Chapter 5
We Know Where You Are. And We're More and More Sure What That Means

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5.1 Introduction

A recent article in *The New York Times* (Duhigg 2012) provides an insightful analysis into the potential of online data collection, data collected in stores, location data, and analytically-determined information about individuals. The article describes how women making online and store purchases from a list of items associated with the onset of a pregnancy were identified and targeted with advertisements for pregnancy and infant products. The targeted advertisements could even arrive before others knew about the pregnancy. For example, a father wrote the company involved complaining about the insult to his teenage daughter who had received these advertisements, but then had to retract when his daughter acknowledged her pregnancy. While there are many privacy and surveillance issues associated with this and similar examples of the collection of personal information (Acohido 2011; Bell 2011; Burmeister 2009; Elwood and Leszczynski 2011; Pogue 2011; Shilton 2009), this chapter considers geographical questions related to determining where an individual is, what can be done with information recorded at different locations, and how this information can be related to individual activities and behaviors. Wide-scale tracking of individual activities and long-term data storage are key parts of an infrastructure that make the pregnancy example possible: Without them, analysis of the relationships between activities, such as purchasing certain items in particular time frame, and locations cannot be used to connect otherwise disparate pieces of information.

Pervasive information technology is crucial to this type of consumer surveillance. This chapter considers the important geographical dimensions of constant data collection, particularly how ubiquitous tracking and long-term data storage of location

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data reveal penetrating information about individual activities and behaviors. But first to a possible rejoinder: If, in the information age, distance is dead (Cairncross 2001), why is geography relevant? Regardless of the ease with which we now send materials around the world in seconds, or converse with family or colleagues residing in multiple countries, the location and the relations among activities, things, and people associated with a location still matter.

In spite of common school-age preconceptions and popular geography games based on rote memorization of states, countries, and their capitals, geography now emphasizes understanding relationships and interactions (Massey 2005; Sheppard and McMaster 2004; Smith 2004; Sui 2004). Although knowing where things are remains an aspect of geography, the main intellectual emphasis of the discipline today has shifted to a consideration of spatial relationships.

The recent "spatial turn" of a broad range of fields in the sciences and humanities, including fields as diverse as cognitive science and history, may seem novel, but the analysis and study of locations and relations has always been, in fact, a central component of the discipline. Briefly, classical western geography, from Ptolemy and Varenius on, has connected the locations of countries, cities, rivers, lakes, and other political and natural features through their relationships (Livingstone 1992), e.g., "Athens is on the peninsula of Attica in the Mediterranean Sea between Mount Aegaleo and Mount Hymettus". The description of relationships and locations remains a key emphasis in the geography of exploration. In the seventeenth century, Berhnard Varenius described the coast of Eastern Africa and the Arabian peninsula in terms of connections from one geographic feature to another – much like a sailor following the coasts would make use of such features – but following scientific principles of the time and offering a comparative geographical analysis that was the inspiration for Alexander von Humboldt and other geographers. Later, influenced by colonization and German idealism, including contributions from Kant, von Humboldt and others developed geographical enquiry to support the nascent nation states and projects of conquest and subjugation while moving between cosmological and practical geographical questions.

Reflecting these disciplinary developments, most geographical topics taught in elementary and secondary schools in the U.S. continue to emphasize geography's contribution to learning about where things are in the world and how they relate to learn their organization: rogue nations and allies, homeland and foreign, western allies and eastern bloc. During the last 200 years, colonization and imperialism influenced the inclusion of certain subjects and exclusion of others in the educational systems of modern states, leading to a constrained role for geography supporting the state and the commerce of its industry and businesses. Although the role of geography for state's purposes continues to be strong, in the late twentieth century geography began to return to scientific and comparative approaches to understand disparate social and economic developments (Massey 2005; Sheppard and McMaster 2004). Geography, and the related field of cartography, have a long history of studying geographical relationships.

Physical relationships still define issues in the movement of physical items, but understanding a key dimension in the development of the information society – the apparent transcendence of physical distance in most human communication (Castells 2000; McLuhan and Powers 1989) – requires considering how virtual relations increasingly mediate our interactions. These relations leave a trail of data, and while physical distance barely matters in the topological network of the Internet, physical distance continues to have considerable impact. Indeed, location remains a crucial factor in most human communication. However, with pervasive computing technology, data can be collected on any and every interaction.

Geographical information technologies provide enhanced surveillance capabilities for recording and analyzing activities. Smartphones are constantly tracked for assuring technical service, but this data can be requested by government authorities or aggregated and later disaggregated. They connect activities, things, and people in a web of relations that can be readily analyzed to reveal highly specific details of our activities and behavior, such as a pregnancy.

Location-based services offer ways to open up new possibilities and augment existing capabilities. The number of these services and technologies is increasing rapidly, with the smartphone becoming the hardware platform of choice. People can use these capabilities in countless ways, including, in the course of one evening: finding a hotel, choosing a restaurant, getting directions to dinner, programming background music to sooth sleep, and, before retiring, check on the family dog back at home. It is the often the unfettered collection of location data that comes with these uses that leads to hitherto unimaginable capability to track individuals and objects 24/7, collect location data, store this data for long periods of time, combine this data with other data sources, and analyze location data. The possibilities are endless and raise concerns.

Isolated data may offer valuable insights, but it is limited to a portion of activities –merely a part of a complex of relations connected to only limited location information. Tracking allows this data to be placed in relation to other activities, things, and locations. Combining data based on location can easily produce a full picture of relations. For example, the analysis by L. Sweeney demonstrated that only ZIP Code (postcode), birth date, and gender were required to uniquely identify 87 % of the US population (Sweeney 2000). This analysis shows that one locational attribute can be combined with one temporal and another physical attribute to yield the very powerful identification of the vast majority of people in the US. Consider what this means: Otherwise unrelated datasets – say databases of Google searches, Netflix viewing, Amazon purchases, and Facebook "likes" – include these three pieces of data, and they can be combined to reveal intimate details and proclivities of millions of identifiable individuals. Large amounts of relatively detailed location information fundamentally change what we can know about each other and the world.

While this capability has been available since the 1970s, it has been limited by the cost and complexities of data collection. It also has been a niche study in the sciences and engineering, although evidence of geospatial statistical analysis has been present for quite some time. Of course, the potential originates with geospatial statistics and the computational support of complex statistical analysis. For instance, in World War II statisticians were able to determine from serial numbers of captured or destroyed German tanks almost the exact volume of production of German

Fig. 5.1 Portion of John Snow's map. The *number of bars* indicate the number of cholera cases associated with an address. Snow determined that the water pump at the corner of Broad and Cambridge was the source of the outbreak (From http://www.csiss.org/classics/content/8)

armor – a number verified after the war. Interestingly, the actual volume turned out to be only 1/5 of the Allied wartime intelligence estimates of production (Davies 2006). Geospatial statistics begins with these techniques, but extends them to take into account principles of geographical relationships. Ninety years before World War II, John Snow, in perhaps the first geospatial analysis, used spatial statistical techniques to analyze the diffusion of a cholera epidemic in 1854 and establish the source of the outbreak (Fig. 5.1).

With huge amounts of data now routinely collected by smartphones, mobile devices, and fixed sensors, the capabilities and surveillance necessary to collect this data has become widely available. The amount and accuracy of location data now collected by digital devices far outstrips the small data sets used 150 and 60 years ago, as well as the less powerful information processing capacities of just 20 years ago. Sweeney's analysis becomes possible due to the digital storage of much larger data sets and the development of automated and semi-automated geospatial analysis techniques. Snow's analysis techniques now enable the identification of disease vectors and the shopping habits of individuals. Beyond studies of economic and cultural relationships, the analysis of geographic relationships is key to understanding the revolution that ubiquitous computing offers for surveillance in the information age. The result is an unparalleled level of private surveillance, providing the detail and breadth of information that make it more and more possible to generate predictive models of behavior and relationships.

5.2 Location Privacy

Location privacy issues connected to PICT are widespread. These concerns are associated with uses of GIS in epidemiology, health care research, and other areas of social science that use demographic data. Data privacy has been an important concern in these areas, and it is helpful to consider distinct phases in working with geographic information (collection, processing and analysis, presentation) and the impacts among these phases. PICT involves these phases, even if they have been largely automated, and, even dealing with streams involving terabytes of data/day, occur instantaneously, for all intents and purposes.

5.2.1 Data Collection

The starting point for all data is, of course, information collection. Sampling bias remains an important concern with sponsored or authoritative data collection, as well as with crowd-sourced data. Sampling bias in research shows up in attribute errors, positional errors, logical inconsistencies, attribute bias, or positional bias. In some cases, the errors are due to calibration errors, or the loss of accuracy. As anyone using a barometer to measure elevation change can testify, a drop in air pressure as a low pressure weather front moves through an area can lead to surprising increases in elevation, even if one is standing still. These errors can occur without notice to most GPS users. More complex error or bias can come through internal sensor failures, or erroneous referencing. Logical consistencies are often related to each other, but frequently come through misuse of measuring devices or misunderstandings. Further complexities and challenges arise through the interpolation of data. Most data is only collected at selected locations and then interpolated for an area. Beyond attribute and positional accuracy issues that can influence interpolation, the results of interpolation are usually not quality-controlled without a cross check against observed values or experts. These problems also apply to aggregations of population data (Rushton et al. 2006).

5.2.2 Data Processing and Analysis

The processing and analysis of data also is open to errors that can lead to incorrect results. The use of inappropriate or invalid techniques can lead to results that seem reasonable, but again, without cross-checking or quality control, are actually wrong. Through news stories, we are familiar with incidents involving entering wrong data. Map makers regularly would produce small errors in out-of-the-way places to allow them to identify copyright violations (Monmonier 1991). Similar issues arise in the processing and analysis of location data, except that the errors originate in misguided analysis. An especially pernicious problem is the reduction in statistical variance and inflated significance that arises when comparing data aggregated for a large area and then applied to smaller areas (Getis 1999; Unwin 1981). Called spatial autocorrelation, this nuanced problem can lead to wildly incorrect conclusions, even though the statistical functions offer support. Bias in data due to aggregation effects and the choice of statistical techniques require cross-checks and verification runs.

5.2.3 Data Presentation

The presentation of location data is especially prone to explicit and implicit errors and errors in judgment that greatly impact the reliability of data. A classical problem is choosing the appropriate projection for a map or image. All projections distort, but it is possible to control the type and amount of distortion in terms of either area or shape. Scale, selection of features, and generalization are common challenges that can seriously impact what is seen. Equally important in thematic maps that show ranges of values are symbolization choices, especially in the selection of class intervals.

A challenge for all publication of personal data remains the possibility of reverse engineering the characteristics of individuals or small groups. Database relational joins can associate data from separate data sets, making it possible to generate associations or use statistical functions to determine probabilities. Map overlays can help develop more specific attribute information by associating the location of attributes from different data sources. Finally, reverse geocoding allows for addresses to be created from geographic locations. In many areas, accurate geographic locations can be readily converted to street address locations for other purposes.

Even though Mark Monmonier warned that "All maps lie" (Monmonier 1991), it is easy to lose sight of the complexities and contingencies associated with location data. Location privacy is tied up with privacy issues in general, and a movement is afoot to recast fundamental themes and attitudes. Recent work that reassesses the evolving concepts of privacy shows a way forward (Duquenoy 2007; Solove 2008; Weiss 2008; Sullivan 2009; Watson et al. 2009; Burmeister 2009; Fischer-Hübner et al. 2011). The underlying challenge for pervasive computing and location information is understanding how to balance opportunities and risks. To understand the potential, geographical concepts in cultural and information geography can be distinguished following Helen Nissenbaum's analysis of privacy in context.

In her work, especially her recent book *Privacy in Context* (2010), Nissenbaum develops a theoretical framework based on a pluralistic concept of privacy. *Privacy in Context* provides an in-depth analysis of privacy that avoids the pitfalls of attempting to create an inclusive and purified concept of privacy. The central idea she advances is that instances of privacy are grounded in contextual integrity. Contextual integrity reflects individually-calibrated systems of social norms, or rules, that "define and sustain essential activities and key relationships and interests, protect people and groups against harm, and balance the distribution of power. Responsive to historical, cultural, and even geographic contingencies, informational norms evolve over time in distinct patterns from society to society" (Nissenbaum 2010, 3). Information technologies that violate contextual integrity lead to privacy anxieties. Computer scientists have adopted this approach to identify variables and their values that in particular contexts would violate a situation's contextual integrity (The Economist 2007).

This pluralistic concept of privacy speaks to the importance of location. Many of Nissenbaum's examples are geographical in nature. For example: Should Google's Street View data include images with identifiable individuals without their permission? Physical location still matters, but many activities are no longer bound to hierarchical scales of institutions, cultures, and norms. We can get step-by-step directions to a museum in Sao Paolo while speaking in real time with a person in London; we can find out precisely where our children are at any time; it makes less and less difference if the person we are calling is on the other side of the globe or city. We can access Street View images from any place in the world no matter where we are. Increasingly pervasive information and communication technologies are in the process of merging physical and virtual interactions in our daily lives.

Following on Nissenbaum's theoretical framework, location privacy has to explicitly consider the role of physical and virtual interactions in different contexts. Contextual location privacy posits a flexible and selectively permeable membrane people maintain to balance private and public spheres of activities. Following the main ideas of contextual privacy, location privacy may become the way people modify the permeability of this figurative membrane between their physical and virtual location based on their desire for sharing information about their whereabouts and locations of activities.

5.3 Much More Than Knowing Where

This section considers the development and important principles of location-based analysis of data associated with pervasive information technology, particularly online and mobile device location data. These are key technologies of ubiquitous surveillance in the information age. Over-arching issues of pervasive information technology surveillance are addressed in Chap. 1 of this book. Consideration of the potentials and challenges of location data and pervasive IT involves engaging recent geographical research and its context. Since World War II, a growing segment of geography research has focused on information technology development and use. Emphasizing quantitative approaches, often simply because they are more amenable to computational representation analysis, but including qualitative aspects, geographical research in this area has advanced ways of understanding location and relationships. In the same time period, researchers in cultural geography have developed qualitative analysis, building on social theoretical frameworks from the twentieth century.

5.3.1 Quantitative Approaches

Reaching back to work by John Snow in the nineteenth century, quantitative approaches have contributed mathematical methods and related theories to study location and relationships. Cartography has played a central role in providing reliable representations for these techniques and supporting government, private, and military adoption. The advent and wide-scale use of computers has allowed spatial analysis to develop in leaps and bounds beyond these roots.

One important reason for these developments is the availability of data. Whereas 200 years ago John Snow had to visit the neighborhood of the cholera outbreak and, through queries, establish its source, with the ascendency of statistics as a key instrument of state control (Kitchin and Dodge 2011; Hannah 2009; Ettlinger 2011; Elden 2010), this information is widely available digitally, in some cases even mapped. To protect privacy, most of this data is now aggregated, which is simply the process of reducing the information content by assigning the information values to a new geographical unit. In the US, census data on households can be aggregated to census blocks and census tracts with around 4,000 people, the lowest census geographic unit. Census tracts are the most common unit for reporting detailed census data because specific information to identify households is indistinguishable from the average tract value. Even then, some data may be withheld to protect privacy. Census tracts only coincidentally share boundaries with zip codes.

Aggregation is not only a technique for increasing anonymity, but a widely-used technique for reducing the values of information to make simpler and more legible representations. It is used for many kinds of demographic data. However, its use can lead to problems if important distinctions in the original data have been abstracted and conclusions are made from the analysis of the aggregated data. Furthermore, employing additional data and advanced statistical techniques, it is possible to reverse-aggregate (or disaggregate). For example, data from a pet store's customer data base could be used to identify pet food shoppers in a particular income range, thereby possibly defeating the anonymization coming through aggregation. The reliability of disaggregation results depends on the additional data and level of aggregation.

Geocoding can be used in conjunction with aggregated data to positively identify individuals (Mazumdar et al. 2008; Rushton et al. 2006). Geocoding is the term used to refer to the transformation of location information, generally street addresses, but zip codes and other enumeration units as well, to geographical coordinates, usually latitude and longitude coordinates. Transforming addresses to geographic location coordinates allows the data to be combined with other data, using operations that combine the data based on location. In this process, it is also possible to use random numbers or reduce the precision of the coordinates to obscure the exact location of geocoded data.

Reverse geocoding, as the name suggests, is the process for transforming coordinate location to readable addresses or place names (Armstrong and Ruggles 2005). It is an important component of the 911-system responses to cell phone emergency calls, allowing abstract location coordinates to be shared and shown as readable addresses or places. The computation of reverse geocoding can be involved, but is widely available. For example a GeoNames web service (http://www.geonames.org/) provides 37 specialized services to determine the location of geographic coordinates by city, nearby streets, postal codes, etc. In the context of surveillance, reverse geocoding is often used with aggregated data to iteratively narrow down the possible spatial range where an individual can be located. A modern-day John Snow may have ready access to aggregations of demographic data, but reverse geocoding can be used to help determine more precise locations.

Spatial analysis provides a cornucopia of transformations and functions for the analysis of geographic information, including aggregation, geocoding, and reverse geocoding. However, determining location remains a research challenge. People often associate places (my office) with locations (its address) and then relate them to other places (my favorite restaurant) and their locations (one block south and two blocks west) with ease, but this is exceedingly difficult to compute reliably with small amounts of data. Other challenges remain and are often the source of significant errors. In particular, the association of the value of aggregated attribute data to all individuals in the area, known as the ecological fallacy (O'Sullivan and Unwin 2003; Longley et al. 1998; Fotheringham et al. 1994), is particularly relevant and pernicious. A deceptive bias can arise when analysts aggregate data to a different enumeration unit and then use this data for statistical analysis (O'Sullivan and Unwin 2003). A common error is to report aggregated data from several neighborhoods as the average for the cumulative error, often ignoring racial or income related differences. Among other challenges are the role of scale in measuring the physical length of objects (Mandelbrot 1983).[1] Almost 50 years ago,

[1]Imagine you are trying to measure the length of a coastline using a one-mile-long ruler. Any feature of the coast smaller than a mile is likely to disappear. If you use a one-inch ruler, almost every squiggle of the coast will be included. Say the one-mile ruler yielded a length of 5.2 miles of coastline; the one-inch ruler might well yield something like 1,035,036 in., or 16.33 miles. All of those squiggles add up to make a much longer coastline.

Julian Perkal challenged the widespread view of map measurements as accurate. His MICMOG paper on stream lengths (1956) shows the scale dependency of length measurements. This an issue we can also consider when we work with demographic data using boundaries that follow natural features and when we use aggregated data about individuals.

5.3.2 Qualitative Approaches

The roots of qualitative approaches to spatial analysis go back to the philosophical idealism of the late eighteenth and nineteenth centuries. Oversimplified, qualitative approaches break from Aristotelian scholasticist-influenced, hypothetico-deductive approaches. They take up elements of the Marxist corpus, Frankfurt School, and Pragmatism. The very complex, and at times contradictory, approaches of qualitative spatial analysis fit in neatly with Critical Theory's focus on studying the conditions and processes of the emergence of objects of knowledge. In other words, a persistent skepticism about the possibility of knowing reality associated with idealism leads to enquiries into the constitutive elements at particular locations and the relationships that give location meaning. Work by feminist scholars in geography and philosophy has strongly influenced the recent development of these approaches.

Commonly used is an interpretative analysis that focuses on individuals through ethnographic techniques and inductive analysis of individual situations. The work of Mei-Po Kwan and Marianna Pavlovskaya exemplifies this approach to spatial analysis. In her work on gendered space-time activities and transportation (Kwan 1999, 2007), Kwan uses travel diaries to determine the activities of women during the day, analyzing them using quantitative tools to establish patterns and relationships. Interviews guide the interpretation and provide much additional insight supporting the analytical process that identifies spaces of safety and spaces of concern, or even threats. Pavlovskaya uses the interpretative analysis of activities to analyze survival strategies in post-socialist Moscow and spatially analyze how households in a neighborhood meet the challenges (Pavlovskaya 2004).

Qualitative approaches have very frequently been used in conjunction with quantitative approaches. In many cases, qualitative data is transformed into formats suitable for mapping and the resulting visualizations used to show relations. In a growing number of research studies, data collected using qualitative approaches is combined and then analyzed using quantitative techniques. Usually these techniques rely more on network analysis than an analysis of aggregated statistical data, but they can indeed be combined. Knigge and Cope (2006) provide a rich example of the possibilities of using grounded theory to guide the analytical visualization of community interactions. Another example of this approach can be found in work that analyzes residential dynamics (Omer et al. 2010). Other researchers have turned to qualitative approaches to understand how maps are used and made (Suchan and Brewer 2000). Meghan Cope and Sarah Elwood have published an edited volume (Cope and Elwood 2009) that provides a succinct introduction and a diverse range of examples of qualitative approaches, especially the development of mixed methods.

5.3.3 Hybrids of Approaches; Hybrids of Surveillance

These hybrids are particularly significant to consider when using information and communication technologies that are hidden, invisible, or often unnoticed. The benefits of pervasive information and communication technology (PICT) for behavioral research and other fields is very evident. The next section offers some examples from published research and explores potential use of location data collected from PICT. The potential for abuse has been noted by researchers and is the focus of the following section of this chapter. As PICT seems to involve no systematic quality control, chances are that errors abound as frequently as with crowd-sourced data.

5.4 The Hybrids of Surveillance

The data collected under statutory requirement or administrative procedure is a critical component of state programs (Liptak 2011; National Research Council (US). Panel on Confidentiality Issues Arising from the Integration of Remotely Sensed Self-Identifying Data 2007). For all the critiques of these programs, they have developed reliable principles to protect privacy. Hybrid approaches that rely on PICT, however, go largely without accepted principles to guide the collection, use, and storage of personal data. In considering some examples of hybrid data collection and analysis this section aims to point out the potential uses and abuses. The first two examples come from published academic research and provide evidence of the need for guidelines for protecting human subjects, and consider known applications. The final two examples consider research that articulates the changing meaning of location and the relationships revealed by pervasive information technology.

5.4.1 Behavioral Changes in a Minority Group

In the first example, I consider the abilities of locational data collection to provide unique insight into behavioral changes in a minority group. The researcher, Mei-Po Kwan, uses location technologies to look at the response of Muslim American women to 9/11 and develop a counter-narrative to dominant images of repressive and violent Muslim culture to show the impact of fear on their daily lives (Kwan 2007). The study involved 37 Muslim women in Columbus, Ohio. Oral histories were collected and sketch maps created to show areas the women considered unsafe before and compare them with areas they considered unsafe after 9/11. One Muslim woman's oral history supports the construction of a GIS-based visual narrative. The visual narrative shows the spatial story of how, immediately after 9/11, this woman remained at home almost all the time for several weeks out of fear. As her fear abated and community activities resumed, the range of her daily activities gradually increased. Although pointing to the ability of location technology to expand understanding of minority groups, the example also demonstrates its potential to reveal details about individual behavior through analytically or visually examining specific locations and relationships that otherwise may have remained unknown.

5.4.2 Locational Data and Personal Information

These issues are at the center of a report from the National Research Council (2007). The report points to the challenges that arise when locational information is linked to personal information (see Chaps. 2, 6, and 8 in this volume for additional related discussion). While these capabilities make new types of social science research possible, adding locational information also makes it possible to reverse-engineer identities. This not only violates the assertion of confidence in the protection of anonymity, but opens up the door to associating additional information with the individual. The ethical and legal issues remain slippery, and the report offers cautious guidance and a proposal for further research to determine what levels of location and personal information produce unacceptable risks to the protection of confidentiality.

The Electronic Freedom Foundation and others would readily claim that the train has already left the station, and the unregulated world of personal data collection and re-use has already advanced to a point where many individual behaviors are known and predictable. Location is seen as key information needed for associating behaviors and other factors with individuals. Since the use of computers has become widespread in marketing, commercial entities have steadily been developing data collection techniques to associate location with behavior, especially for consumer-related activities and characteristics. Micro-scale marketing analysis in the 1980s and 1990s enabled ZIP Code (postcode) level identification of consumer types (Goss 1995). Small-scale marketing analysis provides means to describe behaviors of individuals and households. The increase in the geographic resolution of this analysis is mainly due to the enhanced collection of data on individuals. Advances in analytical capabilities play a far lesser role, but are crucial for making sense out of the ever-growing mountains of data.

The types of analysis that are now possible have been covered in a variety of venues. An eye-opening investigative article (Duhigg 2012) provides a great deal of insight into how in-store surveillance is currently used with other data collected in shopping transactions to analyze shoppers' activities, develop models, and then contact individuals directly with marketing materials aimed to increase their purchasing.

5.4.3 RFID Surveillance

That industry has already begun to understand that the possibilities of further enhanced surveillance and data collection have raised the concerns of citizen groups. Katherine Albrecht and Liz McIntyre in their book *Spychips*: *How Major Corporations and Government Plan to Track Your Every Purchase and Watch Your Every Move* (2006) highlight the potential of widespread use of Radio Frequency ID tags (RFID). Companies praise the tags for improving the ease of managing inventory, while their marketers suggest the tags will improve availability of products, ease consumer negotiation of the complex market place, and remove the onerous check-out till. Albrecht and McIntyre report on many of the less scrupulous industry activities, including: following shoppers to record car license plate numbers, scanning garbage and analyzing rates of product use, and connecting wireless RFID toll road passes with travel behavior, including visits to stores.

5.4.4 Geoslavery

Pervasive information technology is essential to assuring that visions of ubiquitous computing become reality. For many, cell (mobile) phones are the key technology, and certainly the bridge technology until comprehensive sensor and monitor networks can be implemented. Of the many writers who consider the surveillance potential and privacy challenges of mobile devices, Jerome Dobson and Pete Fisher have written the most poignant review of pervasive location monitoring. In an article published in 2003, Dobson and Fisher refer to the real potential that mobile phone tracking can be used to create Geoslavery – persistent monitoring that leads to control (Dobson and Fisher 2003). This is not control in the physical sense, but rather control in the sense of Orwell's *1984*, wherein surveillance plays on an individual's fear of being 'out of place.' Risk and fear make it possible to regulate how and where an individual moves in the real world.

5.5 Conclusion

In summary, I have focused on existing technologies, analysis techniques, and nascent technologies. To complete the consideration and raise an issue that may likely become more relevant in the coming years, I should mention unmanned aerial vehicles (UAVs), which are becoming increasingly common platforms for surveillance. Functional UAVs are available for less than 1000 USD. They are very limited, but quite capable of overflying an event, such as a gathering or party, carrying a small sensor that can record visual images. Larger, more capable UAVs can carry larger and more sensors and stay aloft for longer period of time. While their use is likely to remain limited at first, local governments are gearing up for more wide-scale usage (Electronic Privacy Information Center 2013). For now, regulation of airspace sharply limits their use.

Regardless of the technology, PICT is and will continue to be an ever more widely used means to collect data with location characteristics. Given the breadth the depth of this data collection, regaining control of privacy will remain a very challenging issue (see Chap. 2 for relevant discussion of GPS-related issues). The Electronic Frontier Foundation also provides more practical information on location privacy issues and ways to minimize tracking. Proposals for the implementation of a "Do-Not-Track" opt-in provision can offer a way for individuals to at least minimize further location data collection.

As other authors in this book suggest, information and communication technologies that are hidden, invisible, or often unnoticed are already common and will continue to proliferate. Knowing where individuals are, tracking them, and analyzing relationships associated with location will undoubtedly become more commonplace. The Geoslavery concept points to a central risk of these developments that perhaps may outstrip the benefits. Sensors intended for inventory control, identification, and system monitoring are being released into the 'wild,' where a multitude of unintended consequences awaits. This development signals a new era in which people no longer understand or control the on/off switch, and location awareness moves into uncontrolled forms of 24/7 tracking.

Faced with dystopian perspectives, and perhaps naively, the proponents of mobile technology and commercial surveillance seem to deny the issues raised by GeoSlavery. Or perhaps the communities involved with these technologies will be blissfully unaware that they are lost, just as drivers who unquestioningly follow routes generated by satellite navigation systems. Indeed, perhaps, our concepts of location privacy can develop to a point to allow us to distinguish between problematic re-use of location data (aggregating data on our application use to other data about our preferences) from benefits we immediately have (finding a good restaurant) and possible benefits we stand to enjoy (finding good restaurants we like in the future).

PICT involves constant interfaces among people and ICT – pervasive indications of the growing ubiquity of ICT in our interactions. The concepts of location-based analysis of data associated with pervasive information technology, particularly online and mobile device location data, are key technologies of constant surveillance in the information age. The assembling of data about where things happen and the analysis that helps construct relations into constantly available infrastructures greatly enhances the ability to take information about where we are and have been and assess what that means.

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