

This PDF includes a chapter from the following book:

# **Urban Operating Systems**

## **Producing the Computational City**

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## Notes

### 2 Operationalization

1. Zwick was presenting at the First Annual Conference on Urban Planning Information Systems and Programs, organized by Edgar Horwood and held at the University of Southern California in 1963. The conference led to the establishment of the Urban and Regional Information Systems Association (URISA). It is hailed by many as one of a few pivotal events marking the birth of GIS (Tomlinson 2012).

2. Within municipal government, ERP systems have been used extensively since the early 2000s to streamline internal operations, linking finance, procurement, payroll, human resources, and e-government in cities such as Des Moines, Pasadena, San Diego, and Cape Town, among others (Beheshti 2006; Raymond, Uwizeyemungu, and Bergeron 2006; Saran 2013; Jeffery et al. 2017).

3. Our way of looking at these illustrations has also been influenced by an acknowledgment of the power of the visual in social science and the extent to which both researcher and informant share a visual culture (Rose 2014). Drawing on concerns around the spatial organization of an image (Rose 2012), visual qualities within the illustrations operate as a point of departure for interpreting the Urban OS. Using a research technique known as graphic elicitation (Crilly, Blackwell, and Clarkson 2006), we treated these paradigmatic framings of the Urban OS as stimuli for a set of research interviews. Methodologically, the analysis of illustrations was complemented with eight interviews with computer scientists and software engineers, working in both the public and corporate sectors. During these interviews, informants provided their own explanations and interpretations of the illustration, which we used to develop analytical interpretations linking the domains of IT, software design, corporate products, and urbanism.

### 3 Datafication

1. Rob Kitchin speaks of the current data revolution as a discursive regime: “a set of interlocking discourses that justifies and sustains new developments and naturalizes

their use” (Kitchin 2014a, 113). Espoused by a multiplicity of actors who might use the same arguments despite significantly different agendas (Kitchin 2014a), urban data narratives as discursive formations find their unity precisely in their dispersion; their power in their ability to constantly generate new objects and purposes; and their transcendence in the coexistence of heterogeneity (cf. Foucault 1972).

2. For Bruno Latour, the statistical fact constitutes an *immutable mobile*: a reproducible object that can be moved from context to context as a material instrument for the reproduction of capitalism (Latour 1987).

3. In 2017 BRIDJ ceased operations in the United States, after failing to develop a viable business model in the cities where it was operating. Despite the failure of the on-demand transport model advanced, BRIDJ is hailed by technology commentators as a template for future public transport provision (Bliss 2017; Marshall 2017). As of 2019, the company continued operations in Sydney, Australia.

4. Crawford, Gray, and Miltner (2014) point to the need to uncover big data science as a mythological artefact. They take on the claim that, given the large scale of datasets and the unexpected correlations they reveal, big data implies the end of theory (Anderson 2008)—a world of knowledge in which algorithmically driven statistical correlation is enough and there is no need to develop and test hypotheses or develop theory (Graham 2012). In contrast, Crawford, Gray, and Miltner propose that big data *is* theory—that its mythic power plays a role in unifying the concept and adding legibility. Big data, as an emerging theory of knowledge, informs how we encounter political, economic, and cultural worlds. Shaped by neoliberal economic logics, big data is used in ways that speak “to the issues of class, race, gender, sexuality, and geography” (2014, 1665).

5. This is illustrated by the promotional material of Rio de Janeiro’s Operations Center (see chapter 7): “[The Rio Operations Center] is the heart, or the brain, of Rio de Janeiro. . . . Today the world operates based on information. Here we are talking about an [information based] system that is public; information is also a public body” (Sávio Franco, 2012 Director of Rio de Janeiro’s Center of Operations; quoted from Operação Lei Seca 2012).

6. In 2009, for example, the Obama administration released the Open Government Directive for the United States, a move that was followed in 2013 by Executive Order 13642 (titled *Making Open and Machine Readable the New Default for Government Information*). Data.gov, the US government’s repository for open data, has supported the adoption of open data standards at both federal and local levels (White House 2016). In the United Kingdom, the Government Digital Service, part of the UK Cabinet Office, has developed a range of initiatives aimed at supporting local governments in adopting open data principles and technologies. This is part of its *Government as a Platform* policy, mentioned in the text and described as “a new way of building digital services . . . a set of shared components, service designs, platforms,

data and hosting, that every government service can use” (UK Government Digital Service, n.d.).

7. We originally accessed the list compiled by Opendatasoft at <https://www.opendatasoft.com/a-comprehensive-list-of-all-open-data-portals-around-the-world/>. That link is no longer operational, but has been replaced by <https://opendatainception.io/> and [https://data.opendatasoft.com/explore/dataset/open-data-sources%40public/table/?sort=code\\_en](https://data.opendatasoft.com/explore/dataset/open-data-sources%40public/table/?sort=code_en), recording over 3,800 entries.

8. For early internet advocates like Tim O’Reilly, who is credited with developing the idea of open source, “the principles of the ‘open source’ software movement—shareable, re-usable code as the basis for improved software products—should in turn inform how we think about the design of public institutions” (Barns 2016, 557).

9. The Open Knowledge Foundation (OKF) is a global nonprofit organization that promotes the idea of open knowledge. OKF, founded in 2004 in Cambridge, England, operates in partnership and with support from the World Bank, among several other funders.

10. For a useful list of US and Canadian open data laws and policies, compiled and updated by volunteers through crowdsourcing, see [https://docs.google.com/spreadsheets/d/1ETZuGZBK24J2viZdxmhyIIIKiJuytAu3Bh1ofo\\_HVBw/edit#gid=0](https://docs.google.com/spreadsheets/d/1ETZuGZBK24J2viZdxmhyIIIKiJuytAu3Bh1ofo_HVBw/edit#gid=0).

11. In his biography Bloomberg tells a story of bold personal advancement and organizational progress through information. In a chapter titled “Computers for Virgins,” he describes the links between the mobilization of data and the possibility for transformation: “Two things haven’t changed in twenty years or twenty centuries: the need for information; and the users of data, with their bravery, jealousy, adventurousness, and fear of the new. No matter what systems we create in the next decades, these two statements will be the same” (Bloomberg 1997, 131).

12. As of 2011, the Bloomberg Terminal still accounted for 85 percent of the annual revenue of Bloomberg LP (MacSweeney 2011); by 2015, the service counted over three hundred thousand subscribers (McCracken 2015).

13. Founded in 2007, Socrata was acquired by Tyler Technologies in 2017, becoming the Data and Insights division of “the largest software company in the [United States] solely focused on providing technology to the public sector” (Tyler Technologies, n.d.).

14. We recognize that there are marked differences in the political orientation of civic hacking communities across countries. However, our experience interacting with hacking communities in various contexts—in the US, UK, Brazil, Taiwan, Hong Kong, and Spain—indicates that there are strong common themes, practices, and shared beliefs, with little space for translation across different cultural contexts.

15. Roadify collects transit data from over four hundred public agencies and bike-share and carshare businesses, disseminating transport data through a smartphone app and via commercial signage companies.

16. Although there are continued attempts to reinforce the embedding of open data into NYC departments, there has been relatively little analysis of the use of the data. A notable exception is a 2016 exploratory review of open data that considered seventy-seven uses for a diverse range of products, tools, and analyses (Okamoto 2016). These include “the Business Atlas ([maps.nyc.gov/businessatlas](http://maps.nyc.gov/businessatlas)), a website created by the New York City government to provide business data to entrepreneurs, and Citygram ([www.citygram.nyc](http://www.citygram.nyc)), a service developed by volunteers from the non-profit, civic technology organization, Beta NYC, which sends updates to users on selected city service activities and complaints within a specified neighborhood. The NYC Cares mobile app (<http://apple.co/28Q7Bhp>) was created to help senior citizens find food pantries in the city, while Cloudfred have provided an interactive visualization ([www.cloudfred.com/labprojects/nyctrees](http://www.cloudfred.com/labprojects/nyctrees)) that illustrates the diversity of trees in the city. Finally, Death Map (<http://deathmapnyc.com>) shows the location of homicides and traffic fatalities during a two-year period” (Okamoto 2016, 4). Sixty-one percent of these applications were developed by individuals with tech backgrounds, indicating that the use of open data requires a high degree of technological skill and knowledge.

17. We use the word *incarnate* as both verb and adjective, drawing on the Latin *incarnare*, to make flesh. To incarnate is to take bodily form and become corporeal. It is worth noting that traditional definitions of the word emphasize the transmutation of spirits or deities into human form, a sense that ironically is not detached from popular fetishizations of the digital-technological as the all-embracing power of our times.

#### 4 Sensing

1. An early example is provided by SOSUS, an oceanic sound surveillance system developed by the US Navy in the early 1950s and arguably an early prototype for today’s wireless sensor networks (WSNs; Chong and Kumar 2003). SOSUS, which operated through hydrophones interconnected by wired cables, was originally aimed at identifying Soviet submarines reaching US coasts.

2. Such use of sensors prefigures the technical infrastructures of today’s wars, which include drones, real-time visual surveillance, and networked sensor-shooter systems (Gregory 2013; Shaw 2016). In the resulting electronic battlefield, the enemy “existed as an abstract signal generated by remote sensors,” supporting “a mode of atmospheric warfare that sought to enclose, police, and pacify hostile forms of life” (Shaw 2016, 689, 695).

3. Urbiotica has designed, piloted, and implemented urban sensors for waste collection, parking, noise, air quality, and other environmental conditions. Founded in 2008 in Barcelona, the company grew rapidly to become an internationally recognized player within the growing market of the Internet of Things. Sensing solutions piloted in their home city led the company to acquire a global presence, with projects in over twenty countries by 2017.

4. Barcelona's City OS was originally planned under the administration of Mayor Xavier Trias (2011–2015), but largely cast aside under the administration of Ada Colau (2015–).

5. Sentilo has been developed via a collaboration between public and private sector partners, including Urbiotica, the Catalan Water Agency, Worldsensing, the Dubai Municipality, and over thirty-five other bodies. While the platform was designed in and by Barcelona, its open-source nature means that the original source code is freely available for others to use, modify, and redistribute. As a result, the system has also been piloted in the cities of Reus, Terrassa, Cambrils, Tarragona, and Dubai.

6. SCADA technologies are used extensively within industrial and financial operations, given their relative high fidelity and low latency. That means that they are particularly well suited for moving large quantities of data in accurate ways, frequently and with little delay—often in close to real time. This makes SCADA technologies relatively expensive systems. The more often a sensor sends information, the less likely it is that its batteries will function for a long period of time. Costly and laborious replacements are therefore required.

7. For example, a city interested in locating sensors in its lamp posts might have over one hundred thousand such fixtures. Given budgetary constraints, it might not be able to fit sensors to all of them within a single procurement cycle. The separation between software of control and urban assets allows for incremental processes of upgrading, allowing the city's operating system to cope with a range of different types and generations of technology.

8. We use the notion of financialization in a broad sense, emphasizing processes of intermediation, value creation through agglomeration, and the capitalization of the future (monetization and the potential for speculation) over the use of financial markets, financial actors, or financial institutions.

9. It is worth noting that Langley and Leyshon (2017) use the notion of platform in a tightly defined sense, focusing on intermediary applications within the IT sector, including social media (e.g., Facebook, Twitter) and sharing economy business (e.g., Uber, Airbnb), but not, for example, aggregator interfaces that provide price-based comparisons (e.g., MoneySuperMarket) or user-generated reviews (e.g., TripAdvisor). Our use of the notion of platform capitalism, while also drawing on the platform's intermediary (brokering) nature, is broader in the sense that it relates to the

sociotechnical arrangements (technologies and practices that provide a base for other applications, processes, or technologies to be developed) for capital accumulation in an emerging digital economy. Such a digital economy transcends the IT sector and cuts across other sectors, such as manufacturing, service provision, and transportation. It is made up of “those businesses that increasingly rely upon information technology, data, and the internet for their business models” (Srnicek 2017, 5).

10. This process of sensing the city, as well as the upcoming spread of urban applications within the Internet of Things, is reminiscent of the early days of the internet. Back then, new value chains were being created through the emergence of digital assets, a process captured by Dodge and Shiode’s analysis of the geography of internet real estate (2000). They realized that points of information networked through ICT technologies created new forms of tradable ownership. In a rather humorous and somewhat simplistic way, this is exemplified by the story of Alex Tew (reported by the *Guardian*): Tew, a twenty-one-year-old British student, made a small fortune by selling one million web page screen pixels for one dollar each (Morris 2005).

11. This further advances a condition of splintering urbanism and the commodification of formerly public or universally available goods and/or services (Graham and Marvin 2001)—with the particularity that in the case of the Urban OS, the means through which the system works involve both fragmentation and reintegration (and not solely splintering). The political economic tendency of the Urban OS is aligned with processes of economic splintering. By way of background, Graham and Marvin’s *Splintering Urbanism* (2001) looks at how the privatization and liberalization of utilities during the second part of the twentieth century resulted in processes of urban splintering rather than integration. Infrastructure networks were formerly seen by planners, engineers, and architects as a way of integrating urban space, but have been reconfigured as specialized, privatized, and customized. Rather than connectivity being something universal, it is offered on an unequal and piecemeal basis. The resulting trend encouraged the fragmentation of the sociomaterial fabric of the city and exacerbated spatial segregation and social polarization, raising questions about the existence of the city as a whole.

12. We agree with Agnieszka Leszczynski and others on the need to challenge narratives of hybridity and virtualization resulting from an encounter with digital technologies, as these assume that digital spaces and real spaces were at some point epistemologically distinct and separate. In effect, physical spaces (or flows, for that matter) are always already information spaces/flows and vice versa. As put by Leszczynski when discussing spatial media, drawing on Zimmermann (2007), “rather than merging virtual and real spaces, the convergence of web-based media and location serves to actually ‘[anchor] the digital,’ which is otherwise ‘viewed as ambling around in a placeless realm, in geographic space’ [Zimmermann 2007, 80]. . . . Spatiality, therefore, must be understood as mediated in the sense of being a project of becoming that is never completed” (Leszczynski 2015b, 745).

## 5 Mapping

1. Such claims are particularly salient in Brazil, a nation that struggled to achieve democracy throughout the second part of the twentieth century following over twenty years of military dictatorship. Despite a notionally inclusive political system, police violence in favelas continues to rise (Arias 2006; D. M. Goldstein 2013), in part due to the criminalization of poverty and the reliance on police to maintain forms of exclusion that have been normalized (Garmany 2014). Favelas are marked by a history of squatting followed by official threats to forcibly relocate those who live there; they are the spatial expression of a “differentiated citizenship” that assigns rights, opportunities, and privileges in unequal ways (Holston 2008). This is also a type of “citizenship that manages social differences by legalizing them in ways that legitimate and reproduce inequality” (Holston 2008, 3; see also Wacquant 2008).

2. Often aided by spatial media or other technological developments, participatory mapping is frequently supported by local organizations and federations of the urban poor. In the hands of such organizations, these calculative ways of knowing urban informality “can help to build a community, define a collective identity, facilitate development priority setting and provide a basis for engagement between communities and government on planning and development” (Patel, Baptist, and d’Cruz 2012, 13). They provide the basis for local planning and upgrade projects and can potentially contribute toward securing tenure and fostering collective discussions around urban issues (Karanja 2010; Livengood and Kunte 2012).

3. In September 2016, AfroReggae filed in California a lawsuit against Google, Inc. and Google Brasil Internet Ltda. for failing to acknowledge AfroReggae as a partner in Rio: Beyond the Map.

4. Often imagined either as a space of crime and poverty or as a site of freedom and creativity, *the favela* (a singular noun that evokes an unfounded spatial homogeneity) is also a historical and political invention (Valladares 2005). For Reyes Novaes (2014), the exclusion of favelas from the map established a “double discourse” that separates ungoverned subalterns and governed middle classes, a perspective that resonates with Holston’s (2008) thesis of differentiated citizenship.

5. Breaking through the limitations imposed by a representational reading of favelas (i.e., one that prioritizes invisibility over visibility), Perlman speaks of “the myth of marginality”: residents of favelas “are not economically and politically marginal, but are exploited, manipulated, and repressed . . . inexorably integrated into society, albeit in a manner detrimental to their own interests” (Perlman 2005, 18).

6. Alvarez León has examined the role of digital mapping in advancing the economic incorporation of space. He argues that Google Maps is embroiled in processes of commodification, “transforming informational resources into market goods” (Alvarez León 2016, 1). However, his analysis of the digitization of spatial resources focuses mainly on how information leads to new property regimes.



## 6 Prediction

1. Early commercial uses of predictive analytics focused on managing credit risk by predicting likelihood of payment default through credit scoring, a technology that by the 1980s “had become the primary decision-making tool across the financial services industry” (Finlay 2014, 2). In the insurance industry in particular, predictive analytics found application in all three core insurer functions: in marketing (to analyze purchasing patterns of customers), in underwriting (to filter out applicants), and in claims (to identify fraudulent claims; Nyce 2007). The use of predictive analytics in the identification of fraud also became important in banking, initially as a mechanism to screen against money laundering (Taylor 2011).

2. This typically involves a series of stages, starting with data aggregation and “cleansing,” followed by the creation of sample groups (both to create and test models), data mining (to identify “underlying trends, patterns, or relationships” [Nyce 2007, 8]), model development (searching specific relationships between variables), and validation. Although data mining is a key stage of predictive analytics, the two should not be conflated. Data mining is a stage of the analytic process that is critical in the identification of “trends, patterns, or relationships . . . [that] can then be used to develop a predictive model” (Nyce 2007, 1)—that is, generalizations that are applicable to other datasets (Kotu and Deshpande 2014, 3; Hair 2007).

3. PredPol’s website boasts “a 20% drop in predicted crimes year over year from January 2013 to January 2014” for Los Angeles (CA); and an “aggregate crime decreased by 8% and 9% in the two areas that first deployed PredPol in July 2013” for Atlanta (GA). In the case of Santa Cruz (CA), the “Police Department saw assaults drop by 9%, burglaries decrease by 11%, and robberies down 27% in its first year using the software” (PredPol n.d., “Proven Crime Reduction Results”).

4. Following a period as a fellow in urban science at the University of Chicago, in 2019 Goldstein was appointed director of the Defense Digital Service office of the United States Department of Defense.

5. This includes programmes such as the University of Chicago’s MS in Computational Analysis and Public Policy (MS-CAPP), offered jointly with the Harris School of Public Policy and the Department of Computer Science; Northwestern University’s Masters in Data Science; City Scholars, an initiative by the University of Illinois at Urbana-Champaign’s College of Engineering; and the Data Science for Social Good Summer Fellowship at the University of Chicago.

6. *Black bloc* is a form of protest in which protesters wear black clothing, scarves, sunglasses, and masks as a means of concealing their identity.

7. Within the media, WindyGrid is at times described as a system that enables access to the city’s SmartData Platform, and at times as its precursor or first stage. GitHub

(acquired by Microsoft in 2018) provides a clue to the relationship between Windy-Grid and Chicago's SmartData Platform. There the latter is described as consisting of "several principal components," with WindyGrid as the system's user interface. According to Chicago's web-based system for collaborative software development, hosted by GitHub, Chicago's SmartData Platform components are "a user interface which allows users to explore historical data as well as future predictions, analytics services which actually performs the predictions, ontology layer which combines data (namely, matches all business-level data with any records pertaining to businesses), and a data services layer which stores data and makes it available through an API" (City of Chicago, n.d.).

8. According to information recorded on GitHub, the SmartData Platform is being developed "through a consortium of partners, including University of Chicago, Argonne National Laboratories, DePaul University, University of Illinois at Chicago, and Smart Chicago Collaborative" (City of Chicago, n.d.).

9. As such, in comparison to deductive reasoning, predictive analytics claims a more revolutionary relationship with theory. Where traditional deductive analytical research starts with hypothesis testing, predictive analytics proceeds inductively or *abductively* (Berry 2014, 20). It starts from the idea that there are unseen patterns within the data: "data mining and predictive analytics begin by identifying relationships in data . . . hypotheses are then developed and tested as part of model building and validation" (Hair 2007, 306).

10. Furthermore, and as already pointed out in this and other chapters (see chapter 2 in particular), the system effectively excludes everything that cannot be reduced to its standardized, gridded and numeric logic, which also influences the type of urban questions that can be asked.

## 7 Circulation

1. Empresa Municipal de Informática—IPLANRIO, the municipal company responsible for managing the information and communication technology resources of the city of Rio de Janeiro.

2. By way of context, it is important to mention that, in a city like Rio de Janeiro, large segments of the population continuously experience infrastructures in an almost permanent state of disrepair and improvisation, providing the context for fragmented urban fabrics (cf. Coutard 2008; Graham and Thrift 2007; McFarlane 2010).

3. Providing a broader Latin American context, this is consistent with Eden Medina's (2011) findings in her examination of the links between national politics and computing technology in Chile during the 1970s (the latter, heavily influenced

by Stafford Beer's conceptualization of cybernetics; at the time, President Salvador Allende attempted to manage Chile's economy through a distributed decision support system, known as Project Cybersyn, that included among other components a sophisticated operations room). Medina, discussing the take-up of cybernetics around the world, differentiates between US and UK configurations of cybernetics. In the United States, command and control logics within cybernetics had a significant influence, partly through the work carried out by Norbert Wiener in collaboration with the US military and think tanks such as RAND—foregrounding the idea of domination. In the United Kingdom, more indebted to the work of Beer, control within cybernetics is not a function of domination but a form of self-regulation, “the ability of a system to adapt to internal and external changes and survive” (Medina 2011, 26). The COR illustrates a form of urban computing in which links between military and urban operations are neither direct nor clear. As this chapter illustrates, rather than being influenced by the military, the COR evolves from an organizational, business, and logistics perspective applied to the city.

4. In the history of computing in Brazilian cities, municipal institutes of informatics appear to have played a central role over and above that of external consultants with links to the military—a point of contrast with the history of computing in cities in the North American context (as examined in chapter 2). See also note 3, this chapter.

5. For an analysis specific to Rio de Janeiro, see Cardoso 2012.

6. In order to guarantee security (in its more traditional sense) for the 2014 World Cup, state and federal governments established another control room, the Integrated Centre for Command and Control (CICC). This integrated a variety of state and federal policing agencies, including the armed forces, civil police, and military police. Although the CICC and the COR exchange information and use similar technological platforms, arguably the CICC operates primarily within the domains of coercion and surveillance, while the COR operates mostly in a governmental fashion.

7. The Complexo da Maré and the Complexo do Alemão are two of Rio de Janeiro's largest favela clusters. Located in the North Zone of the city, they have a combined population of 200,000 and some of the city's lowest social development indicators.

8. *Olhos da Cidade* was short-lived. In 2019, the COR launched a new mobile phone app called COR.RIO.

9. In 2016, with the support of the Rockefeller Foundation and as part of the 100 Resilient Cities program, Rio released its resilience strategy. Rio's COR features extensively here, as well as in the literature of the Rockefeller Foundation's 100 Resilient Cities program (Rockefeller Foundation, n.d.). The municipality has designated the COR as the primary site from which the city's resilience strategy is to be designed and implemented, with the director of the COR acting also as the city's director of resilience.

10. For Cooper, there are marked similarities and linkages between how contemporary financial markets and environmental crises are dealt with. In both cases, and often working through each other, the primary aim is to maintain “the topological cohesion of a world in and through the most extreme periods of turbulence”—something that has pervasively come to be known as *resilience*. As we enter a world in which turbulence cannot be avoided, “the precise when and where of turbulence is indifferent. What matters is whether the accidental event of turbulence can be harnessed to . . . strategic ends” (Cooper 2010, 183, 184).

## 8 Resistance?

1. It is worth noting that this is precisely the conceptualization that Hughes sought to challenge in her analysis of resistance, given the “*predetermination of form* that particular actions or actors must assume to constitute resistance” (2019, 1, original emphasis). However, for the purpose of our analysis, what is at stake is precisely the constitution of such form, and therefore we decided to use the conventional definition of resistance over the more “emergent” configuration put forward by Hughes.

2. For a critical account of the dominance of social media in the mobilization of protesters, see Chu (2018).

3. By bypassing the mobile cellular network, Firechat would also allow protesters to communicate if the mobile network were to be taken down by the authorities precisely for the purpose of curtailing connectivity. However, in the Umbrella Movement, the popularity of Firechat was short-lived. At the time of the protests, it did not have the capacity to provide private messages; instead, it operated through open chatrooms that anyone could create and where anyone could participate (R. Chao 2014; Li 2015). Chatrooms (and users) proliferated during the protest, often flooding feeds with spam and irrelevant messages. This led to a lack of focus in communications, making it impossible to distinguish what was real from what was fake.

4. The game awards points to players as they defend themselves against the police, angry pro-China locals, and the city’s chief executive, Leung Chun-ying.

5. Hackpad closed in 2018 after being acquired by Dropbox.

6. In June 2019, at the start of a new wave of prodemocracy protests in Hong Kong, the UK newspaper the *Guardian* was reporting that technology that in the past helped protesters was now being used against them, as social media and messaging apps became a key tool of the Chinese state for monitoring and surveillance purposes: “Wary of being tracked and targeted like activists inside China, protesters are keeping a low profile online” (Kuo 2019).

## 9 Conclusion

1. In Gabrys's view, computational processes in the city, such as sensing, generate new infrastructural agents, whether through measurement, automation, or contingency. These infrastructural agents are not simply the coming together of code, software, and the materiality of the city, but "transductive articulations of urban environments, technologies and inhabitants" (Gabrys 2016, 254). Measurement, in particular, becomes infrastructural—both a condition and a resource for new urban processes. In the Urban OS and the digital infrastructures that it relies upon, using the language of Gabrys, a "becoming with others" occurs through a "becoming calculable."