



DELIVERABLE 6.7

EXPLOITATION PLAN FOR DECENTRALIZATION SUSTAINABILITY MODEL

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Description: Final update of the exploitation plan that takes into account first and foremost the long-term sustainability of decentralized Internet eco-systems. A focus will exist on commons-based non-market solutions and other metrics outside of profit, although the potential for profit-making enterprises, public-private partnerships, and the “privacy market” will also be assessed, along with entrepreneurship and innovation strategies and market analysis. This will be presented and a list of exploitation activities performed during the last year of the project will be reported.

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Executive summary

In this deliverable, we presents our strategy in terms of sustainability for the NEXTLEAP project beyond the EU funding period. We concentrate on how the NEXTLEAP partners anticipate sustainable models for the development of their tools. A focus will be proposed on commons-based non-market solutions and other metrics outside of profit, although the potential for profit-making enterprises, public-private partnerships, and the “privacy market” will also be assessed, along with entrepreneurship and innovation strategies and market analysis. This will be presented and a list of exploitation activities performed during the last year of the project will be reported. IRI will introduce the Contributive Income model experimented in Plaine Commune (north of Paris) where NEXTLEAP’s values and researches will be put into practice in the building of a decentralized and privacy-enhancing public territorial platform which is at the core of the new urban intelligence narrative developed there, against the mainstream thinking on the Computational Smart City. Finally, we will discuss new blockchain models for making privacy more financially sustainable.

1. Exploitation activities of partners

The partners of NEXTLEAP are each working at exploiting the project results of NEXTLEAP and continuing the research and development started by NEXTLEAP. In particular:

Inria will continue to pursue the work done in Message Layer Security at the IETF, as well as any additional new standardization done due to Autocrypt and NEXTLEAP in the IETF PGP Working Group via the ERC CIRCUS grant. The French government has signalled it will continue to help Inria work on the IETF MLS work, which will be the main topic of the Ph.D. student Benjamin Beurdouche. Furthermore, the work of Inria has started to attract grants from companies such as Mozilla. Inria’s work on decentralization and privacy has gained the attention of blockchain companies, and in particular, the large Ethereum company Consensys has been inspired to start a new “Project Hellhound” jointly with Inria to enable privacy-enhanced side-chains on Ethereum. This grant should allow the formal verification of homomorphic encryption, and work from the Ethereum Community Foundation will pursue the formal verification of zero-knowledge proofs and other fundamental privacy primitives. Lastly, interest in governance continues, with Tezos donating to Inria as well.

University College London: The work we did as part of NEXTLEAP was foundational, and has allowed us to secure a number of opportunities for impact, as well as subsequent research funding. Specifically, the work we did as part of the 3rd year of the project on decentralization and open consensus has been picked up by the Chainspace.io (<https://chainspace.io>) start-up, in which some of the UCL team are involved. The aims of the start-up is the creation of a decentralized smart contract platform, and there are

considering blockmania as the basis for consensus, and SybilQuorum as a way of strengthening proof-of-stake Sybil defences. Besides impact and commercial activities, the work on NEXTLEAP has allowed us to secure further research funding. In particular, Prof. Danezis is a co-Investigator in the EPSRC funded IRIS project – dealing with “interfaces” in computer systems in general, and decentralized privacy systems specifically. Our experience with the decomposition of private communications into an encryption layers, and a separate key distributions / authentication layer (ClaimChain), as well as the structure of blockmania into separate block-DAG and consensus layer has shaped our thinking about compositions and interfaces in decentralized systems, and as part of the IRIS project we plan to formalize those and generalize the approaches. More information over is available here:

<https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/R006865/1>

Merlinux's product development relies on NEXTLEAP R&D results and is committed to further and collaboratively develop the "Chat over E-Mail" ecosystem. Merlinux is partnering with other players in the field, most notably with OpenXChange who maintains DOVECOT, the world's most popular open source IMAP server. Merlinux is well networked with developers from DAT, Secure Scuttlebut, Cryptpad and other striving decentralization projects - jointly aiming to evolve a federated non-cloud centered app eco-system integrated through secure decentralized messaging. Merlinux has already secured funding from the Open Technology Fund for the "DeltaChat usability and robustness project" which will sustain further Autocrypt and other protocol improvements in 2019. The protocols developed during the NEXTLEAP project will be further refined within the next 1-2 years, based on continued user-testing and adaptive, well prioritized R&D. Merlinux currently expects 2020 to be the year where Autocrypt will be gaining more significant traction in the general public and aims to release commercial products and further fund efforts with it around the "Chat over E-Mail" ecosystem.

CNRS has received a large grant called RESISTIC from the French National Research agency. Compared with the currently available literature, the research project innovates by including an investigation of online resistance in Russia that reveals less well-known social practices and techniques for circumventing online constraints. It is intended, beyond Russia, to contribute to thinking about changing patterns in politics as it is exposed to information and communication technology (ICT) in the modern world. This project will be led by Francesca Musiani and Ksenia Ermoshina from NEXTLEAP. Also, due to the work of NEXTLEAP in part, CNRS is setting up a new research centre on the Internet and Society.

EPFL: As a result of the NEXTLEAP project, EPFL could publish 4 open-source libraries (ClaimChain, Lightnion, LoopTor, and Tandem). We plan to continue the integration of the

two first libraries into Autocrypt, seeking for more funding together with Merlinux to continue the development. However, we will also pursue the integration of Lightnion on other projects. In a first project we work with other EPFL laboratories to integrate the prototype into EPFL internal services to improve student's privacy. We are also in conversation with other privacy technologies providers (e.g., CryptPad) regarding integration in their products. Regarding LoopTor, we plan to integrate it in a larger project focused on providing privacy-preserving tools for the International Consortium of Investigative Journalists.

IRI has, as a result of its work on NEXTLEAP, taken part in a new project proposal to further investigate new models of commons-based sustainable development via the CO3 project, currently under review and described in Section 3.3. IRI has received a three year Marie Skłodowska-Curie RISE (Research and Innovation Staff Exchange) Action Programme (<http://realisms.eu/>) that is further described in Section 3.4.

2. The Privacy Market and the General Data Protection Regulation

One of the hypotheses of the General Data Protection, that all European states in 2018 are now compliant with, is that it would lead to what has been termed a **privacy market**, where there would be competition between companies to provide General Data Protection-compliant software. Indeed, it seems that in 2018, due to concerns over “fake news”, surveillance, and so on, popular public opinion has finally turned against Facebook, Google, and other centralized Silicon Valley giants. Facebook's scandals of data breaches, provoked by Cambridge Analytica, are estimated to be worth at least 76 million euros, with Google recently being fined 50 million by French Data Protection authority CNIL (<https://www.cnil.fr/en/cnils-restricted-committee-imposes-financial-penalty-50-million-euros-against-google-llc>). In total, the privacy and cybersecurity markets are estimated to be worth between 2 and 3 billion euros. The question is can Europe take advantage of this new market, and how?

While privacy is composed of many different layers (ad blockers, privacy-enhanced search engines, and so on), since in particular, NEXTLEAP focussed on secure messaging standards, this market would be the first to analyze. It is considered that the market size for secure messaging and encrypted e-mail gateways is approximately 1.4 billion euros in 2012, with a growth rate of 7%, and thus an estimated value of 2.2 billion euros in 2018 (<http://www.eb-qual.ch/en/assets/Document-s-events/Doc-events-news/Magic%20Quadrant%20for>

[%20Secure%20Email%20Gateways.pdf](#)) As NEXTLEAP is in Europe, as detailed in D4.6 we are pushing that the European public sector move to self-hosted open-source solutions based on open standards. Furthermore, encrypted e-mail is still growing, with an annual growth of 3%, despite concerns that it will be replaced by messaging software such as Slack for corporate use (<http://radicati.com/wp/wp-content/uploads/2015/02/Email-Statistics-Report-2015-2019-Executive-Summary.pdf>) This market will naturally move, due to threats of mass surveillance, to higher security solutions with servers being placed in European jurisdictions due to the unification of various European data protection (privacy) regulations by the General Data Protection Regulation. This is compounded by the fact that the European-America data-sharing "Safe Harbour" agreement was recently deemed illegal and its replacement "Privacy Shield" is seems stillborn, as it is so far deemed not strong enough by European Union Data Protection regulators. Thus, we can imagine that companies such as Merlinix will be able to receive a substantial income stream from consulting services related to Autocrypt and similar solutions, and existing European companies such as e-mail provider Greenhost in the Amsterdam, Protonmail in Switzerland, and German e-mail providers will start taking advantage of Autocrypt. MLS will be supported by the German company Wire, allowing it to complete more effectively against WhatsApp.

There is a long-standing issue that while there may some revenue streams available, it is still difficult to make money provisioning secure e-mail and messaging applications even with the higher trust "Made in Europe" provides. Therefore, the rest of this deliverable focusses on new solutions that focus on non-market commons solutions, where European industry can work in "public-private" partnerships to provide real solutions for European citizens. For example, the French government is working with Inria to support the MLS standard, replacing the non-standard Matrix.org currently is use for their internal communications, and a call for tender is expected soon that both local French companies as well as MLS early-adopters such as Wire may be very competitive for. This allows Europe to develop its own capabilities for open-source in the market. However, what is really needed is an entirely new economic model that puts user rights and re-invents the economy in the digital age in the forefront. This is the topic for Section 3 of this deliverable. Another question is whether or not consumer-driven micro-payments can make privacy-enhancing technologies sustainable, as being pursued by the Brave Project for web-browsers and new decentralized VPNs funded via ICOs (Initial Coin Offerings) such Mysterium. This question is pursued in Section 4.

3. Theoretical Basis of the Contributive Economy

3.1 From *digital technologies* to their social, legal and political impacts

Education to digital technologies is to be related to what Amartya Sen calls one's *capabilities*, a

central context in the economy of contribution IRI is developing on the Plaine Commune Territory. In the context of an education to decentralization and to secure and trustful communication, it means that in order to maximize one's liberty of choice in the digital environment one has to develop capacities to choose among different kinds of communication systems, decentralized systems or crypto-secured communication. Following Sen's theory, identifying the different technical options allowing the communication and production of common knowledge, understanding the difference in their functionalities and then learning how to maximize the combination of those differences is beneficial.

Education to decentralized systems, P2P communication or blockchain-based certification is frequent, but sparse and it is very often highly specialized. In the context of the Nextleap project, our goal has been to bring a deeper understanding of digital social issues but also of the epistemological and political consequences of decentralized and crypto-based architectures and services. We tackled these issues in the context of two seminars series entitled ["Decrypting algorithms" with 4 sessions in 2017 and 5 sessions in 2018](#), bringing the most accurate expertise to people who have not been exposed to these issues, and start Sen's capacitation dynamic within our publics.

Inspired by the general organology approach proposed by Bernard Stiegler¹ and by other perspectives² advocating for a necessary education on how algorithms modify our day-to-day life, we have organized various education seminars, focused events and conferences, and produced educational material analyzing decentralized and crypto-based technologies and their social and political impact. This research has been conducted within the philosophical context of four main questions (or functions) supported by decentralized and crypto-based systems:

- 1) individuation and the question of *capacitation*;
- 2) categorization and the question of knowledge (i.e which new categories are produced by decentralized systems and how they can be controlled);
- 3) communication, social networking and the question of trust (for instance how certain P2P systems rely on trust and contribute to its production);
- 4) certification and the question of "truth" (i.e how decentralized certification and blockchain-based systems produce new *veridiction* regimes in the sense of Michel Foucault).

For a more detailed description, see the Complete Education Report deliverable (D6.6, M24). All these questions have been theoretically explored in the previous three years and start to be put into practice thanks to the Contributive Learning Territory Project that IRI is leading in Plaine Commune (9 cities in the north of Paris) where NEXTLEAP's values and researches will be put into practice in the building a decentralized and privacy-enhancing public territorial

¹Organology is a generic term to designate biological, technological and social organs which conditions the production of knowledge (see B. Stiegler, *Digital Studies, Organologie des savoirs et technologies de la connaissance*, Fyp 2013)

²Dominique Cardon, *À quoi rêvent les algorithmes, nos vies à l'heure des big data*, Seuil 2015

platform which is at the core of the new urban intelligence narrative we have developed, against the mainstream thinking of the data-mining Smart City.

3.2 The Plaine Commune Project

As we have shown in our 2017-2018 seminars, knowledge is not information. Information, in the form it takes in the information industries, is just one stage of exosomatization – and a strict distinction must be established between this notion and the concept of information as it is used in physics and biology. This leads in turn to questions regarding the criteria of choice and selection in exosomatization, with different artificial organs giving rise to different forms of knowledge and politics. All of this work has an immediate practical import for the questions tackled by Nextleap, since we are rethinking architectures of information in order to place them in the service of knowledge in all its forms (conceptual knowledge, *savoir-vivre* and *savoir-faire*), and to question the macroeconomic models that automation imposes. These multiple forms of knowledge can serve to *de-automatize* (and to *de-proletarianize*) the apparatuses of the automated society, thereby preserving the prospect of developing negentropic, or life-enhancing, modes of production, and limiting entropic forms of production.

Led by IRI, the Contributive Learning Territory project in Plaine Commune (an area with more than 140.000 inhabitants in the north of Paris) is meant to facilitate experimentation to shape and materialize the possibility of developing a contributive territorial economy based on decentralized and privacy enhancing networks.

Such an economy will be based on the redistribution of time gained as a consequence of industrial automation, put towards the collective production of capacities and knowledge, which are valued in this new macro-economic model. This project also aims to develop new contributive digital resources and interfaces allowing the creation of a local collective intelligence, by articulating research activity with the territory's administrative, economic and socio-political life. The Capacitation retributed by the Contributive Income – conditioned by period of employment like in the French model of the “Intermittent du spectacle”³ – is to be related to what Amartya Sen calls one's “capabilities”.

3.2.1 Sustainability, Entropy, Anti-Entropy and Negentropy

The economy of the contribution - or contributive economy - targets the sustainability of the territory. This sustainability is analyzed in three dimensions: social, economical and environmental. The aim is to strengthen social sustainability (quality and standard of living) in the long term through a sustainable economy (solvent and profitable) and favorable to the sustainability of ecosystems (state and resilience).

³<https://www.wonder.legal/fr/modele/contrat-travail-intermittent>

Faced with this triple challenge, the strategy of the contributive economy is the fight against the entropy produced by the economic model of our society. To do that, we act against the dissipation of the knowledge (*savoir*), know-how (*savoir-faire*) and *savoir-vivre* available to individuals and social groups in a given locality. This means to fight against the disappearance of activities which are based on this knowledge, and by which this knowledge is created, organized and structured (at the level of individuals and social groups); it is mobilizing knowledge to combat the disruption of the ecosystem renewal cycle by limiting the abstraction of natural resources and the flow of waste (materials, pollutants, CO₂, etc.) resulting from the use of these resources.

The goal of sustainability are set according to a territorial knowledge heritage which is intrinsically local and particular. The *negentropy* corresponds to the possibility of accessing the knowledge and mobilizing it to put it into practice in the context of an activity. It is a local state of low entropy that reinforces and renews the ability to interpret what is socially, economically and ecologically played within and around this activity.

In stieglerian terms, technology is a *pharmakon* – that is, simultaneously, the remedy and the poison. If the current historical period has been defined *post-truth* or sometimes *post-democracy* era given the upheaval caused by a misuse of the digital technology by the platform capitalism, we think that a negentropic web (a web based on hermeneutic digital tools and semantic functions following Tim Berners Lee) is the remedy, if used correctly, in this moment of political and social disorientation.

This is why a Deliberation Platform based on the decentralized platform ePLANETe is at the core of our project and will be experimented on 3 specific domains on the territory starting (Urban wastes, Urban building, Urban care and food). This experimentation will start in January 2019.

3.2.2 Territorial analytical accounting

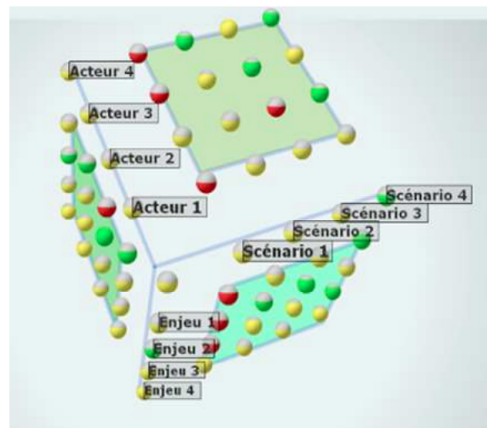
In the contributive economy, value must be represented in terms of sustainability objectives, which reflects both the sustainability of the territorial system and the sustainability of the activities of this system. This induces the need for new indicators at the local level. On the one hand, a set of territorial sustainability indicators must be considered at the meso scale. On the other hand, sustainability indicators specific to local activities must be thought at the micro level. These types of indicators must be connected: the challenge is to report on how local activities contribute to the sustainability of the territorial system, and, in turn, how the improvement of territorial sustainability is favourable to local activities. The contributive economy proposes a "win-win" logic between micro and meso sustainability: participants in

a contributive activity locally create knowledge necessary for territorial sustainability (anti-entropy); this facilitates their access to the territorial heritage of knowledge (negentropy) and thus reinforces the potential for collective recognition of the social, economic or ecological utility of various objects or phenomena, some of whose functions (functionalities) could be reinforced locally.

3.2.3 How ePlanete works

ePLANETe web portal is a participative and contributive model dedicated to collective decision making. A heuristic navigation motivated by crosslinks through a meta organization allows to engage collectivities in a process of social, economic and ecological improvement. This approach is based in particular on a Deliberation Matrix through which the actors can question and evolve together the representation of a system (for example the Contributing Learning Territory system) and accompany the construction of the social meaning of this system.

In a first step, the analysis of grounds and the formulation of objectives following an in-depth study lead the collectivities to the identification of a problem of "social choice" characteristic of this system. A second step is to structure the representation of this problem in terms of stakeholders (*Acteurs*), categories of issues and action scenarios. The Deliberation Matrix is then produced according to the three axes: actors, issues and scenarios.



After the definition of the axes, it is a question of analyzing, for each of the scenarios studied, the risks and opportunities, as expressed by the actors, by resituating them in relation to the stakes. A "basket" consisting of 1 to 5 indicators is then composed at the level of each crossing between the 3 selected axes (for example: which indicators make it possible to describe the point of view of an inhabitant on a stake "quality of life", as part of a "digital urbanity" scenario?). These indicators are intended to help deliberation: they can come from a preselection of indicators or be proposed directly by the actors. For each of the indicators selected, the judgment expressed by an actor will be visualized by a color so that the voice or of each actor won't be a binary decision (yes/no), but it will be taken into account qualitatively. It is also possible to provide a comment to justify the choice of color, and to assign a subjective weight to balance the importance of the argument in the overall judgment concerning the issue-scenario crossover. Here, it is not the quantification or the qualification of the indicator which matters, it is the meaning that it makes it possible to provide to the judgment issued.

More generally, at the level of the Deliberation Matrix, it is a question of selecting a small number of indicators which – without seeking exhaustivity – express the diversity of points of view concerning the crossing of the axes considered and will serve to support the judgments scenarios as part of a subjective, multi-criteria and multi-stakeholder assessment of these scenarios. ePLANETe also proposes a gallery dedicated to the co-production of Multicriterion Evaluation algorithms (*normative*, *qualitative* and *quantitative*) of the performances of the system described by the matrix. In line with the philosophy of Bernard Stiegler and Tim Berners-Lee, ePLANETe wants to be part of the movement to create a hermeneutic and empowering web which allows the discovery of the issues of sustainable development, and the deliberation around these issues of given localities. It can be considered, in a more technical way, as an innovative and experimental approach to integrative participatory modeling of eco-socio-economic systems. This portal has the potential to support new approaches to territorial political economy, to cope with the usual

constraints of collective decision related to the subjectivity of actors, their number, dimensions of analysis and changes of scale. In particular, it allows the co-production of an *ad hoc* evaluation methodology based on shared representation, intended to foster the emergence of local and circumstantial compromises between actors that do not initially mobilize the same issues, spaces, temporalities and rationalities.

3.2.4 Digital *Intermittent Jobs* : A new Digital Urbanity

The goal is to create intermittent jobs in different sectors including in digital development based on an extension of the (*régime d'intermittent du spectacle*) that is already existing in France, but restricted to the artistic fields (Live performance, cinema, music, etc.). On a similar basis, the right to get a Contributive income is conditioned to intermittent employment periods (507 hours per year in the current *intermittent du spectacle* model). It is meant to sustain capacitation activities such as the participation in open source and free software decentralized systems development.

If the creation of knowledge takes place through interaction in an activity, the territorial



structuring of knowledge is done through the interaction between activities. That is why the evolution of the contributor from one activity to another conditions the achievement of the triple objective of sustainability (social, economic, environmental). Intermittent employment is provided by public or private employer organisations that are involved in the contributory economy because they seek to employ workers who have benefited from a period of

capacitation and who are therefore able to recognise and to strengthen multifunctional productions.

Knowledge creation analysis requires a common data repository, shared between several organizations. The mesoeconomic grid will draw a local reference framework around which to carry out a contributory and deliberative valuation of what counts, what costs, and what is worth, as well as a collective analysis of the knowledge that could help actors to reach what counts and what is worth while reducing what costs.

Digital development related to the decentralized capacitation plateforme is one of the first candidate to be supported by the Contributive Income. Decentralized functions to be developed includes :

- ContribTech, a set of contribution/annotation/interpretation tools for allowing inhabitants to analyse territorial data and to create collective activities (so called knowledge cooperatives).
- Deliberation Tools for assessing the contributivity of territorial activities, labelize and support them within the Contributive Income scheme.

The operational ambition of the contributive economy is to produce territorial web platforms to collectively establish inter-and trans-scalar bridges, by promoting the interaction between actors during deliberations around this territorial social issue (comparison of scenarios, challenges of sustainability, production of indicators, expression of value judgments, ...). Establishing these bridges between the evaluation frameworks and the analytical frameworks of the one and the other will allow to extend the negentropic locality of accessibility to the knowledge up to the scale of the territory - and beyond, in particular to solicit the contribution of macro organisms. It will also provide stakeholders with a collective decision support, a capacity for shared representation of their mutual interests, and an ability to produce ad hoc standards for collective evaluation. This platform - and the territorial accounting that is closely linked to it - form a common property of the Contributing Learning Territory.

The platform is seen here as the mechanism for cooperation by which the actors of the territory will reorganize their economic models to create conditions of solvency and profitability favorable to the spontaneous adoption of sustainable modes of activity. This mechanism must ensure the link between new projects and existing activities that do not benefit from direct funding, it must allow the solvency of the latter, so as to ensure that this investment is synonymous with inclusion and territorial coherence.

3.3 Empowering citizens, Commons and Blockchain: the CO3 project

3.3.1 The Commons-Approach

Decentralized networks and access to cryptography is a key technological, industrial, political and economical issue⁴. The younger generation is leading the way toward a "sharing society"; a form of collaborative consumption; renting, lending and even sharing goods instead of buying, supported by new social media technologies.

Answering to a widespread interest in not hierarchical participation, some Public Administrations are rediscovering the pre-modern practices of the commons, as an alternative model of co-production. Commons leverage abandoned spaces to foster the creation of self organized communities that produce services such as guerrilla gardening for healthy and fair food, cultural hubs, educational services, self managed kindergartens, assistance to the elderly or the needy. In all of these experiences, the idea of "commoning" and the language of the commons have developed into a fully fledged alternative model where solidarity, inclusion and public-private cooperation are crucial.

NEXTLEAP partner IRI started to work with the Agence Française pour le Développement (AFD) creating links between the contributory economy and the commons approach. The contributive economy, as it is based on the valorization of knowledge from the work of individuals and groups – this knowledge can be those of daily life, domestic or more broadly social, as well as the *savoir-faire* characterizing any professions (or sports, arts, etc.) and the formalized knowledge of the academic world, spiritual and ritual practices, etc. – is very close to the economy of commons such as from Elinor Ostrom's analyzes, it must be defined first of all by the fact that the communities constituting these commons are above all communities of knowledge (cf. Charlotte Hess, in Benjamin Coriat et al., *Le retour des communs*).

In this respect, the economy of commons is a fundamental segment of the contributive economy. But the latter also negotiates with the market or with the public power, through the assumption of intermittent jobs (constituting themselves objects of market valuations) or of collective properties (classically related to public goods). Thereby the contributive economy leaves the framework of the economy of the commons in the strict sense: what we

4 In this section we provide some elements from: Managing the commons in the Knowledge economy, D-cent report, 2013; Financing a sustainable European Economy, Final Report 2018; Debate about the concept of value in Commons-based peer production, Morell, Salcedo, Berlinguer; MoneyLab reader, overcoming the hype, Lovink, 2018 and the CO3 project, 2018.

are studying with the AFD are the conditions in which the logic of these *commoners* – who are also *contributors* – can and must negotiate with the classical forms of private property or public property, given the last changes in the digital-technological and hence socio-political spheres.

What defines a common (whether it is a material good, an environmental resource or a "common knowledge"), it is above all the social arrangements and rule systems that allow its preservation and regeneration. These social arrangements and rule systems constitute shared knowledge, through which individuals connect together and take care of a common object. The (collective) ownership of a common is based less on a right of ownership than on the practice of knowledge allowing the maintenance and renewal of this common : whether it is a material good, an environmental resource or a "common knowledge", only the community of those who practice a given knowledge (*savoir-faire*, *savoir-vivre*, or theoretical knowledge) to take common care can "take ownership" of the common - giving the fact that the appropriation of a given common is based on the ability to taking care of it.

Finally, the constitution of commons thus supposes the sharing and the practice of knowledge. It is in this sense that we can say an economy of the commons is an economy which rests on the valorization of the knowledges (know how, to know how to live, to know how to conceive), and thus of capacities (techniques, practical and theoretical) to take care.

To conclude, if the production, maintenance and renewal of the different types of commons presupposes the practice of different types of knowledge by the social groups taking care of these commons, then the economy of the commons can only be an economy valuing the sharing of the practice and of the knowledge. Such an economy must therefore rethink the value of its *savoirs* and practices, and develop new economic indicators to "measure" such a value, and this, in negotiation with the market or administrative dynamics in the case of public policies.

As a follow-up of the NextLeap project, IRI will start to work with the CO3 project in January 2018. CO3 aims at assessing the benefits and risks of disruptive technologies, namely: blockchain, augmented reality (AR), geolocated social network, liquid democracy tools and gamification, in the co-creation, co-production and co-management of public services with citizens as Public Administrations partners. Augmented Reality becomes a single shared layer on the urban paysage and part of citizen's public life, AR enables manipulation of financial objects built on blockchains, information sharing on a map, online deliberations and so constitutes an infrastructure for service co-production by citizens. CO3 will pilot the technologies' ecosystem of in three sites, evaluating the outcomes of the new interaction

model between PA and citizens under a set of metrics in three dimensions that are also at the core of the Contributive Learning Territory (TAC) and the NEXTLEAP projects :

- 1) social and cultural: citizen engagement, change in relationship with public servants;
- 2) economic: value of services produced, effects on workplaces, consumptions and economic sustainability;
- 3) legal: legal implications for PA including privacy and data protection.

CO3 will devise a business plan ensuring long term sustainability for the Public Administrations on the basis of the metrics applied on the pilots' data. CO3 is a participative and interdisciplinary and international project⁵. The Municipalities of the Plaine Commune in Paris (FR) has been chosen as one of the three pilot sites.

3.3.2 Disruptive technologies for Co-creation, Co-production and Co-management

The increasing need for innovation in social services has been recognized by the EC Bureau of Economic Policy Advisors' report. Innovation does not only mean the introduction of new technologies to digitize services and the optimization of work processes, but it also means rethinking the role that citizens have in the public service creation, production and management together with public servants. The role of the citizen is evolving: citizens seem more ready for a more active and collaborative role in the delivery of public goods. We are experiencing the transition from a "mere passive consumption of public services" to one of "active involvement to jointly tackle social problems" (Mattson, 1986), overcoming the current market-driven, transaction-oriented approach to the management of public services (New Public Management) that leaves little rooms for active citizen participation (Nam, 2011). This strategy is suggested by the eGovernment action plan 2016-2020: *"Future initiatives [...] should contribute to engaging citizens, businesses and civil society in the collaborative design, production and delivery of public services"*⁶.

⁵Consortium involves: University of Torino (IT)(Computer Science, Economics, Sociology and Law), ISMB private research center (IT), Fundación Universitaria Balmes (ES), Institut de Recherche et d'Innovation of Centre Pompidou (FR), and OpenLab Athens (EL), with its Laboratory of the Digital Commons. It also involves three highly innovative SMEs: Brainbot, leaders in the Ethereum Blockchain development(DE), FlexiGuided (DE), the company that created LiquidFeedback, Geomotion (ES) working on augmented reality and location-based technologies. Municipality of Torino (IT) together with the Neighbourhood Houses, Municipality of Athens (EL) via its public company DAEM and the Municipalities of the Plaine Commune in Paris (FR) will be the pilot sites.

⁶<https://ec.europa.eu/digital-single-market/en/news/communication-eu-egovernment-action-plan-2016-2020-accelerating-digital-transformation>

Benefits of co-creation, co-production and co-management of services along with citizens go beyond government cost- savings. Such a collaborative approach:

- opens “formerly closed processes to broader input and innovation” (O'Really, 2010), and differentiate services “in response to heterogeneous preferences in the community” (Goldsmith & Kettl, 2009);
- creates public value and build trust (Ostrom, 1996), empowering the people and increasing resilience of the wider community” (NEF, 2010) and produce positive spillovers in other areas (Ostrom, 1996)
- fosters social capital and strengthens civil society (Torres, 2007), unleashing social innovation, and reinvigorating democracy (O'Reilly, 2010), putting people in touch with each other and thus strengthening social networks (NEF, 2010),
- engages the poor and disadvantaged citizens more effectively than general civic participation (Bovaird, 2007) contributing to people sense of wellbeing: connecting, learning, giving, being aware, and being active.

3.3.3 CO3 and the Blockchain

Technology provides channels, not just for mass dissemination, but also for mass production and collaboration (Benkler, 2006).

The CO3 project will build an analytical framework for studying the potential benefits and risks of new disruptive technologies such as Blockchain, Augmented Reality, Geolocation in Social Networking, Opinion Formation and Gamification and their potential to foster co-creation, co-production and co-management of open public services. The project aims to properly evaluate their social impact, identify emerging best practices, understand how to overcome legal barriers, individuate metrics for a long-term sustainability plan and define appropriate applications.

Blockchain is the key enabling technology for CO3's thesis: it represents a revolution in how information is gathered and collected. By creating inter-organizational databases, the Blockchains or, more in general, distributed ledger technologies allow a paradigm shift at all levels. Blockchains can be applied to homogeneous entities, for example to consortia of

financial institutions, enterprise alliances or can swiftly connect different branches of Public Administrations. However, less is known about the possible consequences of a general interconnection of parties different by nature, for example a Public Administration could be connected with a system of enterprises jointly managing some kind of operations and creating a new form of public-citizens partnership.

CO3 wants to test the hypothesis that Blockchains could lead to a generalized cooperation system between individuals, groups and public authorities. And such framework is very similar to the aforementioned commoning model. Actually, a Blockchain is a common good in itself, a distributed infrastructure: not by chance, the pseudonymous creator of bitcoin announced the invention of the Blockchain for the first time on the Peer to Peer Foundation's web forum - an organization advocating a commons-based peer production model. Augmented Reality (AR) is the other high potential technology whose implications are far from being understood. In fact its applications presently regard a relatively tiny market, largely occupied by a single game (Pokemon go) and frivolous marketing operations. AR – given the difficulty of the Blockchain technology – is the ideal interaction layer for Blockchains and can be conducive to a wider acceptance and to a large class of value bearing innovations in local economies.

A fundamental part of CO3 is involving grassroot movements on commoning and commoners, P.As, university campuses, retailers, artists and other relevant stakeholders, in a process of mobilisation, mutual learning and doing things together. Bottom up experimentation will be carried out in the three pilot sites: Municipality of Torino (IT), Municipality of Athens (EL) via its public company DAEM in charge of EU projects, the 9 Municipalities belonging to the territorial public institution "Plaine Commune" of the Development Areas within the "Grand Paris Project" (FR) via their partner IRI of Centre Pompidou; Plaine Commune is a dynamic cosmopolitan territory in a process of renewal after deindustrialization but facing the challenge of social cohesion.

Social pathways. The benefits digital technology bring to everyday life have been discussed by many scholars (Castells, 1996, Benkler, 2006). In spite of this in the Public Administrations (PA) as well as in the other sectors there is a common human characteristics to have a certain degrees of resistance to change. Often resistance to change is triggered by the lack of knowledge about a certain technical topic. Also the fear of changing an existing occupational status could be an important factor that triggers resistance to change. These benefits and risks should be understood through a specific inquiry and methodology. This means to use these methods in order to explore various dimensions which are fundamental for the success of the program.

An organizational and sociological glance will provide the understanding about the changes in the PA and it will be focused on what is changing in the content of public servants jobs, once it is expected an improvement of their sense of purpose within a new relationship with the former users and current co-producers. Tailor made quantitative and qualitative metrics will be used to monitor and assess the change in content, sense of purpose and the new relationships. This will be done by looking at outcomes, processes (what was done) and structures (how the work was organized) but also to what that motivates people to take a certain course of action and what provides them with a sense of well being and personal and professional fulfilment.

Legal Pathways. By combining conventional models, rules or policies with innovative technologies or civil society initiatives, different 'generations of solutions' can develop in response to gaps in traditional policies. Such hybrids can function as 'transitional solutions', allowing PAs to face disruptions and confronting the emergency of new needs and societal challenges. As such, our project emphasises the need for multifaceted solutions responding to multiple correlated objectives, thereby opening a new perspective in the design approach to policies and prototypes, inducing to evaluate ex-ante all possible attainable results. The project will also refer to legal traps and tricks (Capra and Mattei, 2015), including rules, regulations and mentalities that maintain the existing state of affairs and disempower citizen initiatives. Transformation or innovation require imagination and risk taking, while rules and regulations are instructions that frame what already exists. Innovation may therefore find itself trapped or falling into the realm of illegality, blocked from having the right or opportunity to prove its benefit or relevance. According to this perspective, the project will support public institutions in their transformation towards collaborative systems by developing a legal assessment in which administrative and legal issues will be combined with the technological transformations introduced by this project. The assessment will be structured as a flexible set of recommendations, so to define legal pathways that will be replicable and adaptable to local contexts and different legal orders. The legal analysis will start from the experience in Torino with the new Regulation on Collaboration for the Care and Regeneration of Urban Commons approved in 2016 by City Council, considered its originality.

3.4 The Real Smart City Project (Marie Skłodowska-Curie Actions, H2020)

The Smart City is not only a descriptor for urban living supplemented with ubiquitous computing and data collection, but has become a mode of aspirational discourse in the governance of the cityscape. In other words, the use of digital technology in the management of urban life is being celebrated through its potential for enhancement. As

such, it is necessary to retain a space for critical engagement in conjunction with the incorporation of technological developments, especially as Smart Cities and Data Cities are transforming the rights and responsibilities of urban inhabitants.

The emphasis of this project is the relationship between technology, data and urban infrastructures. Other EU funded projects that emphasise overall enhancement of citizen engagement with the Smart City are: Sharing Cities, BigClouT (Big data meeting Cloud and IoT for empowering the citizen impact in smart cities) and CROSS (Citizen Reinforcing Open Smart Synergies). There are also various projects with specific applications of citizen engagement identified, such as CITYCoP, which concerns community policing, and MONICA, which is a pilot project that investigates and tests the use of wearable technology for smart ecosystems in conjunction with the Smart City. Among other important attempts to involve citizens in data collection and deliberation we can mention : Making Sense in Barcelona and EU project and EMPATIA for participatory budgeting. The shared goals of these projects is to enhance the use of Smart City technology, realising aspirations to improve urban efficiency. However, there remains a gap in regards to citizen understanding of digital technologies, which includes a critical understanding of what technology is and how it is used. At the same time, there is little to address data biases and the complexities of urban life—such as homelessness, race and gender, precarious employment, drug abuse, immigration—from a humanities perspective. These aspects of city living are complex, begging political, social, economic and ethical questions that arise from public conversations and engaged citizen participation. RealSMs sets out to introduce a critical humanities context for the issues raised in and through Smart City and Data City projects, formulating a model for the Real Smart City that emphasizes various forms of public engagement in conjunction with expanding citizen knowledge of the technological infrastructure of the Smart City.

The Smart City and Data City, with their reliance on digital technology, sensory input and the collection of data, is introducing new forms of infrastructure that not only alter how people inhabit urban space, but how they relate to each other socially, culturally, aesthetically and politically. In addition, these structures inform the knowledge transfer systems that comprise the city and how this information is relayed to its inhabitants. Smart Cities and Data Cities encompass more than technological systems, the growing quantity of accumulated data and the implications for urban management. Tim Berners-Lee, one of founders of the internet, has called for critical appraisal of the current model of participation which focuses on the data collection of citizens without an awareness of how data is used. Questions emerge through the process of implementing the Smart City that cannot be anticipated in advance, including questions regarding: access to data collected; the expertise needed to understand data; the biases that arise in how data is collected and formatted; and the behaviors anticipated and suggested by the Smart City, especially as Smart Cities transition from flow

management (the model of the 19th century city) to what Picone (2015) refers to as “event control.” In addition, modes of citizenship are changing in conjunction with the increased presence of digital technology in urban life. The use of the term citizen is intentional, particularly during a time when international migration affects Europe and other parts of the world as well as recent political events (like the Brexit Referendum and recent US presidential election) that earned support through the promotion of restricted definitions of national citizen. For ReaLsMs, the definition of citizen goes back to Jean-Jacques Rousseau (1762) and the social contract, which treats the citizen as someone who sees beyond their own needs as an individual and recognizes the needs of the other, emphasising social connectivity of the term. The very distinction between the notion of individual and citizen is premised on the ability to participate in society beyond the individual’s needs. The results from these projects will be used to inform good practice in the development of new forms of citizen engagement and Smart City Technologies, the results will also enhance possible forms of economic development such as the contributory economy.

Emphasis in this project is placed on improving relations between data processing (and more precisely open data) and citizen deliberation, thus paving the way to a new relationship between the public sphere and the marketplace. ReaLsMs proposes to offer Dublin City Council, as a local governance already dedicated to Smart City technology and practice, a new critical perspective lacking in other projects that aims to improve citizen participation in civic policy making while drawing attention to the potential benefits and shortcomings of data collection and mediation of urban living through technological infrastructures. The Plaine Commune municipality, that is implied in this project, has a less developed deployment of Smart City technology than Dublin. However, it brings together 9 local authorities in the wider Parisian urban area and has set out an ambitious program to foster and develop new forms of critical citizen engagement, which has been done through the development of new forms of political economy - the Contributive Economy. Plaine Commune has funded a chair on contributive research and is planning to fund a number of PhD researchers who will carry out contributive research projects that are contextualised by the development of the territorial experimentations within the 9 local councils. IRI will lead the project on Plaine Commune in concert with the local municipality and various citizen associations pointing to the urgent need to develop new forms of citizen engagement that take place through a more comprehensive understanding of the development of digital technologies in relation to evolved human physiology and social organisations.

The Real Smart City, as an alternative to the exclusive use of automation in current Smart Cities, is seen as a primary example of the mobilisation of digital technologies in relation to the active engagement of citizens and new forms of citizenship towards the co-creation of urban-commons. This return to decentralized, local, sustainable, and privacy-enhanced communities has already began with the work of the DECODE project in cities such as Amsterdam and Barcelona, and the next steps of NEXTLEAP will be to empower these

communities in Paris, the centre of NEXTLEAP activity, via Plaine Commune and so create a European alternative that goes beyond standard “market”-based metrics and establishes a true commons.

The Blockchain Revolution: Can sustain decentralization?

Since NEXTLEAP started in 2014 the blockchain / distributed ledger space has exploded. These innovations have introduced two major new aspects to decentralized systems, namely platformization and tokenization. Those two features of blockchain platforms have profound implication for privacy, even though the platforms themselves today do not protect data privacy very well: they have the potential to undermine the monopolistic position of large service providers. By virtue of accumulating masses of user data, and using it as part of an advertisement based economic model, such service providers cannot fundamentally be privacy friendly. Undermining those large silos of data both frees people from the whims of monopoly platforms, the wide use of data to manipulate them, but also the secondary threats of governments (domestic and foreign) then dipping into those databases for their own purposes. The key feature that distinguishes the blockchain space from traditional platforms are features related to decentralization (no trusted authority), censorship resistance and transparency. Platformizing and tokenizing decentralization opens up significant new complexities as well as opportunities, which are discussed below.

Platformization

The platform economy can be traced to previous efforts and excitement over the possibilities of peer-to-peer architectures that in turn led to new forms of intermediation and platform businesses (Scholz, 2015, 2016). Early hopes for peer-to-peer technologies were that these would allow people to share knowledge and resources directly with one another. But instead of direct communication between people, new platform businesses emerged that facilitated such connections, becoming kinds of monopolies in their own right, and the emergence of the so-called “platform economy” or “platform capitalism” (cf. Langley and Leyshon, 2016). A description of emerging platform economics offered by van Dijck, 2013 defines platforms as establishing multi-sided markets, giving rise to new business models and financial products and that curate connectivity. New platform business models would seek “rapid up-scaling and extracting revenues from circulations and associated data trails” (Langley & Leyshon, 2016:2) in order to, following O’Dwyer, (2015), become monopolized rentiers of network data circulations. Platform businesses, instead of empowering individuals, largely created an “on-demand service economy” where human labour could be plugged in as and when needed and evading existing labour and tax regulations in the process (Scholz, 2016).

Blockchain/ DLT came about as an explicit critique of and disruption to existing platform monopolies. But in all these senses, blockchain protocols can indeed be considered a new form of platforms (this time at a protocol layer rather than for services): many blockchain projects seek “rapid upscaling” to become the generalized platform on which all other tokens, contracts or protocols will be built, essentially seeking a form of monopoly status; they also facilitate connections and establish new multi-sided markets, providing the conditions for decentralized markets at the data layer, not only between people but also between things (for example smart contracts for IoT economies); these are paid for through fees that seen in a different light might also be considered network rent; and indeed, the general gist of smart contracts and their clustering into Decentralized Autonomous Organisations is exactly to approach human labour as something to be plugged in as and when necessary; and finally, in keeping with the history of decentralization as a strategy of circumvention, blockchain projects are often unapologetically positioned as vehicles for circumventing regulation and taxation. What exactly is then the difference between the potential of blockchain and incumbent monopoly intermediaries?

Blockchain projects came about and were positioned from the beginning as explicit disruption and critique of platform businesses like Facebook, Uber and AirBnB (Valenzuela, 2016). The differences have been articulated as one between centralization and decentralization, but with a very specific operationalization of these terms in mind – as discussed in more detail above. The distinction between centralization and decentralization as generally understood in blockchain projects, is neatly captured in this quote from an interview with Vitalik Buterin, founder of Ethereum, one of the largest smart contract platforms: “This is the difference between people like me and Mark Zuckerberg. I live in a world where I presume that I could be a potential adversary to the system.” (<https://tankmagazine.com/issue-74/features/vitalik-buterin/>) What Buterin is saying here is that the Ethereum platform is built in such a way as to be beyond the control of any authority, including himself (a claim that could be contested, see D3.6). The main difference between the two kinds of digital regimes was stated through a network security understanding of control and authority. – Namely that the system itself would be resilient to authority attempts at shut down, but importantly, and as stated above, this does not necessarily translate into resilience towards authority for those using the systems. Instead, when such notions of authority are generalised, the engineering task becomes one of designing systems that are beyond the control of *anybody*. This was an early promise of smart contract systems, but which since has been tempered by events where indeed different communities have taken control of aspects of the infrastructures when things went wrong. In other words, new forms of decentralized control and accountability are being experimented with. More work is needed then, for fleshing out what are to be the primary differences and the more precise nature of the disruption proposed in blockchain technology in relation to existing platform monopolies.

The focus on authority does however extend in important and interesting ways to questions of governance and hopefully will continue to matter for those building new systems. The critique of authority at the basis of decentralized designs does imply that protocols remain open source, privacy aware and also governed in ways that are transparent and to some extent decentralized (see D3.6). Such conditions go a far way to ensure that protocols do not become the same model of monopoly platform businesses, but instead draw on non-profit, commons approaches and/ or will have to innovate in terms of economic sustainability (see below). Blockchain and distributed ledgers provide platforms to make building decentralized apps more humane. While writing larger and correct decentralized applications on Ethereum, in the native language Solidity, is still a significant undertaking, it is much more accessible than having to start from scratch writing your own byzantine consensus protocols, and ensuring these are correct. Significant efforts are made across the industry towards broader legibility of smart contracts as well as the design and development environments. The ideal outcome of platformizing the engineering of decentralized protocols then, is to make accessible the design of censorship resistant platforms for applications with new economic dynamics, establishing new multi-sided markets that are non-monopoly based.

Scaling up those platforms to make them truly competitive with large on-line service providers and other 'sharing economy' silos is a necessary but challenging task. But as long as Internet services make most of their money from mining user data for ads or optimization, privacy enhancing technologies stand no chance to see the light of day at a large scale. Can decentralized infrastructures be made economically sustainable? Will blockchain and distributed ledger have the same fate as previous peer-to-peer efforts, becoming new forms of monopoly intermediaries? Much of this is likely to be decided by economic and business model innovation and should therefore be an area of careful consideration and deliberate development.

Tokenization

The incorporation of financial incentives into the Bitcoin security model turned out to be hugely generative, opening up new fields of experimentation in computational and economic technologies. For the first time, economic theories entered into the toolbox of decentralized systems engineers, opening up new areas of computational research. Such economic dynamics on the one hand present an opportunity: to articulate decentralized information and communication systems that might be sustained by new kinds of business models, thereby posing both a technical and economic challenge to existing surveillance based infrastructures of the Internet. On the other hand, they introduce new kinds of complexity deep into protocol designs in ways that exceed purely technical concerns,

opening these up for all the complexities of economics and finance. And on a more fundamental level, token creation brought with it the tools for curating and designing scarcity in the otherwise infinitely replicable digital space, a possibility that also caused a change in the economic ideas and assumptions of peer-to-peer decentralized technologies. The following discusses each of these three implications of tokenisation in turn.

The hope: a system that pays for itself

A major attraction of Bitcoin and the idea of incorporating tokens into a decentralized system was the idea of *a system that pays for itself*. Decentralized initiatives had largely been run voluntarily or with ad-hoc funding. The Tor network, for example, operates on the basis of volunteers running relays, research, foundations and state department funding — a model that cannot scale to run significant infrastructures. The possibility of a system that pays for its own upkeep is therefore an attractive prospect. Not least as an alternative and challenge to the current economic models of the Internet. The hope was that the incorporation of economic incentives and token economies could make the infrastructure economically self-sustaining such that it would not be dependent on service providers and surveillance based business models. This potential could entail a radical transformation of the Internet eco-system and alleviate and transform otherwise voluntary work done on the basis of ideals into economically sustainable infrastructures. The hope is that **blockchains provide both technical and economic potentials to enable decentralization**.

When the Googles and Facebooks of this earth established themselves it was not clear how they would make any money. Therefore they innovated, and developed the ad-based model by which the user is not the customer, but rather their attention is a product to be profiled, targeted and sold for adverts. From there, it was a short jump for such profile and targeting techniques to be repurposed for security and military systems (Amoore, 2007, 2014). This has led to the establishment of what has been called surveillance capitalism (Zuboff, 2015) that now seems to run deeper, and also interacts in questionable ways with the advancements in machine learning. And so for the years 2000-2010 the main monetization vision and business model of online services launched was the collection of personal information, and the resulting generation of ad revenue. Data is more akin to tar sands than oil: an organization needs a lot of it to refine it into something useful. This leads to a monopolistic situation in which platforms that already have captured a lot of personal data and the ad revenue are difficult to dislodge. For a while an alternative model, based on selling mobile apps first, and then selling in-app purchases offered a different kind of business model and gave rise to a new wave of innovation, but that did not last. The most monetized app were akin to “digital crack”, seeking to develop users with strange addictions in order to maintain revenue streams. Eventually, widely used apps such as Instagram and Whatsapp were bought by already established online monopolies. Today, most independent

app developers make little money are subject to the whims of every app store that may delist them at will — also controlled by large incumbents that take up to a 30% cut on revenues.

This is where the economic promises of blockchains became attractive. In particular for decentralized alternatives. Decentralized systems come up against the problem of how to motivate strangers to contribute to the network. Some peer-to-peer platforms managed to do so in the past, for example filesharing platform demonoid, through invitation only and an expected share-ratio that helped create a community amongst anonymous nodes. Other communities formed around and were motivated by specialised content. But in terms of large-scale, generalised protocols and platforms, the question remains – how to motivate multiple authorities to run the network and how would they cover their costs of doing so? The Bitcoin incentive structure proposed a solution to the question of more general incentives that might have blocked the deployment of such decentralized systems before. Allowing users to pay for services they access also ensures that those services can survive and be sustainable, in ways other than selling out their users' data. Thus services on blockchains do not have to rely on ad revenue, but can instead rely on fees to survive and be sustainable, at least in theory. The open access model of most blockchain / DLT platforms also ensure that both infrastructure nodes and developers can invest in building apps without fear they may be arbitrarily excluded. A fruitful area for further empirical research and economic development would be to look into the specific economic motivations for adopting decentralized systems amongst dApp developers in particular, in relation to app stores and platforms in the existing Internet economy. For example, would decentralized platforms prove more economically equitable and profitable for (d)App developers? The ability for people to economically sustain themselves in and through decentralized systems could be a major factor in whether or not decentralized systems will replace aspects of existing centralised infrastructure.

But what is the actual value of a token and how does it help run a network? **A token is not the same as an economy.** The invention of a token might seem to enable a certain level of economic or financial autonomy, but in the meantime, the labour, the hardware, the electricity most all of the hardware, resources and efforts required to run a system is priced, assembled and paid for through fiat economies, dollars, euros, yen and so on. The economic power of a given token-based platform is therefore at the mercy of exchange rates and the full range of events and actions that might affect these, which in turn therefore also affects the level of remuneration of a miner or node, and the cost of running a smart contract. This detail and consequence of incorporating economic dynamics into protocol design is only recently being addressed more explicitly, through efforts towards so-called stable-coins that are tethered to other government-backed currencies. In this sense, blockchain and token-based DLT projects are beginning to look less like decentralized initiatives that allow a certain autonomy from existing systems, and more like another layer that interacts with existing

systems in complex ways that require more careful design attention.

There are three main ways in which funds tend to be raised and distributed in token based blockchain / DLT so far. Namely, **mining** rewards that double as a money creation and distribution mechanism; **fees** have become another area of research and development of economic incentives, motivated early on by the final cap of total Bitcoin set to 21million; and finally **Initial Coin Offerings** (ICOs), something in between crowdfunding and unregulated securities issuance, became for a few years the main economic model through which new blockchain/ DLT would launch. Each of these face issues that are being addressed in the industry. Mining is incredibly wasteful in terms of energy, and has a tendency towards centralization. In response, new consensus mechanisms (see for example proof-of-stake or non-consensus based systems) as well as hardware designs seek to rectify these two main issues. Fees entail pricing issues, whether these should be dynamic or not and an issue around willingness to pay in the context of ingrained habits of free online services. One of the arguments for peer-to-peer payment systems were that costs would be minimized by eliminating third-party intermediation – a promise that current fee structures are disappointing. ICOs in turn became one of the main areas of fraud and have been banned in multiple countries. The ICO model did however work for a brief period of time as an effective means for fundraising. And so while several of these economic tools have turned out to be problematic, and the fluctuating exchange rates severely impede the claimed uses of blockchain/ DLT, when considered over time, they have nevertheless played a significant role in garnering interest, funds and attention for a broader agenda of decentralization. The question is what comes next.

It is likely that a large aspect of the future shape and condition of Internet provision and governance will be determined through questions of economic and business models. – In other words, which models provide the economic support needed for running and maintain decentralized infrastructure at scale. Token systems are an important and potentially powerful accounting method for distributing and remunerating the cost of running a decentralised infrastructure. But there is significant work still to be done in order for token systems to make sense economically and financially, and in particular in relation to the interfacing economies of fiat currencies, resources, raw materials and efforts that sustain a given infrastructure. And there is much consideration still to be done about the appropriate uses of token systems, and when they simply add unnecessary complexity, scarcity and volatility.

The complexity: Cryptoeconomics

Incentives, as an integral part of the Bitcoin protocol design, gave rise to what is called cryptoeconomics. Expanding on the gist of Bitcoin mining rewards and their security function – making it more profitable to contribute to the network than attack it – the budding interdisciplinary field is concerned specifically with incentive designs for securing and running decentralized systems. The incorporation of economic concepts into security modelling and decentralized protocol design is a significant development and is becoming an area of research and development in its own right across computer sciences departments and in the fields of information security and cryptography (cf. Buterin, 2014; Garay, Kiayias and Leonardos, 2015; Kiayias, 2015; Bano *et al.*, 2017; Davidson *et al.*, 2016; Foundation, 2017). A high level description of this new field might therefore be something along the lines of: the employment and operationalization of concepts from economics, game theory, cryptography and mathematics (such as probability) in order to align the desires and behaviour of individual nodes in a network with that of the overall system. This proves much more complex than a cursory glance at the Bitcoin mining rewards might initially seem.

On the philosophical and systemic deep end, the question of what is the wellbeing of the system is not always straight-forwardly obvious. Cryptoeconomics would design systems such that certain behaviours are made either impossible, through the use of cryptography, or undesirable, by making them costly, while encouraging behaviour that benefits the system through rewards. It is, in a sense, a complex endeavour of shaping a landscape of the possible and desirable actions. Blockchain/ DLT systems are intended to be (net)neutral, meaning the infrastructure is open for anyone to use and participate in. This means that cryptoeconomics and incentive design tends to be discussed and addressed purely as security questions – how to prevent or discourage “malicious” behaviour and encourage “honest” behaviour. Security concerns are considered neutral concerns. But what is malicious and what is honest behaviour in an open decentralized system? When is something an attack, or when is it simply a different understanding of how the system should or could work? Who gets to decide? And at what point does incentive design simply become large-scale behavioural engineering? There is a grey-zone where what might seem like a security question might be politically, socially or culturally contested. This raises the question of protocol governance, who gets to write the rules of the system, who gets to design the landscape (see D3.6).

A second complication in the field of cryptoeconomics the implications of incorporating any and all potential economic dynamics into the protocol design and security model. The

concept of the proof-of-work consensus algorithm was to incentivize verification in the network, such that this task (mining) would be more attractive and profitable than attacking the network. But this seemingly simple idea quickly becomes quite complex in attempts at measuring or assessing this. Even calculating the profitability of mining involves a number of more or less understood variables: the cost in terms of energy consumption and hardware which needs to be weighed against the potential for reward in terms of the likelihood of computing the nonce for a block, which gets further complicated by the competition with other miners and the addition of mining pools, ASICs and so on. Calculators have been cobbled together in order to be able to determine the profitability of mining. This is just to mention the economic complexity of just one actor, namely the miner – which in turn needs to be understood in relation to the broader economic dynamics such as exchange rates, concentration of wealth amongst so-called “whales” potentially manipulating the markets, the overall money supply and so on in order to achieve an understanding of the full security implications. In such conditions, is it possible to model whether it is more profitable to contribute to the system than attack it? What do economic incentives actually do in a decentralized system?

An associated complication is that once there is economic value in the network, generalising the incentive to contribute, it conversely also generalizes the incentives to attack the system. This has become an intensive area of modelling, testing, research and development in order to anticipate attacks. In Ethereum, research is focused in particular on the security issues of shifting from a proof-of-work to a proof-of-stake consensus mechanism. Proof-of-stake, rather than paying the cost of energy to get a reward, instead employs the idea of a “stake”, and the threat of losing that stake, to secure the intentions of nodes in the network. That there are significant assumptions and that the system tends to get very complex is fully recognised and acknowledged amongst researchers and developers working on this transition, evident here in Ethereum developer Floersch explanation of the Casper version of proof-of-stake:

We have this complex behavior emerging from really simple economic rules, right, and this actually not specific to Casper by any means, this is any protocol that we are messing around with economics we are going to have people spending their lives trying to break it, there is crazy stuff happening, so we need better tools for evaluating these economic incentives. If we don't actually have the right methodologies for coming up with these kind of attacks that we might face we are not going to be able to properly defend our protocol.

- Karl Floersch on Casper and proof-of-stake, 2017 <https://youtu.be/ycFOWFHY5kc> 12:18

Economic incentives then, both increase the incentives for attacks and vastly expands the

potential attack surface.

This seemingly simple idea – to use the economic self-interest of actors in the network to ensure that it is more lucrative for them to contribute rather than attack the system – very quickly becomes quite complex as these open up the network and field to the full range of economic dynamics. Navigating economic decisions in protocol design have so far been considered primarily for network security questions and incentives as a form of behavioural engineering for security purposes. This helps for delineating some core priorities and primary concerns in design considerations that might otherwise be hard to contain. And yet, the impact of these decisions cannot be so simply isolated network security concerns: a cryptoeconomic design decision is simultaneously an economic, monetary and financial decision, that will also affect the price of running smart contracts and dApps, and therefore immediately impacts and shapes the potential business models that might come out of these designs. With these complications in mind, it is worth considering the full range of possible incentives, not just the economic, and assess which might be most appropriate for a given system. When there is a clear community with shared incentives already existing (social, political, cultural or otherwise), these might only be complicated by adding a further token layer. It is also worth considering more striated incentive systems rather than generalised open ones, so that the surfaces of interaction with other economic systems and dynamics limited and carefully considered, for example in terms of listings on exchanges or other interactions with currency systems and economies.

The change: from pirates to police

This particular effect of tokenization is rarely discussed, but presents a significant change in the economic ideas and assumptions prevalent amongst peer-to-peer technologists since Bitcoin. Earlier generations of decentralized technologies employed decentralization as a strategy to make a given system resilient against potential legal persecution. In peer-to-peer network culture at the time, a critique of intellectual property circulated based on the idea of digital copies as next to zero cost and infinite, and therefore naturally abundant (cf. Arvanitakis and Fredriksson 2016). File sharing communities resisted digital rights management technologies as an artificial imposition of scarcity on information, knowledge and digital goods, epitomized in the slogan “information wants to be free”. The infinite replicability of the digital formed the intellectual justification for filesharing and digital piracy. Networks were spaces of free flows of abundant knowledge and information, entailing multiple pathways that would circumvent any attempt at blockage or control. And because code, information and knowledge are infinitely replicable, there had been an underlying critique of in particular Intellectual property rights and any attempt at forcing scarcity on abundant resources. Bitcoin marked a significant shift in this history of peer-to-

peer network politics, a shift to an economic position that could be said to be the exact inverse – concerned with the expansion of what might be deemed property, building some of the most fine-grained IP management systems aimed at immediate and “unmediated” policing of property rights (see for example Mattereum⁷, Slock.it⁸).

Bitcoin introduced the possibility of scarcity into the digital space and with it the possibility of fine-grained control of access to uniquely defined digital objects, determined in a ledger. With Bitcoin, cryptography went from being tools to ensure privacy to determining ownership more broadly. For the purposes of establishing a peer-to-peer payment system, this was necessary in order to prevent infinite replication of token records, and thereby rendering the system meaningless. But in the meantime, it has had major implications across several different scales and has significantly changed the very culture and assumptions of peer-to-peer in ways that have not been sufficiently acknowledged and understood. The proposition of replacing aspects of payment systems, contracts, identity registration and legal enforcement with a decentralized version of these has drawn those who might previously have been critical of the very techniques of such state and economic institutions into their reinforcement in and through digital technologies (Käll, 2018; Manski and Manski, 2018). The affiliation of the current generation of decentralization movement is primarily grounded in decentralized networks rather than particular economic and politically informed ideas. And so, the field is becoming characterised by the adoption of many of the concepts and frameworks from what might otherwise be understood as centralized entities to be deployed in new decentralized ways. The social, political and economic is addressed from the perspective of the decentralized computational network rather than the other way around. And so notions like security, property, sovereignty and so on are not critiqued per se, but instead sought to be decentralized such that these are no longer determined and enforced by a state, but by potentially anyone. It is a splintering of existing social-political and economic conditions and power dynamics, such that they are adopted and replicated by potentially anyone, rather than an explicit articulation of an alternative. On the one hand, the possibility of establishing scarcity and fine-grained control of access grants powers and tools previously only available for those who had access and command of financial and legal institutions to anyone with access to coding skills. On the other hand, this has also altered the orientation and understanding of economics in peer-to-peer development from one of open networks towards one of establishing scarcity and control. The effects of this splintering of existing economic and financial tools is yet to be seen, but there is currently very little systematic economic analysis of the different

There are of course important legacies from earlier generations of peer-to-peer: educational

⁷<https://mattereum.com/>

⁸<https://slock.it/>

material and knowledge tends to be open and shared widely, there is a culture of leaking if relevant information is being withheld, and code is open source and frequently defended as a commons. But these are increasingly justified through network security issues rather than a consideration of the socio-political effects of different property regimes. It is no coincidence that the first product of the first smart contract start up company, Slock.it, was a physical lock. The tendency to use examples of locks, property and access is not simply due to a lack of imagination or a coincidence. It is an extension of what cryptography can do well, which is to determine access criteria and, with Bitcoin, expanded to criteria for spending and use. The ability of cryptographic tools for determining access conditions maps well to existing understandings of property and allows for very fine-grained determination of property relations and so has a momentum of its own. If blockchain protocols are to facilitate a decentralized version of applications like AirBnB managing access to property, or a decentralized carpooling, or any other thing one might want to “sell, rent or share” (<http://slock.it>) it becomes necessary to determine property and access and incorporate such physical things into the realm of digital and automated execution. This does not mean there are not other possibilities for different economic ideas to be generated and the possibility of innovation of businessmodels towards more privacy aware and collectively beneficial forms. It does mean however that the tendency has been towards enforcing existing property regimes because disruption and critique has not as of yet been explicitly formulated beyond centralization vs decentralization.

Decentralized, open architectures however pose some complications for existing business models that can in part be traced back to the political sensibilities of early decentralized systems. For example, most major blockchains are fully public, what has since been called “unpermissioned blockchains”, meaning one does not need special credentials or permissions to take part in the network and browse the data. This poses a problem for many types of businesses that would rather keep most of its operations and agreements relatively private. Entities like the Enterprise Ethereum Alliance have been established specifically for industry, including exploring permissioned uses of the otherwise unpermissioned Ethereum chain in order to curate the transparency of contracts and transactions in ways that would be workable for existing business models. And so new, so-called permissioned layers have been added so that new types of privacy arrangements could be established (cf. Didil, 2017). These layers add the potential for fine-grained management of privacy and transparency. What becomes clear is that neither privacy, transparency nor new open business models are in any way guaranteed by the protocols. New layers are developed on top of such systems that can exacerbate or ameliorate privacy as well as issues around IP, ownership and access. There is an implicit arrangement of commons, public and private economies, but also some significant areas of negotiation over appropriate economic and property regimes currently taking place. And so much of the political-economic potential and outcome of decentralized systems is very much up for negotiation.

The attraction of blockchain is the possibility of achieving a systems design that renders surveillance based business models impossible. With their fall the adoption of Privacy Enhancing Technologies can finally be unblocked. And already we see some of the most advanced cryptographic techniques, including zero-knowledge and selective disclosure credentials, being fielded in the context of blockchains, where they have seen little traction elsewhere in the past 20 years. So in brief, blockchains are intended to align incentives correctly: firstly, control over the service is decentralized, and usually subject to code (smart contracts) to ensure users are not subject to the arbitrary and opaque decision making of large online service monopolies; *but in the meantime however, code, as it turns out, is not neutral making the decentralized, code executive system more risky for some users because the recourse to justice when things go wrong is more diffuse.* And secondly payments are made to those that maintain infrastructure and services, to ensure they do not need to be tempted to pry as a business model; *but incorporating tokens opens up the protocol to the full range of economic dynamics and new dependencies.* So while the incentives are aligned this does not mean that current blockchains actually achieve all those great goals, and in particular that they provide strong privacy guarantees.

If this model is a success — subject to a number of contingencies — it may provide a good foundation for better, more open and humane, systems that could actually redecentralize the Internet. But if these are to pose an actual alternative to current monopoly and surveillance-based systems, significant research and innovation needs to take place, not only in terms of revenue models of those using decentralized systems but in particular in terms of new business models and the interface between internal protocol token economies and the existing economies that these are dependent on. This requires serious attention – leaving the economics up to the existing tendencies are likely to reproduce in more fine-grained and insidious manners already existing property, economic and financial regimes and policing of these rather than allowing for new innovation. This would be to miss out on a significant opportunity for shaping new forms of economies, enabled by decentralized open networks.