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Born Networked Records: A History of the Short Message Service Format

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Born Networked Records: A History of the Short Message Service Format

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Amelia Acker

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ABSTRACT OF THE DISSERTATION

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by

Amelia Acker

Doctor of Philosophy in Information Studies

University of California, Los Angeles, 2014

Professor Anne J. Gilliland, Chair

Abstract

This dissertation is a history of the development of the Short Message Service (SMS) format, also known as the text message. The SMS teleservice that was developed by the Global System for Mobile Communication in the mid-1980s for second-generation mobile networks is made up of standards, protocols and infrastructure that make text messaging the most popular data service on mobile networks. The teleservice has since been used in all subsequent generations of digital cellular mobile telephony. The dissertation shows how SMS standards and infrastructure represent a significant innovation to mobile telephony and how they have figured in the history of wireless data transmission in the late twentieth century.

The standardization of SMS and telecommunication protocols that make the transmission of text messages possible influences the future uses of these digital traces, including their

evidential capacity, future access, and curation. As a new mobile communication format, text messages have cultural, political, and economic consequences that span the world. Billions of text messages are sent and received every day: they are used in personal communication, crisis management, elections, mobile banking, business communications, and increasingly through applications that serve as gateways to the Internet. Despite the ubiquity of this mobile communication format, text messages are deleted, lost or overwritten at staggering rates by users and mobile operating systems. Mobile traces such as text messages currently fall outside of institutional digital archives as well as personal digital collections. This dissertation demonstrates how the infrastructure of mobile communication, including transmission protocol and the stabilization of the format, is integral to the curation, future access, and preservation of mobile communication at the personal and institutional levels of collecting.

The dissertation examines the development of SMS by contextualizing the research need for the study of mobile information objects in information science by presenting the importance of layers of infrastructure to the creation and circulation of born-digital records transmitted across wireless networks. It applies a research framework for studying new information communication technologies and emerging electronic records contexts. The framework has three elements: (1) Layers of Infrastructure and Context, (2) Examining Networked Recordkeeping, and (3) Engaging with Information Retrieval. Using techniques from infrastructure studies and media archaeology, it illustrates how the text message as a digital format has been enacted by the mobile operating system on mobile phones. In turn, it shows how the text message format structures mobile communication over time in different contexts of creation and collection. It also highlights how the format is enacted in a mobile operating system: how text messages are stored on device hardware such as flash memory, and in various end-uses such as deletion and in surveillance. The digital materiality of text messages in transmission, storage, and receipt is shown to have social and political consequences for the future of *fonds* or collections of personal digital records that people create with their mobile phones.

The dissertation also illustrates how the generation, circulation, and collection of mobile telephony metadata represents a new form of collecting for institutions, under the law, and for the theory and practice of archival science. It argues that new contexts of metadata creation and collection have led to a mobile forensic imaginary based on the infrastructure and transmission of born-networked records created with mobile ICTs. The dissertation finds that a more productive way of confronting emerging mobile information objects and their digital preservation over time is to critically engage with their development as formatted digital objects and presents a theory of text messages as born networked records.

The dissertation of Amelia Acker is approved.

Jean-François Blanchette

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Anne J. Gilliland, Committee Chair

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Dedicated to my grandmother, Winifred Huntington Acker.

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Chapter 1: Introduction

Staples of context

I began thinking about this project and the emergence of new records coming out of mobile technologies many years ago as a practicing archivist while removing staples from mid-century documents. While reprocessing a collection of more than two hundred linear feet of materials, I spent many hours manually removing staples from documents and sleeving them into Mylar. The subject of the collection I was archiving had been a poor graduate student, a government worker, a university professor, and a diplomat. Over the course of his distinguished career he had a variety of offices, institutional responsibilities, secretaries and support staff that created a mass of records from his everyday life, both professional and personal.

Well into the second year of reprocessing the collection, I was able to look at the staples, paper clips or fasteners that I was removing and could approximate the year, decade, office of use, and sometimes even the secretary who had stapled the sheaf (one was left handed, while many others were right handed). During graduate school my subject used straight pins and bits of foil to keep papers and field notes together, during wartime at the Office of Strategic Services the intelligence agency used large tin staples that looked like small railroad ties. Fasteners from his work at the United Nations varied in size, shape, and weight depending on what delegation he was working with. Even after I removed these bits of metal, the angle, the tack, and the curve of the top left-hand corner of the documents could be seen clearly through the left over bite of the staples and clips. Often rust or oxidation residue would be left over from different filing cabinets that had weathered various office climates from the 1930s through the 1960s.

Most staples, paperclips and other office fasteners are removed from business records in the general course of best practices in archiving and preserving records. These fasteners bite the paper, cause rips as researchers read them over time, and often corrode and rust easily. The rust will bleed through the document and sometimes obscure important textual information like the address or date of the record. They can also be extremely sharp and cut archivists and researchers alike.

In 2009, I received a text message from another archivist colleague in Atlantic City, informing me that Michael Jackson had just died in the Bel Air neighborhood near the library where I was processing in the basement. I couldn't get any calls in the basement, or email updates through my phone, but text messages always seemed to arrive. At the time I thought it was peculiar that I was getting an update from the other side of the country about an event happening less than a mile away. I also wondered how fast I would lose this text message, and what structural context, or staple that might keep it together in the present moment, would be lost in the future. Staples, and the structural description that they provide about the things they bind together, can operate as a metaphor for how we approach the interpretation, identification, access and preservation of records. I started thinking about what kinds of staples of context would be sloughed off as part of the creation of cell phone records. Who would remove them? How would they be removed? What would be the reasoning?

I have found, in this work on text messages and mobile communication infrastructure, that there are many staples, or things that hold the records together, that will be lost or deliberately removed or sloughed off, just as metal fasteners are before paper documents are sleeved in Mylar and bound together again in paper slings. In this dissertation, I call the staples of context for mobile records "traces of transmission". These metadata provide information about the creator, time of use, the formation and nature of the record. I find now, after this dissertation has been written, that the staples of context for mobile records are being collected, sometimes removed from contents of the records they bind together, and being used in ways we that have yet to imagine.

While text messages themselves may be lost, deleted, or overwritten, often, what remains are the traces of transmission or the metadata about how these records move across wireless networks. Recently, the capture and interrogation of mobile telephony metadata in the United States has been framed as part of the effort to protect against terrorism and to build a safer, more secure world. However, the impact of telephony metadata created as part of wireless transmission continues to be an under-examined area of interest for information studies. This dissertation looks at how text messages, records created with mobile devices, came to be. How they were imagined, conceived and stabilized as a new format that has become one of the most popular forms of written communication in less than 20 years. I do this by telling a format story.

Format Story

Formats are how information objects move easily across systems, are accessed, organized and retrieved by people. Formats also govern the limits or affordances of how they can be moved or transmitted across time and space. Studying formats involves following the material, political, and economic influences of their development, often these influences are hidden or carry embedded limits and values from earlier technologies, standards, or political realities. The stories of how formats come to be involves situating them in particular contexts and examining the different people, especially groups of people (like standards bodies, or consumers) and how they negotiate their interests and concerns in different circumstances and over time.

The study of formats and their impact on communication, information and society is nothing new. Print historians, librarians, cataloguers, archivists, and bibliographers, have always been concerned to some degree with formats, how they come to be, and how their affordances and constraints impact their uptake, use, preservation, and the transmission of knowledge. For archivists, the format is synonymous with form and has, until recently, referred to "a standard size or configuration" (SAA Glossary, 2014). For example, for films, the format represents the aspect ratio, or for records, the format is how the document is laid out. In computing, it is understood as "preparing a disk for storing data" (SAA Glossary, 2014). Different aspects of the form of an information object will interest information researchers and professionals for different reasons. For example a bibliographer may be interested in the how the author or the publisher becomes a stabilized part of the format of the front matter and publication of a book. These categories will impact the book's description and later its classification and storage in a library. While a conservationist may be interested in the photograph emulsion of photo postcards, and how these artifacts were mailed and circulated through a particular geographic area.

For technologists, computer scientists, and digital preservationists, the notion of format "permeates all technical areas of digital repository architecture and operation" (Abrams & Seaman, 2003, p. 1). Digital formats are represented with a series of properties so they can be retrieved and sustained in systems over time. Formats, as representations of structured information, enable the effective interchange of digital objects between systems and repositories. The qualities that make up a format influence their effects of exchange and depend on the mutual agreement of syntax and semantics of what is represented in the structure of a particular format. Digital preservationists, librarians, and archivists have developed an international format registry that provides authority control identifiers of formats, called the Unified Digital Format Registry, which combines two existing registries: PRONOM created by the National Archives of the United Kingdom and the Global Digital Format Registry from Harvard University Library. These registries primarily provide information about file format identification because often, as formats become obsolete, documentation regarding their creation, playback, backup, or transmission is lost, discontinued, not published or publicly available. Format registries also commit to providing digital representations in "human readable form" (GDFR, 2014). Despite the international library and preservation community's commitment to format registries, format identification continues to be a crucial issue and there continues to be formats that are not documented with unknown syntactic or semantic information about how these digital objects maybe recovered or accessed in the future.

The data model for registries involves identifying the high level properties of formats that range from the tool that is used to create or access them, to administrative properties such as the owner or maintenance authority (Table 1).

Table 1 - High-level format properties

Name	*Type*	Format *Function*
Identifier	URI	Primary, or canonical identifier
Alias *	URI	Variant identifier
Author *	Agent	Author
Owner +	Authority	Owner
Maintenance *	Authority	Maintenance agency
Classification *	Class	Ontological classification
Relationship *	FormatRelation	Arbitrary typed relationship
Specification *	Document	Specification document
Signature *	Signature	Internal or external signature
Tool *	System	Process or service
Status	Enumeration	"Active", "Withdrawn", "Unknown"
Provenance +	Event	Provenance event
Note *	UTF-8	Informative note

High-level format properties (Abrams & Seaman, 2003, p. 5)

Table 1 features the properties that format registries try to capture about digital object formats. Detailed and authoritative representations of information objects are used by all sorts of stakeholders, ranging from libraries and archives, to standards bodies, to commercial businesses, consumers and content providers. However, format registries cannot keep apace with the creation of new digital objects appearing everyday. For example, few of the leading public and private format registries contain entries for digital objects created with mobile phones.

This dissertation is a history of a new format, the text message, as a new kind of digital information object coming about of second-generation mobile telephony and now, the format that has become one of the most popular forms of mobile written communication on wireless networks. The text message is formatted, or operates as a format in different ways, first it was conceived and created as a transmission protocol (the way that data moves across systems), and then it becomes a standardized teleservice for the GSM which was the first wide scale standards protocol for second generation mobile communication.

Archivists are often concerned with records or document genres as groups, these formats, in manuscript collections range from correspondence, to memoranda, to personal papers and business records. However, most formats are studied after they reach a certain amount of consumer buy-in and are in wide use, or until they become inactive and their systems of transmission become outdated, unstable, or old.

The advantage of telling a history of a new format this way gives us a few different opportunities. First, it allows us see the impact that telecommunication standards and policy can have on the emergence of new textual objects, even if they are not initially planned or imagined to be recorded information objects. Second, it supports the early work of preservation, and we know that format histories are the increasingly the fundamental work of personal information management, and digital preservation (Lee, 2011).

Format stories are also an entry point into new theories of communication, information objects, and the establishment of new kinds of records. Records, that document transactions between people, organizations, and institutions are the basis for information studies, and of course the core commitment in archival science. The format story of the text message involves its stabilization, standardization, and circulation. It closely examines the infrastructure that make these new digital records possible, including the metadata produced as they are pushed and pulled across wireless networks. This dissertation is both an answer to a question (what is a text message?) and a call for more work in the nexus of infrastructure, new forms of recorded information, and recordkeeping practices that come from the convergence between mobile networks, personal computing, and wireless transmission. Some have called this nexus the primary concern for the future of personal information management (PIM), personal digital archives (PDA), or data curation because the future of personal computing (including organizational communication) will be tied to mobile devices and wireless networks. I am less concerned with tying it to a disciplinary commitment and more interested in focusing on how this kind of work crosses boundaries for information scientists, archivists, technologists and designers, lawyers, historians, and communication scholars concerned with records of culture and their preservation in the digital age.

Research Questions

In my dissertation, I am trying to get at three broad research questions:

The first research question is, if we assume that text messages are a format, what makes this so? What are the layers of infrastructure, that is the standards, code, network architecture, devices, platforms, policy and regulation that make such a format possible? The idea here is that the answer to this question can help us understand what makes all sorts of people around the world, from teenage girls, to heads of state, to micro-bankers, to disaster relief workers, all use this format so regularly and for so many different reasons. Chapters 2 and 4 are especially concerned with describing the layers of infrastructure needed to send, create, and enact the text message as a format.

The second research question confronts the materiality of wireless transmission, and what traces of transmission are made of. Here I am specifically engaging with second-generation digital mobile telephony, and the processes needed to leave traces of transmission as text messages are created, sent and received. This question is examining how these metadata are separate from the message content that users create. What are these traces of transmission, are they more layers of context, are they records in and of themselves? How do they shape how texts are used and understood in different times and places? We've all heard that the NSA is "just" collecting telephony metadata, and this second research question is specifically engaging with the metadata that is created and harnessed in the process of network coverage and mobile communication. These questions and their answers are picked up in chapters 3 and 5.

Finally, the last research question addresses the stabilization of text messages as new records that people and institutions are collecting (and in some cases, not collecting). How do people use text messages as records, and how is this changing or incommensurate across different activities? This question is answering ongoing debates in archives about what Caroline Williams (2013) calls "exclusive" definitions of records (classic examples of exclusive definitions will be things like InterPARES I or the Pittsburgh project), and "inclusive" definitions of records (think Brien Brothman, Kalpana Shankar, and Geoffrey Yeo), that are based on understanding recordness through boundary objects, semantic structure, and cognitive models. Inclusive definitions rely upon how people use and understand things as records. This means, instead of satisfying a set of rules of what a record should be to ensure electronic evidence, we ask, do individuals, do organizations, and institutions see these things as records? Does the law accept these things as evidence of transactions? And if they do have some kind of semantic structure that a group of people understands then we can identify them as, what Yeo (2008) calls neo-prototypical or at least non-prototypical records with content, context and structure. Case studies presented in each chapter of the dissertation discuss how text messages as formats are indeed records, based on these inclusive and exclusive qualities. Chapter 2 provides a review of the current literature that engages with debates about defining records in the digital age.

Method

I use historical analysis to tell this history of the Short Message Service. According to Philip Gardner (2006), this is the systematic and disciplined analysis of traces or primary sources to make sense of the past. This is asking the who, what, where, when, and how to a collection of documents created in a certain time and for certain purposes. I use techniques from infrastructure studies and media archaeology to examine and interpret primary sources related to the development of the text message. I am especially focused upon primary sources related to the Global System for Mobile Communication standards suite, from 1982-1996.

A basic description of techniques from infrastructure studies is that they provide researchers the ability to explore new forms of sociality that are being enabled by Internet connected information and communication technologies, by examining the social, ethical and political value of infrastructures, as well as changes in the nature of distributed knowledge work (Bowker, et al. 2010, p. 105). This includes scales of analysis (Edwards, 2002), histories of networking (Russell, 2006), infrastructural inversion (Star, 1999) and following traces (Geiger and Ribes, 2011).

I also use approaches from media archeology. Media Archeology is a fairly new method coming out of critical studies and media history that largely credits Michel Foucault's later work (Huhtamo & Parikka, 2011), and in this history of the text message, it means digging into the reasons why this thing, this information object as a standard and then as a format has been born and picked up and circulated. We know from media theorists that excavations not only tell us how something came to be, but also how things work and effect this present moment.

Figure 1 - Phone stack at dinner table

For example, consider the phone stack (Figure 1). The phone stack is a kind of game that you play when you go out to dinner with friends that keeps you from looking at your phone, it prevents participants from specifically reading or sending text messages. One of the things that I discovered in my research of primary sources that describe early conceptions of data transmission is that originally, SMS was conceived as a machine-to-machine protocol (not for human eyes to read). The documents show us a very real transition or chance that texting could have only been for machines or not for people to use for reading and writing messages. These documents show the possibility that there is another history that could have been, a story where we would use our phones only for calls and not needing to stack them because mobile devices would only support voice telephony. We know from media theorists like Wendy Chun, Lisa Gitelman, and Jussi Parikka, that all archaeology excavations of media not only tell us what happened in the past with these technologies, but they are also are meant to elaborate our current information realities. By confronting the technical conditions of emergence and the adoption of this new format we can see how practices like phone stacking show the story that is and what could have been. In one sense, the phone stack is way for people to connect to friends in the moment sitting across from each other at the dinner table. In another sense, the phone stack connects us back to this idea of being able to establish two-way connections with people by using mobile phones to transmit this new textual format.

Data and Evidence

In addition to popular accounts of text message transmission captured in news reports, legislation, and legal proceedings, I gathered and interpreted a variety of primary documents created as part of the Global System for Mobile Communication. These included meeting minutes, memoranda, reports, protocol drafts and updates, frozen protocols and news releases from GSM, 3GPP, and the ETSI archives. I also examined messaging client applications from popular mobile operating systems (including Symbian, Android, iOS, Nokia OS/Series 40, and BlackBerry OS).

Scales of Analysis

By pairing approaches from media archaeology and infrastructures studies to historical inquiry based on primary archival sources like standards documentation, I can go back and forth between scales of analysis, and here I rely upon what Paul N. Edwards (2002) has described in "Modernity and Infrastructure" based on Thomas Misa's scales of society for studying technology. Studying infrastructure at different scales produces different views of how technology develops but also how they affect individual practices, like recordkeeping or evidence building, and increasingly in social organizational practices, like business communications. Edwards is building upon Misa's (1988) framework for scalar analysis and he describes the micro, the meso and the macro scales of society and how infrastructure can be approached in different ways at each scale. Micro refers the individual or personal level, the day-to-day practices that make up our lives. The meso scale is the organizational or institutional change that we see with groups of people in weeks and years. Finally, the macro scale refers to infrastructure over long periods of time, decades, possibly centuries of civilization.

The beauty of approaching infrastructure through scales of analysis is that scales of inquiry are adaptable, like a pocket telescope, extensible and collapsible with quick gestures. Most importantly both media archaeology and infrastructure studies allow for the chance to really examine the meso level of infrastructure, where people create and rely upon new forms of information. This is where ethnographers that examine documentation like Peter Botticelli, Kalpana Shankar and Susan Leigh Star all agree, it is at the meso level, this messy in between area where groups of people are communicating with documents, where the stuff of records creation, stabilization, appraisal and reception, actually happens.

Roadmap

The dissertation examines the text message as a format in three parts.

The next chapter is an introduction to the problem of locating records in infrastructure. Part of understanding a format involves accounting for how it works, including how it moves across systems through time and space. This chapter provides an overview to the debates and theories of records as vulnerable objects, electronic records in archives, and the lack of concern for digital materiality. The framework is directly intervening into debates about "what is a record" by instead asking, "when is a record?" I apply elements of the framework in the subsequent chapters.

The third chapter is the story of how text messages are conceived as a transmission protocol in the 1980s, then standardized in the 1990s, and how they become a format in the 2000s on all mobile phones. It proposes two reasons for the success of SMS as an innovation to the GSM standards. The first is the consensus framework of mobile 2G standards in Europe that competing standards frameworks found in the US and Japan do not imitate. This is significant in terms of the circulation and uptake of SMS, its ubiquity across mobile platforms, and later, data transmission across third and fourth generation mobile networks. It is also a reading of early GSM documents created by the Draft Messaging Handling Group, a subgroup working party of the GSM, where mobile subscribers (users who are writers and readers of actual text messages) are written in and out of the possibilities for texting as a kind of data transmission. It shows that the SMS teleservice was a unique innovation to the GSM as all other teleservices in the standard replicated existing transmission protocols found in landline telephony. It also features a short overview of the parts of SMS transmission that influences the creation of mobile telephony metadata, which is picked up later in chapter 5.

The fourth chapter confronts the format as it is enacted at the micro level of the mobile operating system and in messaging clients. As we move over to using and relying upon mobile platforms to create records, application and device constraints like memory and code govern the format and circulation of text messages. This chapter engages with the deletion of texts, which happens to many of these formats because of local storage, client settings, and privacy laws. At the micro level, this chapter engages with the day-to-day practices of what it means to send and receive text messages, and what actually happens when texts get deleted. This has stakes for how we think of subjectivity, control, writing and reading these new documents. It also highlights the primacy of context that users create and the context clues that are needed to interpret the meaning or reception of texts in very real ways that are resisted by current platform functionalities and messaging client design.

The fifth chapter confronts the creation of telephony metadata and engages with it as one of the more considerable parts of the cultural significance of the text message as a new kind of cultural record. In June of 2013, Edward Snowden leaked many documents, and has continued to throughout 2014, that show how the NSA and the other five eyes (Australia, Canada, New Zealand, and United Kingdom) have been collecting signals intelligence, and in particular, telephony metadata in bulk as if they were business records. The definition of metadata is important to the understanding and impact of how text messages are transmitted, collected, and deleted over time. Until these revelations, very few, known and coincidental collections of text messages were thought to have existed. In fact, as chapters 2 and 3 show, many texts have been actively deleted or overwritten by users themselves. Privacy laws prevent most service providers in the US and the UK from saving the content of mobile communications. This chapter engages the use of text messages and their traces of transmission by states in legal and political contexts, including the Presidential Records Act, and few cases where governments are using text messages to suppress dissent or to address immigration. It also presents some emerging obfuscation and encryption technologies that individuals are using to send next generation messages with smart phones. Both chapters 4 and 5 ask questions about the current and future possibilities of becoming metadata subjects as we create born-networked records that leave traces of transmission through mobile communication infrastructure.

The conclusion of the dissertation presents an overview of what I call “born networked records” that we can see in the stabilization and standardization of SMS and its mobile telephony metadata as a new information object. Born-networked records are not limited to SMS, they are in fact multiplying with the rise of mobile ICTs.

Born networked records represent a bouleversement to our present understandings of born digital records in information and archival science. This rupture is in how we imagine collecting information as institutions and as citizens with networked communication technologies. Metadata generation, including the constant creation and collection of it by mobile computing infrastructure create new collecting futures. A new collecting present and future that traditional information institutions, like libraries, archives museum, and laws that govern such records have yet to confront. The format story of text messages shows how this incunabula comes to be stabilized not only as born digital records, but how they are born networked records, impacting recorded information with the rise of mobile networks. It not only has impact on how we conceive the effects of texting, sending or receiving, even saving or deleting them, it also changes the future of how we confront born networked records collection, access, preservation, appraisal and self-hood at the beginning of this century.

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Chapter 2: When is a Record? A Research Framework for Locating Electronic Records in Infrastructure

Abstract: This chapter presents a framework for archival researchers to account for the transmission and materiality of electronic records research by locating them within the infrastructures of contemporary, networked communication. The first section contextualizes the research need by presenting the importance of layers of infrastructure to the creation and circulation of born-digital records transmitted across wireless networks. The second section presents a research framework for studying new information communication technologies and emerging electronic records contexts, and reflects on why such a framework is necessary and how it has been constructed. The framework, which builds upon records continuum theory and the concept of spacetime, takes up the logical and physical aspects of Thibodeau's digital object model and applies Trace's microethnographic approach to networked communication, has three elements: (1) Layers of Infrastructure and Context, (2) Examining Networked Recordkeeping, and (3) Engaging with Information Retrieval. The third section presents the case study of Kurt Mix and the British Petroleum Oil Spill in order to illustrate the possibilities of how this framework might be applied in archival research.

Counting Kangaroos

On a recent trip to Australia, I took a twelve-hour train ride from Melbourne to Sydney. Within a few stops we entered the countryside and I began to count kangaroos as the train passed through open fields. After seeing well over twenty kangaroos, I started sending text messages to acquaintances back in the United States. The kangaroos were not a surprise to my fellow Australian passengers on the train, but I wanted to share my excitement with friends and family back home at how many kangaroos I had counted in the countryside. I had traveled to Australia to present preliminary research upon the infrastructure of mobile communication. In my research I examine how technologists, recordkeepers, archivists, and information scientists are confronting issues of digital materiality and preservation with emerging formats and the information systems that create, delete and store digital traces created with mobile devices.

Texting while riding the train gives us the opportunity to think about how we organize ourselves around networks. Infrastructural networks, or large scale technical networks and incumbent standards, protocols and the social institutions that enforce them engender the creation and reception of records, which are also comprised of the digital traces of transmission that produce such records. When I arrived in Australia, I had bought a Vodafone prepaid subscriber identification module (SIM) card at the airport to send messages, access the Internet and make a few calls while traveling. This SIM card allowed me to use my phone to make calls and send text messages via an Australian service provider's mobile network infrastructure. Sporadically throughout the rest of the train trip I would receive a flurry of text messages in my inbox responding to messages I had sent earlier in the day. After receiving a few batches of new messages all at the same time, it became clear to me that the mobile data network coverage that my new SIM card afforded followed the station stops of the train. The network would go dark as the train traveled between stations, and I would lose the network connection at the places along the way where the kangaroos actually were.

My inbox, with five or six new text messages, pointed to a fleeting mobile data connection and eventually, I was able to predict when we would approach the next station. I would reply as quickly as I could once the train was within network range of a station with the hopes of receiving a text before the next train stop, usually forty minutes away. It was in this fevered pace of playing catch up and responding to texts at each train stop that I realized I was experiencing the limits of two types of network coverage. First, I was playing with the clock, aware that as soon as a few more people got on or off the train I would lose the data connection. And second, just as the train would continue speeding towards my next destination, I was experiencing the possibilities of connection and disconnection through the affordances of infrastructure, in one sense from industrialization by way of the train network and another, due to the information age as manifested by my mobile phone and its access to network coverage. My experience of "boundedness" from both networks was producing an information landscape as I moved through time over the course of the daylong trip, and through space along the several hundred miles of train tracks (Lindtner et al., 2012). As I traveled through this landscape I was creating and receiving records along the way.

Information Landscapes and the Postcustodial Era

Paying attention to networks across geographical landscapes allows us to consider how infrastructure influences the possibilities of records that can be produced, and furthermore, how they are circulated and transmitted in digital networks. As mobile computing begins to influence the fabric of social life, important research questions arise: How do we locate and identify records *within* infrastructure? How does infrastructure shape the records that are preserved, identified, and the ways archival scholars evaluate them?

We experience the infrastructure of digital information networks in our everyday lives in the same way we experience other industrial infrastructures, such as trains, indoor plumbing, central heating, or copper-wire telephone landlines. The absence or presence of certain nodes in a technical network, whether that be a train station, a cellular tower or a Wi-Fi hotspot characterizes modern living and the feeling of *being infrastructured* is something that we all experience at different junctures in everyday life (Dourish & Bell, 2007). Network connections (and disconnections) reconfigure the spaces around us, just as they influence the ways we move ourselves around these networks because they enable a multiplicity of experience (Farman, 2011). Train networks and mobile phone networks create mobility; both networks move things through time and space in material ways. At first glance, it may not be obvious why archivists should focus upon infrastructures that create *records* (by which I mean information with content, context and structure recorded on a fixed media). Increasingly however, records of our time are created, transmitted and stored in distributed infrastructures and large-scale technical networks of digital information communication technologies (ICTs) ranging from mobile phones to cloud storage services. Archival scholars need proactively to locate records in infrastructure because in digital information infrastructure the threshold between active and inactive records is dissolving and the process of transmission is not well theorized (Pearce-Moses, 2007).

Locating such a threshold, or even discrete stages in the circulation of electronic records, has proven to be a challenge for traditional archival theories and practice, and in particular to the life cycle approach as electronic record systems have become increasingly networked and complex. The life cycle model for records management, as described by Theodore Schellenberg, was the primary model for records management in North America from the 1960s to the 1990s, and in many cases the influence can still be seen especially as it relates to the archivist's custody over records (Bantin, 1998, p. 23). The life cycle model prescribes stages of recordkeeping in addition to who will manage records and when, offloading specific management roles to records managers and archivists in different stages (Bantin, 1998, p. 23-25, Penn, et al. 1994, p. 12-17). Perhaps most importantly, it is not until records become inactive in the life cycle model that archivists take responsibility for their management (Duranti, 1996, p. 252).

In the 1990s, scholars such as David Bearman, Terry Cook, Sue McKemmish, and Frank Upward, argued for a new paradigm in archives. They argued that it should account for the new realities of electronic record environments that moved beyond the discrete stages of the life cycle approach and the limited archival oversight of inactive records only (Henry, 1998, p. 309). This new paradigm supports a *postcustodial era* where the role of the archivist shifts from a custodian over inactive records in a centralized repository, to the management of records over time, beginning where and when records are created through the practices of use and circulation. Postcustodial theory, as Frank Upward has written, is not the opposite of custodial, but instead de-emphasizes the physical custody of records and focuses upon the transactionality of electronic records (Upward, 1996, p. 4).[1]

Despite the attention to process that comes with postcustodial approaches, many archivists are trained to think that whenever electronic records move across space (conceptually or physically), they are at risk of having elements of record-ness stripped by another system, thus rendering them as non-records (MacNeil, 2002, p. 28). These moments of risk for electronic records are largely located at transfer points, processes of transmission that move information through space and time, because there exists a possibility to violate authenticity and change a record's fundamental attributes. The condition of becoming a record also threatens that

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[1] A note on terminology, in this chapter "transactionality" refers to physical and conceptual transactions, where "transmission" refers to the cultural logic of transmission in the digital age, including practices and social institutions such as standards built up around transactions.

existence. When a digital entity passes from one system to another, the control over the authenticity and integrity of that record follows. Such a "systematic vulnerability" has been identified by some historians as a condition of high modernity separating technology from the social and is not just limited to archival spaces of enactment and custody (Edwards, 2003, p. 195-196).[2] Archival theorists have written extensively about what the era of postcustodial recordkeeping signifies for archivists as professionals (Cook, 1994; Cook, 1997). Many archival scholars believe that it is at these junctures of transition, that we should "reinsert" ourselves into digital preservation planning efforts, especially through description and metadata (Bearman, 2007). It is interesting to consider the power of custody in approaching the problem of transition because it is the archivist's shifting custody over the recordkeeping system and the description of the processes of archiving that is radically transferred in the postcustodial era (O'Shea & Roberts, 1996; Upward & McKemmish, 1994). Yet there remains a dearth of work that theorizes or even describes the archivist's role, in what Manuel Castells (2004) has called, "the material organization of time-sharing social practices that work through flows" (p. 147).

In the space of flows, the time between active and inactive records has become disjointed and indistinguishable: as records are created and distributed across memory sites that range from mobile phones to USB flash drives to gaming systems, they instantly become subject to backup or digital storage (the so-called "archive" created by copying stored information across file structures in data storage), even when they are deleted or deaccessioned. This rupture of time with digital ICTs forces archivists to reconsider how records emerge in current networks and how they are kept, transmitted and received across space but also where archival callings shift in the space of flows. Locating records as they move through infrastructure relies on identifying the

[2] Edwards argues that systematic vulnerability is a result of "modernist settlement" or that of separating the social from the technological as theorized by Bruno Latour.

material culture of mobile communication and recognizing change: from devices, to cell towers, undersea cables, wires and server farms, even to phone bills. Furthermore, archivists have an imperative to account for recorded information as it moves through infrastructure, because the mobility of electronic records through spacetime is an indelible aspect of their enduring value in the postcustodial era.[3]

Even with the postcustodial emphasis on the processes of archiving and understanding of complex transactionality, the transmission of records across wireless networks has often been overlooked in archival studies and is not well understood (Upward, 2009b). This is possibly due to the fact that infrastructure can be "mundane to the point of boredom" (Star, 1999) and that wirelessness remains ripe for examination.[4] It may also be that most postcustodial approaches privilege logical aspects of records over the physical, and lean towards a tendency to treat electronic information as immaterial. The ways in which information infrastructure moves records from one system to another is conspicuously missing from the study of electronic records in archival scholarship (Hedstrom, 1991). To address this gap, the framework I propose here looks carefully at the historical ontology of records, or how records move through infrastructure at the point of creation, transmission, and reception. The following discussion examines how and why this framework was developed to address how records that are being generated today challenge all archival functions as we know them.

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[3] For more on the concept of spacetime, see Frank Upward "Modeling the Continuum as Paradigm Shift in Recordkeeping and Archiving Processes, and Beyond a Personal Reflection," *Records Management Journal* 10, no. 3 (2000): 115-139; and Sue McKemmish "Placing Records Continuum Theory and Practice," *Archival Science* 1, no. 4 (2001): 346.

[4] The significance of wirelessness on the network culture has been theorized at length by Adrian Mackenzie. See Adrian Mackenzie, *Wirelessness: Radical Empiricism in Network Cultures* (Cambridge, MA: The MIT Press, 2010).

Examining Electronic Incunabula in the Twenty-First Century

Margaret Hedstrom's framework for analyzing electronic incunabula urges archivists to examine evolving forms of documentation and to "think big enough."[5] Her framework drew heavily upon concepts and techniques from the history of technology that placed electronic recordkeeping into historical, social and cultural contexts. It was, however, developed before microprocessors and the rise of personal computing and perhaps most importantly, before the Internet revolutionized networked communication. Twenty years later, mobile communication devices, search engines and social media platforms present radically new kinds of formats, or networked electronic incunabula, for archival scholars to consider. Hedstrom's framework for studying electronic records begins with the consideration of specific contexts of information technology, starting with the origins of its development and looking at the evolution of documentation and organizational change.[6] I argue that by examining the infrastructure of records, archivists can think big enough about the "black box" and all the layers of construction behind new digital records and emerging documentation practices (Latour, 1987).[7]

In the same year that Hedstrom published her framework for electronic records research, Terry Cook commented on the problems posed by the transmission of emerging formats through telecommunication:

> Combining computerized information in these new formats with a telecommunications revolution affecting the transmission of electronic records threatens decision-making accountability and corporate memory: if an electronic document has no physical

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[5] As in the first outputs of the printing press prior to 1501, incunabula refers to "the earliest stages or first traces in the development of anything." *Oxford English Dictionary*, 1933, I:188.
[6] A close reading of the framework reveals that Hedstrom describes infrastructure (through stabilization and co-constitution of the social) but does not specifically identify it as such.
[7] For more on the significance of opening "black boxes" see Langdon Winner, "Upon Opening the Black Box and Finding it Empty: Social Constructivism and the Philosophy of Technology," *Science, Technology, & Human Values* 18, no. 3 (1993): 362-378.

existence, but rather is a "virtual" composite of disparate information appearing but fleetingly on a terminal, how does the institution let alone the archivist preserve evidence […]? Where is the evidence of accountability of the transaction? Where is the context? What is the provenance?

(Cook, 1991, p. 206)

If we update our approach to electronic incunabula to account for the infrastructure of large-scale networks, the realities of instant back-up and distributed storage, and the processes of producing and transmitting such digital traces, archivists may be able to answer, with confidence, the questions Cook posed. In the space of flows of the network society "transactionality is rampant. The distinctions archivists make between hierarchy and functionality, chatter and business, organizational structure and authority, become less easy to make" (Upward, 2009b, p. 18). As wireless transmission becomes more complex and pervasive in the twenty-first century, the need to focus upon the processes of transactionality, and their means through infrastructure, has increasing material consequences and archival relevancy.

Digital Materiality and the Physicality of Information

The *materiality* of digital communication in infrastructure is essential to understanding the context, content and provenance of new electronic formats.[8] In her microethnography of the creation of a digital document on a personal computer, Ciaran Trace encourages archivists to go inside the black box of the computer in order to understand the nature of born-digital records and

[8] Materiality, as a concept, refers to the medium or physical format used to store information or a text. For more on digital materiality and archiving, see: Matthew Kirschenbaum, Erika L. Farr, Kari M. Kraus, Naomi Nelson, Catherine Stollar Peters, Gabriela Redwine, *Digital Materiality: Preserving Access to Computers as Complete Environments*. UC Office of the President: California Digital Library (2009), http://escholarship.org/uc/item/7d3465vg .

adequately serve the communities that they document (Trace, 2011). This is what Richard Pearce-Moses (2007) has identified as “under-the-hood IT skills” (p. 13) for archivists. The digital materiality of records is an underdeveloped area of scholarship in archival studies, in part because electronic records are often seen as being without physicality:

> [T]he record remains a problematic construct even within the archival community. Within the U.S., there is insufficient common understanding of the nature of the record and how the record as a construct might be operationalized in digital environments, such as distributed and multiprovenancial databases where there is often not a readily discernible physical information object that corresponds to paper notions of a record. (Gilliland, 2005, p. 219)

Over the past two decades, the “problematic construct” of the record has persisted in archival research, in part, because how records exist across distributed environments is not well-documented (through microethnography or otherwise) or understood in material ways. While recent work examines the nature of the record in digital environments as constructs at the conceptual level, there is little research that examines records as material things that move through systems with physical constraints such as storage memory, or devices.[9]

The 1990s saw two influential research projects that sought to identify the functional requirements for preserving electronic evidence: the University of Pittsburgh Electronics Records Project (hereafter, the Pittsburgh Project) and the UBC-MAS Research Project.[10] Both projects reveal conceptions of evidence that overlook the unique materiality of electronic records.

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[9] In this case, I am referring to both primary (i.e., Random Access Memory) and secondary (i.e., magnetic or optical disc media) memory in computing.

[10] See: The University of Pittsburgh Electronic Records Project *Functional Requirements for Evidence in Recordkeeping*. School of Information Sciences, University of Pittsburgh; 1996. Luciana Duranti and Heather MacNeil, “The Protection of the Integrity of Electronic Records: An Overview of the UBC-MAS Research Project,” *Archivaria* 42 (Fall 1996): 46-67.

While the Pittsburgh Project advocated a new postcustodial paradigm shift, the UBC-MAS Research Project tested the validity of traditional diplomatic and archival concepts in electronic records systems. The UBC-MAS project identified an archival threshold for electronic recordkeeping systems, as a "space beyond which no alteration or permutation is possible, and where every written act can be treated as evidence and memory" (Duranti, 1996, p. 252). The Pittsburgh Project identified a new postcustodial paradigm to preserve evidence and develop strategies for archivists' distributed governance over electronic records corpora. Instead of applying tests of validity to recordkeeping systems or requiring application models as UBC-MAS advocated, the Pittsburgh Project developed best practices for distributed custody informed by the latest research in the legal, records management and information technology professions. Or as Philip C. Bantin described, "a distributed strategy for custody [that] necessitates the creation of legally binding agreements with offices, of reliable means of auditing records, of an extensive network of training programs, and of other mechanisms designed to ensure that custodians of records understand their responsibilities and are living up to those expectations" (1998, p. 23). In both projects the materiality of electronic records is understated, this is largely due to a focus on evidence as a logical concept.

Herein lies a deep fold in archival theories of electronic records. The materiality of electronic records—the processes of their production, transmission and storage—has been at once overlooked and overtaken by an unrelenting commitment to definitions. Whether these definitions are tied to early eras of traditional archives and analog recordkeeping, or to the distributed model of professional responsibility and functional requirements of best practices in a new era, both subsume the nature of electronic records in part, (and perhaps in favor) of the archivists' ability to ensure evidence and authenticity through governance or distributed custody.

Moreover, since Schellenberg's landmark appraisal framework, many North American archivists have focused on the informational content of transmission (how a record informs) as well as a record's capacity as evidence (Schellenberg, 1996). If we understood the electronic record to be an aggregate of physical, conceptual and logical entities, then we could trust diffused control of electronic records to many actors (records creators, managers, and archivists), and even more it if such entities reside across many platforms and are supported by networked infrastructure. Materiality includes the physical form (however atomic the bits), but also extends to the systems, practice, and social institutions that are built up around artifacts.

Records Continuum Theory and Relationships Between Record Concepts

Increasingly, the transmission and distributed custody of digital collections rely upon the infrastructure of many platforms (Abreu et al., 2012).[11] One significant way to approach the processes of transmission of electronic records is through the lens of continuum thinking. Historically attributed to the work of Australian archivist Ian McLean, records continuum theory has gained increasing traction in archival debates about electronic records since the 1990s (Upward, 1994). The continuum approach stresses the processes of transactions and the overlapping character of evidentiality, which is significant for theorizing electronic recordkeeping environments. As records acquire "ever-broadening layers of contextual knowledge in order to carry their meanings through time," conceptualizing a records continuum allows us to consider the significance of archival interventions as part of a process (McKemmish, 2001, p. 354).

[11] For the purposes here, platform means (hardware architecture and software framework).

For continuum theorists, such as Frank Upward and Sue McKemmish, recordkeeping is a continuum of processes that encapsulates the life cycles of records and their attendant activities. These activities range from the creation of records, to capture, organization of recordkeeping processes, and pluralization of records. Taken together, these four dimensions of recordkeeping establish the evidentiality of context as records move across spacetime, just as they may serve differently in multiple contexts (Cumming, 2010, p. 42).[12] The continuum approach allows archival scholars to move beyond artificial distinctions from the records life cycle model by deemphasizing static stages of records. Continuum thinking enables theorizing of multiple possibilities and future layers of meaning (pluralization).

Continuum scholars have also argued for understanding records as having both logical and physical properties, while focusing on the logic of processural realities (Upward, 2009a, p. 5). The shifting landscape of digital preservation has given rise to approaches that compliment the continuum approach.[13] For example, Kenneth Thibodeau has proposed a model of preserving digital objects that moves beyond the traditional understanding of records as physical or conceptual things.[14] He argues for understanding records as logical, physical, and conceptual objects (Thibodeau, 1997, pp. 7-9). If we approach records as physical objects with a material history that is represented and moves through information systems, then we can understand their creation and preservation from the inside out—from abstract to concrete networked communication realities.

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[12] I employ the concept of spacetime as employed in the records continuum model developed by Frank Upward. As he has argued, no records can be outside of spacetime, but are subject to it, an archivist's actions upon records reverberates through it.
[13] New areas include the emerging fields of personal digital archiving, digital duration, and scientific workflow and provenance documentation.
[14] A digital object is an object of any type of information or any format that is expressed in digital forms, and includes a range of electronic records and their digital traces of transmission.

For Thibodeau (1997), this is illustrated through relationships among the three properties of digital objects, however "the relationships between levels must be *known or knowable*" (p.11, emphasis added). These relationships between logical, physical and conceptual levels may be one-to-one or one-to-many. In any case, understanding and describing the relationships between concepts must be process oriented and understood across a continuum. But these relationships must also be described at the platform level, in addition to the scales of infrastructures that are enacted as records are created, used, and preserved.

Framework for Locating Records in Infrastructure

Based upon my review and contemplation of the approaches described above, I propose a framework that takes into consideration infrastructure, technological practice, and information retrieval aspects, updating Hedstrom's research agenda by expanding it to include broadening layers of infrastructure in ICTs moving between scales of analysis.[15] It takes up the logical and physical aspects of Thibodeau's digital object model and applies the methodological approach that Trace has developed in her microethnography of computerized document creation. The framework relies on the records continuum to map these infrastructures and illustrate dimensions of recordkeeping in spacetime.

Employing a framework that examines infrastructure, especially at the level of transmission points to conditions of modernity: including the fluency of infrastructure and the vulnerability of transactions across electronic recordkeeping environments.[16] This proposed framework enables archival scholars to move between registers of analysis and develop a mutual orientation towards infrastructural analysis and continuum thinking. The framework aims to

[15] Scales provide the opportunity to move between registers of analysis and levels of infrastructure.
[16] Edwards has examined such infrastructural fluencies and vulnerabilities in "Infrastructure and Modernity."

illustrate the significance of what can be learned by going into the black box, following records through infrastructure, and knowing what happens at moments of transmission.

First Element: Layers of Infrastructure and Context

The first element of the framework is concerned with describing the multiple levels of infrastructure that make records possible in different contexts. Understanding layers of infrastructure also reveals information about the digital materiality of electronic records in logical and physical ways.

According to Geoffrey Bowker and Susan Leigh Star, there are four elements of infrastructure: when technologies become a part of established routines; soon they are understood commonly across different communities of practice (as boundary objects); these technologies become transparent through use; and become embedded into socio-technical systems (Bowker & Star, 1999). By examining what lies beneath these processes of such stabilization—the code, standards, network architecture, public policy, and market forces that make pushing an electronic record from a recorded event to an information object, archivists can see the layers of context that shape records as they move through spacetime. This approach also allows us to consider how records are continuously active, always in the process of becoming entities in a continuum (Upward, 2009a).

Peter Botticelli argues that incorporating such an active view of the record into organizational contexts gives archival scholars the opportunity to observe the process of networked recordkeeping. Instead of understanding records as by-products of organizational transactions (that is, traditional Schellenbergian and Jenkinsonian understandings of records), Botticelli (2000) suggests that archivists appraise records as a "class of technological artifacts in a socio-technical system" (p. 174). Applying the study of infrastructure to records in systems is a way of examining how the historical context and development of distributed activities are technologically and socially co-constituted because of the focus on mobility and processing of information across networks (Bowker, 2010). As the nature of knowledge work changes with twenty-first century ICTs, it is incumbent upon archivists to understand the shifting contexts and layers of infrastructure. The method of infrastructure studies explores new forms of sociality that are being enabled by ICTs and the social, ethical and political values of self-perpetuating infrastructures (Bowker, 2010, p. 105). I argue that there is a mutual orientation between infrastructure studies and the records continuum model: both are attuned to the layers of technologies, practices, and events in different contexts.

In digital environments, records are more malleable and, many argue, more accessible than they are in analog formats. This raises questions such as: what are the layers of infrastructure that make the use, access and re-use of electronic records possible? And how do layers of infrastructure affect the enduring value, authenticity, and integrity of electronic records? Numerous contemporary archival scholars have pointed to the fact that "the digital" destabilizes inherited concepts such as original record or the authentic first copy (Bearman, 2007; Duranti 1998; Duranti et al., 2002; Gilliland-Swetland, 2000). However few of these scholars go beyond this conceptual bind and look at the material history and the social choices such as standards development or the design of platforms that lie behind that destabilization. Historians of technology know that many of these givens are the result of a series of choices that have been made. Each is filled with values that must be located and the influences of those values taken seriously (Dourish & Bell, 2011). For example, consider systems that delete records after certain storage limits are reached (e.g. mobile phones and computer operating systems).

This is a design choice of which archivists, lawyers, and historians should be aware because it changes our ideas about the history and evidence values of records as well as their data structure and context.

Sue McKemmish, writing about capturing documentary context in information systems, has touched upon the problem of complexity and context in electronic environments:

> The loss of physicality that occurs when records are captured electronically is forcing archivists to reassess basic understandings about the nature of the records of social and organizational activity, and their qualities as evidence. Even when they are captured in a medium that can be felt and touched, records as conceptual constructs do not coincide with records as physical objects. Physical ordering and placement of such records captures a view of their contextual and documentary relationships, but cannot present multiple views of what is a complex reality. The traditional custodial role takes on another dimension when it is accepted that the record is only partly manifest in what is in the boxes on the repository shelves. The purpose of archival systems is to ensure that records are preserved in the context of their creation and use, and retain their qualities as evidence so that when retrieved for future use their meaning and significance can be understood.
>
> (McKemmish, 1994, p. 187)

McKemmish uses the physicality of records (or loss of it) as an entry point to reiterate the importance of data structure on context of creation, whether that be on the shelf or in the file structure of an operating system, and how the creator or user experiences that in practice. In addition to platform design decisions and local memory storage limits, the history of object oriented data structures, relational databases, even NoSQL (not only structured query language) are approaches that do not adhere to relational approaches and affect the realities of archival objects in different digital environments and their contexts of creation. Further, data structures can heavily influence the flavors of database populism that may arise and recordkeeping possibilities with systems such as in social media (Driscoll, 2012).

The data structures that we employ are not only conscious design choices, but also affect the possibilities for description, retrieval and access in the future. Data structures "infrastructure" the representation of records in existing systems as well as shape the contexts of their reception or access. In some cases, the design of the system limits possibilities of creating traces at the same time as it institutes values. Archivists should examine multiple contexts of record creation, use and interpretation in different contexts in addition to the creation of metadata during transmission, but they should also consider how the data structures that infrastructure record creation shape evidence. This includes considering system design, user experience, and limits of creating records with a device that involves (to name but a few) an external battery, an operating system, a Wi-Fi or mobile data connection, limited local storage, and possible cloud back up. In each of these cases (and beyond) these objects involve layers of infrastructure that have significant archival implications for preservation, authenticity, and evidence.

Second Element: Examining Networked Recordkeeping

Contemporary recordkeeping practices rely on distributed, networked systems, yet there are very few descriptions of records transitioning across systems as a process, or how their history of stabilization (as formats) affects their circulation. This raises a key research question: What do these processes look like, conceptually, logically, and physically (i.e., "under-the-hood")? Archival scholars and practitioners who have worked with electronic records since the 1980s agree that there are some crucial "moments of risk" for electronic records throughout their creation and existence (Bearman, 2006). The moments that present the greatest risks are, paradoxically, those transactional points when entities cross systems and result in the creation of records. Furthermore, this is how these transactions, from web publishing, to retrieving electronic records off hard disks, to accessing online information *work*. Moments of risk are points where control is ceded or diminishes over a record at the levels of capture, ingest, and accession.[17] In other words, these are moments of transition across information systems, or when the record itself is transformed, copied from one user to another or from system to system, or accessed by one platform from another (Kirschenbaum, 2008).

Conceptually, these threats are understood as areas for archival concern and logically, they have been theorized for several decades. However, physically, they are not well documented. Records are seen as fragile and at risk during transmission, instead of being understood as a fundamental part of how electronic records physically and logically function in contemporary modes of communication. According to Bearman, the greatest risks are at the level and capture and access because these two moments are "outside the scope" of most models of archival preservation. However, the nature and effects of these risks are critical to the archival perspective, while still seen as beyond the threshold of the archivist's responsibility in the life cycle model. Where traditional analog archives ingest records after they become inactive, electronic records are *always active*, even as they are accessed as archives. Instead of assuming that these are innate moments of vulnerability, the proposed framework allows us to ask what if archivists approached transmission as moments of authority—to locate, understand, and describe

[17] If a draft, mp3 or a digital photograph is sent, whether through email or transfer from one machine to another with a USB flash drive, there are a series of junctures that it goes through to move from one (physical) place to another (at the levels of copy, capture, ingest, access). Users who use networked ICTs to communicate understand the distributed nature of transmission and failure in a variety of conceptual and logical ways. Further, they create practices and improvise around these junctures.

as archival objects of interest? Bearman and other postcustodial scholars argued for examining process through continuum thinking but what does that mean for networked recordkeeping environments that include multiple platforms and distributed storage?

Despite the supposed riskiness, Bearman (1994) focuses on the relationships that records have across systems because it transforms the nature of the information: "[ICTs] are not just providing a new method for transmission of information but changing the social character of the communication" (p. 14). Understanding the nature of electronic records as a process of creation and transmission is a useful conceptual move and can be seen in Bearman's commitment to the materiality of electronic records. Bearman was one of the first scholars to raise the importance of 'the conceptual' to electronic records theory in the early 1990s, and a decade later he began to publish about the "material conditions for communication" in twenty-first century computing environments. He wrote that the most problematic part that makes an electronic record is in its identification, which then poses some serious, practical problems for managing them:

> A record is any communication between one person and another, between a person and a store of information available to others, back from the store of information to a person or between two computers programmed to exchange data in the course of business. What is excluded in this definition is any information that remains within the computer workspace of a single individual, inaccessible to others, for private information or under editing and development. When the information is shared with another person or a machine accessible to others, it becomes a record.
>
> The virtue of this definition is the ease with which individuals can understand it and the simplicity of instructing computing and communications systems to capture it.
>
> (Bearman, 1993)

For Bearman, the nature of the electronic record is “the when” of accessibility and sharing in transmission between systems that signifies a transaction. Or as McKemmish has argued, when a record crosses boundaries is what defines it (1994).

Crossing boundaries, moving between systems, sharing information, and sending drafts that become records are all descriptions of records for postcustodial archival scholars, the explanation relies on transmission to ‘become’ a defined record. Yet it remains unclear why transmission is not examined as part of this process of becoming a record. I argue that even postcustodial definitions of electronic records becoming in spacetime overlook material constraints and employ tropes of immateriality (Blanchette, 2011). Frequently, these tropes rely on a loss of physicality or a reliance on understanding electronic environments as “purely logical” constructs without material constraints.[18] Despite a reliance on immateriality to explain transmission, we can credit Bearman for drawing attention to the material conditions of electronic communication, the physical constructs of recordkeeping systems, and the logical boundaries of archival principles such as *fonds* or provenance.

Archival systems produce as much as they record and document and this is dependent on the context and materiality of the records they hold. As new information technologies shift the ways of communicating, exchanging, organizing and preserving knowledge, they also transform the very terms of that knowledge. This second element assumes that the description and deep understanding of the processes of transmission are viable and essential parts of arriving at archival understandings regarding distributed records, this also has stakes for our evaluation of

[18] Bearman often uses metaphors of immateriality when describing the future of archival principles in electronic systems, often diametrically opposing them to the past of analog (paper-based) recordkeeping systems: “The ‘fonds’ as a physical construct will completely disappear because the boundaries of recordkeeping systems will be purely logical ones,” *Electronic Evidence*, p. 254.

the materiality of recordkeeping. It prompts archivists to examine networked recordkeeping in order to locate new and improvised forms and practices of record creators and users.

Third Element: Engaging with Information Retrieval

The rise of digitally-born records and the cheap cost of digital storage present a pressing and challenging area of information management, it is also an opportunity for archivists to apply traditional principles to new possibilities for retrieval and access in an era of big data collections and inquiry. Increasingly it is cheaper (and arguably easier) to save swaths of electronic records through backup instead of weeding through appraisal and deletion. Claims of the "big data revolution" have generated significant response in virtually every area of society.[19] Big data is positioned as a potential resource in business, government, academic research, and military applications, and many information professions are developing analytic tools for retrieval and enterprise (Borgman, et al., 2007; Lynch, 2008; LaValle et al., 2011). Likewise, academic big data initiatives in disciplines such physics and astronomy have promised new levels of analytics and discovery. The ability to capture more data has grown as sensors for collecting data become smaller and more ubiquitous. Moreover, the cost effectiveness of saving and the ability to re-use recorded information has led to a paradigm of data intensive science (Borgman, 2007). In an age of big data, there is potential for archivists to leverage traditional principles like provenance and archival bond to enhance information retrieval and access (Bearman & Lytle, 1985).

Historically, information retrieval (IR) has been understood as retrieving documents and sometimes portions of text in order to satisfy a user's need (Spärck-Jones & Peter Willett, 1997).

[19] For critiques of the promises of big data see, danah boyd and Kate Crawford. "Critical Questions for Big Data: Provocations for a Cultural, Technological, and Scholarly Phenomenon," *Information, Communication & Society* 15, no. 5 (2012): 662-679.

Among the most common is the retrieval of single documents that can be accomplished in two ways, through indexing by subject or searching by keyword or phrase. Where indexing is concerned with representations of documents (or information objects), searching refers to the ways documents are matched to specific queries by unique markers within the body of a document's text or internal structure. A great preponderance of early-automated information retrieval systems that were designed and built in the twentieth century were intended for retrieving references to surrogates of documents through indexing and abstracting (for example, union catalogs). Then, with the rise of institutional and personal computing and the decrease in storage and processing costs there was a shift to full-text retrieval of documents by searching with key words. Some IR systems, including search engines combine both indexing and document structure of web based objects (such as web pages) to leverage both approaches. In both retrieval applications, the design and approach to indexing and searching are obliged to use the document as the base unit of measure—words, phrases and structures within a given document were and are the guiding principles of searching for relevant information with automated retrieval systems. By virtue of privileging the internal structure of the document as the guiding measure, both IR applications neglect relationships between documents, known as "intra-document structure" and their context of creation as meaningful information or possible access points.

While most IR approaches are concerned with retrieving records as single entities, archivists and records managers are concerned with how records should be collectively managed in aggregate as opposed to single documents. Records have the most power in aggregate, according to Schellenberg (1996), because "records have a collective rather than a unitary significance" (p. 67). Accordingly, for some diplomatic scholars, like Luciana Duranti, it is only after a document is set aside and designated to be “put into relation to other records” that it becomes a record and acquires an archival bond (1997, p. 216). For Duranti, the record and its archival bond are dependent upon a formal method of setting records aside after transmission for capture, description, and preservation. Such an orthodox border of designated capture that is dependent on a recordkeeping system may leave some types of records on the sidelines. Some scholars have noted that transitory records may escape system safeguards and further, that systems often intentionally do not capture transitory or secondary records, which may be the most important metadata in networked contexts (Stuckey, 1995, p. 121; Shepherd & Yeo, 2003, p. 108-109). Although escaping such a system safeguard may forfeit the diplomatic conceptions of the archival bond for some stray records, many archivists agree that they are no less important to the historical record.

From a continuum perspective, the archival bond is a relationship that perdures through the dimensions of creation, capture, organizing and pluralization. Continuum theorists have argued that the principle of provenance (often dependent upon a single record creator or *fonds*) should be expanded to include the interaction among multiple *fonds* or creators. Such an expansion can be seen in Chris Hurley's critique of provenance (Hurley, 2005a; Hurley, 2005b). In traditional western archival practices, provenance has two distinctions, “records of the same provenance should not be mixed with those of a different provenance, and the archivist should maintain the original order in which the records were created and kept (Gilliland-Swetland, 2000). Hurley argues that a single context of provenance denies the possibilities of records crossing and interacting with multiple *fonds* and bodies of records (e.g. networked social platforms or Web 2.0). The concepts of simultaneous multiple provenance and parallel provenance, for Hurley and others, is a means for archivists to capture the recordkeeping realities of distributed digital environments like social networks. As opposed to traditional understandings of provenance, parallel provenance allows for the archival description of multiple contexts of creation, records creators, and individual *fonds* to exist as a part of the co-creation or convergence of collections. When applied to archival description, parallel provenance offers a way to account for the networked nature of platforms by expanding the possibilities for description, and in turn it enables dynamic retrieval that traditional IR approaches cannot accomplish.

By leveraging the principles of multiple simultaneous and parallel provenance and archival bond to expand description, archivists are in a unique position to locate and interpret evidence of records in the aggregate and as collections of value in information retrieval approaches. Retrieval through provenancial information and valuing the power of connective tissue across records in data structures, enables archivists to locate and thus support emerging recordkeeping contexts in ways that traditional and most current IR approaches overlook. The implications of online retrieval for archivists lie in the context of a record's formation, interaction among *fonds*, and parallel provenance in collections. Each can be used as access points in retrieval (Lytle, 1980).

Despite such significance, there is still little understood about the implications for archival retrieval with large-scale digital record corpora. In 1985, Richard Lytle and David Bearman claimed that archivists' "unique perspective" provided by the principle of provenance would be their contribution to the future of information management in the digital records era (Bearman & Lytle, 1985). Lytle and Bearman predicted that automated information systems would greatly benefit from provenance-based retrieval and identified design factors and guiding principles for empirical research. Retrieving archival evidence through description and access by searching across relationships between networked records is still under-explored for professional archivists and the communities they serve. Increasingly, the ways in which "provenance" is incorporated in contemporary system architecture do not employ provenance as understood by archivists. Instead, it stands in for workflow processes in an organization or distributed work group (Moreau, 2006).

Information retrieval systems are designed according to the standards and conventions of the institutional networks in which they operate. As archives increasingly ingest electronic records they will need to confront new ways of organizing and providing access to their collections. There is evidence that data scientists grappling with databases and massive amounts of data are on the forefront of the conceptual and technical retrieval problems of document structure, workflow, and what many scientists who work with big data are increasingly calling "provenance" (Moreau, 2007). The dearth of work in archival scholarship that is looking ahead to these retrieval issues is both a poison and a cure. Identifying places outside of archives where provenance and multiple contexts are seriously considered is one step towards building a meaningful hermeneutic, or guiding interpretative principle, for the future of automated retrieval systems that embed archival infrastructure into the design and implementation.

This third element in the framework, therefore, emphasizes the archival approach to groups of records, interaction among *fonds*, and evidence that the archival bond affords and that many current information retrieval approaches neglect. In the next section I present the case study of Kurt Mix to illustrate the applicability of the framework for encouraging archival scholars to expand their inquiry into scales infrastructure and electronic records' boundary crossing through the continuum. The case points to the problems that arise as information is shared and distributed between people across systems and the multiplicity of archival conflicts that can arise in connection with emerging records practices using mobile, networked communication.

Kurt Mix and the BP Oil Disaster

On 20 April 2010, the Deepwater Horizon mobile offshore drilling rig exploded off the southeast coast of Louisiana in the Gulf of Mexico. The explosion killed 11 people and injured 17 more rig workers. The Deepwater Horizon rig burned and sank causing the Macondo oil well to blow out. The *Deepwater Horizon Oil Spill*, also know as the 'BP Oil Disaster', is the largest marine oil spill in the history of the petroleum industry. The oil well leaked unabated for three months as British Petroleum (BP) attempted several times to cap off the blown well using different methods. BP and the US government initially underestimated how much oil spilled during the crisis, now estimated at 205.8 million gallons.[20]

A month after trying to stop the spill on 26 May 2010, BP announced a project called "Top Kill" to drill mud at a high pressure into the broken well. Kurt Mix, a BP drilling project engineer was on a team that used models to approximate the flow of the blowout as part of preparation for Top Kill. For two days Mix reported progress back to his supervisor regarding the progress of Top Kill using his mobile phone. He exchanged approximately 200 text messages with his supervisor in a text thread (a thread is a series of text messages exchanged between users) sharing estimates of the flowrate. Later Mix used text messaging to discuss the project with another BP contractor. Three days later, on 29 May 2010, BP announced that Top Kill had failed and that they were exploring other contingency options. In October 2010, Mix deleted the thread of text messages with his supervisor. In August of the following year, he deleted another

[20] As investigations and civil lawsuits are ongoing, see: "Deepwater Horizon Oil Spill" 2013 http://en.wikipedia.org/wiki/Deepwater_Horizon_oil_spill.

thread of communications between him and another contractor. Mix deleted approximately 300 text messages related to Top Kill from his iPhone in total, comprising two text threads between him and two other BP employees.

Two years after the Deepwater Horizon explosion, in April 2012, the first criminal charges associated with the BP oil disaster were filed against Kurt Mix for obstructing justice by destroying evidence related to the actual amount of oil leaking from the blowout.[21] Throughout the spill, BP released flow estimates that were later found to be several times lower than the actual amount spilling from the Macondo well. The U.S. Justice Department alleges that the text messages that Mix sent and received contain information related to the actual flowrate of oil during the spill, contrary to the information that BP reported to the government, media and the public during the time of the disaster. Court documents allege that Mix deleted the text threads after learning that a vendor working for BP's outside counsel would be imaging his mobile phone. According to these charges,

> there is probable cause to believe that (1) on or about October 4, 2010, and (2) again between on or about August 19, 2011 and August 20, 2011, Mix did knowingly and corruptly alter, destroy, mutilate, and conceal a record, document, or other object, and attempted to do so, with the intent to impair the object's integrity and availability for use in an official proceeding, in violation of 18 U.S.C. § 1512(c)(1).
>
> (O'Donnell, 2012)

[21] Later these charges would expand to include deleting hundreds of voicemail messages. Walter Pavlo, "Former BP Engineer Kurt Mix Still Deleting 'Stuff,' Government Alleges," Forbes Blog, March 28, 2013, http://www.forbes.com/sites/walterpavlo/2013/03/28/fmr-bp-engineer-kurt-mix-still-deleting-stuff-govt-alledges/.

Digital forensic analysis was able to recover some of the texts deleted from Mix's phone but not all of the texts he received. The complete exchanges were recovered from other devices through forensic discovery.[22]

The threads of text messages that Mix allegedly deleted present a case study through which to read records moving through infrastructure, to examine emerging records practice with material constraints, and to consider the implications for information retrieval in archival contexts. Mix is not being charged for the content of the text messages, but instead for deleting threads of texts from the local storage on his mobile phone with the intent to hide or obscure information. The evidence of obstruction is located in the metadata and transmission data about the texts and in the practice of managing them, or in this case deleting text threads. The text thread itself is consequential because it is both evidence of a read receipt from his coworker's devices, and confirmation of multiple text transmissions over a given period of time. The thread also indicates that there are digital traces of the conversation on multiple telecommunication servers, message centers that store and forward text messages, possibly hosted by multiple network providers, as well as on the devices belonging to the people who texted with Mix. The text thread as a physical, logical and conceptual entity exists in many different places and times, and there are records of transmission that prove this (e.g., timestamps, billing statements, messaging application logs). Indeed, such charges of obstruction stand against Mix because these traces do exist in many places—on the supervisor's phone, the vendor's image backup service, BP's discovery files as part of legal proceedings, AT&T's servers (for a time the only U.S.

[22] In legal investigations, forensic discovery is used to recover electronic evidence to support or disprove claims in a court of law or in civil proceedings. Luciana Duranti has written about the future of digital forensics to archival practice in "From Digital Diplomatics to Digital Records Forensics," *Archivaria* 68 (2010): 39-66.

network provider with iPhone devices and coverage), and perhaps even Mix's MobileMe account.[23]

The charges against Mix speak to each element of the framework that I have proposed. We can consider the infrastructure that makes the text messages possible—the large scale technical telecommunication networks that send and transmit the text messages, as well as the metadata, or the records of transmission that prove such texts where sent and received between the BP employees. The mobile phone practices of Mix himself also have archival consequences: What is at stake when we use personal mobile devices to send business messages to supervisors or collaborators? Who is responsible for documenting and preserving business transactions that occur with (almost) real-time text messages during federal emergencies or ecological disasters like the BP Oil Spill? And further, as the Justice Department charges against Mix illustrate, the evidence of obstruction is not the content of the texts themselves, but instead the intent to obscure or destroy the evidence between communications—the texts in aggregate as a thread. The retrieval implications are not in the words used within the text messages, but instead in the structure of the records as aggregates, or the thread as a collection of records. The transmission processes are crucial in addition to their timeliness, for example, consider if Mix and his supervisor were in limited service ranges and texts were delayed or lost during the disaster. The original order and provenancial information in the case of Mix is as important to the first criminal charges filed against BP as it is to the archivists who will document the largest spill in the history of oil disasters.

[23] MobileMe is a subscription-based suite of online services and mobile software used by iOS users, including the iPhone 4. Since June 30, 2012 the service has ceased to exist and replaced by iCloud. John D. Sutter, "iCloud: Revolution of the next MobileMe?" *CNN Tech Blog*, June 9, 2011, http://www.cnn.com/2011/TECH/web/06/07/icloud.reaction/index.html.

When is the future? Or, how soon is now?

Given that text messaging has increasingly become a part of the modality of documentation in modern life, archivists need mechanisms to understand how mobile communication like text messages exist physically and conceptually, and how the technology will reach closure and stabilization through social construction (Pinch & Bijker, 1987). Most archival scholars would approach this documentation quagmire by asking what is a record in terms of text messaging as a records creation practice, however the digital traces of the thread's transmissions may well be more consequential than the content of the texts themselves, as, for example, at the time of Mix's trial. What is a record on Mix's mobile device now, is different from what it was in Spring 2011, and it is still becoming, acquiring layers of context as it moves through infrastructure both technological and socially. Moreover, the infrastructure that makes mobile communication possible will change over time.

Digital traces such as text messages evade many definitions of stable and fixed electronic records with enduring value (Latour, 2007). However, digital traces should be important to archivists because archival theories about evidence can intervene upon ontological questions of how these traces will be enrolled in regimes of evidence in forensics, digital preservation and jurisprudence in the twenty-first century. As in the unfolding story of Kurt Mix, or other high profile litigation and civil suites that involve electronic communication, or the presidential records act that has expanded to include emails and phone.

Historically, archival scholars have been concerned with materiality and have developed highly faceted ways for interpreting context in and through the materiality of records (e.g. conservation science, diplomatics, and descriptive bibliography). By reinserting the concern for materiality into electronic records discourse as it relates to the digital preservation and description of layered digital traces that are networked and wirelessly transmitted, archivists have the opportunity to revisit the importance of the materiality of information to the field of information science as wider discipline.

As I have written earlier, Gilliland asserts archival scholarship in the 1990s focused upon the nature of the record; concepts were defined and redefined as archivists confronted the impacts of computing on ICTs. In 1997, Peter Marsden identified this same trend in archival scholarship of electronic networked environments, where commentators would proffer predictions for how archivists should prepare for future technology and information systems. He wrote,

> One witnesses a constant redefinition of terms and the appropriation of others, all of which leaves a sense that whatever archival footings remain, they are on very unstable ground. For most archivists, however, the need is neither to attack the past nor to resist the future.
>
> (Marsden, 1997, p. 158.)

There is a pervasive commitment to defining the record in electronic environments that has existed in archival scholarship since the 1980s. A remnant of positivist orthodoxy, the commitment dictates we must redefine, "What is a record?" each time a new electronic record, platform, or information object is encountered. Although practitioners, as Marsden points out, simply need some guidance that does not create disjunction between now and the future, I argue that many archival scholars are fixated on coming to universal understandings and applications of 'what a record is' in the diplomatic sense and have been slow to find universal, catholic approaches that include all information objects of evidential value, and multiple contexts of records-becoming. We must open the scope of our inquiry to the layers of infrastructure, networked recordkeeping practice and the possibilities for archival retrieval within the records continuum. By incorporating spacetime, and scales of infrastructure to our analysis we can arrive at a fuller understanding of electronic records, but also the expansion of archival callings.[24]

Always becoming, or, when is a record?

The project of defining a record should be abandoned in the age of networked records. Instead we must expand our focus to the ever-broadening layers of infrastructure and context through which digital records move. As we have seen with text messages, in the digital age the ontological purity and drive for the true nature of the record is over. It cannot be located because it is not in a single place, it never ends, and is "always in a process of becoming" in the continuum (McKemmish, 1994, p. 187). Instead, a record's mediation through time and space, its mobility and perdurance as archival infrastructure are the ultimate factors in determining enduring value. Analyzing how a record moves through networks, and asking when a record is becoming, and how and where it persists is a more productive method for understanding effects of infrastructure and ultimately how electronic evidence is socially constituted with technologies. The nature of the electronic record that is wirelessly transmitted across networks, platforms, and information systems cuts through the inertia of the tired defining exercise: the very basis of the digital is its flexibility, unfixity, combinations and recombinations.

Instead of asking, "what is a record?" when we encounter new information communication technologies, it behooves archival scholars instead to ask, "when is a record in infrastructure?" How can we account for the processes of creation, transmission, storage and retrieval that occur

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[24] Richard J. Cox has described part of these new archival callings as educating and informing "citizen archivists" in *Personal Archives and a New Archival Calling: Readings, Reflections and Ruminations* (Duluth, MN: Litwin Books, LLC, 2008), pp. 23-24.

throughout the continuum? Tracing evidence through infrastructure proves to be a way to get at record-ness without getting caught up in the rigmarole of asking what a record should be or how it is complete every time archivists and records managers encounter 'new' digital traces and unknown systems, from new platforms, to emergent ways of communicating with new formats. Marsden pointed to a sense of "unstable ground" that kept archival scholars from resisting the future. Fifteen years later, we are still encountering unstable ground with digital landscapes. But what has been overlooked are the layers of infrastructure and large-scale technical networks that really have hardened and stabilized around emerging recordkeeping practices in networks that create a constant sense of instability for archivists.

An updated framework of archival scholarship that accounts for this unsteady terrain and the multiple ontologies of recordkeeping practice is needed for digital records scholarship. Continuum scholars have begun this work in modeling spacetime, parallel provenance and recordkeeping in the continuum, still, infrastructure often remains invisible. Moreover, such a framework must account for infrastructure from an archival perspective. Archivists can also locate new possibilities where such a framework can be applied. The framework I have proposed pushes back upon the conception of information and electronic records as abstract and immaterial. Furthermore, it prompts a critical challenge to recover the material-ness of things like digital traces, by examining the infrastructure, technical architecture, code and standards that shape our ability to migrate the digital landscape in addition to continuum thinking about recordkeeping.

Archivists also face a pervasive trend information science that deemphasizes the genre and form of electronic records. Matthew Kirschenbaum calls this the "tactile fallacy," arguing that electronic information's lack of tangibility does not negate form and physical qualities

(2002, p. 43). In addition to overcoming a reliance on immateriality to explain digital forms, we need to describe new ways of being in the world that are supported by electronic records. Many archival scholars take contemporary recordkeeping practices as objects of study. But emerging social practices around records in networks and social platforms such as the law, digital forensics and telecommunication policy remain ripe for analysis. Presently, archivists do not have a method for understanding the stabilization of emerging formats over time, how they are created or used.[25] By studying the conditions of possibility for things to exist, at moments of creation and then over time, examining the historical ontology of records within infrastructure provides a means of analyzing epistemological transformations, emerging categories of knowledge, and techniques of inscription (Ribes & Polk, 2012).

The Future of Digital Communication

There are whole swaths of records created with personal communication devices (ranging from digital cameras, to media players, to tablets and so on) that are not and will not be documented by historical collecting institutions like libraries, archives and museums. Instead emerging documentation will be fixed by individuals and survive on networks, what we are now calling *personal digital archives*. Presently we use our mobile phones as primary communication devices. There are more than 6 billion mobile phone subscriptions worldwide, and texting with mobile phones is now the most popular form of daily communication (Noah, 2012). We use these mobile devices to communicate in a variety of ways beyond voice traffic—we send messages, access the Internet, contact friends, family and co-workers, take photographs, and use them for location services.

[25] For example, we can trace the historical ontology of blogs (and their comments), from personal weblogs or commentary published online to established, structured forms that are now seen as primary sources.

In a relatively short time, mobile computing with handsets has become the primary way of communicating information in terms of volume, frequency and penetration throughout the world. Clearly, archivists must account for emerging electronic formats such as mobile records, however it is uncertain that existing approaches to electronic records can account for the complexities of today's digital infrastructure. Consequently, archivists face a challenge to update and expand their methods for both understanding and managing such records. This is a daunting task as multiple devices, new formats, operating systems, service providers, local storage and cloud backup, mobile applications, and shifting legal landscapes keep many records managers and archival scholars from seriously considering the future of mobile communication or personal archives in archival institutions. Each aspect adds layers of context, links in multiple chains of custody, and distributed provenancial information to the continuum. The significance of this framework addresses the challenge of complex systems, the invisibility of infrastructure and the shifting responsibilities of the archivist in the digital age. Heather MacNeil (2001) writes that there needs to be a "more equitable balance between the product and the process of documentary creation and transmission." Given the possibilities of emerging digital traces in contemporary society, it is time for archivists to consider how infrastructure supports and shapes record creation and transmission and is mutually oriented towards continuum models. In order to more fully understand the archival realities we need to understand the processes of communication in the continuum, the practices of communicating as well as the traces that are generated, produced, and exchanged as part of a trail of evidence that bonds the data, texts, pictures, and tweets that have been sent and transmitted across systems. Studying how and when records move along infrastructure, in networked practice, and through retrieval contexts will give archivists a renewed opportunity to examine the new physical realities of our work with material traces in new forms and new spaces in the postcustodial era. It may be a daunting task, but if I am right that locating records within complex scales of infrastructure provides archivists with a renewed calling to examine the possibilities of transmission within the continuum, then we must attempt to try.

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Chapter 3: Infrastructure, Standards and Innovation of the Short Message Service

Abstract: The Short Message Service (SMS) is a teleservice that was developed by the Global System for Mobile Communication in the mid-1980s for second-generation mobile networks. SMS is made up of standards, protocols and infrastructure that make text messaging the most popular data service on mobile networks. The teleservice has since been used in all subsequent generations of digital cellular mobile telephony. This chapter discusses the development of the SMS teleservice standards (GSM 03.40), how it has influenced mobile telephony infrastructure, and how it remains a lasting communication innovation today. It historicizes text messaging standards and their technical realization by describing the network architecture and elements required for the transmission of SMS. This chapter focuses on illustrating how SMS standards and infrastructure represent a significant innovation to mobile telephony and how they have figured in the history of wireless data transmission in the late twentieth century.

Keywords: Short Message Service, infrastructure, innovation, standard, store-and-forward paradigm, telephony metadata

What are Text Messages?

Six billion text messages are sent and received every day around the world (CTIA 2013). Presently, text messaging with mobile phones is the most widely used teleservice on mobile data networks. The Short Message Service (SMS) that makes text messaging possible is a confluence of protocols, standards, design and infrastructure that has existed for more than two decades. Despite its influence, SMS is still known as one of the simplest innovations of second generation mobile telephony and very little has been written about the history of its development (Brown et al. 2007, Goggin 2005).

Text messages are short alphanumeric communications sent from one mobile phone user to another with messaging applications on mobile handsets (also known as cell phones, mobiles, or handyphones). They are frequently used for social coordination because text messages are quick and cheap to send. Moreover, they have enabled a culture of abbreviated communication, known as a texting argot or "txt talk" (Kasesniemi 2003, Vincent 2006). When cellular networks were first being conceived in the late 1980s, a large portion of the telecommunications industry in Europe and the United States predicted that circuit switched data services would be the most important mobile applications for individual end users after voice calls. During the initial development of teleservice standards for pan-European mobile telephony (ETSI 1992), SMS was seen as an add-on without much potential for commercial significance. Facsimile, Videotex, and other data format transmission appeared to be more lucrative. But within a decade of its introduction, the text message teleservice would soon be the fastest growing teleservice. The International Telecommunication Union (ITU) estimates that there are as many mobile handsets are there are people in the world and that penetration is quickly reaching 100% (ITU, 2013).

More than 77% of the world population SMS text messaging at least once a year--it is the most popular teleservice today measured by sheer volume of transmission and market share (Dudley 2013). Most mobile subscribers send and receive text messages several times a month, some (especially adolescents) as many as hundreds a day (Quadrello et al. 2005, Smith 2011).

While mobile telephony has significantly influenced personal communication in the twentieth century, few teleservices have influenced communication and wireless data transmission more than text messaging. The ability to send and receive text messages shapes many things that we do with our mobile phones and our expectations of mobile network services. SMS effects a range of networked applications, from point-to-point messages, to social networking with micro-blogging platforms (Oulasvirta et al. 2010), to mobile banking (Barnes et al. 2003), to crisis management and emergency aid services (Gomez et al. 2011). Once a user sends an SMS, they are handled by network operated message service centers that aggregate messages and connect to carrier operator databases to transmit messages to the devices of intended recipients. If the recipient is not within a user's home network, operators forward the message to another carrier's service centers for handoff. In order for this information and communication technology (ICT) to work it must be interoperable, modular, and flexible. These qualities are achieved through standards. Standards and standardization make mobile telephony and the large-scale technical architecture of wireless data transmission possible.

The history and development of SMS standards, network architecture and protocol govern how mobile data is transmitted across networks today. It can also be attributed for the uptake of other services such as picture messages (Multimedia Messaging Service), microblogging and social location services with SMS integration like Twitter. These developments also shape how users experience infrastructure such as network coverage and other applications, like SMS gateways to the Internet. This infrastructure also shapes the evidence of transactions that is created by the transmission of text messages. Though SMS has a variety of applications, personal text messaging between users remains one of the most popular uses of mobile phones.

This chapter seeks to answer the questions: What makes the SMS teleservice possible? What makes text messaging common in our everyday lives? And moreover, how has it become a universal format for mobile communication? While many social scientists have examined the motivations of *why* people text—from activism, to flirting and breaking up, to communicating with employers, there is little research that has examined the history and significance of SMS standards protocol in our daily lives (Ito et al., 2005; Katz & Aakhus, 2005). This chapter examines three factors that make SMS possible: avenues for consensus needed for standards development, the modularity of standardization through phases of introduction or "roll-outs", and the innovation of the SMS format and the short message service center introduced into mobile network architecture of the GSM. Each of these factors speaks to the success of SMS as a wide-reaching teleservice and form of written communication made possible by standards and standardization work. I argue that these factors are possible because a modern, organized standards body made a series of decisions built upon a consensus framework that contributed to the universal success of text messages.

To study SMS infrastructure, I employ the method of information infrastructure studies. The second section discusses the significance of infrastructure studies to histories of networking such as second generation mobile telephony. The early landscape of telecommunication standards, radio services, and first generation mobile communication are presented in the third section. The fourth section discusses the development of the GSM and the significance of its

Memorandum of Understanding to standards development and a consensus framework. The fifth section discusses significant parts of the SMS standard (GSM 03.40), the basic network architecture of the GSM, and the features that make SMS an innovation (both as a product and process) in the history of mobile telephony. The final section argues that examining the development of the standardization and standards introduction phases of the GSM is integral to the history of mobile information infrastructure because of their significant impact on the uptake and development of mobile teleservices that transmit data wirelessly.

Information Infrastructure Studies

The GSM standards, subsequent technical mobile networks, and related public policy are all examples of infrastructure. Taken together they make up large-scale information infrastructures that made mobile communication possible in the 1990s through to the present-day. Infrastructure is made up of the devices, standards, technical architecture and network elements that make ICTs work. This includes the global information and communication technologies that transmit information across national and regional boundaries (Bowker et al., 2010, p. 98). Distributed mobile communication practices, such as texting or using Twitter are built up around infrastructures, and in turn are influenced or "structured" by the infrastructure that enable such practices. Many communication and information scholars have pointed to the fact that new infrastructure is bootstrapped to existing or earlier forms (Bowker & Star, 2000). Often, standards and infrastructure are bootstrapped to other complementing, sometimes competing, or historical infrastructures.

Recent histories of mobile communication infrastructure focus upon mobility—or the wireless transmission of data while a user or device is moving in a network of coverage (Farman, 2012; Mackenzie, 2010). Instead of fixed point-to-point communication that the telegraph or analog telephones afforded, mobile networks allow users to receive messages or calls wherever data can be transmitted to cells through network coverage. The text messaging teleservice is made possible by such networked wireless data transmission. When cellular networks were being conceived in the 1960s and first technically created in the 1970s and 1980s, the mobile telecommunications industry in Europe and the United States predicted that circuit switched data would be the most important mobile applications for end users, instead, teleservices that provided packet-switched data transmission became more popular over time. During the initial conception of teleservices in the mid-1980s, SMS was seen as a unique, add-on without much potential for commercial significance. While Facsimile and Videotext transmission, as well as other data transmissions formats like Mobitex appeared to be more lucrative teleservices (Hillebrand et al., 2010). Telecomm operators imagined that these data transmission formats which already had been standardized and in use would be bootstrapped into mobile telephony standards and carried over into mobile communication. But within a decade of its introduction, the text message teleservice would outpace these other forms of data transmission and be the most popular teleservice used with mobile phones (it continues to be the highest earning teleservice today). Originally conceived as part of the GSM standardization of second generation digital cellular radio, it became a true innovation that is unique to the history mobile telephony.

The Impact of Standards on Mobile Communication

Standards and standardization development are cultural practices that influence and shape how our society communicates and creates culture. From public transportation systems, to the ways that books are shelved in libraries, these practices rely on standards and their development over time. They have specific histories with politics, economics, technologies, and ethics. However, as many infrastructure scholars have noted, the power of standards is in their ubiquity and invisibility (Star, 1999). Often, the significance of standards and standardization cannot be seen until something breaks down or becomes inoperable. Researchers and historians who examine ICT standards show that these hidden standards structure our experiences, they "shape not only the physical world around us but our social lives and our even our very selves" (Busch, 2011, p. 2). Our experiences of large-scale technical infrastructures structure our lives in a variety of ways, in many hundreds of ways each day, and these are all based on decisions created by standards development (Dourish & Bell, 2007). Standards represent consensus, reliability and repeatability over time and place. Wireless communication such as text messaging, just like library cataloging or bus route networks, relies upon groups of organized people (private and public actors) to agree to rules, regulation and modularity (Russell, 2006a). Often the very important work of consensus building is overlooked and under-examined in histories of standardization of information and communication technologies.

Because standards structure our experience of telecommunication, histories of their development, infrastructure, and economic possibilities are important for telecommunication and mobile communication research. Infrastructure studies aims to do this by contributing to a comprehensive historical understanding of the development of things, practices, and cultures through information infrastructure, including the development of standards. Information infrastructure studies examine large-scale ICT infrastructures ranging from cyberinfrastructure (Borgman, 2003), the Internet (Bowker et al., 2010) to satellite networks (Parks, 2005) to show how these infrastructures influence our lives and our shaped by cultures of practice, including governance, consumption, and the circulation of knowledge. Information infrastructure studies emerged in the 1990s in an effort to historicize and analyze cyberinfrastructure, the Internet, and large scale networks and the groups of people that use and communicate through them, such as scholarly communities. A variety of scholars from history of technology, science and technology studies and information science have coalesced around a variety of descriptive large scale examples of infrastructure and expert or professional communities (Edwards, 1996; Lee et al., 2006; Traweek, 1992). Infrastructure studies allows us to examine the nexus of "histories of networking" as Andrew Russell has argued between Internet protocol development and telecommunications in the late twentieth century (2012). Histories of networking infrastructures bring into relief how telecommunication policy, standards and international cooperation changed and the landscape of mobile communication today.

The transmission of text messages and texting as communication practices are distributed activities. The SMS format carries a history of competing telecommunication standards and operational constraints from technology, including older media, as well as carrying references to ancillary mediums and devices, such as instant messaging, pagers, and portable media players, even telegraph architecture (Winston, 1998). Infrastructure studies serves as a model for addressing the multiple layers of context involved in distributed mobile communication activities and how they are developed and built over time. I use the interpretive method of information infrastructure studies that relies on primary sources such as standards, code and policy to create an analysis of infrastructure for phases of GSM standards development. Later in the chapter, I present the SMS format, known as the transfer protocol data unit, as an entry point. Examining stabilization and transmission of the text message is way of looking beneath the format at the layers of history and development of standards and mobile communication infrastructure (Sterne, 2012). By examining the social, ethical, and political value of mobile telephony standards and infrastructures, as well as the changes in the nature of distributed knowledge work, we can account for limits and affordances in different contexts and formations (Bowker, et al 2010, p. 105). Stories of innovations and standards, are not always smooth or sequential however (Millerand et al., 2013), and it is worth examining how and why text messages succeeded as the data transmission of choice over a variety of other teleservices as well as earlier generations of mobile telephony that were developed to transmit textual information and did not succeed.

Historical Background to Mobile Telephony

Before SMS as an innovation can be adequately described and historicized, some brief background about mobile communication infrastructure should be covered. I begin by discussing the history of wireless textual communication messages beginning with wireless telegraphy, Telex and Teletype, and pagers. I then present an introduction to first generation mobile telephony in the US, UK and Scandinavia. Then, the chapter addresses the significance of the establishment of the GSM Memoranda of Understanding (MOU) between countries, telecommunication providers, handset and equipment manufacturers, and network operators as a driving force for innovation and the uptake of SMS as part of a consensus. Infrastructure and standards development are brought to the fore as an influential part of the success of the SMS innovation.

Early radio teleservices

There were a variety of early technologies, including radio and short cell mobile services that transmitted data and voice information before the rise of mobile phones. Arguably, radio telegraphy from the nineteenth century is the earliest form of transmitted textual messages through circuit-switched networks. Despite the fact that many people believe that mobile phones mark the beginning of truly 'mobile' communication, media historians argue that wireless telegraphy figures in heavily to the history and conception of mobile communication and data transmission at the turn of the early nineteenth century (Carey, 1989; Marvin, 1988; Wythoff, 2013). Telegraphy infrastructure predates the cellular idea of transmitting data across mobile networks by many decades (Agar, 2013), however Wythoff has argued (2013) that as early as the 1890s hobbyists and telegraph enthusiasts were imagining pocket wireless transmissions as an early form of mobile communication. Station-to-station Morse telegraphy, both wired and wireless are the origins of "modern technical texting communications" according to Friedhelm Hillebrand, the chairman of the non-voice teleservices committee of the GSM (2010, p.1). The difference between wireless textual communication over radio in the nineteenth century and the late twentieth century is the support of network architectures. Networks allow information to be transmitted through nodes, routed to a variety of nodes instead of station by station.

While telegraphy was used throughout the nineteenth and twentieth centuries is the modern antecedent to text through Telex and Teletype, a more recent technology is often pointed to as a successor teleservice to SMS. Early GSM commercials marketed the ability to use mobile phones anywhere and suggested that SMS service would be a "mirror image of paging" (Taylor & Vincent 2005, p 79). Pagers and paging services are seen as an early touchstone of transmitting alphanumeric short messages, especially in terms of market penetration, price points and coverage for consumers in the modern sense. Paging services allowed users to receive notification that a voice mail was waiting at a phone bank, and later pagers were allowed to receive messages of numbers to call back. Users later created codes and shorthand practices such as "hello" by inputting 0-7-7-3-4 and reading the code on the device upside down (Kushner

1999). By the late 1990s, pagers were seen a primary communications accessory for the business class in the US and Europe.

Before paging services there were other forms of limited wireless textual transmission with a long history of analog development used in business, financial and military communication systems. During the 1970s and 1980s, dedicated radio networks were also developed. Professional Mobile Radio (PMR) in the UK and Land Mobile Radio (LMR) in the US were used in enterprise systems and by organizations that needed dedicated radio networks for short-wave communication such as military, emergency services and the police. In response to pagers and PMR and LMR networks, the telecommunications industry foresaw the need for mid-sized mobile networks for consumers beyond business, military and policy service applications. In the first generation of mobile telephony, the mobile communications landscape of standards and technologies in the world was varied and uneven, coverage was unreliable because of the patchwork of telecomm monopolies and national boundaries.

Telex, Teletex

Despite its more recent roots in pagers and paging systems, other textual transmission incunabula reach back to the telegraph era that have mostly become obsolete have influenced the history and development of the SMS. Early radio textual communication includes Telex, Teletex, Facsimile, and Mobitex. Telex, and many other textual transmission tools coordinated teleprinters connected to a switched analog networks such as telephone networks (Easterlin, 1962). Teleprinters were used to transmit data in business and financial organizations. The Telex network and standards were developed by the International Telecommunication Union and as the first system to use standardized signaling for international communication of text-based records (ITU, 1988).

Hillebrand argues that the Telex service is the "forefather" of SMS as it was limited to 50 bits per second and there was a premium on the length of messages sent because of cost of transmission (Hillebrand, 2010, p. 3). It is also a good example for the conception of standardization of a data connection for systems across large-scale international networks. Teletex was standardized to overcome the limits of Telex, and most importantly both Teletex and Telex used networked architecture to store and forward information which would be used in future SMS network architecture.

Many of the standards and protocols developed in the early phases of GSM reproduced teleservices that already existed as part of analog systems or plain old telephone system (POTS) infrastructure. However the SMS teleservice represented an innovation: the confluence of two data services that were already seen with pagers and teletext, but connecting them together with a mobile device and network coverage created a completely new teleservice as well as a new form of communication and wireless data transmission. It was not immediately identified as an innovation because of the shadow of mobile voice services and other teleservices initially designed for GSM 02.03 Teleservices supported by GSM for Public Land Mobile Networks (ETSI, 1992).

First Generation Mobile Telephony

Early radio communications services were station to station but did not have the handoff capability that many nodes or cells as network architecture does. Network based communication services use nodes, such as cell towers and base stations, to pass on information and enable a portability that does not rely on connected to a pre-fixed end point to transmit data or voice calls. However, in the late 1970s, the first mobile networks were still seen as extensions of fixed networks or landlines. The idea that a network structure would support telephony is rather new to the history of telecommunication. While these technologies used to transmit data, they were not built with networked architecture, instead they are largely built on station-to-station infrastructure, instead of cell broadcast or networked service.

The idea of cellular architecture for mobile transmission was created in the US in the 1940s but the technology did not take shape until the 1960s at Bell labs (Agar, 2003). In the late 1970s the Advanced Mobile Phone System (AMPS) was introduced in the US. While the technology to send and receive mobile calls was technically feasible, regulation and competition monopoly in the telecommunications industry left standardization to the open market. Competing mobile standards and FCC regulation kept AMPS from becoming a leading analog mobile phone standard in advance of other digital cellular radio standards outside of the US.

With first generation mobile telephony, telephony and radio were combined for analog transmission. Despite a variety of incompatible standards and limited frequency bandwidth, first generation analog mobile communication was available across Europe within different regions by the early 1980s: Nordic Mobile Telephony (NMT) in Scandinavia, Total Access Communication System (TACS) in the UK (similar to AMPS), and C-Net in Germany (Dupuis, 1995; Agar, 2003). The Nordic countries of Norway, Sweden, Denmark and Finland would see the first regional mobile telephony standards implementation that crossed national boundaries by January 1980, eventually using two different frequencies NMT-450 and NMT-900. By 1985 it was the largest first generation mobile analog network, and in many ways the NMT consensus model was the foundation for the GSM's Memorandum of Understanding. NMT specifications were finalized between 1975 and 1978 (McKelvey et al., 1998). Though standardization of NMT had began in 1970 and took 10 years to stabilize and implement the standards across the network. Coincidentally though, the first implementation of the NMT standard happened in Saudi Arabia in August 1980 (Edquist, 2002).

The history and development of NMT standards and implementation across the Nordic countries in the 1970s proved that first generation mobile telephony and standards development could succeed across national boundaries through consensus development.

The pan-European approach to cooperation in the GSM during the following decade after the introduction of NMT speaks to the historical significance of consensus and competition in standardization development. The next section provides an introduction to the history and development of the GSM, which was the first standards protocol for digital cellular radio mobile networks and is seen as the leading, great success of mobile telecommunications industry of the 1990s.

History of the GSM and the Memorandum of Understanding

In 1982 the European Conference of Postal and Telecommunications Administrations (CEPT) created a working group to address the future of digital cellular mobile radio communications. This working group, called Groupe Spécial Mobile (later named Global System for Mobile Communications) was charged with developing specifications and standards for a pan-European digital mobile radio, and supporting digital equipment (Taylor & Vincent, 2005, p. 77). Initially, CEPT used consensus voting to create standards, but could not enforce standards compliance from operators, the working group could only recommend that manufacturers, telecommunication operators and participating nations make use of them (Edquist, 2002, p. 93).

Deregulation in telecommunications in the late 1980s brought remarkable changes to standards development: European standardization initiatives evolved away from national regulators and telecommunication monopolies to regional standards organizations made up of state regulators, telecommunication operators, network service providers and private manufacturers. For the first time, private equipment manufacturers could participate and influence standards development. This allowed manufacturers to test designs early and work out technical problems as standards were being theorized and developed. Newly organized regional standards bodies represented a new regime shift in the “transfer of power” away from nationalized telecommunication monopolies to industry organizations made up of different private and public actors (Russell, 2006, p. 104). This increased competition and allowed for faster market penetration and interoperability across regions and national boundaries in Europe (David & Steinmueller, 1994).

In the post-monopoly era of the 1990s, privatized telecommunication providers and manufacturers were able to contribute to standardization efforts, with multiple iterations of development, aiming towards a common goal of a pan-European standard for mobile communication while competing for a new, open market (Dupuis, 1995). With this new model of private-public partnership, standards setting bodies such as the GSM could coordinate and create technical and organizational avenues to rapidly innovate and test network principles. They could even abandon techniques in early iterations of testing experiments, in ways that previously nationalized monopolies backed by government run telecommunications operators could not achieve. Russell has argued that this de-regulation of the telecommunications industry combined with global reforms that enabled competition made ICT standardization more *modular* in character (Russell, 2005 p. 250).

Modularity in standards development can be seen in the standardization processes created by the European Telecommunication Standards Institute (ETSI), which took over the GSM from CEPT. The handover from CEPT to ETSI marked an important shift in the ability of the standards body to enforce standards because of a new consensus framework based on a memorandum of understanding where all signatories had to use and rollout services and products compliant with the GSM standards by certain, binding dates. After the founding of the ETSI, the GSM was absorbed and became a technical committee in 1989. The structure of the working party would be that the GSM developed technical recommendations for approval through ETSI. Within the GSM, proposals were written and produced by Special Mobile Groups with working groups called Sub-technical Committees divided into tasks of oversight ranging from theoretical to technical iterations of teleservices, network services, general utilities, and so on. Before approval, development was carried out through general meetings that were held every few years; these meetings were divided into three phases, and afterwards the newest phases of standards were introduced to the market.

In 1987, the Memorandum of Understanding was drafted and acted as a binding document to all signatories. The MOU created an open approach to the development of digital cellular standards and created a platform for the effectiveness and the modular character of the GSM. Initially, the MOU was signed by telecom operators and regulators from 13 countries who committed to introduce GSM cellular standards in Europe by 1991. Earlier, the GSM had been only composed of network operators and national administrations. In early meetings, equipment manufacturers participated in GSM by invitation only, but in 1988 CEPT members agreed to open membership to any European telecommunications manufacturers who wanted to participate (Edquist, 2002). By including a range of private and public actors, the MOU created a consensus framework for standardization development. The MOU eventually enabled transnational mobile station operation and standardized interfaces between equipment. This would pave the way for rapid GSM updates and faster market penetration worldwide. By 1996, the GSM MOU had 167 operators, from 103 countries with 20 pending applicants from Africa, Asia, Australasia, and Middle East as full signatories (Garrard, 1998).

In addition to enabling transnational operation, the MOU also required service providers and equipment manufacturers to make all their devices compliant with teleservices standards, and this included SMS capabilities (Hillebrand, 2010, p. 132). By 1990 the MOU framework required members to make SMS available for subscribers. Though it was initially rejected by other working parties as an optional add-on service, the fourth meeting of the GSM decided that it would become mandatory (Hillebrand, 2010, GSM 1991). The binding contract of the MOU framework was a lynchpin for the success and interoperability of SMS because the MOU required manufacturers and service providers to make the SMS teleservice available on all early handsets, operating plans for subscribers (Temple 2002).

The MOU also established *phases* into GSM protocol introduction (GSM, 1997; GSM, 1991; GSM 01.06; ETSI, 1992). Initially, three phases were planned from 1985 through 1996 (Phase 1, Phase 2, and Phase 2+) (GSM, 1991; Abdel-Aziz, 2011). SMS was introduced during the Phase 1, however handsets could only receive texts from service providers (e.g. to alert them of a voice mail message waiting to be heard). Standardization development and technical realization of the GSM continued through to 1996 until it was "frozen" in the Phase 2+ rollout (Abdel-Aziz, 2011).

In addition to phases of introduction, the MOU Association formed a base of transnational operation of mobile stations using GSM standardized interfaces and equipment.

This included what bandwidth frequency the national states and service operators would use for GSM. The majority of GSM operates in the 900 MHz band (GSM900) in Europe, but there also networks that operate in the 1800 MHz band (GSM1800) also called Personal Communication Network (PCN) Digital Communication System (DCS1800) and in the US the 1900 MHz band (GSM1900) Personal Communication System (PCS). While identical technology and architecture are employed in GSM, different radio frequencies are used because of national limits and governance over radio frequencies and their bandwidth (Eberspächer et al., 2001).

There are two types of broad services covered by the GSM standards. The foundation of data transmission that provides the technical facilities are called "bearer services" (ETSI, 1992; Hillebrand et al., 2010). Bearer services provide asynchronous and synchronous data transport that can be circuit switched or packet switched. These services carry information that is independent information between the user and network interfaces.[26]

Built on top of bearer services are teleservices, or what users are provided access to when they use a mobile handset with mobile network coverage. Teleservices were developed in GSM 02.03 and included voice calls, Fax transmission, SMS, MHS access, Videotext access, and Teletext transmission (ETSI 1992, p. 6). The SMS teleservice requires network operators to create service centers, which accept messages from fixed networks, stores them and "processes them in a store-and-forward modes" (Eberspächer et al., 2001, p. 52). The Short Message Service Center (SMSC) accepts SMS from mobile stations (mobile handsets) which can be forwarded to fixed networks, through gateways such as Fax or Email. In the GSM architecture this new SMSC server was required for users to send and transmit messages from their mobile

[26] Bearer services represent Layers 1-3 of the OSI Reference Model.

handsets. The significance of the SMSC to the GSM architecture and the impact of SMS innovation will be described at length later in this chapter.

In 1991, second generation digital technology was fully implemented creating the possibility for data transmission in addition to voice calls. GSM data transmission was first introduced through SMS as a two-way variant of the already existing and popular paging networks (Edquist, 2002, p. 25). The MOU had aimed to establish the first phase by 1991. It was finally accomplished in 15 countries by 1992 (Garrard, 1999, p. 164). Phase 2 standardization was completed in 1995 with market introduction the following year. In Phase 2, ETSI included more teleservices; these new services involved reworking portions of the earlier GSM standards and introducing new features like user generated SMS. The terminals and network structure of the Phase 2 standards had backwards compatibility with Phase 1 terminals and equipment but would also include the SMSC as a new important network element (Mouly & Pautet, 1995).

A portion of the development and success of GSM and the SMS teleservice was because of billing and industry cooperation (Taylor & Vincent 2005, p. 82). With the ability to store sent and received messages on their devices in contrast to early models of voice messages stored on operating servers, paved the way for market success over early forms such as paging. Consensus, modularity through phases are both features of the GSM MOU framework that enabled the introduction of SMS and other teleservices in the 1990s. The next section examines how SMS as a teleservice is a unique innovation to the GSM standards.

Short Message Service as an innovation

Innovations are defined as “new creations of economic significance,” they can include new products, but also new processes (Edquist, 2002, p. 2). The SMS standards are a unique innovation to mobile telephony because they are made up of both processes of transmission and components that create a new information object, the text message format. By 1990, the SMS standard had been defined as a theoretical service, but it was not market ready. While the MOU required service providers to provide services by 1991, they were only built around the reception of text alerts. That is, users could receive text messages with their handsets, but not send them. These early uses of SMS were usually to provide the user with a voice mail alert for messages waiting to be heard or other notices from service providers (Hillebrand, 2010).

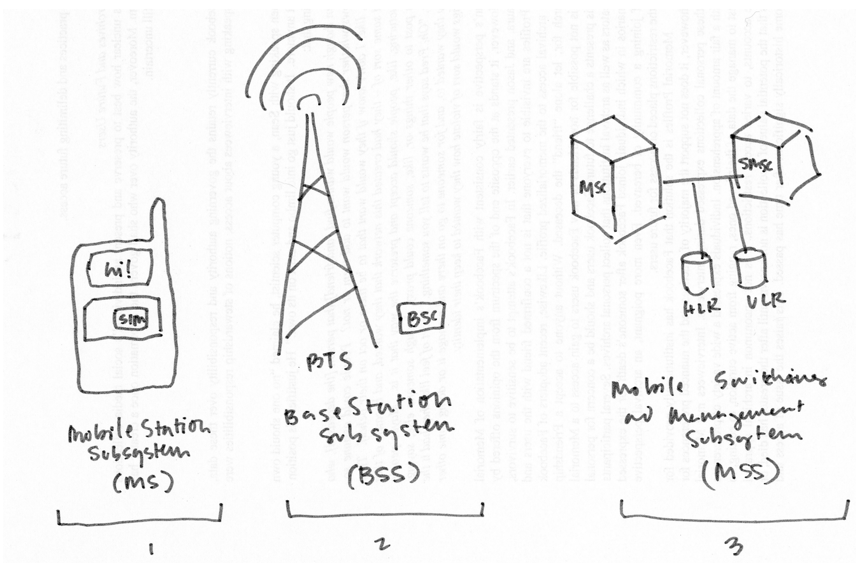

Figure 2 - Three parts of the GSM Architecture

In order to understand how SMS is an innovation within the GSM, a description of the network architecture and elements is needed. The basic network architecture of GSM is made up of three interconnected parts. The first part is the mobile station subsystem (MSS), and it contains two elements. The first component is the user's mobile handset or mobile station (MS). The MS is a terminal that includes the equipment to make and receive calls, to send and receive data within a mobile network. The MS contains a subscriber identity module (SIM card) that allows users to make calls or send data through a mobile network, and be billed and located by their service provider. SIM cards can be put in and taken out of the MS with relative ease, so that subscribers can exchange service and handsets over time. The MS also has an International Mobile Station Equipment Identifier (IMEI) number that is unique to the handset. The combined and decoupled SIM cards and handsets in the GSM to provide users privacy and different mobility options (such as a SIM card for work and a SIM card for personal calls but a handset for private and business work). Users can switch out SIM cards as well as switch and change mobile stations depending on network coverage and teleservice pricing. The mobile handset also includes a radio transceiver, the display to the user, and a digital signal processor to send and receive calls and data.

When users send a text message from their phone, their handset transmits the message to the second part of the network architecture known as the base station subsystem (BSS). The BSS is made up of a base station (BS) and a base station transceiver (BST). The base station (or cell tower) and a base station transceiver hands off the message to the network's closest Message Service Center (MSC), which is an intelligent terminal connected to other terminals.

The third part of the GSM architecture includes the Mobile Switching Network (MSS), in includes the switching centers and databases that contain information for routing and teleservices. MSCs are also connected to SMSCs for text message transmission. The SMSC locates the receiver's handset through geolocation registers databases stored by the network provider and send off the message if the receiver's handset was on, or hold it until the message could be delivered to a handset that was on and within range of mobile network coverage.

The addition of the new SMSC server allowed users to send and receive messages across a network, instead of point-to-point (as they would with analog or landline phones). GSM network providers were required to introduce SMSCs to their network architecture so that they could route and deliver messages to subscribers in their network or handoff messages to another service provider. The SMSC acts as a checkpoint or way station to send off messages to network operators and handoff confirmation back to users on any network. SMSCs deliver text messages that are a maximum of 140 octet payload, or up to 160 characters. Text messages can also be sent in Unicode, 8 bit and 16 bit encoding, though usually infrequently. There exists another service for batch, one-way transmission of SMS to users in a given network area called cell broadcast. It is often used by network operators or authorities to send emergency alert messages, such as Amber Alerts in parts of the United States (Abdollah, 2013; CTIA, 2012). Moreover, Unicode can be used in cell broadcast as "hidden SMS" for operators to update firmware (Trabelsi et al., 2008).

As a new introduction and intelligent terminal, the SMSC is not just another piece of banal equipment: it represents a significant introduction to the GSM network architecture that makes SMS transmission possible. Moreover, because of the GSM MOU, it was a mandatory application for mobile handsets. It is the element of store-and-forward transmission process that illustrates the two-fold innovation of SMS as a new product and wireless communication process. With the ability to store, send and receive messages on personal mobile handsets in contrast to early models of voice messages stored on operating servers, mobile subscribers loved text messaging. A "new unique SMS argot" began to appear, and many communication scholars have argued it was an early driver for the mass uptake and catalyst for the success of mobile communication (Taylor & Vincent, 2005, p. 83).

Network Architecture and Elements

The basic network architecture of the GSM structure is hierarchical and the system is made up of two areas of network components: infrastructure that is fixed and supports the reception and transmission of data (such as voice calls); and the mobile handsets that users use as they move throughout network coverage. The network services that operators provide to users use a radio or air interface to communicate information to the network infrastructure. Within the fixed network there are subnetworks called subsystems in the GSM standards, including the radio network, the mobile switch network and the management network (Eberspächer et al., 2001, p. 35).

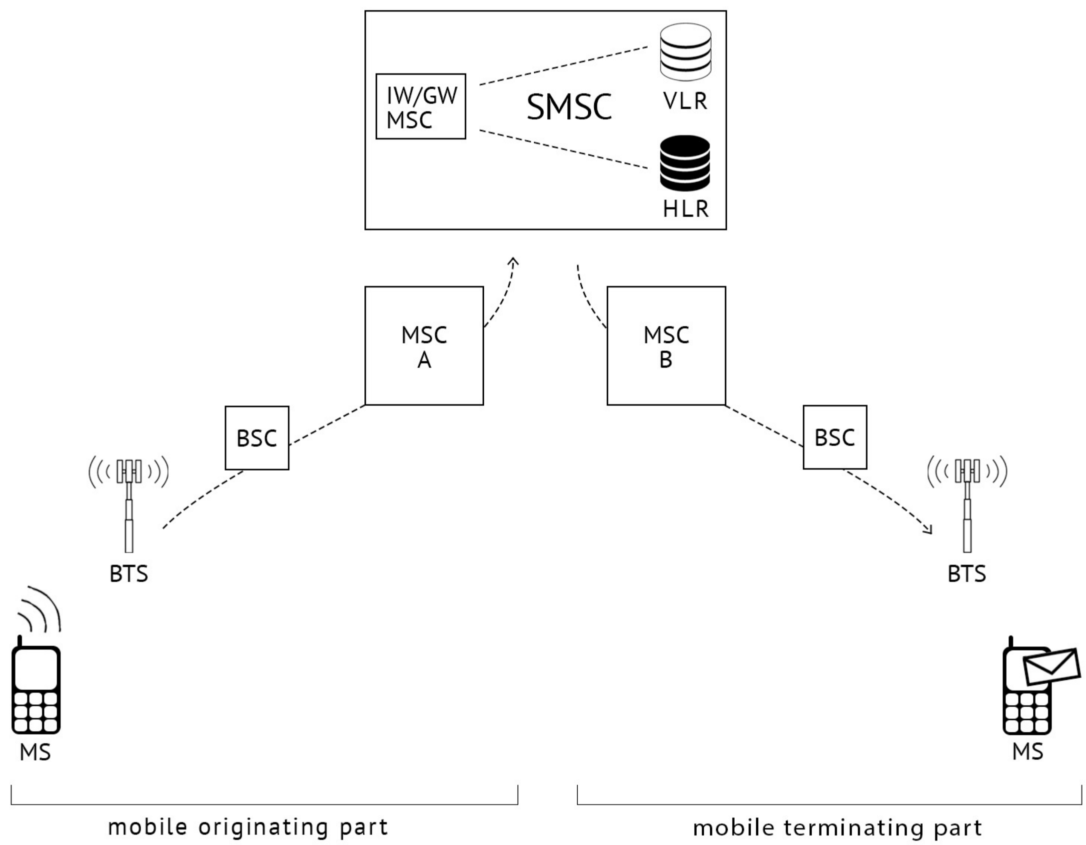

Figure 3 - Mobile originating and terminating message transmission

Figure 3 illustrates the general system architecture of the GSM network that supports the transmission of a text message, which relies upon an SMSC as an intelligent terminal to store and forward the text message. The SMS standard splits SMS operation into two different processes of data transmission: Mobile originating transmission, where the text message is being sent from the MS to the closest MSC, and mobile terminating transmission, where the mobile switching network routes the text message to the receiver. While SMS is two-way communication system, the process of sending a text to the network infrastructure and the process of the network's transmitting the message to a receiver's mobile station are standardized in separate ways.

In the mobile originating process, the MS sends the SMS to the base station, which uses a wireless interface to transmit the data from the originating MSC nearest to the user. The MSC hands off the data to the SMSC which stores messages, interrogates databases for more routing information, and delivers text messages to recipient users through the appropriate MSC. The SMSC's ability to store messages is important because when the GSM was first being conceived users did not keep their phones on all the time, and there was a high likelihood that the SMS could not be received the first time it was sent. In the event that the receiver's mobile station was turned off the SMSC would store messages until their phones were back in range of network coverage or were turned on to receive data.

The Mobile Switching Network is made up of switching centers and databases with routing and service information that relies primarily on the Mobile Switching Center (MSC) to perform the switching function of the fixed networked to the mobile network. While there may be many MSCs in a network, a single MSC controls BSC and BST in the BSS. Between each of these stations are different air and grounded interfaces, and there are a variety of communication relationships that transfer user data through signaling and wire transfer. SMS data are transmitted across the Mobile Switching Network through Common Channel Signaling System 7 (SS7). Within the management layer, each of the network elements (both wireless and wire-line) use SS7 for call setup, authentication routing, and management for the control of information transmission (Zerfos et al., 2006).

The MSC is the interface to the SMSC to originate and terminate message delivery. The transmission of text messages and confirmation of their receipt is built upon authenticating and gathering data from subscription databases known as the home location register (HLR) and a visitor location register (VLR) in the SMSC. These databases contain billing and user information registered in the network and their current location of their mobile handset within a cell of network coverage. This geolocation data is captured as part of a mobile station roaming number (MSRN) based upon the number of the last visited MSC to route a call.

MSCs use these HLR and VLR subscriber databases to authenticate and transmit call and text data. Primarily there is one central HLR for each public land mobile network (PLMN), and one VLR for each MSC within a network. As a central repository of user data, HLR has records of every subscriber and their mobile handset in the provider's network. It stores all of the permanent subscriber data as well as the link to the current location of the mobile station. While the VLR stores register stores, which are traveling in a current cell area associated with a MSC. As users move through networks cells, mobile stations update MSCs and VLRs store these over time, mobile users from outside networks can also appear in VLR of a visiting network (if they have an agreement with other network operators). This creates a way for incoming calls or other teleservices like SMS to be routed to a MS quickly, as a user moves throughout cells in network coverage. These constant updates to the VLR, create traces of information, or data about data.

The information about the location of MS moving in networks are part of what makes telephony metadata. In addition to locations of MS, SMS metadata is also generated by the transmission wrapper of the transfer protocol data unit (TPDU), or the data format that SMS messages are formatted.

The SMS Format: Transfer Protocol Data Unit

The way that SMS data is formatted and transmitted has a significance not only to the GSM standard, but to how it is enacted by the system and interface on it is received by a mobile station. The message itself can be used and rendered in a variety of ways. There are 3 types of formats of SMS (7 bit and 8 bit encoded, cell broadcast, and Unicode) (GSM 03.40). There are four layers in the SMS protocol stack: the application layer, transfer layer, relay layer, and a link layer. The protocol stack transmits a transfer protocol data unit, a format that will be discussed in this section. Just as the SMSC became a new element in the basic architecture of mobile transmission it also enabled a new format of written communication.

The SMS in a format that is sent from the MS to the SMSC to the forwarding MS. The signaling protocol that a GSM network uses to exchange signal messages has a physical layer, a data link layer and a message layer. For the mobile station's message layer, there are three sublayers within the mobile stations message layer, including connection management, mobility management and resource management. Where connection management sublayer manages call services and SMS. The mobility management layer establishes connections to between the MS and the MSC, it can also update location data. While the resource management sublayer creates the physical connection over the air interface to transmit signaling information between the MS and the BSS. The message layer for the MSC has four sublayers, including the base system substation application part (BSSAP), the message transfer part (MTP), and the signaling connection control part (SCCP) protocols. SCCP packets carry SMS messages through transfer protocol data units (Table 2).

Once the MS receives the TPDU, the messaging client in all GSM phones should be able to receive a TPDU, decode and store the message on the MS. Table 2 illustrates a 7 bit encoded mobile originating text message that says “hellohello”. It breaks the TPDU up by octet. Within the TPDU there are several pieces of information: the length of the SMSC, the address of the originating phone number, the service center, and the delivery message. It includes the user’s phone number, international time stamp, and how the message is encoded.

Transfer protocol data unit:
07917283010010F5040BC87238880900F10000993092516195800AE8329BFD4697D9EC37[27]

Table 2 - Transfer Protocol Data Unit

Octet(s)	Description
07	Length of the SMSC information (in this case, 7 octets).
91	Type-of-address of the SMSC (91 means international format of the phone number).
72 83 01 00 10 F5	Service center number (in decimal semi-octets). The length of the phone number is odd (11), so a trailing F has been added to form proper octets. The phone number of this service centre is "+27838890001").
04	First octet of this SMS-DELIVER message.
0B	Address length. Length of the sender number (0B hexadecimal = 11 decimal).
C8	Type-of-address of the sender number.
72 38 88 09 00 F1	Sender number (decimal semi-octets), with a trailing F ("+27838890001").
00	Protocol identifier (00 = SME-to SME protocol—implicit).
00	Data coding field (00 = 7 bit, 01 = 8 bit, 10 = 16 bit, 11 = reserved).
99 30 92 51 61 95 80	Time stamp (semi-octets) in order (YY, MM, DD, HH, MM, SS, TIMEZONE in relation to GMT in units of 15 minutes). So, 0x99 0x30 0x92 0x51 0x61 0x95 0x80 means 29 Mar 1999 15:16:59 GMT+2.
0A	User data length: length of message. The data coding field indicating 7-bit data, so the length here is the number of septets (10). If the data coding field were set to indicate 8-bit data or Unicode, the length would be the number of octets (9).
E8329BFD4697D9EC37	Message "hellohello," 8-bit octets representing 7-bit data.

The SCMC uses a store and forward paradigm that is largely based upon the gathering and creation of telephony metadata created through the GSM 03.40 protocol that retrieves routing and authentication data from databases like the VLR and the HLR. In the messaging terminating

[27] Source: Brown et al. (2007).

process, the SMSC creates layers to the TPDU be creating and returning message delivery receipts. The SMSC stores messages until the receiver's handset is turned on or the within network range of a MSC.

Within SMSC can be two more intelligent terminals, Interworking Service Center (IWSC) or a Gateway Service Center (GWSC). Depending on whether the message is originating or terminating the IWSC or GWSC looks up the routing information in the HLR and sends the message to the matched receiver's closest MSC. The MSC then forwards the short message to the appropriate MS for delivery. Once the message has been routed, the SMSC adds a time stamp (in SMS-DELIVER TP-SCTS). All MS must receive and submit a short message TPDU and return delivery reports after they have been received.

This section discussed the basic network architecture and network elements needed to send and receive text messages with GSM mobile equipment. It also examined the format with which SMS are delivered, the TPDU format and the traces of metadata that are used and created in order to transmit messages. Each of these processes, artifacts and information were built upon standards that are often hidden yet their materiality and effect on mobile communication and data transmission cannot be underestimated. The next section discusses the significance of this infrastructure and standards as innovation to the wireless text transmission landscape the future of the mobile communication.

Concluding Remarks

This chapter has presented a history of the infrastructure and technical architecture that makes SMS possible. It presented the standardization process, the primary development point that led to the network architecture and the establishment of the SMS format. The format itself is made up of routing information and other user-created data that creates telephony metadata s part of transmission through the SMSC. These traces of transmission are not only evidence that messages are being sent and received, their generation speaks to the significance that this form of communication has at the beginning of the twenty-first century.

For all these elements to work together, standards, standardization and infrastructure needed to be developed. A clear example of consensus framework and modularity in action can be seen through the MOU agreement that enforced mandatory services into the introduction of second generation mobile communication infrastructure in the early 1990s. Policy researchers, such as Jacques Pelkmans (2001) have identified the European approach of the MOU consensus framework as more successful than the non-cooperative, market driven and competing process that the FCC encouraged in the US for digital mobile standards development in the late 1980s. Even today, the US has a handful of competing mobile network standards that users can choose from (including GSM) that make it difficult for cost-switching and new contracts. However, Americans from every demographic participate in texting despite the fact that texting had a slower uptake than in Europe because of pricing. Clearly, the harmonized European approach of the MOU framework and the prevalence of competing standards in the US points to the tradeoffs that are present between mandated and market-driven standards development in wireless telecommunications policy (Gandal et al., 2003; Goggin & Spurgeon, 2005).

The development of the GSM standards, from theoretical planning, to technical realization, and eventual market dominance in the early 2000s, relied upon a number of hidden and under-examined elements of standardization and information infrastructure (Hillebrand, 2002). Consensus through the GSM MOU and mandatory implementation, modularity in standardization through three phases of standards rollouts and updates, and the introduction of a new element to the network architecture led to the innovation of SMS on every network and every mobile handset that uses GSM. The SMS format and the SMSC intelligent server terminal were crucial in creating the history of the text messaging teleservice in the GSM network architecture. Cooperation from national regulators across regions, international professional organizations, and the telecommunications industry made the commercial success and universal uptake of SMS possible, however without the open standardization process shaped by the GSM's MOU and signatory stakeholders second generation mobile telephony as we know it would not have been. Without pan-European cooperation, we may have seen competing mobile telephony standards stall interoperability and connectivity (as it happened in the US) for decades. What was originally seen as an inconsequential data channel where surplus data could be transmitted--by some accounts a "strange duckling" of all the GSM teleservices (Trosby, 2004)—led to a universal format. This swan shows little sign of slowing down. Further, SMS has led to a variety of internet connected platforms that have transformed the digital landscape in the 21st century--from Twitter to M-Pesa, to crises and public health initiatives through cell broadcast. There is no doubt that the history of SMS emergence and standardization led to its uptake and broad appeal, and still, that this standard format of networked data transmission will shape the future of wireless personal communications with mobile devices.

As I have argued, it is the consensus and modularity of the GSM MOU standards framework that made SMS proliferation possible, and can be credited for why it is so prevalent, even today. While GSM is still one of the most widely used standards suite for mobile communication across the world (Goggin, 2012; Pelkmans, 2001; Temple, 2002), SMS is even more prevalent because it was created as a unique teleservice innovation through consensus and modularity. The MOU created a principle of consensus that many other standardizations stories are not tied too, and like many abandoned forms of communication, it's easy to see how SMS might not have survived if the GSM had not required signatories to enable SMS as a mandatory teleservice for second generation mobile telephony. Given this unique history of standards development that enabled text messaging, and its ubiquity as a practice at every level of society—it becomes all the more important for us to examine the recent history of the hidden, invisible standards and standardization processes that make mobile communication all across the world possible.

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Chapter 4: Sending and Deleting Text Messages: Mobile Media and the Future of Personal Digital Collections

Abstract: This chapter provides an introduction to the processes of sending, receiving, deleting, and storing text messages. Using techniques from infrastructure studies and media archaeology, it illustrates how the text message as a digital format has been enacted by the mobile operating system on mobile phones. In turn, it shows how the text message format structures mobile communication over time in different contexts of creation and collection. It also highlights how the format is enacted in an operating system: how text messages are stored on device hardware such as flash memory, and in various end-uses such as deletion and in surveillance. The digital materiality of text messages in transmission, storage, and receipt is shown to have social and political consequences for the future of *fonds* or collections of personal digital records that people create with their mobile phones.

Keywords: *Respect des fonds*, format, deletion, telephony metadata, digital materiality, personal digital archives

Introduction to the problem

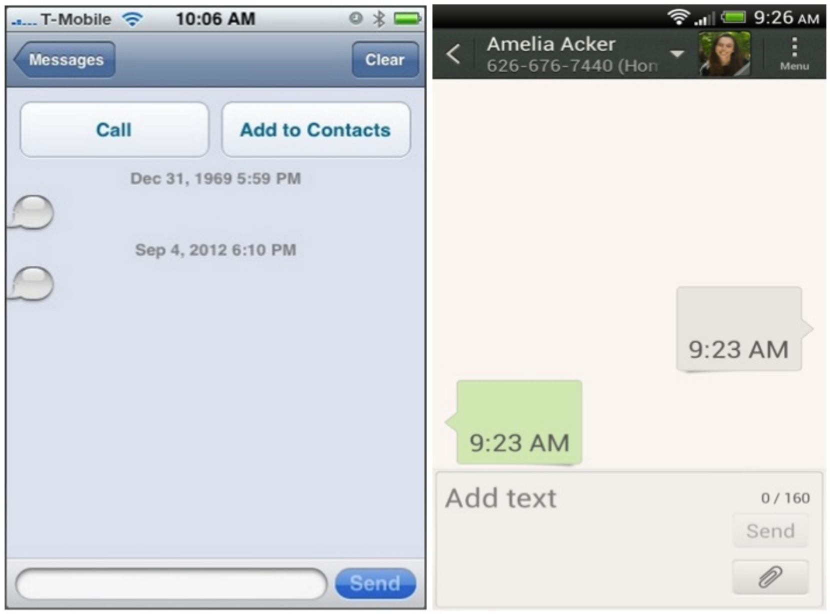
The text message, or Short Message Service (SMS), is one of the most circulated digital formats created with mobile devices. Curiously however, text messages are not as curated, or managed as are other digital formats that appear in personal digital collections (like email, MP3s, and digital photographs). They are often seen as ephemeral, without lasting or transferable qualities because of the nature of the format as an information object and how it is used in information behavior. Few empirical studies of personal information management (PIM) or personal digital archives (PDA) created with mobile devices mention mobile media such as texts, instead they focus upon digital photographs or mobile video. Coincidentally however, there is a rapidly growing field that focuses upon recovering SMS corpora in mobile digital forensics, and small-scale digital device forensic science. Despite advances in forensic science, there are very few institutional efforts or policy outside legal contexts for e-discovery that directly address the collection and access of text messages over time. Why and how do we actively manage text messages? And moreover, why don't we save them like other personal digital records and mobile media? Text messages as an early mobile format are not only indicative of our increasingly networked world, but they also represent a genre of emerging digital records of everyday life and new information practice (Aspray & Hayes, 2011) that is often described as the "constant touch" or connection to the network (Agar, 2013).

While SMS increasingly make up a portion of our personal digital collections--what archivists call the *fonds* of our lives--they often don't last beyond the life of the phone itself because they are not transferred for backup or emulation. Because texts often don't cross boundaries after they become inactive, they are subject to the device settings, or the user's curation decisions based on the limits of the local storage. Currently, text messages don't exist in archival or preservation contexts. If mobile devices and mobile networks are the present and future of personal documentation and thus social and cultural archives, it is important to understand how these new digital formats operate at material, conceptual and logical levels (Thibodeau, 2002)—ranging from the mobile operating system on device hardware to the markets in which we buy and use these services. Text messages are created by users, they are built around device practices and the infrastructure of wireless transmission. In the next section I present an entry point for understanding how the device, messaging client, and local storage affect our experience of self and identity in the networked age. Then I discuss the importance of approaching the text message as a format story, and how that is important to the description and appraisal of personal digital collections (or *fonds*). I take a media archeology approach and employ the technique of layers analysis from infrastructure studies to show how the format is enacted in the messaging client through sending and receiving text messages.

Some Contexts for Blank Texts

In the early 2000s teenagers in Poland reportedly began to send each other blank text messages. According to online discussion forums like PolishForums.com, Reddit, or GSM Arena, the blank text was originally conceived as a way to communicate to your sweetheart without words. Just like most text messages, there is a sender who creates the message with a SMS client, a receiver who receives it with their mobile device, a metadata wrapper (also known as a transfer protocol data unit) for the text message as part of its transmission, and finally a mobile network to support the transmission of data between users' devices. Except, unlike most text messages, blank texts appear empty of content in the recipient's messaging client (see Figure 4). A way of letting your girlfriend or boyfriend know that you are thinking of them in a message that rejects the need for words. These sentimental texts are beyond, or outside of words, but still framed in the messaging client. The blank message is a potential expression of intimacy.[28]

[28] The "nothingness" of blank messages and their materiality has been explored in Dever, M. (2010). Greta Garbo's foot, or, sex, socks and letters. *Australian Feminist Studies*, *25*(64), 163-173.



iOS5 Android 4.0.4

Figure 4 - Blank text messages in messaging clients from two mobile operating systems, iOS5 and Android 4.04

A decade later in a lifestyle article reporting on why texting turns working adults "back into teenagers" (Bernstein, 2011) the blank text was described as a power play for professional New Yorkers to carry on earlier face-to-face arguments. A short time later, *Glamour* magazine's sex and dating advice column would describe the motivation behind the blank text as a way to "score a callback" and perhaps seem mysterious to your partner (Slater, 2013). The blank text had become a way for Americans to continue arguments, flirt, or create confusion without the stakes of creating a textual trace within the metadata wrapper of the transfer protocol data unit by leaving the content of the message empty. Another way to let your sweetheart know you were annoyed with them or to cause a reaction, the blank text became a way to continue earlier encounters, a trace without a trace. Empty of textual content, but still gravid with meaning, the blank text power play puts the onus of interpreting possible meanings and varied intentionality of the sender upon the recipient.

Indeed, blank texts have increasingly begun to appear and to confuse recipients in other ways. Quite recently, Apple's popular iPhone mobile operating system (iOS) updated to its seventh version. This version update employs a new codec of emojis, popular (sometimes animated) emoticons of cartoon faces and icons like a heart or a shovel. The iOS7 codec is proprietary and builds off of the ISO/IEC 10646 Unicode standard but it is not backwards compatible (including most other library messaging codecs) on other mobile operating systems. The result of this iOS7 platform update involves, among other incompatibility issues, a slew of blank texts when iOS users send emojis in texts to recipients whose mobile operating systems are not versions of iOS. Symbian and Android users report receiving blank texts, in addition to other kinds of corrupted iMessages (the proprietary messaging format that iOS defaults to unless otherwise changed). More simply, these kinds of blank text messages are a result of receiving emoji texts from a closed platform mobile operating system like iOS. Amongst many possible meanings, blank texts from iOS users communicate the incompatibility issues across mobile platforms.

Blank texts are also often reportedly received during natural disasters, such as earthquakes, storms, or hurricanes that debilitate and knock over cell towers. The store-and-forward architecture of most 2G and 3G mobile networks involves storing data (like text messages) until transmission hand-off.[29] Cell towers that are damaged, power down, or go off-the network because of natural disasters may produce empty, corrupted, incomplete or delayed text messages sent to recipients long after text messages were sent, or after cell towers and networks

[29] See chapter 3 for more on how text messages are originated and terminated through the GSM architecture.

went down and the storm has passed. This can often lead to heartbreaking stories from families of victims abroad waiting to hear whether loved ones caught in such disasters have survived, characterized as a “delayed signal or a dying plea” (Barnard, 2010). The blank texts can give hope for survival, and they may also later be recast as messages from the deceased in the afterlife.

Blank texts, and what they may mean over time, resist what Mark Poster (2004) has called the grammatical structure of the information system found in our text messaging clients, because they carry multiple possibilities of interpretation, intention and agency as traces of mobile communication. Still further, they rely upon individual users, writers and readers, to interpret their contexts at points of creation, boundary crossings (transmission), and reception. And still further, the possibilities of storing or deleting these empty traces are subject to the data structure and storage media of our mobile devices. While the primacy of their creation contexts as digital records may be obscured, their interpretation and significance through time, as evidence of transactions between people, may change are subject to multiple infrastructures. The contexts of sending, receiving, even deleting blank texts provides a promissory encounter to the power that text messages as digital formats have over the reception and storage of mobile media as well as their growing presence in our personal digital collections. It also shows the power of metadata that is generated, collected, and imbued with meaning when we communicate with text messages and how metadata, separate from content, can be interpreted and used in different ways. The manifold reasons for blank text messages (and their reception) illustrates the knot of infrastructure, communication practices, meaningful records, and digital collections that continue to unfold and form, even now as I write this. In the following chapter I show how the future archival possibilities of text messages as digital records, a new mobile media format, depends on the infrastructures of transmission and storage.

The Text Message as a Format Story

Many communication scholars have studied the transition from telecommunications to mobile media and what "the shift into media brings" (Goggin & Horth, 2009, p. 5). We have seen portable communication devices like mobile phones that primarily supported mobile telephony become media devices that transform into production tools with memory storage, because they have, among others, cameras, video recording capability, and applications that connect to the Internet. As our phones are increasingly used to create and capture traces, they become apart of our documentation practices, including the ways in which we collect things. Personal collections that include digital formats represent a change in the kinds of digital traces that represent individuals' collections, or the *fonds* that people create as part of living their lives, creating records with information and communication technologies (ICTs). The word *fonds* comes from the French, literally fount (as in fountain or source) and underpins "*le respect pour les fonds*"—a fundamental organizing principle in archival science of respecting the creator or source of an organic collection or records group. Since the 1990s, archival theorists such as Terry Cook have argued that the fonds should be an "intellectual construct" (1993, p. 33) that is made up of both physical artifacts and conceptual understandings, including descriptions of how an organic collection comes to be created. In earlier chapters, I argued that the description, theory, and material understandings of mobile communication infrastructure is vital to the future preservation and appraisal of digital records coming out of mobile ICTs. For our purposes here, connecting the story of how a format is created and enacted to the infrastructure of its transmission will guide theory about how text messages are increasingly part of the fonds of personal digital collections.

The infrastructure that supports SMS is not only important to the processes of transmission and pricing, but also represents the production of a new digital format at the turn of the century because it has implications for labor, value, and evidence. Many social scientists have studied the unique text speak or texting argot that has developed in conjunction with the teleservice (Taylor & Vincent, 2005). Still further, linguists have identified the new forms of orality that this "typed speech" supports (Gurak, 2008; McWhorter, 2013; Parks, 2013). As texts become more commonplace they are frequently seen and represented all around us, in commercials, as plot devices in television and in movies, for political and charity campaigns, even in real-time voting on television.[30] We also are beginning to see them as objects or categories of digital evidence in our laws and governance. For example, many states in the United States ban texting while driving, while the president has the ability to text emergency alerts for national disasters through a cell broadcast system. Universities use text messages for campus safety alerts. And recently, texting Amber alerts have come under scrutiny in parts of California. Short code texting, that is, sending a short text to a clearinghouse instead of a complete phone number is also frequently used in voting for variety shows on television such as American Idol or Dancing with the Stars. As a new digital format, there exist evolving sets of genres for text and methods of transmission, for coordinating social events (e.g., "i'm running late to our meeting"), to maintaining and creating primary relationships between immediate

[30] See for example, Gossip Girl television series (2007-2012), Sherlock television series (2010-2013), President Obama's texting fundraising during his first presidential campaign, or voting for winners on American Idol television series (2002-2014).

family,[31] or even group text messages. Text messages can also be enrolled in SMS gateways to the Internet, and many social networking sites such as Twitter, Facebook, and Tumblr have SMS client applications that allow users to send text messages to update their profiles.

As this tide of mobile media devices, social media platforms, and digital formats circulated amongst them rises, it is instructive, if not necessary, for information and communication scholars to examine how these digital traces are captured, but also how they are lost, half-hidden, and obscured. It is incumbent upon us to locate the places and occasions for these traces to reveal themselves, including the conditions of their development (both technical and social). One avenue for locating these conditions of emergence is through the development and enactment of formats in their use and stabilization. In a recent book on the development of the MP3 digital music format, historian of sound Jonathan Sterne (2012) argues that formats structure our experience of media and the ways societies communicate over time. Formats, which have long, unusual, and sometimes competing histories, structure our experiences of recorded communication, in the moment and over time because of the way that they capture and tailor our consumption of information. From telegrams, to hanging files, to JPEGs and PDFs, formats both analog and digital have a material power over how we interpret, use, and communicate information (Blanchette 2011, Yates 1993).

We interact with formats as information objects with content and context in a variety of ways: we consume them; rely upon them as evidence of change; they prove that transactions between people, organizations, and states have occurred. Formats not only represent recorded information, they document and reveal clues about the political and economic moments in which systems and devices were built, conceived, used and store information for access and retrieval.

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[31] Recently, Pew Research found that 25% of American couples text each other while both are at home (Lenhart & Duggan, 2014).

The circulation of formats is co-constitutive, meaning that they shape our communication practices, just as we build up expectations around them through their use. Formats as representations of digital objects, and the ways they are enacted in systems, are worth examining at the logical and material levels, because they point to the significance of standards, protocols and infrastructure in our lives. The circulation of formatted objects can also reveal the political and economic impact of ideas that move through networks culture (see for example Allen 2000, Brunton 2013). Moreover, mobile media formats point to how perceptions of place, space and the transmission of information have changed with the transition to wireless networks that support the connectivity of mobile devices (Farman 2011). While archival preservation, analytical and descriptive bibliography, and museum conservation are all examples of applied format inquiry in library and information science, digital formats and computers have yet to be engaged in the same ways that records collections, books, or material objects are in histories of formats.[32]

As mobile devices and mobile networks increasingly connect us to the Internet, our banks, our employers, and our governments, there is a diffusion of digital traces that are formatted in a variety of ways, sometimes in competing or closed ways that may not be easily understood and may prevent long-term archival preservation. Often these range from open unencrypted formats to proprietary formats that are device or platform specific. The formats that mobile users encounter with their devices can be staggering: Multi-Media Messages (MMS), iMessages, Tweets, BlackBerry Messages (BBM), Email, GPS pins. Each of these digital traces

[32] Media archaeology centers such as the Maryland Institute for Technology in the Humanities at the University of Maryland, the Media Archaeology Center at the University of Colorado at Boulder, and the Berlin Media Archaeological Fundus at Humboldt University are all examples where this kind of applied research happens, each are primarily situated in media studies and digital humanities.

are formatted through standards and technical protocol that allow messages to be transmitted across a network of devices, phones, transceivers, routers, intelligent terminals, and location databases. These messages have content, context, and structure, and through the shell of a standardized format, information is captured, structured, exchanged across systems and rendered to users. While many digital formats intended for mobile devices have become obsolete (consider mobile 8-bit ringtones, Sega Game Gear console and games, or MiniDisc players), some formats have formidable staying power because of industry lock-in, ease of use, or consumer popularity. However, ubiquity and ease of use may not guarantee possibilities for preservation and long-term access.

One of the earliest forms of mobile media incunabula is, in fact, the text message. The format is used by many millions of people around the world everyday, and remains enrolled in digital collections despite the ease with which they are lost, deleted or overwritten with our mobile devices. Further, they may be used *because* of the ease with which they can be deleted. And as I will argue, text messages, their circulation and deletion points to the conditions of emergence and information practices related to the personal digital collections that are created today with mobile devices. This argument is about the significance and stabilization of a format, but it is also about device context, because devices structure formatted information but also, ultimately, shape our personal digital collections and archival contexts through thresholds of access and processes of transmission. The next section discusses the framework that informs this work and the method of analysis.

Theoretical Framework, Methods

This chapter takes a media archaeology approach (Parikka, 2012) to the text message and the infrastructure that supports the processes of sending, receiving, and deleting. It reveals the stakes of infrastructure of mobile communication, and the material consequences of transmission, in the vein of what Heather Horst (2013) has called the "third wave of mobile media communication studies" (p. 147). As I argued in chapter 2, sending and receiving text messages may appear to be immaterial processes, but instead they are utterly material processes because of their digital transmission and storage, as well as the individual and social practices that we have built up around them that range from sleeptexting (Roberts, 2013), which is now classified as a new kind of parasomnia (akin to sleep walking), or phone stacking games that are seen as part of emerging small group digital detoxing customs (Ha, 2012; Tell, 2013). The materiality of text messages can be seen in their transmission and storage, but also in the ways that we organize our lives around the practices that incorporate (or exclude) them.

In chapter 3 I show how standards development, transmission protocols, and network architecture create the text messages that are subsequently relied upon as a formatted digital record. This chapter argues that text messages have material consequences through processes of transmission, storage, and deletion. It illustrates how, at the levels of the storage and memory, the text message emerges as a digital format that is enacted in a mobile operating system through the messaging client application, through its transmission and storage, and through the generation and collection of telephony metadata as part of transmission and storage across devices in mobile networks. In turn, it shows how the text as a format, its reception and storage on mobile devices, structures the experience of mobile communication with networks.

Understanding the process of sending and receiving text messages at the micro or individual level of the device (in hand) gives us insight into what the text message is, both as cultural product and evidence of social technical change. However text messages are not alone in personal computing contexts and digital collections. Many new digital formats and information objects coming out of personal computing and social media can and have been documented in comprehensive detail (Sterne, 2012; Van House et al., 2005). Mobile media appear to be fuzzy, if not completely overlooked by studies on the formation of personal digital collections today, despite having circulated since the mid-1990s.[33] While many new media, communication, and technology scholars note how digital formats such as the powerpoint, digital photographs and the MP3 format point to the materiality of digital information in our everyday lives (Blanchette, 2011), few engage with the impact of the mobile phone as a site of inscription, or as a writing technology--one that creates and sends texts as a site of inscription, but also serves as a storage technology. By bringing enduring archival constructions (such as fonds, collection, metadata) to this archeological excavation, we can reveal possible archival contexts and collecting futures.

Some would tell this format story through the development and standardization of the telecommunication protocol (as I have done in Chapter 3) or how it is conceived in juridical contexts (as I do in Chapter 5). The conception and stabilization of standards is often seen in the form of format histories in bibliography, sociology of texts, critical code studies or digital forensics. But another way to tell this story is through the *enactment of the format* through its use, exchange and circulation as part of personal digital collections. In the second half of this chapter I discuss the significance of mobile data transmission through the sending and receiving of text messages, how they cross boundaries through their transmission across networks, and how they cross boundaries of storage in mobile devices. First, I briefly introduce the elements

[33] See for example, Lee (2011) or the recent Archivaria special issue 76, on personal digital archives that neglects traces created with mobile devices (2013).

needed to send and receive texts, including standards, infrastructure, and equipment. And then I look deeper into the elements of the text message itself as a format by examining its digital materiality and its relation the future of mobile media and personal digital archives as conceived by archival scholars, personal information management (PIM) researchers, and individual archive creators themselves. In the rest of this article I discuss the elements needed to send a text message and what these are built on top of, below the interface, and the process of receiving a text message. I then discuss the acts of storing, deleting messages and the landscape of local memory storage on phones as it has changed dramatically in the last 25 years. In the last section I discuss text messages as possibilities for personal and institutional digital collections. This includes the metadata that are generated and collected when we transmit text messages.

For our purposes here I have chosen to examine the text message at the level of the device and the mobile operating system at the micro level (Edwards, 2002; Misa 1988) cutting under the motivations of the sender and the actual text content, to the level of the device and how the format is enacted within the system. My reasoning is twofold: First, examining the text message at the level of the mobile operating system and the message client allows for a close examination of an application that undergirds a range of other technologies (I argue that this kind of close reading has not been done before). Messaging clients are not add-ons or creative applications on mobile phones, they come factory issued on all devices and in all mobile operating systems.[34] Second, despite the increasing memory storage and processing power of each new iteration of phones, they all operate under the same principle of discrete elements,

[34] This is because of the standardization of 2G digital cellular mobile telephony, see chapter 2 on the consensus framework of the GSM and why all mobile telephony standards since the 1990s support SMS.

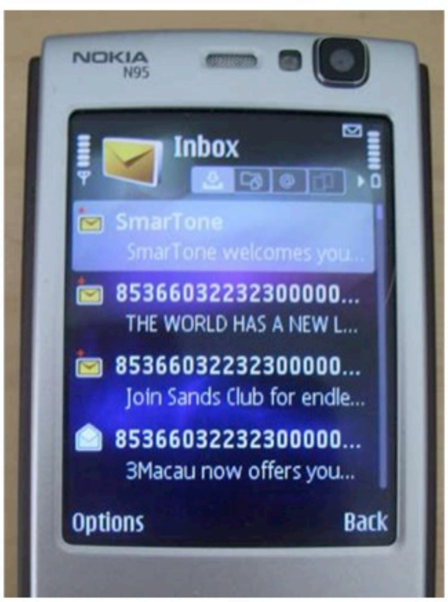
modular in character, messaging clients across all operating systems, hardware and software, enact the same functions of reception and transmission of SMS.

Sending and Receiving

The processes that support sending text messages are deceptively complex, hidden by wirelessness, the smallness and the brevity with which messages are created and arrive. Let's take it apart from the initial input encounter or site of creation, the initial inscription. First, the user is responsible for creating some content, like "hey, what's up?" and then they choose a recipient, selecting their phone number and sending the message (the user may also choose a recipient first and then create a message). The subscriber's mobile network provider adds more pieces of information about the message, including location data about what cell the message is being sent from, the provider's service center attempts to locate the recipients location by pinging a visitor location registry. The metadata that is wrapped around the SMS as it is being transmitted is described at length in Chapter 2, but in summary, it involves the time of transmission, location data about the cells that the users are in, and time stamps from the hand-offs between networks.

When a user writes the text message or when a recipient receives the message, she employs the messaging client, or a native application on her phone. This application is accessed through the mobile operating system on the phone. In earlier years, manufacturers created their own operating systems and updates specific to the phone, (there were 11 handset models offered for most of the 1990s, each with different operating systems). By the 2000s, thousands of phones and hundreds of interfaces with proprietary mobile operating systems existed. Today the main operating systems that have emerged across the world include Android, Bada, Blackberry, iOS, and Windows Phone. Each of these and historical operating systems have messaging clients for

SMS support. For most of the 1990s and early 2000s, text message clients were structured similarly to Email clients--they had inboxes and outboxes for incoming and sent messages. The inbox/outbox data structure is still supported by most featurephones used throughout the world, however smartphone operating systems and featurephones are not mutually exclusive categories. Some high-powered feature phones (also known as "smart phone lite") support touch screens and web browsing. Since the early 2000s, smartphones operating systems and some featurephone operating systems have supported threaded text messages. In clients that support threaded text messaging, messages are grouped together akin to instant messaging interfaces (Figure 5). Although threaded text messages do not structure the SMS data in a different way, the impact on how users read, write and receive threaded text messages in newer messaging clients needs further study.



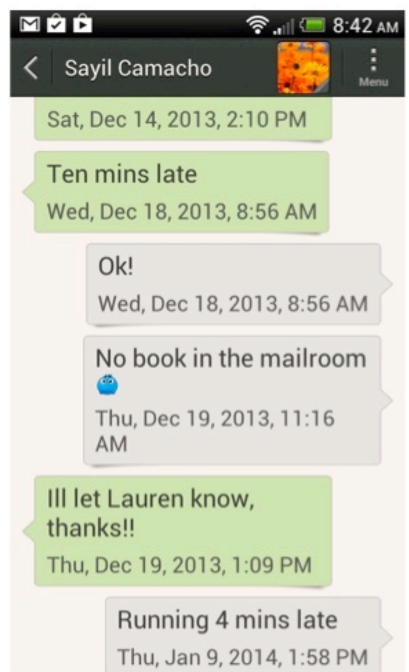


Figure 5 - Inbox/outbox messaging client and threaded messaging client

A sent text message also represents different kinds of transactional data that may not be read or seen by users. This transactional data may inform different actors in the delivery and receipt of messages (e.g. service provider, network provider who hosts the Short Message Service Center, the handset manufacturer, operating system developers). It contains wrappers of metadata that enable transmissions amongst other uses, which I will address in the next section, but the metadata is collected in different ways through the transmission infrastructure for different means. The sender in effect pays for (and expects) the delivery of the message. The subscriber who originates the message automatically contains a return address from their mobile station; this includes their SIM card number, the equipment's IEMEI number, and some information about their home network. For a service provider the teleservice is a data transmission, and it requires a network, cell towers, a home location registry and a variety of other identifiers to carry the message to the recipient. It may also involve one or more network providers depending on the location and service provider of the recipient. For the recipient, it involves a message that, in the U.S. for example, she pays for as well, however pricing is different in different markets. The SMS message can be stored on her phone for a certain amount of time and this is a significant to the impact of its reception, and evidence as proof of its reception on a recipient's mobile station shows that metadata has been created and supported throughout the transmission process by crossing boundaries (Bearman 1996), creating and acquiring traces of its transmission along the way.

When a text message is transmitted across wireless mobile networks it leaves traces of its transmissions, at each level and juncture of infrastructure store and forward architecture. These boundary crossings represent a vulnerability in ensuring the authenticity and integrity of a complete and fixed record. Earlier I have written about the boundary crossings of records in information systems as a moment of weakness in archival theory and archival records management (see Chapter 2). The layers of context that are acquired as messages are sent, delivered and received are information about the reality of the information object of a thing. This data about data is metadata, both structural and contextual.[35]

The Necessary Parts

A few things are needed to send or receive text messages with a mobile phone's interface, including a device with a SIM card (Figure 6), network access to a service provider's area of coverage, and network architecture (like cell towers and base station transceivers). Each of these parts is enrolled into large-scale technical network architecture and infrastructures bootstrapped to plain old telephone systems (POTS) and PLMN, as well Internet gateways. Mobile phones all operate with a few different global digital cellular telephony standards (including GSM, CDMA, UMTS). In order for a mobile phone to connect to a mobile operator it must be able to speak to your network service provider through one or more of these standards. For telecommunication and mobile standards bodies, mobile phones or handsets ("handys" in some parts of the world), they are called "mobile stations" (MS). In each MS is a microprocessor, a digital signal processor to send and receive messages and voice data over radio frequency, an antenna, a speaker, a microphone, a battery, internal ROM and flash memory with a mobile operating system (some phones have removable storage cards and multiple SIM card slots), and finally a subscriber identity module, also known as a SIM card. The handset itself has an International Mobile Station Equipment Identity (IEMI) number which is an essentially a serial number for the

[35] Metadata can also be a record of transaction, too. Chapter 5 engages with this concept.

device. SIM cards and most mobile phones have interchangeable slots, so that subscribers can switch coverage, plans, and devices as they move.

Figure 6 - SIM card, front and back

The mobile station is the primary node through which users reach other mobile subscribers in the mobile network, access network coverage, call grounded telephone lines, and send text messages among other uses. Users can also receive messages from their network provider. For example, how many minutes they have left to use in their call plan, if their payment has been received, or if they have voicemail messages waiting to be heard.

Since the early 2000s, some mobile stations have been able to access online Internet content through technologies like Wireless Application Protocol through a mobile interface to web content (though many have argued that WAP was a resounding failure for early mobile internet services). The WAP standard made use of higher bandwidth networks, and HTML5, enabling websites to be optimized for viewing on smaller screens of mobile phones. Since then, mobile operating systems for smart phones have begun to rely on “apps” or small applications to connect to Internet content. Instead of using browsers, apps provide access to limited kinds of online information in corridors (for example movie show times, traffic updates, or weather reports). There are also mobile apps that don't reside on the phone but use SMS clients (e.g. daily horoscope text). Most mobile phone users in the world do not yet have smart phones (insert estimate), yet feature phones have become incredibly powerful, and the ITU (2013) estimates that by 2014 active mobile handsets will reach more than 90% of the world's population. The Pew Research Global Attitudes Projects forecasts that all new Internet users in coming decades will adopt the Internet through mobile networks because mobile phones are nearly ubiquitous nations that are still "offline" (Wike & Oats, 2014).

Mobile stations have operating systems that structure how we interact with our phones, how we input entries through the keyboard, how we receive information through the LCD screen and so on. Mobile operating systems, like operating systems on personal computers, process, structure and access data on the RAM and ROM memory. Unlike personal computers however, mobile operating systems spend less time storing, and more power processing and running many operations at once, more time and power processing radio transmissions through the network. The mobile operating system and user interface structure our experience of what we can do with our phones, but they also influence our perceptions of mobile network coverage, which is both varied and hard to pin down. Wirelessness as an affordance of mobility leads to different ways of locating constraint, limits, and blackouts of mobile network coverage. However, our experiences of wireless networks are instead tethered to the power of network speeds and processing power of mobile devices.

In addition to the information that we can transmit and access through the network, our mobile phones increasingly allow us to do small daily tasks that involve scheduling, maintenance, and especially time management that do not depend on network access or coverage. The memory on the phone and operating system usually store a limited amount of phone numbers in the address book application, alarm clocks and timers, and simple calendars. Incidentally, though, users cannot go beneath the interface of the mobile operating system (Brown & Duguid, 2002). Mobile operating systems (like many operating systems on personal computers) don't let you program your own recordkeeping decisions, they enforce a certain amount of constraint that is especially subservient to processing and storage space because of the limited amount of local storage on the phone.

Mobile applications on smart phones present interesting implications for privacy, data formats, and personal digital traces because it's not totally clear how accessing traffic data is used by the applications that we use and access. Increasingly with smart phones, mobile network providers such as Verizon or T-Mobile work with equipment providers to create "skins" or a layer on top of Android of Symbian that involve their own apps that users are required to use. These data are enrolled in user feedback programs. Privacy experts find that these proprietary factory installed apps often have less permission and turn over more personal information to the equipment manufacturer. Typical privacy terms of service for downloaded and factory set applications involve sharing your usage, location data, and power with service providers, handset manufacturers, application developers and more. Despite the principle that record creators own the traces they create, the usage patterns, data analytics, and recorded information behavior are shared or co-owned as parts of terms of service with service providers, handset manufacturers, and mobile operating system designers. This kind of co-ownership by sharing usage patterns is yet another kind of networked personal trace that is yoked to mobile service providers.

As noted earlier, a mobile station must be compatible with a network provider in order to make use of mobile network coverage. Mobile network infrastructure, including standards and protocol deserves some more engagement to understand how texts are received. The way that mobile network providers provide cell coverage to subscribers in their network is through cell towers (that create coverage by sending and receiving radio transmissions) and service centers and base stations. While users primarily interact with their devices, most of us are also familiar with cell towers that structure our landscapes (Parks, 2007). Cell towers are laid out in urban and rural areas to create coverage, towers overlap each other and overlay like patches on a quilt. Seams of coverage exist in a variety of interesting places that are often unincorporated, unmanaged, or have few official residents like national parks or desert landscapes. It's worth noting that the punctuation of cell towers in our landscape that supports the quilt of coverage that at times appears seamless is often unevenly distributed and partial. See for example network converge maps between service providers. Often these seams of coverage highlight existing or emerging economic and infrastructural inequities in urban or rural environments, contributing to another kind of digital divide built upon wireless access through mobile network coverage instead of broadband Internet access.

The transceivers that support network coverage are connected to service centers with servers that retrieve information from subscriber databases about switching and handing over data transmissions (whether that be voice or text transmission) to other subscribers in the network. These service centers are interoperable and have billing and handoff procedures if a subscriber sends a text message to a user outside of the originating sender's network provider. Built on top of all this physical infrastructure is a suite of telecommunication standards and protocols, code and policies, technical principles, that make the sending and reception of messages and calls possible. Telecom protocols, such as GSM, CDMA, or 3GPP take years (some times decades develop) and roll out, they also need buy in from equipment manufactures, telecom companies and mobile network providers, and nation states that govern the broadcast spectrum that mobile networks use. In each of these nodes of the network, metadata is constantly created and generated as part of network coverage and data reception. These mobile telephony metadata are generated in support and as part of transmitting text messages. Text messages, like all records, are metadata encapsulated objects. However, mobile telephony metadata, its collection, and leverage in aggregate are still becoming (McKemmish, 1994).[36] The next section discusses the relationship between content, context (captured through metadata and information behavior), and storage of text messages.

Deletion, Storage, Memory

In addition to the creation and transmission of these records, their deletion, storage and memory are at stake and shape our personal records, and our information management practices. Users, system designers and handset manufacturers are still negotiating the limited storage capacity of first generation feature phones and now smartphones. And still further, the cloud storage back-up for devices that we use today to circulate traces often limit our ability to store, retrieve and archive records. Increasingly, we internalize the technical limits and affordances of our mobile devices. For example, psychologists have found that many users experience phantom rings--the belief that their phone is ringing or buzzing when it isn't. Other social scientists have found that users feel anxious or insecure with they leave the house without their phones, or when a phone runs low on power. Users also internalize their phone's storage capacity by working around, improvising and performing with its limited memory and processing capacities.

[36] Sue McKemmish (1994) explores the transactionality and contextuality of records, which are "always in a state of becoming" in "Are records ever actual?" *The Records Continuum*, 187-203. See chapter 2 on the records continuum and for more on this idea of records becoming.

In her book *The Breakup 2.0: Disconnecting Over New Media* (2010), anthropologist Ilana Gershon discusses the complexities of electronic communication, the material limits of digital media, and social networking interfaces. Differing structures of media provide better ways of saving, retrieving, or extending conversations, whether to continue on a fight, to flirt without face-to-face rejection, or to share and discuss with friends later. Gershon found that undergraduates use the limited storage capacity of their mobile phones to negotiate evidence of relationships beginning and ending. She describes an interview with a woman named Summer about her decision to break up with her boyfriend:

> Summer: […] After a while, it was "What the hell am I doing with him?" And I saved the texts that we got into an argument about. I started deleting all the good ones that he sent me, and I started saving highlights of the bad ones. The ones that he sent that really really hurt me, I would save all those…And when it gets to this point of number of texts, then I know that definitely it is time to break up. That kind of thing. When it gets to that number of texts, because this is like ridiculous.
>
> Ilana: What number?
>
> Summer: My phone says like a hundred or whatever, but I don't know how much it actually holds.
>
> (Gershon, 2010, p. 108)

In Summer's case, her mobile phone can hold about 100 text messages in her inbox; she decides that after a certain amount of hurtful messages the limit of the phone's storage coincides with her limits of being in a relationship with her boyfriend. Summer makes a conscious effort over time to curate her texts. She manages, edits down "highlights" of conversation threads, and eventually deletes text messages from her boyfriend. The ability to store, save, and delete text messages shapes Summer's relationship, her breakup is an example of embodying the material limits of the local storage/flash memory of her phone. Just as it enables connection through sending and receiving text messages, the limited space of the phone's memory allows her to gather, appraise, and curate enough evidence to disconnect from a primary relationship.

As mobile devices come equipped with more memory, users' curatorial practices are shifting the ways in which they relate to the digital materiality of phone storage and collection of mobile media. The stakes of use now govern the authenticity, preservation and future access to traces created or received via mobile devices. Increasingly, mobile operating systems have auto-delete features for text messaging, so that users rely on the device to manage and delete such traces of communication. Smartphone users can thus rely on the phone's operating system to weed out "threads" of texts automatically. For example, Android version 2.3.6 "delete(s) old messages as limits are reached" (e.g. Figure 7). The default limit is 200 messages per conversation with another user. One may change and expand the limit to 5000 messages per conversation on this version of Android, but with noticeably sluggish results if more than 1000 messages are stored in a thread. Such default storage settings manage the longest threads of text messages with frightening precision—the longer the thread is, the sooner it will be deleted. The factory setting appears to be efficient for frequent texters: the more texts a user has from another person, the longer it takes to load that specific conversation thread. The auto-delete setting ostensibly makes room for more messages through deletion under the aegis of increased processing efficiency.

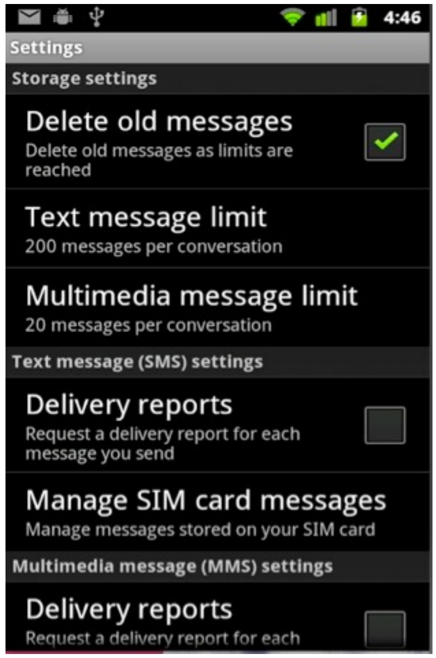


Figure 7 - Auto-delete settings for Android 3.5.2

The shift from curating inboxes and outboxes to relying on operating systems indicates a change of state for mobile records and information management with personal digital collections. And this leads us to ask, what does it mean to store? How do data structures and settings in the operating system change our intentions and willingness to store, save and curate future collections? This question asked of personal communication in mobile computing means something different then in business and legal contexts, as storing is shifting. Especially as these personal records, ephemeral messages are becoming enrolled in business communication networks as official records. In this way we can think about it in terms of the operating system that governs the ability to store and later retrieve. There are layers involved in saving, at the level of ingest, capture, inscription, storage, and later retrieval that involve more inscriptions. At each layer is a state of change, a point of transaction where a boundary is crossed over. In digital environments, boundary crossings may result in multiple copies, inscriptions, points of storage. For example, with cloud storage, we may have local storage on multiple machines and backup copies stored on a service provider's servers. Saving involves updating and storing traces at multiple points, distributed across many boundaries including platform functions, software and hardware.

Automatic deletion gives rise to another notion about whether anything can actually be collected and archived in the digital era. Some conflicting ideas about evidence and materiality appear in discussions of digital collections. On the one hand, there is a pervasive perception that anything created in digital form will last forever, and this has to do ideas about copies, storage, and the power of the digital. On the other hand, there is the belief that digital things are fleeting, ephemeral and always shifting. We can also consider it from an alternative pose, that of the enduring ephemeral (Chun, 2012) that relies on traces in aggregate stored in many places. These devices are fragile, crash, or can be lost at any moment—they can be dropped in the toilet, or a malware on an app can crash the operating system, the phone can be stolen or the hinges or buttons wear out. There is a sense that the mobile phone's storage itself is limited to the internal memory of the device. Precisely because of its portability is its poison and cure. The mobility is a quality of its vulnerability to storage because it's not locked away in the basement as most records and databases. A safe space, and iron mountain of storage for retrieval.

The ability to be continuously connected necessitates a feeling of always already being able to retrieve, except for when the phone disappears/is damaged a network reaches limits (as it requires a tremendous amount of processing power, energy and coordination to access traces in the cloud from mobile networks with your phone). There is also the idea that the internal storage on the phone is not enough, it is limited, it is too small. And this idea pervades and is felt by the actual limits of the mobile operating system combined with the internal memory storage of the phone. For example, early handsets could only hold twenty to thirty address contacts in the phone book, later phones could hold hundreds of address contacts but a limited amount of photographs or mobile video.

Increasingly the storage on phones is expanding, but the processing power and the mobile operating system and data networks add more layers to the ability of the machine to store, access and retrieve more information, more documents. So can anything be saved created with phones for an archival collection? Yes and no.

In the first sense, the only way to save it is to stop using the phone. The more traces create the likelihood of more traces being overwritten, deleted, lost. The second answer is no, the mobility afforded by the phone, the immediate access provides the user with no reasonable expectation that the information should last more than a few days or weeks. Americans go through new phones every two years, they may go through as many more data networks, contracts, and billing plans as well. This includes the storage memory within the devices. I argue that the ability to move and access the network, create and transmit information forfeits the expectation of long term storage in an meaningful sense, or at least in an archival sense. We can fetishize the device, and keep it, treasure the user experiences of the interface. Or we can privilege the traces being created that are gathered up and then unbound each time we get a new device and change the SIM card. We can also talk about SIM cards as a kind of removable storage that carries important data from phone to phone, sloughing off data and losing it as more is overwritten.

The discourse of having access to everything, or total recall, relies upon a third kind of storage. An ideal storage where the user curates what is collected in context and that is transferred to another platform, devices or memory paradigm that involves transferring it, breaking it out of the mobile device through upload, convergence, backup, creation and management. We see that many consumer grade content management systems are pushing in this direction; for example if I plug my camera into my MacOS to upload my photos to my iPhoto program on my personal machine, I am prompted to share and connect my photos to Flickr the cloud based storage, photo platform. This process takes the photos from the storage on my phone, copies it to my personal computer into the iPhoto library data storage structure and then uploads the photos to the cloud based storage service and social networking platform where my photo sharing account is subject to a host of terms of service for storing and accessing my photos for retrieval at a later date. This process of backup is fraught with copies, tags, metadata, terms of service, and distributed storage memory (device, pc, database, cloud storage).

So, can you ever save anything? Can mobile digital traces actually be collected into personal archives? Depends on the way you frame the expectations of memory and storage. If, for example, you are looking for the archival notion of storage for preservation, that it is unlikely at this time as text messages are still not seen as conceptual, physical, but only as logical, digital objects. If, instead, you are interested in the memory of flash storage, then possibly, but this kind of saving with this memory is device specific, and there are layers of encapsulation that depend on variables like the operating system, the messaging application, the make and model of the handset, the power CPU processing power. The lifetime of most handsets of is 5 years before the CPU, DSP, battery or screen wear out because of such heavy, daily use. If you are in a memory transfer paradigm, where you want to transfer it to another storage medium, data structure and storage system then possibly, you can save text messages. But like many device specific formats this type of collecting and preservation involves active and constant curation in terms of emulation or format migration. In many ways, the promise of saving everything isn't actually interesting as the ways that forgetting and appraisal are changing with the constant collection of metadata by state actors and corporations in an interconnected web of telecommunication infrastructure and vendors.

Some problems with Personal Digital Collections and Mobile Media

There has been little research on the ways in which digital records are moved, accessed, and stored across distributed wireless and mobile networks; they can be complex, unstructured, software dependent and often difficult to reproduce. The two most fundamental principles in archival science: provenance and original order are based upon the ideas of keeping records together in an organic bunch, the "tissue" of records (archival bond). And Provenance, which is preserving the chronology of custody that the records came in. While original order has to do with how records were created, commenced (used and circulated), and eventually became inactive. Provenance has to do with the evidence stored in between records, a layer above the layer. While original order preserves the evidence as whole corpora. Given the rapid device turn-over, messaging client settings, and limited storage settings on mobile phones, ideas about provenance and original order in personal digital collections made of media are shaken up, broken, insufficient.

What does the *respect des fonds* for a mobile device look like? What does it mean for the traces (context and content) created with a messaging client? I may keep the same address book, and those contacts may grow and shift, but in all likelihood I will always have a few people that I text over the course of my lifetime. For example, my Mom, my sister and best friend from college. If text messages are saved, as are correspondence in personal archives what would that look like? How should these collection be appraised, accessed, collected? And further, what are the contextual layers, organic and above the texts themselves that are worthy to look at? How has reception changed with born networked records like text messages? The blank text messages and even batch deletions turn ideas about collecting records and the evidence that they reveal upside down. As Richard Cox (2010) has argued that while, "[c]ollecting has played an important role in forming what archivists do, [it] has played havoc with systematic or standardized approaches to the management of archival records" (p. 208). The principles of archives, acquisitions, collecting, appraisal and selection have shifted with networked record creating environments.

There is a large body of research in archival science that addresses conceptual definitions of records in electronic, networked environments beginning in the 1990s (Akmon et al 2011, Botticelli 2000, Cook 1994, Galloway 2009, Hedstrom 1997, Henry 1998), however few approaches account for the digital materiality of electronic records or their transmission in mobile or wireless transmission. And while archivists have always confronted loss and decay as records have moved across space and time, transmission and the ubiquity of mobile phones represent a shift in the present and future of electronic records as well as archiving mobile communication. The problem with wireless handsets and their mobile records for creators and stewards of digital archives are their contexts of production, transmission and storage. Is it a record once it is stored? What of records stored in many places (phone, SIM, service provider cloud backup, third-party application's servers)? The limited memory and storage capacity of mobile devices is in conflict with earlier regimes of media storage and evidence because of the stuff that makes their mobility possible, the infrastructure of transmission and their digital materiality. The traces of transmission created as part of records creation (like a sent text message) may become separated, and become another kind of business record on its own. There may be conflicts in collecting that result in a new, networked archival bond.

The Archival Bond and Telephony Metadata

The collecting practices and strategies that make up digital collections are a way of getting at the materiality of digital traces. Archivists use formal elements in recordkeeping to determine the identity and integrity of records, in order to see if they qualify for preservation, whether they are analog or digital. We start by describing the technological environment in which the records exist, and then analyze their documentary representations within a given information system. Archival science focuses upon bodies of records, or records in aggregate to appraise for preservation. When a record is put into relation with other records it carries context and can be placed in an archival bond. The archival bond is the "core" of archival science: the concept is originary to every record's creation. In being set aside for further reference, it becomes part of the "connective tissue that joins a record to those surrounding it" (Duranti, 1997, p. 217). The archival bond thus shapes and carries the contextual meaning that a record bears as part of a collection. Increasingly the bond of metadata has become more valuable than the content of individual records. Metadata is being leveraged in state surveillance contexts in aggregate to predict terrorism, locate targets and interpret content (Office of Inspector General, 2009).

Historically, metadata in Library and Information Science has referred to information retrieval systems such as catalogues and classification systems. With mobile phones and data networks, metadata is called "telephony metadata". Telephony metadata is both structural and contextual because as standard formats dictate the way systems must decode data packets like text messages, further, these metadata are contextual because it involves personal information such as geolocation in a cell network, the SIM, IEMI number. Telephony metadata has been given a lot of attention in the last few months because of the news that a secret court has been collecting "telephony metadata" from Verizon business solutions (Greenwald, 2013). Mobile telephony metadata has become more and more complex and layered, as we have transitioned from 2G networks to 3G networks that use Internet Protocol to transmit data. It is worth noting that that has to do with how the wireless data is transmitted over the air and through infrastructure and how wireless data and recorded telephonic voice data has been governed in earlier paradigms by the US legal system (Landau, 2014). For the intelligence community, aggregated metadata is valued over content, but for archivists, the quotidian collection is valuable as a standalone object, or fonds. Increasingly we are seeing collections of metadata take on organic bonds of context.

Without criteria for a bond that accounts for the networked transmission and for appraisal of metadata we risk "the older antiquarian tradition of collection for collection's sake becomes the guiding principle" (Cox, 2010, p. 210). We need to change ideas about archival collecting and keep apace with other kinds of collection contexts (individual lives but also in new information institutions like telecommunication providers). Another change is that digital collections are both individual and institutional as we create records with platforms and where content intermediaries govern the formats, terms of service, and storage. We know that *fonds* is a core abstraction to the study of records collections, "the fonds cannot be treated as a clearly bounded category (Lee, 2011, p. 33), instead it is a living organic thing. How is the archival bond determined in this new era?

This conflict can be seen in ideas about appraisal, or the process of selecting what records are worth keeping, and what records should be lost. We know from 20th century archival theories about appraisal that "the practices determination of primary use value is notoriously difficult and [the] precise determination of secondary value is simply impossible" (Lee, 2011, p. 51). And yet in this era of big data, there is rhetoric that these personal data and their secondary uses will be more valuable that we know (boyd & Crawford, 2013). We also see conflicts in appraisal with government records—what should be preserved and what should be deleted. For example the litigation of the National Archive's appraisal of emails related to Iran Contra affair (Steinwall, 1986) Despite these apparent conflicts in appraisal which guide collections we haven't considered how the archival bond changes with these new kinds of records that are born digital but also created and used in networks, fonds cannot be created?

In their research on connections between Personal Information Management (PIM) and archives, Lee and Capra (2011) write that practitioners in PIM, records management, and archival science have not adequately addressed the desirability of disposing information that is no longer needed (pp. 55-56). Yet the destruction of records has a long history in public records management (Leahy, 1940) and had legal protections in many European countries by the nineteenth century (Lee & Capra, 2011, p. 54). Moreover, Terry Cook (2011) famously argued, "appraisal is the *only* archival function" (p. 3). Keep everything approaches that belie the rhetoric of big data analytics that promise a vast fonds that many sociologists of the Internet have been quick to critique. However a lack of attention to these metadata generation and collection practices suggest the need for developing new archival appraisal criteria for metadata in the first place, and systematic approaches to the collection and generation of metadata created as part of mobile media like text messaging. In the next chapter I examine a few cases where the creation and circulation of metadata shapes the nature of collections, it aims to show some of the conflicts and roles that these defining power takes. I argue that the stabilization of mobile telephony metadata is a social process that archivists and information technologists can influence in this moment.

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Chapter 5: Traces of Transmission: Metadata and Collecting Futures

Abstract: This chapter illustrates how the generation, circulation, and collection of mobile telephony metadata represents a new form of collecting for institutions, under the law, and for the theory and practice of archival science. It describes a few current case studies where the definition and common understandings of mobile telephony metadata is unstable, shifting, and stabilizing. It argues that new contexts of metadata creation and collection has led to a *mobile forensic imaginary* based on the infrastructure and transmission of born-networked records created with mobile ICTs.

Keywords: born-networked records, mobile forensic imagination

Texts from States

On 21 January 2014, thousands of mobile phone users in and around the area of Independent square in Kiev, Ukraine received the following text message, "Dear Subscriber, you are registered as a participant in a mass disturbance" from an unknown number identified as 111 (Hooton, 2014). The three main mobile service providers in Ukraine, Kyivstar, MTS and Life, deny turning over subscriber data to the government or sending mass text messages in the capital during the protests (Kramer, 2014). The Ukrainian interior ministry denied sending the mass text as well. One service provider admitted that "pirate towers" are known to exist and were likely used to send the text messages. Policy analysts and journalists emphasized the use of the phrase "mass disturbance" in the text as new laws recently went into effect in Ukraine for participating in public protests (Walker & Grytsenko, 2014). Indeed, the mass text message that was reportedly received by protestors, bystanders, and first responders alike, was probably a cell broadcast text message sent by an independent (or usurped) cell transceiver in or near Independent square.

Cell broadcast text messages are part of the GSM standard known as the Short Message Service-Cell Broadcast (SMS-CB) (3GPP TS 23.041, 2013). They are received like any other text message, but are transmitted using local broadcast technology and not through cellular network coverage. The SMS-CB is a one-to-many transmission protocol that allows a sender to transmit SMS messages to all powered-on mobile devices active within a particular range of a single base transceiver station (or cell tower). In GSM cellular networks, each cell has a unique signaling channel that can be used to send SMS-CB across the air interface. SMS-CB text messages are transmitted across a cell broadcast channel that is a unique signaling channel to a single cell tower, instead of being handed-off through a network of cells.

The cell broadcast text message sent to protestors and bystanders in the Ukraine represents a significant moment in the stabilization and standardization of "text messages" as a formatted electronic record. First, a blast of text messages to mobile phones users in a particular area is known as a cell broadcast text message *because* it's broadcasted, it's not a two-way transmission like most text messages that are used by individual users. It represents a one-way communication with no call set up for receivers to send back text messages to the sender. It depends on a cell tower that can send SMS messages to all devices in a particular cell, within a particular range of coverage, depending on the landscape and the amount of devices in the area.

The motivation behind broadcast text messages is particularly tied to location, and especially to people who are carrying mobile phones and happen to be occupying specific places.

Cell broadcast text messages are often used by government institutions in the US, Mexico and in Japan for weather warnings, earthquakes or tornadoes. They are usually operationalized as warning messages, sent to people in particular places, to motivate evacuation or alerting people to a disaster. For the people in Kiev, Ukraine, this particular cell broadcast text is interesting because it has not been claimed by a sender, and further, the content of the text message itself implies data collection about the subscriber ("you have been registered"), but the service providers with the customer records to create such contact-chaining deny cooperation. The potential for total registration is particularly chilling. Although the technology of the cell broadcast text cannot gather information about subscribers, cell towers on their own gather information from active handsets that can be gleaned when they ping the transceiver, reporting location and the amount of mobile users moving in and out of cell. This kind of information collected within cells can be incredibly powerful, but it's hard to individualize without customer records like SIM cards or IEMI numbers (Blaze, 2010). The transceiver can gather a fair amount of data about the terminals in the cell (number of mobile phones), and how fast they are moving in and out of the cell. However, without supporting two way transmission, a limited about of information can be ingested, and aggregated usefully without a mobile service provider's home location register (HLR), SIM numbers of subscribers, and IMEI numbers of devices connected to the network. It remains unlikely that mobile users were actually registered with information from their mobile devices without a cooperating service provider turning over customer records. The chilling effect of the message plays on the purchase of the possibility of metadata collection or aggregation, service providers cooperating with the state, and the future uses of such metadata in different ways (e.g., prosecution for protesting or participating in dissent in a public space).

The situation in the Ukraine remains unstable and continues to unfold with Crimea voting to secede from the Ukraine in a referendum that Western governments have called a sham and illegal. While the use of broadcast text messages during protest that are unclear and imply state-sponsored messages of suppression is salient, it's not particularly not unique to oppressive regimes or even democracies. Many gaffes with cell broadcast and other kinds of group text messages from states involving subscribers as citizens (or undocumented residents), their location, and personally identifying information, have appeared all over the world in the last 20 months. In October of 2013, the Home Office in the United Kingdom hired a third party company Capita to send 39,100 text messages to people living in the UK who may not have the right to live in the country. The text messages read, "Message from the UK Border Agency. You are required to leave the UK as you no longer have right to remain" (Wintour, 2013). Many citizens reported receiving the text messages mistakenly, still others received hoax messages that were threatening, and further, the controversial campaign itself was overwhelmed with thousands of imposters who texted back the immigration hotline about voluntarily leaving (Hope, 2013). Hundreds of people who are legal residents reported mistakenly receiving the text message to leave the UK. According to an investigative report, only 11 people left the country voluntarily as a result of the Home Office immigration campaign, two-thirds of the people who received 'go home' texts turned out to be fakes (Travis, 2013).

Mass text messages from states to citizen subjects, or from contractors who may pose as speaking for the state, perforce discussions about the collection and creation of mobile telephony metadata as records—and how to classify them, are they business, state, or individual records?

What does it mean when states and citizens use text messages and their subsequent metadata as records? How does mobile telephony metadata become records independent of content? As I have argued, sending, and receiving text messages in this century is to engage with the problems and anxieties about complete digital archival collections of metadata. This includes personal digital archives created with mobile devices and professionally delineated archives that are made up of electronic records for legal requirements or for posterity. Complete digital archival collections of metadata are possible, and emerging, but have yet to be an object of interest outside small niche groups of mostly corporate data enthusiasts like social media technologists (like Mark Zuckerberg), big data evangelists, quantified selfers (like Gordon Bell), and privacy scholars. In each of these cases, the collection of metadata is at question, it is both a poison and cure to the future of efficient information management. For this discussion, it is important to scale back and locate where (and why) metadata is generated, because it is conceived as a fundamental part of the store and forward architecture of mobile networks, as seen by archivists and records managers as a way to examine the contexts of records including the structure of their creation, and as new kinds of business records in corporations and under the law—they also represent digital evidence in new networking contexts.

Individuals and organizations create records to conduct business, to make decisions, and to keep track of decisions that have been made. Records are used for accountability within organizations, accountability under the law or with business communication policies and prove when events or transactions between parties occur. Collections of records also give people and institutions the ability to protect their rights and assets in legal, financial or regulatory environments. Records also protect people—citizens and consumers, as records can enable transparency and protect our rights. Formal archival collections of records are created for posterity, ensuring their access and use for cultural, historical or research purposes. Increasingly however, with digital records, collections are being created in ways that rupture traditional ideas about the preservation of individual or community identity. They also disrupt historic models of records management like the life cycle model and some have argued, the records continuum model as well (see Chapter 2). For example, text messages and their subsequent metadata are becoming enrolled into business record keeping contexts and in some cases becoming new kinds of government records without consumers or creators knowing, or they become collected in corporate or surveillance contexts, but consumers themselves may not have the tools to collect text messages themselves.

In chapter 3 I wrote about the mobile telephony metadata that is created as part of the sending and receiving of text messages that originated on a user's mobile device, and as part of the transmission through a service provider's network. I argued that mobile telephony metadata is both structural and descriptive, providing incredible resolution and unique information about mobile phone users (de Montjoye et al., 2013). This chapter will connect parts from chapters 2, 3, and 4 by exploring the emerging role that telephony metadata is playing in contexts of collected mobile digital records as traces of transmission, in legal and surveillance contexts, including how it is seen as a communication tool for heads of state like President Barack Obama. It argues that mobile telephony metadata represents new challenges and opportunities for archival science and studies of infrastructure in information studies.

First, I present an overview of some recent cases in the US where policy and legislation have expanded and enrolled text messages, call detail records, and mobile telephony metadata as electronic communications, including the Presidential Records Act, section 215 from the USA Patriot Act, the Inspector General's report leaked by Edward Snowden, and some current bills that aim to limit the collection of metadata in surveillance, as well as some bills that have died in congress that aim to preserve electronic messages (as distinct from metadata). I want to put these parts together and suggest that ideas about metadata, especially how they are operationalized and understood in circulation are part of a sea change in archives and the future of collections. I focus on the points of intersection that I have described in earlier chapters that emphasize elements of the framework I presented in chapter 2 especially as they related to engagements with user practice, layers of infrastructure and new contexts of information retrieval.

Why is Mobile Telephony Metadata Different?

In the last chapter I wrote about the ways that text messages are enacted and created as metadata encapsulated objects (Bearman, 1996) and that collected telephony metadata in aggregate are unlike personal data collections because they are based on transmissions between two or many parties (including receivers, service providers, platforms, and multiple networks). I wrote about how the contents of messages are created by users and then interpreted by readers, messaging clients, users, designers, and states in different ways, some are still even unfolding. Metadata is evidence of the distributed materiality of text messages across mobile networks, as well as different collection contexts. Telephony metadata is used and protected in different ways under the law. In this chapter I want to connect these different ways and show how they change ideas about collections, ingest, appraisal and storage. How is mobile telephony metadata its own kind of content as traces of transmission?

Metadata is becoming more important than the content of messages we send by virtue of its inevitable and constant creation and collection as part of mobile telephony, but also because of its aggregation into collections that can be queried and interrogated over time to predict and analyze actions. I argue that it is the ability to network them together, as part of their creation and structure that makes metadata a new kind of organizing principle for archivists to confront. What are the stakes of collecting it? I start with the basic idea that records and metadata are now ingested all the time as part of the infrastructures of creation, transmission, and access, in particular with our mobile devices through mobile network coverage. While there are many laws that govern security, privacy, and retention of telephone communications, the ways in which we use and interpret them are primarily based on stationary telephones. Until quite recently, most telephones sat on desks or were attached to walls, on the bedside table or in the kitchen. Now phones are carried on our bodies and do more than support voice telephony—they transmit and capture rich data not only about text messages, but also about the users, in a variety of ways. Explaining the stakes of those mobile telephony metadata is the goal for the remainder of this chapter. Metadata circulation and collection provides a particularly interesting case for the future of archives and the status or primacy of the record as an organizing principle in modern archival science, theory, and practice. If modern collecting institutions move towards collecting and aggregating metadata instead of traditional business record groups, how will our theories catch up?

Remember, SMS was originally designed as an optional add-on service for service providers and manufacturers to support with early mobile telephony (Hillebrand, 2002, p. 79, GSM4 162/190). But by end of 1990 GSM4 Liaison decided it would be a mandatory teleservice (SMG4 23/92). This decision to make it a mandatory service is seen as the success of the service because all mobile phones could send and receive SMS by 1994. The unified GSM standards and technology allowed for infrastructure to support the use and availability of wireless communication, but also the potential for data transmission like text messages. Kasesniemi argues that the spread of GSM enabled the birth of the text messaging culture, which could not have emerged without the technological innovation of SMS, which itself "was originally designed for an entirely different purpose" (Kasesniemi 2003, p. 94). Now texting is used in business, government, development, banking and beyond. In many contexts the metadata of their use and transmission becomes more important than the content on its own. Throughout the chapter I will engage with leaked NSA documents and their connections to ideas about collection in existing policy because we know content is being collected (including from US persons). Concepts I describe include: mobile forensic imaginary and born-networked records. These examples underscore the political, juridical and archival consequences of metadata definitions and what those definitions do in this moment. I am historicizing metadata of text messages and mapping its political and archival implications.

In June 2013, Glen Greenwald of *The Guardian* reported that call data records or "telephony metadata" from American Verizon subscribers was being handed over to the NSA under secret FISA court orders. According to the leaked court order, all of Verizon's telephony metadata and all other transactional data related to communications metadata were turned over in bulk to the NSA on a daily basis. Many members of Congress and representatives from the Obama administration came forward to claim that this kind of metadata is not personal because the information being gathered is not the actual content of voice calls, but instead minimally personally identifying information. *The New York Times* (Savage et al., 2013) quoted Senator Saxby Chambliss from Georgia saying, "It's metadata only and it's what we call minimized." Senator Chambliss's statement was repeated over and over in ways to diminish the significance of what metadata in bulk might actually mean for US citizens. Congress, political pundits, and the media defined telephony metadata as benign for the rest of the summer, often likening it to the information found in a telephone book. Metadata, and the way it is defined, depends upon theoretical commitments to frameworks of surveillance, information access, and ideas about belonging. The ways we define it and the power it can have necessarily conditions and shapes the information (and the people) that are represented by it. After agitation from privacy activists and technologists in light of more leaked documents from Edward Snowden to Greenwald, it became clear that the telephone book definition of metadata belied the importance of mobile infrastructure and wireless transmission of personal information.

The differences between telephony metadata and mobile telephony metadata were hashed out in the media for the rest of the summer and fall of 2013. Most of these differences focused upon the capacities of mobile handsets and the traces that they create in support of voice and data transmission, especially call data records. Call data records that mobile phones generate include information ranging from location, time, length of transmission, and information about other phones a user may try to connect through a voice call or text message (for example their phone number or service provider). Call data records also include unique identifying information about users and their phones such as the SIM card and the International Mobile Equipment Identity (IMEI) number for mobile handsets. Swaths of metadata are created each time you use your phone to connect to a mobile network and place a call, check your email, or send a text message. Mobile telephony metadata is also created and collected whenever phones are powered down or powered on, as they are tracked by the closest cell tower.

Metadata is a powerful concept that has been used to justify and defend many domestic surveillance programs based on the collection and aggregation of communications data. A diluted definition of metadata was being used by the Obama administration and the NSA in the summer of 2013 to obviate the significance of what this data from mobile phones actually is and how this information being handed over to the federal government by mobile service providers is understood by Americans who use cell phones and create metadata everyday. According to Tom Boellstorff in his study on the making of big data, “[a]ttempts to depoliticize metadata hinged on assuming a self-evident, distinction between data and metadata”(2014). Telephonic metadata is quickly becoming the most private information that we have because mobile phones are increasingly our primary communication tools, and the significance of these digital traces is being overlooked because the “meta” prefix. Boellstorff has argued that the prefix subsumes a tension, a tension that hasn’t been resolved and involves the implementation of power, and identity. We can also argue that there have been discursive junctures when “mobile” as descriptive term has been dropped from explanations of telephony metadata, and that it too, has significant effect on the power of the idea that is being circulated.

The formal definition of “metadata” in the field of Library and Information Science is “data about data” (Greenberg, 2005). For archives, metadata is known as structure data about data, as provenance and original order are both information about the structure of record creation and aggregation. Metadata can be structural or descriptive information about content, and it helps people find things in information systems. Structural metadata is information about things to help us find things in systems, for example the address to your house refers to a building on a street in a grid somewhere in some place. Descriptive metadata is lots of pieces of information (think “breadcrumbs”) about a thing, so that when it presents itself to you, you can identify as the right thing you are looking for. The information on your drivers license about your height, weight, age and hair color that identifies you as a person is descriptive metadata. Historically, catalogs in libraries have been the most common instances of metadata. The catalog numbers on the spines of books are structural metadata, because they help us find books on shelves. While catalog records that describe what books are about, their contents, what they look like, and where they were published are descriptive metadata. In tandem, structural and descriptive metadata can create powerful access and retrieval systems. In the information age, metadata is all around us and is used in almost every encounter we have with technology, other people, and things. It is the information we need to describe, find and analyze information objects in the world. As metadata becomes a ubiquitous part of modern life, it becomes something that we encounter and create in everyday living. We need metadata for our bus routes, traffic lights, banking systems, e-mail, and health records.

Increasingly, metadata can be generated and gathered through small sensors in our environments, ranging from RFID chips in passports to turnstiles in parking garages. These sensors generate information, and data about that information can be deduced in powerful and expansive ways. How many people have passed through this checkpoint? How many cars are in this parking lot? How many trucks are on this freeway? One of the most ubiquitous forms of metadata that we can create as individuals is with our mobile phones. Currently, more than 85% of Americans carry phones, and the Pew Internet & American Life Project (2013) has found that more than half of those users carry smart phones, which generate more detailed call data records than feature phones. Like bankcards and drivers licenses, we carry our phones all day in public and in private places. Most users keep their mobile phones powered on for most of the day. But unlike the choice between using a bankcard or cash, we do not have choices about what traces we can leave, how they are tracked, if we want to use these traces and now, since the USA Patriot Act, how these structural and descriptive metadata can be enrolled in domestic surveillance programs.

When mobile phone users have control over the metadata that they collect and then share it, it is called participatory sensing (Acker et al., 2010), or sometimes souveillance. Participatory sensing data from phones can be used by people for many good and empowering reasons and it relies on a faceted understanding of what data traces can be generated and how they relate to privacy. For example, there have been many participatory sensing projects at UCLA that give community members the opportunity to collect environmental data from their phones and make arguments about the neighborhoods around them, such as finding less congested bike routes to commute to work (Goldman et al., 2009). When people use participatory sensing to generate and collect data about individual movements, location, and communication with their phones we find that they are concerned about confidentiality and security of their personal metadata (Shilton, 2009).

The problem with the minimized "data about data" definition that has been used in defense of NSA surveillance program that collects metadata in bulk is the difficulty of connecting telephonic metadata to the everyday uses of carrying a mobile phone that is almost always creating and generating digital traces. The way that metadata is currently being explained to citizen subjects and to mobile subscribers denies the powerful kind of sensemaking that can happen when structural and descriptive information becomes "meta" and then gets enrolled in big data projects like domestic surveillance programs, or when the information about these data has to do with your movements, location, and primary communication contacts. Metadata from our phones that has been accumulated over time can tell personal things about actions with precision, for example how often we shop, when we go through the drive through for fast food, where we live, where our loved ones live, how and where we spend our nights and weekends. When mobile telephony metadata is aggregated from small groups of individuals through contact-chaining, many more things can be inferred about how groups of people interact and move around in their communities.

Deploying sensemaking information from the metadata collected from thousands of mobile phone users can be very powerful in different collection contexts. It can be even more powerful when it relies on a simplified understanding of metadata that overlooks the unique, personally identifying aspects of sensors in our lives, such as phones that broadcast our location or the duration of conversations between people. Accumulated metadata from mobile phones has possibilities that we are still discovering (Willason, 2003; Willassen, 2005; Glisson et al., 2011). It is important that we understand that the definition of metadata is not without consequences, it is not benign and that mobile telephonic metadata is unlike any other metadata that has ever come before because it is both personally descriptive and structural. A complex and comprehensive understanding of ownership over our call data records is needed because they constitute expectations of privacy from both our mobile service providers and government records over time. The creation and collection of metadata for surveillance becomes in Boellstorff’s words (2014), a “form of belonging” in this surveillance state. In order to confront the power of how definitions of metadata are deployed, we must engage with the motivations for collection. Historicizing and rethinking the terms of collections of metadata (instead of records), will uncover what it collecting means with wireless infrastructure and mobile technologies. Historicizing it can also help us imagine what resistance to these cultural logics of control might actually be.

The Shift from Business Records to Collections of Metadata

In chapter 2 I wrote about Kurt Mix, a BP project engineer who was convicted of obstructing evidence by destroying text messages related to the course of business in the Top Kill oil spill project. The Department of Justice found that the text messages that Mix had exchanged with his supervisor over the course of 2010 were indeed part of the course of regular activities related to the business of stopping the oil spill. As of this writing, Mix continues to appeal his case based on juror misconduct and the interpretation of text message content as business records (Krauss, 2013).

The International Council on Archives defines records as having context, content and structure (Committee on Electronic Records, 1997, p. 22), however the formal definition of business record and the inclusion of text messages as part of this definition has a significant impact on the future of metadata collections, but also business communications at the turn of this century. Business records are documents that are created as part of regular business activities, historically these records are pretty well understood, however with digital technologies and the proliferation of social computing platforms, new genres of records are pushing the limits of what is and isn't a business record.

According to the Federal Rules of Evidence business records include things such as, "[a] memorandum, report, record, or data compilation, in any form, of acts, events, conditions, opinions, or diagnoses, made at or near the time by, or from information transmitted by, a person with knowledge, if kept in the course of a regularly conducted business activity, and if it was the regular practice of that business activity to make the memorandum, report, record or data compilation, all as shown by the testimony of the custodian or other qualified witnesses" (Federal Rules of Evidence 804 §6). In general, business records must satisfy four qualities from a juridical standpoint (Skupsky & Mantaa, 1994): the record must be created near the time of the event that it records, it must be created or transmitted by a person with direct knowledge of the event, it should be created as part of regular business activities, and the making of records must be part of the regular practices of the business (p. 23-24). The definition of when a business transaction or event occurs has been influenced by the rise of mobile devices and mobile network coverage that afford an always-on, always available connections to workers and their employers.

What is significant about Mix's conviction is that it isn't the content of the text messages, but instead the evidence of curation and the metadata that was collected to show that these text messages were business records because of who and when he was texting. We know from scholars of business information technology, like JoAnne Yates, that communication technology like the telephone, telegraph and the telex fundamentally changed the recordkeeping and formal communications practices of business and governance in the 19th century. As a format, text messages provide an entry point into the history of communication networks of the late 20th century, but it also tells us something about the significance of digital collections in this moment as they shift from analog or formal business records to collections of metadata and in particular mobile telephony metadata. It also shows a shift of where business records can be created and stored, including personal devices like mobile phones. The lesson to learn here is that as mobile ICTs become increasingly relied upon to communicate and create records, we need to consider the shifts in collecting (and deleting) digital traces in our culture that are tied to these mobile devices, their platforms, and the infrastructure of mobile network coverage. And moreover, what this mode of positioning does for traditional understandings of records and recordkeeping contexts.

Positioned as we are with always on devices, telephony metadata influences the organizational logics of control and communication, and saving or deleting texts becomes an exercise of self regulation as a worker in the information economy, curating texts is at once underestimated by design settings and features in messaging clients, and then over-relied upon in business recordkeeping contexts as part of what Ian Bogost (2013) and other feminist labor thinkers have addressed as the part of hyper-employment effects of mobile technologies (Gregory, 2013). If you always carry your mobile device, you always-already have the potential to be creating business records that are subject to discovery, collection, and retention, wherever you may be located whether that's at work, lunch break, at home, on the road, and so on.

Throughout this dissertation I have written about how the limited storage capacity on mobile devices combined with the design constraints of messaging clients on mobile operating systems keep users from collecting and preserving their own text messages over time. Users, their devices, and even their service providers do not actively collect text messages for very long periods (under the ECPA of 1996, they must be destroyed within a reasonable amount of time to protect telephonic communications privacy). In addition to the content of text messages, the lion's share of data collected by service providers is the metadata that is constantly generated as part of supporting mobile telephony teleservices. I am arguing here that metadata collections, if not already, will become the new organizing principle or concern of archives and collections of information institutions. Metadata collections also turn businesses like mobile service providers into new kinds of collecting institutions, with different expectations and goals for stewardship than traditional collecting institutions like libraries, archives, and museums. We will move past collecting and archiving the content of records, or groups of records, and instead, begin to support vast metadata collections as businesses are quickly becoming new kinds of information collecting institutions—collecting metadata as business records, and harnessing that big data for predictive analytics.

We are seeing the ascendency of metadata collections transformed into business records with the new role that mobile service providers play in state surveillance programs, in addition to the course of providing data transmission with 3G and 4G networks. For example, Senator Markey's (2014) annual inquiry on the wireless surveillance of Americans has found that all seven leading mobile service providers in the US have turned over user's cell phone records, including metadata ranging from CDRs, geolocation data, call lists, and the content of text messages themselves. Where before mobile service providers were primarily responsible for rendering transmission services (such as connecting calls, transmitting text messages, holding voicemail alerts), they now have stores of information that when interrogated, aggregated, and queried represent new kinds of "wholes" of collections for inquiry. In this way, we see collection of mobile telephony metadata outpacing the evidential value of the content of text messages themselves as individual records or record groups created by individuals, and see them as networked collections of records. You may ask, how can this metadata be used meaningfully? Simply, it can be used for contact chaining to build up information about groups of people and their habits. Where they meet, how they move through spaces, where they go during different times of the week, and most importantly where and what they buy and consume. In June, Snowden leaked the Inspector General's report, which remains the only real published rationale for the NSA collecting Internet and mobile telephony metadata in bulk under project "Stellar Wind" (Office of the Inspector General, 2009). From the report, metadata and collection is outlined:

> The authority to collect bulk telephony and Internet metadata significantly enhanced NSA's ability to identify activity that may have been terrorist-related. Contact chaining is the process of building a network graph that models the communication (e-mail, telephony, etc.) patterns of targeted entities (people, organizations, etc.) and their associates from the communications sent or received by the targets." Metadata is data that describes other data, specifically information that describes the content.
> (Office of the Inspector General, 2009, p. 15).

Boellstorff argues that the implicit histories in the prefix of meta "expand frameworks, addressing time, context, and power" meaning that the data and primacy in the context of creation is always tied to the temporal formation, in addition to the structural and technical processes that shape metadata. As you might imagine, the law has not kept up with the power of technology, and it is still tied to immobile telephones and their metadata, and as privacy theorist Susan Landau (2103) has written, "the law provides less protection for metadata than for content" (p. 57). In 1976 Archivist Lester Cappon lamented the holes that telephone conversations would leave in business documentation in the 20^{th} century:

> On the archival edge the archivist as collector is confronted with certain dilemmas, not inherently new in the twentieth century, that are insoluble, to some degree, but open to accommodation. On the one hand, the quantity of certain records demands measures wisely to save and to destroy; on the other hand, the paucity of lack of certain records attributable to telephone communication tempts him to fill the void by creating records for the service of scholarship.

(Cappon, 1976.)

It is likely that archivists of the 21st century will lament the *lack* of holes created by mobile telephony metadata as part of business communications in this present moment.

Blackberry 1 and the Presidential Records Act

In her book *Virtualpolitik* (2009), Elizabeth Losh argued that the Bush and Clinton administrations actively dissuaded citizens from using digital technologies (ranging from file-sharing, copying media, to online gaming). The Bush administration also suppressed and changed the ways digital technologies would be used in circulating communications in the White House. In 2008, Judith Butler argued that it would be Obama's "dis-identification" with the Bush Administration that drive his popularity and allure, centered on his use of digital technologies and social media. In contrast to Bush and Clinton, President Obama during his campaigns and presidency has made use of many social media technologies and Web 2.0 platforms, using what Henry Jenkins (2006) calls participatory culture to his advantage and connecting with constituents. During his election campaigns, candidate Obama was often seen using his BlackBerry or an iPod, and once he became president-elect, was quoted as saying, "I'm still clinging to my BlackBerry. They're going to pry from my hands" (Zeleny, 2009).

But since being in office, as Losh (2012) has crucially noted, President Obama's use of his BlackBerry (like his smoking) is only indulged in covert spaces, outdoors, in corridors, away from "official spaces of statecraft" (p. 258).

Figure 8 - President Barack Obama checks his BlackBerry

"President Barack Obama checks his BlackBerry as he walks along the Colonnade to the Oval Office", photo taken by a White House photographer Pete Souza, The White House, image available at [http://www.flickr.com/photos/whitehouse/4456732652/] under a Creative Commons license.

This is in sharp relief to the transparency and records accountability that President Obama began his administration with. His first order issued on the first day of his presidency, Executive Order 13489 restored the original Presidential Records Act (PRA) of 1978 and revoked Executive Order 13233 issued by President George W. Bush in 2001, which included the documents of former vice presidents. The 1978 PRA, 44 U.S.C. §§ 2201–2207, mandates the preservation of all presidential records and changed the legal status of who owned records, transforming presidential records from private to public records. The act creates a statutory structure for managing records created during presidential administrations. However, Obama's use of digital technologies and mobile devices has proven to be a hurdle for the PRA, and it remains to be seen how his continued use of his BlackBerry and the records he creates with it will be documented and preserved under the PRA.

Obama's relationship to his mobile device is as Melissa Mazmanian has argued, a "relationship [that has] emerged from, and is steeped in, a particular culture in a particular time" (2009, p. 16). Early media reports of President Obama's mobile device, called it the "BlackBerry 1" and speculated that the device would unlikely be a Research In Motion (RIM) device, but instead, likely a Sectéra Edge Device certified by the Department of Defense. General Dynamics which manufacturers the Sectéra Edge offers two models. One is NSA approved for federal workers and the other offers consumer-grade high-level encryption that many smart phones do not provide (LaVallee, 2009). However most evidence, including the official Whitehouse Flickr photo stream, suggests that the BlackBerry 1 is indeed a BlackBerry model 8830, and continues to be, despite the fact that Obama is now rarely seen using it. Early attention to the president's BlackBerry was upon the security of the device (Harauz & Kaufman, 2009; Sorensen, 2009), later though; it became clear that problems with email and text messages on the device itself would be another challenge for federal records managers. The BlackBerry operating system uses unique encryption and a proprietary messaging format known as the BlackBerry Messenger (BBM) to send encrypted text messages. Electronic proprietary formats (from word processing documents, to keynote presentations, to electronic mail) continue to be a thorny issue for the National Archives and federal electronic records management.

House Resolution (H.R.) 5811 amended title 44 charging the Archivist of the US to create solutions to preserve email and digital records created during federal agency administration, including Presidential records. Bush's executive order, and the Clinton's limited use of electronic messaging, had hemmed in the PRA from actually implementing or creating solutions to preserve and archive digital communications (because there was a dearth of email that actually existed). The HR 5811 would implement a "solution [that] must be able to operate within a Microsoft Windows/Exchange, Storage Area Network and Active Directory infrastructure. Internet gateways are Unix-based using Sophos, PureMessage for filtering. Client access is through Microsoft Outlook, Outlook Web Access and Blackberry hand-held devices" (Miller, 2008). Unfortunately, H.R. 5811 was introduced in the 110th Congress in 2008, passed in the house and died in the senate.

Similarly, H.R. 1367 also called the Electronic Message Preservation Act, amended the PRA and would require the national Archivist to certify annually whether electronic records management controls established by a President meet the requirements of the PRA. Representative Paul Hodes introduced H.R. 1367 in the 111th Congress in 2009. It passed in the house and died in the senate in 2010. While the PRA has expanded to now include electronic devices, servers, and mobile phones that send and receive electronic messages, it remains unclear whether the Archivist of the US will be able to carry out these duties without bills like H.R. 5811 or H.R. 1367 that layout how the preservation and collection will actually be done at the technical level. Essentially, the PRA provides a legal mandate to collect and preserve the traces created with the BlackBerry 1, but there is no legal or technical infrastructure for it to happen when Obama's term ends. Moreover, financial issues with RIM have led market forecasters to predict the demise of the company, as it nearly went bankrupt in 2012 (Savitz, 2012).

Two digital preservation issues that archivists and digital curators face can be seen in the problems with archiving the BlackBerry 1. First, is that the cost-benefit of keeping the president's proprietary operating system preserved is undue given the likelihood that it will remain a popular smart phone operating system as the BlackBerry has the smallest marketshare of the leading mobile operating systems (Tuutti, 2012). Second, migrating the data, or gathering it from other devices (service provider's, Whitehouse servers, or other BlackBerry's or mobile devices) may be easier and more cost effective than preserving the device itself. Gathering the metadata traces created by the BlackBerry 1 is easier and cheaper than investing in a proprietary encrypted format like the BlackBerry Message. The PRA and the two dead Electronic Message Preservation Acts point to a rupture in the approach to preserving content created with mobile phones. Many still argue the cost benefit of mutually preserving the Blackberry 1 as a device itself, instead of preserving the content, migrating, and put all the attention on the metadata.

The Power of Metadata Collection

The documents that Edward Snowden leaked through the Summer of 2013 and even today as I write this should give us pause to consider the power of the collections of metadata that the US government currently is creating under the auspices of Section 215 of the USA PATRIOT Act, where the NSA has interpreted telephony metadata as business records (Inspector General's Report, 2009). While some of these collections come from private citizens in the US, still others, contain metadata from whole markets, political leaders, and individual citizens from other nation states.

In one of the first leaks, Snowden claimed that the NSA had access to Chinese telecommunication networks and millions of text messages, which is the country's most preferred communication tool (Lam & Chen, 2013). Despite the ongoing leaks, and President Obama's security task force report (2014) the policy, rules, and regulation of this kind of secret data collection remain unpublic, and often, overclassified. As Landau (2013) has written, "On the one hand, we see care in collection (at least for US persons), but on the other, the leaked IG report is the only public description we have of the purpose behind the NSA's bulk collection of communications metadata" (p. 58). A striking dearth of information about the motivations for what guides these collecting processes is worth thinking about it terms of the kinds of things collected, but also the power of what can be done once these collections are organically bound together and networked. For example, researchers who have examined the electronic retention of mobile phones (Glisson et al., 2011), and telephony metadata (Mayer & Mutchler), have both found that thousands of artifacts can be recovered through mobile forensics, and that metadata is "unambiguously sensitive, even in a small population and over a short time window." Mayer and Mutchler we were able to infer medical conditions, gun ownership, and more, simply using aggregated telephony metadata.

The interpretation of Section 215 to include telephony metadata as business records, which many have argued is a secret law, has led to the bulk collection of telephony metadata from mobile service providers. This telephony metadata includes data from cell towers, not simply from GPS (from phones shared with service providers). But also, data to and from cell towers as we see in the Ukraine case and the UK immigration text case above, is increasingly powerful for alertness and suppression (Blaze, 2010). Bulk collection of metadata also raises questions about the distinctions between individuals, communities, and discrete groups of people. These data are created not only by individuals, but also by service providers. These data are yoked together, once they are collected in aggregate, it becomes impossible for an individual to be the primary owner or custodian of that information. Further, the issue of ownership becomes murky if the US government is collecting it in secret (Landau, p. 58). As metadata is collected it binds traces together into organic wholes that we may not know the power of now or in the future. It also shifts the power of who owns what and when. The power of ingest and appraisal become fraught with the meaning of context and evidential value—that is, in the arché sense, what can and cannot be said institutionally, juridically and under the law (Derrida, 1996).

In the US, many legal protections of telephony metadata were developed in the late 1980s with the 1986 Electronic Communications Privacy Act (ECPA). The ECPA governs the real time capture of calling data, CDRs, as well as electronic communications that are stored. It is worth remembering that in late 1980s when the ECPA was passed, telephones didn't move, they were stationary communication technologies. They sat on desks, were bolted to walls, in private call booths, tethered to wirelines and stationary power sources. Moreover, groups of people, small groups like families, students in dormitories, and people in public places like the library or university, shared most telephones. Today, mobile phones are carried on bodies, powered on for most the day and in most countries, on one person throughout the course of their day (though there are places where mobiles are still used by families, or at the corner store as a payphone). Part of using a mobile phone also means sharing your mobile metadata with service providers. In addition to outdated protections on telephony metadata that don't confront mobility, because service providers generate, steward, and keep most of the metadata individuals create, it isn't subject to the same constitutional protections as content (Landau, 2013, p. 56).

A series of laws have weakened the ownership of metadata and enabled the swift collection of it, including the 2007 Protect America Act, the 2008 FISA Amendments Act, which gives telecommunication companies immunity for participating for in warrantless wiretapping, and Section 215 of USA Patriot ACT that authorizes the collection of business records in bulk. Now these business records are interpreted by FISA courts and the NSA to include phone records and mobile telephony metadata. Since the fall, new bipartisan bills have been prepared by Patrick Leahy, an architect of the USA Patriot Act, to limit the bulk collection of telephony metadata by tightening section 215 by instituting formal reviews to prove that targets are "agents of a foreign power[s]" or are legitimate subjects of investigation (Roberts, 2013). In March, Representatives Zoe Lofgren, Ted Poe, and Suzan DelBene introduced legislation to modernize the ECPA with the bill, H.R. 983 (2013), the Online Communications and Geolocation Protection Act, which requires that the government get a warrant based on probable cause before intercepting or forcing disclosure of communications from Internet or mobile service providers. At the time of this writing, it remains unclear whether any of these bipartisan bills will pass.

Encryption, obfuscation, and ephemeral messaging apps and the mobile forensic imaginary

According to Jonathan Sterne (2012), a format denotes a whole range of decisions that affect the look, feel, experience, and working of a medium, but it also names a set of rules according to which a technology can operate, not just in the present moment, but in future context. I want to extend this argument and not only reiterate that histories of formats matter to the preservation, analysis and circulation of culture in the digital age, but that the history of how SMS came to be and exists today is a history of how new mobile records operate in the present, and are collected as well as deleted.

The NSA's own documents suggest that the agency retains Americans' communications indefinitely and that there are no plans for appraisal or weeding. These collections are not merely for monitoring (that is descriptive information), but for predictive use cases, and according to many privacy theorists, increasingly prescriptive analytics. Predictive policing models exist and continue to make use of mobile telephony metadata, amongst other environmental data about citizens in particular residential locations (Graham & Winston, 2014). The ubiquity of text messaging, SMS gateways to the Internet, and the increased use of smartphones has led to what market forecasters call the next "killer app" in mobile technology development (Kessler, 2013; Reyburn, 2013): it is the new market of messaging applications ("apps") that allow users to send enhanced messages, including video, picture, and text in a variety of new ways with their mobile devices. With the rise of these new messaging platforms, an increase in ephemeral and self-destructing mobile communication tools have increased. Many of these new messaging platforms use next generation mobile networks and Internet Protocol (IP) to transmit messages, encrypt them, and auto-delete messages shortly after recipients have received them.

As messaging over IP on 3G and 4G networks gains traction, we see it influencing other markets, like social media and personal computing. For example, Facebook bought WhatsApp (2013) for $19 billion in February 2014 (Covert, 2014). Shortly afterwards, Bill Gates claimed that Microsoft would have bought the messaging service too (Gibbs, 2014). As messaging applications creep into every social media platform, including Twitter, Gmail, and Facebook, there is a trend towards these applications ensuring encryption, "off-the-record" capabilities, or complete deletion in the name of privacy and security. The popular tagline for Wickr (2013) is, "The Internet is forever. Your private communications don't need to be." The motto implies that existing norms don't give you control over the longevity of your mobile communications data, but that this messaging app offers the solution.

Messaging apps, including mobile obfuscation apps that ensure encryption and deletion like Wickr or Backchat (2013), and their valuation and popularity amongst mobile users (ranging from teenagers to professionals) point to the emergence of a mobile forensic imaginary surrounding the use, longevity and evidential value of mobile messages. Mobile obfuscation and encryption apps that use IP to transmit data over Internet connected mobile networks, unlike call data channels that SMS uses. The forensic imaginary fueled by these apps at once plays with ideas of traces in ingest and appraisal in security contexts, but also betrays a move to jettison long-term evidence with the idea that everything stays on the Internet. Snapchat is billed as a game, while Confide is advertised as "Snapchat for professionals". Each messaging app ensures that your message will be deleted within seconds of it being received.

I argue that we are seeing the emergence of a mobile forensic imagination with the rise of messaging applications that tout obfuscation or ensure encryption and deletion. For example, Snapchat and Wickr both play with popular perceptions of the security and longevity of messages created with mobile devices. The promise of security by way of ephemerality and complete deletion with new messaging applications points to the emergence of a mobile forensic imaginary built upon popular understandings (or misunderstandings) of telephony metadata, and further, how "leaving no mobile traces" supports notions of better lives created with mobile ICTs. This move towards mobile encryption and deletion can be foreseen in text messages being deleted, but also in the NSA collection. How does this imaginary motivate use and influence practices? What are its consequences? Finn Brunton and Helen Nissenbaum (2013) argue that "computer aggregation changes the nature of contemporary surveillance" (p. 169). The metadata from mobiles can be combined tougher, yoked, networked with other kinds of data (business, government, personal records) that have historically been siloed. Once they are combined, these databases can be pulled, "unprecedented new wholes" (Brunton & Nissenbaum, 2013, p. 169).

For Brunton and Nissenbaum, obfuscation is seen as informational self-defense. This can also be seen in participatory sensing and organizing with mobile phones. These tactics speak to the asymmetry that is present in the collection of mobile telephony metadata. The asymmetry of this power is that you don't choose to be monitored; the epistemic is that we are not aware, and the NSA captures everyone's. Another level of the asymmetry of this collection is that the ingest does not have checks for appraisal, technically or judicially, and that metadata, while more powerful, is less protected under the law than content. Ephemeral messaging apps offer a solution to something that text messaging clients and mobile operating systems do quite well with auto-deletion, overwriting, and limited internal storage. Despite their supposed newness, self-destructing messaging apps address problems of persistence and digital preservation by simply deleting the content of messages faster. They are halfway technologies "built to solve problems only half understood" (Sterne, 2007, p. 23). The traces of transmission, or the metadata that many of these encryption and ephemeral messaging apps create is still stored on phones, and appears in CDRs.

Metadata collections by business and governments mark a significant cultural shift in the experience of mediated life with wireless communication and mobile computing. And here I want to argue that text messages as born-networked records created with mobile infrastructure represent a significant shift in the criteria of archiving for traditional recordkeepers like archivists because of the historic commitment to appraisal and weeding as part of the processes of collecting. These kind of complete collections also have a significant impact on the American culture, not just of collecting or of personal information management, but of core American myth of reinvention, based on the dream of starting over (Raley, 2013). The classic American second act of beginning again and starting over, if your first act is constantly creating traces of transmission that are collected, indexed and searchable by the state and other corporate actors while you yourself are deleting traces or have limited access to these records, or knowledge of how they are being used in aggregate. I think here we can see that there are future directions that have far reaching implications for collecting, appraisal, and preservation. The rise of mobile obfuscation practices, and tools, point to a new kind of mobile forensic imaginary influenced by the future contexts of metadata in aggregate used by states or corporations through big data analytics. Explaining the future effects of those on subjectivity is my goal for the remainder of the chapter.

Data subjects and collection futures

The transmission of text messages creates traces of metadata that represent how we move in space and the patterns of our everyday lives. Foucault described the disciplinary societies of the 20th century that replaced the sovereign society in the 18th and 19th centuries (1970, 1972). In a society of continuous control, as Deleuze argues (2010), we are constantly enclosed within the network; one of the ways we can see this in what Manuel Castells would call "in the space of flows" at the beginning of the 21st century is with the constant creation of metadata with mobile devices and its pervasive collection by nation states and private corporations. Subjects cannot escape the power of surveillance in Foucault's model of society. For Deleuze, once you locate circuits of power, it has moved elsewhere. Both provide ways of thinking about the power of surveillance and control in a networked society however neither engage with the generative possibilities of surveillance and control through documentation.

While the creation and collection of records about workers and citizens is not entirely new, some have argued it is fundamentally American to document workers (Jennings et. al, 1996; Yates, 1993; Orlikowski, 2000), the aggregation of metadata that is both personal and professional (as mobile phones support) through networked platforms changes what collections are made up of, and transforms the nature of business records to mean almost all metadata created with wireless infrastructures. Mobile ICT infrastructure supports *born-networked records* in ways that collapse difference, contradicting identities that we may hold and live as workers, citizens, community members, and individuals. This new kind of subjectivity is built upon the constant creation of metadata that is enrolled in aggregate in new collections that fall outside the bounds of traditional collecting institutions like archives, instead they are now networked and layered in ways that our practices, laws, and technologies are at odds with each other.

For most mobile phone users, the method of transmission and the production of telephony metadata affect the information being communicated, in the moment and over time. However, these collections of metadata inscribe us as new kinds of records creators when they are enrolled and ingested by the state. It is not only a product but also a discursive frame of this moment of communication, transmission, and collecting. By studying the conditions of the possibility for a thing to exist like the text message format and its storage, deletion, as it is enrolled in different memory regimes, whether at moments of creation, transmission, now collection within mobile communication infrastructure provides us with ways for locating and identifying the changes that mobile communication traces in personal and institutional digital collections bring. The historical ontology of mobile records and telephony metadata gives us a renewed opportunity to examine material traces of new forms and spaces of social and cultural memory created with mobile devices and wireless infrastructure.

Mobile ICTs support, enforce, and calcify this subjectivity through the traces of transmission that we create and enrolled apart of as we are “continuously integrated into a larger information economy and technological apparatus” (Elmer, 2004, p. 17). In this chapter I identify the asymmetry of collecting metadata, when users are unaware of, or have an outdated understanding of metadata. We should ask, how does metadata creation and collection “transform the basic archival attitudes towards collecting, when everything can be indexed and sorted at the level of metadata (Cox, 20104, p. 214)? How do we become subjects of and subjects to these metadata processes? How does this change the nature of the record with the asymmetry of collection in surveillance contexts, how will notions of evidence change with predictive analytics? Will exclusive or inclusive definitions of records be useful? How can they be leveraged? That different actors, from users, to lawyers, lawmakers and surveillance programs, have incommensurable understandings of the metadata that is captured and leveraged in different collection contexts points to a shift in the understandings of records, collections, the definitions of metadata. It also points to the ways we are interpellated by these metadata, in Mark Poster’s (1996) terms, “a complicated configuration of unconsciousness, indirection, automation, and absentmindedness” (p. 187). These unstable definitions are evidenced by mobile obfuscation apps, encryption apps, and the shifting legal and security state. But these conflicting practices and unstable expectations also point to a mobile forensic imaginary that is fueled by fears of surveillance state, administrative control over what can and can’t be captured, the unknown circumstances what can be done with metadata in aggregate or alone is significant for collecting futures and well as our understandings of belonging to states, communities, and society.

For more than a decade, text messages, and the metadata that is generated as part of transmission they create as part of their creation collection and circulation have been increasingly enrolled in a variety of organizational, business, state, and policy contexts—they represent a shifting landscape between personal communications and transactional business communications supported with mobile ICTS. These metadata collections also point to a shift in understandings of metadata as business records. Metadata is a social process that creates subjects, and this process is materially tied to carrying a mobile device that creates such metadata. For example in Afghanistan the national police force receives their paychecks through a customized M-Pesa money transfer system based on SMS. The reasoning behind the change to SMS payroll was the large amount of "ghost" officers on the account books picking up paychecks, to the point where the government wasn't aware of how many policy officers were actually employed before 2010 because of graft and corruption (Munford, 2010). Police officers themselves did not know how much they were actually paid by the government because commanding officers would often skim from subordinates' paychecks. The metadata that is created and circulated based on the Afghan national police M-Pesa payroll system not only disappeared the ghost police picking up paychecks, it legitimates the officers who do get the money transfers, because their mobile phones ensure money transfer.

What's most interesting about these records, even text money transfer receipts, is that within a few days, months or years, most of these text messages will be deleted to make more space for more incoming texts, overwritten because of mobile operating system device settings, or simply thrown away or recycled as part of the e-waste we create with rapid device turn over as I have shown earlier for all users. However, the metadata of transmission of these records will be aggregated, circulated and networked across systems in both business and state organizations for indefinite information unknown amounts of time. Broadcast SMS in Independence Square in Kiev, immigration texts from the Home Office in the UK, and President Obama's Blackberry 1 provides a particularly interesting case for the future of collections, including professionally delineated archives for states and businesses. In each of these examples the telephony metadata becomes a part of the fonds of the record, and can include geographic, inferential and exogenous information that provides patterns about the intimidate details of people's lives, whereabouts, locations and coming and goings. When telephones used to be bolted to the wall there were different expectations of privacy, public and private context, with mobile or mobility, the telephony metadata that we have come to rely upon deepens and expands sometimes in unknown and hidden ways.

Given the documents that Mr. Snowden leaked over the summer (Greenwald, 2013), and Senator Markey's (2014) investigation that found all major mobile providers were providing customer records to federal law enforcement, amongst others, this is an important moment for us to engage with the significance of traces of transmission, or what the NSA is calls telephony metadata in very new, and significant ways not only as archivists and information scientists but as citizens concerned about privacy, accuracy, and civil liberties in the networked information age. Histories of networking are tethered to the stabilization of metadata. Yet most descriptions of metadata focus upon the collection and the reuse of it in secondary perhaps tertiary uses, most notability in juridical contexts. As I have shown in this chapter, contexts of metadata creation and conception under the law, can prove to be useful in showing the (dis)junctures or moments of incommensurability between users, designers, policy makers, and lawyers at points of conception and generation. Moreover, secondary and tertiary uses of metadata in aggregate are promised in many consumer analytics and surveillance programs, but are still largely unknown. Computer scientists, technologists, and privacy researchers continue to warn about the effects of metadata telephony and the left over traces on mobile devices, how this information can be collected, and what can be inferred through its structure.

Archivists have been engaging with the significant impact that metadata can have on description, appraisal, and access since the 1990s. Scholars such as David Bearman (1996), David Wallace (1993) and Margaret Hedstrom (1993) have shown the unique contributions that metadata can bring to the future of archives. But I want to argue here that there will soon be, if there isn't already a shift in the criteria that archivists and other record keepers use for collecting that will be primarily based on metadata, but by constant creation and collection of it by corporations, nation states, even cultural institutions like schools and universities. Metadata is seen as less protected under the law, but we can also see under these FISA court orders and section 215 that the form of transmission, the infrastructure that supports mobile networks and indeed the protocols of those networks does matter, and we see that the law is struggling to keep up with the impact of mobile metadata because we don't have working theories about how mobility changes current understandings of telephony metadata.

These metadata, or what I call traces of transmission earlier, are governed by transmission protocols. In his new work *Digital Memory and the Archive*, Wolfgang Ernst (2013) writes that increasingly, as primary sources appear on the Internet, or in the network for immediate information consumption, the real archive on the Internet in the arché sense, or the origins is in its system of technological protocol (p. 85). Despite these claims that protocol, decentralization, and transmission matter to the creation and establishment of electronic records, we still spend a fair amount time reviving analog expectations of business records what records should be when we confront new forms of metadata.

Throughout the dissertation I called text message metadata, quite purposefully, *traces of transmission*. I am using Latour's definition of digital trace to mean the range of traces we create and leave behind when we use ICTs that collapse the social, economic, and psychological while instantly becoming "information" to be rendered and represented in systems (2007). Trace is also meant to play with ideas about electronic writing, or writing on screens, because since the 1990s that electronic writing somehow transcends form and that the computer dematerializes the written trace (Derrida 1996, Poster 1994). Part of this argument is that I'm arguing that these mobile phones are pocket computers that we write and read on, meaning just because we can't touch these text messages made of bits, doesn't mean they aren't stuff, with form and physical qualities distributed across a material network.

The shift to metadata collections points to new directions for archival scholars and information researchers to examine significant changes in ingest and appraisal as they are combined with networked ICTs. That is, service providers that traditionally have supported transmission and delivery are now becoming record creators in tandem with their users, and de facto records managers a new kind of business records, which are metadata, created as part of transmission. Senator Markey's (2014) inquiry found that these stewards are handing over not only metadata, geolocation data, call data records, but also the content of text messages, which we ourselves, and our devices are actively deleting and do not have access to in the future, and that surveillance programs, and content intermediaries are collecting at staggering rates for big data analytics.

In her dissertation on the social impact of the BlackBerry, Mazmanian (2009) writes, "Tools do not determine use, but they may disrupt current patterns of relations. As such, they affect the evolution of individual 'selves' and the character of social worlds. If self, structure, and society are continuously re-created through interaction, than the nature, record, and vehicle of that interaction carry great power (p. 17)." We are quickly becoming new kinds of data subjects with mobile networks and mobile devices as records; this subjectivity is supported by born networked records as a result of constant creation and collection of metadata. The historical ontology of these born networked records deserves more attention from archival research and theory, especially as it relates to appraisal and accountability. Further, mobile communication infrastructures are worth examining closely and judiciously if we want to document and preserve the emergence of this new subjectivity. What is clear, from the stabilization and history of text messages, is that their appraisal, ingest, and storage as born-networked records are increasingly complex, and that we need new tools and theories for approaching the practices of deletion and metadata collection that specifically occur with mobile communication and information technologies.

What most stories that focus on metadata collection get wrong is the bouleversement of common definitions that rely on misunderstandings of transmission, analog expectations, or in comprehending the possible future use cases once metadata has been aggregated over time. This chapter documents the varied understandings of text traces of transmission, or metadata that different actors have, use, and stabilize as parts of bigger arguments about digital collections at the beginning of the 21st century. And what appraisal for born networked records looks like. This doxa has kept many archives and information scholars envisioning or seeing the future and present of metadata aggregation for it is right now, and what it will be in coming years of ubiquitous computing with mobile network coverage and the wireless devices that we carry on our bodies, that support this new metadata subjectivity and futures of collecting. The discourse surrounding encryption and obfuscation messaging apps wants us to see the Snowden leaks as a new kind of metadata subject, where everything is collected and captured. However, archival science teaches us that the creation of structural metadata and records is in a condition of modernity. To be true the means, material and the scale may be different with mobile network infrastructure. But it gives archival scholars a generative moment, a renewal. The critical purchase of studying mobile information objects as archival able records shows us that the archive is not particular place with hallowed ground. And further, the archive is not just a bankrupt concept, associated with nostalgia for the past. It shows us that archive is material, in that it has matter and it does batter to the everyday lives of individual subjects in the present and the future. Studying the social process of metadata creation like the transmission of text messages reveals the material nature of the trace, the multiple layers and the distributed nature of these networked material records. The hailing of infrastructure, provides us an archival consciousness in relation to mobile born networked records that gives users, record creators, stewards and archivists to think about the generative possibilities that we have and consequences and future of collections.

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Chapter 6: Conclusion: Born Networked Records

This dissertation is a history of the emergence of a new information object. Part of what the story of the text message as a format does is map a study of the infrastructure of wireless transmission and examine how that shapes information objects emerging out of mobile ICTs. When I began the dissertation I was concerned with the staples of context that would be removed as part the aggregation of groups of records with mobile phones. I was surprised to find that these staples of context turn out to be quite useful and they are collected in all sorts of ways. These traces of transmission are becoming the fundamental organizing principle of emerging collections of what I identify as born networked records. Metadata created in network represents its own kind of documentation, records of transactions between people, institutions, and cultures. The creation of new kinds of metadata also points to a shift in the history of recorded information and the ways we communicate with mobile networks.

One of the problems with telling a history of a new thing that is on the archival edge is that it represents a kind of boundary work that may not be useful or understandable in this present moment. But there are a few generalizable results and I want to share them in the next few pages. First, the ways that standards get made and sorted effect the information objects that we create and circulate 10 and 20 years later. Reading about standards development is fairly dry and lonely, but it was truly exciting to find that SMS was originally for machines to read, and not for people to use as a writing technology. As I've written, eerily, we could not know how the "ugly duckling of the GSM" (as it is known) would transform microfinance, mobile banking, social media platforms like Twitter or Sina-wiebo, or fundamentally change how we provide information services during disaster relief. The second thing that this dissertation points to is a convergence that we have yet to confront in infrastructure studies, and in archival science, and that is the cross over from second generation mobile networks to third and fourth generation mobile networks. This move towards mobile computing, with mobile networks will fundamentally change the mobile information objects generation and circulated in the future. We still don't have very good understandings about how these always-on, always-connected machines will shape the knowledge that we create, the ways we read and write, and how we will save those traces. With this work, I have tried to highlight the importance of studying mobile information objects in library and information science. While the analysis of mobile information objects is not new to the histories of recorded information and material culture found in libraries, archives, and museums, many information scholars have yet to really start engaging with the significance of these mobile machines, their interfaces, and network coverage that will affect ways we collect and create records in the future. For information professionals, such as librarians, archivists, digital preservationists, this work represents a call for us to begin the process of defining metadata generation and collection, network literacy, mobile information objects, and new kinds of records including born digital and born networked records. This also involves evaluating the traces that have been and will be preserved and confronting the possibilities of deletion, objects that resist collection, and the right to forget in an era of big data.

There's a long history of studying mobile, portable, material culture in applied LIS studies, such as in print history, conservation science, museum studies, human information behavior and moving image archives. One thing that I often have to remind myself is that we have always transmitted, lost, even deleted mobile traces, and further, there's nothing inherently "new" about mobile information objects in LIS. We have always had mobile, portable information devices that carry evidence of transactions that communicate culture across time and space. Consider cuneiform tablets, girdle books from the 13th century, or ladies handfans, even metal fasteners, which I wrote about in the introduction.

So what makes the study of mobile information objects coming out of mobile ICTs different than earlier eras of mobile information objects? For me, and for other mobile communication and information scholars, it's about the information landscape that is shaped by network coverage and produced by access to mobile networks. Simply put, carrying a mobile phone means carrying access to network coverage and this changes how we create, circulate and record our culture. When we carry mobile devices with network coverage our experiences of information landscapes change, and the possibilities of what we can do with mobile phones transforms in a variety of ways, from everyday life to surveillance programs. Moreover, network coverage presents some really sticky questions for those of us concerned with digital traces, because traces of metadata are constantly created in order to support the potential connections and more traces that mobile devices can create. Increasingly we are developing a new kind of network literacy that is embedded in how we see the potentialities of these always-on, always-connected devices.

Rich Ling (2012) has recently written about the ways we take our phones for granted. We use them all the time; they are the first screens we look at in the morning and the last screens we look at night. People have been documented sleep texting and experiencing phantom rings alerts for calls and texts that haven't arrived. Many of us feel anxious if we forget our phones at home or if the battery runs out before we can get back. I argue that these effects are from a new kind of network literacy that are folded into the daily patterns of our lives, they have become apart of what Anthony Giddens (1991) calls our "ontology of security". Early definitions of network literacy meant the ability to "identify, access and use electronic information from the network," but increasingly, as phones become taken for granted and the penetration rate of use comes closer to 100%, I want to argue that the definition should expand to include the tacit experiences of connection; including the potentialities of transmitting metadata with mobile networks (McClure 1997, ITU 2013). That is, our definition of network literacy should include ideas and possibilities that being connected to the network affords, not just consuming information in the network, but the potential of creating and accessing more records and traces of transmission.

Mobile phones produce information landscapes just as they allow us to read the boundaries of networks and the coverage they provide, so this new kind of network literacy not only includes how mobile network infrastructure supports record making, but the ways we construct recordkeeping and cultures of collection in the 21st century. This includes the traces of transmission that are collected for surveillance and big data analytics. In order for mobile networks to provide coverage our mobile devices is constantly creating metadata, or traces of transmission, about your location and what your doing with the phone so that service providers can provide seamless access.

Increasingly, metadata, the ties that bind the content together is becoming the organizing principle of collections in the digital age. I described how these traces of transmission, these staples of context, are just as important as the content and semantic structure of these records that we create and receive with our mobile devices. We not only need basic ideas about how computers and the Internet work, we also need to expand these competencies to understand how our mobile phones (which are indeed pocket computers) and how mobile network coverage works.

Contributions to the field

This dissertation tells the story of a format and asked some questions about what it means to create records with mobile devices, transmit them across wireless networks, and collect them.

In the second chapter I outline a framework for how to approach electronic records in infrastructure. I try to get past the debate of asking "what is a record?" when we encounter a new technology and ask, "when is a record?" when we use this new technology. This question isn't just important for mobile ICTs, this framework can be applied to almost anything, and probably should be used by archival scholars, because lots of ink, paper, energy, and disc space is being used up trying to answer what is a record in new digital environments. The framework for locating records in wireless infrastructure focuses upon three elements, including how they all fit together. The first element looks at layers of infrastructure. The second element is to look at device practice or use, how people actually create these things, how are the used, understood and operationalized as formatted digital objects, and the last part of the framework focuses upon new information retrieval contexts. This framework can be applied to many digital records moving through infrastructure, and I hope to continue to apply it in research questions in the future.

In the third chapter on SMS standards, I asked yesterday the question, "How did SMS come to be?" I wanted to know how standards are developed and how they influence the creation of formats. The third chapter tells the history of the standard SMS teleservice, the transmission protocol and how it came to be. Including, how the standards protocol and network architecture create this new digital format that is a metadata encapsulated object. The third chapter is one of the first accounts of how human readers are written in and out of the SMS data transmission protocol, and establishes the significance of the two-way transmission. It also points to a history that *could have been*—one where mobile users do not use messaging clients for textual messages between other people, but instead a machine to machine protocol.

In the fourth chapter, I asked a question of the systems that we use today, "How are text messages created, used, sent and deleted with our devices?" I especially focus upon how the format is enacted at the sites of creation and reception and in device messaging clients. It shows how users create and receive these traces as things. These findings demand an archival engagement with the various people who are involved in creating, collecting and designing messaging clients on mobile operating systems. Part of this engagement should begin by historicizing and rethinking personal digital collections and the fonds that are a result of telephony metadata and wireless transmission.

In the fifth chapter, I ask a question for tomorrow, "What will collections be?" It shows how users, governments and service providers understand text messages and how their accounts are in conflict, commensurate or likely to change. Bringing metadata, which is one of the most historical principles of LIS, to the foreground presents an opportunity for next steps and future work that will look at how obfuscation occurs politically and ethically under the law. It also illustrates how this asymmetry of metadata collection is changing our relationship to moral actors like states and corporations. Appraisal was a 20th century archival invention created to deal with the overflow of information. We need to reinsert it, and find generative strategies for resistance and change, as the mobile obfuscation, encryption and ephemeral messaging apps attempt to do. In the last chapter I aim to show how metadata creation is a social process, and how power, information and the individual record creators come together in specific times and places with different infrastructures.

This era of mobile communication has significance not only for how we create lines of inquiry, ask questions, and enable policy, but how we think culture is fundamentally recorded and collected in the third millennium. The text message as a new format is a kind of incunabula for mobile communication and provides a lens for which to see this change. The digital distributed materiality of text messages presents another way for us to think about this, the content is being deleted and subsumed but the metadata of these texts are being leveraged in different ways that is asymmetrical to the point where users themselves don't even know how it is being collected and how it is being used, and still further we know that databases and information retrieval is becoming more and more powerful. My framework can also be applied in different contexts, not just mobile computing contexts but for social media, for digital records, and studying how groups of people organize around metadata

This dissertation represents boundary work where I am bringing techniques from media archaeology and infrastructure studies to examine an archival object of inquiry and then reinsert ideas from archives back into the study of infrastructure and new information objects that are stabilized as formats. I'm excited to think about what these changes will mean for the relevancy and impact of archival studies. . This kind of work is a matter of negotiating the new opportunities and challenges that new information and communication technologies bring to archiving culture. Format histories, such as this, represent a valuable intervention into traditional archival theories but also into studies of infrastructure, system design, and the history of communication technologies.

Future work

The argument I have made here, then, concerns the future of text messages and mobile telephony metadata in collections as they are networked. My concern with these born networked records is less about the content of this new format and more about the processes of transmission of texts becoming, stabilized and standardized into a format. We need to remember old debates about records based on the assumption that transactions give rise to stable ideas about evidence, but at the same time disinter the ways in which infrastructures of transmission shape recorded information, in the moment and over time as collections of structured metadata. This involves giving an account that is itself historical, of how metadata happens, what is happening now to the collections that record creators and institutions do with these traces of transmission: including how we think, communicate, remember and archive. A discussion of how new formats are born networked records forces contemplation of the archive, which, as both an actual place and everyday experience, tells us a great deal about the present and future impact of mobile communication technologies on collection futures. And as this work ends, the future work begins.

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