Is the OS National Geographic Database Digital Public Infrastructure?

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Introduction

Digital Public Infrastructure (DPI) is being hailed as the key to solving some of our most pressing challenges. Claims for DPI include that it will "accelerate action towards the Sustainable Development Goals" (Steiner 2022), "[support] empowerment, inclusion, and resilience" (Desai *et al.* 2023) and "[enable] responsive and effective public finance" (Massally and Sharma 2022). After several years as an emerging technology, three examples of DPI are universally agreed: digital identity, digital payments and data exchange (O'Neil and Rasul 2022). It may be that this is the limit to the scope of DPI or possibly there are other forms of DPI that have yet to be discovered or acknowledged.

The purpose of this paper is to consider the nature of DPIs to understand what makes a specific technology Digital Public Infrastructure. I will explore the maturing technology of the Ordnance Survey (OS) National Geographic Database (NGD) to test whether this meets the criteria required to be considered DPI.

What is the OS National Geographic Database?

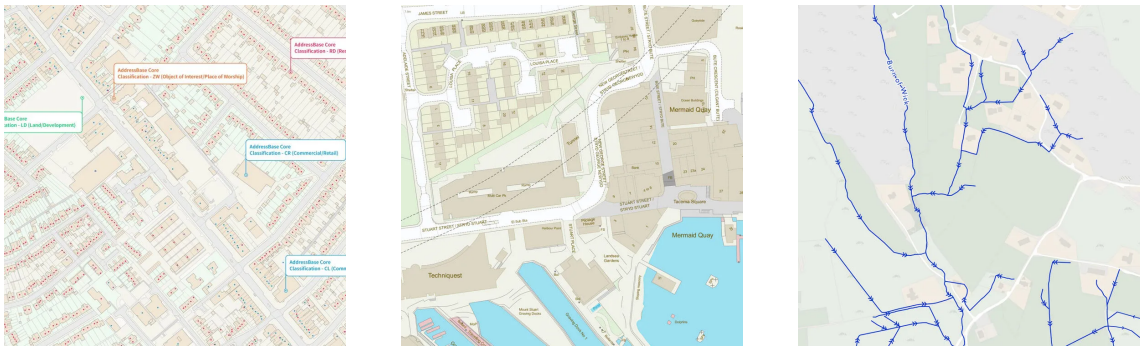
> *OS is responsible for surveying all 243,241 square kilometres of Great Britain on an ongoing basis making more than 20,000 edits to real world features within its datasets, every single day. This national geographic database is one of the largest structural databases in the world with records and details on more than 500 million objects, and a file size measuring over two petabytes*
>
> ESRI UK, 2022

Ordnance Survey (OS) has been creating maps of physical, political and social manifestations in the landscape for over 230 years. In the 1970s, OS began creating a digital version of its mapping of Great Britain (Holland and Allan 2001) and in the late 1990s the idea of the Digital National Framework (DNF) was conceived (Holland 2001). This resulted in the development of a new data structure, whereby each entity within the database had a unique identifier, and the data had a defined spatial referencing system (Holland and Allan 2001; Holland 2001).

DNF data comprised points, lines and polygons that described topographic[1] features in the landscape and administrative boundaries. The objective for the DNF was to create the georeferencing framework onto which knowledge and analysis could be built (Murray 2008, p1709). The data were built on Open Geospatial Consortium (OGC) standarads and released as the commercial product OS MasterMap in 2001. Over the following years, OS MasterMap was extended, and further digital location products were added to OS's portfolio. Together, these products became known as the National Geographic Database (Ordnance Survey 2006), which now comprises around 70 products (Cabinet Office *et al.* 2020) and is delivered under the Public Sector Geospatial Agreement (PSGA) (Cabinet Office and Geospatial Commission 2020).

The OS NGD represents the geography of Great Britain in terms of the physical attributes

[1] Topographic features are often described idiomatically as "things you can trip over or walk into". This arose from OS's origin as a military survey – mapping the landscape to identify places where soldiers may be concealed.



(a) Addresses with geographic location defined with points

(b) Topography defined with points, lines and polygons

(c) Water networks

Figure 1: Example vector data from the OS NGD. ©2023 Ordnance Survey Limited https://www.ordnancesurvey.co.uk/customers/businesses/sample-data

of the landscape and administrative boundaries (Figure 1). The database includes vector, raster and coverage data types. Confusingly, these data are often described as being made up of "features", which approximately describe what are also called "features" in the real world[2]. This paper will use the following terms:

data feature any single vector (point, line or polygon) entity within OS NGD, for example a polygon that describes a section of railway. If the data type is raster or coverage, the data feature can be the manifestation of a real-world feature, for example all the pixels in a land cover map that pertain to the same water body or field.

real-world feature any single object in, or characteristic of, the landscape or a location that may be described by a data feature. For example, a building, a road, area of sparse woodland, an electoral district.

Is OS NGD Infrastructure?

> ***i'nfra-*** *Below;* ***-structure****, subordinate parts of an undertaking esp. permanent installations forming a basis of defence*
>
> The 1981 Pocket Oxford Dictionary

The meaning of the word "infrastructure" can be difficult to nail down. A general definition, that infrastructure is "the basic, underlying framework or features of a system or organization"[3], is vague. Star and Lampland (2009, p17) foreground this vagueness when they describe infrastructure as "boring" and "invisible", and yet "to-hand", and to Star and Ruhleder (1996, p112–3), infrastructure is found to become such by its use.

Star and Lampland (2009) studied infrastructure because it is deeply entwined with standards, and standards are a core theme in the story of OS NGD. DNF standards for

[2]OS edits data features, not the real-world features stated in the quote at the start of this section. This is the role of construction workers and nature, among others.

[3]This definition can be found in https://www.dictionary.com/browse/infrastructure, alongside more specific definitions.

identifiers, reference systems, metadata, data quality and data cataloging were developed for more than a decade by the DNF Experts Group, which spanned a number of private and public sector organisations (BCS 2015). Recognising the risk that software and data may be mismatched, OS intensified its involvement in the OGC (Open Geospatial Consortium 2006; OGC 2015). The principles and practises established by the DNF Experts Group and through the OGC contributed to the development of location data standards for the EU INSPIRE directive (Geographic Information Panel 2008, p21), on which core components of OS NGD have been built since 2011 (WIRED GOV 2011).

These standards-defining and -complying initiatives were driven by a desire to improve the discovery of, access to, sharing of, and use of location data. In fact, many of the standards initiatives referred to location data as "infrastructure". The 2008 UK Location Strategy aimed to create a "common infrastructure of standards, technology and business relationships" for sharing location-related information (Geographic Information Panel 2008) and the INSPIRE directive proposed to establish "Infrastructure for Spatial Information in the European Community" (INSPIRE 2008). Murray (2008) describes how Spatial Data Infrastructures were being realised through the development of DNF and OS Mastermap. For a couple of years the term National Information Infrastructure (Cabinet Office 2013) was used to refer to the strategically important data made available through data.gov.uk, much of which was location data that developed into today's OS NGD.

A 2021 blog post about the PSGA (Clark 2021), describes a wide range of uses of OS NGD including security planning, emergency and pandemic response, utilities roll-out and property management. However, despite OS NGD being key to the PSGA, this post does not directly refer to OS NGD. Thus, invisible and yet to-hand, OS NGD meets at least some criteria for being infrastructure.

Is OS NGD Public Infrastructure?

> ***infrastructure****: the fundamental facilities and systems serving a country, city, or area, as transportation and communication systems, power plants, and schools*
>
> www.dictionary.com

Of course, in the above discussion about "infrastructure", I left out the most obvious meaning of infrastructure – the meaning that any internet search returns – which is the structures and facilities needed for the functioning of a society. Such "public infrastructure" often emerged and evolved as plain "infrastructure". However, at some stage its necessity to wider society was recognised and one or more body was charged with oversight of its maintenance and development. In the UK, the indisputable infrastructure types, transport and utilities networks, began as local ventures and privileges but are now coordinated by national organisations using standards for their design and maintenance, and codes of conduct for their use. We can also talk about the infrastructure of education, of welfare and even democracy. None of these examples worked well for the population when their allocation was left solely to markets and all have a broader reach as public infrastructures. Star and Ruhleder (1996, p114) described how infrastructure is only such when – or while – it facilitates value. Thus, it may be reasonable to consider an unused railway, an inaccessible hospital, a parliament that doesn't deliberate, as *not* public infrastructure

while they facilitate nothing.

This recognition of the wider importance of location data to society, to defence and offence in the original case, was the reason for the creation of a national mapping effort, and later agency, in Great Britain. More recently, various studies have calculated the economic value of location data. The release of freely available data was predicted in 2013 to increase Great Britain's Gross Domestic Product by between £13m and £28.5m by 2016 (BIS and OS 2013) and a later release in 2018 was expected to boost the economy by £130m per year (Cabinet Office *et al.* 2018). More generally, "The NGD ... forms a valuable resource for both private- and public-sector organisations in this country, and an independent report published in 1999 estimated that Ordnance Survey mapping underpinned £100bn of economic activity" (Cabinet Office *et al.* 2018). This, if correct, is considerable compared to the £36bn contributed annually by the UK rail industry (Oxford Economics 2018).

Two key properties of public infrastructure are ease of access and permission to use. There has long been an acknowledgement of functional limitations to access for OS data (Geospatial Commission 2019) and the PSGA obliges OS to improve access to OS NGD to start-ups, businesses and innovators (Cabinet Office *et al.* 2020). Consequently, OS NGD has been remodelled and redesigned, and made available via OGC-standard APIs (Application Programming Interface) (Ordnance Survey 2023; Gordon 2023). Also, OS began making some products freely available for personal and commercial use in 2010 (UK Government 2010)[4] and opened up parts of OS MasterMap in 2018 (Cabinet Office *et al.* 2018). Other parts of OS NGD are available only to commercial partners or members of the PSGA[5]. This contrasts with other public infrastructure, where tolls and service charges are established but cost is the only intended limitation to access.

It has been claimed that "every adult in Great Britain interacts with OS location data an average of 42 times a day" (Emerson 2022) but most adults will be entirely unaware that this has happened. There are parts of utility networks that people never encounter and aspects of the welfare or democracy that they don't know exist but the failure of these aspects of public infrastructure can have severe consequences to people's lives. Therefore it may be that components of OS NGD can be considered public infrastructure either because they are publicly accessible, or their loss will impact on people's lives.

Is OS NGD Digital Public Infrastructure?

> ***digital public infrastructure (DPI)****: society-wide, digital capabilities that are essential to participation in society and markets as a citizen, entrepreneur, and consumer in a digital era*
>
> Co-Develop (Eaves and Sandman 2023)

One could glibly claim that any part of OS NGD that is public and infrastructure is, by nature of also being digital, a DPI. However, Digital Public Infrastructure has a more exacting meaning. Quoted above is Co-Develop's definition, which emphasises not just the ability for public to access the capability or even its impact on people's lives, but its

[4] After years of lobbying by the Free Our Data campaign (Arthur and Cross 2006; Arthur 2010).
[5] See *Who can access the OS NGD?* on https://osngd.gitbook.io/osngd/.

necessity to the participation of individuals in society. This characteristic is true for other public infrastructure but is rarely emphasised.

OS NGD is core to many functions of government and the public sector. In the absence of OS NGD, it would be necessary to source other location data, including for all of the UK's critical national infrastructure (Geospatial Commission 2022). However, it is not a necessity for the participation of individuals in society and therefore it is not a DPI. We could refer to this varied collection of location data (Geospatial Commission 2022) as "Digital *State* Infrastructure" (DSI), of which OS NGD is a component.

OS NGD as Digital State Infrastructure

Like the digital identity DPI, OS NGD is founded on unique identifiers for every data feature. Therefore, it is compelling to consider what other DSIs, that mirror DPIs, could achieve. What would a location data exchange layer and the ability to perform transactions with other location data features facilitate? For instance, instead of payment transactions, can we model the emission and absorption of pollutants or understand better the flow of people and vehicles through geographic space? True, we are not inventing a new technology here, Digital Twins have been around at least in theory for years. However, there may be value in exchanging and integrating these different approaches to digital infrastructure.

As railways are valueless without trains, DPIs are valueless without Digital Public Goods, such as open source software that extracts value from DPIs (UN 2020). In parallel, we could look to precipitate the development of Digital *State* Goods[6], open-source software, models and standards that countries can use to operationalise and extract value from Digital State Infrastructure.

Another consideration is what a DPI that mirrors location data could achieve. Location data describe extents of real-world features and their static relationships to each other with concepts such as *is adjacent*, *overlaps*, *intersects* and *contains*. Network data describe connectivity and flow. Raster and coverage data describe change over multiple dimensions. The management and analyses of these is established practice. Could this offer new functionality to citizens, entrepreneurs and consumers, perhaps as complex communities of connected individuals, that better facilitate their participation in society?

These parallels between the concept of DPI and the OS NGD may be valuable to develop understanding and capability in both fields. For OS NGD, which matured under a closed culture that obliged public sector bodies to be self-financing (Rogawski *et al.* 2016), richer arguments for opening up public sector data may be found in the world of DPI. Also, the field of DPI may provide wider opportunities to improve ease of access to location data. Further, there is good reason to strive to adopt similar principles for OS NGD as are being proposed for DPI, namely that DPI are inclusive, foundational, interoperable, publicly accountable, locally sovereign (Eaves and Sandman 2023), the first three of which match, in spirit, the foundation principles of DNF (DNF Expert Group 2010) and the FAIR principles that have been suggested for UK location data (Geospatial Commission 2022).

[6]It is quite possible that this is the same as Government as a Platform (O'Reilly 2011; Pope 2019) which Long (2021) linked with DPIs.

For DPI, there may also be learning points. For instance, OS NGD is founded on decades of standards development and consolidation by coordinating many organisations and initiatives. This experience may provide useful insights into strong standards and the coordination of interests.

Conclusion

This paper has explored the nature of OS NGD, which is widely understood, and the definition of DPI, which is still emerging. It found that OS NGD can, and is, variously described as digital and as public and as infrastructure. However, these location data, by their nature of not being about individuals but rather being about real-world features, cannot meet the "essential to participation in society" aspect of DPI. The strong parallels between DPI and OS NGD suggests opportunities to open up the data and stimulate the engagement of citizens in developing state goods for more inclusive operation of government and potential for a sharing of experience in both fields.

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