Mobile netware, social graphs, and the reconfiguration of space

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Abstract
Scholars are well-aware that the smartphone is much more than just a mobile telephone. A plethora of applications have been developed to run on smartphones, covering just about every aspect of human life. What is distinctive about the fact that these apps run on smartphones (as opposed to other kinds of devices) is that the smartphone makes them mobile (the apps travel with the user) and locative (the apps know the location of the user). As a result, smartphone applications that take full advantage of these characteristics have the ability to bring users together in real space and real time. The key to the success of such “netware” apps is their generation and retention of social graphs that connect their users both socially and physically. Netware apps like ride hailing that are built around mobility and location have the potential to dramatically restructure economic and social life by reconfiguring their users’ experiences of the physical and temporal world. We use ride hailing as a case study to illustrate how the new social geographies generated by mobile netware apps interact with physical geography to generate a new sense of space that can only be mapped by the companies that “own” our social graphs.

Keywords
Globalization, locative, mobile applications, mobile communication, mobility, smartphone

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Introduction

Smartphones are ubiquitous in today’s world. The Pew Research Center puts US smartphone ownership at 81% of the population in 2018, with most other developed countries reporting penetration rates above two-third of the population (Taylor and Silver, 2019), although usage rates are uneven and reflect larger patterns of inequality and access to technology. Pew reports a smartphone ownership rate of 24% in India, and in China, a majority of the population is now able to access the Internet through smartphones (McCarthy, 2018). Although we still call these devices “phones”, they are, of course, radially multifunctional; making phone calls is one of the least important of their many uses. What’s more, a large percentage of what are functionally understood to be phone calls are actually voice connections made within mobile apps. The difference is important, because a mobile app generates much more data from a voice connection than a phone does from a phone call, including data on the callers’ identities, personal networks, and physical locations. This new multi-dimensional flexibility allows us to communicate in new ways in certain social contexts, meaning that we have greater and more complex communication possibilities than before. Smartphone technology has rapidly developed to the point where big data analytics can simultaneously harness social and locational data to generate new forms of mobile networking, like autonomous RH services, that were in the realm of science fiction only a decade ago.

Many writers with backgrounds as technologists have emphasized the role of material features in mobile phones’ mass adoption and usage (Klemens, 2010), as well as the ways that these networks take on an infrastructural element (Farman, 2014, 2015). Social scientists have been more nuanced, but some freely acknowledge that the material qualities of mobile technology facilitate certain types of interaction and activities (Latour, 1999). In a collection of essays on the mobile telephone and its users, Reingold (2002) argues that mobile phone networks enhance the public sphere by creating new networks and new flows of information. Agar (2003) argues that mobile phones have allowed spatially dispersed networks of people to prosper while pre-existing (often local) hierarchies have suffered. Similarly, Geser (2005) highlights the subversive potential of mobile phone networks and their ability to erode the power of traditional authority. In his foundational text, Nyíri (2003) emphasizes the new spatial dynamics that mobile phone networks create, enabling more global communication while reinforcing the local. Scholars have also debated the social implications of cheap, mass horizontal communication (Fortunati, 2003; Ibahrine, 2008; Tenhunen, 2011).

An important and growing sub-section of the mobile communications literature has focused on location as a component of mobile communication enabling a shift from “cyber to hybrid” spaces (De Souza e Silva, 2006). The reconfiguration of urban spaces “as connected spaces, as mobile spaces, and as social spaces” (De Souza e Silva, 2006: 261) identified by de Souza e Silva even before the introduction of the smartphone has since then led to a much more advanced blurring of lines between physical and virtual spaces. Further emphasizing the changes brought about by Web 2.0, Bilandzic and Foth (2012) highlight the significance of the new digital layer that goes beyond physical space to create the new hybrid space. These advancements change how people interact with their physical space and boundaries. In this same spirit, De Souza e Silva and Frith
Agur and Babones (2012) argue that “mobile technologies can be viewed as interfaces to public spaces . . . that enables people to filter, control, and manage their relationships with the spaces and people around them” (p. 45).

We also draw from Frith’s (2015) book, *Smartphones as Locative Media*, which emphasizes location and spatial theory in the context of mobile networks. Importantly for our purposes, it examines the infrastructural aspects of mobile communication, showing how networks of networks have taken on aggregative and structural features that belie their nimble appearances. This aggregative tendency means that, over time, new formats of mobile media can reconfigure our perceptions of, and relationship with location (Frith, 2015: 137–141). Our preferred term, netware, applies much of the locative theory Frith develops, while also seeking to incorporate new and emerging features of mobile devices and mobile networks.

In a broader sense, numerous scholars have found that mobile phone networks have the potential to disrupt old norms and enable new spatially based social relations (Agur, 2015, 2019; Arminen, 2005, 2009; Castells et al., 2007; Ekine, 2010; Katz, 2005; Wilken, 2011). Examining mobile augmented reality, Liao and Humphreys (2015) described the ways that this technology lets users “reengage, reproduce, and reappropriate” public spaces. Looking at the phenomenon of Pokemon Go, Hjorth and De Souza e Silva (2017) found that many users feel a heightened connection to everyday physical spaces when there is also a connection to the digital world in these spaces. In their study of ride sharing and mobility, Chan and Humphreys (2018) identified a “mediatization of social space” in which the features of the Uber app shape the expectations of drivers and passengers.

In a broader sense, we can see the altered situational geography brought about by a combination of connectivity, material features of devices and networks, and users’ understandings and uses of mobile technology. Castells (2010) argues that this can be understood as a “space of flows,” in which space becomes an expression of society. We see something more aggregative and infrastructural: as this article will show, mobile “spaces” have become hybrid, interdependent, generative, and dynamic.

In recent years, an ever-denser set of mobile networks have brought new users, more frequent usage, and the integration of mobile communication into many new aspects of social life. In this mobile-ization of communication, location, and mobility have emerged as major themes for scholars, an exciting and, at times, worrying element for users, and a profitable endeavor for a wide variety of commercial players. Worldwide, the proliferation of cell phone towers and improvements in global positioning system (GPS) technology have led to ever more precise locational data for mobile devices, a trend that will only accelerate with the transition to 5G. Locational data have become valuable for advertisers, apps, websites, and users. Some sites and mobile apps have used geofencing as a condition for certain outcomes or benefits to the user, but more often location has been leveraged to generate value through mobility. Amid these developments, the revolution in mobile communications has led to changes in the meaning of previously closed-off spaces; it is harder to remain off the network, and even harder to keep people off the network.

Internet companies routinely request access to users’ location data, which increasingly can be accurately ascertained from environmental electromagnetic signals even
when a phone’s GPS functionality is turned off (Liang et al., 2017). Many popular apps will only function fully when given unrestricted access to both social and location data on users’ smartphones. The ubiquity of data harvesting has given rise to concerns about the rise of a new form of “data capitalism” (West, 2019) or, more alarmingly, “surveillance capitalism” (Zuboff, 2015, 2019). West’s data capitalism differs from Zuboff’s surveillance capitalism more in focus than in findings, with data capitalism placing “primacy on the power of networks by creating value out of the digital traces produced within them” (West, 2019: 21). For West, data capitalism represents a reversal of the initial premise of the Internet, a shift from offering goods to people through websites to offering people to goods through apps.

But the shift in the structure of the online economy from a focus on straightforward sales to a new focus on leveraging user data has led to a largely unexplored transformation in the character of Internet companies themselves. Although Internet companies use software in the form of mobile applications (“apps”) to implement their business models, their business models do not primarily consist of the provision of software services. The main source of value for these businesses is their possession of and ability to analyze massive semi-structured datasets containing the social and locational ties that connect their users. They generate profits by applying machine learning algorithms to their users’ interlocking social and locational graphs. Their locative “big data” business models thus flip the pattern of West’s data capitalism by offering services to people based on data about how they relate to other people.

In this article, we propose a new term to describe these mobile networking business models using a new term—“netware”—and explore their potential to reconfigure social and economic space(s). We apply our approach to RH, an industry that sits at the nexus of social networks and location services, and that we believe has the potential to become a paradigmatic industry of the 21st century, playing a role analogous to that of the automobile industry in the 20th century. The intangible and non-isolable nature of netware services like RH makes them extraordinarily difficult to pin down and regulate. Much more transformative, however, is the fact that their possession of the social and locational graphs connecting their users gives netware companies sole access to a map of the new hybrid social-locational space in which the rest of us move and live.

**Hardware, software, netware**

The multifunction smartphone and the app economy it supports have so quickly become central to everyday economic and social life in developed countries (and beyond) that it is important to remember just how recently they came into existence. The first Apple iPhone was released on 29 June 2007. Assembled almost entirely in East Asia of mostly East Asian components, the iPhone leverages regional production networks that developed over a 40-year period beginning with the emergence of offshore contract manufacturing in the late 1960s (Hamilton and Kao, 2018). Coincidentally, a little over a year after the release of the first iPhone, the investment bank Lehman Brothers went bankrupt on 15 September 2008, an event that marked the beginning of the Global Financial Crisis and the end of 40 years of increasing global trade. Since 2008, global merchandise trade has been flat or declining as a proportion of global gross domestic product (GDP; Babones, 2019a).
The Global Financial Crisis might thus be understood as marking a boundary or inflection point between two kinds of connectivity: physical connectivity through trade versus virtual connectivity through the Internet. Since the introduction of the iPhone, the mobile Internet has become so thoroughly interwoven into all aspects of economic life in developed countries that it is difficult to disentangle online from offline economic activity. The three traditional economic sectors that form the basis of the system of national accounts (agriculture, industry, and services) are all deeply penetrated by and densely connected by the Internet. Emerging technologies such as cloud computing and blockchain database structures will make that penetration deeper and those connections denser still. The new mobile Internet economy seems to demand a new categorization of value-generating activities. Taking a cue from the computer industry itself, it might make sense to reconceptualize economic activity from the old, goods-era trinity of “agriculture, industry, services” to a new, Internet-era trinity of “hardware, software, netware.”

**Hardware** is familiar as a term for computers and their components, but as the Internet of things develops and more and more devices become “smart” devices with some degree of computing power built into them, it makes sense to think of all physical things as forms of hardware. Certainly, some physical things will remain “dumb” and chipless, but such things are of declining economic relevance. Rather than persist in using an economic categorization that distinguishes dozens of categories for dumb things like nuts, bolts, and screws, while lumping all mobile phones together in a residual category of communications equipment, it seems more productive (for conceptual purposes at least) to lump all physical things together as hardware, relegating dumb hardware to a residual category of a larger group of mostly smart (and getting smarter) devices. In this approach, one might think of a screw as a hardware device of smartness level zero.

**Software** is also a familiar term, but it has become too broad to be analytically useful when applied to the Internet economy. Operating systems, productivity software, and enterprise software are extraordinarily complex structures of computer programming that run into multiple gigabytes of code. They represent software “as such”; their value as intellectual property is embedded in their code. For example, word processing software is valuable mainly because its computer code enables desktop publishing. Although such software may be physically intangible, there is nonetheless something quite substantial about it. Like hardware, software is isolable, in the sense that most software programs can in principle be run in isolation by individuals on their own computers.

But today, many valuable smartphone apps run on relatively small compilations of code, with the software itself representing a relatively trivial component of their value. The intellectual property of a social network, online marketplace, or RH app consists mainly of its user base and network graph, not of its software as such. Facebook, Amazon, and Uber do not seem to be primarily “software” companies. These emerging network services constitute a new analytical category. The neologism “netware,” formed on the model of hardware and software, might be used to denote apps that generate value by connecting people and/or things. **Netware** is a loose category of technologies that include social networks, search engines, online marketplaces, entertainment platforms, e-payments providers, sharing apps, RH services, and even multiplayer computer games. Hardware is tangible and isolable. Software is intangible, but
also isolable. Netware is intangible and non-isolable. It is a new form of product that derives its value mainly from connectivity.

Although the value of netware may be difficult to calculate with publicly available economic tools, it is certainly large and getting larger. The world’s top five most valuable brands are all, to varying degrees, netware companies: Apple, Google, Microsoft, Facebook, and Amazon (Forbes, 2018). Although the netware share of their brand values is unknown, all five companies are showing through their behavior that they believe netware-type activities to be crucial to their futures. They are all eager to develop, acquire, and/or invest in netware services, and they are all attempting to leverage their existing customer bases into social networks of one kind or another. Apple, Google, Microsoft, and Facebook all offer short message services to tie customers more tightly into their ecosystems. Amazon is an outlier among the five, but like the others, is driving into netware fields like entertainment and e-payments. All five companies are eager to build (and monetize) the social graphs connecting their customers (Zaidi, 2018). And all five have invested in, or are developing, RH services (CBInsights, 2018).

Mobile netware—the use of netware on mobile devices—has rapidly reshaped patterns of economic activity. It has introduced a new, unforeseen “third interval” into Vililio’s (1993) technological reconfiguration of space, not the “absolute speed” (p. 6) in the Cartesian space-time of Vililio’s prognosis, but absolute speed of connectivity along invisible geosocial networks. Netware apps have emerged as an essential and defining aspect of how people connect with others, conduct business, manage tasks, and keep in touch with social connections. This growth of digital production and consumption of information reveals a new informational structure that has emerged, and a corresponding new set of flows. These flows reflect more than just an increase in speed (although that is visible as well). The new flows of mobile netware manifest themselves in the relationships users have with commercial and cultural phenomena. Mobile netware gives structural depth to mobile telephone networks.

But a set of limitations—in economics, geography, language, and connectivity—shows that mobile netware is still incomplete and unequal. On one hand, mobile netware has illustrated some ways that new communication networks (including mobile phones, websites, and social media) can foster greater participation. On the other hand, mobile netware is not as inclusive as it might be: several of its core aspects (its elite-oriented political economy, its urban-centrism, and preference for high-end mobile technology) can exclude much of the population in low- and middle-income countries.

Paradoxically, mobile netware can also be a tool for inclusivity, as, for example, poor people use inexpensive data services as functional substitutes for tolled phone calls and messaging. Basic handsets and service are cheap, roaming charges have been phased out, and governments have created initiatives (such as the USO Fund in India) to expand cellular coverage to ever-more-remote places. And for vast spaces divided by geography, class, religion and language, the mobile phone offers a new spatial logic. An owner of a mobile phone with a few megabytes left in its account can communicate with other users anywhere in the world. As a result, mobile phones are quickly becoming the new offices and entertainment platforms for many young entrepreneurs, and the conduits for matchmaking by parents eager to find a spouse for their children.
While these stories are often celebrated as the deconstruction of a spatial reality based on inequality, most quotidian mobile phone usage takes place within pre-existing local social networks, as mobile netware adds new complexity and immediacy to existing social relations and strengthens family and community networks (Tenhunen, 2008, 2011). The mass usage of mobile phones has not, and likely will not, dissolve the world’s geographical and social divides; what this usage has done is reinforce existing social relations, while exposing users to communication with their fellow citizens near and far by design, by accident, and by the motivations of users. In this sense, the new online networks that have formed in the past 20 years have challenged the traditional sense of space and have offered a new sense of proximity based on flows of information and capital.

Mobile netware is reshaping concepts of locational proximity (both spatial and social) by making possible new social interactions that are redefining location and centrality in economic and social networks. The netware revolution results in both the de-territorialization of location (the propagation of networks across borders and great distances) and the re-territorialization of location (the identification of how particular individuals fit into massive social graphs). One netware application that takes advantage of both trends is RH (the use of smartphones to match riders with drivers, for example, by Uber and Lyft). Ride hailing is an especially fertile test bed for exploring the transformational potential of mobile netware because it is so inherently concerned with location. Thus, we use RH as a paradigmatic case for exploring the implications of netware for personal mobility, industrial transformation, and ultimately, the distribution of power in society.

**Ride hailing and the personal transportation technosystem**

RH apps are smartphone applications that are designed to facilitate the sharing of personal transportation services. Originally conceived to help coordinate carpooling (people sharing their cars, for example, to take advantage of carpool lanes or to reduce operating costs), it quickly became apparent that the same technology could be used to enable people to offer personal transportation for hire—that is, taxi services. RH apps make it possible for people to offer taxi services by “sharing” their personal cars for a fee. The fee is usually determined by the app, which charges the driver a percentage (usually around 20–25%) for the service of finding a customer, setting the route, providing liability insurance, and so on. Following the historical practice of the taxi industry, many RH services maintain the legal fiction that drivers are independent contractors providing personal transportation services directly to their passengers, but from an economic (and consumer) perspective, the company offering the service is clearly the app.

Big technology companies are (in)famous for their overlapping investments in emerging technologies, so evidence of the “big five” netware companies investing in RH should, perhaps, be taken with a healthy grain of salt. But it is at least worth noting that Apple has invested in the Chinese RH app DiDi (Love, 2016), Google in Lyft (Korosec, 2017), and Microsoft in Uber (Arce, 2015). Facebook is linked to both Uber and Lyft through its Messenger service (Bailey, 2018), leaving only Amazon out of the running—for now. Amazon has invested heavily in autonomous (self-driving) vehicles (AVs; Sullivan, 2017). These may be initially intended to serve as delivery vehicles for
Amazon’s online consumer marketplace, but once built, they could also conceivably offer autonomous RH services. Apple, Google, and Microsoft are also developing AVs. Several technologies are simultaneously coalescing around RH apps with an extraordinary level of cross-investment among major players: the apps themselves, AVs, and battery electric vehicles (BEVs). The leading RH apps Uber (Johnson and Fitzsimmons, 2018), Lyft (Moon, 2018), and DiDi (Lee, 2018) all have AV programs. Tesla most prominently represents the cross-over between AVs and BEVs, though most major automobile manufacturers have programs to develop both AVs and BEVs, and many of the companies engaged in AV research envision their AVs as BEVs. General Motors has taken things one step further with plans to roll out an integrated RH service in San Francisco based on a fleet of autonomous BEVs in 2019 (Welch et al., 2018). It is this last model, the “all three” approach, that has perhaps the greatest potential to completely transform the personal transportation technological ecosystem.

A technological ecosystem or technosystem might be understood as a suite of technologies that reinforce each other through positive externalities in a well-circumscribed positive feedback loop. In other words, the technosystem has positive feedbacks among its components, but does not (at least, not “as such”) expand exponentially outward. For example, before the Internet, personal computers, operating systems, and productivity software formed a distinct technosystem, to which peripheral components like printers and modems could be connected. Ultimately, the tail would come to wag the dog, as the modem reduced the personal computer (PC) itself into a peripheral device of a much larger technosystem, the Internet.

Currently, the personal transformation technosystem is centered on individual car ownership, petroleum (gasoline or diesel fuel) power, and widely dispersed filling stations. The rise of RH apps has the potential to displace the first element, BEVs the second, and AVs the third. Individually, these displacements are not particularly transformative, and not mutually reinforcing. For example, RH apps, in principle, offer a little more than an alternative to existing taxi services. The switch to BEVs has been driven mainly by environmental concerns and limited by range anxiety; from the perspective of a simple substitution of individual technologies, plug-in hybrids that include a backup petroleum engine have many clear advantages over fully electric BEVs. And AVs are being promoted mainly as a productivity tool, freeing the owner to engage in other work or leisure activities while moving from Point A to Point B.

Taken together, however, RH apps, BEVs, and AVs have the potential to radically transform the personal transportation technosystem and replace it with an entirely new technosystem. This is because the use of AVs in a RH context solves the range anxiety, battery capacity, and battery charging problems of BEVs. In the RH-AV-BEV technosystem, individuals would order a car to meet a specific trip need. An AV from among the fleet of available AVs would respond only if it had sufficient battery life to make the trip. When an AV’s batteries ran low, it would return automatically to a charging station. It would even be possible for AVs to self-coordinate a daisy chain to ferry passengers over long distances, with hand-offs between AVs made, for example, at highway rest areas. Thus, although any individual BEV might have limited range, the RH-AV-BEV technosystem as a whole would be able to replace the existing personal transportation technosystem in its entirety.
The BEV industry has, to date, followed the model of personal ownership, which raises the need for public charging piles where people can charge their cars, while away from home. The RH-AV-BEV technosystem obviates the need for public charging facilities—and along with it, the need for people to wait while their cars charge. Current charging times of a minimum of 30 minutes (Pod Point, n.d.) are clearly too long for BEV charging piles to operate on the model of petroleum service stations. Thus public charging piles have been associated with urban parking spaces. The need for public charging piles effectively limits BEVs to urban or metropolitan use under the current private ownership model. By contrast, when BEVs are run as AVs in a RH environment, no user needs to wait for a charge. The car charges; the user moves on.

Similarly, the RH-AV-BEV technosystem solves the most serious challenges faced by the RH industry. RH faces risks from the potential criminal behavior of its drivers. It also faces regulatory risks relating to its treatment of drivers as independent contractors. Both of these risks potentially disappear with the transition to AVs, as do the costs of compensating the drivers themselves. On the other side of the ledger, the RH-AV-BEV technosystem would dramatically increase the capital intensity of the RH industry, as RH companies develop their own in-house car fleets. Alternatively, the RH apps could contract with regional fleet managers on a franchise basis. Either way, the RH app would remain brand recognized by the consumer and the lead firm in the personal transportation technosystem.

Like any technosystem, the emerging RH-AV-BEV technosystem does not exist in a social vacuum. Myriad social and political factors shape its prospects and will determine its future. It also exists within a larger technological world, and parallel developments in closely related technosystems seem likely to favor the transition from a personal transportation technosystem based on individual car ownership, petroleum power, and filling stations to one based on RH, BEVs, and AVs. The transition may occur first in China, or at least, be prototyped in experimental special zones like southern China’s technology capital, Shenzhen. In addition to a high level of central planning (which can sweep aside democratic opposition to change), the two factors that are likely to facilitate China’s implementation of a complete (local) RH-AV-BEV technosystem are easy access to high speed rail (HSR) connectivity and the rapid development of smart power grids.

The existence of a nationwide HSR network for medium distance travel, supplemented by a well-developed commercial aviation system for medium and long distance travel, reduces the utility of car ownership for personal travel between metropolitan areas. The development of an RH-AV-BEV technosystem would further reduce the attraction of personal car ownership. Since RH apps can integrate with GPS and train timetables, it is already technically feasible for them to offer seamless door-to-door services linking intercity HSR travel with metropolitan automobile connections on each side (although it seems that, as of the time of writing, no major company offers such services). The synergies between HSR and RH are even closer than those between air and RH, since trains run on firmer schedules than airplanes and GPS can be used to continuously track terrestrial travelers’ progress. Travelers can already book train rides from their car seat and car rides from their train seats; presumably, in the near future, they will be able to book a car-to-train-to-car trip as an integrated service.
More subtly, but perhaps even more powerfully, the development of smart electrical power grids is strongly synergistic with the RH-AV-BEV technosystem. Smart grids use “two-way flows of electricity and information to create a widely distributed automated energy delivery network” (Fang et al., 2012). They are, in effect, online systems for continuously managing power usage at a very localized level. Smart grids are technologically indispensable for the shift from conventional baseload power generation to “green” energy sources that may be intermittent, like wind and solar (Hossain et al., 2016). They also enable consumers to sell power back to the grid, for example, from solar cells on their roofs. Smart devices on smart grids can, in theory, continuously adjust their electricity consumption based on local and system-wide needs; for example, a dishwasher could be set to run automatically overnight at the optimal time of low-grid demand, triggered by a signal from the smart grid itself (Xu et al., 2017). Similarly, personally owned BEVs could be programmed to charge at optimal times in coordination with the smart grid, and through the smart grid in coordination with each other. Neighbors’ cars could dynamically “take turns” charging in such a way as to minimize overall stress on the grid, and even feed electricity back to the grid, if needed (Shaukat et al., 2018).

The enormous aggregate storage capacity of all the BEVs connected to a city’s smart grid thus has the potential to be used as a kind of energy reservoir for the entire electrical system. The use of BEVs as mobile storage units for a green energy smart grid is known as the “vehicle to grid” (V2G) concept. The key to making V2G practical is the introduction of an “aggregator” to coordinate the energy usage and contribution of thousands (or millions) of vehicles (Shaukat et al., 2018). The role of the aggregator is especially important for frequency regulation (i.e. ensuring that the grid continuously supplies power at a standard frequency 50 Hz or 60 Hz). In the individual ownership model, there is a little to be gained from V2G, since energy spikes are not likely to occur in the deep overnight when cars are plugged in at home, and individual BEVs cannot regulate the frequency of the grid as a whole. Thus, under the individual model, the advantage of BEV feedback to the grid would, practically speaking, be limited to the systematic draw-down of residual BEV charges during the few hours of peak demand when people return home from work. But in an RH-AV-BEV technosystem, unoccupied BEVs could be wirelessly signaled to return to charging stations at any time during the day to contribute electricity to the smart grid. The entire BEV fleet would become part of the smart grid, not just when parked overnight, but throughout the day as well (Babones, 2019b). Thus, the RH-AV-BEV technosystem could become part of a larger restructuring of infrastructure, transportation networks, and users, all enabled by mobile netware.

**Netware and industrial restructuring**

The globalization of production networks between 1968 and 2008 was characterized by the reorganization of global commodity chains (Gereffi and Korzeniewicz, 1994) into global value chains (Gereffi et al., 2005). Global value chains are production networks in which a “lead firm” leverages its direct relationship with the consumer to organize production processes in such a way as to extract maximum value for itself. If the paradigmatic case for the classical analysis of production networks was the automobile industry (Feng, 2018), the paradigmatic case for the contemporary analysis of value chains is the
mobile phone industry (Gereffi, 2014). In mobile phone manufacturing value chains, consumer-oriented brands (Apple, Samsung, Huawei) are able to act as lead firms in modular value chains. They garner the lion’s share of the profits associated with the products they sell, leaving their turnkey suppliers to operate on razor-thin margins.

From the perspective of people shopping for personal transportation services from a traditional taxi service or RH app, the relevant brand is not the brand of the manufacturer of the automobile, but the brand of the taxi or app. In the traditional world of taxi services, this did not pose a serious threat to automakers, since taxis were usually used as a supplement to (not a substitute for) car ownership. Taxi services were mainly used by tourists (who were traveling without their cars), by the poor (who could not afford cars), or in big cities (where car ownership was not practical). In fact, automakers were often happy to have the opportunity to liquidate excess inventory through fleet sales to taxi companies, which typically did not care to purchase the latest or most attractive automobiles. This allowed automakers to discount surplus stock without devaluing their brands in the eyes of ordinary consumers.

In the emerging world of RH apps, the substitution of the app’s brand for the automaker’s is potentially disastrous for automobile manufacturers. If reliance on RH apps grows to the point where substantial numbers of people choose to rely on apps as a substitute for owning cars of their own, auto manufacturers will find themselves selling cars primarily to app drivers or fleet operators rather than directly to consumers. That prospect poses at least two multiplicative threats to their business model: (1) that they will sell fewer cars and (2) that the people buying their cars will choose cheaper models. The first threat simply reflects the ultimate promise of the “sharing” economy that by sharing things (cars), people will consume fewer of them in unit terms. The second threat follows from app drivers’ incentives just like taxi fleet operators, they will choose the cheapest cars, not the ones that are most profitable for the auto industry.

Put simply, when people buy a car, they buy a brand. They tend to buy much bigger, more powerful, and thus, more expensive cars than they need. They also buy high value-added options and extras, like special features, entertainment systems, and extended warranties. Automobile manufacturers rely on such premiums for most of their profits. But when a car becomes something you use, not something you own, the relevant brand is the app, and few riders care what brand of car their RH driver operates. In effect, automobile companies could be downgraded into a little more than original equipment manufacturers (OEMs) for the RH apps that people turn to when they want to go from Point A to Point B. That threat will only become real if people switch in large numbers from car ownership to RH as their primary mode of personal transportation. There is some evidence that this is already happening, especially among urban millennials (Schwartz, 2018).

The possibility that netware companies might induce a revolution in personal transportation that restructures global value chains in such a way as to turn today’s branded integrated manufacturers into OEMs is not purely theoretical. It is already happening in China’s bicycle industry. As a form of personal transportation, the bicycle is obviously much simpler than the automobile, but from a technosystem standpoint the principle is the same. In the hardware-based, pre-netware bicycle technosystem, individual riders owned and maintained their own personal bicycles. Public bicycle rentals through
automated docking stations made some inroads in a few cities, but overall, their impact was limited and certainly not transformative. Then, in 2015, Mobike introduced a netware-based model of dockless bicycle rentals in Beijing. Other companies soon followed, so that within 3 years most large Chinese cities were saturated with bright orange, yellow, and red bicycles for hire.

As a result of the disruption caused by these netware apps, consumer sales of branded bicycles in China have collapsed (Cai, 2017). It took just 3 years for netware companies like Mobike, Ofo, and oBike to dominate self-powered personal transportation in China. These companies still buy bicycles—millions of them—but their suppliers have been reduced from high-margin branded manufacturers to generic OEMs. Ironically, Giant, the world’s leading branded bicycle manufacture, started out as an OEM for Western brands, then developed its own brand, but is now once again a supplier of generic bicycles—to China’s Ofo (Bloomberg, 2017). Apple’s lead OEM for the iPhone, Foxconn, is also a major bicycle OEM for Mobike (Jing, 2017). When Giant, a manufacturer of bicycles used in the Tour de France, finds itself in direct competition with Foxconn, it is clear that the bicycle industry has been severely disrupted.

Other industries that are ripe for similar netware disruption include retail, restaurants, and hospitality. The e-commerce giant Amazon has long threatened traditional retailing, as has its Chinese competitor Alibaba. The key limitation of e-commerce has always been the cost and inconvenience of delivery. Custom-designed delivery AVs could solve that problem, and indeed, are already beginning to do so: Amazon has been using specialized package delivery AVs on a trial basis since the beginning of 2019, albeit with human monitoring (Holley, 2019). Restaurants, too, are already threatened by food delivery apps that rely on bicycle messengers for fulfillment. Food service netware companies such as Deliveroo and Uber Eats could develop their own centralized kitchens, transforming the restaurant delivery business into a full-menu custom cooking technosystem. Such “dark kitchens” are now under development in some cities (Bradshaw, 2019). Netware app Airbnb has already disrupted hospitality in ways that are transforming entire city centers, their residential patterns, and their real estate markets (Guttentag and Smith, 2017).

Of course, restaurants continue to serve food, hotel companies continue to offer rooms, and automobile manufacturers continue to turn out cars in their millions, even in the era of mobile netware. What netware promises (threatens) to change is not necessarily the material reality of these industries, but the distribution of power within them. Netware companies are rapidly and successfully inserting themselves as intermediaries between consumers and providers. They are able to do so because they own (or at least stand in possession of) the map that connects consumers to producers, and to each other: the social graph. Control over the social graph gives netware companies the power to prevent the kinds of disintermediation that would allow the peer-to-netware-to-peer “shared” economy to become a true peer-to-peer “sharing” economy.

Thus, Airbnb goes to great lengths to prevent hosts and guests from networking directly; it then attempts to use its monopoly of the social graph to promote additional transactions between hosts and guests (e.g. meal services) through their enclosed platform (O’Regan and Choe, 2017). Similarly, by possessing of two users’ location data, the “happn” dating app monetizes a social graph of which its users may not even be
aware, by linking people who are frequently in physical proximity to each other (Knox et al., 2020). Netware companies can generate value by using their social and locational data to connect particular consumer to a particular producer, but they can also extract value by threatening to withhold connections that would have been readily apparent in the pre-smartphone world. Anyone standing on a busy city street can flag down a marked public taxi. But that same person must use a RH app to access an unmarked private car.

As the RH-AV-BEV example demonstrates, mobile netware applications have the potential to unleash synergies of such extraordinary breadth and depth that it will likely become impossible for anyone to do business at scale without participating in their networks. Early indications of this can already been seen in the unprecedented power wielded by Google due to its dominance of Internet search. Anyone can offer services through the Internet, but Google’s mastery of the informational graph connecting consumers and producers has given it almost exclusive power over discoverability: consumers and producers can only “find” each other by using Google. Mobile netware takes that key intermediary role and enriches it with data on social and geographical location. These turn a relatively static informational graph like Google’s into a social and mobile one. Just as Google has set itself the mission to “organize the world’s information,” mobile netware has the potential to organize the physical world in which we interact and move around.

Conclusion

Today, no other communication device links so many people, and no other device is used as publicly, as the mobile phone. Users now routinely integrate their mobile phones into face-to-face situations, bringing together the distant, the local, the face-to-face, and the digital, in new spatial arrangements over which they have only imperfect information. Mobile phones also serve as aggregators of content and users. The period since 2007 has seen the emergence of smart devices, smart networks, and flexible service plans that dissolve distance, both within national boundaries and, in certain more limited ways, across borders. With the elimination of roaming fees in many countries, users can call, text, access the Internet, and use social media anywhere there is a signal. Users can connect to friends and family without the pricing barriers that discouraged inter-regional calling.

In the eyes of optimists, basic mobile telephony is a gateway for users to more advanced smartphone telephony. This type of thinking can neglect the economics of phone acquisition and service for low-income users, and the communicative divide that exists between basic and smartphone users. At the other end of the spectrum, it can neglect the possibility that the very applications that make smartphones so useful and attractive also tend to concentrate power in the hands of those who are able to see the social networks in which their users are embedded; that is, the owners of netware apps. Whereas, basic mobile telephony mostly left users in possession of their own data, advanced smartphone telephony transfers user data to companies that are able to extract value from the emergent properties of the data in aggregate.

Mobile netware is spawning significant new technosystems that have the potential to restructure economic and social life. Crucially, netware is bigger than just networks; it is
a whole new form of intangible infrastructure. By exploring RH, this article has sought to illustrate emerging changes in infrastructure, purchasing, ownership, costs, and how consumers relate to the service. In this new technological context, transportation tells us a lot about the emerging netware. RH services are both local (often hyper-local) and mobile. They remind us that a lot of everyday economic activity follows routinized and predictable patterns, often close to home or work and with a fairly limited set of other people. So for scholars studying the emerging netware technosystems, it is worth noting that as dizzying as the number of apps and services has become, most people use them within a narrow set of social and geographical contexts.

Ironically, it is that very local world that netware apps are often most able to “discover” for us. In the pre-smartphone era, most people were able to make connections in the macroscopic social and physical geographies of work, family, friendship, shopping, and the like without the assistance of artificially intelligent online assistants. But netware apps are indispensable for uncovering microscopic geographies that are invisible to the naked eye, like the availability of a potential shared ride one block away or a neighbor’s sudden demand for electricity. In these new configurations of space, intentional human planning must give way to automated machine learning, not so much because computers have greater processing power than we do, but because the data to be processed exist only in aggregate form on cloud computing servers. Social graphs exist only as emergent properties of aggregate data; they cannot be isolated in the individual user.

We see RH apps as part of an emerging trend; netware apps draw on users’ social graphs and contribute to the continued evolution of these social graphs. For RH apps, much of the information is locational and temporal, but different apps have their own features (e.g. the ability to share rides, or track a friend’s movement in real time, or order and pay for a ride for another user) that both draw from and add to the social connections among users. Beyond RH apps, there are rich possibilities for research in mobile payment, where apps such as M-Pesa allow for group accounts, community-based fundraising, and collective lending and investment. In these and other contexts, netware apps succeed to the extent that they incorporate users’ social graphs and evolve as individuals’ lives and social networks change over time. In this sense, we see the social-infrastructural element at the heart of mobile netware.

In this article, we have focused on the worldwide phenomenon of RH, which initially grew out of ride sharing. RH and ride sharing are similar services from a customer point of view. But they operate very differently, have different barriers to entry and cost structures, and require different thinking in terms of everything from regulation to investment to measuring economic value. Ride sharing involves a genuine peer-to-peer connection through which sharers save money, help the environment, and perhaps, even make friends, but that when that connection is facilitated by netware, the relationship chances from a peer-to-peer network to a peer-to-app-to-peer network. Once the netware app came to sit in the middle of the inter-human relationship, what began as an idealistic and affective project was quickly transformed into an opportunity for economic arbitrage.

As netware continues to develop and densify—and as it integrates related technologies such as automation—its significance will only increase. And while netware
is intangible and non-isolable, it will allow for a new set of visible and transformative processes. Thus, in the years to come, the social significance of connections and users’ economic reliance on online commerce might give some aspects of netware an infrastructural and even tangible form. Thus, the medium-term future of netware could involve a blurring of lines between technosystems and infrastructure. The long-term future could make us extraordinarily dependent on netware companies to guide us through new kinds of spaces that only they are able to map and navigate.

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