International Journal of Communication 12(2018), 612–628 1932–8036/20180005

Unraveling the App Store: Toward an Interpretative Perspective on Tracing

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Big data and its potential, use, and hopes seem to grow more valuable for commercial and research purposes alike. Nevertheless, problems start to arise as soon as the technical and epistemic potential of big data is overemphasized. Big data, like any other traces of human behavior, must be contextualized. This seems even more important since all types of digital traces are molded by specific operations and procedures as well as methods inscribed into digital infrastructures. These infrastructures are the necessary precondition for the emergence of digital traces, yet they pose a challenge for research because they are by no means static, but rather moving continuously. By reconstructing the trajectory of the UDID (unique device identifier) and its contested role within Apple's App Store ecology, this article presents an empirical perspective on how the contexts and preconditions of tracing capabilities are the result of continuous negotiation processes. The method presented in the article bridges the debates on the moving architectures of digital media and the search for suitable process-driven approaches.

Keywords: digital traces, big data, interpretative research, trajectories, App Store ecology

Looking back on several years of an ongoing debate, the term *big data* is increasingly discussed as misleading, be it the slippery notion of data itself (Reigeluth, 2014) or the fact that different phenomena are described and analyzed in reference to different ranges of data (Parks, 2014). Both of these arguments not only signal that big data is a "poor term" (boyd & Crawford, 2012, p. 663), but raise fundamental concerns (Brooker, Barnett, Cribbin, & Sharma, 2016) for the ongoing debate on the often latent ideology, fears, and—especially—hopes bound to the idea of capturing large amounts of data processing and improving communication nowadays (Crawford, Miltner, & Gray, 2014).

The relevance of big data for media, communication studies, and sociology may therefore be seen as bound to a critical understanding of the limitations of big data (Parks, 2014). Put briefly, this means that big data do not speak for themselves. It is, at the same time, the biggest challenge as well as opportunity that big data are "deeply socially embedded" (Tilson, Lyytinen, & Sørensen, 2010, p. 749): They are always left by people, integrated by people, used by people (Baltus, 2016)—in times when,

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Date submitted: 2016–06–17

without a doubt, the rise of digital media created new possibilities for the study of social existence (Rogers, 2004). Big data thereby turn out as digital traces in context. However, tracing in terms of actors that use data as trace data is based on specific architectures of platforms (Marres, 2012). These architectures shape as well as enable data collection in the first place; they channel measures of tracking (e.g., links, navigation structures) as well as the emergence of specific kinds of trace data—mostly in the back end and invisible to users. Datafication structures are political because they follow the interests of their—mostly commercial—designers. These structures are far from stable; they are changing as the result of controversies and "endless negotiations," as Venturini and Latour (2010) rightly point out.

With this in mind, the aim of the article is to shed some light on the ever-changing nature of "digital material" (van den Boomen, Lammes, Lehmann, Raessens, & Schäfer, 2009). Following Brügger and Finnemann (2013), the characteristics of digital material pose a major challenge for the development of adequate methodologies that have to grasp the "moving architecture" (Burgess, Bruns, & Hjorth, 2013, p. 2) from which they emerge. To understand a phenomenon such as the *perpetual beta*, which leaves digital media in a constant unfinished state, we have to understand the contexts in which media architectures and its complex arrangements within digital infrastructures are evolving and contested (Parikka, 2012). Therefore, we need stringent methodological approaches that capture these processes adequately. To develop these methodologies, we have to elaborate on the role of digital traces, because these are the first and foremost resource to step into the political arena (O'Reilly & Battelle, 2009) of providing, contesting, and negotiating media architectures. We describe an empirical program we developed in regard to studies in the field of the App Store ecology and the specific event of the *in-app purchase hack* that happened in 2012. By combining the most recent methodological approaches on the biography of platforms (Burgess & Green, 2009) with the theoretical insights and challenges identified by the moving architecture of digital media (Brügger & Finnemann, 2013), we present an approach on interpretative tracing to capture the ever-changing background structures of datafication.[1]

The Socially Embedded Nature of Traces

The advent of digital communication and information technology fostered an explosion of digital traces. These are widely understood as "evidence of human and human-like activity that is logged and stored digitally" (Freelon, 2014, p. 59; Howison, Wiggins, & Crowston, 2011). Therefore, digital traces rely on the necessary precondition of digital infrastructures, which enable specific forms of logging as well as

[1] To shed some light on this perspective, we would propose to further delve into the relations and cultural contexts that make up this embeddedness. For this purpose, we bring together two perspectives: first, the emerging biographical approaches to platforms and media objects (Burgess & Green, 2009; Lesage, 2013; Parikka, 2012), which emphasize an understanding of the cultural contexts in which specific technology emerges, and, second, the methodological considerations of moving architectures of digital media, which highlight the importance of temporality for research. Methodologically, this turn in perspective consists of three major variables: (a) software architecture is made by people, (b) software architecture is moving, and (c) traces are left by people. These three characteristics have major implications for research because they challenge researchers to interpret the contexts and trajectories in which traces are enabled and left through the specifics of the software architecture at that time.

storing. Furthermore, logging and storing refer to forms of "interpretative work" (Bowker, 2013, p. 170) done by computers, software, and algorithms, which ultimately are products of people. In this sense, digital traces must be understood as data "by the means used to handle and process it" (Puschmann & Burgess, 2014, p. 1702). In other words, the ontological status of digital traces as a form of objective data has to be abandoned in favor of a perspective on traces as socioculturally embedded products that are designed by people, left by people, and used by people (Baltus, 2016). Thus, as with other remains of human conduct, digital traces are always in need of contextualization and interpretation.

With this shift in perspective, researchers face the challenge of accounting for the sociocultural and sociotechnological preconditions of digital traces. Furthermore, the data available to researchers are only mediated traces of "communicative action" (Knoblauch, 2013, p. 302); the dynamic processes from which this data emerged remain vague. We would argue that it is this vagueness of origin that poses a major challenge for research on and with digital trace data. Thus, researchers must adjust their framework to meet these requirements. This includes both a theoretical understanding of the uniqueness of digital material (Brügger & Finnemann, 2013) as well as methodological considerations that enable researchers to capture the moving architecture of digital media (Burgess et al., 2013).

With digital material undergoing constant changes and modifications, the disappearance of content and reconfigurations of relations (Brügger & Finnemann, 2013) relate to what we call a permanent unfinished state. This renders digital material a moving target for research that must be adequately captured in its speed and archived due to its storing capabilities (Finnemann, 2014). From a methodological point of view, the unique temporal qualities of digital material both enable and challenge how researchers can make sense of what is presented on their respective screens. On the one hand, the storing capability of digital infrastructures allows access to vast amounts of traces, which at best are contextualized in regard to the intertwined practices and meaningful contexts from which they emerge (Lupton, 2014; Rogers, 2015). On the other hand, the speed with which these traces occur, vanish, or change demands a framework that can adjust accordingly. Such a framework has to capture this speed and the involved dynamics (Hartley, Burgess, & Bruns, 2013) by tracing the trajectories of digital material. In consequence, we would argue that, in regard to digital material, it does not suffice to capture a specific status quo; rather, we argue that, due to its constant unfinished state, it becomes necessary to shift toward process-oriented methodologies (Bruns & Burgess, 2016; Grenz, 2017; Snee, Hine, Morey, Roberts, & Watson, 2016).

Some approaches have already established how research benefits from taking a process-oriented perspective. With platform biographies tracing the dynamics of Twitter APIs (Bruns & Burgess, 2016) and the changing user interface of YouTube (Burgess & Green, 2009), media archaeological approaches to software that emphasize both the discursive and the material manifestations of culture (Lesage, 2013; Parikka, 2012) or the comparative cultural analysis of the intertwined processes of negotiation on Wikipedia (Rogers, 2015) not only demonstrate the importance of contextualizing traces, but highlight the dynamics surrounding these cultural technologies. Moreover, all the examples share a common epistemological position that questions the ontological quality of traces and by doing so, we want to emphasize, a perspective toward the relation between technology and the people who are either responsible for or affected by these traces. Even though we strongly endorse the emergence of process-

oriented methodologies, we see a lurking danger in relying too heavily on the sole interpretation of digital traces without also including methods and data that support research on the people responsible for their existence. Adding to the mentioned challenges, we therefore want to highlight the role of other forms of data, such as interviews (or, e.g., over-the-shoulder observations) to support researchers in contextualizing their interpretative work, which is eventually needed to unravel the interwoven sociotechnological prerequisites of digital traces (Orgad, 2009).

Interpretative Tracing

So far, we have discussed the most recent debates on capturing digital media as a process (e.g., in regard to the biographies of platforms), and we have argued that research must be able to capture controversies and negotiations that influence the development of digital infrastructures and with it the emergence of digital traces. To elaborate on this perspective from a methodological standpoint, we refer to the interactionist approach on which the "social world" (Strauss, 1978, 1984) paradigm is built. Central to this paradigm is the concept of negotiation, which highlights the inherent dynamics and politics that constitute social worlds (Rumens & Kelemen, 2016) as a "set of common or joint activities or concerns bound together by a network of communication" (Strauss, 1984, p. 123). In this sense, the order of sociotechnological worlds unfolds through negotiation processes that take shape in specific "trajectories" (Strauss, 1993, p. 52).

The fateful character of these trajectories may become visible only when actors in retrospect relate the outcome of past actions to the current circumstances or when they interpret past events as constitutive for contemporary structures—even to the extent that they were neither foreseeable nor intended (Biniok, 2014). From a researcher's perspective, the reconstruction of the negotiations, events, and dynamics shaping these trajectories requires a methodological foundation as well as specific methods of data generation and analysis. With regard to the (inter)activities and practical consequences that constitute social worlds, we outline interpretative tracing based on the principles of grounded theory in the notion of Strauss and Corbin (1990). The analysis in this sense focuses on the reconstruction of the specific negotiation processes and the often frictional dynamics of specific events and critical incidents that over time take shape in specific trajectories. The reconstruction thereby follows the principles articulated within the concept of "theoretical sampling" (Strauss & Corbin, 1990, p. 176), in which data collection, systematization, and analysis are continuously related to one another, which eventually leads to sufficient contextualization for the reconstruction of a specific trajectory. In this process, researchers develop concepts and categories that are compared, related, and finally arranged around a core category—or, in our case, an unfolding event—to establish a "story line" (Strauss & Corbin, 1990, p. 116).

Based on our experiences and the results of our research, we outline interpretative tracing as an approach that combines multiple methods to address the challenges posed by digital material. Interpretative tracing is based on five core pillars: *outlining the field*, *constructing connections*, *tracing and theoretical sampling*, *interviewing focal actors*, and *compressing and writing the "story."* However,

these five pillars should not be treated as occurring in a strict sequential order, but rather as basic principles and guidelines for reconstructing the trajectories of digital material.[2]

Outlining the Field

As a first step in interpretative tracing, researchers have to outline their field to gain knowledge about involved actors, repeated semantics as well as features of specific media technologies. In this first phase, any published or press-released documents provided by the identified actors can be of value (McCann, 2012). To identify relevant topics as well as semantics, it is necessary to gather data that outline the view each of the actors involved, including traces as well as off-line data. The topics should be captured in short memos that additionally function as sensitizing concepts that support the ongoing research (Bowen, 2006).

Constructing Connections

A second core principle of interpretative tracing revolves around events within the field. An event in this sense is linked to a fateful incident that is highly relevant to the involved actors. Building on already identified topics, researchers should collect the accessible documents of the event, map them to specific actors, and openly code and match the activities and involved media technologies. At this point, it is necessary to explain that this coding system is by no means taken as an *objective* code system, but rather as setting up a basic vocabulary. With the help of this vocabulary, it becomes possible to describe what people did with which specific resources (e.g., written instructions, video tutorials, software), which of their actions or effects are eventually related, and consequently which follow-up actions and effects are evoked. Some indications of these reciprocal communicative actions can be identified in various materialized statements by focal actors. In other cases, this first mapping may help to identify and evaluate the coincidental relation of the event and specific actions.

Tracing and Theoretical Sampling

Constructing the first hypothetical connections and, with them, elaborating memos outlines a first story line, which establishes a guideline for further theoretical sampling. In this phase, depending on the specific data gathered, the constructed story memos are questioned, expanded, or even revised. Now the center of attention throughout all events lies on traces in the realm of the digital and the digital infrastructures responsible for them. Users, journalists, and postings of any kind are to be considered, and therefore the focus shifts from focal actors to the periphery of the field. Marcus (1995) offered specific strategies for keeping track of these traces. These tracking strategies resemble a concentrated search on (a) specific names or (b) specific practices and materials. Because the Internet also works as an archive

[2] We have elaborated the following methodical program over the last years via different empirical studies within the fields of online poker, app stores, e-sports, and blocking apps. Interpretative tracing thereby can be seen as one of the scientific outcomes of our ongoing participation within the priority program 1505 "Mediatized Worlds" (German Research Association) within the subproject "Mediatization as a Business Model" (project leader Prof. Dr. Michaela Pfadenhauer).

for research in which the origin of data may be captured and stored, the data acquired can be woven into trajectories. Hence, research on and with the Internet provides data that allow for not only insights into the "here and now" but also a systematic approach of "going back into the past" (Baumgarten & Grauel, 2009, p. 100). With projects such as the Internet Archive and its Wayback Machine, researchers are able to access past versions of websites, blogs, and the like, which, on the one hand, assists researchers in identifying specific key incidents over time and, on the other hand, protects them from overestimating the sometimes-convincing evidential qualities of trace data. Hence, we suggest that tracing as an interpretative practice is necessary to contextualize and contrast the data collected. These condensed strategies thereby help to build up a diverse corpus of data. By further sorting the dates on specific data, the newly gained insights will either support or revise the story already established in and across memos, which ultimately leads toward a systematic reconstruction of the time line leading toward specific events.

Interviewing Focal Actors

Eventually the data collection points toward contacts or persons in the field who participated or played a major role in the event. These may range from developers to hackers, users, or company employees. The aim is to confront the constructed fateful trajectory with the point of view of actors in the field (e.g., Flick, von Kardorff, & Steinke, 2004). The people involved typically remember a coherent course of action. Yet this is again by no means taken as an objective truth, since data collected via interviews are always data on how an event is portrayed in situ, which is why researchers have to be cautious about whether to revise their story memos based on these statements. This holds especially true when the main focus of the research relies on trace data gathered over time. Nevertheless, we acknowledge the limitations to these forms of data because not all the actions and effects, whether intended or not, may materialize in traces and may therefore never be accessed by the researcher (Baur & Lahusen, 2005). It is exactly the lack of context that researchers can address by interviewing focal actors. The interviewees may hold knowledge crucial for further research and may contribute the missing links that benefit the systematic reconstruction of the trajectory.

Compressing and Writing the "Story"

The four pillars described above aim toward reconstructing a trajectory—the methodically controlled and intersubjective comprehensible *story*—as a consistent and compressed text that captures the phenomenon in its complexity (Strauss & Corbin, 1990). Because the research process is already paved with documents such as memos, notes on research, and working papers, so is story writing. Interpretative tracing in this sense also includes the iterative compression of the accumulated data, which ends, at best, in an empirically and theoretically saturated story. This may still hold true even though the degree of saturation can be defined only approximately (Glaser & Strauss, 1967), and the impact of research economic factors cannot be underestimated. Despite these characteristics, we would still argue that the inner plausibility of the story can be ensured by presenting and discussing it within the frame of the respective scientific community as well as when newly collected data hold no new insights.

Unraveling the App Store

The iPhone Moment

With the arrival of the first version of the iPhone in 2007, its haptic communication and manifold sensory functions set it apart as a groundbreaking device. Today, these formerly innovative traits make up mere aspects of what is cited as the smartphone being a digital version of the Swiss army knife, with applications that transform the device with the sleight of hand into a flashlight, a city guide, a webcam, or a gaming console. The available customization options not only reflect the way people shape technology to fit their needs (Greenwood, 2011), but point toward another success story that is closely linked to the development of an infrastructure that enabled a flourishing application market (Goggin, 2012). This relates to the metamorphosis capabilities of apps as well as to the simple yet very effective concept that the app store business model is based on a seemingly endless armada of people who autonomously develop and market their products. Nevertheless, to become a listed and therefore downloadable app, the developers have to abide by Apple's approval policies. Additionally, developers pay a small fee to take part in the so-called developer program to receive the software development kit that includes the necessary tools to create apps. Ultimately, Apple receives 30% of the sales price. With these insights, the App Store turns out to be a complex cultural arrangement rather than a mere technological infrastructure.

The Coming of the App Store

The arrangement responsible for the digital infrastructure of the App Store today is the result of neither a rationally planned business strategy nor a sole commercially driven innovation process. Instead, from its beginning it was paired with the confrontation between Apple and a group of active users who called themselves the iPhone Dev Team in 2007. Apple's initial business model was based on providing regular updates that included new apps and functions to invoke and induce new needs among iPhone users (Burgess, 2012). The iPhone Dev Team's proclaimed aim was to bypass the artificially built-in limitations of the iPhone to gain access to the otherwise secure operating system. This jailbreak allowed the installation of applications that were not provided by Apple as well as modification of the user interface of the iPhone at will. Even though Apple tried to stop jailbreaking from happening by continuously releasing updates, it was able to contain neither the spread nor the use of jailbreaks. This loss of control can be seen as a turning point in Apple's strategy regarding these nonintended appropriations of its product. It was from this frictional interplay that the idea of the App Store business model arose.

The new approach was based on the rule that value could now be generated only if app developers would agree to the terms of service, which meant building and distributing apps only via Apple's platform. A participation model still regulates today that 30% of the price per app is shared with Apple. A couple of years after the introduction of the App Store, numerous app developers started to circumvent this model of participation because the sales in apps stagnated. Their strategy was to have users download the apps for free and offer additional content within the app, thereby excluding Apple from their margin. At first Apple prohibited these strategies in its terms of use of the App Store, but in 2009 it embedded these strategies into its business model as the *in-app purchase*, again with a 30% share for the company.

The Role of the Unique Device Identifier

Behind Apple's strategy lies a complex value-creation process: the so-called Apple ecology, which is grounded on tracking user data. Its core resource enabling this tracking, storing, and eventually monetizing is a 40-digit alphanumeric code of each device with Apple's iOS operating system, called the unique device identifier (UDID). Until 2012, this seemingly random string of numbers and letters provided every iOS device, including the iPhone, with a hardware-bound type of serial number, which made it unique and therefore address-specific, store-specific, and trackable for developers and marketers alike. Through its specifications, the UDID additionally allowed tracking across multiple platforms or apps since it was not bound to an account or a user, but to the device. Hence, the UDID became the precondition for device-bound payment processes as well as cross-platform usability and A/B testing of specific features. Furthermore, the UDID is fundamental for online and mobile advertising. The reaction toward the implementation and use of the UDID might best be captured by a phrase that gained popularity across bloggers at the time: "If you're not paying for the product, you are the product." With developers selling the UDIDs of iPhones to advertising networks, the latter were able to store them. The more developers were involved, the more complex the data bound to the specific UDID within these databases became, which eventually led to advertising companies buying and selling data sets to one another to maximize their profits through targeted advertising.

Already in 2010, an article published by the assistant director of information security and networking at Bucknell University presented findings that a high percentage of apps were sharing UDIDs without the users' permission (Smith, 2010). For example, Amazon's application communicates the logged-in user's real name in plain text along with the UDID, permitting both Amazon.com and network eavesdroppers to easily match a phone's UDID with the name of the phone's owner. The CBS News application transmits both the UDID and the iPhone device's user-assigned name, which frequently contains the owner's real name. Later on, other controversies added fuel to the fire in regard to privacy concerns. In the social networking app Path, for example, the UDID was stored on the developer's private servers in combination with the contacts saved in the address book. Apple allowed developers to track devices via UDID for years until it released the new operating system version iOS 5 in 2011. After this change, Apple threatened developers with app rejection on the App Store if they would not abide. This was a consequence of a class-action lawsuit against Apple and developers of apps that shared UDIDs and thereby deanonymized user data in 2010.

The Rejection of UDID Use and the In-App Purchase Hack

In consequence, the lawsuit led to unforeseen consequences as Apple had to intervene into its own profitable digital infrastructure of the App Store ecology. More precisely, it undermined the payment process of in-app purchases. Before the rejection of UDID use, this payment process was initiated by a payment request sent by the specific app to Apple's authentication servers. After the authentication succeeds, the server sends a receipt to the servers of the app developers, which then unlock content on the user's device. The use of the UDID secured this payment process because it guaranteed that only one purchase per device was possible. With the UDID rejected, the App Store ecology was disrupted yet again in 2012 by a single actor who challenged Apple to an arms race. Our search for traces eventually led us to

identifying this person as Alex B., with whom we conducted an interview to further contextualize and reconstruct the frictional negotiation revolving around the UDID and its impact on user datafication.

It was in the gold rush times of in-app sales (2012) when Alex B. installed the free-to-download game CSR Racing on his iPhone. CSR Racing is a simple racing game in which the player can use the touchscreen to compete against the programmed artificial intelligence opponents. For each race in the game, a player needs energy, which is depleted rapidly. The app developer's business model is based on this shortage. Players can either pause playing the game to refill the energy or buy energy via coins, the in-game currency, which can be purchased via an integrated in-app sales model.

This shortage-based model, based on the continuous depletion of a central resource to use the app, was and still is especially popular with gaming apps. Alex B. struggled with the idea to continuously pay money to use such an app. In addition, he knew that all the new features generated by in-app purchases would be nullified if he had to reinstall his operating system. As a result, he became deeply engaged with the technical details of the in-app purchase model, including the use of security protocols and specific forms and content of data. He concluded that it was possible to bypass the App Store and official Apple servers by setting up a *man-in-the middle* server (see Figure 1 for an illustration of the hack created by Alex B.). In doing so, every in-app purchase would automatically be processed and a transaction would be confirmed without money ever changing accounts. This was possible due to Alex B's reverse engineering,[3] which revealed that, instead of any buyer-specific data, only less specific information about the unlocked content was transmitted per purchase. In other words, no purchase was saved and registered to a specific iPhone, which made it possible to use any confirmed purchase repeatedly.

This anonymization, which made Alex B.'s hack possible, was bound to the formerly described regulation of digital trace data that was introduced in 2011, as a reaction to a class-action lawsuit brought forward at a district court in California. The indictment heavily criticized Apple's implementation of UDID, which enabled the company to assemble vast databases tracking almost everything users do with their Apple devices, including iPods and iPads as well as iPhones. By the end of 2011, Apple rejected the UDID identification model. Without the UDID securing the App Store ecology, the circumvention of the in-app purchase via Alex B.'s hack allowed users to access otherwise fee-based content for free.

This method of nonintended appropriation quickly became quite popular among users because there were no major consequences, such as a loss of warranty for the device. The In-App-Store, as Alex B. called it, was published on his private blog on July 12, 2012. After two weeks, a total of 8 million unofficial transactions had been registered, which meant a potential loss of millions of dollars for Apple and the affected app developers. Alex B. also continuously provided tutorials on how to install his method on various platforms: on his personal In-App-Store blog, via YouTube, and through an Excel list he provided on his blog of all the apps on which his method worked (via Torrent and direct download). Furthermore, Alex B. invited people to donate to him via PayPal to keep his server running.

[3] "The concept of reverse engineering . . . normally refers to a variety of practices undertaken to understand how a software program is built and how it achieves its functionality" (Lande & Sobin, 1996, p. 240).

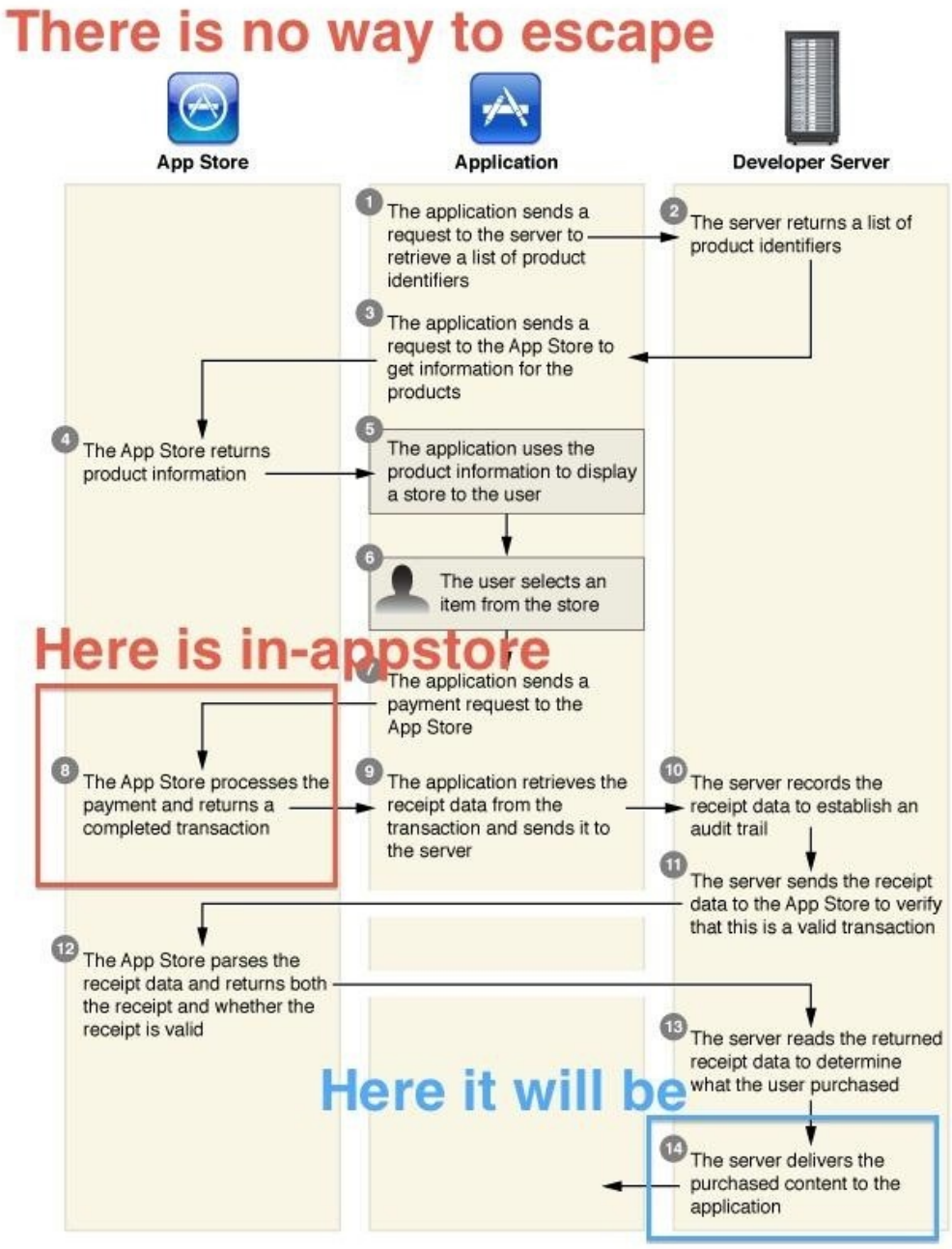

Figure 1. An illustration by Alex B. to promote and explain his hack.

In a press release one day after the release of the hack (July 13, 2012), Apple announced that it would look into the event. First, the company banned the service provider that hosted the man-in-the-middle server to prevent further free purchases. In response, Alex B. moved his server to a Russian cloud provider, and then again moved to an offshore provider shortly after to escape Apple's reach. Following Alex B.'s multiple server migrations, the company attempted to freeze the PayPal account used to pay for the server. This forced Alex B. to change the payment method to keep the server running. As a result, he switched to the crypto-currency Bitcoin. Since Bitcoin is an encrypted and decentralized payment method, there was no contact within Apple's reach to prohibit further funding. With the switch to Bitcoin, Alex B. also introduced advertising on his server, which secured the funding for his server. Another angle of Apple's attempts to contain the spread of the hack was to get the YouTube tutorials deleted. Again, this led to Alex B. continuously uploading his tutorials on different channels and accounts.

After many failed attempts, the conclusion for Apple was to shift the responsibility for the hack: In a press statement, the company expressed that it would be up to the app developers to ensure compliance with the terms of service. In addition, a best-practice model was introduced recommending that developers should provide additional servers for the security and validation of purchases—all in all, a quite costly recommendation since many app developers have neither the money nor the knowledge to provide for such servers. The same can be said for implementing newer types of encryption. Furthermore, the press release included code that previously was unavailable to app developers. These lines of code were to temporarily protect apps from an attack until a new update would roll out that aimed to close this security breach for the current operating system, iOS 6.

All the while, Apple had pursued a change of plans that was not included in the press release. One of the independent app developers who was heavily involved in the new lines of code provided by Apple noted that Apple had tried to reimplement the use of the UDID; as Protalinski (2012a, 2012b) pointed out, Apple had quietly started to reinclude unique identifiers into the validation receipts for in-app purchases. Developers started seeing the new receipts, which included a new field called *unique identifier*.

This step toward reenabling the de-anonymization of users concerned many developers as well as market experts, because it lacked the former given transparency on the side of Apple. It was at this point that trace data and its regulation reentered the arena of negotiation as a specific sort of resource among developers and users. Against all doubts, Apple later implemented a tracking method into its new operating system, iOS 6, which also included some of the previous recommendations. In doing so, the company was able to place in its business model digital certificates called *shared secrets*, which declined the repeated use of payment certificates, hindering the performance of the man-in-the-middle-server. Despite these efforts, the hacks and methods of circumvention are still used today in a globally dispersed network—albeit with the requirement to jailbreak one's device first.

Conclusion: Interpretative Tracing in Times of Mediatization

Any discussion about how generating and storing vast amounts of data can, in a fundamentally new way, be beneficial in gaining insights and further understanding the complexity of the world we live in (Rogers, 2015) must also account for this complexity regarding its ontological accounts. As articulated by

Davies (2013), "data is being icily naturalized, with its institutional and methodological preconditions being marginalized from discussion" (para. 7; quoted by Crawford et al., 2014, p. 1667). Hence, with the focus on digital traces, we want to highlight the importance of accounting for the contexts from which data emerge, because it reminds us that traces are the products of human conduct and thereby have to be addressed and interpreted with regard to the cultural, economic, and political factors shaping their existence. An in-depth perspective on the contexts of datafication may save researchers from the risk of an ontological fallacy when interpreting traces by overemphasizing their epistemic potential, which may ultimately risk overestimating the potentials of data technology for understanding the cultural complexity of communication (Anderson, 2008). Technology such as big data does not speak for itself; nor does it have an inherent epistemic quality.

Nevertheless, we should not throw the baby out with the bathwater by rejecting the beneficial procedures, scripts, and capabilities of digital technology. Instead, we present an outline for an interpretative understanding of how to adequately capture the cultural dynamics that constitute digital infrastructures, which themselves make up the necessary prerequisite for digital trace data. We would argue that the benefits of interpretative approaches on digital traces lie within their capability to address the theoretical challenges posed by the moving architectures (Brügger & Finnemann, 2013; Finnemann, 2014) of digital media.

With regard to already established approaches and digital methods, we want to further capture, reconstruct, and highlight the often controversial developments and frictional negotiation processes that shape and affect tracing technologies in their current state. This perspective further undermines the idea of a constant and linear development of knowledge and the epistemic qualities of technology. Moreover, it sensitizes for the only recently stressed argument that the advent of digital trace data forces researchers now more than ever to focus on controversies, frictional negotiation processes, and critical incidents (Venturini & Latour, 2010).

Because of the dynamics that leave digital material in a permanent unfinished state, we have proposed a methodology that is able to trace the specific trajectory of the App Store ecology. Building on the work of Anselm Strauss, we follow his argument that people's reciprocal actions based on one another's practical consequences are responsible for the dynamics of social worlds, which culminate in and become visible through specific fateful incidents, as in the case of the in-app purchase hack. While some trajectories are based on rational planning of involved actors toward a common goal (e.g., media events), some have to be characterized as "fateful . . . courses of action but also . . . interaction of multiple actors and contingencies that may be unanticipated and not entirely manageable" (Strauss, 1993, p. 53).

Finally, we conclude that the proposed shift from traces as forms of evident data toward an interpretative approach on tracing the trajectory of digital material and its infrastructures refers to the cultural techniques of the "evidential paradigm" introduced by historian Carlo Ginzburg (1979). Because of a "growth of disciplines based on reading the evidence" (Ginzburg & Davin, 1980, p. 14), this paradigm spread across the humanities from the second half of the 19th century onward. At its core lies the epistemic practice to find the tiniest evidence or indication to reflect on and interpret its reasons. This epistemic practice unites modern criminalistics as well as, for example, history of arts and other disciplines

alike—and it also characterizes many of the empirical approaches dealing with the moving architectures of digital technologies. Our proposed methodology in this sense is no exception; on the contrary, interpretative tracing is rather to be understood as reference that highlights the importance of interpretation and the contextualization of the tiniest amount of data to avoid the pitfalls of attributing evidence solely based on the amount of data presented. At times when media architectures and the fabric of everyday life are volatile, media and communication studies as well as sociology have to develop new instruments and approaches to match this dynamic and capture the elusive sociotechnological dynamics and wider sociohistorical contexts that shape how we live today.

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