

# 1 **Operational Framework: Institutional Controls - The New Deal** 2 **on Data**

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## 19 **1 The New Realities of Living in a Big Data Society**

20 To realize the promise and prospects of a Big Data society and avoid its security and con-  
21 fidentiality perils, institutions are updating operational frameworks governing business, legal,

22 and technical (BLT) dimensions of their internal organization and interactions with the outside  
23 world. In this chapter we explore the emergence of the Big Data society, outline ways to support  
24 it in the context of institutional controls within the framework of the New Deal on Data, and  
25 describe future directions for research and development.

26 The control points traditionally relied upon as part of corporate governance, management  
27 oversight, legal compliance, and enterprise architecture must evolve and expand to match oper-  
28 ational frameworks for Big Data. An operational framework used for a Big Data driven organi-  
29 zation requires a balanced set of institutional controls. These controls must support and reflect  
30 greater user control over personal data, as well as large scale interoperability for data sharing be-  
31 tween and among institutions. Core capabilities of these controls include responsive rule-based  
32 systems governance and fine-grained authorizations for distributed rights management.

33 Sustaining a healthy, safe, and efficient society is a scientific and engineering challenge dating  
34 back to the 1800s when the Industrial Revolution spurred rapid urban growth, thereby creating  
35 huge social and environmental problems. The remedy then was to build centralized networks  
36 that delivered clean water and safe food, enabled commerce, removed waste, provided energy,  
37 facilitated transportation, and offered access to centralized health care, police, and educational  
38 services. These networks formed the backbone of society as we know it today.

39 These century-old solutions are, however, becoming increasingly obsolete and inefficient. We  
40 have cities jammed with traffic, world-wide outbreaks of disease that are seemingly unstoppable,  
41 and political institutions that are deadlocked and unable to act. We face the challenges of global  
42 warming, uncertain energy, water, and food supplies, and a rising population and urbanization  
43 that will add 350 million people to the urban population by 2025 in China alone [15].

44 It does not have to be this way. We can have cities that are energy efficient, have secure food  
45 and water supplies, are protected from pandemics, and enjoy much better governance. To reach  
46 these goals, however, we need to radically rethink our approach. Rather than static fixed systems  
47 separated by function — water, food, waste, transport, education, energy — we must consider  
48 them as dynamic, data-driven networks. Instead of focusing only on access and distribution, we

49 need networked and self-regulating systems, driven by the needs and preferences of the citizens.

50 Sustainable, future societies depend on our new technologies being used to create a *nervous*  
51 *system* maintaining the stability of government, energy, and public health systems around the  
52 globe. The digital feedback technologies of today are capable of creating a level of dynamic  
53 responsiveness required by our larger, more complicated, modern society. We must reinvent  
54 the systems of societies within a control framework: sensing the situation, combining these  
55 observations with models of demand and dynamic reaction, using the resulting predictions to  
56 tune the system to match the demands.

57 The engine driving this nervous system is Big Data: the newly ubiquitous digital data, now  
58 available about all aspects of human life. We can analyze patterns of human experience and  
59 idea exchange within the *digital breadcrumbs* we all leave behind as we move through the world:  
60 call records, credit card transactions, GPS location fixes, among others [25]. By recording our  
61 choices, these data tell the story of our lives. This may be very different from what we decide  
62 to put on Facebook or Twitter; our postings there are what we choose to tell people, edited  
63 according to the standards of the day and filtered to match the persona we are building. Mining  
64 social networks can give some great insights about human nature [4, 29, 44]; who we really are,  
65 however, is even more accurately determined by where we spend our time and which things we  
66 buy, rather than just what we say we do [28].

67 The process of analyzing the patterns within these digital breadcrumbs is called reality  
68 mining [14, 33], and through it we can learn an enormous amount about who we are. The  
69 Human Dynamics research group at MIT found that we can use them to tell if we are likely  
70 to get diabetes [34], or whether we are the sort of person who will pay back loans [36]. By  
71 analyzing these patterns across many people, we are discovering that we can begin to explain  
72 many things — crashes, revolutions, bubbles — that previously appeared to be random acts of  
73 God [31]. For this reason, the magazine Technology Review named our development of reality  
74 mining as one of the ten technologies that will change the world [18].

## 2 The New Deal on Data

The digital breadcrumbs we leave behind provide clues about who we are, what we do and what we want. This makes personal data — data about individuals — immensely valuable, both for public good and for private companies. As the European Consumer Commissioner, Meglena Kuneva, said recently, “Personal data is the new oil of the Internet and the new currency of the digital world” [24]. This new ability to see the details of every interaction can be used for good or for ill. Therefore, maintaining protection of personal privacy and freedom is critical to our future success as a society. We need to enable even more data sharing for the public good; at the same time, we need to do a much better job in protecting the privacy of the individuals.

A successful data-driven society must be able to guarantee that our data will not be abused; perhaps especially that government will not abuse the power conferred by access to such fine-grain data. The abuses may be directly targeted at users, for example, by offering them higher insurance rates based on their shopping history [17], or create problems for the entire society, such as limiting user choices and closing them into information bubbles [20]. To achieve the positive possibilities of a new society, we require the *New Deal on Data*, workable guarantees that the data needed for public good are readily available while at the same time protecting the citizenry [33].

The key insight motivating the idea of the New Deal on Data is that our data are worth more when shared, because these aggregated data — averaged, combined across population, and often distilled to high-level features — inform improvements in systems such as public health, transportation, and government. For instance, we have demonstrated that data about the way we behave and where we go can be used to minimize the spread of infectious disease [27,34]. Our research has reported how we were able to use these digital breadcrumbs to track the spread of influenza from person to person on an individual level. And if we can see it, we can also stop it.

Similarly, if we are worried about global warming, these shared, aggregated data can show us how patterns of mobility relate to productivity [32]. In turn, this provides us with the ability to design cities that are more productive and, at the same time, more energy efficient. However,

102 in order to obtain these results and make a greener world, we need to be able to see the people  
103 moving around; this depends on having many people willing to contribute their data, even if  
104 only anonymously and in aggregate.

105 To enable sharing of personal data and experiences, we need secure technology and regulation  
106 allowing individuals to safely and conveniently share personal information with each other, with  
107 corporations, and with government. Consequently, the heart of the New Deal on Data must  
108 be to provide both regulatory standards and financial incentives enticing owners to share data,  
109 while at the same time serving the interests of both individuals and society at large. We must  
110 promote greater idea flow among individuals, not just corporations or government departments.

111 Unfortunately, today most personal data are siloed off in private companies and therefore  
112 are largely unavailable. Private organizations collect the vast majority of the personal data in  
113 the form of mobility patterns, financial transactions, and phone and Internet communications.  
114 These data must not remain the exclusive domain of private companies, because then they are  
115 less likely to contribute to the common good. Thus, these private organizations must be key  
116 players in the New Deal on Data framework for privacy and data control. Likewise, these data  
117 should not become the exclusive domain of the government, as this will not serve the public  
118 interest of transparency; we should be suspicious of trusting the government with such power.  
119 The entities who should be empowered to share and make decisions about their data are the  
120 people themselves: users, participants, citizens.

121 Through the years, the great goal of human societies was to find the efficient ways of gov-  
122 ernance. The Big Data transformation can contribute to this ultimate goal of providing the  
123 society with tools to analyze and understand what needs to be done, and to reach the consensus  
124 on how to do it. This goes beyond simple creation of more communication platforms; the as-  
125 sumption that more interactions between users will result in better decisions being made, may  
126 be very misleading. Although in the recent years we have seen some great examples of using  
127 social networks for better organization in society, for example during political protests [6, 19], we  
128 are not even close to the point where we can start reaching consensus about the big problems:

129 epidemics, climate change, pollution. We can improve the discussions by making them data  
 130 driven, involving both experts and wisdom of the crowds – users themselves interested in im-  
 131 proving the society. The problems we are dealing with as a now global society are more difficult  
 132 than ever. We are responsible for many of them, and being able to tackle them on a global scale  
 133 is necessary for our survival as a people.

### 134 **3 Personal Data: Emergence of a New Asset Class**

135 It has long been recognized that the first step to promoting liquidity in land and commodity  
 136 markets is to guarantee ownership rights so that people can safely buy and sell. Similarly, the  
 137 first step toward creating more new ideas and greater flow ideas — idea liquidity — is to define  
 138 ownership rights. The only politically viable course is to give individual citizens key rights over  
 139 data that are about them; these types of rights have undergirded the European Union’s Privacy  
 140 Directive since 1995 [13].

141 We need to recognize personal data as a valuable asset of the individual, which is given to  
 142 companies and government in return for services. We can draw the definition of ownership from  
 143 English common law on ownership rights of possession, use, and disposal:

- 144 • You have the right to possess data about yourself. Regardless of what entity collects the  
 145 data, the data belong to you, and you can access your data at any time. Data collectors  
 146 thusly play a role akin to a bank, managing the data on behalf of their customers.
- 147 • You have the right to full control over the use of your data. The terms of use must be opt-  
 148 in and clearly explained in plain language. If you are not happy with the way a company  
 149 uses your data, you can remove the data, just as you would close your account with a bank  
 150 that is not providing satisfactory service.
- 151 • You have the right to dispose of or distribute your data. You have the option to have data  
 152 about you destroyed or redeployed elsewhere.

Individual rights to personal data must be balanced with the need of corporations and governments to use certain data-account activity, billing information, etc. to run their day-to-day operations. This New Deal on Data therefore gives individuals the right to possess, control, and dispose of copies of these required operational data, along with copies of the incidental data collected about the individual, such as location and similar context.

Note that these ownership rights are not exactly the same as literal ownership under modern law, but the practical effect is that disputes are resolved in a different, simpler manner than would be the case for land ownership disputes, for example.

In 2007, one author (Pentland) first proposed the New Deal on Data to the World Economic Forum [45]. Since then, this idea has run through various discussions and eventually helped shape the 2012 Consumer Data Bill of Rights in the United States, along with a matching declaration on Personal Data Rights in the EU. These new regulations hope to accomplish the combined effect of breaking data out of the current silos, thus enabling the public good, while at the same time giving individuals greater control over data about them. This is still a work in progress and the battle for individual control of personal data rages onward.

The World Economic Forum (WEF) has dubbed personal data as the “New Oil” or resource of the 21st century [45]. The discovery of oil and the subsequent development of the oil industry over the past 100 years has spurred not only the development of the automobile industry but, also the creation of the global transportation infrastructure, including the massive freeway networks we see today in the developed nations. The “personal data sector” of the economy today is still in its infancy, its state akin to the oil industry during the late 1890s, prior to the development of the Model-T Ford automobile. The productive collaboration between the Government (building the state owned freeways), the private sector (mining and refining oil, building automobiles), and the citizen (the user-base of these services) allowed the developed nations to expand their economies by creating new markets adjacent to the automobile and oil industries.

If personal data, as the new oil, is to reach its global economic potential, there needs to be a productive collaboration between all the stakeholders in the establishment of a *personal data*

ecosystem. As mentioned in [45], a number of fundamental questions about privacy, property, global governance, human rights — essentially around who should benefit from the products and services built upon personal data — are major uncertainties. The rapid rate of technological change and commercialization in the use of personal data is undermining end user confidence and trust.

The current personal data ecosystem is fragmented and inefficient. Too much leverage is currently being accorded to service providers that enroll and register end-users. These siloed repositories of personal data exemplify the fragmentation of the ecosystem, containing data of varying qualities; some are attributes of persons that are unverified, while other represent higher quality data that have been cross-correlated with other data points of the end-user.

For many participants, the risks and liabilities exceed the economic returns. Besides not having the infrastructure and tools to manage personal data, many end-users simply do not see the benefit of fully participating in the ecosystem. The current focus of many Internet-based services is to capture personal data from the end-user and to sell this data to the advertising industry. Personal privacy concerns are thus inadequately addressed at best, or simply overlooked in the majority of cases. The current technologies and laws fall short of providing the legal and technical infrastructure needed to support a well-functioning digital economy.

Recently, we have shown how challenging, but also possible it is to open such institutional Big Data. In the Data For Development (D4D) Challenge <http://www.d4d.orange.com>, the telecommunication operator Orange opened access to a large dataset of call detail records (CDRs) from the Ivory Coast. Working with the data as part of a challenge, teams of researchers came up with life-changing insights for the country. For example, one team developed a model for how disease spread in the country and demonstrated that information campaigns based on one-to-one phone conversations among members of social groups can be an effective countermeasure [26]. As we have seen in several cases, such as the Netflix Prize privacy disaster [30] and other similar privacy breaches [39], true anonymization is extremely hard. In the Unique in the Crowd [10], de Montjoye et al. showed that even though human beings are



highly predictable [37], we are also very unique. Having access to one dataset may be enough to uniquely fingerprint someone based on just a few datapoints, and use this fingerprint to discover their true identity. In releasing and analyzing this data, the privacy of the people who generated the data was protected not only by technical means, such as removal of Personally Identifiable Information (PIIs), but also by legal means, with the researchers signing an agreement they will not use the data for re-identification or other nefarious purposes. Opening data from the silos by publishing static datasets — collected at some point and unchanging — is important, but it is only the first step. We can do even more substantial things when the data is available in real time and can become part of a society’s nervous system. Epidemics can be monitored and prevented in real time [34], underperforming students can be helped, and people with health risks can be treated before they get sick [9].

The report of the World Economic Forum [45] suggests a way forward by recommending a number of areas where efforts could be directed:

- Alignment of key stakeholders: Citizens, the private sector and the public sector need to work in support of one another. Efforts such as NSTIC [40] — albeit still in its infancy — represent a promising direction for a global collaboration.
- Viewing “data as money”: There needs to be a new change in mindset, in which an individual’s personal data items are viewed and treated in the same way as their money. These personal data items would reside in an “account” (like a bank account) where it would be controlled, managed, exchanged, and accounted for just like personal banking services operate today.
- End-user centricity: All entities in the ecosystem need to recognize end-users are vital and independent stakeholders in the co-creation and value exchange of services and experiences. Efforts such as the *User Managed Access* (UMA) initiative [2] point in the right direction by designing systems that are user-centric and managed by the user.

## 232 4 Enforcing the New Deal on Data

233 How can we enforce this New Deal? The threat of legal action is important, but not sufficient; if  
234 you cannot see abuses, you cannot prosecute them. Moreover, who wants more lawsuits anyway?  
235 Enforcement can be addressed significantly without prosecution of public statute or regulation.  
236 In many fields, companies and governments rely upon rules governing common BLT practices  
237 to create effective self-organization and enforcement. This approach holds promise as a method  
238 by which institutional controls can form a reliable operational framework for Big Data, privacy,  
239 and access.

240 One current best practice are systems of data sharing called trust networks, combination of  
241 networked computers and legal rules defining and governing expectations regarding data. For  
242 personal data, these networks of technical and legal rules keep track of user permissions for  
243 each piece of data and act as a legal contract, specifying what happens in case of a violation.  
244 For example, in such a system all personal data can have attached labels specifying what the  
245 data can and cannot be used for. These labels are exactly matched by the terms in the legal  
246 contracts between all of the participants, stating penalties for not obeying them. The rules can  
247 — and often do — reference or require audits of relevant systems and data use, demonstrating  
248 how traditional internal controls can be leveraged as part of the transition to more novel trust  
249 models.

250 When a trust network involves use of personal data, user permissions and corresponding  
251 limits on use are fundamental to the trust model. In this context, the permissions, including  
252 the provenance of the data, should require appropriate levels of audit. A well designed trust  
253 network, elegantly integrating computer and legal rules, allows automatic auditing of data use  
254 and allows individuals to change their permissions and withdraw data.

255 The mechanism for establishing and operating a trust network is to create system rules for  
256 the applications, service providers, data, and the users themselves. System rules are some-  
257 times called operating regulations in the credit card context, trust frameworks in the identity  
258 federations context, or trading partner agreements in a supply value chain context. Several

multi-party shared architectural and contractual rules create binding obligations and enforceable expectations on all participants in scalable networks. Furthermore, the system rules design pattern allows participants to be widely distributed across heterogeneous business ownership boundaries, legal governance structures, and technical security domains. Yet, the parties need not agree to conform to all or even most aspects of their basic roles, relationships, and activities in order to connect to systems of a trust network. Cross-domain trusted systems must — by their nature — focus enforceable rules narrowly upon commonly agreed upon items in order for that network to achieve its purpose.

For example, institutions participating in credit card and automated clearing house debit transactional networks are subject to profoundly different sets of regulations, business practices, economic conditions, and social expectations. The network rules focus upon the topmost agreed items affecting interoperability, reciprocity, risk, and revenue allocation. The knowledge that fundamental rules are subject to enforcement actions is one of the foundations of trust and a motivation to prevent or address violations before they trigger penalties. A clear example of this approach can be found with the Visa Operating Rules, covering a vast global real-time network of parties agreeing to rules governing their roles in the system as merchants, banks, transaction processors, individual or business card holders, and other key system roles.

Such system has made the interbank money transfer system among the safest systems in the world and the daily backbone for exchanges of trillions of dollars, but until recently those were only for the ‘big guys’. To give individuals a similarly safe method of managing personal data, the Human Dynamics group at MIT, in partnership with the Institute for Data Driven Design, co-founded by John Clippinger and one author (Pentland), have helped to build open Personal Data Store (openPDS) [11]. See <http://openPDS.media.mit.edu> for project information and <https://github.com/HumanDynamics/openPDS> for the open source code. The openPDS is a consumer version of a personal cloud trust network that we are now testing with a variety of industry and government partners. Soon, sharing your personal data could be as safe and secure as transferring money between banks. We have also applied the system rules approach to

development of integrated business, technical architecture, and rules in large scale institutional use of personal data stores, available as an example under MIT creative commons license at <https://github.com/HumanDynamics/SystemRules>.

When it comes to data intended to be accessible over networks — whether big, personal, or otherwise — the traditional container of an institution makes less and less sense. Institutional controls apply, by definition, by or to some type of institutional entity such as a business, governmental, or religious organization. A combined view of the BLT facts and circumstances surrounding Big Data is necessary to know what access, confidentiality, and other expectations exist. The relevant contextual aspects of Big Data at one institution is often profoundly different from that of another. As more and more organizations use and rely upon Big Data, a single formula for the institutional controls will not work for increasingly heterogeneous BLT environments in play. Many organizations are structured with clear leadership on BLT issues, which are functionally assigned to top level executive roles. Business issues are typically allocated to roles such as CEO, COO, or CFO, while leadership on legal issues is commonly assigned to roles like general counsel and regulatory compliance, and technical leads are often the roles of CIO, CTO, or CSO. Having top level leadership for each of the business, legal, and technical aspects of a trust network is a critical success factor.

The capacity to apply the appropriate methods of enforcement for a trust network depend upon a clear understanding and agreement among parties about the purpose of the trusted system and the respective roles or expectations of those connecting as participants. Therefore, an anchor is needed to have a clear context of a Big Data operational framework and institutional controls appropriate for access and confidentiality or privacy.

## 5 Transitioning End-User Assent Practices

The way users grant authorizations to their data is not a trivial matter. The flow of personal information, such as location data, purchases and health records can be very complex. Every tweet, geo-tagged picture, phone call, or purchase with credit card provide the user's location

not only to the primary service, but also to all the applications and services that have been authorized to access and reuse these data. The authorizations may come from the end-user or be granted by the collecting service, based on an umbrella terms of service and how it allows the reuse of the data. Implementation of such flows was a crucial part of the Web 2.0 revolution, realized with RESTful APIs, mashups, and authorization-based access. The way personal data travels between the services has, however, become arguably too complex for a user to handle and manage.

Increasing the amount of data controlled by the user and granularity of this control is meaningless if it cannot be exercised in an informed way. For many years, the End User License Agreements (EULAs), long incomprehensible texts have been accepted blindly by the user, trusting they have not agreed to anything that could harm them. The process of granting the authorizations cannot be too complex, as it would prevent the user from understanding her decisions. At the same time, it cannot be too simplistic, as it may not sufficiently convey the weight of the privacy-related decisions. It is a challenge in itself, to build the end-user assent systems that allow the user to understand and adjust their privacy settings. Complex EULAs do not promote the privacy of the users, effectively pushing them to press *I Agree* in every presented window.

This gap between the interface — single click — and the effect, can render the data ownership meaningless; the click may wrench people and their data into systems and rules that are antithetical to fair information practices, such as is prevalent with today's end-user licenses in cloud services or applications. Managing the potentially long term and opposite dynamics fueled by old deal systems operating simultaneously with the new deal systems is an important design and migration challenge during the transition to a Big Data economy. During this transition and after the New Deal on Data is no longer new, personal data must continue to flow in order to be useful. Protecting the data of people outside of the user-controlled domain is very hard without a combination of cost effective and useful business practices, legal rules, and technical solutions.

339 We envision Living Informed Consent, where the user is entitled to know what data is being  
 340 collected about her by which entities, empowered to understand the implications of data sharing,  
 341 and finally put in charge of the sharing authorizations. We suggest the readers ask themselves a  
 342 question: *Which services know which city I am in today?*. Google? Apple? Twitter? Amazon?  
 343 Facebook? Flickr? This small application we have authorized a few years ago to access our  
 344 Facebook check-ins and forgot since then? This is an example of a fundamental question related  
 345 to user privacy and assent, and yet finding the answer to it may be surprisingly difficult in today's  
 346 ecosystem. We can hope that most of the services treat the data responsibly and according to  
 347 user authorizations. In the complex network of data flows however, it is relatively easy for the  
 348 data to leak to careless or malicious services [7]. We need to build the solutions to help the user  
 349 to make well informed decisions about data sharing.

## 350 6 Big Data and Personal Data Institutional Controls

351 The concept of “institutional controls” refers to safeguards and protections by use of legal, policy,  
 352 governance, and other non-strictly technical, engineering, or mechanical measures. The phrase  
 353 institutional controls in a Big Data context can perhaps best be understood by examining how  
 354 the concept has been applied to other domains. The most prevalent use of institutional controls  
 355 has been in the field of environmental regulatory frameworks.

356 A good example of how this concept supports and reflects the goals and objectives of en-  
 357 vironmental regulation can be found in the policy documents of the Environmental Protection  
 358 Agency (EPA). This following definition is instructive, and is part of the Institutional Control  
 359 Glossary of Terms [42]:

360 *Institutional Controls - Non-engineering measures intended to affect human activ-*  
 361 *ities in such a way as to prevent or reduce exposure to hazardous substances. They*  
 362 *are almost always used in conjunction with, or as a supplement to, other measures*  
 363 *such as waste treatment or containment. There are four categories of institutional*

364        *controls: governmental controls; proprietary controls; enforcement tools; and infor-*  
 365        *mational devices.*

366        In the legal domain, this concept frequently emerges under the moniker “regulatory compli-  
 367        ance” or “legal compliance” anchored in legal and regulatory frameworks such as Health Insur-  
 368        ance Portability and Accountability Act (HIPAA) and Sarbanes-Oxley (SOX). These statutory  
 369        legal frameworks require covered organizations to establish integrated sets of governance, legal,  
 370        transactional, security, and other internal controls to avoid violating the rules. The institutional  
 371        controls are accomplished in tight integration with engineering and other measures in order  
 372        to ensure compliance and to control legal and security risk. The use of institutional controls  
 373        of this type are fundamental methods for achieving and maintaining the transition to a dig-  
 374        ital, networked, and Big Data footing for any private company, government agency, or other  
 375        organization.

376        The concept of an “institutional control boundary” is especially clarifying and powerful when  
 377        applied to the networked and digital boundaries of an institution. In the context of Florida’s  
 378        environmental regulation frameworks, the phrase is applied to describe the various types of  
 379        combinations risk management levels related to target cleanup standards and extend beyond  
 380        the area of a physical property boundary. Also see a recent University of Florida report on  
 381        Development of Cleanup Target Levels (CTLs) [8] stating “Risk Management Options Level  
 382        III, like Level II, allows concentrations above the default groundwater CTLs to remain on site.  
 383        However, in some rare situations, the institutional control boundary at which default CTLs must  
 384        be met can extend beyond the site property boundary.”

385        When institutional controls would apply to “separately owned neighboring properties” a  
 386        number of issues arise that are very relevant to the problems associated with managing personal  
 387        data across legal, business, and other systemic boundaries. Requiring the party responsible for  
 388        site cleanup to use “best efforts” to attain agreement by third parties to institute the relevant  
 389        institutional controls is perhaps the most direct and least prescriptive approach. When direct  
 390        negotiated agreement is not successful, then use of third party neutrals to resolve disagreements

391 regarding institutional controls can be required. If necessary, environmental regulation can force  
 392 an acquisition of neighboring land by compelling the party responsible to purchase the other  
 393 property or by purchase of the property directly by the EPA [43].

394 In the context of Big Data, institutional controls are seldom, if ever, the result of government  
 395 regulatory frameworks such as are seen in the environmental waste management oversight by the  
 396 EPA [8, 12, 16]. Rather, institutions applying measures constituting institutional controls in the  
 397 Big Data and related information technology and enterprise architecture contexts will typically  
 398 employ governance safeguards, business practices, legal contracts, technical security, reporting,  
 399 and audit programs and various risk management measures.

400 Inevitably, institutional controls for Big Data will have to operate effectively across institu-  
 401 tional boundaries, just as environmental waste management internal controls must sometimes  
 402 be applied across real property boundaries and may subject multiple different owners to enforce-  
 403 ment actions corresponding to the applicable controls. Short of government regulation, the use  
 404 of system rules as a general model are one widely understood, accepted, and efficient method  
 405 for defining, agreeing, and enforcing institutional and other controls across BLT domains of  
 406 ownership, governance, and operation.

407 Following the World Economic Forum recommendations of treating personal data stores in  
 408 the manner of bank accounts [45], there are a number of infrastructure improvements that need to  
 409 be realized, if the personal data ecosystem is to flourish and deliver new economic opportunities.  
 410 We believe the following infrastructure improvements are necessary for the coming personal data  
 411 ecosystem:

- 412 • *New global data provenance network:* In order for personal data to be treated like bank  
 413 accounts, the origin information regarding data items coming into the data store must be  
 414 maintained [22]. In other words, the provenance of all data items must be accounted for  
 415 by the IT infrastructure upon which the personal data store operates. The heterogeneous  
 416 provenance databases must then be interconnected in order to provide a resilient and  
 417 scalable platform for audit and accounting systems to track and reconcile the movement



of personal data from the respective data stores.

- *Trust network for computational law*: In order for trust to be established between parties who wish to exchange personal data, we foresee that some degree of “computational law” technologies may have to be integrated into the design of personal data systems. Such technologies should not only verify terms of contracts (e.g. terms of data use) against user-defined policies but also have mechanisms built-in to ensure non-repudiation of entities who have accepted these digital contracts. Efforts such as [1, 2] are beginning to bring better evidentiary proof and enforceability of contracts into the technical protocol flows.
- *Development of institutional controls for digital institutions*: Currently there are a number of proposals for the creation of virtual currencies (e.g. BitCoin [5], Ven [38]) in which the systems have the potential to evolve into self-governing “digital institutions” [21]. Such systems and institutions that operate on them will necessitate the development of a new paradigm to understand the aspects of institutional control within their context.

## 7 Scenarios of Use in Context

Development of frameworks for Big Data that effectively balance economic, legal, security, and other interests requires an understanding of the relevant context and applicable scenarios within which the Big Data exists. Although Big Data straddles multiple business, legal, and technical boundaries it will nonetheless have one or more institutions that are capable of, or in some situations required to, manage and control it. The public good referred to in the title of this book can be articulated through the use of system, service and software modeling, requirements setting, development, testing, and certification processes. Discrete use cases of actors and actions is one approach to model BLT requirements in a way that can objectively be agreed in advance and tested against implemented systems and components. However, those are typically atomic or very granular and operate deep within layers of assumed context. Higher level contexts and corresponding scenarios of multiple use cases can describe fundamental expectations about

443 matters like interests in property, rights to liberty, and honoring the social compact.

444       Consider that the applicable scenario within which the data exists can provide a method and  
445 mechanisms of sorts to establish the basic ownership, control, and other expectations of the key  
446 parties. For example, it may not be sufficient to describe the exchange of money and financial  
447 information because the nature of the transaction and their respective data and systems are not  
448 identified enough to predict the rights and obligations or other outcomes reasonably expected  
449 by individuals and organizations that engage in the activity of a financial exchange. The sale of  
450 used cars via an app, the conduct of a counseling session via Google Hangout, and the earning  
451 of a masters degree via an online university all represent scenarios wherein the use case of  
452 a financial exchange takes place. However, each of these scenarios occurs in contexts that are  
453 easily identifiable, involving the sale of goods and deeper access to financial information if the car  
454 is financed, or involving the practice of therapy by a licensed professional involving confidential  
455 mental health data or involving elearning services and protected educational records and possibly  
456 deeper financial information if the program is funded by scholarship or loans. Identifying the  
457 people (a consumer and a used car dealer) the transaction (purchase of a used car) the data  
458 (sales and title data, finance information, etc) and the systems (the third party app and it's  
459 relevant services or functions, state DMV services, credit card and bank services, etc) provide  
460 enough context to establish generally what existing consumer rights under the relevant state  
461 lemon laws, the Uniform Commercial Code and other applicable rules will govern when duties  
462 arise or are terminated, what must be promised, what can be repudiated, by whom data must  
463 be kept secure and other requirements or constraints on the use of personal data and Big Data.  
464 These and other factors vary when a transaction that is otherwise identical seeming operates  
465 within different scenarios, and even scenarios will differ depending upon which contexts apply.

466       Which scenarios are relevant and what lower level use cases apply are knowable in detail  
467 only with reference to the relevant context of a factually based situation. Relevant scenario of  
468 use are comprised of people conducting transactions through systems in which personal data  
469 and Big Data exists or flows. It is possible to test whether frameworks for engagement success-

470 fully address Big Data, privacy and the public good by testing outcomes of relevant scenarios.  
 471 Scenarios are capable of adequately defining these high level goals and objectives when they  
 472 identify each of the following four elements:

- 473 1. Who are the people in the scenario (e.g. who are the parties involved and what are their  
 474 respective roles and relationships)?
- 475 2. What are the relevant interactions (e.g. what transactions or other actions are conducted  
 476 by or with the people involved)?
- 477 3. What are the relevant data and data sets (e.g. what types of data are created, stored,  
 478 computed, transmitted, modified or deleted)?
- 479 4. What are the relevant systems (e.g. what services or other software is used by the people,  
 480 for the transactions or with the data)?

481 The basic common law inspired ownership tenants of the New Deal on Data are general  
 482 principles that guide and inform basic relationships and expectations. However, the dynamic  
 483 bundle of recombinant rights and responsibilities constituting "ownership" interests in personal  
 484 data and expectations pertaining to Big Data vary significantly from context to context and  
 485 even from one scenario to another within a given general context. Institutional controls and  
 486 other system requirements or safeguards are important methods to ensure context-appropriate  
 487 outcomes consistent with clearly applicable system scenarios that set the contours and under-  
 488 pinnings for a greater public good. The New Deal on Data can be achieved in part by sets of  
 489 institutional controls involving governance, business, legal, and technical aspects of Big Data  
 490 and interoperating systems. Reference to relevant scenarios reveal signature features of the New  
 491 Deal on Data in various contexts and can serve as an anchor to evaluate what institutional  
 492 controls are well aligned to achieve a balance of economic, privacy and other interests.

493 The types of requirements and rules governing participation by individuals and organizations  
 494 in Trust Networks vary depending on the facts and circumstances related to the transactions,

data types, relevant roles of people and other factors. Antecedent but relevant networks such as credit card systems, trading partner systems and exchange networks are instructive not only for their many common elements but also as important examples of how vastly different they are from one another depending upon contexts, scenarios, legal obligations, business models, technical processes and other signature patterns. Trust Networks that are formed to help manage Big Data in ways that appropriately respect personal data rights and other broader interests similarly will succeed to the extent they can tolerate or promote a wide degree of heterogeneity among participants for those BLT matters that need not be uniform or directly harmonized. In some situations, new business models and contexts will emerge that require fresh thinking and novel combinations of roles or types of relationships among transacting parties. In these cases, understanding the actual context and scenarios will serve as a critical anchor for establishment of acceptable and sustainable BLT rules and systems.

The scenario below describes deeper fact-based situations and circumstances in the context of social science research and studies involving personal data and Big Data. Note how the roles of people, their interactions, the use of data and the design of the corresponding systems reflect and support the New Deal on Data in ways that deliberately provide immediate and increasing value to the stakeholders than is typical or expected typically.

## **7.1 Example Scenario: Research System for Computational Social Science**

Computational Social Science (CSS) studies are often based on data collected with an extremely high resolution and scale [25]. Using mathematical models, such data can be used to provide insights into human nature. However, much of the data collected, for example mobility traces, are sensitive and private; individuals may feel uncomfortable sharing them publicly.

Data collection in the CSS context relies on the informed consent of the participants. Countries have different bodies regulating such studies, for example Institutional Research Boards (IRBs) in the US. Although certain minimal requirements for implementing informed consent in these contexts exist [35], they are often not well suited for large-scale studies, where the

521 amount and sensitivity of the data calls for sophisticated privacy controls. As the scale of a  
522 study grows — in the number of participants, collected data, and duration — the EULA-style  
523 informed consent is no longer sufficient, and makes it hard to claim that participants in fact  
524 expressed informed consent.

525 One author (Stopczynski) has recently deployed a study at Technical University of Denmark,  
526 where 1,000 freshmen students received mobile phones in order to study their networks and  
527 social behavior during an important change in their lives; joining the university. The study,  
528 SensibleDTU (<https://www.sensible.dtu.dk/?lang=en>), uses not only data collected from  
529 the mobile phones (location, Bluetooth-based proximity, call and sms logs etc.) but also from  
530 social networks, questionnaires filled out by participants, etc. As the data is collected in the  
531 context of the university, the students may feel obligated to participate in the study or assume  
532 that the data may influence their grades. Here, we see Living Informed Consent not only as  
533 a technical means to put participants in control of the collected data, but also to clearly and  
534 comprehensibly convey broader New Deal on Data principles, such as the opt-in nature of the  
535 study, the boundaries of the data usage, and parties accessing the data.

536 As the study will last for several years, ideally allowing us to observe a student's life from  
537 the very first friendships made until the graduation party, the consent must remain alive. While  
538 we do not want participants to feel that they are under constant surveillance — data are used  
539 in anonymous, aggregated form — they must remember that the data are being collected and  
540 used. We are still trying to understand how to achieve this equilibrium: how often should we  
541 remind them about the collection? Should they re-authorize applications from time to time? We  
542 see great hope in providing services for the users based on their data, such as simple life-logging  
543 where they can see how active they are or more advanced artistic visualizations of their social  
544 networks. Making users aware of the data by transforming it into value can greatly benefit their  
545 privacy — they become aware not only of what is being collected, but also what it says about  
546 them.

## 547 7.2 Scenarios of Use Today, Tomorrow, and the Day After

548 The New Deal on Data is designed to provide good value to anyone creating, using, or benefiting  
549 from personal data, but the vision need not be adopted in its entirety before its value becomes  
550 apparent.

551 Adopting New Deal on Data principles on a large scale can be accomplished iteratively —  
552 economic sector, transaction type, or data type at a time. A reasonable success metric for  
553 adoption of such a large scale vision is whether the value it provides to all participating parties  
554 is worth the effort to adopt the vision. While adoption has a fixed initial cost, the value to all  
555 parties participating in the New Deal on Data increases as direct or indirect use of personal data  
556 is available in greater volumes and varieties.

557 Adopting the New Deal on Data in successive phases helps address the typical objections  
558 to change based on cost, disruption, or over regulation. Policy incentives can further address  
559 these objections, such as allowing safe harbor protections for conduct of organizations operating  
560 under the rules of a trust network.

561 Pre-designed use cases can provide a benchmark for measuring whether a given use of per-  
562 sonal data is consistent with measurable criteria. Such criteria can be used to establish com-  
563 pliance with the rules of a trust network and for certification by government for the right to  
564 safe harbor or other protections. Since the New Deal on Data is rooted in common law and  
565 the social compact, the appropriate set of rights and expectations covering privacy and other  
566 personal data interests can be enumerated, debated, and agreed upon in ways that fit the given  
567 use cases.

568 The nature of personal data in these use cases compels us to move beyond the closed,  
569 laboratory-based, post-hoc process that we currently use, and begin to manage our society in a  
570 new way. We must begin to test connections in the real world far earlier and more frequently  
571 than we have ever done before, using the methods the Human Dynamics research group and  
572 collaborators have developed for the Friends and Family [3] or the SensibleDTU (<https://www.sensible.dtu.dk>) study. We need to construct Living Laboratories — communities willing to  
573

try a new way of doing things or, to put it bluntly, to be guinea pigs — in order to test and prove our ideas. Since this is new territory, it is important for us to constantly try out new ideas in the real world in order to see what works and what does not.

An example of such a Living Lab is the ‘open data city’ just launched by one author (Pentland) with the city of Trento in Italy, along with Telecom Italia, Telefonica, the research university Fondazione Bruno Kessler, the Institute for Data Driven Design, and local companies. Importantly, this Living Lab has the approval and informed consent of all its participants — not only do they consent to sharing of their data, they know that they are part of a gigantic experiment whose goal is to invent a better way of living. This can be a model followed by many types of systems within and beyond the social science research contexts. More detail on this Living Lab can be found at <http://www.mobileterritoriallab.eu/>.

## 8 Conclusions

Our societies today face unprecedented challenges. Solving these problems will require access to personal data, so we can understand how the society works, how we move around, what makes us productive, and how everything from ideas to diseases spread. The insights must be actionable, available in real-time, and engaging the population, creating the nervous system of the society. In this chapter we have reviewed how Big Data collected in institutional context can be used for the public good. In many cases, the data needed for creating better society is already collected and exists closed in silos of companies and governments. Using well designed and implemented sets of institutional controls, covering business, legal, and technical dimensions, we described how the silos can be opened. The framework for doing this — the New Deal on Data — postulates that the primary driver of the change must be by recognizing that ownership of personal data rests with the people about whom that data is about. This ownership, the right to use, transfer, and remove the data ensures that the data is available for public good, while at the same time protecting the privacy of the citizens.

The New Deal on Data is still new. Here we described our efforts in understanding the

technical means of how it can be implemented, the legal framework around it, business ramifications, and the direct value that can be derived from researchers, companies, governments, and users having more access to the data. It is clear that companies must play the major role in the implementation of the New Deal, incentivized by business opportunities and pressured by the legislation and demand of the users. Only with such orchestration will it be possible to change the current feudal system of data ownership and finally put the immense quantities and capabilities of collected personal data to good use.

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