INCIDENTAL INTERNET INFRASTRUCTURES

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TERRESTRIAL CONNECTIONS

"Next time you visit, if you would please bring some fibre," was the request made by West Virginia Senator Shelley Capito to Mark Zuckerberg at the Facebook CEO's congressional hearing in April 2018 following the Cambridge Analytica controversy. Reporters criticized Capito and her fellow senators for using the hearing as an opportunity to ask Zuckerberg to bring internet connectivity to their respective communities, but perhaps this was not such a ridiculous prospect.[1] While Facebook is not in the business of building conventional fibre infrastructure, the company has multiple plans to develop new technological means for delivering high-speed internet connectivity.

One such initiative, called Terragraph, is currently being trialed in the city of San Jose.[2] In this system, a distributed network of relatively closely situated street level nodes relay low-dispersal, 60 GHz radio signals, counteracting signal-blocking caused by tall buildings and high traffic in built-up urban environments. So, unlike traditional fibre infrastructures built underground, Terragraph can be imagined as "Fibre in the Air."[3] It uses the existing street furniture sited at regular intervals throughout the city—infrastructures such as lampposts and street poles—as critical instalment sites for deployment of the technology.

TERRAGRAPH CAN BE IMAGINED AS "FIBRE IN THE AIR"

The Facebook Terragraph system is only one of many attempts to address the growing demand for increased, high-speed internet connectivity. Network traffic is slated to accelerate exponentially as services requiring large amounts of data—from sensor-based applications to high quality video, from augmented reality to mission critical applications—become ubiquitous. The main mechanism for effectively delivering these services will be through the densification of telecommunications networks. While purpose-built amenities like fibre connections and cell towers will still be essential, technology companies will increasingly rely on existing urban artifacts—traffic poles, trash cans, and bus shelters—to build out and extend a diversity of internet networks. In this context, overlooked objects that populate our streets and public spaces will take on new functions, identities, and values as they become essential for constructing new, and reinforcing existing, network infrastructures.

Image 1 | *Grand Canal Square, Dublin, 2017. Image by Neil J Smyth*

ARCHITECTURES OF THING AND NODE

The idea of technologically "augmenting" everyday objects and environments with network capabilities has been a longstanding fascination in architecture. Amid the cultural and political upheaval of the 1960s, architects began exploring the potentials of embedding networked technologies, sensors, and actuators into objects and environments to push architecture and urban design in a new direction. Cedric Price's conceptual project, the Fun Palace, was one of the first examples of architects exploring the use of sensing and communicating technologies within an artificially generated structure. In the Fun Palace, buildings become responsive to users' needs and to the multipurpose activities that take place within it.[4] Archigram's Computer City and Plug-In City imagined the city as a complex network in which sensors attached to nodes distributed across the built environment controlled the flow of people, goods, traffic, and information.[5]

The project "Logplug" by David Greene, who was also a member of Archigram, explored concepts of instrumentation and embedded technologies at the scale of an object. Logplugs were designed to be discreet in the landscape, disguised as natural logs but functioning as terminals and intermediaries for technology services. Equipped with homing devices, Logplugs connected users via the physical logs to whichever specific services, utilities, and technology outlets they selected. In this way, the Logplug embodies the same plug-in capabilities that the contemporary street objects do. The object's identity is two-fold—it is itself an object and a host for other functions. Describing how technology will mediate the built environment, architect Sam Jacob states:

Physically, the future city is a place where everything is itself and, variously equipped with sensors, computing power, and autonomous mobility, also something else. […] Street furniture is recast as both comfort and control. In other words, Greene's Log Plug acts as a precursor to the transformation of the entire city fabric into both thing and node.[6]

STREET FURNITURE AS INSTRUMENTED INFRASTRUCTURES

As mundane and unworthy of attention as they must appear to many, the objects that punctuate our streets and public spaces—streetlights, traffic lights, bus stops, and trash cans—represent an array of value systems, political structures, economic practices, and social norms. Art Historian Eleanor Herring writes,

Lampposts, benches, and litterbins exemplify the way that different agents shape the street and its uses according to their own social, economic, and political purposes. As a consequence, such objects reflect the broad range of tensions and conflicts that characterize the uses and appropriation of public space by different agents, and equally our anxieties about how public life is shaped.[7]

TECHNOLOGY COMPANIES WILL INCREASINGLY RELY ON ALREADY EXISTING, URBAN ARTIFACTS

Until recently, the street furniture elements that populate our streets were, by and large, mono-functional objects. Streetlamps lit city streets, phone booths hosted telephone calls, and trash cans acted as waste receptacles. Each of these typologies has evolved over time along with advances in technological invention, mandatory regulations, and cultural changes. Meanwhile, the principal functions of these objects have endured. But a quiet, two-part transformation of these streetscape objects and infrastructures is currently underway. Firstly, street furniture objects have become essential hosts or "minor telecommunications architectures" for the deployment of internet networks, as we have seen with the case of Terragraph. But secondly, more than simply just hosting the network technology, the operations of the street furniture objects themselves—lighting, waste collection, etc—have become the subject of sensing, monitoring, and actuation. In other words, while some street objects are designed to be critical sites for internet infrastructure, other analogue street objects are themselves becoming part of "the internet of things" (IoT) as they are infused with digital technological capabilities that allow for communicating, sensing, and actuating. Carlo Ratti and Matthew Claudel, researchers at MIT's Senseable City Lab, explain:

The idea behind IoT suggested that if individual objects could be imbued with a digital connective element, collectively they could become a physicalized network. A world full of interconnected objects would create an unprecedented internet-like structure in physical space. Everyware will become an ecosystem of quiet technology, deeply assimilated in urban space. Using that infrastructure, every element of the city and its building could be designed to derive maximum resource efficiency by working coherently and systemically.[8]

As these "instrumented" objects become both auxiliary hosts for network technologies and nodes within the internet of things, they take on a variety of functions and identities, complicating the relationships between physical and digital urban infrastructures and raising new questions concerning the ownership, governance, and control of such objects and services.

MINOR TELECOMMUNICATIONS ARCHITECTURES

"I am not celebrating their function as providers of light. Their real power comes from a transformation—into neutral platforms that provide the tools of connectivity to everyone."[9] So writes journalist Susan Crawford when describing the new supplementary function of street lights in the city of Santa Monica, California. Positioned at regular geographic intervals with access to fibre-optic cables, poles are potential hosts for wireless transmission boxes, which in turn can facilitate advanced high-speed and high capacity wireless internet services. But given that these innocuous poles have emerged as critical components in the development of network infrastructure, they have also become contested objects since most municipalities do not own their own utility poles. Instead, poles are often owned by private utility and telecommunication companies who recognize the financial and political value of these new assets. But there are also unique cases like that of Chattanooga, a municipality that owns and runs the electric company and where this access to the city's own pole infrastructure has given rise to new business and urban developments.[10]

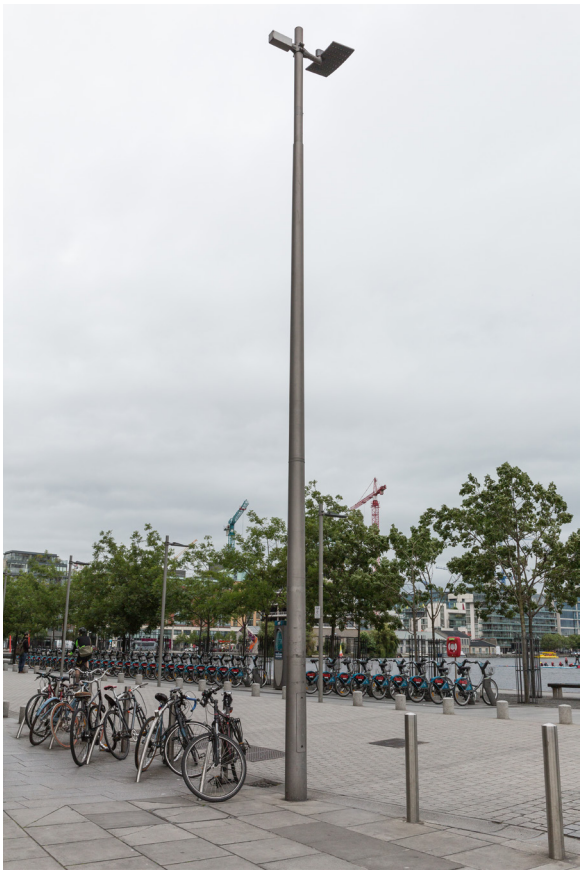

Image 2 | *Grand Canal Square, Dublin, 2017. Image by Neil J Smyth*

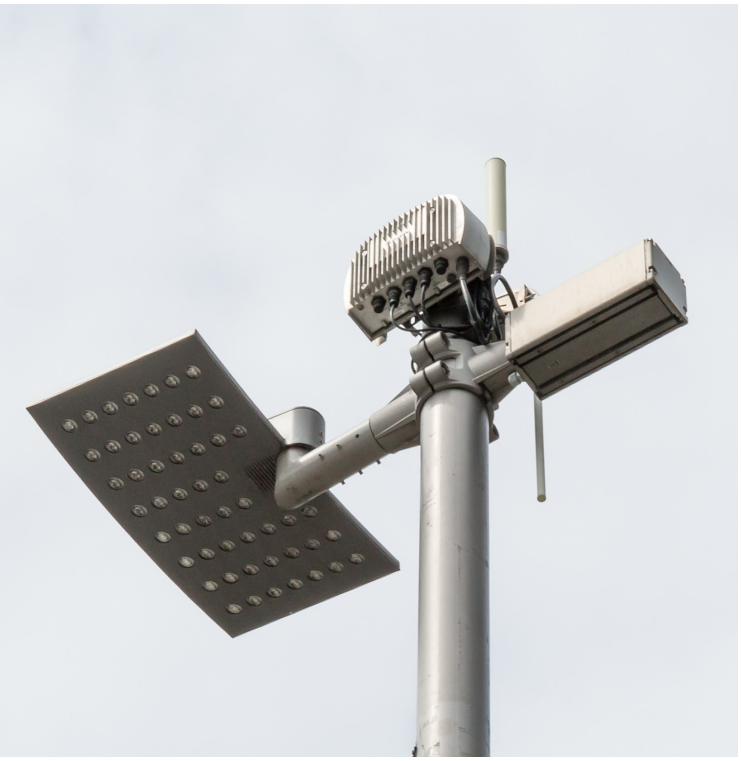

Image 3 | *Hanover Quay, Dublin, 2017. Image by Neil J Smyth*

THE INFORMATION OF THINGS

One of the most significant implications of IoT instrumentation is that the material object somewhat recedes and the data generated by the object becomes more important than the physical object itself. Writing about the emergence of electronic items in the 1980s, designer Ezio Manzini's description of their polyvarient quality is also true for IoT objects today: "Although the physical aspects of these objects are still within the world of materials, their operation and their very state of being is well beyond the manipulation of matter and has more to do with information."[12]

Related to the capture and transfer of data from the objects is the resulting shift in the relationship between customers and companies that comes with IoT applications. What Adam Davidson describes in the case of IoT domestic appliances is also true for street furniture elements: "When an appliance is sending a constant stream of data back to its maker, that company has continuous relationships with the owners of its products, and can find all sorts of ways to make money from those relationships."[13]

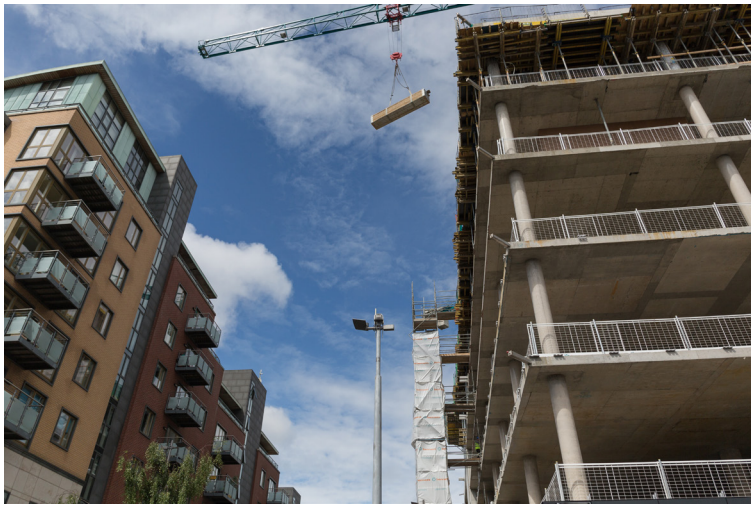

Image 4 | *Blood Stoney Road, Dublin, 2017. Image by Neil J Smyth*

It is not just street elements like utility poles and street lights that are becoming hosts for network infrastructure. Writing on New York City's more than 1,500 LinkNYC kiosks that provide free public Wi-Fi, media academic Shannon Mattern notes how in many different cities, "minor telecommunications architectures are changing to reflect new patterns of use, new network architectures, new political economies."[11] In this way, even the unheeded waste receptacle could now be thought of as an emerging "minor telecommunications architecture." As of 2014, smart trash cans in Lower Manhattan feature Wi-Fi hotspots. Here again, we see that fundamental street furniture objects in cities are moving beyond their primary functions and becoming subject to function creep as they provide the essential material siting for the ever-expanding network of internet infrastructure.

This relationship between customers and companies is arguably even more complicated in the case of IoT objects in the public realm. Unlike in the smart home setting, it means that public services and the related data is being fed to private companies, further politicizing the objects, obscuring the relations between physical and digital urban infrastructures and raising new questions of ownership, governance, and control. In this sense, municipalities need to think more broadly and long-term about the value of its infrastructures, services, and the data that they are producing.

Writing about the potential impact IoT could bring to architecture and the built environment, design critic Justin McGuirk notes that much like other technological advancements in the past, the changes and how they affect architecture are being largely ignored by the architecture community. Commenting on the influence that IoT will have on the future development of the city, McGuirk writes that "the real financial assets of the city will be measured less in ostentatious skyscrapers than in the invisible substrate of cables and sensors."[14]

COMPLICATING THE RELATIONSHIPS BETWEEN PHYSICAL AND DIGITAL URBAN INFRASTRUCTURES

EXPAND, CONTRACT, EXPAND

Post-telegraph and telephone, it seems that the physical presence of modern telecommunications infrastructure has shrunk and become difficult to identify with the burying of wires. Shannon Mattern notes that "while the machinery of old-school telecommunications has evolved, its terrestrial mark on the urban landscape has diminished."[15] Similarly, architect Kazy Varnelis echoed the sentiment that modern telecommunications have become obscured and intangible, that "the space of global technological flows does not desire to become visual or apparent: perhaps only some spray-paint or a flag in the ground marks the presence of fibre below, and sometimes even that is elusive."[16] But as we have seen, the demand for increased network coverage and connection speeds has brought with it an amplified pressure to build out physical infrastructure a need that is increasingly integral to, and reliant on, physical street furniture.

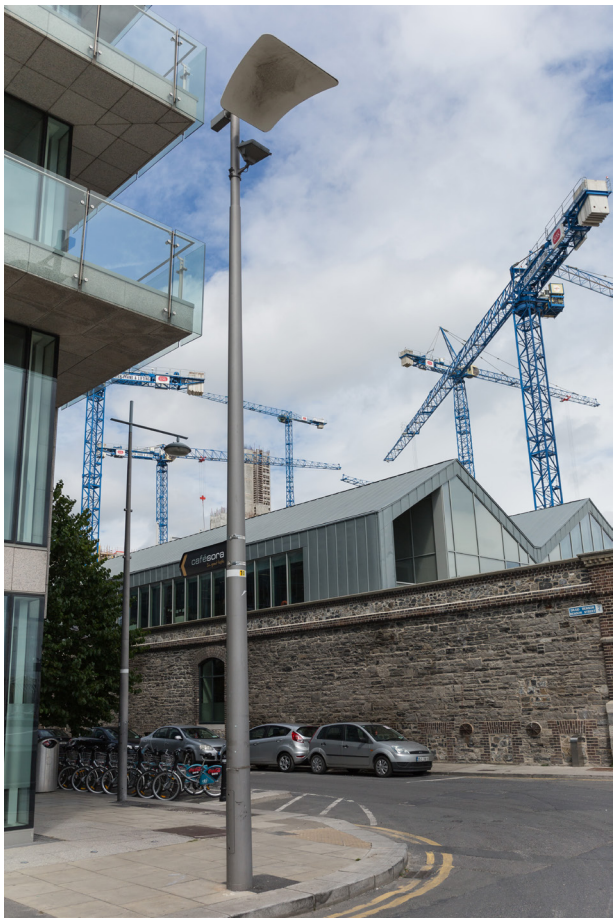

Image 5 | *Benson Street, Dublin, 2017. Image by Neil J Smyth*

The technologically instrumented city of the future is often presented in its extreme: a robot-laden science fiction or an abstracted, totalitarian state. But in reality, network infrastructures and IoT technologies have already been applied to the most innocuous, everyday urban infrastructures in the most ordinary places. And despite the feeling of immateriality and abstraction in the data-driven city, it is worth considering the material, quotidian means through which it emerges and is operationalized. As Malcolm McCullough reminds us, "however much augmented, the city is also unmediated experience: fixed forms persist underneath all these augmentations and data flows, and for that you might be thankful. Without persistent environments, the sense of confusion and flux might only worsen."[17]

AMPLIFIED PRESSURE TO BUILD OUT PHYSICAL INFRASTRUCTURE STREET FURNITURE IS BECOMING INTEGRAL TO NETWORK INFRASTRUCTURE

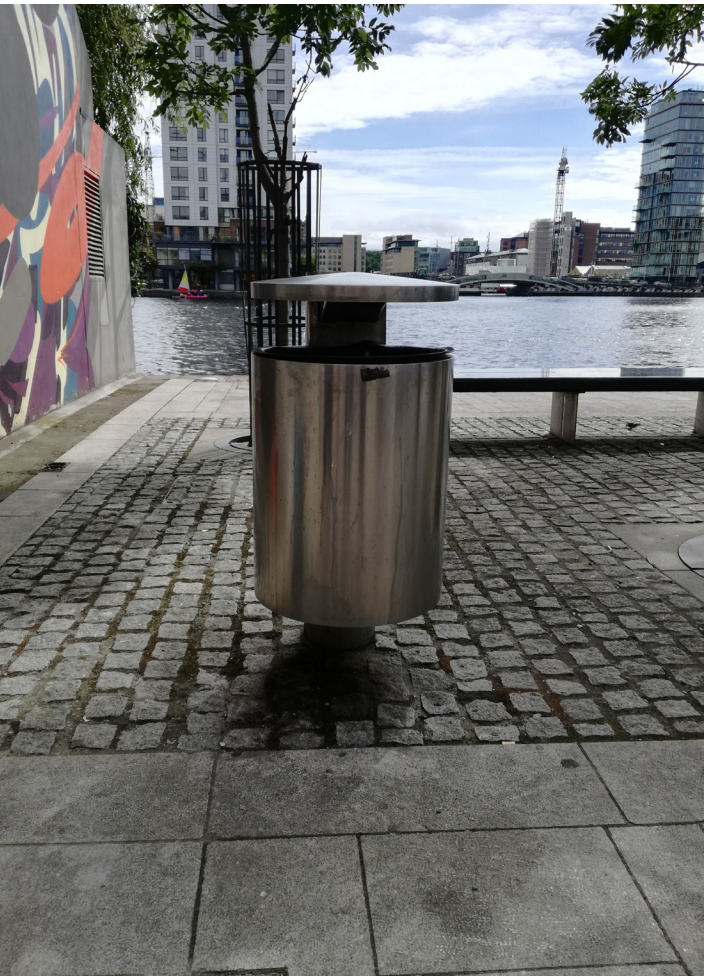

Image 6 | *Hanover Quay, Dublin, 2017. Image by Neil J Smyth*

ENDNOTES

[1] My thanks to Shannon Mattern for informing me of this news commentary.

[2] Neeraj Choubey and Ali Yazdan, "Introducing Facebook's new terrestrial connectivity systems — Terragraph and Project ARIES" April 13, 2016. Accessed June 5, 2018. https://code.facebook.com/posts/1072680049445290/introducing-facebook-s-new-terrestrial-connectivity-systems-terragraph-and-project-aries/.

[3] Quoted from Yael Maguire in: "A Gigabit Wireless Network," Terragraph, accessed 17 August, 2018, https://terragraph.com/#terragraph.

[4] Molly Wright Steenson, Architectural Intelligence: How Designers and Architects Created the Digital Landscape (Cambridge, MA: MIT Press. 2017), 131.

[5] Simon Sadler, Archigram – Architecture without Architecture (Cambridge, MA: MIT Press, 2005), 21.

[6] Sam Jacob, "Machines of Loving Grace" Uncube Magazine, no. 36, accessed June 5, 2018, http://www.uncubemagazine.com/sixcms/detail.php?id=15799831&articleid=art-14367957429 97-98ea2758-9e62-4211-9b51-d4dbf8a82c23#!/page17.

[7] Eleanor Herring, "Street Furniture and the Nation State: A Global Process," in A Matter of Design: Making Society through Science and Technology. Proceedings of the 5th STS Italia Conference 2014, eds. Claudio Colletta, et al. (Milan: STS Italia Publishing, 2014), page numbers, http://www.stsitalia.org/?p=1548.

[8] Carlo Ratti and Matthew Claudel, The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life (New Haven: Yale University Press, 2016), 30.

[9] Susan Crawford, "The Surprising Backbone of the Internet of Things" Wired, October 12, 2016, accessed June 5, 2018, https://www.wired.com/2016/10/the-surprising-backbone-of-the-internet-of-things/.

[10] Keith Schneider, "Chattanooga's Innovation District Beckons to Young Entrepreneurs," New York Times (New York City, NY), August 16, 2016, accessed June 5, 2018, https://www.nytimes.com/2016/08/17/realestate/commercial/chattanoogas-innovation-district-beckons-to-young-entrepreneurs.html?_r=1.

[11] Shannon Mattern, Code and Clay, Data and Dirt: Five Thousand Years of Urban Media (Minneapolis: University of Minnesota Press, 2017), 30.

[12] Ezio Manzini, The Material of Invention (Cambridge, MA: MIT Press, 1989), 12.

[13] Adam Davidson, "A Washing Machine that tells the Future," The Financial Page, The New Yorker, October 13, 3017,accessed June 5, 2018, https://www.newyorker.com/magazine/2017/10/23/a-washing-machine-that-tells-the-future.

[14] Justin McGuirk, "Honeywell, I'm Home! The Internet of Things and the New Domestic Landscape," E-flux Magazine, no 64, April 2015, accessed June 5, 2018, https://www.e-flux.com/journal/64/60855/honeywell-i-m-home-the-internet-of-things-and-the-new-domestic-landscape/.

[15] Mattern, Code and Clay, Data and Dirt, 31.

[16] Kazys Varnelis, "Invisible City: Telecommunications," in The Infrastructural City: Networked Ecologies in Los Angeles, ed. Kazys Varnelis (New York: Actar, 2009), 128.

[17] Matthew McCullough, Ambient Commons: Attention in the Age of Embodied Information (Cambridge, MA: MIT Press, 2013), 8.