common pilots. Network is also creating reports and surveys to support the information sharing across the network, e.g. “Hajautetun luottamuksen teknologiat ihmiskeskeisen yhteiskunnan mahdollistajana” (Decentralized trust technologies enabling human centric society) (Hallinnon lohkoketjuteknologiaverkosto. 2018a) was published in April 2018.

As another example of Finnish government positive attitude towards Blockchain technologies, Prime minister’s office Finland, has been active and ordered several Government Plan for Analysis, Assessment and Research surveys concerning Blockchain use, e.g. in food sector (Latvala T. & al. 2017), social and health sector (Salonen J. & al. 2018) as well as in transport (Kinnunen T. & al. 2017).

3.5 Big data value association (BDVA)

The Big Data Value Association (BDVA), http://www.bdva.eu/, is a fully self-financed non–for-profit organisation under Belgian law. The Big Data Value Association (BDVA) is the private counterpart to the EU Commission to implement the BDV PPP programme (Big Data Value PPP).

BDVA has publish in October 2017 a document with the title: European Big Data Value, Strategic Research and Innovation Agenda, where decentralized architectures, Distributed ledgers, Blockchain and Smart Contracts has been raised as part of possible solutions in Big Data environment related projects (BDVA. 2017a).

The BDV PPP was launched in 2014, but its operationalization has been especially pushed forward with the launch of the LEIT work programme 2016/2017.

3.6 European Digital Currency & Blockchain Technology Forum (EDCAB)

EDCAB, http://edcab.eu/, is a public policy platform for virtual currencies and distributed ledger technology. Independent, non-profit, Brussels-based, EDCAB provides a forum for dialogue on live issues and future policies; creating better understanding and building trust and transparency. The aim of EDCAB is to help shape a sound regulatory and policy agenda for virtual currencies and distributed ledgers in the European Union.

Membership is open to businesses, non-profit organisations, think tanks, academic and research institutions, and anyone with an interest in virtual currencies and distributed ledger technology.

3.7 Blockchain Forum ry, (BcF)

Blockchain -forum ry, http://Blockchainforum.fi, is an officially registered Finnish PRH reg.no 219100 non-profit organisation to produce services in the area of Education, Training, Research and Development. Organization wants to collect all Finnish Blockchain players together to create new common businesses. Blockchain Forum is also connecting to Blockchain associations in other counties to enable international networking between members and organizations.

3.8 Nordic Blockchain Association

Nordic Blockchain Association, http://nordicBlockchain.com, claims to be the largest Blockchain community in Scandinavia. It is a newly started Non-governmental organization, which aims to bring together students, developers, companies and other relevant stakeholders. Mission of the Nordic Blockchain Association is to connect organizations, developers, students, and enthusiasts, who wish to be part of this transition into the future, in order to foster knowledge sharing, testing, and development of impactful Blockchain applications.

3.9 Dutch Blockchain Coalition

The Dutch Blockchain Coalition (https://www.dutchdigitaldelta.nl/en/Blockchain) is a joint venture between industry, government and knowledge institutions. Together they have assumed a leading role and joint responsibility for the success of the Action Agenda of the Dutch Blockchain Coalition. Twenty partners from the sectors financial services, insurance, logistics, energy, security and knowledge as well as supervisory bodies like the Nederlandsche Bank (DNB) and the Royal Notary Association (KNB) have joined forces in the coalition.

Dutch Blockchain Coalition is cooperating with the Dutch government organizations. Dutch Government reports that more than 30 Dutch government organizations have concluded in recent years Blockchain pilot or project (Dutch Government. 2018a).

3.10 British Blockchain Association (BBA)

Biritish Blockchain Association (BBA), https://www.britishBlockchainassociation.com/, is a not-for-profit organisation that has been set up to promote the comprehensive adoption of Blockchain technology across the public and private sectors in the United Kingdom. It was launched in January 2018. BBA's mission is to work in strategic collaboration with organisations and individuals in the Blockchain space by innovating best practices and adopt promising Blockchain solutions to benefit wider community.

3.11 German Blockchain Bundesverband

Blockchain Bundesverband, https://www.bundesblock.de/, is a German non-profit organization for promoting the decentralized technologies and Blockchains in Germany. These include promoting education, transporting the participation of citizens in the democratic constitutional state by means of Blockchain technology and dezentralized technologies based on cryptography; promoting social development by use of Blockchain and cryptography for using the added use of Blockchain for society in Germany.

3.12 Blockchain Association of Ireland

The Blockchain Association of Ireland, https://www.Blockchainireland.org/, facilitates Irish business leaders, educators, policy-makers and citizens in learning how Blockchain technology can be applied to make Ireland the World's most Blockchain literate nation. Blockchain Association of Ireland was launched in December 2016.

3.13 The European Blockchain Center

The European Blockchain Center, http://ebccenter.eu/, is located at the IT University of Copenhagen (ITU). Its mission is to be the globally leading institution that understands, creates, and realizes Blockchain-based solutions in a cross-industry and cross-disciplinary private public partnership to generate value for society.

3.14 Other forums, research and expert advisory groups

Expert groups are consultative entities set up by the European Commission. They provide advice and expertise to the Commission and its departments prior to the preparation of legislative proposals and policy initiatives, delegated acts and in view of the implementation of existing EU legislation, programmes and policies. Advisors and expert groups in the European Commission are a forum for discussions, providing high-level input from a wide range of sources and stakeholders.

For example, the Digital Single Market Strategic Group facilitates upstream policy discussions and prepares the members for policymaking and implementation in areas covered by the Digital Single Market.

The Digital Single Market strategy aims to open up digital opportunities for people and business and enhance Europe's position as a world leader in the digital economy (https://ec.europa.eu/digital-single-market/en/digital-single-market)

The advisors in the Digital Single Market area constitutes of five groups namely, DSM Strategic Group, Digital Champions, Leaders Club, CEF and FETAG. These are groups are divided into economy and society advisors and research advisors, and are briefly described as follows.

Economy and society advisors

The Commission regularly meet with web entrepreneurs, expert groups and digital champions to discuss new ways to promote a more inclusive digital society:

- The Digital Champions (https://ec.europa.eu/digital-single-market/node/326) promote the benefits of an inclusive digital society in their own countries. They work with citizens, communities and businesses to develop the growth potential of the digital economy.
- The Startup Europe Leaders Club (https://ec.europa.eu/digital-single-market/node/50853) is a group of founders in the field of tech and web entrepreneurship (founders of Skype, Spotify, Tuenti, Rovio, HackFWD, TheNextWeb, Seedcamp, TechCity, Atomico). They act as role models for European web entrepreneurs, and provide us guidance on what needs to be done to keep web entrepreneurs in Europe and facilitate start-ups.

Research advisors

Research advisors helps to ensure that the research and innovation funding programme Horizon 2020 delivers on its promise to improve the lives of European citizens by pushing research all the way to innovation and value creation.

The two Official DG connect expert advisors are:

- CONNECT Advisory Forum for ICT Research and Innovation (CAF) (https://ec.europa.eu/digital-single-market/connect-advisory-forum)

- CAF has been set up as part of the preparation for Horizon 2020. The CAF's guidance should help DG CONNECT to put in place an ICT research and innovation portfolio that promotes European competitiveness in a digital world. CAF focuses on ICT, both by ensuring the ICT contribution to industrial leadership, and by linking ICT related topics across the three priorities of H2020 - industrial leadership, excellent science and societal challenges.
- The Future & Emerging Technology Advisory Group (FETAG) gives advice on how to further strengthen the impact of FET on science, technology and innovation. Fit is an advisory entity set up to ensure that the Commission receives consistent and consolidated advice during the preparation of the Horizon 2020 work programmes, with respect to the Future and Emerging Technologies.

The European Strategy Forum on Research Infrastructures (ESFRI), http://www.esfri.eu/about

- ESFRI is a strategic instrument to develop the scientific integration of Europe and to strengthen its international outreach. The competitive and open access to high quality Research Infrastructures supports and benchmarks the quality of the activities of European scientists, and attracts the best researchers from around the world.
- The EU e-Infrastructures call is influenced by the ESFRI board and managed also in DG Connect directorate “excellence in science” director Thierry Van der Pyl.

4. Blockchain Standardization

Blockchain technologies are still quite novel and rapid technological development is constantly ongoing. The importance and potential impact of this technology has been recognized across all domains. To ensure the common concepts and interoperability between systems, both national and international standardization forums have started the work to create standards in the Blockchain field. In this section, we will briefly present some of the Blockchain standardization forums working with the Blockchain standardization in global level, European level and national level.

4.1 International Organization for Standardization ISO

Discussions to start Blockchain standardization were ongoing in ISO during end of the year 2016 and the first meeting of the technical committee ISO/TC 307 (ISO. 2018a), Blockchain and distributed ledger technologies was organized in Sydney, Australia in the beginning of April 2017. In this first meeting, five (5) study groups (SG) were initiated. The purpose of the ISO study groups is to seek topics, from which the actual standards would be later created in the working groups (WG).

These initial study groups were:

- SG 1: Reference architecture, taxonomy and ontology
- SG 2: Use cases
- SG 3: Security and privacy
- SG 4: Identity
- SG 5: Smart contracts

Work in the standardization has progressed and study groups have evolved to working groups resulting to the following structure of the TC 307 technical committee (situation 05/2018):

- ISO/TC 307/SG 2 Use cases
- ISO/TC 307/SG 6 Governance of Blockchain and distributed ledger technology systems
- ISO/TC 307/SG 7 Interoperability of Blockchain and distributed ledger technology systems
- ISO/TC 307/WG 1 Foundations
- ISO/TC 307/WG 2 Security, privacy and identity
- ISO/TC 307/WG 3 Smart contracts and their applications

The work started with 17 participating and 16 observing members in 2017, but currently (05/2018) ISO/TC 307 has 35 participating members and 12 observing members. In ISO work, participating members are countries. Currently over half of the participating countries in Blockchain standardization are from Europe.

There are several liaison committees to exchange information between ISO/TC 307 technical committee and other ISO and International Electrotechnical Commission (IEC) technical committees. These committees are listed in the ISO/TC 307 public internet pages. Some information of the standardization work can be accessed publicly, but according to the ISO policy on communication of committee work, documents such as working documents, minutes, or working group recommendations shall not be shared externally (ISO, 2018b). Similar policy, not to publish most of the information for non-members, is followed also by the other standardization bodies.

Currently there are five (5) external category A liaison organizations with ISO/TC307:

- EC - European Commission
- FIG - International Federation of Surveyors
- ITU - International Telecommunication Union
- SWIFT - Society for Worldwide Interbank Financial Telecommunication
- UNECE - United Nations Economic Commission for Europe

These liaisons organizations are allowed to share information and participate in the working without voting possibility for the working group decisions.

4.2 European standardization CEN / CENELEC

The European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC) are two distinct private international non-profit organizations based in Brussels. Both CEN and CENELEC are financially supported by the European Commission. Although their target is to provide European standards, they are cooperating with the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) to ensure one standard to be accepted everywhere.

The European Commission has published a rolling plan for ICT standardisation 2018 (European Commission 2018a). In this rolling plan, new sections for Blockchain and Distributed Digital Ledger Technologies has been added. In this rolling plan document, it is mentioned that the Commission has established a liaison A with ISO/TC 307 and they will engage and follow the works of the ITU-T Focus group on Application for Distributed Ledger Technologies. A white paper is expected to be published on the EU perspective on Blockchain standardisation and for identifying use cases relevant for the EU.

CEN/CENELEC has published in March 2018 a white paper with a title “Recommendations for Successful Adoption in Europe of Emerging Technical Standards on

Distributed Ledger/Blockchain Technologies", where the objectives is to identify potential specific European needs to be addressed by standardization (CEN/CENELEC. 2018a.).

4.3 European Standards Organization - ETSI

The European Standards Organization (ETSI) is still considering, what is the role of regulators and standardization bodies in distributed ledger technologies, as the field is still novel and evolving rapidly. Therefore ETSI is organizing a Security and Trust in ICT: the Value of Distributed Ledger Technology event in June 2018. Objectives besides DLT technology topics, which concern standardization are:

- Investigate how ETSI can use such technologies within services and technologies it standardizes
- Investigate what ETSI can do in the standardization of DLT in complement to other standardization initiatives
- Investigate to what extent ETSI standardization is impacted by these technologies

4.4 Institute of Electrical and Electronics Engineers - IEEE

Institute of Electrical and Electronics Engineers (IEEE) has formed the IEEE Blockchain Initiative (BCI) in January 2018. IEEE's BCI is defined to be the hub for all IEEE Blockchain projects and activities. These include the standards, education, conferences, event, publications and special projects. Lot of information is available from their website (IEEE. 2018).

Examples of IEEE Blockchain standardization activities include among others:

- Blockchain for clinical trials
- Pharma Supply Blockchain (Pharmaceutical industry)
- IEEE P2418 Working Group - Standard for the Framework of Blockchain Use in Internet of Things (IoT)
- IEEE 2418.2 - Standard Data Format for Blockchain Systems

4.5 International Telecommunication Union - ITU-T

International Telecommunication Union's Telecommunication Standardization Sector, ITU-T has established a focus group on application of distributed ledger technology (FG DLT) in May 2017. (ITU-T. 2018a) Another ITU-T establish group is the Focus Group on Digital Currency including Digital Fiat Currency (ITU-T. 2018b).

FG DLT main mission is to identify and analyse DLT-based applications and services, draw up best practices and guidance, which support the implementation of those applications and services on a global scale and propose a way forward for

related standardization work in ITU-T Study Groups. Participation in the FG DLT is open to any interested party.

4.6 World Wide Web Consortium - W3C

World Wide Web Consortium (W3C) has formed a Blockchain Community Group to generate message format standards of Blockchain based on ISO20022. Other mission of the group is to generate guidelines for usage of storage including torrent, public Blockchain, private Blockchain, side chain and CDN. This group will study and evaluate new technologies related to Blockchain, and use cases such as inter-bank communications. (W3C. 2018)

European Commission rolling plan for ICT standardisation (European Commission. 2018a) presents also other W3C chartered groups (doing standards), which are coordinated closely with web payments, such as security, crypto, privacy or authentication (also accessibility and internationalisation) and a number of other community-driven groups at W3C are doing work related to payments.

4.7 Finnish Standards Association SFS

Finnish standards association SFS organized in March 2017 workshops to prepare participation in the first ISO/TC 307 meeting in Sydney, Australia. Delegation from Finland was participating the first ISO/TC 307 meeting and Finland has been a participating member from the beginning of this ISO technical committee. Formally the SFS standardization group SFS/SR 229 Lohkoketjuteknologiat (Blockchain technologies) was established in June 2017, although working meetings had been arranged prior to this date.

The SFS/SR 229 standardization group is acting as a national standardization expert group for the Blockchain technologies. Tasks of the group is to follow the international standardization, participate in the international standardization by deciding the Finnish comments on ballots and draft standards and nominating specialists to international working groups and meetings. Group will also evaluate the need for translation of standards and participate on the translation process.

SFS SR 229 group is also acting as a national level mirror committee for the ISO/TC 307 Blockchain and distributed ledger technologies. SFS is representing Finland both in European CEN and international ISO standardization and the delegates are nominated and chosen from the SFS group.

4.8 Blockchain in transport alliance - BiTA

Blockchain in transport alliance (BiTA), https://bita.studio/, has announced that it will start Blocchain standardization for the transport industry. According to their Internet pages, “BiTA was formed by experienced tech and transportation executives to create a forum for the development of Blockchain standards and education for the freight industry. Our goal is to bring together leading companies in the freight technology industries that have a vested interest in the development of Blockchain technology.” BiTA comprises from more than 200 freight transportation companies and their target is to develop Blockchain standards for the logistics industry and the supply chain as a whole.

4.9 Mobility Open Blockchain Initiative - MOBI

Mobility Open Blockchain Initiative (MOBI), https://www.dlt.mobi/, was established in May 2018 and it announces its mission to be: “mobi is a nonprofit organization working with forward thinking companies, governments, and NGOs to make mobility services more efficient, affordable, greener, safer, and less congested by promoting standards and accelerating adoption of blockchain, distributed ledger, and related technologies”. MOBI is starting with vehicle identity and history Use Cases but later spanning to the entire mobility services value chain. Founding members include big car makers, car-part manufacturers, major companies and Blockchain industry groups.

5. European Commission and Parliament Blockchain events

The amount of organized Blockchain events has exploded in the last few years. International and national Blockchain and Cryptocurrency are organized almost on weekly or daily basis. Also European Commission and European Parliament have organized Blockchain events. Here we present some of them.

Already on the 27th of April 2015 Startup Europe (European Commission initiative) organized a Blockchain and Digital Currencies Workshop (European Commission. 2015a). In the workshop topics covered issues about cryptocurrency introductions, market analysis, legislative issues of digital currencies, how Bitcoins could be brought to masses and IoT related smart devices and Blockchain. Presenters were entrepreneurs from the Cryptocurrency (Bitcoin) Space side by side with senior experts in the financial area.

In February 2017 European Parliament's Scientific Foresight Unit (STOA) published an in-depth analysis report "how Blockchain technology could change our lives". (Boucher, P. 2017a). Report was published for the European Parliament as background material to assist them in their parliamentary work.

European Parliament / Science and Technology Options Assessment (STOA) and European Commission DG CONNECT organized a Joint Blockchain event on 11th of May 2017. (European Parliament. 2017a.) Title of the event was "Spotlight on Blockchain: a new generation of digital services". Purpose of the event was to discuss about Blockchain technology and present some Blockchain pilots implemented.

The European Commission's DG Connect organized a Blockchain and Distributed Ledger Technology policy and standardisation workshop on the 12th and 13th of September 2017. The first day gathered experts directly active in Blockchain/Distributed Ledger Technologies (DLT) standardisation while there was a broader audience for the second day, with representatives from governments, industry, NGOs, standards development organisations (European Commission. 2017c).

On the 19th of December 2017 European Commission organized an Blockchain info day with the title: Information Day on Horizon 2020 Blockchain and Distributed Ledger Technologies Topics and Fintech coordination action in Brussels. (European Commission 2017b.). Webstream of the event and the presentations can be found from the event's webpage. Links to the presented calls were introduced earlier in this document in section 2.1.2.

On the 10 of April 2018, 23 European countries signed a declaration on the establishment of a European Blockchain Partnership. Purpose of the partnership is to exchange experience and expertise in technical and regulatory fields. Cooperation should lead also to EU-wide Blockchain applications across the Digital Single Market for the benefit of the public and private sectors (European Commission. 2018c. 2018d.)

6. Conclusions

The Blockchain research is still in its infancy but many simultaneous actions are rapidly enhancing the knowhow of this technology. Earlier there has not been many open research project calls for Blockchain research, but the situation has changed during the last year, when EU Horizon call for years 2018-2020 has been opened. Several projects have already been funded and the funding for new Blockchain projects is expected to grow significantly.

This topic has been realised to be vital and hence there are various associations and organisation as well as other forums and expert advisor groups working on the distributed ledger technologies and Blockchain. Blockchain associations have been founded practically in every country. Also the standardization has been seen important to ensure the common concepts and interoperability, which has resulted the standardization work of Distributed ledgers and Blockchain to start in all relevant international standardization bodies. European countries have been active in the international Blockchain standardization work, which hopefully brings advantage in the future to the European companies and institutes.

Partially thanks to Bitcoin exchange rate rally at the end of 2017, Blockchain has become known term to the masses. Although the knowledge of what it really is, is still quite unclear to most. Future Blockchain projects will progress from Use Case definitions and small-scale proof of concepts to bigger working ecosystem concepts and eventually move to real use.

Blockchain technology has changed from dubious to presentable and companies, institutes and governments take it seriously seeking novel use of it to make better solutions across various domains, both industrial as well as societal.

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Series title and number

VTT Technology 331

Title	**European Blockchain analysis** BOND project (Blockchains Boosting Finnish Industry) report
Author(s)	Arto Laikari, Jere Backman, Heli Helaakoski, Tanja Suomalainen
Abstract	Blockchain is a decentralized transaction and data management technology developed first for Bitcoin cryptocurrency. The possibilities of the blockchain technology has inspired and fueled an entire ecosystem around it, focused on fully unleashing its potential. Use of Blockchain technology is not limited to cryptocurrencies, but countless Blockchain Use Cases have been proposed across various domains. Blockchain technology is advertized in several sources to be as big innnovation as Internet has been. As a novel technology, Blockchain has raised a lot of discussion and even hype. Because of the big promises of the Blockchain technology opportunities, European Commission, industries and several other communities have taken Blockchain technology serious and would like to get a grip on it. This report summarizes what are the most important research activities within this theme in EU blockchain H2020 research agenda, how Blockchain standardization has started and presents various Blockchain forums.
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Nimeke	**Euroopan lohkoketjuanalyysi** BOND-projektin (Blockchains Boosting Finnish Industry) raportti
Tekijä(t)	Arto Laikari, Jere Backman, Heli Helaakoski, Tanja Suomalainen
Tiivistelmä	Lohkoketju on hajautettu tapahtumien ja datan hallintateknologia, jonka ensimmäinen laajasti tunnettu toteutus on Bitcoin-kryptovaluutta. Lohkoketjuteknologian mahdollisuudet ovat inspiroineet kokonaisia ekosysteemejä ympärilleen, joiden tarkoituksena on päästää valloilleen sen lupaukset. Lohkoketjujen käyttömahdollisuudet eivät rajoitu kryptovaluuttoihin, vaan teknologialle on esitetty lukemattomia käyttötapauksia erilaisille sovellusalueille. Lohkoketjuteknologian on mainittu useissa lähteissä olevan yhtä suuri keksintö, kuin Internet oli aikanaan. Uutena teknologiana lohkoketjut ovat herättäneet paljon keskustelua ja jopa yliampuvia odotuksia. Lohkoketjuteknologian suurten lupausten takia Euroopan komissio ja parlamentti, teollisuus ja monet muut yhteisöt ovat alkaneet ottaa lohkoketjuteknologian vakavasti ja haluaisivat saada sen hallintaan ja käyttöön. Tämä raportti kokoaa yhteenvedon tärkeimmistä tämän teeman tutkimusaktiviteeteista EU:n H2020 lohkoketjujen tutkimusohjelmista, miten lohkoketjujen standardisointi on lähtenyt liikkeelle, sekä esittelee erilaisia perustettuja lohkoketjuforumeja.
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European Blockchain analysis

BOND project (Blockchains Boosting Finnish Industry) report

BOND project (Blockchains Boosting Finnish Industry) has been researching Blockchain technology usage for noncryptocurrency Use Cases from Q4/2016 to Q2/2018. As one part of our project, we have collected information of European level Blockchain activities, standardization and organizations to support our project as well as the Finnish industry.

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