Route Services

NetworkRail

TRAN5340M
Transport Data Science

Will Deakin

20 March 2025

Trains Portfolio

Network Rail

Putting passengers first

Introduction

Will Deakin

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Trains Portfolio Architect
IT Delivery

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Other Stuff

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X/Twitter: @WillDeakin1
GitHub: @anisotropi4

Such as...

LEEDS DIGITAL FESTIVAL | 2022

Sheffield DIGITAL FESTIVAL 22

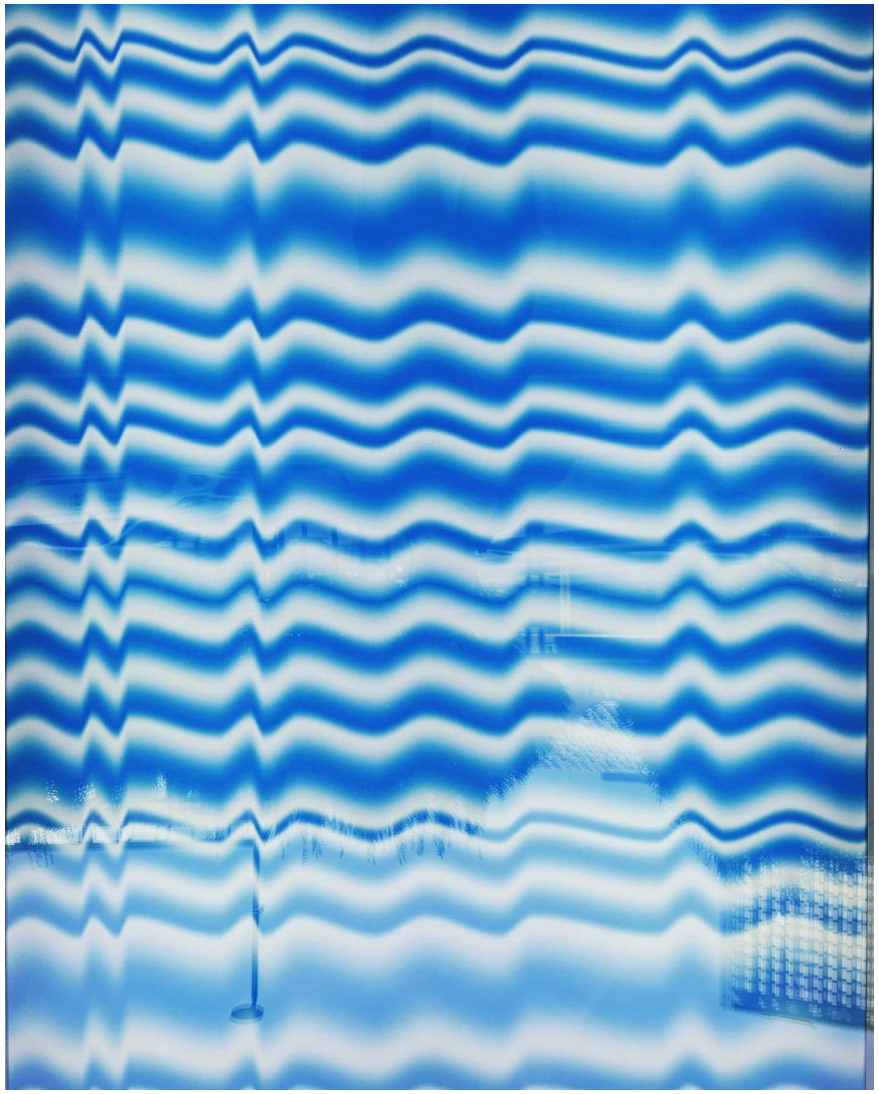
Leeds Digital Festival 2023

COM3523
Software Re-engineering

INF4000 Data Visualisation

TRAN5340M
Transport Data Science

INF4001 Information Visualisation for Decision Making



TRAN5340M Transport Datascience

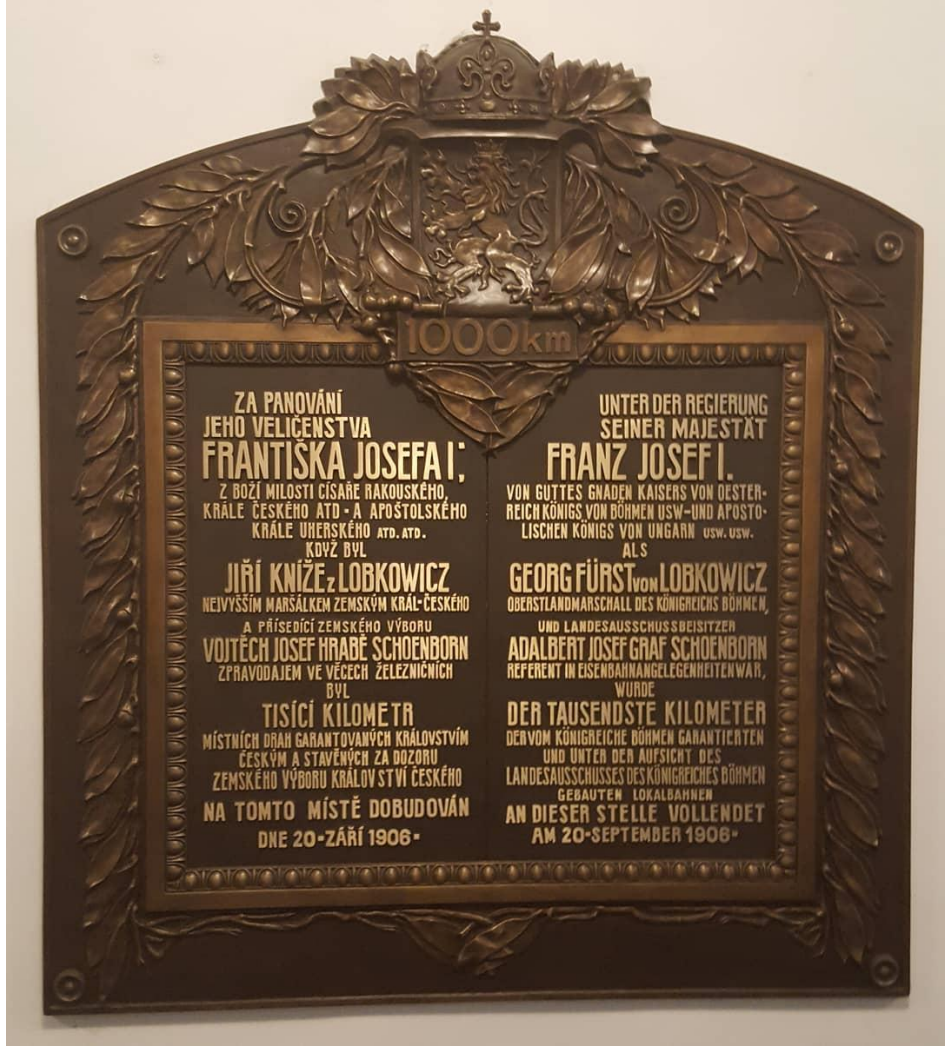
The quantity, diversity and availability of transport data is increasing rapidly, requiring skills in the management and interrogation of data and databases. We are in the midst of an accelerating data revolution and data science have never been more important in the work place.

Transport planners, consultancies and researchers increasingly need to take data from a wide range of sources and perform non-standard analyses methods on them to inform the decision-making process...

More importantly, you will be empowered to support sustainable transport policies using new techniques and datasets, ranging from openly available origin-destination datasets to huge datasets from global positioning systems (GPS). Not only does the module teach data skills, it also teaches the importance of understanding how advanced data analysis, modelling and visualisation can support the global transition away from fossil fuels.

Where did it all begin?

Before Rail



‘Nel mezzo del cammin di nostra vita
mi ritrovai per una selva oscura,
ché la diritta via era smarrita

Ahi quanto a dir qual era è cosa dura
esta selva selvaggia e aspra e forte
che nel pensier rinova la paura!

Tant’è amara che poco è più morte
ma per trattar del ben chi’vi trovai,
diro’ de l’altre cose chi’vi’ho scorte’

Canto 1 - Inferno

Dante Alighieri

Early Forays into Data

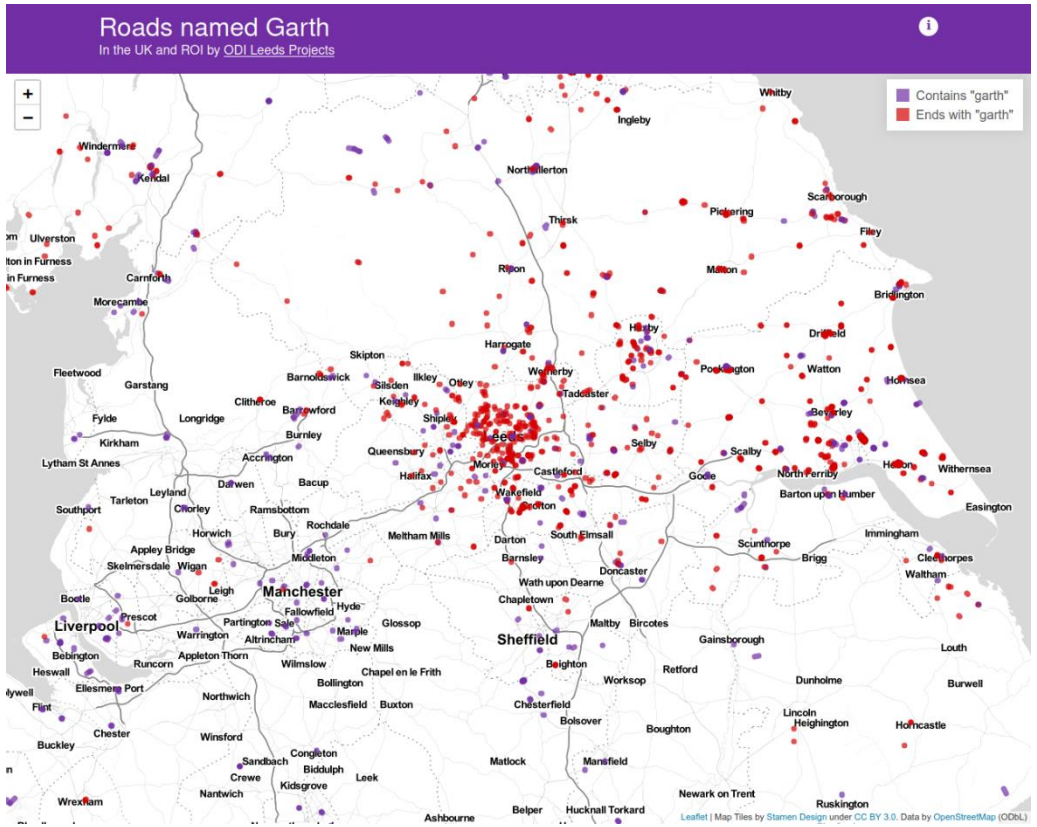
Parasocial Activities

The Garthiness of Leeds

‘It turns out **Leeds** is a bit of a **Garth** hotspot and their distribution generally correlates with regions settled by the Vikings around 1000 years ago.

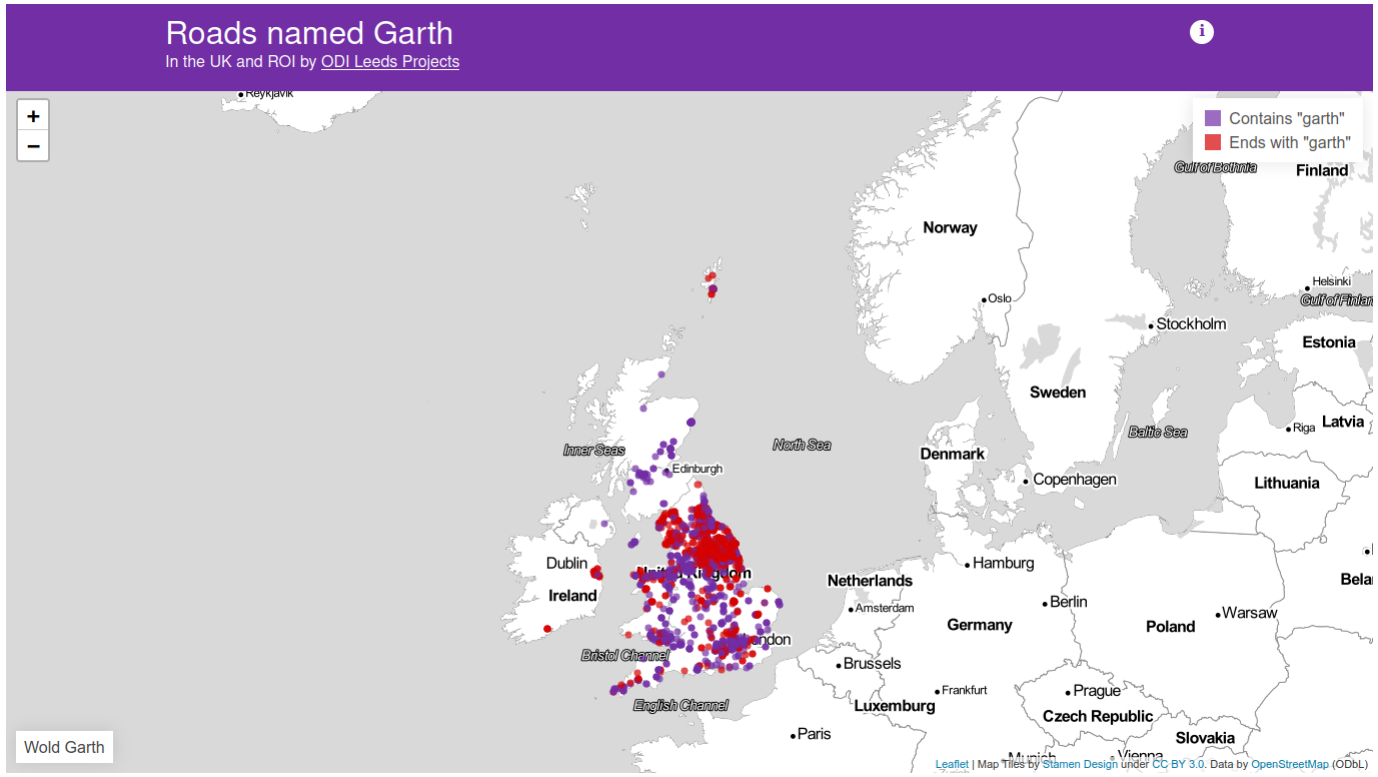
Party on!’

Stuart, ODI Leeds



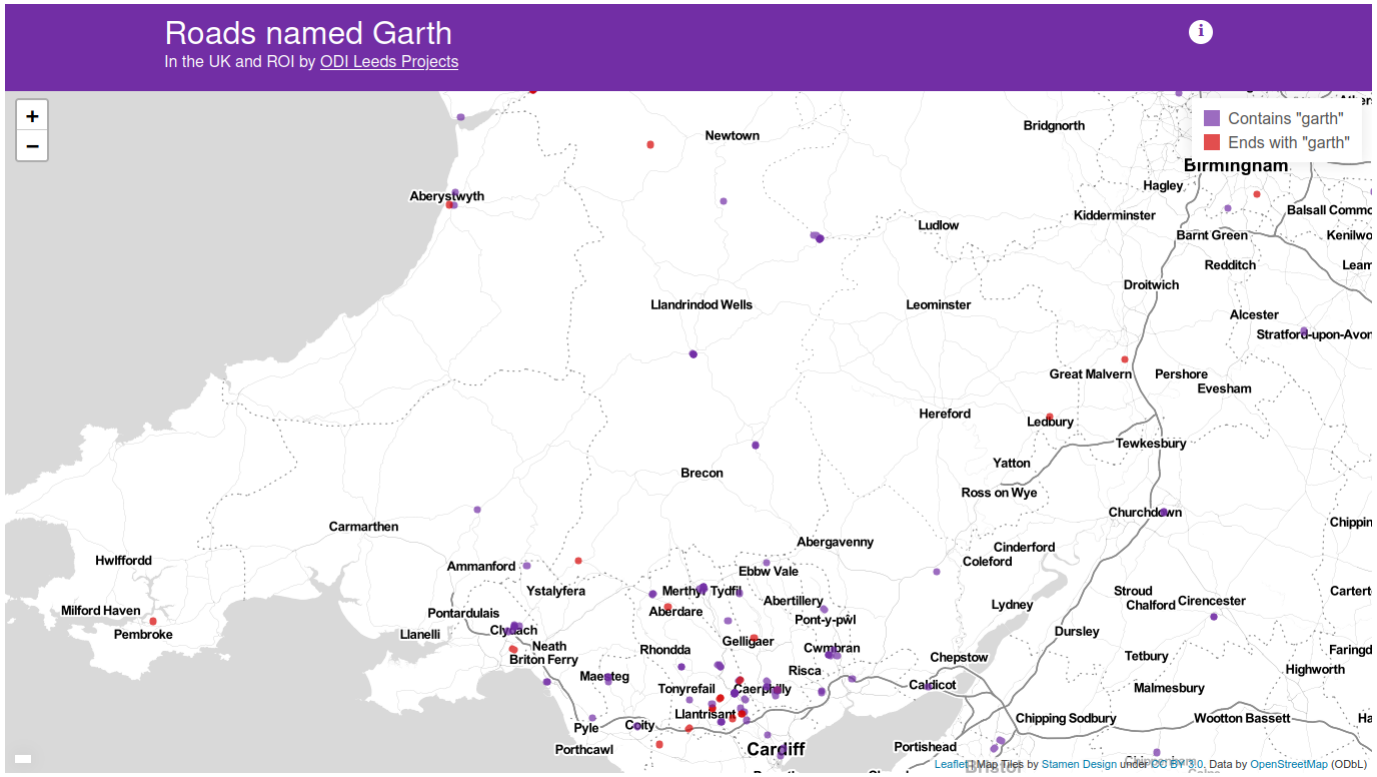
Hiraeth of Irfon Valley C.P. School

Hiraeth: a mixture of longing, yearning, nostalgia, wistfulness or an earnest desire for the Wales of the past



Party On!

But where was Garth?



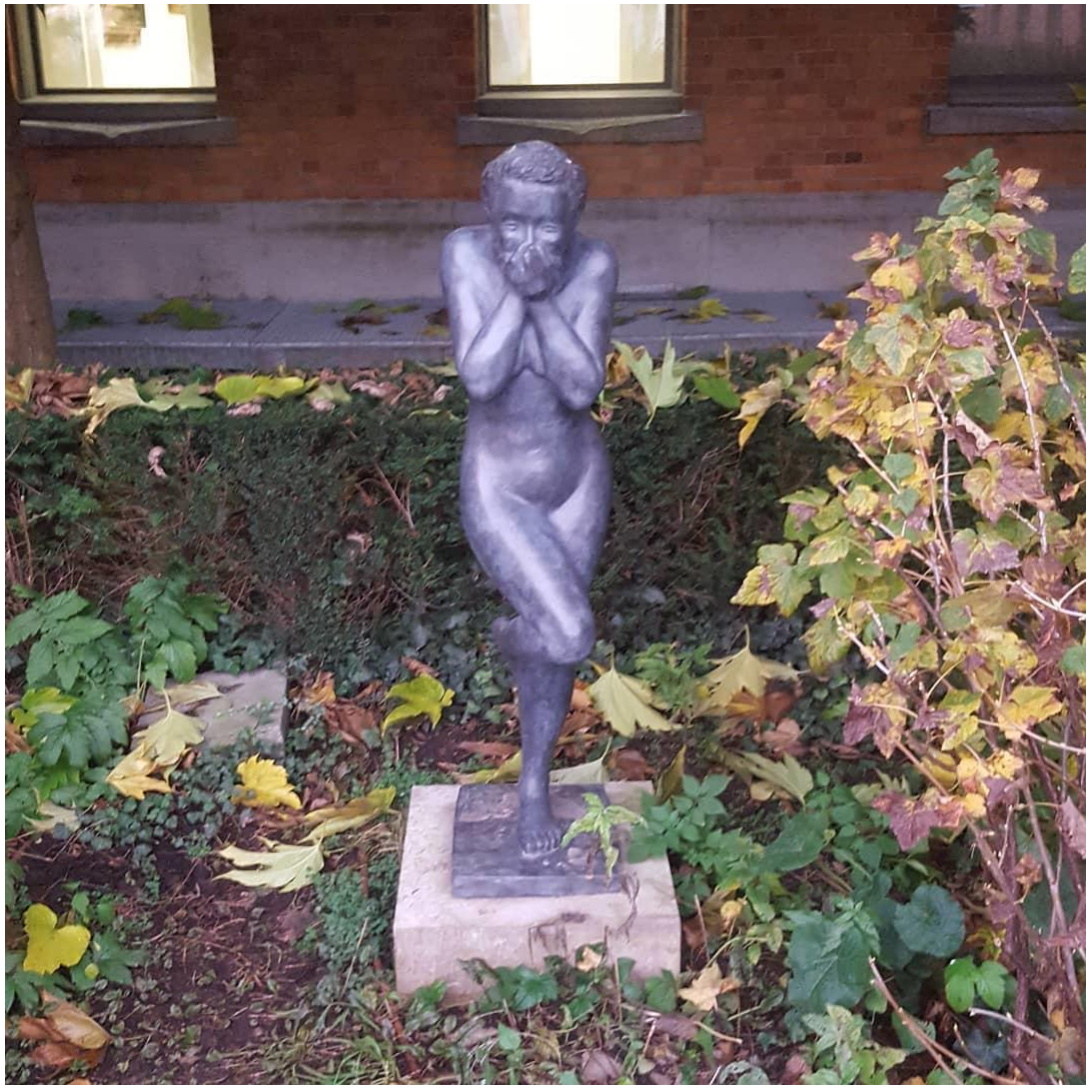
British Map of Wayne!

British Wayne

The Global Map of Wayne!

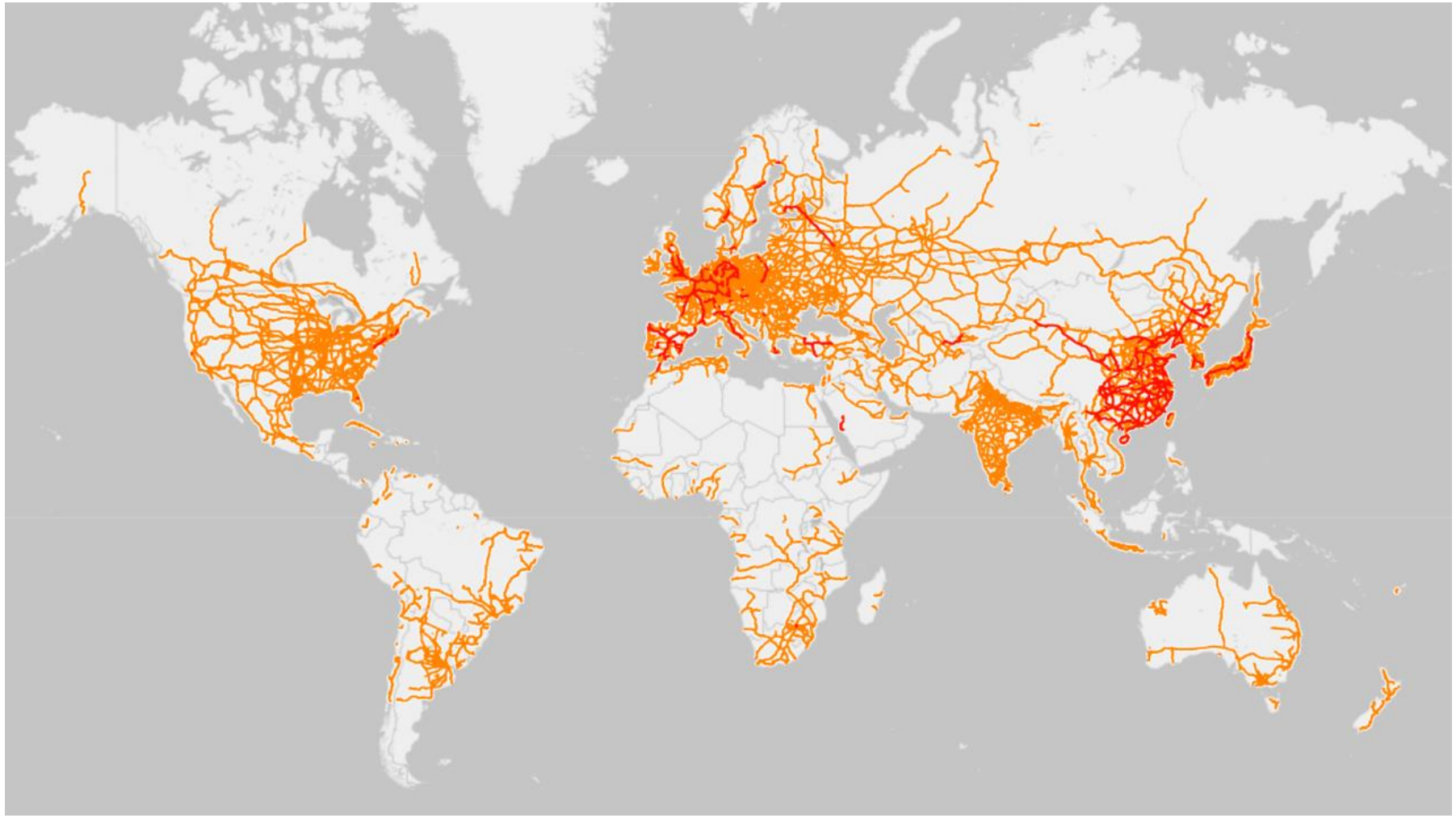
‘In tribute to the work of the Open Data Institute Leeds I bring you global mapping of Wayne, or as it were, **Wayne’s World**’

Excellent! Excellent!

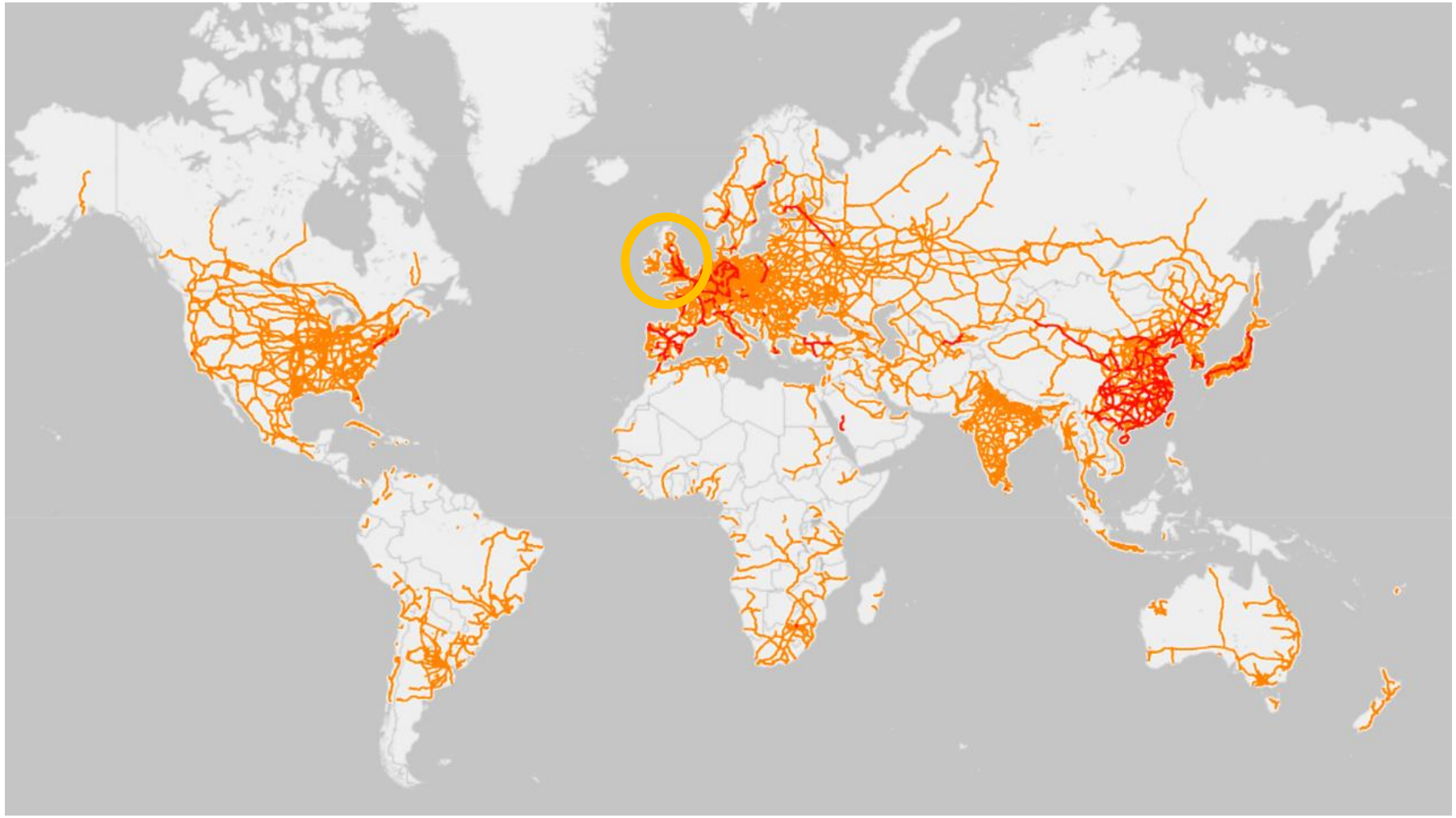


International Rail

The Rail-Sector and Network Rail



The Rail-Sector and Network Rail



British Rail Data

The Timetable

‘Madame Helena, the timetable is the most perfect product of the human mind’

R.U.R.
Karel Capek

…but it’s all Greek to me…

μῆνιν ἄειδε θεὰ Πηληϊάδεω Ἀχιλῆος
οὐλομένην, ἣ μυρί᾽ Ἀχαιοῖς ἄλγε᾽ ἔθηκε,
πολλὰς δ᾽ ἰφθίμους ψυχὰς Ἄϊδι προΐαψεν
ἡρώων, αὐτοὺς δὲ ἑλώρια τεῦχε κύνεσσιν
οἰωνοῖσί τε πᾶσι, Διὸς δ᾽ ἐτελείετο βουλή, ἐξ
οὗ δὴ τὰ πρῶτα διαστήτην ἐρίσαντε
Ἀτρεΐδης τε ἄναξ ἀνδρῶν καὶ δῖος Ἀχιλλεύς

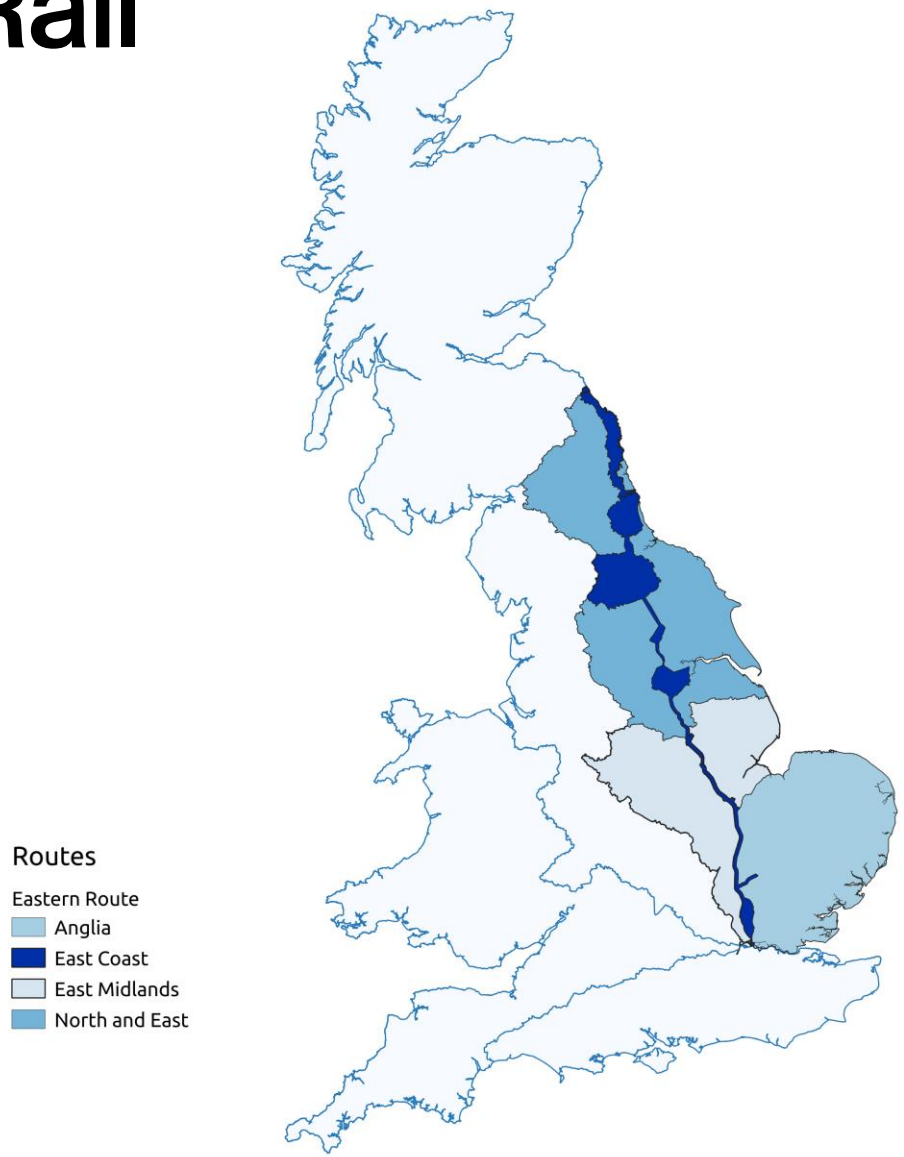
The Iliad book 1 - Homer

A British Approach

The Rail-Sector and Network Rail

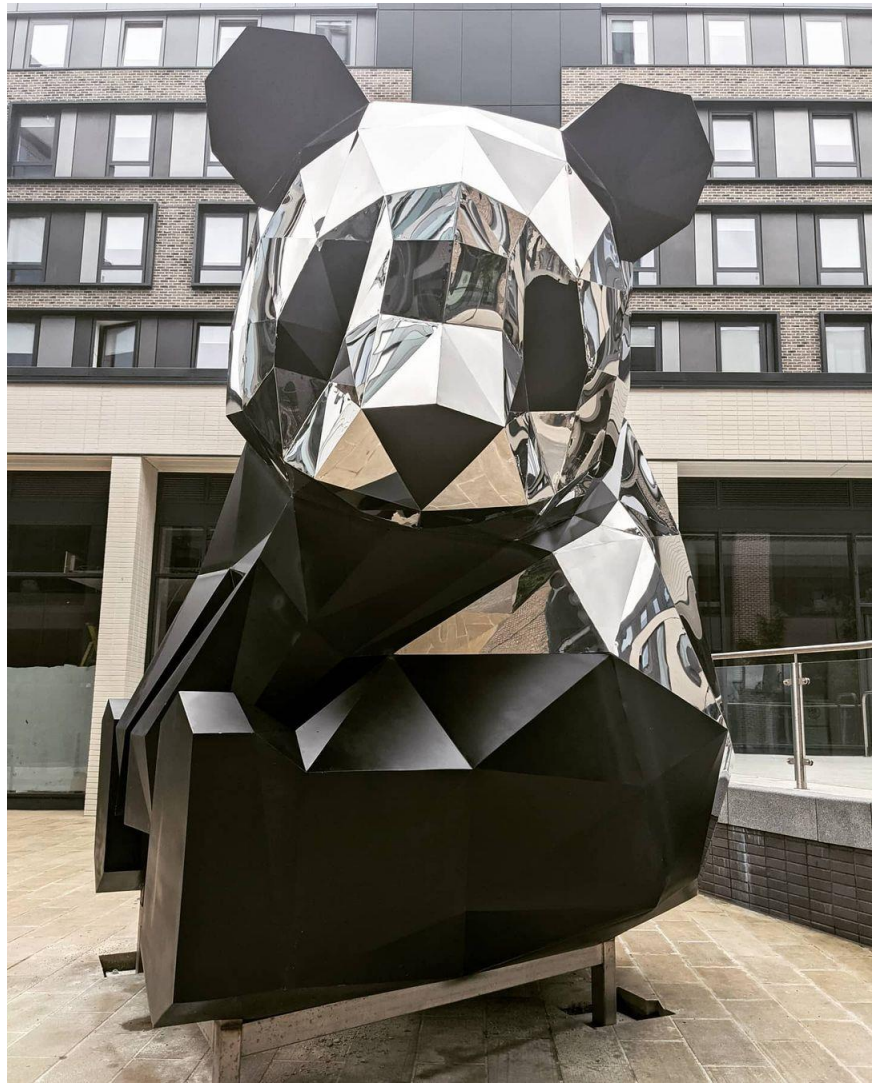
Routes and Regions

- Scotland
- North-West and Central
- Wales and Western
- Southern
- Eastern



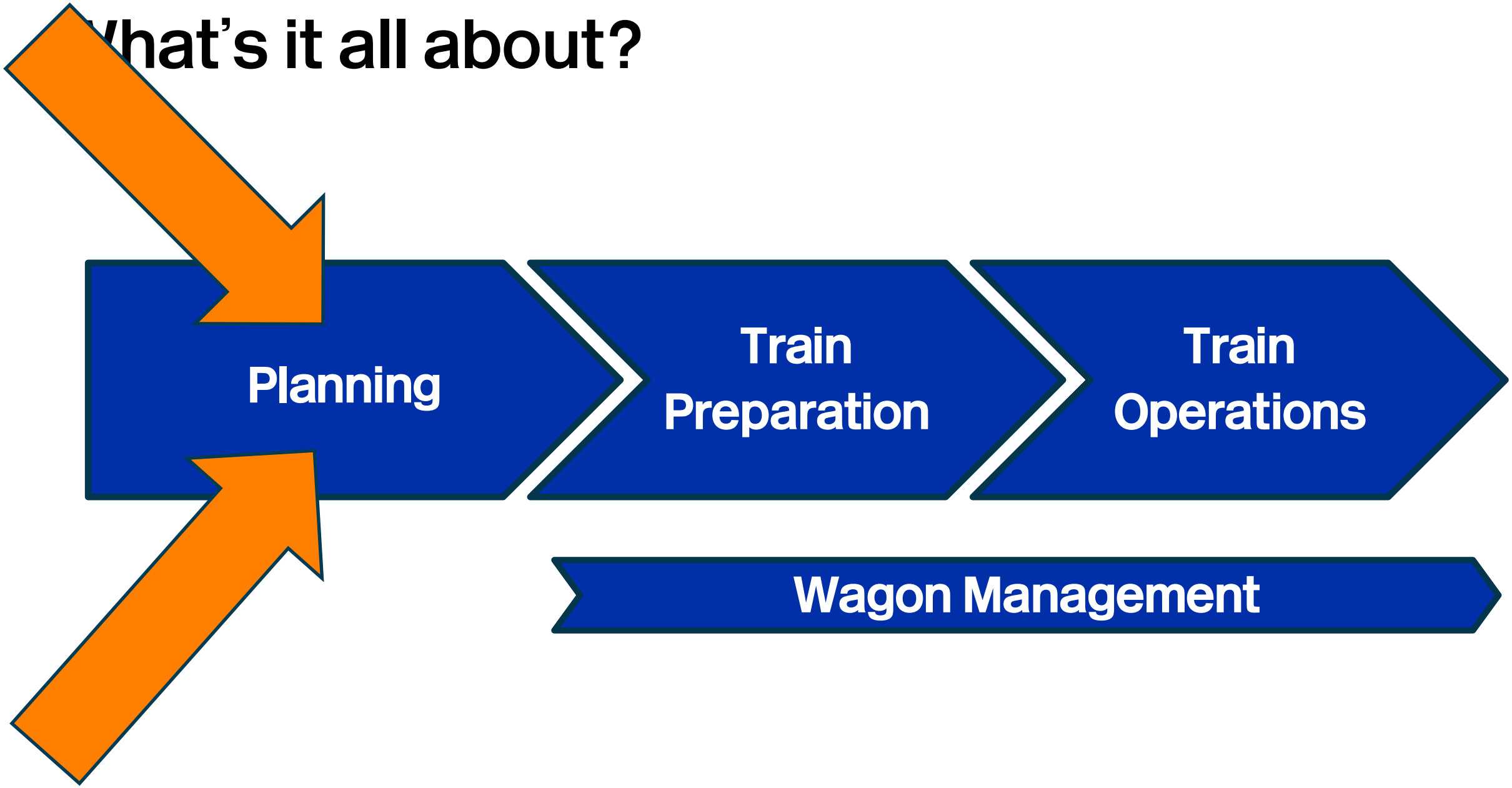
Data is Everywhere

Decision Making Contexts



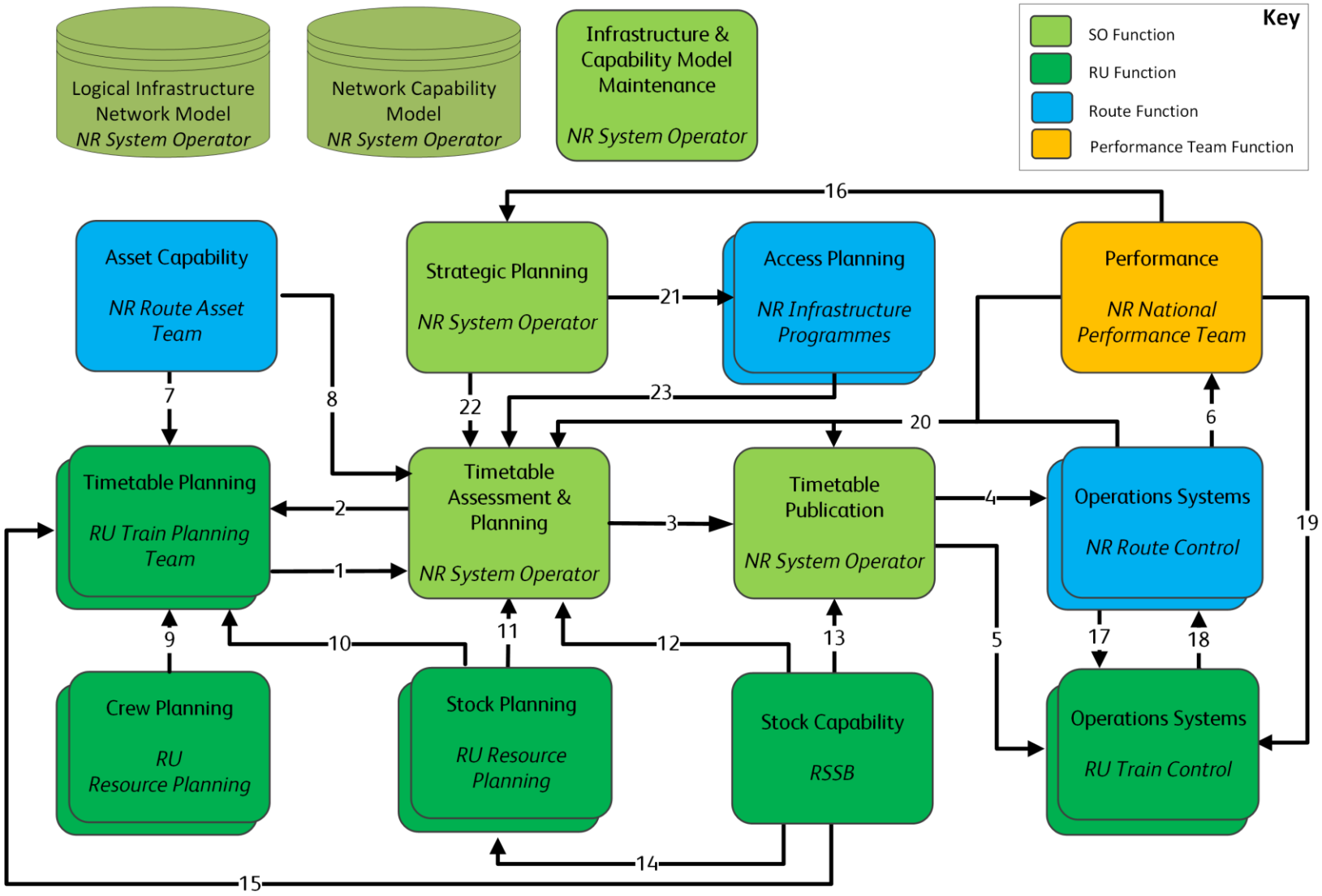
Timetable Development

What's it all about?



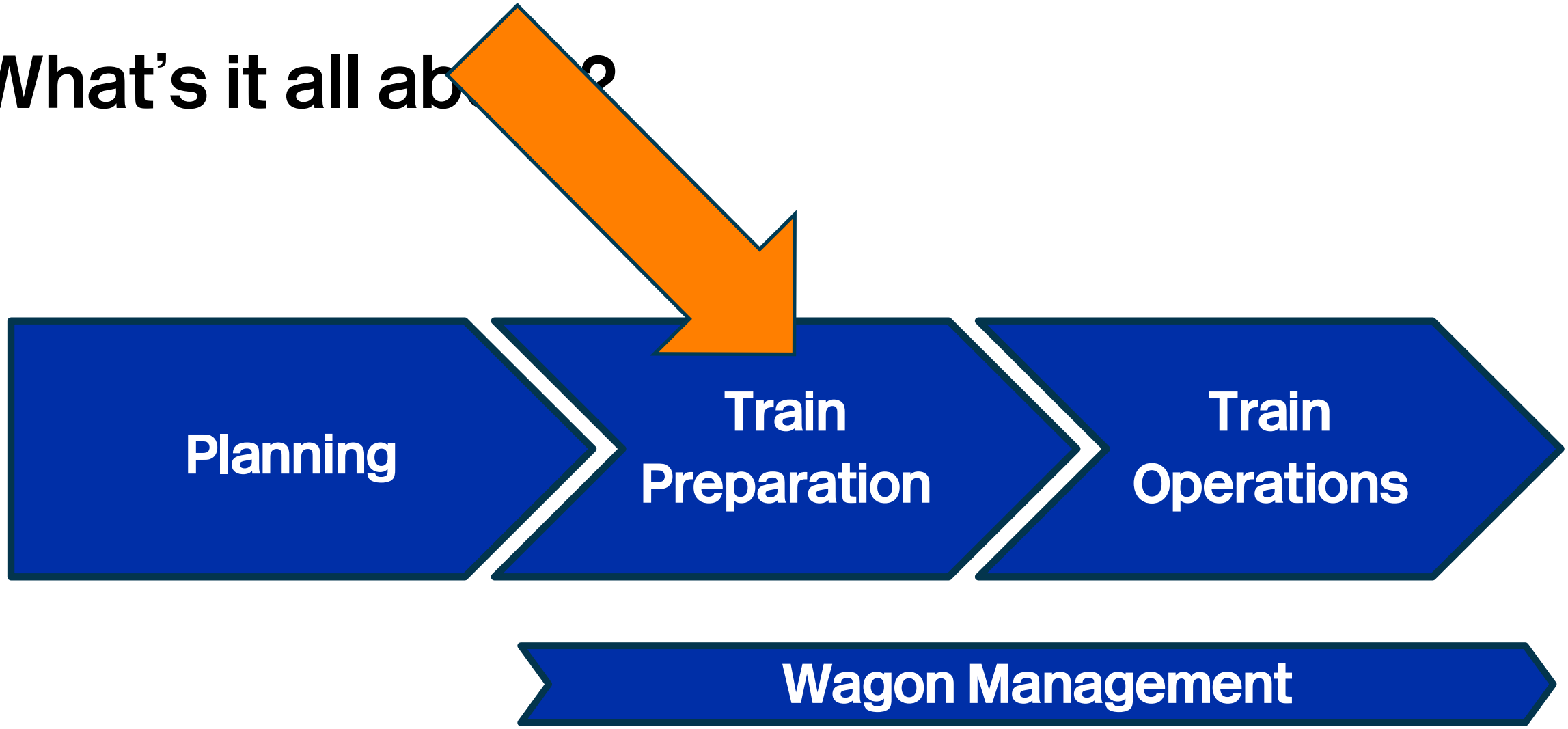
Strategic Planning
Performance
Access Planning
Timetable
Operations
Timetable Planning
Timetable Assessment

A Logical Network Model



Train Preparation

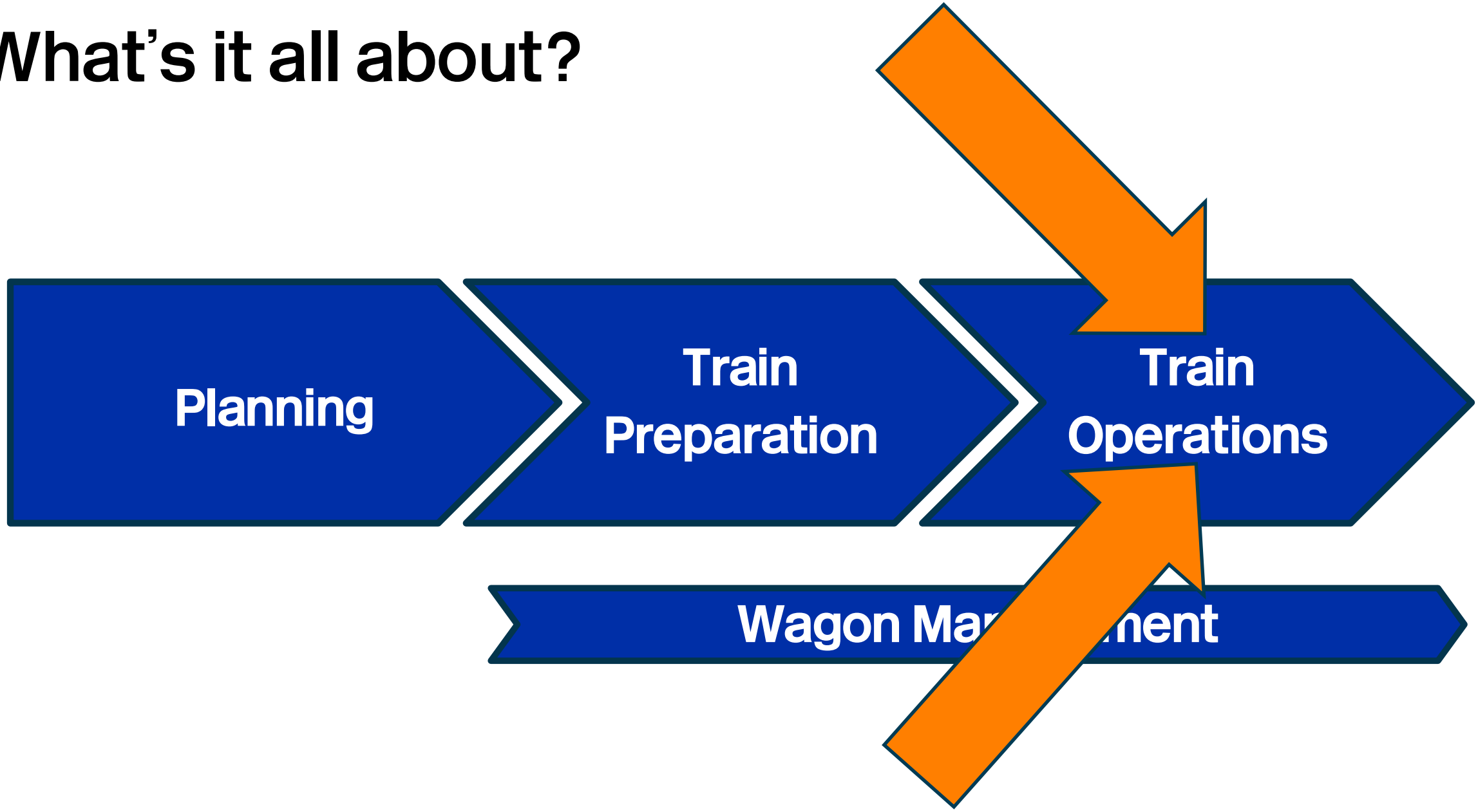
What's it all about?



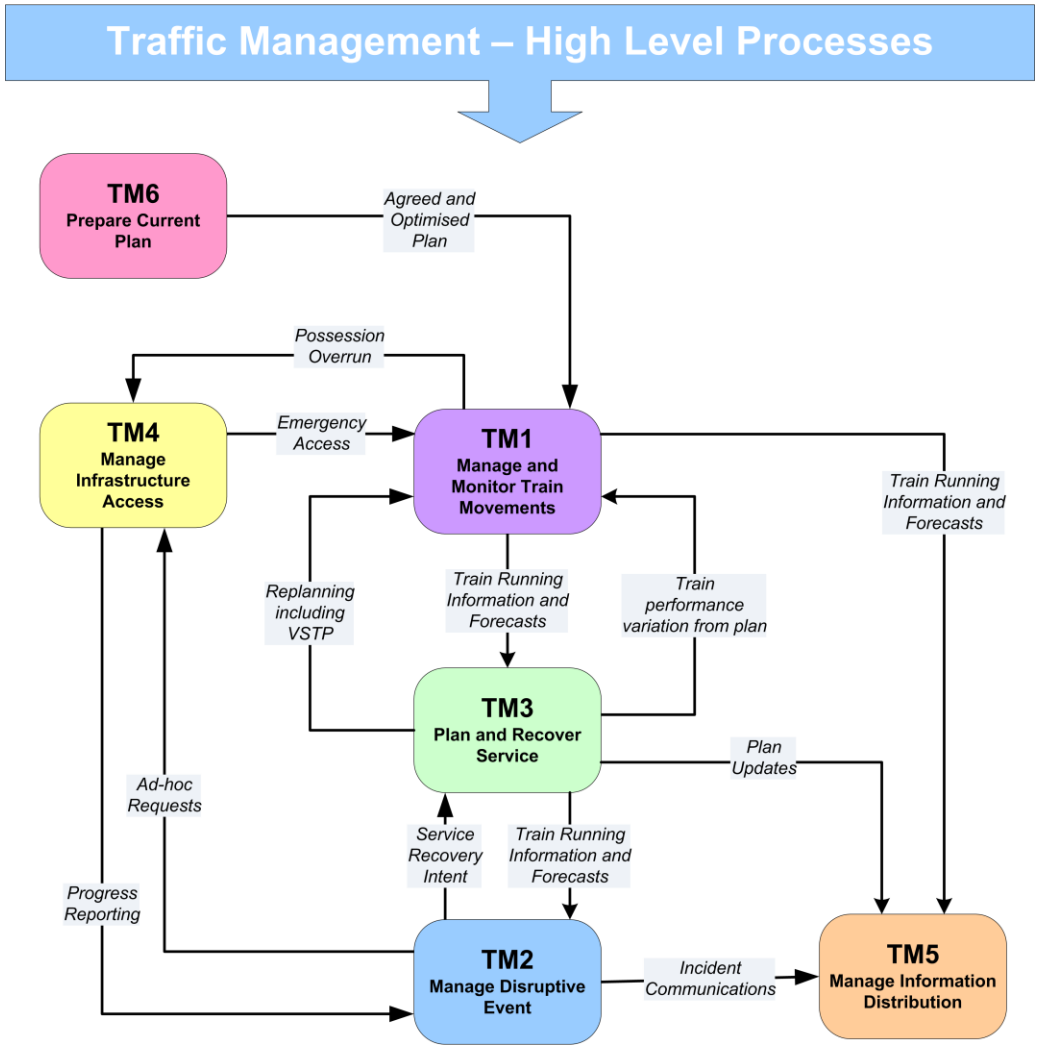
Loading Gauge

Train Operations

What's it all about?

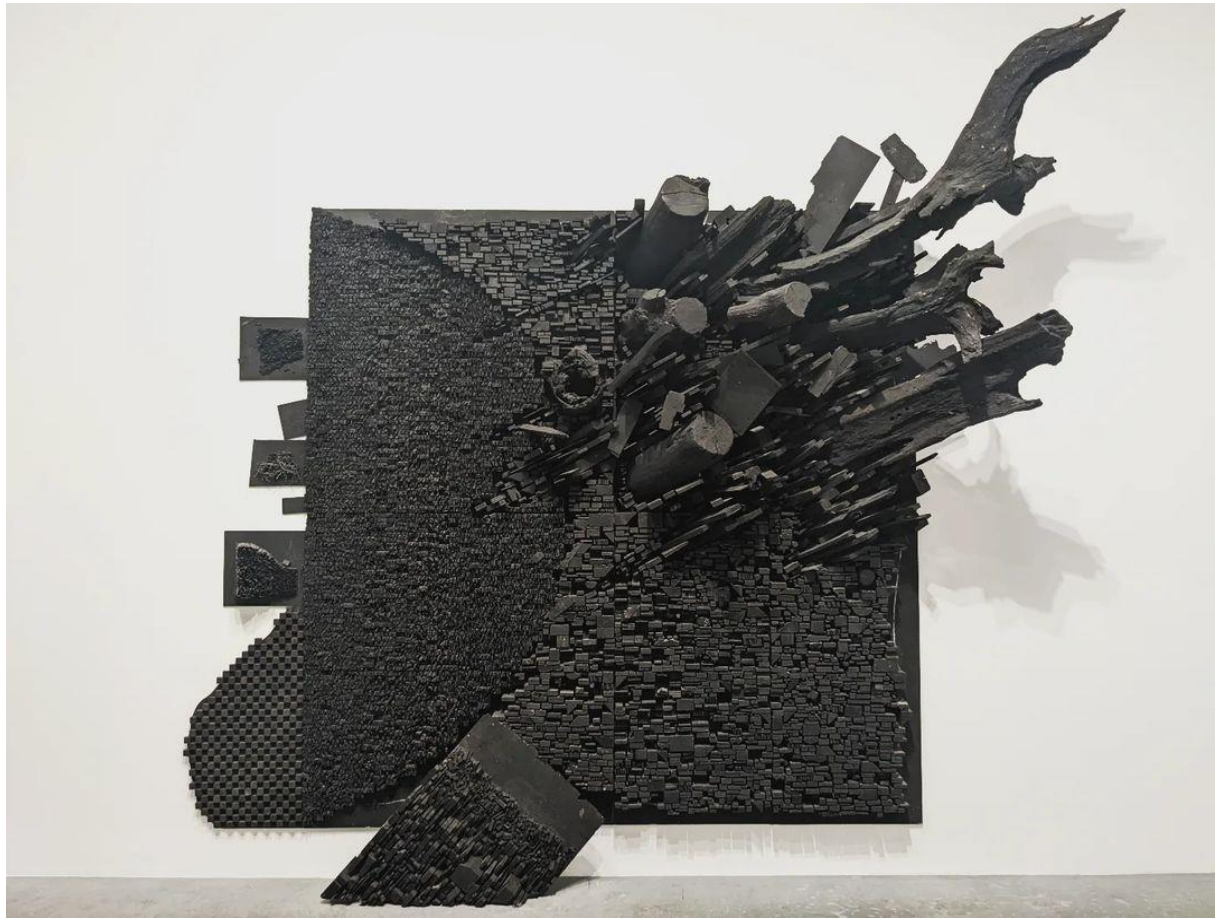


Traffic Management



Operational Control

Emissions



Blah Blah Blah

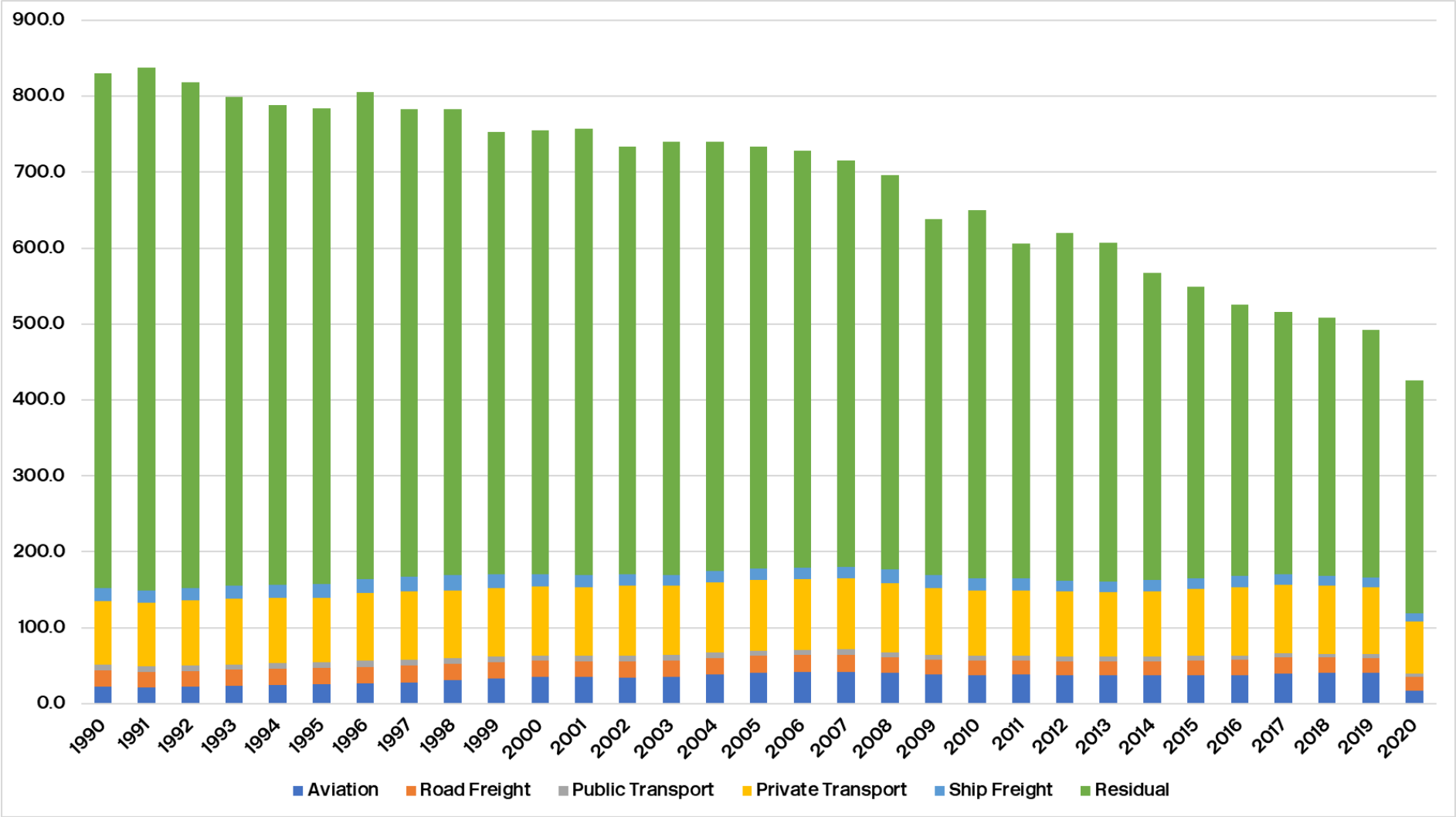
Climate change and environmental degradation are an existential threat to UK, Europe and the world

We need UK rail modal shift to rail freight transport to delivery

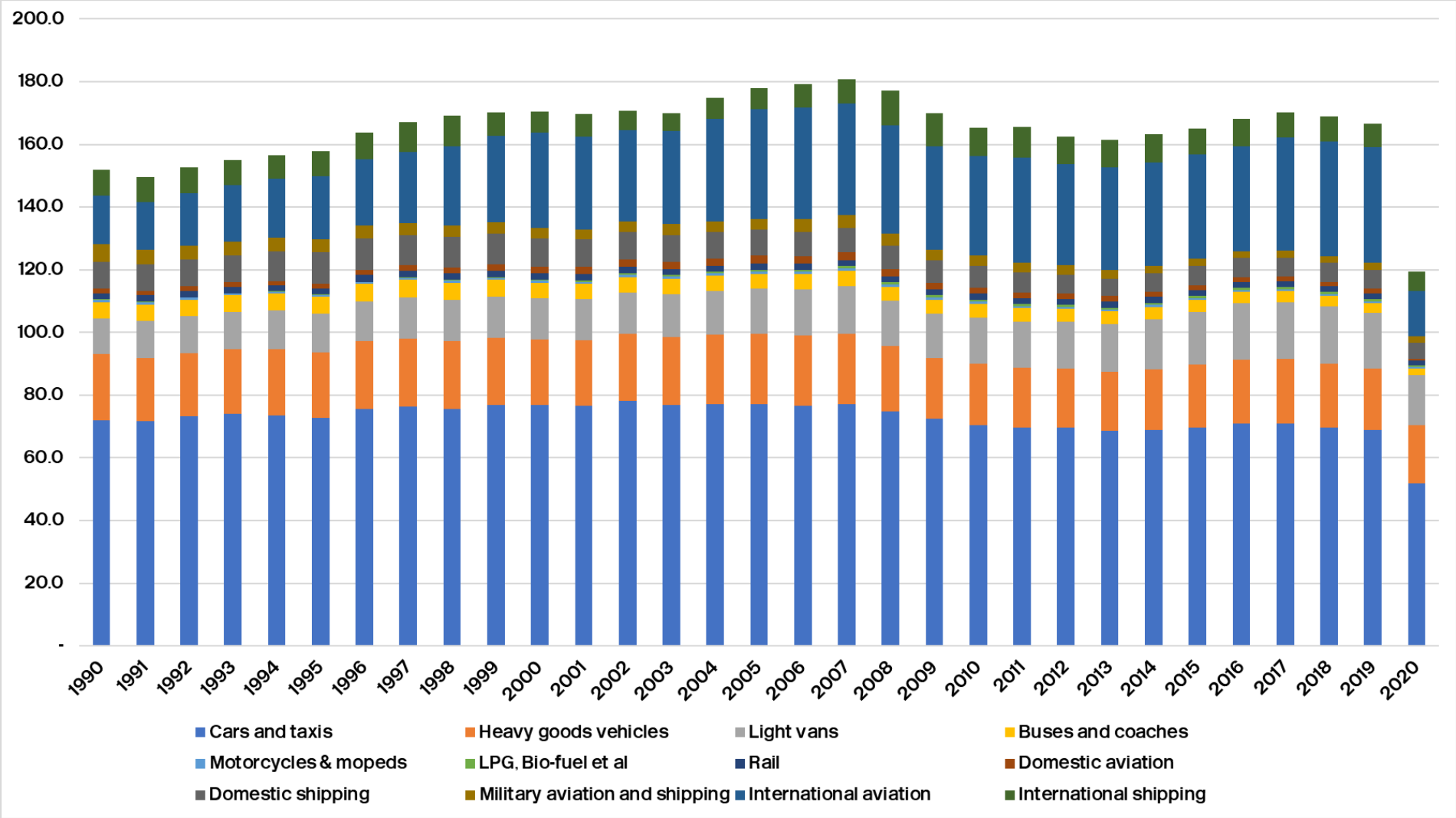
- no net emissions of greenhouse gases by 2050
- economic growth decoupled from resource use
- no person and no place left behind

The European Green Deal, 2019

UK CO_2 Emissions 1990-2020



UK CO_2 Emissions 1990-2020



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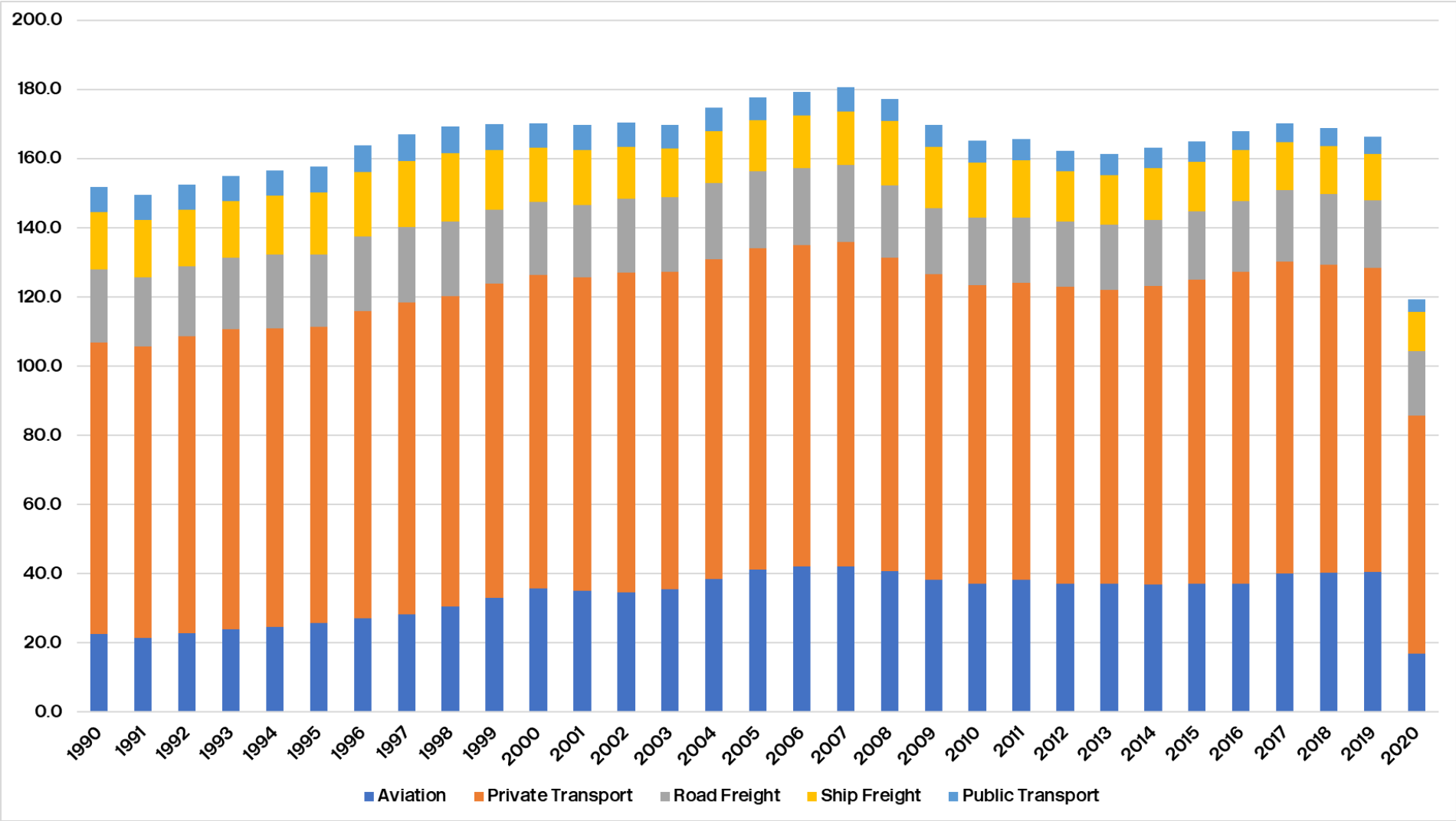

How Does Visualisation Help?

Why Rail Freight?

Green House Gases (CO_2)

UK produced 455 million tonnes CO_2 equivalent (mtCO2e) in 2019

Transport accounted for 122 mtCO2e (26.8%) of which

- HGV 19.5 mtCO2e (16.0%/4.2%)
- All rail 1.7 mtCO2e (1.4%/0.04%)

A freight train removes up to 76 HGVs from our roads

DfT Transport Statistics (2021)

CO_2 Comparison

Activity	Type	kg CO_2 / tonne km	Ratio
Cargo ship	General cargo	0.01323	0.52
Cargo ship	Container ship	0.01614	0.63
Rail	Freight train	0.02556	1.00
All Articulated	50% Laden	0.10775	4.22
All Articulated	100% Laden	0.06713	2.63
All HGVs	50% Laden	0.14606	5.71
All HGVs	100% Laden	0.0882	3.45

UK Government GHG Conversion Factors for Company Reporting

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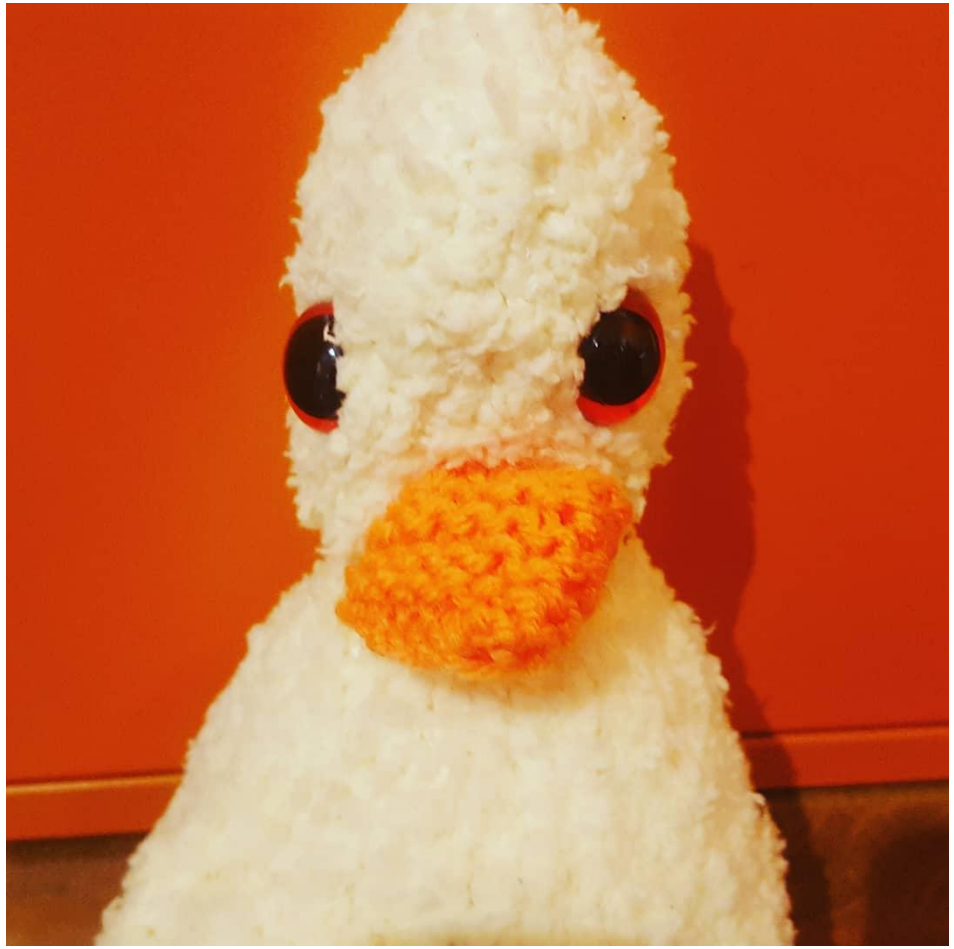
One freight train removes 76 HGVs from our roads

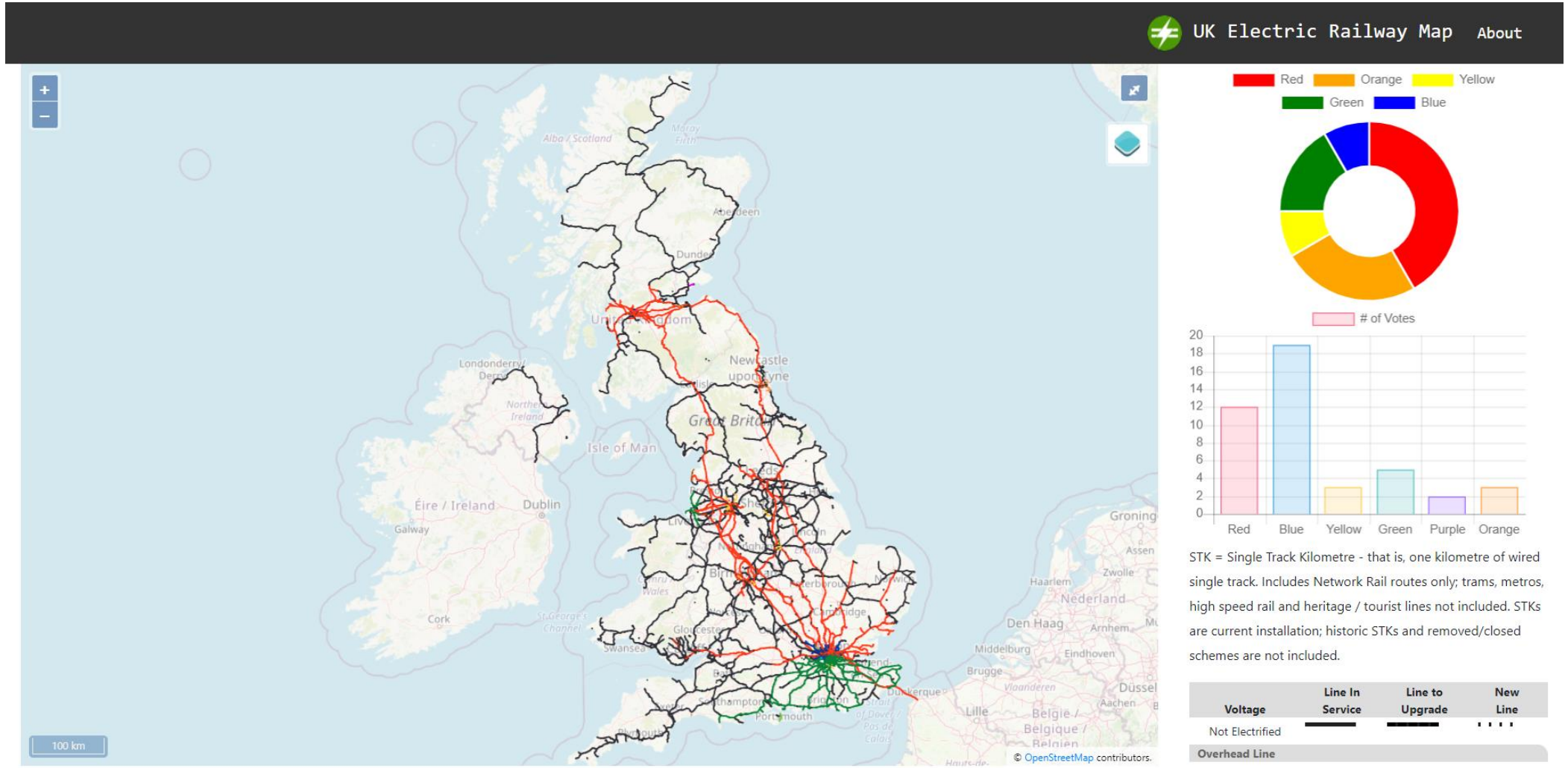
Rail Electrification

Rail Electrification

‘Once upon a time on a hot day in May 2020 amidst a pandemic lockdown, a rail engineer tweeted….’

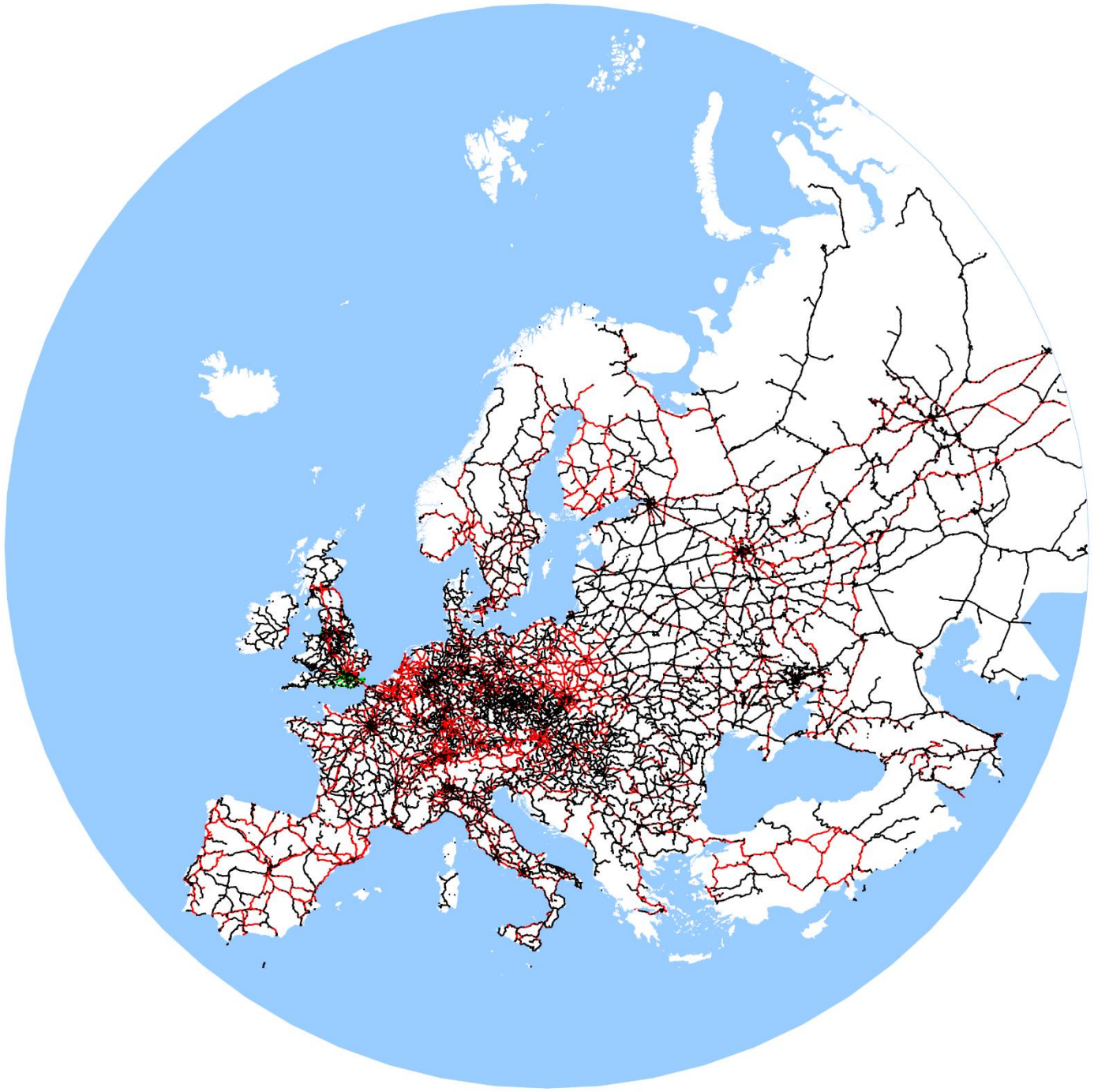


Rail Electrification

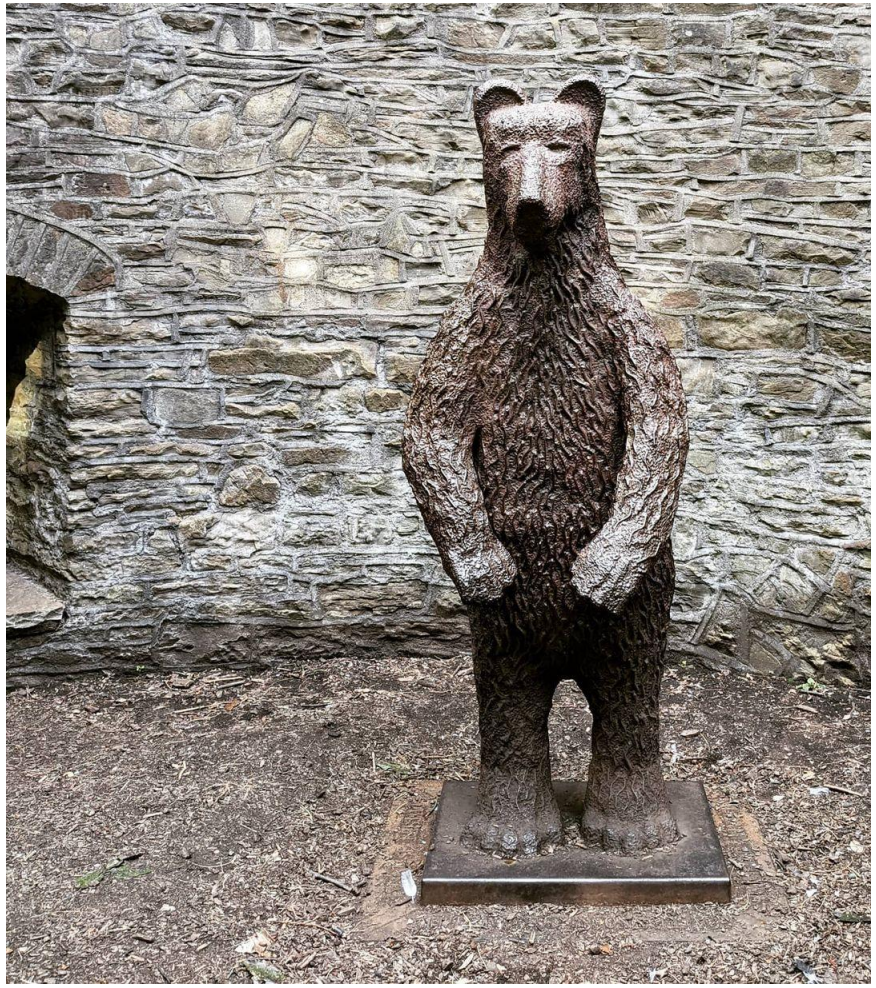


Rail Electrification

A rail map showing European electrification using Open Streetmap Data



Open Rail Data



Time	Destination	Plat	Expe
08:30	Glasgow Queen St	15	On time
08:38	Helensburgh Ctl via	3&4	On time
09:00	London Kings X	2	On time
09:00	Glasgow Queen St	10	On time
09:06	Helensburgh Ctl via	3&4	On time
09:08	Bristol Temple Mds	11	On time
09:10	Aberdeen	19	On time
09:11	Tweedbank	–	On time
09:15	Aberdeen	17	On time

Page 1 of 1

08:28:28

Online Links

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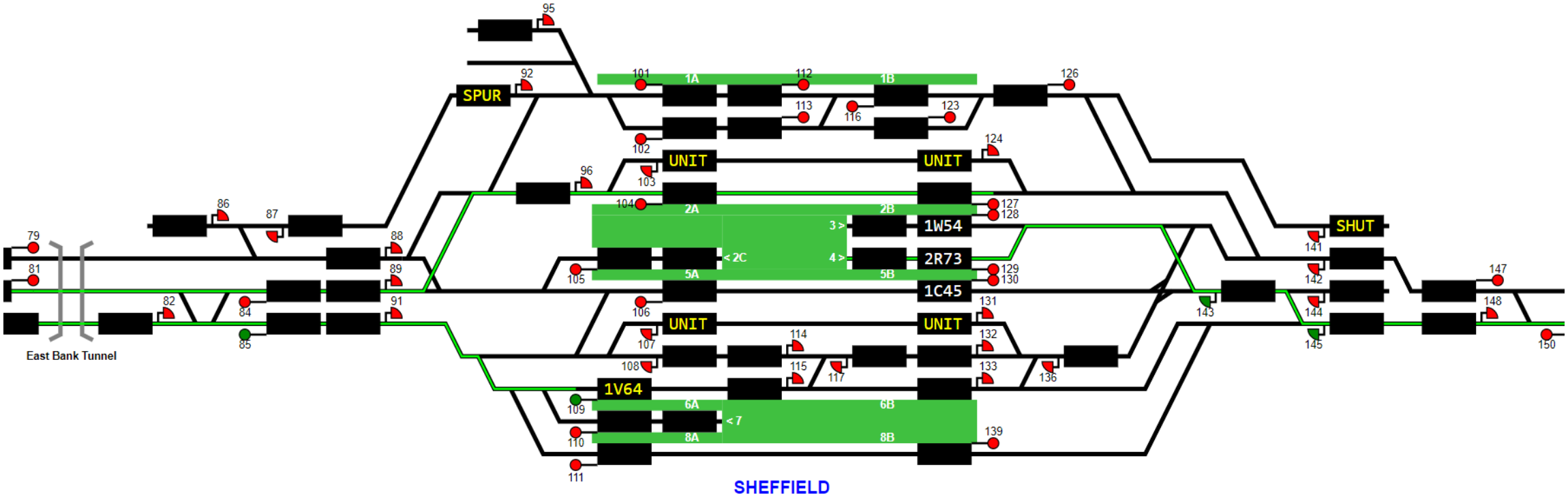
[Realtime Trains - Sheffield]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East Bank Tunnel
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SHEFFIELD

Future industrial action (2) Show all

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Single from £41.90

Based on 1 adult

Dep. From	Dur. Chg.	Arr. To	Status		
Departs at 17:10 Sheffield [SHF] Platform 1B	2h 25m 1 change(s) view details	Arrives 19:35 London Kings Cross [KGX] Buy from Greater Anglia	disrupted Alternative trains	£110.30 Off-Peak	Buy Now Other tickets Other services you can travel on
Departs at 17:28 Sheffield [SHF] Platform 5	2h 11m 0 change(s) view details	Arrives 19:39 London St Pancras International [STP] Platform 3 Buy from East Midlands Railway	on time	£89.00 Off-Peak	Buy Now Other tickets Other services you can travel on
Departs at 17:51 Sheffield [SHF] Platform 2	2h 18m 0 change(s) view details	Arrives 20:09 London St Pancras International [STP]	on time	£89.00 Off-Peak	Buy Now Other tickets

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SHEFFIELD LIVE DEPARTURES

SIMPLE | DETAILED

-1 hour | +1 hour

STP	Plan Arr	Act Arr	Origin	Pl	ID	TOC	Destination		Plan Dep	Act Dep	
WTT	1630	**1631¼**	Lincoln Central	3	2P25	NT	Terminates here				3
WTT			Starts here	4	2N64	NT	Leeds	At platform	1631	*1631*	
WTT	1634	**1635¼**	Huddersfield	1	2P26	NT	Terminating short here Originally Lincoln Central		1637	Cancel	
WTT	1636	**1637¾**	Peterborough	7	1R62	EM	Liverpool Lime Street		1639	**1641¾**	4
WTT			Starts here	3	2B54	NT	Huddersfield		1639	**1639½**	3
WTT	1639	*1714*	Liverpool South Parkway	*1B*	1L13	EM	Norwich		1643	*1719*	4
WTT			Starts here	4	2L14	NT	Leeds		1644	**1644**	2
WTT	1649	**1652**	Scarborough	3	1J13	NT	Terminates here				2
WTT			Starts here	2	1C42	EM	St Pancras International		1651	**1651½**	5
VAR	1652	**1654½**	Edinburgh	6	1V64	XC	Birmingham New Street		1656	**1658**	8
WTT	1656	**1659¾**	Leeds	4	2N15	NT	Terminates here				2
WTT	1705	*1704*	Manchester Piccadilly	*2*	2S86	NT	Terminates here				4
WTT	1706	Cancel	Leeds	-	1Y45	NT	Nottingham		1706	Cancel	
VST	1703½	*1705*	Leeds		5Y45	NT	Nottingham		1706	*1707*	
WTT			Starts here	4	2R73	NT	Doncaster	At platform	1706	*1706*	2
VST	1701	*1709*	Manchester Piccadilly		1Z14	EM	Nottingham		1706	*1712*	8
WTT	1708	*1740*	Liverpool South Parkway	*1*	1B84	TP	Cleethorpes		1710	*1742*	6
WTT	1709	*1709*	Cleethorpes	*6A*	1B85	TP	Liverpool Lime Street		1711	*1711*	6
WTT	1714	*1713*	Doncaster	*4A*	2R21	NT	Terminates here				2
WTT			Starts here	*2*	2S89	NT	Manchester Piccadilly		1714	*1714*	4
WTT	1714	*1712*	Nottingham	*1B*	1Y44	NT	Leeds		1717	*1717*	4
VAR	1718	*1721*	Birmingham New Street	*2*	1S51	XC	Edinburgh		1721	*1723*	5
WTT			Starts here	3	1W54	NT	Scarborough	At platform	1725	*1725*	2

A Very European Railway

High-Speed Rail

Integrated dedicated tracks and specialised rolling stock to enable faster than traditional rail

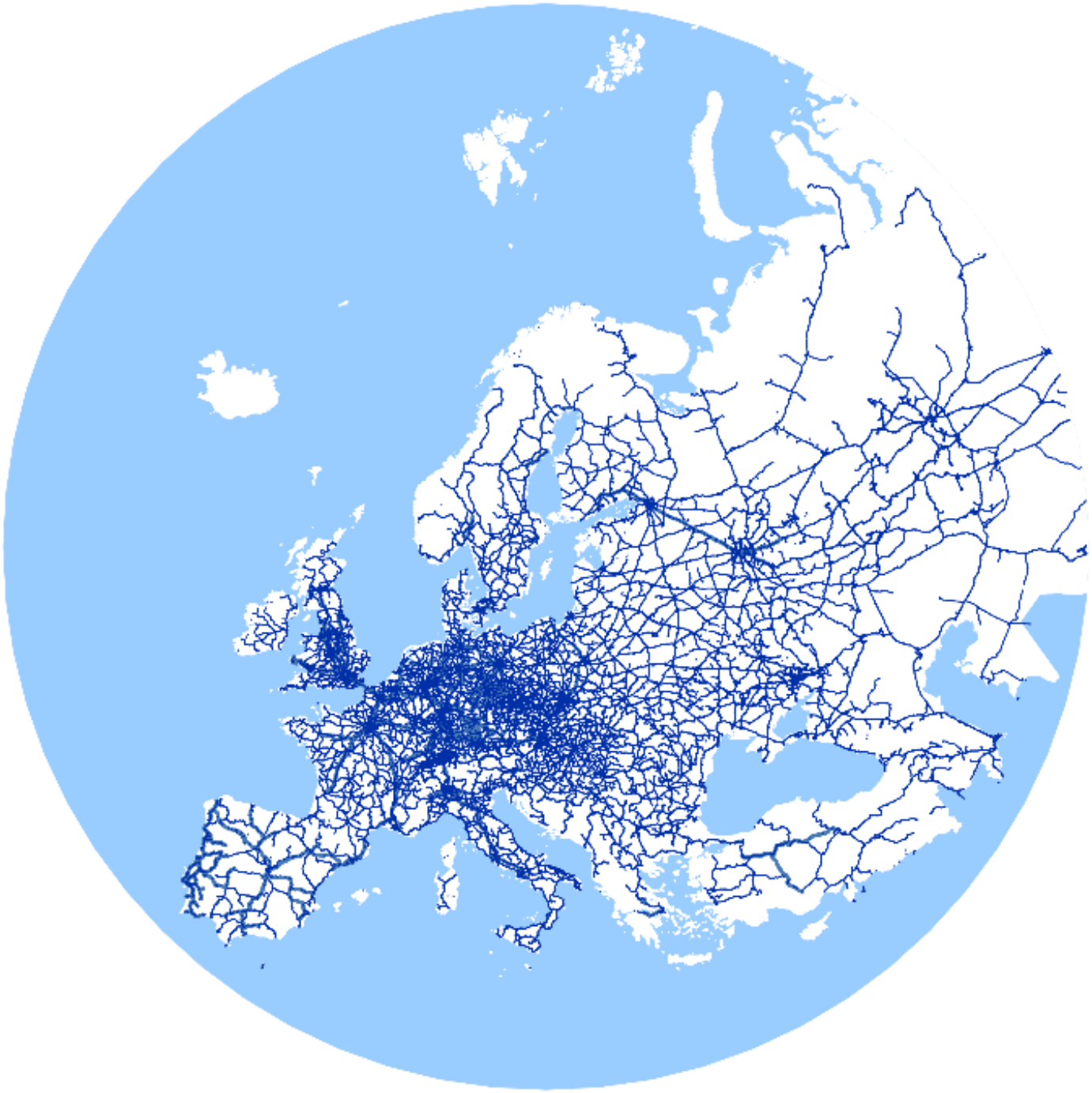
High-speed permitted line speeds:

- by design 250 km/h
- through upgrade 200 km/h

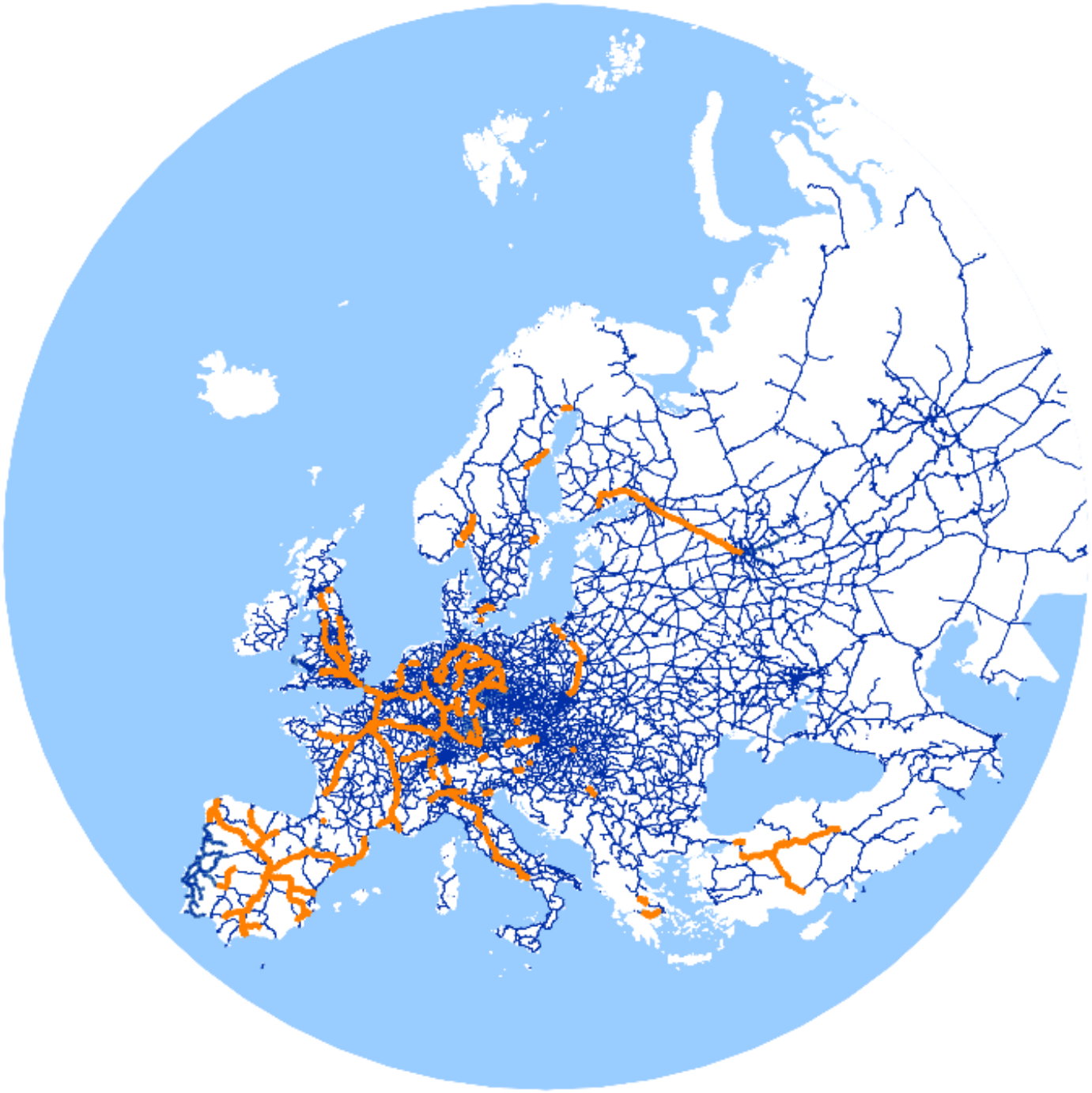
Rail

Omsk
Tyumen
Yekaterinburg
Chelyabinsk
Izhevsk
Ufa
Saint Petersburg
Kazan
Nizhny Novgorod
Helsinki
Yaroslavl
Tolyatti
Samara
Oslo
Stockholm
MOSCOW
Riga
Saratov
Glasgow
Newcastle upon Tyne
Copenhagen
Minsk
Voronezh
Dublin
Leeds
Gdansk
Volgograd
Nottingham
Hamburg
Sheffield
Kharkiv
Astrakhan
Rotterdam [The Hague]
Amsterdam
Poznan
Warsaw
Kyiv
Bristol
Brussels
Dusseldorf
Berlin
Lodz
Dnipro
Donetsk
Rostov-on-Don
Lviv
Lille
Cologne
Dresden
Wroclaw
Krakow
Kryvyi Rih
Zaporizhzhia
Makhachkala
Nuremberg
Prague
Krasnodar
Odesa
Baku
PARIS
Stuttgart
Munich
Vienna
Tbilisi
Budapest
Zurich
Yerevan
Lyon
Zagreb
Milan
Belgrade
Bucharest
Bordeaux
Turin
Genoa
Samsun
Bilbao
Toulouse
Nice
Sofia
Porto
Marseille
ISTANBUL
İzmit
Ankara
Diyarbakir
Zaragoza
Rome
Tirana
Madrid
Bursa
Kayseri
Gaziantep
Lisbon
Barcelona
Naples
Thessaloniki
Konya
Adana
Valencia
Izmir
Denizli
Athens
Mersin
Seville
Antalya
Palermo
Malaga

Rail



Rail



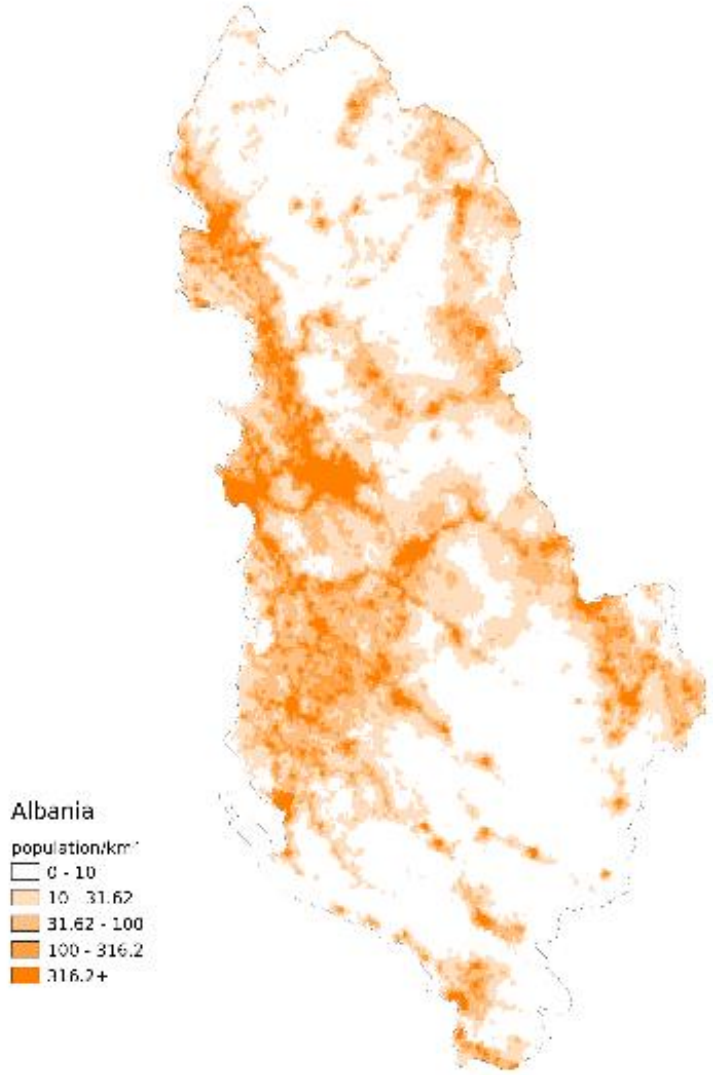
How I

WorldPop

WorldPop

Open subnational population data

- country boundaries
- 1km^2 unconstrained data



Urban

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Izhevsk
Ufa
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Helsinki
Saint Petersburg
Yaroslavl
Tolyatti
Samara
Stockholm
Riga
Nizhny Novgorod
Oslo
MOSCOW
Saratov
Glasgow
Newcastle upon Tyne
Copenhagen
Mirisk
Voronezh
Gdansk
Liverpool
Manchester
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Volgograd
Sheffield
Birmingham
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Astrakhan
Dublin
Leeds
Nottingham
Hanover
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Poznan
Warsaw
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Bristol
Antwerp
Lille
Katowice
Dnipro
Donetsk
Lviv
Kryvyi Rih
Rotterdam [The Hague]
Berlin
Wroclaw
Rostov-on-Don
Makhachkala
Nuremberg
Krasnodar
Brussels
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Dresden
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Málaga
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Denizli
Izmir
Mersin
Antalya

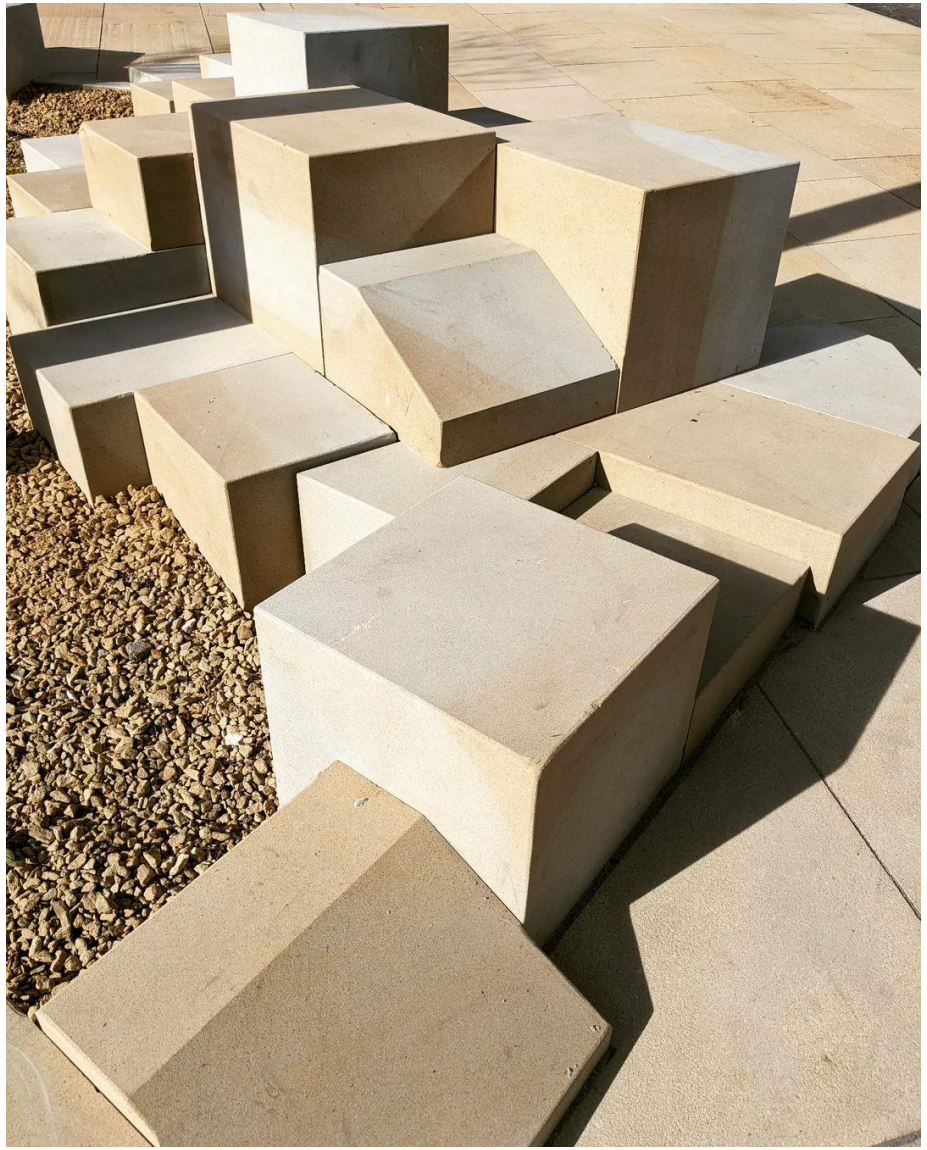
Urban GHSL

Urban

- 50k population
- 1 500 population/km^2

Sub-Urban

- 5k population
- 300 population/km^2

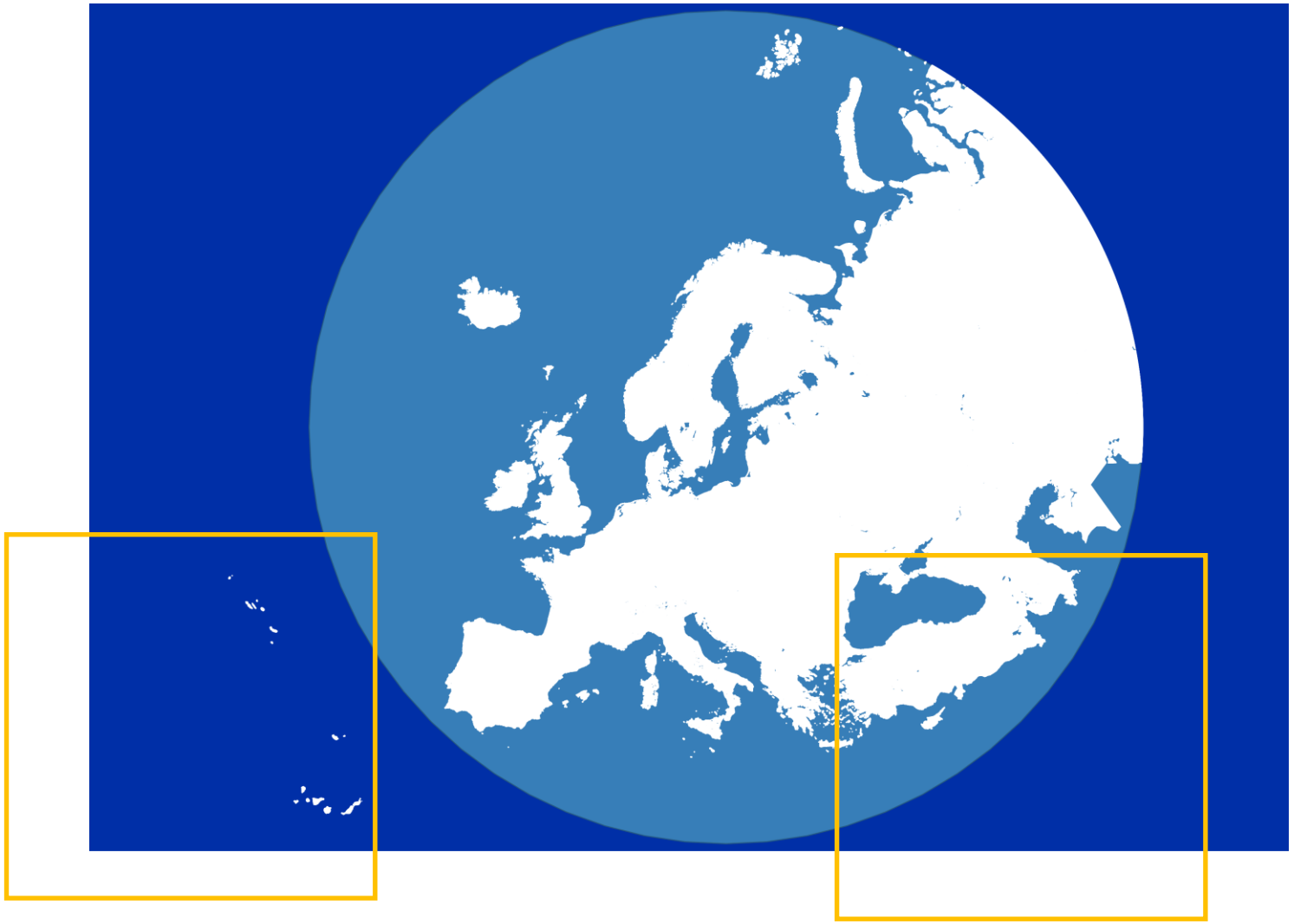


How II

Europe

Where is Europe?

Europe



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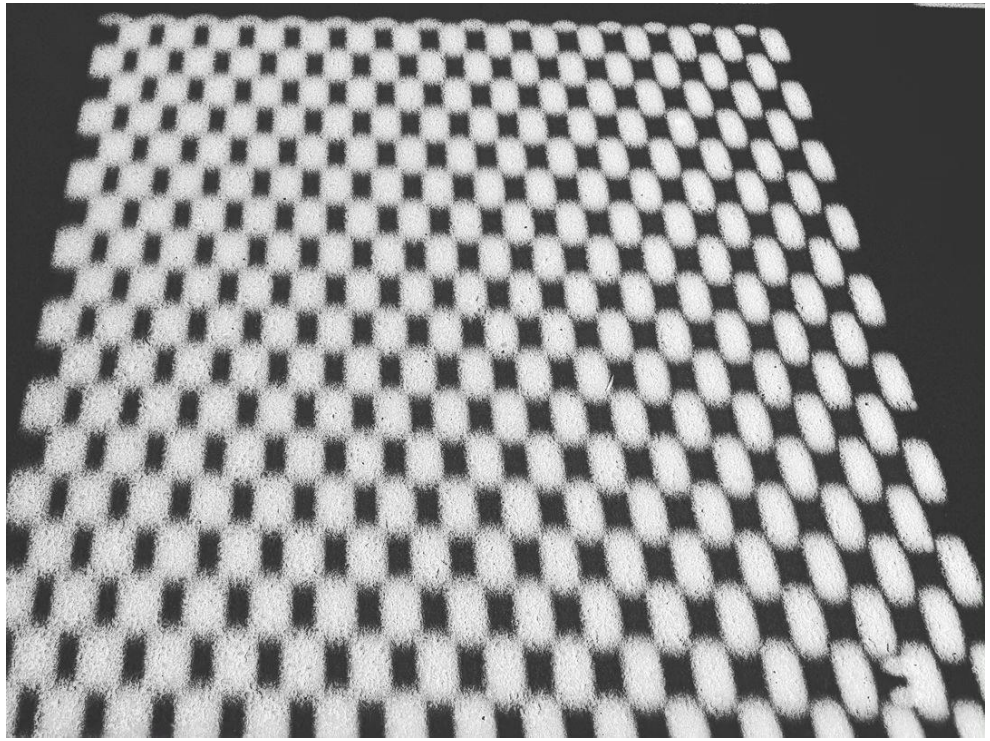

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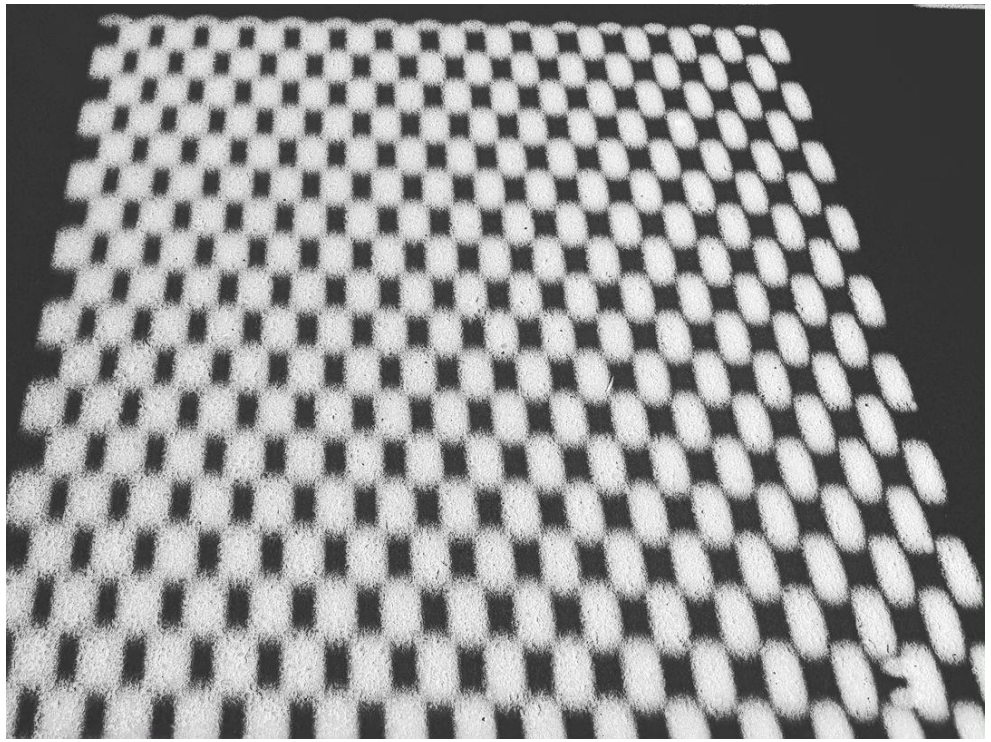

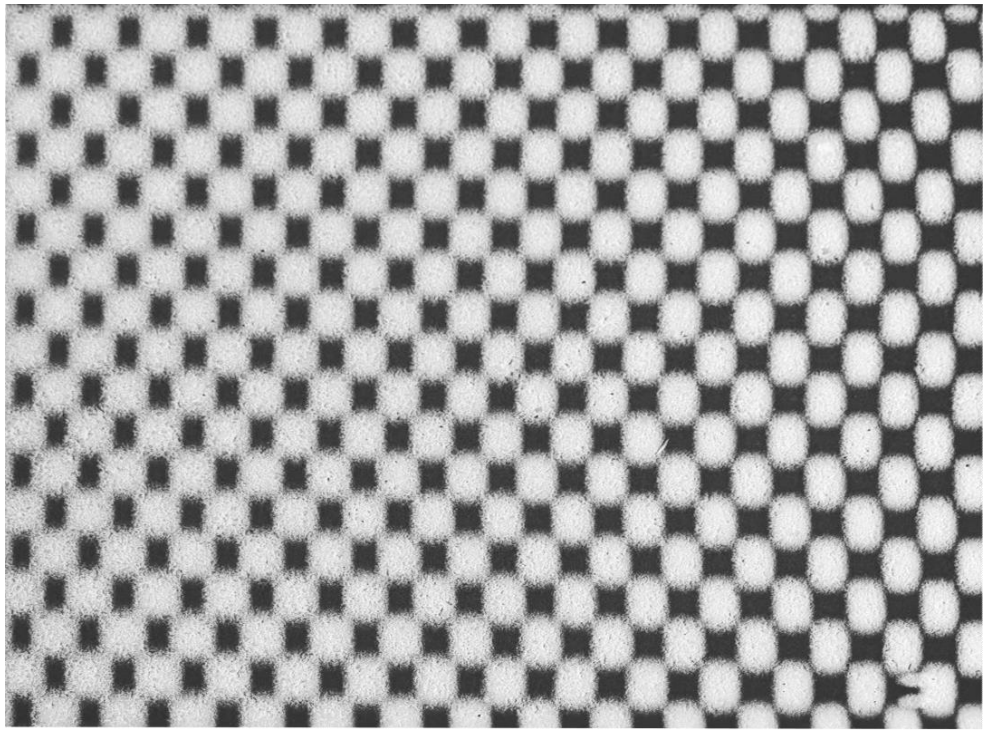

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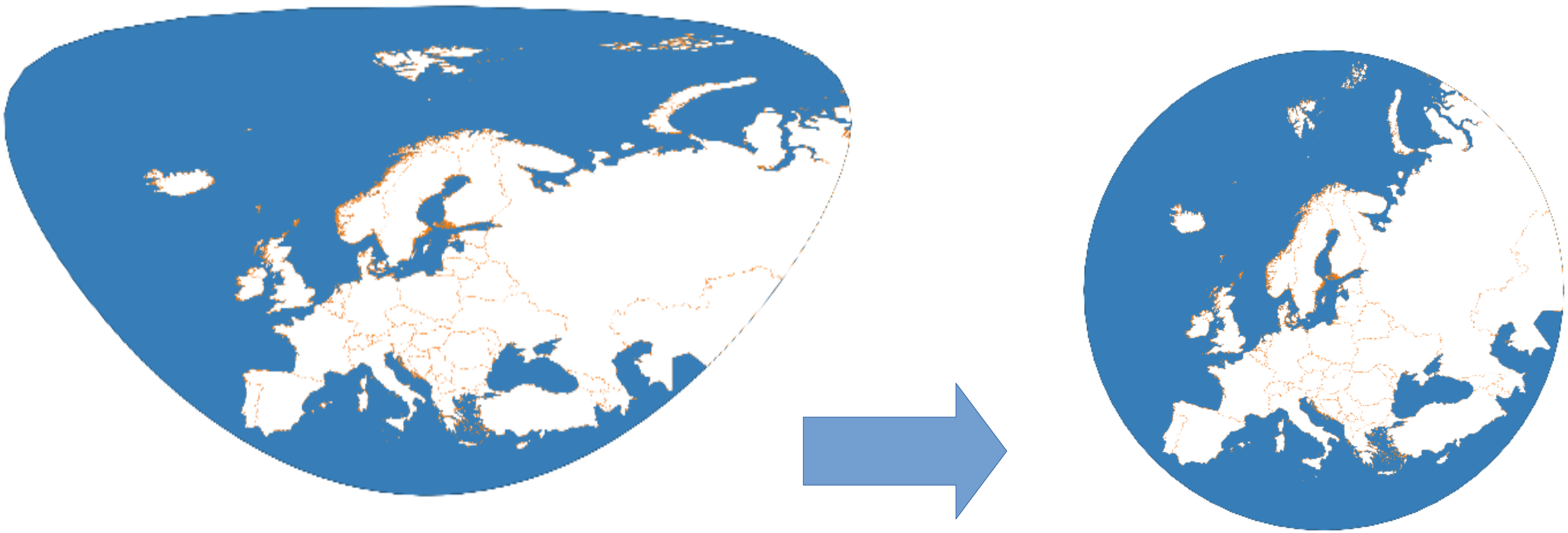


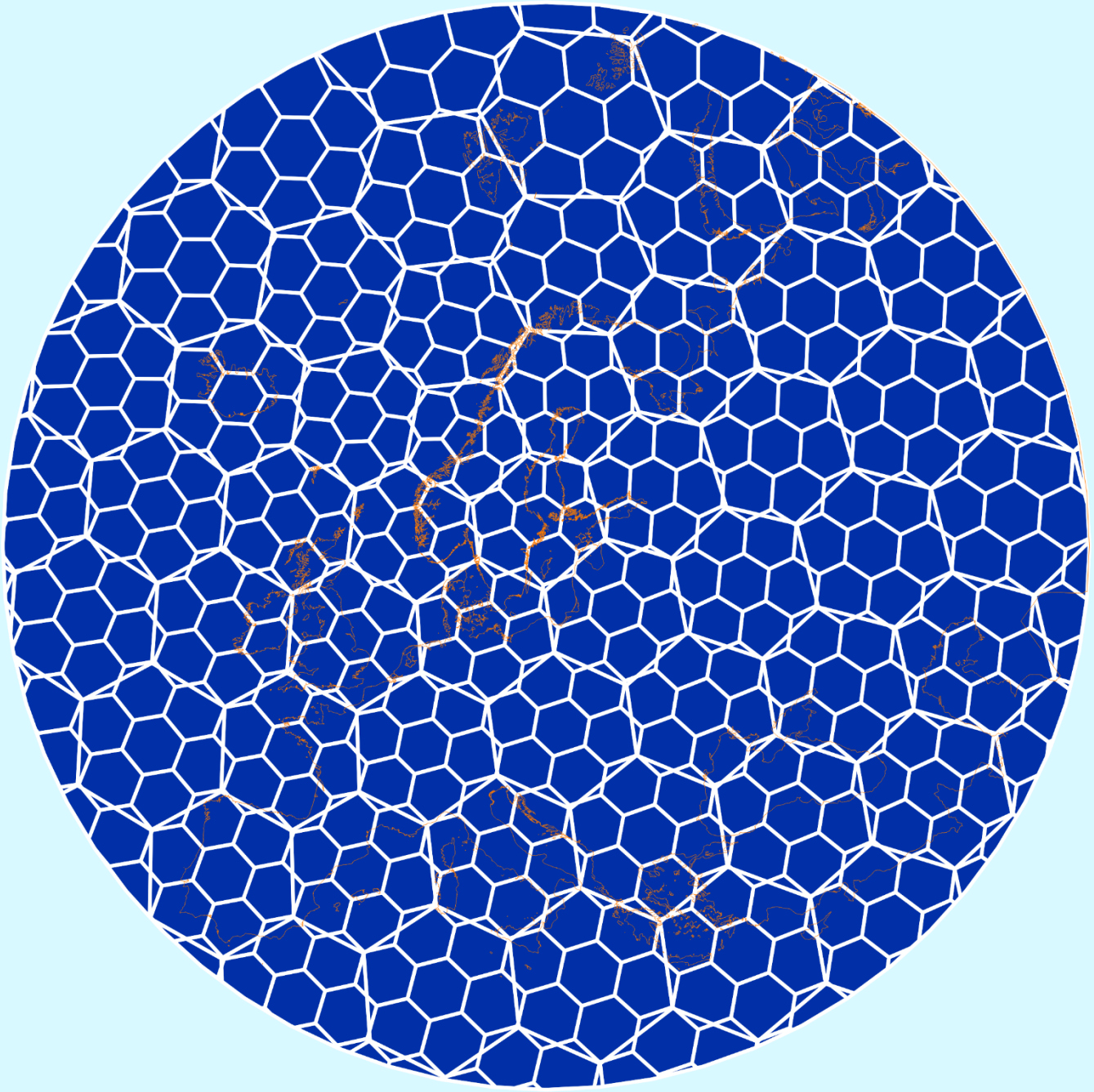
How IIII

Hexagons

Hexagons

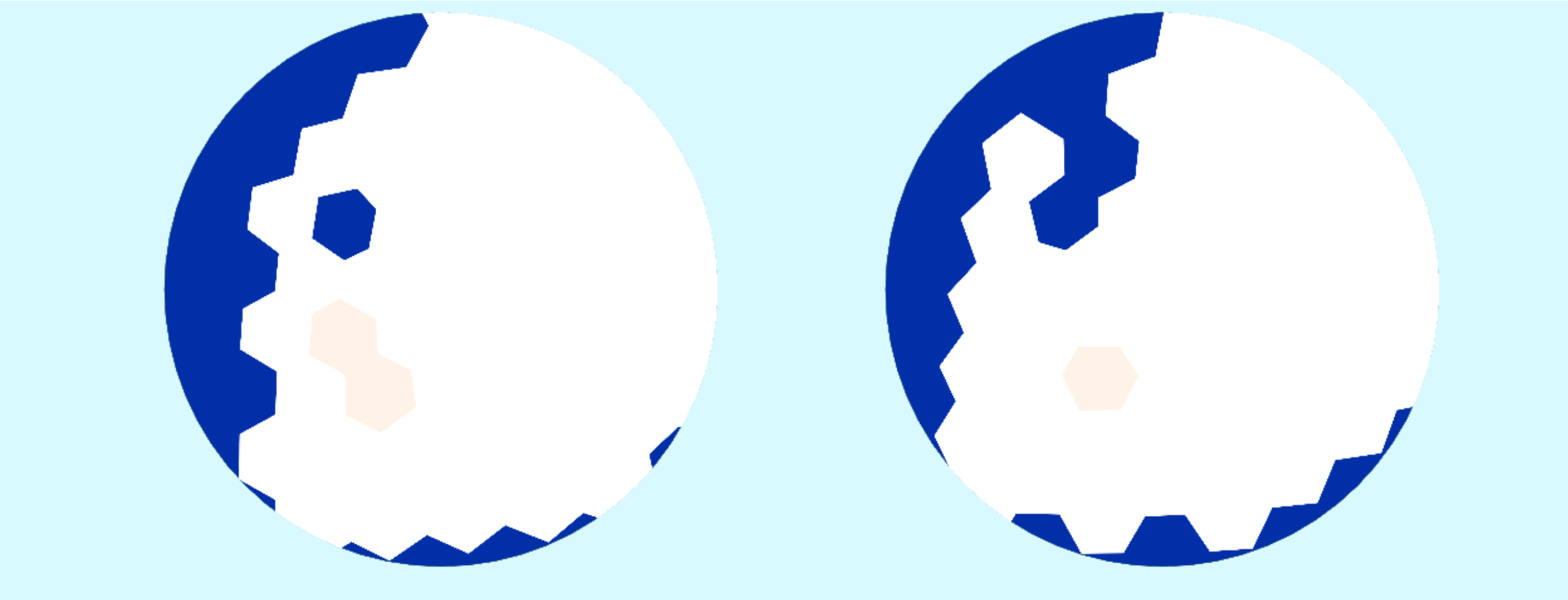
Hexagons

Hexagons



Part I

Population



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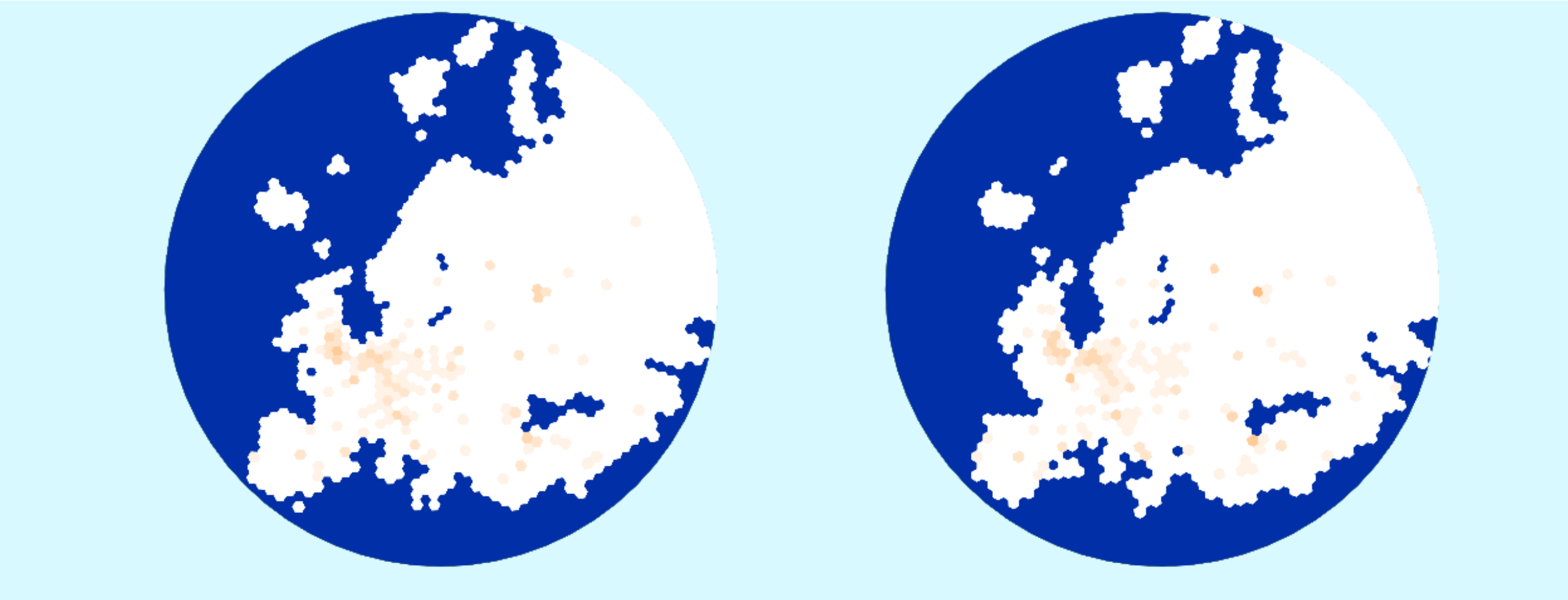

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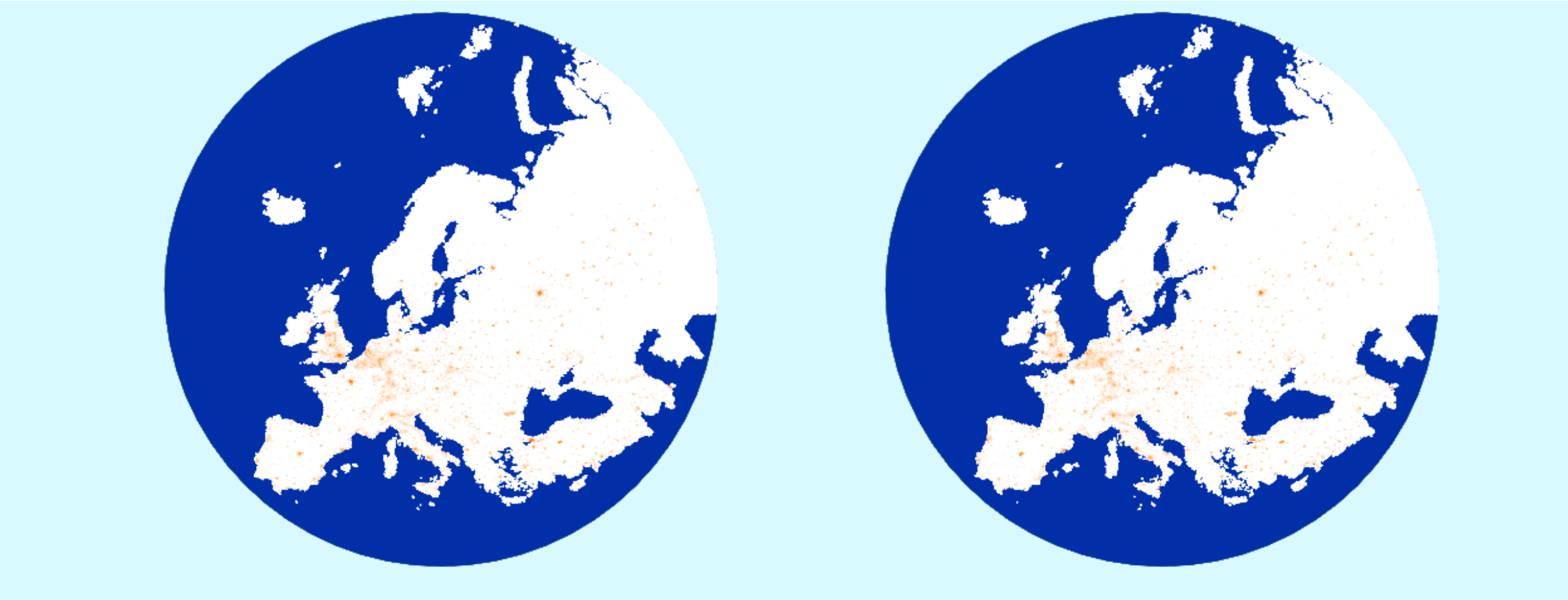
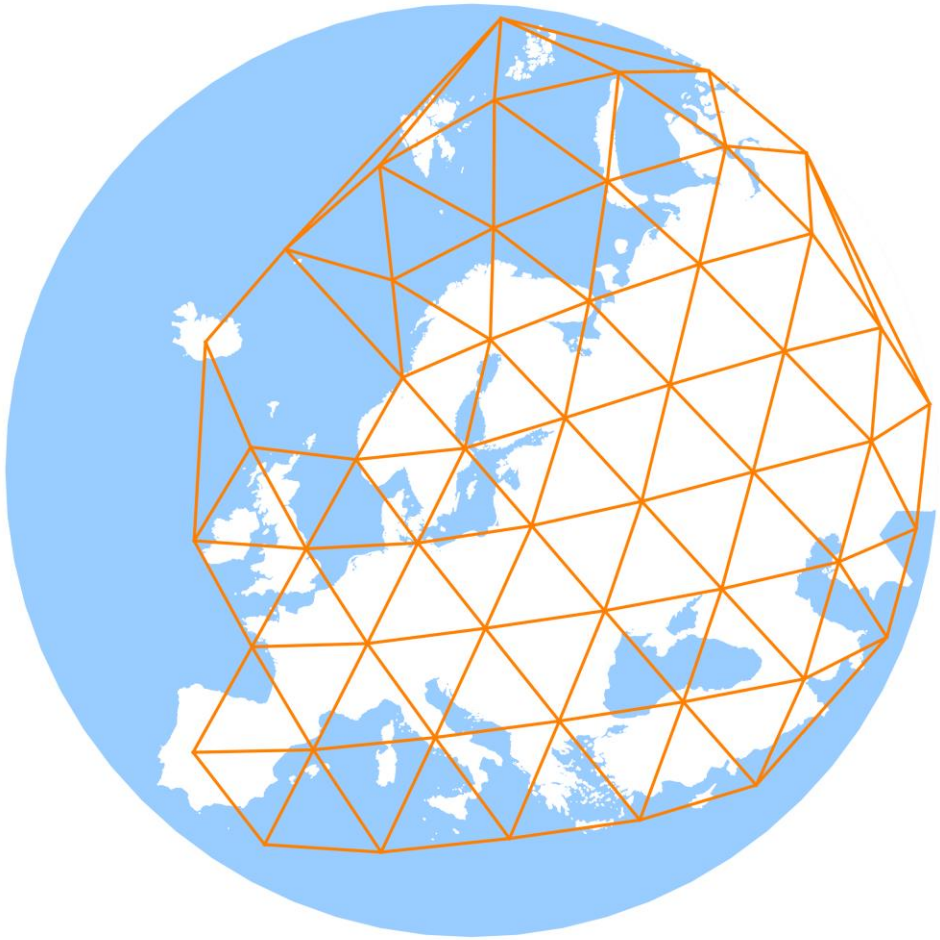
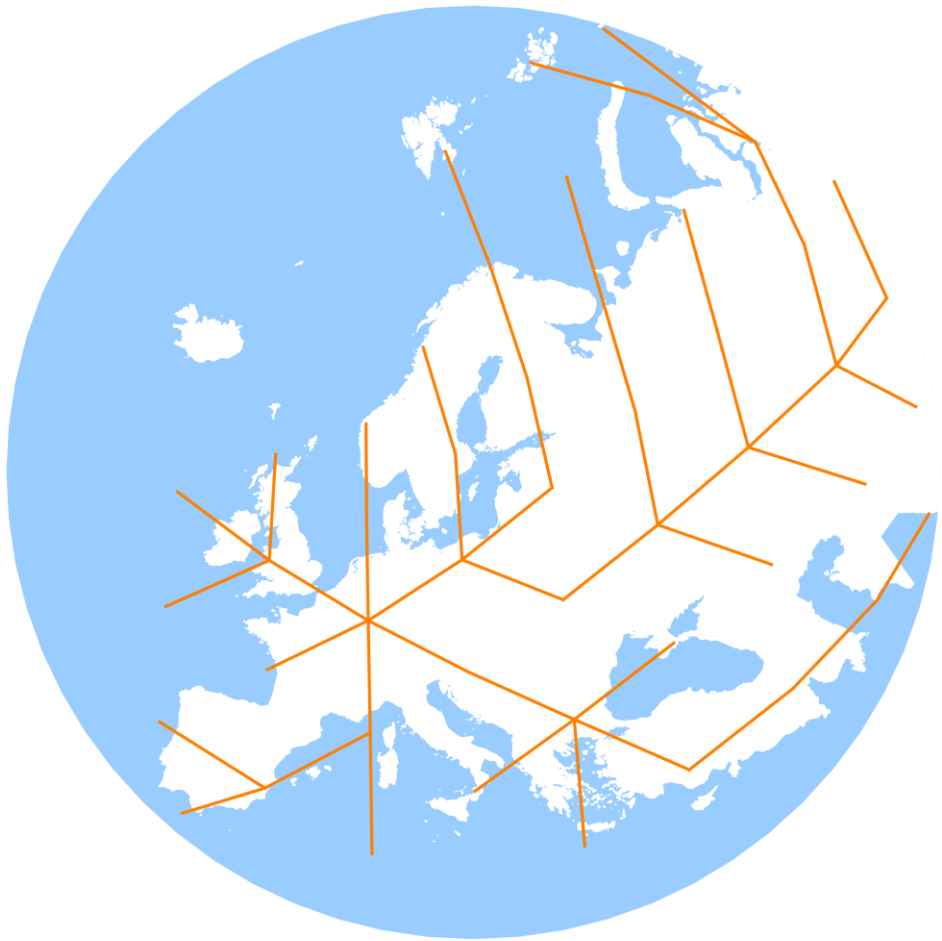


How V

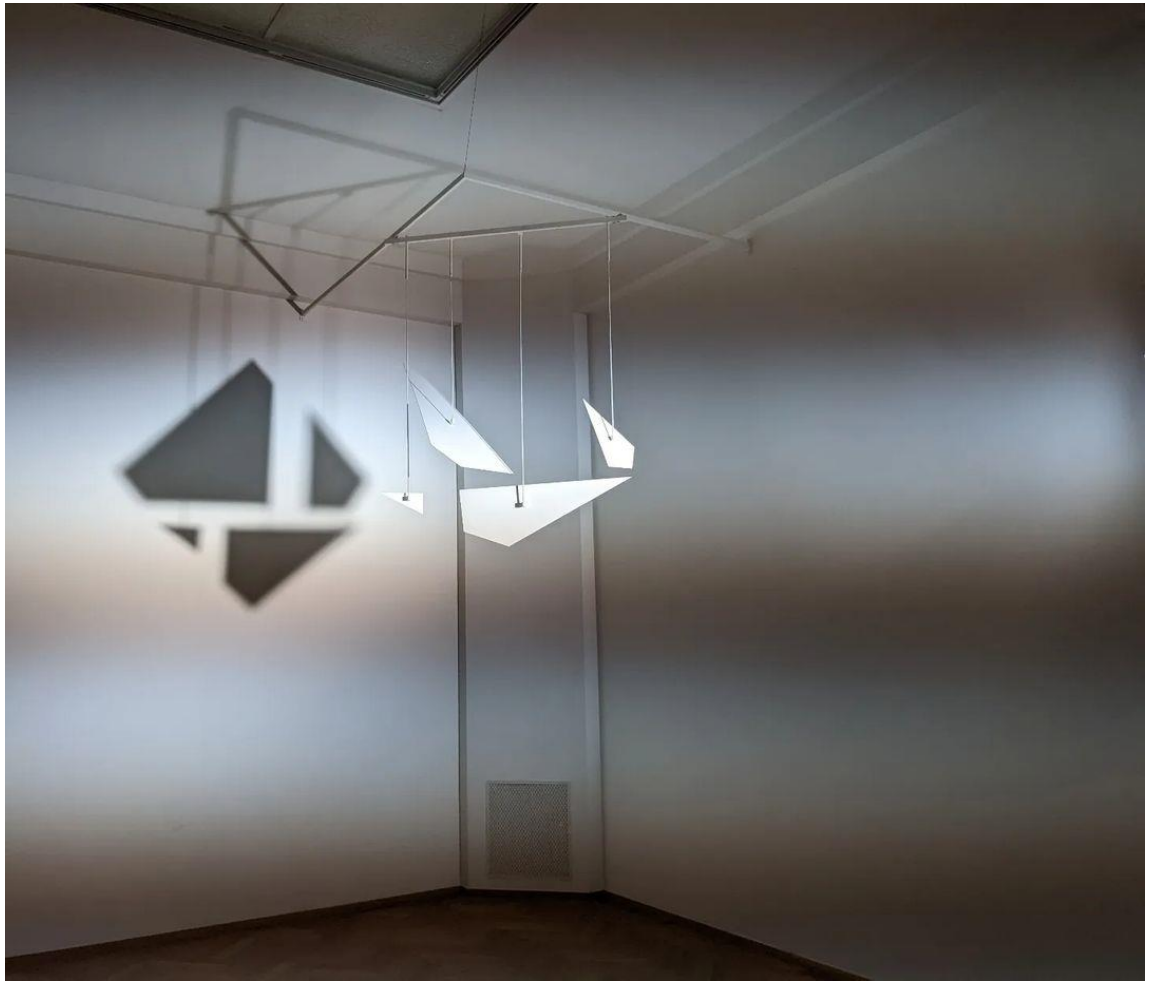
Delaunay Mesh



Spanning Tree



Part II



Tree
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Tree
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How VI

Labels

Novy Urengoy
Nizhnevartovsk
Murmansk
Yugorsk
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Serov
Reykjavik
Severodvinsk
Arkhangelsk
Kurgan
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Part IIII

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Insights from Raw Data

15 Seconds of Fame

Citylab | MapLab

Nine Maps Show How Britain Is on the Move

A new dataset allows anyone to explore almost 1 billion journeys from every one of its more than 2,500 train stations.

By Conrad Quilty-Harper and Patricia Suzara

8 February 2024 at 05:01 GMT

Save Listen 5:03

Sign up for MapLab, CityLab's monthly newsletter about maps that reveal and shape urban spaces.

When he started playing with Great Britain's train data, Will Deakin didn't intend to create a monster.

Poor Northern Rail Links

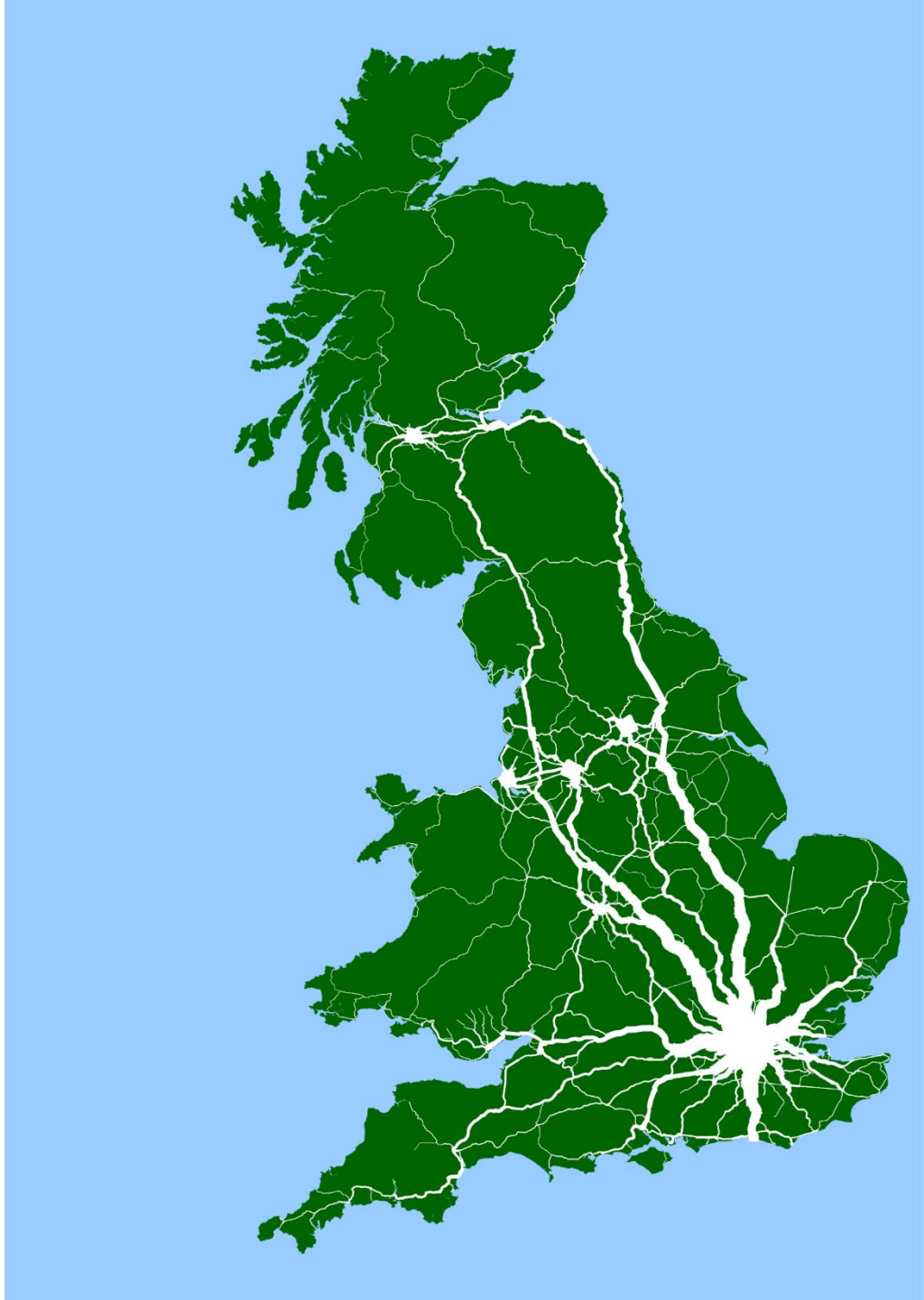
Deakin says the thinner lines between northern cities reflect lower capacity

Manchester Piccadilly

Leeds Central

In the beginning

“Over a weekend Deakin collected several open datasets about travel on the national rail network and combined them into a series of some 2,500 maps, one for every rail station, depicting 894 million journeys. The width of each line shows the frequency of travel between two points. So the result shows a rough approximation of how millions of people used the country’s near 10,000 miles (16,000 kilometers) of track in the 2021-2022 financial year.”



In Media Res?

Distances

FoI centre-line track-model to find the shortest-path distance between ORR passenger-flow stations

How hard could it be?

Passenger Origin Destination Matrix

Rail Data Market Place data set
Financial Year 2018-19
1,534,186 line Comma Separated Variable (CSV) file
Origin and Destination by Computer Reservation System (CRS) code

File Edit View Search Terminal Help

```
Financial_Year,origin_nlc,origin_station_name,origin_station_group,origin_region,destination_nlc,destination_station_name,destination_station_group,destination_region,journeys
20182019,375,Energlyn and Churchill Park,,Wales,577,Farringdon,LONDON BR,London,3
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20182019,375,Energlyn and Churchill Park,,Wales,3030,Didcot Parkway,,South East,3
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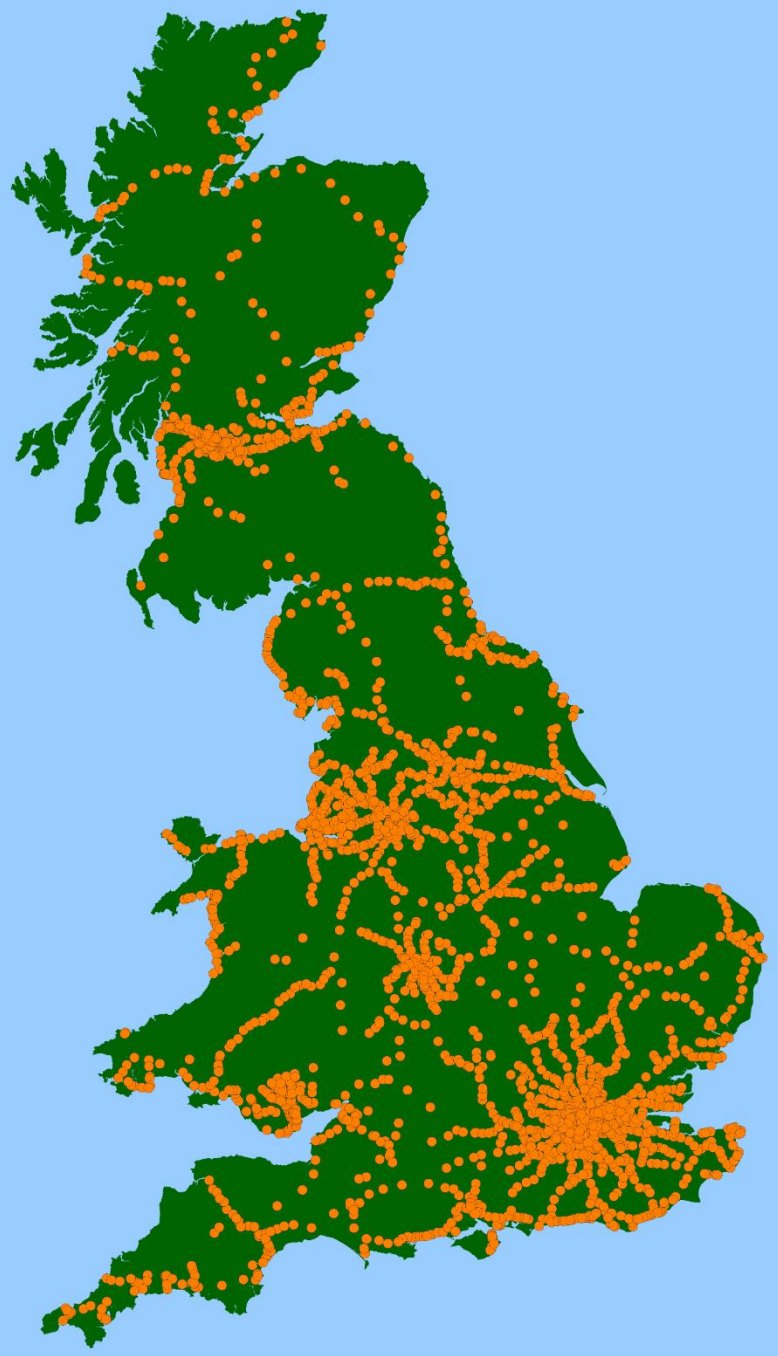
Wrinkles and Data Wrangling

Add station point locations

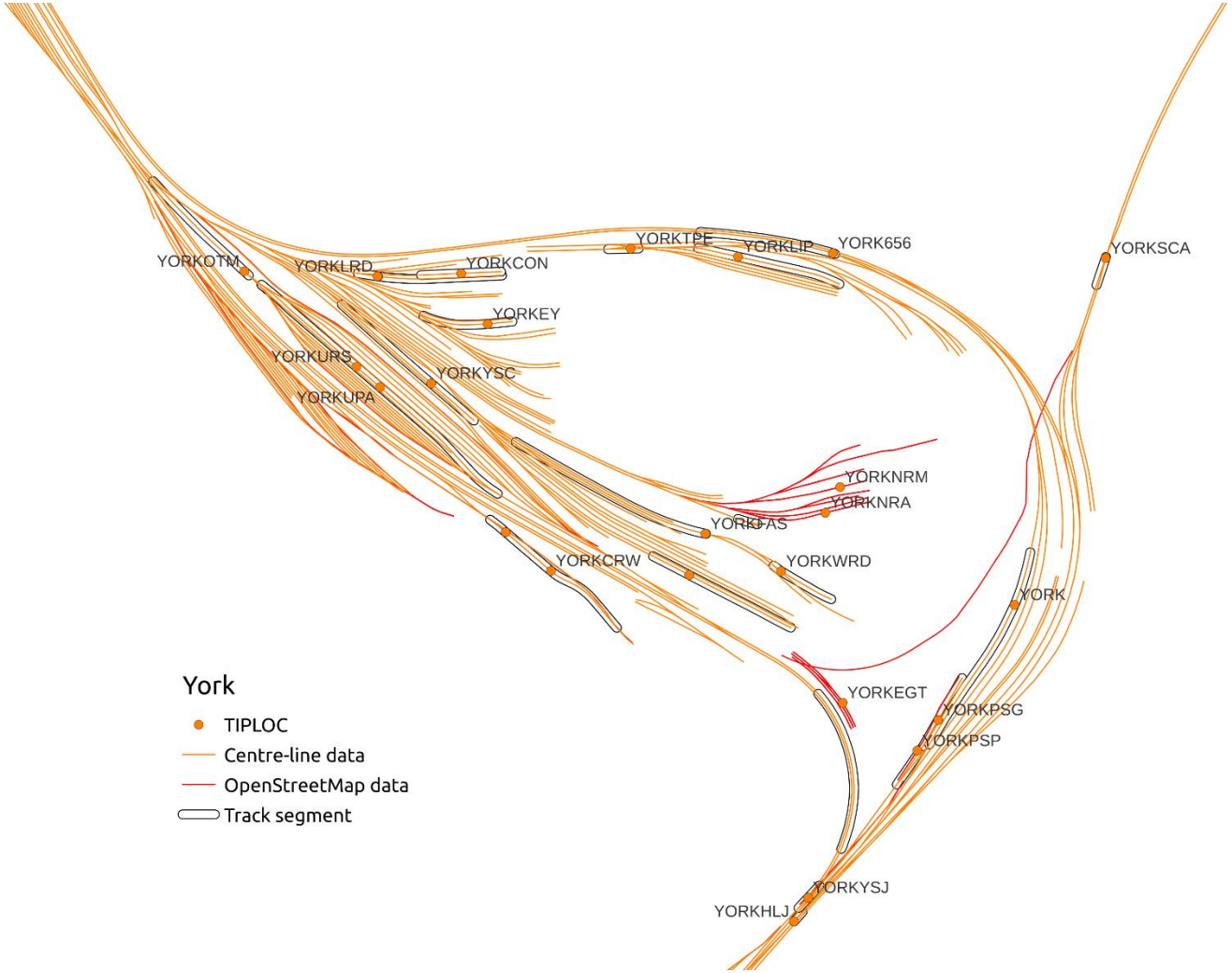
- Use National Public Transport Access Network gazette (NaPTAN)
- NaPTAN has Timing Point LOCations (TIPLOC) codes Map TIPLOC to CRS using CORPUS Network Rail open data
- Fix the six wrong TIPLOCs matches
    - Use OpenStreetMap to find the four missing CRS



Wrinkles and Data Wrangling

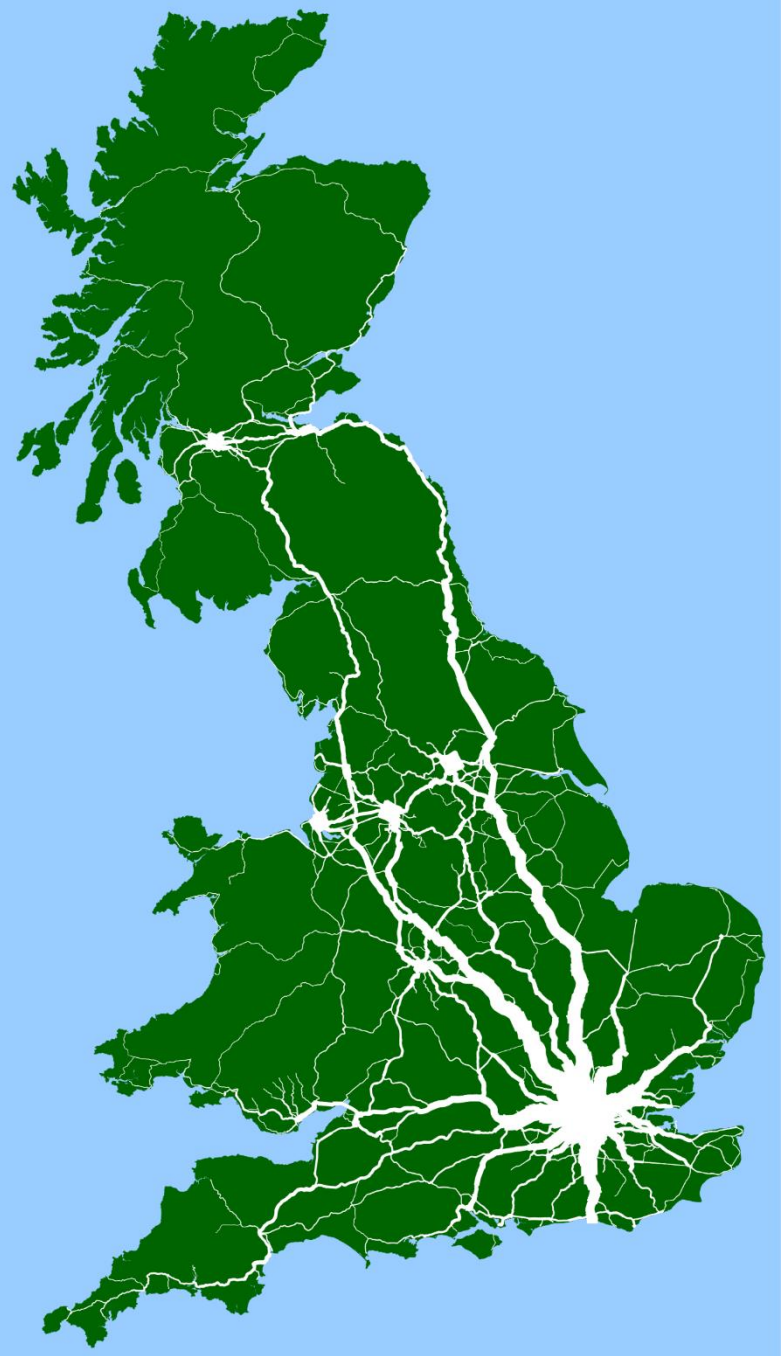
Combine with the centre-line track-model

- Simplify to remove simple connected links
- Snap the station locations to track on the network model
- Split the track at snapped station locations



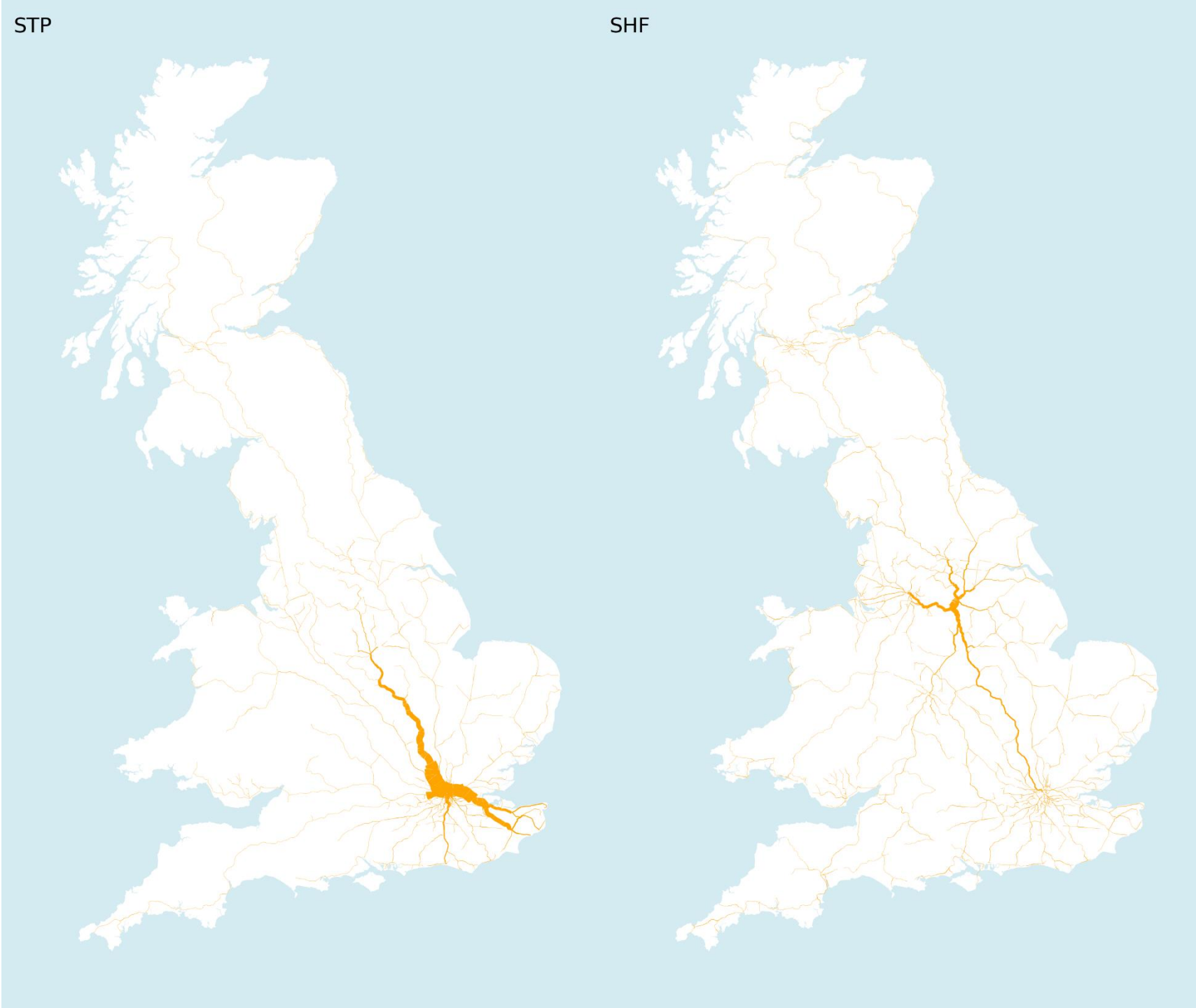
What I planned

Deliver a nation passenger flow for the 2018-2019 ORR dataset ↗



What I did

A passenger flow for each station in the 2018-2019 ORR data



So what?

Social Media Redux

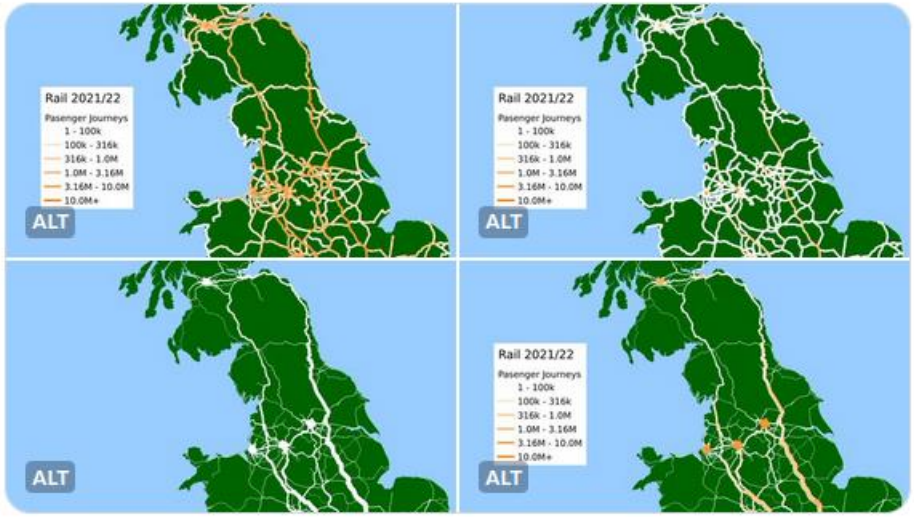
Will Deakin @wnd@fosstodon.org
@WillDeakin1

Promote

For those interested in such things, here are cuts of the @railandroad 2021/22 passenger travel data projected onto a shortest-path network using the centre-line track-model with log and linear colour gradient and line width

Thanks to @undertheraedar @poggs

#rail #DataVis



Alasdair Rae
@undertheraedar

@WillDeakin1 has now done a passenger flow map for every station in Britain - all 2,657 of them - you can find them here:

github.com/anisotropi4/ki...

7:56 PM · Jan 2, 2024 · **495.2K** Views

107 601 3.9K 1.7K

One Column Only

What Did People Think?

- 90 % amazing, wow, love it - unreal piece of work
- 5 % MY StATiON isNT ListED
- 3 % It's all fake, this guy doesn't know anything about trains
- 2 % Have you considered x, y, z approach that actually isn't possible anyway?

State of the Art Cloud Hosting

L’enfer c’est les autres

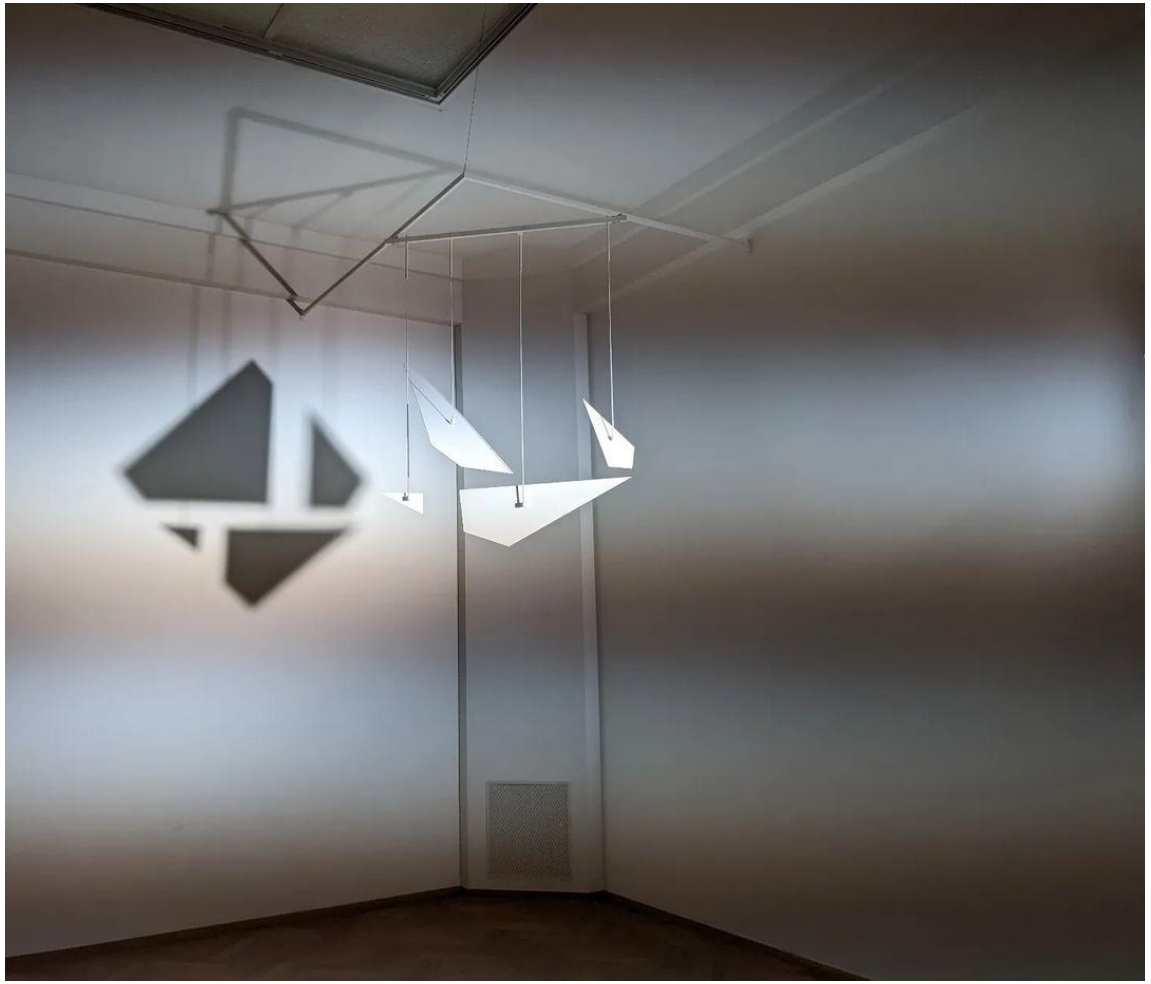
Open Data

Open Data (Current attribution)

All data used on the basis that it under open or permissive license.

1. The base map of mainland Britain is derived from the WorldPop base maps under CC 4.0 by deed retrieved 2023-09-07.
2. The centre-line track-model is hosted by OpenRailData under the Open Government License by Network Rail, retrieved 2023-07-11.
3. The Origin Destination Matrix data, for example ODM 2022-23, were published by the Office of Road and Rail on the Rail Development Group Rail Data Marketplace, under the Open Government License. Retrieved 2024-02-18.
4. The Station Attributes for All-Mainline Stations published by the Office of Road and Rail under the Open Government License. Retrieved 2024-02-18.
5. The Network Rail CORPUS dataset is an open data feed which is released under a OGL. Retrieved 2023-11-29 as a local copy.
6. The National Public Transport Access Network NaPTAN under OGL and is updated each time the scripts are run.
7. While this implementation now uses NaPTAN and CORPUS to validate and identify six closed stations, the Isle of Wight ferry-link continues to use OpenStreetMap data, licensed under CC-BY-SA 2.0 through the OverPassAPI Turbo service, and is updated each time the scripts are run.

Shadows Appear on the Wall of a Cave



15 Seconds of Fame

About | Data & projects | Knowledge & resources | Sponsors | Events

Passenger Journeys: Pictures at a (Rail Transport) Exhibition

This blog is about using the Office of Road and Rail (ORR) financial year 2021/22 passenger travel data projected onto a shortest-path network, using the centre-line track-model. The project looks to create a visualisation for passenger journey numbers for the active rail stations across the British rail network. This post sets out the background how it seemed to get a bit daft. I'm not sure if it went viral, at just shy of 500k page impression on X, and 15k on LinkedIn in under a week, maybe more bacterial?

Will Deakin
Trains Portfolio Architect Network Rail

Published: Monday 8 January 2024, 11:10AM

15 Seconds of Fame

Citylab | MapLab

Nine Maps Show How Britain Is on the Move

A new dataset allows anyone to explore almost 1 billion journeys from every one of its more than 2,500 train stations.

By Conrad Quilty-Harper and Patricia Suzara

8 February 2024 at 05:01 GMT

Save Listen 5:03

Sign up for MapLab, CityLab's monthly newsletter about maps that reveal and shape urban spaces.

When he started playing with Great Britain's train data, Will Deakin didn't intend to create a monster.

Poor Northern Rail Links

Deakin says the thinner lines between northern cities reflect lower capacity

Manchester Piccadilly

Leeds Central

Distances Part Deux

For the 2,579 stations with CRS codes
The maximum path 1478.23km Wick and St Ives
Wick and Bodmin Parkway, 1396.26km and 23-hours
Dorchester over the Glenfinnan Viaduct takes 14-hours
Walk between

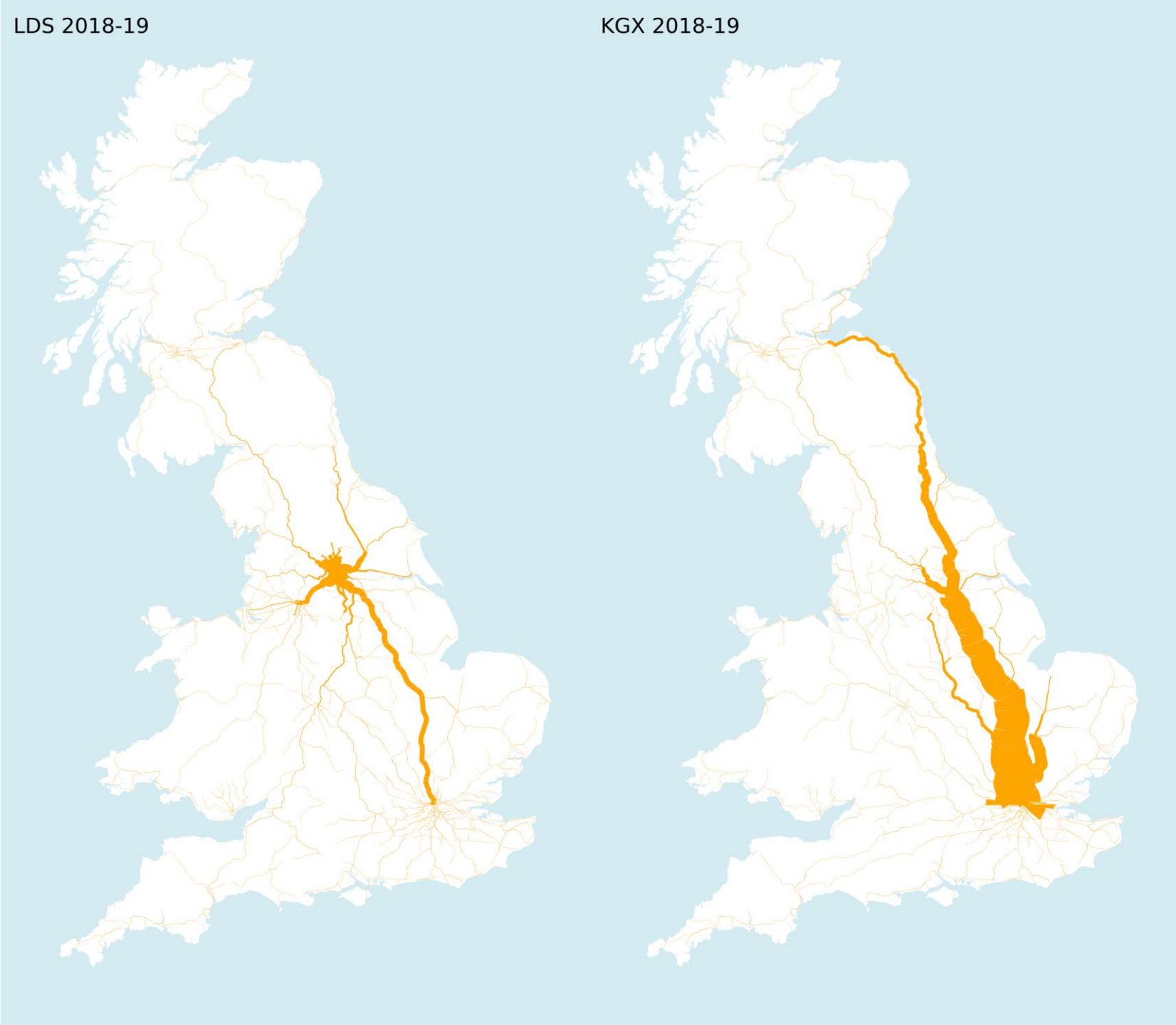
- Southend Central and Southend Victoria
- Dorking Deepdene and Dorking

Larbert to Shanklin commute is nine train changes and 10 hours plus a ferry trip

What next?

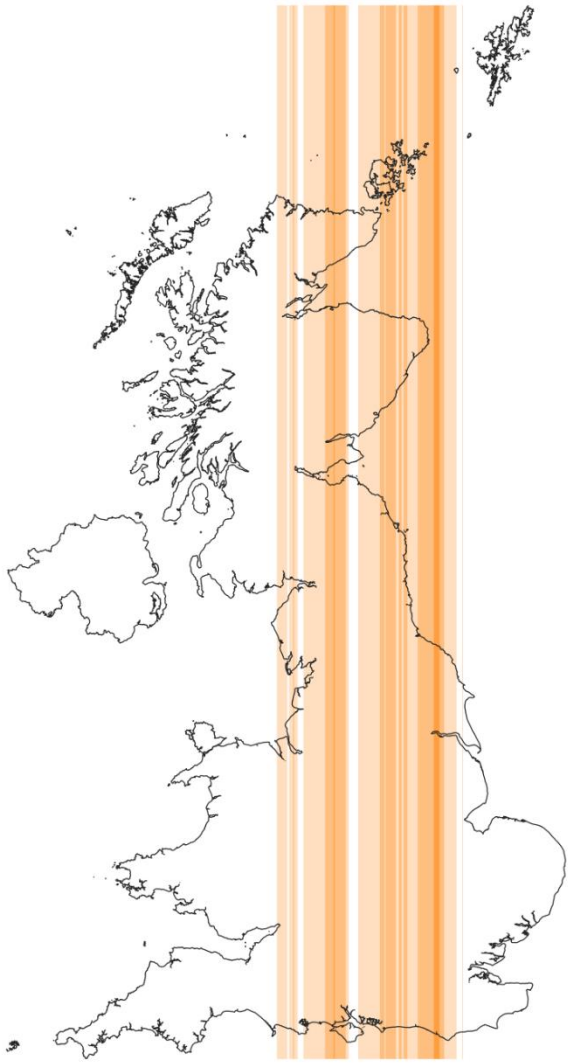
More data

Passenger Origin Destination Matrix

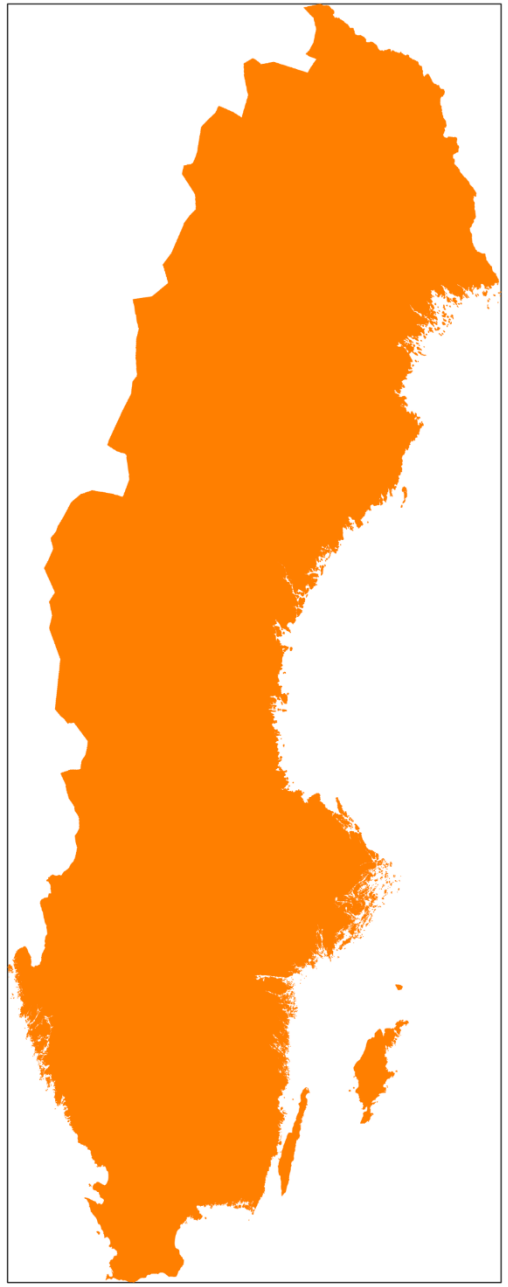


What else?

More Social Media



More Social Media



Network Simplification

Network Simplification

Route network simplification for transport planning

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Robin Lovelace
Zhao Wang
Will Deakin
Josiah Parry

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Digital, Data and Technology services, Network Rail, UK
Environmental Systems Research Institute, Redlands, CA, USA

On this page

Abstract
1 Introduction
2 Problem definition
3 Data and Methods
4 Application to Edinburgh City Centre
5 Discussion and Conclusion
6 Data Availability
7 References

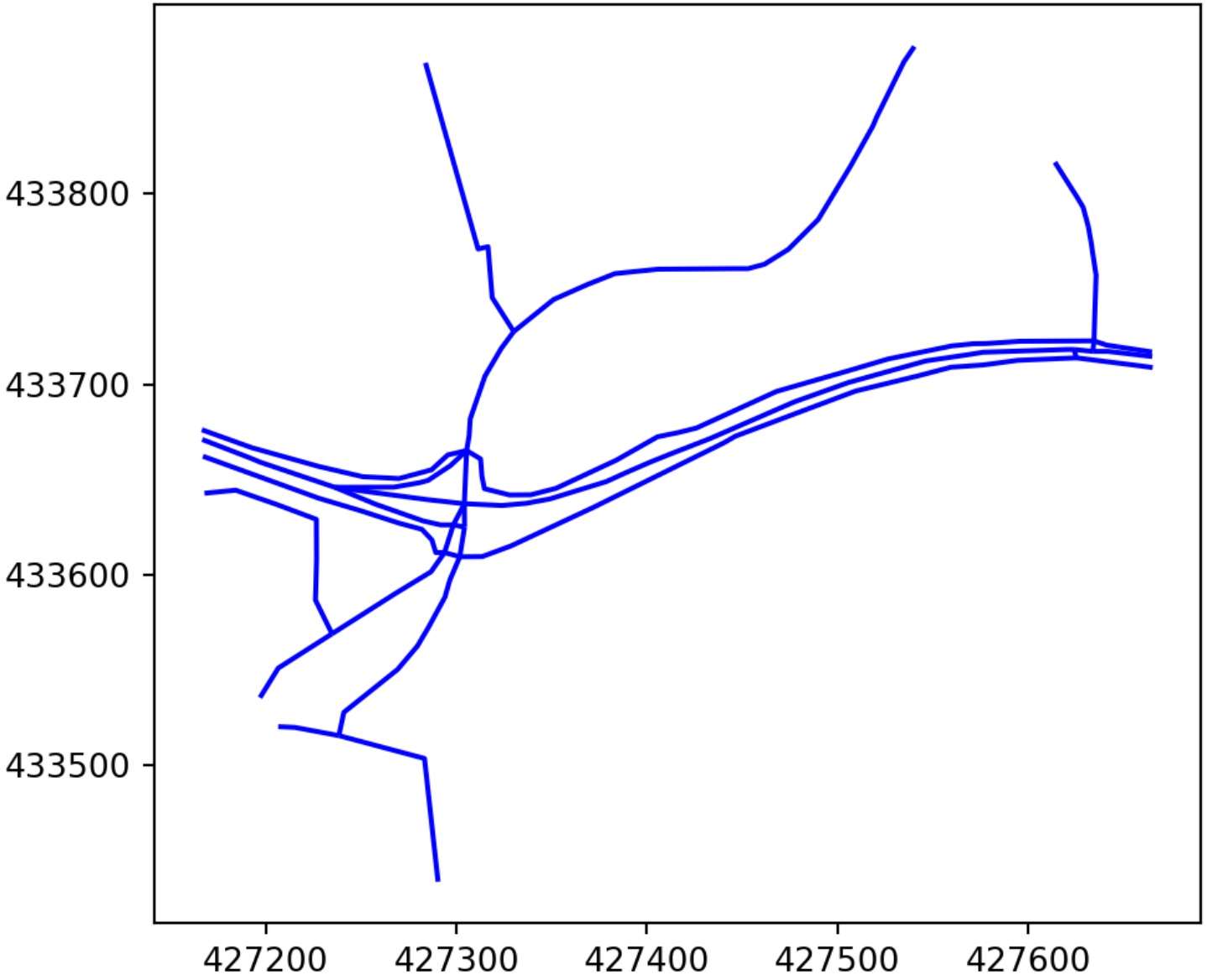
Abstract

Route network datasets are central to transport models as key inputs and outputs. The complexity of route network inputs from sources such as OpenStreetMap has increased over time, enabling more precise modelling of sustainable modes such as walking and cycling. However, this complexity can affect the visualisation of model results. A common issue is the presence of multiple parallel ways on the same corridor, which can lead to visual artefacts and misinterpretation of model outputs. To address this challenges, we present and compare two methods for *simplifying* route network datasets: 1) image skeletonization and 2) Voronoi diagram-centreline identification. These methods have real-world applications, as illustrated in the "Simplified network" layer in the Transport for Scotland funded Network Planning Tool, which is publicly available at www.npt.scot. Based on open access data and the open source `parenx` Python package, available on the Python Package Index, these methods are not only reproducible but also adaptable, enbabling their use in new contexts.

1 Introduction

Datasets representing route networks are important in every stage of transport planning. Transport network datasets are *spatial networks* composed of nodes and edges, in which each edge has an associated edge cost (its weighted or unweighted length) (Barthélemy 2011). Nodes (points connecting edges) and the edges that connect them (lines between nodes representing ways) are located in space, with the edges representing the physical infrastructure of the transport network, often with attributes such as the type of way, its physical characteristics,

Armley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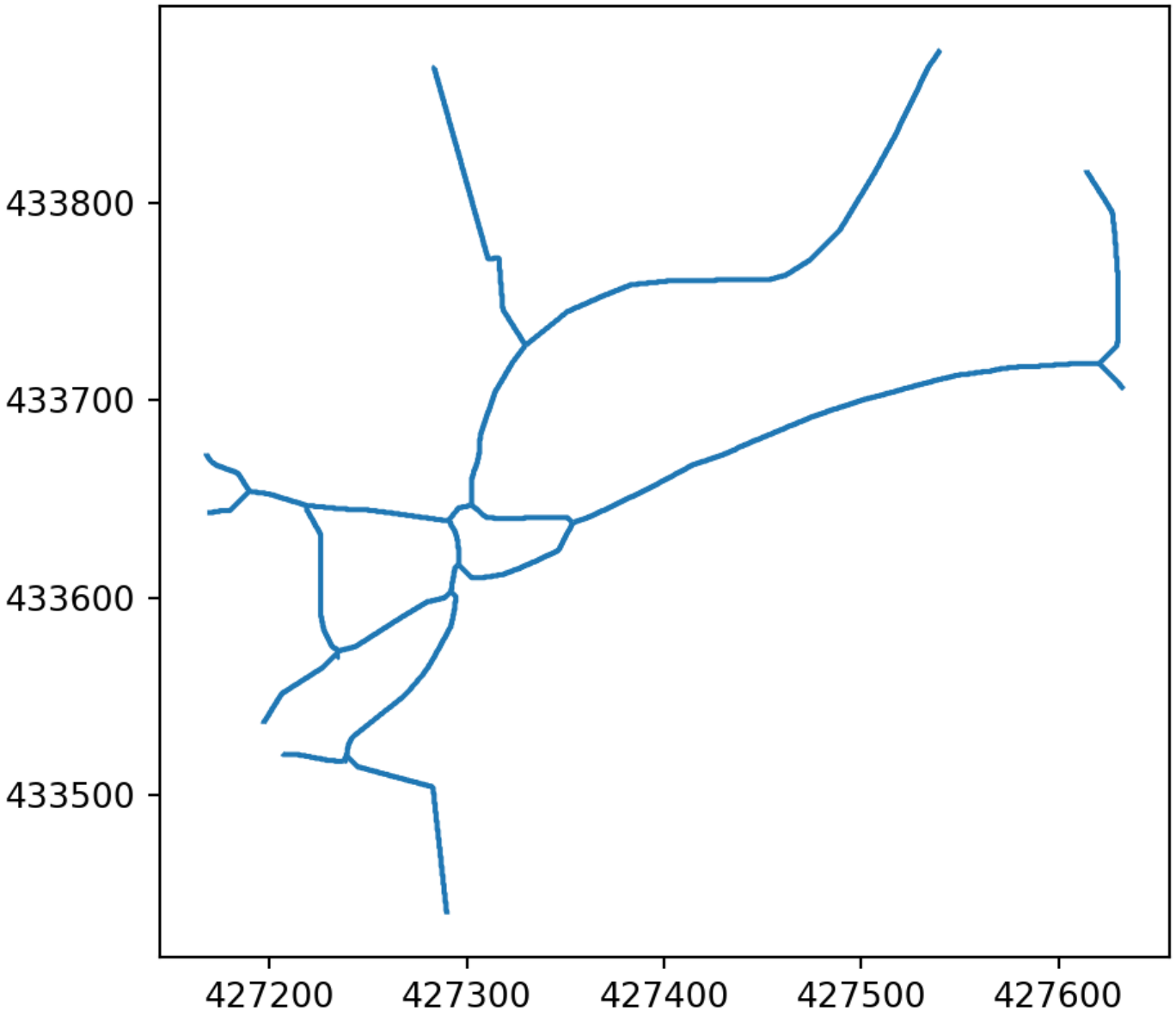
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Network Simplification

How to use the `parenx` module scripts to simplify linear network features

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Will Deakin
Robin Lovelace
Zhao Wang
Josiah Parry

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Leeds Institute for Transport Studies, University of Leeds, UK
Leeds Institute for Transport Studies, University of Leeds, UK
Environmental Systems Research Institute, Redlands, CA, USA

On this page

Reproducibility
1 Introduction
2 Set up and run
3 Simplification: TL;DR
4 Helper script
5 Acknowledgement

Reproducibility

▸ Details

1 Introduction

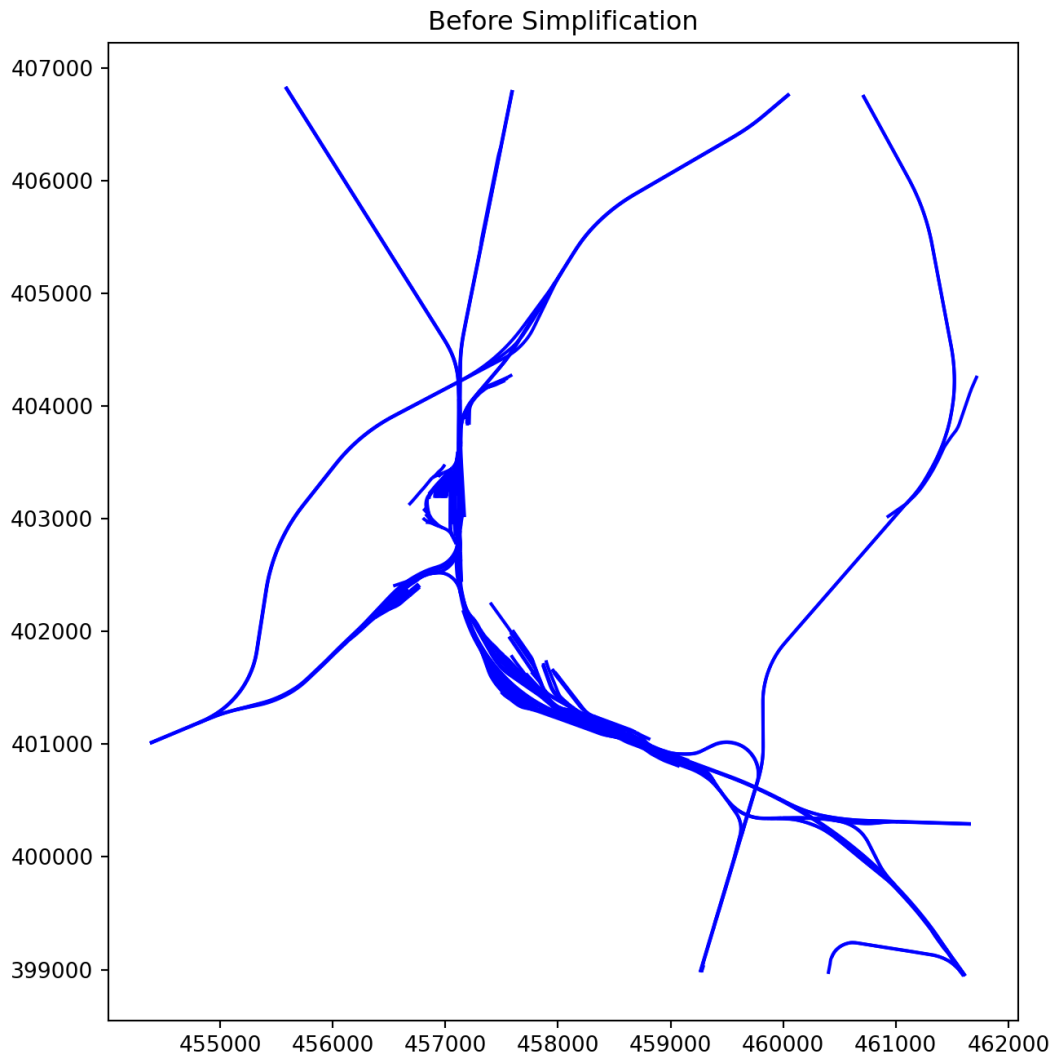
This cookbook is an addendum of the network merge paper[1], and consists of a number of examples based on real datasets used in the development and testing. As part of this for the paper the standalone `parenx` module[2] was developed and deployed to `pypy`. However, noting this is **beta software**, this module is neither well documentmed nor intuitive to use. So the hope is that by sharing these examples will make using these scripts a bit less painful.

This was developed and tested on a Debian Linux variant[3] and run on the command-line interface with various versions of `python3`. While not tested on other environments they should work on under environments and operating systems.

2 Set up and run

In this example create a working project directory, say `elegant-tern`, and set a virtual-environment and simplify data there. This assumes you have `bash` and a working base `python3` installation.

Doncaster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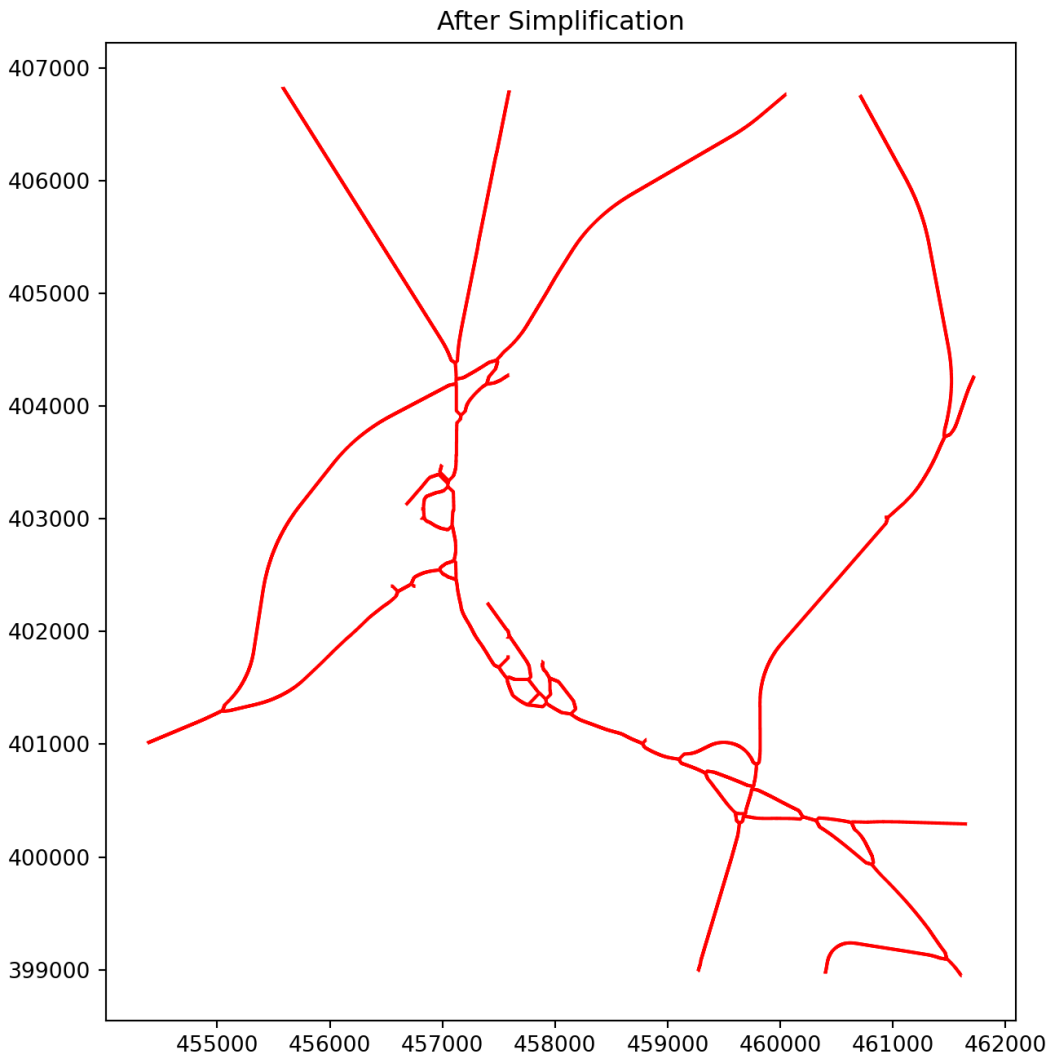
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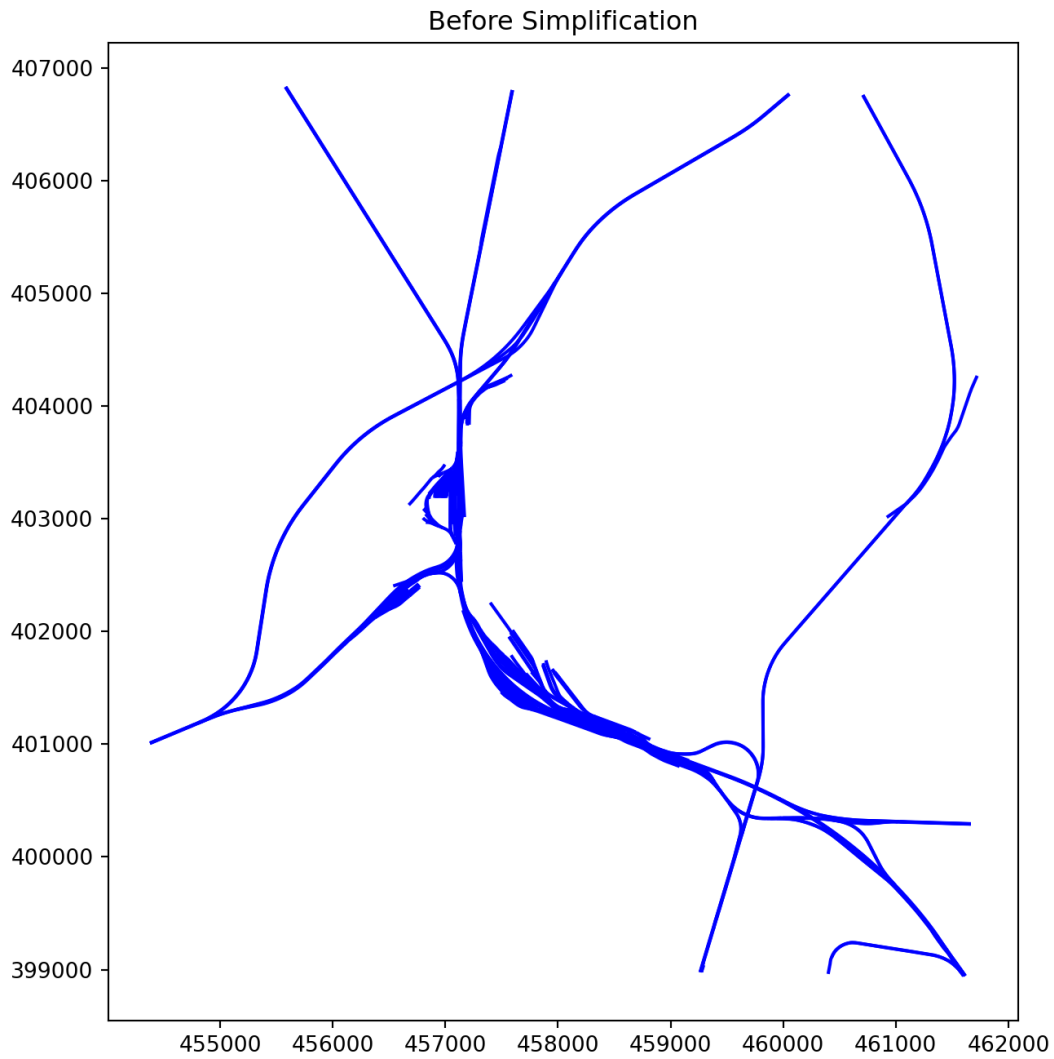
Doncaster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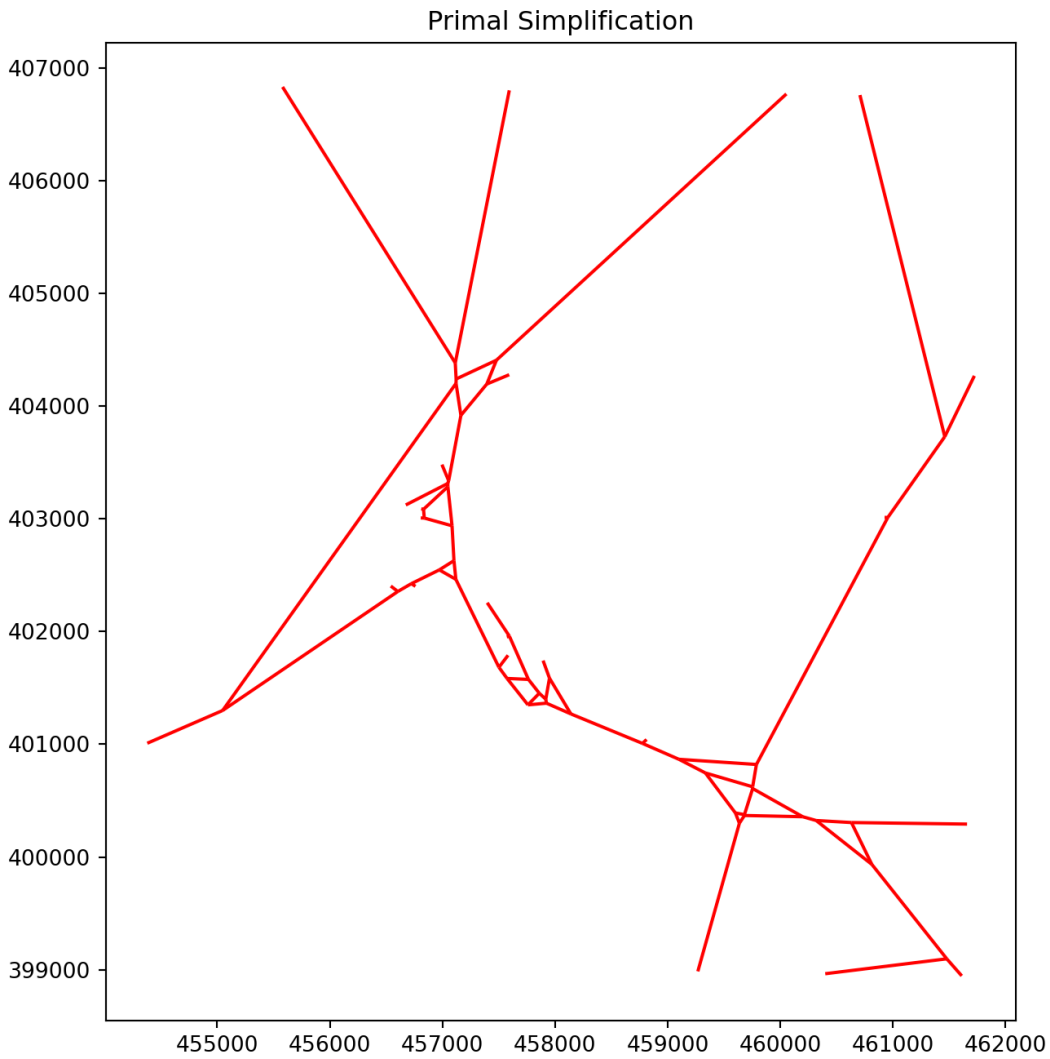
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PyPI

Search projects

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parenx 0.6.1

```
pip install parenx
```

Latest version

Released: Sep 29, 2024

GeoJSON network simplification using raster image skeletonization and Voronoi polygons

Navigation

- Project description
- Release history
- Download files

Verified details

These details have been verified by PyPI

Project links

- Homepage
- Issues

GitHub Statistics

- Repository
- Stars: 12

Project description

parenx

Simplify (or "pare") a GeoJSON network ("nx") using raster image skeletonization an Voronoi polygons

Provides functions that use image skeletonization or Voronoi polygons to simplify geographic networks composed of linestrings. The outputs are geographic layers representing simplified or 'primal' representations of the network. Primal networks only contains straight line segments

Sample datasets include:

- Princes Street in Edinburgh, in data/rnet_princes_street.geojson
- Rail lines in Doncaster, in data/rnet_doncaster_rail.geojson

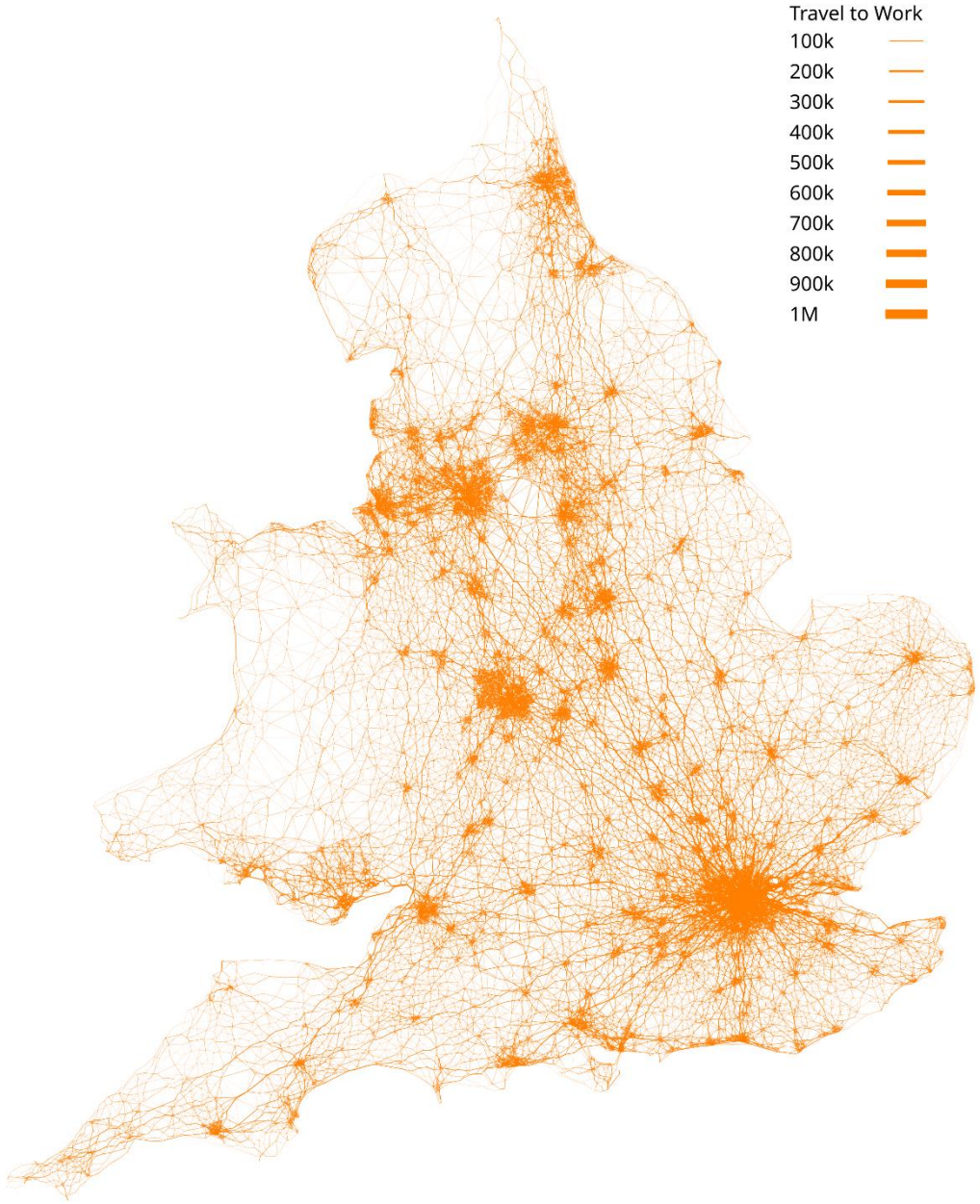
Installation

Install the package into an activated `python` virtual environment with the following command:

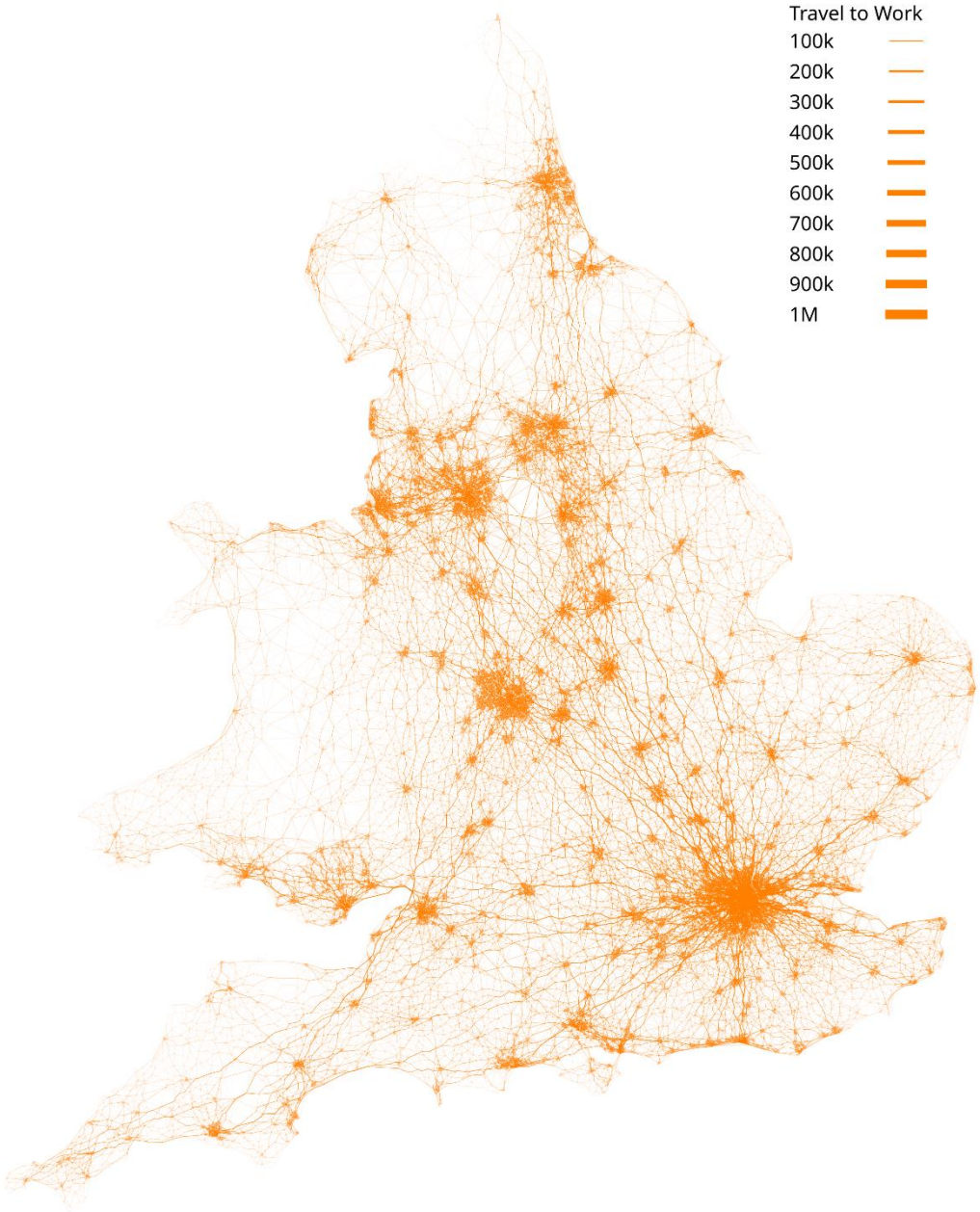
Work in progress

Census 2011 MSOA Census 2011 OA

MSOA Travel to Work
Census 2011

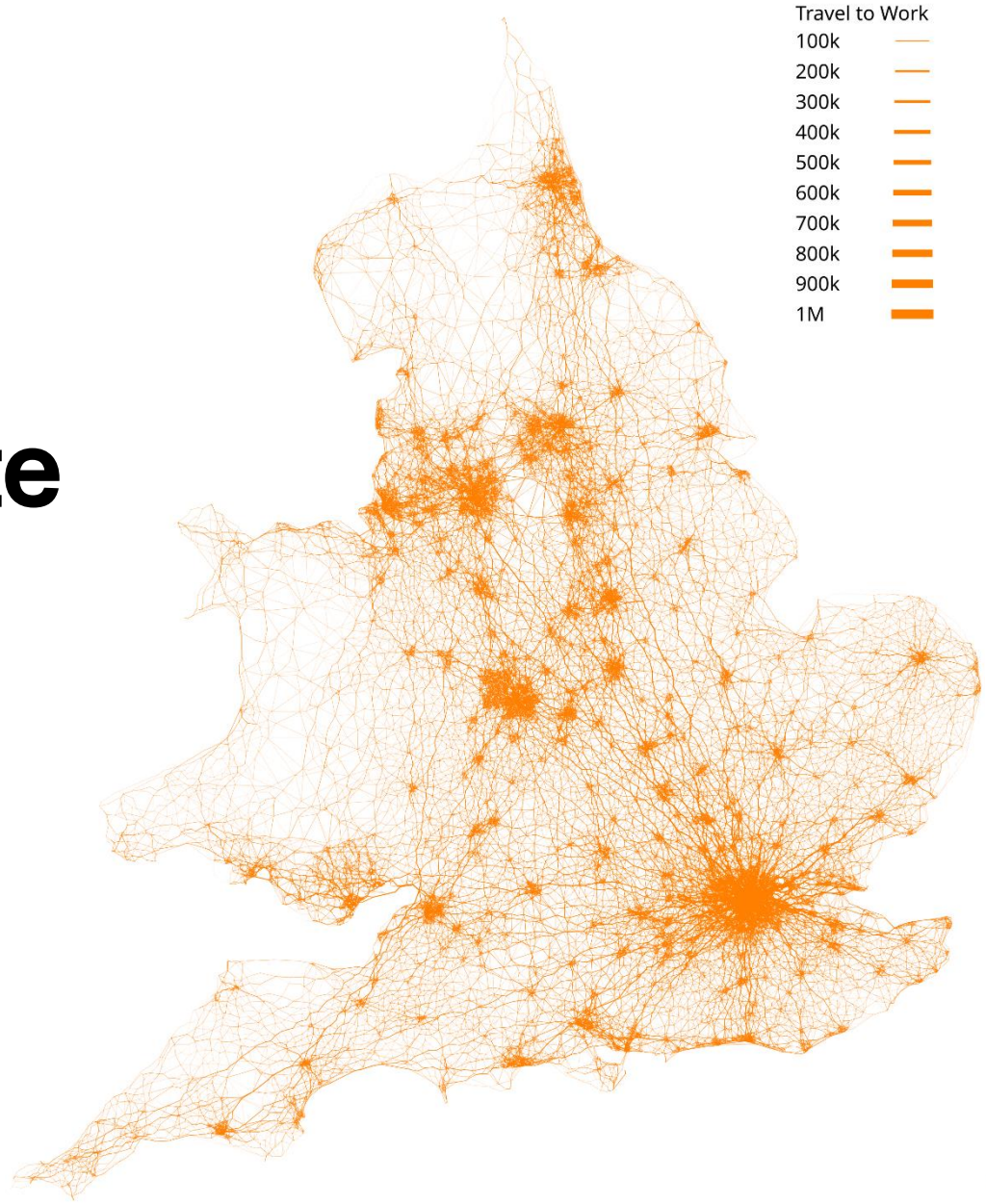


OA Travel to Work
Census 2011

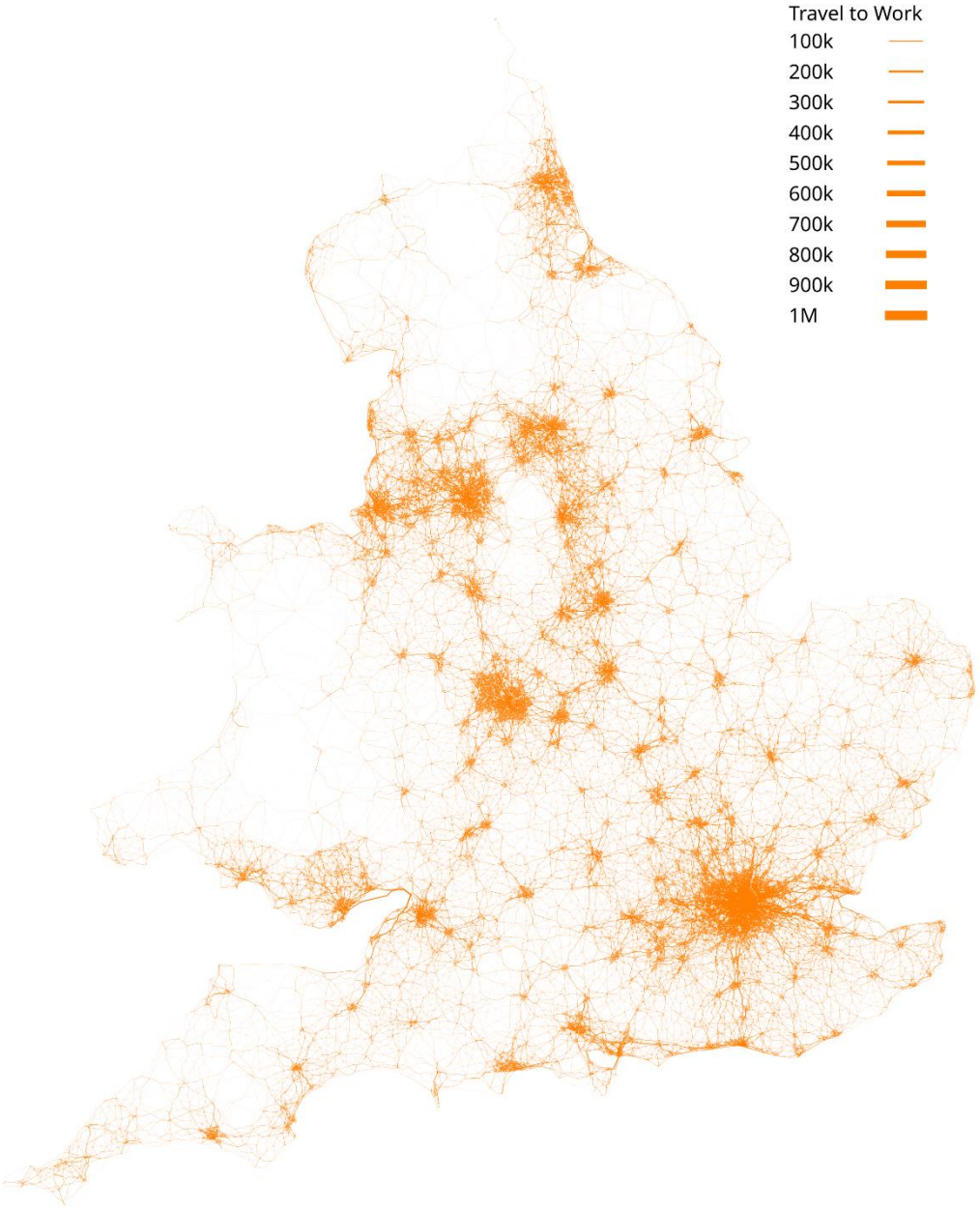


Census 2011 Census 2021 Estimate MSOA

MSOA Travel to Work
Census 2011

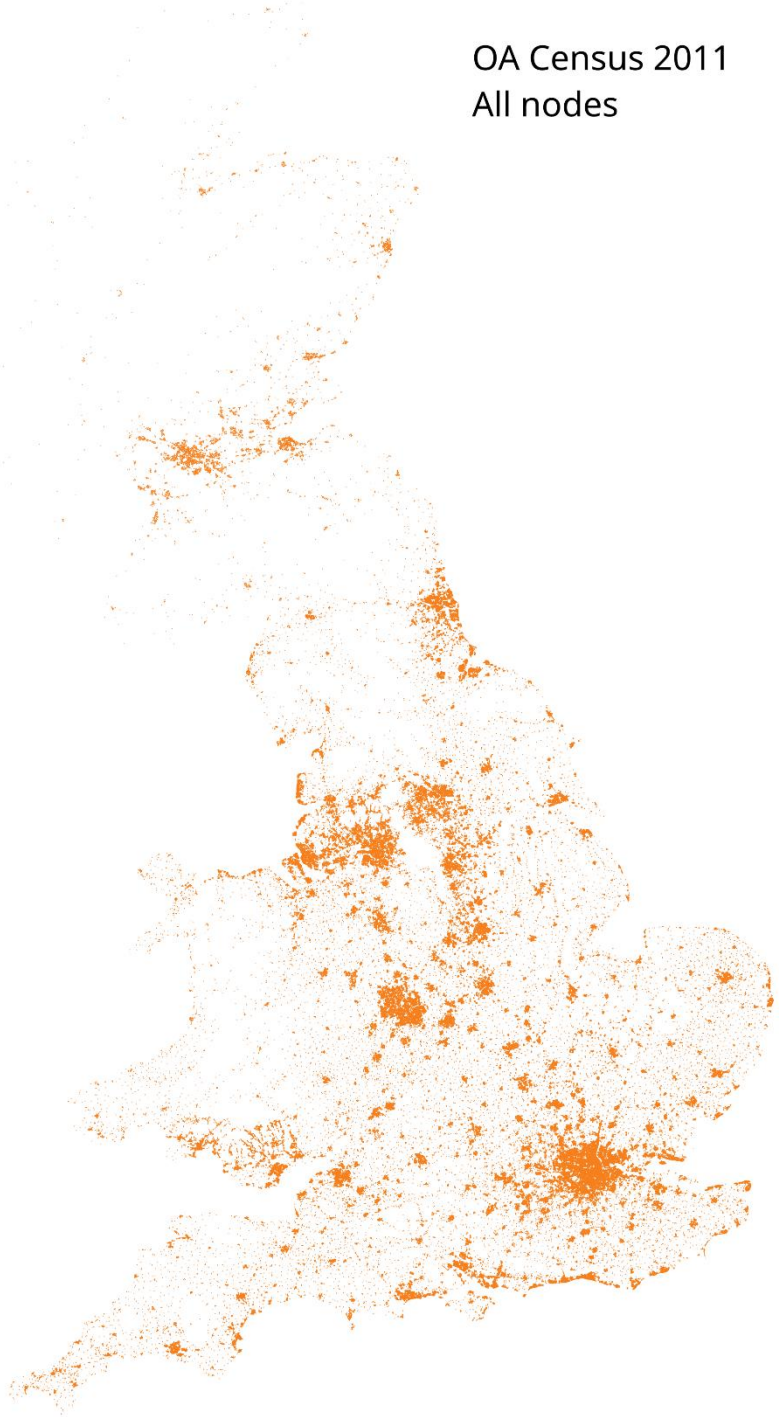


MSOA Travel to Work
Census 2021

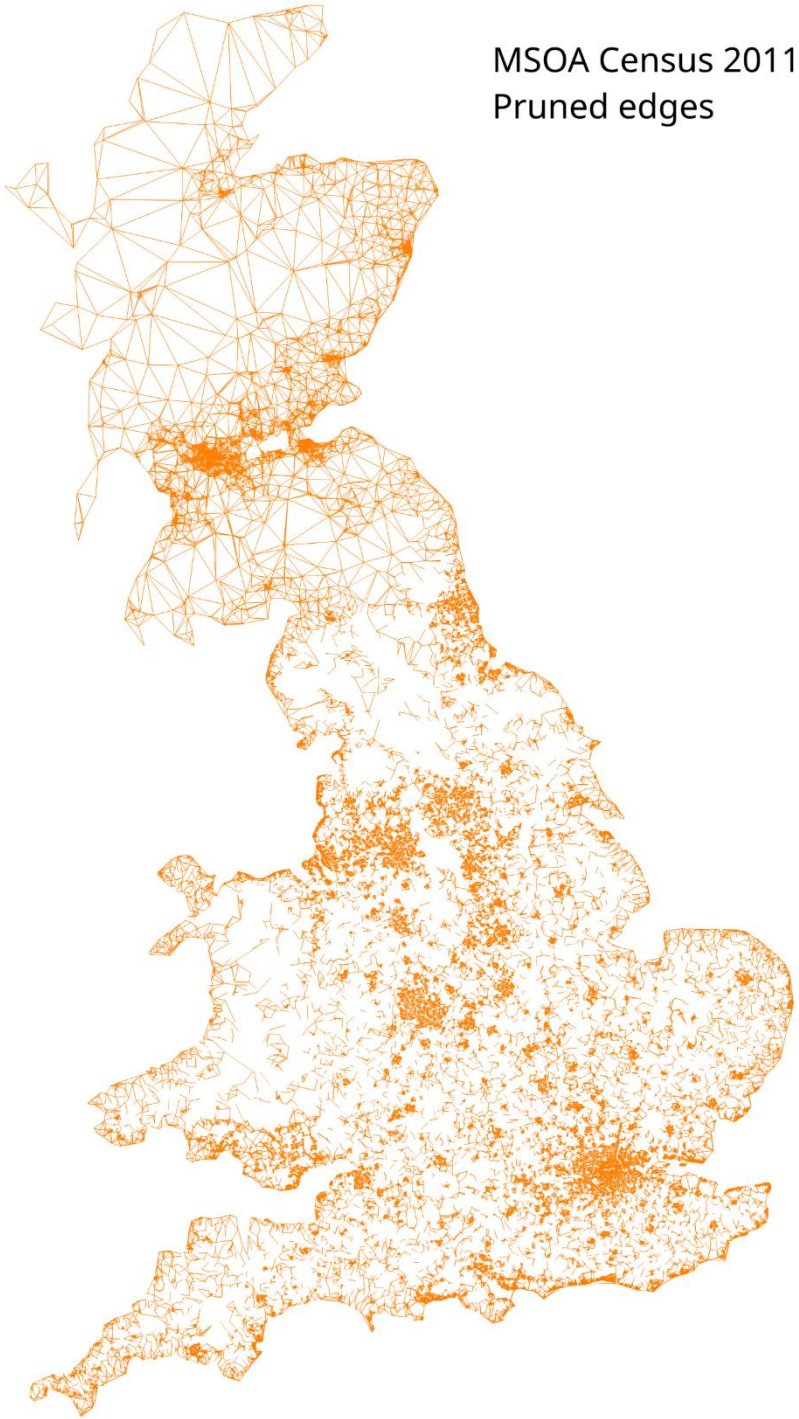


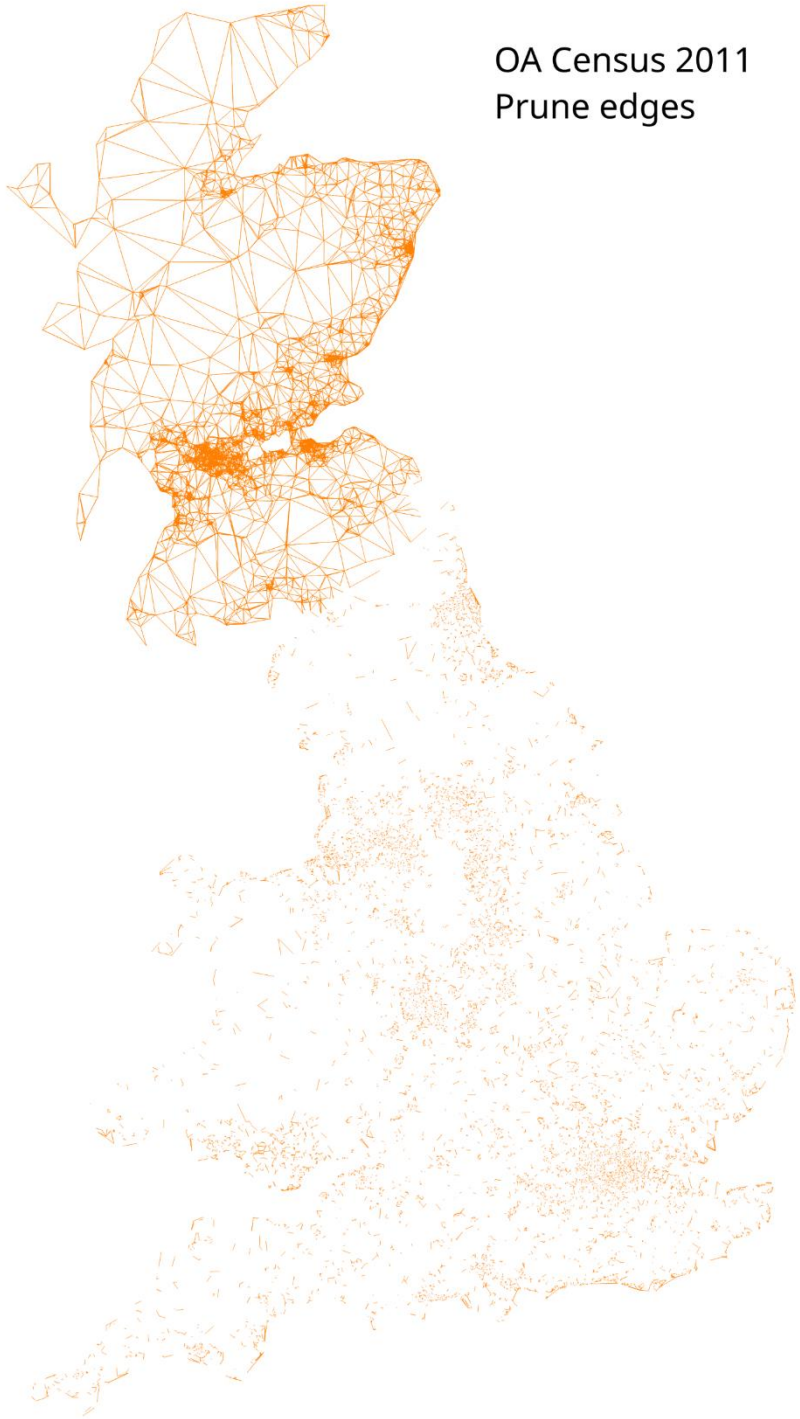
Where is Britain?

Full Network



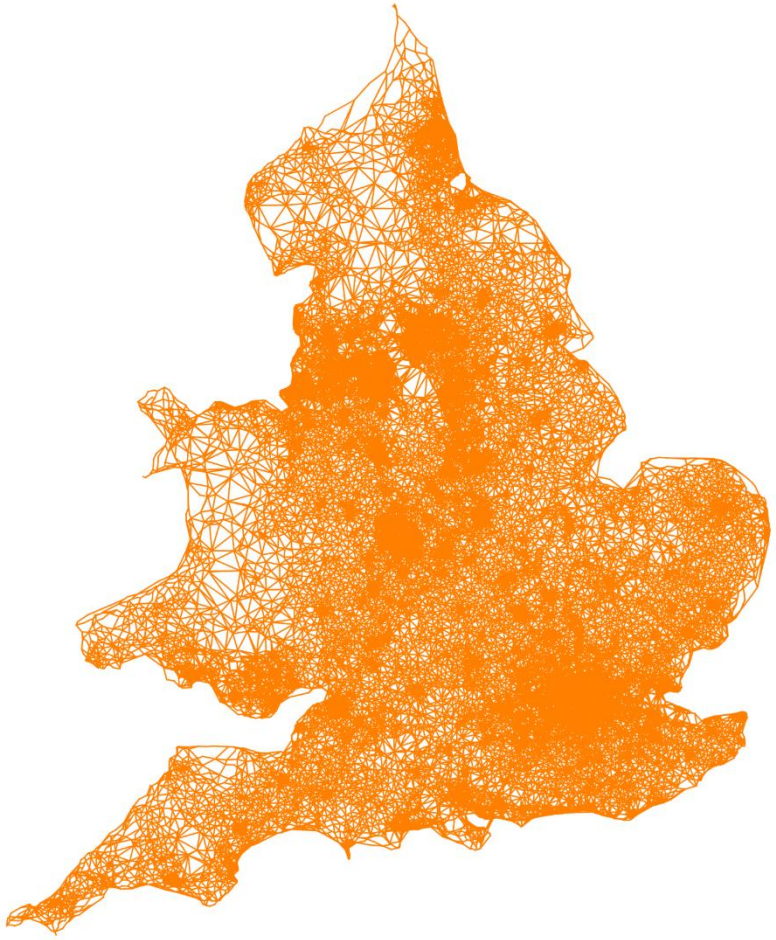
Pruned



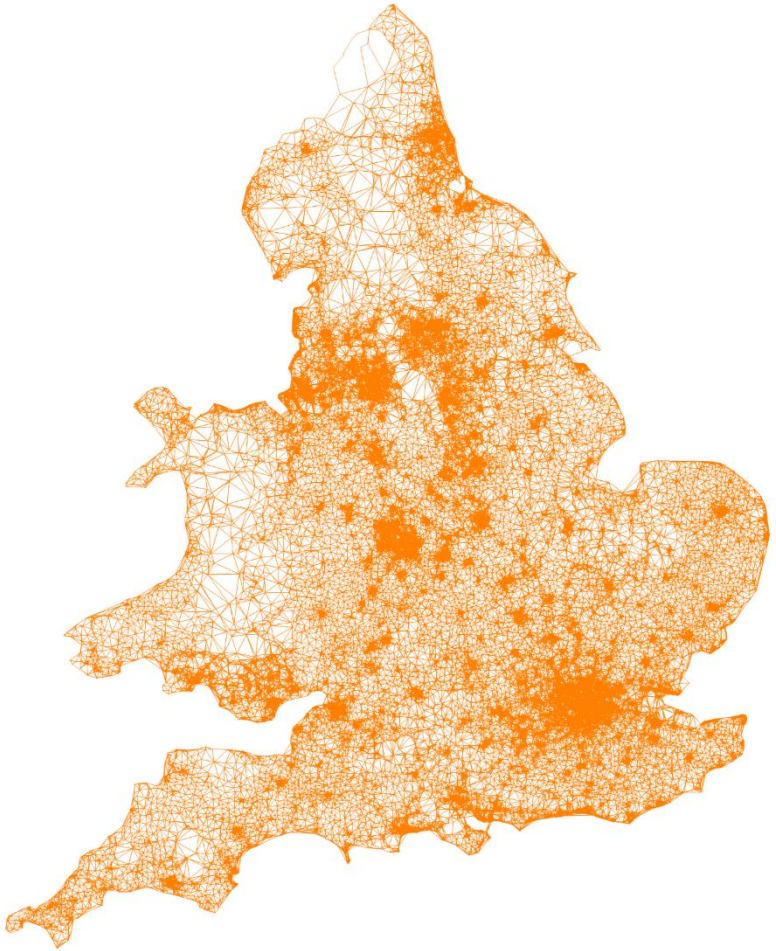


Core Network

MSOA Census 2011
Core edges



OA Census 2011
Core edges



Census 2011 MSOA Census 2011 OA

MSOA Travel to Work
Census 2011

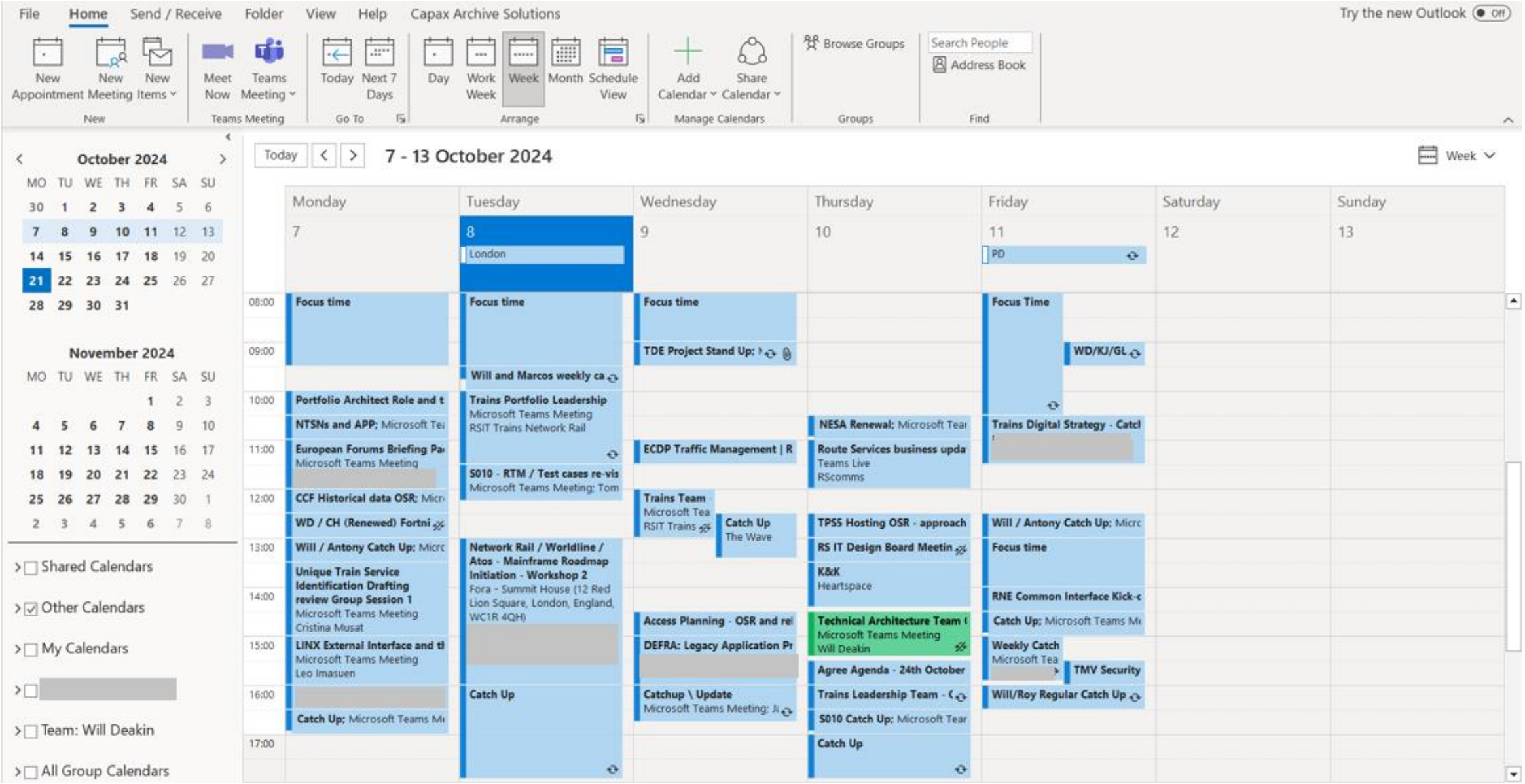
OA Travel to Work
Census 2011

Project Delivery

The blether of IT Delivery

"He who neglects what is done for what ought to be done, sooner effects his ruin than his preservation"

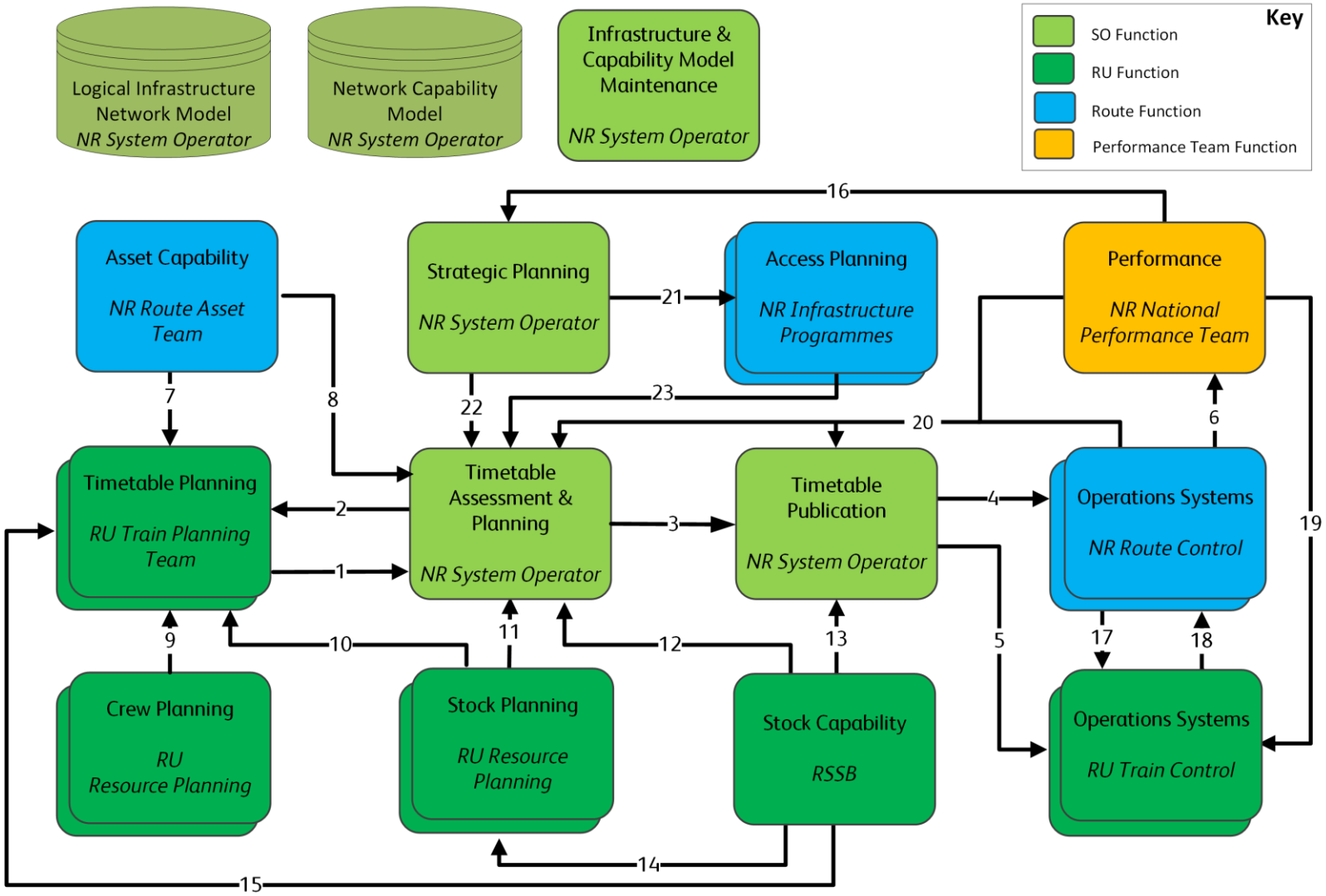
- Niccolò Machiavelli



Route Services

Putting passengers first

Business Processes



Route Services

Operational Processes

TM1: Manage and Monitor Train Movements

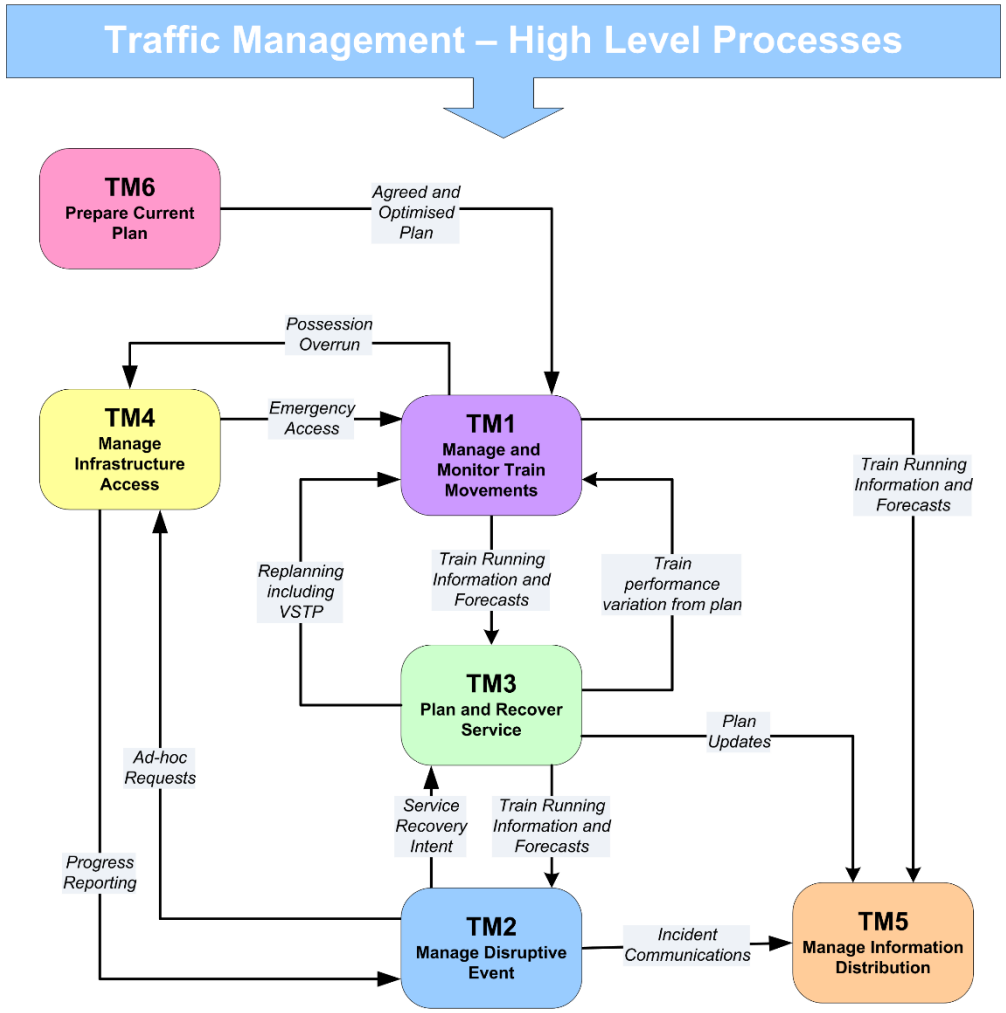
TM2: Manage Disruptive Event

TM3: Plan and Recover Service

TM4: Manage Infrastructure Access

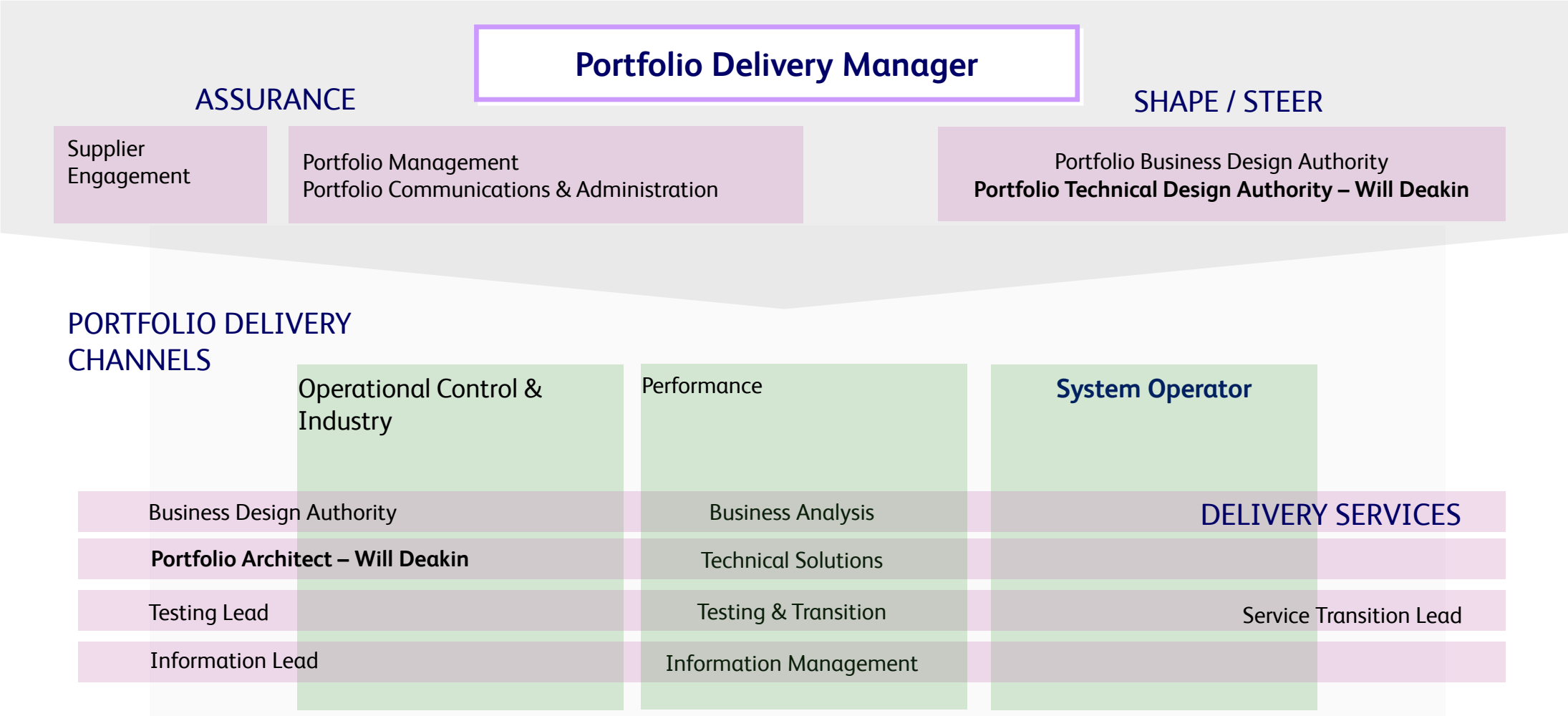
TM5: Manage Information Distribution

TM6: Prepare Current Plan

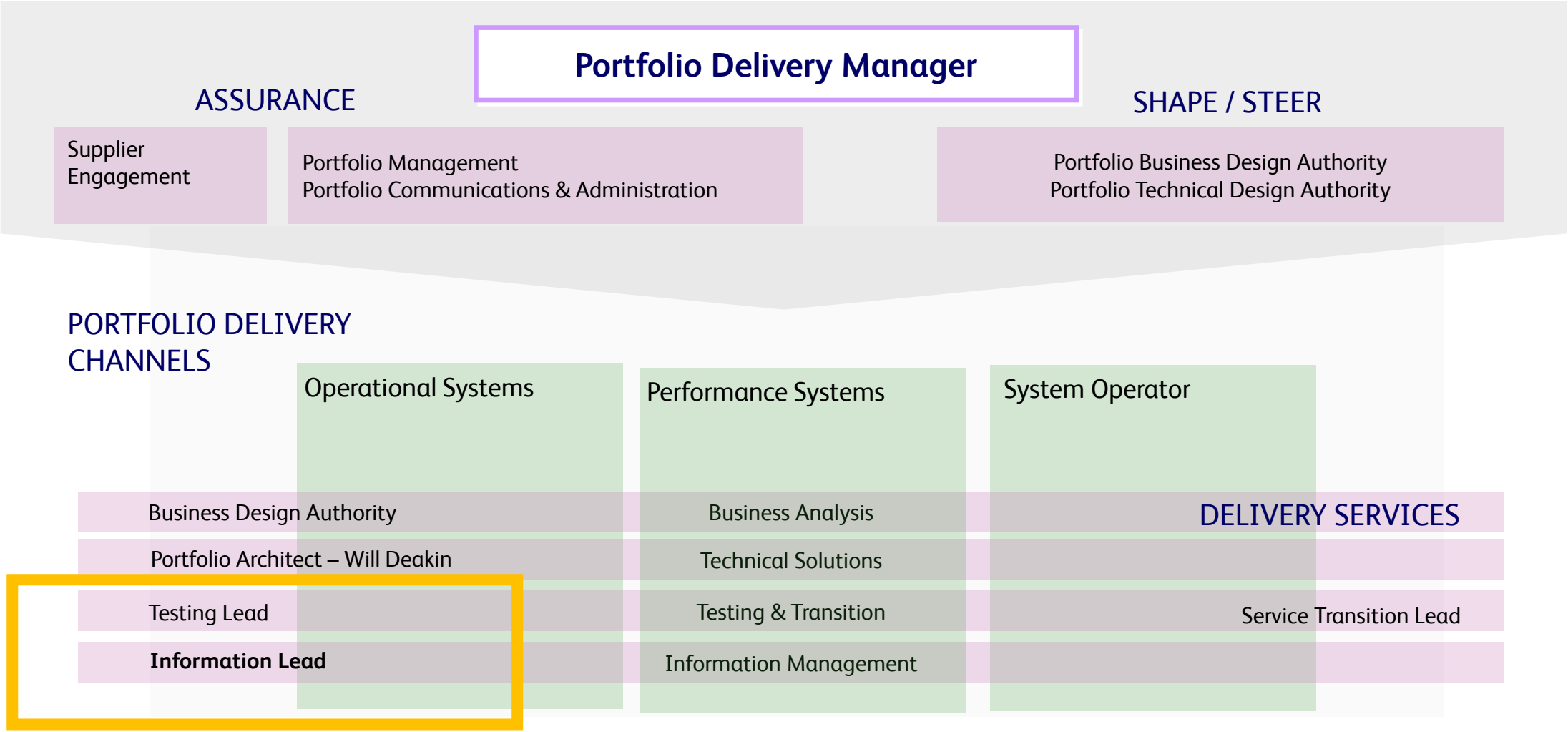


Who We Are

Route Service IT Delivery Trains Portfolio



Route Service IT Delivery Trains Portfolio



Who we want to be

We are trusted advisors who deliver business aligned technology with integrity in everything we do

Build it and they will come!

Route Services

Questions and Answers

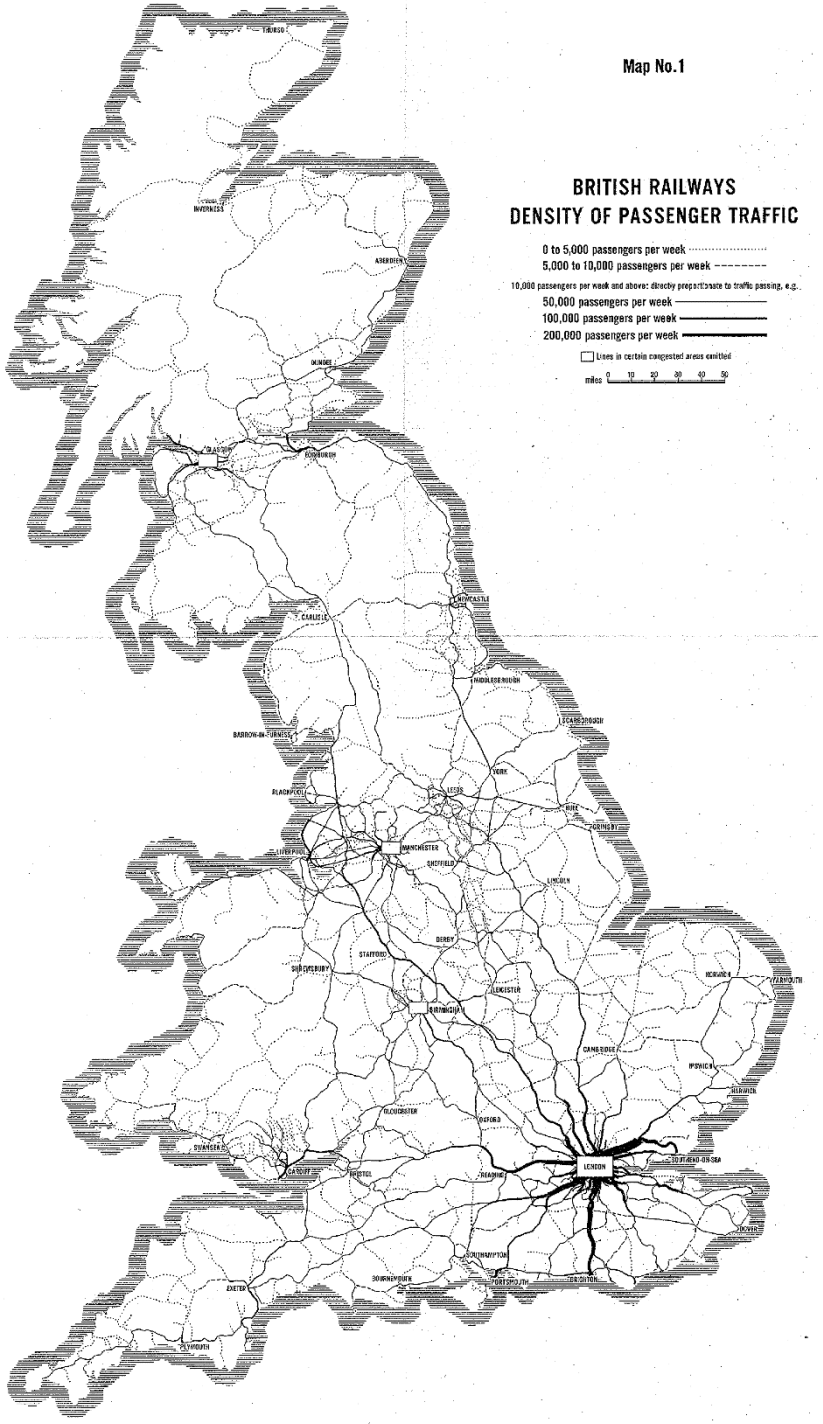
Parting Words

Art

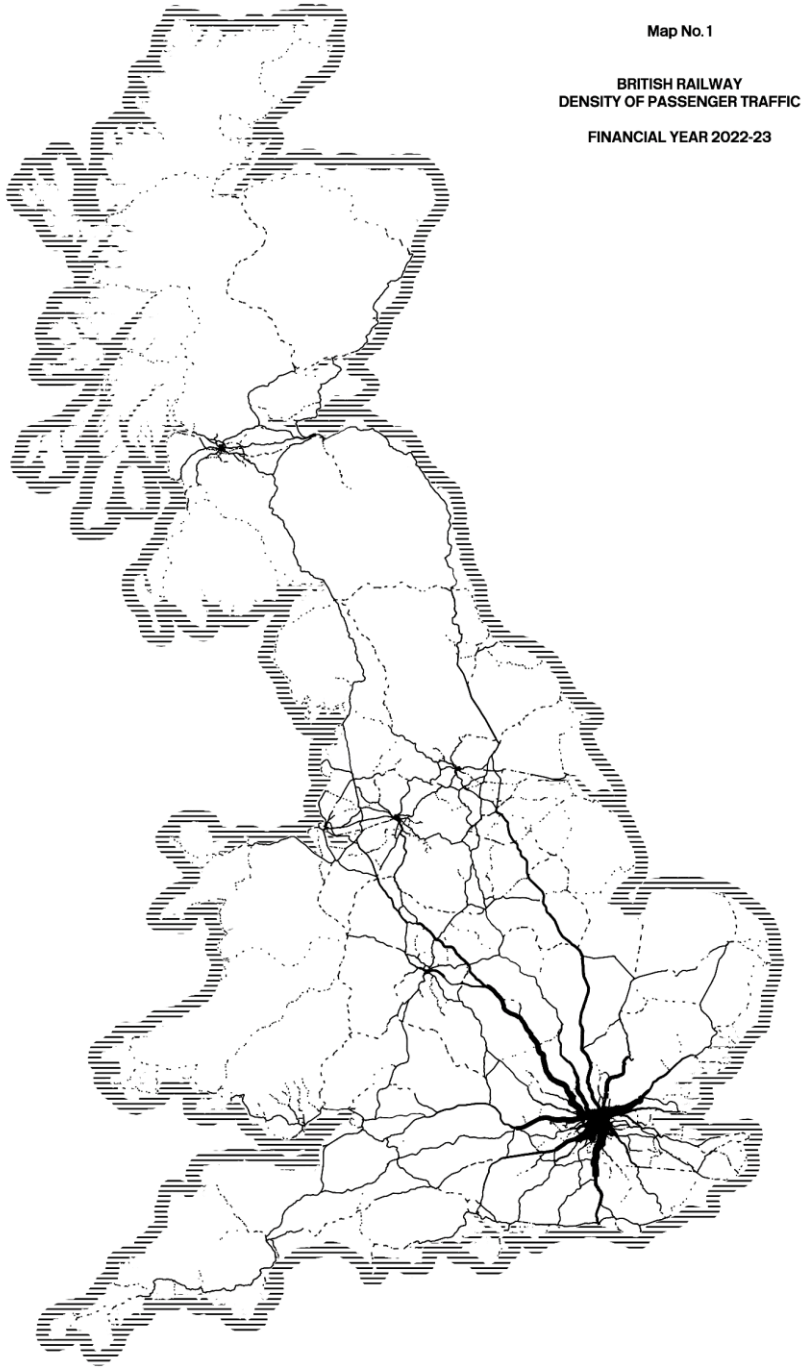
The Railway

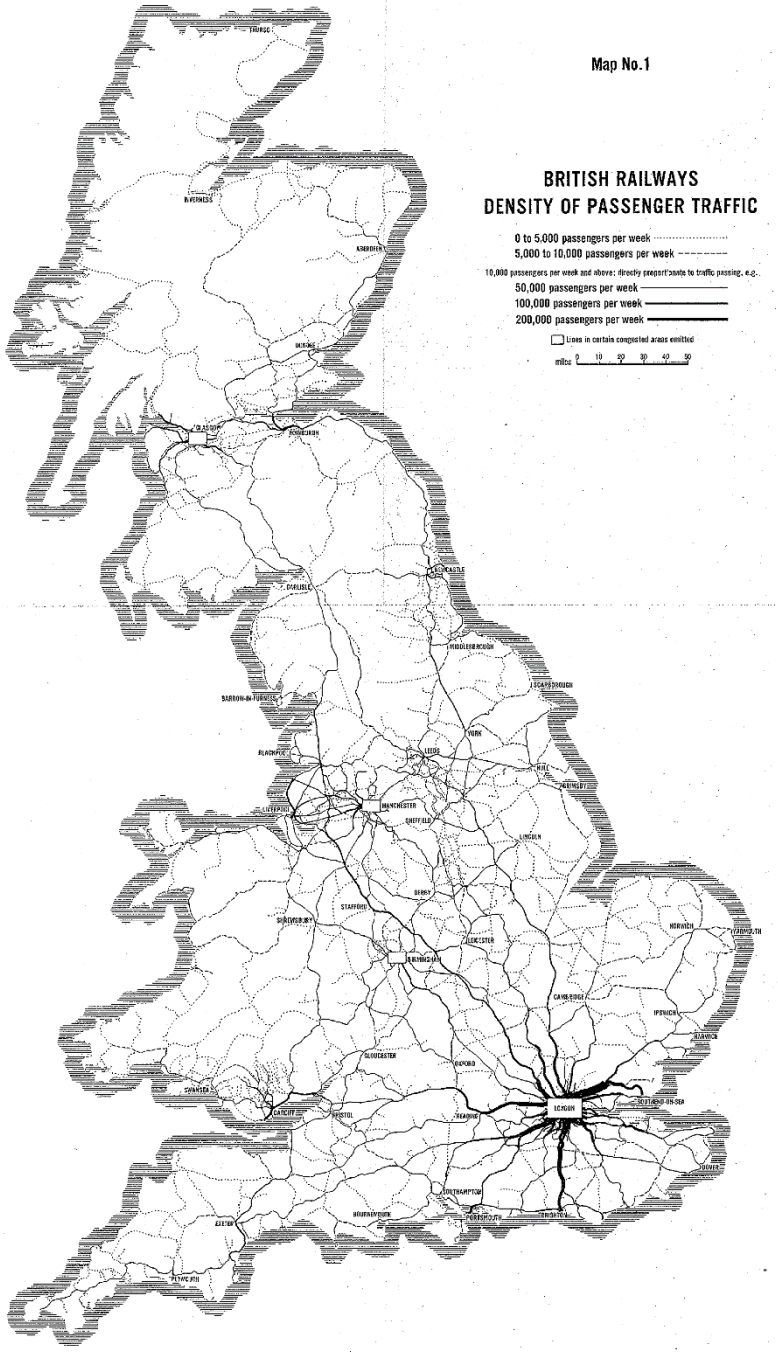
The Reshaping of British Railways

‘The Beeching Report’ 1963



The Railway


Map No. 1
BRITISH RAILWAY
DENSITY OF PASSENGER TRAFFIC
FINANCIAL YEAR 2022-23


Map No. 1
BRITISH RAILWAYS
DENSITY OF PASSENGER TRAFFIC
0 to 5,000 passengers per week
5,000 to 10,000 passengers per week
10,000 passengers per week and above; directly proportionate to traffic passing, e.g.,
50,000 passengers per week
100,000 passengers per week
200,000 passengers per week
Lines in certain congested areas omitted
miles 0 10 20 30 40 50
INVERNESS
ABERDEEN
DUNDEE
EDINBURGH
GLASGOW
CARLISLE
NEWCASTLE
HUDDERSFIELD
LEEDS
YORK
HULL
MANCHESTER
SHEFFIELD
LINCOLN
STAFFORD
NORWICH
GLOUCESTER
CAMBRIDGE
IPSWICH
OXFORD
SWANSEA
CARDIFF
BRISTOL
READING
LONDON
SOUTHAMPTON
BOURNEMOUTH
EXETER
PLYMOUTH

It is Never Enough

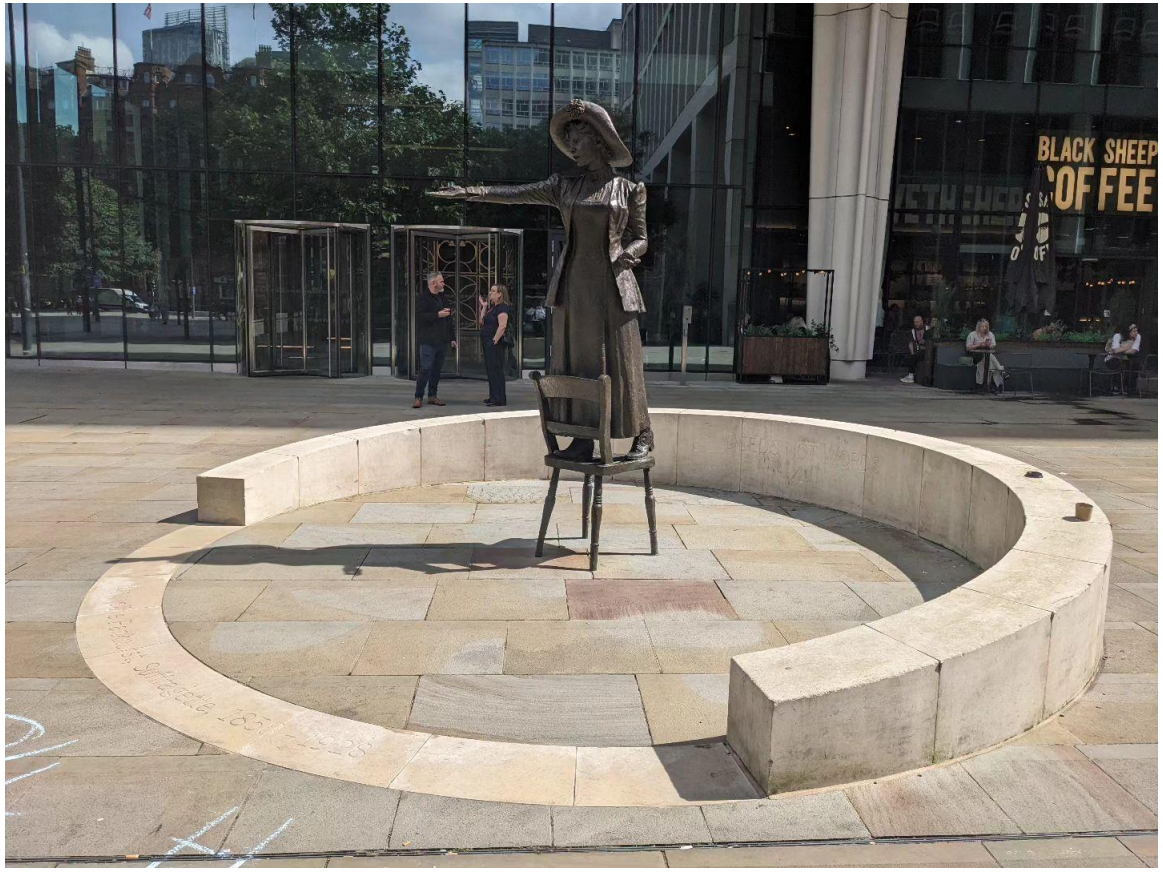
"Any sufficiently advanced technology is indistinguishable from magic"

- Arthur C Clarke

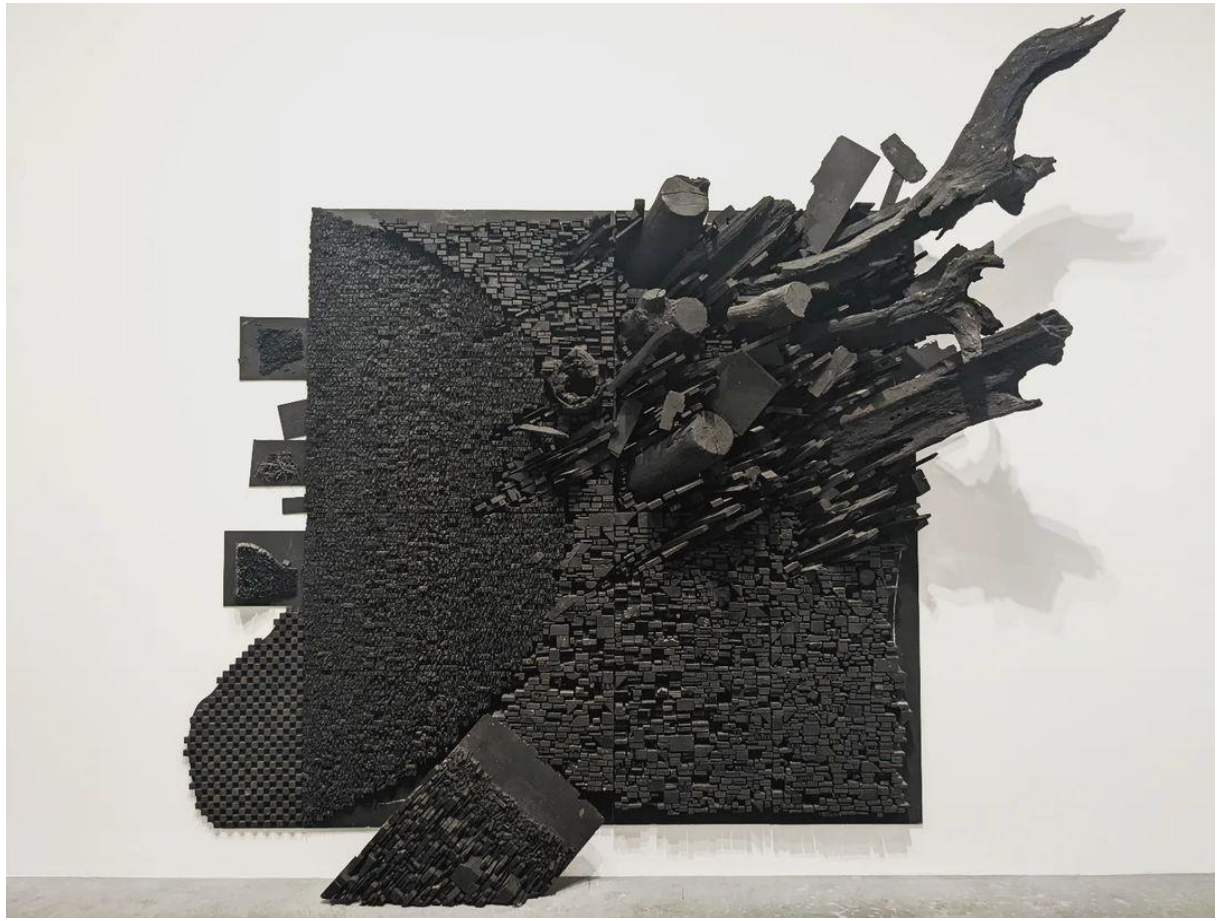
The wish for the moon-on-a-stick

- Manage expectations
- Focus on quality
- Make it look nice

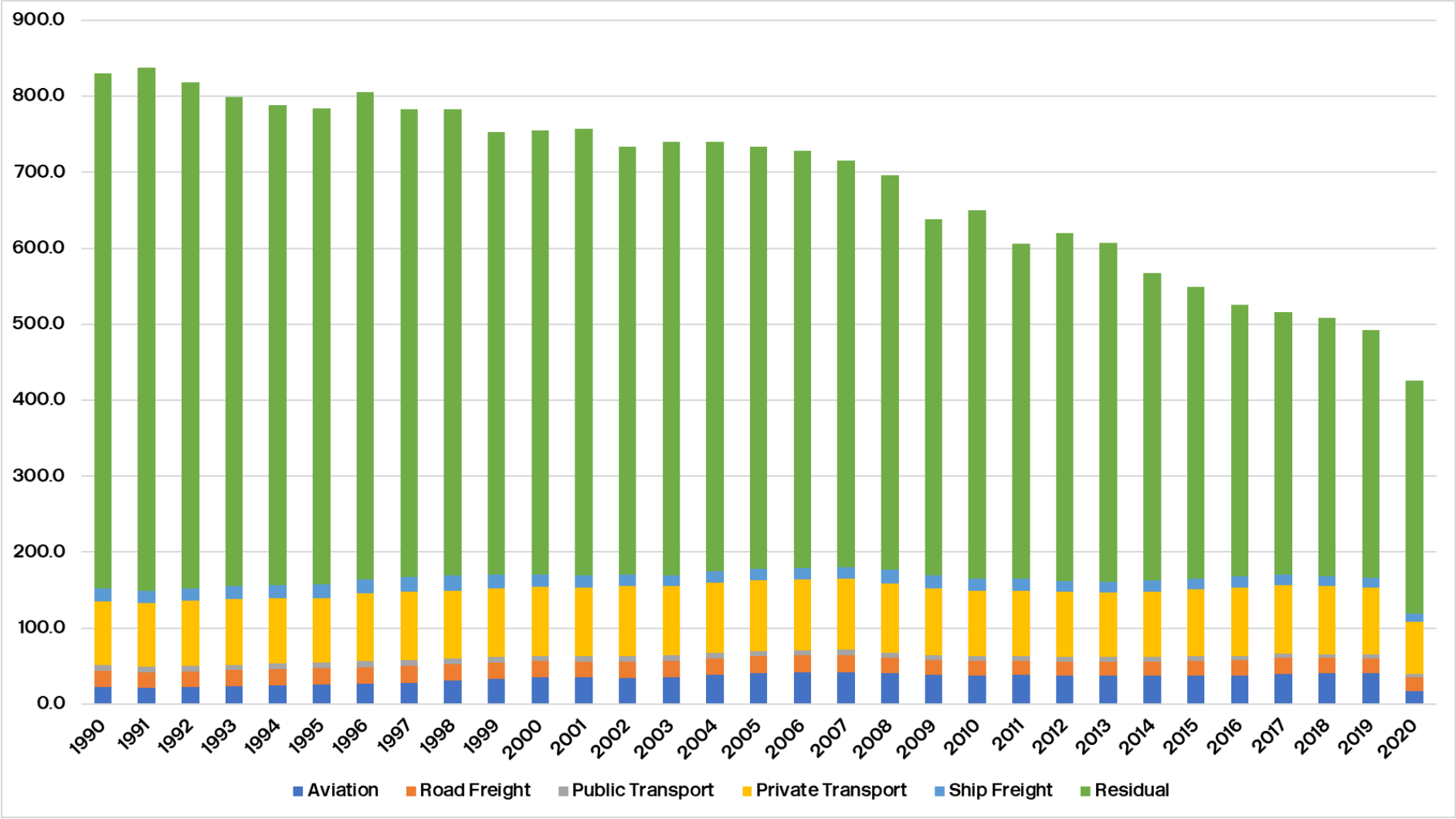
The then so what?



Emissions

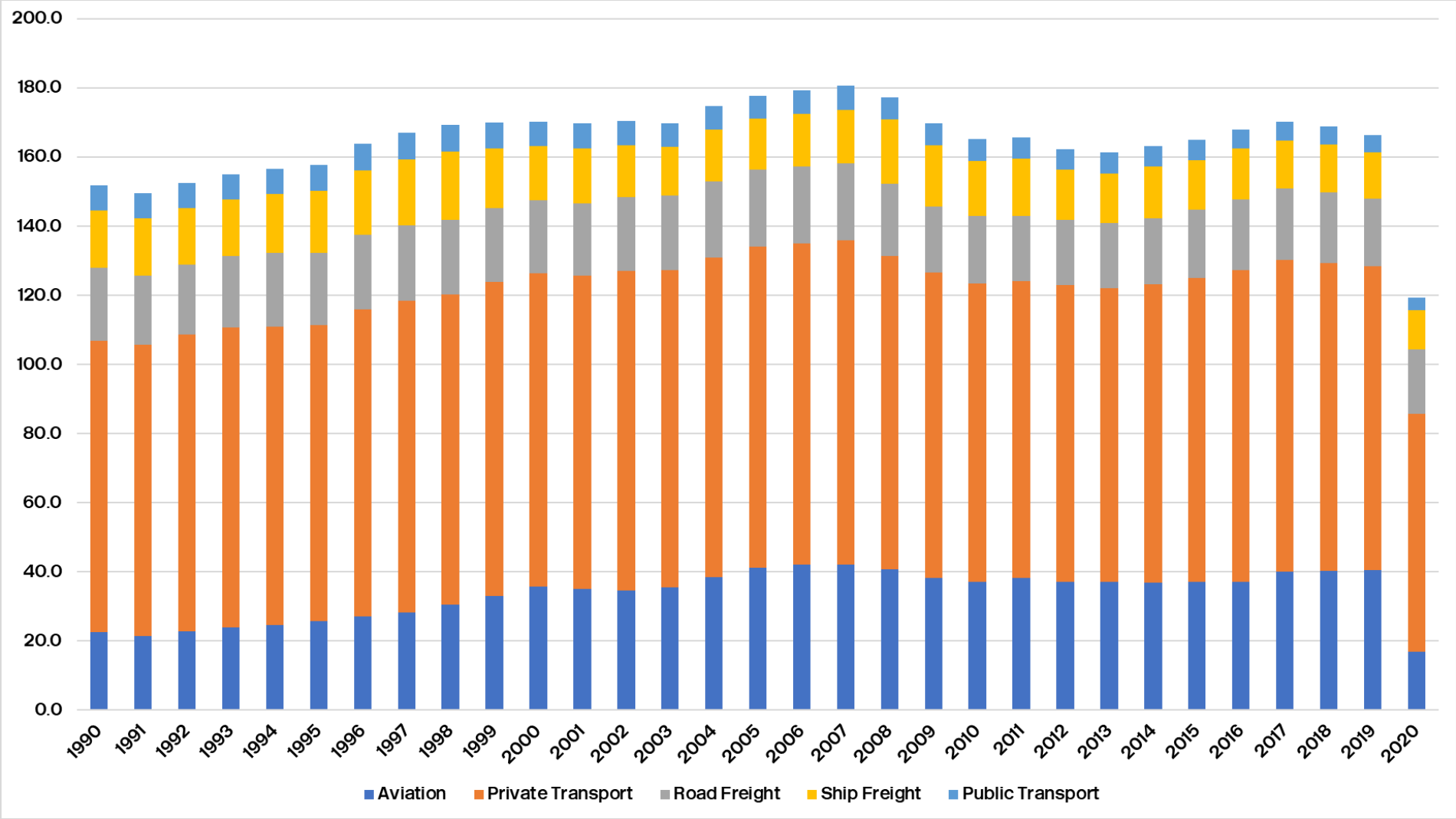


UK CO_2 Emissions 1990-2020



Route Services

UK CO_2 Emissions 1990-2020



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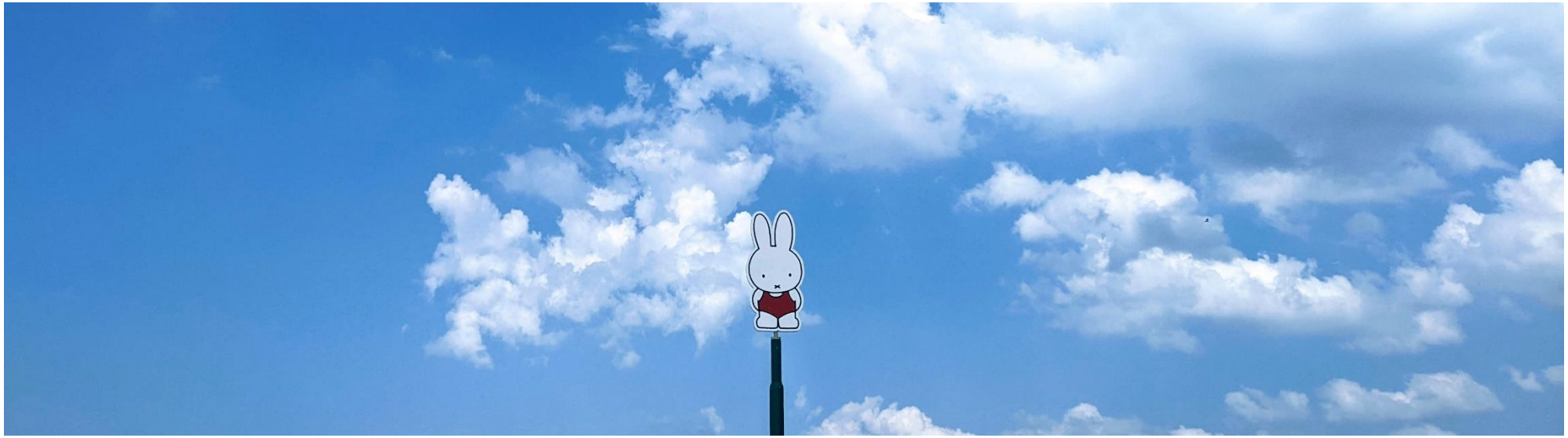
The big

BUT

Is it enough?

Thank You



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Route Services

Putting passengers first

Postscript

NetworkRail

‘It is better to ask some of the questions that to know all of the answers’

- James Thurber

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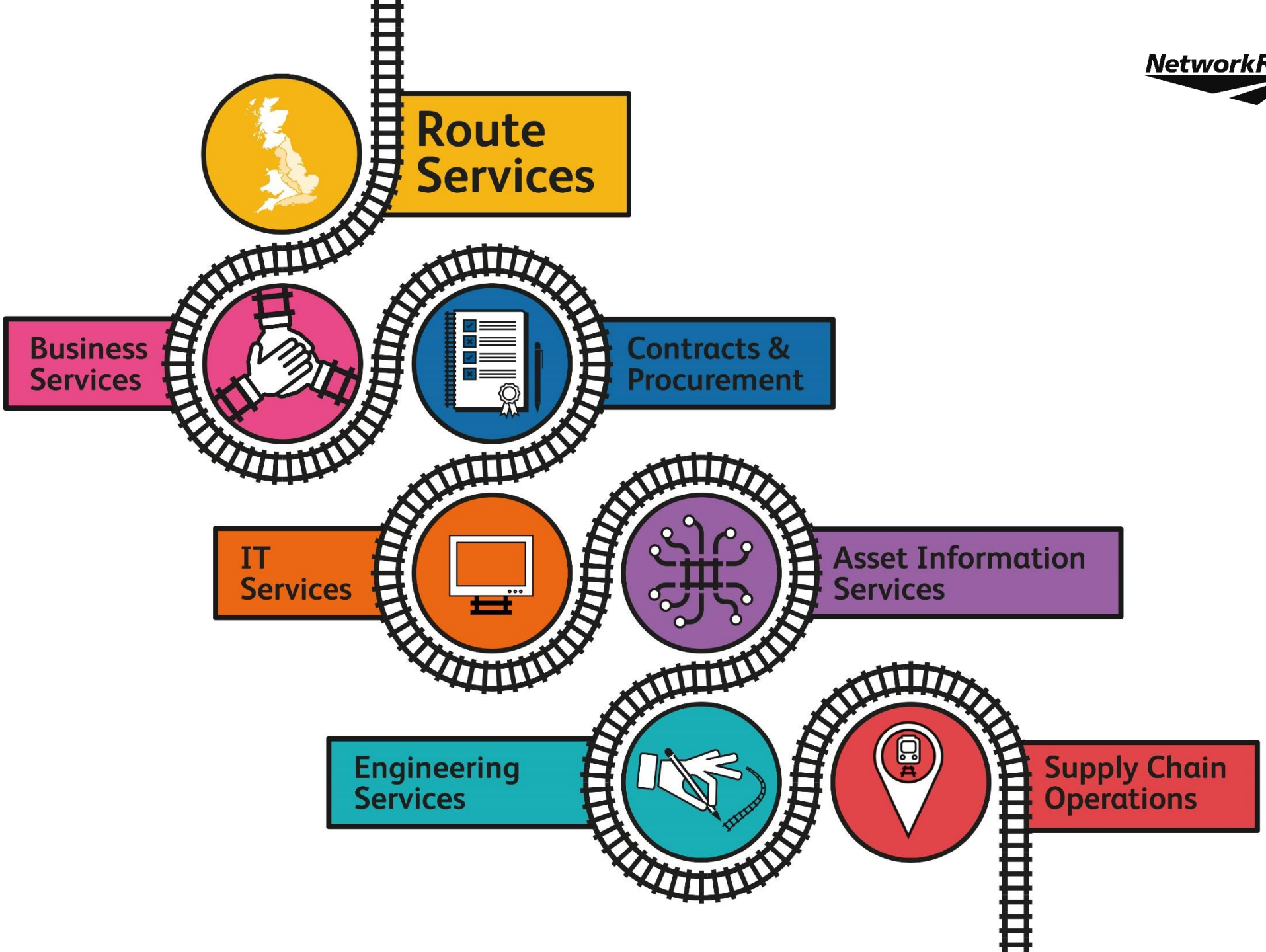

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NetworkRail

everyone
home safe
every day

Route
Services