5th February 2014

2 Smart Cities

Big Data, Real Time Transport, Social Media, and Urban Simulation

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http://www.complexcity.info/

http://www.casa.ucl.ac.uk/

Outline

- Smart Cities: A New Paradigm? Or Just Routine Business?
- An Old Exemplar 1: Land Use Transportation Modelling
- An Old Exemplar 2: Moving 2D into 3D – Symbolic into Iconic
- My Main Exemplar 3: Public Transport Networks & Flows
- Exemplar 4: Public Bike Schemes: Local Routing and Local Models of Movement
- Exemplar 5: Crowd-Sourcing and New Data: Sources from Social Media

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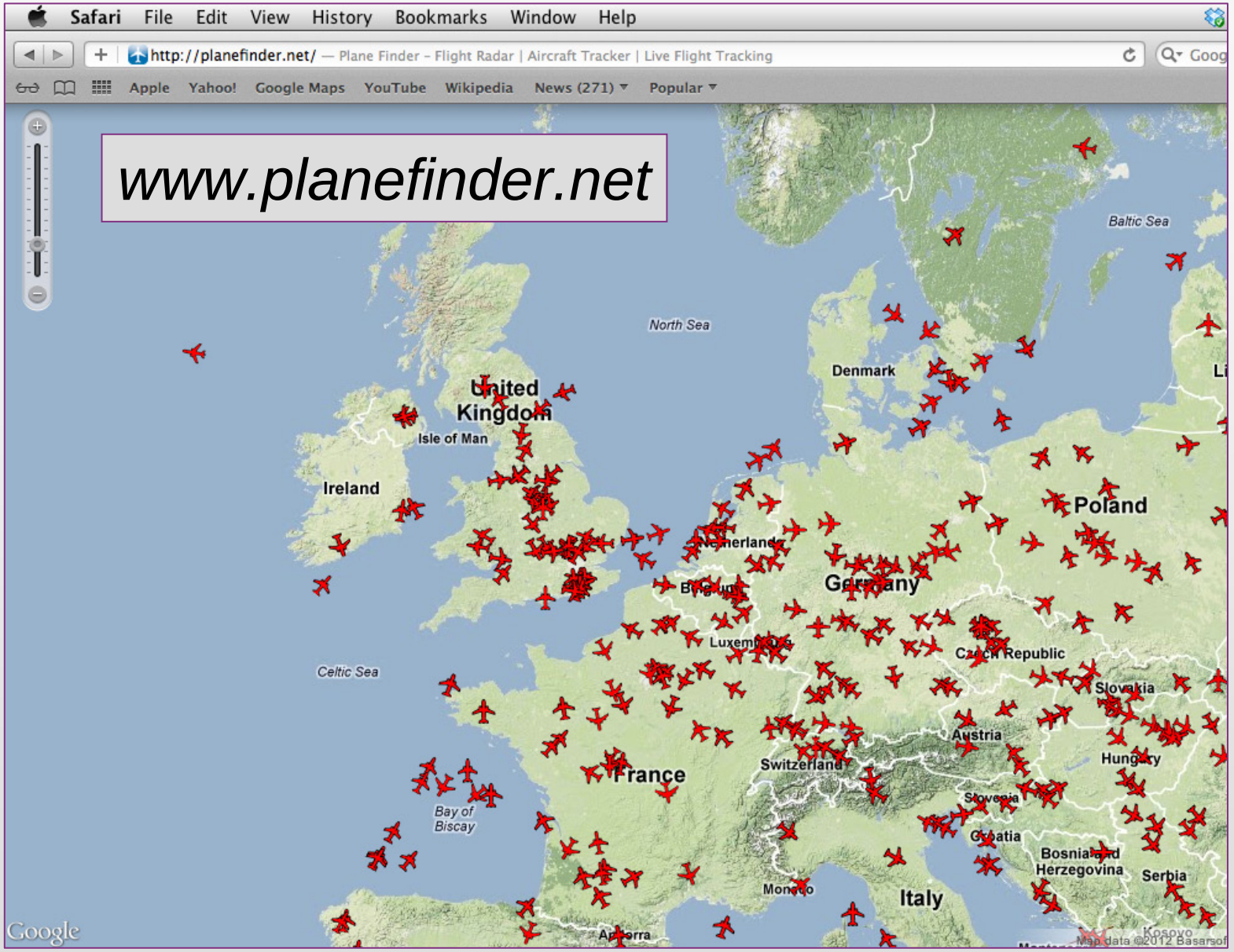
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Smart Cities: A New Paradigm

I am going to look at several examples which various people in our centre are developing where we are able to use new online data sources – *big data* – with *new forms of model*, to make predictions about the smooth running of traffic and the economy.

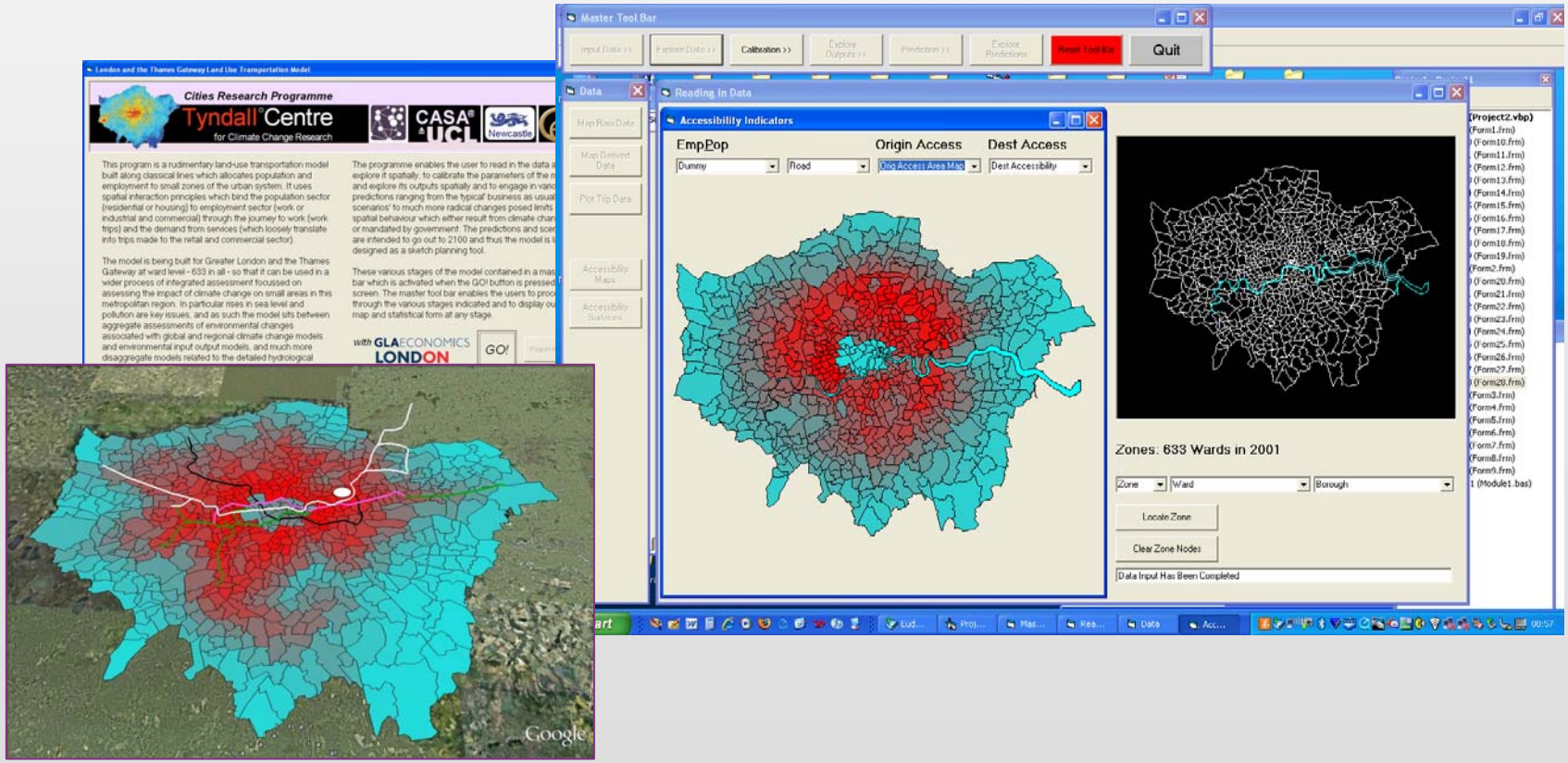
At many scales: the regional-metropolitan, at area-wide network infrastructure scales, and at the local street scale

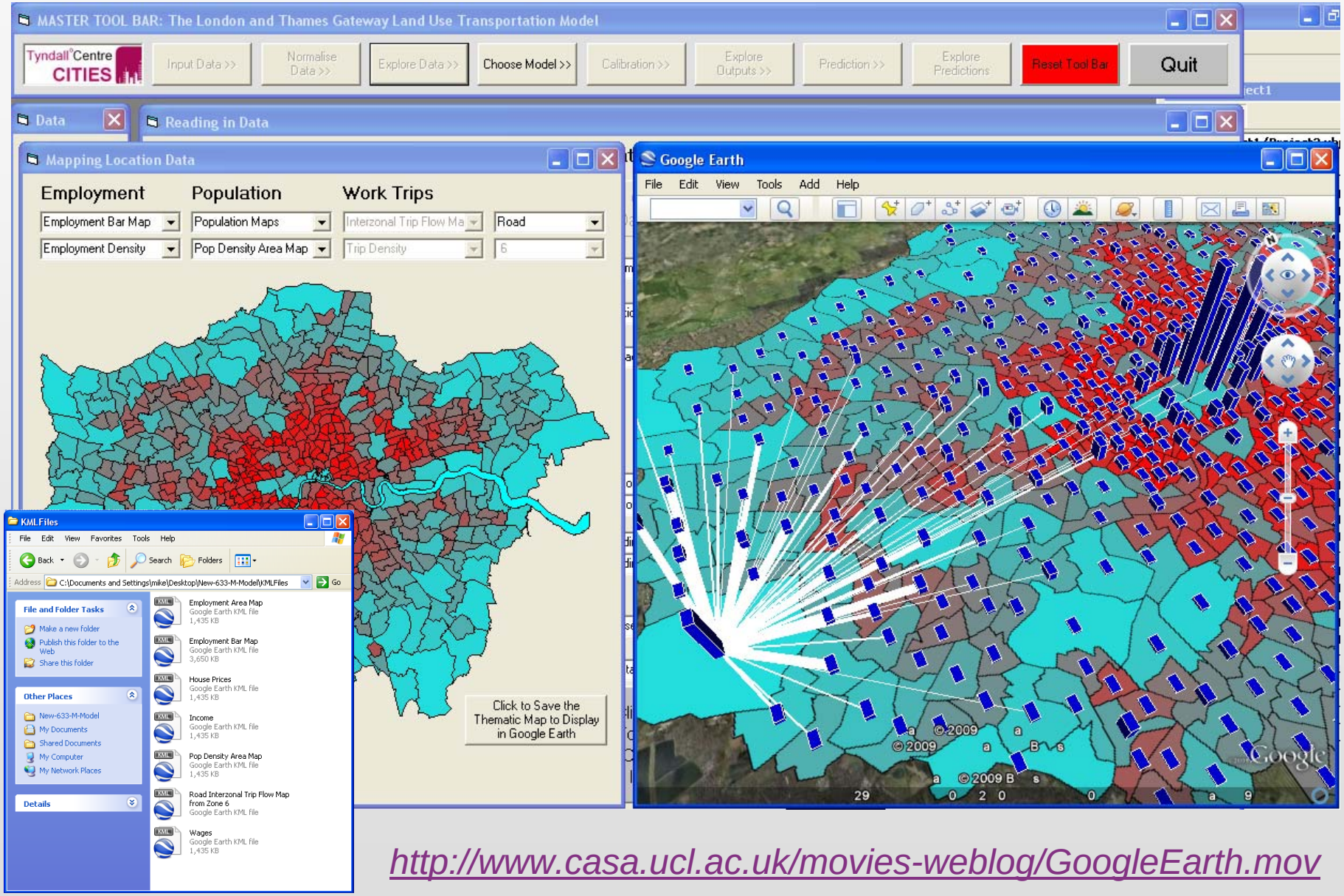
These examples show how we can fuse the strategic with the tactical and it also shows how visual media can inform simulation and vice versa.

One of our key themes is the focus now on time as well as space and on the short term rather than the long term.

1. Modelling Land Use Transportation, Energy, etc

Our core expertise is in land use transportation modelling and we have several such models for the London region:





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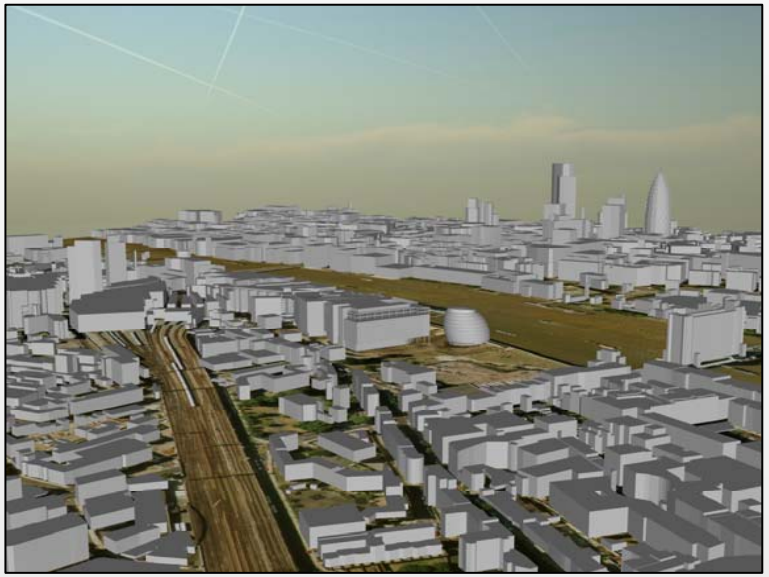
Modelling the Geometry of Cities: Virtual Cities

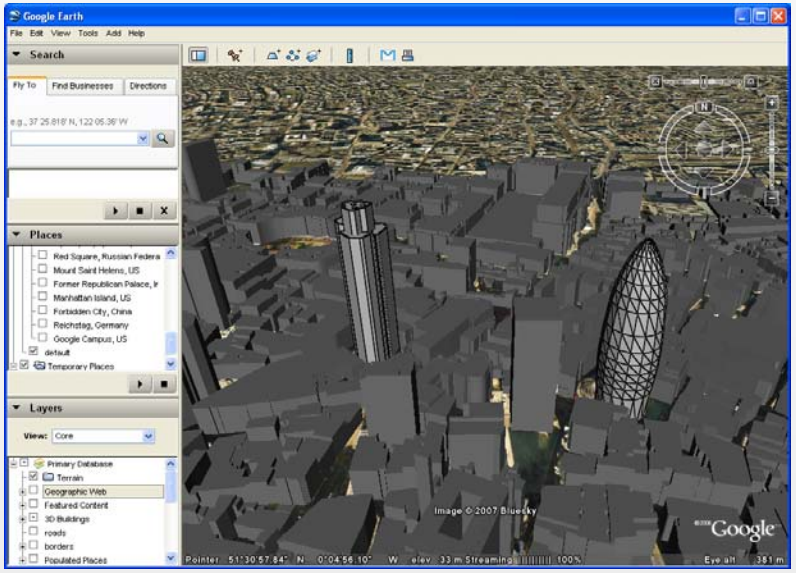
We have built a large scale 3-D model for London based on RS data at parcel levels. The model is different from our LUT models – requiring different skills

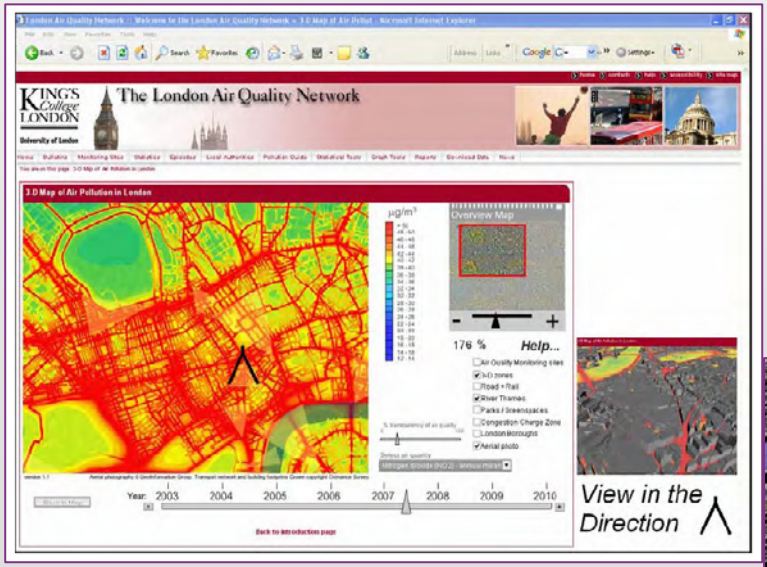
The models are being tagged with socio-economic data. We have used it for flooding, visualising air pollution, we have looked at the morphology of building form, and used it to visualise 2D to 3D design proposals.

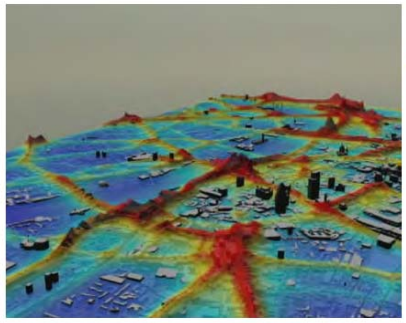
When I last talked here in 2007, I think, in the technical university, I talked on these ideas – mainly on visualisation.

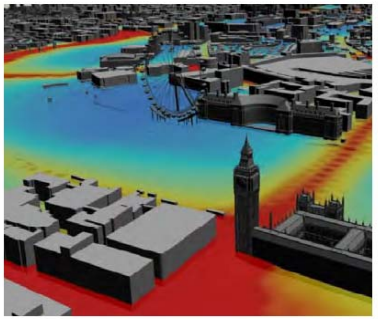
What is intriguing is the way *iconic and symbolic models are beginning to merge* – land use transport models with virtual city models.



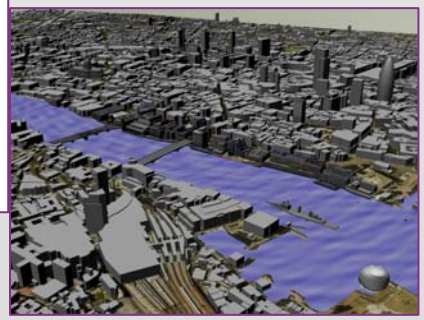


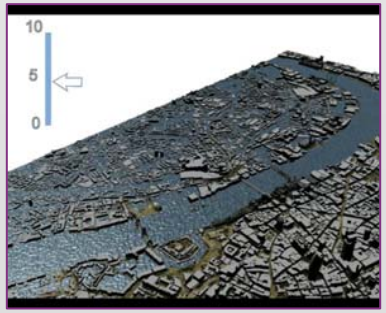






http://www.londonair.org.uk/



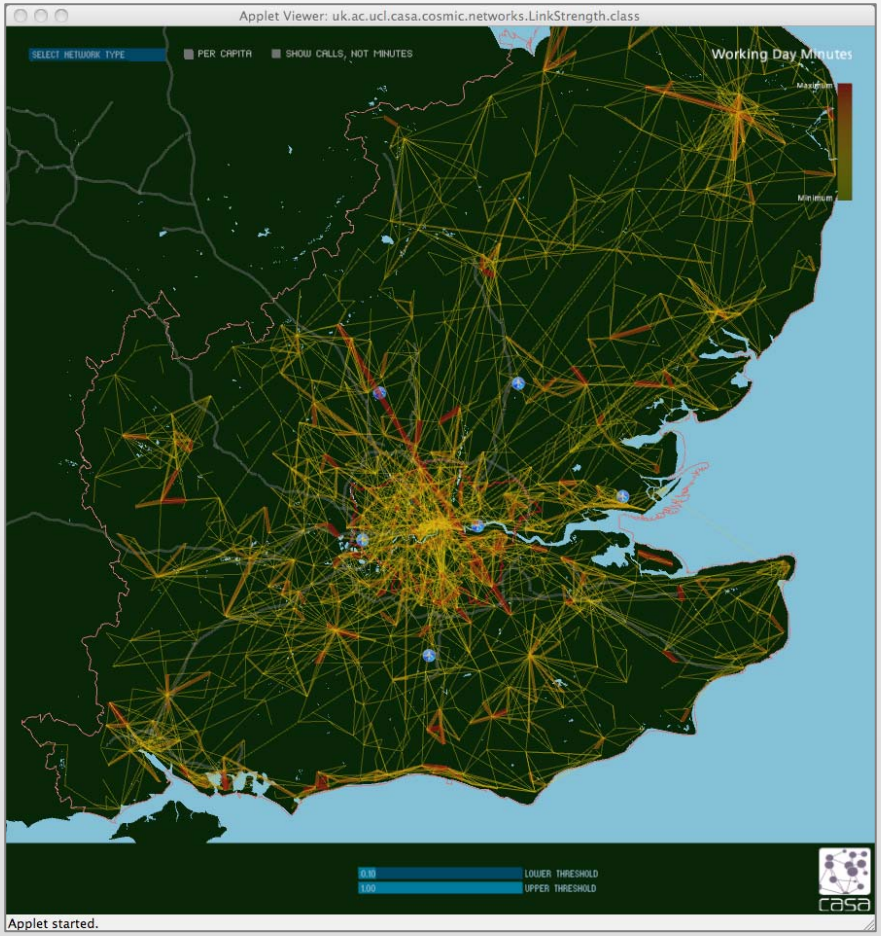


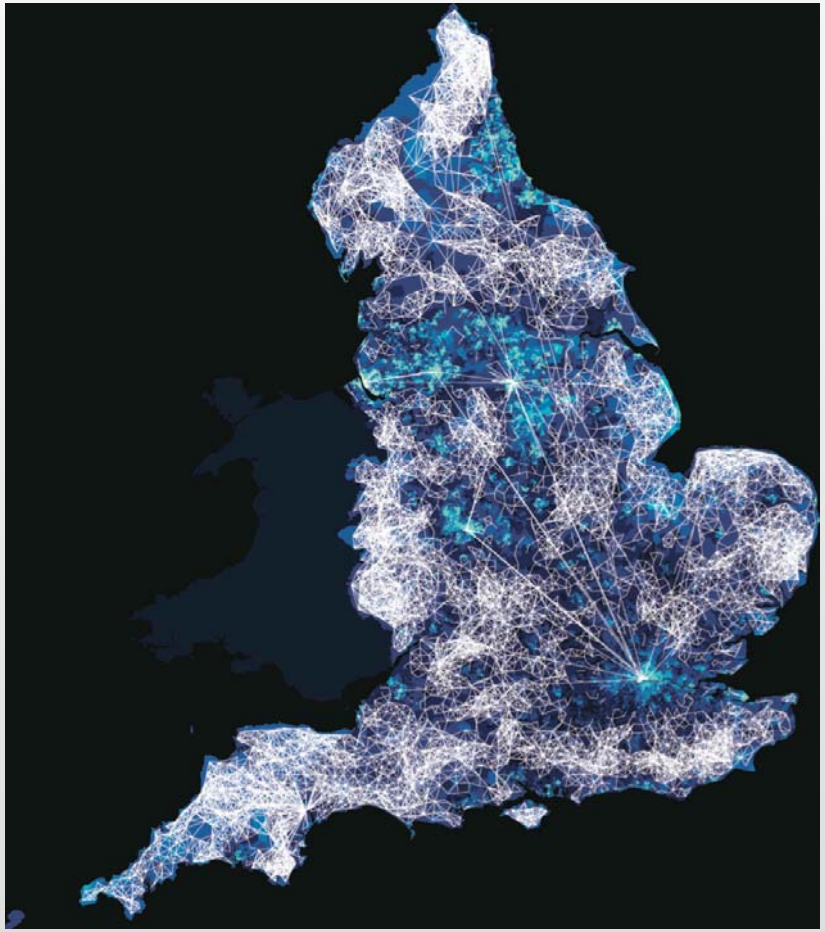
Representing Networks: Telecoms, Subways & Rail, Bikes

Many new sources of network data now exist, much of coming from digital sources and we are working with mining this data and extracting functionality from it

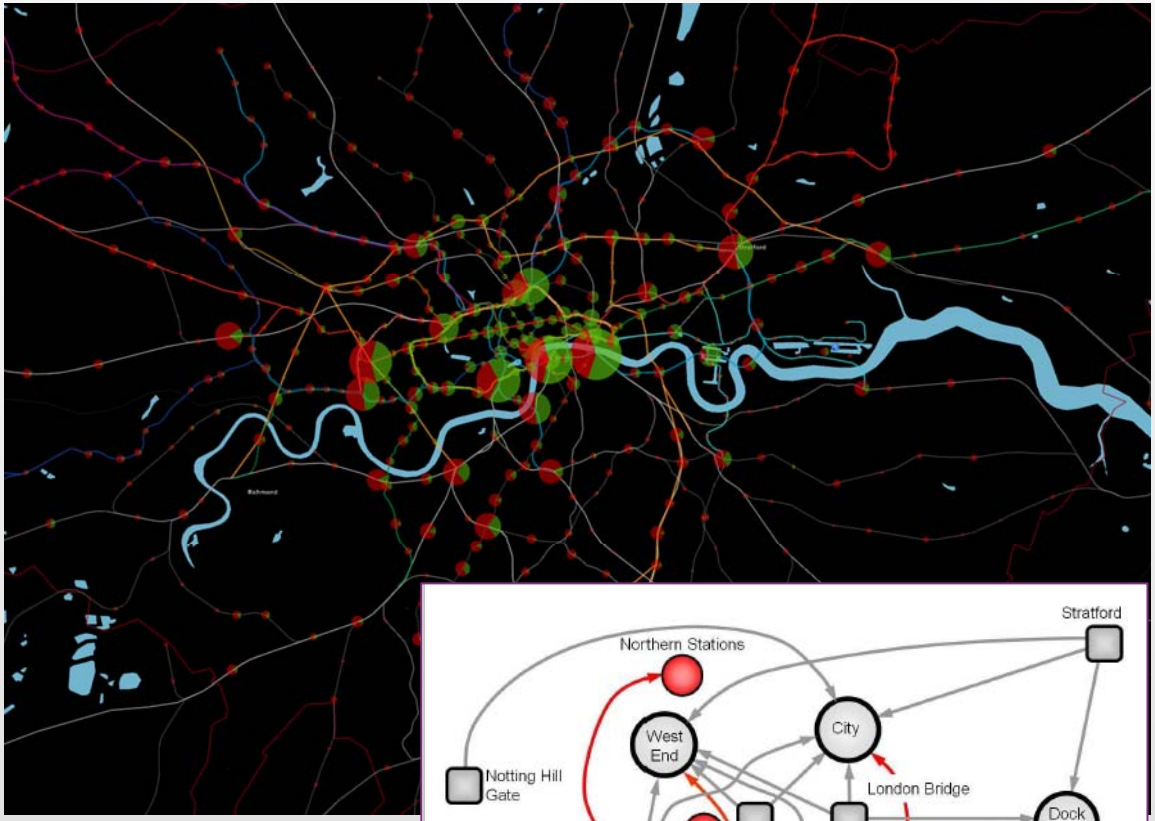
Our key data sets are telecoms data (landline) for the UK, the online travel card data (Oyster) for public transport schemes in London which is massive, really massive and the online bike movement data for the London bikes scheme. These are big data sets that record every phone call, trip etc over a period of days with each object time stamped. Let me show three static shots of this data.

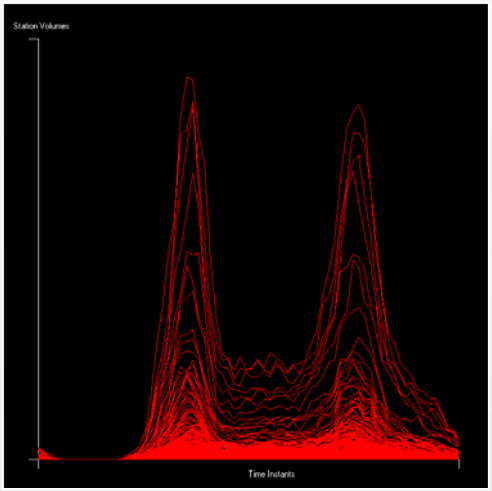
Telecoms – Jon Reades' work with a large UK telecoms provider and with Sensable City Lab at MIT

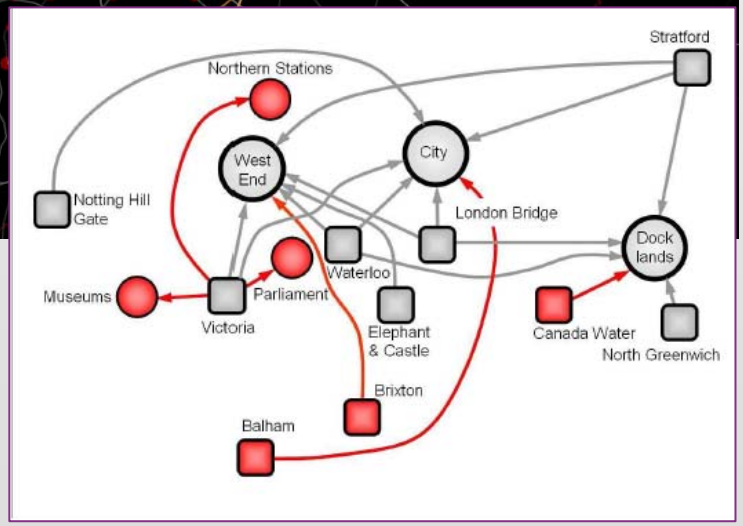


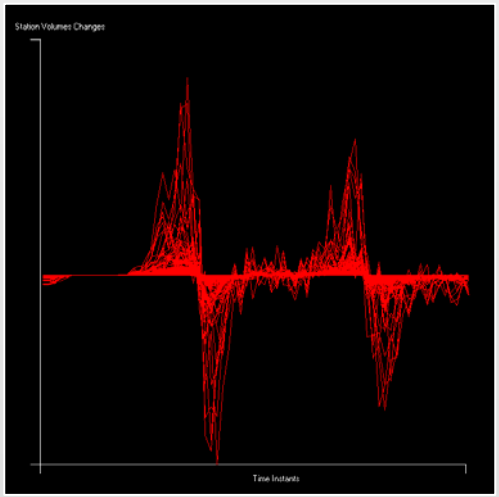


Oyster Card Data – interpreting urban structure, multitrips, etc.

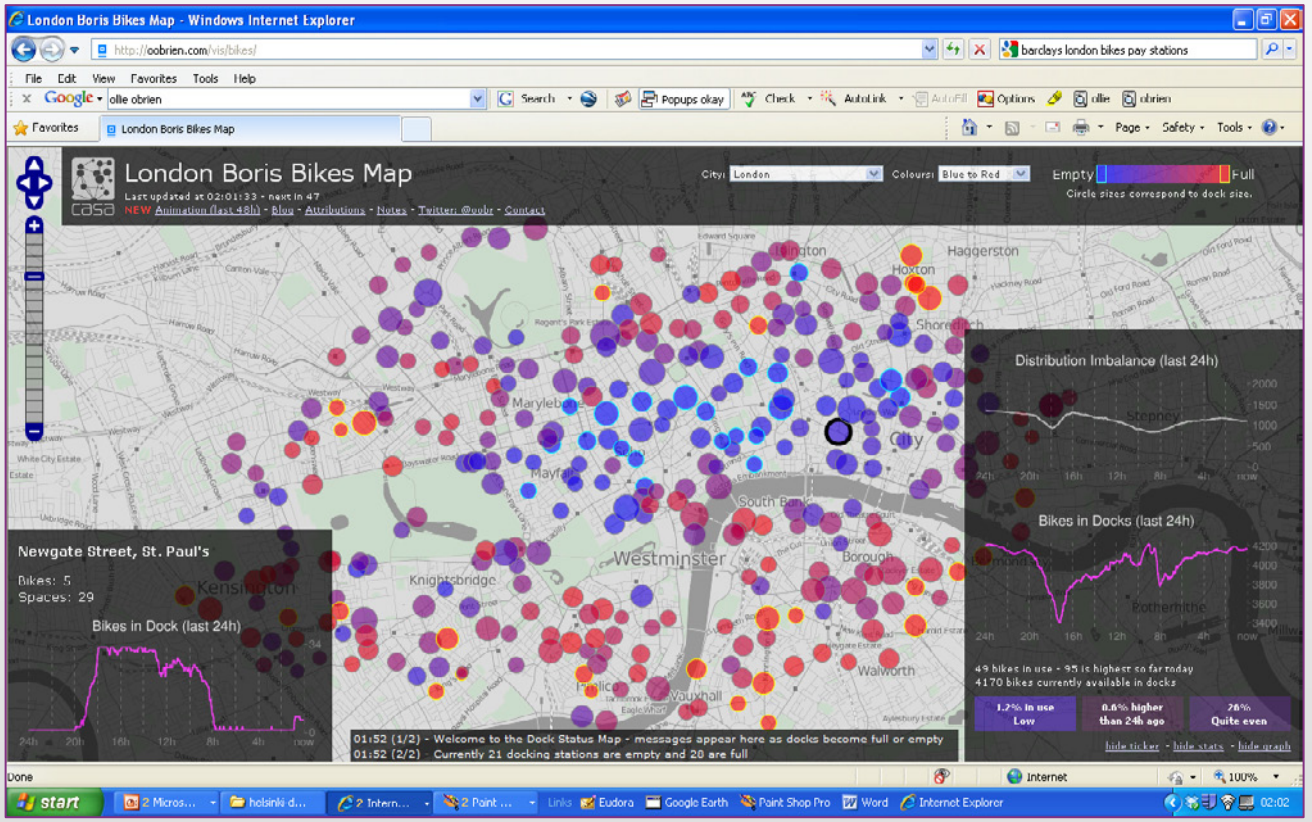








Bikes Data – 4200 bikes, started Nov 2010, all the data– everything – all trips, all times, all stations/docks



Our Oyster Card Project

We are hard at work with our Big Data set on London's public transport system. Let me emphasise yet again that we are talking here of 7-8 million swipes/trips a day, crudely – 40 million a week, 200 million a month, 2.4 billion a year, more than 10 billion in five years ….

As E. M. Forster in his short story of 1909 called "The Machine Stops" implies, this will only end when we or something switches off the machine … the implications of data ***forever*** are interesting. We can mine this data a million ways but there are issues.

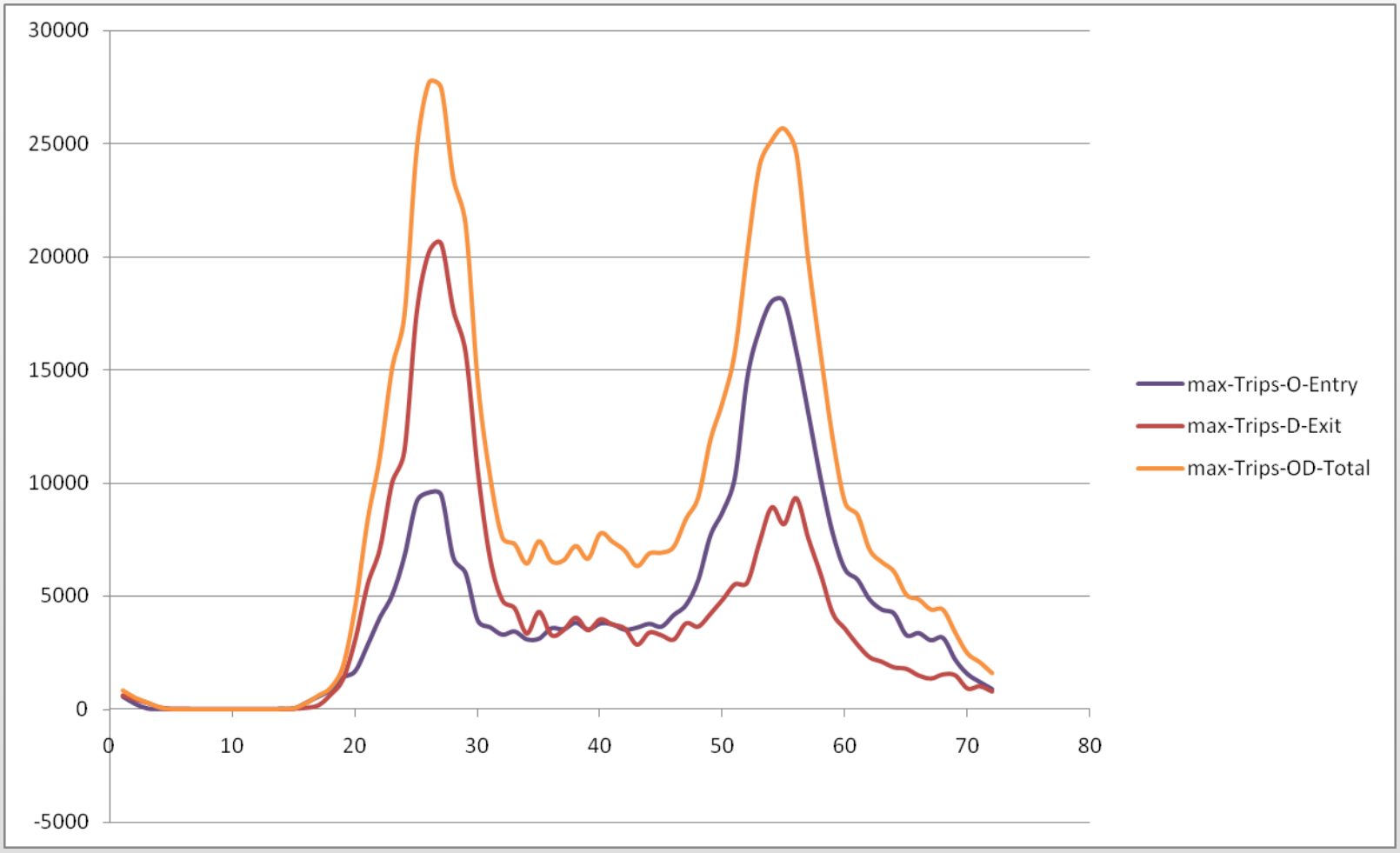
Let me give you a sense of what we are doing with our billion record data set

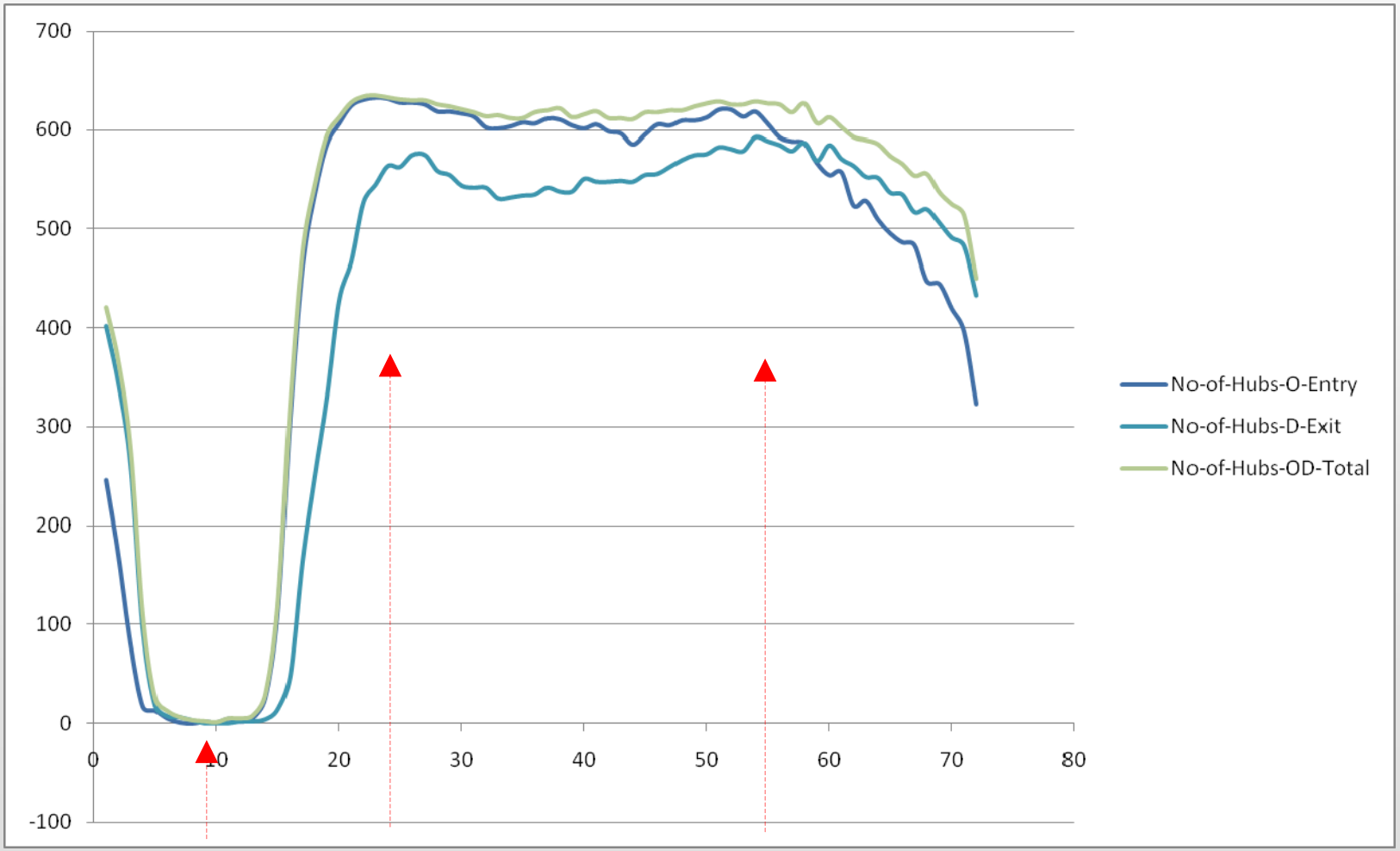
We can examine origins volumes, destination volumes separately and we are doing but here we will simply add these together as total volumes – in this sense they will not have meaning any longer as trips

	A	B	C
1	1	London-Bridge	599568
2	2	Victoria	502127
3	3	Waterloo	486861
4	4	Liverpool-Street	437658
5	5	Kings-Cross	395919
6	6	Shepherd's-Bush	346027
7	7	Hammersmith	274623
8	8	Wimbledon	198913
9	9	Paddington	196067
10	10	Vauxhall	180411
11	11	Stratford	177964
12	12	Oxford-Circus	150704
13	13	Charing-Cross	149290
14	14	Ealing-Broadway	139911
15	15	Euston	138394
16	16	Canary-Wharf	132206
17	17	Barking	112842
18	18	Balham	111090
19	19	Brixton	108814
20	20	London-Terminals	93026

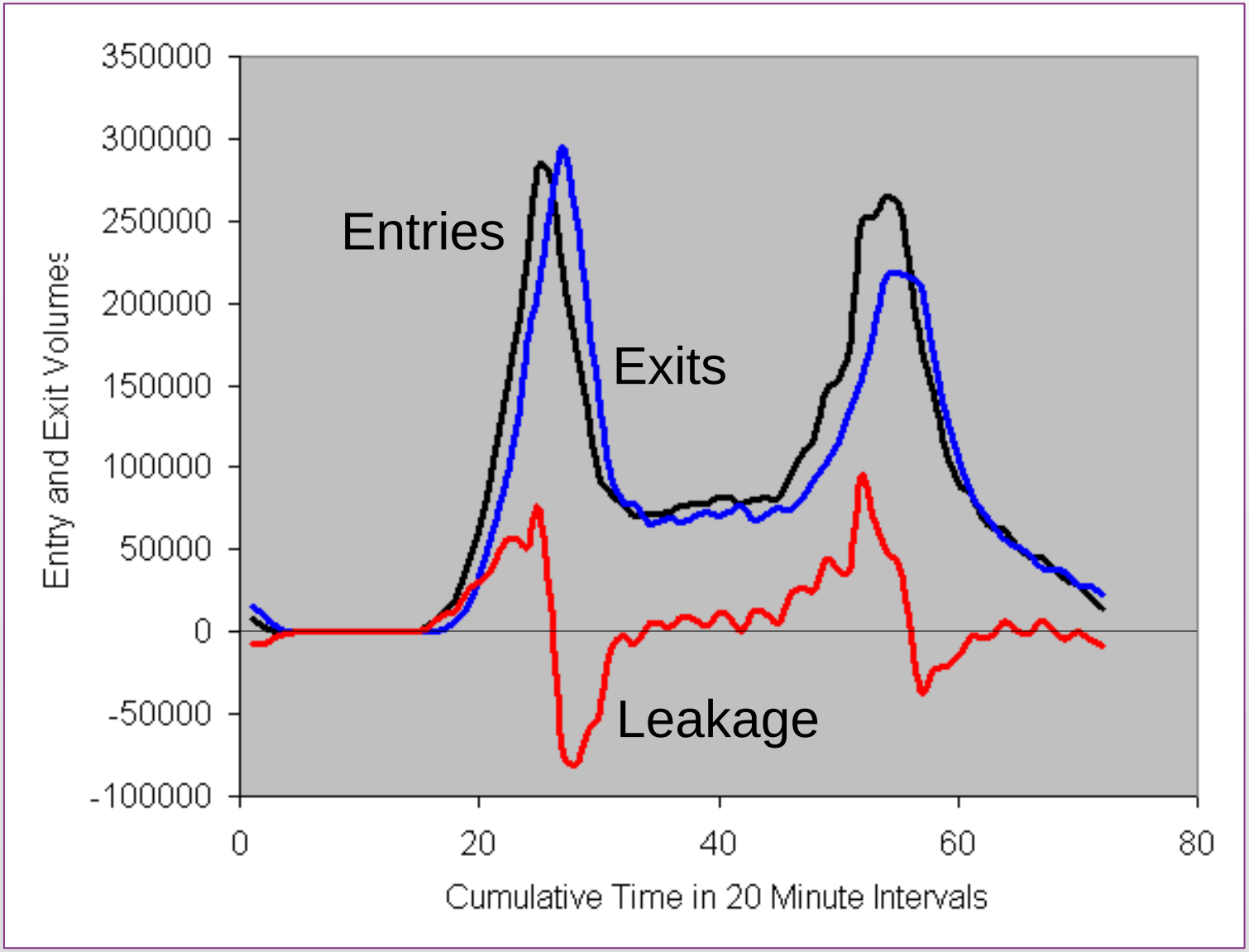
We will now examine the profiles of behaviour during the 24 hour day to provide some sense of the problem

Examining the Dynamics of the Hub Volumes

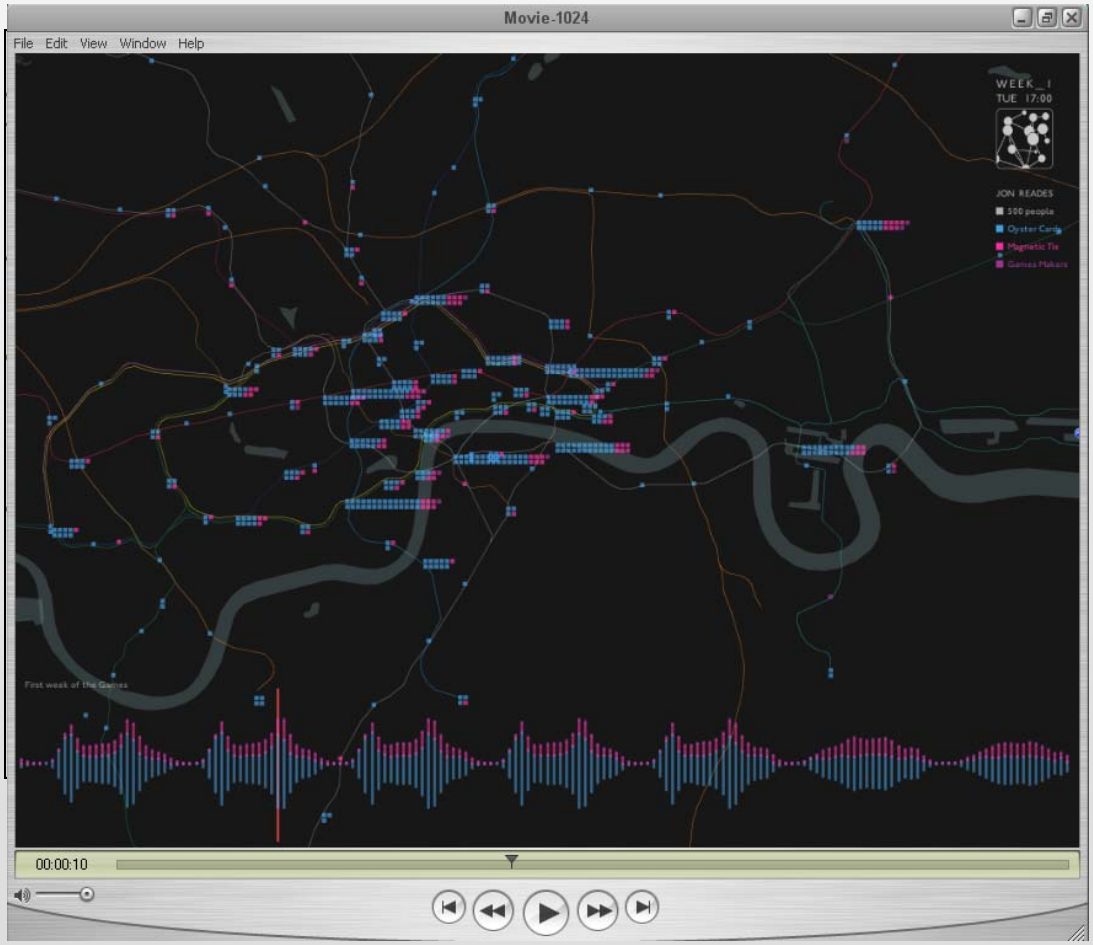




Night am peak pm peak

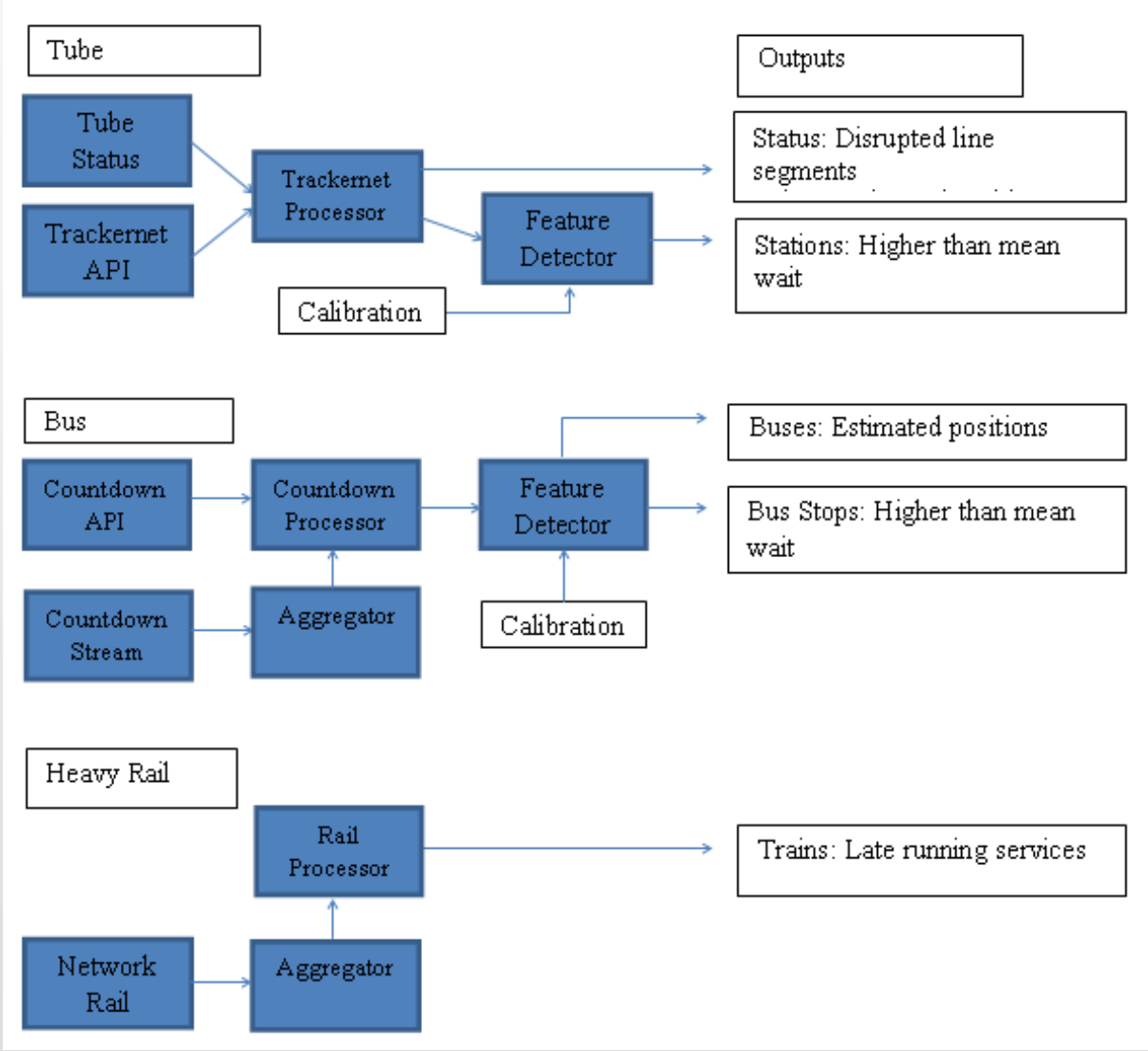

350000
300000
250000
200000
150000
100000
50000
0
-50000
-100000
Entry and Exit Volumes
Entries
Exits
Leakage
0
20
40
60
80
Cumulative Time in 20 Minute Intervals

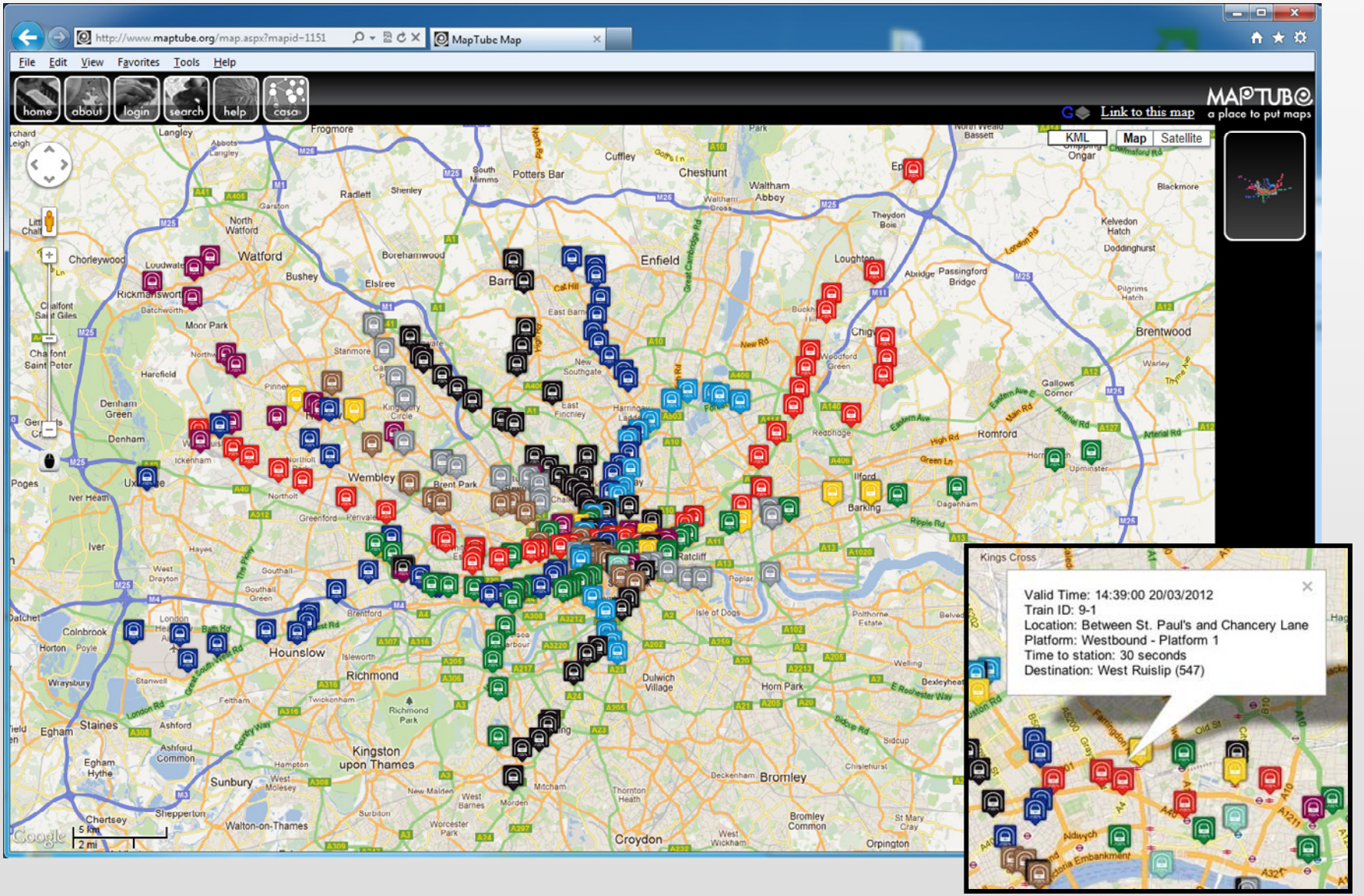
We are doing a lot of work on disruption – what happens if a subway station closes or line goes down – billions of possibilities that can provide information useful to travellers



We are looking at the impact of the *Olympic Games*, and lots of stuff like this. And that would have been what my lecture would be on. But this is more generic and I will now turn to data sensing of vehicles

The Public Transport System in Terms of Vehicle Flows

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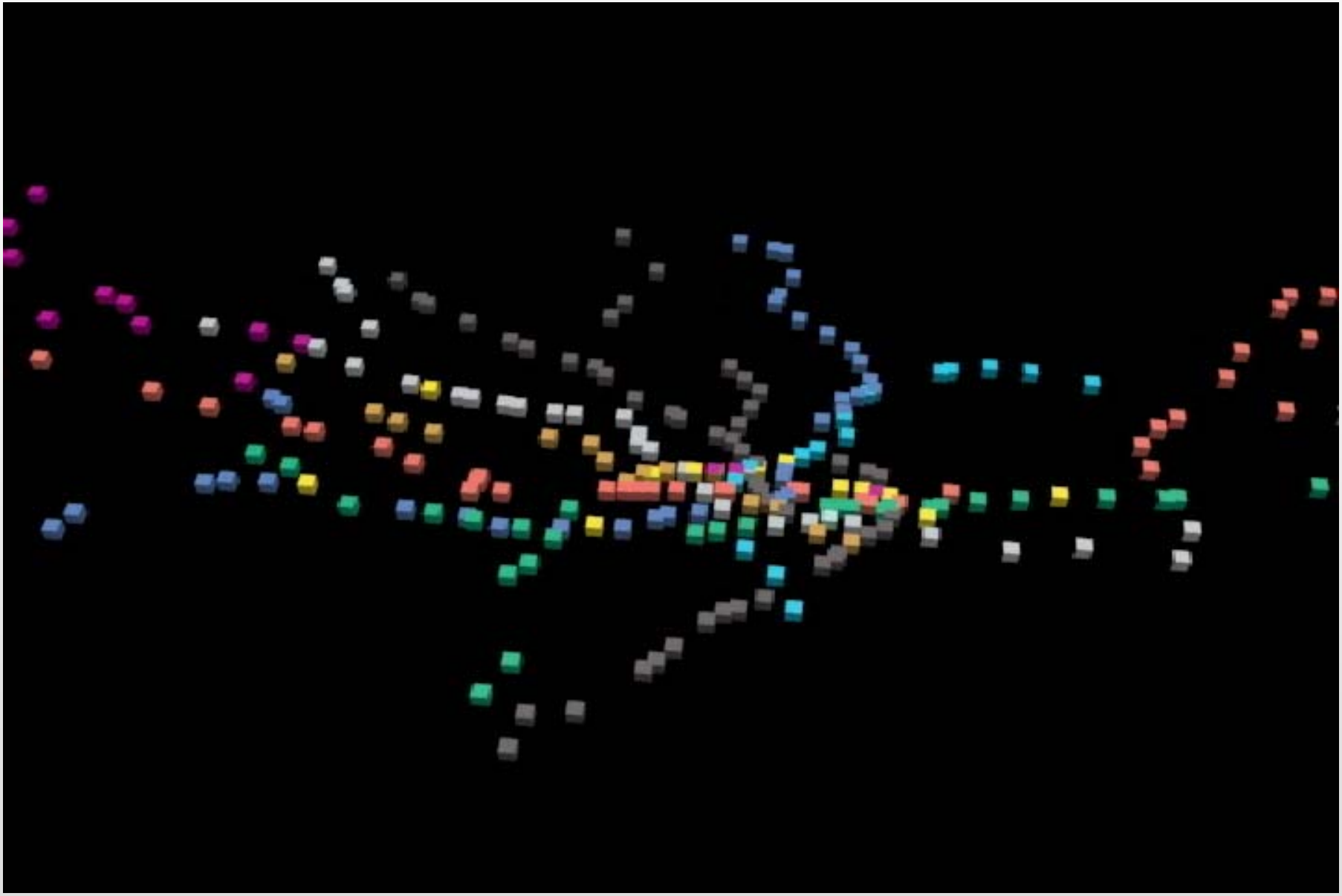
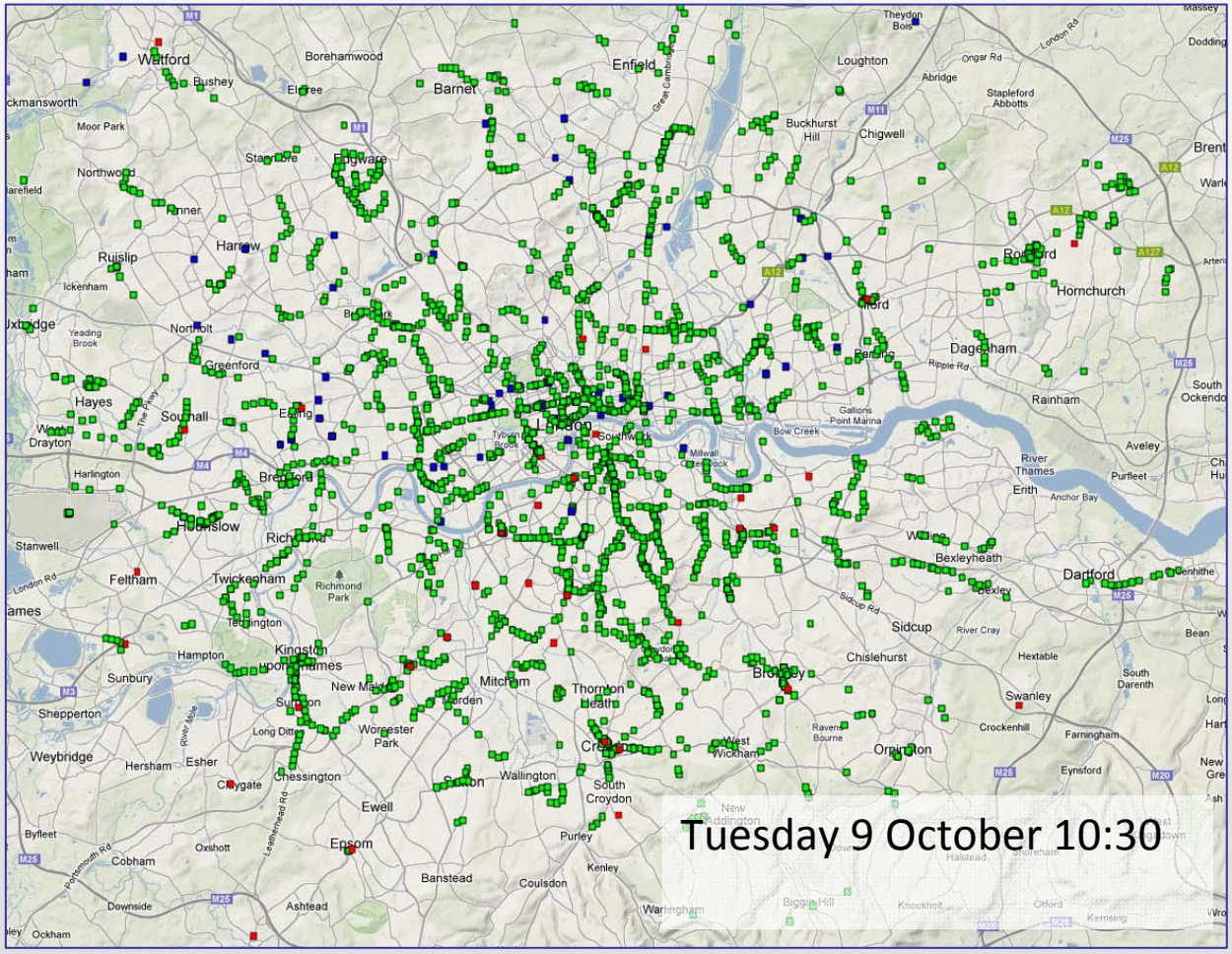
a place to put maps
Link to this map
KML Map Satellite
Valid Time: 14:39:00 20/03/2012
Train ID: 9-1
Location: Between St. Paul's and Chancery Lane
Platform: Westbound - Platform 1
Time to station: 30 seconds
Destination: West Ruislip (547)
Kings Cross
Google
5 km
2 mi



Delays from Tube, National Rail and Bus Fused

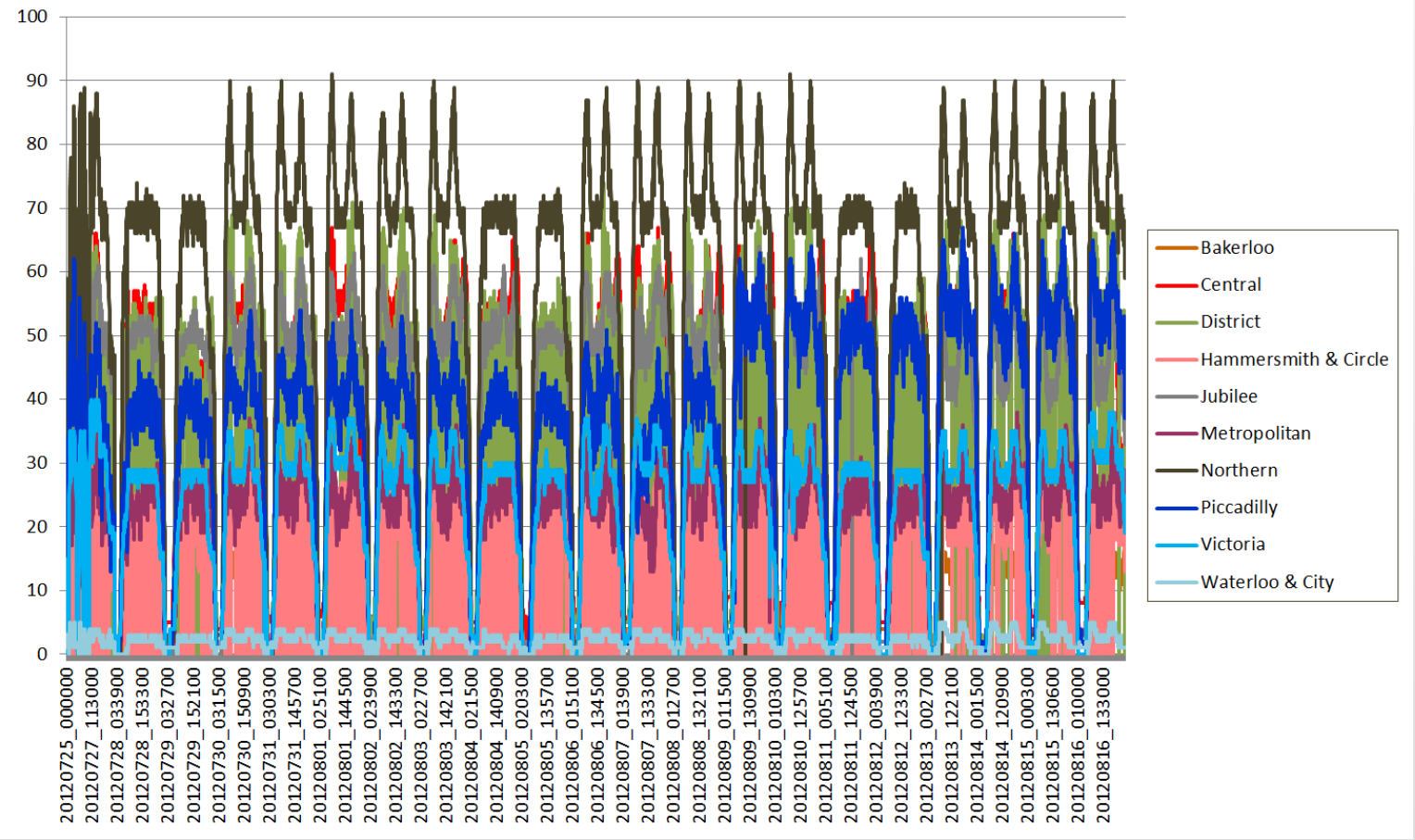


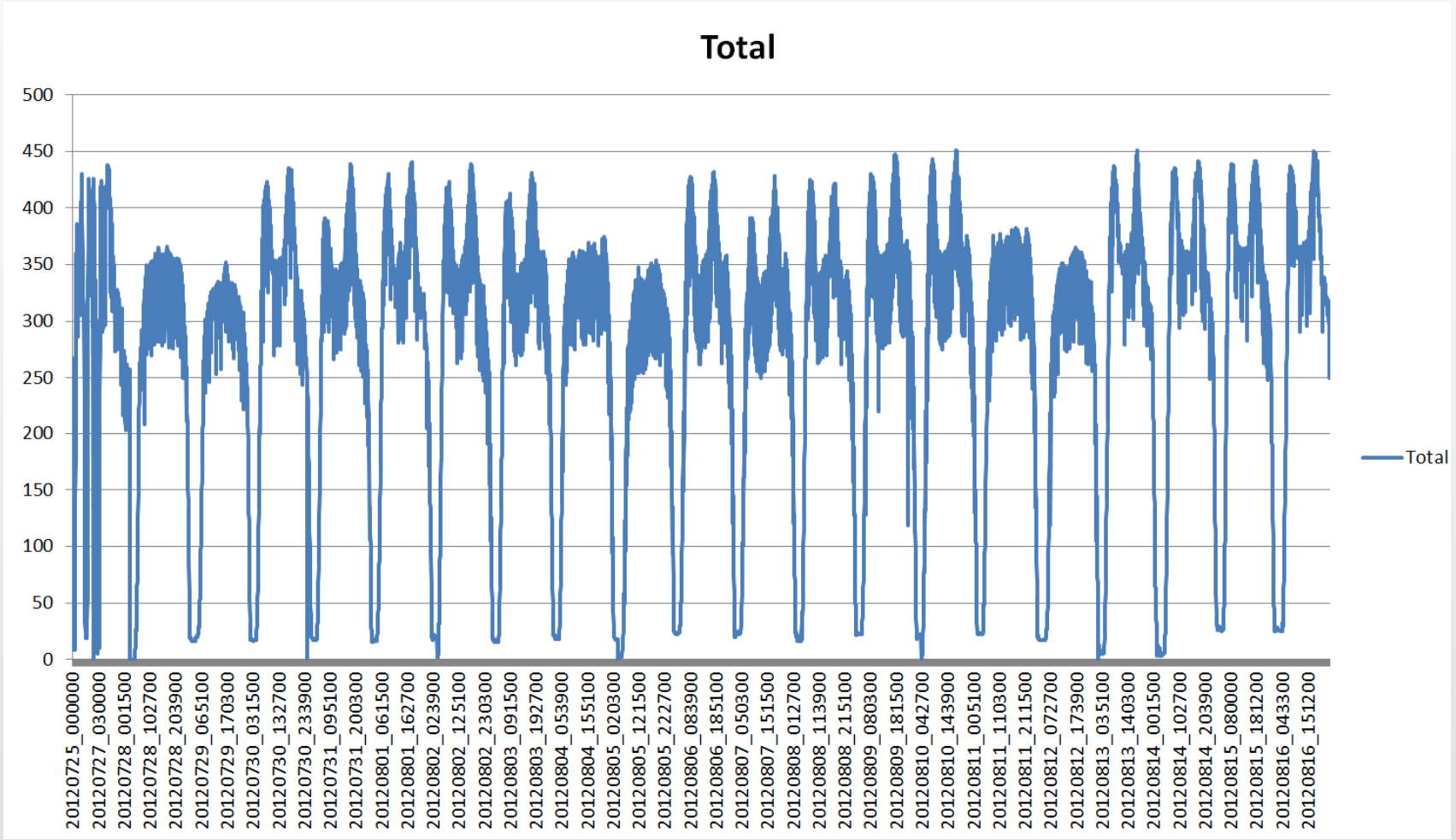
Key

- 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

Flows During the Olympics – we are looking at this as a case study




Total
500
450
400
350
300
250
200
150
100
50
0
20120725_000000
20120727_030000
20120728_001500
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20120728_203900
20120729_065100
20120729_170300
20120730_031500
20120730_132700
20120730_233900
20120731_095100
20120731_200300
20120801_061500
20120801_162700
20120802_023900
20120802_125100
20120802_230300
20120803_091500
20120803_192700
20120804_053900
20120804_155100
20120805_020300
20120805_121500
20120805_222700
20120806_083900
20120806_185100
20120807_050300
20120807_151500
20120808_012700
20120808_113900
20120808_215100
20120809_080300
20120809_181500
20120810_042700
20120810_143900
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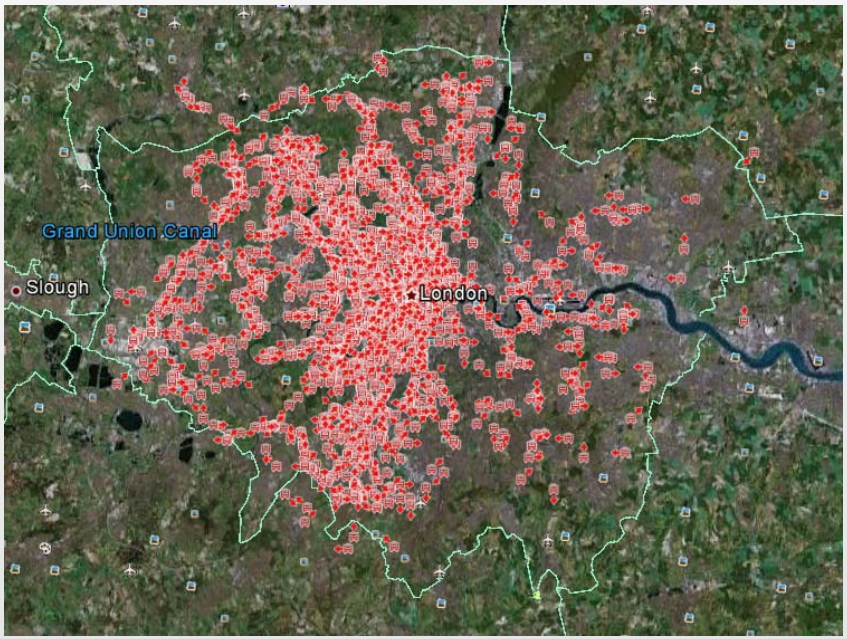
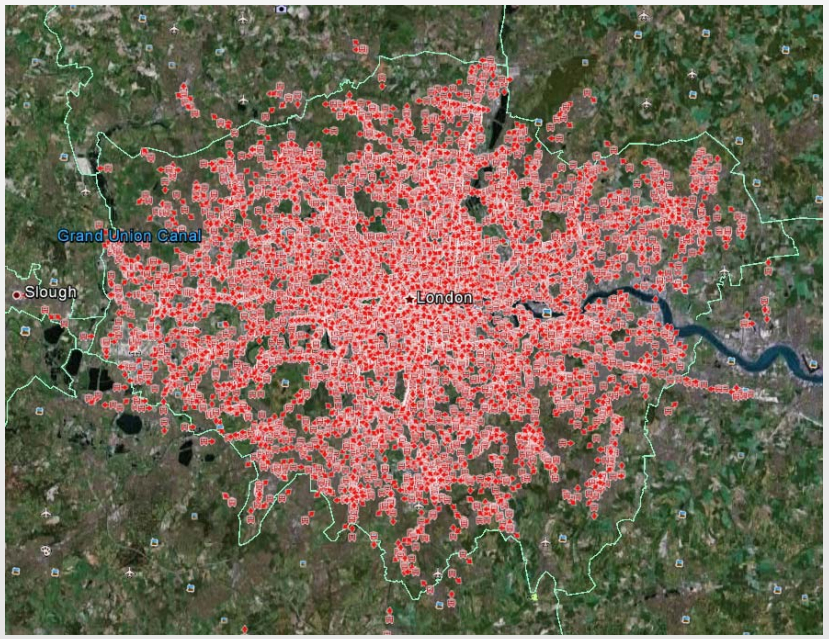
20120811_110300
20120811_211500
20120812_072700
20120812_173900
20120813_035100
20120813_140300
20120814_001500
20120814_102700
20120814_203900
20120815_080000
20120815_181200
20120816_043300
20120816_151200
Total
Weekend
Weekend
Weekend

The Effect of Bus Strike



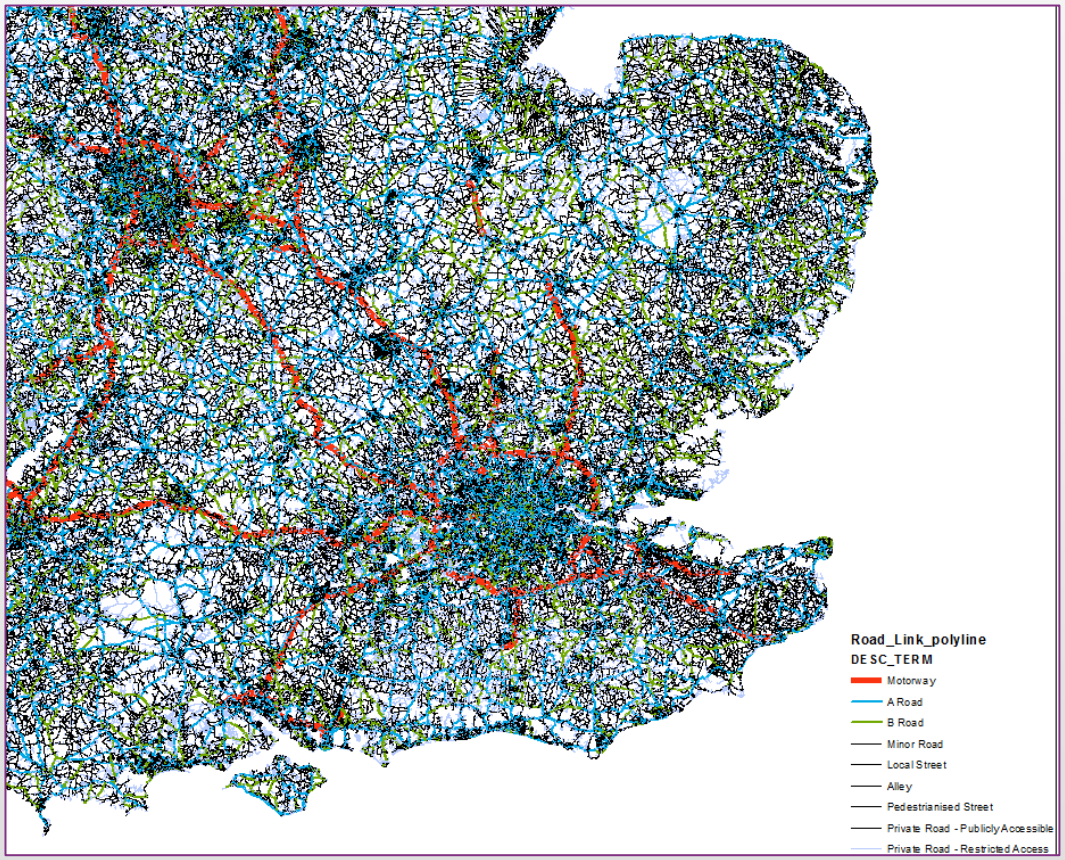
Tuesday 22nd May 2012, 09:00

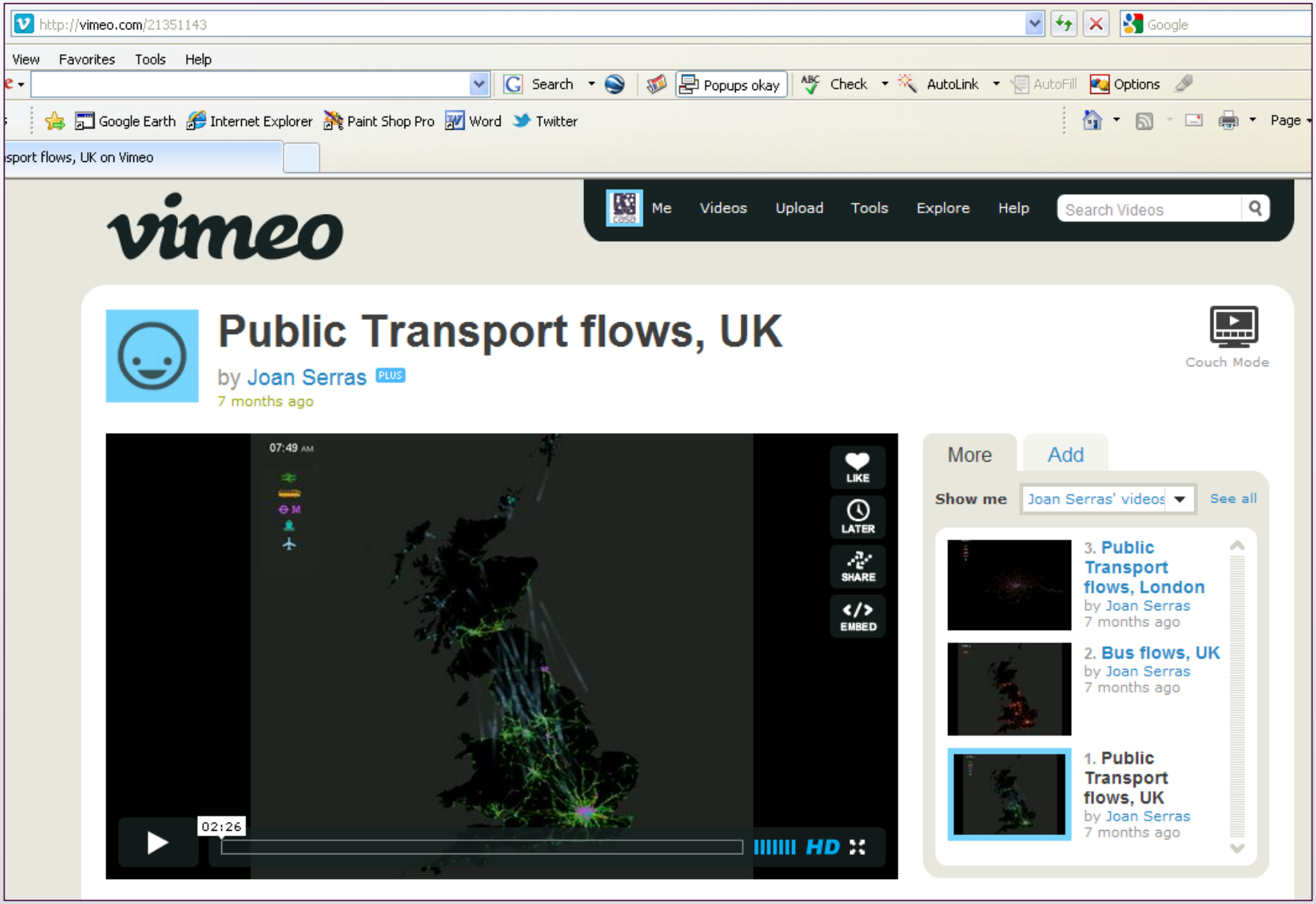


Wednesday 23rd May 2012, 09:00

The left image shows the effect of the bus strike on 22nd May 2012, while the image on the right shows a normal day.

Public Transport Vehicle (not People) Flows from Timetable and OS Streetline Data by Joan Serras (CASA)

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Public Transport flows, UK
by Joan Serras PLUS
7 months ago
Couch Mode
07:49 AM
LIKE
LATER
SHARE
EMBED
02:26
HD
More
Add
Show me
Joan Serras' videos
See all
3. Public Transport flows, London
by Joan Serras
7 months ago
2. Bus flows, UK
by Joan Serras
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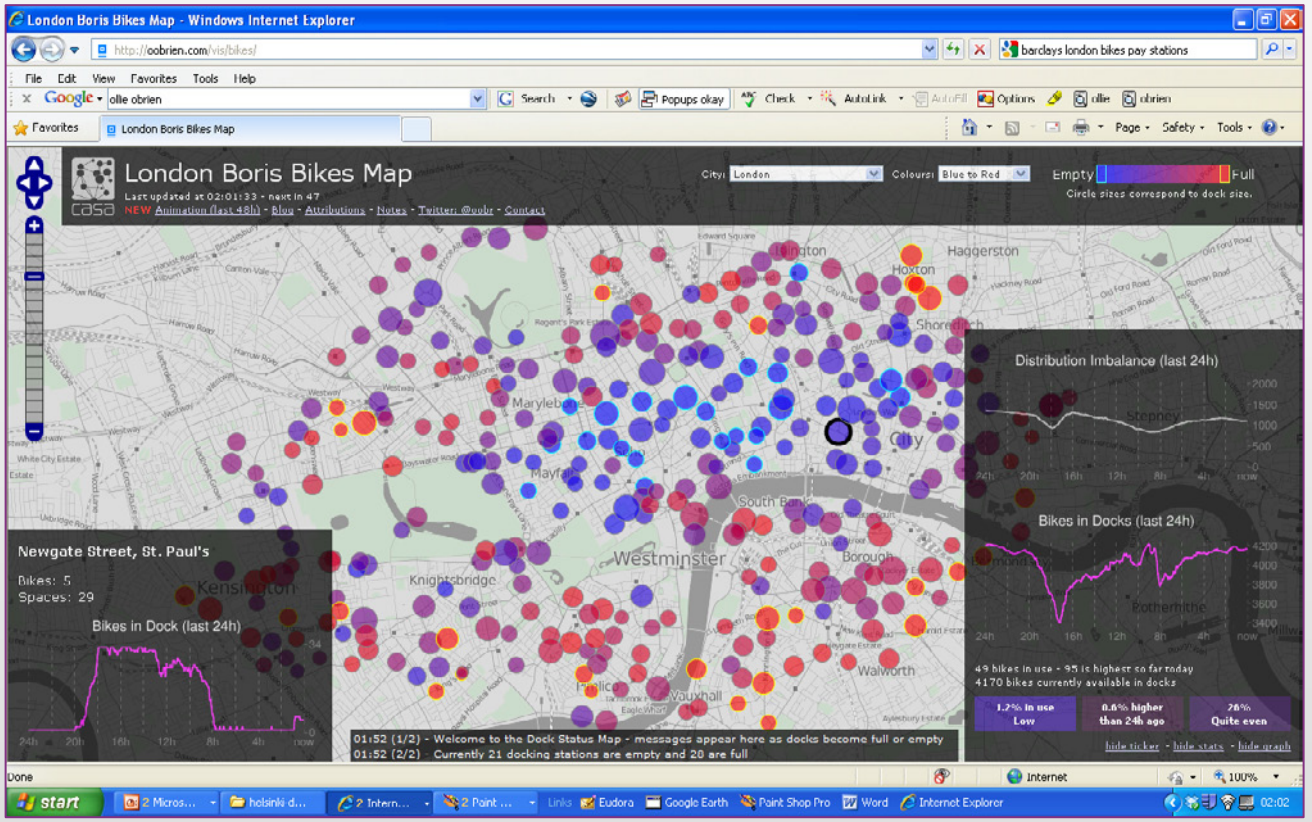
Our Bikes Project: Bikes Data – 4200 bikes, started Nov 2010, all the data– everything – all trips, all times, all stations/docks

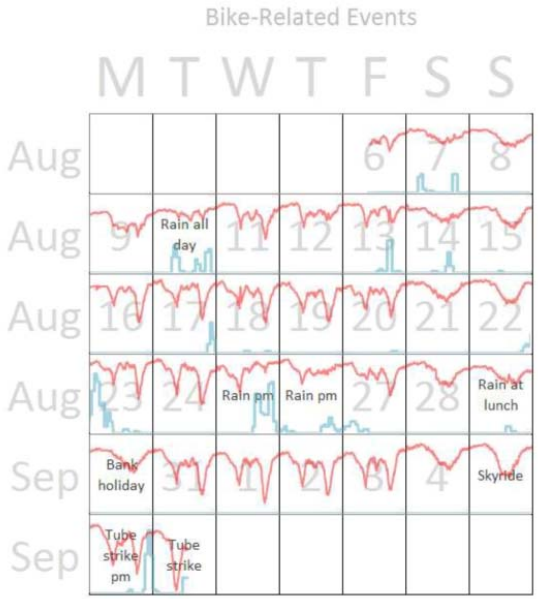


Animations of Public Bike Movements

Animations of Changes in the Bike Nodes: Docking

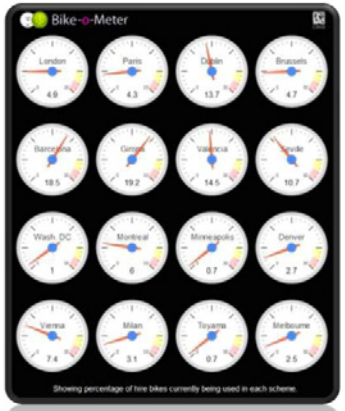
More Analysis

- **London**
- Graph shows number of bikes available to hire
- Effect of rain
  - Using the CASA weather station
- Effect of the tube strikes



Bike-o-Meter
casa.ucl.ac.uk/bom

- Tweet-o-Meter for bikes
  - Steven Gray (@frogo)
  - Using Google Gauges
- See the real life Tweet-o-Meters at the new British Library "Growing Knowledge" exhibition
  - Should be easy to hack to show the Bike-o-Meters instead ☺



Flow Network Analysis - Martin Zaltz Austwick - Windows Internet Explorer

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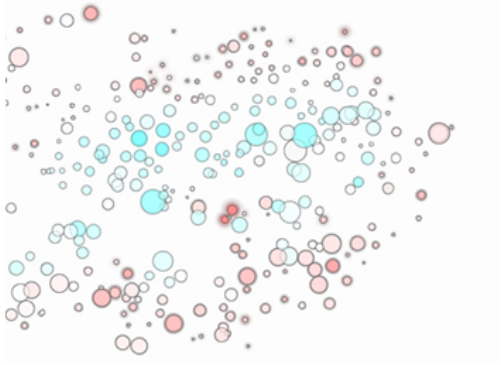
17:00 29 February 2012

Location: Pearson Lecture Theatre (North East Entrance)

Flow Network Analysis by Martin Zaltz Austwick, Lecturer in Advanced Spatial Analysis



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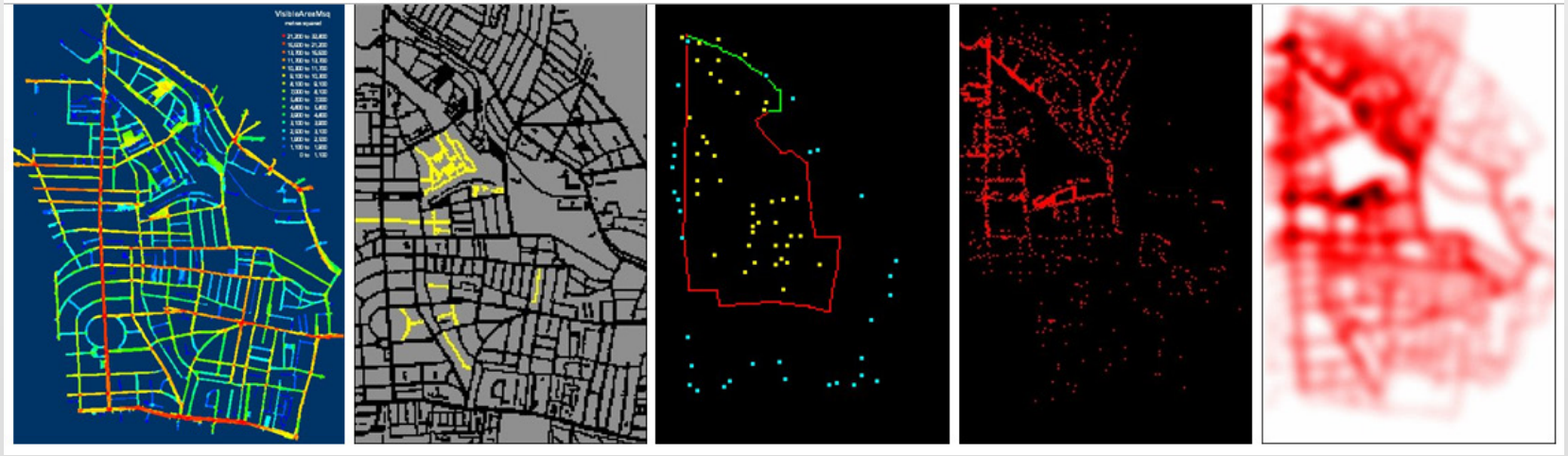
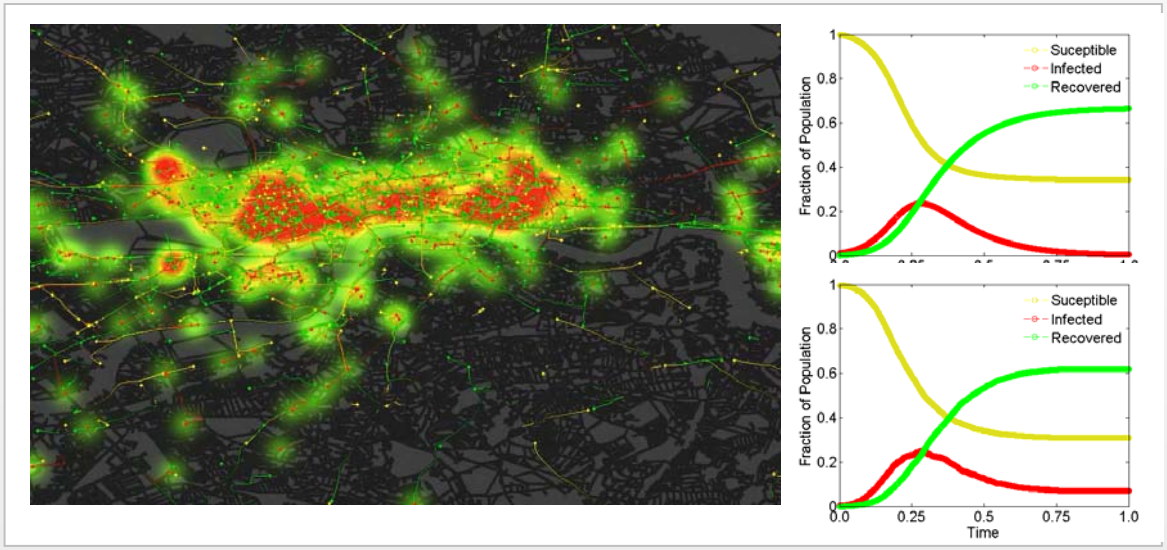
Simulating Crowds: Fine Scale Modelling and Sensing

In a different tradition but one which is rapidly converging with our interests in sensing and networks, we have developed a number of pedestrian models, first for the Notting Hill Carnival, and then for many town centres



We are now working on fine scale models which are mirror diffusion and spread in situations ranging from epidemics to evacuation and shopping.

We have a simple model of epidemics on networks in London and we are looking at evacuations of major shopping centres such as Covent Garden (right)



Let us change tack from sensing to mapping

Eliciting Data: Online Mapping & Crowdsourcing

We have a number of mapping projects using Web 2 and these involve using these online mapping systems to elicit simple data from the crowd – but data that is geotagged, hence the production of online maps of the crowdsourced data in real time

We have looked at Manchester congestion charge, anti social behaviour and credit crunch where in all cases we have used the BBC to broadcast the questions and provide the forum for response while our servers and software have produced the maps.

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MAPTUBE
a place to put maps

BBC RADIO 4

Radio 4: Mapping the Credit Crunch

Welcome to Radio 4 Listeners, below is the Credit Crunch question, simply select an option and then input the first part of your postcode - for example RG11

MapTube will then take your answer and every hour automatically create a map of the nation's mood.

What single factor is hurting you most about the credit crunch?

- Mortgage or Rent
- Petrol
- Food Prices
- Job Security
- Utility Bills
- Not Affected

Enter the first part of your postcode:

Submit

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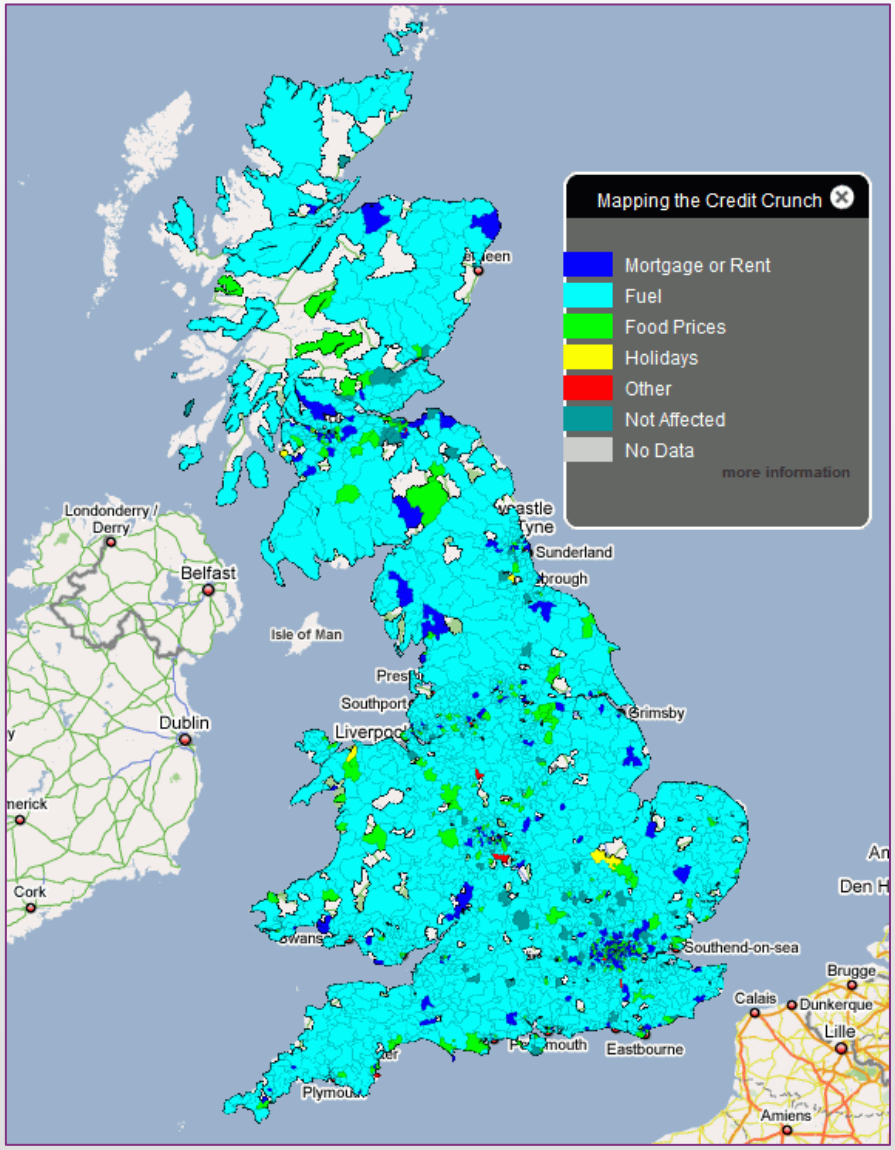
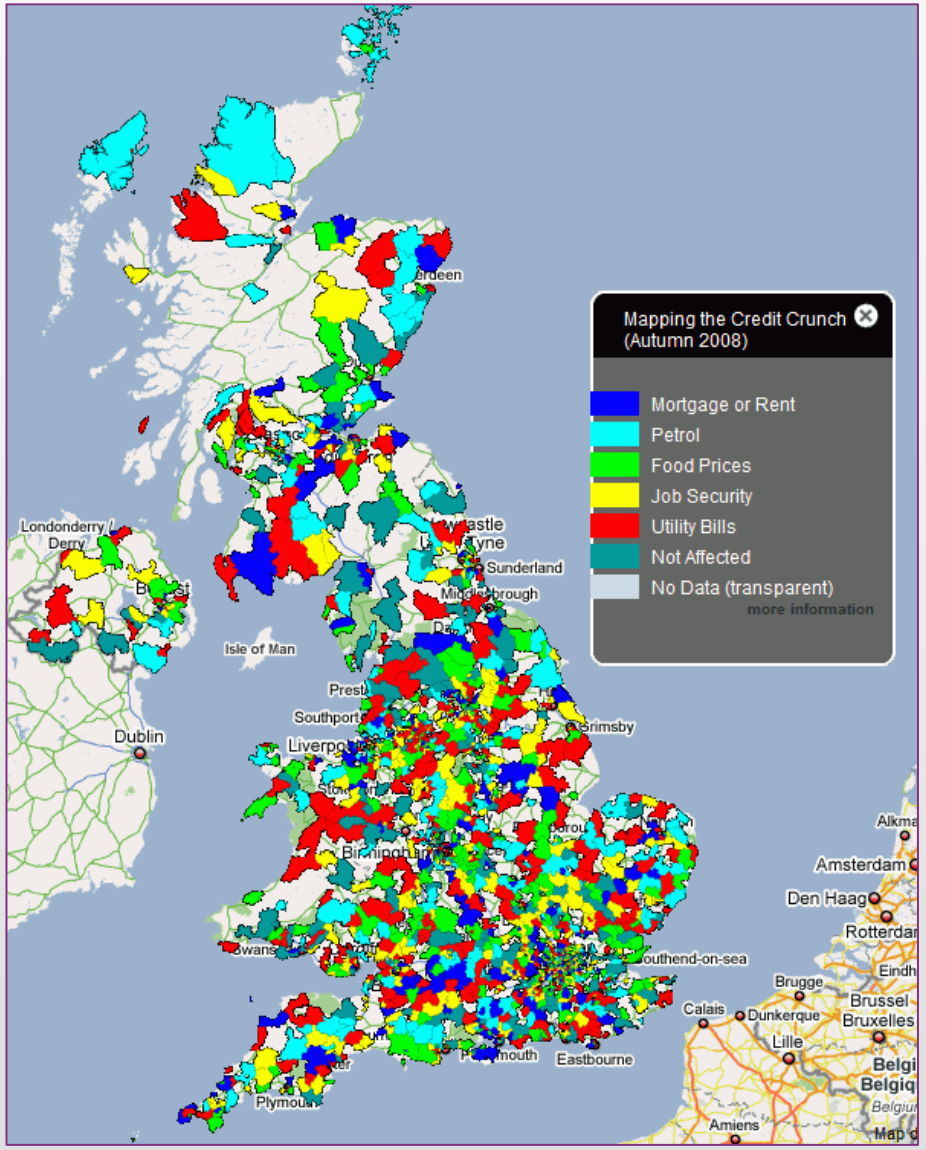
23,475 responses
April, May, June 2008

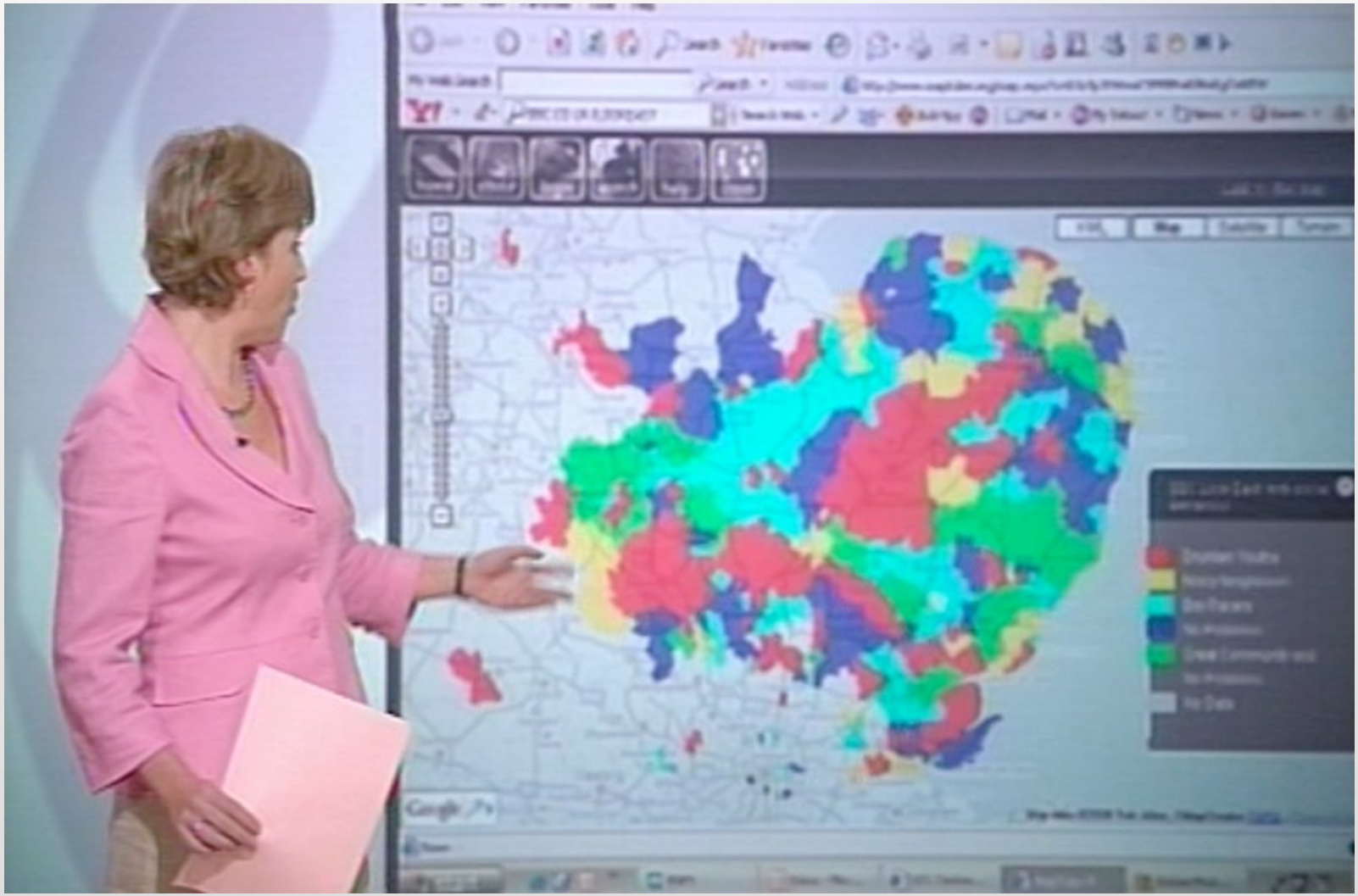
A new credit crunch survey started in October and currently has 3,802 responses.





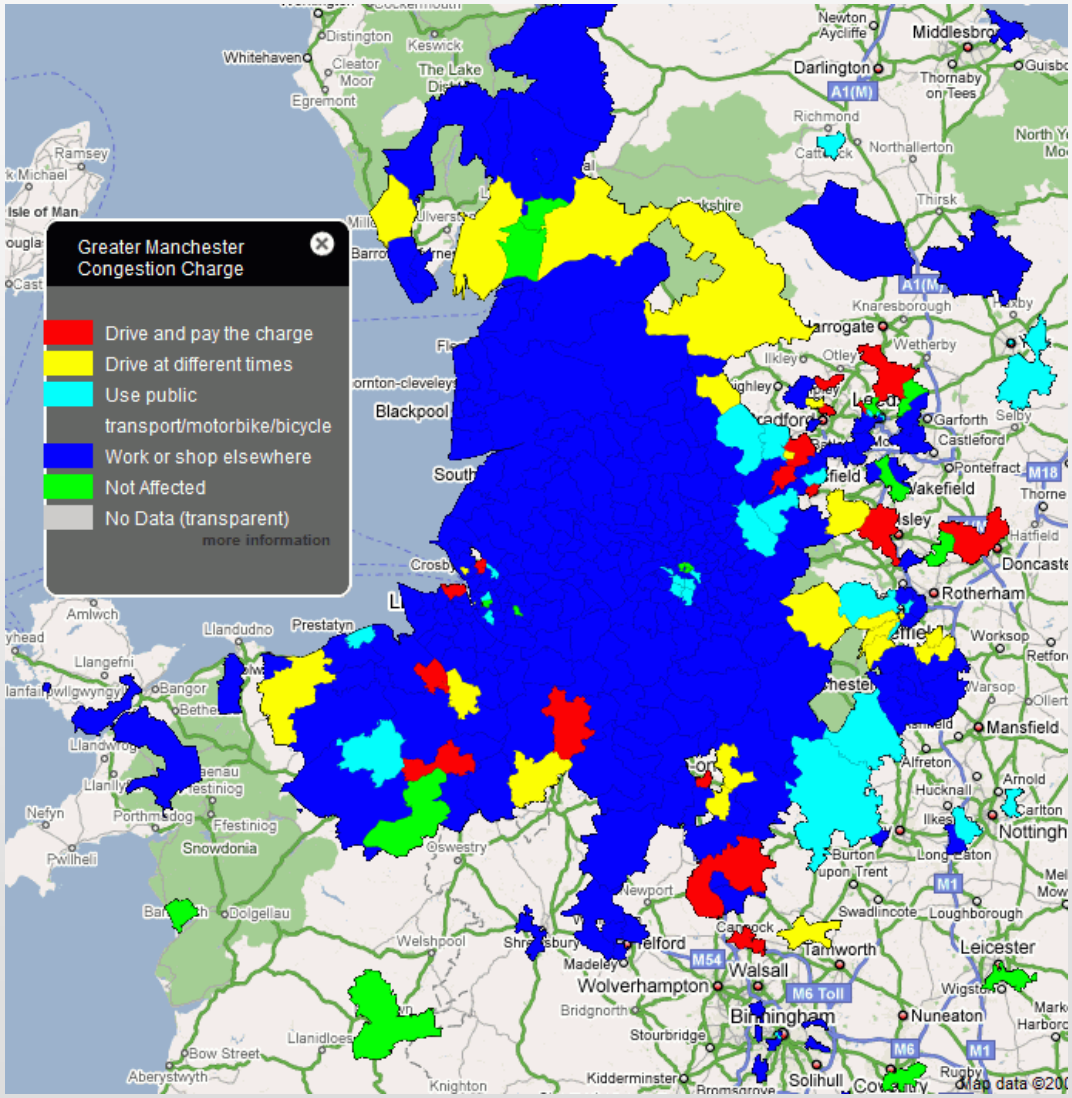
http://www.maptube.org/creditcrunch/

BBC Look East: Anti-Social Behaviour

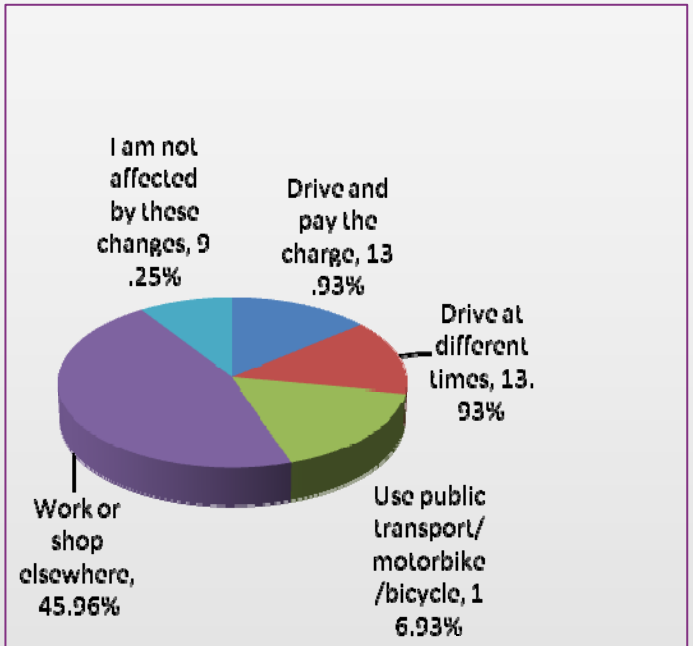


http://www.maptube.org/lookeast

Manchester Congestion Charge



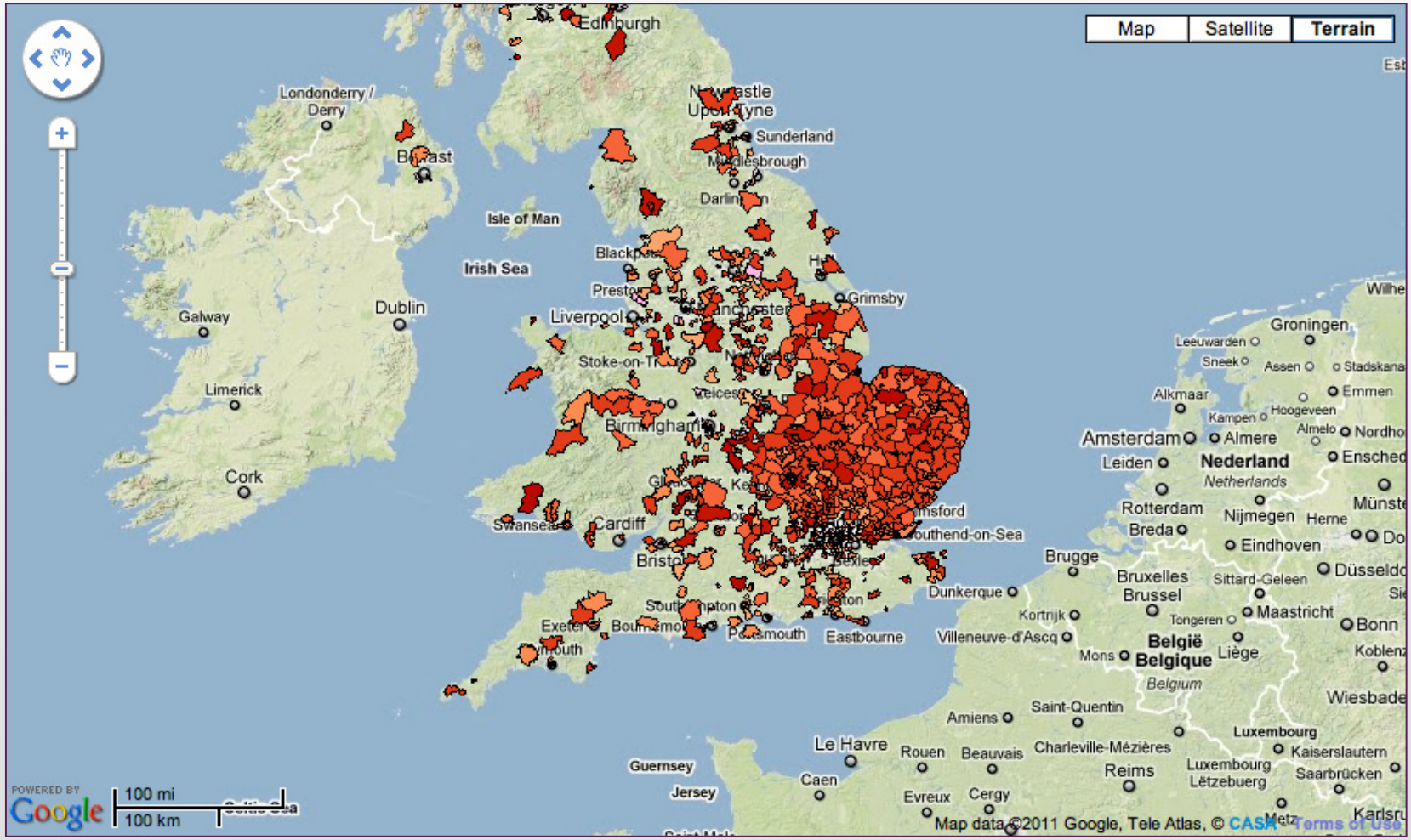
15,902 responses
October to December 2008



SurveyMapper

- Real-time Geographic survey tool.
- Up to 50 questions per survey
- Up to 50 answers per question
- Live stats and graphs
- Geographic Regions:
  - Worldwide Countries
  - European Countries
  - UK Counties
  - UK Postcode
  - Adding more soon
- Frequently updating regions

BBC Look East Survey - Broadband Speed Test

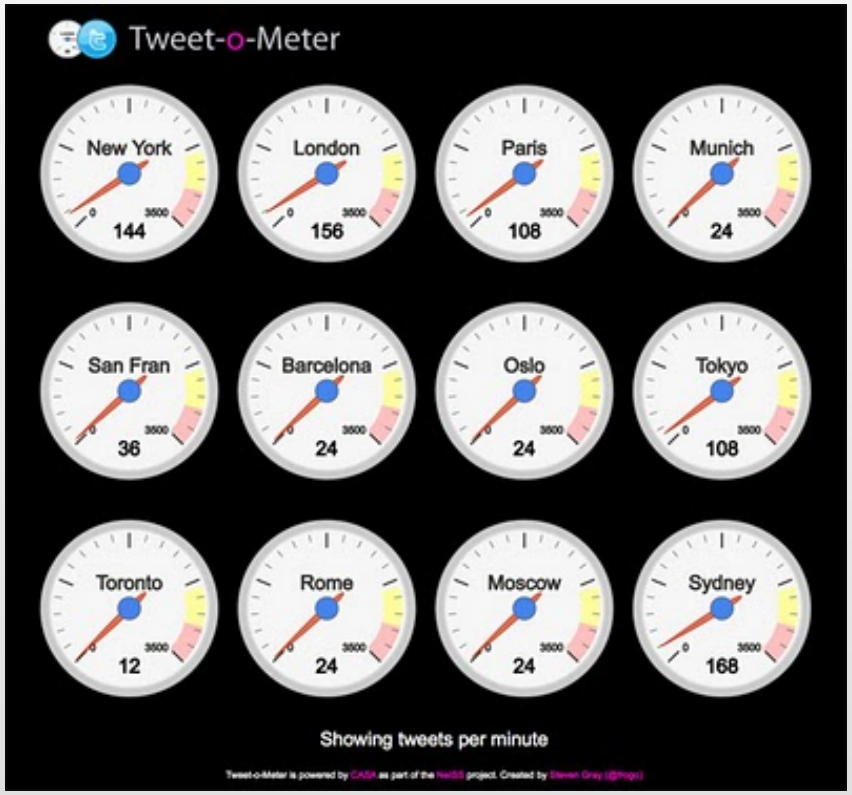


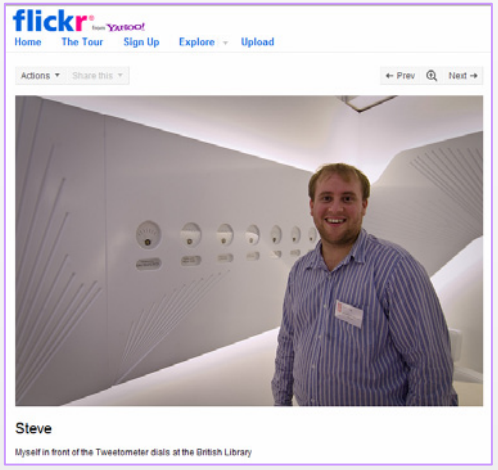
Extracting and Mapping Social Media

We have started to mine, map, interpret much social media because of the ease of its availability – and we have started looking at Short Text Messaging – Twitter data.

We have also begun to look at phone tracking data – from the iPhone for example but many of our data sets such as the bikes data, the Oyster card and such like data are really part of the same domain of new bottom up data. We have no control over this but some of the social media data we are mining we have greater control over. Here are some examples.

Spatial Analysis of Urban Activity using Twitter data

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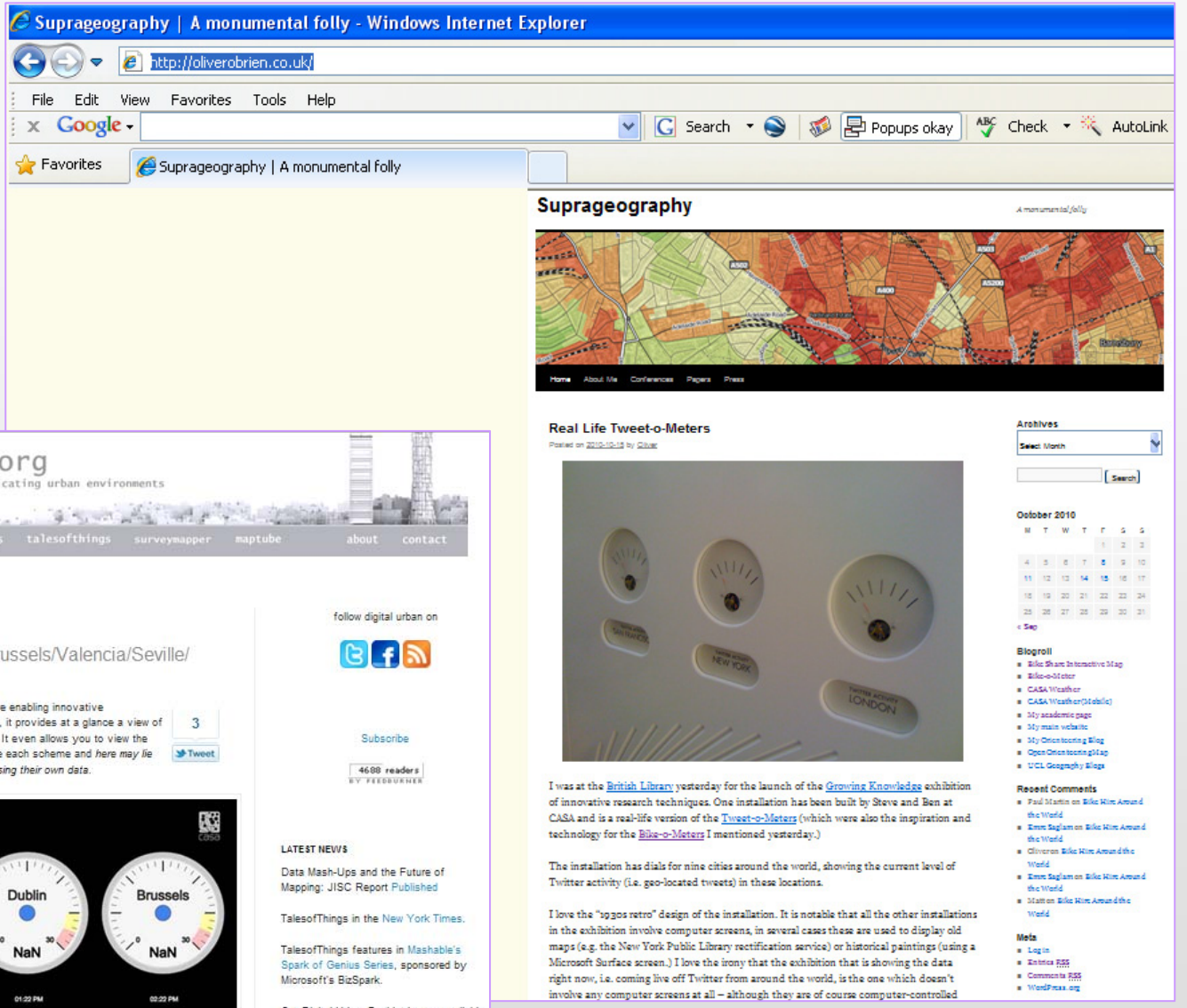
Home
The Tour
Sign Up
Explore
Upload
Steve
Myself in front of the Tweetometer dials at the British Library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AutoLink
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Suprageography | A monumental folly
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A monumental folly
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Papers
Press
Real Life Tweet-o-Meters
I was at the British Library yesterday for the launch of the Growing Knowledge exhibition of innovative research techniques. One installation has been built by Steve and Ben at CASA and is a real-life version of the Tweet-o-Meters (which were also the inspiration and technology for the Bike-o-Meters I mentioned yesterday.)
The installation has dials for nine cities around the world, showing the current level of Twitter activity (i.e. geo-located tweets) in these locations.
I love the "1930s retro" design of the installation. It is notable that all the other installations in the exhibition involve computer screens, in several cases these are used to display old maps (e.g. the New York Public Library rectification service) or historical paintings (using a Microsoft Surface screen.) I love the irony that the exhibition that is showing the data right now, i.e. coming live off Twitter from around the world, is the one which doesn't involve any computer screens at all – although they are of course computer-controlled
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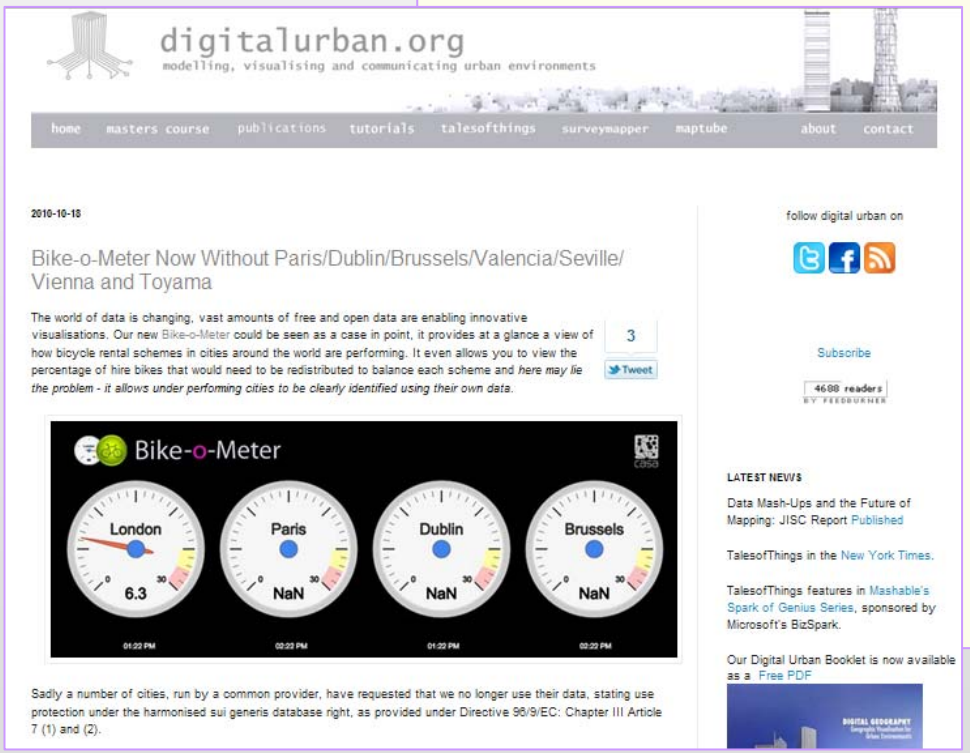
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contact
2010-10-18
Bike-o-Meter Now Without Paris/Dublin/Brussels/Valencia/Seville/ Vienna and Toyama
The world of data is changing, vast amounts of free and open data are enabling innovative visualisations. Our new Bike-o-Meter could be seen as a case in point, it provides at a glance a view of how bicycle rental schemes in cities around the world are performing. It even allows you to view the percentage of hire bikes that would need to be redistributed to balance each scheme and here may lie the problem - it allows under performing cities to be clearly identified using their own data.
Tweet
Bike-o-Meter
London
Paris
Dublin
Brussels
6.3
NaN
NaN
NaN
Sadly a number of cities, run by a common provider, have requested that we no longer use their data, stating use protection under the harmonised sui generis database right, as provided under Directive 96/9/EC: Chapter III Article 7 (1) and (2).
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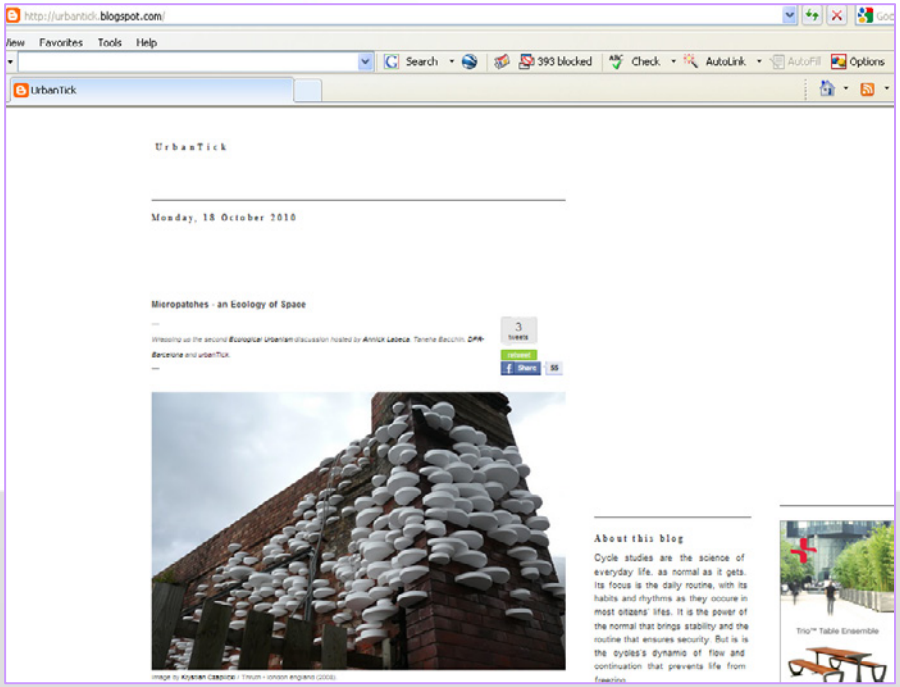
TalesofThings in the New York Times.
TalesofThings features in Mashable's Spark of Genius Series, sponsored by Microsoft's BizSpark.
Our Digital Urban Booklet is now available as a Free PDF

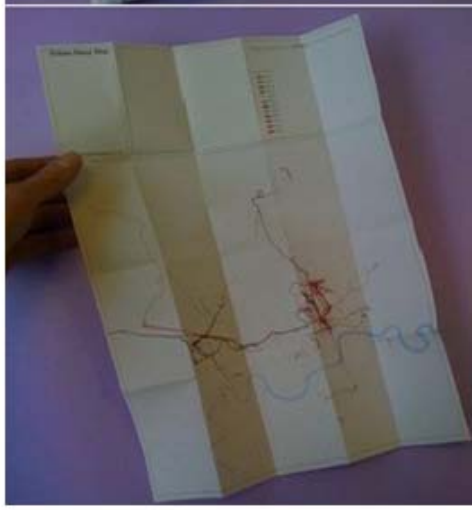
Tweets as Background Radiation about Dynamics in the City

Urban Tick

Urban Tick is a new blog which is written by Fabian Neuhaus who is studying rhythms and cycles in the city for his doctoral work. An important way of looking at cities is through the fast processes that define the functions of the urban environment of which local movement is key. Tracking individuals and relating their space time trajectories to their behaviours and the activities that they frequent and use is basic to the way cities are organised. We can begin to define spatial structures in terms of such movement and tracking individuals is fast becoming one of the ways in which such structures can be defined. Contemporary IT with embedded GPS is central to all of this and Urban Tick seeks to record what is moving and shaking this fast developing field .

http://urbantick.blogspot.com

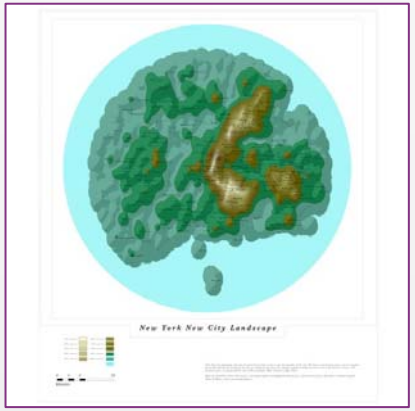




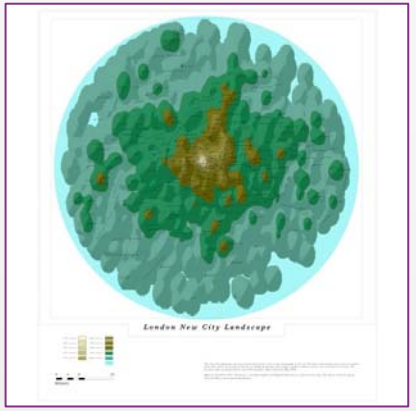
About this blog

Cycle studies are the science of everyday life, as normal as it gets. Its focus is the daily routine, with its habits and rhythms as they occure in most citizens' lifes. It is the power of the normal that brings stability and the routine that ensures security. But is is the cycles's dynamic of flow and continuation that prevents life from freezing.
Cycles therefore stand for stability but are at the same time the engine of change.

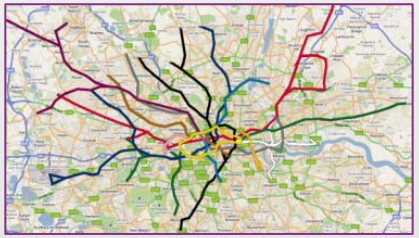
With this blog the research on cycles and rhythms will be embedded in the most recent developments in technology, covering a range of areas with a focus on space-time related technologies.

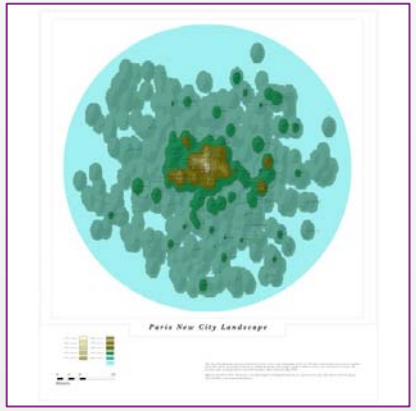


New York

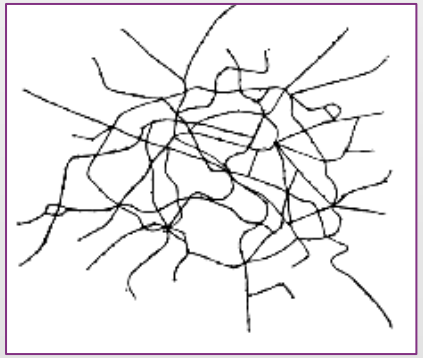


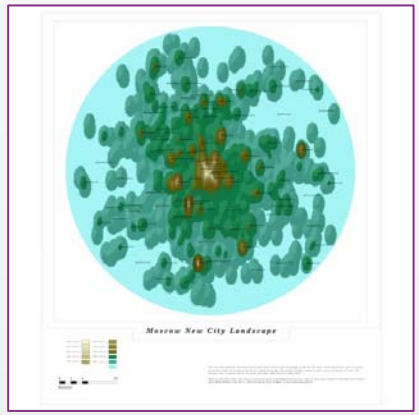
London



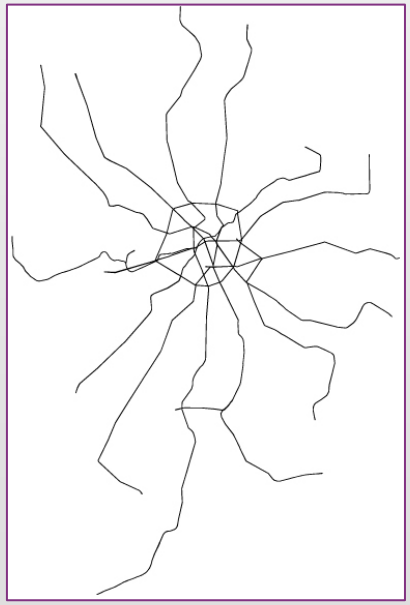


Paris

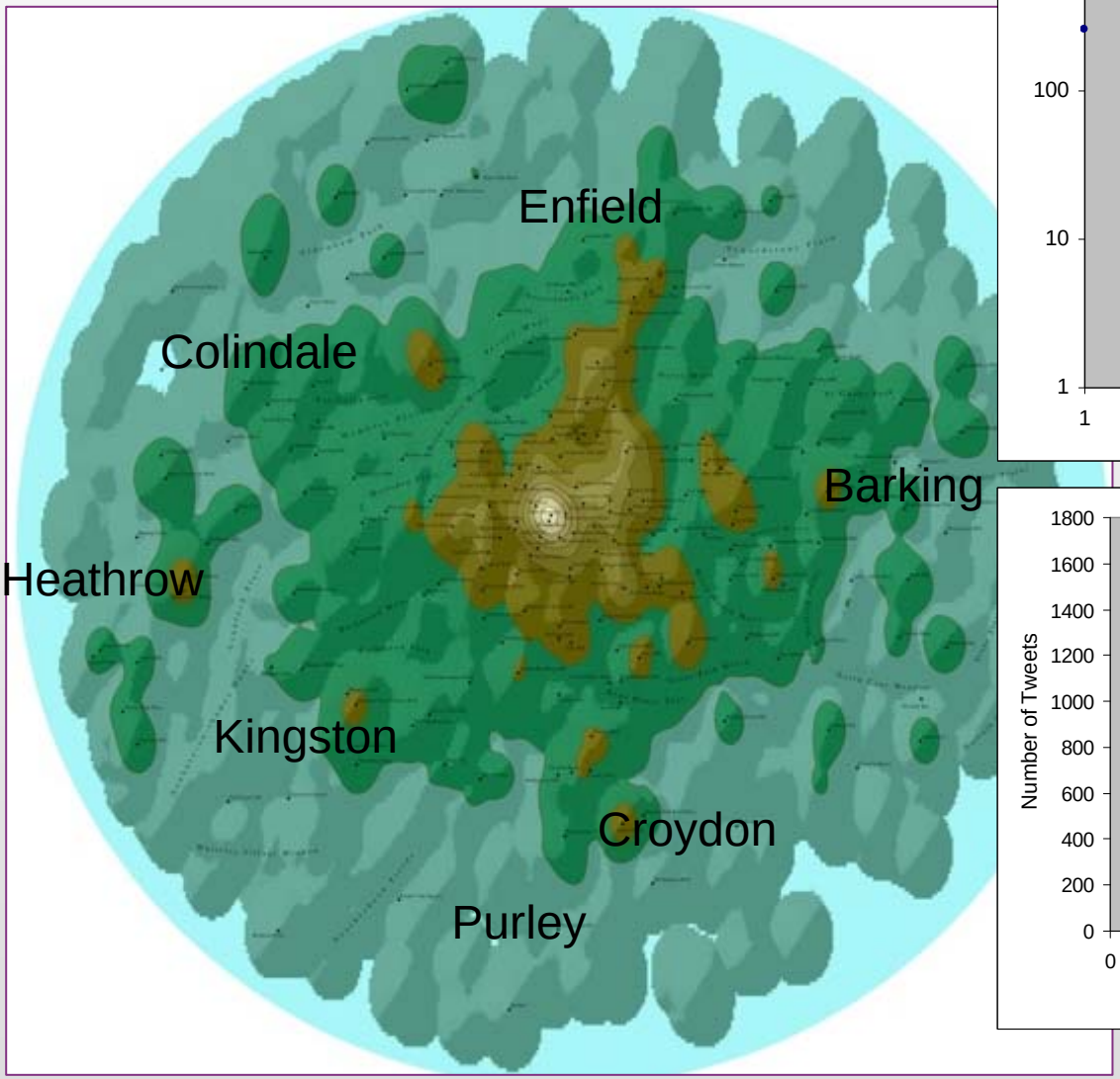




Moscow



London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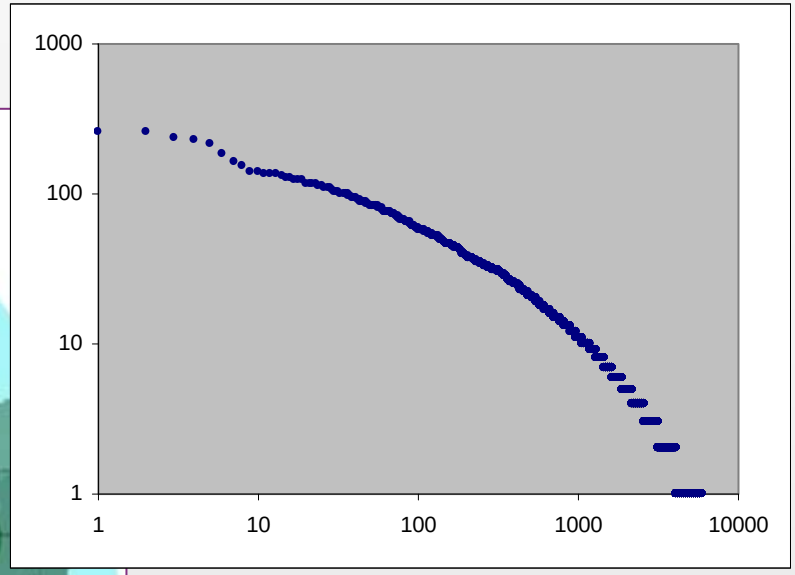
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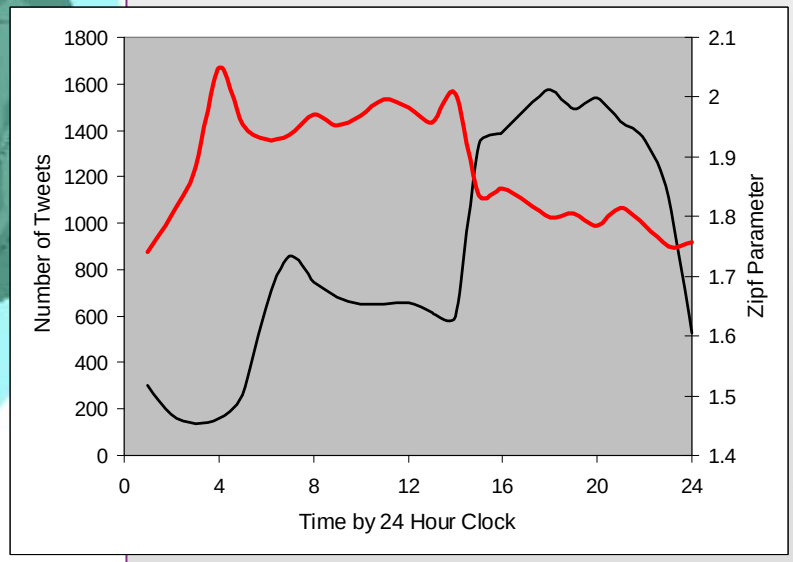
1800
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Number of Tweets
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2
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20
24
Time by 24 Hour Clock

A Framework for All of This: The Complexity Sciences

I will not labour this much longer but much of our work is informed by our general interest in understanding cities using the complexity sciences. Some of us in CASA have a bigger picture that involves how all this fits into urban theory and planning.

We are thus interested in understanding the social physics of the city, networks, flows morphology, dynamics, resilience, emergence and so on

I refer you to my own weblog – www.complexCity.info

which I call **A Science of Cities** (because I believe there is more than one science – there are many)

And some of our blogs

A Science of Cities http://www.complexcity.info/

Spatial Complexity http://www.spatialcomplexity.info/

Big Data ToolKit http://bigdatatoolkit.org/

Digital Urban http://www.digitalurban.org/

GIS and Agent-Based Modelling http://gisagents.blogspot.com/

Simulacra http://simulacra.blogs.casa.ucl.ac.uk/

Sociable Physics http://sociablephysics.wordpress.com/

Spatial Analysis http://spatialanalysis.co.uk/

Suprageography http://oliverobrien.co.uk/

The Mapping London Blog http://mappinglondon.co.uk/

Urban Tick http://urbantick.blogspot.com/

http://blogs.casa.ucl.ac.uk/

http://www.casa.ucl.ac.uk/

Thanks, Questions?