University College London

The Information City

Cities in the Next 100 Years

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Outline

- The Kaleidoscope of the Information City
- Information Everywhere: A Walk Through the City
- Different Ideas About Smart Cities: Information, IoT, Big Data, Learning and Virtual Realities
- Real Time Streamed Data: Open Data, Big Data
- Dashboards, Portals & Gateways to the Digital World
- Transit: Automating the City
- Individual Data, Social Media: What Does It All Mean
- Future Form and Function: The Great Disconnect
- Cities in the Next 100 Years

The Kaleidoscope of the Information City

- The development of computers has brought a real dilemma to science – traditionally we use computers to understand and to predict
- But what happens when the very stuff you are predicting is made of computers - often the same computers
- This dilemma is everywhere – in this room – I am showing you a powerpoint – on a computer which is part of the infrastructure of the environment, you are doing your email on another one, and so on
- But I can run my model on the same computer as I am showing you this and so on – ad infinitum

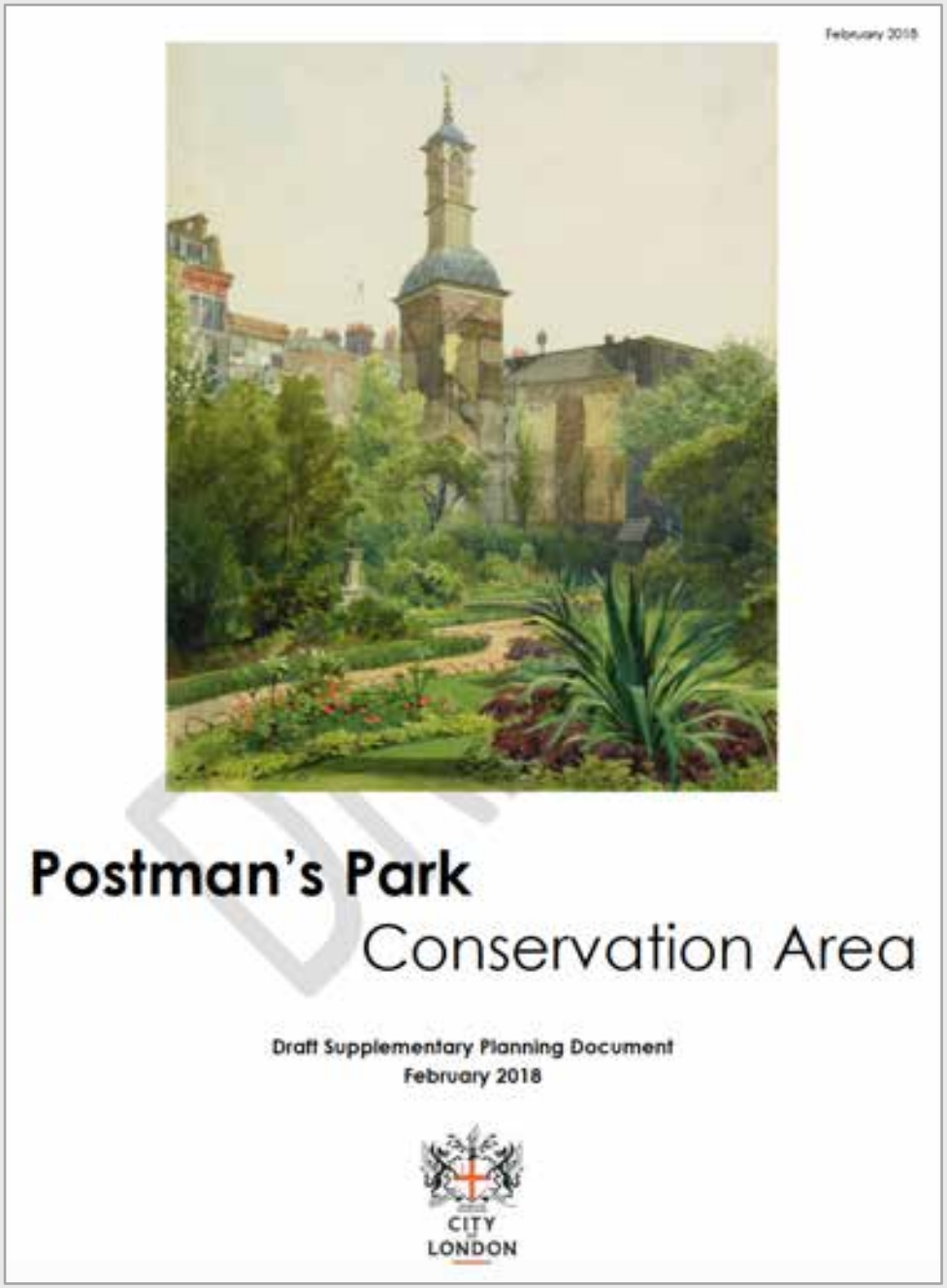
- And I can use my computer to link to many other ones across the ether – everywhere
- All this happening to systems that are not digital – so inevitably all this is getting more complex – much more complex when digital is fusing with material this is happening quickly – it is confusing
- To an extent using computing for predicting and for communicating – is a little different from much more routine functions – moving around. Think of your own use of phones and smart cards
- This is all about information flow – cities of course are information flows – definitions from people like Lewis Mumford to Jane Jacobs and Ed Glaeser define cities as places where information flows

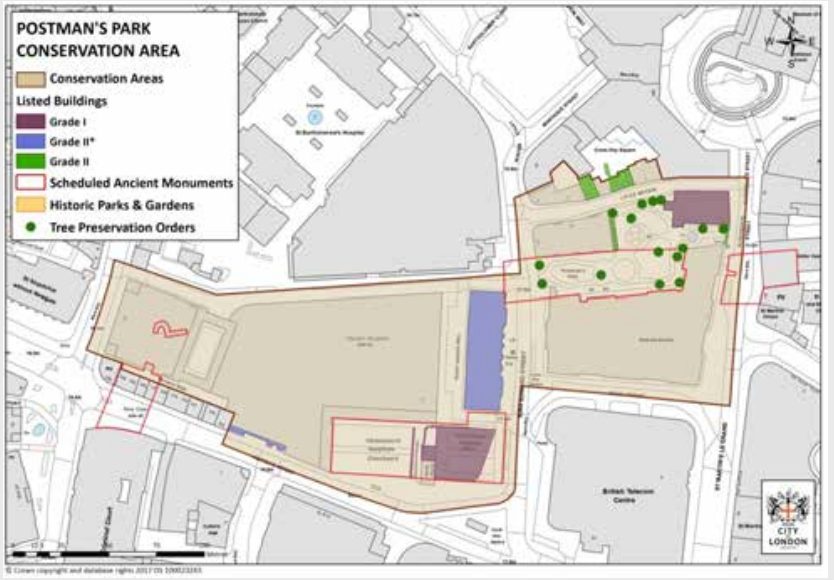
- Key issue is that much of this new stuff and a good deal of the old stuff is ***invisible*** – we can't see it – we can't measure it – and if we can't do this, we don't get much agreement about it – in short we cant develop good science
- And much of the new stuff is digital mixing with manual – ethereal rather than physical or material
- Let me illustrate this invisibility by posing the question as follows – many people come up to me and say – what is the smartest city in the world, is London a smart city, how much smarter is one city or another
- Well there is no answer to this and as you peel back the layers of the city its smartness in terms of information will be revealed

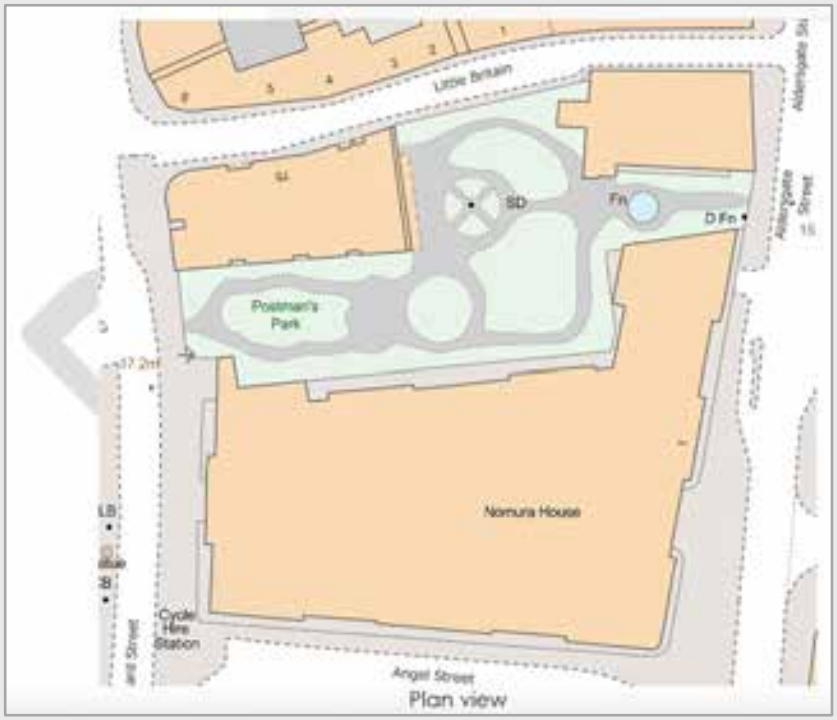
- So let me explore a pretty traditional city with respect to information. I will begin by looking at a small bit of the central city
- Now if we look at the centre, this is where the markets are and one might expect a cluster of IT. Of course. But can we see it? – yes and no – and if cities have always been about information – then let us see how all this is changing
- We will begin at the centre of the post code system
- EC1A 1AA
- In fact it is in the city of London near St. Pauls and historically we will see it is full of information ….

Information Everywhere: A Walk Through the City

- Let me start with a report that I received recently. This is about the area where I live, a small part of central London which is a conservation area. It is a report about how to maintain and improve an area of very high historic value.
- It is a tiny area which is surrounded by listed buildings which cannot be touched but it is subject to enormous development pressures.
- Apart from the way it was delivered to me – by email – and accessible on the web – it does not mention IT or computers once ! Not quite – it uses Google Maps

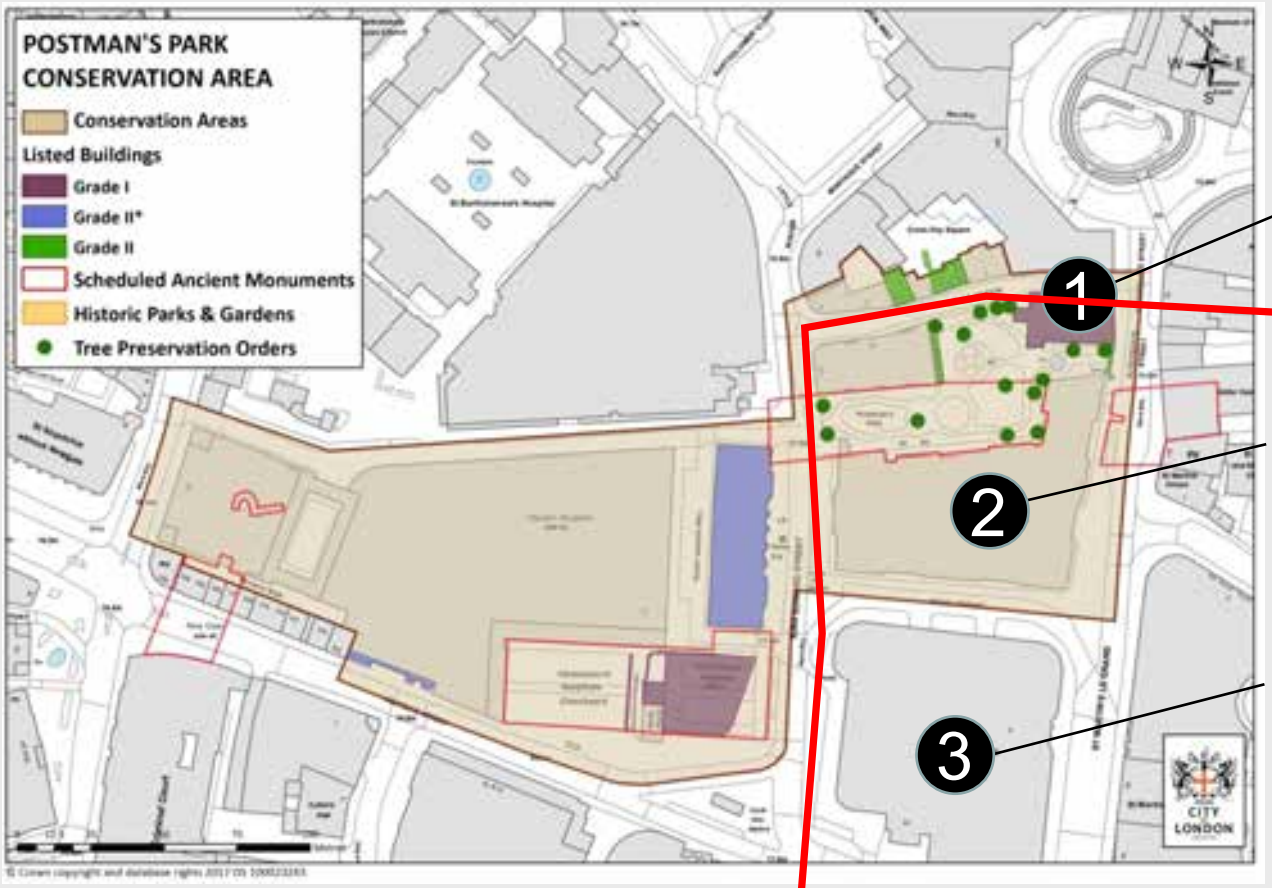

February 2018
Postman's Park
Conservation Area
Draft Supplementary Planning Document
February 2018
CITY
LONDON


POSTMAN'S PARK
CONSERVATION AREA
Conservation Areas
Listed Buildings
Grade I
Grade II*
Grade II
Scheduled Ancient Monuments
Historic Parks & Gardens
Tree Preservation Orders
CITY
LONDON


Little Britain
Aldersgate St
SD
Fn
D Fn
Postman's Park
Namura House
Cycle Hire Station
Angel Street
Plan view

View looking NE from Postman's Park: map view

View from within Postman's Park



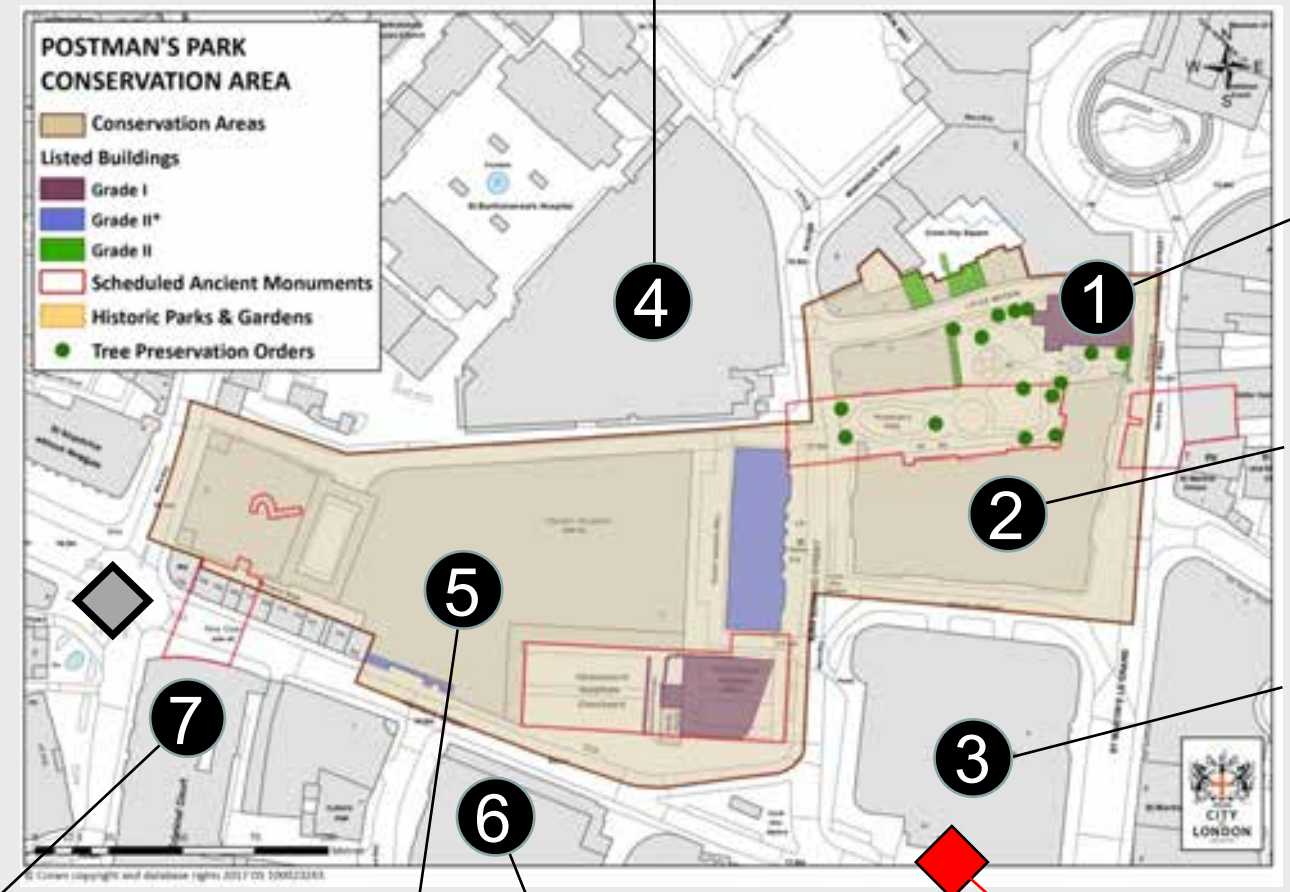
Georgian Church

Nomura Bank – General Post Office 1880

BT (British Telecom HQ)

THE POST OFFICE, ST PAUL'S CATHEDRAL, and BULL & MOUTH INN,
LONDON in 1829.

Barts Hospital



Georgian Church

Nomura Bank – General Post Office 1880

BT (British Telecom HQ)

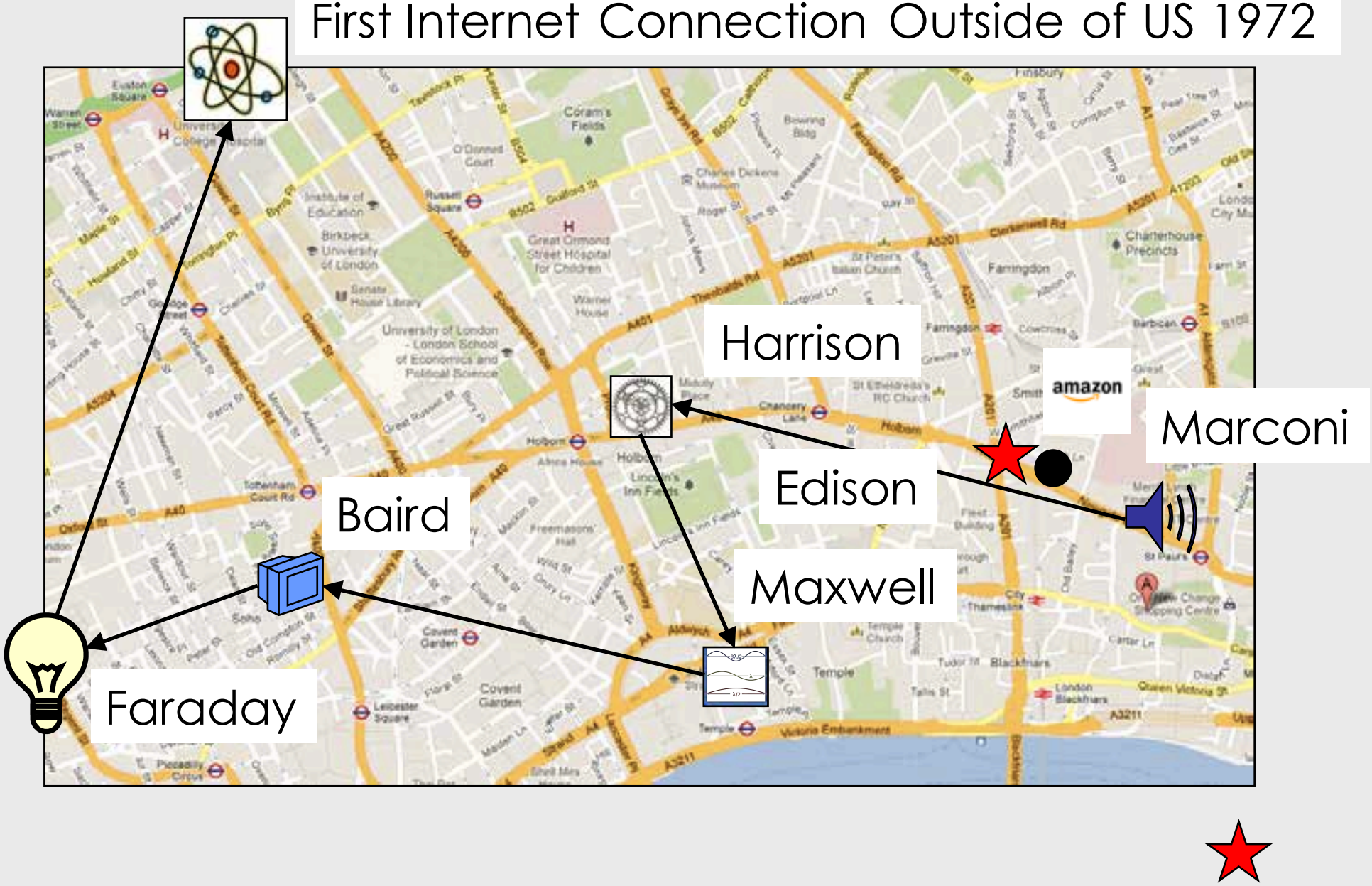
Central Criminal Court (Old Bailey)

New London Stock Exchange

Meryll Lynch – Bank of America

Marconi sent the first wireless signal ever in 1896

First Internet Connection Outside of US 1972



Marconi, 1890s

Marconi made the first public wireless transmission from the General PO Office to PO Office South in 1896


58 OGDENS


Amazon London Office - Holborn office Look amazing - Amazon Leadenhall Unique Building
1:37 / 2:51

John Harrison, Clockmaker to the Board of Longitude, 1750s

John Harrison invented mechanical clocks that worked at sea so position could be determined accurately – longitude, that is

Maxwell, Physicist, 1860s

$$dU = TdS - PdV \implies \left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$$

$$dA = -SdT - PdV \implies \left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$$

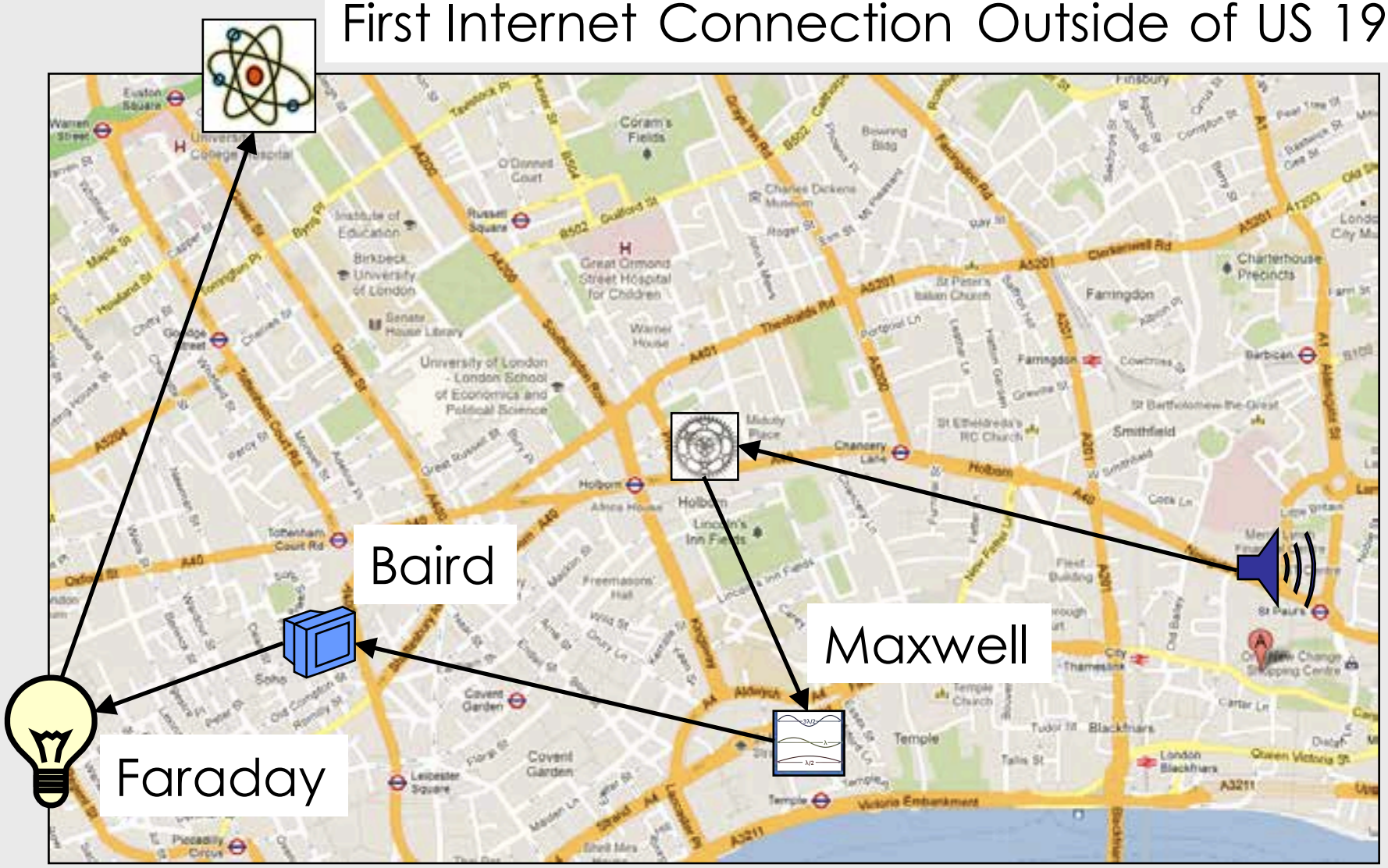
$$dH = TdS + VdP \implies \left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$$

$$dG = -SdT + VdP \implies -\left(\frac{\partial S}{\partial P}\right)_T = \left(\frac{\partial V}{\partial T}\right)_P$$

Maxwell pulled it all together at Kings in 1860

Note Bush House, the original home of the BBC World Service is nearby

First Internet Connection Outside of US 1972



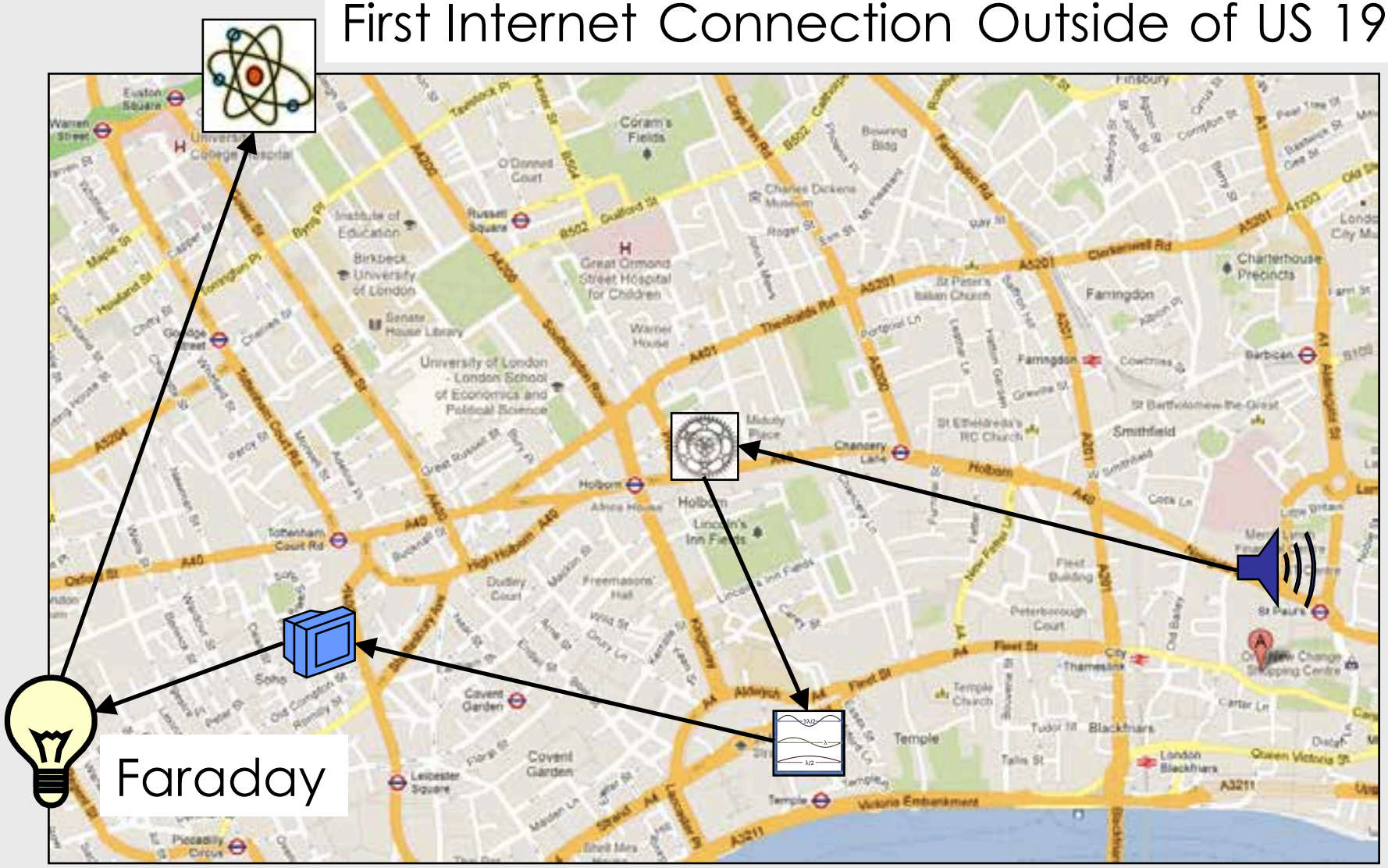
Baird, Inventor of TV, 1926

John Logie Baird demonstrated TV for the first time in 1925-1927 in London's Soho

Faraday, Electromagnetism, 1820s

Michael Faraday explores electromagnetism in the 1820-30's at the Royal Institution

First Internet Connection Outside of US 1972



| NEWS |

UCL celebrates Internet pioneers

On Tuesday 18th November UCL celebrated the 30th anniversary of the first international link to the ARPANET: the precursor to the Internet, by granting Honorary Fellowships to Dr Robert E. Kahn and Dr Vinton G. Cerf, who conceived of the original Internet Protocol which made the Internet possible.

Dr Khan receives his award from UCL Provost Professor Malcolm Grant

The award ceremony was one of a number of events taking place during a week-long celebration of that historic milestone in the emergence of the global Internet. Dr Kahn, Dr Cerf and other Internet pioneers participated in these events, which were organised jointly by University College London and the Internet Society (ISOC).

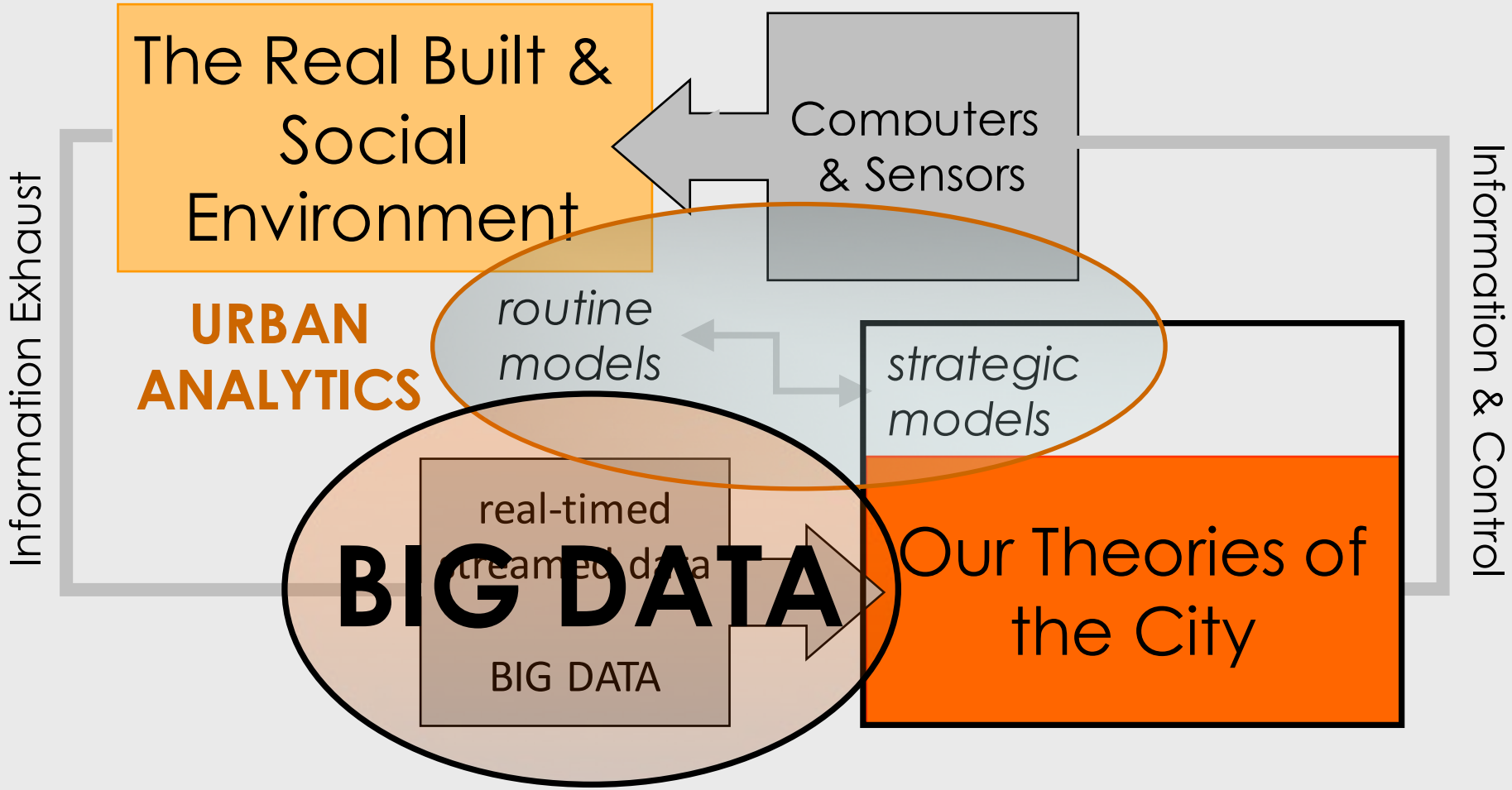
Different Ideas About Smart Cities:

My walk through the 'smart' city illustrates that ICT or IT touches all our lives, and it is only to be expected that in an age when most of our material world is at least being complemented, if not replaced, by the digital, we find it hard to make sense of it all.

- My walk did not reveal the use of smart technologies in planning and design in particular but they were there alright. If only in using our smart phones to Google everything in sight.

- So in terms of planning we must distinguish between the ***everyday, reactive, routine*** where IT is changing our behaviour, and our use of IT in a ***considered, strategic*** sense where we plan to change behaviour

Here is my interpretation of the paradox of using computers to understand systems – cities – built of computers – embedded into the physical environment



- So to summarize. Smart cities techniques and tools and concepts are not theory; they are what they say they are – tools to show us how to use information technologies to do many things we have done manually (or differently) in the past
- Elements of smart cities are everywhere. We hardly know we are using them, they are now so common.
- We don't have a theory, we have just lists of ideas. It's is hotch-potch. Nothing wrong in this but we have to see if for what it is
- It has certainly thrown time and the 24 hour city onto the agenda
- And last but not least we need to define ***Smart*** better

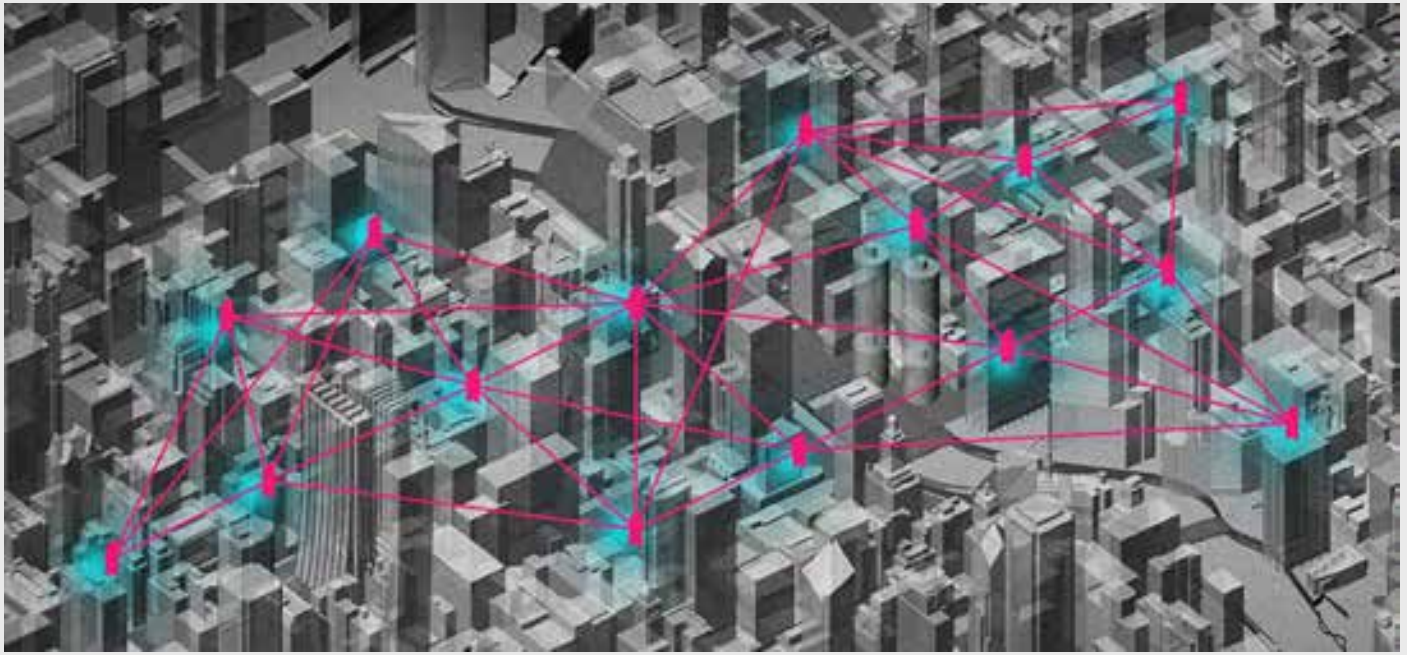
Real-Time Streamed Data: Open Data, Big Data

- Everywhere we are now seeing the hardware of how we measure the city in real time appearing
- We are seeing massive volumes of data being streamed from simple ubiquitous sensors
- Data is now available within the given limits of confidentiality at an individual level
- More and more data is open; and this data is often big, meaning it 'won't fit into an Excel spreadsheet' my definition
- Let us look at some examples that are familiar

Cameras capturing people and vehicles

Telephone masts – cell towers

Wifi Kiosks, Massive telecoms towers mobile phone masts, pollution monitors



More pollution monitors

Chicago's Array of Things

Dashboards, Portals & Gateways

- I could go on for a long while but I need to get to how we can use all of this stuff. But first how all-embracing are these new real time streamed data. Dashboard and portals are emerging everywhere

http://www.citydashboard.org/

London Panopticon

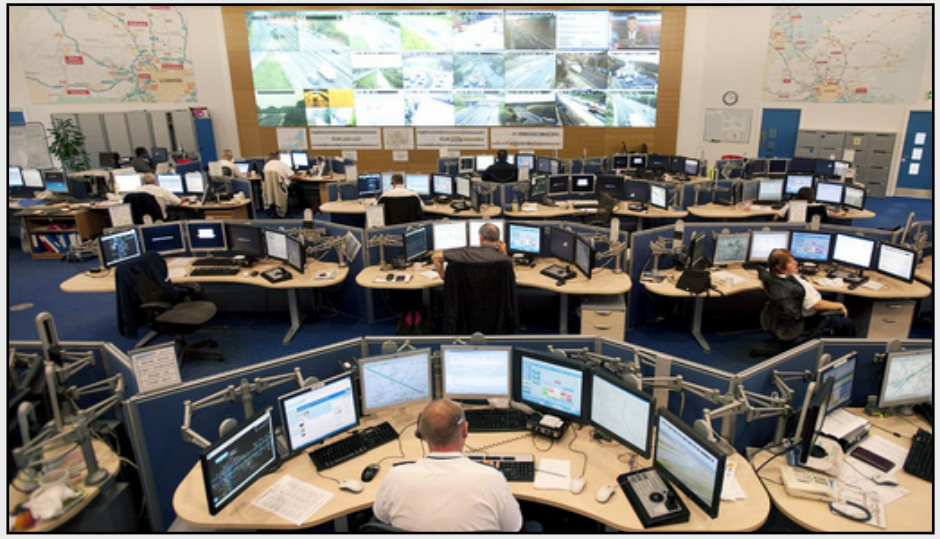
6 April 2016 London

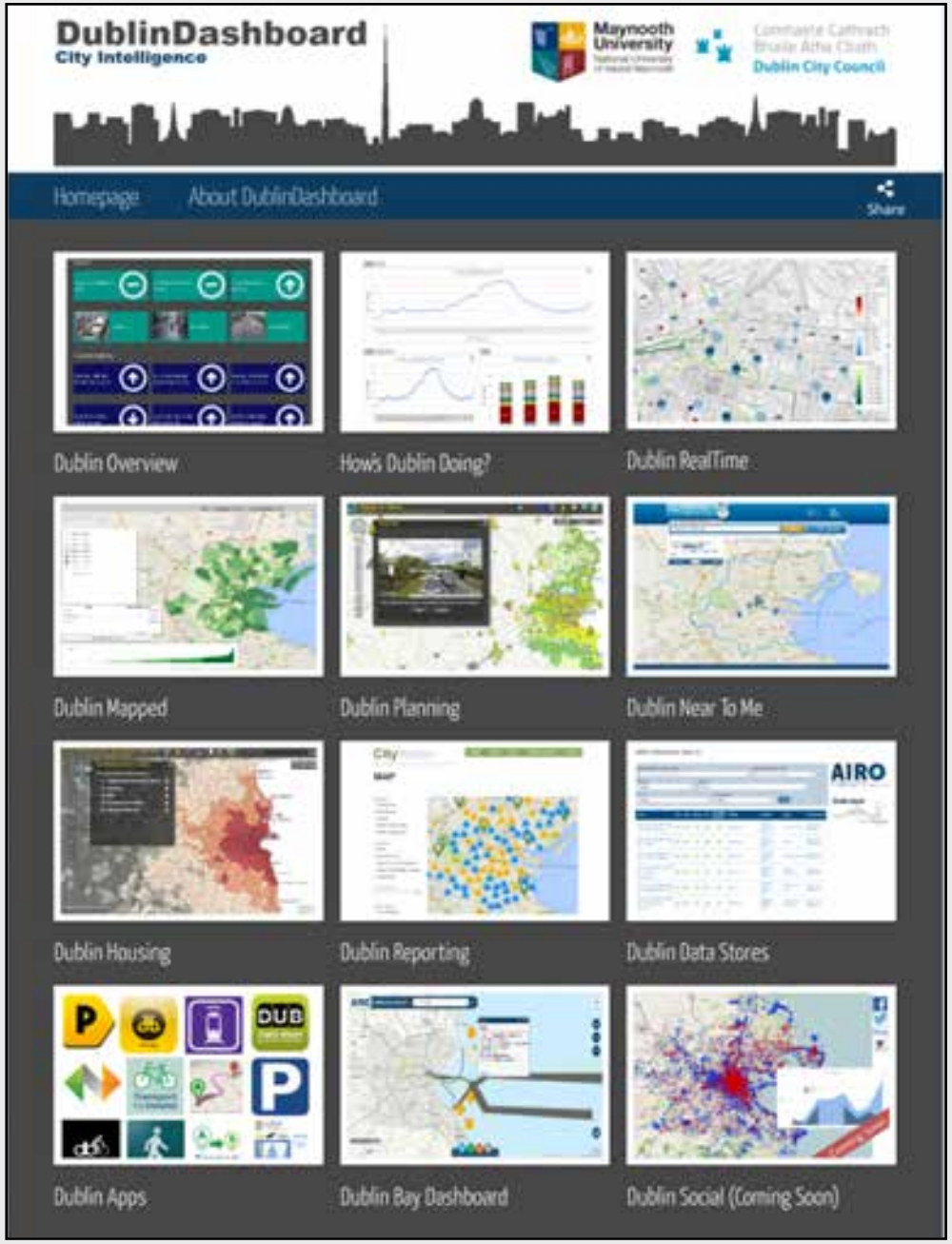
http://vis.oobrien.com/panopticon/

Tweet Like Share 0

Traffic control systems in London


CENTRO DE OPERAÇÕES
PREFEITURA DO RIO

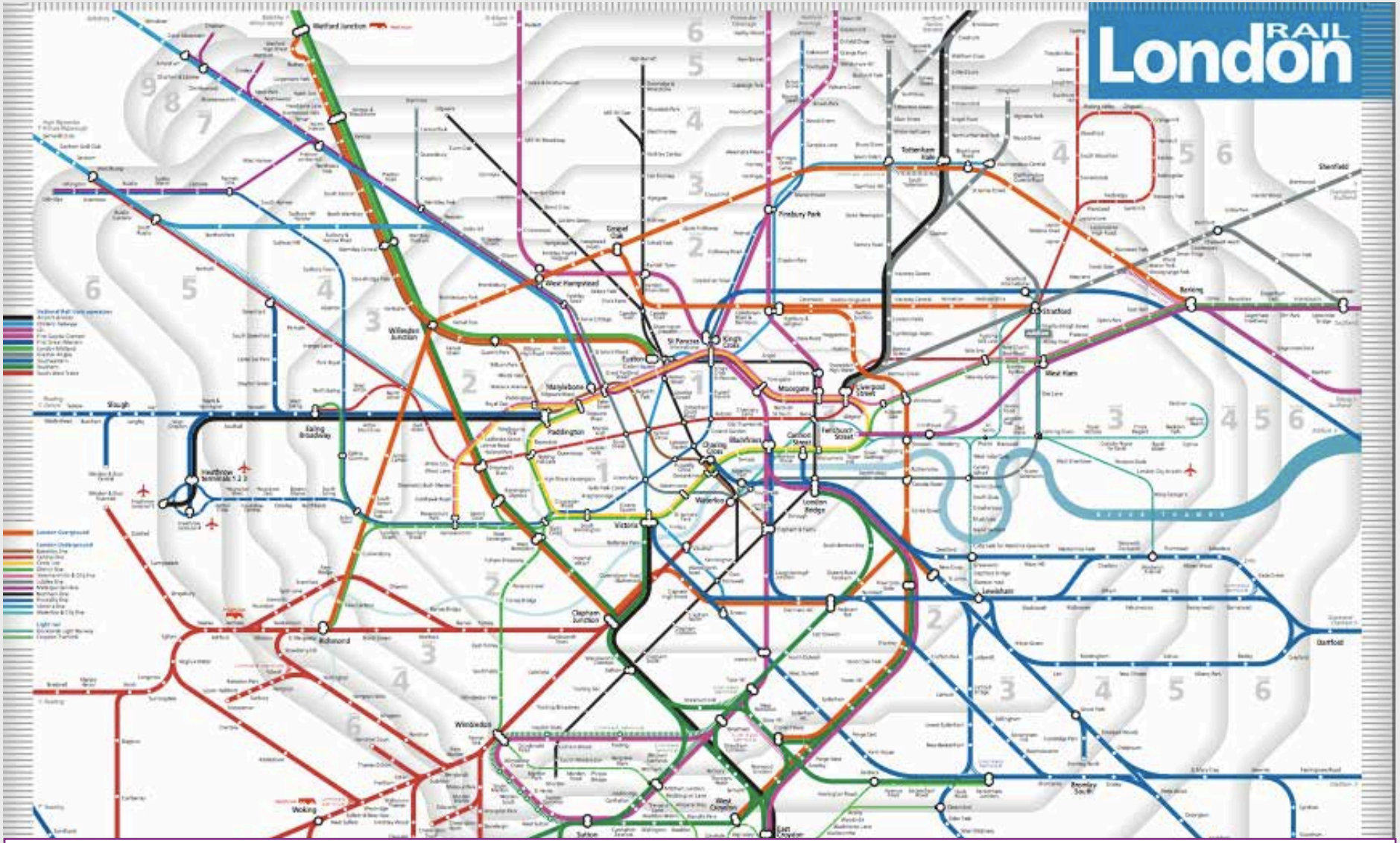



DublinDashboard
City Intelligence
Maynooth University
Dublin City Council
Homepage
About DublinDashboard
Share
Dublin Overview
How's Dublin Doing?
Dublin RealTime
Dublin Mapped
Dublin Planning
Dublin Near To Me
Dublin Housing
Dublin Reporting
AIRO
Dublin Data Stores
Dublin Apps
Dublin Bay Dashboard
Dublin Social (Coming Soon)


CITY of BOSTON
Employee Demographics
Gender
Annual Rate
Tenure - Years
Ethnicity
Annual Rate
Tenure - Years

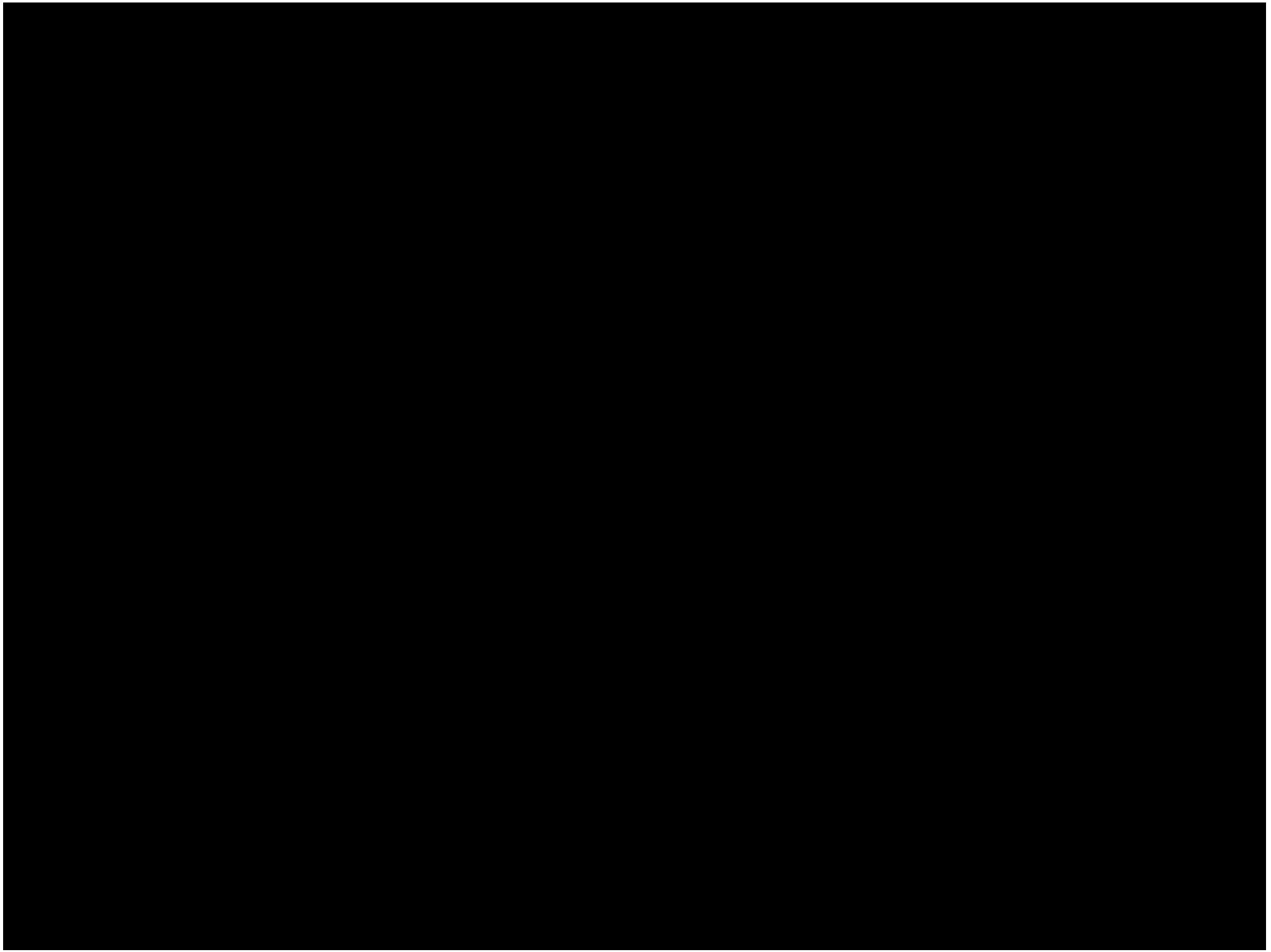
Transit: Automating the City

- Tap at **start** and **end** of train journeys
- Tap at **start only** on buses
- Accepted at 695 Underground and rail stations, and on thousands of buses
- **Many Variants of the Data Sets**
- **991 million** Oyster Card taps over Summer 2012 – this is big data
- Quality of Data
- What Can We Use It For
- Missing Data and Noise



Tube, Overground and National Rail Networks in London where Oyster cards can be used


UCL ENGINEERING
Change the world
UCL
Menu
Home » Projects » Oyster gives up pearls
OYSTER GIVES UP PEARLS
How studying millions of Oyster Card journeys reveals London's 'polycentres'
Researchers from UCL have analysed millions of Oyster Card journeys in a bid to understand how, why and where we travel in London.
Professor Michael Batty (UCL Centre for Advanced Spatial Analysis) and Dr Soong Kang (UCL Management Science and Innovation) applied the techniques of statistical physics to their mountain of raw data.
The pair joined forces with a computational social scientist and a physicist, both based in Paris, to explore patterns of commuting by tube into central London.
UCL Engineering - Oyster Gives up Pearls
They used Transport for London's database of 11 million records taken over one week from the Oyster Card electronic ticketing system.
Latest news from UCL Engineering
New web privacy system could revolutionise the safety of surfing
UCL host Google Girls Coding Programme with Generating Genius and University of West Indies
Professor Palma Bayval to Give Royal Society Lecture
Twitter feed
Join our mailing list



And how can we make sense of this

http://www.simulacra.info/

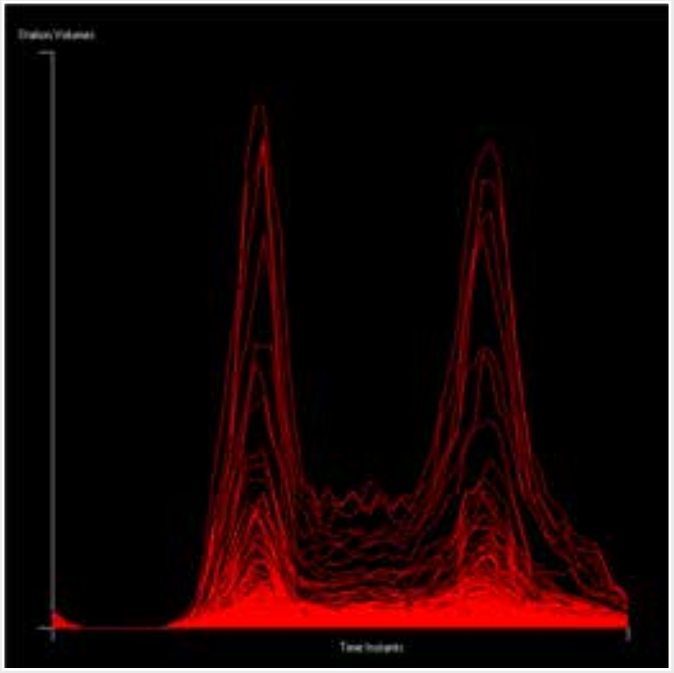


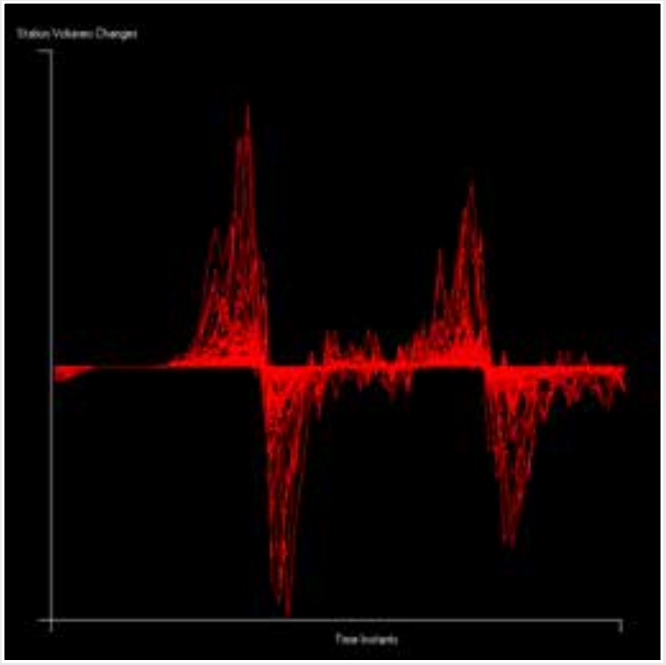


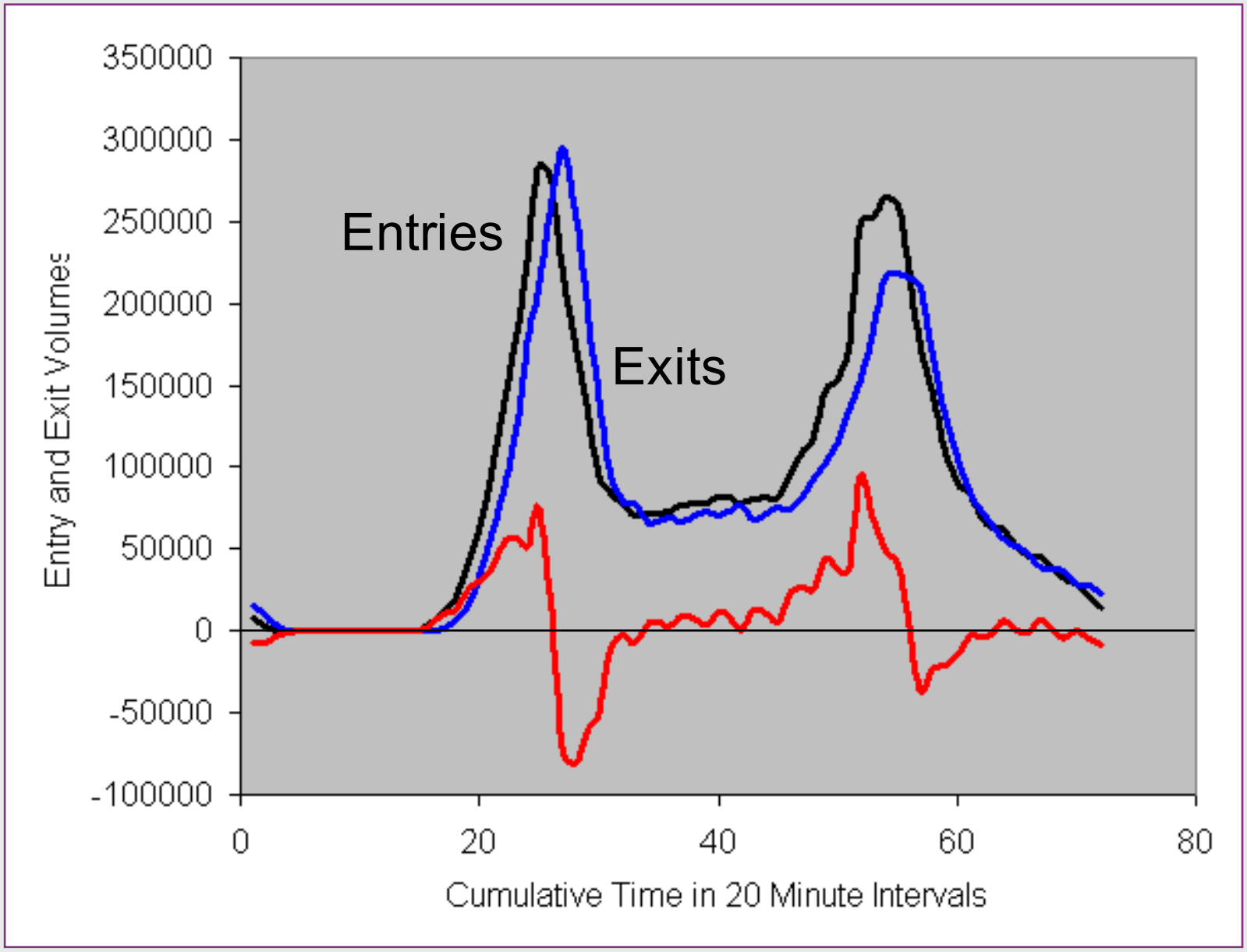
This of course was the thing that Lt Henry Harness did in Dublin in 1837 and what Minard et al. did a little later. In our LUTI models, this is an enormous problem as the scale of this assignment to networks is different

Variabilities – Heterogeneity and Travel Profiles

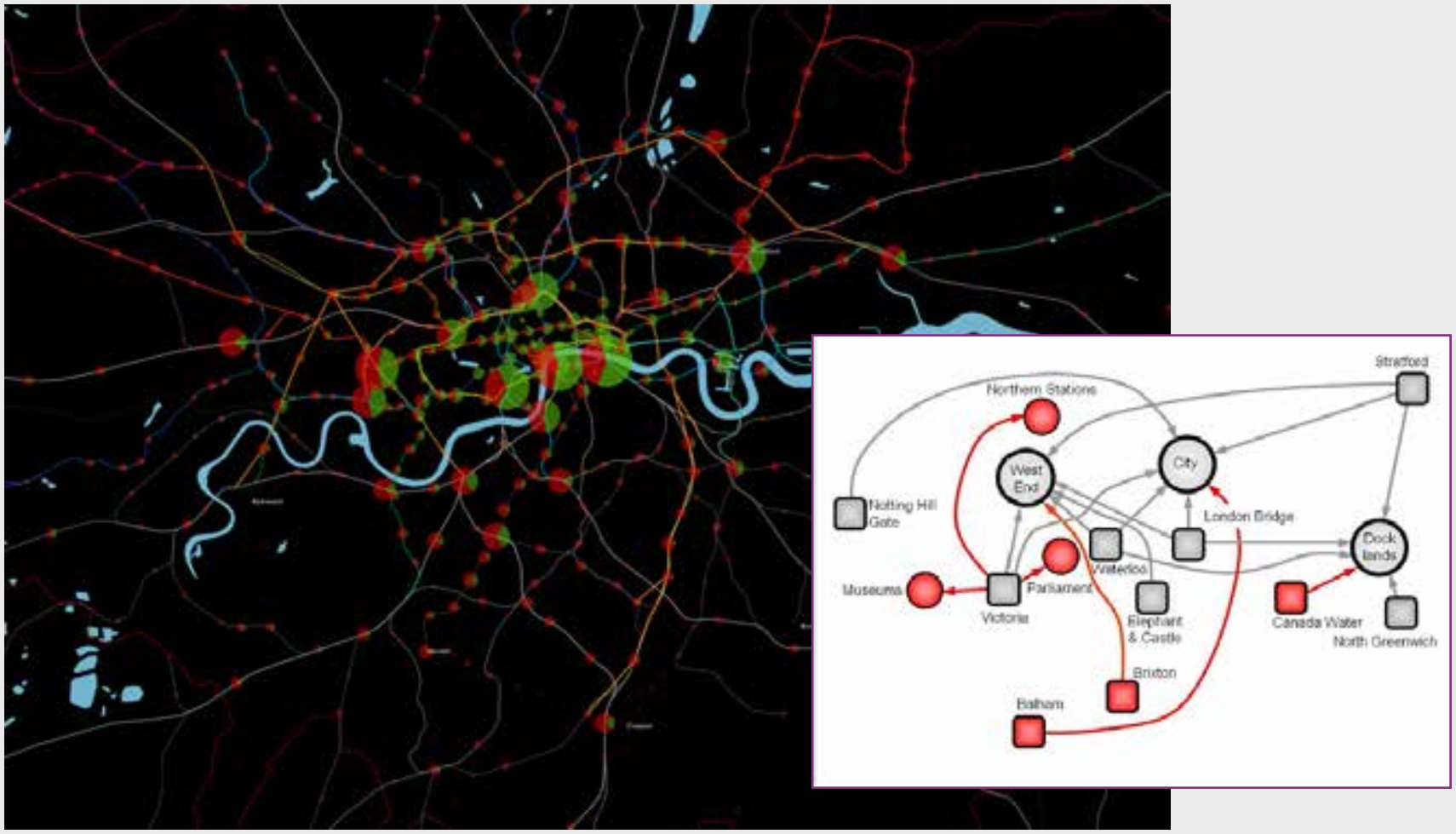
First we will look at some of the data and how it varies in terms of the diurnal flows usually morning and evening peaks, with a small blip (peak) around 10pm at night





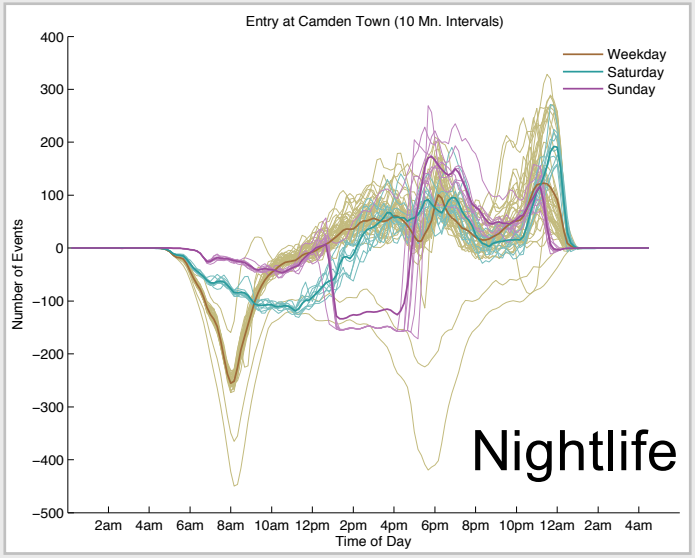

350000
300000
250000
200000
150000
100000
50000
0
-50000
-100000
Entry and Exit Volumes
Entries
Exits
0
20
40
60
80
Cumulative Time in 20 Minute Intervals

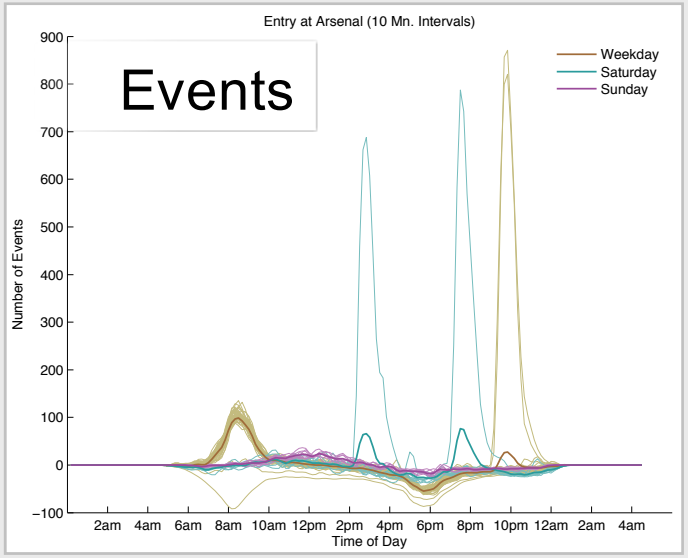
Oyster Card Data – interpreting urban structure, multitrips, etc.

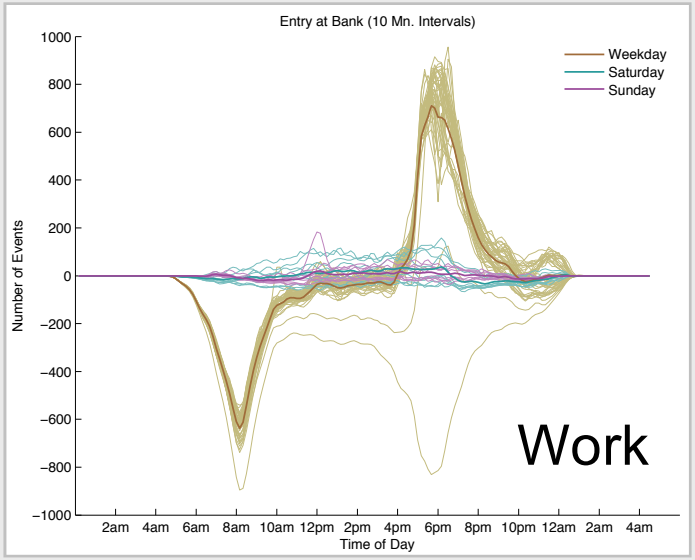


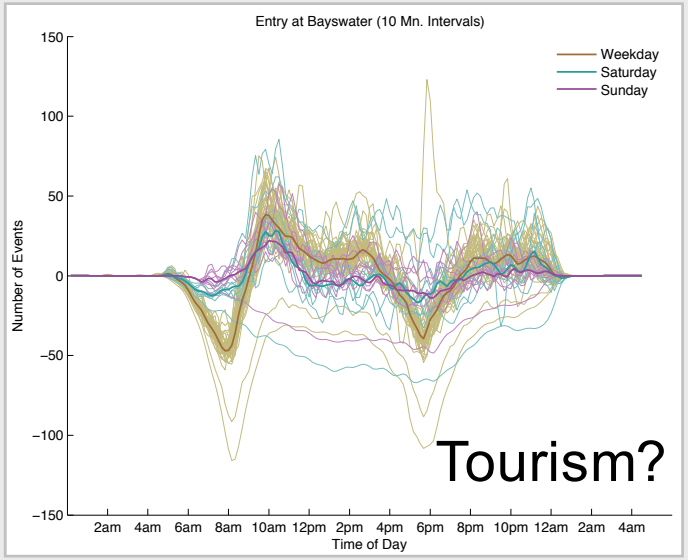
Roth C., Kang S. M., Batty, M., and Barthelemy, M. (2011) Structure of Urban Movements: Polycentric Activity and Entangled Hierarchical Flows. **PLoS ONE 6(1):** e15923. doi:10.1371/journal.pone.0015923

Particular Events: Weekdays, Saturdays and Sundays









Comparing Variability for different time intervals for Three World Cities: London, Beijing and Singapore

Table 1. Summary statistics of one-week of smart-card data (metro trips only)

	London	Singapore	Beijing
Monday	3,457,234	2,208,173	4,577,500
Tuesday	3,621,983	2,250,597	4,421,737
Wednesday	3,677,807	2,277,850	4,564,335
Thursday	3,667,126	2,276,408	4,582,144
Friday	3,762,336	2,409,600	4,880,267
Number of stations (1)	400	130	233
Number of tube line	13	4	17
Area (2)	1,572 km^2	718.3 km^2	2267 km^2
Total population (3)	8.63 million	5.3 million	21.15 million
Ridership of Metro	20%	35%	21%
Length of metro lines	402km	182km (MRT+LRT)	465 km

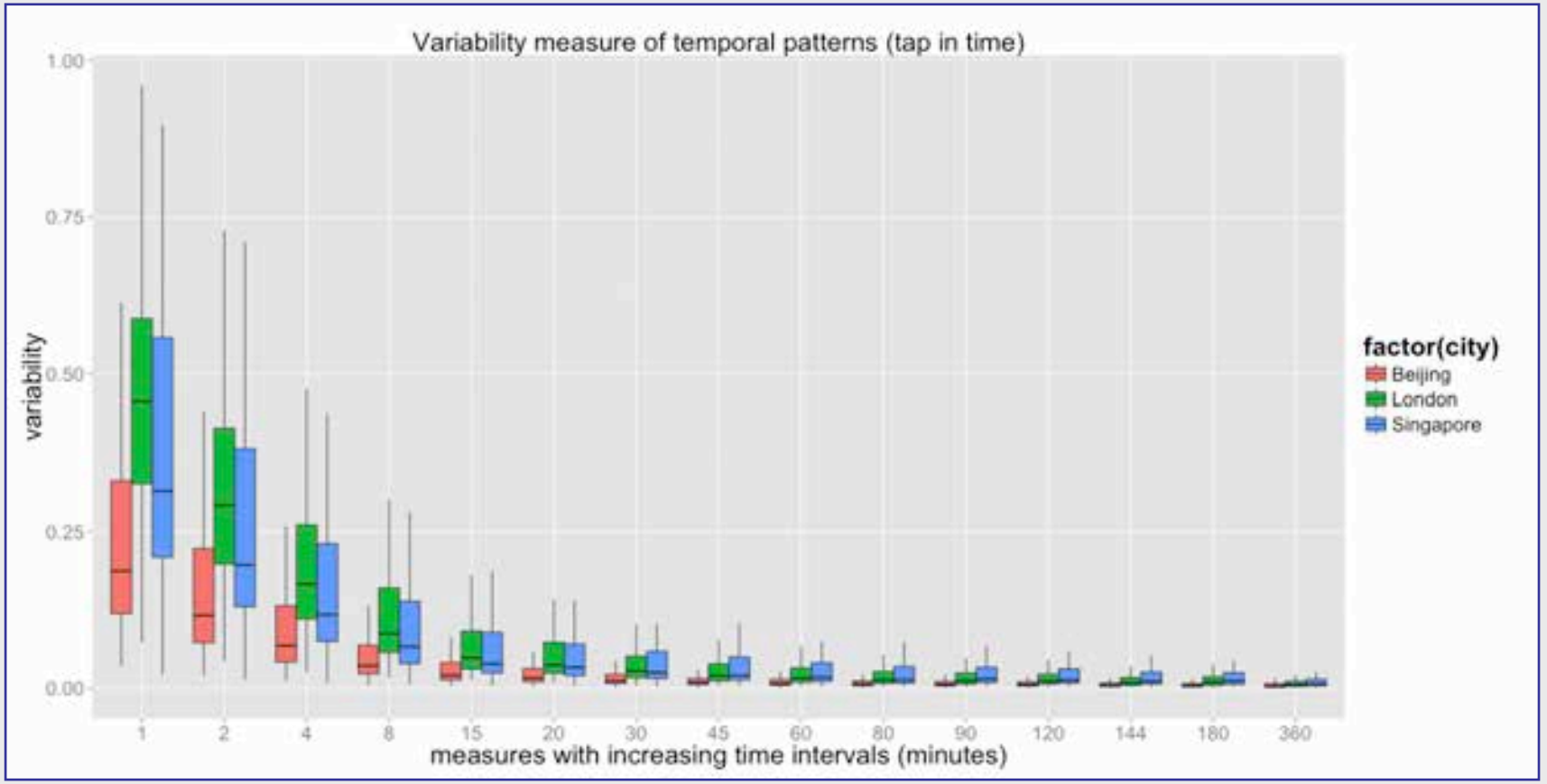
(1) Number of stations is the number of stations with smart-card records generated.

(2) The area of Beijing only counts the area enclosed by the 6th ring road for a fair comparison.

(3) From the World Population Review, http://worldpopulationreview.com/world-cities/ accessed 17 January 2016

Zhong, C., Batty, M., Manley, E., Wan, J., Wang, Z., Che, F., and Schmitt, G. (2016) Variability in Regularity: Mining Temporal Mobility Patterns in London, Singapore and Beijing using Smart-Card Data., **PLOS One**, http://dx.doi.org/10.1371/journal.pone.0149222

From 1 minute intervals to the whole day



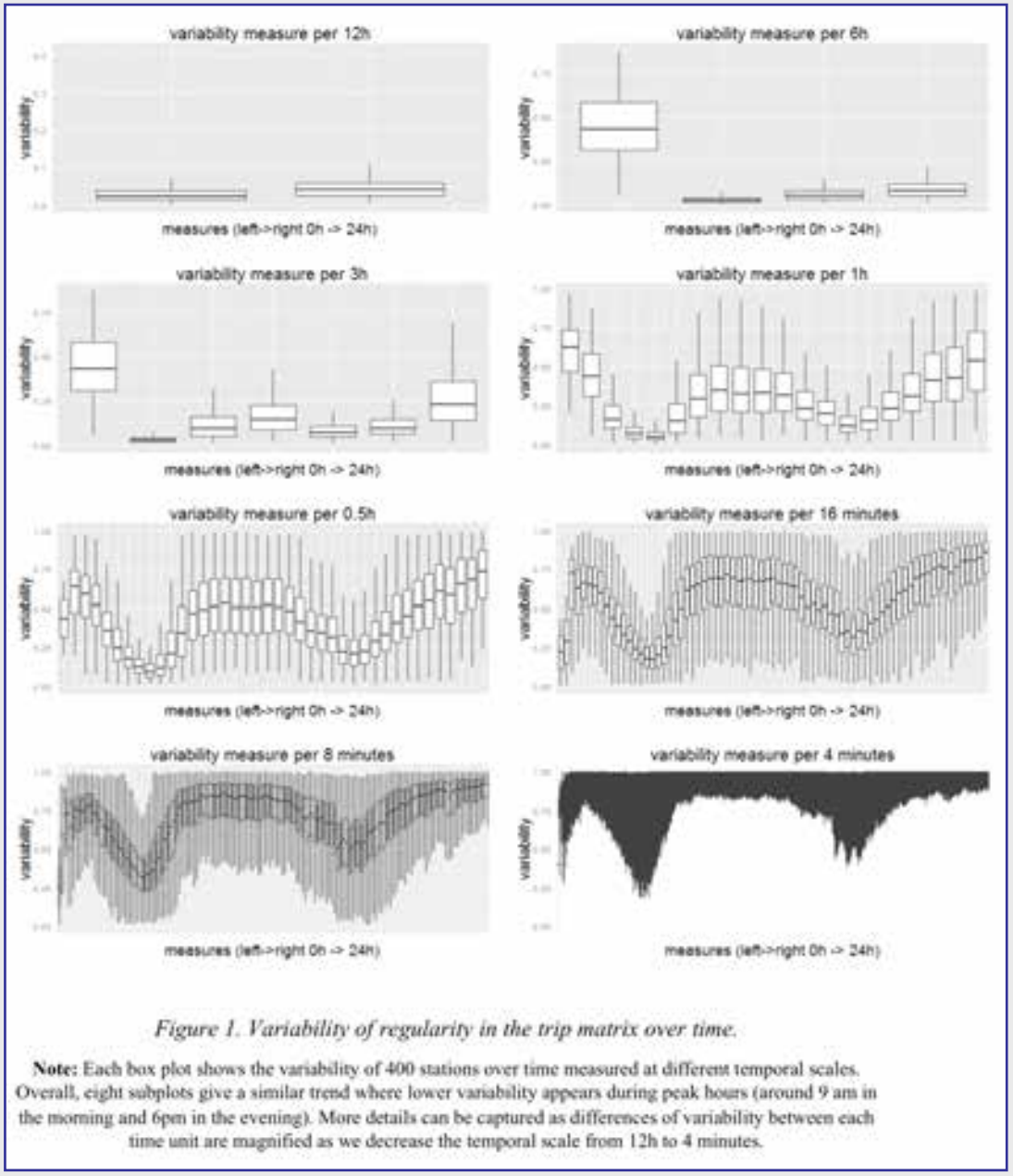
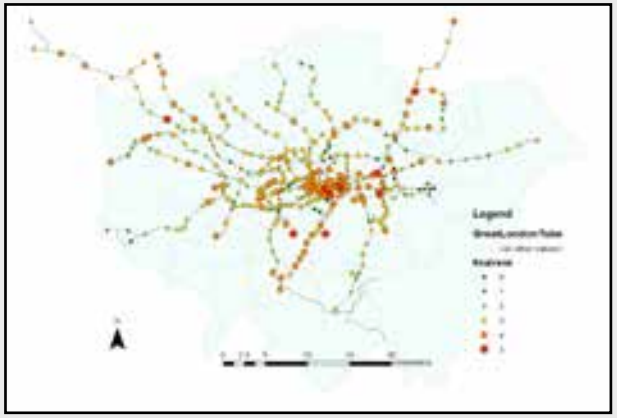


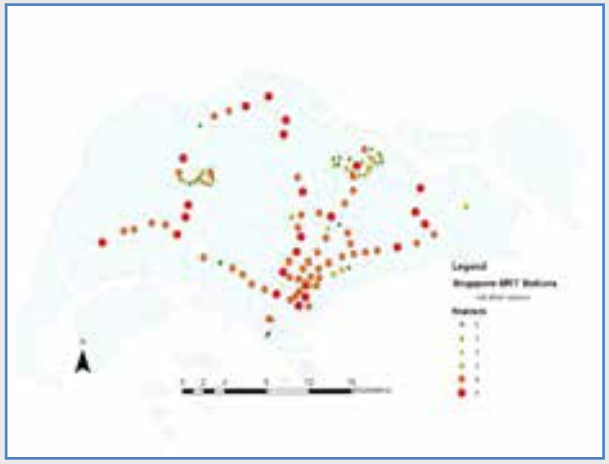
Figure 1. Variability of regularity in the trip matrix over time.

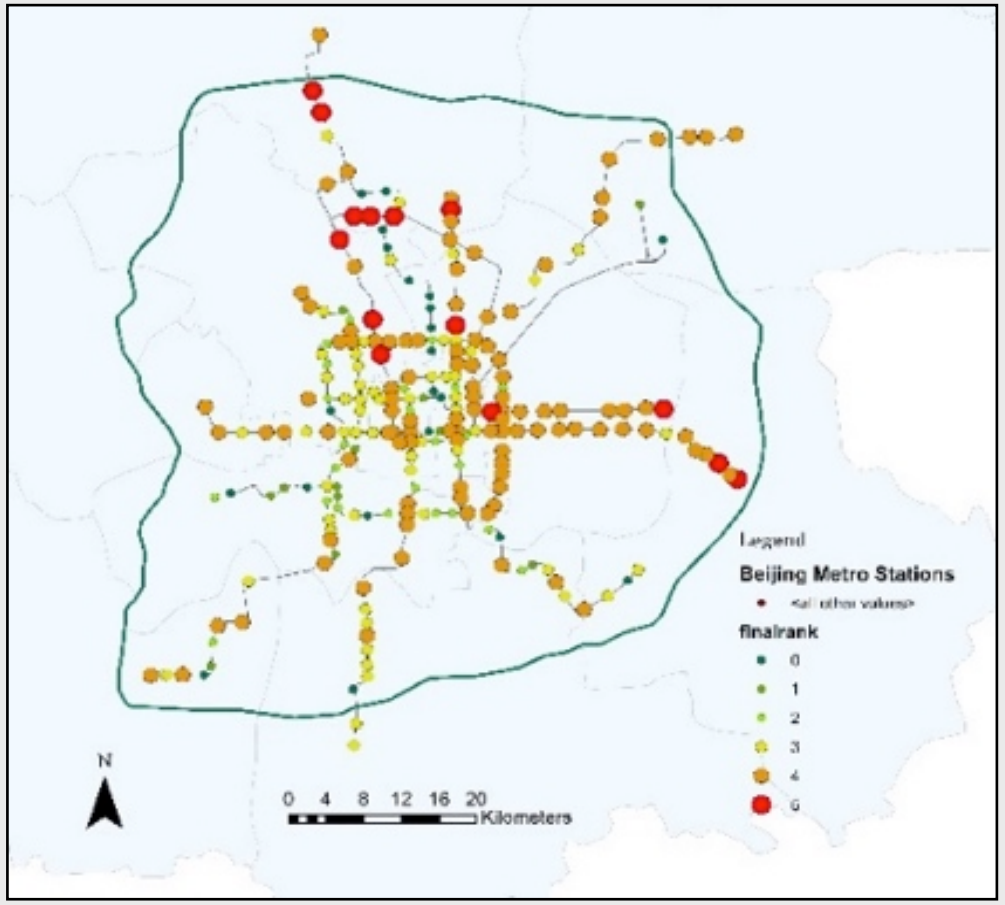
Note: Each box plot shows the variability of 400 stations over time measured at different temporal scales. Overall, eight subplots give a similar trend where lower variability appears during peak hours (around 9 am in the morning and 6pm in the evening). More details can be captured as differences of variability between each time unit are magnified as we decrease the temporal scale from 12h to 4 minutes.

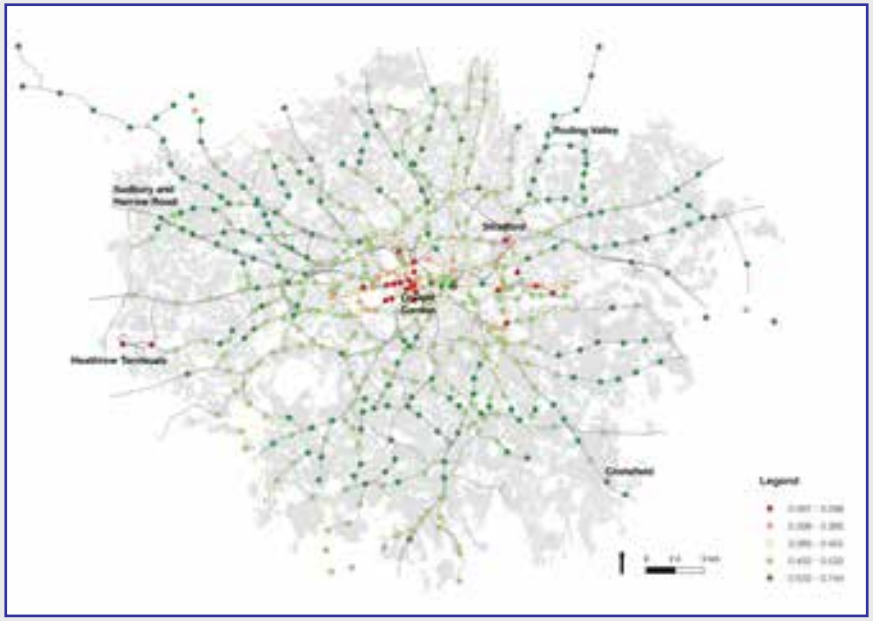
Comparing Variability for different time Intervals over the day

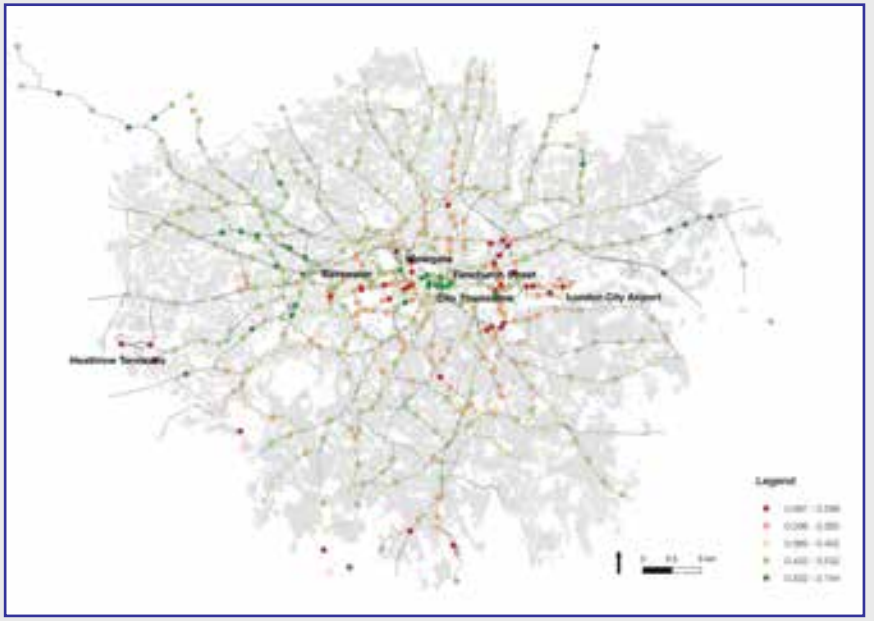
Comparing Variability for different time intervals for Three World Cities: London, Beijing and Singapore

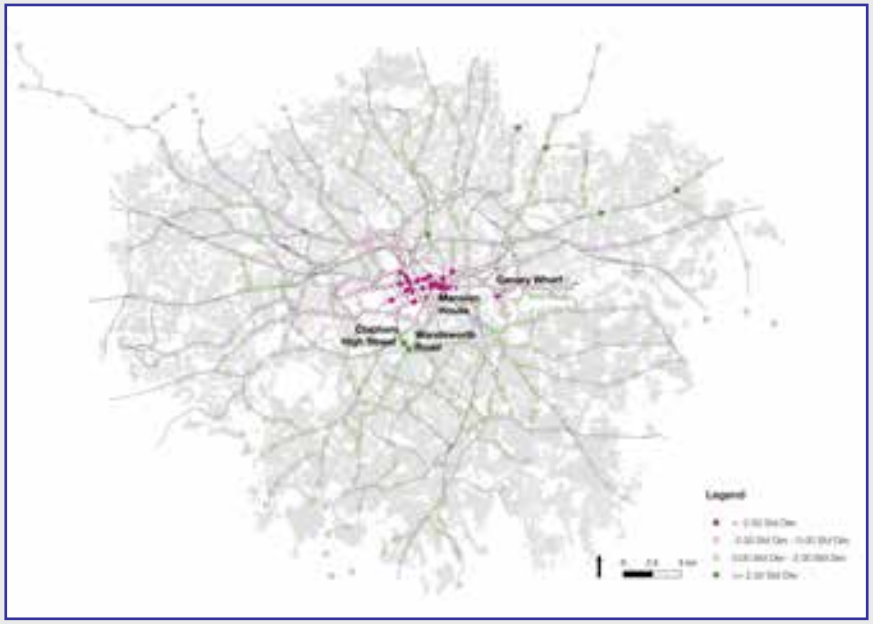












Maps of Underground and Rail stations in London visualised by the proportion of regular trips

originating at each location

ending at each location

starting and ending at each location

Disruptions – Routine Analysis of Daily Events

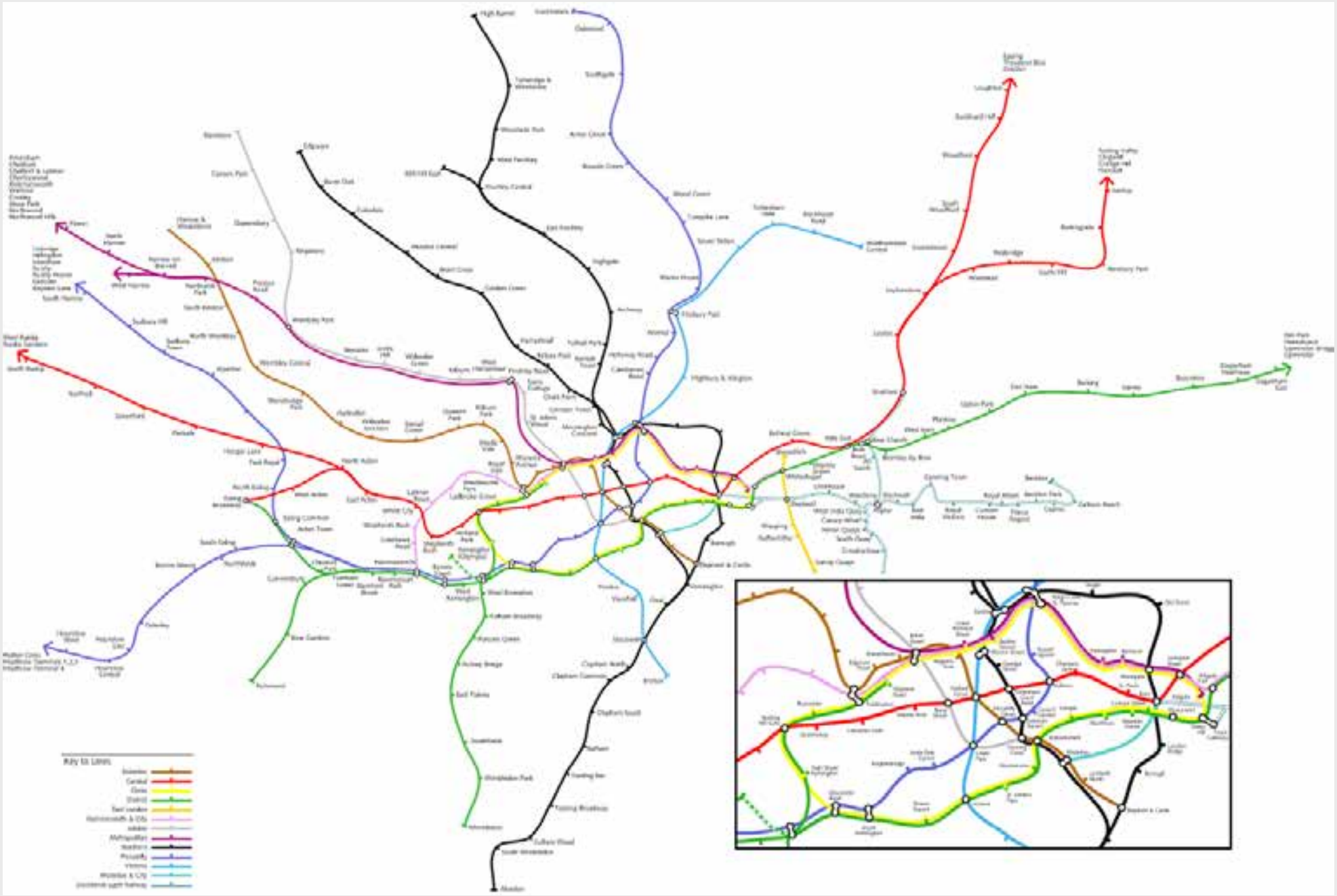
- Behaviours vary across network
- Different areas of network more resilient to disruption, due to available infrastructure and individual ability to change
- But areas of network are naturally closely tied through established usage patterns
- Individual-based analyses provide insight into behaviours underlying macroscopic flows

We will look at several kinds of disruption

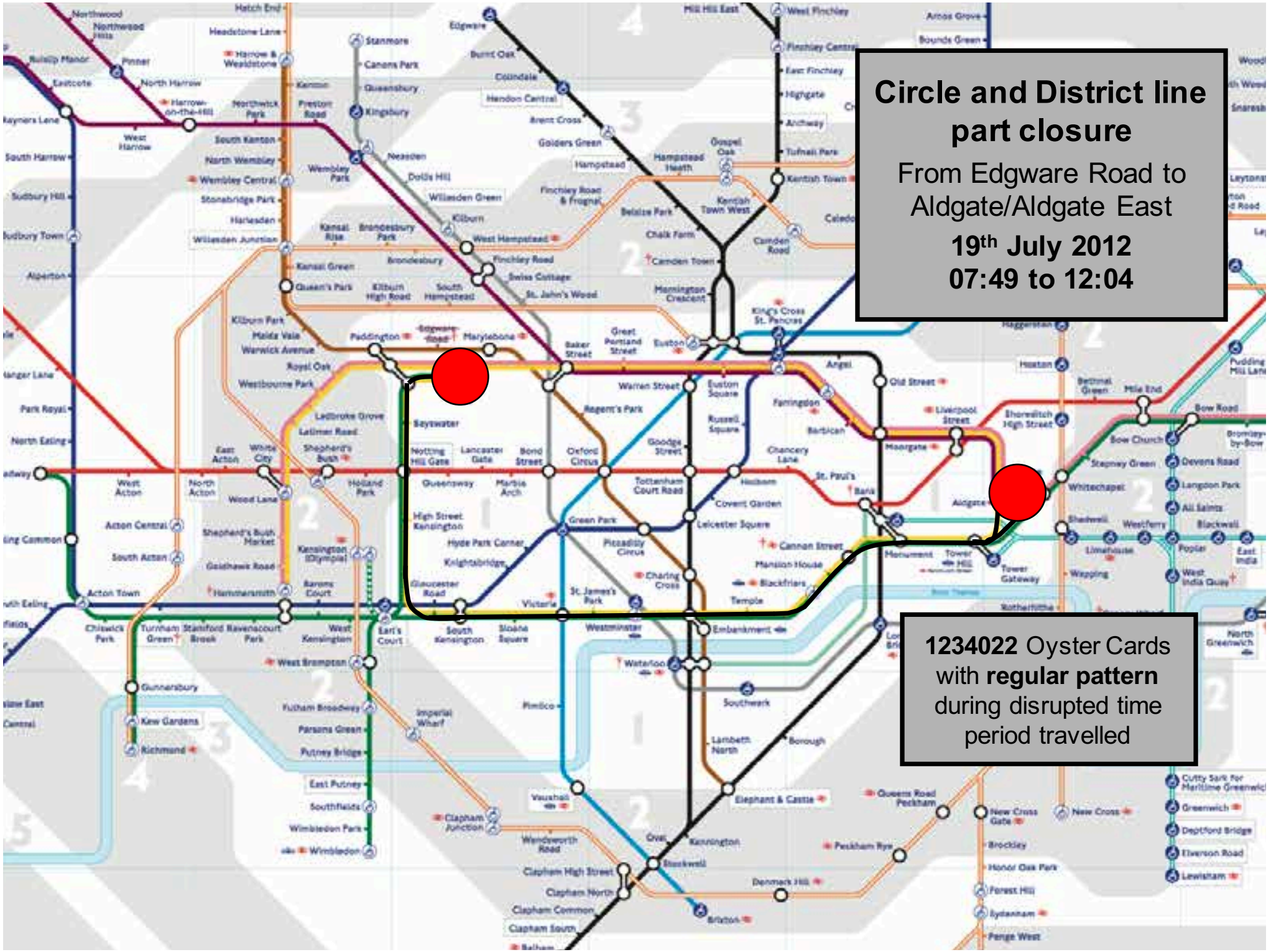
- First hypothetical disruptions simply by examining breaks in the network
- Then an example of the Circle and District Lines which had a 4 hour stoppage on July 19th 2012
- And a Bus Strike in East London and how this shows up in the data
- And typical pattern of delay on all modes visualised for Greater London

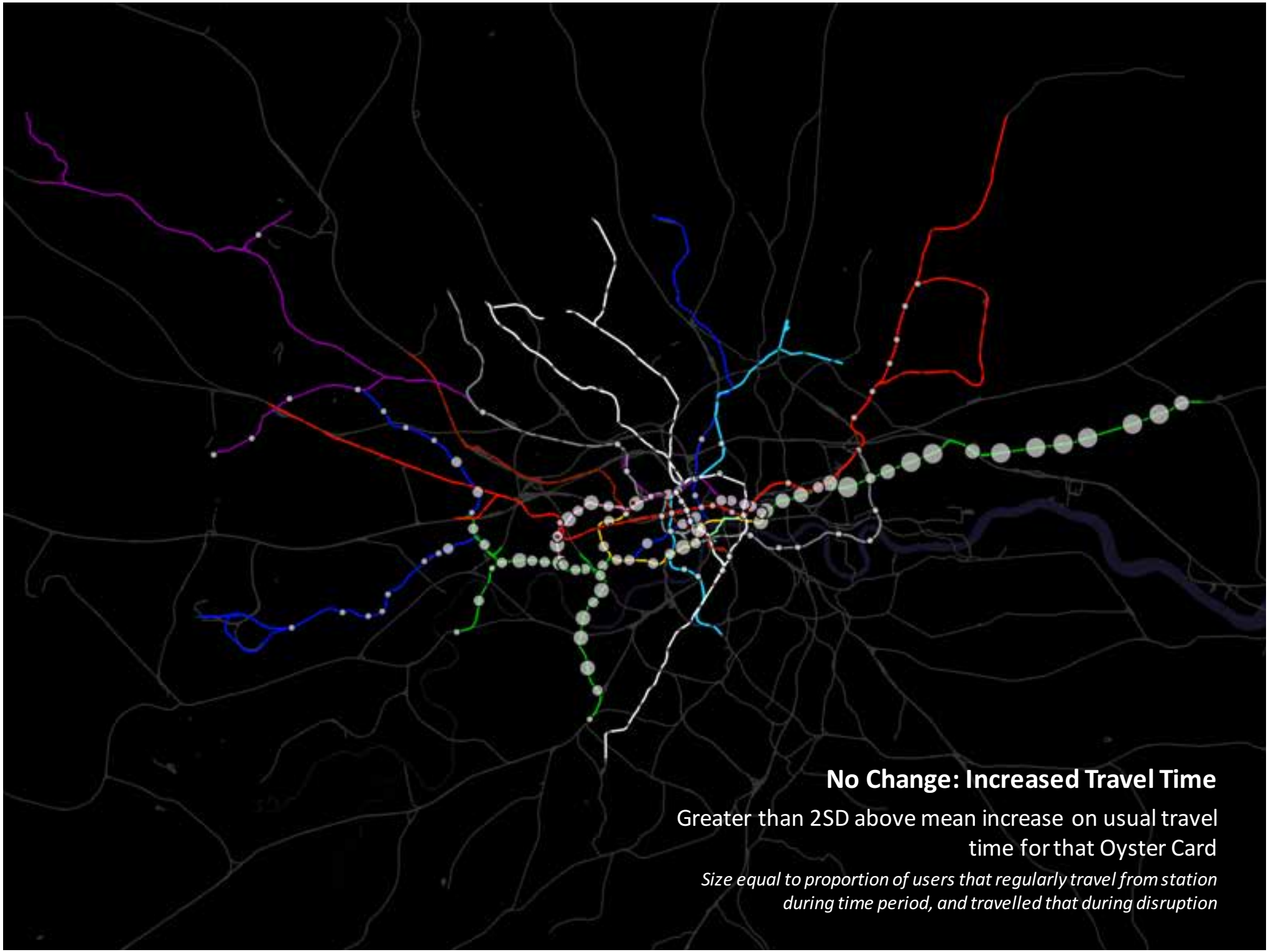

Service information

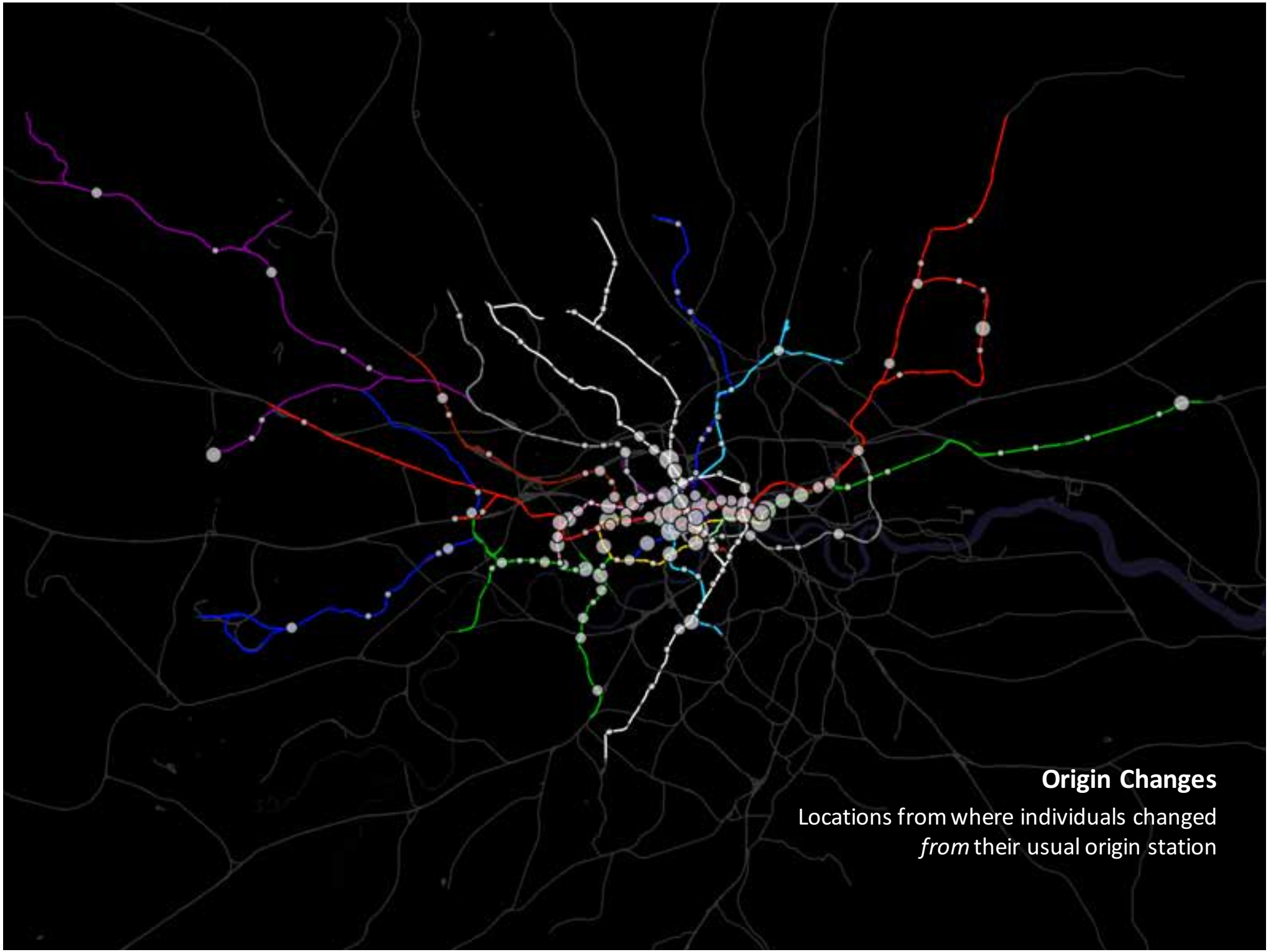

UNDERGROUND



The Information City: Cities in the Next 100 Years

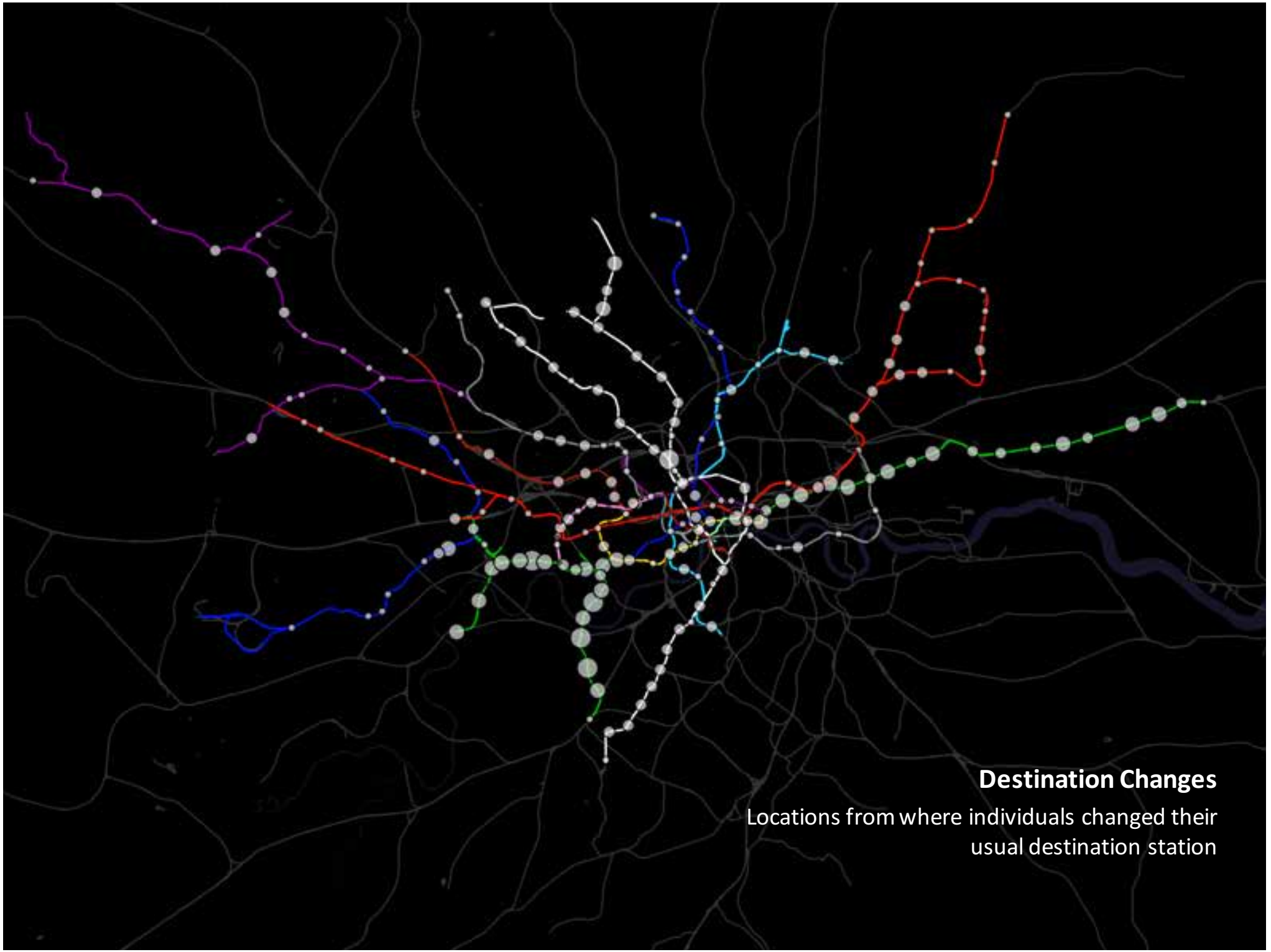

Circle and District line part closure
From Edgware Road to Aldgate/Aldgate East
19th July 2012
07:49 to 12:04
1234022 Oyster Cards with regular pattern during disrupted time period travelled


No Change: Increased Travel Time
Greater than 2SD above mean increase on usual travel time for that Oyster Card
Size equal to proportion of users that regularly travel from station during time period, and travelled that during disruption



Origin Changes

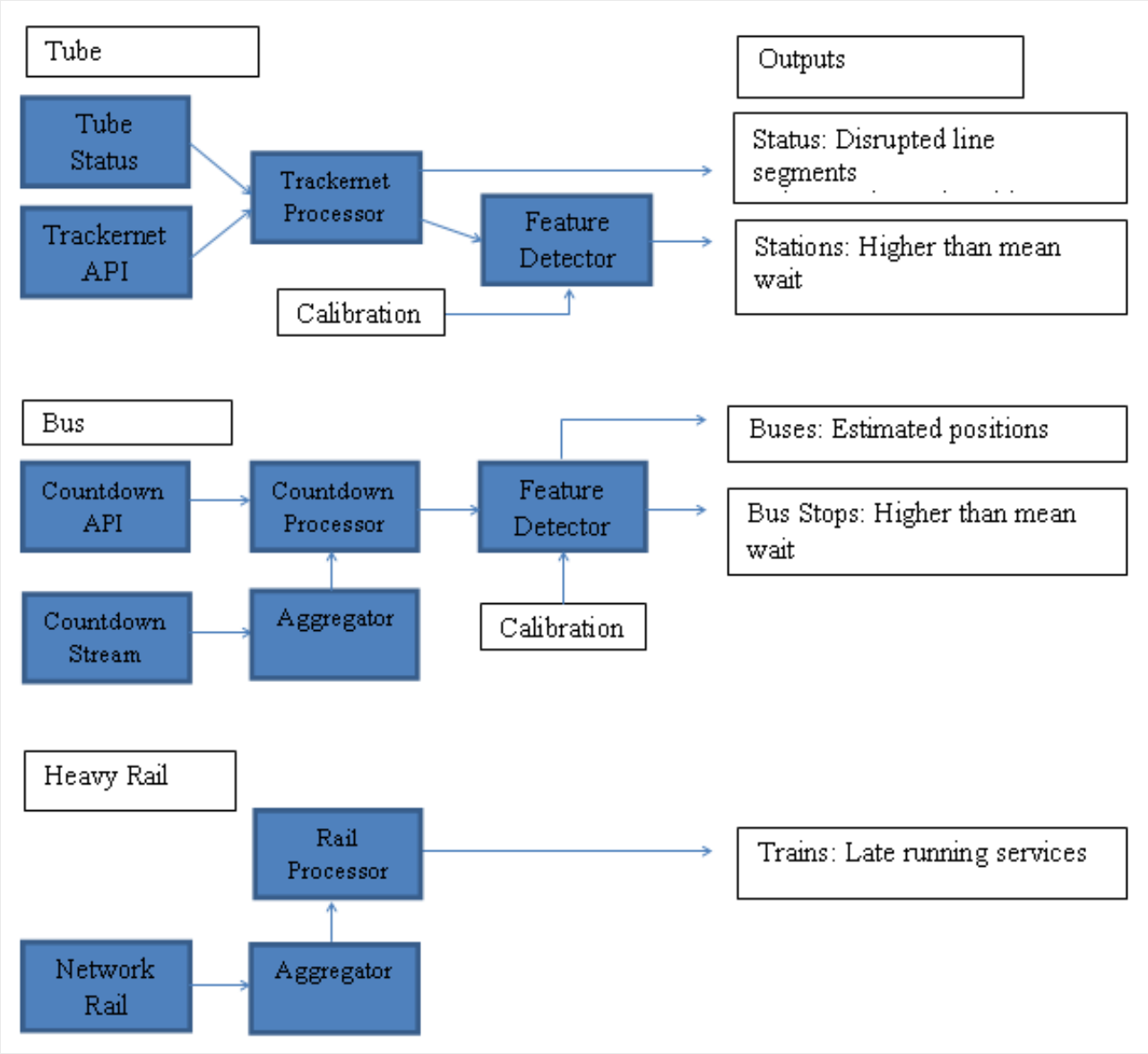
Locations from where individuals changed *from* their usual origin station

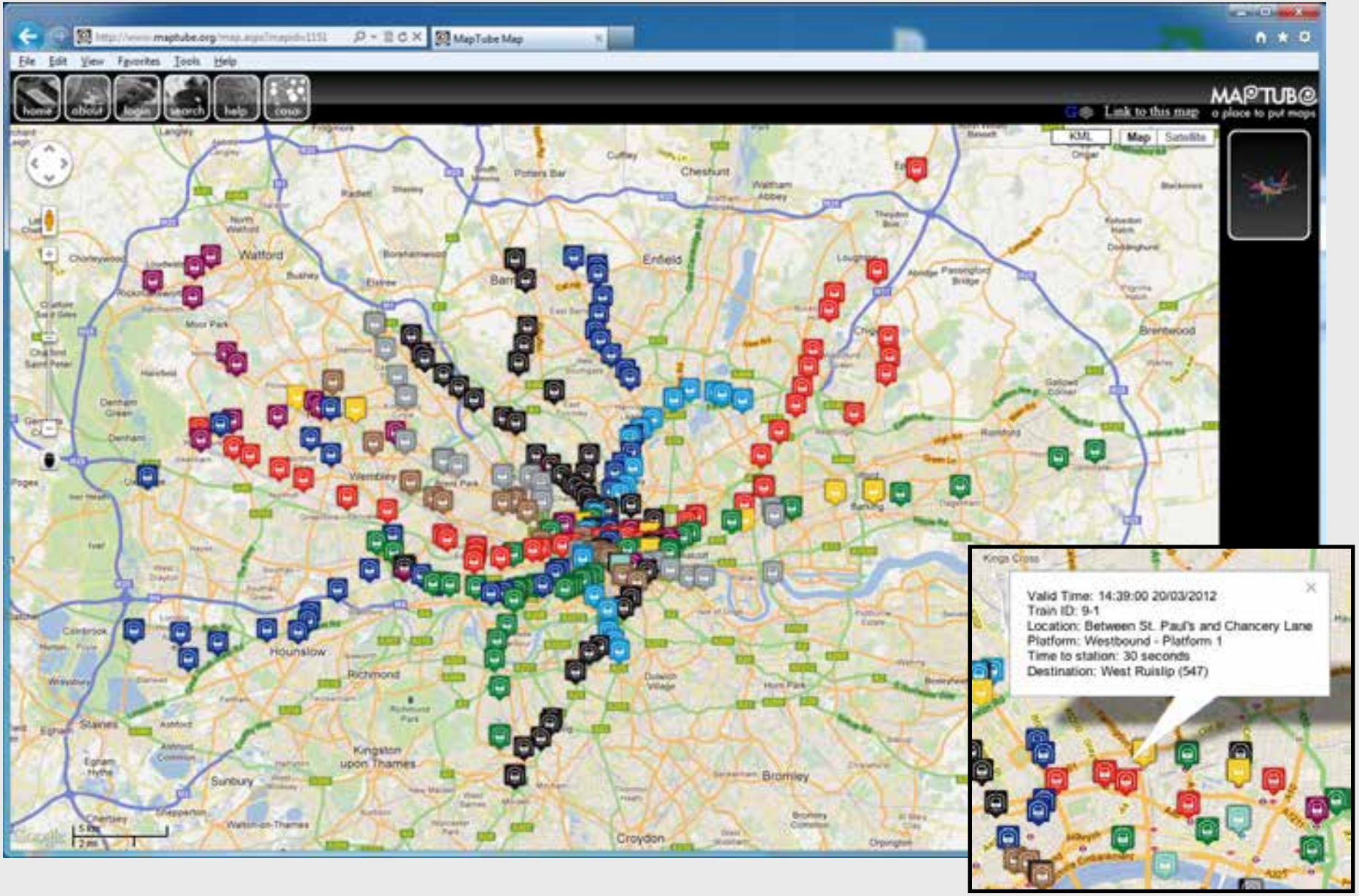


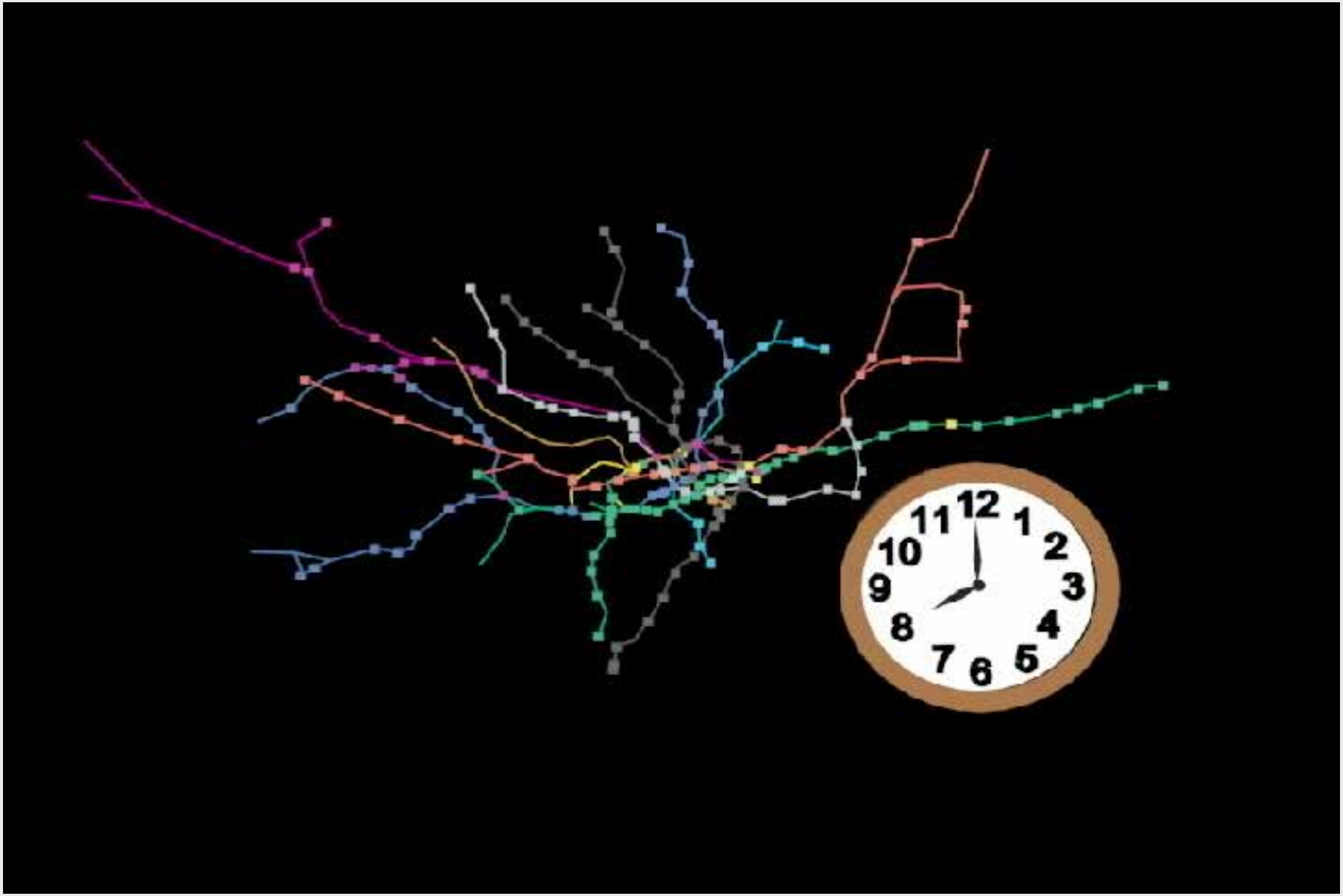
Destination Changes

Locations from where individuals changed their usual destination station

The Public Transport System in Terms of Vehicle Flows




MapTube Map
File Edit View Favorites Tools Help
home
about
login
search
help
close
MAPTUBE
a place to put maps
Link to this map
KML
Map
Satellite
Watford
Enfield
Cheshunt
Brentwood
Wembley
Hounslow
Richmond
Kingston upon Thames
Sunbury
Bromley
Croydon
Kings Cross
Valid Time: 14:39:00 20/03/2012
Train ID: 9-1
Location: Between St. Paul's and Chancery Lane
Platform: Westbound - Platform 1
Time to station: 30 seconds
Destination: West Ruislip (547)


12
1
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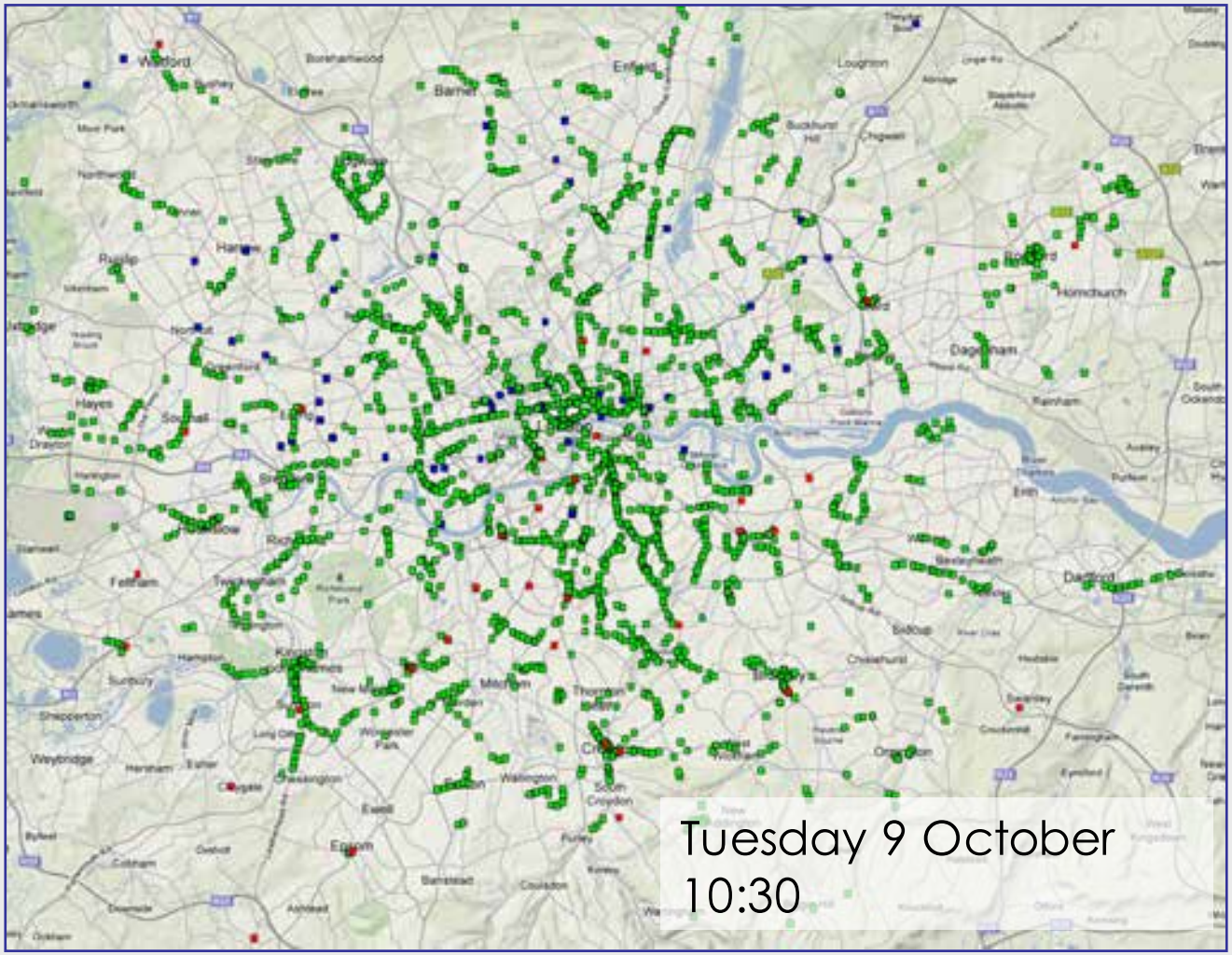
Delays from Tube, National Rail and Bus Fused



Key

National Rail more than 5 minutes late

Tube stations showing a wait time 15% above expected

Bus stops showing a wait time 20% above expected

Tube delays from the TfL status feed are also plotted as lines

Individual Data, Social Media: What Does It All Mean

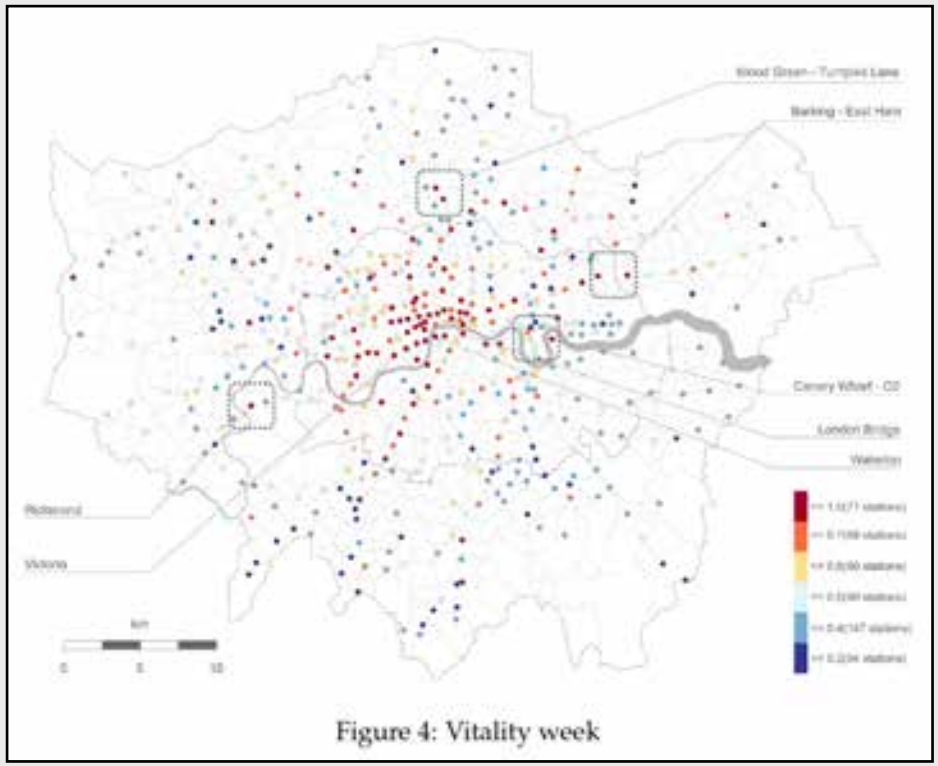


Figure 4: Vitality week

Measuring Vitality In London

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Number N (YYYY), pp. xx–yy
doi:10.5311/JOSIS.YYYY.II.NNN

RESEARCH ARTICLE

Using mobility data as proxy for measuring urban vitality

Patrizia Sulis[1], Ed Manley[1], Chen Zhong[2], and Michael Batty[1]

[1]Centre for Advanced Spatial Analysis, University College London, United Kingdom
[2]Department of Geography, King's College London, United Kingdom

$$tweet\ count \sim \alpha_1 * intensity(I) + \alpha_2 * variability(V) + \alpha_3 * consistency(C) \quad (5)$$

We run the regression model using different values of the variables for an average weekday and an average weekend day, to extract appropriate weights for different times of the week. Once we obtained the corresponding attribute weights, we assigned them to each attribute (intensity, variability and consistency obtained from Oyster data), and we calculated the final values of diversity (Dv) for the average weekday and the average weekend day, and for hourly intervals, as indicated in Equation 1.

attribute	week (Adjusted-R^2 = 0.843)	weekend (Adjusted-R^2 = 0.831
intensity	1.46	1.64
variability	0.51	0.39
consistency	-0.11	-0.46

Table 3: Regression results: coefficients (weights) and Adjusted-R^2

Detecting Gentrification From Airbnb in London

Figure 3: Cumulative Airbnb counts in London using 3D and 2D perspectives showing centre-periphery patterns.

Figure 4: Areas in London with the highest cumulative Airbnb counts in each 500m x 500m spatiotemporal bins. Five out of six areas with highest cumulative counts are located in Hackney and Tower Hamlets, areas with rapid gentrification

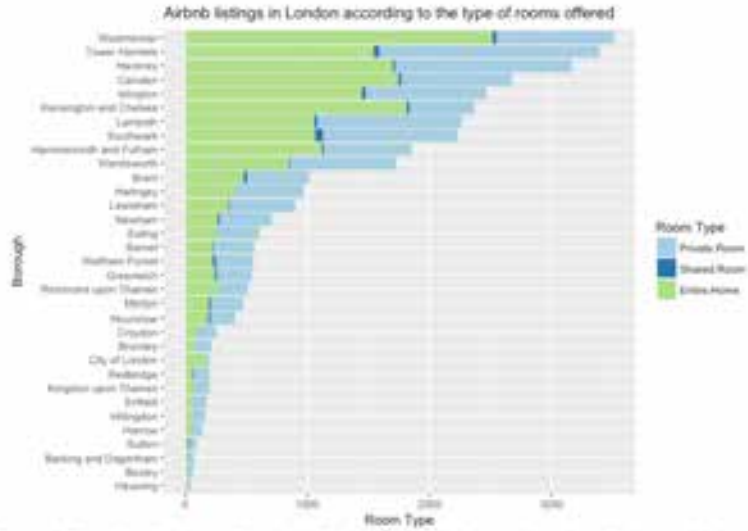
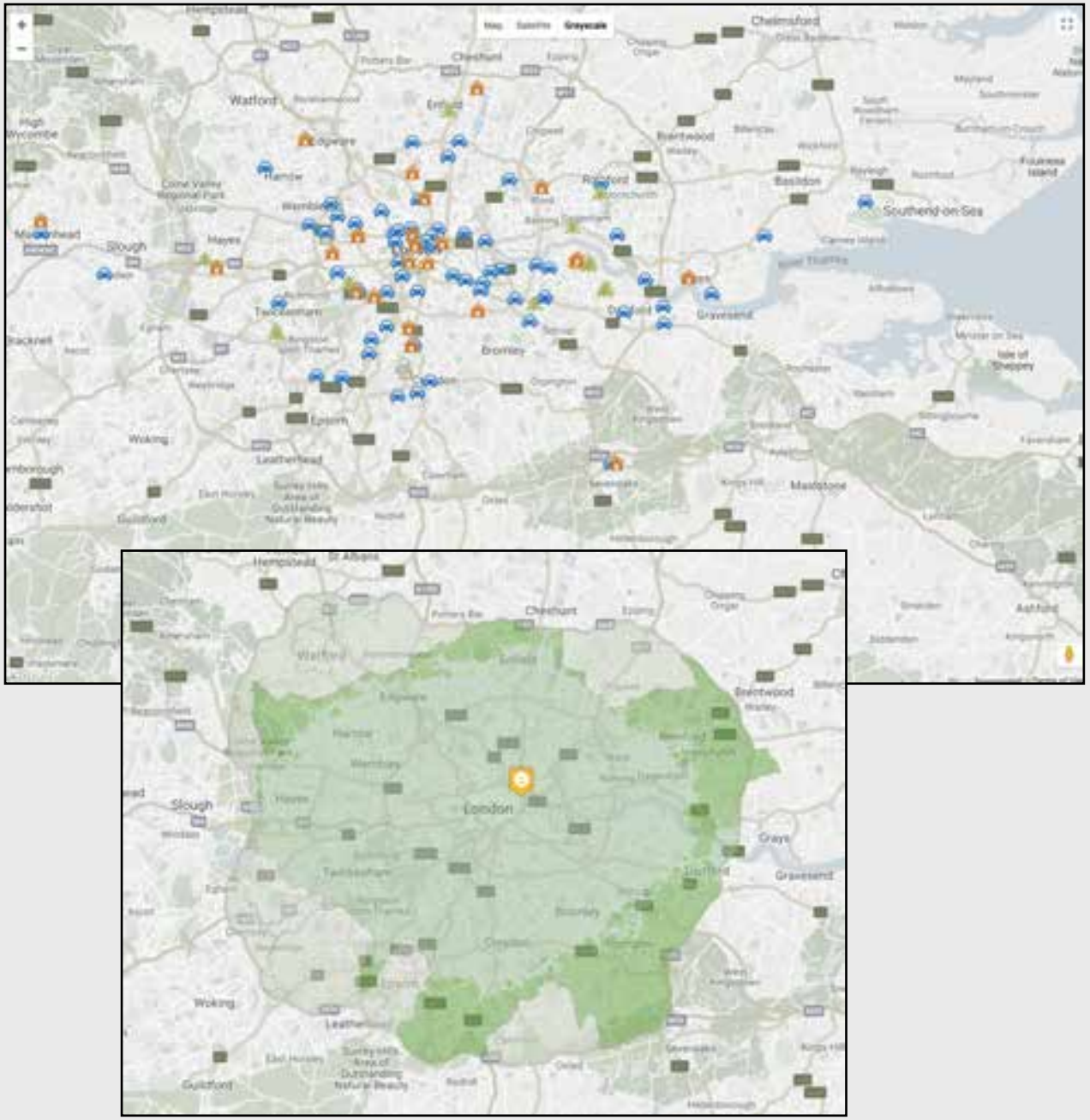
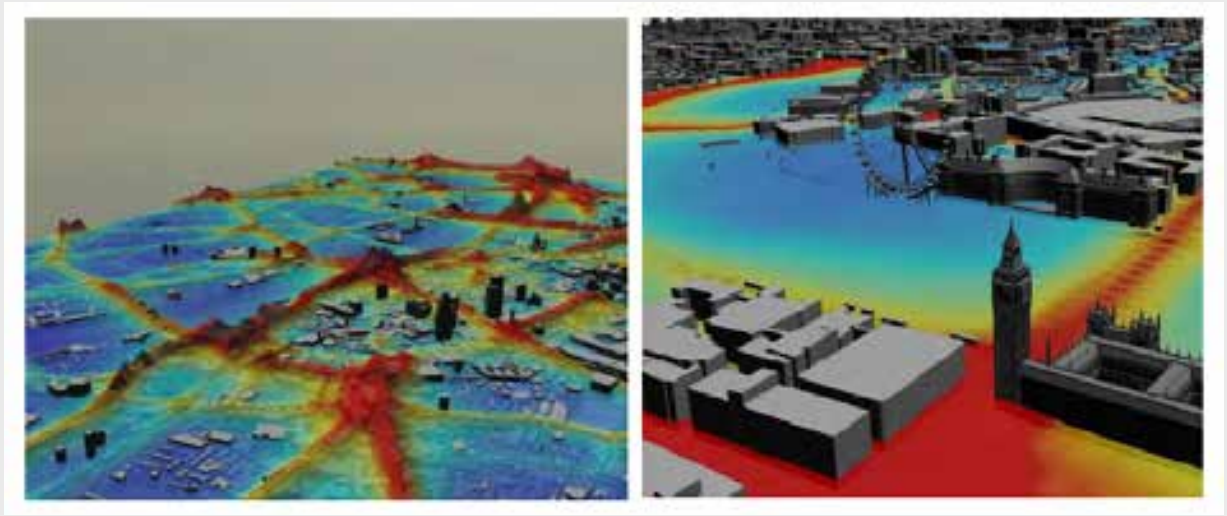


Figure 1: The distribution of 'active' Airbnb listings in Greater London (listings with at least one review) based on the room types. In nearly all the boroughs, almost 50% of the properties being listed are entire homes. Data from Inside Airbnb.

Measuring Air Pollution in London



https://www.londonair.org.uk/LondonAir/Default.aspx



Measuring, Modelling and Predicting Levels of Pollution under different community scenarios

Future Form and Function: The Great Disconnect

- Every since industrialisation there has been an increasing disconnect between form and function
- This is largely because distance is being annihilated or at least transformed. Maybe there is no 'death of distance' but increasingly what we see in terms of the physical city is not what we get
- Social media is central to this but so is everything we do digitally as it is hard to trace where this happens.
- In terms of the smart city, this is happening everywhere but it differs of course due to all the things that still make our cities and places different from each other

Cities in the Next 100 Years

- I could write a book on what cities might be like over the next 100 years but the key point I want to get across is that if we are to continue to think of society in terms of cities – and I am not completely convinced this is the case – ok let me assume we do continue in this way – then physical form will be treated quite differently
- I believe that what I began with – treating the city as a key information processor is a good analogy and worth exploiting a lot – thinking of cities not as smart or even digital but as informators, thus reflecting the great transition we are living through from a world built around energy to one built around information
- Its an old idea but it makes you think.

Thanks

My colleagues in CASA-UCL & KCL –
Patricia Sulis, Zara Shabrina, Ed Manley, Chen Zhong, Jon Reades, …
and all the others for their applications

http://www.complexcity.info/
http://www.spatialcomplexity.info/
http://blogs.casa.ucl.ac.uk/

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