9 Bodies in the Cloud: A Geography of Electronic Health Data

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Clouds suggest ephemerality—wisps of mist high above that cannot be grasped, tinkered with, or tossed around. They are apart from the Earth's surface, in many ways the opposite of rock and soil and of being grounded. In computing, the cloud metaphor has grown because it offers a way to imagine a spatial relationship between computing devices and the information that populates their screens. People ask devices to retrieve information that is floating around in an all-containing atmospheric cloud above them, waiting to be instantaneously zipped below to the surface, where it appears and can be manipulated. Or so the metaphor goes. Many readers will know that this is not in fact how the storage and retrieval of information in the cloud works. The geographic reality is that data must be stored on servers, collected inside highly protected buildings, and anchored into the Earth, where it can connect with energy networks and communication cables. Data is material, it takes up space and, in the aggregate (for 1 digital bit is actually close to ethereal), requires a massive infrastructure of data centers that are located somewhere.

To speak of information landscapes, then, is to speak of how changes in the visible field of our planet's surface reflect, as well as constitute, the geographical organization of data in the Information Age. Affecting this visual field—where data centers are built and what they look like—includes the political economies of energy (where is energy cheap?), the architectural design of data centers (e.g., security measures and power backups), and the rise of a cultural ethos that everything digital can and should be saved forever. However, we cannot pretend forever that the material effects of infinite data do not affect our landscapes—the places that we live in, work in, and move through every day. Governing this often-ignored materiality of information is crucial as the categorical and geographical boundaries between people, electronic data, and landscape continue to blur.[1] Writ most broadly, this chapter explores the distinction between virtual and real. More specifically, it is about what happens when we seriously attend to the materiality of the cloud, halting assumptions that the physical manifestations of data are insignificant. Instead of being massless or devoid of form, the virtual is as much a part of the real as any other object with a tactile presence would be.

Understanding the relationship among electronic data, people, and landscapes is about understanding how objects in space become related to one another in the first place. The materiality of electronic data, in other words, is an instance of object relations, an issue of sustained interest to spatial and environmental theorists (Robbins 2007; Coyle 2006). Blurring virtual and real becomes a matter of blurring different types of objects that significantly alter each other's existence—objects that are not normally thought of as being relatable, such as digital information and people. This should also be of great concern to political theorists interested in land use, zoning, or environment. If digital representations of people come to be considered material extensions of bodies, then the places in which those extensions rest might be given the same rights to health as would a person. To abstract, the bigger implication is that by reconceptualizing object *relations* as object *extensions*, protecting the health of landscapes becomes as crucial as protecting the health of people. To substantiate this line of thought, the chapter examines the case of a form of medical biotechnology called *Wireless Body Area Network (WBAN),* articulating how electronic data, bodies, and landscapes all should be considered part of the same phenomenon. It is argued that the bodies of people who use this technology geographically extend into the landscape of data storage, such that the shape of their bodies follows the very mundane, the very grounded infrastructure of the cloud.

Vignettes from New Jersey

In 2012–2013, the Superior Court of New Jersey reached decisions on two cases that break down the categorical and geographical distinctions between bodies and electronic data. While neither of these cases is explicitly about electronic health information or data centers, together they begin to build a concept of what a class of legislation that gives a person equal standing with the digital information associated with him or her might look like. It is helpful to start with these two vignettes from the judicial system before moving into the main case study of the chapter because they frame the relevance of two concepts introduced afterward: *body-data* and *extensible space*.

In 2012, the state of New Jersey convicted V. M. Patel of attempted sexual assault of a child after he was caught in a law enforcement sting in which a police officer posed as a 13-year-old girl in an online chat room (*New Jersey v. Patel* 2012). After driving to meet the girl and being arrested, the defendant argued that no crime was committed because the girl only existed virtually, and "he could not be found guilty of committing a crime against a virtual child." There was no girl at the prearranged meeting place—only police cars. The judge rejected the defendant's argument "that he could not be convicted of the charged offenses which require, as a material element, there be a person or child, because [the girl] was only a 'virtual' person or child." This decision by the judge offers an example where the legal standing of a virtual person was upheld regardless of a "material element." In this case, interaction with the person's virtual body through communicating online, coupled with the intent to interact with that person's physical body, was enough to find the defendant guilty of attempting to commit sexual assault.

In 2013, an 18-year-old driver named Kyle Best grievously injured two motorcycle riders when his vehicle crossed into their lane and hit them head on (the left leg of each rider was amputated at the hospital). Best was texting with his mobile phone at the time of the collision. The trial court found settlement in favor of the injured plaintiffs, Linda and David Kubert. The Kuberts, however, did not stop there—they sought further damages from Shannon Colonna, the person with whom Best was texting at the time of the accident (*Kubert v. Best* 2013). While Colonna was nowhere near the scene of the accident, she was accused of culpability via her virtual, electronic presence. In his written opinion on the case, the judge stated:

> Although Colonna was at a remote location from the site of the accident, plaintiffs say she was "electronically present" in Best's pick-up truck immediately before the accident and she aided and abetted his unlawful use of his cell phone. … We must determine as a matter of civil common law whether one who is texting from a location remote from the driver of a motor vehicle can be liable to persons injured because the driver was distracted by the text.

In this particular case, there was not enough evidence to hold Colonna liable since it could not be proven that she knew that Best was driving at the time; it was Best's responsibility not to use his cell phone while driving. But for the purposes of this chapter, it is powerful that the three Superior Court judges who heard the case did *not* dismiss the Kuberts' claim against Colonna as outlandish or misguided, as the trial court did.

On the contrary, they held that "the sender of a text message can potentially be liable if an accident is caused by texting …. We do not adopt the trial court's reasoning that a remote texter does not have a legal duty to avoid sending text messages to one who is driving."

In each of these vignettes, it becomes clear that actions taken in a virtual, digital medium can have material consequences in the real world. In neither case was there a geographical co-presence between the body of the accused and the body of the victim. In the sexual assault case, Patel never touched or saw a 13-year-old girl (and unbeknownst to him he never communicated with one either), while in the texting case, Colonna was far from the accident she was accused of causing. In each situation, however, the court found that damage or potential damage to someone's body can be achieved from a distant location by use of transmitted electronic data. Importantly, the court cases hint at how the notion of geographical proximity is changing in light of digital information. For two people to be in the same location no longer requires that their traditional biological bodies (defined for now as ending at the skin) be in the same place at the same time.

Through the poignancy of their subject matter, these cautionary tales help us recognize in a concrete way that actions taken at the terminals of electronic devices (i.e., computers or smartphones) alter physical reality in other places. Here, they do so immediately, discretely, and in a way that is traceable, such that they become the subject of a court case. From this, it becomes totally conceivable that the collective, societywide actions taken at the terminals of our devices have equally profound effects on distant parts of the material world. That is, the series of cause and effect that begins with the creation of electronic data ends with an alteration of landscapes near and distant. One significant landscape alteration is the erection of data centers and the accompanying changes in surrounding land use they require to meet their high energy consumption. City and regional planners, for example, are vastly remodeling landscapes to accommodate this new economy, retrofitting business parks to attract companies that specialize in data storage and retrieval. Data centers can be visually arresting in the new landscape of business parks. "As the growth of cloud computing forces providers to super-size their infrastructure, their energy needs scale as well. The energy park concept is a way to join these trends in a real estate play" (Miller 2012). The energy park is a planned landscape that allows data center operators to control a variety of infrastructural needs in one campus setting. These needs include different types of energy (including grid, wind, and solar), and access to the fiber optic cable network (Niobrara Data Center Energy Park 2012).

Bringing Together Bodies and Landscapes

In the two court cases discussed previously, physical closeness between people and distant places is achieved by geographically extending oneself through space via the transmission of digital information. The Superior Court of New Jersey found that Colonna's electronic presence in the cab of Best's truck was the same as if she were there in person, distracting the driver. Likewise in Patel's case, his attempt at sexual assault—his physical presence—was considered as real as if he had begun undressing a young girl and then was caught in the act. He was considered physically near his victim, normally a given for culpability of bodily harm done to another person.

With these rulings in place, what is the next step in understanding the relationship among electronic data, bodies, and landscapes? The geographical extension of oneself to another place necessitates rethinking the idea of a singularly located body. With the potential to be hyperconnected through digital media and telecommunications, it is becoming clearer that the electronic data we create have the potential to not only represent us in different places, but to *be* us in different places without our biological body (as normally defined) having to move. To clarify, two types of geographical extension are going on. The first is when a transmitted piece of information ends up in a particular place and has an immediate effect there (such as causing a car accident). The second is the more general principle to be drawn from the first: that all electronic data in the cloud go somewhere and affect the physical state of that place. Yes, people create electronic data, and yes, those data feed the growing infrastructure of data storage, requiring more data centers and more energy contracts and more servers. In this way, we know at the most basic level that actions on devices affect the way landscapes are built and the way they look.

Now, here is an interesting question: what happens when the content of transmitted data is not linguistic communication, but a measurement of someone's body? In the New Jersey vignettes, the geographical extension of people via electronic data happened because the defendants transmitted textual information to another person who was not close to them. But in the next and final case study of this chapter—the WBAN—the data being created, transmitted, stored, and retrieved are measurements of biological functioning. As a case study, this medical biotechnology offers a more direct way to talk about how it is possible that bodies could be geographically extended along the infrastructural pathways of the cloud.

Wireless Body Area Networks

WBANs are used to monitor the condition of hospital patients who are away from the hospital. Monitoring from afar in this way is possible because in a WBAN, biosensors are placed either on, or implanted inside of, the patient's body. The sensors then transmit data, through a series of data-handling technologies, to computers where medical professionals use the streamed and stored information to make diagnostic conclusions or to be warned of impending danger in a patient's condition (Kirbaş and Bayilmiş 2012; Yuce and Khan 2012). The path that this electronic *body-data* takes, from the patient's body through the physical infrastructure of the information landscape to the medic's viewing screen, is the way that the patient's body is materially extended to other places.

WBANs are the critical technological component in the growth of *tele-health,* a sector of the health-care industry involving the transition from in-person doctor visits to remote consultation and monitoring. Telehealth promises to serve immobile, remote, geriatric, and low-income populations by reducing the travel and financial challenges associated with going to the doctor's office (Jurik and Weaver 2008). With the advent of more readily available wireless networks (e.g., WiFi and 3G/4G), telehealth is moving from its beginnings—where a patient would, say, phone in self-test results—to incorporate a more comprehensive and mobile version that operates independent of the patient's location (Khan and Yuce 2010). While some WBANs used in this new version of telehealth require the patient to consciously submit their body-data from a temporary data storage device, such as a personal digital assistant (PDA) or a smartphone (e.g., iPhone), systems built for the automatic and continuous streaming of body-data for the electronic construction of a patient at another location are underway (Alemdar and Ersoy 2010; Bowden 2012). With the sensors of a WBAN measuring and transmitting data, a patient's body-data becomes part of the electronic information infrastructure, and therefore can be seen by anyone (but presumably only health-care practitioners) with access to the storage locations of the body-data (Al Ameen et al. 2012; Kargl et al. 2008). It is the built infrastructure of data storage that makes this new type of electronic, spatialized body possible.

Heartbeat and body temperature are commonly cited as parameters monitored by a WBAN. Figure 9.1, however, demonstrates that WBANs

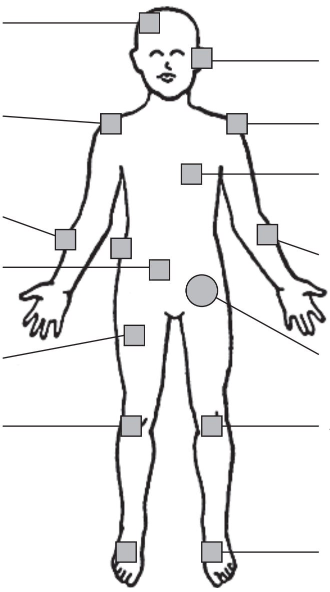

Figure 9.1
Body places and functions that can potentially be monitored by a WBAN system (Latré et al. 2011). Used with permission from Springer Science and Business Media.

also can be used to monitor a variety of organ functions and body movements (see "Artificial Knee" in the illustration), and can even administer the appropriate dosages of medicine based on sensor feedback (see "Insulin Injection").

Although it is less obvious, figure 9.1 also demonstrates the next stage in the transition of human biological processes into the world of electronic data storage. A personal device, represented by a circle at the person's hip, serves as an immediate, temporary receptacle for "fresh" data. The WBAN sensors then transmit this data through a series of storage devices, ending at an external server where it can be stored and analyzed (figure 9.2).

Contrary to the image of a cloud in figure 9.2, WBANs require a robust built infrastructure of data storage to make the electronic measurement and analysis of biological processes possible. As hospitals coordinate multiple patients at once streaming "live" body-data into a WBAN system (figure 9.3), a long-term storage place is required for longitudinal analysis of a patient's health-care progress.

The process of sensing, transmitting, storing, and analyzing a patient's body-data can be clarified by making a distinction between data at rest

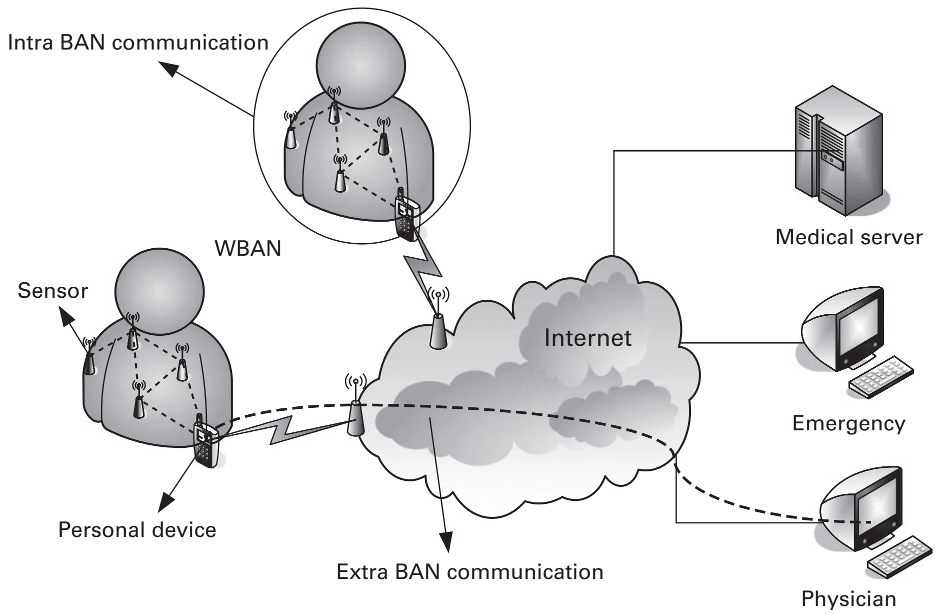

Figure 9.2
The connection between the body and other devices in a WBAN system. Information is transmitted through the Internet, represented by a cloud (Latré et al. 2011). Used with permission from Springer Science and Business Media.

and data in motion (Martell 2012). Data at rest is not immediately analyzed as it streams from the sensor node, while data in motion are analyzed before it reaches a final resting place such as a data center. WBANs have the capacity to perform both of these functions, the former for nonemergency cases where monitoring over a longer time span is necessary, and the latter for emergency cases. A premature baby connected to a WBAN, for example, may transmit thousands of unique body-data items every second, which in a data-in-motion analysis structure can be used to make diagnoses up to 24 hours sooner than they otherwise might be. At a hospital using a WBAN system, this could mean that hundreds of patients are streaming hundreds of thousands of body-data items at once. The capacity to handle—i.e., securely store, query, aggregate, and cross-reference—large data sets is according to some (boyd and Crawford 2012, 663) the definition of Big Data itself. Entering into a Big Data paradigm means that the materiality of data must be considered. Since data is stored and accessed from data centers located in the built environment, data centers become one of the major sites of corporeal extensibility; they are

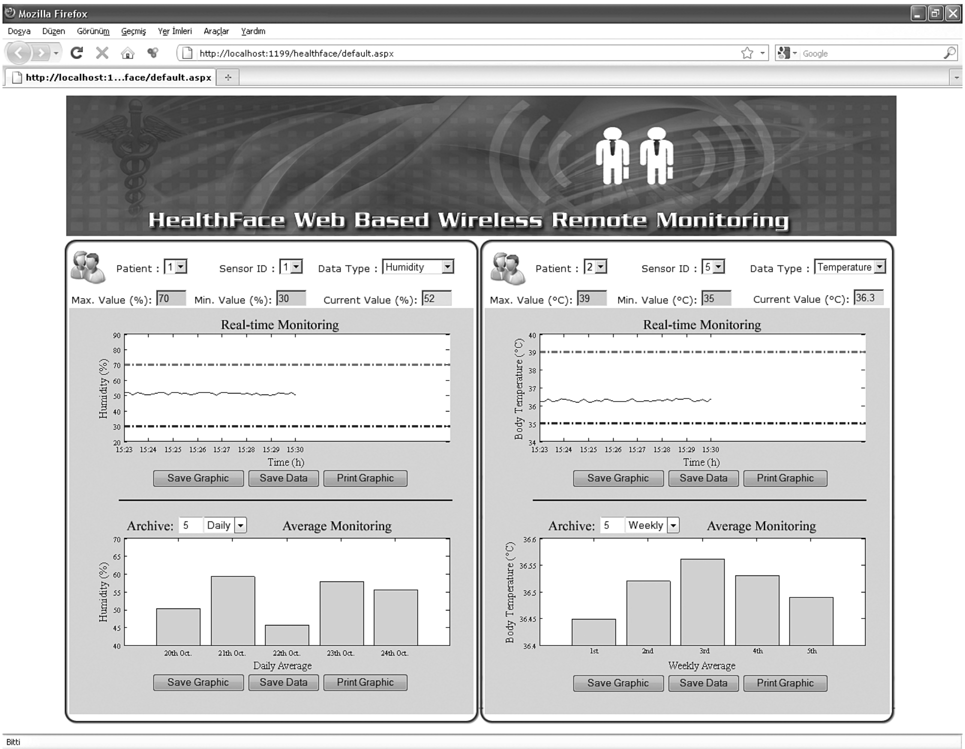

Figure 9.3

Real-time monitoring (live streaming) and average (long-term) monitoring in HealthFace, a WBAN interface. Here, two patients are being monitored at the same time. Patient no. 2, on the right, has at least five sensors. The storage technology required to operate such a system is the data center (Kirbaş and Bayilmiş 2012). Used with permission of Dr. Ismail Kirbaş.

the means by and the locations onto which patients' bodies in a WBAN are extended spatially.

The concept of body-data has been introduced in this chapter to highlight the argument that there are many potential instances where the biological body of a patient and the digital data created about his or her body are one and the same. The geographical version of living in the borderlands between real and virtual is accepting that a distant object (in this case, electronic data) contributes to the objecthood of something else (in this case, a human body) in a different location. Body-data, therefore, is a term that offers a way to talk about how biology and technology co-constitute one another without having to categorically or spatially separate them. The term *body-data* means the digital information created about someone's body being treated as if it is an extension of the body itself.

An important corollary of body-data is the concept of extensible space. If bodies exist in geographically disparate places simultaneously, then in theory, they can be plotted onto a cartographic system (i.e., the bodies can be mapped out using the locations of where their body-data is stored and accessed). While mapping is clearly not new in geographical practice, it may come as a surprise that the impulse to map out the constitutive objects of any phenomenon has a strong precedent in geographical thought as well. Allow me to explain this further. I am drawing out the idea of extensible space from a different kind of space—relational space—that has been heavily theorized by geographers over the past two decades.

How Relational Space Leads into Extensible Space

The formation of a relational space is contingent—perhaps not surprisingly—on the relation among a diverse set of objects and events, foundationally described within geography by Murdoch (1997, 325) as "heterogeneous associations, that is, associations which somehow bring together the social and physical/material." Inspired by a desire to question the ontological categories of nature and society (Castree and Braun 2001), geographers have since offered a variety of examples of how relational spaces are brought into being and how they constantly change through political processes or new types of associations among the objects in any such network (Routledge 2008; Kaika 2005; Castree 2003). At its most profound, relational space provides an ontology described not so much by objects, but by the space, or relations, between them. Objects do not exist alone, but only through their connection (loosely defined) with other objects. Any given object, then, has its own network of connections with other objects, a network that can be mapped out on a geographic grid. Described thus, relational space is apart from absolute, measurable, mathematical space, resting on the notion that objects and events inherently have their own spatiality; that is, the constitutive relations that any object has with other objects. The political relevancy of seeing objects as existing in relation with other objects is vast, and will seem familiar to many readers. For example, if one considers the technologies, machines, and people used to harvest coffee beans, it becomes easy to recognize that the object "coffee bean" itself is related to those machines and people; it would not exist as it does without them. This recognition has spawned several enormous political-economic movements, including fair trade and organic, the former affecting labor and the latter affecting cultivating techniques.

Stemming from this, however, little has been said about the subsequent possibility for a single object to exist in multiple places at once. I argue that in some cases, when one maps out a relational space rather than a connection with other objects, all the things on the map become the original object. To take another example, a t-shirt consists of cotton, but it is also the soil where the cotton grew, the geologic and human processes that created that particular soil quality, the sweatshop where the cotton was spun and sewn into a t-shirt, and the life of the worker who made sure that the shirt was the right size. This is different than saying the object becomes enrolled in a network involving all these other things. It is a move from epistemology (i.e., we can only really know objects through their various relationships with other objects) to ontology (i.e., an object is partially composed of other objects). This is the move from relational space to extensible space.

A related tendency in theorizations of relational space is to treat objects as spatially discrete and singular. As the term *heterogeneous* suggests, the objects being associated to forge a network are separate from one another in type, name, material, and spatial location. Without this discreteness, in fact, there could be no relation; the relationship itself entirely depends on the objects being different. The continuous becoming of networks in a relational space, then, relies on the assumption that an object is one bounded thing that exists in one location. In the discussion that follows, utilizing the philosophy of Graham Harman, I challenge this presumed discreteness of objects, offering a way to conceive of space making founded on object extensibility rather than object relation. This requires a reconceptualization of the nature of objects.

Graham Harman's Object-Oriented Philosophy

Graham Harman, inspired by Martin Heidegger's tool-being and Bruno Latour's actor-network theory, has crafted what he calls "object-oriented philosophy" (Harman 2010a). Aiding geographical efforts to define relational space through its "heterogeneous associations," Harman's philosophy offers a way to think through how exactly objects could possibly be connected (or related) in the first place. This line of inquiry digs up the fundamental core of relational space and presents possibilities for an alternative type of space making based on how objects exist. In his own words, Harman's (2010a, 2) object-oriented philosophy has "a single problem at its core: the tension between objects and relations." Objects in this view include animate, human, and inanimate things, and relations always involve the distortion of the objects in relation with one another. Harman's skill as a philosopher lies in placing the issues raised (especially by Latour) regarding exactly how objects "relate" within broader histories of philosophy, theology, and metaphysics (Harman 2009; Bingham 1996, 647–649).

The key to Harman's argument is that object relations are not reciprocal, a phenomenon termed "the asymmetry of contact." When a person perceives a tree, for example, it can likely perceive the person in return. This perception is not symmetrical, though. That is, how the tree perceives the person is entirely different than how the person perceives the tree. "[T]his," says Harman (2011, 75), "must occur as part of a different relation, not as the reverse side of the same one." Consider in more detail how a WBAN functions. When WBAN sensors take measurements from inside a patient's body, three separate events must happen for body-data to be extended into space. First, the sensor node must detect the biological process. Second, it must digitize and code it for communication. Third, it must transmit the data to another device. Using the asymmetry of contact theory, this means that the WBAN sensor node and, say, the beating heart perceive each other, but on different planes of reality. Harman claims that there is always just one real object involved in any interaction between objects. The thing doing the sensing—in whatever way it does so, whether biological or not—is what he calls a "real object," and the thing being sensed is a "sensual object." This is because, following Heidegger's Geviert (fourfold), Harman believes that there is an unknowable depth to objects that makes them irreproducible and gives them the ability to affect the world in a different way each time they interact with a new object. This appears to challenge the nonessentialist materialisms of Latour, Gilles Deleuze, Donna Haraway, and Michel Serres, each of whom "rejects the idea that there might be a supplemental dimension or transcendental cause that lies beneath or behind the material worlds in which we dwell" (Anderson and Braun 2008, xiv–xv). Yet Harman's argument suggests that there is room for a space making that derives from objects but operates in a mode different from relationality.

According to Harman, objects do have a supplemental dimension, and they do emit something that allows them to travel to different locations in space. This emission is an altogether different object, which is why it cannot be included in the reciprocal perception (e.g., between a person and a tree). A human perceives the tree as a real object but is perceived by the tree as a sensual object, and vice versa. This creates two different relationships, not one, going on at the same time. And it makes sense, I believe, when applied to the relationship between the sensor and a patient's body part, such as a beating heart.

Harman derives this conception of objects from Heidegger's tool analysis. In *Being and Time* (1962, 96), Heidegger observes that by addressing entities as things, or objects, "we have tacitly anticipated their ontological character." Here, Heidegger is making the case that there is a phenomenological depth to objects that exists outside human perception or culture. Another way to think of this statement is: If objects are actually singular and discrete, then there can be no tacit anticipation of their ontological character because the ontological character is obvious—there would be nothing to anticipate. Harman picks up on this in a search for a depth of objects, one that I am using to promote a material extensibility of tiny digital objects to other places. He describes a being of objecthood in which "all objects are encountered more often as tacit components of our world than as blatant objects of awareness" (Harman 2010b, 109). Most objects are encountered as tacit or go unnoticed—instances in which they are functioning properly. They become part of conscious awareness only when they malfunction. Continuing, Harman says that "the substance of a thing, whatever it is, must precede its functional form, since the thing is never exhausted by all that it does, and since it can support several usages at the same time" (2010b, 115). This means that reality is deeper than objectification (e.g., naming, labeling, or making assumptions about an object), and reveals the key insight of the tool analysis: even when things are not noticed, they still serve as tools for human living. Human existence is inextricably bound to the tools that make us—psychologically and physically—what we are.

This fits neatly with how relational space has been described (Murdoch 2006; Gandy 2005), such that there must be an association among things to make the world what it is—no one object, including the human body, can exist in spatial or objective isolation. The argument being presented in this chapter, however, challenges what exactly those objects are in a way that asks spatial theorists to rethink the metaphysics of networks themselves. A "depth" of objects is mandatory if we are to accept Harman's notion of an asymmetry of contact among objects, and Heidegger offers the philosophical foundation for doing so (Leszczynski 2009, 610). If objects are more that their immediately recognized form, then there is room for accepting that they emit in multiple ways that are sensed by other objects uniquely. This multiplicity of emissions is how objects become simultaneously located in different places. It is not an attempt to destroy or flatten objects, but rather an attempt to redefine their geographical character.

A return to the case study of WBANs will help to clarify this point. The digital reappearance of the patient in the computer console of the health-care provider is a moment in the body's travel along the WBAN network (figure 9.4).

When the patient's body appears in the doctor's computer console, it is not completely virtual, if virtuality is considered the opposite of reality. The WBAN sensor begins its sensing with an "amplifier/filter/multiplexer." It is then changed into an 8–12-bit digital signal, and finally it is transmitted via an antenna to a temporary storage device on its path away from what we would normally call the body (figure 9.5).

The pulse, or heartbeat, becomes digitally captured and preserved, eventually being stored at a location administered by the hospital that issued the WBAN system for the patient. The hospital's data centers become filled with people's personal biological information.

Why is this *the person*, though, and not an electronic representation of the person? Returning to object-oriented philosophy, the distinction between "real" and "sensual" objects helps us move away from the

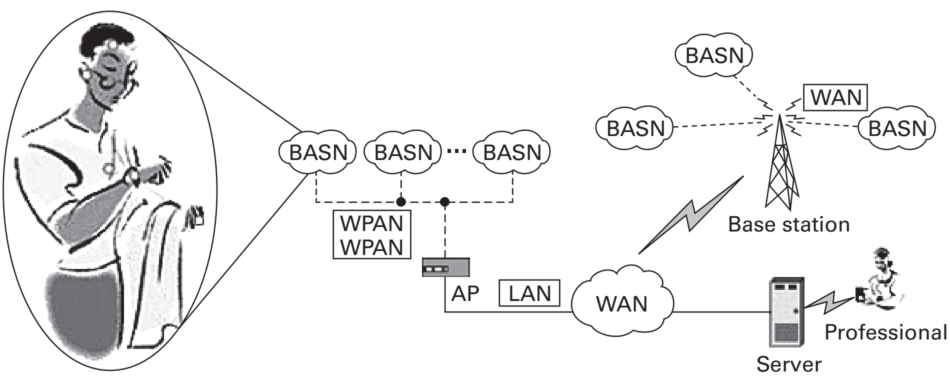

Figure 9.4
In this drawing, a patient's pulse is sensed through a watchlike sensor, then transmitted wirelessly to the body area sensor network (BASN), proceeds to the wireless local area network (WLAN), then to a wide area network (WAN), and finally to a server from which a "professional" can see the patient's body-data. Image © 2006 IEEE. Reprinted with permission from Poon, Zhang, and Bao (2006).

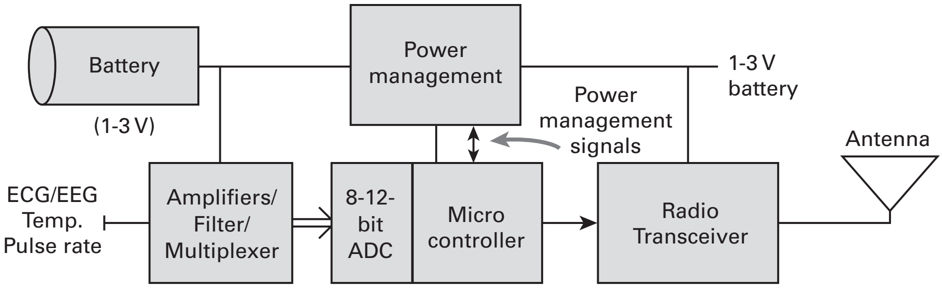

Figure 9.5
Schemata of a WBAN sensor node placed on or inside a body to measure body parameters such as muscle cell action, heart rate, blood pressure, and brain activity. Image © 2010 Jamil Y. Khan, Mehmet R. Yuce. Originally published in Khan and Yuce (2010) under CC BY-NC-SA 3.0 license.

trappings of representation (Thrift 2008; Lorimer 2005). Real objects, again, are things in themselves, while sensual objects are the things that are sensed by other things. Even though each of us is a real object, we can never know real objects—only sensual objects. In this ontology, each object simultaneously exists as two different things.[2] When the pulse signal is amplified and filtered, it is the sensual object of the beating heart that becomes transmitted, not the "real" heart.[3] But do not confuse Harman's meaning of the word *real* here as meaning the opposite of *virtual*. On the contrary, to Harman, *sensual* is as real as *real* (perhaps even more so) since it is the only thing we are capable of knowing. Therefore, the coded signal is the sensual beating heart as sensed, or known, by the ("real") WBAN sensor node, and as such, exists as part of the person somewhere else.

The reason we should take this proposal seriously is that it offers a detailed explanation for how the moment of interaction between objects can be imagined and described. Harman's real and sensual objects defend the possibility for an ontology based on extensibility. By allowing the interpretation that a sensual object can travel along the lines of a network while its companion real object cannot, it is possible for objects to be in more than one place at once. This depends on a conceptualization of objects in which any single thing consists of modes that are not required to be in the same Euclidian location but are still a necessary part of that object's reality. As such, the simultaneous locational existence of bodies, and therefore the possibility for a spatially extensible body, is crafted.

WBANs in the Context of Body Theory

In her *Manifesto for Cyborgs*, Haraway (1994, 83) writes that modern medicine is full of cyborgs, "of couplings between organism and machine, each conceived as coded devices, in an intimacy and with a power that was not generated in the history of sexuality." Her claim that humans are already hybrids of machine and organism resonates with the case of the WBAN presented here. With modern-day cyborgs, she argues, the boundary between the physical and nonphysical is imprecise (Haraway 1994, 88). However, the spatial extension of bodies into the landscape of electronic information infrastructure—as seen with WBANs and data centers—clarifies this imprecision by materializing the invisible character of electronic body-data. In addition, the WBAN example offers a cartographic conception of Haraway's cyborgs, such that the intimate, powerful, and (I would add) integrative extension of organism to machine exists spatially. She does offer a more vague spatial conception of cyborgs by citing them as "ether, quintessence." However, the words *ether* and *quintessence* suggest that cyborgs exist everywhere, all the time, while I am arguing for a precise, descriptive rendering of where cyborgs, or body-data, exist cartographically.

The question of where the body begins and ends has proven an important topic for scholars in a variety of disciplines. In his conversation about the ecological "mesh," Timothy Morton (2010, 36) wields advances in biochemistry to question the notion of self-containment in organisms: "[a]t a microlevel, it becomes impossible to tell whether the mishmash of replicating entities are [sic] rebels or parasites: inside-outside distinctions break down. The more we know, the less self-contained living beings become." Self-containment is masterfully explored in Emily Martin's (1994) account of the scientific development of the immune system, while others (Greenhough and Roe 2006, 418) "explore the body as a medium through which we encounter and become incorpor(eal)ated into biotechnology." The subdiscipline of environmental history has—perhaps better than any other genre—sought to explicate body-environment relationships. Here, scholars have succeeded in drawing connections between toxic landscapes and human health, reminding us that how we choose to make the places in our society affects the material makeup of human bodies (Langston 2010; Murphy 2006; Mitman 2005).

Leveraging the object-oriented philosophy of Harman to help take the insights of environmental historians a bit further, I argue that in the case of WBAN technology—and the data storage infrastructure to support

WBANs—it is less accurate to think of bodies as being *affected* by certain environments, and more accurate to think of them *as* certain environments. This augments the claim of environmental historians that "the very chemical composition of our bodies is being altered in ways that reflect the transformations of our everyday environments" (Roberts and Langston 2008, 629).

One of the major assumptions I have sought to dispel in this chapter is that bits are not material and are placeless. In fact, they have mass and exist somewhere—bits are objects (Blanchette 2011). The transmission of objects along the lines of an electronic information network questions what exactly is material, though. If sensual objects travel to other places as they encounter (i.e., as they are sensed by) real objects, then it should follow that *modes* (not pieces or parts) of objects exist as one another. Following Anderson and Wylie (2009, 321), the "assembling of materialities," or making of what I would call *object modes,* "can only be a continual *process* of gathering and distribution." The sensor node in a WBAN system gathers the sensual object and distributes it along networks of electronic data storage infrastructure, computer terminals, data centers, etc. This clarifies and fits with Harman's observation that objects do not emit a piece of themselves, but they do emit something. While he leaves this "something" open, other scholars (Wilson 2011; Coole and Frost 2010) have made it possible to claim that sensual objects cannot possibly be operating in the same material mode as real objects. Their work expands the types of materialities that can affect the world. We might say that a beating heart is in a gathered object mode, while the beating heart as sensed by the WBAN sensor node is in a distributed object mode. Each is equally required to make the beating heart a geographical object. It is appropriate, though, to say that there is still a relationship between the beating heart and the sensor node. In proposing extensibility, I am interrogating the *character* of relationship through a close look at objecthood, not trying to eradicate the category of "relationship" altogether. The space between objects—their mapping—is not so much the mapping of spatial relations, but is the mapping of things themselves. Sarah Whatmore (2006, 602) points out that at the root of geographers' interest in materiality is the connection between *geos* (earth) and *bios* (life). She says that "this return to the livingness of the world shifts the register of materiality from the indifferent stuff of a world 'out there,' articulated through notions of 'land,' 'nature,' or 'environment,' to the intimate fabric of corporeality that includes and redistributes the 'in here' of human being."

It is this redistribution of corporeality that has been the focus of this chapter. As applied to the biotechnology of WBANs, however, the redistribution is not to land, nature, or environment, but to the electronic information landscape. This landscape is most readily exemplified and visualized in the form of the data center, the infrastructural component that is the mundane core of cloud computing, where material, electronic bits of body-data are housed.

In the case of patients who use WBANs, this means that their bodies are in places ranging from the server that stores their vital statistics, to the room where the physician examines them from afar, to the "real" beating heart. In an extensible space such as that of a WBAN, the construction of a network is not about the unique linking of a heterogeneous collection of objects (i.e., beating heart, sensor node, electronic data, or data center). Rather, it conceives of the network itself as the singular object, distinguishing multiple spatial locations. This extensible space relies on Harman's distinction between real and sensual objects as a way to argue for the material, ontological extension—or travel—of bodies through electronic data infrastructure.

Conclusion and Policy Implications

Where the body begins and ends is important for policy because it blurs legal concepts such as virtual and real. The political project here is that land use and environmental legislation must be given the same priority as medical and public health legislation. To care about corporeal health is to care about the things and places that—in my view—should be considered our bodies, too. Ultimately, that is, the places we make and the infrastructure we build are our bodies, and so they matter to the health of a society. We know that the environment affects bodies, organisms, and other objects, but this does not seem to have been enough to thwart lawmakers from around the world from stopping toxic pollution on a massive scale. Treating objects in a network, including human bodies, as extensions of one another existing in multiple places instead of as discrete entities connected by a relation introduces new possibilities for legal arguments to be made concerning the effects of detrimental actions. When the landscapes we gaze at as we move through life are part of us, then we notice and care more about how they are designed, built, and maintained. When, for example, places that house toxic waste are also potentially conceived as human bodies, it would likely be easier to argue for stricter laws concerning the creation and disposal of such waste. If such a scenario existed today in the United States, perhaps the Food and Drug Administration (FDA) would be as concerned with toxic waste sites as the Environmental Protection Agency (EPA) is.

Notes

This chapter is based in part on an article published in *GeoJournal* (Bauch 2013).

1. Greenpeace's 2011 "Un-friend Coal" campaign against Facebook's use of coal to power its data centers has been one of the most visible instances of political action concerning cloud infrastructure. See Gary Cook and Jodie Van Horn (2011).

2. In Harman's book *The Quadruple Object*, he ultimately outlines four components to any object—time, space, essence, and *eidos*. These derive from real objects, sensual objects, real qualities, and sensual qualities.

3. Filtering the static noise of a body's emissions has proved to be a major problem for WBAN technicians and scientists. See G. K. Ragesh and K. Baskaran (2012). Although outside the scope of this chapter, further theoretical analysis can be found in other sources (cf. Serres [1982]).

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