Marvin Landwehr

Surveillance Capitalism and two Cases of Currency Innovation

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Dissertation 2023
angenommen von der
Fakultät III
Wirtschaftswissenschaften, Wirtschaftsinformatik und Wirtschaftsrecht
der Universität Siegen

1. Gutachter: Prof. Dr. Volker Wulf
2. Gutachter: Prof. Dr. Gunnar Stevens

Datum der mündlichen Prüfung: 12.05.2023

Dekan der Fakultät III: Prof. Dr. Marc Hassenzahl

Bibliografische Information der Deutschen Nationalbibliothek

Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte Daten sind im Internet über **http://dnb.dnb.de** abrufbar.

Impressum

Druck und Bindung:
UniPrint, Universität Siegen

Gedruckt auf alterungsbeständigem holz- und säurefreiem Papier.

Siegen 2023: univers*i* – Universitätsverlag Siegen
www.uni-siegen.de/universi

ISBN 978-3-96182-162-4
doi.org/10.25819/ubsi/10441

With love
to Lari, David and Katka, who outstandingly felt care for my journey
and to the parts within me that felt left behind along the way.

Contents

1 Introduction

1.1 The Explorative Journey of this Thesis

Problems with IT Infrastructure

Among the multiple and interrelated major problems and crises that humanity is currently facing, and which reveal where our lifestyles are unsustainable, a more recent one is the societal impact of the software services that large IT companies offer. It is not only discussed in the academic community, in particular in information systems [1, 2] and also in human computer interaction (HCI) and computer supported cooperative work (CSCW) [3, 4, 5, 6], but since the time we published our first paper on that topic in June 2019 broader society is becoming increasingly aware of it: A Netflix documentary with this topic had according to their own account 38 million views in its first month, and the documents leaked by whistleblower Frances Haugen were picked up by many news media as the "Facebook Files" [7].

In the IT industries, the expectations for profit have grown over the past two decades, similar to the banking industry until the financial crisis of 2008. Among other things, this is also reflected in their valuation on the stock market. In 2020, among the ten most valuable companies in the world (in terms of market capitalization), seven were IT companies: Microsoft, Apple, Amazon, Alphabet, Facebook, Alibaba, and Tencent. A large portion of their software services are provided "free" to the end users. Yet, they were able to meet investors' tremendous profit expectations. The business model that makes this possible involves customized advertising and behavior manipulation, powered by intensive gathering and cross-correlation of personal information. Significant other parts of our IT infrastructure use fees-for-service but still involve intensive information gathering and behavior manipulation. We will argue that the profitable monetization of such data comes at the expense of a devastating societal spillover.

Therefore the first guiding question of this thesis is:

What are the negative societal consequences of the dominant IT business model and what are possible countermeasures and alternatives?

Regarding countermeasures and alternatives it is worth noting first that this should be considered a wicked problem [8]: Due to the involved complexity and irreconcilability of its actors, it can not be expected to find any fixed solution. Yet, improvements can be achieved and this is what the first half of this thesis aims to contribute towards.

The contributions we make in the first two papers of this thesis are developed out of a problem analysis which traces the societal consequences of the IT companies back to their business models. In the first paper we discuss sustainability problems, such

as fueling consumerism, and political problems, such as undermining the democratic process — others include polarization, concentration of wealth and power and privacy concerns. In terms of improvements, we differentiate between more immediate ones which we consider as "steps toward a solution" and those improvements that are radically addressing the root cause, which is the business model. One aspect in this regard will be the discussion, how decentralized technology might help to return control to the end users. Yet, especially for a decentralized approach, alternative funding models are essential.

In the second paper we expand on the steps towards a solution. In particular, we discuss how true informed consent and adversarial interoperability could combat user exploitation and monopoly respectively. Furthermore we differentiate, which of the funding options and ownership models are applicable in the different categories of physical infrastructure, software, data and protocols.

The First Case Study

On the 18th of June 2019, one of these IT giants ventured into new territory; Facebook, by today rebranded as Meta, announced their cryptocurrency project Libra, by today rebranded as Diem [1]. For this purpose the Libra Association was founded, a group based in Geneva that was planned to consist of 100 members upon release. In 2021 it moved to the US. Facebook and the also newly founded Libra wallet provider called Calibra, whose rebranded name became Novi, would have been only two of these members. The announcement already included a list of 28 participants, among them were the payment service providers VISA, Mastercard and PayPal, as well as commerce in form of ebay, Uber, Spotify and strikingly no ordinary bank. Since then, several times members joined or left. In April 2020 the Whitepaper was updated with significant changes to the Libra Reserve. Finally, in 2022 the Libra Association terminated the project and sold their assets. They justified this step by the regulatory pushback they received [9]. However, this case of an attempted currency innovation remains interesting, even though and precisely because it was ultimately unsuccessful.

If it was successful, it would have acted as a currency in which people can make digital transactions globally and within seconds, easy-to-use integrated with services like Whatsapp. Given Facebook's business model, it seemed ludicrous to give the company an additional ability to gather data, in this case particularly valuable data on payment and consumption behavior, and at the same time giving the company control over a new private monetary system. In an interview, David Marcus, the head of the project, said: *We don't have control over the network. We don't have control over the currency.* and advised to *read the documentation [...] [to] learn that actually we painstakingly removed ourselves from governing this new network because we believe that a public utility like an internet of value shouldn't be controlled by any company.* [10] Thereby, he referred to the fact that the currency would not have been under the sole control of Facebook, but of an international body consisting of a hundred members, including among others NGOs

[1] Because the publications predate this rebranding, I will use the names Libra (currency) and Facebook (company) consistently throughout this thesis.

committed to social and justice issues. Technologically, the cryptocurrency was supposed to be based on a private blockchain, an adaptation of the technology behind Bitcoin that is more resource-efficient and scalable. The idea of a blockchain is precisely to distribute control to a decentralized network of users instead of a centralized institution such as Facebook.

It's unlikely that the company voluntarily wanted to relinquishing control. However, the announcement that regulatory pushback eventually brought the project to an end hints to why Facebook chose such a control relinquishing structure. An endeavor like establishing a global currency would have been even less convincing to governments and central banks, nor for potential users, if the currency was subject to Facebook's profit driven will. However, in the proposed form, the termination of the project was not at all obvious. And our discussion will include arguments for why, if regulators take the proliferation of digital currencies as a given anyway, they would have had an interest in the success of a currency structured like Libra and under the influence of regulators. So did the whitepaper and associated publications really envision an internet money that is as neutral as possible, and for which Facebook is simply one company that profits from its existence? And would that have perhaps even taken away some of the power of the banking sector? What would have been the societal consequences also in terms of macroeconomics and international relations, if that was the case? To answer these questions, the third paper does what David Marcus suggested and closely analyzes the plans of this cryptocurrency.

In light of the findings of the first paper, the data collection aspect is particularly critical. However, the paper also asked about alternative business models and the use of decentralized technology to return control to the end users. At least at first glance, the project seems to unite these points. Was Facebook actually suggesting to use decentralized infrastructure to limit its control over the currency project it attempted to launch? And would this project have been an instance of a different business model? In analogy to the first research question, which asks in general about the societal consequences of the business models of dominant IT-companies, the question here is about the societal consequences of this particular project that this particular IT-giant attempted to launch. That part, will therefore address the research question,

What might be the negative societal consequences of the Libra currency and what are countermeasures and alternatives?

Unlike the first research question, this one addresses IT whose existance and, more importantly, whose usage lies, from the point of doing the research, in the possible future. At that point in time, there was no way of knowing whether the currency would prove successful. For this reason our discourse will use different future scenarios of a successful Libra currency. We develop these scenarios from the technical documents as well as the insights from the first paper and the history of currencies. These mutually non-exclusive scenarios are (1) the direct monetization of the payment infrastructure, (2) (ab)use of sanctioning power, (3) a reduction of the reserve ratio, and (4) an abandonment of reconvertability. They suggest a number of regulatory strategies in response. As a result, we derive criteria that future currency systems can be measured against. These

insights remain valuable regardless of the project being ultimately stopped by regulatory pushback.

From our perspective there is a potential for emancipatory currency innovations, but an even bigger risk of loosing sovereignty and becoming further dependent on a small number of private corporations. This puts weight onto a considerate handling of the topic.

The first research question about the negative effects of the dominant business models of IT-companies lead to the principle of central data collection as a core element. Applied to the Libra case, other possible scenarios of how Libra could be used by the association, complemented this thread of central data collection. What is remarkable about this insight is not so much the fact that Facebook has prepared itself in various ways how it can use Libra, but to see how e.g. the orientation for central data collection manifests itself in the operating mechanisms of this currency: Even though, the currency markets itself as being a cryptocurrency similar to decentralized currencies such as Bitcoin, its software architecture is a so called private blockchain, which distributes control to a consortium. This makes it relatively centralized, there merely is, instead of a single company, a consortium in the center. If the project is successful, the users are at the discretion of that consortium. Among other things, each of the consortium members will have a copy of the private blockchain, i.e. access to the full transaction data. Similarly, scenarios where the Libra Association changes its monetary policy are supported by the software and institutional structure. They merely require small but significant rule changes. In this sense, the orientation of Facebook's business model is reflected in the currency mechanisms.

To see how underlying principles are reflected in the mechanisms of a currency, it is fruitful to also consider a very different case of currency innovation. To this end, I understand the attempt to launch Libra as a first of two case studies of currency innovations, which I examine.

The Second Case Study

Whereas in the first case study the launch of a global currency is motivated by the capitalist interests that result from Facebook's business model, I chose a very different currency experiment as a second case study. It is a small local community project and the currency innovation can, according to the community members, be rather understood as an attempt to break out of the logic of consumerism and ideally even capitalism in general.

Our current forms of production and consumption lead to ecologically and socially destructive externalities. In response there is an increase of critical, ethical and sustainable consumption, that is more than simply a consumer trend. It is an attempt to fix a broken system, but it cannot succeed by focusing changes in consumption practices alone. A root cause for unsustainable practices, then, lies in our economic system and it calls for new modes of organizing economic activity in local, resilient and quality of life oriented production. The exploration of these new modes involves new forms of communication, accounting and expressions of value [11]. Various alternative food movements address

this problem. Among them, Community Supported Agricultures have attained a certain level of professionalism and are about to become providers of a relevant fraction of food production.

The "Luzernenhof", a particular community in Buggingen in the south of Germany, is such an example of experimenting with new, alternative, more sustainable and resilient modes of production. Informed by the crises spawned by capitalist development, their modes fall into the category of Community Supported Agriculture (CSA). CSAs address the problems, that conventional forms of production and consumption bring about, but require new means of exchange. An distinctive feature of this community, is that their distribution system involves their own currency: the "Luzerne". Therefore we are interested in how principles of solidarity, according to the self-understanding of the community, are reflected in the mechanism they constructed and the associated currency.

What solidarity principles underpin community agriculture in Buggingen and what exchange mechanisms or currencies might support this?

This part of the thesis presents a two months participatory observation in a food movement. Based on ethnographic observations, we focus our discussion on (1) the solidaristic principles upon which the movement is based and (2) techniques of mediating between consumers' wishes and the constraints of local agricultural production. By relating to the continued development of CSAs, we identify innovation gaps and discuss new software architectures aimed at resolving the problems which arise as the movement grows. Their currency is a crucial tool in mitigating the supply and demand in the coummunity in a way that is according to their understanding of solidarity.

It addresses our research question, as the community is about a transformative practice of coordinating the production and distribution of organic food. Finally, this case study also explores the potential of decentralized technologies in a local context. The local context of food production opens literally a new field, that mirrors the global issues, and it should be considered as in the core of Sustainable Human Computer Interaction.

A Buddhist saying goes, *if you want to see the whole universe in a single grain of sand, make sure you pick a good grain of sand*[2]. In this sense, the second case study is to be understood as such a good grain of sand, that reflects the global themes in a progressive way: Among other things, this case study touches upon the sovereignty of a community that is trying to emancipate in this case from relatively sovereign structures of food production. This includes independence from large food corporations and global supply chains, but also, if possible, from the monetary system and the logic of capitalism in general. In doing so, it creates a new dependency on a cloud service provider, a big IT corporation. The discussion will revolve around forms of accounting, locality versus globality, currency and most importantly trust and the intermediation of it. It illustrates how values like trust and solidarity translate into (software) structures. These threads are also closely related to the ideas of blockchain. That is why we also include a discussion of more generally the potential of Distributed Ledger Technology in this context.

[2] unknown author

1.2 The Structure of this Thesis

As a cumulative work, this thesis builds on the publications of four papers. On the one hand, it establishes the connection between the papers and supplements the explanations that had to be excluded due to space limitations. On the other hand, it also synthesizes findings in such a way that an overall picture emerges that goes beyond the individual papers. Here is an overview of the structure of this thesis and of which parts are the published papers and which are new.

The State of the Art (chapter 2) is divided into three parts. The first part (2.1) prepares for the two chapters about IT infrastructure. The second part (2.2) establishes a background for the two case studies. Following is a third part about Distributed Ledger Technology (DLT), that goes significantly deeper into the technology than the previously published papers. This technology is a cross-cutting theme in all papers, as it provides new ways to design software architechture and a new perspective on currencies. 2.3.1 to 2.3.4 establish a foundation for understanding DLT and develops an assessment of fundamental problems of the technology mostly out of original whitepapers of Bitcoin and Ethereum. This assessment has been used in the individual papers, yet, due to space limitations it was not included in their publication. Finally, 2.3.7 relates this assessment and the contributions of this thesis in general to the academic discourse about DLT, especially in the fields of HCI and CSCW.

The methodology chapter (3) motivates and contrasts the two different approaches that were used in this thesis. The first three publications were technology assessments, whereas the CSA case study was a participatory observation. The way in which these methodologies act complementary is reflected in 8.6.

Following are the four publications that this thesis is based upon as chapters 4 through 7[3]. These publications are listed below. Subsequently in 8, I [4] finish the discussion by relating the insights of the individual papers to each other and places them in a broader context. This part of the discussion goes beyond what was previously published.

1.3 List of Publications

This cumulative thesis consists of two parts. Each of them includes two publications. The first part addresses the Problems of IT-Infrastructure, whereas the publications in the second part are case studies of innovation on digital currencies.

[3] Due to the cumulative nature of this thesis the previously published papers appear in their original text. As a result, some redundancy occurs, both because the chapters 4 and 5 share the same topic, and because papers have their own Introduction, State of the Art, and Methodology sections. Furthermore, this causes inconsistencies between the choices of capitalization.

[4] Moreover, when refering to previously unpublished parts of this thesis, I write in first person singular, since I am the only author. Chapters 4 through 7 have co-authors. When refering to that work, subsequently the first person plural is used and I am refered to as the "first author".

Title	The High Cost of Free Services: Problems with Surveillance Capitalism for IT Infrastructure and Possible Alternatives
Authors	Marvin Landwehr, Alan Borning and Volker Wulf
Published at	LIMITS '19: Proceedings of the Fifth Workshop on Computing within Limits
Date	10 June 2019
DOI	https://doi.org/10.1145/3338103.3338106
Chapter	4

Title	Problems with Surveillance Capitalism and Possible Alternatives for IT Infrastructure
Authors	Marvin Landwehr, Alan Borning and Volker Wulf
Published at	Information, Communication and Society - Special Issue: Tech Companies and the Public Interest, Taylor and Francis
Date	19 Dec 2021
DOI	https://doi.org/10.1080/1369118X.2021.2014548
Chapter	5

Title	Toward Emancipatory Currencies: A Critique of Facebook's Libra Cryptocurrency and Ideas for Alternatives
Authors	Marvin Landwehr and Volker Wulf
Published at	LIMITS '20 in: Proceedings of the 7th International Conference on ICT for Sustainability
Date	31 July 2020
DOI	https://doi.org/10.1145/3401335.3401365
Chapter	6

Title	Community Supported Agriculture: The Concept of Solidarity in Mitigating Between Harvests and Needs
Authors	Marvin Landwehr and Volker Wulf
Published at	CHI '21: Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems
Date	07 May 2021
DOI	https://doi.org/10.1145/3401335.3401365
Chapter	7

2 State of the Art

Even though the topics of this thesis have evolved through following the case studies, they are united in the intersection of three motifs. The structure of the State of the Art chapter is therefore divided into three parts.

The first motif is the business models of large IT companies. The first two research questions ask explicitly for the consequences of the business models. But also in the second case study the local community has used a Google Cloud service as a central tool. Thus, understanding the implications of the business models that these IT companies apply is fundamental. Accordingly, section 2.1 lays the foundation for that discussion in chapters 4, 5 and beyond. It situates the contributions that this thesis offers on the threats posed by Surveillance Capitalism within the scholarly and polical debate, as well as within the ongoing regulatory process.

Facebook's push to introduce a new currency begged the question of whether this is part of its familiar business model or enables a new one. Thus, the second motif are attempts to invent on currencies and their relation to today's capitalist system. The two case studies explicitly address two contrasting currency innovations. But even for the papers on surveillance capitalism, there is some connection, since some Scholars [1, 12] see its manifestations as a new form of capital, even if it is not made transferable into a form of currency. To comprehend the attempted currency innovation, 2.2 provides a brief overview over the current monetary system and various efforts to innovate on it. Furthermore, it describes how economics is devided along questions of money — divisions that I later use to discuss the case of Libra. In this sense, it prepares for the monetary case studies of chapter 6 and 7. Further, for chapter 7, 2.2.4 introduces the topic of Community Supported Agriculture, motivates the community of the second case study as particularly interesting CSA, and explains why it is also of particular interest to our research approach.

The third motif that appears in all papers is the potential of decentralized software architecture, or Distributed Ledger Technology in particular. Even though, this is never the main focus of the discussion, it can contribute an aspect to all of the issues — first as protection by design against central control, second for what is presented as a cryptocurrency, and third in intermediation of trust as addressed in the second case study. Section 2.3 is an addendum honoring the fact that all papers address Distributed Ledger Technology as a cross-cutting interest. It comprises a rather extensive state of the technology (2.3.1 to 2.3.4) and afterwards a state of the academic discourse about DLT, especially in the fields of HCI and CSCW (2.3.6 and 2.3.7). I have chosen the step, to work mostly with primary sources first, before relating to the academic discourse, in order to show that certain problems of blockchain are fundamentally baked into the technology. It is the most extensive part of this chapter, because I go into the technical

depth that I think is just necessary to be able to really assess later which DLT makes sense in each context. In contrast to the previous parts, 2.3 does not aim to identify a research gap, that a particular paper of this thesis aims to fill; for none of the papers the primary contribution is about DLT. Instead, this part suggest to shift the research about DLT onto post-blockhain DLT. And the papers are well aligned with this suggestion. One can read all of the papers taking my assessment regarding the applicability of blockchain versus post-blockchain technology as a black box; indeed the papers have been published this way due to space limitations. Nevertheless, for the sake of thoroughness, I deliver this missing part, as it is the basis for estimating the potential of DLT for IT services and in the case studies.

2.1 Problematic Developments in the Computing Industry

In this section, we give context to the first motif, the dominant business model among IT companies.

In the aftermath of the dot-com-bubble, the surviving IT companies had to find business models that would continue providing a growing return on investment to their venture capital funders [13]. In order to keep increasing the user base, it was important for free services to continue to be free of charge for the end users. Therefore, they chose to incorporate advertising to generate revenue. However, instead of merely placing ads, user actions were tracked and recorded in large data bases. When computer scientists at these companies invented algorithms to effectively analyze the vast amounts of data and employed statistical methods to derive predictions from user profiles [14], they invented a new business model that proved so profitable that even companies funded by fees also adopted this practice. Based on the gathered data, these companies generate revenue primarily by selling customized advertising. However, influencing political opinions [15, 12, 16] and behavior in general [17] become increasingly relevant.

2.1.1 Surveillance Capitalism

Zuboff [1, 2] coined the term "surveillance capitalism" for the system that of companies that apply this business model. I use this term, agreeing with her argument about the far-reaching and highly negative consequences of this business model. The problems of surveillance capitalism are not simply issues of surveillance and loss of privacy. Moreover, it is an attempt at a radical and ominous automated manipulation of behavior that is undermining sustainability, democracy, human dignity, and much more. Zuboff writes [18, p. 515]:

> For more than three centuries, industrial civilization aimed to exert control over nature for the sake of human betterment. Machines were our means of extending and overcoming the limits of the animal body so that we could accomplish this aim of domination. Only later did we begin to fathom the consequences: the Earth overwhelmed in peril as the delicate physical systems that once defined sea and sky gyrated out of control.

> Right now we are at the beginning of a new arc that I have called information civilization, and it repeats the same dangerous arrogance. The aim now is not to dominate *nature* but rather *human nature*. The focus has shifted from machines that overcome the limits of bodies to machines that modify the behavior of individuals, groups, and populations in the service of market objectives. This global installation of instrumentarian power overcomes and replaces the human inwardness that feeds the will to will and gives sustenance to our voices in the first person, incapacitating democracy at its roots.

One could read Zuboff's perspective to imply that people can be arbitrarily manipulated — Lenhart and Owens [19] summarize this as the myth that "social media is addictive and we are powerless to resist it." Doctorow [20] presents a similar critique that puts much more emphasis on individual choice and control. We could caricature extreme versions of these positions as (a) a behaviorist view that assumes people can be arbitrarily manipulated by targeted ads, carefully curated feeds of more and more provoking content, and so forth; and (b) a self-determination view — people have free will and they can simply decide for themselves whether or not to pay attention to the content. My own position is an interactional one that is analogous with the interactional stance taken by value sensitive design [21, 22] regarding technology and human values: corporate manipulation of (for example) news feeds and content doesn't rigidly determine particular responses by the users; but on the other hand, the design of the feed is certainly not neutral either. People's social practices are shaped historically by the activities they conduct, as well as by artifacts and the way these are used. Information delivered by social media sites, as with any other IT system, affects human actors in their practice context. Thus, a certain news feed does not determine an overall behavioral reaction, but, depending on the context, reading those items it may make a particular action more likely, statistically speaking.

Furthermore, I want to extend Zuboff's definition of Surveillance Capitalists to include not only corporations offering services at no cost to end users, but also corporations whose business centers on selling goods and services to end users, but who apply similar methods. The key elements that characterize these businesses are the collection of personal data in a "data exhaust" of additional information that accure as a by-product of the user's primary activity, tracking and cross-correlating this data between multiple contexts, and attempted behavioral manipulation based on this data.

Besides these two extensions, the interactional stance on the question of the degree to which people can be manipulated and the expansion of Surveillance Capitalists, I adopt Zuboff's definition of Surveillance Capitalism.

2.1.2 Surveillance Capitalism and Regulation

Even though the largest IT-companies are located in the USA, the EU plays a special role in their regulation. On the one hand, it represents a substantial sales market, and on the other hand, other countries have oriented themselves to EU legislation in the past [23]. Therefore, instead of operating different services for different markets, IT

companies have sometimes implemented the adjustments to EU consumer protection globally. The principal example of EU privacy law influencing global norms [24]is the General Data Protection Regulation (GDPR) from the European Union, which took effect in May 2018. Among the problematic consequences of IT-business models the GDPR aims to address the privacy issues. However, it is questionable whether it really meets the privacy needs of the population [25]. In addition, future legislation, such as the ePrivacy Regulation, may create loopholes [26]. Since then, however, regulatory strategies to counter the more far-reaching social consequences have also been discussed. The EU has convened an expert group for the EU Observatory on the Online Platform Economy that published their final reports in February 2021 [27]. They conclude that *the power held by platforms over individual consumers and citizens as well as over our society and democracy also deserves further scrutiny.* That is what my contributions contribute towards.

The concern about the broader societal consequences are also incorporated in the orientation of the EU Digital Markets Act (DMA) [28] and a Digital Services Act (DSA) [29], for which the final negotiations started in January 2022. Following my first publication, I contributed in a group of authors to a policy brief for the EU and the G20 group [30]. In it, we emphasised the business model as the root cause and argued in favor of regulatory sandboxes, digital ad revenue tax, reducing accumulation of data to technical necessity only, and adapting procedures and ethics from human subjects research. Furthermore, in the second paper (see 5.3.1) I advocate to compel interoperability regulatorily, for which in his recent book *How to Destroy Surveillance Capitalism*, [31] uses the term "adversarial interoperability". And indeed the negotiations of the Digital Services Act, suggest to oblige interoperability on the part of the market leaders [29]. The outcomes of this regulatory response remain to be seen, but these actions on the regulatory side indicate that my contributions meet an urgency by providing academic foundation for e.g. the DSA and DMA.

For a solution to the problems of surveillance capitalism, regulation is only one aspect, another are technological alternatives.

2.1.3 A Technological Alternative to Surveillance Capitalism

Clearly, the problem is manifested in how people interact with technology and is therefore subject of research, among others, in the field of HCI. There is no shortage in HCI research on social media and other IT services, yet from the surface of the interaction it is hard to see the economic interests that brought the design of the technology about. To the effect that in 2015 Ekbia and Nardi admonished that the *media and academic focus on exciting, innovative cultural activities tends to divert our collective attention from [...] the relationship between economy and technology* [3]. They own up to the fact that even though researchers are aware of the economic drivers behind technology, *[w]e in HCI [...] do not incorporate these understandings into our research and practice.* Since then, an awareness of the resulting problems has lead to a recent search for alternatives. The result is a progression of HCI research that Shibuya et al. [32] map onto three phases that shift their focus from user behavior (2008-2012), onto privacy and health

(2013–2016), onto design (2017–2020).

The latest phase brings possible solutions for privacy by design on the table [26]. However, as Ekbia and Nardi make the case, such solutions need to incorporate an understanding of the economic incentives of IT companies. McDonald and Forte show how even arguments for the protection of privacy and of vulnerable groups are instrumentalized by social media companies themselves in order to influence expectations of privacy and social norms in ways that favor data capitalism [4]. An aware privacy by design approach must therefore, as Wong and Mulligan argue, utilize *values- and critically-oriented design approaches to foreground social values and help define privacy problem spaces.*

But for the overwhelming part of our IT infrastructure, it seems as if any critically-oriented design approaches were corrupted by the orientation of a particular business model. Foregrounding social values therefore requires a very different orientation, like the one that is present in the peer-to-peer and open source movement as well as in the cryptocurrency scene. Within these, orientations towards software design that includes certain protections against network control and surveillance are well established [33]. Yet, there is a gap to connect the software architectures of these orientations to circumventing problems of surveillance capitalism that include but go way beyond privacy issues. In order to fill this gap, the first paper characterizes properties that would cure some problems of surveillance capitalism by a different software design, inspired by these alternative orientations.

However, if this software fulfills its purpose, it will make the dominant IT business model impossible. This leaves the obvious gap of new models of financing and governance of this software. What is still missing, to my knowledge, is a systematic overview of which alternatives for funding and controlling digital IT infrastructures could be considered for which parts of the infrastructure stack.

2.2 The Monetary System, Libra and CSAs

Bank failures and recession are intrinsic to our way of banking from the beginning. But at least since 2008 it is in an ongoing crisis. The banking sector is characterized by too-big-to-fail banks that are interconnected covertly into a highly fragile system that the global economy depends upon. The role of banks is better understood in relation to the economic system, the financial system and the monetary system. Although many people use the words interchangeably it is useful to distinguish between them and conceptualize them as being stacked on top of each other.

2.2.1 Economic, Financial and Monetary System

As the monetary system, at the bottom, I understand the currencies that exist, how they are issued and redeemed, how they are controlled and how they interact with each other – today largely a matter of (central) banks. The financial system builds onto it and consists of the institutions that use those currencies to finance long-term projects – to a large extent private banks. The economic system is the system of all the businesses

that operate with actual goods and services and use financial and monetary systems for everyday settlements.

The unsustainability of the economic system has an origin in the financial system: The type of investments that are financed are increasingly destroying vital ecosystems and driving species extinction [34, 35, 36]. This financing takes place through the granting of loans, a process in which credit money is created (see 2.2.2). This process therefore touches the core of the monetary system. Accordingly, scholars trace back the growth obligation of the economic system back to the monetary system [37]. Proposals for reform and innovation exist at all three levels. But since the monetary system can be understood as the root in this sense, it is of particular interest.

The unsustainability that is thus baked into the economic system, but also the disproportionate power that banks have through their role in it, has lead to a flourishing of proposals that address the monetary system. It has also lead to the invention of cryptocurrencies; the genesis block of Bitcoin included the text of a headline from that day: *"The Times 03/Jan/2009 Chancellor on brink of second bailout for banks."* This section will provide an overview over the state of the monetary system and the range of attempted currency innovations, in a way that is as brief as possible for this vast topic.

2.2.2 Our Conventional Monetary System

What money really is, is highly contested in economic theory. Different schools of economics do have their view on how to deal with money, regardless of its definition. To capture this controversy, I will characterize money according to five divides in economic theory in section 6.2.1.

Usually economic textbooks define money in terms of its functions [38, p. 266-269]. Those are, a medium of exchange, a store of value and a unit of account. However, there are many things that could fulfill these functions and are commonly not considered money. The defining aspect is, what people use as money. Furthermore, this functional definition shifts the focus away from the actual structure of the monetary system. But it is this structure that must be considered in order to understand what the case studies are attempting to innovate. Therefore, I will in the following describe the monetary system in terms of its structure.

Today all developed nations have adopted roughly the same monetary system that itself consists of two layers. The first layer is central bank money. It is issued by the central bank and citizens can only hold it in form of cash. Banks and financial institutions can have an account at the central bank on which they hold digital central bank money. The second layer is private bank money. It is issued by licensed and regulated commercial banks. E.g. every time a bank gives a loan, it issues private bank money that is formally a claim on central bank money which the account holder has against his bank [39, 40].

In terms of the monetary supply, the biggest part exists in form of bank deposits on private banks, which is to say on the second layer. When customers withdraw their deposits in form of cash, their bank redeems this commercial bank money and needs to expend central bank money. This process of invoking the claim, which is a conversion

from the customer's point of view, destroys the previously issued commercial bank money and is therefore a reduction in the monetary supply. Instead of withdrawing money, customers can also spend central bank money by transacting it to a customer of another bank. In that case, the commercial bank money of the sender is redeemed while an equal amount of money is issued on the receivers account by its bank; the monetary supply remains unchanged. Yet, in order to credit the receiving customer, its bank wants to be paid in an equal amount of central bank money. So in both cases of a customer invoking their claim (commercial bank money e.g. in the form of bank deposits) its bank must pay an equal amount of central bank money (though most of these inter-bank payments balance each other off in a clearing process).

However, banks do not hold central bank reserves for a 100% backing of the commercial bank money they issued. This causes problems, when customers want to spend too much deposits. Even though, from the perspective of a single bank, this threat limits the amount of money it can issue, the private banking sector as a whole would only have to worry if customers were excessively withdrawing their money in the form of cash. There also can be a limiting minimal reserve requirement, but its ratios vary between 10% and zero. In practice, therefore, the limiting factor for money creation by the private banking sector is not so much the amount of central bank money, but rather the willingness of the public to take loans.

In this way the biggest part of the monetary supply is issued by private banks, while central banks use key interest rates as one monetary policy instrument officially trying to ensure the currency's stability in value. However, since the financial crisis of 2008 central banks have successively expanded their repertoire of measures to prevent a collapse of the banking system. For example, they directly affect the stock of money by tools like Quantitative Easing. However, according to the Bank of England and the European Central Bank, these tools are reserved for unusual times [39].

The infrastructure of our conventional monetary system therefore, apart from coins and paper notes, is at its core an interconnected collection of balance sheets, which are predominantly recorded digitally in financial institutions.

Legally this system is underpinned by the state which defines central bank money as the legal tender. Usually the second layer of commercial bank money is not legal tender itself, but a legal claim on it. Not least due to this connection, commercial bank money is usually also accepted as a means of payment by government agencies. In the Euro system the national banks have delegated their privilege to create the legal tender and their mandate for monetary policy to the European Central Bank [41]. Nevertheless, in the Euro and the Dollar case the amount of central bank money that could be created is theoretically unbounded. Therefore, the reserves that fractionally back private bank deposits are themselves only paper currencies without any scarcity anchor.

2.2.3 Currency Innovation

Complementary Currencies

From different angles of critique many initiatives have created currencies that aim to complement the shortcomings of the conventional monetary system. They realize that money is a social tool that can be designed to fit a purpose. It is essential for their relative success to find a group of users that transact with each other on a regular basis.

Therefore these initiatives usually target a local group of people and thus their currencies can be characterized as local community currencies. Examples are the WIR [42], the Brixton Pound [43], the Chiemgauer [44], or the Bangla Pesa [45]. While all of them put a different emphasis, such as on an interest free credit creation or on negative interest on cash, they share in common a focus on the local usability that aims to keep the money circulating locally and prevent it from drifting away to big companies. Often they are merely tolerated by the national banks and could be expected to be forbidden, if they would gain relevance on a bigger scale. Furthermore, they generally neither have the ambition nor the capacity to do so.

Examples for currencies with a global focus, suffer from the need of a global community of people transacting with each other on a regular basis. The cryptocurrency scene is a rare example, where such a community was created along with the proliferation of cryptocurrencies. We will discuss them in detail below (see 2.3.5). Of the monetary case studies in this thesis, one has a local and the other a global focus.

Central Bank Digital Currencies

Another category of currency innovation is coming from a different direction. In recent years the idea of central bank digital currencies (CBDCs) gained some traction [46]. As mentioned above, central banks already maintain accounts where the registered commercial banks digitally store their reserves, this is not what the term CBDC stands for. Instead the term stands for central bank money that is issued in another digital form and that can be used by a broader audience. There are different takes on CBDCs.

One model of how a CBDC could be implemented is to allow citizens to hold central bank money in digital form. This approach transfers cash into the digital age and can be seen as central banks catching up in the digitalization of the monetary system. One strain in the controversy regarding this approach is, that it paves the way for central banks to abandon cash. The abandoning of cash would enable the expasion of a negative interest rate onto all central bank money. The discussion is particularly relevant, since CBDCs by default would not preserve the anonymity aspect of cash. Criticism of this approach is that if too many people prefer this way of holding money to bank deposits, the banking system could be destabilized (see [46]). Therefore, ceilings on CBDC holding are also under discussion. This requires central bank to know the identities of their account holders. In particular this measure is incompatible with anonymity. Complete anonymity is a feature of cash that can hardly be preserved for digital currencies, since any digital payment needs to leave some trace in order to be verifiable at all. However, Zcash comes arguably close to the ideal of cash utilizing so-called zero knowledge proofs

[47].

Another approach is for central banks to provide CBDCs only to larger companies. Such a version is called a wholesale CBDC, as opposed to the previous approach, which would be called a retail CBDC [48].

For the infrastructure to implement a CBDC Distrubuted Ledger Technology (see 2.3) is often discussed, due to the protection against surveillance and centralized control that decentralization might offer. CBDCs can be implemented with or without such technology. However, the existence of cryptocurrencies as competitors fuels the development and central banks consider catching up with not only digitalization.

The farthest ahead on the foray of implementing a CBDC are probably Sweden and China. In February 2020 the Swedish central bank launched a pilot program for the CBDC E-Krona [49]. In April 2020, the Chinese central bank launched the pilot program for the e-CNY, which has since been expanded. It refrained from ther their initial announcement in 2019 [50, 51] to use blockchain technology.

Private Currency Innovation: Libra

This state of the affairs suggests that there is a potential for new currencies and the popularity of cryptocurrencies (see 2.3). The fact, that Facebook invested heavily into a currency project support this assertion: In June 2019 *Libra* was announced and afterwards intensively discussed in politics and media as a cryptocurrency that was developed by a dominant social media company and carried by an association of renown enterprises. The heated discussion however mostly focuses on the justified privacy concerns [52], or demands that the issuance of money stays under central bank control [53]. Although the degree to which it actually is under central bank control today is questionable (see 2.2.2). In January 2022, it was reported that Facebook is shuttering the project [9].

It can be expected that over the next years other non-central-bank actors will follow in the attempt to establish future currency systems and the Libra discussion can be developed into a precedential case. An attempt to launch a currency that is not issued by a central bank (or e.g. the IWF) but a private company and that is invested in on such a scale is unprecedented. This fact alone is reason enough to investigate this currency innovation from an academic point of view, despite its eventual failure. As this section showed, there are various areas of research that add important perspectives to the Libra project, proving it not just to be a minor technological utility.

However, I suggest that the insights of this case study suit particularly well into a line of sustainable HCI research on new forms of currencies [54], including peer-to-peer value exchange [55], cryptocurrencies [56, 57, 58], time banking [59] and more. Based on the case of the Bristol Pound, Perry et al. focus on, what they call moneywork, the interactional work around the use of money [60]. Their research yields design implications around practice that, as they suggest, extend across a variety of potential forms of digital money and payment technologies. They acknowledge the *limits to which generalization can be made, and that the moral, ethical, and social agenda of the Bristol Pound CIC is likely to provide a different set of use concerns to those of other forms of digital money.* They see cryptocurrencies as an extreme example that could be contrasted with this;

the Libra case did not exist at the time.

2.2.4 Sustainable Agriculture

What sustainable agriculture activists believe is described by Naomi Klein as "What the climate needs to avoid collapse is a contraction in humanity's use of resources; what our economic model demands to avoid collapse is unfettered expansion. Only one of these sets of rules can be changed, and it's not the laws of nature." Whereas there is general agreement in science about the first part of the statement (e.g. the Club of Rome reports), strangely mainstream economics is partly in denial about the second [61]. The second case study is about a community that attempts to emancipate from this growth obligation and the logic of consumerism. In accordance to the characterization that the monetary system plays a causal role, this case study involves a currency innovation in support of this emancipation. This community stems from a movement of so-called Community Supported Agricultures (CSAs).

Community-Supported-Agriculture

Community Supported Agriculture is an organizational form that represents an alternative to traditional companies. There is no uniform set of rules that define nor protect the term CSA, but the most characteristic feature is the mutual commitment between producers and consumers. A group of consumers unites and pays for the entire costs of a farm for the coming year. In return, the farm commits to providing the consumer community with healthy food to the best of their ability. The farm is thus secured and the community steps in the role of shareholders of the food the farm produces. This business structure aims to free the farm from market based pressure and constraints [62].

Although CSAs are an alternative form of business, they are usually also associated with other aspects of non-conventional agriculture. This is because CSAs grew out of a movement, whose ideas can be traced back to the German philosopher Rudolf Steiner. For example, this movement values practices of biodynamic agriculture and the ideal of food sovereignty [63]. Furthermore, the transformative character in regard to the agricultural sector, also involves an increased resilience, due to the shortening of supply chains [64, 65]. There exists (limited) economic research [66, 67], ethnography [68] and consumer sociology [69] on CSAs.

However, CSAs have themselves been confronted with difficulties. Notably, in attempting to provide alternatives to market mechanisms they sometimes reintroduce problems that were usually solved by traditional market exchange mechanisms. In particular matching their produce with their members wishes under the constraints of local and sustainable agricultural production is a challenging task. Most CSAs distribute their produce equally among the shares. Thereby, they can neither satisfy individual preferences, nor do they have a feedback mechanism for adapting to average preferences. Furthermore, forms of flexible product cooperation between CSAs become complicated. We suggest that this search for a new mechanisms to exchange (within and between CSAs) offers a design opportunity for sustainable HCI research. For the challenges of

internal exchange a CSA in Germany has found a solution that involves a currency innovation.

Sustainable HCI

For more than a decade, research on sustainability issues has been conducted within HCI establishing the subfield of sustainable human computer interaction (S-HCI). DiSalvo, Sengers, and Brynjarsdóttir [70] first *mapped the landscape* of S-HCI into genres. However, there is developing concern about the lack of agreement on what sustainability means and how S-HCI as a community can actively contribute to a change towards more sustainability [71, 72]. The fragmentation of S-HCI can be understood as follows. Within S-HCI an approach has dominated that considers a rationally acting consumer and thereby confirms a neoliberal world view [73, 74]. Consequently, contributions aimed to influence and nudge people to sustainable consumption by persuasive design. Meanwhile, voices that critically question the long-term effect of these contributions emphasize a different point of view (e.g. [75, 76]): This is constituted in research that examines practices, i.e. everyday routines in which people, meanings, materials and competences are gathered [77] to support sustainability. In their Grand Challenge to HCI, Norton et al. [78] argue that *the paradigms and practices of HCI risk perpetuating the shortcomings of food systems.*

Weber et al. [79] argue that what is needed is a deep change, by which they understand a *systematic societal change, entailing fundamental change in social norms and values, institutions and behaviors, practices and technologies that together produce the functions, structure and identity of the food system.* The second case study (7) combines at least two of Weber's five approaches, namely sustainable agriculture (e.g. [80]) and grassroots food production (e.g. [81, 82]).

But how can people, in the words of Norton et al. [78], *enable food sovereignty, push for new policies and reconfigure the power and trust relationships in food systems*? Hirsch et al. [73, 74] conclude *Given their vulnerability to environmental change, their complicity in creating environmental threats, and the fact that most of the world's population depends on their labor for its sustenance, one may well argue that small-scale food producers should be at the center of any serious sustainability movement, including the one forming within the HCI community.* On CSAs, however, there is relatively little research within S-HCI yet [83, 84, 85].

Agriculture and Money

When Norton et al. [86] investigated permaculture communities in the United States, one of the findings was that participants *framed modern financial systems as the culprit, believing that an overhaul of the financial sectors away from extractivism and consumerism is fundamentally necessary to address local and global ecological crises.*

In this regard, Hewitt [87] identifies "Slow Money" as the most important movement connecting money and agriculture. For the CSA example in this thesis, the Kulturland

Genossenschaft[1] represents a very similar idea. These approach sustainable agriculture on the financial layer.

A distinctive feature of this case study, however, is that its currency innovation even permeates the underlying monetary layer. There is even an ambition to further develop the currency and make it available to other CSAs, which is endeavored by the Terrafina project [88]. This suggests, that the case study fits in a research gap, at the intersection of sustainable HCI, agriculture and money.

2.3 Distributed Ledger Technology

The third motif that is of cross cutting interest throughout this thesis is the potential role of *Distributed Ledger Technology* (DLT). To this end, this chapter lays the groundwork on which the assessments of the potential for DLT in the different areas is based upon. The term DLT is describing a class of technologies which solve a certain problem. A *blockchain* is the paramount example of DLT and the Bitcoin blockchain is its first implementation.

This section starts with what could be called a state of the technology. This extensive part (2.3.1 to 2.3.4) chooses the technical depth I consider necessary to understand the architecture of a blockchain and the fundamental problems inherent in it. Unconventional for a state of the art section, I develop this part myself mostly from primary sources, namely the publicly available technical documents of mostly Bitcoin and Ethereum. This unusual step lends itself to the fact that in this area, whitepapers and accompanying material make the essential technical information public, allowing for the most undistorted analysis of the technology. In particular, this part finds that any blockchain approach inherits a scaling problem. Secondly, any blockchain that uses the same consensus mechanism as Bitcoin is prone to the same energy problem. Furthermore, this part gives an outlook on how these fundamental problems are currently trying to be fixed and how they could be circumvented completely.

That assessment is followed by the actual state of the art for Distributed Ledger Technology. 2.3.5 and 2.3.6 make the connection between DLT and the areas of the two case studies 6 and 7 respectively. Finally, 2.3.7 attests how HCI and CSCW have taken note of DLT this far. It closes by pointing out the research gaps that the respective parts of this thesis address.

2.3.1 Blockchain

In 2009 a Whitepaper was published about a protocol for a decentralized cryptographically secured digital currency - Bitcoin. Bitcoin describes itself as

> an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party [89].

[1] https://www.kulturland.de/

The protocol that the Bitcoin whitepaper suggests is called *blockchain* and it let technologists and business people (e.g. the World Economic Forum and pwC [90]) but also academic scholars envision applications beyond payment in all areas of economy [91], politics [92] and much more [93].

But what exactly is the problem that apparently exists in all of these areas and that a blockchain supposedly states a solution to?

The General Problem that DLT Solves

According to the Bitcoin protocol, all the *willing parties* that transact with each other form a decentralized network. The purpose of this network is to record the transactions — in other words a database. Yet, with the distinctive difference that the parties *transact directly with each other* — a peer-to-peer network. Thus, the general problem for which blockchains provide a solution can be described as trying to construct a database on a peer-to-peer network (with enough data integrity that the information in it can be trusted). A blockchain is not the only possible approach to this. All protocols that attempt to solve this problem are summarized under the term *Distributed Ledger Technology* (DLT).

Each member of the decentralized network should be equally able to add data to the ledger, but at the same time a certain integrity of the data should be ensured (what is meant by this will be clarified in the following using the example of Bitcoin). Instead of only being stored on a central server, this ledger should be stored by the members. But changes to the ledger do not instantaneously reach every other member. If conflicting changes propagate through different parts of the network, it needs a mechanism to resolve this conflict. So the problem is how to agree on the current version — a single truth. With a central server, the problem would not arise; the true version is the one stored in the one central location, changes are incorporated at the time they arrive there. For a distributed ledger, however, this is a serious problem.

The way a blockchain solves this problem, each (full) member of the network stores a complete copy of this data. The blockchain's protocol simply governs the exchange of how members come to a consensus on which version is the correct and latest one. The protocol is designed to provide protection against individual members attempting to manipulate the data in their own interests. Specifically, a blockchain allows members to add (legitimate) data, but it is not allowed to delete data. For applications such as cryptocurrencies, this data are legitimate transactions in the corresponding currency. Account balances then uniquely follow from all transactions made. So legitimate in this case means that users only write outgoing transactions to the blockchain from one of their accounts with sufficient funds. They cannot delete or change transactions that have already been executed, or even add transactions in someone else's name, as this would be tantamount to manipulating the account balances. In this sense, therefore, a data integrity is established; a blockchain is more than a decentralized file storage system.

To avoid having to find a new consensus for every change, the data of a blockchain are gathered and combined into data blocks, which are then linked to form a chain — hence the name blockchain. Furthermore, as we will later see, the chain structure makes it fast

to check whether versions coincide and spot if the data has been tempered with. When new data is added, it is done by adding a new block at the end of the chain. Which block this is is determined by the consensus protocol.

Hash Functions and Proof of Work

Like Bitcoin, most cryptocurrencies use *Proof of Work* [89, p.3] as a consensus protocol. The basic idea is that in order to create a new block, one has to prove to have expended a certain amount of energy — this is the proof of work. A central role in it is played by a so-called hash function. Hash functions are mathematical functions whose properties make them suitable for many applications, also outside of Proof of Work. Hash functions receive arbitrary data as input and deliver a (in the case of Bitcoin) 256-bit number as output (the so-called hash of the input data). The relevant property here is that there is no effective way to choose input data so that the output number is particularly small (let alone a certain number). Indeed, no method exists that is more efficient than simply guessing with arbitrary data as input.

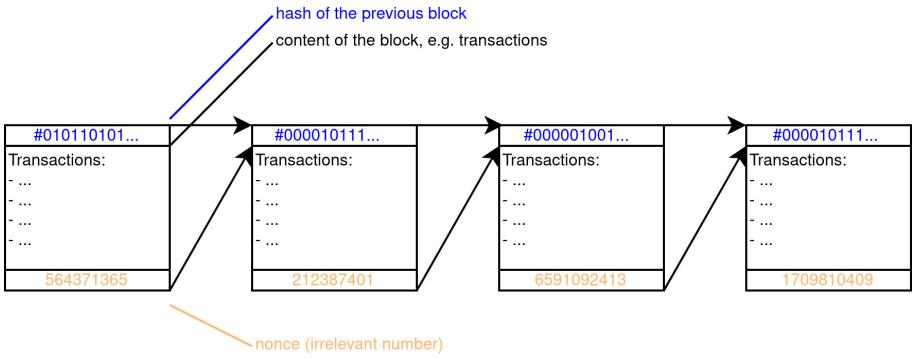

Figure 2.1: Illustration of a blockchain

The trick of Proof of Work is to only recognize blocks as valid whose hash is very small. A valid block can thus only be found in an energy-consuming way by computers that guess very often. For each guess, they slightly change the block that is given as an input in a way that is irrelevant to the actual information contained in it. This is repeated until the output hash happens to be small enough. As a result, one can assume that a lot of computing power (and thus energy) must have been expended to find a block of this form. The consensus mechanism states that the valid chain of such blocks is the one for which (in the expectation value) the most computation power, and thus energy, must have been expended. (The bitcoin whitepaper suggested it to be the longest chain, but roughly speaking the chain with the most energy spent into it is the longest chain.)

We now look at, what this means for the process by which the blockchain is progressively updated. For simplicity, we pretend that at a fixed point in time all members of the Bitcoin network have the same version of the blockchain. Now a member wants to add a new block. To do so, it first collects transactions via the Bitcoin network that are

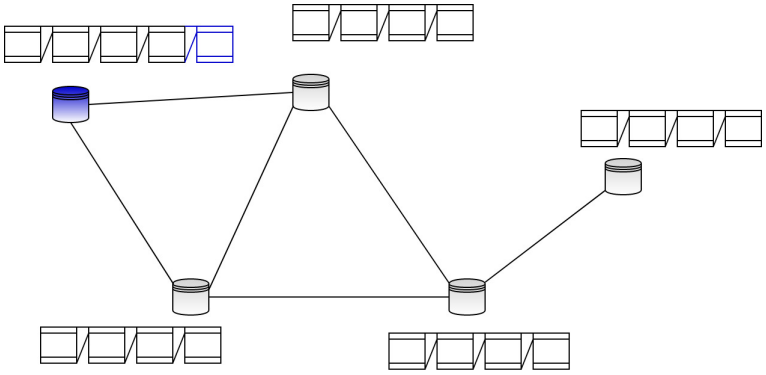

Figure 2.2: Illustration of a blockchain network
The blue node found a new block (i.e. a nonce so that the block hash is small enough).

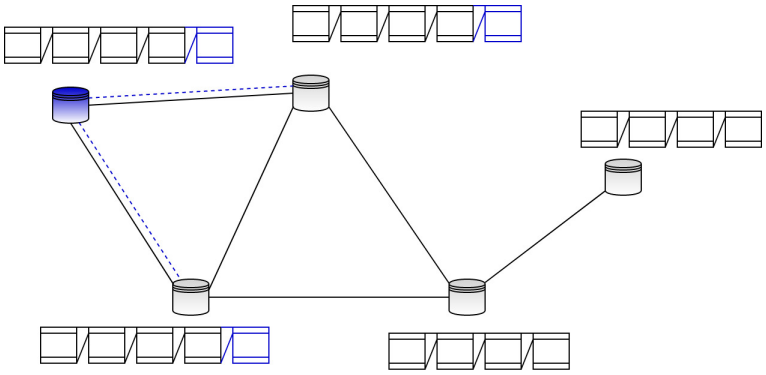

Figure 2.3: Illustration of a blockchain network
The adjacent nodes update by adding the new block (blue). Next, they communicate this update further. They stop attempting to mine at the old position and switch to the newly extended blockchain.

requested to be added to the blockchain. In addition to these transactions (more precisely, the root hash of the Merkle-tree of these transactions), the block also contains the hash of the last block of the blockchain and a so-called *nonce*, the irrelevant information that is changed with each guess attempt. Then it calculates the hash of this block and checks if it is small enough to be considered a legal block. In case it is not, the member tries another block. Therefore, it uses the same data, but to get a different hash changes only the nonce. This is repeated until either the hash is small enough, or it hears from another member that they were faster in finding a legal block. Then the blockchain is updated with the new block and this update is communicated through the network, the transactions in it are considered recorded. The members who now learn about a new block can now check by recalculating the hash of this block themselves. Since it is very small, they can estimate that a lot of guesses must have been made and therefore a lot of energy must have been spent to find this block. To do so, they do not have to believe any authority certifying the use of this energy, nor do they have to repeat the entire calculation.

This process of finding a block of this form is called *mining*. Since mining contributes to the continuation of the blockchain, miners are rewarded with both newly created currency (the *block reward* or *subsidy*) and the transaction fees of the transactions in this block. However, the difficulty of "mining" a valid block (how small the hash has to be), increases the more computing power is spent globally on mining. This is done in a way that ensures that a relatively even block production is achieved. For Bitcoin, this is set at an average of one block every 10 minutes.

The transaction fees are set by the sender of a transaction and can be understood as a bid, since the miners by default include those transactions that offer the highest fees into their block. In contrast the block reward is algorithmically predetermined. The bitcoin whitepaper only considered constant rewards up to some point in time and suggested that *once a predetermined number of coins have entered circulation, the incentive can transition entirely to transaction fees and be completely inflation free* [89, p.4]. (Inflation is here not understood in terms of the buying power in reference to any goods, but in terms of expansion of the Bitcoin supply.) However, the Bitcoin protocol that was developed, adopted a model, where the block rewards halved periodically. In this way the Bitcoin supply increases according to a geometric sum, that is capped at roughly 21 million Bitcoin [94].

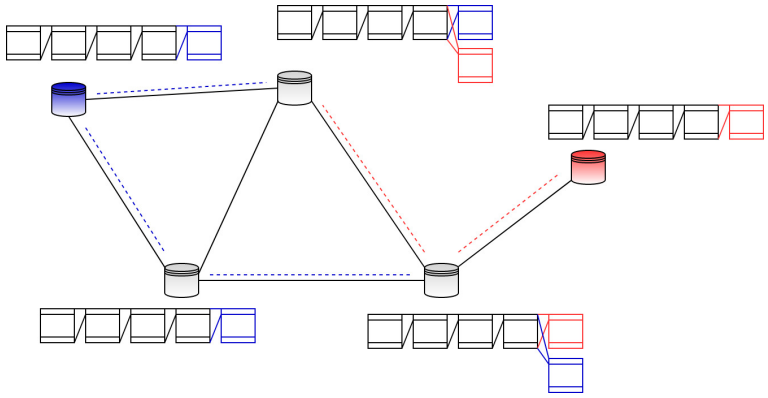

Figure 2.4: Illustration of a blockchain network
Two nodes (blue and red) found concurrent new blocks. All nodes need to come to a consensus about which version to continue.

But how does mining contribute to the security against manipulation? In order to understand this, one needs to consider what happens, if two concurrent blockchain extensions are found in different parts of the network. Nodes will receive both of them and will have different perspectives on which one came first, thus they need a different criterion to resolve the conflict and decide upon one chain. That is why the criterion is the amount of computing power that went into the mining of the blocks, which can be estimated from the smallness of the involved hashes. Regarding this criterion, all nodes will come to the same conclusion. Nodes will continue mining on the chain with the highest expenditure of computing power, to have the best chances of their block being inherited by the rest of the network. They have an incentive to do so, because they want

the blocks in which they receive a mining reward (which is to say the blocks that they mined), to be inherited in the chain that the network is coming to a consensus about. The reality that the nodes are behaving that way is itself the reason, why the network stabilizes on the same chain, that is continually extended.

Consequently, for a manipulation attempt, one would have to do the following. First, one needs to take the current version of the blockchain and change relevant data in a block. This changes the hash of this block. Therefore, the computing power must be expended again to bring the block into a form that the hash is small enough. Second, to convince the rest of the network, the manipulated blockchain also needs to be longer (or have more computing power spent into it) than the current version. However, the way in which the blocks are linked to form a chain is, that the following block contains the hash of the previous one as a data point. Therefore, the following block would also need to be changed, and so on. The situation is similar to what is illustrated in figure 2.4, only that the blue and red versions have a chain of concurrent blocks, not just one. *To modify a past block, an attacker would have to redo the proof-of-work of the block and all blocks after it and then catch up with and surpass the work of the honest nodes* [89, p.3]. Thus the manipulator would have to expend an amount of computational power equal to how much the mining network has spent and then still overtake it in further block production. In other words, it would take more mining power than the entire rest of the network has expended since the targeted block was created. In particular, therefore, transactions become more secure the longer they are in the past.

Such a manipulation is called a 51% attack, since more than half of the computing power of all miners would need to be combined in order to perform it. In this sense, the amount of power used by miners is exactly what makes the blockchain secure. However, as profiteers of Bitcoin, miners have no interest in such an attack at all. How much energy is spent on mining is not based on fending off a realistic attack anyway, but on the financial incentives for mining, which depend largely on the Bitcoin price (more on this below).

From a monetary perspective, it should be noted that the required energy limits the creation of the coins, but the coins cannot be destroyed by miners to get the energy back. Therefore, it would be misleading to say that Bitcoins are "backed" by the required energy.

Smart Contracts

Like many things the whitepaper did not provide for, Bitcoin has implemented a scripting language. Instead of sending bitcoin directly to the address to which another user has access, a script allows bitcoins to be sent with a list of instructions describing how the next person who wants to spend the bitcoins transferred will gain access to them. Such programmable transactions enable a variety of applications in payment and finance that do not rely on the trust in a bank, escrow or other entity. However, the scope of what is expressible in such a scripting language is limited [95].

A leap in the programmability of cryptocurrencies was the launch of Ethereum in 2015, that implemented the most noteworthy feature of so called *Smart Contracts*. As

the Ethereum whitepaper puts it: *Smart contracts, cryptographic "boxes" that contain value and only unlock it if certain conditions are met, can also be built on top of our platform, with vastly more power than that offered by Bitcoin scripting because of the added powers of Turing-completeness, value-awareness, blockchain-awareness and state* [96]. Without going into the details, what these features mean, they are the reason why Ethereum became the dominant blockchain for a variety of so called *tokens*. Like cryptocurrencies, tokens are digital objects that can be moved between addresses according to preprogrammed rules. But unlike cryptocurrencies, tokens do not have their own blockchain (that depends on them). For tokens that depend on the Ethereum blockchain there are many different token standards, like the widely spread ERC-20 standard for fungible tokens (or ERC-721 and ERC-1155 standard that are used for non-fungible tokens in the arts market).

Yet, this is but one example of the possible applications of the blockchain as a distributed ledger. The takeaway is that, whereas Bitcoin applied this ledger as merely recording the transactions of the currency, Ethereum used it in addition as a decentralized data storage for program code. For this reason it is sometimes considered as a generalized computer and the first of a new generation of technology under the name of *Blockchain 2.0* [97]. That this programmability is a key feature is also shown by the case of Libra (see 2.2). Not only is Ethereum's smart contract approach the model for Libra [98], but it is also what enables the currency to be more strongly interoperable with the technology sector.

2.3.2 The Energy Problem

A fundamental problem of Proof of Work blockchains is the immense consumption of energy and computing power. The principle of Proof of Work, described above, can be summarized as: To retroactively manipulate an entry, one would have to expend more energy than all other miners combined. In this sense, the high energy consumption is exactly what makes the blockchain secure. And the miners compete in spending that energy. As a consequence, the direct energy consumption of the Bitcoin blockchain alone is in the order of magnitude of entire countries (such as Switzerland) [99]. Add to this the energy and resources used on the production of the mining hardware. Large server farms are build at places, where energy is cheap, in particular next to power plants that run on fossil fuels [100]. This tragedy is currently unfolding in oil rich states [99]. That is an ecological disaster pushed to the peak of absurdity, considering that mining is a competition to burn energy. The problem of energy and resource wastefulness is a consequence of the Proof of Work consensus mechanism.

The miners incentives

This subsection explains how the incentive structure that results from Proof of Work achieves this high energy consumption which the security is based upon. In particular an increasing energy consumption and is caused (among others) by an increasing Bitcoin price.

The incentive for miners are determined by their mining hardware, by how many blocks they can be expected to mine with it and by how much the rewards for doing so can be sold on the market. Specifically, a miner's revenue (in $ per second) equals the product of the following factors:

- Computing power (in hashes per second),
- The inverse of the difficulty to find a valid block (interpreted in blocks per hash),
- (Mining reward + transaction fees) per block (in unit of cryptocurrency per block),
- Price of the cryptocurrency (in $ per unit of cryptocurrency).

Out of these factors, only the first one comes at a cost: The computing power is what the miner invests in. The second one is the difficulty that is determined by how much computing power is spent on mining globally. The block reward is set in the agreed upon protocol of the currency. Transaction fees and Price of the currency are given by the market.

In particular, this means that a rising price of the cryptocurrency makes mining more profitable. This attracts new investments into mining. The additional energy and computing power invested increase the difficulty for mining (to counteract too fast block production). Thus, the second factor decreases. This happens until further investments become unprofitable. The size of the mining network has adjusted to the increased bitcoin price. Similarly, if the bitcoin price drops so much that, for miners, the revenue generated no longer covers the operating costs of the mining hardware, the mining network would shrink.

That is the incentive structure, by which an increasing price of the cryptocurrency causes an increasing waste of resources.

From this calculation, however, it can also be concluded that with each halving of the block rewards (see above), mining becomes less profitable and thus counteracts the increasing energy consumption. Likewise is the impact of transaction fees. It is (at least in the short term) in the miners' interest when transaction fees increase (e.g. due to the scalability problem, which will be discussed below). In particular, even without block rewards if transaction fees are high enough, miners would be incentivized to waste an enormous amount of energy.

Inadequacy of Proof of Work

It has now become apparent that the energy-consuming part of the Bitcoin infrastructure is not the communication and verification of transactions. Instead, it is the way the proof of work provides a certain security against tempering of data in the blockchain.

But even if one considers the idea of making a blockchain secure by the amount of energy spent into it to be reasonable, the actual energy consumption of the blockchain is not based on how much energy attackers are realistically expected to expend. As explained above, it is determined by (as one factor) the Bitcoin price and transaction fees. Therefore it is (in terms of security) unreasonably high.

The necessary size and energy expenditure to make the Bitcoin blockchain secure against realistic 51%-attacks would be orders of magnitude smaller. Realistically required expenditure is not a fixed value, since it depends on the mining power in the world and the incentives of their owners. However, if someone was able to gather enough mining power to perform such an attack, he would not want to execute it. First of all, the fact that such an attack happened would be easily detectable by the network. And secondly, this would destroy the integrity of the Bitcoin system. The Bitcoin price can be expected to plummet which would make both any possibly attained Bitcoin and the mining hardware almost worthless. This is another point in favor of the fact that the amount of energy that would be required for tamper resistance would be much lower.

One might also be tempted to consider all the investments in mining a positive development, since the mining network in a certain sense provides the hardware infrastructure of the blockchain. However, these investments do not increase the blockchains capacity, they only unnecessarily increase its security (in the above sense). But very much so, it also increases the overall energy consumption of the mining network.

In short, the extreme energy (and resource) expenditure originates from the Consensus Mechanism that is supposed to make it secure, but it is uncoupled from and excesses the real security needs of a blockchain. Furthermore, attaining security by competing in the waste of energy is not a sustainable model in the first place, especially given that there are better alternatives.

Other Consensus Algorithms

The energy problem is a result of the Proof of Work consensus mechanism. A solution therefore is using another consensus mechanism. The most widely discussed alternative is called Proof of Stake [101]. In Proof of Stake, mining is replaced by so-called *minting*, which works as follows. Members are able to stake an amount in the cryptocurrency they hold, like a security deposit. The right to determine the next block is then randomly given away among members. The probabilities of winning are proportional to the amount deposited. Just as in PoW-mining, those who mint a block receive a block reward as well as the transaction fees. If they have abided by the rules of the blockchain, all members then receive their deposited stakes back.

The attack, discussed above, that required 51% of the mining power translates for Proof of Stake, roughly speaking, into an attack that requires 51% of the staked currency. So the rationale behind Proof of Stake is that the members who have invested a lot in the currency have a natural interest in not losing their investment. This makes them suitable maintainers of the infrastructure.

So instead of large server farms for mining, all you need to mint is a large amount of cryptocurrency. As a result, the energy problem does not arise in the first place. The energy consumption and hardware requirements for maintaining the network is negligible compared to that of PoW-mining. Since the expected income members receive from minting is proportional to the amount of currency held, it can be compared to interest payments. Since minters do not have large expenses for power costs and Proof of Stake redistributes currency from users to minters through a) transaction fees and b) the

changes in purchasing power due to the newly minted block rewards, it can be expected to have an accumulating effect on the distribution of the currency. The large inequality in wealth distribution already seen with Bitcoin can be expected to be more directly amplified by Proof of Stake. Even though the protocol is decentralized, it expectedly has a certain centralizing effect at the distribution level through the concentration of wealth.

However, it should be noted that the wealth distribution for a cryptocurrency is to be interpreted differently than for national currencies: Most people have their lives mediated through national currencies, while presumably no one through cryptocurrencies, which are mostly used as gambling tokens.

It is worth noting that the consensus methods discussed are procedures for finding consensus on data which only work through the financial incentive that the associated cryptocurrency offers. The participants have an interest in reaching agreement by incentives that are set in monetary terms. Therefore they only work together with a native currency. For example, the Ethereum blockchain (although its standout feature is that it uses the blockchain for program code, rather than just currency transactions) would not work without Ether as a currency. A blockchain without a native cryptocurrency would need a completely different consensus procedure.

2.3.3 The Scaling Problem

The second fundamental problem of the Bitcoin approach is scalability. *Scalability* describes the ability to function even with a significant change in size. The scalability of a blockchain therefore refers to remaining functional even with many active users. However, since the blockchain approach, as explained above (see 2.3.1), involves storing the (transactional) data of all members with everyone, many users would be a problem. Member storage capacity would quickly be overloaded. Likewise, members' bandwidth would quickly be exhausted when trying to communicate updating this data among themselves. For this reason, public blockchains typically use a limited block size. For Bitcoin, this block size is 1MB and there has been a long debate within the Bitcoin community to change this [102] (Even though the Bitcoin whitepaper did not include a block size limitation [89]). On the one hand, this limitation ensures that the requirements for storage space and bandwidth of the members (full nodes) do not become too difficult, but on the other hand, it also causes the capacities of the blockchain to have an absolute limit. Thus, the blockchain becomes less and less suitable the more members want to store their data (e.g. transactions) there.

I will now discuss attempts to solve the scaling problem, categorized by which part of the protocol they address.

Layer 1 Solutions

An often discussed approach in order to increase the capacity of a blockchain is to simply change certain parameters, such as increasing the block size or block frequency. To the extent that these parameters are used to increase the capacity of a blockchain, the

technical requirements for the full nodes that keep a full version of the blockchain up-to-date also increase. If these requirements can no longer be met by common computers, this role can only be filled by a few highly invested members of the network. However, this contradicts the idea of decentralization. Thus, the choice of these parameters is more a trade-off between capacity and decentralization. Changing such parameters is therefore not a solution to the scalability problem.

From a technical perspective, this tradeoff can be described as a tradeoff between the simplicity of writing to the blockchain versus reading and storing it. What is interesting here from an economic perspective is that the supply of capacity in the blockchain is fixed by the choice of technical parameters. The price of that capacity, the transaction cost, is determined solely by user demand (In particular, the blocksize that would be most favorable by the miners depends on the shape of the demand curve). Further investments in mining do not increase the supply, but merely change the distribution of who collects the transaction fees and block rewards.

A supposed solution to the scalability problem could therefore be to increase the supply by simply switching to other blockchains. One could use a separate blockchain for each separate application area (for example, for the money of each individual currency area, for the digital representation of supply chains of individual economic segments, etc.). Each member would then only be a member of one application area and would therefore only need to stay up-to-date on all the data for that area. If cross-scope interactions are to take place (e.g. an exchange between two currencies), a bridge would have to be built between these blockchains. However, this is problematic if all these blockchains were to use Bitcoin's consensus mechanism, Proof-of-Work. As explained above, a 51% attack is a possibility, but one that Bitcoin miners have no interest in. For a small blockchain, however, such a scenario would be very possible. Both the required mining power would also be low, and for such cases there could be more motives for external groups with large mining power to carry out such an attack. In other words, small PoW blockchains offer no protection against this attack.

A similar systematic approach is discussed under the term Sharding [103]. The idea with Sharding is that the large blockchain is fragmented into smaller parts. Each member only needs to stay up-to-date on one of these parts, and if a part becomes too large, it can be further subdivided. In this way, better scalability is achieved. The problem remains that each individual part is vulnerable to a 51% attack. All that would be needed for such an attack is the preponderance of mining power on that part. Therefore, the idea of Sharding is not so easily compatible with PoW consensus, at least. One further difficulty with Sharding is how to systematically split the blockchain so that as little interaction as possible is needed between the individual parts.

All these attempts are considered to be *layer 1 solutions*, since they target the layer of the blockchain itself.

Layer 2 Solutions

Another solution approach are the so-called *layer 2 solutions*. These are further systems that are not a blockchain themselves but use an existing blockchain (the first layer)

for the final settlement of payments, for example. Such systems can be constructed as peer-to-peer systems, which are decentralized but do not have the scalability problem of a blockchain, as long as it remains the exception that the underlying blockchain must be accessed.

The most well known of these second layer solutions is the lightning network of the Bitcoin blockchain [104]. This is an approach that uses so-called *state channels*. Here, a deposit is made in the corresponding cryptocurrency in a smart contract on the blockchain. The smart contract regulates how the deposit is divided between the depositor and the recipient, establishing a connection channel between these two addresses. The two parties can issue permission to each other to retain the money from the smart contract in a specific distribution. This distribution then represents the current state of the channel. In this way, many small direct transactions can take place between the two parties without having to write them to the actual blockchain, as long as the accumulated difference of these transactions is between zero and the amount of the deposit made. The trick of the Lightning network is to link several such channels, allowing transactions between members who do not know each other directly if there is an indirect connection through existing channels. This creates a decentralized payment infrastructure that only needs to access the underlying Bitcoin blockchain for final settlement.

An alternative approach is what under Ethereum is called *Plasma* [105]. In this approach a deposit is stored in a smart contract, whose owner publishes the distribution of this deposit to a list of addresses on the blockchain in regular updates. These addresses can then claim their portion of the deposit at any time and thereby effect a transaction on the blockchain. The owner of the smart contract does not have to be a centralized institution, but can also be controlled by a predetermined decentralized protocol. As like state channels, this approach enables an infrastructure that can process many payments quickly. The advantages over channels are that in order to join this structure as a member, one does not have to add new smart contracts to the blockchain first. In addition, a lower deposit is required overall. In return, however, there is a constant consumption of space on the blockchain due to the regular publication, while channels do not write to the chain at all during operation.

A third class of second layer solutions are so-called *rollups* [106]. These are procedures that compress data before loading it into the blockchain. Compressing and decompressing means a higher computing effort, but this happens off-chain and allows the capacity to be used more effectively on-chain. This can improve scalability by a certain factor, but it also does not fundamentally solve the scalability problem.

Ethereum pursues the approach of combining all these layer 2 solutions, which are already in use on a small scale, together with Sharding in order to achieve an overall size that is not arbitrary, but sufficient. Additionally, the move from PoW to PoS is intended to solve the energy problem. At the time of this writing (early 2022), these long planned upgrades are tested but not yet implemented through a hard fork. The reason for mentioning the Ethereum project, besides Bitcoin, in particular here is that it combines, to my knowledge, the most far-reaching existing advancements in public blockchain technology. They show that the fundamental problem of scalability can be significantly mitigated, but not completely solved.

The Consensus Approach as the Origin

The Ethereum whitepaper describes the origin of the scalability problem like this: *Like Bitcoin, Ethereum suffers from the flaw that every transaction needs to be processed by every node in the network* [96]. This flaw, however, is insurmountable, when the aim is to find a consensus, that every node in the network agrees upon. To establish such a consensus seems necessary because in a decentralized network, each member has a different perspective. Information about different events may reach different members in different orders. By default, there is no absolute order of events, at least not a single objectively correct one. For the implementation of money this is problematic.

Take the example of Bitcoin. In order to check whether a transaction is valid, a part of the validation procedure is checking whether the account from which the transaction originates has enough funds — that is the balance of previously received and not yet spent Bitcoin is high enough. The outcome of this check (whether the transaction is valid) should not depend on the perspective of the member that is executing it. Therefore, the order of transactions is crucial.

At this point, the consensus mechanism is a solution. The genius is that the consensus mechanism creates an incentive structure (see 2.3.1) that ensures that members come to an agreement, or rather a shared perspective. The blockchain embodies this shared perspective on the data. By definition, blockchains always use a consensus mechanism to create a unified perspective on data.

However, the consensus approach is not the only solution. It would be sufficient, if the peers that check the validity of a transaction would come to the same conclusion. Therefore they need to know and agree upon where in the network they have to look for the data that is relevant for that transaction. Furthermore, this data must not be tempered. We will later point to alternative approaches of achieving this, without requiring to establish a unified perspective on all data (or even making every member store all the data, like blockchains without Sharding do).

In summary, the consensus approach overshoots the target of what would be necessary for the implementation of money (and many other applications). It achieves that every member has the same perspective on all events. The scalability problem is a direct consequence. The more members and the more data that is added, the less feasible this approach becomes. To introduce Sharding to a blockchain means that the members are still finding a consensus about the data of which they only hold a fraction. Successful Sharding would significantly reduce but not eradicate this inefficiency. Members would not store all the data. Yet, they will be involved in coming to a consensus about data that is irrelevant for them. This is the price of the consensus approach: In any attempt to construct an objective truth or to determine an absolute order of events, some inefficiency will remain. DLTs that refrain from this objective clearly go beyond the blockchain approach.

2.3.4 Post-Blockchain DLT

As explained above, for the two fundamental problems, the energy problem is a consequence of proof-of-work as consensus. The scalability problem is more profound, because it is a consequence of pursuing a consensus at all. In particular, this inefficiency can not be solved by choosing proof-of-stake or any other consensus protocol. DLTs that aim to overcome this fundamental problem have to refrain from constructing an objective truth or determining an absolute order of events. This, however, goes beyond the blockchain approach.

For some applications, it is certainly necessary to construct an objective truth, or an absolute order of all events, but for many applications it is not. There the hurdle is rather that programmers are not used to such a new paradigm. However, the properties that are expected from a distributed ledger can in many cases be fulfilled by architectures that are not blockchains. We therefore call such architectures post-blockchain DLT. However, it is not obvious how to forgo a global consensus, while still maintaining a certain data integrity and minimizing the degree of central authority that is required.

Existing solutions include IoTA [107] and Hashgraph [108], which apply directed acyclic graphs (DAG) instead of a single Hashchain as the underlying mathematical topology. Kannengießer et al. [109] did a comprehensive analysis of the tradeoffs between different DAG and blockchain consensus protocols.

As an even older peer-to-peer structure BitTorrent uses Distributed Hash Tables (DHT) to store data in a distributed way since almost 20 years. Holochain combines DHTs with hashchains to a data integrity framework that enables trustworthy authentication of data [110]. In its report *P2P Accounting for Planetary Survival*, the P2P Foundation envisions *a ledger design that is not centralized, without oligarchic validation: this is what Holochain brings to the table.* They see a necessity to *embed different values in the design of the shared ledgers, such as through replacing the blockchain with the holochain.*

2.3.5 Distributed Ledger Money

The primordial example of an application for Distributed Ledger Technology is money. Distributed Ledger Moneys are better known as cryptocurrencies. A cryptocurrency is a currency for which the payment, the storing and the management is governed by a decentralized computer protocol instead of a central bank and which is secured against forgery by computer cryptography.

The first generation of cryptocurrencies starts with Bitcoin in 2009 [89], whose functioning we explained above (see 2.3.1). Many people in this early field held the view that the banking sector and governments are equally oppressive when they control the monetary system. This spawned the idea of decentrally issued money (compare [111]). Contrary to this original idea, we can understand Private Ledger Currencies and Central Bank Digital Currencies as the responses of private sector and central banks; they are (or can be) based on similar technology but contradict the original idea.

Blockchain Cryptocurrencies

Among the advocates of Bitcoin a combination of two separate but often intermingled narratives are dominant (compare [111, 112]).

On the one hand, Bitcoin advocates uphold the idea of decentralization. Thereby, Bitcoin promises to break the power of the centralized institutions, that currently control the monetary infrastructure, and which in their view abuse that power exploitatively. Generally speaking, the idea of decentralization, as a means to emancipate from established institutions can be considered rather progressive. However, it only partially played out in reality: Today the mining, which can be considered to be the issuance of the currency, is concentrated in the hands of a few mining pools, contrary to the vision of decentralized issuance.

On the other hand, they argue that money should not be inflated by their issuing institutions. Prone to the ideas of the Austrian school of thought (see 6.2.1), they instead argue for a fixed currency supply. This is supposed to model Bitcoin like a a commodity; often the term *digital gold* is used [113]. Which is remarkable, because to consider entries on a ledger to be money, seem much more compatible with other (partly more progressive) schools of economic thought that regard the *essence of money* (see 6.2.1) to be credit instead of commodity like.

The fixed supply brings, in addition to the two problems of energy wastefulness and lacking scalability, an economic problem to the table. Due to the fixed supply of the cryptocurrency, its price is determined by the usually rapidly changing demand and thus becomes volatile. Such a construction makes the currency vulnerable against value speculation. Although some advocates of cryptocurrencies may characterize this as the basis for a good investment opportunity instead of a vulnerability. However, it also makes the currency unqualified as a medium of exchange. From a medium of exchange point of view, a currency should be stable in value, which might require the money supply to grow and shrink dynamically (depending on whether the part of the economy in which people use that money is growing or shrinking). Admittedly, central banks have largely deviated from this money supply control for their currencies in favor of interest rate control, but no central bank would try to keep the money supply constant or deterministically predetermine it.

As a consequence, cryptocurrencies that aim to be used as a means of exchange need to abandon the idea of fixed supply. One common approach is to instead add a construction that aims to bind the price, at which the currency is traded to e.g. the Dollar, such currencies are called stablecoins. The G7 published an investigation of the impact and regulatory expectation for these currencies [114]. However, it is far from obvious how a cryptocurrency with a dynamic money supply, much less a fixed exchange rate to an existing currency, is to be constructed without granting special rights to central institutions. Therefore, the most noteworthy stablecoin, Tether [115], is instead simply issued by a single private company, Tether Limited. The decentralized aspect of Tether, therefore, only consists of the blockchains that it uses. Among others, Tether is implemented as a token using Smart Contracts on the Ethereum blockchain. At the time of writing, Tether has a market capitalization of roughly 80 billion USD and is used as

the representation of the USD on many exchanges for cryptocurrencies. The reserve of supposedly equal value is held by Tether Limited. We will discuss the responsibilities for such companies and the risk to the users of such currencies later in this work (6.3.5).

Private Ledger Currencies

If one forgoes the principle of decentralization, e.g. like tether does by their centralized issuance, one could arguably also use a private or permissioned blockchain. We will see in 6 that this is what the Libra project pursues. This step has the advantage of also circumventing the scaling problem (see 2.3.3).

For a private or permissioned ledger the distributed consensus algorithm is replaced with a single or a group of authorities that decide, who can read or write data into the chain. Thus, for a currency that is implemented via such a blockchain, all transactions reside with the control of these central authorities. Cryptocurrency enthusiasts would argue that such a construction has lost the advantages that a blockchain was all about. After all, Bitcoin is based on the libertarian ideal of money that is independent of banks and states. Nevertheless, a blockchain pattern can in some cases bring merit in the private or permissioned case, especially when mediated by a group of authorities that trust each other to some degree but not perfectly.

In any way, it is worth mentioning that money is not the only use case for private and permissioned ledgers. Private IT companies like IBM (Hyperledger) or R3 (Corda) are examples that offer related services.

2.3.6 DLT for Agriculture

There is plenty of literature asserting a vast potential for blockchain in the Agricultural Sector [91, 116, 117, 118]. Yet, twelve years after the invention of Bitcoin notable examples are, to my knowledge, still not forthcoming.

The literature mentions technical difficulties [116] as one category of problems. This point also subsumes the problems of scalability and energy consumption elaborated above (2.3.1-2.3.4). And many authors consider these problems on their list of challenges [118, 117]. However, the reason I went into deliberate technical depth is to make it clear that these are not just minor imperfections in a technology that is still in its infancy, but fundamental problems that are inherent in the core of a blockchain. These problems become even more relevant in the context of agriculture than for Bitcoin. Sustainable agriculture cannot afford energy and resource waste on a large scale. And the problem of scalability becomes critical with the volumes of data that would be generated in the scenarios envisioned here [117] (as opposed to what is required for the transactions of a speculative asset). In the use cases I am familiar with in agriculture, it simply does not make sense for every data point to be stored at all nodes.

Nevertheless, I do not completely oppose the literature with my assessment. After all, the potential that the literature sees primarily in the transparency and disintermediation of food supply chains [116, 117] is certainly connected to the characteristics of DLT. However, this does not have to be a classic blockchain. So it is worth differentiating be-

tween possible DLTs. Equally, it is also important to look at the cases in a differentiated enough way, taking into account the values of the actors involved. My second case study (7) is therefore in this research gap: One thing it does is reconstructing how solidarity, first an abstract concept, is understood by the community and how this interpretation of solidarity is embodied in their structure. It relates this to DLT in an understanding that DLT is not simply blockchain.

2.3.7 DLT in HCI and CSCW

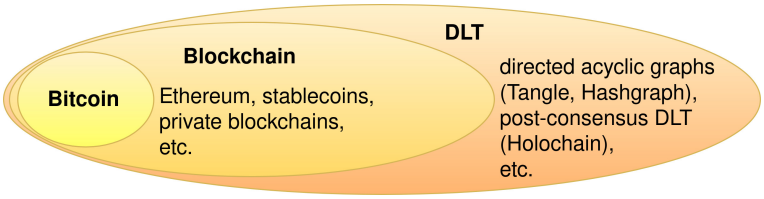

Figure 2.5: Bitcoin technology is a subset of blockchain technology, which is itself a subset of DLT.

Already at CHI 2015, Sas and Khairuddin [57] presented a framework for HCI research on Bitcoin. Since 2018 at the latest, the HCI community started exploring applications of blockchain that go beyond Bitcoin, including blockchain 2.0 (see 2.3.1) [119]. Yet, usually the focus was on users of existing blockchains, and Bitcoin remained to be the primary example [120, 121, 58]. Jabbar and Bjorn describe how actors have built out blockchain infrastructure [122]. Prinz makes the connection between blockchain and issues in CSCW [123].

However, the current discourse mostly speaks of DLT as if it were blockchains only, sometimes even using the terms interchangeably. To the contrary, Kannengiesser et al [109] find in their survey that beyond blockchain the true potential of DLT might lie in decentralization of applications that are not as restrictive as Bitcoin transactions while still empowering the individual. This supports my point from the previous technical discussion that the energy and scaling problem of Proof-of-Work blockchains are fundamental. In all of the cases that arose in this thesis, I came to the conclusion, that I can see a potential application only for post-blockchain-DLT. Therefore, similar to the broadening from HCI research about Bitcoin to HCI research about blockchain, I aim to contribute to a further broadening of HCI researach onto (post-blockchain)-DLT. The typology of blockchain applications developed by Elsden et al. [56] easily applies to DLTs in general as well. According to it, the potentials discussed in this thesis fall into the application areas *Underlying Infrastructure* and *Currency*.

Even though naturally HCI (and CSCW) research starts at the point, where users get in contact with the technology, future research will also need to embrace the socio-political, economic and cultural implications of DLT. I see my contributions in that broader line of thought and want to highlight in this regard just two concepts that I will later relate to.

The first is the concept of *algorithmic authority* for which Lustig and Nardi [124]

see a case in Bitcoin. Even though, as they describe, Bitcoin users acknowledge the need for mediating algorithmic authority with human judgment, there is a tendency to apparently transfer some agency from humans to algorithms. I want to remind that deterministic algorithms can never have any agency, instead humans are using their agency to choose according to algorithmic tools. Yet, there are ethical considerations, when people increasingly choose that way and are nudged to do so. This motivates the second concept of *technological sovereignty* [125]. Ultimately it refers to an unattainable ideal, rather an awareness of technological sovereignty means to apply technology in ways that introduce the lowest possible level of structural dependence. The term is usually applied on a national scale and in particular discussed for Europe [126]. Norton et al. [86] show that also local communities use it, and in her case subsumes it as an aspect of food sovereignty. Those are but two concepts that arise. There is plenty of work to be done comprehending the deeper socio-political, economic and cultural implications of people increasingly using DLT. The cases of this thesis only start to embark on this journey.

3 Methodology

Methodologically this thesis approaches the problems from two sides. First, it employs an analytical conceptual approach that describes problems and dangers arising from Surveillance Capitalism. This approach is suitable to the scale of the problems at hand. It aims to forsee these dangers before they manifest in observable user practices. Arguably, as we will point out, some indicators can be observed already, yet it is the purpose of this work to contribute to preventing negative consequences before they become observable.

When the research questions can be brought down to a local level, my methodology shifts accordingly. Therfore, later this work follows an empirical approach. Where it is possible to observe and interact with, in this case, a currency project on a small scale, the approach of the Siegen school [127] of socio-informatics is particularly well suited.

3.1 IT Infrastructure and the First Case Study

For the chapters that discuss the business models of IT infrastructure (4, 5 and 6) I chose argumentative technology assessments as a methodological approach. Technology assessment has been defined as a form of policy research that examines short- and long-term consequences (for example, societal, economic, ethical, legal) of the application of technology, with the aim to provide policy makers with information on policy alternatives [128]. The argumentative mode of technology assessment aims to clarify and bring under public and political scrutiny the normative assumptions and visions that drive the actors who are socially shaping science and technology [129]. It does not consider the perspectives of stakeholders, in particular citizens, as fixed but engages in their mutual transformation. At its root, the argumentative technology assessment asks for the values and the kind of social order that we as a society want to strive for. Doing so involves, but goes beyond analysing the consequences and side-effects of technology. As such, this research is normative and aims to deepen the political and normative debate about technology and society.

For the chapters 4 and 5 the technology under consideration is rather general. It is any software services that involve intensive gathering of personal data from their users. This generality, however, is a strength of the assessment, that becomes possible due to the relative uniformity of business models behind these software services. The starting point for the assessment is relevant literature in the areas of information systems, human-computer interaction, and beyond. Due to the timelyness of the issues recent newspaper articles serve as examples to illustrate the developments that erode democracy and sustainability, as described in the assessment. Nevertheless, the goal is not an accurate monitoring of where exactly in that development we currently are, but to see where the development is going and how the course might be changed.

The first case study 6 has a narrower focus on Facebook's proposed currency project and accordingly uses the publicly available whitepapers of as a basis. It also involves publicly given interviews by the head of the project. From these sources, the technology assessment develops scenarios for future monetarization given the assessment of Facebook's current business model.

3.2 The Second Case Study

The second case study (7) is of empirical kind. Following an ethnographic approach, I conducted a participatory observation [130, pp. 259-299]. Over the biggest part of two months I lived and worked in a local community full time — an active form of participation. Moeran terms this methodology observant participation [131], to highlight the importance of the researchers shift from mainly observing to participating in the workflow.

In a broader research agenda, I consider this to be a context study, the first step in a design case study (such as [132, 133] etc.) of grounded design. Grounded design can be considered to be the research and design approach developed by the Siegen School of Socio-Informatics [127]. Methodologically, this approach is committed to qualitative research and orients to participatory action research. However, I will argue in section 8.6 for how this approach can benefit from a complementing methodology as well. Epistemologically, grounded design emphasises the importance of the understanding of the perspectives of the stakeholders and practitioners, in order to design digital artifacts that really meet their needs. Therefore, an in depth context study is only the first of three phases. To constitute a full design case study [134], two consecutive phases need to follow. Based on an understanding of the practices of coordination in this local community, digital artifacts can be designed in a second phase. Finally, in an appropriation phase, usage of the (prototypically) designed artifacts are introduced into the community and observed in realistic social contexts. However, the three phases may overlap and be iterated, e.g. by adapting the design based on insights from the appropriation study.

In this case the use of existing IT artifacts offered enough insights, to already publish this context study as a standalone research. Nevertheless, my characterization of innovation gaps aims to follow up towards a full design case study. One of the reasons for embarking on this study in the first place was to better understand what technological solutions might aid in sustainable local food production. In order to do so, the next step is what Knowles et al. [135] argue for as *designing for sustainability*. The overall research approach is action-oriented [136] or even participatory action research [137]. This is to say, in the words of Alice McIntyre [138], who describes participatory action research as to *participate with people in improving and understanding the world by changing it.* Even though, the phases of design case studies that have a higher degree of action (the "changing the world" parts) are yet to follow.

4 The High Cost of Free Services: Problems with Surveillance Capitalism for IT Infrastructure and Possible Alternatives

Abstract

A large portion of the software side of our information technology infrastructure, including web search, email, social media, transportation information, and much more, is provided "free" to the end users, although the corporations that provide this are often enormously profitable. The business model involves customized advertising and behavior manipulation, powered by intensive gathering and cross-correlation of personal information. Significant other parts of our IT infrastructure use fees-for-service but still involve intensive information gathering and behavior manipulation. There are significant indirect costs of these business models, including loss of privacy, supporting surveillance by both corporations and the state, automated manipulations of behavior, undermining the democratic process, and consumerism with its attendant environmental costs. In a recent book, Shoshana Zuboff terms this "surveillance capitalism." Our primary focus in this essay is how we could develop new models for providing these services. We describe some intermediate steps toward those models: education, regulation, and resistance. Following that, we discuss a partial solution, involving for-profit corporations that provide these services without tracking personal information. Finally, we describe desired characteristics for more comprehensive solutions, and outline a range of such solutions for different portions of the IT infrastructure that more truly return control to the end users. A common feature of several is the use of highly decentralized storage of information (either on the end user's own personal devices or on small servers), a modular architecture and interface to allow for customization of what information is to be shared, and a distributed ledger mechanism for authentication.

4.1 Surveillance Capitalism

In the aftermath of the dot-com-bubble, the surviving IT companies had to find business models that would continue providing a growing return to their venture capital funders. In order to keep increasing the user base, it was essential for free services to continue to be free of charge for the end users. Therefore it comes as no surprise that they chose to embed advertisements to generate revenue. However, the way in which they implemented

this turned out to make them highly profitable at the expense of a devastating societal spillover. Instead of merely placing ads, user actions were tracked and recorded in large data bases. When computer scientists at these companies invented algorithms to effectively analyze the giant volumes of data and employed statistical methods to derive predictions from user profiles, they invented a new business model that turned out to be so profitable that even companies that are financed by fees also adopted this practice.

Based on this data, they generate revenue primarily by selling customized advertising. User data becomes much more valuable for this a) in contexts of past and planned purchases, b) when data corresponding to the same user can be connected across different contexts to generate a significantly more sophisticated user profile, c) profile data can be compared and correlated to similar profiles from the database, and d) it serves as a basis for behavioral manipulation. Since it is their predictive and manipulative capital [12], usually the data is not sold directly, as that would undermine the basis of their business model. Although smaller companies exist that employ trackers and presumably serve as additional data suppliers, these transfers of user data are typically not visible to the end user. For the big IT companies instead revenue is generated by predicting and influencing user behavior [17].

Shoshana Zuboff has named this business model "surveillance capitalism" [1, 18], and we use this same term here as well. Her recent book makes clear that its downsides are not simply issues of surveillance and loss of privacy, but also radical and ominous automated manipulation of behavior.

However, despite this very dark side of surveillance capitalism, at the same time these services have enormous utility for business, social engagement, political work, and much more. So in any potential measures to address these problems, we want to retain as much as possible the benefits.

To relate this analysis to work presented at LIMITS 2018 [139] and elsewhere [140], the SEED[1] project is based on the observation that quality of life for growing numbers of people on the planet is threatened by a set of integrated, systemic problems in the environment and our economic and political systems. Its goal is to form an international network of scholar/activists, advocates, and practitioners who seek to address these problems in a similarly integrated fashion. The work presented here is a step in working out how the SEED ideas play out in a particular economic sector, namely IT. (We can imagine similar efforts in the future for other sectors.)

In describing SEED, we put forth an ideal of the relationship among the environment, society, government, and the economy, firmly grounded in the natural world. Within and bounded by the natural world is human society, with a goal of prosperity for all and supporting human flourishing. Government in turn is subservient to society, and finally the economy is subservient to all three other systems. This vision is in sharp contrast to our current system, in which the economy takes priority. A major added problem of surveillance capitalism is thus: in addition to making the natural world subservient to and serving the needs of the economy, now human nature is being similarly dominated.

In the following section we discuss the processes by which surveillance capitalism

[1] Solutions for Environment, Economy and Democracy

impacts consumerism, threatens democracy, fuels social fragmentation, undermines our ability to tackle major environmental problems, and thereby ultimately constitutes a hurdle to living within planetary ecological limits. While a number of leaders in those IT companies were well aware of a range of negative effects on society [141, 142], in the past these effects have been underrecognized by major parts of society.

4.2 Problems

This business model produces a range of problems. In order to maximize the value for advertisers the companies need to capture the user for as long as possible on the website or using the application. This is achieved by applying knowledge of human psychology [14] and experimenting with different interfaces using A/B and other testing. (Another more publicized example of manipulation is the Facebook emotional manipulation study [143].)

One strategy to maximize the time spent on social media is to push toward more provocative content, both on the side of the viewer (who becomes more engaged or outraged when confronted with extreme positions, so that feeds tend to select for such content [144]), and also on the side of the contributor (since these posts then tend to receive more positive feedback, encouraging users to post more in that direction). This feedback loop is just one example based in a kind of psychological trap. Other strategies are to trigger anxieties (fear of missing out (FOMO) or how one compares with others), or exploit tendencies toward certain kinds of addiction. Overall these methods aim to result in a strong pull toward the website, platform or application.

In addition to maximizing the number of people who see an advertisement and the length of time they attend to it, the ad also becomes much more effective if seen by groups most likely to respond to it. IT companies that gather personal user information not only identify the users as members of particular groups, they also use their elaborate algorithmic tools of statistical analysis to identify for the advertiser which target group to aim for [17, 14]. However, in order to provide these services to the advertiser, the company needs to gather and correlate more and more personal information. There are three things happening. The first is the gathering of any available possibly relevant raw information by tracking the user, including actions taken in the browser, contact addresses, and the mobile location. In addition, if the records that belong to a given person can be connected during a series of visits and between different websites and applications, a far more sophisticated user profile is generated. This is the reason these websites use trackers that are able track the entire activity during the browser session. It is also a reason that Facebook and Google are highly motivated for users to log in with their accounts for identification to other service providers. Third, the correlation of many of these sophisticated user profiles makes it possible to statistically make predictions about user behavior, and thereby understand the users possibly better than they understand themselves.

Another practice is the *manipulation* of user behavior, not just surveillance. One motivation for this is that predictions about user behavior can be made more precise if

those behaviors can be nudged in particular directions, making those predictions even more valuable for the surveillance capitalist firm's customers, namely the advertisers. However, if the manipulation is no longer directed just at improving predictions to make them more valuable to advertisers, but instead (for example) to strengthening a particular political opinion or nudging a citizen toward voting a given way, the IT company has developed a tool that can wield significant power and control over civic life.

Above we noted the effect of this business model on the orientation of these IT companies. We now explore the outcomes for individuals and society, including how the intensive gathering, tracking, and correlation of personal information, along with behavioral manipulation, poses a threat to sustainable economies and democracies in multiple dimensions.

4.2.1 Consumerism and Excessive Consumption

The increasing precision and effectiveness of customized advertising serves the imperative for consumption and unending growth. The generation of artificial needs is valuable to the advertisers, which can serve these needs, while having a destructive influence on the individual as well as society. On the individual level the users pay twice for these artificially generated needs, while true needs remain unsatisfied: once with the money of their purchases; and the second time with the time they spend due to the provocative content and in psychological traps. On the level of society, (1) personal information bubbles amplify social fragmentation and thereby hinder effective action on global problems/challenges, while (2) such a level of consumption cannot be sustained within ecological limits. Let us now examine these two outcomes more closely.

4.2.2 Threats to Government and Democratic Processes

Social media platforms such as Twitter, Facebook, and Instagram offer new types of (semi-)public spaces. They play an increasingly important role in the exchanges of ideas, visions, and convictions that are central to civic life. However, the algorithms by which content is selected are often opaque to the reader [145]. On the one hand, these public spaces can have an emancipatory effect, for example under conditions of surveilled telephone lines and censored mass media, as occurred in the early stages of the Arab Spring when discussions critical of the regime, planning for demonstrations, and the distribution of news were facilitated by these platforms [146, 147]. On the other hand, the content of these exchanges will be recorded by the platforms and can contribute to the personal profiling of the discussants. Thus, these semi-public spaces have a Janus nature. They offer emancipatory potential, but at the same time contribute to the refinement of personal profiles and opportunities for manipulation. The role of Facebook in the 2016 U.S. election and the appropriation of the Whatsapp messenger in the recent elections in Brazil shows the manipulative power that comes with the ability to create personal profiles and to distribute targeted political propaganda via social media platforms [148, 149].

A lack of privacy with regard to political communication on social media platforms can lead to less participation and to self-censorship, depriving the debate of opinions that could support political progress. Particularly due to the potentially unlimited lifetime of the data and lack of transparency with regard to what personal data was gathered and how it was used in profiling, people in public offices or running for them will have to permanently fear that unpleasant private matters from their past could be dug up. In addition, the pressures toward more and more provocative content drives extremism and social fragmentation.

Looking, for instance, at the experiences of the Arab Spring [147, 146], it is clear that authoritarian regimes can use the personal data stored in social media platforms for surveillance and propaganda. This is true for Western governments as well, as demonstrated by the Snowden papers. The platforms themselves do not need to be in hands of the government; it is sufficient for the government to gain access to the gathered data. As the case of NSA indicates, platform providers could grant the access if they are coerced by legal action or threats of losing government support or even market access. A state does not need to initially be an authoritarian regime to develop in that direction as a result of building up these types of surveillance techniques.

In China, the government is accessing different social media platforms to profile the behavior of its population by means of a point-based social credit system [150]. In the West this is often regarded as a development toward an Orwellian surveillance state [151], even thought similar software architectures and personal profiling capabilities are being built up in the private sector. Although states in the West are generally not (yet) legally able to access these profiling data and match between the different platforms directly, security services seem to have these abilities.

Governments in general will not want to see any drift toward political opinions that do not support their own political mandate. If instead they can use these services as a tool to propagate their own worldviews, it could in the eyes of the government even be seen as a good thing to do so. Therefore it comes at no surprise that many countries deploy significant resources to manipulate domestic and/or foreign online public spaces [152].

Particularly in democratic countries, the targeting of voters based on their psychological profiles becomes politically charged, as the case of Cambridge Analytica shows. This company played an important role in the Brexit referendum as well as in the Trump election [12, 15]. Once the sovereignty of humans over their personal data is lost, the borders with a propaganda and surveillance state blur. Or as the Cambridge Analytica whistleblower Christopher Wylie puts it [15], “If you do not respect the agency of people, anything that you’re doing after that point is not conducive to democracy.”

4.2.3 Privacy Concerns

The practices of amassing personal data conflict with principles of privacy. Although people usually deliberately choose to use the services and thereby provide their personal data to the companies, they are pushed to do so, due to a lack of transparency and little understanding by most users regarding which data is tracked, how long it is held, and

to whom else it is given, as well as the lack of real alternatives or options that provide end user control.

While general business conditions or national law may regulate the handling of this data, a) this regulation is only on a legal level, whereas misdemeanor can be hard to prove on a factual level, where the IT companies still control the data and b) these regulations do not apply to predictions generated out of this raw data.

4.2.4 Concentrations of Wealth and Power

The power that arises from control over the service and personal data is more profitably turned into revenue, not by selling the service, but instead by predicting and manipulating user behavior. This concentration of power is followed by a concentration of wealth, as evidenced by the amount of capital these companies have been able to accumulate. Furthermore, the existence of a tool to wield control provides wealthy customers with more power that can be used to accumulate even more capital. In other words, surveillance capitalism enhances the concentration of power within and outside these IT companies. In addition, the small number of employees in comparison with the revenue generated by these companies exacerbates inequality, which undermines sustainability, democracy, and much else.

4.2.5 Economic Growth and Sustainability

Our overall economic system is currently predicated on unending economic growth, which is on a collision course with sustainability. This requirement for unending growth interacts with surveillance capitalism in two ways. First, it leads to pressure for increasing consumption, which in the developed world means that more and more needs are generated artificially, rather than being necessary for real prosperity (also see Section 4.2.1). Advertising, precisely targeted to the individual consumer using the tools and data provided by surveillance capitalism, helps fuel this consumption. Second, it leads to pressure for growing corporate profits, which for firms practicing surveillance capitalism drives them to bring more and more of human experience under the domain of surveillance and conversion to data, and increasingly to engage in behavioral manipulation as well, in service of behavioral prediction markets [1, 18].

Challenging this worldview and tackling the global issue of transitioning to a truly sustainable economy requires careful thought, deliberation, and action. However, the behavioral patterns that are encouraged by social media platforms, even if as yet underinvestigated, seem to drive people toward fast emotional rewards and less focused pursuit of long term goals.

4.3 Steps Toward Solutions

Ultimately we need new models for these services that do not rely on the logic of surveillance capitalism. We outline a partial solution in Section 4.4, and a number of more comprehensive and hopefully effective ones in Sections 4.5 and 4.6. Getting to any of

these solutions (especially the more comprehensive ones) will be very difficult. In this section, we outline some intermediate steps that we believe will help pave the way toward making these new models feasible. These steps are grouped into three categories: education, regulation, and resistance. However, the categories are interrelated and build on each other. For example, regulations that make it easier for people to see what information about them is being stored support both education and resistance.

4.3.1 Education

One key step toward finding solutions is for people to understand how these services are being funded, what kinds of information is being gathered about them, how their behavior is being manipulated, and the consequences of all this. A great deal of the rhetoric around the corporations using a surveillance capitalist business model has focused on individual choice, limitless access to information, empowerment, and personalization, until recently with relatively little focus on the model's dark side of surveillance and manipulation. There were flare-ups of negative reactions, for example, in 2004 to the initial description of how Google's Gmail scans private correspondence to place targeted advertising, but subsequently this became (perhaps grudgingly) accepted as normal. In the last two years, there has a been a substantial shift as more of the extent of the surveillance and manipulation has become visible, especially in light of the reports of extensive online Russian targeting of the 2016 U.S. presidential election. In addition to numerous reports on election hacking, there have been increasing numbers of editorials, articles, and books on this topic, with Zuboff's book [18] being a significant milestone in terms of presenting the depth and broad scope of the problem along with an intellectual framing.

It is essential that the education process continue, with ongoing discussion and exposure of the extent of surveillance and political and other behavior manipulation. It is also important that we do not fall into the trap of assuming such a world is now normal and acceptable. However, neither being in a state of numbness or grudging acceptance, nor being in a state of continual outrage for years, are attractive alternatives. We also need positive visions of how we can use information technology to support human flourishing without surveillance and manipulation, and the collective political will to move toward those visions.

4.3.2 Regulation

Another key step is stronger regulation [153] of the corporations practicing surveillance capitalism. An important milestone here is the General Data Protection Regulation (GDPR) from the European Union, which took effect in May 2018. The GDPR is certainly a major step forward; how it plays out in the next years remains to be seen. Two obvious concerns are that it applies only in the EU; and also that the corporations most affected by it will be able to afford to hire numerous highly-skilled lawyers, lobbyists, and others to counter its impacts on their profits. Given that the profits of Google and Facebook in their current forms, for example, are almost completely linked to surveillance

capitalism, these efforts will likely be formidable. (In other words, the basic business model of surveillance capitalism leads to the problems described in Sections 4.1 and 4.2 — they are not incidental byproducts. Absent different models, regulation can help mitigate but not eliminate these problems.) An in-depth discussion of regulation of this industry, including its international ramifications, is well beyond the scope of this essay. Instead, here are a few additional ideas. (Not all of these will be feasible — but we hope they will be at least provocative and help further the discussion.)

It should be possible for individuals to know just what information various corporations are storing about them and which other corporations have access to it, to challenge inaccurate information, and to demand deletions, all in easy-to-understand presentations. Regulation can help support education, for example, by making it easier for people to see what information about them is being stored. Zuboff [18, p. 482–483] describes the unsuccessful struggle of Belgian mathematician and data protection activist Paul-Olivier Dehaye to uncover all of the web pages where Facebook had tracked him, despite several years of persistent efforts. (If a determined activist will not be successful in such a pursuit, what are the chances for an average citizen?) Regulations that require companies to make this information easily available, and tools provided by activists to help us digest it, can make these abstract threats much more personal and tangible, and motivate pushing for change.

In particular, if people knew just how much data was being amassed about them under surveillance capitalism, perhaps enough of them would be sufficiently outraged to push for alternate models. This is of course likely to get even more intense pushback, but it would be difficult for a corporation to argue that the data it holds about its users should not be revealed to those users because they would be angry — the pushback will instead likely be about technical feasibility, inhibiting innovation, undermining the corporation's ability to provide highly personalized service, claims that existing privacy policies provide full protection, and so forth. (Pushback aside, there are in fact some real dangers that might arise in conjunction with such visibility, such as the danger of misuse if someone else fraudulently obtains your data or coerces you into providing it, and the problem of indirect stakeholders — other people who were tracked at the same time you were and whose information would also be exposed or made public if you did so.)

The GDPR includes a high threshold for the definition of "consent," but when possible there should be strong privacy protections that instead entirely eliminate classes of data collection and sharing and behavior manipulation. For cases where consent is still appropriate, it is likely that additional requirements could help. Regulations could require unbundling what is being consented to, with different options for what can be gathered and how long it can be retained, and with which other entities it can be shared. Consent should be opt-in and not opt-out, and policies clearly and concisely stated — a recent *New York Times* editorial [154] notes that "The average person would have to spend 76 working days reading all of the digital privacy policies they agree to in the span of a year. Reading Amazon's terms and conditions alone out loud takes approximately nine hours."

Corporations engaged in this kind of data gathering and manipulation could be subject

to an impartial external audit, conducted by skilled researchers who investigate what the corporations are storing and manipulating, and publicize the results.

An action that is regularly proposed is to declare that corporations such as Google and Facebook are monopolies, and to require that they be broken up. We have concerns about such a move: the result could well be that there would be a multiplicity of surveillance capital firms, with all the same problems but harder to keep track of. Somewhat better would be to break up firms by functional capabilities, in particular to separate out the common carrier and similar functionality (network, storage, and cycle server infrastructure) from content functionality, and to restrict the data that the common carriers and their analogs can share.

Regulation is likely to result in lower profit margins for surveillance capitalist corporations [155]; arguably this should not be the goal of such regulation, but should nevertheless be an acceptable outcome. Finally, another important purpose of regulation could be to deliberately nudge the market to make it easier for other models for providing IT infrastructure to flourish — or ideally, to make surveillance capitalism models untenable.

4.3.3 Resistance

There are several potential goals for resistance to surveillance capitalism, including personal integrity, undermining its profitability, and raising awareness and calling people to action (i.e., education). Trying to maintain personal integrity is of course important as an end in itself, and also in helping avoid having surveillance become normalized. However, such actions, or other actions whose purpose is to undermine the profitability of the business model, seem unlikely to have sufficient impact on their own. But doing these things (and discussing doing them and the challenges of doing them) can contribute to awareness and calls to action.

Resistance can take a variety of forms. One is to simply not use certain parts of the IT infrastructure, e.g., the `#DeleteFacebook` movement. This certainly has merit, but can also make it difficult to participate fully in society, given the extent to which Facebook enters into many social interactions, into deliberations among members of a political movement, and so forth. It also recasts a political issue as a willpower issue [156]. And it seems simpler to delete Facebook than for example Google, given Google's pervasiveness. (As a more extreme example, Hill describes her attempt over a period of six weeks to block the five tech giants [157].) Another important form is as art directed at the themes of surveillance and resistance [18, p. 491–492], which (among other things) can push back against such surveillance and manipulation as being considered normal. Finally, there are various kinds of technical resistance that seek to avoid being tracked, or to disrupt surveillance.

Regarding specific tools for such technical resistance, web browsers often provide a switch to block setting third-party cookies. This is only somewhat useful, since among other things it often just blocks cookie writing, not reading/sending. For example, if a user visits Facebook directly, it would be a first party and so a cookie could be set and then subsequently used by third parties. Also, there are many other techniques for

tracking besides cookies, notably browser/machine fingerprinting [158]. Web browsers may also provide a "do not track" setting — unfortunately, though, this option is effectively dead since it only works if trackers honor the request (and many do not). Simply turning off JavaScript can help as well, although doing so will also cause many sites to be unusable.

There are also a variety of ad blocker plugins and other anti-tracking browser extensions, such as uBlock Origin[2], Privacy Badger[3], AdBlock Plus[4], and Ghostery[5]. On the more stringent (and difficult-to-use) side, uMatrix[6] can be set up to block all third-party requests by default, and then let the user choose which domains to enable for a particular webpage. The Firefox browser itself also includes some tracking protection [159], including in "private browsing" mode. (In other browsers, "private browsing" modes may not really protect against tracking — the goal there is more to protect the user's web history from someone with access to the user's device.) Panopticlick[7] from the Electronic Frontier Foundation will analyze how well the user's browser protects against tracking.

A different approach is taken by AdNauseam[8], built atop uBlock Origin, which simulates clicks on every blocked ad to generate a stream of meaningless data that obscures the user's actual interests and behavior (also see [160]). Another is a Firefox add-on called Multi-Account Containers[9], which are like normal tabs on a browser except that each container has its own preferences, advertising tracking data, and other information, which cannot be seen by the other containers, making it harder to do tracking across sites. However, they can be unintuitive for users, and it can still be difficult for users to reason about tracking since webpages often load from so many different sources.

Relevant papers in the academic literature include an early study on tracking with measurements in Summer 2011 [161], a longitudinal study of tracking 1996–present [162], and a demonstration that anyone can buy ads to track a targeted individual [163].

Stepping back, one is struck by the considerable effort that is going into these technical approaches to resistance, how complex the solutions are, and the extent to which there is a cat-and-mouse game going on between the trackers and the tracked. The economic impact on surveillance capitalism of this technical resistance is liable to be limited by its complexity. However, the main practitioners of both its development and use, such as computer science students and software engineers, are also likely the potential employees of the big IT corporations, and employees are a scarce resource, so they may have power by other means. Finally, if technically skilled users find the landscape challenging and confusing, nontechnical users must find it even more so. If one were a journalist reporting from on-the-ground in a repressive regime, one can imagine it being reasonable to require

[2] https://github.com/gorhill/uBlock
[3] https://www.eff.org/privacybadger
[4] https://adblockplus.org
[5] https://www.ghostery.com
[6] https://addons.mozilla.org/en-US/firefox/addon/umatrix/
[7] https://panopticlick.eff.org
[8] https://adnauseam.io
[9] https://support.mozilla.org/en-US/kb/containers

these kinds of precautions. But should ordinary citizens who just don't want corporations tracking everything they do online need to do this also? Ultimately, the most important role for such technical resistance may be as part of education and helping build pressure for more comprehensive change.

4.4 A Partial Solution

The problems of surveillance capitalism can to some degree be addressed by regulation, pushed by an educated population and selective resistance. A further step in this direction is to encourage the development and growth of for-profit corporations that still provide these services but without tracking personal information, both to provide an alternative for users and thereby also to nudge the existing big IT corporations. This partial solution is thus still very much capitalism, just not surveillance capitalism (or at least not surveillance to the same extent). Despite its partial nature, we believe it is worth calling out explicitly. Among other things, this is (we claim) implicitly the solution that is being proposed in approaches based on regulation alone, absent measures specifically to foster alternate business models.

Two systems to be noted in particular are Brave[10] and DuckDuckGo[11]. Brave is an open-source browser that (the company says) blocks ads and trackers, in both mobile and desktop versions. It includes a facility for giving micropayments to publishers of content being viewed using blockchain-based tokens. The DuckDuckGo search engine, according to the company, does not collect or share personal information. Its business model is still based on advertising (and also affiliate marketing). The ads shown on DuckDuckGo are based just on the keywords typed in the search box, rather than also on tracked personal information. Revenues come from Amazon and eBay affiliate programs: when users are referred to one of those sites by DuckDuckGo and then buy something, the company collects a commission. Finally, Apple among the big five tech companies has a significantly better record with respect to privacy. Apple still has other major problems — with respect to labor practices, sustainability (for example, encouraging frequent purchase of expensive new devices), and so forth — but to date they have resisted to a considerable extent adopting a surveillance capitalist business model.

In terms of why we label this as only a partial solution, Brave and DuckDuckGo are still advertising-supported — this seems potentially problematic because it leaves the companies vulnerable to the desires of the advertisers. Also, to what extent will this challenge the power of the entrenched surveillance capitalist corporations?

In Section 4.6 we discuss approaches for a variety of application areas. Systems that implement some of these approaches, for example for public transit information (Section 4.6.2), can be provided now without needing to use a surveillance capitalist model, making them quite compatible with this partial solution approach.

A final idea here is to nudge the market by having institutions such as libraries, universities, and others buy ad-free, no tracking versions of services for their patrons/students,

[10] `https://brave.com`
[11] `https://duckduckgo.com`

either from new companies, or from existing large IT corporations if they are willing to unbundle their services to support this. (Note that it would be essential to carefully monitor the corporations to ensure they are not tracking these users [164, 165].)

4.5 Issues of Funding and Control

Section 4.4 described approaches that are still very much capitalism, just not surveillance capitalism as currently practiced. We view these as partial solutions only. In this section and the one that follows, we instead consider more far-reaching alternatives that question not just the "surveillance" part of the phrase but also the "capitalism" part (also see [166]). Two major issues are thus funding and control. We now consider some alternatives to for-profit corporations for funding and controlling IT infrastructure.

4.5.1 Public Funding

One alternative for funding IT services is public funding. However, if these services can be used as tools to influence public opinion and behavior (and it has been shown that they can [14]), government control of IT services brings with it the danger of manipulation. All the concerns regarding threats to the government and the democratic processes (Section 4.2.2) hold equally if not even more strongly if governments not only have some influence on the tools but in fact are their owners and creators. Of course, it makes a huge difference whether the government is under the control of a functioning democracy, a democracy in name only, an authoritarian government, or something in between. Democracy itself is also under huge stress at present. But for purposes of this essay, we want to at least contemplate the possibility of having a well-functioning democracy that might fund and oversee some of these services.

More radically, these considerations raise the issue of whether society is better off with the immense power that arises from the control over a communication medium that people rely on being in the hands of governments or of private corporations. Particularly if the government is not a functioning democracy, arguably neither provides a satisfactory solution, since in both cases there is a strong interest in trying to control the behaviors of individuals.

Despite these considerations, we do believe there is a substantial role for government funding. One example that provides a useful analogy is the public radio and television systems that exist in many countries; another is the subsidies to newspapers that existed in the U.S. in the 19th century via subsidized postal rates and tax policy [167]. Or there could be other programs that emphasize individual choice and responsibility. For example, "journalism vouchers" could be issued to every resident that would allow people to provide grants to investigative journalists, whose work would then appear on social media.

4.5.2 NGOs and Cooperatives

Another possibility is having other societal institutions that control the service. If the continued existence of such institutions is insulated from day-to-day changes in public opinion, this removes one source of pressure to engage in propaganda or surveillance. One possibility here is NGOs (e.g., the Mozilla Foundation, which is the sole shareholder in the Mozilla Corporation). However, being a nongovernmental organization does not automatically guard against conflicts of interest arising from funding, nor does being an NGO automatically mean the organization will be benevolent. Minimally, a close look at the organizational structure is needed.

Schneider and Schulz [168] advocate placing these alternatives in the hands of worker cooperatives. Using this model, more of the relevant stakeholders would be included in the ownership model, particularly if it also includes the end users of the infrastructure. However, if one takes a closer look at the ownership structure, often the potential for conflicts of interest among different sub-groups of a coop becomes apparent. Although such a structure would be a significant advancement in the power balance, it still leaves open questions. By which mechanism would the formal owners coordinate and exercise their right to make decisions? What if one group of stakeholders, e.g., the programmers, refuse to implement the changes the majority of owners decided upon?

4.5.3 No Funding or Minimal Funding

Freely contributed work is another alternative. Examples such as Wikipedia and OpenStreetMap show how an enormous amount of knowledge can be contributed by volunteers, perhaps along with funding for hardware and support staff. Such a model can work well if a clear structure is provided that guides how to arrange and connect the different contributions. While the development of an entire IT service is probably not suitable for volunteers alone, such a group could very well do the maintenance, given that a clear structure to do so is provided. Such a structure can be given by a modular design, which we propose in Section 4.6.1.

On the other hand, to provide hardware infrastructure without funding would require freeing up idle capacity of existing infrastructure. There are working examples where the infrastructure is provided freely by the users themselves. These include file sharing and streaming services, utilizing decentralized architectures as we propose in Section 4.6.2.

Having freely contributed labor and infrastructure still does not address the question of who controls the data. Who is its legal owner? For social media, who designs and controls the algorithms that selects the content that is presented to the users? Such questions motivate the considerations outlined in the next section.

4.6 Toward a More Radical Solution

In the previous section we discussed some general issues for alternatives to surveillance capitalism. For each of these alternatives we still have the question of who controls the service. Who is the legal owner of the data? Who (if anyone) is able to do datamining

on it? Who has the ability to design the digital environments users employ and that help shape their behavior? Arguably, the power that arises from these privileges is simply too big to be placed in the hands of any entity. This gives rise to the question of whether the service itself can be structured in a way that there is no such entity. In the next section we consider some necessary properties such liberating software would need to possess.

4.6.1 Desired Characteristics

The first necessary condition is user control over personal data. Personal data here consists not only of the information users give about themselves, but also records of all the actions they take that are at least theoretically trackable while interacting with the service. For the latter kind of data, in many cases this will mean that they are not tracked at all. Since that depends on the program code, the source code must be visible. For the first kind, the users need to be able to choose who is allowed to see this data. Although current service providers often offer some choice regarding which other users are allowed to see the data, there is no option to hide the information from the service provider itself. Realizing this requirement suggests not being satisfied with end-to-end-encryption, but instead saving user data locally rather than on a central server.

The second point concerns the development of features that users desire. In an economy run according to capitalistic principles, the approach to this is a corporation investigating the desired features and developing them. If these features turn out to be valuable to the users, this gives the corporation a competitive advantage. However, a corporation might have no interest in implementing a feature users desire, for example one for more privacy, if it would reduce the corporation's ability to generate revenue. If there are a few dominant players, competitors have no chance of out-competing that corporation by implementing such a feature, because network effects constitute a barrier to adoption that is larger than the benefit. In such a situation progress is stalled.

One approach to avoiding this is to design software with options to add, hide, and connect with other features, rather than monolithically with only small APIs that enable some limited connection with other services. This is also compatible with an End User Development approach [169]. Not every user will have the technical knowledge or the willingness to experiment with such options, but the lower the hurdle is to do so, the more easily user desired designs and features will be developed. As it is not required for all users to migrate to the new service, but instead new features come as optional add-ons to the existing ones, users don't lose connection to their existing peers upon testing a new feature. In such an environment two users who want to interact with each other simply have access to all of the features they share in common. For such a modular set of features to be manageable, ideally users have software that arranges these tools in a customized way that they are familiar with. Such a design also lessens their unwilling exposure to manipulation and pull toward extremism. For example, it would empower users if there were a choice among different news feeds that are not all designed to constantly draw them in and spend more and more time on the platform. Therefore a modular architecture is the second ingredient to enable users to create an

online experience oriented toward their personal needs.

Modular solutions that leave individuals in charge of their data and experience could still be tools to concentrate power if there is an entity with the ability to read or deny the exchange of information via this service. Therefore, the third requirement is for truly peer-to-peer services. There are many platforms that label themselves as peer-to-peer, because peers do communicate with each other. However, if the communication uses the central server of the platform provider as a channel, this does not meet the stronger understanding of truly peer-to-peer communication as used here. This strong understanding of a peer-to-peer system requires that the entire communication, including the channel, be held by the peers. Such applications, instead of answering the question in whose hands power over the communication system might be relatively safe, solve the problem of power by not letting it manifest in the first place.

In combination these three architectural choices seem promising to solve the problems from Section 4.2:

1. User control over personal data
2. Modular design
3. Truly peer-to-peer communication

We do not see any indications that these properties are incompatible; to the contrary, user control over personal data strongly hints in the direction of peer-to-peer communication. To substantiate this, the following subsection illustrates how these properties could be realized for particular classes of IT services.

4.6.2 Returning Control to the Users

The outlined properties radically place the control over the services into the hands of users. They are well aligned with what Tim Berners-Lee seeks to accomplish with the SOLID project[12] at MIT. However, in order to achieve this, we propose that distributed ledger technology (DLT) play a key role in implementing truly peer-to-peer structures. (For other decentralized alternatives, also see for example [170]).

The most prominent DLT, blockchain, is not suitable for our purposes, since it requires the full data load of all members to be held by every peer. (Changing precisely this property is called sharding, which is difficult and not achieved by classical blockchains.) As a result, it neither scales up, nor does it prevent excessive data mining. Proof-of-work blockchains, such as the ones Bitcoin and Ethereum are based upon, require ecologically unsustainable energy consumption. However, there are promising blockchain alternatives that do not suffer from these weaknesses and that are potentially able to implement these desired characteristics. One of them that in particular is intended to support these properties is Holochain [110]. To give examples of how alternative services could use such distributed ledger technology to support these principles, we need to distinguish between different classes of services.

[12] https://solid.mit.edu/

Social Media Services

Social media services and publishing platforms are one class of services for which currently the surveillance capitalism business model is common. Examples of this class include Facebook, Twitter, Instagram, Medium, and LinkedIn. For these applications, users create a personal profile themselves and want the content they create to be connected to that profile, visible to other users. They might want to create different categories of visibility and authenticate other users for these categories. In our proposed alternative, the user profile and its content are stored locally on the user's device. Since that will not be available all the time, the DLT stores the data with some redundancy on other devices. When somebody wants to visit the user's profile, instead of sending a request to a central server, he or she now needs to connect to one of the devices that holds the user profile data. That means that all users need to carry in addition to their own data load the backup for other users. Because mobile devices in particular are not designed to carry and upload large amounts of data, these obligations can be fulfilled by devices with a better hosting capacity and a broadband connection. It would of course be highly inefficient to require every user to own a tiny server. Instead, we imagine many hosts to fulfill these obligations, for which they can be paid using micro-payments. Technologically this is enabled by deploying an appropriate distributed ledger technology. With the demand for tiny hosting volumes and the technical abilities to pay for these automatically, it would for example become feasible to rent out idle capacity of existing computers, resulting in a much more decentralized network than the central structure of big companies like Amazon Web Services that exist today. In addition, the capacity of public institutions such as libraries and universities could be integrated in such networks. This structure does introduce some inefficiency, since the data is stored with a higher redundancy than on a central server, where redundancy only needs to counter the rare case of hardware failure. However, it grants complete control over private data to the user, who is freed from the service provider. That service provider no longer plays any role in the communication between users and cannot easily datamine the user profiles, because there is no single database of user profiles, and because it would not be authorized to access the profiles unless the users permit it.

The second dimension of user control is over the features the service offers, especially the algorithms that selectively present content. Where today the features are determined by the service provider, with very limited APIs and algorithms that are a mystery to the users, in our proposal the requirement for a modular software structure gives users the ability to add in their own modules. Those could include modules for simple features such as a dislike-button. Using this process the community can find out whether such a module enriches or frustrates their experience. A more complex example is a content filter for the activities of friends, implementing a new algorithm. This would enable users to better control their online experience, and overcomes the network effect problem that blocks adoption of such a feature unless the infrastructure provider itself adds it. Admittedly only users who are sufficiently educated and motivated in that direction would embrace that opportunity, but the modular structure is intended to make the barrier for participation as low as possible.

Employment and Rental Platforms

A second class of services consists of platforms that connect different user groups with complementary needs, for example digital employment platforms. Examples for this class include Airbnb, Uber, Deliveroo, blablacar etc. These platforms are the backbone of the gig economy, and although they do not rely heavily on advertising for funding, they still involve many of the same characteristics of surveillance and behavioral manipulation [171], so we view them as also being instances of surveillance capitalism. Alternative applications that would avoid this surveillance and manipulation (and also perhaps some of the high fees) could be analogous to what we just described in the first class of examples, including different user groups. Once such an application with a license that allows free usage of the software is distributed, no fees can be imposed by the software provider, who is no longer a part of the communication.

Search Engines and Browsers

Two other classes of services are search engines and browsing applications. For these, users usually do not want any information to be shared with other users or corporations. There might be some interest in sharing certain customized settings or bookmarks between different devices that belong to the same user, and where a generalized structure for peer-to-peer applications is in place it might be used for this case as well. However, in general, for this class of services versions that do not track any personal information (Section 4.4), perhaps with a funding source other than advertising, seem appropriate.

Email and Messaging

For the class of email providers and messaging applications a serverless peer-to-peer structure would not be far fetched. Many of these applications are encrypted end-to-end already, but the provider can still try to monetize meta-data. The difference would be that the emails or messages are not stored centrally at the providers server, but instead locally on the user's device. Again some redundancy is required, so that the role of the server is replaced by the DLT, or more precisely, a small part of the peer-to-peer network of users. This backup also enables the users to synchronize between their different devices. In contrast to social media, something like a tool to micro-pay for hosting services might not even be needed when the application requires users to carry this backup for other users, because messages are small. Only for attaching large files, such as pictures, audio or video recordings, a solution similar to what we suggested for social media would need to be provided.

Public Transit Information and Other Specialized Applications

There are also a variety of specialized applications that are clearly appropriate for public funding and do not require the peer-to-peer approach. One example is apps for public transit information, including schedules, trip planning, and real-time arrival information. In Europe, these are often already publicly funded, but in the U.S., many transit agencies

make their schedule and real-time information available via an API and perhaps a website only, so that users who want to access this information online via apps on mobile phones must do so via ones that are funded by the surveillance capitalism model (or by startups funded by venture capitalists whose business model is presumably to garner as large a user base as possible for eventual sale to the surveillance capital market). Public funding for the apps as well as the servers, with open source software that guards rider privacy, would be a relatively small additional expense and definitely worthwhile. One example of such a system is OneBusAway[13], which also includes open source versions of the server side software as well. OneBusAway is in production use in a number of regions in the U.S., Canada, and Europe. In informal presentations and discussions with transit riders, they often do not realize the surveillance potential of for-profit transit apps, but once they do, they typically strongly support an open-source surveillance-free alternative — thus providing another example of the importance of education.

Wrapping Up

The example application areas presented above that rely on strongly decentralized peer-to-peer architectures are structured in a fundamentally different way from current practice, while others would need only a different funding mechanism (although that alone is a formidable barrier). The peer-to-peer applications would not only require a rebuild of a significant part of modern software infrastructure, but also a fundamental rethinking by the developers of these new services. We have presented a first examination of the design space shaped by the three properties listed in Section 4.6.1, and new obstacles may well arise. Let us therefore at least consider funding as one obvious source of obstacles.

4.6.3 Revisiting Funding Options

For many of the relevant applications we could describe implementations of the peer-to-peer approach described in Subsection 4.6.2 embodying the three desired properties, which by design provide considerable protection against the undesired outcomes of surveillance capitalism. This provides a fresh view on the funding and control possibilities outlined in Section 4.5: given the modular and decentralized nature of this approach, different implementations of services, with funding from any of private, state, cooperative, or volunteer sources, should be capable of co-existing and evolving.

4.6.4 Open Problems

Significant numbers of open problems remain. For example, the approach described in Section 4.6.2 applies only to certain classes of applications, such as social media. Other classes, including the important cases of search engines and browsers, do not seem amenable to peer-to-peer structures — approaches here must focus more entirely on funding and control. There are also a set of other critical problems not addressed by these suggestions. For systems using machine learning, these include bias in training

[13] https://onebusaway.org

sets and explainability. For social media, these include the effects of personal information bubbles, use by extremists, and the vulnerability of the political process to targeted misinformation, trolls, bots, and the like (perhaps controlled by state actors). For employment platforms, the lack of the legal safeguards for employees, the uncertain nature of the work, and competition between workers that pushes wages to a precarious level, may result in significant economic insecurity. A last major set of issues concerns how the industry could evolve and be restructured, as well as how to overcome an imbalance between the largest companies and new entrants in funding and incentivizing good developers and designers.

4.7 Conclusions

We began by describing the ominous implications of the surveillance capitalism model that underlies most of the major IT corporations, which include intensive gathering and correlation of personal information and behavioral manipulation. We then described three categories of steps toward solutions: education, regulation, and resistance. Following that we discussed a partial solution that involves encouraging the development and growth of for-profit corporations that still provide similar IT services but without tracking personal information. We then outlined a range of more comprehensive solutions for different portions of the IT infrastructure that more truly return control to the end users. While many challenging problems remain to be worked out, particularly with the more comprehensive solutions, we hope that this essay can help stimulate discussion of these problems and more importantly potential solutions.

Acknowledgments

Many thanks to Franzi Roesner, Anna Kornfeld Simpson, and the ever-helpful members of misc@cs.washington.edu mailing list at UW CSE for recommendations and references regarding tools for technical resistance to surveillance; to Lance Bennett, Jeff Chase, Jared Moore, Matt Ziegler, and the LIMITS referees; and to the University of Siegen for funding the SEED workshops, which started the authors on this project.

5 Problems with Surveillance Capitalism and Possible Alternatives for IT Infrastructure

Abstract

Over the past two decades, the business model of surveillance capitalism has emerged in the IT industry. This model has turned out to be highly profitable, but, if left unchecked, will very likely undermine the foundations of liberal democracies and quality of life on this planet. It involve customized advertising and behavior manipulation, powered by intensive gathering and cross-correlation of personal information. There are significant indirect costs of this model, including loss of privacy, supporting surveillance by both the state and corporations, undermining the democratic process, other kinds of automated attempts of behavior manipulation, and excessive consumerism with its attendant environmental costs. Turning to what could be done, we propose a co-development of regulation and technology, as well as the key roles that can be played by citizens and civil society organizations. The regulatory measures are intended to safeguard privacy, require true informed consent, and to foster interoperability (even among rival firms, nonprofit organizations, and others). We also identify key enabling technologies, including open source, APIs to support interoperability and portability, encryption, and peer-to-peer systems. Finally, we discuss the crucial role of ownership structures for these IT services, and argue for an ecosystem approach as a counter narrative to surveillance capitalism.

5.1 Introduction

Over the past two decades, business models have emerged in the IT industries that have turned out to be highly profitable while providing services mostly free of charge for their end users. However, we argue that the economic successes of these business models that have radiated throughout the computing industry have moved it in a socially problematic direction.

In the following section we describe how the business models orient these companies toward amassing huge amounts of data about their users and toward centralization, as well as how their infrastructure innovations reflect and enhance these developments. We then situate the role of these business models in the conflict between growth imperatives and sustainability. Ultimately, they endanger liberal democracies, provide additional tools for surveillance and control to autocratic governments, and threaten the quality of life on this planet.

Next, we outline some possible solutions for these problems. This section is the core of the paper. We suggest a co-development of regulation and technology, along with key roles that can be played by citizens and civil society organizations, to challenge the currently dominant IT business model that is at the heart of surveillance capitalism, and to foster the creation of alternative services that are more aligned with democracy and quality of life. We describe how actions in these areas interact with each other and show where they counteract the problem dimensions that we have identified. In particular, we propose regulatory measures that directly challenge the user surveillance and manipulation, and monopoly position of key corporate actors, that are central to the prevalent surveillance capitalism business model. We also identify key technologies to support this program, including open source, APIs to support interoperability and portability, encryption, and peer-to-peer systems. Finally, we discuss the crucial role of ownership structures for these IT services, and argue for an ecosystem approach as a counter narrative to surveillance capitalism.

5.2 Problematic Developments in the Computing Industry

In the aftermath of the dot-com-bubble, the surviving IT companies had to find business models that would continue providing a growing return to their venture capital funders. In order to keep increasing the user base, it was essential for free services to continue to be free of charge for the end users. Therefore it comes as no surprise that they chose to embed advertisements to generate revenue. However, the way in which they implemented this turned out to make them highly profitable at the expense of a devastating societal spillover. Instead of merely placing ads, user actions were tracked and recorded in large data bases. When computer scientists at these companies invented or refined algorithms to analyze effectively the giant volumes of data, and employed statistical methods (especially machine learning algorithms) to derive predictions from user profiles, the result was a new business model that turned out to be so profitable that even companies that were financed by fees also adopted this practice.

There are four phenomena taking place simultaneously. First, the companies are gathering enormous volumes of potentially relevant raw information by tracking the user, potentially including actions taken in the browser, contact addresses, mobile location, and more. Second, if the records that belong to a given person can be connected during a series of visits and between different websites or applications, a far more sophisticated user profile can be generated. This is the reason these websites use trackers that are able to track the entire activity during the browser session. It is also a reason that Facebook and Google are highly motivated for users to use their Facebook or Google accounts for identification with other service providers. Third, the correlation of many of these detailed user profiles makes it possible to make statistical predictions about user behavior, and thereby make sophisticated assumptions that are not even necessarily limited to what the users themselves are conscious of [172]. Because of this intra- and inter-personal connection, new data is more valuable the more it can be correlated with already-held data. As a consequence, a network effect occurs that amplifies the

centralization of data.

A fourth practice that is becoming increasingly relevant is the manipulation of user behavior on the basis of that data. A detailed knowledge of the environments to which a given user can be most usefully exposed to increase the probability of a desired behavior leads to a whole new category of customers. In addition to classical product advertisement, the companies can now offer political influence, particularly in general elections. If the desired user reaction is no longer limited to buying a certain product, but also to nudges toward adopting a certain political opinion or voting in a certain way, the IT companies have deployed a tool to help wield power and control over society. This shift from merely advertising goods and services to political influence would only be accelerated by a regulation that tackles merely the commercial advertising part. We do not attempt to quantify in this paper to which degree these companies have already performed this shift. The point is, instead, that they have the incentive to do so and that is highly problematic.

[1, 18] has named this business model "surveillance capitalism," and we use this same term here as well — and agree that this is a model with far-reaching and highly negative consequences. The problems of surveillance capitalism are not simply issues of surveillance and loss of privacy. Rather, it is in addition an attempt at a radical and ominous automated manipulation of behavior that is undermining sustainability, democracy, human dignity, and much more.

We adopt Zuboff's definition of surveillance capitalism, with two modifications. First, we want to extend the definition to include corporations whose business centers on selling goods and services to end users, as well as on corporations offering services at no cost to them. The key elements that differentiate these businesses from others are the intensive collection of personal data, in particular the "data exhaust" of additional information produced as a by-product of the user's primary activity, tracking and cross-correlation between multiple contexts, and attempted behavioral manipulation based on this data. Second, we take an interactional stance on the question of the degree to which people can be manipulated by social media and other services, in analogy with the interactional stance taken by value sensitive design [21, 22] regarding technology and human values. Thus, corporate manipulation of (for example) news feeds and content doesn't rigidly determine particular responses by the users; but on the other hand, the design of the feed is certainly not neutral either.

This orientation of IT companies not only produces centralized data silos, it nudges power relations toward centralization as well. Furthermore, it has resulted in the creation of technological infrastructures that have significantly shaped the software industry during the last two decades.

5.2.1 The Technological Infrastructure

The success of this data-gathering business model required the development of infrastructure that was able to integrate a wide range of data sources and to store large amounts of data. Amazon and Google were the first to open these extensive server structures, along with sophisticated programming environments and information on how to use them, to

external companies and individuals as a separate profit-making business. In some cases, basic services are offered for free (Google Cloud) and monetized via the gathered data, whereas more extensive services are offered for a fee. The largest market shares are held by Amazon Web Services, Azure (Microsoft), and Google Cloud. Even though they found a business model that does not rely on advertisement and manipulation, all of these services are still based on a centralized data architecture and increase the power and reach of the surveillance capitalists. This is because they successfully established an infrastructure that an increasing part of the economy depends on: which companies that have integrated cloud services into their work flow are prepared for the case that their service provider would suddenly deny the service?

In addition to storing the data, its effective evaluation for monetization required new kinds of algorithms. Targeted advertisements and other means of adaptive functionality are based on the evaluation of all the available personal data. In addition, particularly for social media platforms, desired functionalities such as page rank, news feed algorithms, and content moderation require a certain degree of individualization. All of these would be much too costly to do manually; the desired individualization conflicts with the standardization and uniformity of the scaling big imperative. This conflict was reconciled by using machine learning. While machine learning has existed in some form for decades, these centralized and data intense platforms offer vastly more data and opportunities to train neural networks, along with an application domain and funding, to enable an explosive growth in research and development in this area.

The trends in the computing industry of cloud computing and machine learning are therefore intertwined with the large IT companies' orientation towards surveilling their users and commercializing the resulting software and infrastructures. Language recognition is an example that demonstrates how the functionality developed in support of the business model evolves and feeds even more data into the data silos. For instance, many people allowed (even paid for) an Amazon or Google device to record them continually in order to benefit from voice controlled services. Another example is face recognition, which makes cameras a significantly more powerful tool for the end user, thereby incentivizing their usage, which yet again feeds in more data. (They are of course at the same time a significantly more powerful tool for surveillance.)

We therefore categorize cloud computing and recent forms of machine learning as enabling technologies that in part emerged from and that feed into surveillance capitalism. In addition, we see cloud computing as another locus of control that surveillance capitalism moves into. The currently dominant loci of control can be considered to be mainly the free services of social media and browsing. They are both the battlefield and the weapons with which surveillance capitalists fight for influence. It is worth looking not only at how this infrastructure is used to generate revenue streams, but also at the selective denial of its use to exercise power.

5.2.2 Problems for Democracy and Sustainability

Following the post-war decades of fast growth, since the 1980s, Western economies have experienced rather low growth rates on average [173]. Under the conditions of rela-

tive saturation all means that can stimulate consumption become very valuable. The high stock market value of platforms whose economic models incorporate elements of targeted advertisement seems to support this assumption. The increasing effectiveness of customized advertising (even if only a modest increase) fuels the imperative for consumerism and unending growth. While the generation of artificial needs is valuable to the advertising companies that can serve them, it has a destructive influence on individuals as well as society as a whole.

For a more detailed discussion of this influence, we refer to other sources [174, 18, 31]. In summary, the current business models have a specific effect on the orientation of these IT companies; in particular, they lead to intensive gathering, tracking, and correlation of personal data. Problematic outcomes are encouraging rampant consumerism (which is incompatible with living sustainably on the earth), and behavioral manipulation targeted at individuals that undermines any democratic system.

Note that none of the problems is entirely new. Strategies to influence human behavior are at least as old as civilization; the same is true for the exploitation of nature for human consumption. [166] also rightly notes in his critique of Zuboff that capitalism has actually been working in the same way for a long time: "To view surveillance capitalism as our new invisible Leviathan is to miss how power, under capitalism, has been operating for several centuries." However, what we do claim is new is that now tools exist to implement these strategies (e.g., attempted manipulation of political convictions) on a larger scale and with fine-grained targeting based on detailed knowledge of individuals. The question is therefore what to do about these powerful tools and the way they are used.

Despite the very dark sides of surveillance capitalism, at the same time these services have enormous utility for business, social engagement, political work, and much more. So in any potential approach to address these problems, we want to retain as much as possible the benefits. Instead, regulations should address the dominant business model and allow for different technological paradigms to flourish. With different business models we will hopefully see a different computing paradigm and thus different innovations emerging from it. In this way, political regulation should impact the direction of the IT industry.

5.3 Possible Solutions

Turning now to what could be done, one goal should be to limit the damage done by the surveillance capitalism business model, while still retaining key benefits of the services it provides. But if possible, we would like to move beyond damage control, and support positive visions of how IT can better support people and communities. Crafting and deploying such solutions is an exceedingly difficult problem. Even though this business model has only recently come into being, the corporations practicing it have become dominant, and the technologies and services are threaded throughout our lives, communities, and economies. Regulation will be a key element of a response. However, regulation should not simply be a reaction to technology and an attempt to curb its worst

excesses: technology should not be taken as a fixed, external force that will inevitably follow a particular path. Nor is surveillance capitalism at its root a technological problem amenable to a purely technological fix. Instead, regulation and technology should be co-designed and co-evolved. Citizens and civil society organizations will play key roles as well, by pushing for more effective regulation and supporting technologies, by helping to foster alternative models for providing needed services, and by adopting new social practice.

5.3.1 Regulation and Law

Regulation and law form key elements of possible solutions. We suggest four principal goals for regulation: protecting privacy, erecting barriers to behavior manipulation, protecting free speech and civic participation, and (probably most controversially) undermining the economic basis of the surveillance capitalism business model so that alternatives can take root and flourish. Having such alternatives should lessen the dependence on these IT companies, while still having a way that people and society can have access to useful IT services — and beyond this, support positive visions of the role of IT in communities and society.

The General Data Protection Regulation (GDPR) from the European Union, which took effect in May 2018, is certainly a major step forward for protecting privacy. In spite of its limitation to the EU, the European user base is large enough that this is having a meaningful influence on the behavior of the major corporate players. However, if the result of such regulation is merely requiring users to give consent, it is not particularly helpful unless there are meaningful alternatives they could switch to.

Another area of legislative activity is do-not-track legislation. The general goal of these bills is to allow users to decide whether or not they are willing to be tracked by third-party websites while browsing websites and potentially while using other internet-based services.

True Informed Consent

One reaction to privacy concerns is to implement much stronger requirements for informed consent, of which the GDPR is one important example. Improving information and consent is certainly a good thing, but in our view is inadequate. Being deluged with pages and pages of consent agreements about what information is being gathered about you isn't that useful, and if the alternatives are to check the "agree" box, or to be left out of a great deal of social and political interaction, this is not a particularly meaningful choice. However, stronger implementations of consent are possible.

As a thought experiment, suppose that surveillance capitalist corporations were required to operate under the same conditions that govern research involving human subjects. For example, in response to past abuses, the US government adopted the Belmont Report [175], which laid out principles for human subjects research. It requires true informed consent, which must be voluntary and ongoing. That implies that the consent form must be straightforward and comprehensible — so no 30 page legal monstrosity as

with typical corporate privacy statements — and the subject must be able to withdraw from the experiment at any time. Further, only data needed to conduct the study should be gathered, and must be deleted once the study is over and analysis is complete. The data must also be held confidential and protected — it would be forbidden, for example, to hand it over to another research group without consent.

If similar requirements were placed on surveillance capitalist firms, they would require true informed consent, the ability to withdraw one's data at any time, and would not allow the data to be shared without permission with a third party. People should be able to challenge inaccurate information and have it removed. Note that today people do not even have access to a transparent overview of how their private data is trapped, transferred, sold and aggregated. Therefore, as a prerequisite, these data pathways need to be visible for the user and the public regulators.

Further, in analogy with the human research requirements, only the data needed to provide the service in question could be gathered, but not the cloud of additional data that is gathered and retained as at present. In other words, what we advocate includes (but is not limited to) the concept of "minimum data." These corporations should not be allowed to collect data that is not necessary to provide their service. However, minimum data alone could still leave loopholes for service providers, e.g., they could claim all personal data collected is necessary for AI-powered algorithms to provide a service optimized to personal needs. Therefore, true informed consent in analogy with human research requirements exceeds the minimum data approach. Finally, the requirements should be much stronger for children and vulnerable populations (e.g., prisoners). For example, in many cases the companies should simply not be allowed to accumulate information on children.

Again, this is just a thought experiment — wishful thinking, perhaps — but is intended to show how regulation might more meaningfully support privacy in these services.

Adversarial Interoperability

The current IT landscape is dominated by a very small number of companies in monopoly positions. Breaking up monopolies would be a useful step in ensuring that users are not too dependent on a single service provider. However, in our view, simply splitting Facebook, for example, into 6 mini-Facebooks, each with the same surveillance capitalism business model, would not be a particularly effective approach. Better would be to break up companies along functional lines, and to regulate the exchange of information among these now-third-party entities. For instance, Facebook could be required to divest from the essentially unrelated parts of its business, including Facebook Messenger, WhatsApp, and Instagram. However, just doing that, each sub-company could hold a monopoly in its niche, so a comprehensive approach must go further. And given the network effect and the resulting centralization mentioned above, which are prevalent for Internet platforms, reverting to a monopoly situation is the most likely outcome without additional regulation and oversight.

Interoperability is one key to reducing the user's dependence on the corporation or organization providing the service, as well as increasing the ability of small competitors

to improve upon single features or to serve specialized markets. In his recent book *How to Destroy Surveillance Capitalism*, [31] uses the term "adversarial interoperability" (or "competitive compatibility" [20]), capturing that interoperability cannot be expected to be implemented voluntarily by for-profit companies if doing so might reduce their profits. But having such interoperability would make it easier for for-profit competitors to enter the market, as well as nonprofit or public entities, and therefore should be legally enforced. [31] argues: "If our concern is how corporations are foreclosing on our ability to make up our own minds and determine our own futures, the impact of dominance far exceeds the impact of manipulation and should be central to our analysis and any remedies we seek." His position that enforcing antitrust legislation in this domain is an important one, although we would add that protecting against surveillance and manipulation is equally important.

Antitrust law may provide a suitable means for motivating requirements for adversarial interoperability. We are not experts in the law, but we can say that it will probably not be enough to apply existing antitrust law consistently to the case of IT services; new regulations will also have to be added. For example, antitrust law as currently interpreted aims at enforcing fair prices for customers. This does not cover the case of free applications, in other words, the users who should be protected are not even the customers in this case.

Since these measures directly attack the power position of IT companies, countermeasures are to be expected, including extensive lobbying and media campaigns, as well as the continuing instrumentalization of intellectual property laws. For example, even if an IT service were involved in the creation of content, it should not be granted any intellectual property rights to it. Otherwise, Facebook, for example, could use intellectual property law to prevent users from scraping their own content and uploading it onto competing systems. The same is true for cloud computing providers. Therefore, IP restrictions are quite consequential and must be considered in responding to the expected countermeasures. However, intellectual property is just one way in which law is used to create abstract forms of capital. In her recent book *The Code of Capital*, [176] shows how the law selectively codes claims and ideas into capital. All of these forms need to be considered as expected legal countermeasures big companies will apply against regulation. Furthermore, investigations and whistleblowers will be necessary for identifying misconduct. As a consequence, there should be compensation paid, and since one of the aggrieved parties is society as a whole, it is easily justifiable to channel this compensation into the development of alternatives, as one source for funding for them.

Consequences for the Business Models

The regulations we suggest would significantly challenge the surveillance capitalism business model and help to foster alternatives. Let us therefore consider which business models would still be possible under such regulatory regimes.

We can conceptualize the evolution of the business models that have led to surveillance capitalism as taking place in stages. There is a stage of broadcast advertising with a general audience, followed by a stage of context specific advertising (this would include

advertisements based on the current behavior, such as the terms entered into a search engine). A third stage is targeted advertising (this would include personal profiling), and a fourth stage is targeted manipulation that is not limited to advertising consumer products but includes influencing political opinions and actions. The shift from context specific to targeted advertising marks the location of a suitable line to draw and challenge surveillance capitalism by prohibiting advertising based on personal profiling. However, even if advertising were to be dropped completely, control over the infrastructure could still be used for attempted behavioral manipulation, and for censorship or selective denial of service (e.g., AWS withdrawing support for Parler), with all the resulting political problems. Prohibiting targeted advertising makes the monetarization more difficult and thereby reduces the incentive to gather this data. Yet, it does not address the full problem. Our suggested directions for regulation, grounded in true informed consent and adversarial interoperability, would make targeted advertising as a basis for business untenable, but that is not the only issue. This regulatory direction is also more adequate to deal with an expansion of the arena in which surveillance capitalism is played out (from free services to offerings such as cloud computing).

The business models that are still viable under such regulations include for instance traditional (context specific) advertising and paid services. This would help avoid undermining services whose business model does not rely on behavioral manipulation, the highly profitable cloud computing business being one example in this category. The benefits from the enabling technologies can thus be preserved while liberating them from their role as surveillance capitalism suppliers.

The Role of Content Moderation

A central feature of many proposals for regulating social media is content moderation. In our view, some content moderation is necessary: for example, social media should not allow child pornography or live-streaming mass shootings. Nevertheless, we should keep in mind that Facebook's algorithms, which tend to incentivize for extreme content, exacerbate existing social problems and divisions, but don't cause them to spring into existence from nothing. And overall, content moderation has significant limitations. For example, political truth can be hard to pin down. Putting the requirements for content moderation on the tech companies will likely stifle smaller companies entering the field [31]. Furthermore, the companies might over-censor to be on the safe side, or use content moderation to censor arbitrarily according to their own agenda. In a quasi-monopolistic situation for social media, we view it as unacceptable that private companies can determine who can publish what (e.g., Twitter and Facebook closing down Donald Trump's accounts). So indeed, we need some content moderation to curb extreme content. However, content moderation alone will not be sufficient to tackle the problems of surveillance capitalism and social media, and in some ways is a red herring that distracts us from the real problem: the business model and its consequences.

Property Rights for Private Data

Finally, we want to make note of the approach of modeling private data as a good to which people have property rights and can sell. The idea is that users could then benefit from the profit made on their data. We view this approach as problematic. Most importantly, fundamental rights, such as privacy, should be above the market and not embedded in it. In addition, people would receive little for their data, due in part to the asymmetric market situation. Finally, none of the problems for democracy and sustainability would be addressed by this approach.

More generally, current legal frameworks seem incompatible with the very idea of data ownership [177]. When data is created by an amalgamation of different technologies and people it is questionable who the owner should be. Furthermore, as information, data can be copied and processed arbitrarily. If various data sources are processed into further data using analysis methods, who would have ownership claims over them? The inevitable legal inadequacies [178, p. 117–119], as well as the impossibility of perfectly protecting against eventual data leaks, are both strong indicators that many data should better never be gathered in the first place.

5.3.2 Technology

As noted at the beginning of this section, in this endeavor, technology should not be taken as a given external force, but should instead be co-developed as needed, along with regulation and support for new social practice. Fortunately, technology that can support good alternatives to surveillance capitalism already exists — it is instead a matter of adopting and applying it. However, there are many opportunities for additional research and software development to support the regulatory work and possible societal shifts, and perhaps to develop even better alternatives. In addition, the interoperability requirements proposed in the section on adversarial interoperability would allow much more experimentation and exploration of novel technical approaches.

Here are key existing technologies for the program proposed here:

- open source
- APIs to support adversarial interoperability and portability
- encryption (e.g., for storing backups on a central server)
- peer-to-peer systems

For portions of the digital ecosystem that form the underlying digital commons in particular, *open source* means that the source code can be easily inspected, shared, and built upon by others.

APIs to support adversarial interoperability and portability are key to enabling a flourishing ecosystem of different applications that can function together, and that allow end users to move to different providers. At the infrastructure level, standard APIs support the notion of a commons, while at the application level, good APIs can support

interoperability of such things as different social media systems (e.g., the ActivityPub standard). In general, interoperability counteracts overdependence on the part of users on service providers and reduces the possibilities of cutting off innovative competitors.

Another key technology is *encryption* to guard user privacy. We earlier mentioned that cloud computing is a key enabling technology for surveillance capitalism. However, we do not go so far as to argue that everyone should keep all of their data on personal devices, backed up on memory sticks kept in a shoebox in the closet. Centralized, reliable storage, with redundancy and good backups, can provide useful functionality without surveillance, if what is being sold is simply storage capacity, with everything encrypted (both what is stored and what is transmitted back and forth). With a separation between basic infrastructure that can be rented (analogous to "dark fiber" of internet service providers), and the applications and content that use this infrastructure, users reduce their dependence on their cloud computing providers without sacrificing the benefits or needing to become system administrators themselves. Overall, we want any technical solutions that are intended for general use to only require commonly available skills.

Finally, *peer-to-peer* systems can be an important tool for avoiding central control altogether in some situations. There are many platforms that label themselves as peer-to-peer, because peers do communicate with each other, but with the communication mediated via central servers of the platform provider. Such platforms are thus peer-to-peer only on a very superficial level. Instead, what we consider here are comprehensive peer-to-peer systems, which mean that the service provider has no way of stopping peers from using the application to communicate directly. Note that this is a very strong requirement, and not every medium of communication needs to be decentralized to this extent, nor may it be feasible. Nevertheless, this as an effective pattern, particularly when there are significant imbalances of power and risks of coercion, censorship, or control.

For social media, Mastodon, Matrix, and Diaspora* are all examples of donation-based social networks that use some kind of federated server structure. Besides of course adoption and the network effect arising from Facebook's dominant position, for some of these architectures there are also problems with scaleability. Furthermore, there is still a power imbalance between users and the federation. Federating these structures is a step in the right direction, but decentralization does not stop there. Some applications that go beyond federation and use truly peer-to-peer networks include Secure Scuttlebutt (a self-hosted social media ecosystem) and Aether (which additionally introduces an election process for moderators of different communities and makes posts ephemeral). All of these have been designed from an awareness of problems of current social media, and all use some kind of peer-to-peer protocol in response. As a consequence, identity is not proven via passwords stored on a central sever, but by cryptographic signatures. This not only fulfills the minimum data requirement naturally but exceeds it in the way that there is no monolithic data accumulation and no central entity to monetize it. Another important design choice concerns which content will get high exposure. In place of the machine learning supported algorithms that tech companies apply today and that are optimized for users maximizing time-on-site, other, different models and metrics are being tried. Interoperability helps to create an ecosystem in which users can

choose and experiment with the algorithms that work in their best interests.

As a counter-design to corporate clouds, a variety of alternative models should be investigated. One important such example is the SOLID project [1] at MIT, headed by Tim Berners-Lee. In the context of alternatives to cloud computing, we propose that distributed ledger technology (DLT) play a key role in implementing truly peer-to-peer structures.

If these technologies are sufficiently easy to use, they can help bring about a shift in social practices. At the same time, the open source approach increases the formative influence that social movements can have on the technology ecosystem. As mentioned, the emergence of technological alternatives depends on the regulatory framework (and may even be funded partially through punitive damages). However, technical tools can also be developed to help detect illegal behavior (under the regulatory regimes proposed here). These are just a few examples of how transformations in technology and law are mutually reinforcing.

5.3.3 Suggestions for Citizens and Civil Society Organizations

We have suggested that regulation should be co-designed and co-evolved along with the technology. In this section, we go on to make some suggestions for citizens and civil society organizations that may help marshal support for more effective regulation, counter some of the excesses of the current business model, and foster alternative models for providing needed services. Social practice can of course not be designed and imposed in the same way that regulations can be. Nevertheless, social practice evolves and is molded in part by education, regulation, economic forces, and other influences; and we can investigate how these interact, and design technology and regulation to support positive social practices and underlying values.

Education

One key step toward finding solutions is for people to understand how these services are being funded, what kinds of information is being gathered about them, how their behavior is being manipulated, and the consequences of all this. A great deal of the rhetoric from the corporations using a surveillance capitalist business model has focused on individual choice, limitless access to information, empowerment, and personalization; but we view these as hollow kinds of choice and empowerment.

It is essential that the education process continue, with ongoing discussion and exposure of the extent of surveillance and political and other behavior manipulation. It is also important that we do not fall into the trap of assuming such a world is now normal and acceptable. However, neither being in a state of numbness or grudging acceptance, nor being in a state of continual outrage for years, are attractive alternatives. We also need positive visions of how we can use information technology to support human flourishing without surveillance and manipulation, and the collective political will to move toward those visions.

[1] https://solid.mit.edu/

Resistance

There are several potential goals for resistance to surveillance capitalism, including personal integrity, undermining the profitability of this business model, and raising awareness and calling people to action. Trying to maintain personal integrity is of course important as an end in itself, and also in helping avoid having surveillance become normalized. Resistance can take a variety of forms. One is to simply not use certain parts of the IT infrastructure, e.g., the #DeleteFacebook movement. This certainly has merit, however, it also recasts a political issue as a willpower issue [156]. And it seems simpler to delete Facebook than for example Google, given Google's pervasiveness.

Finally, there are various kinds of technical resistance that seek to avoid being tracked, or to disrupt surveillance. These include such tools as ad blocker plugins and other anti-tracking browser extensions, sites that analyze how well a a user's browser protects against tracking, and even a tool that simulates clicks on every blocked ad to generate a stream of meaningless data that obscures the user's actual interests and behavior. See our earlier paper [174] for technical details.

Stepping back, one is struck by the considerable effort that is going into these technical approaches to resistance, how complex the solutions are, and the extent to which there is a cat-and-mouse game going on between the trackers and the tracked. Ultimately, the most important role for such technical resistance may be as part of education and helping build pressure for more comprehensive change.

5.3.4 Funding, Ownership, and Control

Under surveillance capitalism, much of our IT infrastructure, such as search, email, and social media, is funded by advertisers, with a small number of corporations owning and controlling the infrastructure. What happens if the business model of surveillance capitalism is undermined?

First let us consider ownership. Here it is appropriate to separate out different categories of things that might be owned:

1. Physical infrastructure, including servers, buildings, networking equipment, fiber optic cables, and so forth (plus of course the end user devices such as laptops and mobile phones)
2. Software, including both system and application software
3. Data
4. Protocols and standards

Different considerations apply to these different categories. Physical infrastructure will generally have a person, organization, or government who owns and maintains them. For software, open source provides an important model, since then the source code can be easily inspected, shared, and built upon by others. In addition, it simply bypasses many of the issues around ownership. Open source projects still need contributors and

governance structures, so the question of control remains, but in a different and easier form. The issues around data ownership are complex, as discussed earlier as well; and in many cases, it seems better not to gather or retain the data at all. Finally, protocols and standards are good candidates for governing structures such as open, participatory processes involving all the affected stakeholders and managed by publicly accountable bodies.

Of course, at present often a single large surveillance capitalist concern owns and controls all of these — but unbundling is likely to be one part of strategies to curb their power. In addition, adversarial interoperability will allow experimentation with multiple models and evolution of approaches.

We now outline some alternatives for funding and controlling IT infrastructure.

For-Profit Corporations

One option is for-profit corporations. We earlier suggested that the shift from context specific to targeted advertising marks the location of a suitable line to draw and challenge surveillance capitalism by prohibiting advertising based on personal profiling. However, for-profit corporations could continue to offer these services, supported by advertising, including context-specific advertising, just without personal profiling. Another funding option is fee-for-service. These options are thus still very much capitalism, just not surveillance capitalism.

There are existing corporations that use these models. Two systems to be noted in particular are Brave[2] and DuckDuckGo[3]. Brave is an open-source browser that (the company says) blocks ads and trackers, in both mobile and desktop versions. The DuckDuckGo search engine, according to the company, does not collect or share personal information. Its business model is still based on advertising (and also affiliate marketing).

Another option is to nudge the market by having institutions such as libraries, universities, and others buy ad-free, no tracking versions of services for their patrons/students, either from new companies, or from existing large IT corporations if they are willing to unbundle their services to support this. (Note that it would be essential to monitor the corporations carefully to ensure they are not tracking these users [164, 165].)

Public Funding and Public Control

Another alternative is public funding. This of course brings with it the danger of manipulation by the state. However, there are a number of models for government funding of information that provide a guaranteed revenue stream and insulation from immediate political pressures. One example is the public radio and television systems that exist in many countries, including Germany and the UK; another is the subsidies to newspapers that existed in the U.S. in the 19th century via subsidized postal rates and tax policy [167]. Or there could be other programs that emphasize individual choice and responsibility. For example, "journalism vouchers" could be issued to every resident that

[2] `https://brave.com`
[3] `https://duckduckgo.com`

would allow people to provide grants to investigative journalists, whose work would then appear on social media and other outlets.

Related choices concern encryption software and crypto-currencies. Should there be trapdoors that allow duly authorized security forces to have access to encrypted contents? Here we would argue they should not: we simply disallow that power by technical means. (Again, this is not an issue with an obvious answer and no tradeoffs — this choice means that actual terrorists would have access to secure encryption that shields them from intelligence services, as would everyone else.) Similarly, if crypto-currencies are set up to truly provide anonymity, there are obvious benefits; but they can also be used for example by criminals who have placed ransomware on hacked systems to get untraceable payments.

NGOs and Cooperatives

Another possibility is having other societal institutions that control the service. If the continued existence of such institutions is insulated from day-to-day changes in public opinion, this removes one source of pressure to engage in propaganda or surveillance. One possibility here is NGOs (e.g., the Mozilla Foundation, which is the sole shareholder in the Mozilla Corporation). However, being a nongovernmental organization does not automatically guard against conflicts of interest arising from funding, nor does being an NGO automatically mean the organization will be benevolent. [168] advocate placing these alternatives in the hands of worker cooperatives. Using this model, more of the relevant stakeholders would be included in the ownership model, particularly if it also includes the end users of the infrastructure.

No Funding or Minimal Funding

Freely contributed work is another alternative, at least for intangibles such as software and data. Examples such as Wikipedia and OpenStreetMap show how an enormous amount of knowledge can be contributed by volunteers, perhaps along with funding for hardware and support staff. Such a model can work well if a clear structure is provided that guides how to arrange and connect the different contributions.

An Ecosystem Approach

Future work is required to paint a positive vision of a paradigm in IT that not only counters surveillance capitalism but also enhances the quality of life. This requires a change from the venture capital driven nature of the IT industry toward one that makes the development of IT more closely related to the real needs of society, including a cultural shift; IT professionals should rethink their role as enablers of societal opportunities.

Our vision of a network of locally anchored software ecosystems based on decentralized software and data architectures could be called an ecosystem approach. Copyright scholar James Boyle has described how the term “ecology” marked a turning point in environmental activism. Prior to the adoption of this term, people who wanted to preserve whale populations didn’t necessarily see themselves as fighting the same battle as

people who wanted to protect the ozone layer or fight freshwater pollution. Similarly this ecosystem approach might mark a turning point for the IT industry, and requirements such as adversarial interoperability could play a role in shaping the currently monopolistic landscape into a system with higher diversity.

5.4 Conclusion

The direction in which the IT industry is moving is highly alarming. The business model of surveillance capitalism, left unchecked, poses an existential threat to liberal democracies, provides further tools for repression to autocratic regimes, and threatens the quality of life on this planet. We argued that this is to a considerable degree a case of companies in monopoly positions playing their users' dependency against them. True informed consent and adversarial interoperability, if implemented and enforced comprehensively, combat user exploitation and monopoly respectively. These regulations must be accompanied by technological development and innovation, along with pressure from citizens and civil society organizations. Our hope is that this will then allow society to move away from reliance on surveillance capitalism to provide basic IT services, and allow alternative models would emerge. Overall, a new paradigm is needed in IT development that is no longer driven by the need to generate high profits through collecting large amounts of personal data and manipulating behavior, but is oriented to serve human needs while staying within planetary boundaries.

Acknowledgments

This research was funded by the University of Siegen through its graduate program "Supply Chains and Economic Development – Plural Perspectives" and the DFG SFB "Medien der Kooperation" (Collaborative Research Centre "Media of Cooperation"). We also want to thank the School of Media and Information for its infrastructure support.

6 Toward Emancipatory Currencies: A Critique of Facebook's Libra Cryptocurrency and Ideas for Alternatives

Abstract

Money underpins everyone's daily life. Possible solutions for the global problems fail if there is not enough money. Yet changes to our monetary system are rarely included in the discussion. Against this backdrop, cryptocurrencies create important new precedents regarding how money can be created. Libra is a recent cryptocurrency project launched by one of the dominant social media companies, which has been the subject of intense international discussion. Because the details of Libra are not yet fully specified, we present different scenarios of how a successful Libra currency might play out and some of the problems that might follow. These scenarios include the monetization of the payment infrastructure, (ab)use of sanctioning power, a reduction of the reserve ratio, and an abandonment of reconvertability. These problems suggest a number regulatory strategies in response. Finally, we describe values and design requirements that might help guide future cryptocurrency innovation and provide ways of evaluating their success or failure.

6.1 Introduction

Bank failures and recession are intrinsic to our global financial system from the beginning. But at least since 2008 it is in an ongoing crisis. The banking sector is characterized by too-big-to-fail banks that are interconnected covertly into a highly fragile system that the global economy depends upon. This fact lead to a flourishing of reform proposals. On the 18th of June 2019 Facebook announced its plans to release a cryptocurrency called *Libra* over the course of 2020 [179]. For this purpose the Libra Association was founded, a group based in Geneva that is planned to consist of 100 members upon release. The announcement already included a list of 28 participants, among them were the payment service providers VISA, Mastercard and PayPal, as well as commerce in form of ebay, Uber, Spotify and strikingly no ordinary bank. In October 2019 Booking Holdings, eBay, Mastercard, Mercado Pago, PayPal, Stripe and Visa Inc exited the Association. Thereafter, Vodafone joined, but left again in January 2020. Since then, seven more members joined resulting in 27 total members at May 14th 2020. In April 2020 the Whitepaper was updated with significant changes to the Libra Reserve and in May the Libra Association appointed Stuart Levey as a CEO [180].

As a cryptocurrency that was developed by a dominant social media company and carried by an association of renown enterprises, Libra is intensively discussed in politics and media. The heated discussion however mostly focuses on the justified privacy concerns [52], or demands that the issuance of money stays under central bank control [53]. The following section will relativize to which degree this central bank control even is the case today. But in addition, further academic discourse is important, to develop criteria that future and present currency innovations can be measured against. After all, it can be expected that over the next years other non-central-bank actors will follow in the attempt to establish future currency systems and the Libra discussion can be developed into a precedential case.

The exits from the Libra Association as well as the update to the Reserve could be related to the regulatory headwind, due to which the currency design of Libra is also up to change. Furthermore, in this open process not only the eventual members of the Libra Association remain to be seen, but also the general adoption and possible further changes to its currency scheme. This uncertainty is further enhanced by the unforseeable consequences of the response to the COVID-19 pandemic. For this reason our discourse will use different future scenarios that are compared against a spectrum of regulatory approaches. For their assessment a more nuanced perspective on money issuance, that acknowledges the respective threats as well as potentials, is required. As a result of the analysis we are able to derive criteria that future currency systems can be measured against.

From the authors perspective there is a potential for emancipatory currency innovations, but an even bigger risk of loosing sovereignty and becoming further dependent on a small number of private corporations. This puts weight onto a considerate handling of the topic.

6.2 State of the Art: Digital Money

6.2.1 Monetary Theory

What money really is, is highly contested in economic theory. Usually instead of a theoretical conceptualization merely the functions of money are enumerated: a medium of exchange, a store of value and a unit of account. After all the defining aspect is, what people use as money. It is well put with the saying *money is what money does*. Nonetheless different schools of economics do have their view on how to deal with money, regardless of its definition. Concerning the questions of money creation which are relevant here we can characterize the discussion by five interrelated divides.

First and foremost, there is the question of the *neutrality of money*, the idea that changes to the stock of money only affect nominal prices and have no impact on real economic activity. Although the assumption of neutral money underlies some mainstream macroeconomic models, like the real business cycle model, today most economists admit that there are at least short term real economic effects. However, many schools of mainstream economics still believe that the neutrality of money holds in the long term. Other schools of economic thinking fully deny the neutrality of money even in the long

run, like John Maynard Keynes and the Austrian School economist Ludwig von Mises.

Among these critics, but not limited to them, there is debate about the *essence of money* being characterized either as credit or as an abstraction from barter. The barter or commodity theory is held for example by most Austrian School economics, who in a consequence often support a monetarian system which is backed by gold - being a highly valued commodity. By contrary, parts of the Keynsian school of thinking support the credit theory of money where money is the social construct of credit printed into a transferable form.

A third divide ranks around the macroeconomic *purpose of money*. Among others the Keynesian school of economics views money as a central instrument to steer the economy. By contrast, from a monetarist perspective, money is often metaphorically characterized as a lubricant for the economy, an sufficient amount of it is required to overcome regidites, but further manipulation is likely to be counterproductive. Monetarists thus argue for central banks controlling the money stock. e.g. according to the Monetarist and Neoclassical economist Milton Friedman's k-percent rule that fixes a constant monetary growth. Also leaning toward the lubricant characterization, but in private hands, Austrian School economist F.A. Hayek argues for a Denationalization of Money where privately issued currencies compete for the trust of the general public [181]. He argues that the most soundly managed currency would persist. Both authors later differentiated their position.

Similarly, not even on the *origin of money* there is an agreed upon consensus. According to the Banking School money resulted from banks as a service or product for the economy. Contrarily Chartalism believes that money originated from states that were able to back this money by their ability to raise taxes. Tendentially both schools advocate money creation in the hands of the entity it originated from. For example, Modern Monetary Theory, a Chartalist school that recently gained some influence in the public discourse especially in the United States, promotes states to actively use money issuance and redemption as a tool to steer the economy.

Lastly the regulation of the *stock of money* is debated. While Monetarists view money as exogenously determined by the central issuing authorities, Post-Keynesian economics argue how money is endogenously determined by the demand for credit in the economy. With endogenous money creation, even if the amount of money issued by the central bank is too scarce, a working financial system would satisfy the existing demand for credit and thereby effectively expand the money stock. To comprehend this part of the discussion and to give a context to money issued by private institutions, it is necessary to have an understanding of our conventional monetary system.

6.2.2 Our Conventional Monetary System

Today all developed nations have adopted roughly the same two layered monetary system. The first layer is the national currency that is issued by the central bank. The state defines this central bank money as the legal tender and citizens can only hold it in form of cash. The second layer consists of licensed and regulated commercial banks that issue private bank money. E.g. every time a bank gives a loan, it issues private bank

money that is formally a claim on central bank money the account holder has against his bank [39, 40]. The biggest part of the monetary supply exists in form of bank deposits on private banks. This private bank money is convertible into central bank money, when customers withdraw their deposits in form of cash. But banks do not hold central bank reserves for a 100% backing which causes problems, when customers want to spend too much deposits by cash or to customers of other banks. The exact reserve requirement ratios vary between 10% and zero. In this way the biggest part of the monetary supply is issued by private banks, while central banks use key interest rates as one monetary policy instrument officially trying to ensure the currency's stability in value. However, since the financial crisis of 2008 central banks have successively expanded their repertoire of measures to prevent a collapse of the banking system. For example, they directly affect the stock of money by tools like Quantitative Easing. However, according to the Bank of England and the European Central Bank, these tools are reserved for unusual times [39].

Some heterodox economists hold the opinion that when money is only spent into existence with interest bearing debt, this creates in the economy an obligation to either grow exponentially or fall into a crisis [37]. When growth stagnates, the threatening crisis is postponed by an expansive monetary policy of the central banks. This however threatens to inflate the value of the currency.

In the past the central bank money was itself backed by gold reserves of the central banks, in which the central bank money was convertible [182]. After the Bretton Woods Agreement in 1944 currencies had a fixed exchange rate to the US Dollar and thereby in theory a gold backing. The US central bank's reserve rate that is the fraction of the central bank money for which it holds gold reserves, decreased over the 20th century. When in 1971 France tried to convert their US Dollar reserves into gold, US-President Nixon overturned this gold standard and the Bretton Woods System altogether. Since then, the US Dollar and all national currencies related to it are unbacked. To preserve the trust in the US Dollar as an anchor and reserve currency the US has an interest that trade is happening in US Dollar, i.e. that oil exporting countries accept only Dollar as a means of payment [183].

In the Euro system the national banks have delegated their privilege to create the legal tender and their mandate for monetary policy to the European Central Bank [41]. Nevertheless, in the Euro and the Dollar case the amount of central bank money that could be created is theoretically unbounded. Therefore, the reserves that fractionally back private bank deposits are themselves only paper currencies without any scarcity anchor.

6.2.3 Complementary Currencies

From different angles of critique of the conventional monetary system many local currencies aim to repair different aspects. They realize that money is a social tool that can be designed to fit a purpose. Examples are the WIR [42], the Brixton Pound [43], the Chiemgauer [44], or the Bangla Pesa [45]. While all of them put a different emphasis, such as on an interest free credit creation or on negative interest on cash, they share in

common a focus on the local usability that aims to keep the money circulating locally and prevent it from drifting away to big companies. Often they are merely brooked by the national banks and could be expected to be forbidden, if they would gain relevance on a bigger scale. Furthermore, they generally neither have the ambition nor the capacity to do so.

6.2.4 Distributed Ledger Money

The libertarian view that the banking sector and governments are equally oppressive when they control the monetary system spawned the idea of decentrally issued money. Most people in this early field were influenced in their perspective by the Austrian School of economics (see 6.2.1). Starting with Bitcoin various cryptocurrencies have been developed. A cryptocurrency is a currency for which the payment, the storing and the management is governed by a decentralized computer protocol instead of a central bank and which is secured against forgery by computer cryptography. Diverting from the libertarian ideal of emancipating from centralized institutions private ledger and central bank digital currencies are the responses of the private sector and central banks respectively to the technical advances of cryptocurrencies.

The technological development, however, did not halt with blockchains, nor their application on money and thus further blockchain alternatives have been developed, which are summarized under the term Distributed Ledger Technologies (DLT).

6.2.5 Blockchain Cryptocurrencies

The first generation of cryptocurrencies starts with Bitcoin in 2009 [89] and uses blockchain (see box). In 2014 Ethereum expands the blockchain from a decentralized transaction ledger to a decentralized computer applying so-called Smart Contracts [184]. However, the clever construction of a Proof of Work Blockchain results in two major downsides.

First an increasing market price of the currency, makes mining more profitable up to the point where the amount of computing power invested into mining drives the difficulty high enough that energy costs exceed the expected rewards and further investments are no longer lucrative. Therefore, the market capitalization of Bitcoin correlates directly with the energy consumption of mining. As a result the energy demand for Bitcoin today is bigger than the one of Switzerland [186, 99]. Since a decentralized consensus would not be necessary, if there would be a trusted authority guarding the data, one could argue that the energy cost is the quantified distrust in institutions.

The second downside of a constant block production is the limited space in the blockchain, constraining the transaction throughput of the network orders of magnitude below what would be needed for a globally dominant payment medium. In other words the network becomes less efficient, the more participants it has. This is called the scaling problem.

Most cryptocurrencies rely on a fixed supply. When their value is solely determined by the demand, the currency's price becomes volatile. Such a construction makes the currency vulnerable against value speculation. Although some advocates of cryptocur-

How a Blockchain works

Most cryptocurrencies rely on the same basic architecture as Bitcoin - a blockchain [89]. A blockchain is a form of storing data. Unlike a common database, for cryptocurrencies it is desired that data can only be added to and not removed from the chain. This is because users should be able to write outgoing transactions from their own account into the blockchain, but not delete transactions that have been carried out, because this would come equal to a manipulation of account balances. While this objective could be achieved easily by a central administration, the whole point of cryptocurrencies is not to rely upon any such central authority. This is the most characteristic feature that separates most of these currencies, from virtual currencies that existed before. To achieve decentralization and temper proofness the data is arranged in small blocks, which are connected with a hash function to a chain. The architecture and the properties of hash functions ensure that any changes to the data in one block would require a modification of all subsequent blocks. This property is crucial but not sufficient to make a blockchain temper proof. In addition, a consensus algorithm is required.

Bitcoin and its imitators use Proof of Work as this consensus mechanism. Therefore, only blocks of a certain form are considered valid and those need to be found difficultly and thus energy intensively by computers in a process called mining. Anyone can perform this task and is rewarded by transaction fees and newly created coins. However, the difficulty to mine a block increases the more computing power is globally spent on mining precisely in a way that ensures a relatively constant speed of block production. For Bitcoin, it is about one block every ten minutes.

How does mining help to make a blockchain temper proof? The consensus protocol states that the true blockchain is the longest one that consists of only valid blocks, each of which was mined with an amount of energy spent into it. Because changes to any block would require further changes to all subsequent blocks as well, these blocks needed to be mined again. In other words more energy would be required than the rest of the mining network invested since that point in time. In this sense the amount of energy that is consumed by the miners is precisely what makes the blockchain secure, because an attack would require more computing power and more energy than the whole network.

Something similar can happen, if instead of an attack scenario a part of the bitcoin network would decide to change the rules for bitcoin. In this case they would extend the blockchain in a different way. Both versions of the blockchain could be continued and everyone could decide which one to use. The result are two inconvertible currencies. Whether it happens via an attack or in good faith, such an event is called fork, since the single chain forks into two consecutives. A fork is made likelier when the interests of different stakeholder groups diverge, such as miners, developers, holders and users as a means of payment. However usually the expected loss of trust in the currency that is associated with a fork unites these groups sufficiently. Thus, a fork where both arms being continued, never happened for bitcoin. Ethereum, the second biggest cryptocurrency by market capitalization, did this once in 2017 to revert certain transactions, resulting in Ethereum classic and Ethereum, and it plans to another fork this year, when the consensus protocol is changed from Proof of Work to one called Proof of Stake [185].

rencies may characterize this as the basis for a good investment opportunity instead of a vulnerability. However, it also makes the currency unqualified as a medium of exchange. A common approach is to add a construction that aims to bind the price, at which the currency is traded to e.g. the Dollar, such currencies are called stablecoins. An example of a stablecoin is Tether [115] and the G7 published an investigation of the impact and regulatory expectation for these currencies [114].

One heatedly discussed aspect of currencies is anonymity. Whereas the Bitcoin approach is pseudonymity, meaning that payments are transparent, but only according to the public addresses, to which the real owners are unknown. This approach argues that the freedom to own any number of accounts, together with pseudonymity offers sufficient privacy. Complete anonymity is a feature of cash that can hardly be preserved for digital currencies, since any digital payment needs to leave some trace in order to be verifiable at all. However, Zcash comes arguably close to the ideal of cash utilizing so-called zero knowledge proofs [47]. Another notable advancement in blockchain currencies is Faircoin, which tried to adopt the bitcoin protocol to ecology and democracy [187].

While the problem of energy consumption is specific for Proof of Work Blockchains, all public blockchains share in common the scaling problem. Nevertheless, Bitcoin proved that digital decentralized money is possible and thereby fueled the imagination of money enthusiasts.

6.2.6 Private Ledger Currencies

One answer to the scaling problem can therefore be to make the blockchain not public. For a private or permissioned ledger the distributed consensus algorithm is replaced with a single or a group of authorities that decide, who can read or write data into the chain. Thus, for a currency that is implemented via such a blockchain, all transactions reside with the control of these central authorities. Cryptocurrency enthusiasts would argue that such a construction has lost the advantages that a blockchain was all about. After all, Bitcoin is based on the libertarian ideal of money that is independent of banks and states. Nevertheless, a blockchain pattern can in some cases bring merit in the private or permissioned case, especially when mediated by a group of authorities that trust each other to some degree but not perfectly.

6.2.7 Central Bank Digital Currencies

In recent years the idea of central bank digital currencies (CBDCs) gained some traction [46]. Although central banks already maintain accounts where the registered commercial banks digitally store their reserves, this is not what the term CBDC stands for. Instead, it can be seen as a catch up by the central banks on to the development of our digital monetary system outlined above. One model how a CBDC could be implemented transfers cash into the digital age by giving ordinary citizens a possibility to hold central bank money in a digital form. A particular difference is that CBDCs by default would not preserve the anonymity aspect of cash. Such a step is particularly controversial, since it

is a necessary prerequisite to abandon cash and expand the negative interest rate onto all central bank money.

On this foray Sweden is probably the farthest ahead where for years already in most places cash is not accepted anymore. In February this year the Swedish central bank launched a pilot program for the CBDC E-Krona [49]. In late 2019 the Chinese central bank announced their own CBDC that uses blockchain technology as well [50, 51]. In 2018 the government of Venezuela has launched an complementing oil based cryptocurrency called Petro. CBDCs can be implemented with or without blockchain technology, but the existence of cryptocurrencies as competitors fuels the development of these. It is debated and sensitive to the design choices of a CBDC, to which degree they attack the core business of commercial banks [**Kumhof.2018**]. When people can store their money safely on and transact between their central bank accounts, would they still use commercial bank accounts in a near zero interest environment? Although the reversal of the trend that the amount of money in circulation is controlled increasing by commercial banks, might seem to be in the interest of central banks, they will not dare to destabilize the monetary system by such a step.

6.2.8 Post Blockchain Technology

The essential component for scalability and resource efficiency is to forgo a global consensus like Proof of Work. It is not obvious how to achieve that, while still minimalizing the degree of central authority that is required. Existing solutions include IoTA [107] and Hashgraph [108], which apply directed acyclic graphs (DAG) instead of a single Hashchain as the underlying mathematical topology. As an even older distributed peer-to-peer structure BitTorrent uses Distributed Hash Tables (DHT) to store data in a temper-proof way since almost 20 years. Holochain combines DHTs with hashchains to a data integrity engine that enables trustworthy authentication of data [110]. Without the room to explain the details here, technology that can facilitate a currency in a distributed, scalable and resource efficient manner exists.

6.3 Libra - Description and Prospect

The first part of this section will neutrally describe the proposed structure of Libra as far as it is determined at this point in time on the basis of reviewing the official documents. In the second part we will critically paint future scenarios that relate to the foundation laid in the previous section. This procedure enables us to later discuss regulatory strategies with the long term prospect that is required for the matter of money. Furthermore, we can thereby take into account pathways that are relevant in response to future monetary innovations even if Libra eventually does not take them.

6.3.1 Libra

Libra is not Facebook's first advance in the direction of virtual currencies. Between 2008 and 2013 it was possible to pay platform related services with Facebook credits, a

virtual currency that had a fixed exchange rate to the US Dollar [188]. The reason that Facebook credits did not find wide adoption could lie in the service fee of 30% that was charged, the limited possibilities to spend them, or the missing convertibility back into other currencies. Libra by contrast proclaims to use a blockchain, more precisely it is a permissioned blockchain. The Libra announcement included the publication of a Libra whitepaper [179] and a Libra Blockchain paper [189], on which the following analysis is based.

Similar to Ethereum, Libra enables Smart Contracts by a custom programming language called Move [189]. In contrast, Libra cites the disadvantage of the prodigal energy consumption of Proof of Work as the reason to instead use a private blockchain (see 6.2.6). In a private blockchain only certain members have the special right to be involved in the consensus. For Libra these members are provided by the Libra Association. The consensus procedure only regulates how these prospective 100 parties agree on the ledger state. From the technical protocol of the method used, it follows that a two-thirds majority (in the Libra Association) is required to obtain control over the network. Conversely, the network can be shut down by an at least one-third minority. So neither Facebook nor Calibra, the Libra-Wallet founded by Facebook, controls the currency. Instead, it is the Libra Association where each of them has only one vote in a hundred. Out of this control over the currency on the technical level follows that changes to the protocol can be made with a two-thirds majority. Consequently, it is also stated at the organizational level that this majority in the Libra Association is allowed to change the rules of Libra. How a change in those rules might play out is discussed in the next chapter. For now, it is important to note that here lies a crucial difference between the Libra variant of a private blockchain and consensus methods, such as Bitcoin's Proof of Work. In Bitcoin a rule change would lead to a fork (see 6.2.5) where both versions can be perpetuated and the users choose which one they continue to use. In Libra, there is no way for users to use an old version of Libra, if they for example disagree with rule changes made by the Libra Association. Since the Libra Association wants to minimize this risk of their users dropping out, these measures can only be expected once Libra has established. Let us therefore inspect how the current rules are supposed to instill trust.

Libra currency is only created by a deposit into a reserve, a similar approach to some stablecoins. Originally one Libra currency was proposed with a reserve consisting of a basket of currencies and assets like short term government bonds [190]. In the updated whitepaper there exist different stablecoins, Libra-USD, Libra-EUR, Libra-GBP, etc., each pegged 1:1 to a national currency and with their own reserves [98]. In addition there is a Libra currency LBR that is a collection of the Libra currencies with a fixed rate. We refer to all these currencies as "Libra". In any case the currency is 100% covered by the reserve. In other words money creation does not take place, given that one does not count both, the Libra currency and the reseve as money. The Libra Association decides on the composition and investment of this reserve. This reserve may be paid out against the redemption and thus destruction of Libra. But instead of every user, only selective organizations, such as exchanges, are authorized to make these deposits and withdrawals. They act as intermediaries in trading between currencies. In especially users that want to convert their Libra back into US Dollar for example sell them to an

exchange. And only if the aggregate supply of Libra exceedes the aggregate demand for Libra on that exchange, it will redeem an amount of Libra to the Libra Association that is roughly equal to that difference. More detailed information on how this process works is not yet published. It is worth stressing that users have no guarantee for reconvertibility, the whitepaper merely states that due to a competitive network of exchanges *"anyone with Libra has a high degree of assurance they can convert their digital currency into local fiat currency based on an exchange rate." [189]*

6.3.2 A Prospect

Whether Libra will establish as a relevant system is even more speculative than the involved companies hidden motives. This is not to say that writing about it is pointless, but quite contrary that the answer is wide open, because it depends on the choices that will be made. The success of the Libra project will be primarily determined by the relative adoption of the currency. Therefore, the participation of commerce companies that accept Libra for payments is significant. The acceptance also depends on the regulatory counterpressure. Let us therefore draft different future scenarios to compare regulatory approaches against. For all of them the upcoming decade is a realistic time dimension. As speculative as they might be, we find tangible hints for them in the publications that accompanied the announcement of Libra. As a common starting point, the year 2020 started with an economic shutdown in response to the pandemic. It has the potential to shock the contemporary banking system with first a deflation, followed by a severe inflation, triggered by the central banks expansive monetary response. It would shake up the trust in the stability of Dollar and Euro, enough to let people search for value stable currencies where Libra steps in.

6.3.3 Monetization of the Payment Infrastructure

On the day of the release, David Marcus, head of Facebook's Libra Wallet Calibra and co-creator of the Libra system, stated in a CNBC interview [10] that their plans to monetize Libra is by bringing small businesses and other Facebook users together as customers. This should result in more trade over the platform, which in turn makes advertising more profitable. More generally, it could just be another building block that in order to let a bigger part of the users' lives happen on Facebook and tie them closer to the platform. If this giant with about 2.7 billion users now wants to establish a currency, in a cooperation with big payment service providers, in view of the business model, it seems natural that this is an attempt to obtain more profound user data. After all, data on consumer behavior has the highest quality for personalized advertising. Even if David Markus claims that *[...] this is not how we will monetize it* [10] the full transaction data is in the hands of every member of the Libra Association. Therefore, in especially the sharing of data from Calibra to Facebook, which he promises will not happen, will be unnecessary anyway. In a previous LIMITS paper we stressed the incompatibility of this business model with sustainability and democracy [191].

The Libra Blockchain Paper [189] also announces that in the future it may introduce

a higher transaction or storage fee for the data in the Libra Blockchain. *"We anticipate that as the system is used, eventually storage growth associated with accounts may become a problem. Just as gas encourages responsible use of computation resources [...], we expect a similar rent-based mechanism needed for storage. [...]. We discuss one option that can be applied to any policy that determines at expiration time after which data can be evicted."* The *gas* that is referred to here is a unit, which is used in Ethereum to measure the computational effort to calculate the outcome of transactions in order to pay miners the transaction fee accordingly. If Libra is established, it is likely that one needs to pay the Libra Association for the storage of transaction data. The greater the role of Libra as a means of payment, the more fees can be charged.

It may therefore be that after a relevant part of global economic activity will have made itself dependent on Libra, the Association will heavily monetize the Libra payment infrastructure. As we have seen, various ways to do so exist within the currently proposed set of rules.

6.3.4 Sanctioning Power

One aspect that deserves its own assessment of regulatory considerations, is sanctioning power. Suppose for a moment that Libra were the dominant currency in the future. As the infrastructure provider for such a monetary system the Libra Association would control who is allowed to make financial transactions. For cryptocurrencies like Bitcoin that deploy a Proof of Work consensus algorithm, such sanctions would require the majority of miners to collude and divert from the agreed upon protocol in something called a 51%-attack. With a private Blockchain like Libra uses it on the other hand, the selective denial of transactions does not even require a change to the protocol, but only a two-thirds majority in the Libra Association. The software that is run by the validator nodes of the association members could for example include a preceding filter of addresses whose accounts should be frozen. It solely requires the qualifying majority to refuse to commit any blocks that include transactions from a certain blacklist. It can be expected to remain the way that the vast majority of members in the Libra Association are US companies. Therefore, a US legislation would suffice to freeze the accounts of e.g. all Iranian users.

During the subprime crisis the US government feared an end of the US Dollar dominance in the global financial system. A call for a Office of the Director of National Intelligenc titled Evaluating the Impact of U.S. Dollar Losing its Status as World Reserve Currency indicates that this concern aggravates with the emergence of Libra and CBDCs [**Unknown.2020**]. It may therefore happen that the US legislators on a factual level encourage the introduction of Libra, while publicly voicing a strong regulation, in order to preserve the power to impose sanctions into a post US Dollar era. In this scenario the establishment of the basket LBR-currency may succeed predominantly in the global south, which the Libra strategy targeted under the pretense of financial inclusion [179], but could be globally used for cross border purchases. China would try the same, resulting in monetary proxy wars between east and west emerging all around the globe. As the first mover in a network effect dominated playing field, Libra could

win through in the areas where facebook is the dominant social media platform. That the thereby established sanctioning power lies in the hand of private companies instead of the state would increasingly manifest toward the end of the decade. Even without fundamental rule changes cases of blacklisting could pile up, whenever political actors, even pro US-government ones, interfere with the companies' agenda.

6.3.5 Reduction of the Reserve Ratio

In the above-mentioned CNBC interview [10], David Marcus puts his explanations of how Facebook will benefit first as *in the short term* and then corrects that this will take several years. This can be taken as a hint that there is another, more long-term strategy. Such a strategy is indicated by the original Libra whitepaper [179], in which the backing by established means of payment is justified: *"This approach has been introduced in the past: to help instill trust in a new currency and gain widespread adoption during its infancy, it was guaranteed that a country's notes could be traded in for real assets, such as gold."* As with most currencies the US dollar, even in the days when the system was officially called gold standard, only a partial backing by the central bank's gold reserves existed. This means that not all US dollars could have been redeemed at the same time in gold. This percentage was reduced further during the course of the 20th century. The comment suggests that the Libra will also repeat the path of the US dollar and drop its 100% coverage in the future.

With a reduction of the reserve rate, the Libra Association could benefit from the creation of money. This can be done in practice in different ways and it requires only a corresponding modification of the self-imposed rules by the Libra Association. A crude way would be simply distributing the money paid for the creation of Libra to the members of the Libra Association instead of investing it in the reserve. Another possibility would be for the Libra Association to issue new Libra that is used for investment, similar to the fractional reserve of e.g. investment banks described in 6.2.2. Such changes could happen slowly and stepwise, as loosening rule changes for the Libra reserve. For example, newly created Libra could be used to buy assets that would be held by the Libra reserve. As a next step loan agreements denoted in Libra could be accepted, allowing the Libra Association to lend money into existence. Further steps would be the purchase of real estate or funding investment programs that promote Libras political agenda.

6.3.6 Abandoning the Reconvertibility

Continuing the path of the US Dollar further, in 1971 US President Nixon announced the cancellation of the central bank's obligation to convert Dollar back into gold. In this sense it is conceivable that at some point in time a reconvertibility of Libra into national currencies will be denied. The promise of reconvertibility is crucial, because if it is abolished, the profit for the Libra Association would be tremendous, since all claims on the reserve would vanish into irrelevance. The current construction creates optimal conditions for this step, since only certain qualified intermediaries are allowed to redeem Libra against currencies from the reserve. Those intermediaries can be pressured, not

to use this possibility, or their number could be decreased to those who are submissively dependent on the Libra Association. The hurdle for abandoning the redeemability will thus not be the required two-thirds majority in the Libra Association. The preceding scenario might continue by an increasing number of Libra users becoming suspicious. A run on the exchanges could take place. Because it exceeds the reserves capacity to pay, the Libra Association would announce that to preserve financial stability, similar to 1971, the reconvertibility is cancelled. Vendors would be pressured to accept Libra anyway and the public would turn back to normal. A new financial elite would have established that has an unlimited ability to print money, as long as the public is willing to use Libra, to which they are manipulated by the entirety of the online environment they encounter.

6.4 Discussion

Facebook's business model is based on the accumulation, evaluation and monetization of the personal data of its users, for which the service is free of charge. That may sound harmless to some people. However, how this business model results in consequences in the form of consumerism, social fragmentation and political manipulation, is described in Zuboffs book and summarized in the authors previous LIMITS paper [191, 2].

The fact that no classical banks are involved in the Libra Association can be taken as an indicator that the project is rather an attack on the banking sector. Compared to the tiny reserve ratios of banks, the Libra Association holds a 100% reserve and offers with Libra a medium that is faster transferable than bank deposits. When a significant part of the liquidity in the economy would be held in form of Libra instead of bank deposits, it would be at least as impactful on the banking sectors business as ordinary citizen using CBDC accounts at their central banks [**Kumhof.2018**]. The members that left the Association in October represented the payment sector. Their exit is presumably a sign that the internally expected regulatory response would conflict with the core business model of the payment industry (but not with others). The temporary membership of Vodafone is particularly interesting, since Libra puts emphasis on their mission for financial inclusion of underbanked people in the global south. *"We believe that we all have a responsibility to help advance financial inclusion" [189].* Vodafone capitalizes on the dominant position they hold in Africa with the M-Pesa. A similar choice between partner and competitor was presumably made by the non-participating Giants Apple Pay, Google Pay and Amazon, of which a competing foray can be expected in the future. With respect to the following scenarios the position of Apple and Amazon is distinctively different to Facebook and Alphabet Inc. (Google), since both have a business model that currently relies less on the monetization of gathered data.

The choice of Stuart Levey as a CEO is a strong public sign for future compliance with political sanctioning [180]. Levy formerly served as the first Under Secretary of the Treasury for Terrorism and Financial Intelligence during the Bush and Obama Administrations. Therefore the sanctioning power scenario becomes particularly likely.

Facebook chose a technical design of the currency that is up to date of blockchain

protocols, it avoids the problems that cryptocurrencies have with scalability, volatility and energy consumption. The result is a private blockchain and therefore fundamentally contrary to the egalitarian approach of the Bitcoin idea. From Facebooks perspective this is not a bug but a feature; it lays the foundation to impose rule changes on the users at a later point in time. The scenarios showed with increasing unscrupulousness, which direction these changes might take. But all of them are based on indications from the publications. Especially the last two scenarios require a significant deviation from the currently proposed rules for the Libra reserve, but not from the Libra technology. Even if it was clearly stated, that such deviations will not happen, how little such proclamations are worth, when they are not legally binding, shows for example the case when Facebook bought Whatsapp in 2014 promising that no user data will be shared between the companies, which was broken only two years later [192]. Positively the updated whitepaper states that the responsible *"FINMA [...] is expected to specify the continued full backing of each Libra Coin as a condition of the [Libra Association's] license"* [98]. Interestingly the update in response to the legislators concerns adheres to the Libra currencies as individual units of account instead of claims on central bank money, like deposits are. A plausible explaination is that the 1:1 correspondence is expected to be only temporary.

As daunting as the scenarios may seem, in the case of a hyperinflation of e.g. the Dollar the Libra Association would instead increase the Dollar price of Libra USD to prevent the spreading of the inflation onto Libra. One can expect the association to change the rules so that other assets are allowed in the reserve instead. Even though a part of the reserve may have become worthless, as long as Libra manages to be significantly less inflationary than its competitors, people will want to use it. In this situation the discussed scenarios would even seem to be the rescue from a collapsing financial system that became impossible to maintain by central banks and governments, leaving society and democracy in a precarious spot.

6.4.1 Regulation

A regulatory objective that the first scenario uncovered is the protection of privacy rights. The pseudonomous approach of most cryptocurrencies is reverted by the fact that businesses using such currencies need to respect KYC ordinances anyway. The main arguments for anonymous payment systems are based on the prevention of either freezing or data mining ones account. Indeed, these practices, especially as a business model, have devastating consequences for society and ecosystem [191]. Therefore, we should demand that any institutions that provide currency infrastructure should not be allowed to datamine or pass on personal payment data. Instead, due to the immense power imbalance, the relationship they enter with the users of the currency needs to be the one of a fiduciary. In result, data mining companies are to be strictly separated from currency providing companies, reminding of the institutional separation of commercial and investment banks that existed in the US until 1999. In especially, any company that chooses to participate in the Libra Association would be as a fiduciary not allowed to have a business model like Facebook.

From the scenarios we painted above a second regulatory objective that comes to mind could try to siphon off the profits from the money creation, to redistribute them to the state. The fact that there is disagreement in the economic profession on how these profits, called seigniorage, are measured, should prove that an attempt to put this into tax law is unrealistic. It is not even clear how to measure the seigniorage for commercial banks that create deposits by giving loans, as mentioned in section 6.2.2. Let alone, how to apply this to existing cryptocurrencies. Furthermore, such currencies are used across national borders and even in simpler cases tax heavens are ubiquitous. Therefore, we desist from supporting such a regulatory objective. Instead, it is our best bet to encourage competition between such currencies. The design of "emancipatory cryptocurrencies" that support the values of sustainability will be discussed in section 6.5 as well as other key humanistic values, will be an important direction for future research.

It is quite significant to note that the threat of the scenarios is not primarily the ability to create money in the hands of private profit seeking institutions. As chapter 6.2.2 explained, in our conventional monetary system the overwhelming part of the monetary supply is already created by private banks. This is not to be said that this is not problematic. A part of the concerns apply to the conventional banking system already. The difference is covered in the connection between the privately issued and the central bank money. When the 1:1 correspondence is eliminated, the Libra system escapes the reach of central banks monetary policy. Currently the Libra versions of national currencies seem safer that bank deposits that are only fractionally backed, but the question is whether Libra currencies represent a legally enforceable claim on the respective reserve. If on the other hand the convertability of national currencies into their Libra counterpart is abandoned, the price of e.g. Libra USD can exceed the US Dollar. For example in case of an inflation the Libra USD could be the stronger currency and in a sense the Libra Association would slip into the role of a central bank. In recent years central banks have expanded their mandate and taken more drastical and costly measures in order to prevent a collapse of the banking system. Similar abilities would in the hand of the Libra Association be combined with the vested interests of 100 companies. Considering this power, it is worth mentioning that once seized, it is hardly put back into the box.

6.4.2 Etatism, Laissez-faire and Nationalism

When David Marcus was interviewed by the United States Congress on Libra on July 17, Republican Carolyn Maloney strongly advised him against the introduction of Libra [53]. The development of a new currency is a core task of the government and should be left to democratically accountable institutions. Even though, it does not seem as if the US Congress would stick to this course. Furthermore, a reasonable question is to what extent the democratic accountability is given for the US central bank (the Federal Reserve). But in view of the above scenarios, this point of view that we call etatist appears appropriate. Shouldn't legislators then try to ban all currencies that are not issued by central banks? This approach would declare the Libra project to be illegal in

any case and if enforced would prevent all mentioned scenarios. Furthermore, it would try to ban all existing cryptocurrencies as well, which is a little more difficult, since there is no issuer to sue.

Contrarily, in the spirit of Hayek's Denationalization of Money, one might ask what is wrong with more competition for central banks. If people can freely choose to use the currencies that serves their needs, one could argue that the power of the issuing institutions is rooted in the choice of the people accepting money, not the ones holding it. In a sense this could be seen as a form of democratic legitimation, even though not expressed in the form of a traditional election, open to all citizens and using a secret ballot. This approach, however, would leave the door wide open for any of the mentioned scenarios to happen.

A third regulatory direction focusses on the sanctioning power over the new currencies. From a nations point of view, there is an interest in establishing or preserving this sanctioning power and therefore promoting those currency projects which are based in the nation's territorium and cooperate with the domestic secret services. This approach is not necessarily in the best interests of the nations citizens. Governments that do not perceive themselves as close allies to the United States, would try to protect their citizens against Libra gaining hold in their country. Similar to the blocking of many US internet platforms taking place in China already.

6.4.3 Matching with the Five Monetary Divides

Let us relate these considerations, to the five divides in the monetary question from section 6.2.1. If money was neutral in the short and long run, there was nothing to fear from the control over a part of the monetary system in the hands of the Libra Association. Those who believe in it can be expected to support either the Laissez-faire or the nationalist regulatory approach.

Similarly, the schools of thought that see money as a commodity might see no reason to regulate Libra, but would expect the project to fail, unless the Libra Association was able to design the currency as truly valuable to its users by a strong backing of the reserve. If, however, money is essentially credit, the currency issued by the Libra Association is basically a credit granted by the Libra holder. Therefore, regulation should focus on the legal enforceablility of the Libra currency as a claim against the Libra Association or the Libra Reserve. In this case, the problematic reconvertability that we discussed is particularly important, but a reduction of the reserve ratio is similar to the low reserve ratios of bank deposits.

If the purpose of money is a lubricant for the economy, regulation should achieve that money is sufficiently provided and for example target interest rates. As long as Libra is only complementing the trade happening in national currencies, it could be sufficient, to enforce a publication of quantitative data that enables the central banks to counteract variations. If the purpose of money, however, is a steering of the economy, it strongly suggests the Etatist regulatory approach.

Accordingly, if money originated from banks one might follow that an appropriate approach was to treat the Libra Association like a private bank. Contrarily if the money

creation belongs in the hands of the state, only the Etatistic approach can be supported. If, however, it only originated from states, Libra shows, instead of the obligation to pay taxes as the basis to enforce value onto their issued money, the Libra Association capitalizes on the participation of commerce companies which people are customers of.

The concept of an exogenous monetary supply suggests that it should not be controlled by a private rent seeking Association. But again, this would only cause problems, when national currencies would be marginalized enough that central banks could no longer counteract the variations in the Libra money stock. However, from the idea of endogenous money we can deduce a new aspect. In a functioning financial system the demand for money that is not satisfied by the issuing institutions, would cause a second layer of institutions that issue credit denoted in Libra to emerge. Similar to the layer of private banks in our conventional monetary system 6.2.2. This would further manifest the role of the Libra Association as a central bank.

6.4.4 Concluding Remarks

The discussion of the divides in the economic profession generated particular leverage points for regulation. But it may have also given the impression that there are many different opinion, some of which see the threats of Libra and others do not. It is therefore important to complement the discussion by an argument for new currencies.

In a world in which our centralized financial system has been in one ongoing crisis since the year 2008 the Belgian central banker Bernard Lietaer saw the solution in establishing many complementary currencies [193]. These are envisaged to increase the resilience of the overall system through decentralization. Whereas our current centralized system optimizes for certain efficiencies in a niche and thereby introduces fragility, resilience would result out of monetary diversity. In addition, innovative currencies could hold the potential to fuel social change and a development towards sustainability. On the other hand leaving, the virtual currency space underregulated could also block the playing field for emancipatory currencies. Because it is cumbersome for people to convert between different currencies, strong network effects occur. Similar to the centralization of the social media landscape into few dominating platforms, it would pull toward a few dominant internationally used currencies. The main reason why it has little effect on cryptocurrencies is that those are primarily used as speculative objects instead of as a medium of exchange. Therefore, the concern that an acceptably functioning, stable, scalable online currency wins the race regardless of its long term consequences for society and economy is justified. May it be the early bird of Libra or the improved version of a competitor, this winner takes it all effect pushes the society into dependency. Regulations for virtual currencies should thus do their part for the prevention of quasi-monopoly positions. The network effect has to be actively counteracted, which cannot be achieved by regulation alone.

6.5 Towards Emancipatory Cybercurrencies

In the following, we will draw design requirements for the creation of cybercurrencies following an emancipatory line of thinking and a design-oriented perspective [194]. The requirements are based on the critique of the Libra approach. However, we will add concerns with regard to sustainability effects of newly designed currencies. The mechanisms by which these sustainability aspects are implemented in a currency are a creative design choice and can thus not be reduced to requirements. Yet, in the authors eyes they are an important part of the discussion and help to justify why we do not support the regulatory approach of Etatism.

6.5.1 Scalability at Reseasonable Ecological Impacts

The evaluation of the technology Libra uses revealed a positive aspect. It is in contrast to classical blockchain technology scalable (while being energy efficient). This upside should not be lost in the discussion of design requirements. However, we believe that future currency innovations utilize solutions based on blockchain alternatives (see 6.2.8) instead of private or permissioned blockchains, because these blockchains bring along the political problems we summarize in the next point.

6.5.2 Democratic Legitimation

The discussion revealed that any institution that slips into the role of a central bank for a monetary subsystem is problematic, unless it is properly democratically legitimized and controlled. We believe that to be fair this demand should also be applied to the existing central banks to take up the discussion to improve their democratic legitimation. If the purpose of money is to steer the economy (see 6.2.1), this requirement is mandatory.

6.5.3 Fostering the Sovereignty of Consumers

We discussed, how the users of a currency can slip into a dependency on the issuer. The opposite of that, an independent empowered user, is what we call sovereignty in this context. The first scenario explored the problematic issues of the Libra design that do not even require a change to the rules of the Libra Reserve. The major concern is privacy and our suggestion is an appropriate regulatory response in form of institutional separation between data analysts and fiduciaries.

The second Libra scenario illustrated the power over our society that results from the control over our payment infrastructure. As a protection the goal should be an empowerment of the user instead of the issuer. This means in especially the requirement to protect the user by design from sanctions of the monetary infrastructure provider. Therefore, it is required that the transaction data is stored on local devices and backed up by a network of users. In addition, the infrastructure provider may not have a veto, by intermediating the transactions. Instead, users communicate directly with one another, to process transactions.

6.5.4 Protection against Extraction

The last two scenarios showed the extractive potential of money creation. We argued in chapter 6.4.1 why the natural response that tries to prohibit these activities or rigorously taxes any profits that result out of them is barely possible. On the other hand ordinary people can hardly anticipate the consequences of their choices of money and once the society slips into a dependency, the power is in the hands of the money creators. Therefore a design solution that protects against the misuse of the money issuance privilege is desirable. Admittedly Facebook is going a step in that direction by sharing the authority with a group of other companies in the Libra Association. But that is not enough and it may eventually become only more costly, if every member wants to capitalize on their privilege. A satisfying implementation of this requirement is tricky. One technical design that would support this would be, if in the event of an impeded rule change by the monetary infrastructure provider a group of users was able to continue using the previous version of money. In blockchain terms that is a fork. A further solution is covered by requirement 6.5.7

6.5.5 Counteracting Monopolies

Also related to Sovereignty is the prevention of monopolies and the promotion of monetary diversity. We argued in chapter 6.4.4 that for that reason counteracting the network effect is paramount. So, if a commercial company incentivizes the payment via their own currency, the conversion should take place frictionless. This enables the customer to hold money in the form he or she prefers. One thing to consider here are open API standards.

More generally designs that hard code the rules of the currency into the protocol and enable a direct interaction between users are aligned with their sovereignty. In a previous LIMITS publication we discussed the design of social network alternatives based on peer to peer structures [191]. The same principles can be applied for the implementation of a currency via peer-to-peer architectures. This lets the transaction data stay under the control of the user as much as suitable.

6.5.6 Responsible Energy Consumption

In the discussion 6.4 we positively noted that the energy efficiency is an aspects of the Libra proposal that considers sustainability. Energy efficiency is a design requirement that must not to be lost in future currency schemes. However, there are further issues around sustainability that are relevant for future currencies. Our current financial system is characterized as highly fragile and after all the goal of a diversification of the monetary system should aim to increase the resilience.

6.5.7 Preservation of Value

Therefore, one sustainability dimension in which future currencies could improve upon is the stability in relation to real value. This would be supported by currency designs that are able to serve the underlying real economic activity in the case that the monolithic

conventional banking system breaks away. Compared to classical cryptocurrencies the Libra Reserve achieves some stability, but only in relation to central bank currencies. This has the appearance of stability in times where the conventional monetary system is stable, but these are not the times when a real stability is required. In the case of a hyperinflation, the Libra Association could cut inpayments into the reserve to make Libra scarce in comparison to the underlying inflating currencies. But then it lacks of a scarcity anchor itself.

Instead of a reserve the value of money could be bound to the economy's ability to produce value. Given that some metric to measure this ability for a business was in place, money in form of interest free credit could be issued proportionally on that businesses account. Although commodity theories of money (see 6.2.1) would characterize this credit by the users as the business being the commodity backing the money, but without a claim on the property. This construction also implements the scarcity anchor (see 6.2.2) based on real value instead of speculation, as it is the case for Bitcoin. Nevertheless, on both sides of most of the characterized divides some economists might strongly disagree with this proposal being an improvement. Because it reduces the institutional control over the currency, which is undesirable in their but desirable in the authors eyes.

6.5.8 Avoiding the Logic of Consumerism

In 6.2.2 we brought up the connection between money creation and the obligation for economic growth. It is the reason, why we required the money creation to happen without interest. A further driver of growth is the business model of Facebook and its reliance on consumerism which chapters 6.3.3 and 6.4 mentioned. A further requirement is therefore, although the consumer is empowered, that consumerism is not supported. The areas of business for which interest free credit is created should therefore be limited to a preservation and enhancement in the quality of life, instead of artificially generated needs. Trying to capture this difference into an objective standard would be difficult, but nevertheless this direction is an important sustainability aspect in the authors eyes.

6.5.9 Respecting Ecological Carrying Capacities

In a third and related dimension it is desirable that the design of a currency reflects the ecological carrying capacities. This is incompatible with currency designs that either enable an indefinite growth of the monetary supply or fix it at arbitrary numbers, which do not relate to the economy. Instead, metrics that monitor the health of an ecosystem could be tied into the monetary system in a way that monetarily incentivizes a farsighted approach to ecology. How appropriate metrics could look like requires further and ongoing research. In any case, the complex ecosystem can never be fully measured and represented in a however complicated currency metric. It can only be an approximation and a significant improvement on our conventional system.

6.6 Conclusions

The success of currencies is determined by a combination of the technical possibilities, the regulatory response and most notably the public willingness for adoption. The technical limitations of blockchains were discussed and solutions were referred to. For a corresponding regulation an orientation was formulated. In its limited scope this article tried to on the one hand illustrate the threats of money creation under corporate control. On the other hand it gave dimensions for the discussion of future post central bank money.

Acknowledgments

We thank Alan Borning (University of Washington) and Helge Peukert (University of Siegen) for very insightful discussions. The University of Siegen has funded this research through its graduate program "Supply Chains and Econimic Development – Plural Perspectives".

7 Community Supported Agriculture: The Concept of Solidarity in Mitigating Between Harvests and Needs

Abstract

There is a developing recognition of the social and economic costs entailed in global supply chains. In this paper, we report on efforts to provide alternative, more sustainable and resilient models of production. Community Supported Agricultures (CSAs) address this problem but require new means of exchange which, we suggest, offer a design opportunity for sustainable HCI research. This paper presents a two months participatory observation in a food movement, a German CSA which developed a distribution system involving their own currency. Based on our ethnographic observations, we focus our discussion on (1) the solidaristic principles upon which the movement is based and (2) techniques of mediating between consumers' wishes and the constraints of local agricultural production. By relating to the continued development of CSAs, we identify three interrelated innovation gaps and discuss new software architectures aimed at resolving the problems which arise as the movement grows.

7.1 Introduction

Our current forms of production and consumption lead to ecologically and socially destructive externalities. In response there is an increase of critical, ethical and sustainable consumption, that is not simply a consumer trend. It is an attempt to fix a broken system, but it cannot succeed by focusing changes in consumption practices alone. A root cause for unsustainable practices, then, lies in our economic system and it calls for new modes of organizing economic activity in local, resilient and quality of life oriented production. Covid-19 has recently drawn attention to a particular fragility in relation to food production and exchange. The exploration of these new modes involves new forms of communication, accounting and expressions of value. Various alternative food movements address this problem. Among them, Community Supported Agricultures have attained a certain level of professionalism and are about to become providers of a relevant fraction of food production.

Community Supported Agriculture (CSAs) is an organizational form that represents an alternative to traditional companies. There is no uniform set of rules for when something may call itself a CSA, but the most characteristic feature is the mutual commitment between producers and consumers. A group of consumers unites and pays for

the entire costs of a farm for the coming year. In return, the farm commits to providing the consumer community with healthy food to the best of their ability. The farm is thus secured and the community are the *harvest shareholders* (They are indeed called "shares" but instead of speculating on an increasing market price of a stock corporation, "shareholders" receive a food). Although the same model has existed in Japan at least since the 1960s, the concept was developed in the 1980s in the United States. It was from the beginning motivated by and intermingled with the ideas of biodynamic agriculture, the agricultural part of an anthroposophical idea complex going back to the German philosopher Rudolf Steiner. Therefore, a common feature among CSAs are practices of *biodynamic agriculture*. In addition, CSAs typically deploy short supply-chains to attain a high degree of *food sovereignty* – the idea of equitable, sustainable and resilient food production systems. In the default approach for community building, members buy a share (or half of a share) and the produce is distributed equally among the shares. In Germany in particular, where solidarity is even eponymous for the German name for CSA, which translates literally as "Solidarity Agriculture", around half of the CSAs extend solidarity to an inter-community level: In a community bidding procedure, in contrast to an auction, the members are predetermined and make voluntary bids. If the total bid does not cover the costs of the farm, all members are asked to raise their bids. This is repeated until either the money is raised or the farm reduces its budget. The idea is that those members who can afford to pay more should pay more so that others can pay less. This *pay what you think* property has echoes of communitarianism (see [195]) and is similar to European models of health insurance. Nevertheless, this is an explicit attempt to escape the logic of the market, and thereby challenges basic assumptions of capitalism and consumerism. In the framework of anti-consumerism CSA membership can be understood as a first step of prosumerism. Consecutive steps are also common among CSA, namely the involvement of members in *voluntary work* on the farm or providing the equity for the enterprise. Usually CSAs are legally a *cooperative*. The degree of prosumer engagement in this sense varies between members as well as between CSAs.

However, CSAs have themselves been confronted with difficulties. Notably, in attempting to provide alternatives to market mechanisms they sometimes reintroduce problems that were usually solved by traditional market exchange mechanisms. In particular matching their produce with their members wishes under the constraints of local and sustainable agricultural production is a challenging task. Most CSAs distribute their produce equally among the shares. Thereby, they can neither satisfy individual preferences, nor do they have a feedback mechanism for adapting to average preferences. Furthermore, forms of flexible product cooperation between CSAs become complicated. We suggest that this search for a new mechanisms to exchange (within and between CSAs) offers a design opportunity for sustainable HCI research. For the challenges of internal exchange a CSA in Germany has found a solution that involves a currency innovation. Therefore the first author conducted an observational study at this research site, which also yielded implications for the external challenge that the CSA faces.

Throughout this paper we attempt to answer the research question:

what solidarity principles underpin community agriculture in Buggingen and

what exchange mechanisms or currencies might support this?

After relating to the state of the art and situating the research site, we will discuss (in section 7.4) the understanding of solidarity that the people at the Luzernenhof have, as the value complex around it is foundational for the distribution and cooperation mechanisms. In section 7.5 we relate these insights to the development of CSAs, identify innovation gaps and offer considerations how information technology can help to fill them.

7.2 State of the Art

What sustainable agriculture activists believe is described by Naomi Klein as "The climate needs to avoid collapse is a contraction in humanity's use of resources; what our economic model demands to avoid collapse is unfettered expansion. Only one of these sets of rules can be changed, and it's not the laws of nature." Whereas there is general agreement in science about the first part of the statement (e.g. the Club of Rome reports), strangely mainstream economics is partly in denial about the second [61].

7.2.1 Sustainable HCI

For more than a decade, research on sustainability issues has been conducted within HCI (SHCI). DiSalvo, Sengers, and Brynjarsdóttir [70] first *mapped the landscape* of S-HCI into genres. Our research is preliminary for what Knowles et al. [135] argue for as *designing for sustainability*. However, there is developing concern about the lack of agreement on what sustainability means and how SHCI as a community can actively contribute to a change towards more sustainability [71, 72]. The fragmentation of SHCI is attributed to the fact that a consideration of a rationally acting consumer and with it the confirmation of neoliberal world view within SHCI has dominated [73, 74]. The results of this were shown in contributions that aimed to influence and nudge people to sustainable consumption by persuasive design. Meanwhile, there are voices that critically question the long-term effect of these contributions and emphasize a different point of view (e.g. [75, 76]): This is constituted in research that examines practices, i.e. everyday routines in which people, meanings, materials and competences are gathered [77] to support sustainability. In their Grand Challenge to HCI [78] argue that *the paradigms and practices of HCI risk perpetuating the shortcomings of food systems.*

In 2005 Warde paved the way for the connection of theory of social practices and research on consumption [196]. For Warde, consumption itself is not a practice, but rather a moment in almost every practice, because most practices, and probably all integrative practices, require and condition consumption. While the vast majority of consumer research conducted to date has examined consumption from an individualistic perspective and used the term rather vaguely in connection with both purchase and consumption, Warde emphasizes the study of consumption as an integral part of most areas of daily life. The act of consumption itself is rarely significant. Therefore, one cannot speak of a human desire to consume [197]. In this view, intentions are derived from practices

rather than being generated by individual desire. Behavior is based on conventions and standards rather than individual choice. In the field of energy, this type of research, for example in the case of Gram-Hansson, has led to the investigation of different forms of prosumption through observation of energy consumers [198]. For prosumers, the levels of consumption and production blend into complementary interrelationships [199, 200].

The global view of food production focuses on how to ensure that sufficient food is available on the supply side in the face of a growing world population (Davies 2014), and also how this economic development is linked to environmental and social levels to meet sustainability and climate change objectives (Poppy et al. 2014). However, Ganglbauer stresses the importance of the local context for food [201]. Weber et al. [79] argue that all of this is needed for a *deep change*, under which they understand a *systematic societal change, entailing fundamental change in social norms and values, institutions and behaviors, practices and technologies that together produce the functions, structure and identity of the food system.* But how do we *enable food sovereignty, push for new policies and reconfigure the power and trust relationships in food systems* [78]? The background of this work combines at least two of Weber's five approaches, namely sustainable agriculture (e.g. [80]) and grassroots food production (e.g. [81, 82]). Hirsch et al. [73, 74] conclude *Given their vulnerability to environmental change, their complicity in creating environmental threats, and the fact that most of the world's population depends on their labor for its sustenance, one may well argue that small-scale food producers should be at the center of any serious sustainability movement, including the one forming within the HCI community.*

CSAs are a small-scale food producer movement addressing the otherwise unsustainable aspects of conventional agriculture and research suggests that CSAs do indeed render ecosystems stable [65]. Furthermore, there exists (limited) economic research [66, 67], ethnography [68] and consumer sociology [69] on CSAs. Within SHCI, however, there is relatively little research on CSA yet [83, 84, 85].

When Norton et al. 2019 investigated permaculture communities in the United States, one of the findings was that participants *framed modern financial systems as the culprit, believing that an overhaul of the financial sectors away from extractivism and consumerism is fundamentally necessary to address local and global ecological crises.* To comprehend sustainability we should then investigate the intersection between agriculture and money. This, again, has been of only minor concern to SHCI, as yet.

7.2.2 The Connection to Money

Although many people use the words interchangeably, the economic system, the financial system and the monetary system are more precisely understood as being stacked on top of each other. With respect to the monetary system, we understand the currencies that exist, how they are issued and redeemed, how they are controlled and how they interact with each other – today largely a matter of (central) banks. The financial system consists of the institutions that use those currencies to finance long-term projects – to a large extent private banks. The economic system is the system of all the businesses that operate with actual goods and services and use financial and monetary systems for

everyday settlements. Hewitt [87] identifies "Slow Money" as the most important movement connecting money and agriculture. This is, however, a new mindset at the level of financing. For the Farm we investigated, the Kulturland Genossenschaft[1] represents this idea, but we should note that their ambitions go right to the monetary layer with their Terrafina [88] project. After all, to address the root causes at the bottom of the stack alternative currencies are of particular interest.

From a sociological standpoint, Dodd [202] argues that money always features social utopianism, whereas his understanding includes what can be called pro-topianism (designing in the right direction instead of designing the ideal world immediately). In economics, in contrast, money is usually characterized by its functions - store of value, means of exchange, unit of account. However, for these considerations the borders of money are blurry and currency innovation is basically about new modes of transacting and accounting [11]. For instance a Blockchain is only a protocol to account for transactions, although in origin, cryptocurrencies like Bitcoin were advocated for their Utopian, anti-governmental disintermediation possibilities. Sas et al. [57] review the role of cryptocurrency and trust in HCI. In their topology of Blockchain applications Elsden et al. [56] regard Cryptocurrencies as *new kinds of programmable money, with intended values*. One noteworthy approach for a new kind of intended value is time-banking, a movement for taking hours as a unit of account. However, Victoria Bellotti finished her investigation on time-banking as a community currency, concluding that *future peer-to-peer systems must incorporate different rewards and incentives in order to accommodate users with different motivation* [59, 54]. This suggests a gap, where S-HCI, agriculture and money intersect, and thus this CSA with their currency invention promises to be an instructive object for observation and a community to engage with.

7.3 Research Context

7.3.1 The Research Site

The Luzernenhof in Buggingen in the south of Germany is a CSA that was founded in 2012. Five years later it reached its capacity of 200 members and today there exists a waiting list to join the community of around 50 people, indicating that their model is a success. In 2018 they launched in collaboration with the "Kulturland Genossenschaft"a successful crowdfunding campaign purchasing land to secure the existence of the Luzernenhof. On a farmland area of 33 hectares vegetables and crops are grown and animals are raised for the manufacturing of a variety of dairy goods and butchered for meat production. This work is done by a changing group of people, whose number fluctuates around 10 full employed cultivators and sometimes volunteering members. With an annual turnover of roughly 480.000 Euro it (partially) feeds an estimated 500-600 people in the households of the members. The degree to which members buy external food ranges from more than 50% down to very rarely (e.g. spices and fruits are almost non-existent in the assortment).

[1] https://www.kulturland.de/

The work on the farm is loosely structured into a gardening-, an agriculture-, a stable- and a dairy-team — Some employees are in multiple teams. The daily work is organized by very short full meetings every morning, where everyone lays out what s/he plans to do during that day. In this meeting the access to tractors and machinery is coordinated. The coworkers perceive themselves as a team that is together responsible to keep the farm going, in which solidarity to help each other and trust play a significant role (more of it later). In addition there is one worker for bookkeeping, and every day someone cooks for the whole team.

Overall the Luzernenhof consists of different legal structures. There is the registered association (we will call it the association), which is the heart of the CSA and which the members and the permanent employees join. It is responsible for the whole project and pays the coworkers for the planning, production and distribution of the food. In addition the land ownership is arranged by the "Kulturland Genossenschaft" into an entity, that aims to transfer farmland into ownership structures, where it can only be used according to organic principles and not be sold again on the market. This cooperative is the financier of the Luzernenhof and other projects. The machinery is the property of a third legal entity, which buys and maintains them and rents them to the Verein. This way, the Verein can calculate regular costs for the machinery and has a buffer for the cases where expensive machinery break. As an example, during the time of the fieldwork a new mower had to be purchased which was not anticipated in the annual calculation, but could be bought on the account of this legal entity which supplies only the Luzernenhof.

As common for CSAs, on an annual gathering the members organize themselves and make bids for the monetary contributions they are willing to pay over the next twelve months. This bidding happens in autumn and takes place partly remotely. If the bids do not add up to the calculated expenses for the next year, it is repeated until enough money is promised. If this failed, the farm would be required to make a more affordable proposal for the year, which until now never happened. Members can order the products from an assortment of more than 200 items and receive them weekly in a package, which they need to pick up at one of nine distribution points within a radius of 30km. About a third of them pick up their package at the Luzernenhof itself. There they can also pick items during the week.

7.3.2 Methodology

The first author conducted an action-oriented research [136] and participatory action research [137] , predicated on a largely ethnographic approach. In the words of Alice McIntyre[138], he *participates with people in improving and understanding the world by changing it.* In particular, one of the reasons for embarking on this study in the first place was to better understand what technological solutions might aid in sustainable local food production. Our epistemological background in relation to design case studies [134] is committed to qualitative research and orients to participatory action research.

Over two months between February and April 2020 the first author spent six weeks living on the farm as a participant observer. With him there lived the cofounder "J", a

full time agriculturalist and part time lecturer, with his wife who roughly twice a week cooked lunch for all coworkers, their three children, as well as three other coworkers doing their intern- or apprenticeship in agriculture. The author conducted all kinds of work, such as gardening, planting, harvesting, stable work, packaging, repairs etc.. His observation was mostly focused on the people and processes on and around the farm. The methods of data collection comprised informal interviews during the collaborative work. The main themes of interests at the outset were the workers perspectives on CSA and the Luzerne currency. The working day started at 8 am with a general team meeting, where the coworkers coordinated the tasks that they planned for that day and the machines (mainly tractors, cars and a electrically powered bike trailer) they would need to use. It included a shared lunch and ended on average between 5 and 6 pm. Sometimes either social events or long conversations with J, the cofounder and inventor of the Luzerne followed. Their topics revolved around currency innovation, values and biodynamical agriculture. The first author did not audio record any of the conversations but documented the findings by writing field notes at night. Therefore, the quotations of coworkers presented in this paper may not be word-for-word (and were translated to English).

During the two months there were only a few occasions to talk to other members when they picked up food at the farm. Because the fieldwork fell into the period when the Covid-19 lockdown took place, close contact with members was problematic. Therefore, in addition three loosely semi-structured telephone interviews of roughly 30 minutes each were then conducted. The author used the farm's weekly email newsletter to its members as an outreach asking for willingness to talk about their view of the Luzerne currency and future developments of it. These three members answered and the interviews focused on their understanding of solidarity, their view on the ordering system, the currency and future cooperation with other CSAs. These interviews were audio recorded, later (partly) transcribed and translated into English.

Theoretical work on the concept of solidarity certainly exists, such as Spades "Solidarity not Charity"[203] and Deans work on "Reflective Solidarity"[204]. While certainly related to this etic notion of solidarity, we investigate solidarity and the related notions as emic concepts – how the people of this CSA understand solidarity.

7.4 Money, Solidarity and Commitment

During its eight-year existence, the Luzernenhof has been confronted with numerous challenges and has had to become creative in order to manage them. Their currency, the Luzerne, is only one of these creative solutions. Like all CSAs, the Luzernenhof was confronted with the problem of fair distribution. A sign on the farm tells the story. *And suddenly there are vegetables [...] and they want to be distributed.* For members, the usual approach of equal distribution was unsatisfactory because the shares received were not responsive to their individual needs. So the farm developed an individual ordering system. Now members are permitted to order or fetch as many products as they desire, within the capacities of the production (details below). The largest part of

the supply is ordered online. In general computer technologies are used. For example, spreadsheets are used for planting and harvesting plans, site plans and in accounting. Within the teams infrequently messengers or phone calls are used for communication. Online searches are made for contact details, organic databases and other information. However, this is usual for agriculture in a western country like Germany. One tool that distinguishes this CSA, however, is the Google Spreadsheets document, which is used to process the orders and their billing. Depending on the stock which depends on seasons and the decisions of the coworkers, a variety of products are offered to the members. Out of this assortment, orders are collected up until Wednesday morning, when the gardeners harvest on demand. Then, the harvesting team takes printouts of the spreadsheet where the orders are summed up to the field. On Thursday mornings the products are prepackaged according to the orders. Here the same document is read out by a customized program running on an old windows pc which supports the packaging team by presenting the orders in a more conveniently readable form. Depending on the members' choices, these packages are either delivered to one of eight collecting points in the region, or stay at the farmyard itself, where they can be picked up. At the farmyard, in addition, products can be picked up without an order during the whole week. These takings are recorded and attributed to the members accounts manually. Accordingly each member receives a recommendation as to how much to bid for the next year (details below 7.4.2).

7.4.1 Distribution

Since most CSAs distribute their produce in equal shares, usually weekly boxes, their members are often dissatisfied with the composition of their share [205]. This, along with moving away, has been cited as the main reason why people leave CSAs. With regard to this problem of demand-oriented food supply, J explains their solution by referring to anthroposophy. He explains how Rudolf Steiner assigns the three ideals of the French Revolution, freedom, equality, fraternity, to the world of ideas, law and economics respectively. According to this, the distribution of food should thus be fraternal rather than equal.

Therefore, any member can order from the product range at will, but the order is visible to all members. This is achieved by the online spreadsheet. Every week one of the coworker decides which products are in stock and selects the relevant columns to be visible to the members. The document has one column for each product that was in the available assortment, ordered by categories like vegetables, dairy goods etc. He can also set quantity limits or change the prices (more on that below). At this point the members are authorized to write in the shared document. Each member has a row with their name and can order products by writing quantities in the appropriate fields. Members can, by accident, write in the rows of other members orders and, in that case the document history enables a resolution. For this Google service the farm pays a negligible fee. This ordering system works well according to members.

The fact that members can order products of any value is quite remarkable. Members do see a price tag, either in the column or in the local farm, but they do not have to

pay these prices. So the prices serve primarily as an orientation point for the members. *I only compare the prices of each bit of produce* described a member. How much each member has consumed during the year is summed, but this amount serves only as a recommendation from the farm as to how much the member should pay in the coming year. As another member put it, *In our first year, we consumed more than our contributions. We offered to remargin, but that was not necessary. Then we simply paid some more in the next year.*

Although in theory members could order and never pay, this has not yet happened in practice. However, it is to be expected that if a member would "free-ride" on this, the farm would have objections. One might think that the social control of the other members is the essential factor that prevents free riding. However, at the annual meeting, the numbers of the members are only disclosed in an anonymous form. Instead, all three members interviewed have reported that it is important for them to pay their fair share. *We are not people who take food for 350 euros and only pay 100* said one member. For the "prices" (with which orders are charged in form of recommended contributions), it makes no sense in the farm's view to use external market prices. Instead the farm's own conditions are used as an indicator to how laborious the production of a product is there. However, to disentangle this is an impossible task, because one cannot simply produce more milk instead of a potato, for example. The plants each fulfill a function in their crop rotation and form a cycle with humans and animals. For example, the cows feed on the grasses of fallow land, the pigs get their manure and the whey produced during milk processing, while their liquid manure is used as fertilizer in the fields to benefit the plants. For this reason, the product quantities can only be varied to a certain extent, without losing the holism of the cycle. Thus a coworker tells how the neighbouring garden Coop held cattle for the manure, which however they did not want to slaughter or use for milk production because of the vegan requirement of some of their members. *When the cattle got old, they sold them and the buyer of course slaughtered them. Now they have a pasture manure cooperation with us.* The Luzernenhof then selected the "prices" in approximate accordance with market prices, but adjusted them upwards or downwards according to the conditions on the farm. On average they are slightly more expensive than in the organic supermarket.

Interestingly enough the approximate quantity ratio of the products fits quite well to the needs of the members. Only for a few products (e.g. cherry tomatoes, which require a lot of care) is there a demand that exceeds the farm's ability or willingness to produce them. If this is the case, first a *product limit* is given, which is the maximum amount of the product available. When it is reached, further orders are not carried out. As second step a *household restriction* can be introduced, which is how much an individual member can order of a product. This rule was felt initially to be unfair, since the members, who want to nourish a whole family from their portion were placed in an inferior position. They would have an incentive to register multiple members to circumvent these limits. Therefore, this limit was multiplied by a self-selected *household factor*, which takes into account the number of people supplied with this share and the percentage of which these people get their food from the Luzernenhof. As a worker put it *What is a 5 person household doing with 100g cherry tomatoes?* However, these measures and even

information about how much of a product is in stock is in many cases not applied. Tubers and cabbage, for example, are warehoused. Many other vegetables do not decay, because they are harvested on demand. Due to these products being always available members also have the option to place default orders which are repeated automatically every week, unless they modify them. Product limits, household restrictions and household factors are all implemented by the same mentioned online spreadsheet. For bookkeeping the orders of every week are also downloaded and stored offline.

7.4.2 "Luzerne" as a Monetary Unit

Due to these demands and the agricultural conditions of the farm, some products at the Luzernenhof have significantly higher "prices" than in an organic supermarket. This means that it regularly happens that members decide not to order these products from the Luzernenhof but to buy them externally. *Then our products are left lying around, but that doesn't make sense because we produced these products for the members and they already paid for them,* says J. That's why in 2018 he developed in collaboration with the community the Luzerne, a currency unit, *to bring them out of the mental state of shopping.* The currency and the farm are both named after the plant (Medicago sativa), which is used for its nitrogen-binding properties to improve soil quality and as fodder for cattle. Since then, the "prices" are given in Luzerne instead of in Euro. This is implemented by simply using a different unit of account both, in the ordering spreadsheet and the price tags at the farmyard. One Luzerne is intended to represent one hundred thousandth of the products ordered each month, so the farm estimates its annual production at 1.2 million Luzerne. In reality, however, this target is only roughly met, since the yield of the harvest and the demand of the members cannot be predicted exactly.

This number can be set in relation to the annual contributions of all members in order to calculate an exchange rate which is also announced by the Luzernenhof ("exchange rate" even if no exchange between Euro and Luzernen is possible). The only conversion takes place when at the end of the year this rate is used to convert the accumulated accounts of the members (in Luzerne) into payment recommendations for the next year (in Euro). Members can therefore use this rate to convert prices back to euros and still compare them with external prices, but the barrier has been raised by the introduction of the Luzerne. The members' opinions about the Luzerne vary. While one of the interviewed members likes the idea and says she does mentally convert between the currencies, another thinks it is important to do exactly that and that the Luzerne is an unnecessary complication: *I understand what this is supposed to do, but I don't see the point.* Most coworkers had a rather indifferent attitude *I don't care about that. That's just so that the prices are not in Euro.*

The only products for which this system has not worked out is meat. When an animal is butchered, which happens roughly once a month, the relevant meat products are ordered in advance. It sometimes happened that some member is shocked by the true cost of meat from animals raised under these conditions. This was because their expectations were shaped by cheap discounted meat, and they found themselves ordering

meat which was much more expensive than anticipated. A hybrid rule was found. Such that 70% of the price is paid directly in Euro, and 30% is accounted in Luzerne, s as to make cost more visible.

Of course the membership contributions are paid in Euro and the farm has to pay their expenses in Euro. There are also no Luzerne issued in monetary form. Instead it is merely used as an accounting instrument for the internal distribution of products and a feedback mechanism for the members to estimate their expenses. The currency is also an expression of an attitude that the community, as diverse as it is, largely shares. It separates distribution at the inside from the prices at the outside. J says *If I had the chance, I would have left behind [the central banking system] years ago*, showing that he has identified the monetary system as somehow a root cause for problems in agriculture. This urge motivated the Luzerne as a currency experiment, although members are well aware of the fact that the Luzerne is dependent on the Euro.

7.4.3 The Topology of Trust

Members have revealed in the interviews (and the board has asserted that this is the dominant view among all members) that the willingness to pay more than one's recommendation is to support the Luzernenhof and its workers , on the one hand securing its continued existence, and on the other hand as a good deed to the commons. Although the transactional structure may suggest a strong trust among the members, most of them do not even know each other. As one member said, *If I wanted to have more contact to other members I could reach out to them, but I don't need anyone taking me by the hand for that.* He also voiced the opinion that, *For this decision the responsibility, and our trust, is with the farm.* This was in response to questions about how the Luzernenhof could cooperate with other enterprises. Thus, the topology of trust is primarily between members and the farm, not so much directly between members. Members' trust in the farm is built through the commitment of supplying high quality food being reliably met. This trust is reflected in the monetary and non-monetary contributions the members make. The farm's trust in its members, on the other hand, is reflected, among other things, in the voluntary nature of the discretionary contributions. Therefore the farm acts as an intermediary for people who do not know each other. This topology of trust and its mediation are relevant to our observations concerning Blockchain in chapter 7.5.6.

J. , a cofounder of the Luzernenhof, explained that the connection with other CSAs should not merely be a trade, since this would place them in competition with each other. Instead the cooperation should incorporate some of the solidaristic characteristics described above. This would be the case if, for instance, the trade balances were not seen as needing to net each other out. This is analogous to the principle that within a CSA the members do not pay according to their consumption, but instead according to what they are able, willing, and what is negotiated to be fair, to pay. When the CSA network "Netzwerk solidarische Landwirtschaft"[2] self-organized their first apprenticeship, the

[2]https://www.solidarische-landwirtschaft.org/startseite/

same principle was applied for the fees, paid by the participants. Compared to the conventional model, where everyone pays for the good or service the same price, with the solidarity principle people who are able to pay more subsidize those, who are not able to pay as much. Therefore applying a rule, that comes close to this solidarity principle between CSAs would also mean that members of one CSA subsidize those of another one which they might have no personal relationship to. Furthermore, it would raise the question, of whether implicit social self-regulatory norms might be corroded, if one's consumption is paid for less by ones own community, and more by other, distant communities.

The impact of the Covid-crisis supported the idea that local structures and short supply chains are indeed more resilient. However, it also illustrated that trust (in this case between the coworkers) is fragile and requires steady attention.

7.4.4 CSA Properties

With this system the Luzernenhof fulfills the CSA properties listed in the introduction. It has the *harvest shareholder* and the *pay what you think* property. It is a *cooperative* that applies practices of *biodynamic agriculture* which their members regard as of a higher standard than organic food production. A member asserted *Best would be Demether [a biodynamical sigil] or at least organic.* He became a member because of the assortment, what the Luzernenhof does not supply are *only be eggs, slaughter poultry and fruit.* However, this indicates how *voluntary work* of the members plays only a subordinate role. During the two months the 1st author was present on the farm, only one of the members joined the coworkers in their fieldwork. However, on 'big' occasions, such as the harvest of onions, the farm invites the members to help and it becomes a big social event. *We did this once. That was really good though [...] to show the junior members where the onions come from and that it is hard work*, narrates a member. These vegetables are then warehoused and distributed over the year. Another one says *I was doing the packaging for a while.* In addition, some members engage in organizational matters such as participation in regular board meetings. Overall, the Luzernenhof tends to attract members who value it as a food supplier more than a community activity. An external person who has placed herself on the waiting list describes it as *The Luzernenhof has a reputation for being a place for people whose time is scarcer than their money. The others tend to go to the neighboring Garden-coop.* Concerning the fact that the engagement of the members is so small J. said, *First we had to develop functioning work structures.* That was regarded as more easily manageable with a small group of paid professional full time workers than many fluctuating and only partly committed community members. He further said, *Now it would be of course nice if the [community engagement] increases again.* With the processing of dairy products, the Luzernenhof has a specially broad assortment of produce. This was pointed out as a main reason to become a member by one of the interviewees.

The practices of the Luzernenhof and its resilience to the effects of the Covid crisis have shown that there is a high degree of *food sovereignty.* This is not an accidental byproduct but a deliberate value. Referring to neighbouring conventional agriculturists

that were protesting about the need for awareness of their problematic situation, J. once mentioned that *they are correct that now they are screwed*. But the reason is, because in the past they made themselves dependant upon big corporations. By analogy to that development, there is an awareness for technological sovereignty being an important aspect of this food sovereignty. As J. jokingly puts it *it is quite nice, when from time to time an email server or something crashes. Than you can say just say sorry and are not distracted by that anymore.*

On top of that the Luzernenhof stands out from other CSAs because members do not simply receive fixed equal boxes which they have no control over. Instead every member is allowed to order the products and in the quantities that he or she desires (see 7.4.1). On the one hand this includes a *free product choice*, a criterion in in demand satisfaction which is significant enough to potentially bring CSAs to the mainstream. On the other hand, it is a significant credit of trust by the farm to its members. In a sense, members have *indefinite share sizes*, which they determine themselves over the year by the size of their orders. It evidences trust in the members. Each member could theoretically break the system during the year by exaggerating their demand and is trusted by all other members not to do so. This trust sometimes confuses people who are market oriented. A member said about former members that left because the Luzernenhof stopped delivering to their village *they didn't get it until the end*. By 'it' he referred to the fact, that members are allowed to order food and not pay accordingly.

Note that these two properties (free product choice and indefinite share sizes) are theoretically independent from each other. Shares were only allowed a fixed monetary amount of produce to be ordered (for free product choice with out indefinite share sizes) or members could be allowed to pick up an arbitrary number of prepackaged equal boxes during the year (for indefinite share sizes without free product choice).

The indefinite share sizes might only be a side effect of the chosen tool, the online spreadsheet, because definite share sizes would be a little more difficult to implement. However, they did not appear to cause any problems although they introduced a significant trust component. This shows the central role the document plays for the ordering and accounting system. Switching to another provider would present a hurdle, since the document is heavily customized with macros. This is typical for the Luzernenhof, and in relation to machines, J says: "Every farm is different, so machines always have to be adapted." And he suggests that this is how it should be. At the same time, he also appreciates the relative independence from technology and jokes: *It's nice when an email account, server or something like that breaks down every now and then and all the data is gone. Then you can say: we are sorry. And you don't have to deal with this stuff anymore.* This expresses the ambivalent attitude towards technical aids quite well.

7.4.5 A Holistic Understanding of CSA

The ideology and practice of the Community Supported Agriculture should only be understood holistically. In addition to the mentioned distinct properties (harvest shareholder, biodynamic agriculture, voluntary work, pay what you think, food sovereignty, cooperative, free product choice, indefinite share sizes), the conversations about solidar-

ity revealed recurring themes. These were (1) generating diversity, (2) solidarity with nature, (3.) being a magnet for alternative practices and (4) food as political.

Generating Diversity

The wide range of products is thus not only due to the goal of full supply for the members, but also as a response to diversity, which is considered a value in itself. A coworker has explicitly named this diversity as the reason why birds are settling in the area again - a step towards restoring the ecosystem. Another coworker explains *there are so many sub-types of plants, that conventional agriculture does not use anymore. CSAs can help to rediscover them.* While passing a field J laughs *here we are probably taking it too far, others would cut this out as weeds, and we are planting it* pointing on a cultivated type of dandelion, that is used as a salad.

solidarity with nature

Another coworker explained that he prefers to loosen the soil slowly and strenuously with a digging fork rather than with a mechanical tiller, as this is much better for underground small animal life. On another occasion he jokingly commented on increasing local birth rates: *The Luzernenhof is bringing fertility back, apparently not only on the fields.* This captures a shared understanding of the work as a duty to the commons. *We are doing it for everything here. For the insects, the birds, all of it.*

Magnet for Alternative Practices

J also teaches in an academic course on biodynamic agriculture and said that he is regularly asked about Permaculture, for example. From his point of view, this is not the actual state the farm is in, but a research direction whose findings can be applied in agricultural practice. Furthermore, biodynamic agriculture is itself experimental.

Food as Political

On a wall next to the yard an event is advertised 'food is political'. This seems obvious to the community. A coworker named the political aspects of food to be the rejection of the market logic, of conventional practices, of universal prices and basically of capitalism in general. Though this may sound radical, the CSA patterns of transaction do, in a very real sense, constitute an alternative to the market economy.

7.5 Discussion

Based on the observations from the previous chapter we now discuss the values at stake and in particular the understanding of solidarity at the Luzernenhof. Afterwards, in chapter 7.5.2, we are able to comprehend their solution for demand orientation. In 7.5.3 we relate this to the development of CSAs and their vision for the future. These considerations prepare us to discuss the potential for IT in second half of the discussion:

After explaining in chapter 7.5.4 how our design expectations were not met, in 7.5.5 we identify three interrelated innovation gaps and finally. in 7.5.6, offer considerations as to how technology can help to fill them.

7.5.1 Values at stake at the Luzernenhof

By the structure of their ordering system, the Luzernenhof relies on trust relationships significantly beyond what is common practice among CSAs. Whereas it is common that members pay different prices for their shares, these shares are predefined as equal. As a result there is a limit on how much a single member could exploit the community. At the Luzernenhof, however, the share of produce that a single member can extract is a matter of demand. The resulting *indefinite share size* places the members in a situation of mutual trust. It goes significantly beyond the mutual trust that is required for the common *pay what you think* property. In particular, with indefinite share sizes it is possible that a member receives less produce than he or she expected at the beginning of the year, because other members order too much. However, the rules addressing limited supply restrict the extraction that would be possible in the worst case. In addition, the hybrid rule offers a protection for precious meat. An additional trust component is (unintentionally) introduced by the fact that in the spreadsheet other members could alter your orders. This component is not necessary and could be removed by changing the software.

Even though the concept of individual members deciding how much they are willing to pay may suggest a form of subsidizing support between the members, their answers regarding what they were willing to pay for revealed, instead that their support is primarily directed toward the farm. Thus the topology of solidarity is not so much between the members, but between member and farm. It is therefore quite surprising that the factual structure presupposes a solidarity that seems to exist only indirectly, via the farm. Instead, each member seems to regulate itself through implicit social norms. It is worth noting, that the behavior of members wanting to pay at least their fair share contradicts the models of selfish utility maximizing agents, that underlies mainstream economics. The so called 'free rider problem', such that members live on expense of others, does not exist in this community.

If the Luzernenhof system should serve as a model for other enterprises, one needs to be aware that it relies on both trustworthiness and actual trust between the community members. The whole CSA model relies on trust of the members into the farm (harvest shareholders, cooperative). The community can then extend this trust back to its members (via pay what you think and indefinite share sizes). For the latter one, the members' self regulation is a prerequisite. In communities where this is not given, the indefinite share sizes might not work (or require further restrictions). Further expressions of solidarity, such as voluntary work, strengthen the community cohesion.

7.5.2 The Luzernenhof solution to demand orientation

CSAs try to escape the logic of markets. However, they need to find ways to coordinate harvest yield and consumers' needs. Thus, in some manner they reintroduce the problem of matching supply and demand. The most common approach to distributing supply equally among all members can be seen as an attempt to force the demand to be equal to the supply. It can, however, hardly change consumer preferences, so that CSAs can fall short of meeting the real demands of their members. This is the problem of demand orientation that all CSAs face.

The Luzernenhof solution to this problem is implemented by a technical tool, the Google spreadsheets document. It enables the members to communicate their real demand to the producer. As a consequence the farm is able to adjust the planned supply for the following years (or earlier for dairy products). Because the members preferences do not change much from one year to another, the Luzernenhof is now able to calculate roughly accurate. Nevertheless, variance in the harvest, changing members, further experiments with the produce stock or an unwillingness or inability to provide certain products or quantities can still cause a mismatch between supply and demand. It is worth noting that their solution would be possible with prices denominated in Euros instead of Luzernen. Therefore, we consider possible solutions in terms of two different innovations. Both will be covered in this section: Firstly, the **ordering system** and secondly, the **Luzerne**.

The Ordering System

The way in which the spreadsheet document is utilized primarily enables the communication of orders and therefore a feature of the members' demand conditions. To match the supply and demand, they apply market mechanisms which work like prices and non-market mechanisms in form of further rules. The market tools are the increase or decrease of the price tags. Apparently these signals function to regulate demand even though the price that the orders are accounted as in is decoupled from the price that the members actually pay with their contributions. After all, orders only result in contribution recommendations for the next year. Price tags can be smoothly chosen on a continuum. The non-market tools are discrete steps for increasing impact. In the direction of scarcity there are first product limits (for instance, there are only 80 glasses of Sauerkraut on the stack) and second through member limits (adjusted by the household factor). In the case of excess the non-market possibilities start with notifications about the excess, after the price is reduced to zero. External give-aways, animal feeding and not harvesting are the options. Due to the farm's by now substantial experience with its members, it today can quite accurately predict members' demand, so that these non-market tools play a less significant role. To arrive at this, it was essential that the members were able to communicate their true demands with their orderings.

The framework of anti-consumerism allows us to understand members of a CSA as prosumers. However, there are increasing levels of involvement in the production, of which membership is the first one. Further levels are helping with administrative work,

doing physical work on the farm and being involved as a co-funder or co-owner. Within the subsystem of a CSA, the demand oriented ordering system also enables some members to take the role of flexumers, adjusting their preferences to the outcome of the harvest and possibly, if the prices reflect that, being rewarded for this behavior.

The Luzerne

The Luzerne is an innovation on the level of the monetary system (see 7.2). Because the Luzerne-accounting is refreshed every year, the currency design makes it unusable for financing. Instead its purpose is accounting in this micro cosmos of the economic system, in particular for the distribution of food. But what difference does using an alternative currency make to economic activity? The observation that the Luzerne is not a necessary component of the ordering system raises the question of its purpose. Why is it that the value of the products is not simply denoted in Euros? There are different perspectives on this.

The Luzerne only projects the a priori incomparable products onto a linear scale of value. Therefore, from a narrow economic theory perspective it can be seen as a unit of account that does not qualify as money, because it does not fulfill the other two functions of money. It is neither a store of value, because one cannot accumulate it, nor is it a means of exchange, because it does not change hands. This perspective, however, gives no insight into its purpose.

One way of understanding the Luzerne is as an expression of a worldview. In the act of creating a new currency the Luzernenhof shows utopian or pro-topian thinking (7.2). It directly addresses the monetary system that we use today as a root cause of fundamental problems. Using a different unit of account as a measure of value, expresses a rejection of the outside markets measure of value. These products do not have a price in Euro, under which system any stranger has the same right to buy the produce. Instead they belong to the community and have a measure of value which helps them organize their distribution. This aligns with the coworkers' description of the political dimension of food which includes the rejection of universal prices (7.4.5). It also echoes the intentions of the currency's inventor when addressing the monetary system (7.4.2). However, it would not be accurate to describe the Luzerne as an expression of value by the whole community. Even people in the community that roughly share this worldview do not necessarily see the currency as related to it. The attitude of indifference to the Luzerne is actually widespread. Some even find it bothersome (7.4.2). Nevertheless, this friction is seen by some as positive, since it brings the members out of the 'mental state of shopping'. Therefore, the Luzerne can also be understood as a psychological tool. As such it nudges the members to order the produce they collectively paid for (instead of buying externally). Thereby (and by not having a limit for how much Luzerne members are allowed to order) the currency contributes to what is in economic terms called market clearing. If a relevant fraction of the produce decays, that can be considered as a failure of the distribution mechanism.

Another perspective is given when the accounting for the orders in Luzerne is regarded as a purchase. In this sense, they would indeed be paying with Luzerne as their account

is charged, although their account exists only implicitly in the form of their accumulated orders in the speadsheet. By analogy, the system works in a fashion akin to credit cards, such that the members have unlimited credit limits, and the negative account balances of the members are settled in the end of the year when they are taken as a recommendation for the next year. An insight this perspective offers is the (almost) unlimited trust in the members. It is only indirectly limited by the rules of the ordering system. If this trust was not justified and a single member misbehaved and exploited it by exorbitant orders, the system would fail. We will discuss alternative design choices for this system in chapter 7.5.4.

7.5.3 At the Frontier of CSAs

In preparation for the discussion of the potential for technology, we first try to describe where the CSA development is going. In the search of new modes of organizing economic activity. . Therefore, uncovering the implicit social rules that are at work is necessary in order to make them explicit and scale them up. The explication of these rules could be then implemented by scaleable software, to design a wider form of social delivery after the model of a CSA. However, as our discussion on solidarity showed, the structure is based on trust which depends in turn on personal relationships (member to farm). Such trust relations are difficult, if not impossible, to manage at scale. Furthermore, the scaled up version would be basically a planned economy and the history of the 20th century can be read as a failure of that model. Finally, locality is an important aspect of CSAs that would be lost. This was already common knowledge among CSA researchers outside of S-HCI [206].

CSA as resilient structures in times of crisis

That being said, we do see a high potential for expanding the role of CSAs and related modes of organizing economic activity. In contrast to cooperatively organized alternative food networks on the one hand and conventional production on the other, CSAs are able to satisfy the critical consumer that does not have time for large overhead (to do either fieldwork or research on the food origin). Achieving this involves a horizontal diffusion and cooperation of CSAs (or alternative food networks in general). Because these enterprises have a certain size, at which they function effectively, but also have the potential to increase their efficiency by working together [206], they could be seen as the atomic units of a new paradigm in food production. The fact that during the fieldwork, external food producers that were considering switching their business model to CSA visited on two occasions, showing that there is a potential for diffusion. Overcoming barriers to this horizontal diffusion and enabling a cooperation that is based on solidarity, is the gap where technology and therefore S-HCI-research and design can contribute. Therefore, instead of scaling up, the vision is a variety of exploratory local initiatives that inform global alternatives.

Because the fieldwork happened to be at the time of the early Covid crisis, we are able to record in a side note how our observations indicate that local food production is

indeed more resilient in times of crisis. First of all the low reliance on external entities enabled the Luzernenhof to continue the food production. In addition, in a crisis the members showed some willingness to support their CSA voluntarily, for example with work, should the coworkers get infected. Finally, due to the fact that the members are the shareholders of the harvest, in the worst case they may receive a poor return on their investment, but the CSA as a food production infrastructure can survive. This finding supports the ideal of food sovereignty as it indeed increases the resilience of the food system, lacking the fragility of global supply chains.

7.5.4 A Potential for IT?

From the many usages of information technology and the infinite circumstances where IT usage would be possible, the following chapters focus on the ones that we regard as most interesting, because they appear specific for, and most useful to, this development in the organization of economic activity on CSA principles.

At the beginning of the fieldwork the authors expectation was that a good next step would be to implement the Luzerne as a means of payment. The model was that members would get an amount of Luzernen that they obtained in the bidding rounds of the membership assembly, issued onto member accounts. Then, they would be able to actually spend the money from these accounts on food orders. If they ran out of currency, they could either start trading with those members who realize that they have more than they need or there might be an option to buy further Luzerne. After one year, any existing currency would become invalid and a new round would be issued. The difference with the existing system can again be understood in analogy to credit cards: The members would have previously negotiated credit limits, whereas currently their credit limits are infinite. This would have introduced the advantage that the farm can precalculate the amount of currency that the entirety of members can spend. That figure, in other words, corresponds to the full harvest (although some margin to achieve market clearing might be required (see 7.5.2). Thereby food shortages, caused by members exploiting the arbitrary large negative balances, can be prevented. Making the currency a scarce commodity might enable a tighter price signaling. After all, in the current model the members could simply ignore the prices completely, since they are only nonbinding contribution recommendations. According to economic theory of markets, this change would be reasonable.

However, a main reason for the Luzerne to exist was stated to be bringing the members out of the mental state of shop-ping. This asserts that the signaling feature of prices is working (at least) strongly enough, despite the fact that they only result in nonbinding recommendations. Implementing the Luzerne as a means of payment, as sketched above, would only worsen this condition, since the Luzerne would be scarce in reality and spent like any other currency. In fact, both expected problems (1. the members' theoretically infinite Luzerne supply not matching the finite harvest and 2. the weak price signaling) turned out not to be relevant. That is because members take the recommendations seriously, or in other words, in the case of the Luzernenhof the trust by and in the members is justified. Nevertheless, the horizontal diffusion might include the formation

of more communities in which this trust is not given at the beginning. Software that implements the demand-oriented ordering system would be very beneficial for them, but 'infinite trust' might not be given. Therefore the modification sketched out above, might be preferable in such circumstances.

7.5.5 Surveying the Innovation Gap

Uniform software that provides an out of the box solution for new CSAs would be a big contribution to diffusion. In germany 'solidbase' ([3]) is an initiative by the german CSA network that is set up for this task. 'Kulturland' ([4]) is a cooperative that has a project looking into DLT solutions for currencies like the Luzerne.

However, we found that there exists an innovation gap at the place where different CSAs and possibly other alternative food movements meet. The CSA network has even written plans to cooperate with other initiatives into their statutes, stating that cooperation should happen according to principles of solidarity as well. To achieve this requires some addition to the existing physical infrastructure at the depots as well as to the software infrastructure for accounting and communicating. Both would require further specification. The S-HCI community has not, as yet, considered the possibilities inherent in the diffusion of this kind of economic model. We offer considerations based on our observed understanding of solidarity.

The main task of a cooperative system is to enable members of one community to use their ordering or purchasing system to acquire goods produced at another community. Therefore it needs to be interoperable with the communities' ordering software and logistics. The order needs to be communicated by the member, to its CSA (A) and further to CSA (B) and the degree to which it can be met has somehow to be determined. In the case of scarce products, this involves rules, (1) how this external order is treated in comparison to the ones from members of B and (2) which of these external orders are prioritized. Specifically, should CSAs have a limited capacity to import, and if so who decides upon its scope and usage? How much is charged for the order? Do CSAs only import what is not in their own assortment? And do they only export what they categorize themselves as excess produce? How is the transportation handled if A and B do not share a pickup point? Do the trade balances need to even out, and if so by what mechanism is that achieved? These design choices imply important differences in trust relationships and there is an issue concerning what mechanisms can be considered to be"according to solidarity".

The central conflict for the design touches upon fundamental questions of economy and is as follows. For the mutual benefit which solidarity demands, an exporting community has to be rewarded with something that is at least as valuable to them (although not necessarily immediately). Usually, this problem is addressed by using free trade. That would, however, place the communities in competition with each other. On the other hand, if the trade balances were not to be offset, the communities would be placed in a relation to each other similar to the relation of members within a CSA. Those who

[3] https://www.solidarische-landwirtschaft.org/das-netzwerk/projekte/solid-base/
[4] https://www.kulturland.de/

can afford to would subsidize the shortcomings of others. Such a system would expand the implicit trust relations from a local to a more global level, if it could be realized. Every community would be trusted to still be productive although it could live from the subsidies of others. Such a system implicitly relies on trust relations which cannot be guaranteed outside of the local context. We therefore argue that the system has to be designed in a tradeoff between risking exploitative competition and risking exploitative indolence. This tradeoff has to be adaptable to changes in underlying trust relations.

The part of the system that communicates the orders between the cooperating CSAs, is not the problem. The difficult design choices are the rules which accompany them. The problem is is very similar to the problem of distribution within a CSA that the Luzernenhof faced. The solution will probably involve a combination of market mechanisms and non-market rules. In some way the different CSAs will come together as members of an overarching structure based on solidarity. But this structure will have features which are distinct from the internal structure of a CSA, because on the CSA layer (a) every member exports and imports (not just consumes) (b) the topology of existing trust will be different (c) locality and transportation needs to be considered.

We separated out three gaps for technology usage, where CSA development has demand conditions that are different to that of of conventional agriculturalists. All of them are interconnected.

(1) The internal ordering system communicating the demand.

(2) The internal accounting system implementing the rules and limits set by the CSA.

(3) The overarching trade structure that enables CSAs to cooperate according to solidarity.

The ordering system (1) and the Luzerne currency (2) are currently implemented by nothing else apart from the google spreadsheets document. This is an extremely lightweight solution. Admittedly this is only possible, because the Luzerne does not fulfill all three functions of a currency. It is neither used as a means of exchange, nor as a store of value, instead it is merely a unit of account. Furthermore, because its application is limited in scope to the CSA, it is not problematic feature that every member is able to write in the document and could mistakenly (or ill intentionally) write orders for other people. This has happened from time to time, but could always be easily resolved. However, on a bigger scale, it would offer a serious weakness. The fact that spreadsheets are a common tool that different providers offer, relativizes the dependence on Google. Nevertheless the shared document function is essential and switching to a different provider would be cumbersome. If this solution were to be scaled up to include all available produce from other CSAs as well (given that an overarching system (3) was in place), it might transgress the boundaries of practicability.

As of today an overarching cooperation structure for CSAs (3) does not exist, yet. For any software system under consideration, the effort for the users needs to be small, the members e.g. would not want to manually buy a foreign CSA-currency on an exchange every time they want to order a product that originated from an adjacent CSA.

7.5.6 Distributed Ledger Technology

Our discussion revolved around forms of accounting, locality versus globality, currency and most importantly trust and the intermediation of it. CSAs wish to widen participation in food networks whilst maintaining commitments to the egalitarian ideas contained in their philosophy but are highly conscious of the challenges this entails. All these threads are also closely related to early versions of Blockchain and Cryptocurrencies or more general Distributed Ledger Technology.

Research suggests a huge potential for Distributed Ledger Technology in the agricultural sector [207, 116, 91]. We will not explain these technologies here because there is insufficient space. Nevertheless, we regard the backend of technology as a design aspect that is in this context important to discuss. Based on the community values expressed, we argue that neither central server structures nor Blockchain would be a fit, but other DLT might very well be.

Although Blockchain is sometimes described in terms of a shift from trust in institutions/people to trust in technology (Lustig coined the term *algorithmic authority* for it[124]), the approach does not work in this case. There are no rules that could be covered by smart contracts. Instead members are legally allowed to exploit others and they are trusted not to do so. Blockchain is also often conceived as a technology to implement currencies. However, it would not have made sense to use it for any implementation of the Luzerne (2). In the current version the Luzerne is a unit of account and because nothing is issued, there is nothing to implement. Literature suggests that the potential for Blockchain in agriculture lies in making information along the supply chain visible on a neutral ground that is not controlled by central intermediaries. If the ordering system (1) was built on a Blockchain, the advantage would be that people can no longer manipulate the orders of other members. But that would have been possible with a central server structure as well. To be able to compete with centralized software, a distributed system must therefore keep the additional cost low enough on a small scale already. A Blockchain does not do this. Besides the high energy cost of Blockchains which use the Bitcoin consensus algorithm called "Proof of Work", there is a fundamental dilemma for these Blockchains at least in the context of agricultural production. All the information that should be processed, for instance the members orders, needs to be stored in the Blockchain. To be stored in the Blockchain means to be stored by every full node of it. If this was viable and therefore adopted by the majority of enterprises in the sector, every full node of the Blockchain would have to store all the data from everyone. The high redundancy does not make sense for data that, for the most part, only the local community cares about. Thus, the advantages of a Blockchain, are not relevant in this small scale, high trust environment.

The advantages of a distributed ledger show up, however, when the scale increases and the trust decreases. Therefore, it might become relevant in the future, if many CSAs or other enterprises adopt similar models and use the same technology. If the system then already heavily relies on a centralized software architecture, this cannot easily be changed. We claim that the main advantages of DLT in this context would only show up in the future. People working in agriculture have almost no chance to

comprehend the consequences of the choice of the back end. Yet, becoming dependent on technology, is something they can very well comprehend and that conflicts with their values of sovereignty.

In their approach towards technology, we observed an emphasis on sovereignty. Technology is welcome only as a useful tool requiring as little attention and dependence as possible. Altieri [208] calls this technological sovereignty and sees it as one aspect of food sovereignty. Based on the experiences that the rest of the agricultural sector has had (see chapter 7.4.4), the sustainable oriented agriculturalists tend to refuse to rely on big corporations. So, there is some awareness that food production is not resilient if it depends on the will of external companies. This is in some conflict with running the spreadsheet document, which is essential for food allocation, through the Google servers. After all, if this access were to suddenly disappear, it would cause significant complications for the farm. Norton et al. [86] summarize these values under 'long-term values' for sustainability. Our point is that these values are on conflict with the implicit values of both centralized server structures and Blockchain technology. However, there is a fraction of Distributed Ledger Technology that goes beyond blockchain and is more sustainability oriented. (One possible candidate that aligns with the technological sovereignty is Holochain, a framework for peer-to-peer applications inspired by biomimicry [110]. We will discuss this in a forthcoming paper.)

In relation to implications for HCI, our study demonstrates the need for a careful understanding of the trust and solidarity issues that underpin community agriculture and cautions against technicist attempts to deal with the issues through classic Blockchain solutions. Attention to the practices of community agriculture and evaluation of potential solutions to existing problems, we believe, fills a current gap in the HCI/food literature.

7.6 Conclusions

We have shown how the Luzernenhof has further developed the system of CSAs and have discussed the significance of this development in the context of solidarity. Addressing our research question, we found mechanisms that go beyond common practices of CSAs. In particular, we were able to separate the free product choice property, the indefinite share size property and the currency as conceptually different. They were simply implemented by the same technical tool. Two innovation gaps consist of making these properties accessible as a software solution for other CSAs, whereas the currency is an optional addendum. We have discussed how, therefore, the trust structures in the community need to be taken into account.

We found a third innovation gap in the enabling of a cooperative distribution and accounting for alternative food networks. Filling this gap builds on the considerations of the internal distribution mechanisms. It involves requirements that are in tension to each other and it could but does not necessarily have to involve a currency innovation. Relatedly, the broader research field at the intersection of sustainable agriculture and currency innovation is still underexplored. Both offer design opportunities that require

S-HCI or CSCW work. Whatever software will be designed, it has to make a technical choice at the backend. We argued that centralized databases as well as Blockchain technology both would conflict the communities long term community values of sustainability. We therefore suggest that other Distributed Ledger Technologies should be considered.

Acknowledgements

We thank Alan Borning and David Randall for very insightful commentary. The University of Siegen has funded this research through its graduate program "Supply Chains and Economic Development – Plural Perspectives".

8 Bringing the Different Strands Together

This chapter brings and weaves together the insights gained in the previous chapters. First, I connect the discussion of Surveillance Capitalism (chapters 4 and 5) to the first monetary case study (chapter 6). Then I contrast the two case studies (chapters 6 and 7) before relating the CSA study back to surveillance capitalism. In between, I present prospects on both the monetary system and the IT sector. These progressive ideas are not strict consequences from my research, but were nevertheless shaped by it. I close the chapter with a reflection on the interplay between the applied methodologies.

8.1 A Surveillance Capitalism perspective on the Case of Libra

The starting point of this thesis were the business models of IT companies and the issues for democracy and sustainability that are resulting out of them. The core of these business models is extensive gathering of personal data. Against this backdrop, the case of Libra raised questions. Should the currency project be seen within this business model, as an instrument to gather valuable payment data? Or is it rather an attempt to diversify into a different business model? In 4.6.2 we suggested to attain a certain protection by design against this data exhaust by involving DLT, but not a classical blockchain, due to the energy and scalability problems. Indeed Facebook does apply DLT in a variant that circumvents these problems and uses it to limit it's own power over the currency — at least in terms of issuance, redemption and the ability to impose sanctions (in terms of data gathering, every member of the Association has the full access). Yet, this power is not distributed among the users, but delegated to a consortium of 100 organizations that are overwhelmingly profit oriented. Of the three criteria, that we formulated in 4.6.1, user control over their data, interoperable modularity and truly peer-to-peer communication, none is satisfied by Libra. The user data resides on a private blockchain held by the organizations in the Association, which intermediates the communication.

The question, whether Libra is an extension of the Surveillance Capitalism business model, or whether it enables a different business model, must therefore be answered with both. The case study illustrated non-exclusive scenarios for either way. Yet, the scenarios that represent a new business model also have striking similarities with the current model. Instead of the free services of social media, users may enjoy the free services around the currency Libra. What is exploited is then again their dependency on the Libra infrastructure, once such a dependency is established. In particular, Libra Association members would be able to make profit from both the interest rates on the reserve as well as the data collected, given they have capacities for predicting and influencing behavior based on that data. The analogy of filtering and censoring content,

would be the freezing of accounts or cancelling of transactions. Such a step is drastic, but it is possible in the conventional banking system as well, e.g. most recently by the freezing of Russian foreign exchange reserves by Western banks, or in Canada, where it was recently applied against supporters of trucker protests in Ottawa [209]. Finally, beyond an analogy in social media, the Libra association could issue unbacked Libra. Thus, when we formulate the insights about Surveillance Capitalism into a simplified lesson for corporately issued currencies (like Libra), it is not simply: "their business model is about gathering data" but rather "when profit driven companies control an essential infrastructure, they have various ways to exploit it".

Conversely, what do we learn from the Libra case for Surveillance Capitalism? Libra also serves as a case for the argument that it would be futile to enforce e.g. Facebook to implement social networks in a truly peer-to-peer way. The case study revealed, what Facebook makes out of the peer-to-peer technology blockchain. Facebook's take on it is something federated, but not at all decentralized. The way, in which they applied blockchain technology in this case was not according to what section 4.6.1 suggested. Not surprisingly, neither did their plans for Libra suffice our criteria, nor can we expect that whatever Facebook would come up with for the social media case would meet our criteria. Since if it did, it would kill their business model. After all that was the intention behind these criteria. We crafted them to counter the business model that we characterized to be the root cause of the societal problems with these services. If we want to see technological alternatives, they have to emerge from a different paradigm, outside the dominant IT companies, that we have today. For that reason chapter 5 explored the circumstances to do so, in especially other modes of funding and ownership as alternatives to the business model. This again highlights the fact that, at its best, technology can be used in ways that contribute to a solution, but it can never be the solution itself.

8.2 Contrasting the Currency Case Studies

I investigated two case studies, that were both snapshots in an experimental process of innovating on what people use as money. In contrast to Libra, where a Surveillance Capitalist aims to establish a globally usable internet currency, the second case study has a local focus and a very different orientation. This disparity also manifest in their architecture.

We characterized the unsustainable contribution of the Surveillance Capitalism business model from their role in the saturating economies, in particular in the West (see 4.2.5). These economies commit to growth, for which some scholars see the origin in the monetary system (see 6.2.1). As the imperative to grow becomes increasingly difficult to satisfy, targeted advertising attempts to generate demand for products, thereby spurring growth but also fueling a consumerism that breaks the boundaries of sustainability. This is the backdrop of the second case study, a currency innovation that attempts to break out of the logic of consumerism and the logic of the market. Instead it is based on the principle of solidarity.

The second case study explained the value of solidarity in the enic notion (meaning how the community is understanding the term), and made visible how this value is reflected in the architecture of the currency. What is less apparent, is how the architecture of the currency, counters consumerism or protects against the resulting exploitation of nature: The currency and distribution model would be possible with unsustainable practices of conventional agriculture as well. Rather, the model grants the farm the leeway to apply more sustainable practices that are impossible under the competitive optimization on market prices. Whether the farm really applies better practices is in a sense outside the model. Yet, the relationship between the members and the farm enable them to sense the actual practices. Good practices by the farm help to build trust by the members, that the model depends upon. First, because the model relies on these trust relationships, and second, because the currency creates a separation between prices within the CSA and prices in the outside world, it is particularly suited to sustainable practices. This is not to say, that there is no potential for additional architectures that incentivize sustainable practices more directly and rely less on the trust of consumers.

In addition to contrasting the different orientations and values manifesting in the currency architectures, we can apply the currency design criteria that the first case study produced to the second case study. Thereby, we first have to admit that these criteria implicitly assumed a possibly global, general means of payment. In particular, the *scalability at reasonable ecological impact, democratic legitimation* and *counteracting monopolies* are not applicable to a currency whose scope is a single CSA. Similarly, there is no *preservation of value*: The currency has an annular life cycle and does not serve as a preservation of value. This is neither a weakness nor a strength, but an intentional design choice: The currency has a more limited purpose (facilitating the distribution of food among the members), which it can serve better (compared to if savings were possible).

However, the other criteria are applicable. Above I explained to which degree the currency contributes towards *avoiding the logic of consumerism* and *respecting ecological carrying capacities*. Indeed, it plays a role in merely providing the necessary leeway. A *fostering the sovereignty of consumers* is noticeable. Consumers are in the role of community members that not only observe, but co-create the practices on the farm. And due to it's lightweight implementation the Luzerne has a *responsible energy consumption*. Yet, the members have no *protection against extraction* by the issuer, instead it is based on trust.

The challenges for a currency change with the context: For the same reason, that we noted in 7.5.6, that the advantages of a blockchain, are not relevant in the CSA context, the Luzerne looks very different to a cryptocurrency; it is a small scale, high trust environment.

Summarizing, behind the two currencies case studies are very different orientations, that result in very different currency designs. But is there something one can learn from these studies about the monetary system?

8.3 Lessons for the Monetary System

One insight that can be gained from analyzing the infrastructure of money (see 6.2.1), but also from the discussion of the scenarios in 6 is what power lies in money issuance: Commercial bank money, which is a form of credit money, always arises as a liability. Similarly the Libra currency is a liability for the Libra Association and truly daunting scenarios consist of decoupling this liability from the corresponding asset, the Libra reserve. This would enable money issuance as an asset that no longer has a corresponding liability.

In other words, it can be described as follows. Credit money always involves two sides. What one side uses as money and would therefore carry as an asset on a balance sheet is a liability for the other side, the bank. Nearly all people experience money only from the asset side; they are never in the role of the money issuer. This goes so far that at least some mainstream economics textbooks treat money as it was an asset that simply exists, completely ignoring the role of money-issuing banks. It is also the reason why it is common in the cryptocurrency scene to propagate Bitcoin was like digital gold; suggesting that the fact that bitcoins have to be mined in an elaborate mining process made them intrinsically valuable. Bitcoin thus attempts to model the money creation process as the creation of an asset that has no corresponding liability: One can not redeem a bitcoin to a miner to regain the energy that was spent on the Proof of Work. On the one hand, cryptocurrencies like Bitcoin are taking the revolutionary step of making money creation decentralized and accessible to everyone [1]. On the other hand, most Bitcoin enthusiasts hold the conservative economic conviction that the money supply should be fixed or predetermined [2]. However, this conviction obscures the liability side of money creation. But if money is to be redeemable into something of value, it must be matched by a liability.

One interpretation of what the Luzernenhof did with their currency is that it issued their own money. It would have been more apparent, if the farm literally issued the currency and accounted for it as a liability to its members. Due to the way that the currency builds on trust between people, it cannot scale up to a general means of payment, which it also does not aspire to be. Yet if many farms followed this example, it would be, in this sense, a decentralization of money issuance outside the hands of banks. The backing for these liabilities consists of the food that these farms produce. For this reason, the innovation gaps that we characterized in 7.5.5 are particularly relevant. Nevertheless, such a development would be far from overthrowing the monetary system, especially since these currencies are not designed as a general means of payment. Providing proposals for the monetary system as a whole exceeds what can be substantiated in the research I conducted. Nevertheless, I can outline very roughly a vision that goes far beyond that,

[1] Even though mining — today only operated by few large mining pools — is effectively rather centralized again

[2] This idea originates from the Austrian School of Economics. It culminates in the concept upheld by the Rothbardian fraction of Austrian Economics that therefore gold would be a good universal currency. This is not to say, that today's contemporary proponents of Austrian Economics have an influence on Bitcoin, even though there might be sympathies.

but is at least consistent with the insights from my research.

In order to free the monetary system from its role as a systemic driver of the exploitation of people and nature, it is paramount to tie the privilege of money issuance, or in other words of being on the liability side in money creation, to goals that are socially desirable. Since at present this privilege is held by banks, one attempt could be to enforce such an orientation of the banks. Whereas movements calling for 100% money [210] are essentially aimed at restricting this privilege to central banks in order to better control it. Such attempts need to go hand in hand with a better democratic control the central bank. Both attempts are reasonable. I, on the other hand, favor a third attempt for alignment between the privilege and the societal goals, by further distributing that privilege to everyone. An emancipatory transformation of the monetary system, and I have only indicated this in 6.5, would exist if people would move to using forms of money in which the privilege on the liability side was decentralized in a clever way into the hands of the people — in other words, if banks were no longer the only issuers of credit money. There are forms of currencies which practice the decentralization of the liability side, such as mutual credit systems or the less well known forms of rippling credit systems, such as Trustlines[3] or Circles[4]. The crux of the matter lies in these "clever ways". They have to be found in a co-design process with the practices of money use.

Reform proposals for the monetary system that advocate an even stronger central bank shift the problem toward the democratic control of this central authority. Democratization would be very important, but it is also very difficult. This is true not only in the case of the monetary system but also in the case of public IT infrastructure. Therefore it is worth relating between these two cases in a little more detail.

In both cases, I consider it to be even more harmful to leave the development to the free markets and hope that this will bring a socially desirable solution: This attempt allows centralized systems to emerge, especially where network effects are at work. Social media platforms and bitcoin mining are not the least examples of this.

The problem with central institutions is that they tend to be susceptible to instrumentalization by some actors at the expense of the general public. For the first case, the monetary system, this corresponds to the discussion of the scenarios of instrumentalization of control over a general means of payment from chapter 6. As a general means of payment, central bank money would definitely be preferable to Libra. For the second case, public IT infrastructure, this corresponds to the discussion of the instrumentalization of central data collections from chapters 4 and 5. Even worse than a surveillance state are the capabilities of a surveillance state in the hands of profit-seeking corporations. In both cases, the private version would be a relatively centralized construction with instrumentation already baked into it. In particular, then, the centralized vs decentralized dimension is not to be confused with the public vs private dimension.

In essence, in both cases, the monetary system and IT infrastructures, reform proposals should at their core be about creating systems that are aligned with the public interest and are as difficult as possible to instrumentalize by a subgroup at the expense

[3] https://trustlines.network/
[4] https://joincircles.net/

of the general public. Decentralization is an essential component of this. But it is not a panacea. Centralization and decentralization both have advantages and disadvantages. Instead, it is a matter of properly combining centralized and decentralized aspects. For IT infrastructure, for example, we have differentiated various levels. For the example of the monetary system, the push for a democratic central bank is basically a push for decentralized control of the central authority. And it is an endeavor that I would subscribe to. However, in addition, I advocate further decentralization of the monetary system, especially of money creation, even though this again restricts the power of the central bank.

8.4 The Issue of Technological Sovereignty

In addition to this prospect for the monetary system, I can work back toward a prospect for the IT sector.

An insight from the second case study is how easily a dependency on a cloud service provider sneaks in. Suppose Google would suspend their services to the farm, what would happen? Even though the farm has local backups of past data and could rebuild the tool on another cloud service providers spreadsheet feature, it would definitely bring a significant disruption and problems to the farms ability to deliver their food according to their members demands; the spreadsheet tool is an integral part of their system. Surely, there are many companies that use cloud services, for which such a scenario is even more threatening. But why does this happen in a community that is quite aware of the technological component of food sovereignty. The answer is simple, that the service is cheap and lightweight and offers a tremendous utility to the farm. Communities could host a collaborative spreadsheet themselves on local servers, but that would require maintenance. This sounds like a potential for Distributed Ledger Technology, where the decentralization offers a certain sovereignty in the sense of independence from central entities, like the cloud service providers. So why not use DLT instead of a cloud? We saw that at least a blockchain would be unbearably inefficient for this use case: Data is replicated with unnecessary redundancy to the cost of wasting the highly limited capacity of the blockchain. In short, this community chose a cloud based solution for the same reason, why cloud services for office applications prevail everywhere: People want the utility of documents that are editable by many users in real time, but don't want the struggle of maintaining their own servers. So, to be fair to the service providers, one has to admit, that the reason why they succeed in establishing dependencies on their infrastructure is the utility that these services offer to coordinate work.

The dependence of economic actors on certain infrastructures is widespread, so why is it particularly problematic in the case of these IT-services? The service providers are the IT companies, whose business models lead to the consequences that we discussed in chapters 4 and 5. In this sense, the CSA study makes another case for why cloud services become increasingly relevant as a locus of control for surveillance capitalism (see 5.2.1).

This only makes the question more urgent: How can these utilities be provided in a way that protects the users against exploitation? We argued to construct these IT-services

as a public good. Not by nationalizing the IT companies, but by providing alternatives as a public good. This has a technological component of protection by design (see 4.6.2) and a funding component (see 5.3.4).

The general thread of the discussion of solutions, therefore applies for cloud services similar to the other IT services, which we focused on in chapter 4. Even more so, there is a reason, why Amazon and Google (Alphabet) established as leading cloud service providers. They had to solve the generalized class of problems, whose solutions later were offered as cloud services (see 5.2.1). In a sense cloud services are the archetype of software services. If there was a public alternative to private cloud services, one could built social media and various other applications in a public fashion on top of them. For this reason we summarize these various different services and see a need to envision a new software paradigm away from the data-centricity that is prevalent today.

8.5 A New Old Paradigm in IT

For the monetary system we asked for a system that is as uncorruptable as possible, in terms of being difficult to instrumentalize in any way. One aspect of digital money is the IT infrastructure behind it. Regarding the uncorrupability (in the above sense) of the IT infrastructure behind digital money we have the same concerns as for the IT services of Surveillance Capitalism.

For a new paradigm in computing, that is able to provide IT services in a non-exploitatable manner, we argued for an ecosystem approach (see 5.3.4) that involves public funding of suitable parts of the infrastructure, in order to release these services from the business model that has grave consequences. Examples of publicly funded, alternative services successfully pushing back exploitative platforms exist already [211]. However, to construct this infrastructure as a public good, goes beyond these examples. It does not mean cloud and other IT services simply hosted on servers by the state. Much less does it mean subsidizing corporations to provide cloud services to the public. Instead this new infrastructure needs to be constructed in ways that are as difficult to corrupt and exploit as possible. This orientation is quite contrary to the data-centricity that brought about the currently dominant services. That is, why we are phrasing this process as a paradigm shift. Yet, it is hard to predict, how services that originate from such a paradigm would look like architecturally. Nevertheless, we at least made a contribution in that direction in section 4.6. We could only do so, because other, slightly neglected software paradigms exist.

As adjacent examples we only dropped endeavors like Tim Berners-Lee's Solid, the P2P Foundation [11] and Holochain [110]. There are plenty more. In my view these are all well aligned with various older movements for software that is open source [212] and/or peer-to-peer, such as cypherpunk and hacker movements [33]. Within these, decentralisation is a well-known response to network control and surveillance. It is rather a matter of applying the existing wisdom to the current challenges. In this sense, the new paradigm we are calling for is not new at all. What we are calling for, is a software paradigm that has its roots in these movements to gain the momentum to supersede the

currently dominant paradigm of surveillance capitalism.

A core difference between the data-centric paradigm of Surveillance Capitalism that is also resembled by consensus based blockchains on the one hand and peer-to-peer based systems that might involve post-blockchain DLT on the other hand, is that the latter do not attempt to construct a universal truth. This very much resonates with the post-objectivist methodology that (among others) the Siegen School of Socio-Informatics is committed to.

8.6 Complementary Methodologies

Methodologically the chapters about Surveillance Capitalism and the case study of Libra were argumentative technology assessments. This section relates that methodology to the praxeological research approach of the Siegen school, in which the CSA chapter fits as a context study. Therefore, I first argue that there are cases in which the the grounded design framework profits from technology assessments in a complementary fashion. Afterwards I point to where I see this complementary character in the work of my thesis already, even though my thesis is not a TA extended grounded design case study.

Circumstances for Compatibility

After conducting research with both methodologies, an argumentative TA and an empirical context study in line with the Siegen School, I suggest that the former can have a complementary character with regards to the latter. As qualifying criteria I suggest that at least one of the following circumstances need to be given:

(1) There is a technology under consideration that is sufficiently defined conceptually but does not yet exist or has not yet been implemented in practice. This was the case of Libra; the currency did not exist. The considered consequences lie in the future. It is precisely the orientation of the TA to provide knowledge about how to prevent negative consequences before they become empirically observable.

(2) The scale of potential societal impacts of a technology demands for an assessment already. Given how much communication technology and money underpin society today, both IT services and digital currency innovation with a global audience qualify as well.

(3) The technology under consideration can not simply be altered or redesigned in practice once it is released. Typical examples are nuclear power or genetic engineering. For the technologies that this thesis was concerned with, the criterion is only partly given. However, it shows the advantages and disadvantages of centralized systems compared to decentralized systems. With centralized software, an alteration (e.g., a software update) can be enforced by the center. On the one hand, this enables the rapid removal of features that are considered harmful. On the other hand, the implementation of alterations depends on the interests of this central entity. In contrast, decentralized software can be altered theoretically by anyone and depends on the acceptance of the users. But once decentralized software is released, it cannot be revoked.

How to Combine Technology Assessment and Grounded Design

These three criteria are rather generally motivating a technology assessment. This leaves open questions: Is a TA compatible with the Siegen School? If so, what does that mean for design case studies? And what are the benefits of loosening the commitment to purely empirical methodology by including a theoretical analysis of a TA?

In their constituting book for Socio-Informatics Wulf et al. advocate the approach of the Siegen school in which they state that "methodological foundations of IT development need to be constantly challenged" [127, p 544]. Thus this research approach is at least open for complementary methodologies. I suggest that argumentative technology assessment can be such a complementing methodology for which this thesis represents an example. Wulf et al. describe the critical issue of the practice-based design agenda to be "to understand more completely just how change might ramify, rather than crossing one's fingers, hoping for the best, and ignoring possible ramifications" [127, p 541]. In this regard a technology assessment (TA) is fitting. The argumentative turn, which does not consider the perspectives of stakeholders as fixed but engages in their mutual transformation (see 3.1), is compatible with the epistemological positioning of the Siegen School, that Wulf et al. describe as a "post-objectivist research agenda" [127, p 547].

With regard to design case studies (see 3.2), a TA should precede the three phases of the grounded design framework. Doing so can lead to a rejection or reconceptualization later in the design phase. Thereby, the TA informs a redesign, before a possible hazardous technology is released, as it would be in a trial-and-error approach. However, conversely, when the design or appropriation phases yield new features and insights that have not been considered in the TA phase, the TA needs to be updated. Therefore, the iterative and ongoing character of the grounded design framework should also be extended on the TA phase. It becomes apparent that in its purpose the TA has similarities to the context study phase. Yet, a context study applies an empirical methodology oftentimes participatory observation.

Of course, social media innovation can also be observed empirically, even in a design case study following the Siegen School. In fact, Hess et al. do study social media usage, asking "how new technology changes the user's media usage and how these changes affect the social structure" [213]. They study the user's behavior in a Praxlabs setting with empirical methods. Their context study is followed by an intervention via a designed technology and an appropriation phase, representing an exemplar of a design case study [214]. However, their design case study has a focus on devices and media usage and interprets the social structure in the local scope of a household. In effect, their findings are accordingly and differ from the consequences of IT services on a national and global scope, which the TA in this thesis found. Impacts that emerge on a macro-level are not suitable for prediction based on empirical findings on the micro-level. Thus, both methodological approaches are valuable and deliver different, complementary insights.

This Thesis as an Exemplar?

Even though these considerations of the compatibility of the methodologies that I used are positive, note that the research agenda that I suggested above is not what I did in my thesis. Thus, the thesis is not an exemplar of a grounded design research extended by a TA: The second monetary case study, a context study according to the grounded design framework, does not focus on the same technology as the preceding TA; the Luzerne does not attempt to be a better Libra. And for the technologies that I was concerned with in the TAs, I did not plan to sequel with a design case study. This is not to say, that doing so would not be worthwhile. In fact, it is one possibility for further research. Nevertheless, from the actual conduction of my thesis I can also provide some examples of how the TAs proved to be fruitful for the empirical case study.

Chapter 6 illustrates how in contexts that are less amenable to empirical methods an argumentative TA can yield design requirements similar to an empirical context study. I did it, by assessing the dangers that a mass adoption of a new technology, in this case the Libra currency, might bring about. Then I contrasted them with measures that could, according to the assessment, protect against these dangers. The limitations of this approach certainly lie in unforeseen second order consequences of the proposed measures. A technology that passes the TA still requires an appropriation study.

There are also limitations to the knowledge transferability between the results of these two different methodologies. However, such limitations exist already between design case studies with the same methodological approach. Praxeological researchers "need to better explore how to establish a creative environment in which researchers with backgrounds in different case studies can be supported in finding conceptual similarities" [127, p 547]. One way of finding such conceptual similarities is the discussion in 8.2. The resulting design requirements are at least one point of reference, to compare insights between the cases even across the methodological differences, and even though no design and appropriation studies followed, yet. However, the juxtaposition between the monetary case studies also hints to the limitations of knowledge transferability: the contexts are different, the Luzerne is not attempting to satisfy design requirements from the Libra case. Nevertheless, this is valuable in and of itself as illuminating the contrast between the local and immediate on the one hand and the global and reflective on the other.

Another way in which the background of the TA influenced my context study was in sensitizing my awareness: First of all, a part of why I chose that particular CSA, was because after the Libra study, I was pondering how a currency could be anchored in the sustainable generation of real value. In this sense the TA influenced the development of my research questions (see 1.1) and thereby guided my focus to a good context study. Second, without the background in Surveillance Capitalism, I would have probably underestimated the relevance of the fact, that the community established a dependency on a cloud service provider. This is relevant since their choice conflicts their ideal of food sovereignty in a non obvious way. This is an example of a connection between a detail in the context study and an issue on the global and reflective scale of society. This is not to say, that the praxeological approach misses such connections. It rather makes the case,

that the approach can benefit, when the implicit assessments that guide the researchers focus can be explicated and made rigor via a complementing methodology. Thus, I can also describe an influence on the praxeological research programme of the Siegen School that a TA can have, even if it is not integrated in the grounded design framework in the way I described above.

Socio-Informatics is concerned with the interplay between societal change, and the design of IT artifacts. The praxeological research program typically starts in a local and immediate context. This raises the question, why this context should be particularly suitable in relation to meaningful societal change, and if so, which aspects of the context deserve particular attention. The decision for a suitable context is consequential and must be made before a context study can even begin; suitable in the sense of contributing to relevant design decisions. This refers in particular to the connection to the global and reflexive level, to the relevance for social change. This decision is usually informally based on the researchers general experience. Researchers have an understanding of societal issues that motivate their research and their decision of context studies, even without previously studying these issues academically. However, making the connection explicitly based on academic study bridges divides between adjacent academic fields and methodologies. My TA took Surveillance Capitalism, a notion termed by Shoushana Zuboff who has at least a strong background in the field of Information Systems, and related it to the praxeological research programme of the Siegen School of Socio-Informatics in the fields of Human-Computer-Interaction and Computer Supported Cooperative Work.

All these arguments illustrate how the methodologies of technology assessment and grounded design can be applied in a complementary fashion.

9 Conclusion

We began by pointing out that the direction in which the IT industry is moving is highly problematic. The business model that underlies major IT corporations practices intensive gathering and correlation of personal information and behavioral manipulation. This surveillance capitalism business model, if left unchecked, poses an existential threat to liberal democracies, provides further tools for repression to autocratic regimes, and threatens the quality of life on this planet. For this wicked problem no simple fix exist, yet there are ways to tackle it.

Therefore, we suggest a co-evolution of (1) pressure from civil society (2) alternative technological development and (3) regulatory responses. We described education and ways of resistance for citizens and civil society organizations. On the technological side we discussed to which degree services can by design be structured in a way that there is no central entity owning the data, data mining it and selectively presenting content to influence user behavior. Therefore, we characterized properties a radical solution would need to embody, namely user control over personal data, a interoperable, modular design and communication that is truly peer-to-peer. We noted that although blockchains adhere to the theme of disintermediating central authorities, the fundamental limitations of blockchains disqualify them in this case. Instead in alternative software services we see a potential for post-blockchain Distributed Ledger Technology. Implementing them requires alternative models of funding, ownership and control and design. And we differentiated components, that software services require, according to the applicability of these models. On the regulatory side, we argued that this to a considerable degree is a case of companies in monopoly positions playing their users' dependency against them. Therefore, we advocate true informed consent and adversarial interoperability, to combat user exploitation and monopoly respectively, suppose they are implemented and enforced comprehensively. Our hope is that this will then allow society to move away from reliance on surveillance capitalism to provide basic IT services, and allow alternative models to emerge.

In the second half of the thesis, we connected this discussion to two currency case studies. In the bigger picture surveillance capitalism is the latest expression of an economic system that requires growth in order not to collapse; the behavioral manipulation attempts to steer growth by creating new demand in otherwise relatively saturated economies. For this growth obligation the monetary system plays a causal role. Therefore, we conducted two currency case studies. One is a currency that originated from within surveillance capitalism and the other originated from an attempt to break free from consumerism and the logic of the market.

In the first case study, Facebook presented a currency with an architecture that uses a blockchain variant to restrict Facebook's control while circumventing the fundamental

problems of classical blockchains. However, it shares the orientation of surveillance capitalism to a large extent. The architecture is prone to use payment data to fuel consumerism. The role of a money issuer only adds more ways how network effects lead to monopoly positions that can be played against the users that made themselves dependent. The limitations of control merely distribute the power to a group of mostly profit driven organizations. By contrast, we suggested dimensions for the discussion of future forms money that is neither issued by central banks nor bound to central bank money in the way commercial bank money is.

The second case study was a currency created by a community at the frontier of the Community Supported Agriculture movement. We differentiated the different aspects of their innovation that go significantly beyond the common practices of this progressive movement. Furthermore, we identified innovation gaps whose closure would also constitute a progression in terms of sustainable money creation. Nevertheless, this currency does not solve any global systemic problems, nor is it the good alternative to the bad Facebook currency. Instead the Juxtaposition illustrates how different values and orientations bring forth different currency architectures. This case builds on solidarity in a low scale, high trust environment.

Besides the importance of the monetary system for the problems of and solutions to surveillance capitalism, the case studies substantiated the need for IT structures that support the technological sovereignty of people. We argued that in the observed cases neither centralized databases nor current blockchain technology are aligned with values of sustainability and democracy. Nevertheless, there is a potential for post-blockchain Distributed Ledger Technologies that originates from an orientation aligned with those values.

Overall, a new paradigm is needed in IT development that is no longer driven by the need to generate high profits through collecting large amounts of personal data and manipulating behavior, but is oriented to serve human needs while staying within planetary boundaries.

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Acknowledgements

First and foremost, I would like to express my professional gratitude for the people who paved the academic path for me that led to this dissertation. These are in especially Alan Borning, Dave Randall, Helge Peukert, Lance Bennett, Peter Tolmie and Volker Wulf. One not to be underestimated part of the challenge at the end of which, in the best case, good academic publications are the result, is to find the necessary orientation in the appropriate academic structures. Another is to let the texts mature in such a way that the resulting academic publications become actually good. In both respects, this work would not have been possible in this form without these people. The fact that my co-author Alan is at the beginning of this list and my supervisor Volker is at the end is owed to the alphabetical sorting of their first names.

Secondly, I would like to express my personal gratitude to the people who have done the care work that remains invisible in the publications. These are especially Lari, Katka, David, Lucia, Elle and my family. Mind the gender gap. What the academy sees as my accomplishments, I see as the byproducts that accrue in the journey that was this PhD. Not only did these people help make sure that those byproducts actually accrue, they also absorbed what their making left in me. Oftentimes with ease. Sometimes without. Thank you.

Finally, on an even more personal note, I dedicated this work with love to both special people and parts within me. Without the naive parts within me that childishly wanted to make this work a contribution to saving the world, I would not even have started. Of course, this aspiration was feeble to begin with, let alone the caveat of the great horrors, that people with a savior complex have brought upon the world in the past. Nevertheless, I want to hold the aspiration to protect and nurture live as sacred, may it actualize in form of feeble ambitions at times. Feeling those parts within me put off and ultimately unsatisfied was rupturing. Here seems to be the right place to mention it, publicly, where a considerable percentage of the readers are myself. Nevertheless, revealing this felt rupture here, is meant to be an olive branch to these parts. Attempting to keep them integrated, is in my understanding an act of self-love.

There always is a loving way to choose.

This thesis picks up and attempts to make sense of several of the interrelated major problems and crises that humanity is currently facing, and which reveal where our lifestyles are unsustainable. A more recent of these problems is the societal impact of the software services that large IT companies offer. The dominant business model behind these largely free services comes at the expense of a devastating societal spillover. A second thread are attempts to invent on currencies and their relation to the crises of today's capitalist system. Here the thesis offers two currency case studies: one by a Surveillance Capitalist and one by a grassroots food movement, a Community Supported Agriculture. The third interwoven thread is the potential of decentralized software architecture, and Blockchain and Blockchain alternatives in particular. This recently growing technology offers a strong narrative to overthrow established centralized monetary and technology institutions. Via a technology assessment and two case studies, this thesis scrutinizes that narrative and comes to disillusioning results.

ISBN 978-3-96182-162-4

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