Some Social Implications of Ubiquitous Wireless Networks

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Wireless computer networks and the devices to communicate with them are about to become ubiquitous. A profusion of devices is likely to emerge quickly in specialized form factors, from handhelds to cheap, disposable sensors. Groups of people using these tools will gain new forms of social power, ways to organize and coordinate their interactions and exchanges just in time and just in place. Using these tools, people will be able to collectively construct a range of resources that were too difficult or expensive, or simply impossible to provide before. Simultaneously, these tools will gather a constellation of intimate data about each of us. Wireless devices will penetrate every nook and cranny of the social world, bringing the efficiency of information technology to the production of panoptic power. In the following, two sociological concepts, Power/Knowledge and social dilemmas, are used as a guide to the kinds of social institutions and relationships that are likely to emerge from the use of these tools.

Cell phones and pocket computers are vying to provide cheap, ubiquitous, mobile access to the Internet, a big step towards computing devices as common as light bulbs. Given the rapid adoption of cell phones and their recent transformation into mobile Internet terminals, portable voice and data devices are likely to merge and then drop to a price that will make them available to a remarkably large segment of the planet's population fairly soon. In most metropolitan areas, relatively broadband wireless access to the Internet is likely to be widely and cheaply available within a few years.

This will mean that most people will soon have a device with them most of the time that allows them to link objects, places and people to online content and processes. These devices will help people coordinate not only with others around the world, but perhaps more importantly, with people nearby. Groups of people using these tools will gain new forms of social power, ways to organize and coordinate their interactions and exchanges just in time and just in place. Just as they have with the existing Internet, people using these tools will be able to collectively construct a range of resources that were too difficult or expensive or simply impossible to provide before, and now do them in places far away from offices and desktops. As the costs of communication, coordination, and social accounting services drop to close to zero, these devices may allow more groups to overcome the obstacles to cooperation and collective action, suggesting the emergence of new forms of self-organizing mutual aid institutions.

Simultaneously, though, these tools will gather a constellation of intimate data about each of us. Wireless devices will penetrate into nook and cranny of the social world, bringing information technology efficiencies to the production of panoptic power. Tracking lies at the core or is an accidental by-product of all of these devices. When several hundred million people or more are using them, the resulting data collection opportunities will be an unexpected boon to social scientists, market researchers, government planners and other agents of social control. Detailed information about the minute behaviors of entire populations will become cost-effective and increasingly accurate and timely.

What is a world likely to be like where these services and devices are ubiquitous? How will social life change in response? Prediction is a dangerous game, but some technical trends seem clear, and two sociological concepts, Power/Knowledge and the collective action dilemma, can be used to map out a range of possible futures and implications. In the following, I discuss the technical infrastructure emerging around wireless computing to set a sense of their scope and power. These tools will enable a range of new forms of social interaction and collective action; I describe some possible examples. From there, I introduce Foucault's concept of Power/Knowledge and his exploration of the Panopticon. In counter-point, drawing upon studies of collective action dilemmas, I will argue that the unique opportunity provided by wireless

technologies is that it may allow panoptic power to be used in consensual horizontal social relationships in a way that can increase the successful resolution of collective action dilemmas. In particular, I highlight the implications of bringing online reputation systems like those provided by eBay and epinions into the synapse of society, face-to-face interaction. To illustrate this, I present a number of scenarios for social applications of wireless devices.

I. Technology

Home and commercial property owners using wireless LAN technologies, cellular networks like OmniSky[1] and Ricochet[2], and satellite services[3] will collectively provide a wide if uneven blanket of wireless Internet access at varying price, capacity, and reliability. The result will be that most urban people are likely to find that almost all of their day is spent within range of wireless access of one form or another.

Although cell networks still lag in terms of speed and cost, the availability of low-cost wireless systems based on the IEEE 802.11 specification[4] means that many business spaces, from offices to manufacturing to retail, are already adopting wireless networks and providing access through them as an efficiency for employees and a courtesy to customers or as a pay service. Software controlling these networks will provide flexible access control, bandwidth, and fee structures. Standards will allow these devices to interoperate with many other manufacturers' devices. Given their low cost[5], wireless networks are moving into commercial, retail, and other public places as value-added services that make physical spaces more desirable to target populations. Hotels like the Palo Alto Hilton already offer wireless network access to guests; soon, shopping malls will see clear advantages to offering customers wireless access to mall directory and ecommerce services[2]. Many property management companies and municipalities may soon identify wireless campus networks as a powerful way to attract sought-after information technology workers to their properties and downtowns. If wireless networks can be used to facilitate commercial transactions, they will defray their cost of ownership and encourage even wider deployment. This means that even if the cell network and alternative services like Ricochet do not become common, broadband or cost effective, wireless local area networks should rapidly become ubiquitous in most homes and wherever people gather in commercial or municipal spaces.

The devices that will be used to access these networks are already available at the higher end of the consumer electronics market, but they will rapidly get smaller, cheaper and faster, and have greater capacity, better displays, and new input mechanisms. Personal communication and entertainment tools like cell phones, beepers, Game Boy's, compact disc, cassette and MP3 players, and handheld computers are steadily improving and are likely to merge and diverge in interesting ways. When these devices can communicate wirelessly with one another, they can begin to offer services to each other. For example, collections of Bluetooth-enabled devices[6] will be able to form ad hoc networks around the body or between the body and nearby resources like screens, keyboards, and network connections. This will allow for further speciation of devices, since they will be able to share resources such as display technologies, processing power, storage, bandwidth, and sensor data, allowing them to act in concert and further reduce costly redundancy.

These devices will be augmented by location-awareness technologies that derive precise position information from cell towers, Global Positioning System (GPS) receivers, and other beacons. When they

[1] OmniSky uses the existing cell telephone network to provide a relatively slow (19.2 kbs) wireless network link for "unlimited" use $40 per month.

[2] Metricom markets Ricochet in three American cities (Seattle, San Francisco, and Washington, D.C.). The device provides a medium speed (128 kbs) wireless link through a network of streetlamp-mounted digital cells. Paul Allen's Vulcan Ventures and Sprint recently invested $600 million to deploy the network in 43 American cities within this year.

[3] Although satellite data networks like Iridium have floundered in the market, satellites are likely to play a role in providing wide area mobile connectivity.

[4] 802.11 is an IEEE specification that defines a wireless networking implementation. When many manufacturers agree upon a interoperable standard the price of hardware often plummets. Ethernet network cards on wired networks are an example. These devices once cost thousands of dollars and are now available for about $10.

[5] An installation of wireless access points in a shopping mall is estimated to cost around $25,000, a relatively small capital improvement that could generate significant revenue. An installation providing a 150" wireless network bubble in and around a private home currently costs about $300. The Apple "AirPort" is an example of the early consumerization of this technology.

[6] "Bluetooth" is the name of a wireless networking specification tailored for "personal" networks (see: http://www.bluetooth.org). This means communication between multiple devices worn on the body as well as their collective interaction with other devices in the environment. Bluetooth should make it possible to connect a handheld computer to a desktop just by standing in front of the machine. A cell phone could provide network services to other devices, like pocket computers, without requiring a clumsy wire to make a connection between them.

are aware of current location, they can offer people services tailored to that context, including directions, maps, and recommendations for restaurants and other points of interest based on the user's current location.

This capacity is further enhanced by the use of bar-code readers and devices for accessing other machine-readable markings. Motorola, a dominant manufacturer of cell phones, recently announced a partnership with Symbol Technologies, a leading provider of bar code readers for warehouse and point-of-sale applications, to put bar code readers in cell phones[10]. At the same time, a number of companies, including GoMark.com and Intacta.com, are refining bar codes, making them smaller, easier to read, and able to store more information. Such improvements allow bar codes to pop up in novel places, like at the end of newspaper articles, next to magazine ads and catalog items and on posters, post cards, and business cards. Properly equipped, people with these devices can bridge the gap between print and related online content with a simple click.

Passive Radio Frequency ID (RFIDs) tags are even more flexible than printed bar codes. These tiny microchips reflect a unique pattern when a radio pulse hits them. A RFID detector can pick up this information without direct contact with or even a clear line of sight to the tag. To improve the efficiency of inventory and distribution tracking, every manufactured object from clothing to tools is likely to have a tag like this embedded in it soon. When cartons of goods are tagged in this way, a box can be accurately inventoried without opening it simply by passing it near a detector device. As a secondary result, consumers will be able to use these tags to locate objects in their homes and link them to related information and network services. Trash containers, for example, may have a tag that links to the page summarizing the account and pickup schedule for the trash collection service.

Used together, ubiquitous network connections, portable computation, and tag readers enable a range of applications that change the nature of objects, places and social action. Scenarios like those pioneered by Xerox and the Tangible Bits group at the MIT Media Lab offer illustrations of the ways machine-readable marks close the loop between an object and its digital shadows[34]. They have demonstrated "spatial annotation" applications that link digital media to places or objects. When a handheld device has a bar-code reader or other machine-readable tag input device, it becomes simple for users to link a document or a web page or other online process to a tag that may be physically associated with a place or object. People will "click" on an object and view related content on the screen of a pocket computer or hear spoken information by means of text-to-speech through a cell phone. Most consumer products are already tagged with bar codes that can be scanned by handheld computers or cell phones. Street signs and lamp posts, building walls, and signs in corridors are also good candidates for tagging. When familiar objects are tagged, their location and organization in terms of one another can be used as input to a computer. "Phicons" become physical handles on digital objects.

The widespread presence of tags and the use of these devices allow a number of applications to be built at low cost. These abilities will change the nature of retail spaces and commercial transactions. Retailers and others will provide product information linked to every piece of clothing, furniture, book or electronic good that can be found in a shopping mall. Price-comparison services like IQOrder.com, Barpoint.com, and Vicinity.com are already transforming objects in stores into physical links to data about their price, quality, availability, competing products, and communities of users. Barpoint allows users of existing cell phones to call an automated service and enter the barcode of any item through the keypad. The Barpoint service then provides pricing information and offers to complete an electronic order for the item. This sets the stage for significant shifts in power between consumers, retailers, manufacturers, and online merchants. For example, widespread use of wireless handhelds may turn every bookstore on earth into a showroom for Amazon.com.

Since few people already have a bar-code–reading wireless handheld just yet, companies like Clixnmortar.com are kick-starting the market by providing wireless handhelds to shopping mall property management companies, starting with the Lenox Square Mall in Atlanta[32]. According to the company's Web site the mall owners will lend them to visitors for the duration of their trip. Each person will be given a simple device that will enhance their shopping and change their experience of the mall.

"The hand held technology, in the form of a 'ruggedized' Palm Pilot PDA (personal digital assistant) with a barcode scanner, allows adults to shop simply and quickly by scanning items they want from favorite retailers, pay through a single channel, and have those items conveniently delivered, avoiding the hassle of checkout lines."

Shopping malls are likely to adopt these devices as a service to their customers. In doing so, they

will be able to reshape the way such spaces are used and experienced. Faced with pressure from online-only merchants, bricks-and-mortar institutions may find that wireless handhelds encourage customers to buy by giving them access to a range of consumer evaluations and related purchase research, including comparative pricing. Malls may encourage and direct foot traffic by recognizing each patron and offering a customized "Scavenger Hunt" that will reward them with a coffee or other small incentive for visiting several selected retailers and looking at particular products within each store. Like night watchmen making rounds, customers will be able to prove they visited each display by clicking on the barcode or other mark on or near the product. But the greatest boon will be vast databases of detailed information about the behavior of people within the mall and their reactions and in particular their transactions in reaction to different stimuli.

For a consumer society, the transformation of consumption may be quite profound. The most mundane but essential element of shopping, the label, raises interesting new political issues in a world of wireless devices. Food and clothing labeling, for example is often an emotionally and politically charged process. Many opponents of genetically engineered foods and pesticides, for example, have lobbied without success to require identification of those foods on their labels. Many labor-rights activists have called unsuccessfully for clothing labels that include a rating of the labor conditions of the manufacturing company or nation that produced the good. With wireless devices that can read object tags, Web services that offer particular kinds of description and warning information can be created fairly easily. Blocking such meta-annotations may be very difficult, making it possible for consumer decisions to be influenced at the point of sale by a range of viewpoints that are not now widely heard.

Beyond consumption, digital annotations of physical objects and places might assist groups of people within a locality catalyze their interconnection. Imagine a neighborhood bus stop where a number of people wait during the day but often at different times. These people may share a good deal in common with other users of the stop but lack effective methods of communicating with one another. Associating discussion boards or Web pages with the bus stop will be trivial, allowing more flexible ways of connecting people with one another.

Discussion tools can be linked to other physical spaces and institutions like parks and schools, for example, which might broadcast their identities or affix machine-readable bar codes or RFID tags around their entries. Parents and local residents would be able to connect to official and unofficial content related to these places. A range of services like news, help wanted listings, discussions, reports of damage or crime, and goods and services for barter or sale could be provided to people while they are present in the space. Entertainment applications, including a range of games, like tag, are easy to imagine, and more elaborate contests seem reasonable as well.

II. Panoptic Power

While many of these applications sound appealing, they generate vast amounts of detailed information as a by-product of their use. This information fosters a kind of power best described by Michel Foucault in Discipline and Punish. By mapping the historical transformation of the technologies of social control over the past four hundred years, he highlighted the ways surveillance, even when intermittent, imposes self-imposed control on its subjects. Information systems can be seen as automating what Foucault called "Power/Knowledge" while radically extending its scope and flexibility. Information technology creates a kind of "furtive" power, one attuned to the miniscule and the detailed, capable of amassing and categorizing social life in ways impossible before their introduction.

Foucault notes that the problem with production methods typical of industries that require large work forces is the potential for resistance inherent in large groups. The challenge, then, is to atomize groups without reducing their value. For Foucault, disciplinary technologies solve the problem of the "inefficiency of mass phenomena." Information systems allow the articulation of organizations over great distances without relinquishing the capacity to monitor and control their activity. Such techniques work isolating each individual through observation and record keeping, assigning to each body an appropriate space and time to occupy each space, to impose a set of actions, refined to the point of individual motions, on the body, and ensure the flow of power from wielder to subject through constant observation, which promotes self-regulation. Discipline "fixes; it arrests or regulates movements; it clears up confusion; it dissipates compact groupings of individuals wandering about the country in unpredictable ways; it establishes calculated distributions."[7]

Disciplinary power, then, has its main function in

[7] Foucault, Discipline and Punish, P. 219

the neutralization of "the effects of counter-power that spring from (an organized multitude) and which form a resistance to the power that wishes to dominate it: agitations, revolts, spontaneous organizations, coalitions - anything that may establish horizontal conjunctions."[8] Discipline uses "procedures of partitioning and verticality... they introduce, between the different elements at the same level, as solid separations as possible... they define compact hierarchical networks, in short... they oppose to the intrinsic, adverse force of multiplicity the technique of the continuous, individualizing pyramid."[9]

The continued growth and interconnection of computation is constructing a new form of the panoptic power described by Foucault. As information systems are increasingly interwoven into the fabric of social life, it becomes more difficult to avoid creating "ripples in cyberspace" that tell of each individual's habits, location, and capacities. The volume of information stored by government bureaucracies, from the driving and ownership records held by state departments of motor vehicles to the records held on real estate ownership to the "political" information held by the FBI is endlessly growing. But this pales in comparison to the data collected by private concerns, banks, credit organizations, schools, publishers of periodicals, retailers, web sites, and phone and cable companies, to name but a few. Driven by the need for information to predict consumer behavior and maintain the security and the accountability of credit use, Andrew Ross argues that these organizations have made effective use of information technology to create

> "...a harvest of information about any individual's whereabouts and movements, tastes, desires, contacts, friends, associates, and patterns of work and recreation becomes available in the form of dossiers sold on the tradable information market, or is endlessly convertible into other forms of intelligence through computer matching. Advanced pattern recognition technologies facilitate the process of surveillance, while data encryption protects it from public accountability."[28][10]

In the process, a new commodity is created.

> "What happens, then, in the process by which information, gathered up by data scavenging in the transactional sphere, is systematically converted into intelligence? A surplus value is created for use elsewhere. This surplus information value is more than is needed for public surveillance; it is often information, or intelligence, culled from consumer polling or statistical analysis of transactional behavior, that has no immediate use in the process of routine public surveillance. Indeed, it is this surplus, bureaucratic capital that is used for the purpose of forecasting social futures, and consequently applied to the task of managing the behavior of mass or aggregate units within those social futures. This surplus intelligence becomes the basis of a whole new industry of futures research, which relies upon computer technology to simulate and forecast the shape, activity, and behavior of complex social systems. The result is a possible system of social management that far transcends the questions about surveillance that have been at the discursive center of the privacy debate."[28]

Ross' concerns are reinforced by the explicit rationale early adopters of wireless devices provide for their investments in them. According to the New York Times, General Growth Properties, the nation's second-largest mall developer, are lending wireless handheld devices to mall visitors predominantly because of their information-gathering function.

> "Amazon knows more about one customer after one trip than we do about a person who comes in year after year,"John Bucksbaum General Growth Properties CEO said. By tracking purchases online and obtaining e-mail addresses through registrations, he said, "we'll be able to e-mail a person about new items coming into the store, or sales."[31]

Once gathered, this information cost effectively creates new forms of influence and persuasion through finely targeted advertising and more subtle customizations of content. As any online services develops a more detailed picture of each customer's interests and purchasing habits they present recommendations and alter the order of search results in an effort to increase sales and improve satisfaction. The collection of this

[8] ibid, p. 219

[9] ibid, p. 220.

[10] See also Tom Athanasiou and Staff, "Encryption and the Dossier Society," Processed World, 16 (1986): 12-17.

data is significant in a desktop-bound online world. Once free to roam along with every person, these devices can capture data about a vast amount of detailed personal information with almost no effort. Foucault writes that it is, "... exercised through its invisibility; at the same time it imposes on those whom it subjects a principle of compulsory visibility. In discipline, it is the subjects who have to be seen."[11] The image of the net connecting individuals and facilitating the creation of groups is replaced with the image of a net drawing closed on the individual. For Foucault, the earliest complete embodiment of this concept was the Panopticon, a prison designed by the Utilitarian Philosopher Jeremy Bentham.

> "... the major effect of the Panopticon: to induce in the inmate a state of conscious and permanent visibility that assures the automatic functioning of power. So to arrange things that the surveillance is permanent in its effects, even if it is discontinuous in its action; that the perfection of power should tend to render its actual exercise unnecessary; that this architectural apparatus should be a machine for creating and sustaining a power relation independent of the person who exercises it; in short, that the inmates should be caught up in a power situation of which they are themselves the bearers."[12]

Freed from the limitations of direct personal observation, the cybernetic Panopticon enhances the capacity of traditional surveillance to create the "measurement of overall phenomenon, the description of groups, the characterization of collective facts, the calculation of gaps between individuals, their distribution in a given population."[13] The construction of extensive dossiers creates and enforces identity and individuality. "There is no universal person on whom power has performed its operations and knowledge, its inquiries. Rather, the individual is the effect and object of a certain crossing over of power and knowledge."[14] Individuality and identity are no longer a right but a responsibility, a legal obligation. One must maintain and cultivate one's identity under threat of some institutional stigma: bad credit, traffic violations, medical histories, military service, incriminating phone calls, even past due library books are firmly attached to the information constituted individual.

[11]Foucault, op. cit., p. 187.

[12]Foucault, op. cit., p. 201.

[13]Foucault, op. cit., p. 190.

[14]Dreyfus and Rabinow, Michel Foucault: Beyond Structuralism and Hermenutics, p. 160.

Thus, contrary to common conceptions of modern society as "mass society," a faceless and homogenized lump, Foucault stresses the utility of individualized power, a power that in fact is primary in the creation of individuals:

> "I don't think that we should consider the 'modern state' as an entity which has developed above individuals, ignoring what they are and even their very existence, but on the contrary as a very sophisticated structure, in which individuals can be integrated, under one condition: that this individuality would be shaped in a new form, and submitted to a set of very specific patterns... we can see the state as a modern matrix of individualization, or a new form of pastoral power."[15]

Pastoral power, a particular form of disciplinary power, attributed by Foucault to the Catholic Church and continued by Protestantism, is directed not at groups in general but at each individual in particular. It requires finely detailed knowledge of its subjects; "this form of power cannot be exercised without knowing the inside of people's minds, without exploring their souls, without making them reveal their innermost secrets. It implies a knowledge of the conscience and an ability to direct it."[16] This power, as distinct from the power wielded by the forms of physical punishment that marked earlier regimes of power, is able to apply itself at all times, it is "coextensive and continuous with life" and penetrates deeply into the individual since it is "linked with a production of truth – the truth of the individual himself."[17]

As wireless networks and computers insinuate themselves into more and more aspects of everyday life, the use and interpretation of these records have been used to create maps that reveal in great detail social spaces that had previously been cloaked by the unwieldy nature of the data or the costs of collecting it. Centers of authority and power are rapidly investing in these technologies of monitoring and control. While there are concerted efforts to create a legal framework around information collection and dissemination practices the technology is moving far quicker than law and poses real challenges to regulation.

Local governments may use these tools to address practical problem of general concern. Imagine city borders that were more than geographic abstractions. Municipalities may require people who cross their

[15]Foucault, in Dreyfus and Rabinow, p. 214.

[16]ibid, p 214

[17]ibid, p 214

boundary to broadcast their identity in the same way that cars on the roads require license plates. Citizens of the municipality may be granted premium tier network services and tracking in order to support improved personal safety and other services. People who fail to broadcast these identifying documents may not be illegal, but they will stand out more easily and be the target of additional attention. Municipal services consume the bulk of local tax dollars; making any savings very attractive. Already Denver, Colorado has plans for a system to track the location of all street department workers (PC Magazine, June 2000). Police and Fire are sensible next steps. While meaningful constitutional issues may arise if municipalities attempt to require citizens to identify themselves to wireless networks, institutions that run campuses will see as many advantages and few legal obstacles. Particularly college campuses which need to maintain a sense of openness as well as provide increased personal safety guarantees will be as eager to embrace such systems as they have to adopt smart card readers and computer controlled access doors on campus buildings.

The integration of a range of other forms of sensors into these devices, from temperature to the heart rate of the person holding the device, point to the emergence of a range of medical and personal safety applications. Telemedicine systems illustrate the use of a wireless networks to provide extensive medical monitoring. More routine use might give far-flung members of families the reassurance that all their members are alive and well. In widespread use, these devices become a form of panic or dead man switch that may lead to a significant shift in the nature of violent crime by automatically calling attention and heightening surveillance wherever people experience sudden and drastic changes in their life signs.

III. Social Dilemmas and Horizontal Panopticanism

In the face of such a juggernaut, it is often difficult to see positive social outcomes. Indeed, there are real reasons to be concerned about the increasingly tight net that is being woven around billions of people. But Foucault focuses on the way central authorities apply power on hierarchically organized masses to the exclusion of any exploration of the ways groups have and persist in mutually organizing their relationships for the mutual benefit of many of their members. The unexpected outcome may be the emergence of a form of counter-power that enables groups to band together and collectively contribute to the provision of important collective goods, like physical security, social interaction, financial assistance, and medical attention through cheap, automatic, publicly visible record keeping.

The primordial reason for social life is mutual advantage and human groups have found numerous ways to arrange their interactions and transactions so that they collectively create mutual value. They do so in the face of significant challenges and succeed, when they do, through the application of mutual monitoring and sanctioning. While Foucault's concerns about the use of intimate knowledge in the hands of vast central authorities like states and corporations remain compelling, the literature on collective action dilemmas highlights the fact that endogenous social order also requires technologies of mutual social control. The most profound social impact wireless devices are likely to make is in the way they catalyze collective action. By exposing the data collected by these systems to one another, groups of people will be able to strengthen their mutual awareness and ability to overcome the collective action dilemma.

Social interactions often have at their core a dilemma. Collective action dilemma theory and research is built around the recognition that in many cases individual rationality leads to collective disaster. This tension between what makes sense for the individual and what is best for the group as a whole is a driving force behind the most serious problems facing human society. From environmental pollution to the conservation of fresh water and fishing grounds or the support of public television, we struggle with the need to manage the way we collectively consume or provide for essential resources. When societies fail – and history is filled with such failures – the implications can be severe. The desertification of regions like the Sahara and the Southwestern United States, the destruction of fishing grounds, or even the rise and fall of speculative markets can all be seen as the result of individual actions that alone have little effect but in aggregate are powerful and destructive.

The tension between cooperation and defection is a common feature of group interaction; the temptation to let others contribute to any kind of collective project or resource and free ride on the rest must be counter-balanced by the others who will likely withdraw their contribution if they see that they are being taken advantage of. All groups suffer from some free riders and every person free rides at one point or another, but groups must succeed in getting the majority of their members to contribute enough and with-

draw little enough to keep the shared resource viable. Ostrom (1990) studied a wide variety of communities with long histories of successfully and unsuccessfully producing and maintaining collective goods in order to determine what features of a group contribute to its success or failure in such endeavors. The set of cases she examined include the maintenance of common forest and grazing grounds in Swiss and Japanese villages, fisheries in Canada and Sri Lanka, and irrigation systems in Spain and the Philippines. She identified a set of features of communities which have successfully met the challenge of producing and maintaining collective goods despite the temptation to free ride and without recourse to an external authority.

In comparing these communities, Ostrom found that groups that can organize and govern themselves well share the following characteristics:

1. Group boundaries are clearly defined.
2. Rules governing the use of collective goods are well matched to local needs and conditions.
3. Most individuals affected by these rules can participate in modifying the rules.
4. The rights of community members to devise their own rules is respected by external authorities.
5. A system for monitoring member's behavior exists; the community members themselves undertake this monitoring.
6. A graduated system of sanctions is used.
7. Community members have access to low-cost conflict resolution mechanisms.

In every successful community Ostrom studied, the monitoring and sanctioning of people's behavior was undertaken by the community members themselves rather than by external authorities. Groups sustain themselves by monitoring and sanctioning their members. A group must be at least broadly aware of its membership's contributions and withdrawals of collective resources in order to maintain itself.

Clearly defined group boundaries and a set of well-designed rules also marked each of the successful communities Ostrom studied. Because community members participated in refining the rules and the rules were well matched to local conditions, most members believed in the rules and were committed to following them. However, this does not seem to be enough to ensure cooperative relations, some type of system to monitor and sanction member's actions was a feature of every successful community. Monitoring and sanctioning is important not only as a way of punishing rule-breakers, but also as a way of assuring members that others are doing their part to use common resources wisely.

Ostrom and other researchers (e.g., Levi 1988) have argued that many individuals are willing to comply with a set of rules governing collective goods if they believe the rules are effective and if they believe most others are complying with the rules. That is, many people are contingent cooperators, willing to cooperate as long as most others do. Thus, monitoring and sanctioning serves the important function of providing information about other people's actions.

The emergence of cooperation in any social group depends on a number of factors. When interactions and transactions are risky or costly, people rely on trusted partners who have developed reputations and stable identities. In online environments this information is often missing while in physical environments it is often limited and costly to verify. To address this void, Web services like eBay and epinions have created systems that track the reputation and history of all participants by encouraging transaction partners to review one another and then publishing the resulting dossier through a link from every reference to the participant's name in their system. Epinions goes further, tracking the amount of attention each person receives as well as the web of endorsements and denouncements that people make with one another.

AltaVista (http://www.altavista.com/) and Deja.com (http://www.deja.com/) both provide reports on the histories of individuals in newsgroups. AltaVista, like a half-dozen similar services, allows users to enter a person's name or email address and get a list of all the messages that person contributed to all Usenet newsgroups since the service started collecting data in March of 1996. Deja.com's discussion search feature goes a step further, explicitly offering a "Poster Profile" report. The report lists the number of times the person selected posted to the Usenet over a period of time. The Netscan service (http://netscan.research.microsoft.com) goes even further, providing the percentage of postings that were responded to as well as a breakdown of each newsgroup the person posted to and the number of messages the person posted there.

These forms of reputation and behavior tracking systems can track the state of social relationships between potentially billions of people in real time. We already have this in the form of the global credit card network and its supporting credit history databases.

The next step is the extension of Internet reputation services into the realm of face-to-face interaction. Wireless handhelds will encourage the penetration of online reputation and personal information systems, from eBay to the more traditional credit, medical, military, educational, and property and tax record systems, into what Erving Goffman referred to as the "Interaction Order", the space of direct association and communication created between people[15].

If every lamppost on the street or every object for sale in every store is associated with potentially millions of comments, annotations, reviews, and any other form of digital object, the welter of information will be overwhelming. There is a need for services on the network that help filter, aggregate, and organize this content. One of the most important ways of organizing this content will be in terms of its author's reputation and relationship to others. Social accounting services in the form of reputation and endorsement repositories will emerge as significant resources for navigating the annotated world. Social accounting is a form of record keeping that tracks interactions as well as transactions between groups of people. This means that almost any set of interactions or transactions including the give and take of conversation, of questions asked and answered, can be tracked, as can exchanges of goods and services. This allows groups to develop reputations with one another (and potentially publish those reputations before a global audience).

By agreeing to participate in interactions and transactions in an environment watched by social accounting systems, participants have the opportunity to benefit both by receiving good information and by gaining a way to build a reputation which, if it is good enough, will make the participant's own material stand out. If data is not only collected but also made publicly and globally accessible, the nature of disclosure and surveillance change in interesting ways. As David Brin has argued in Transparent Society, universal disclosure can have unexpectedly positive results. Groups may find that there are benefits to operating within such an environment by helping them see themselves better.

Online reputation systems take on new importance when they can be accessed in any place or at any time. Wireless networks offer a range of new opportunities for both monitoring and sanctioning behavior. Successful examples of collective action share an ability to engage in appropriate, scalable mutual sanctioning. Sanctions sound like unpleasant aspects of social systems, but they are critical to the success of collective action. If people cannot impose accountability and some form of stigma on others who are not complying with the rules of a collective endeavor, it is likely that the entire system will unravel, leading to collective failure. However, imposing a sanction requires one to make a contribution of time and energy and assume a risk of retaliation. To contribute sanctioning services is itself a collective good that suffers from its own provision dilemma.

Effective sanctioning relies upon monitoring. If it is difficult to identify either the largest contributors or the most egregious free riders, sanctioning cannot function effectively. In the physical world, monitoring occurs in many ways. The mutual awareness of coworkers around common coffee pot chores or neighbors around maintaining common spaces is often constructed through casual interaction and fairly cheap monitoring and record keeping. But without the background of a social network of general awareness among neighbors most neighborhoods become more dangerous and shabby. The widespread use of wireless devices means that monitoring the contributions and consumption of a common resource by potentially vast groups is made fairly cheap and fluid.

In the physical world, sanctions can range from a quiet comment to banishment, physical containment, or violence. But successfully cooperative communities in Ostrom's study employed a graduated system of sanctions. While sanctions could be as severe as banishment from the group, the initial sanction for breaking a rule was often very mild. Community members realized that even a well-intentioned person might break the rules when facing an unusual situation or extreme hardship. Severely punishing such a person might alienate him or her from the community, causing greater problems. Reputation services offer an almost infinitely fine-grained system of reward and punishment.

The most interesting implications are the ways these tools can allow loosely related people to cooperate and collectively create a range of services that are otherwise costly or impractical. These tools allow groups of unrelated people to cooperate with one another by providing a framework for possible sanctions for misconduct and assurances of prior cooperation. As a result, matchmaking services supported by reputation services may be the one of the most central applications. If people who can provide one another with a needed good or service can easily find one another and get assurances and recourse so that they can trust one another a wealth of pent-up value can be released.

Automobile ride-sharing programs have for the

most part been a failure in the United States. Despite fuel costs, congestion and pollution, Americans are reluctant to relinquish direct control and ownership over their transportation. A ride-sharing system could be built that allowed a person in search of a ride to request transportation from a server through a mobile device. This service can link people based on a number of criteria, including a direct relationship, shared membership in a common institution or association, or historical reputation score and comments. Employees of large companies might be willing to offer rides to one another; as would members of the same church or community organization. By allowing people to rate and review one another in terms of politeness, safety, promptness, and an open ended set of other qualities, informed judgments can be made before agreeing to offer or accept a ride. People could request rides just in time and just in place while available drivers would signal their location and route just as they start their cars. Each party can be granted a chance to review and possibly reject any driver or passenger. When both agree, the driver is given directions and picks up the passenger. After being dropped off, both parties can file reviews of the other.

Such a system may have many ramifications that go beyond traffic management and intersect with concerns over race, class, and gender. Danny Glover's recently publicized difficulty getting a cab in New York City illustrates a persistent social problem with racism [37]. While technology is no panacea and is unlikely to magically fix racial conflicts and stereotypes, the reality is that race is often used as a poor proxy for class and risk. Faced with an ambiguous and risky environment, cab drivers often overcompensate with racial discrimination. Using wireless networks people who can pay their fares and have a proven reputation for being a low risk for violence will be able to signal that fact unambiguously through their network connection. Mr. Glover will no doubt be able to tell his cell phone or pocket computer that he wants a cab, and the network will solicit a ride for him. The result is not an elimination of racism, but it should reduce the incidence of racism used as a proxy for classism. Wealthy people will be discriminated against less, while the poor will be so more effectively.

Groups bound together by such matchmaking and connection tools may collectively create some of the network services themselves.

Companies like Cybiko, whose namesake product is a wireless network device that can send and receive messages to and from other Cybiko devices near it, illustrate the ways in which ubiquitous devices can provide one another with services including basic data connectivity. All the devices in an area can share Internet access if just one of the devices nearby has a direct link to the Internet. Families, friends, and members of more formal institutions like associations and corporations might offer access to other members of controlled terms providing, for example, network access to an otherwise disconnected device. Although this device currently has a 150-foot range, there is no reason to think that more powerful transmissions are impossible, possibly allowing for ranges of one to 10 miles. So long as you are within a reasonable distance of a friend or fellow member of a mutual aid association, you can use resources selectively exposed by that device. Neighbors might lease a single DSL line but share its bandwidth via a wireless network. If these device gain power, it is possible that neighborhoods blanket themselves with wireless access to network services. The result could be a cooperative phone and data network that allowed groups to provide for themselves network connections.

IV. Conclusion

Wireless networks are socially profound technologies because they bring the power and connectivity of computer networks into the gap between humans as they interact in physical space. It is easy to focus on the ominous implications of panoptic technologies, but the more important phenomena may be that these tools can help groups of people successfully achieve cooperative collective action.

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