

# nominet

## Fun with IPv4 Heatmaps

Roy Arends

Nominet UK

Open Resolver Addresses  
Mapped in Hilbert Order  
Colored by /24 saturation

code: Duane Wessels

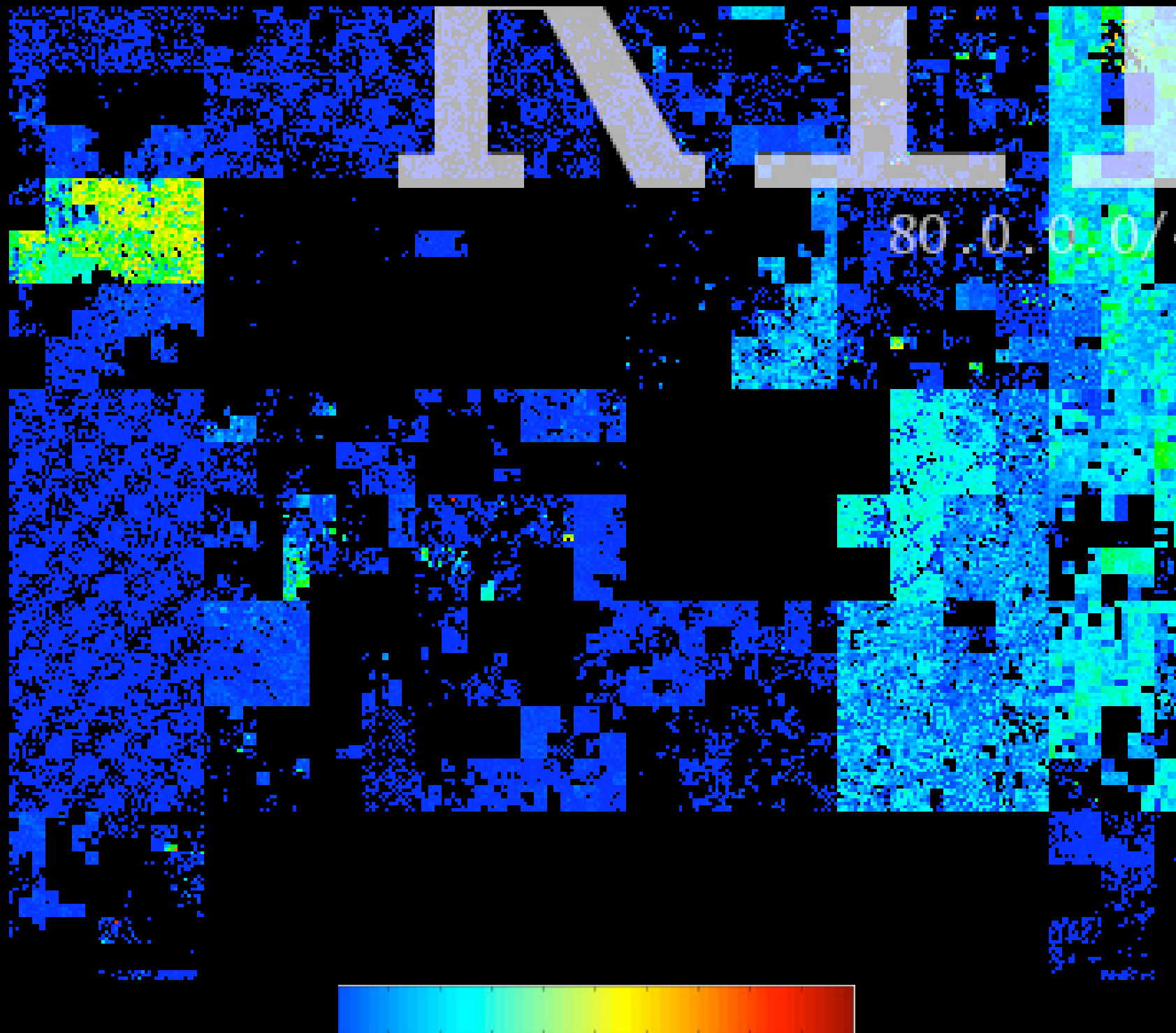
data: John Kristoff



More than 16,000,000 open resolvers during a sweep of the IPv4 address space.



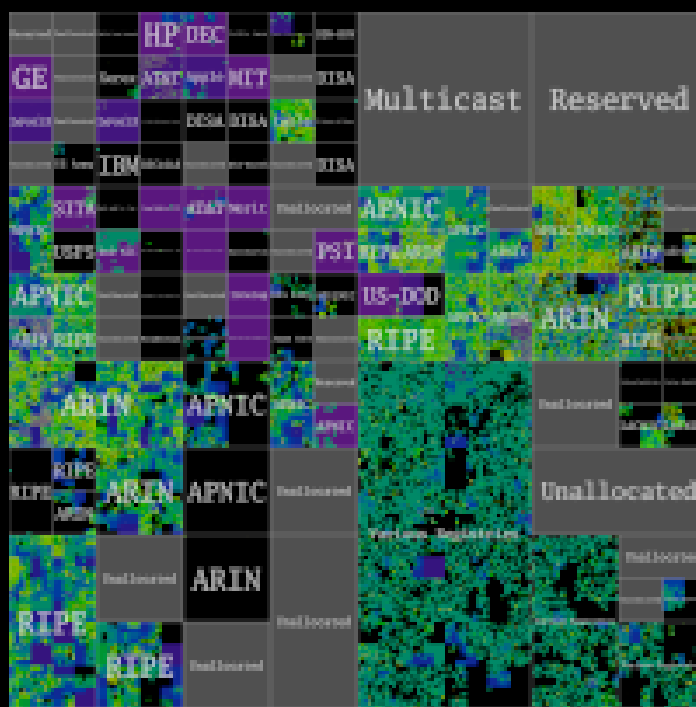




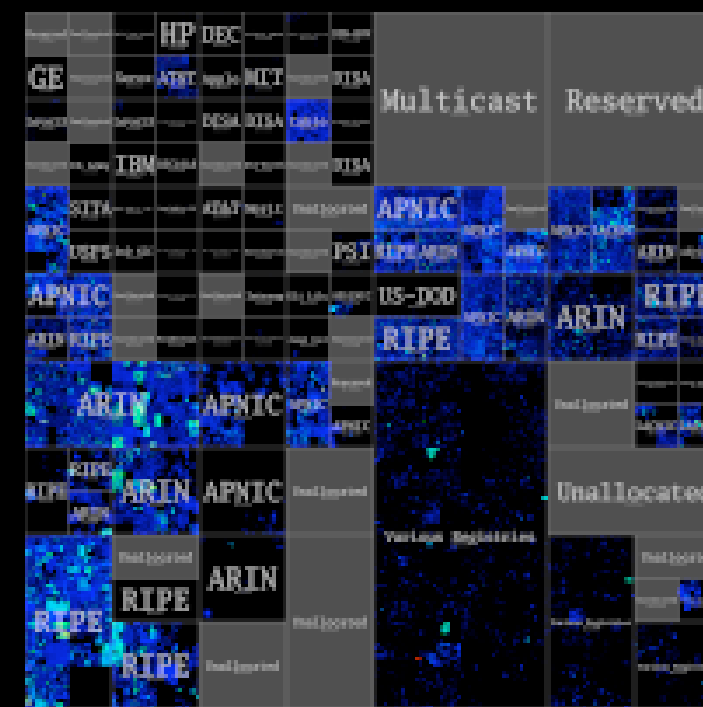
detail of 80.0.0.0/4  
One /24 network per pixel, colored by saturation.



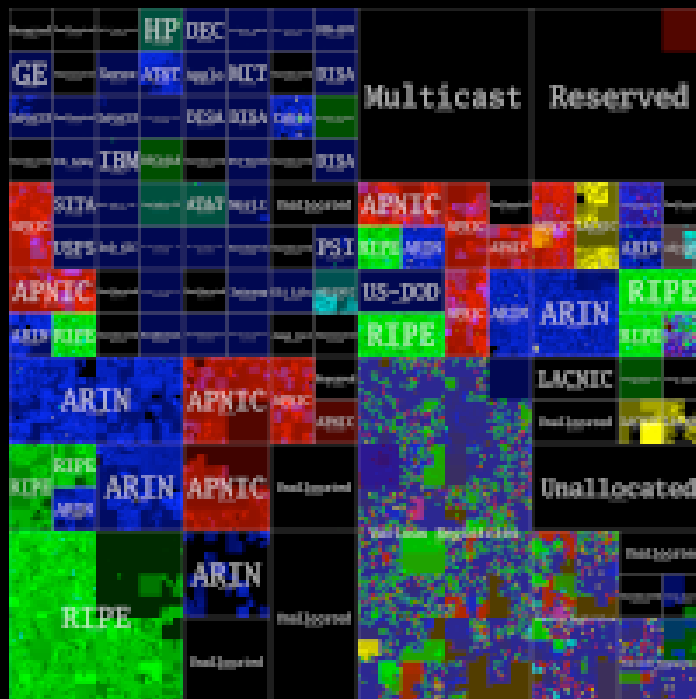
## BGP Routeviews



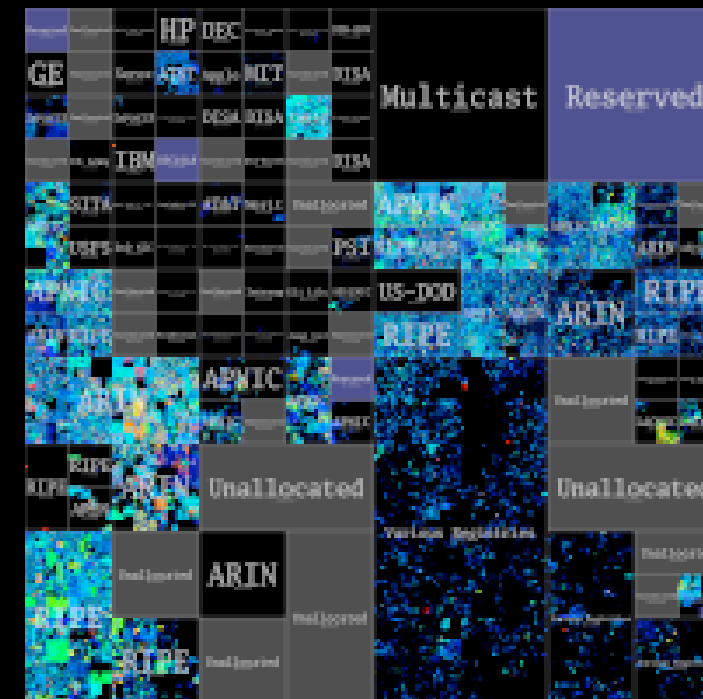
BGP Routeviews



Open Resolvers



RIR whois



Census



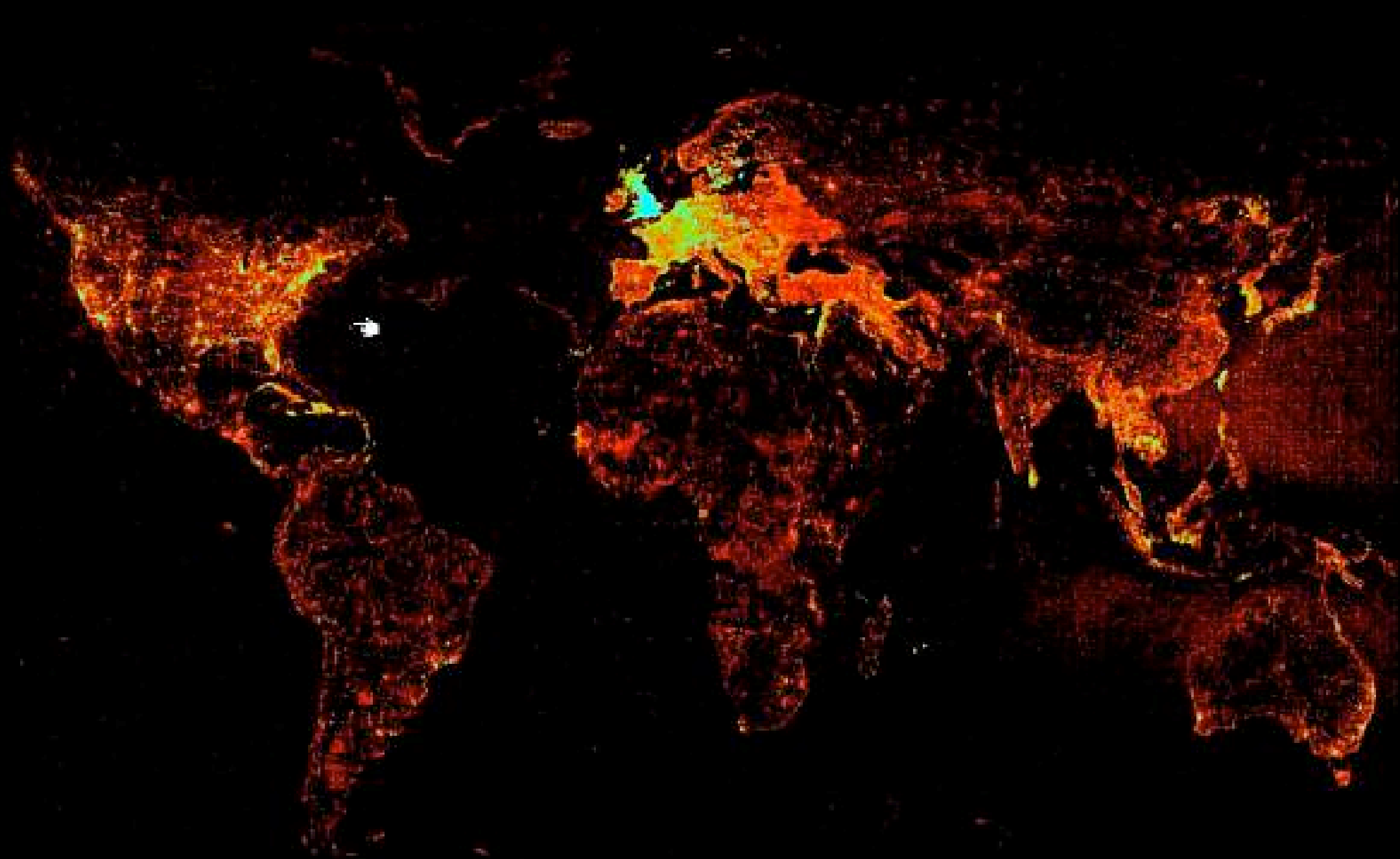
# Inspired by XKCD





Inspired by XKCD

# Examples of Heatmaps



Ed Parsons “the Cathedral and the GPS”  
footprints of google’s KML/GeoRSS database





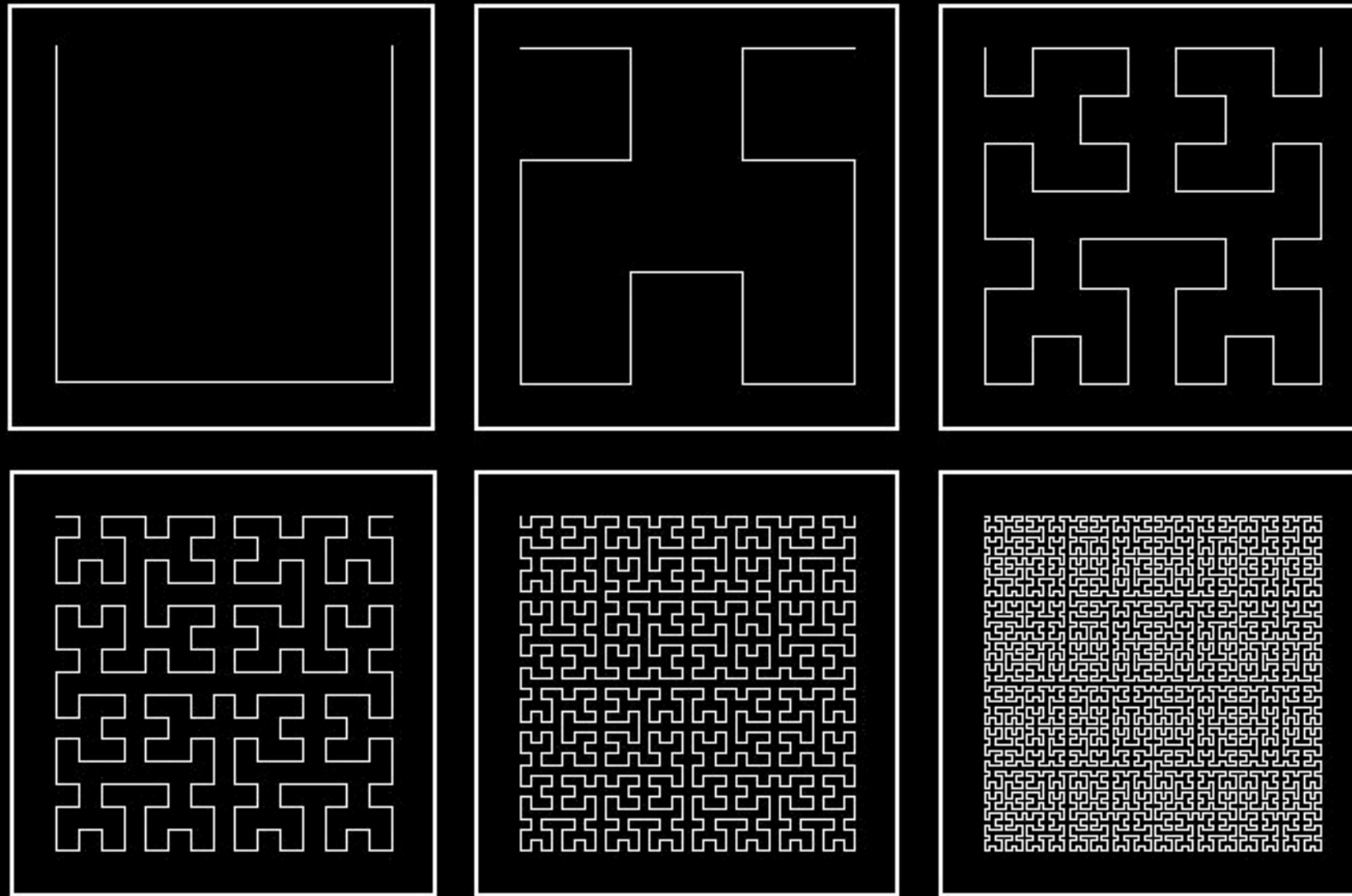




GeoIQ  
Heatmap layer for Google maps



# IPv4 Heatmap in Hilbert Order.



Hilbert curves, order 1 to 6  
Direction changes with every order

1	2	15	16
4	3	14	13
5	8	9	12
6	7	10	11

16 points on a 2<sup>nd</sup> order hilbert curve



Using Hilbert Curves:  
Consecutive netblocks can be grouped together.

Using Hilbert Curves:  
Consecutive netblocks can be grouped together.

However

In networking, only those consecutive netblocks  
that share the same prefix need to be grouped together.

Using Hilbert Curves:  
Consecutive netblocks can be grouped together.

However

In networking, only those consecutive netblocks  
that share the same prefix need to be grouped together.

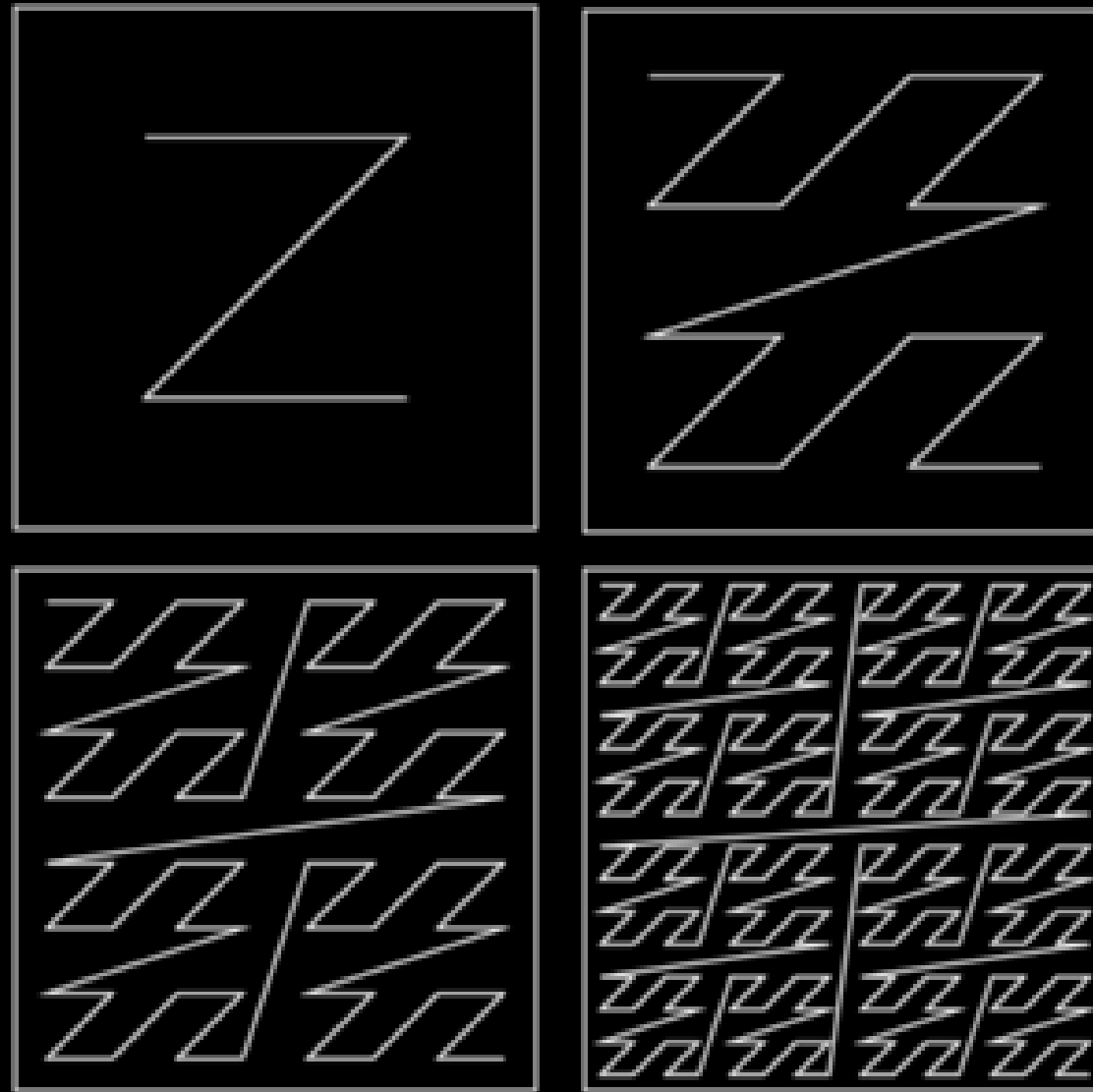
$$127 / 8 + 128 / 8 \neq 127 / 7$$

Using Morton Curves:

consecutive netblocks that share the prefix  
can be grouped as one netblock.

Which is tailored to our needs.





Morton curves, order 1 to 4  
 Direction is the same with every order

1	2		5	6
3	4		7	8
9	10		13	14
11	12		15	16

16 points on 2<sup>nd</sup> order Morton curve

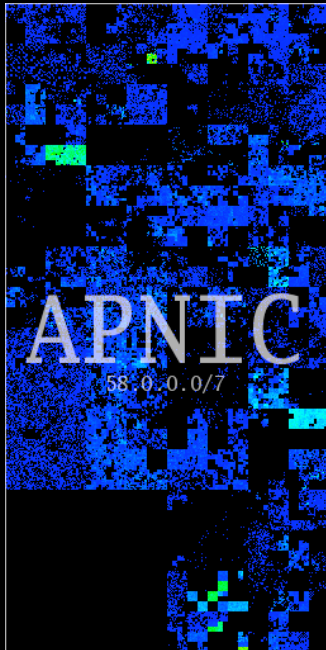


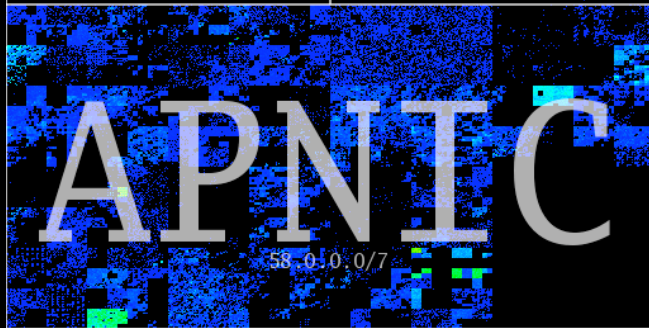


IPv4 Heatmap in Hilbert Order.



IPv4 Heatmap in Morton Order.



 APNIC 58.0.0.0/7	SITA 57.0.0.0/8	Merck and Co., Inc. 54.0.0.0/8	Cap Debis CCS 53.0.0.0/8	Prudential 48.0.0.0/8	Unallocated 49.0.0.0/8	E.I. duPont de Nemours and Co., Inc. 52.0.0.0/8	Cap Debis CCS 53.0.0.0/8
	USPS 56.0.0.0/8	DoD NIC 55.0.0.0/8	E.I. duPont de Nemours and Co., Inc. 52.0.0.0/8	Unallocated 50.0.0.0/8	Department of Social Security of UK 51.0.0.0/8	Merck and Co., Inc. 54.0.0.0/8	DoD NIC 55.0.0.0/8
 APNIC 60.0.0.0/7		Unallocated 50.0.0.0/8	Department of Social Security of UK 51.0.0.0/8	USPS 56.0.0.0/8	SITA 57.0.0.0/8	 APNIC 60.0.0.0/7	
ARIN 63.0.0.0/8	RIPE 62.0.0.0/8	Unallocated 49.0.0.0/8	Prudential 48.0.0.0/8	 APNIC 58.0.0.0/7		RIPE 62.0.0.0/8	ARIN 63.0.0.0/8

Hilbert

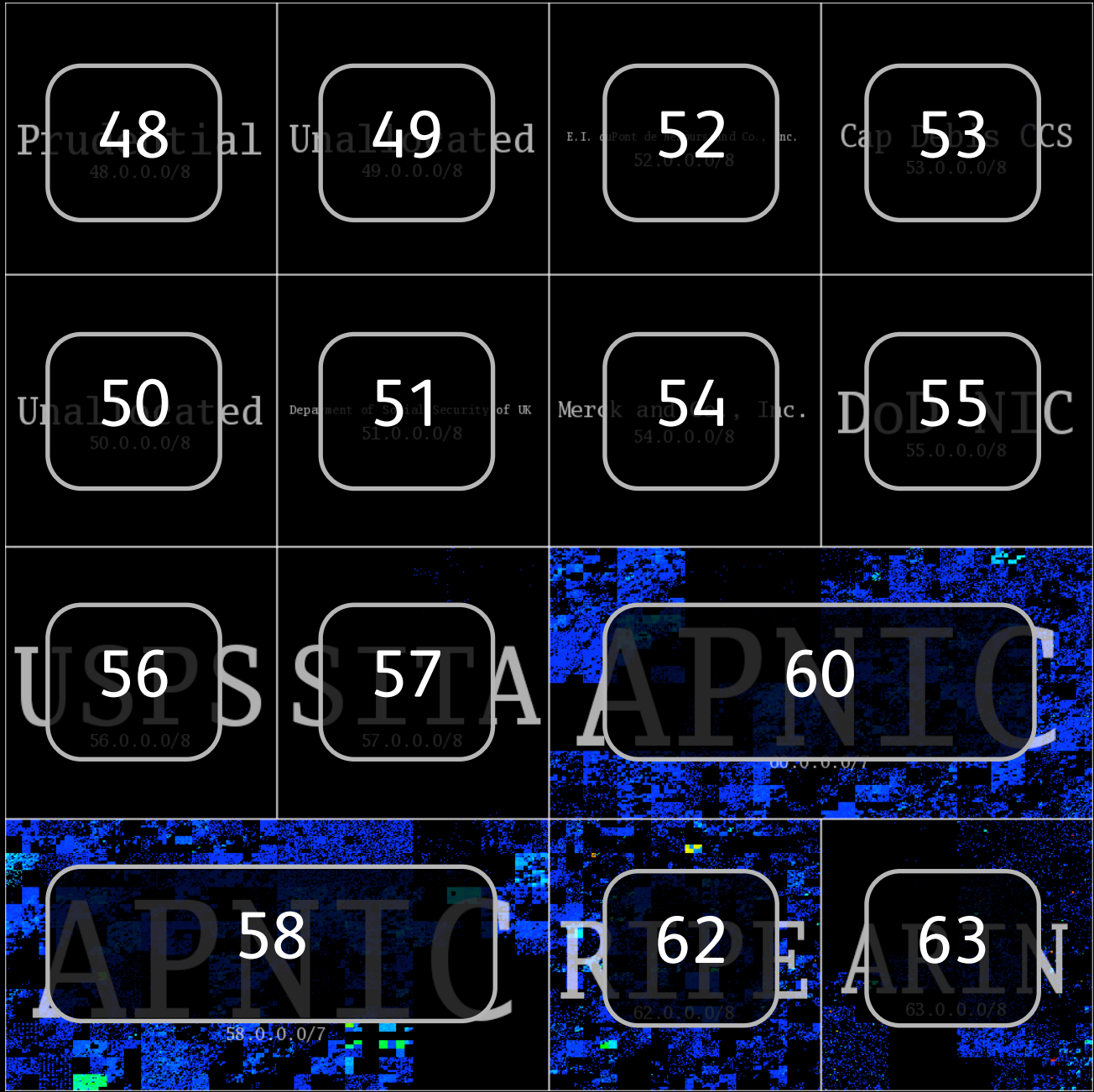
Morton

Detail of 48/4



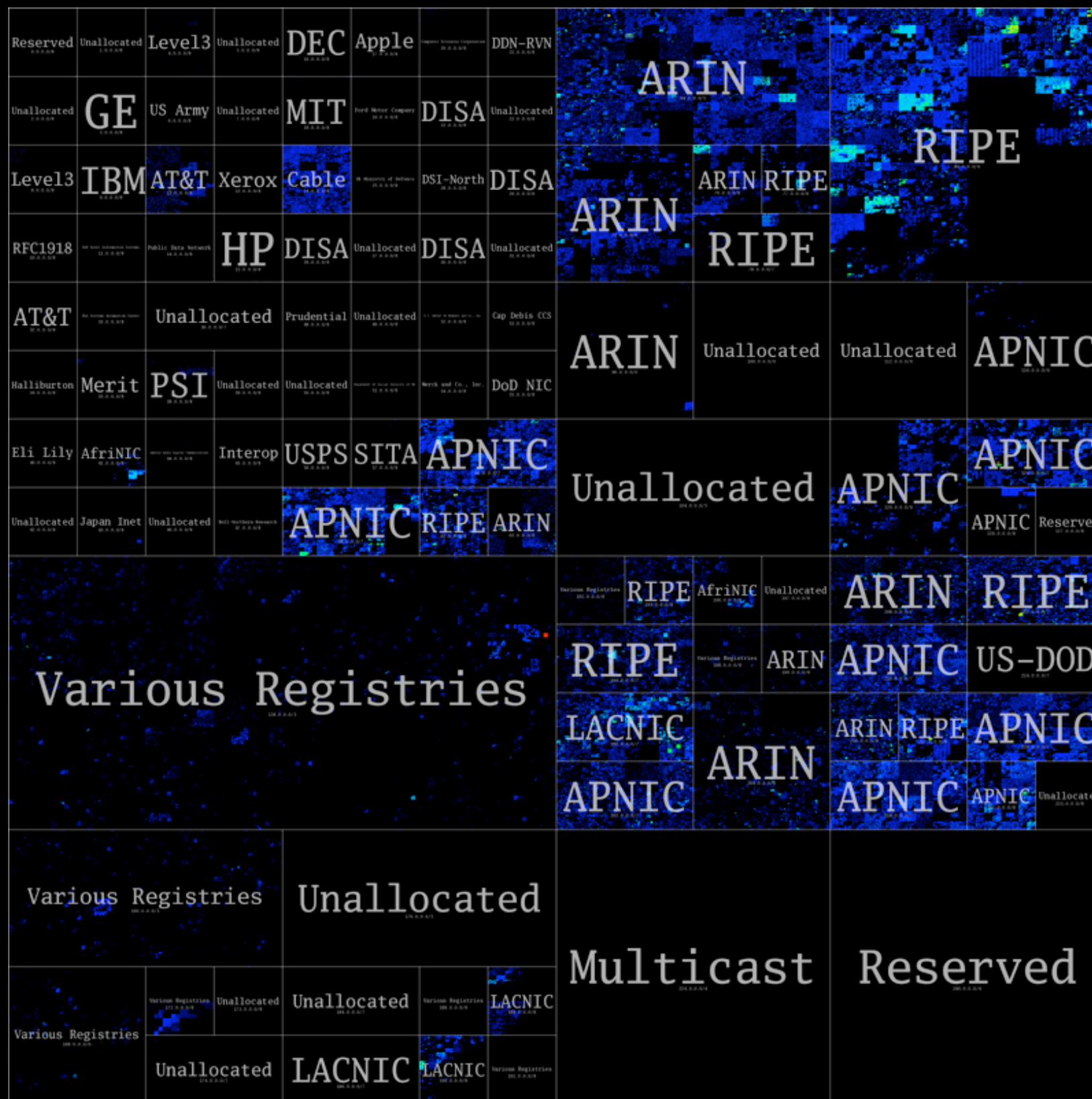


Hilbert



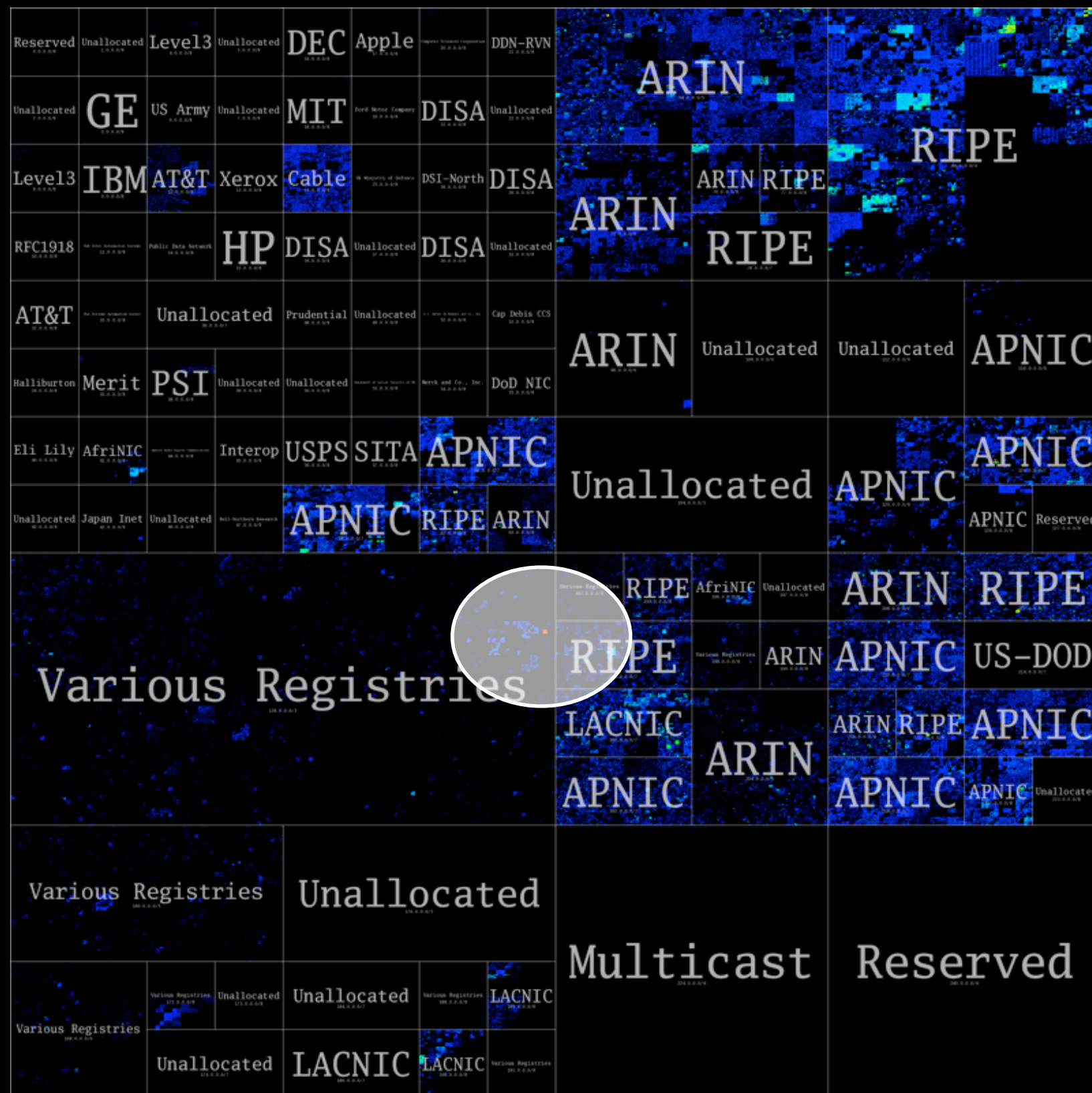
Morton

Detail of 48/4

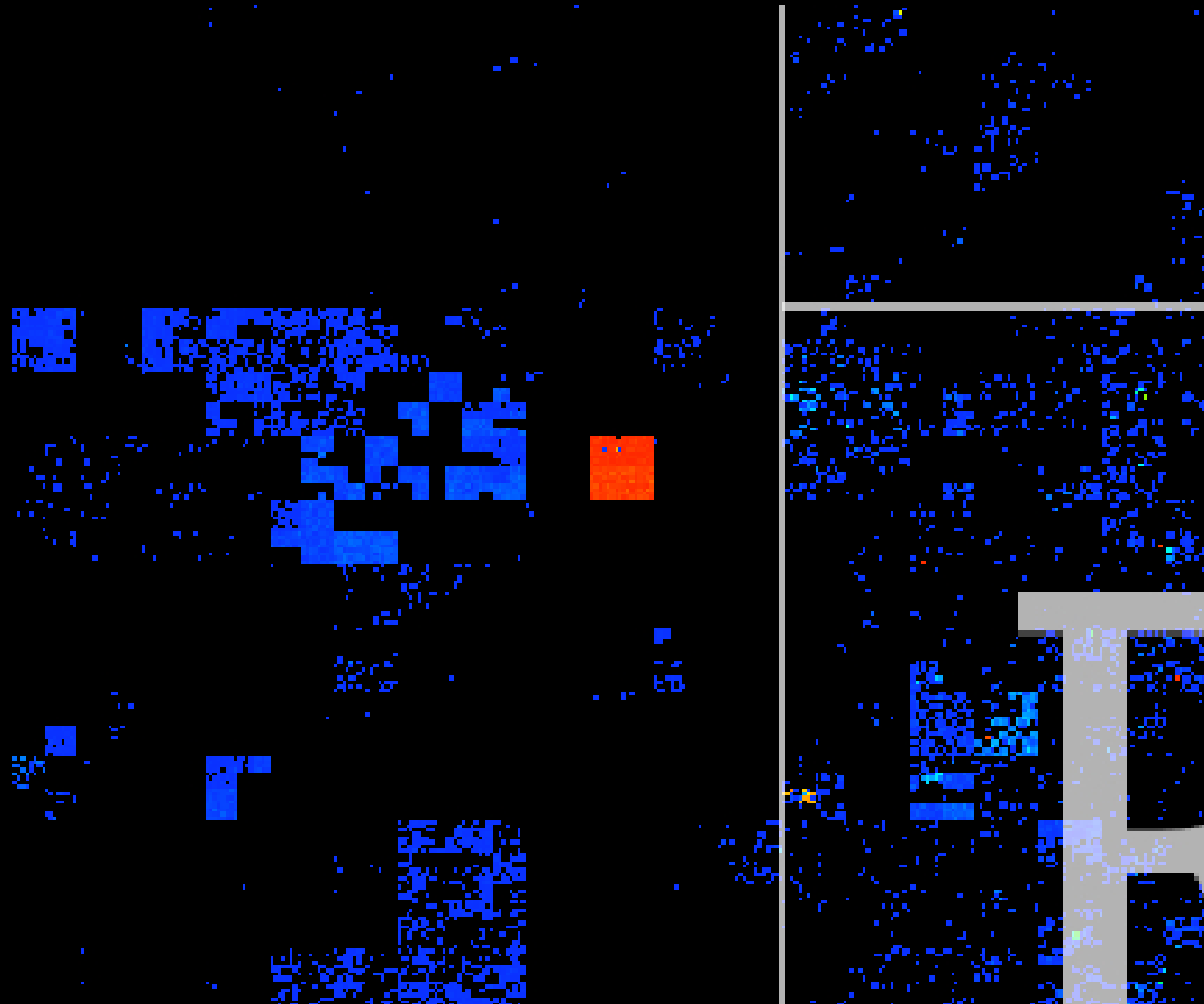


IPv4 Heatmap in Morton Order.





IPv4 Heatmap in Morton Order.  
Notice the very red spot.



This is a /16 network

These curves work in three dimensions

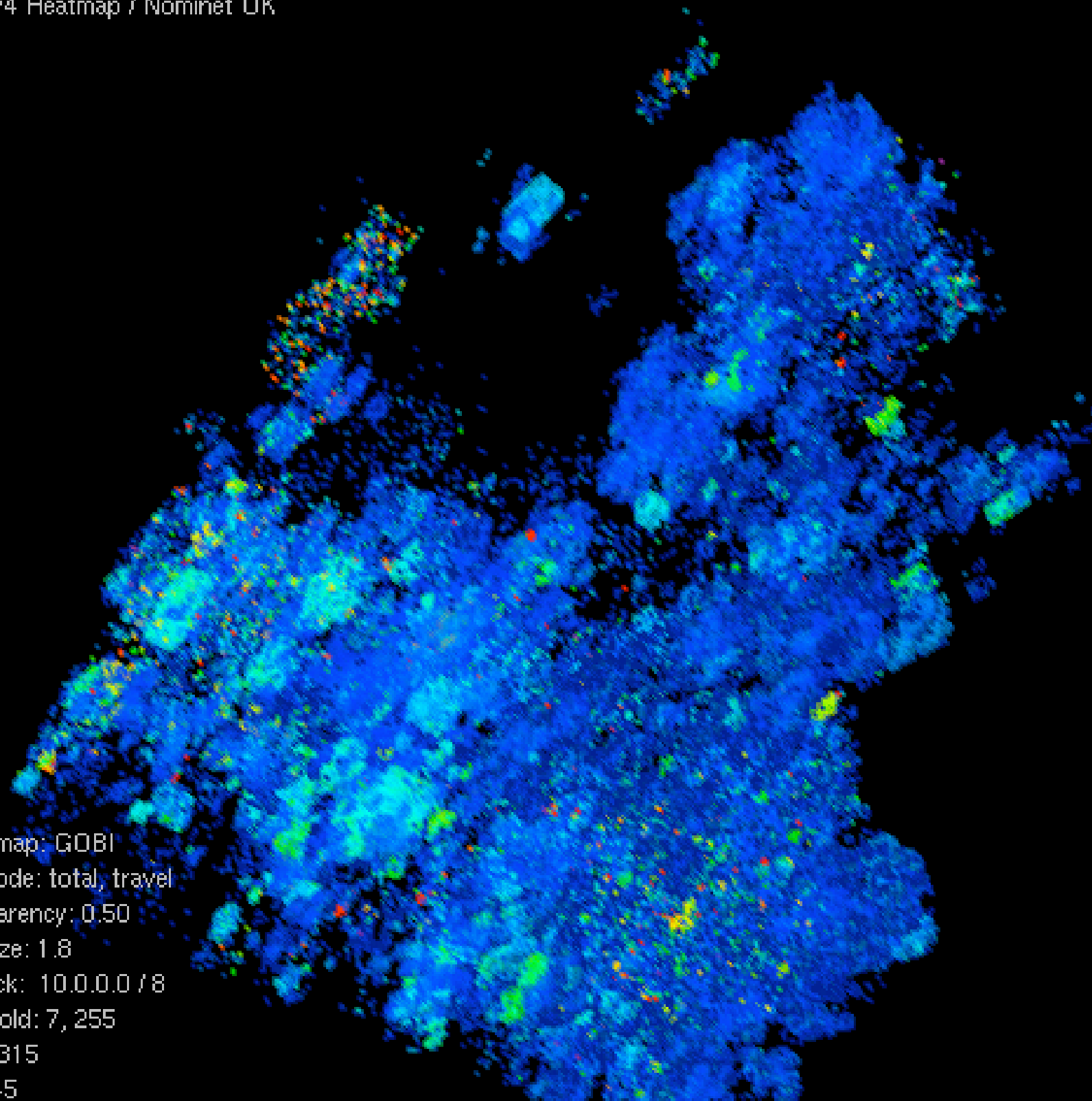




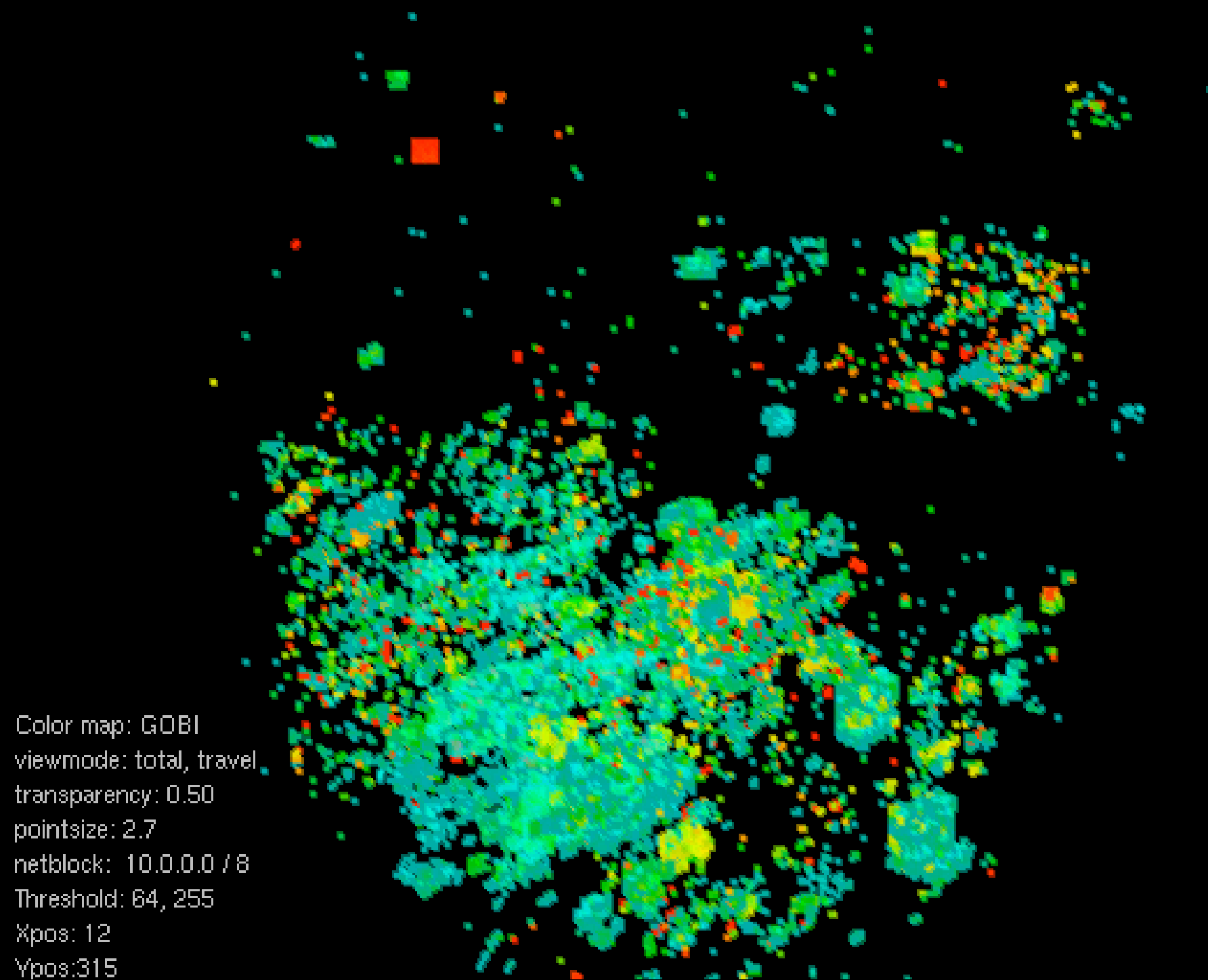
These curves work in three dimensions

# 3D IPv4 Heatmap / Nominet UK

Color map: GOBI  
viewmode: total, travel  
transparency: 0.50  
pointsize: 1.8  
netblock: 10.0.0.0 / 8  
Threshold: 7, 255  
Xpos: 315  
Ypos: 45

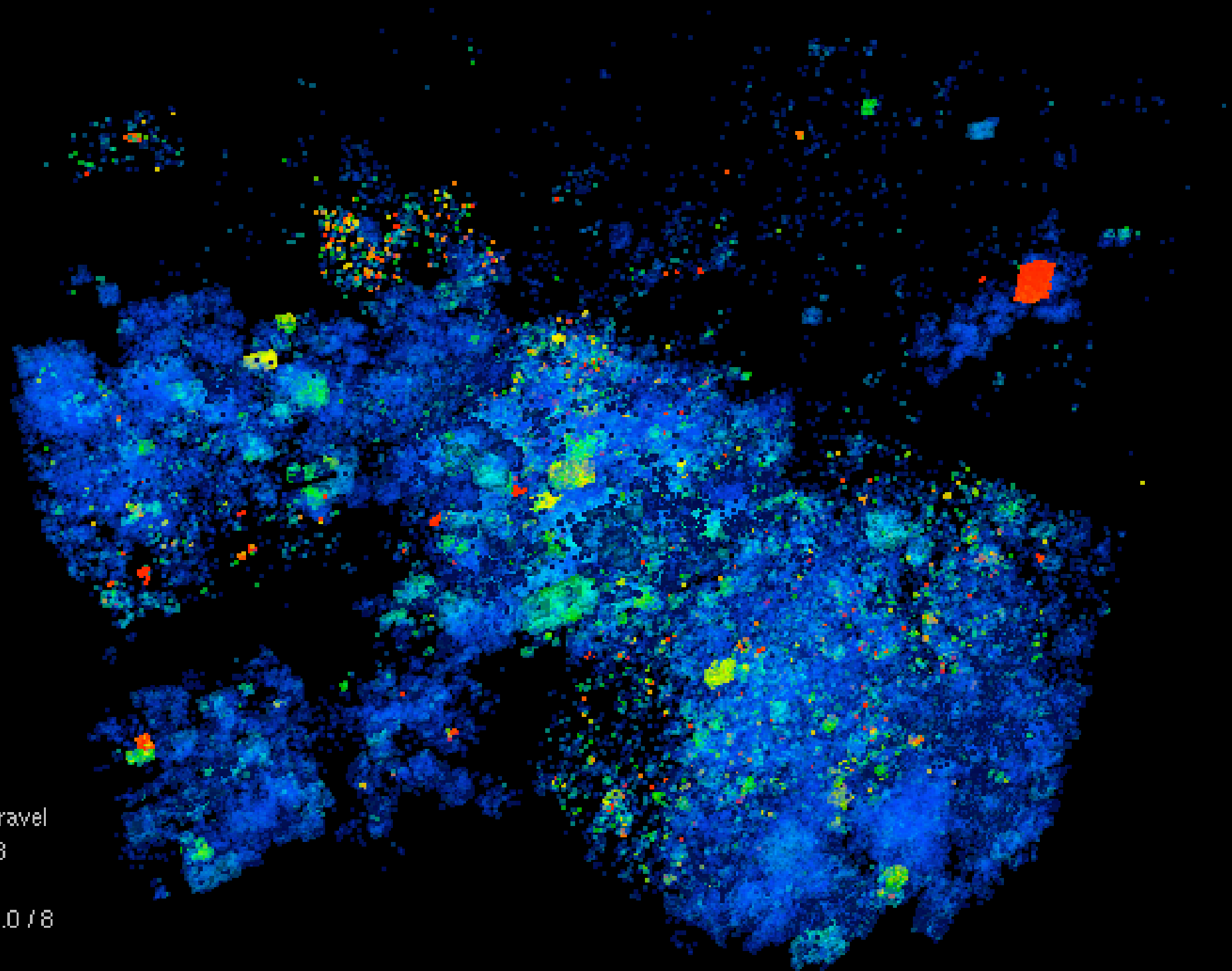


# 3D IPv4 Heatmap / Nominet UK

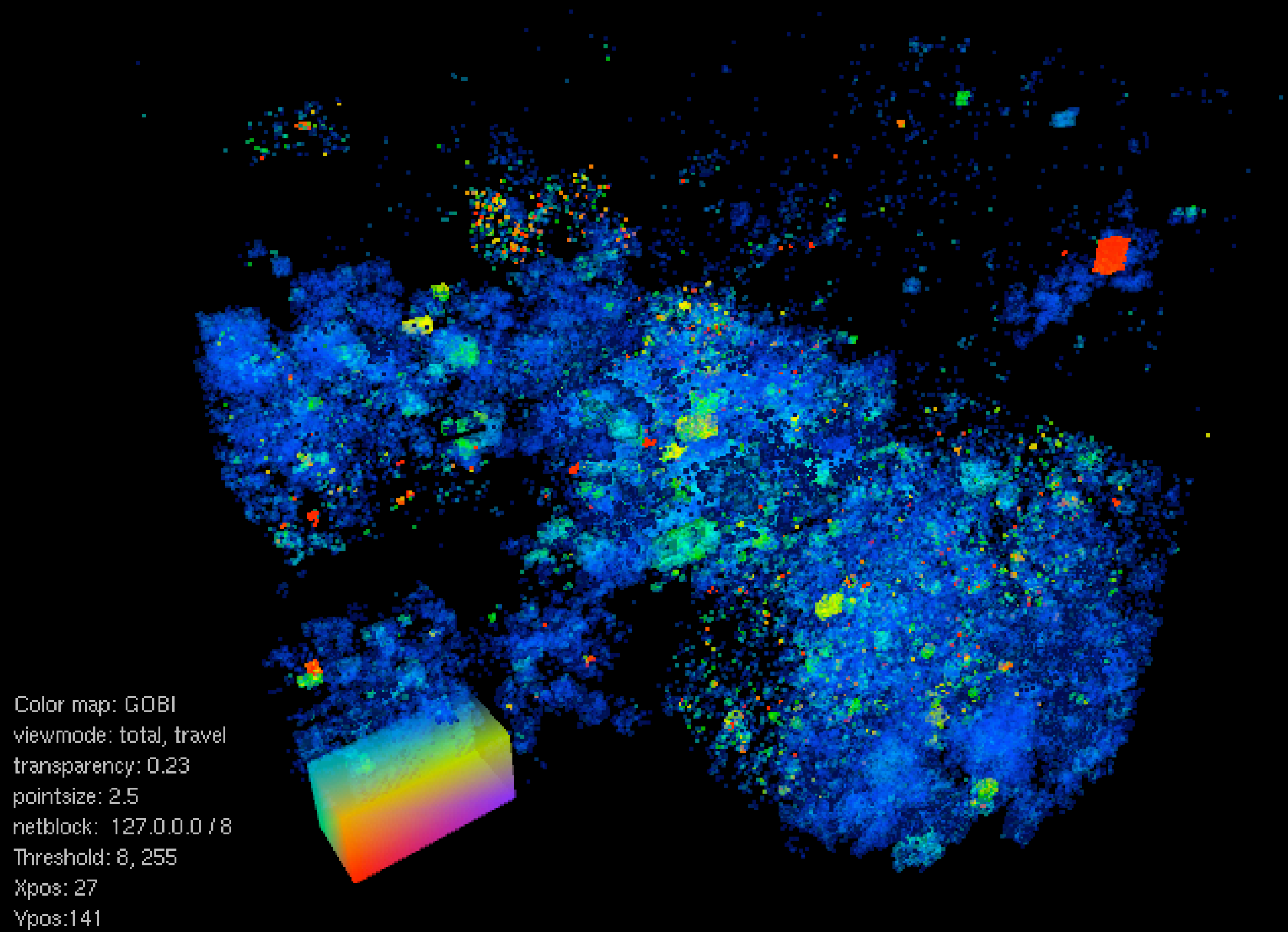


# 3D IPv4 Heatmap / Nominet UK

Color map: GOBI  
viewmode: total, travel  
transparency: 0.23  
pointsize: 2.5  
netblock: 127.0.0.0 / 8  
Threshold: 8, 255  
Xpos: 27  
Ypos:141

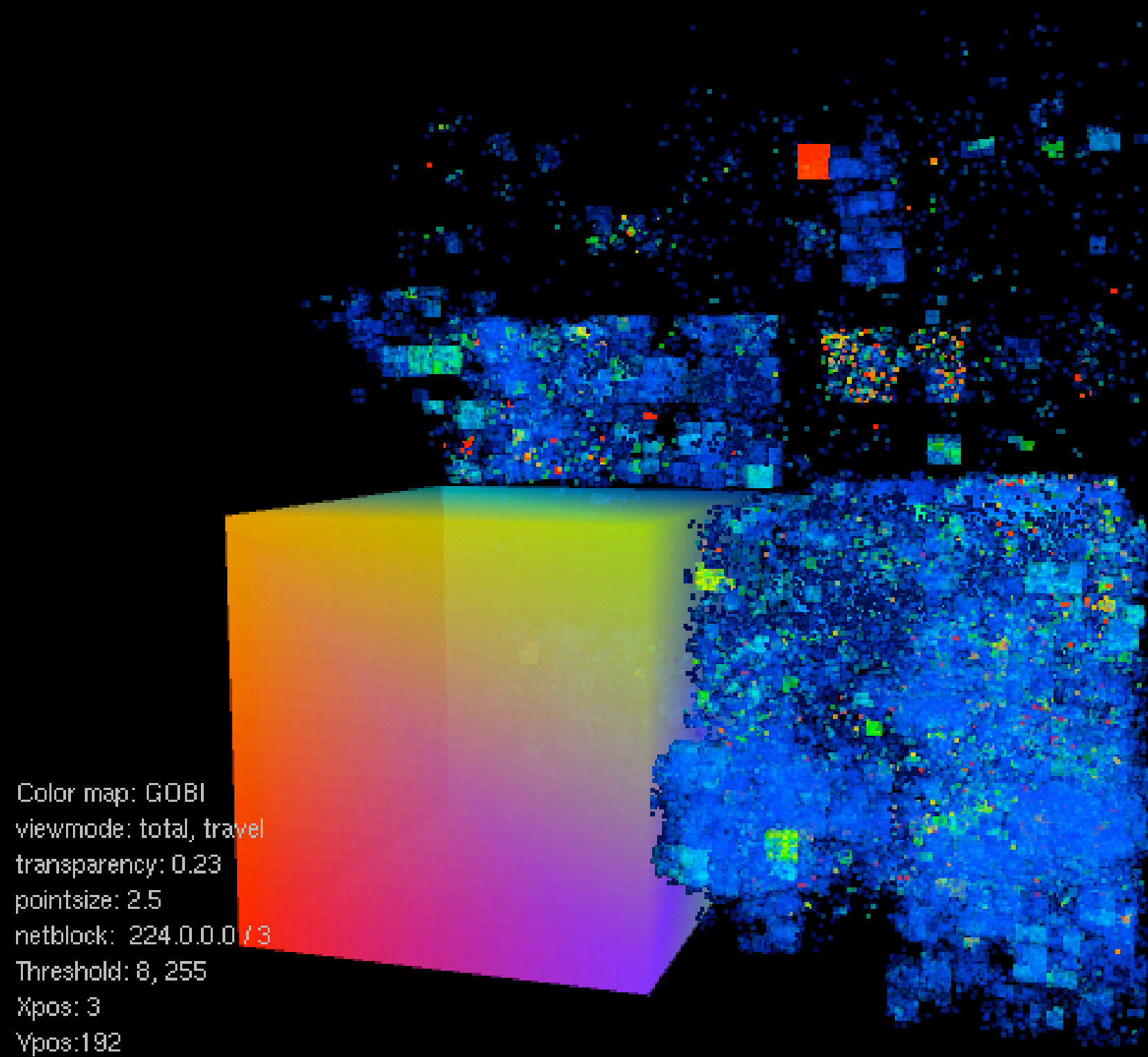


# 3D IPv4 Heatmap / Nominet UK

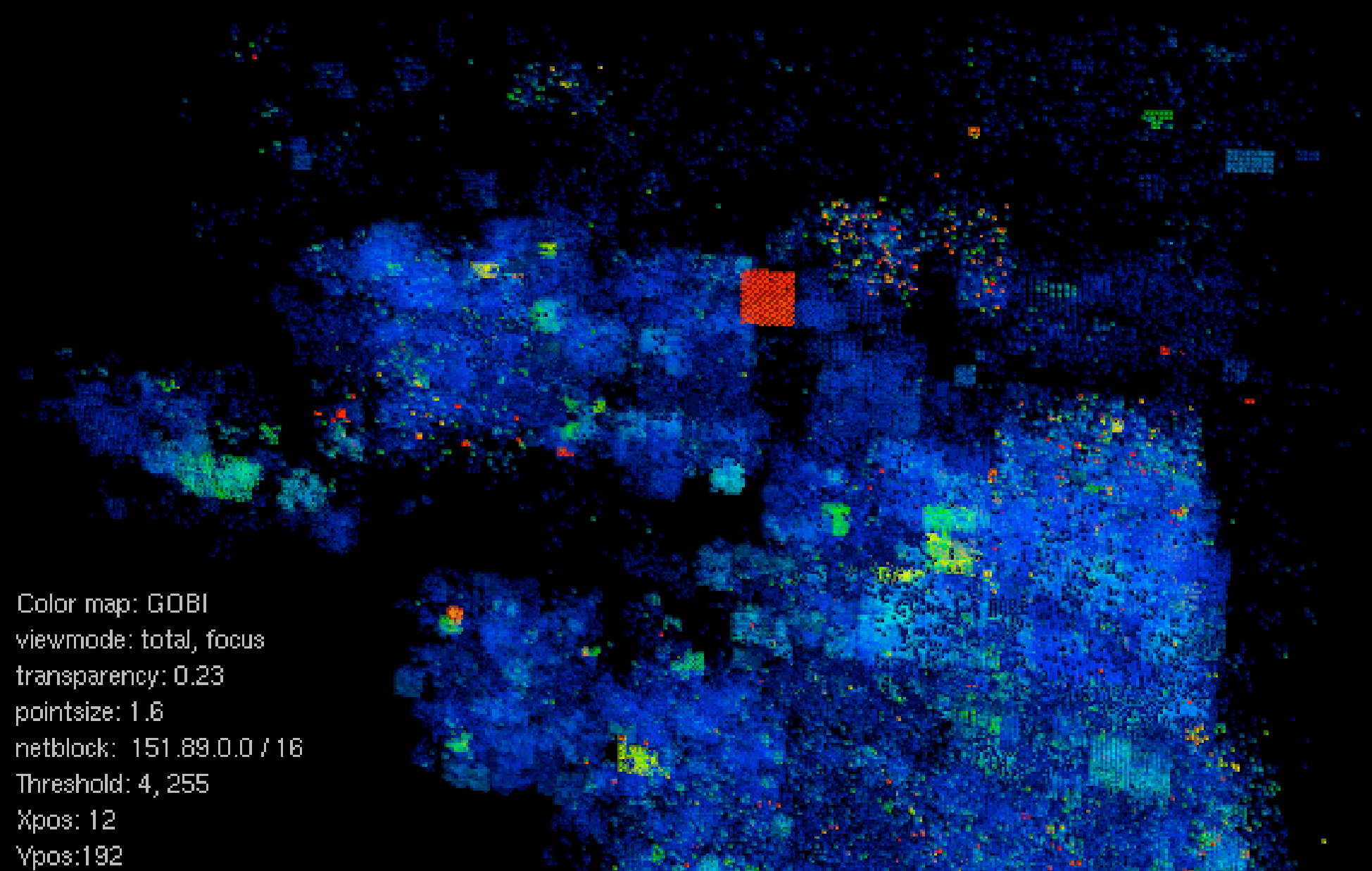




# 3D IPv4 Heatmap / Nominet UK



# 3D IPv4 Heatmap / Nominet UK

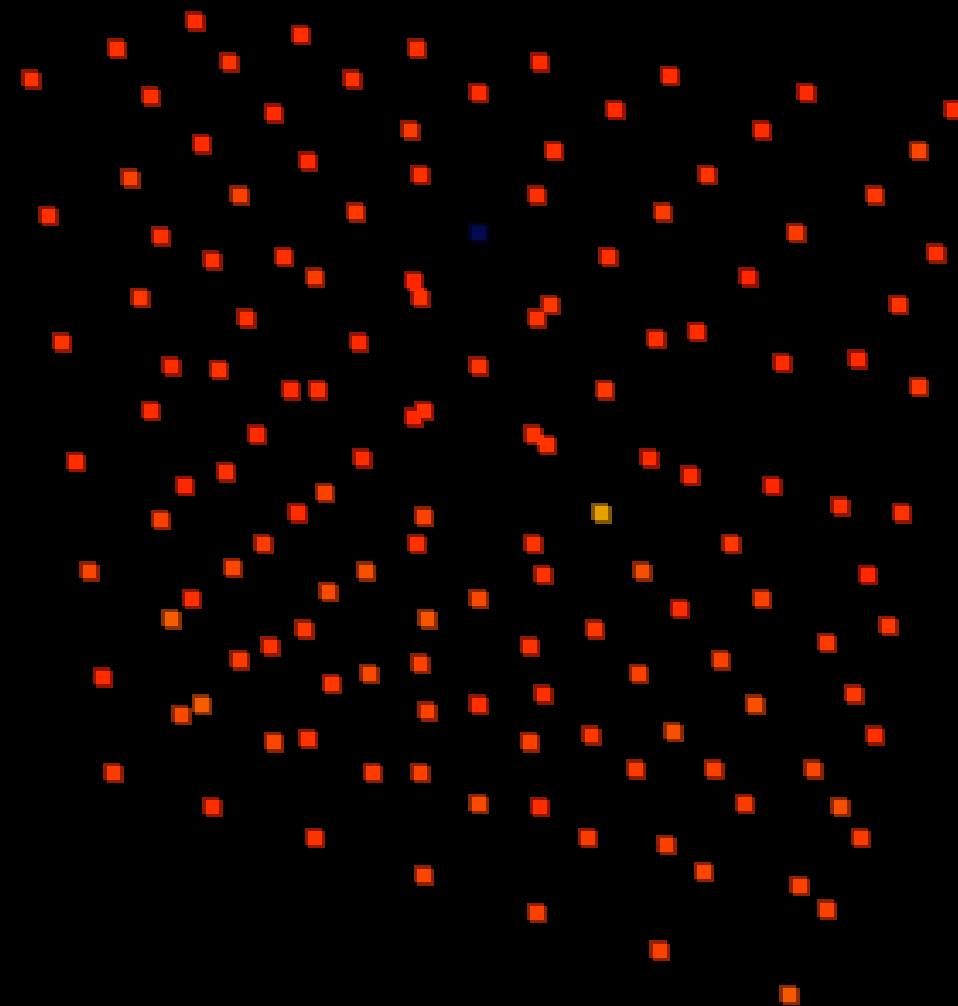


3D IPv4 Heatmap / Nominet UK



Color map: GOBI  
viewmode: cube, focus  
transparency: 0.23  
pointsize: 1.6  
netblock: 151.89.0.0 / 16  
Threshold: 4, 255  
Xpos: 12  
Ypos: 192

# 3D IPv4 Heatmap / Nominet UK



Color map: GOBI  
viewmode: cube, focus  
transparency: 0.23  
pointsize: 4.8  
netblock: 151.89.0.0 / 16  
Threshold: 4, 255  
Xpos: 27  
Ypos: 204



Thanks to  
Duane Wessels  
&  
John Kristoff

Color map: GOBI  
viewmode: cube, focus  
transparency: 0.23  
pointsize: 4.8  
netblock: 151.89.0.0 / 16  
Threshold: 4, 255  
Xpos: 27  
Ypos: 204





Thanks to  
Duane Wessels  
&  
John Kristoff

Color map: GOBI  
viewmode: cube, focus  
transparency: 0.23  
pointsize: 4.8  
netblock: 151.89.0.0 / 16  
Threshold: 4, 255  
Xpos: 27  
Ypos: 204

Questions?