IPv4 Census 2013

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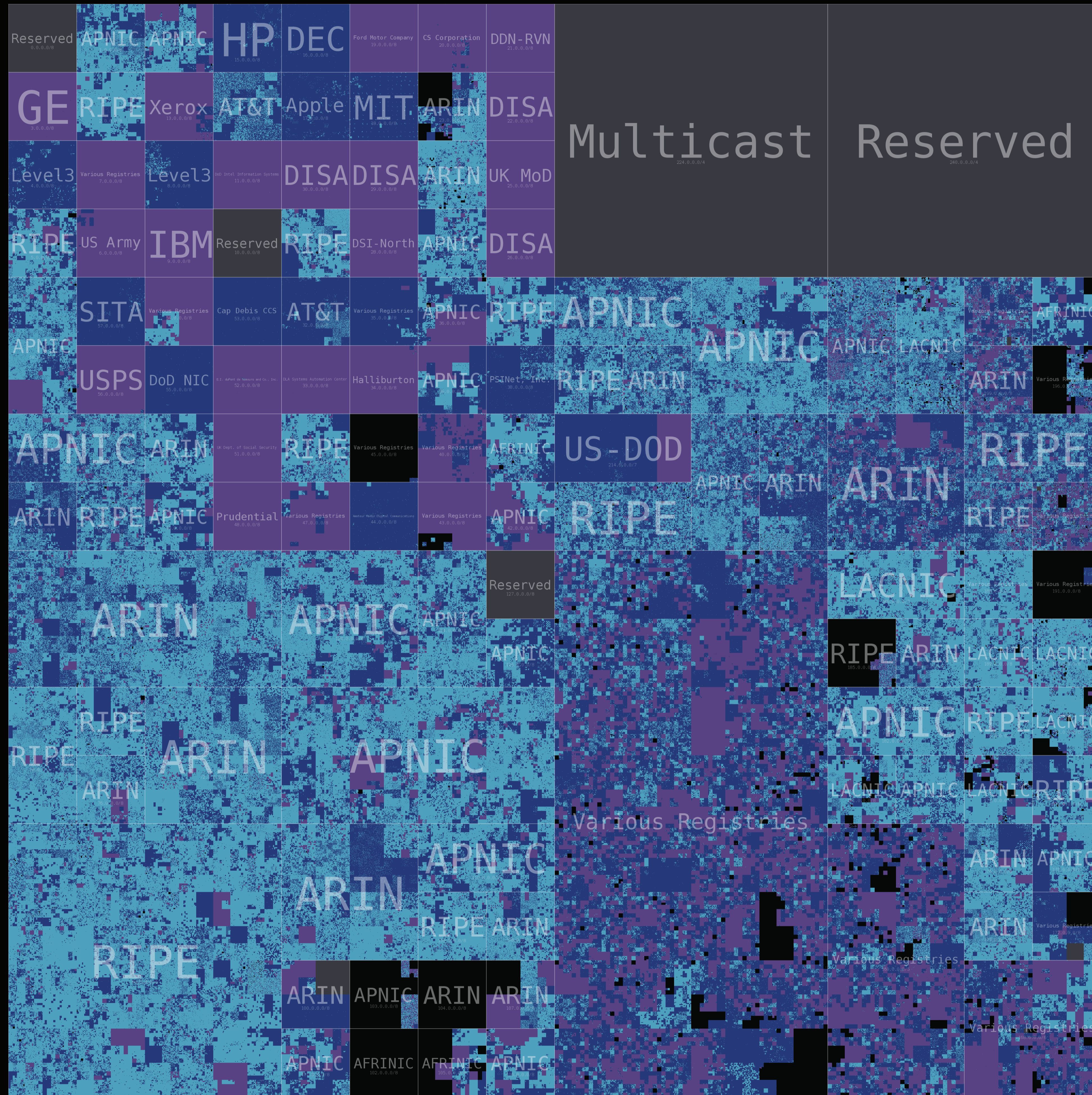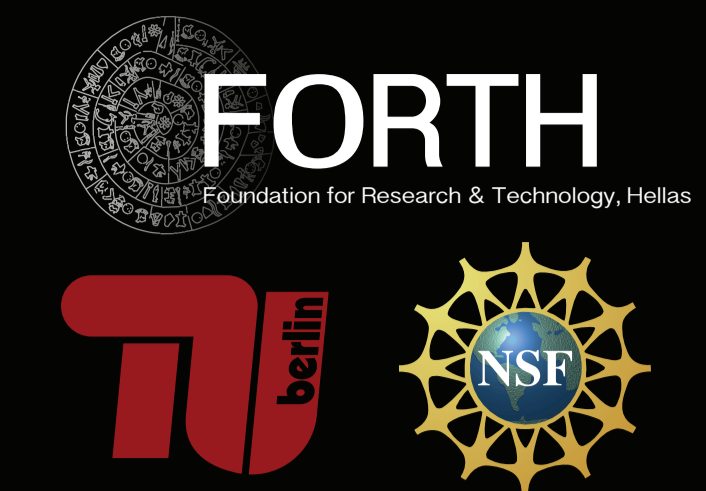
IPv4 Address Space Utilization:

Using a space-filling continuous fractal Hilbert curve representation to visualize IPv4 address space utilization is a technique pioneered by ISI [1]. We integrated their active measurement approach with additional sources of active measurements as well as inferences from passive measurements. The visualization on the left illustrates IPv4 address space utilization using a Hilbert curve of order 12, where each pixel represents a /24 block (256 contiguous addresses). The dataset resulting from this study is available through the DHS PREDICT repository [2].

[1] John Heidemann, Yuri Pradkin, Ramesh Govindan, Christos Papadopoulos, Genevieve Bartlett, and Joseph Bannister, "Census and survey of the visible internet", Proceedings of the 8th ACM SIGCOMM IMC 2008
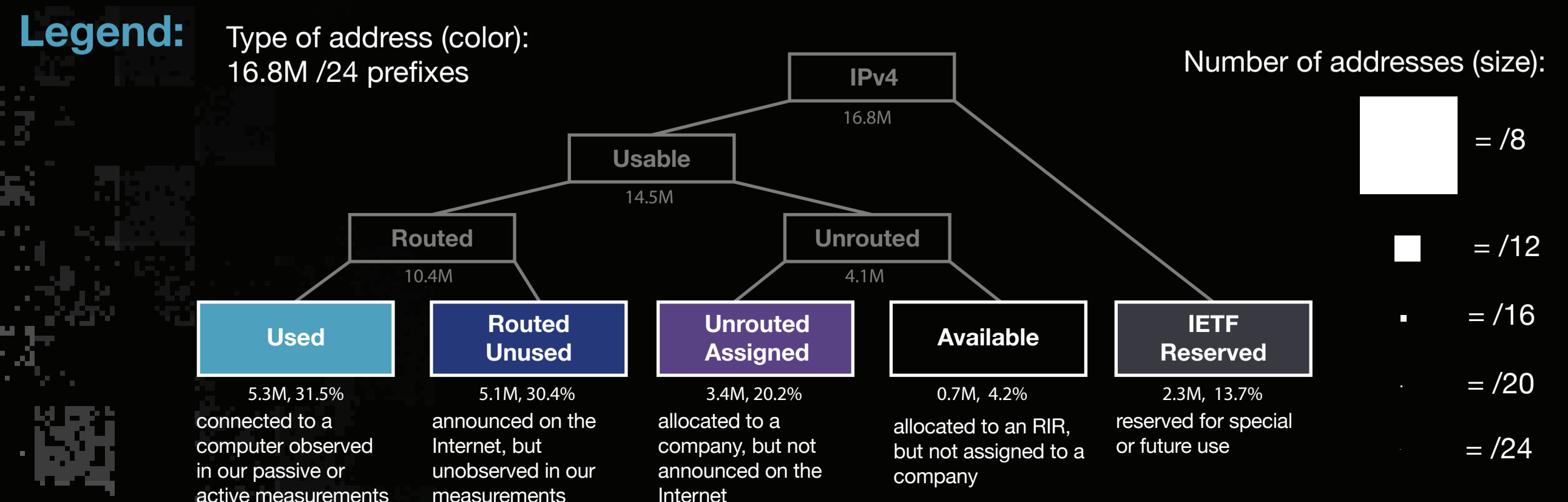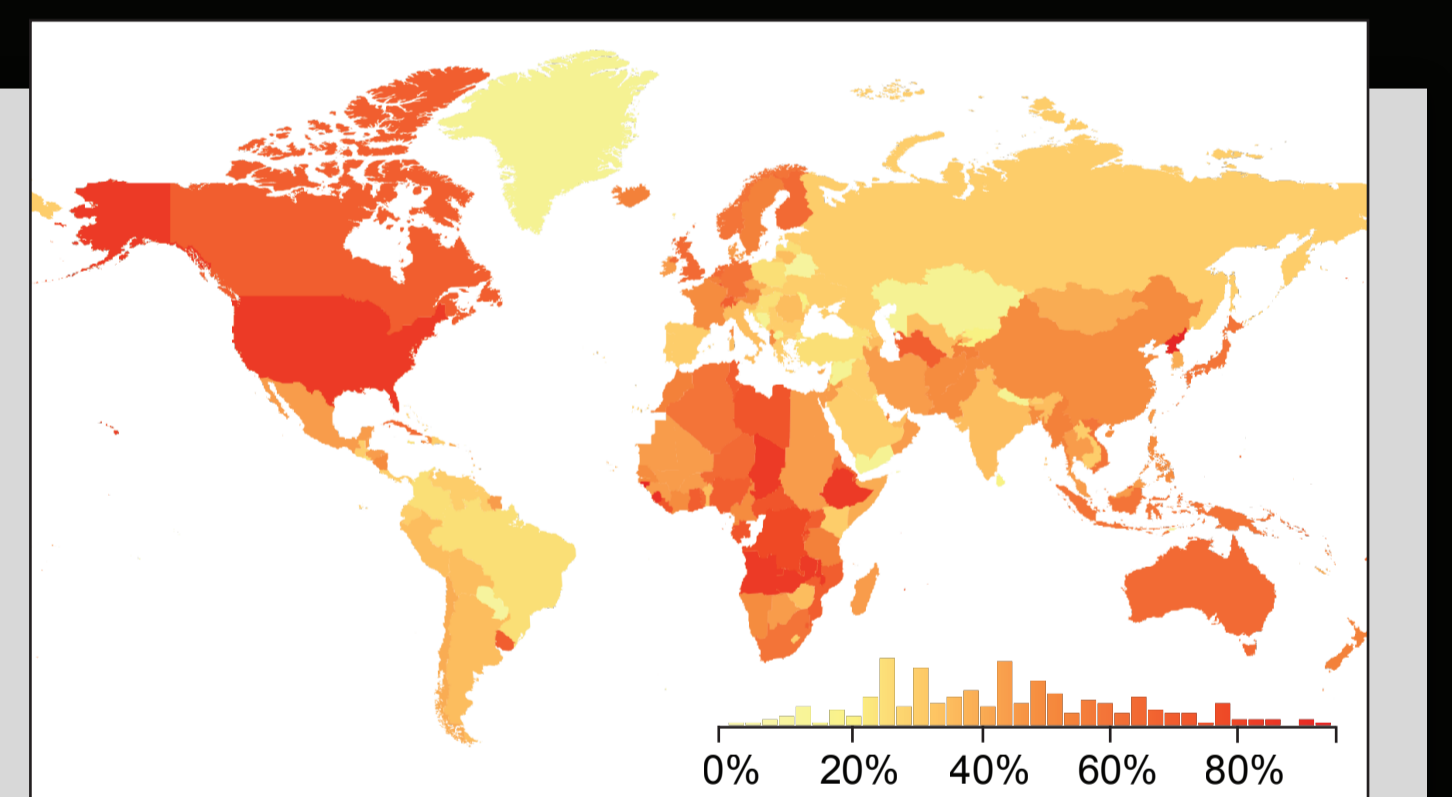[2] https://www.predict.org/
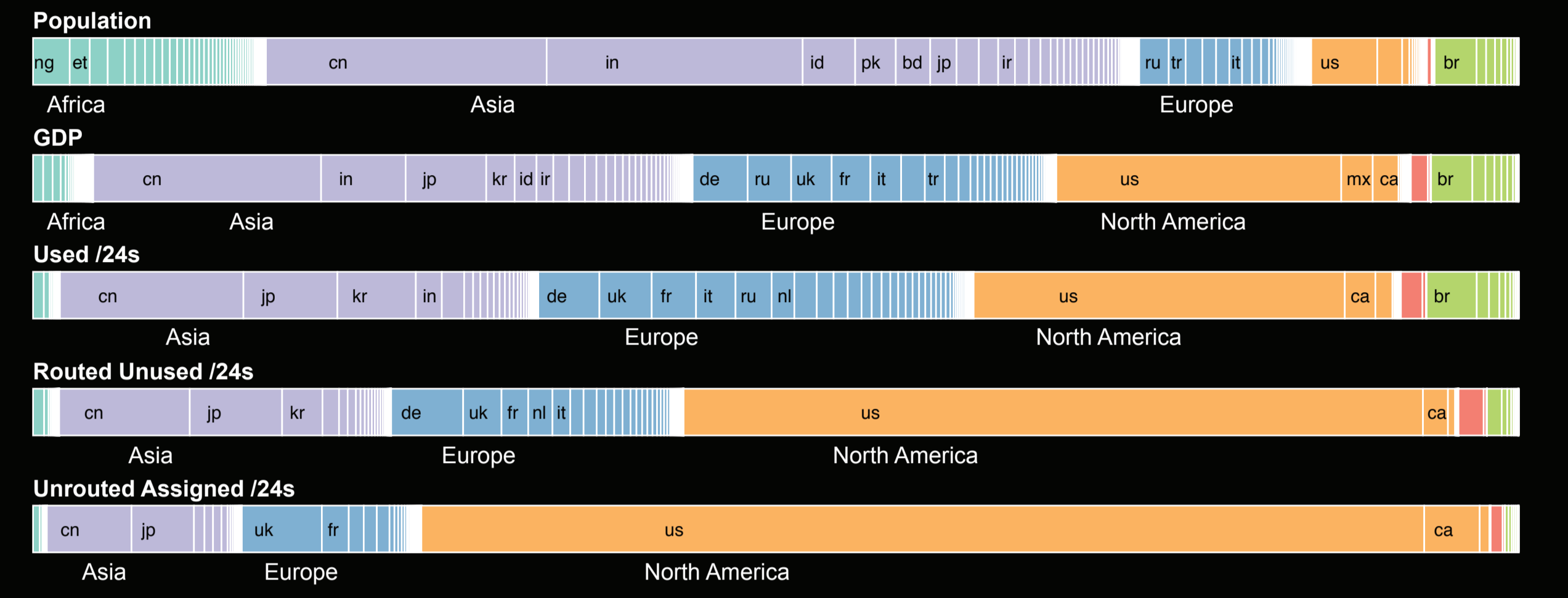
Country Inequality:

The visualization above compares per-country address space utilization with population and GDP. The width of a country (and continent) represents its relative size within a dataset. For example, the top bar shows the percentage that each country contributes to the global population, with China (cn) contributing the most (1.36B, 18.9%). Comparing bars reveals correlations between datasets. There is not a strong correlation between population (top bar) and number of used /24 blocks of a country, in large part due to high IPv4 address usage by the United States. However, there is a strong correlation between the GDP (2nd from top) and number of used /24 blocks of a country (3rd bar). Not only does the U.S. dominate /24 block usage, it also represents a significant portion of both the routed unused and unrouted assigned space, with 49.8% and 67.5% respectively.
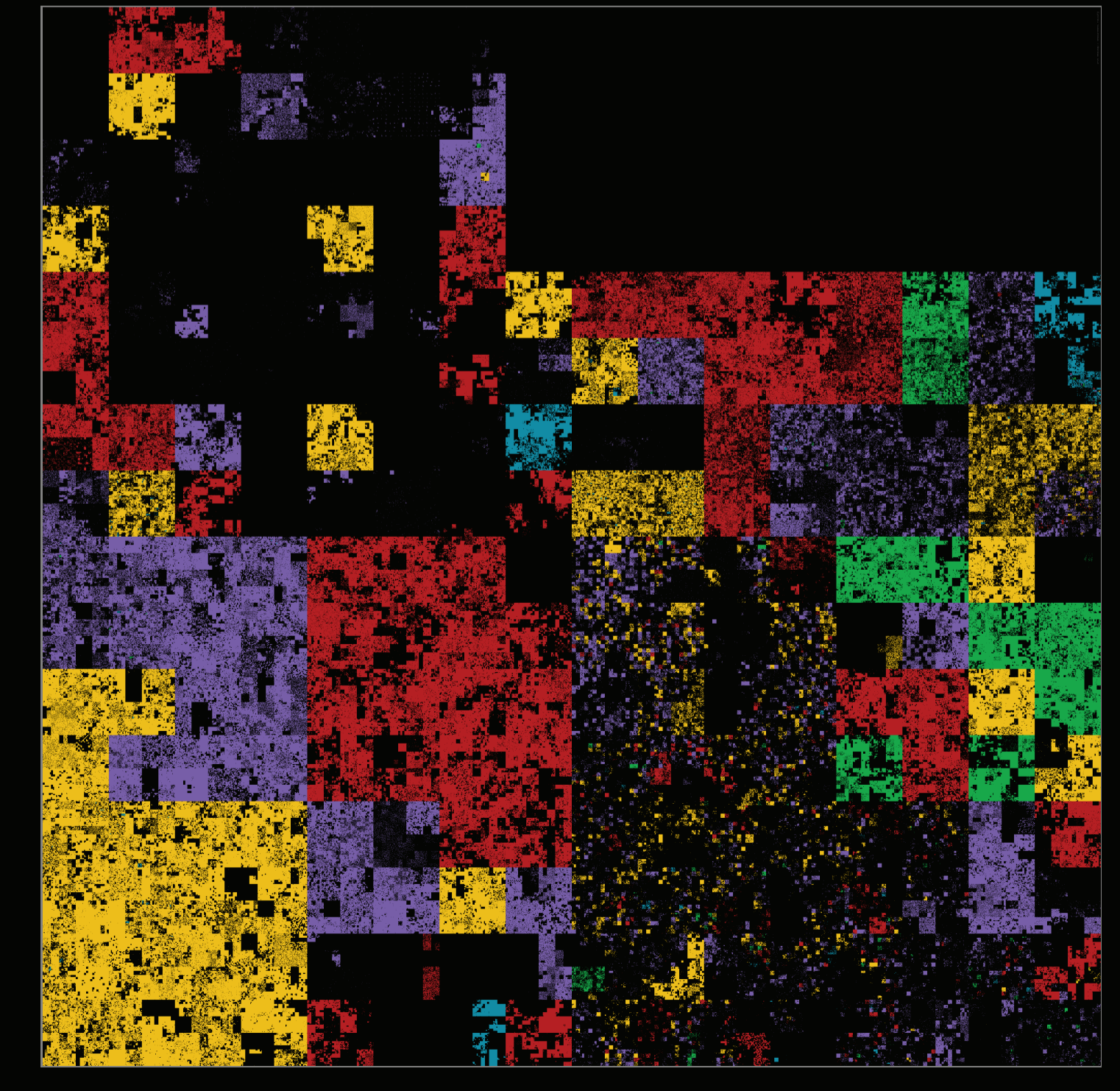
Map of Unused Address Space:

This geographic map represents the *Unused Space Ratio* as a per-country percentage of unused space (routed unused + unrouted assigned) out of the space assigned to organizations in that country. The U.S. is red in this map due to a few large but underutilized allocations, while some African countries are red because they use a small fraction of their assigned space.

Regional Internet Registries (RIRs):

Regional Internet Registries (RIRs) manage the allocation and assignment of internet resources.

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Above: Regional Internet Registries (RIRs) and their corresponding geographical responsibilities.
Left: Hilbert graph of observably used addresses colored by the RIR currently responsible for that address space.

Acknowledgments:

Legend:

Type of address (color): 16.8M /24 prefixes

Number of addresses (size):
= /8
= /12
= /16
= /20
= /24

IPv4 16.8M
— Usable 14.5M
—— Routed 10.4M
——— Used — 5.3M, 31.5% — connected to a computer observed in our passive or active measurements
——— Routed Unused — 5.1M, 30.4% — announced on the Internet, but unobserved in our measurements
—— Unrouted 4.1M
——— Unrouted Assigned — 3.4M, 20.2% — allocated to a company, but not announced on the Internet
——— Available — 0.7M, 4.2% — allocated to an RIR, but not assigned to a company
— IETF Reserved — 2.3M, 13.7% — reserved for special or future use
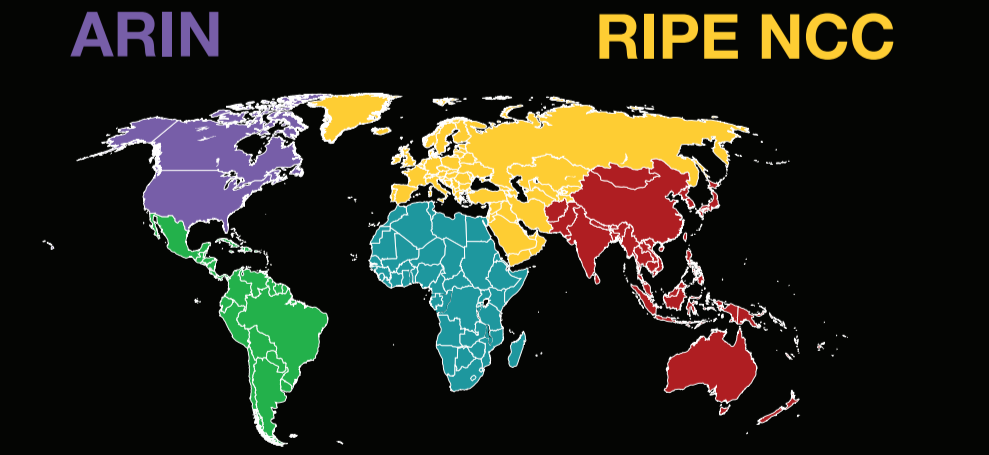
Hilbert Graph:

The Hilbert curve is a fractal space-filling curve that preserves locality in a 2D structure. The black line in this graph represents a second order Hilbert curve.