Internet Visualization

with

Walrus

Graph Visualization Tool

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CAIDA

2009 Spring Simulation Interoperability Workshop (SIW)

Outline

* Internet Measurement
* Hyperbolic Geometry
* Walrus Demo
* Future Work

Internet Measurement

- CAIDA conducts large-scale, ongoing topology measurements
  - *monitors* distributed around the world perform traceroutes continuously

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monitor$_2$

monitor$_1$

monitor$_3$

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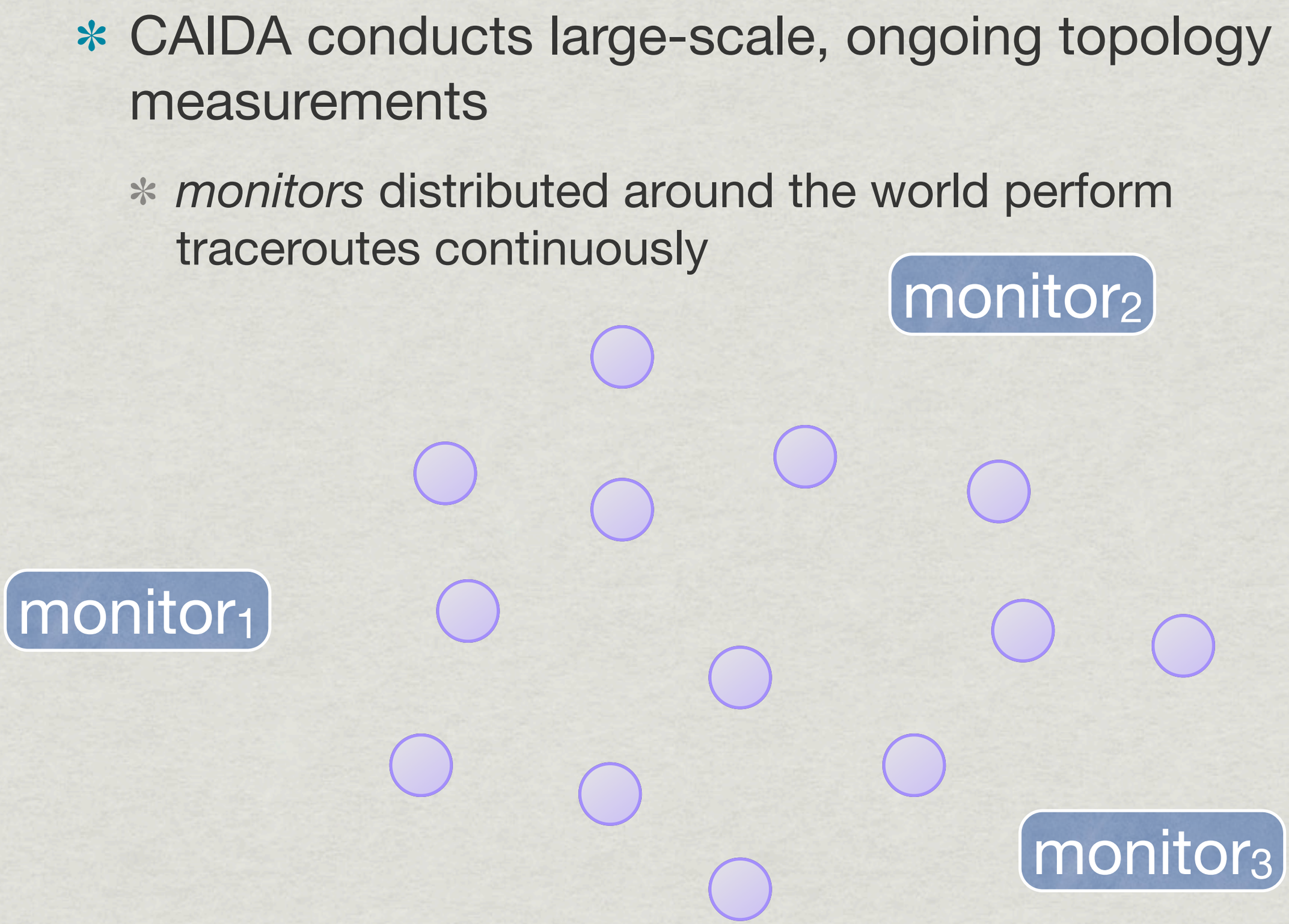

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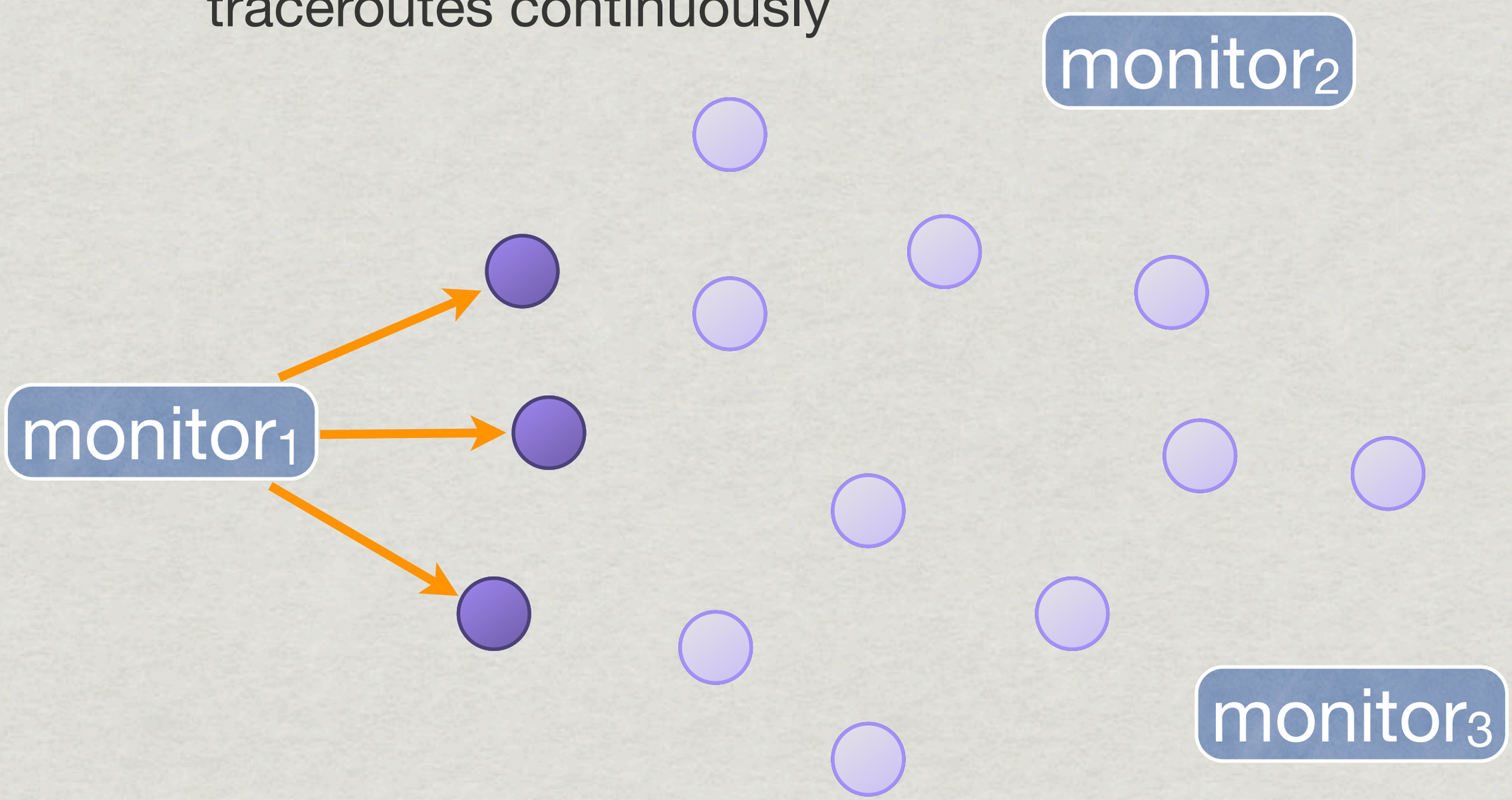

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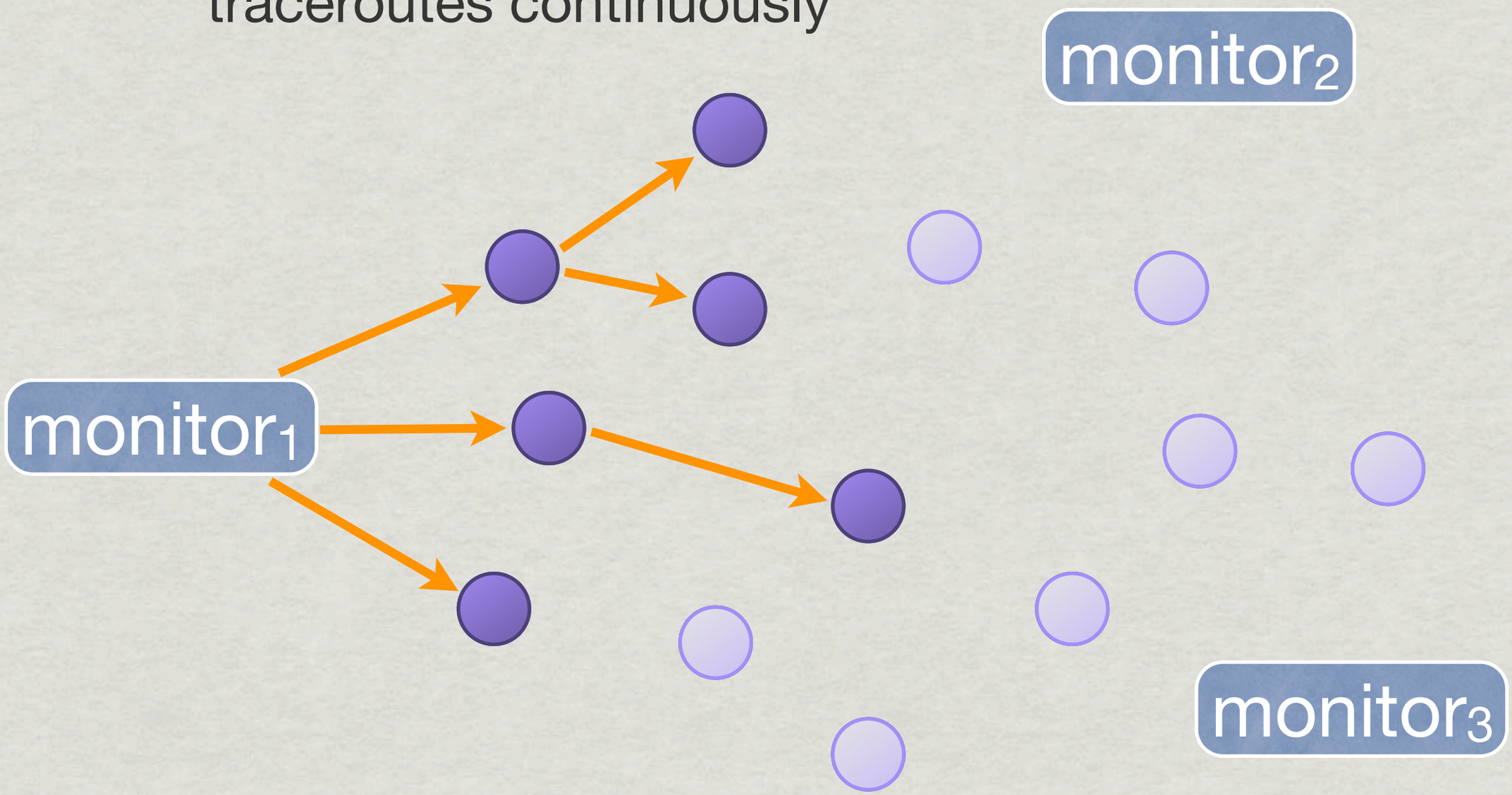

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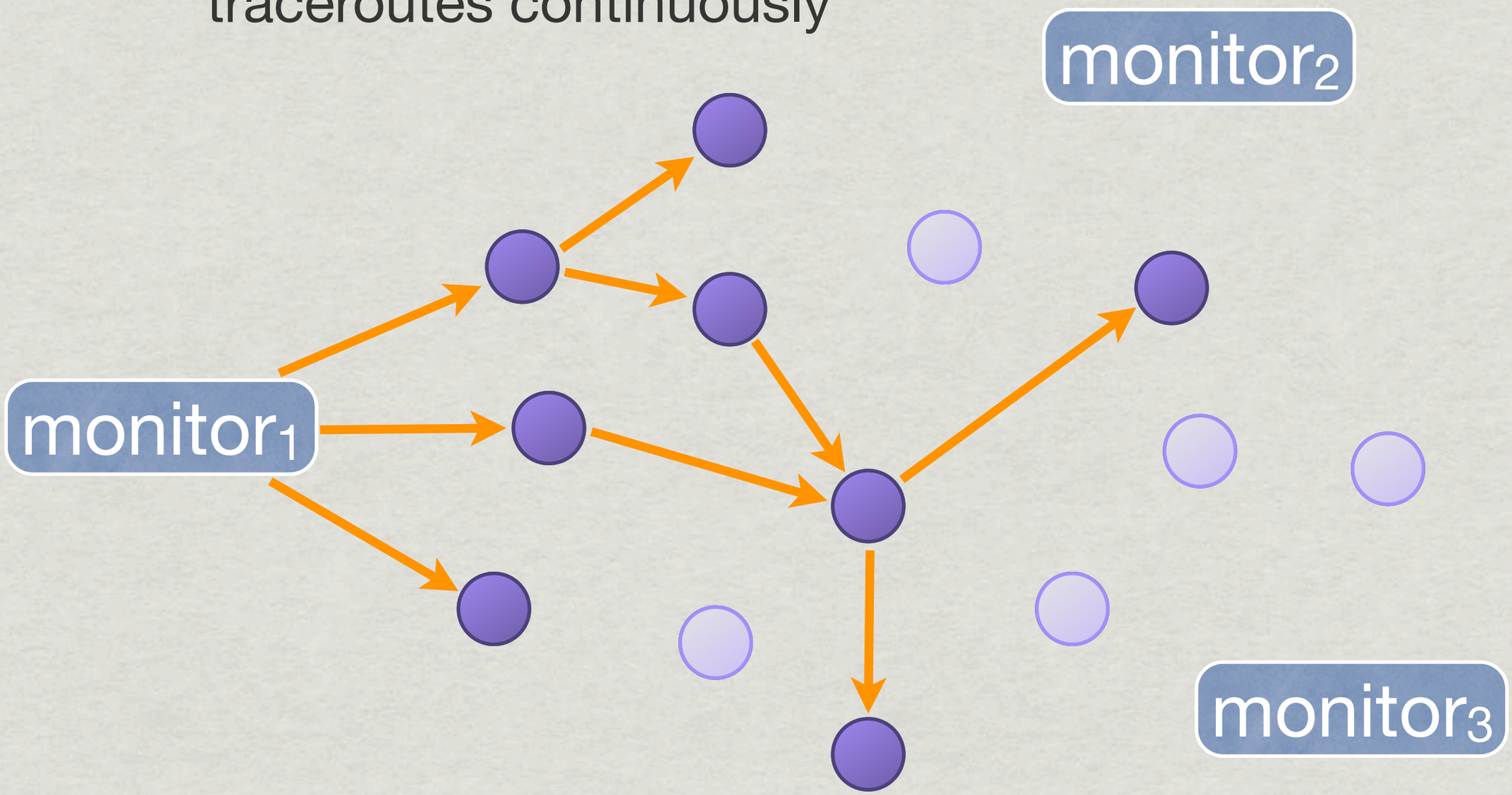

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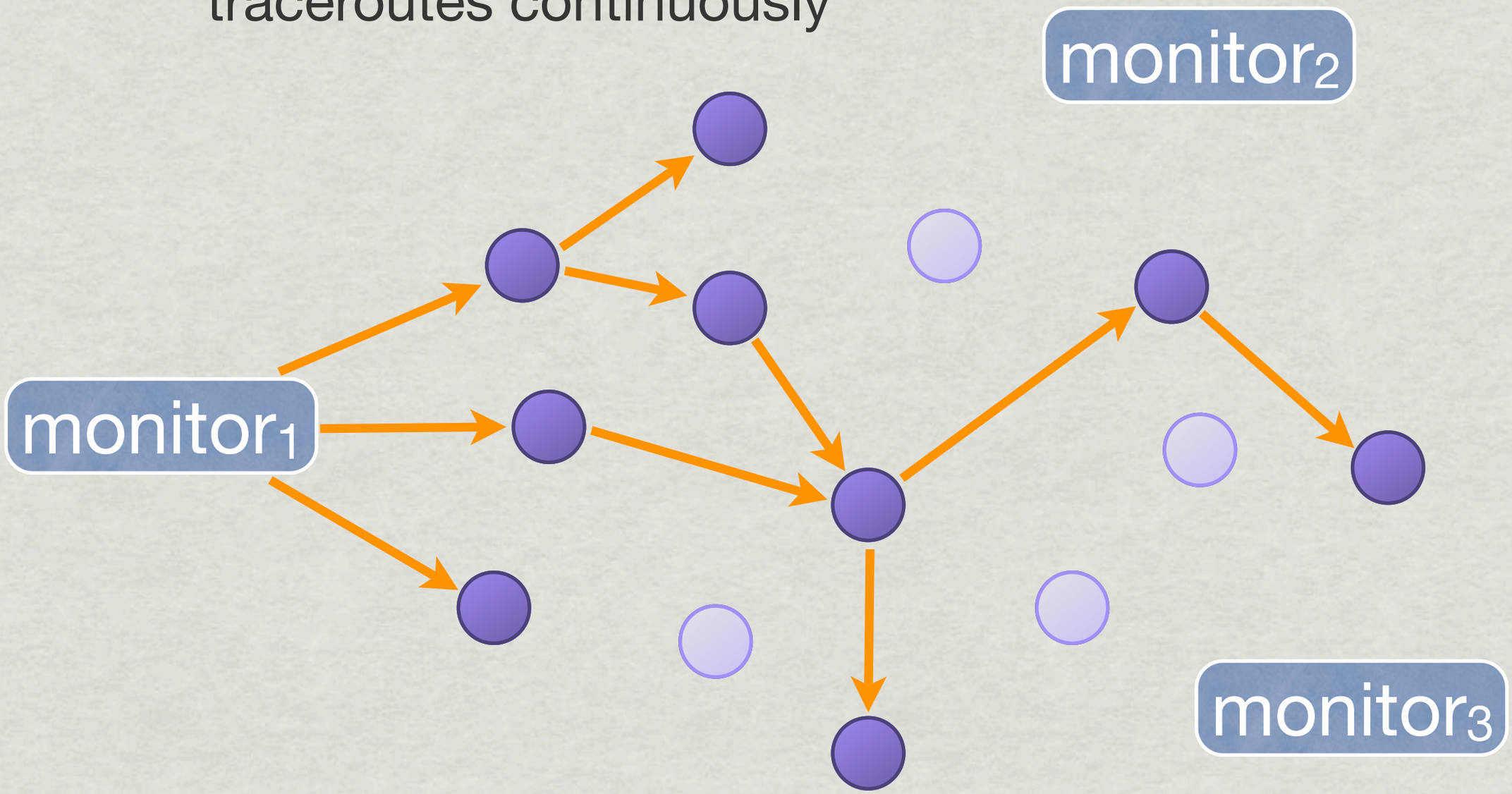

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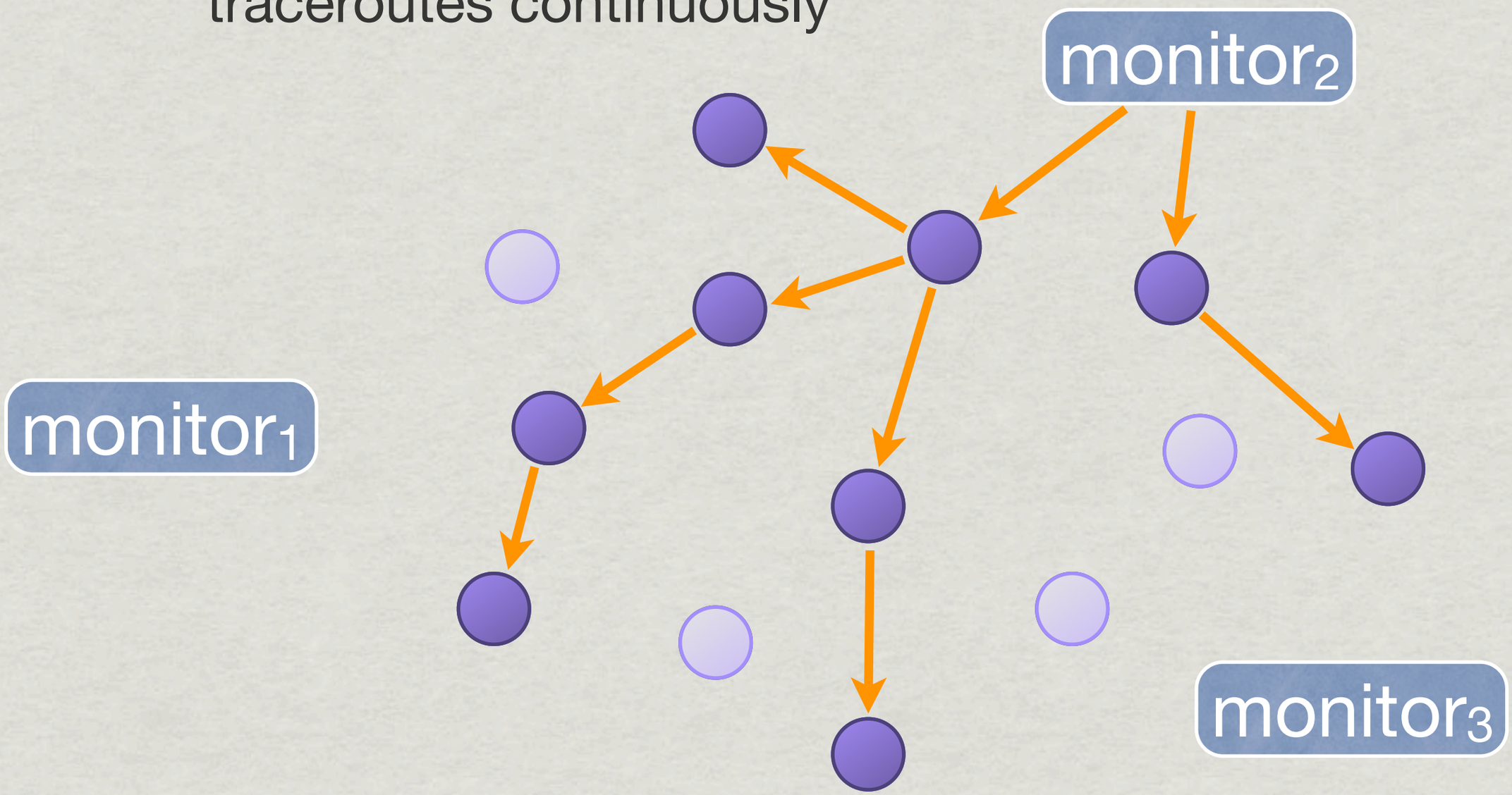

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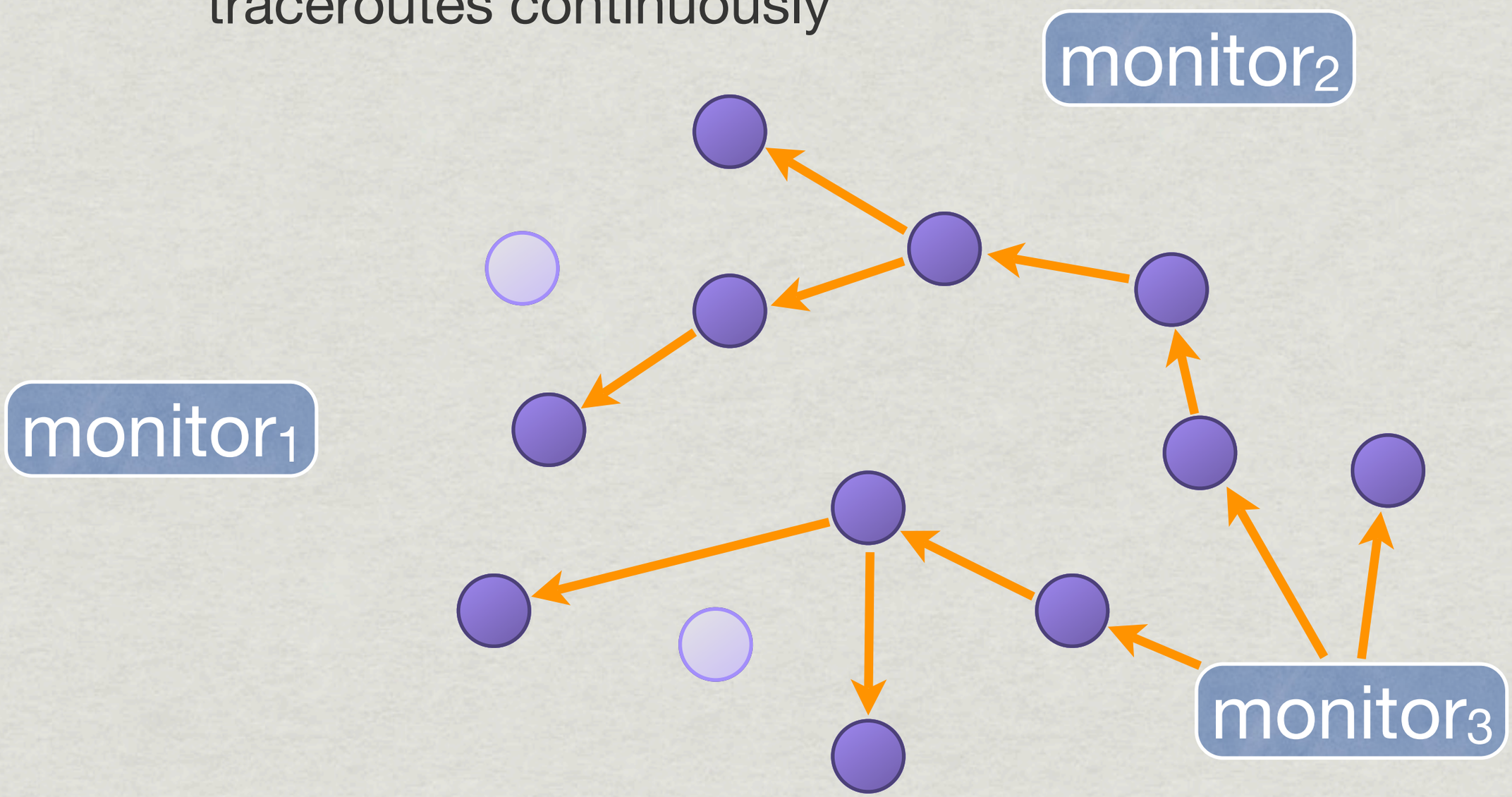

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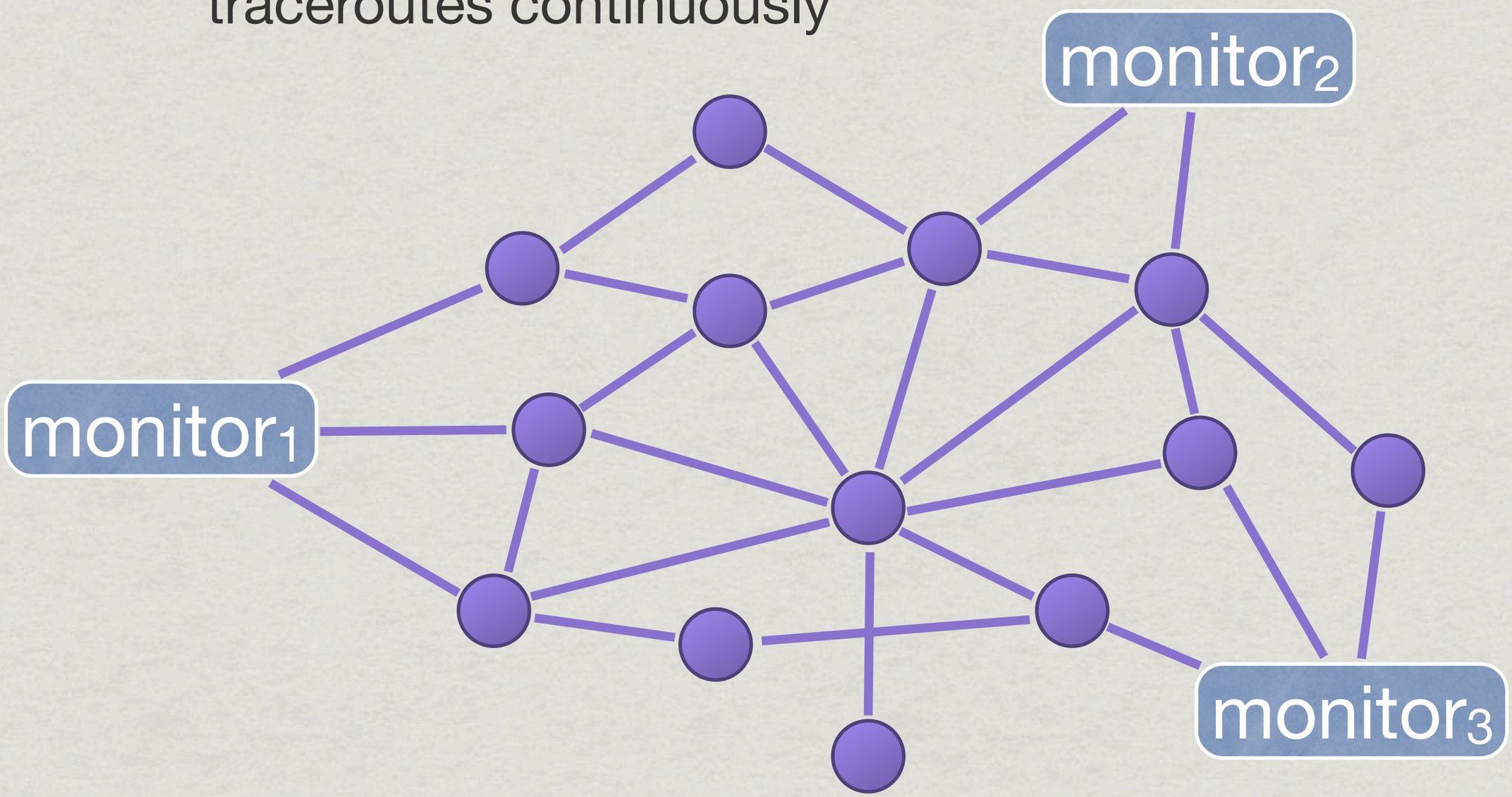

Internet Measurement

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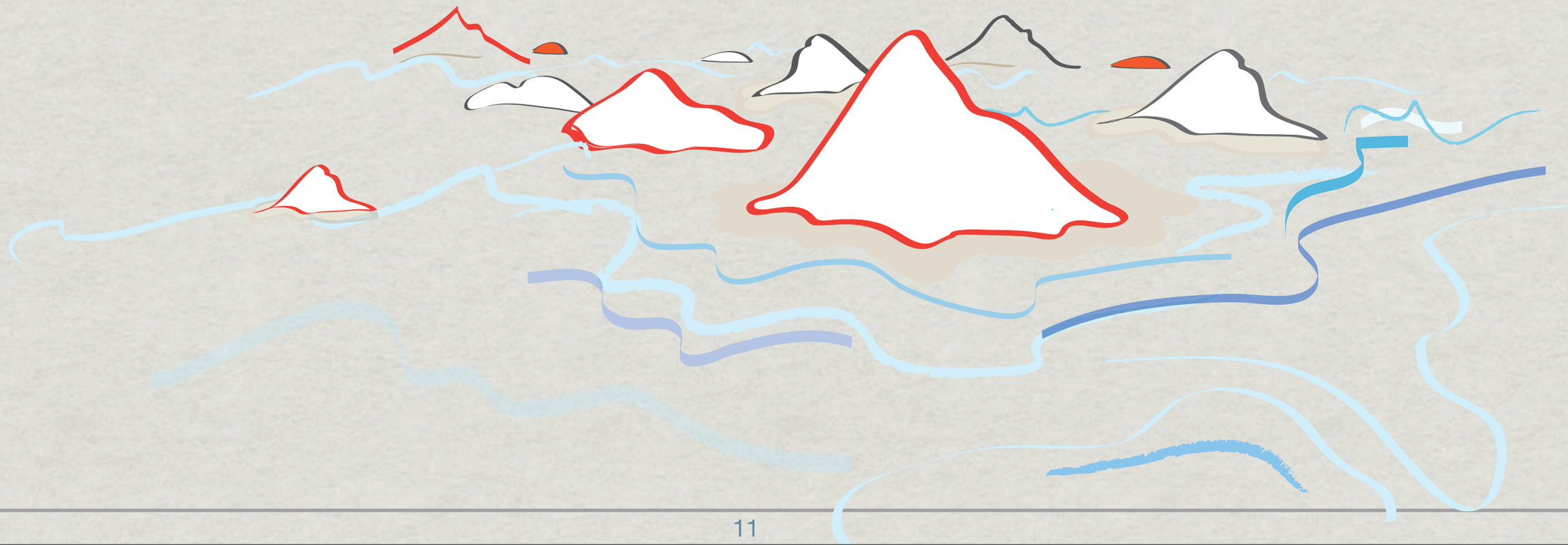
- Archipelago (Ark) next-generation infrastructure
  - in production since Sep 12, 2007
  - 2.90 billion traceroutes; 1.1TB of data



Ark Monitor Deployment

* 33 monitors in 22 countries

	Continent
12	North America
2	South America
11	Europe
1	Africa
5	Asia
2	Oceania

	Organization
19	academic
9	research network
2	network infrastructure
1	commercial network
1	community network
1	military research

Ark Datasets

- IPv4 Routed /24 Topology
  - traceroutes to every routed /24 prefix (~7.4 million)
- IPv4 Routed /24 AS Links
  - autonomous system (AS) is approximately an ISP
- IPv**6** Topology
  - traceroutes to every routed IPv6 prefix
- DNS Names
  - names of routers and hosts seen in traceroutes
- DNS Query/Response Traffic

Walrus

- interactive tool for visualizing large hierarchical graphs in 3D
  - goal: handle 1 million nodes
- employs fisheye-like spatial distortion techniques
  - permits simultaneous viewing of local detail and global context (that is, Focus+Context)
  - uses 3D hyperbolic geometry to achieve distortion

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  - uses 3D hyperbolic geometry to achieve distortion
- based on Ph.D research by Tamara Munzner
- written entirely in Java using Java3D
- source code available under GPLv2+

Why Hyperbolic Geometry?

- Euclidean space is *infinite* but ***too small***
  - a complete binary tree of height h has 2^h leaf nodes
  - but the circumference of a circle only grows linearly on the radius:

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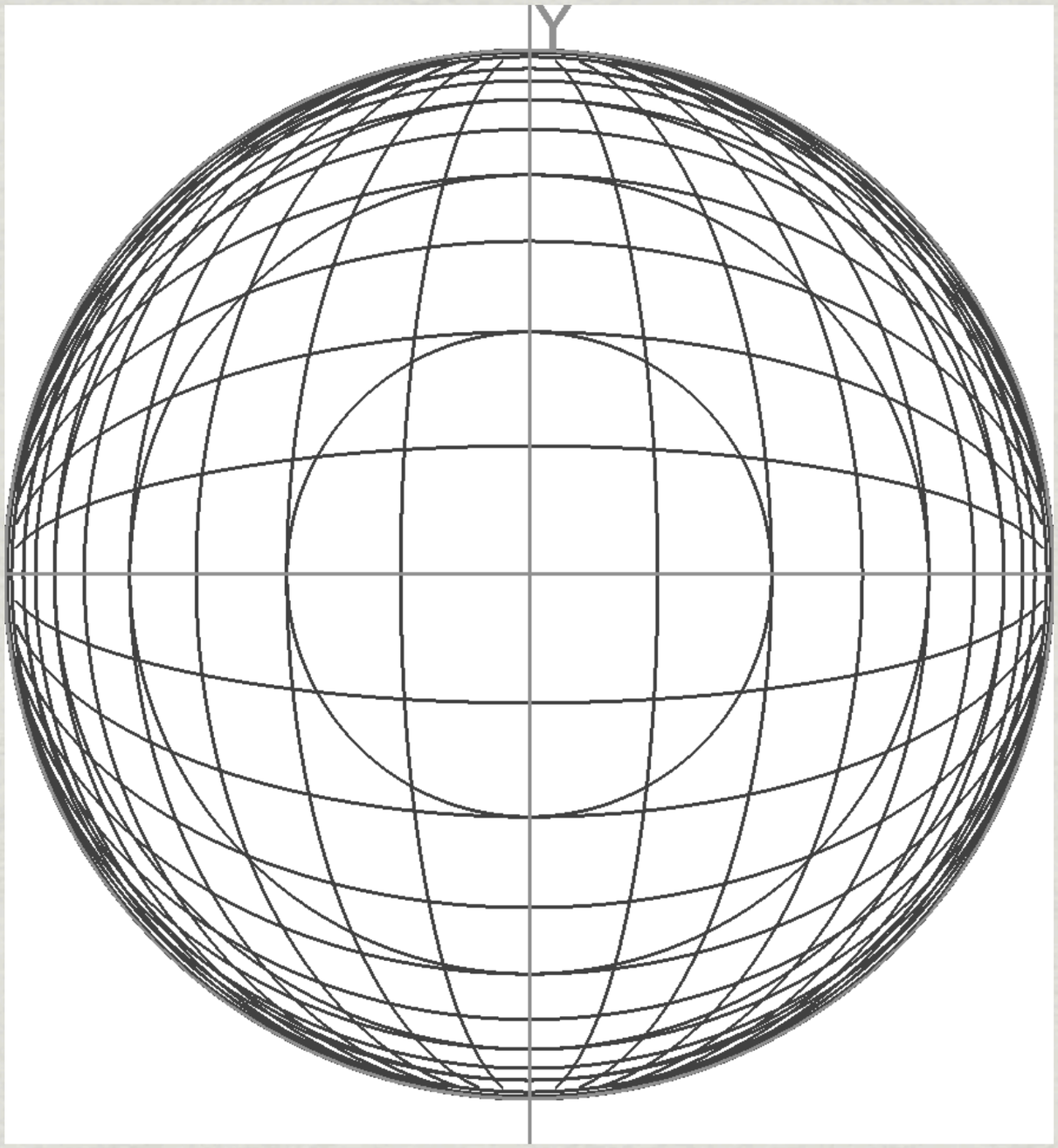
- hyperbolic space is bigger
  - the circumference of a circle grows exponentially on the radius:

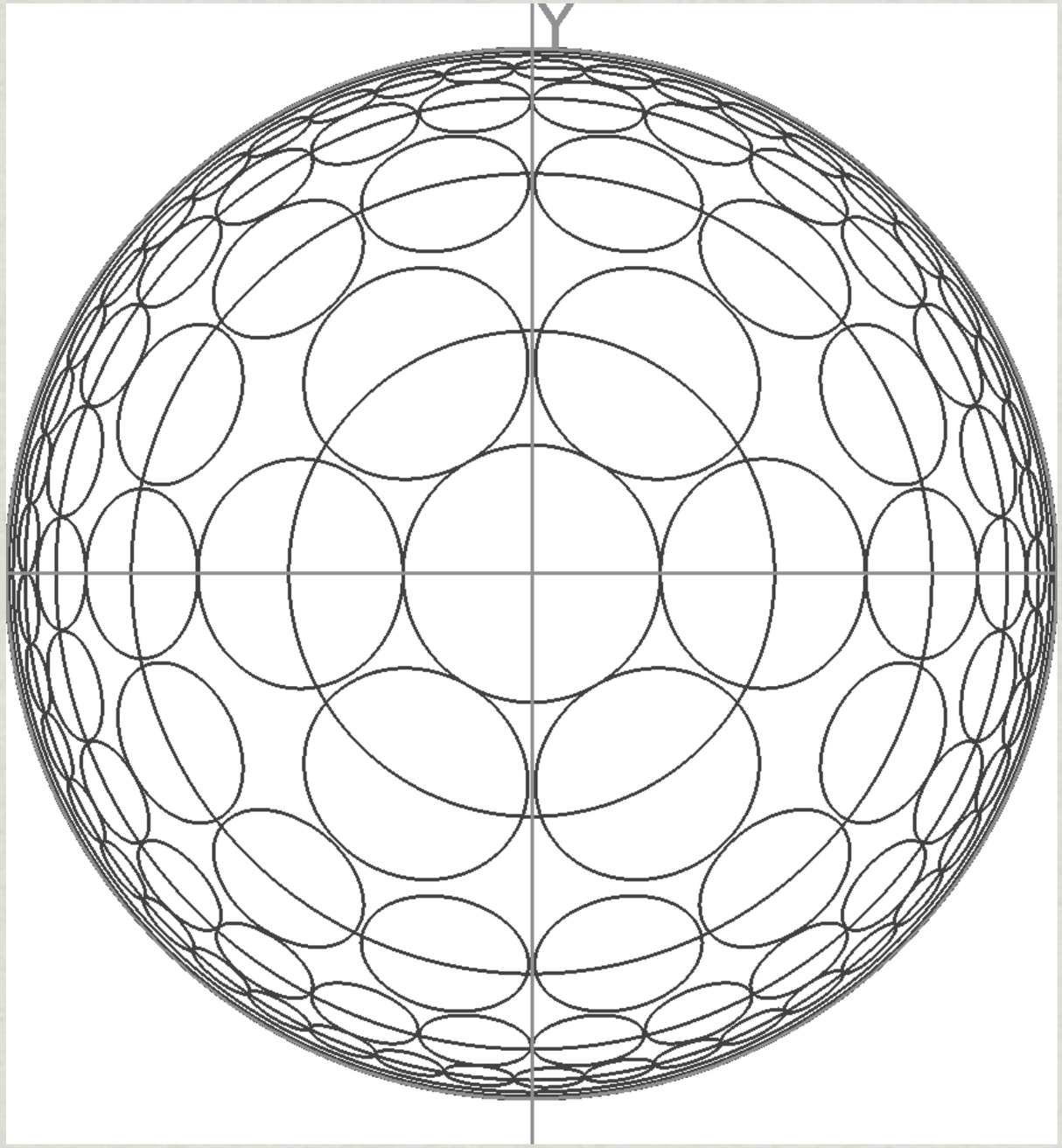
$$C = 2\pi \sinh r = 2\pi \left(\frac{e^r - e^{-r}}{2} \right) \sim e^r$$

Hyperbolic Visualization

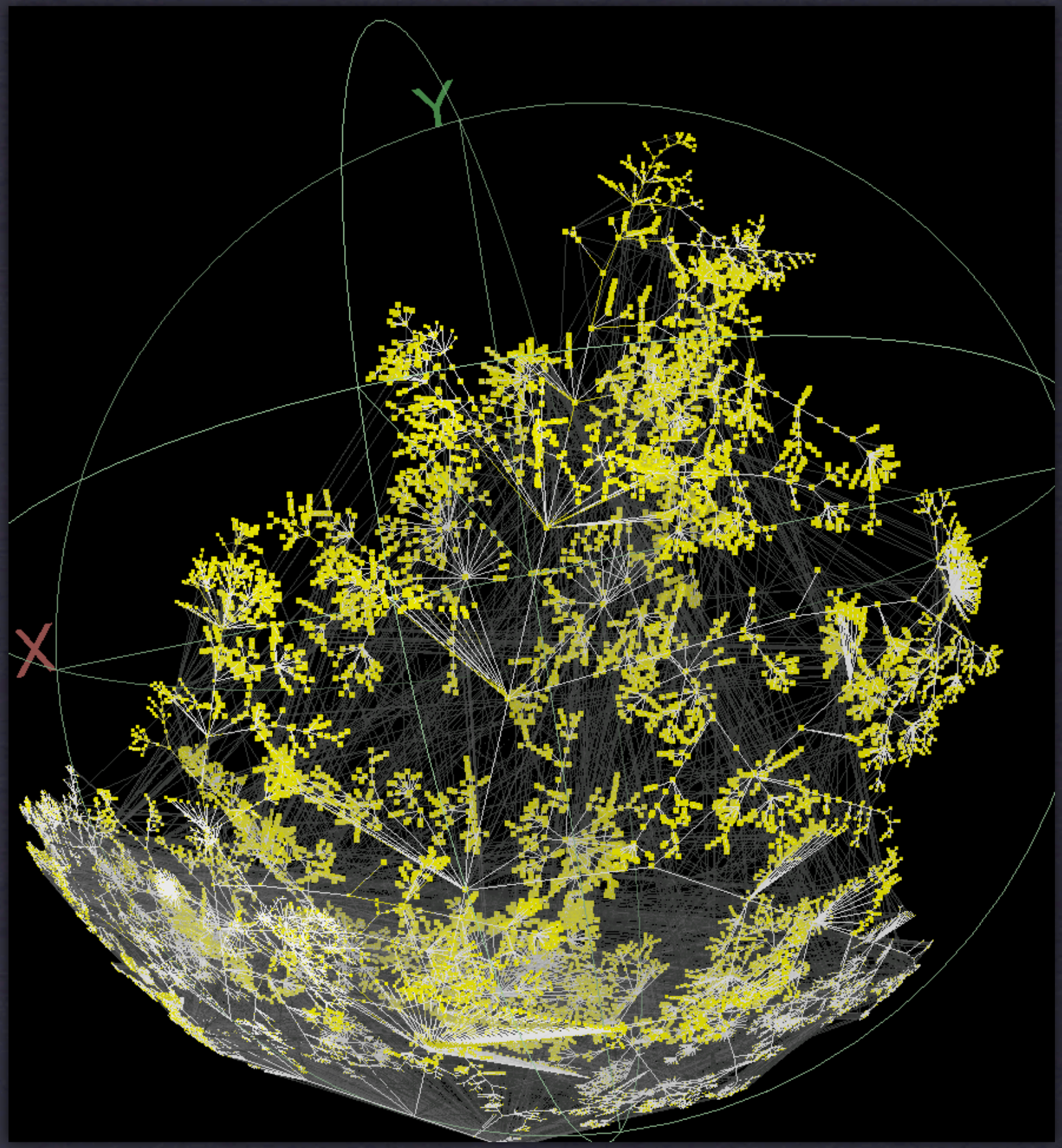
- lay out graph in 3D hyperbolic space
- project 3D hyperbolic space into 3D Euclidean space for visualization
  - Klein model: hyperbolic lines remain straight lines

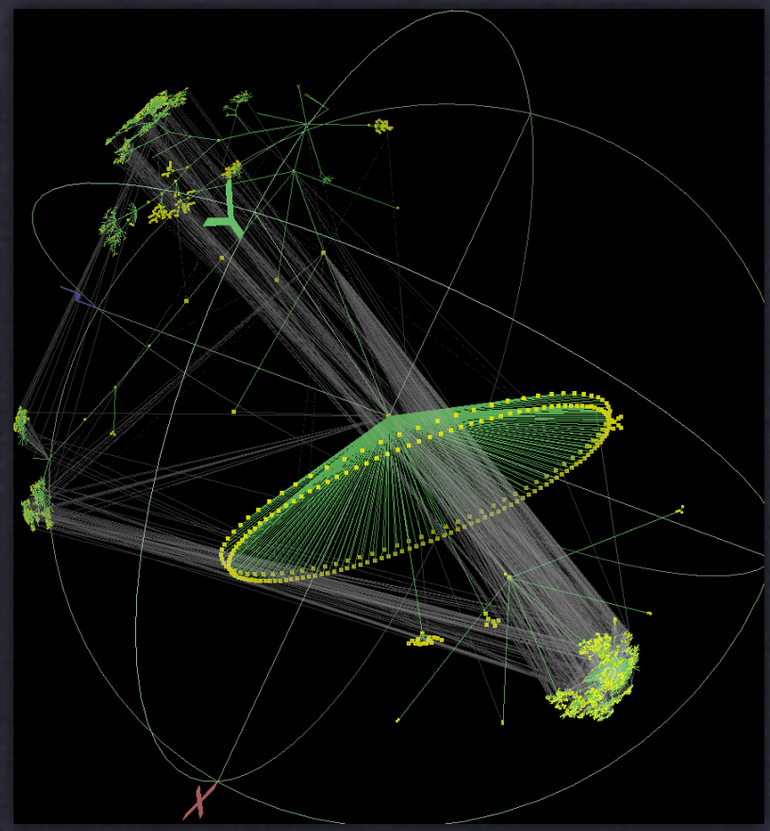
Hyperbolic Visualization

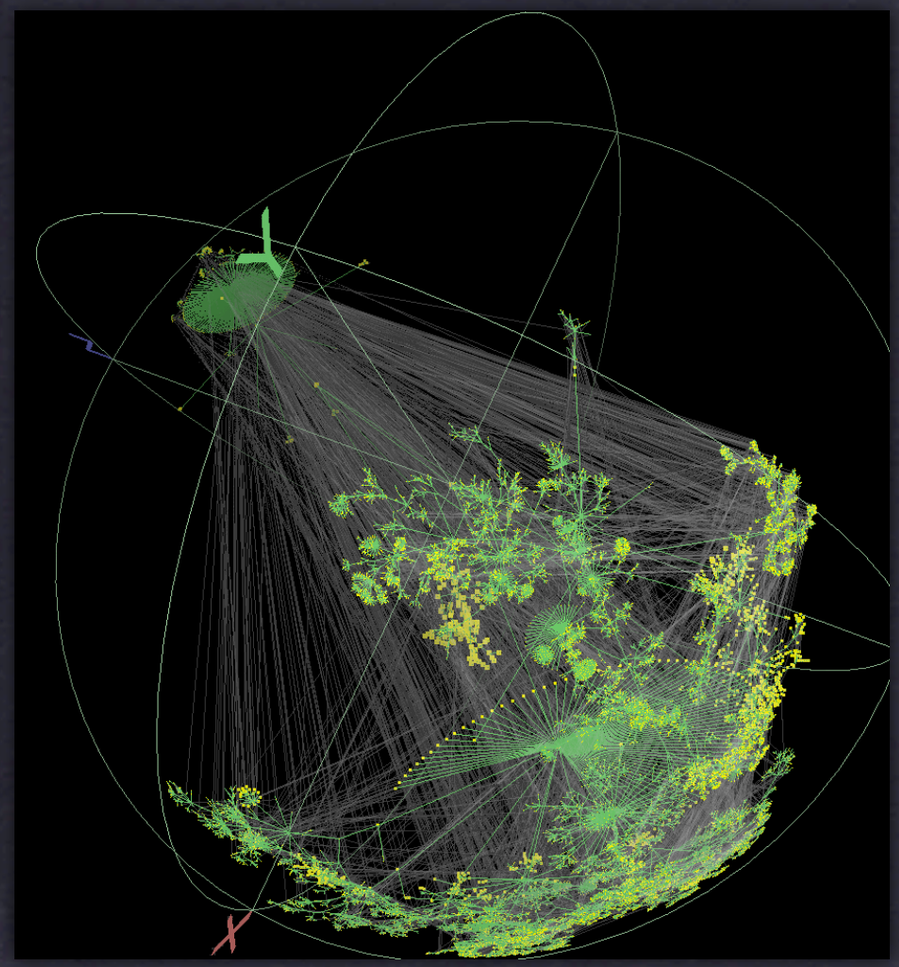


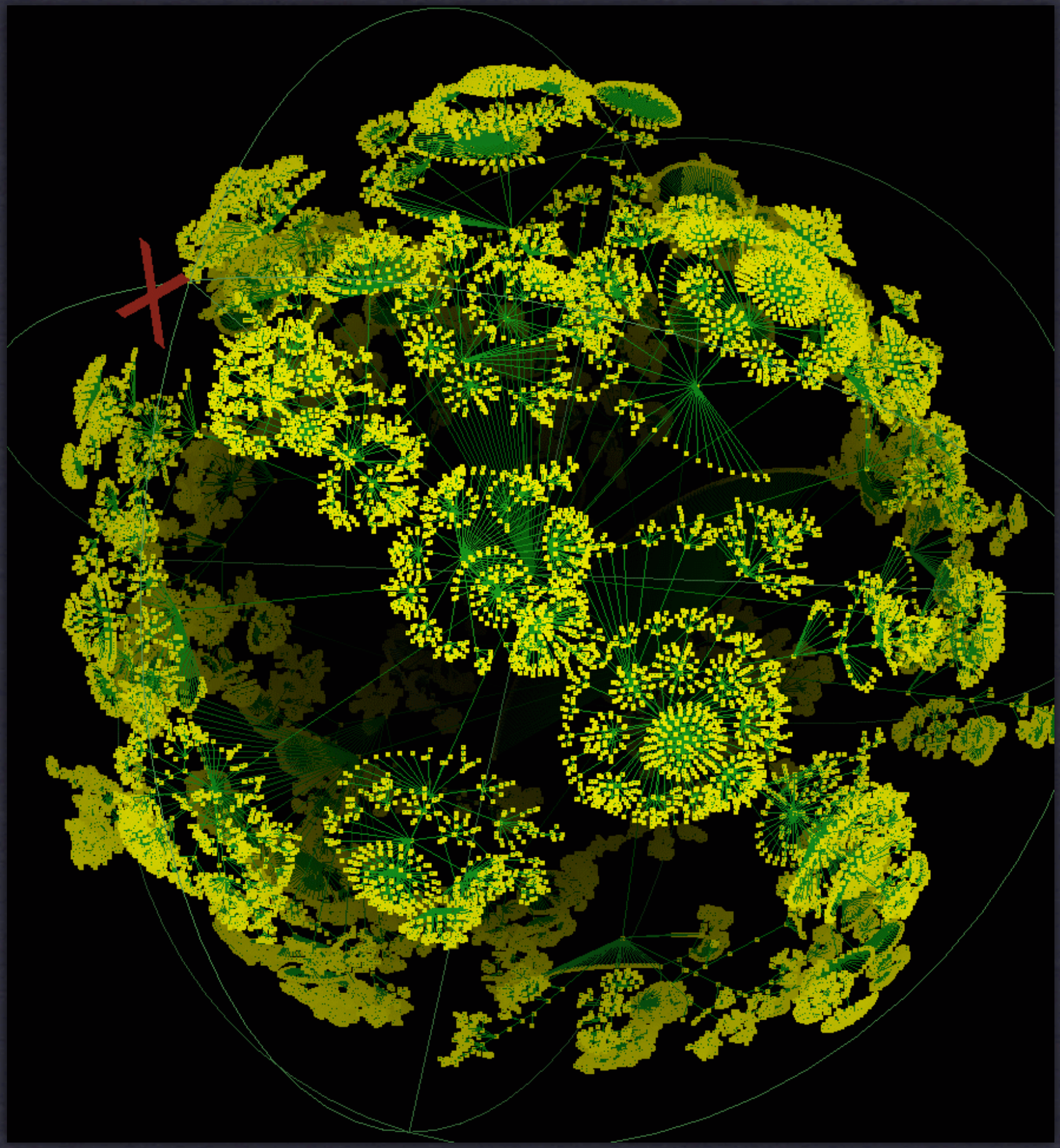


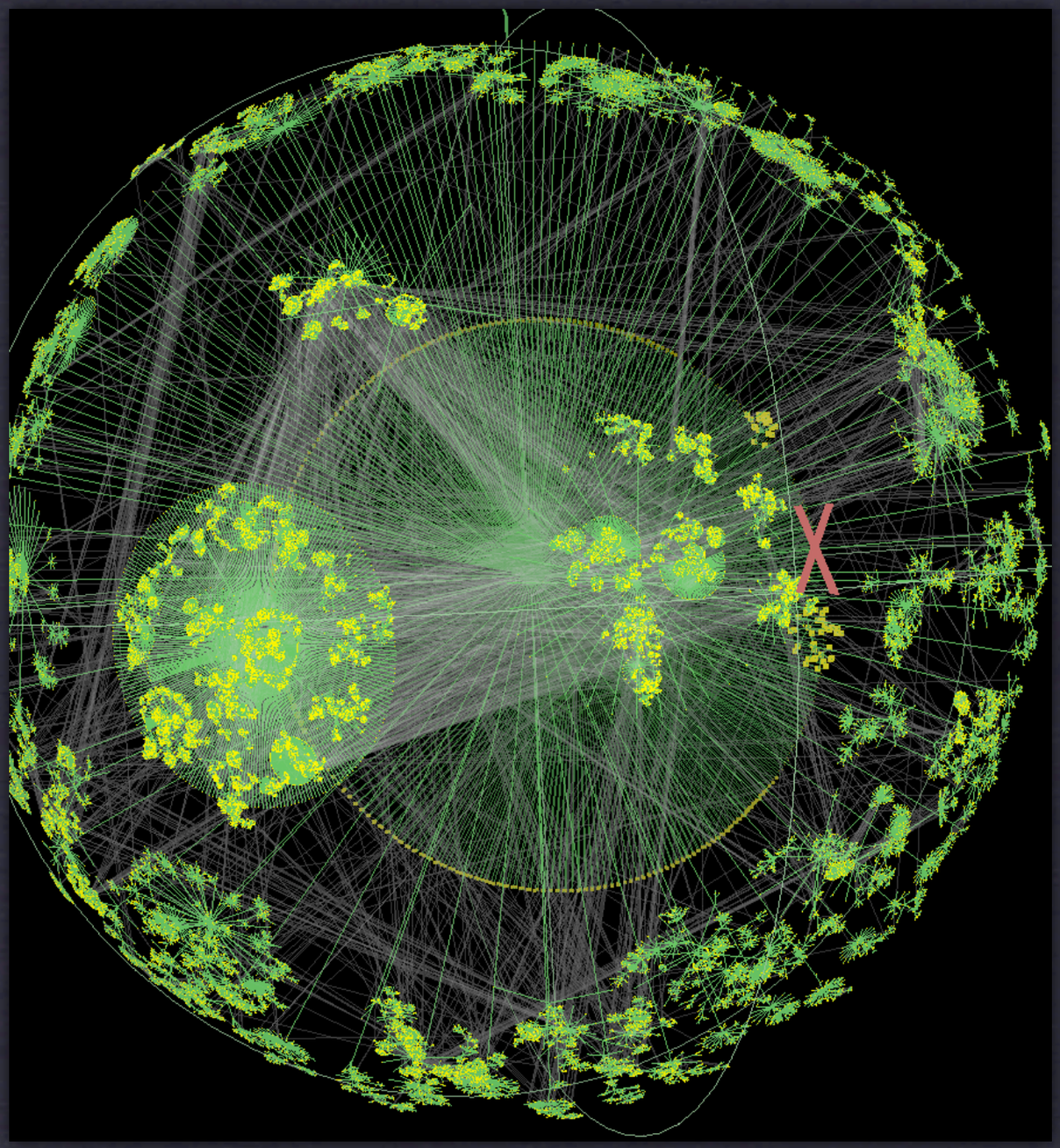
Walrus Gallery

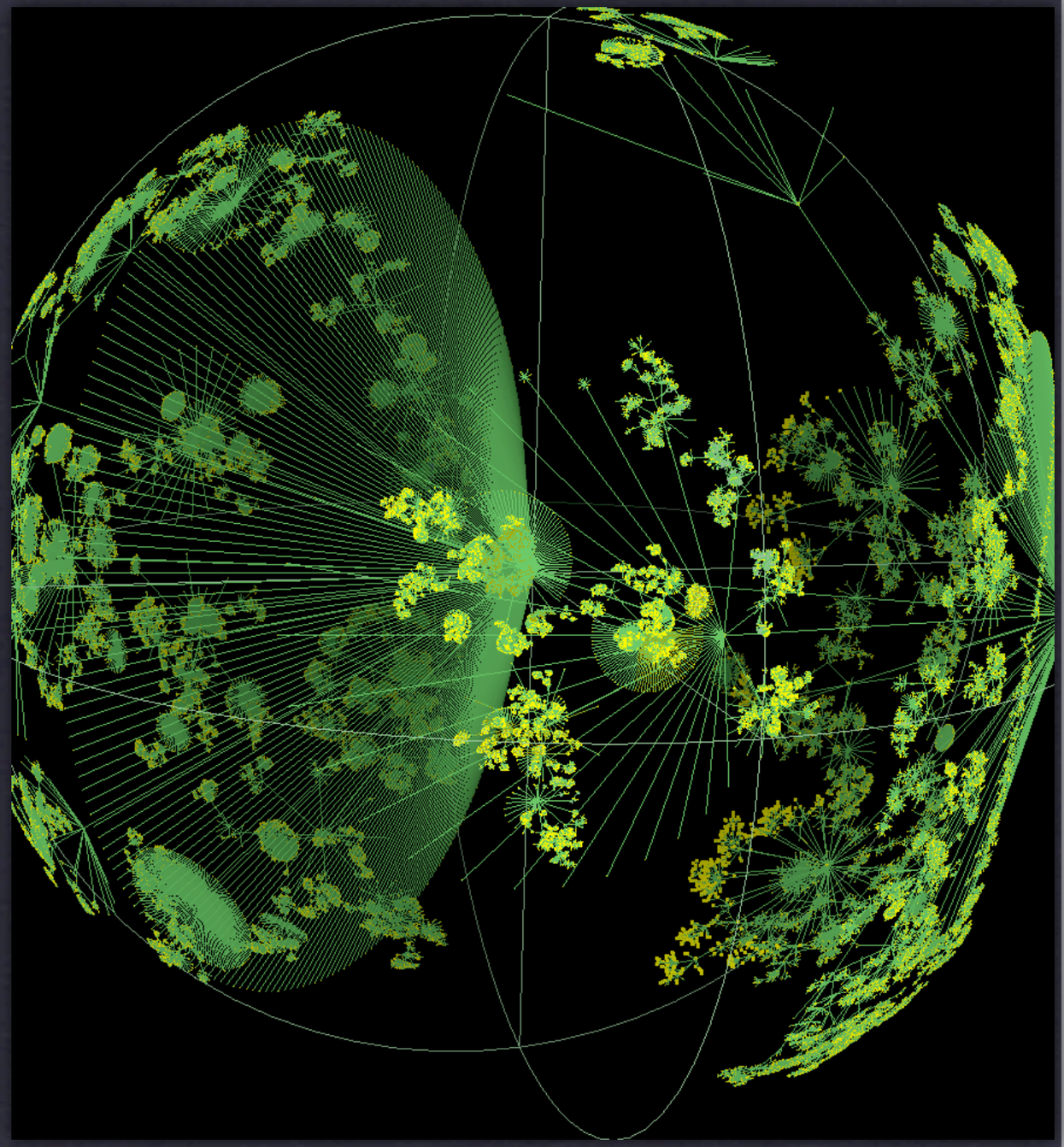


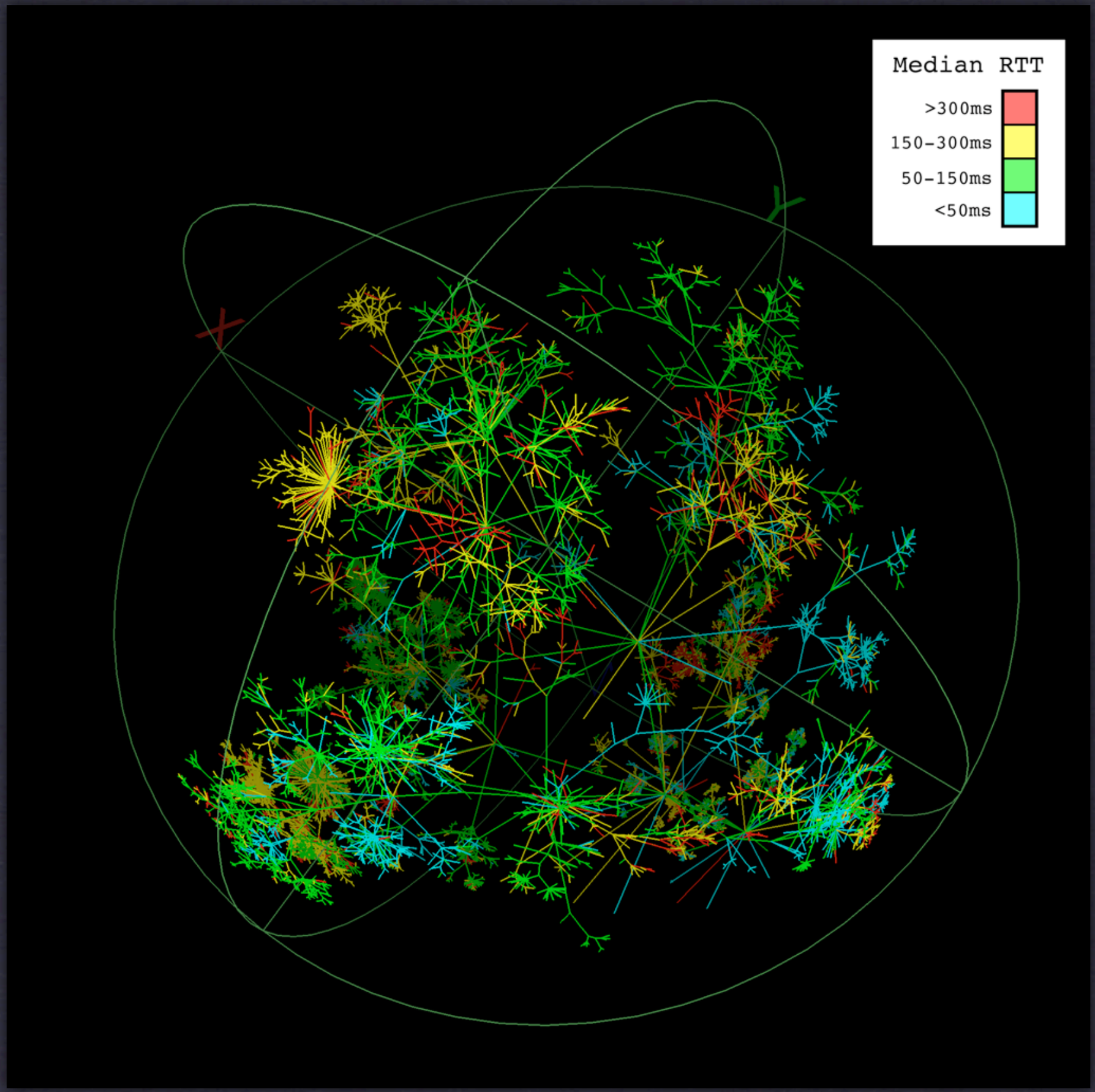


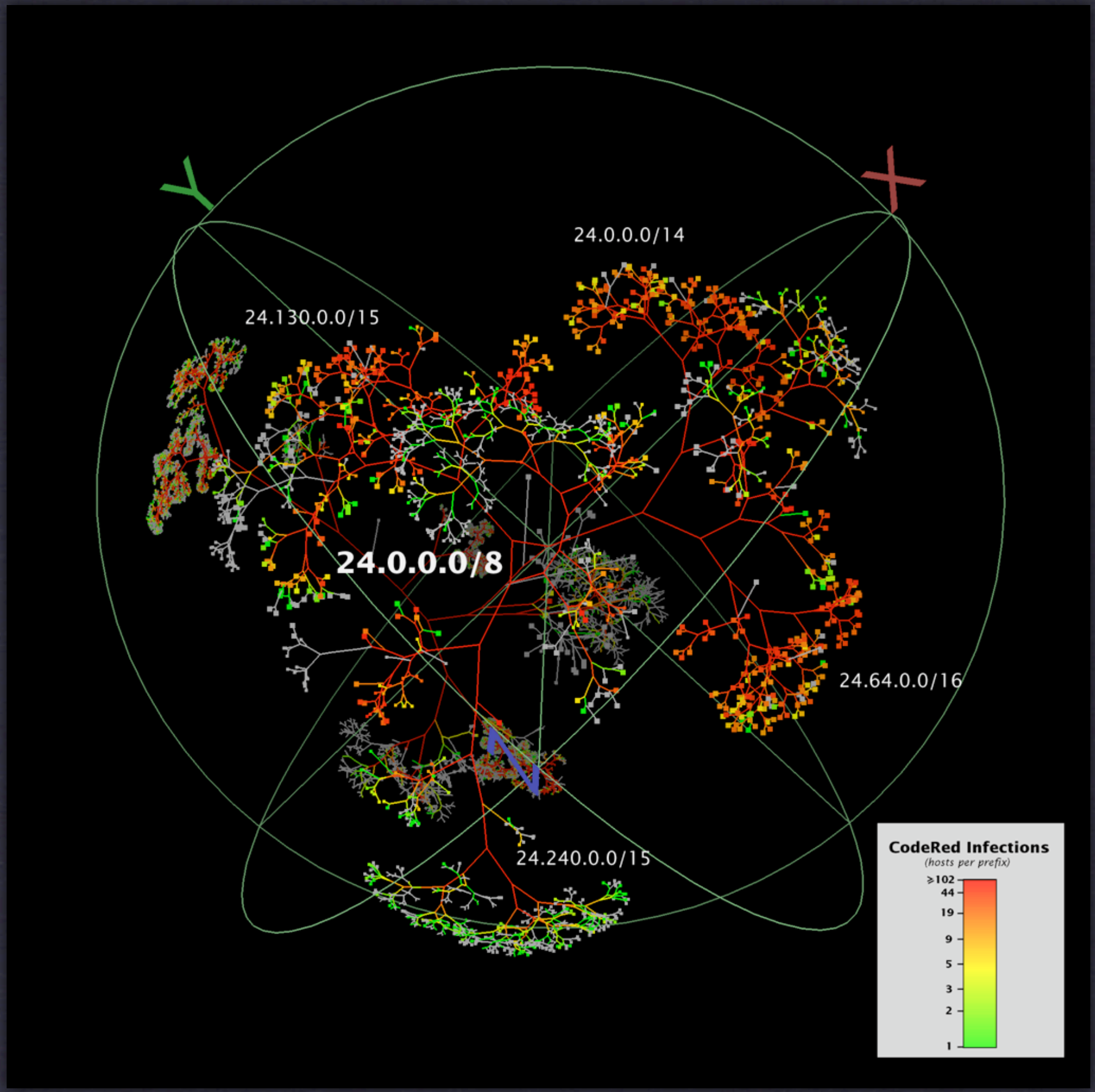





X




Median RTT
>300ms
150-300ms
50-150ms
<50ms


Y
X
24.0.0.0/14
24.130.0.0/15
24.0.0.0/8
24.64.0.0/16
N
24.240.0.0/15
CodeRed Infections
(hosts per prefix)
≥102
44
19
9
5
3
2
1

Walrus Demo

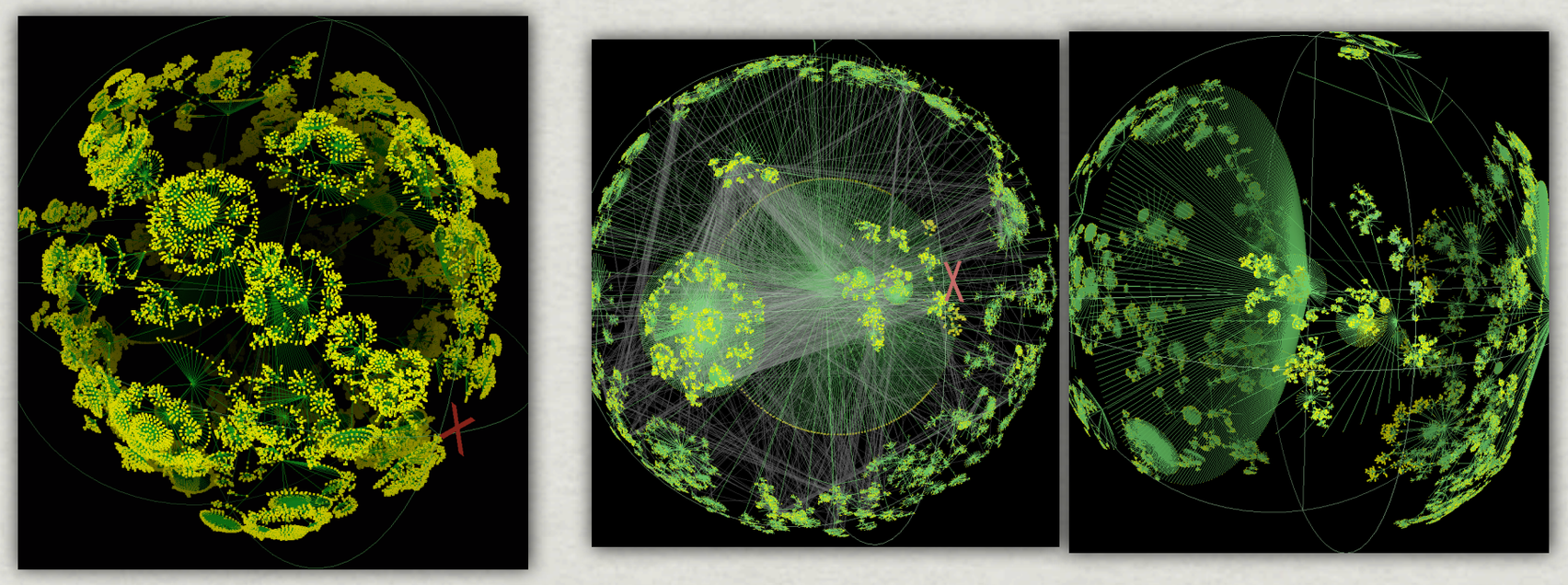
Walrus

Graph Visualization

Future Work

* get adaptive rendering working again with Java3D
* port Walrus to OpenGL

Thanks!



www.caida.org/tools/visualization/walrus

www.caida.org/projects/ark