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The Recession and the Routing Table

Reading the Transit Tea Leaves

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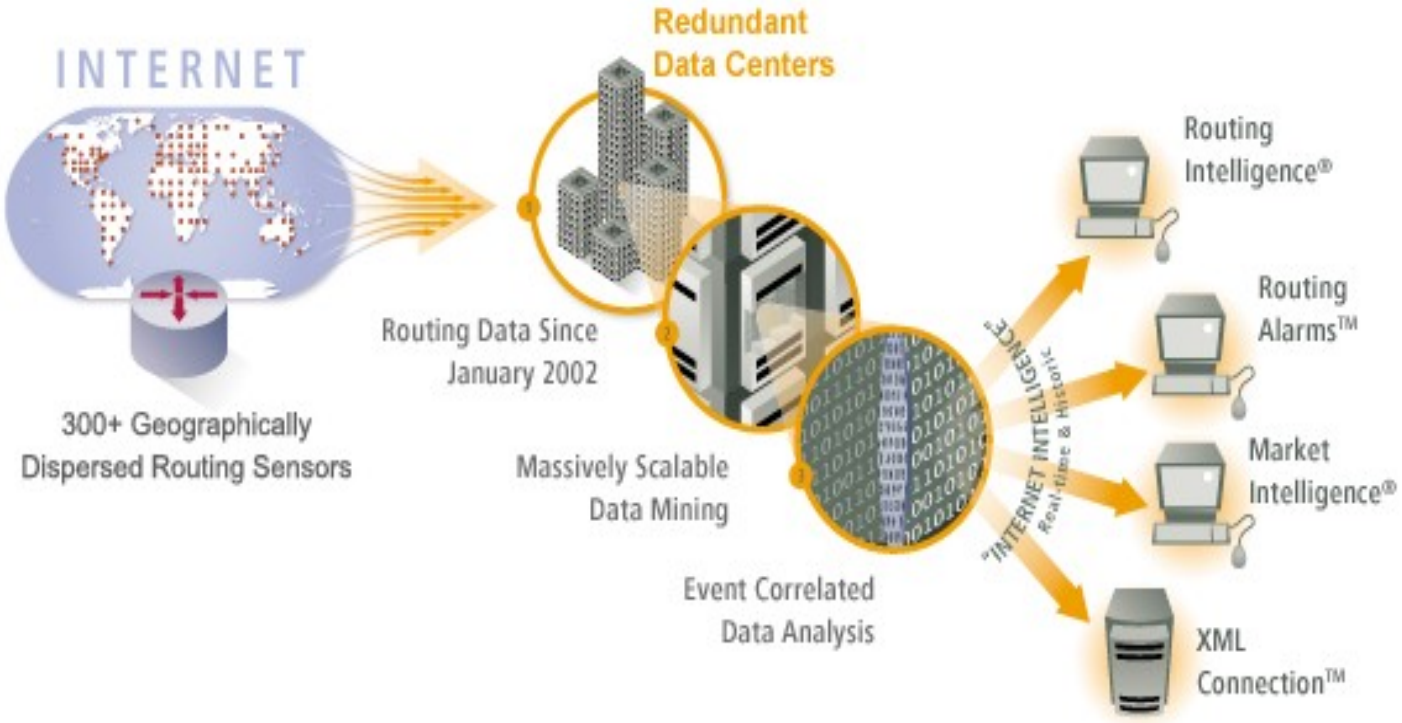
Overview

- Renesys data collection
- Thanks to peers (will trade RI for routes)!
- New metrics; transit diversity
- Looking for the recession!

Data Collection Infrastructure

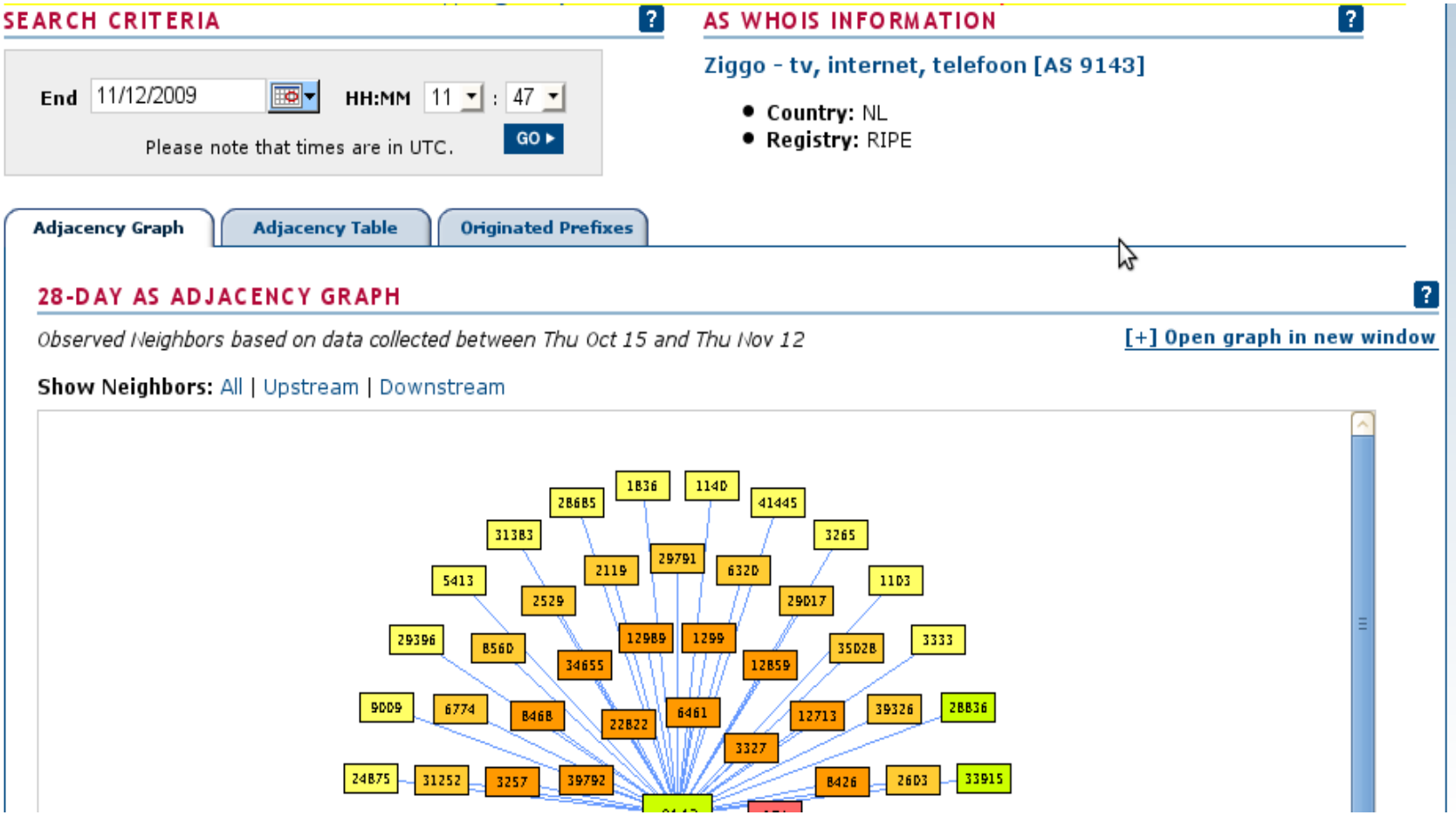
- 330+ peering sessions from 200+ different ASNs



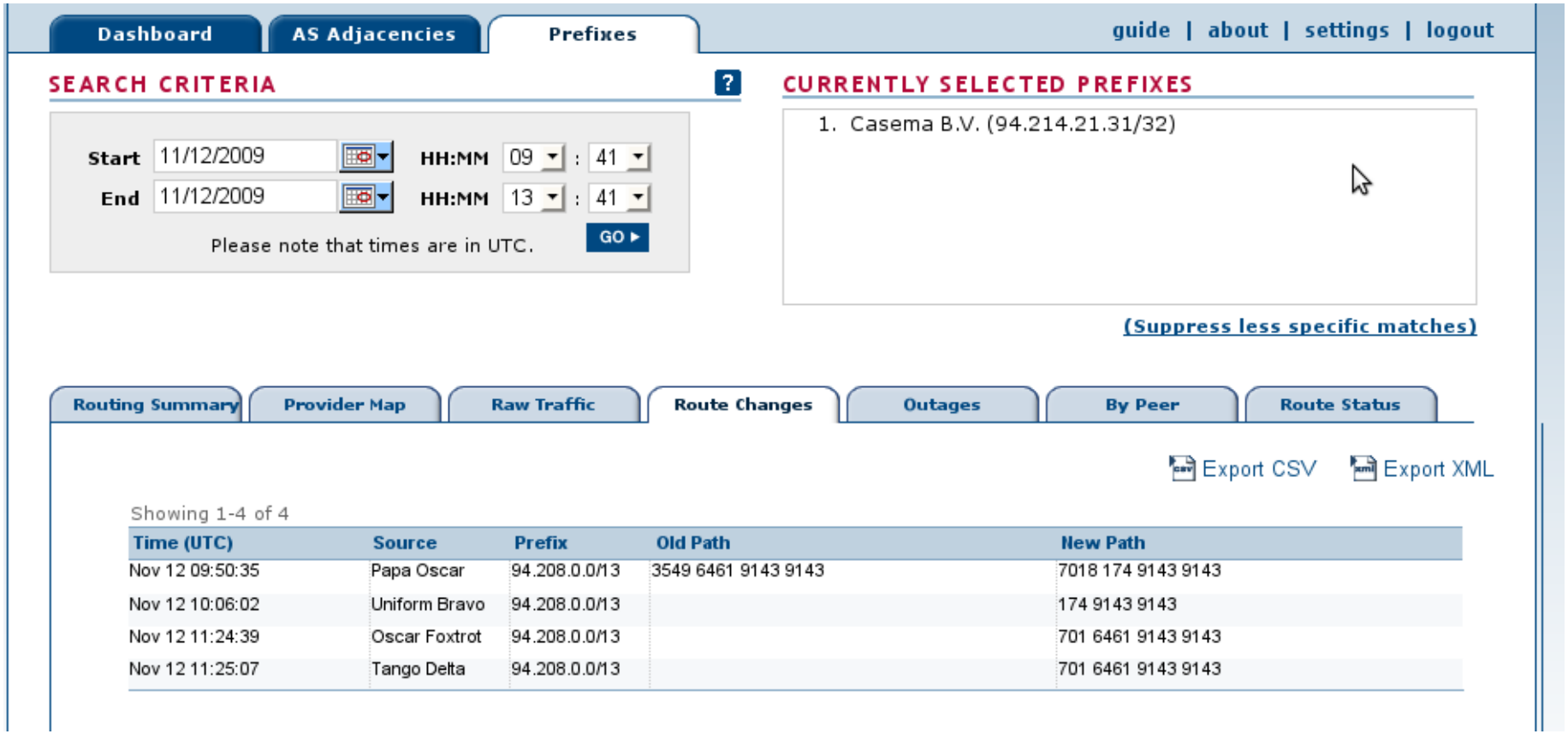
Peers at LINX

- Thanks to all of our existing peers, 85 of the approximately 300 members at LINX, which is our largest BGP collection point by peer count.
- Our relationship with LINX helps support and enable our global analytics.
- In exchange for your full public tables, through LINX, we offer access to one of our applications, Routing Intelligence.

Routing Intelligence application



Routing Intelligence application



Peer with Renesys at LINX

- Active peers at LINX since May 2005.
- IPv4 and IPv6 peering
  - peering@renesys.com
  - AS 64597
  - IPv4 195.66.225.224
  - IPv6 2001:7f8:4::fc55:1
- We peer silently, announcing no routes – we collect full table routes from peers.
- Or, find me after the meeting (also, mabrown@renesys.com)

Recent work

- Exploring new possible metrics, for example
  - a stability metric with predictive value
  - a transit diversity metric to measure an organization's transit resilience.
- Imagining better ways to model subsets of the Internet, by grouping parts of the Internet into network ecosystems.
- Searching for evidence of the economic slowdown in Internet transit.

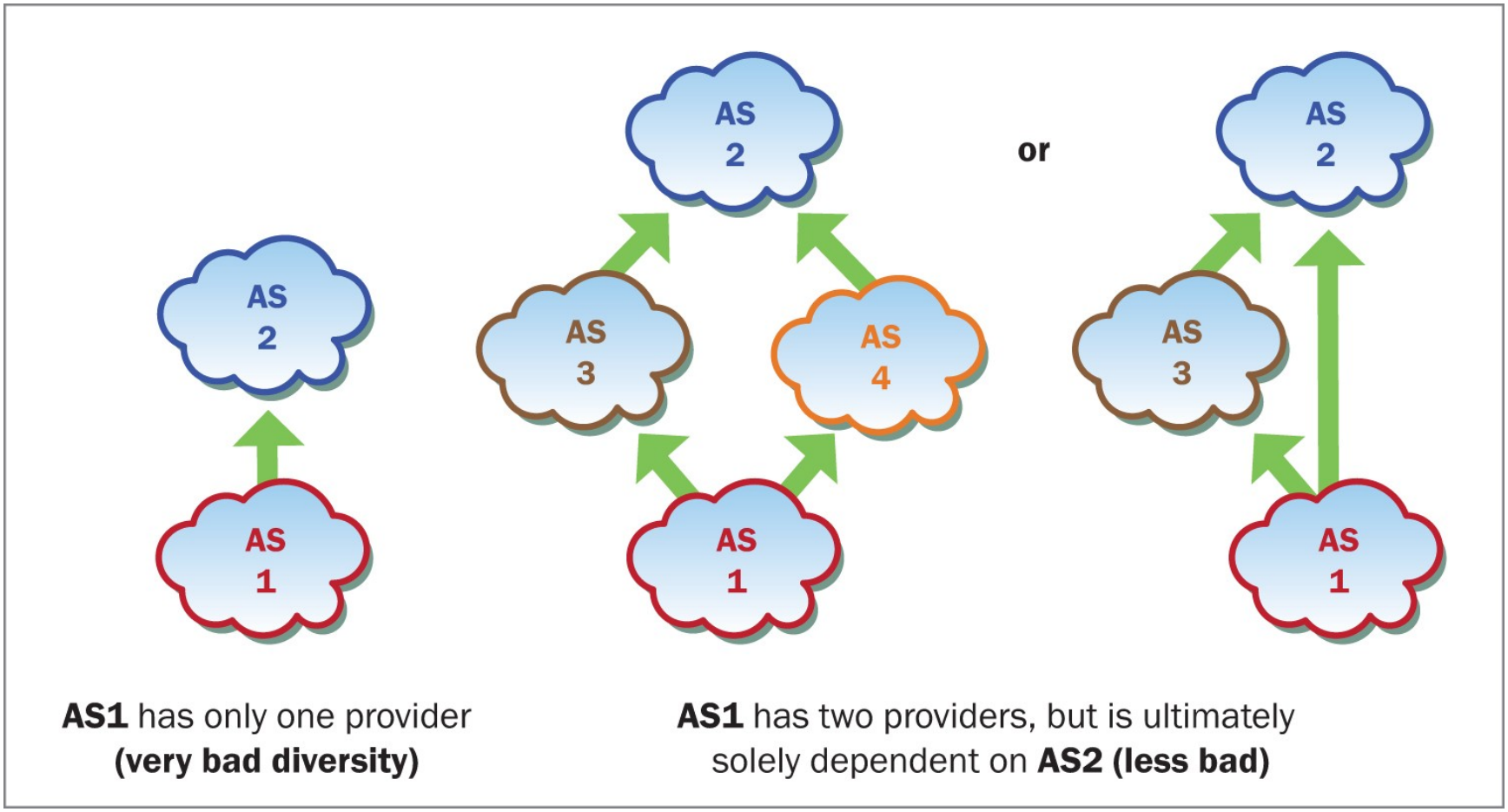
Quantifying transit diversity

- Identify the transit providers (transitively). Can be accomplished algorithmically, but needs manual tuning.
- Create a per-prefix scoring algorithm.
- Aggregate the individual prefix scores across a set of prefixes (an organization's footprint).
- Does not address the question of physically diverse paths—this is about routing diversity.

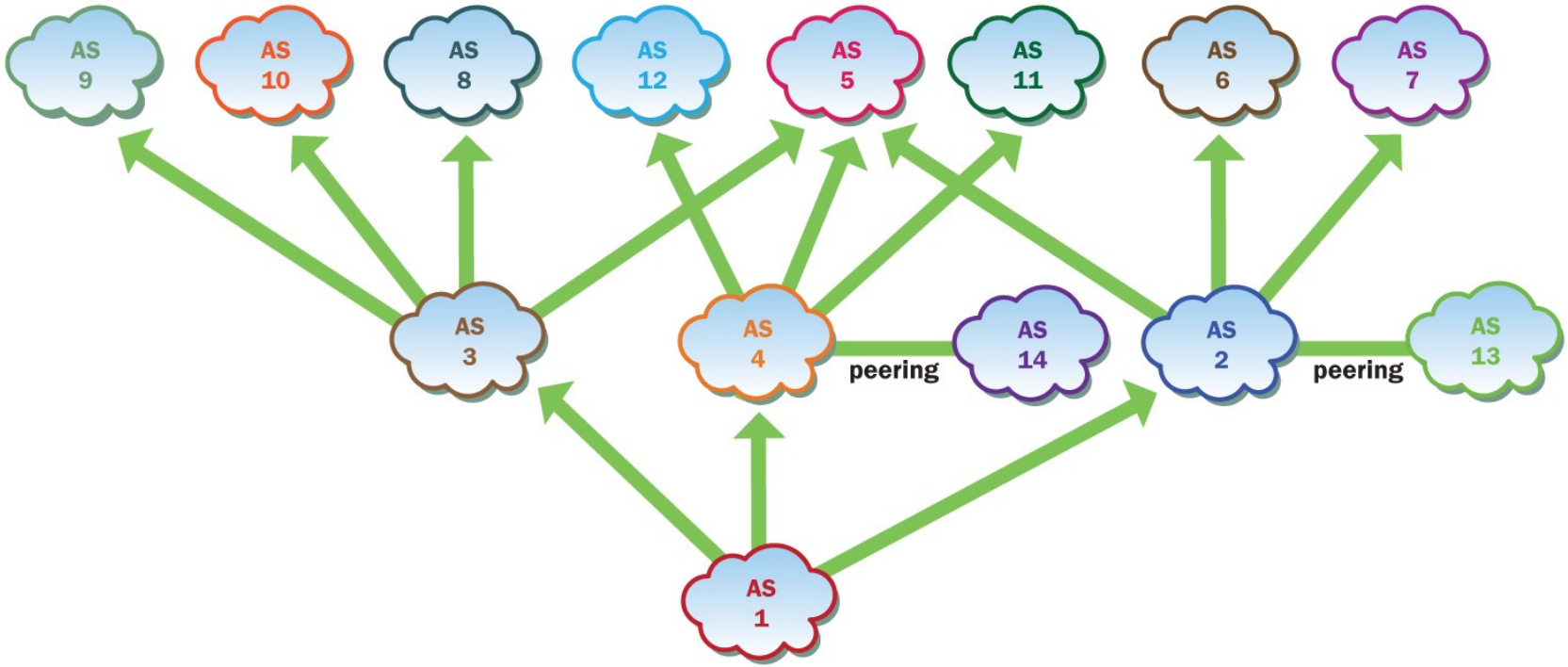
Identifying transit relationships

- We observe around 10 million distinct AS paths containing over 125,000 unique AS-to-AS relationships
- Each AS-to-AS adjacency represents a business relationship
  - Customer → Provider
  - Provider → Customer
  - Peer → Peer
  - Transit Swap
  - AS Cluster
- (Re-)Compute the relationships on a daily basis.

Diversity – Finding single points of failure



Diversity – Eliminating single points of failure



AS1 has three providers, each of which is richly interconnected to the rest of the Internet.

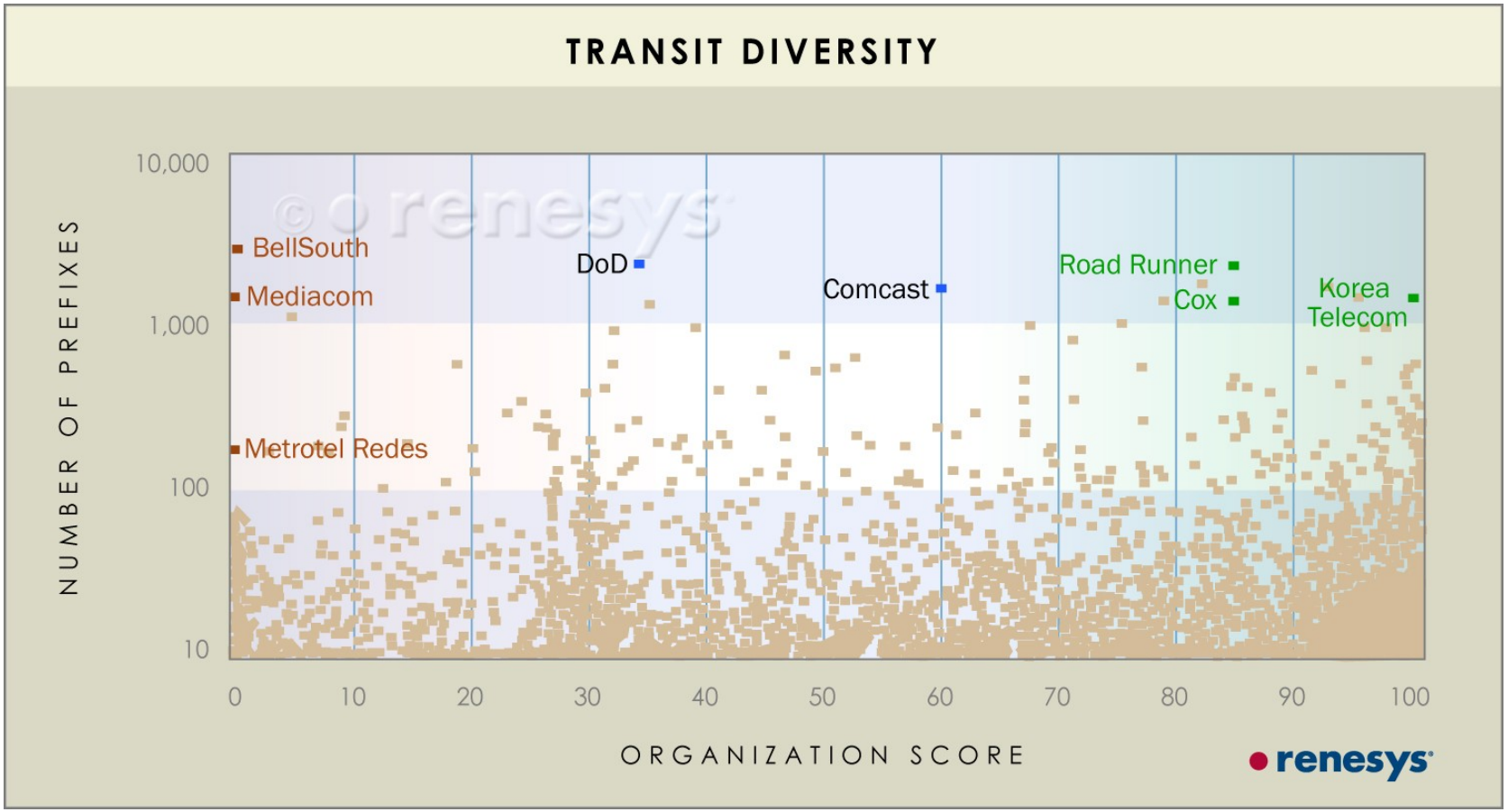
Measuring Diversity

- For each prefix …
  - How many direct providers are seen? (majority of score)
  - How many big providers ultimately provide transit?
- For each grouping …
  - Average their prefix diversity scores in some way
    - Here we weight each prefix by its size
  - Composite score measures total *Internet transit diversity*
    - Score range: 0 (no diversity) – 100 (3 or more providers & TFZs)
  - Higher score → More diversity → Less risk

Qualifying and aggregating diversity metric

- Observe the transit paths to individual prefixes over long periods of time (allowing for and crediting backup transit links).
- Penalize ASNs whose paths are captive to a single Transit-Free Zone member (single point of failure).
- Aggregation of scoring complicated by traffic engineering and multiple ASNs in use by the same organization.

Diversity scoring by organization



Tough Times, Tough Questions

- We know that Internet transit purchases are sensitive to business conditions (2000 crash)
  - Is the 2008-2009 recession affecting growth in the global/regional routing tables?

- It's tempting for enterprises to scale back provider diversity, choosing **cheap** over **reliable**
  - As contracts expire or companies fold, we should be able to see the signs in reduced connectivity

Do we, in fact?

Three Years of the S&P 500

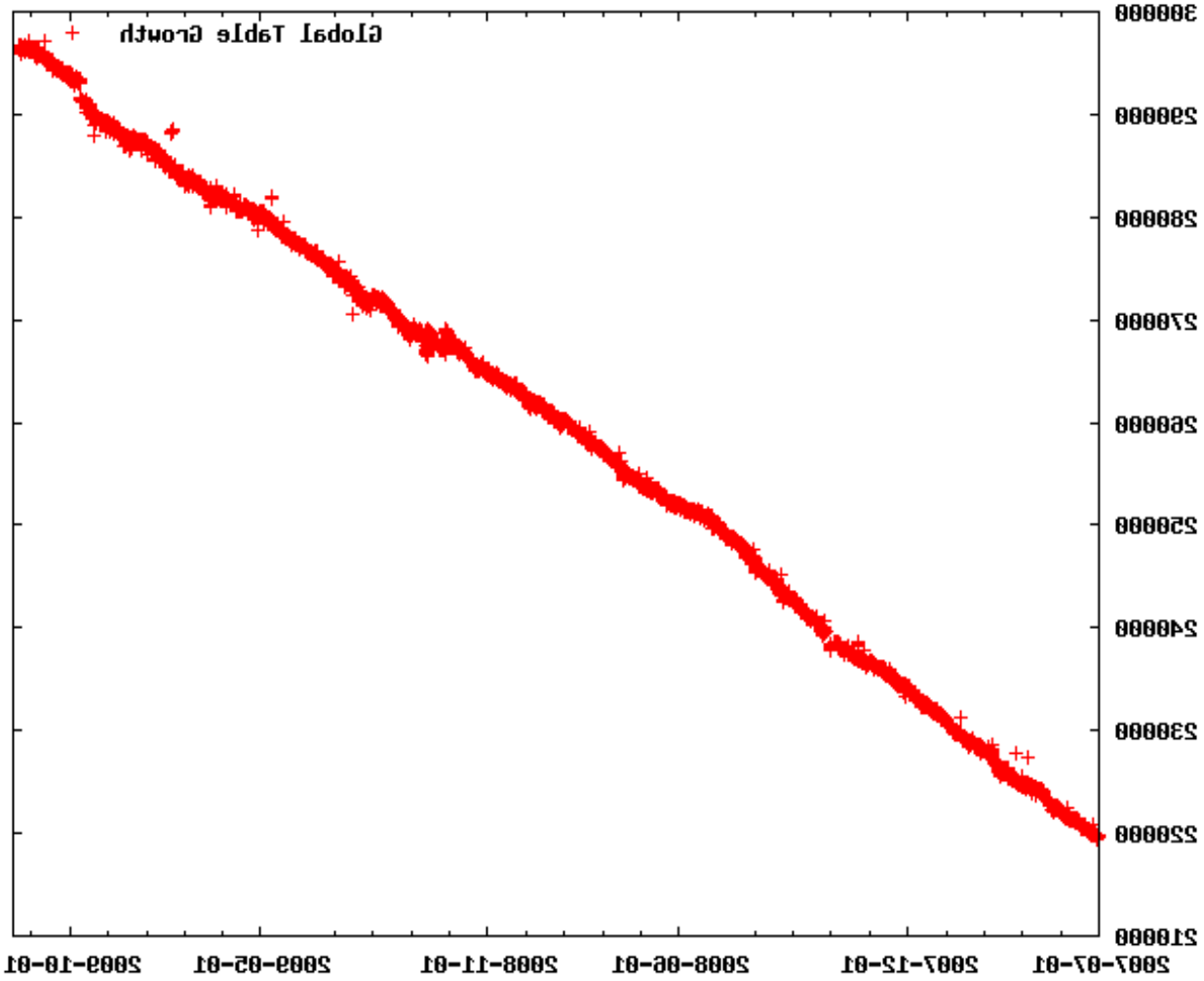
You probably read about this in the newspaper.

It was big news.

Three Years of the Baltic Dry Index

The cost to ship physical objects across the oceans collapsed by 90% from October 2007 to October 2008.

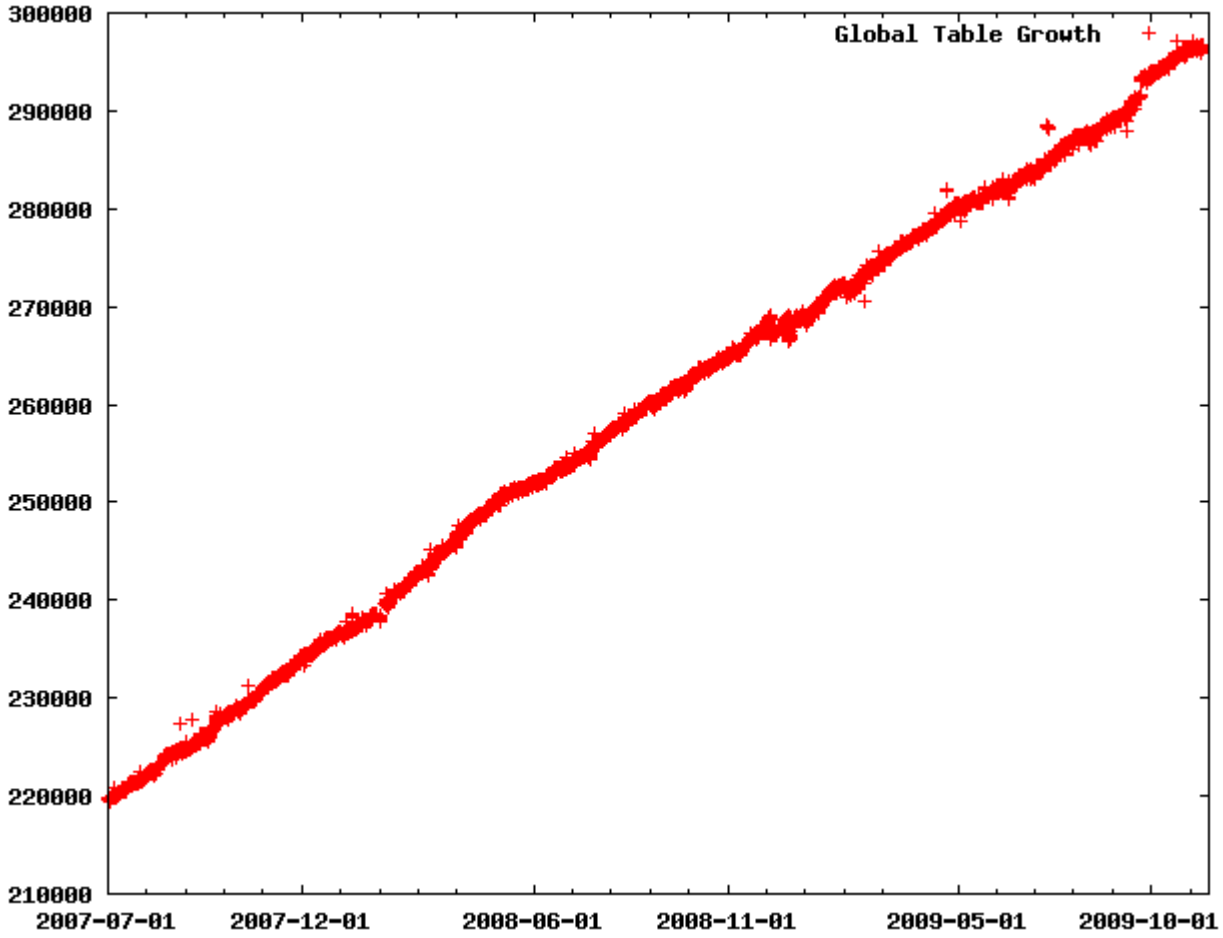
Three Years of the Global Routing Table



Oh, wait.

I have it upside down.

Three Years of the Global Routing Table



Very consistent growth over nearly 3 years in the number of IPv4 prefixes advertised in the global routing table.

Where's the depression?!

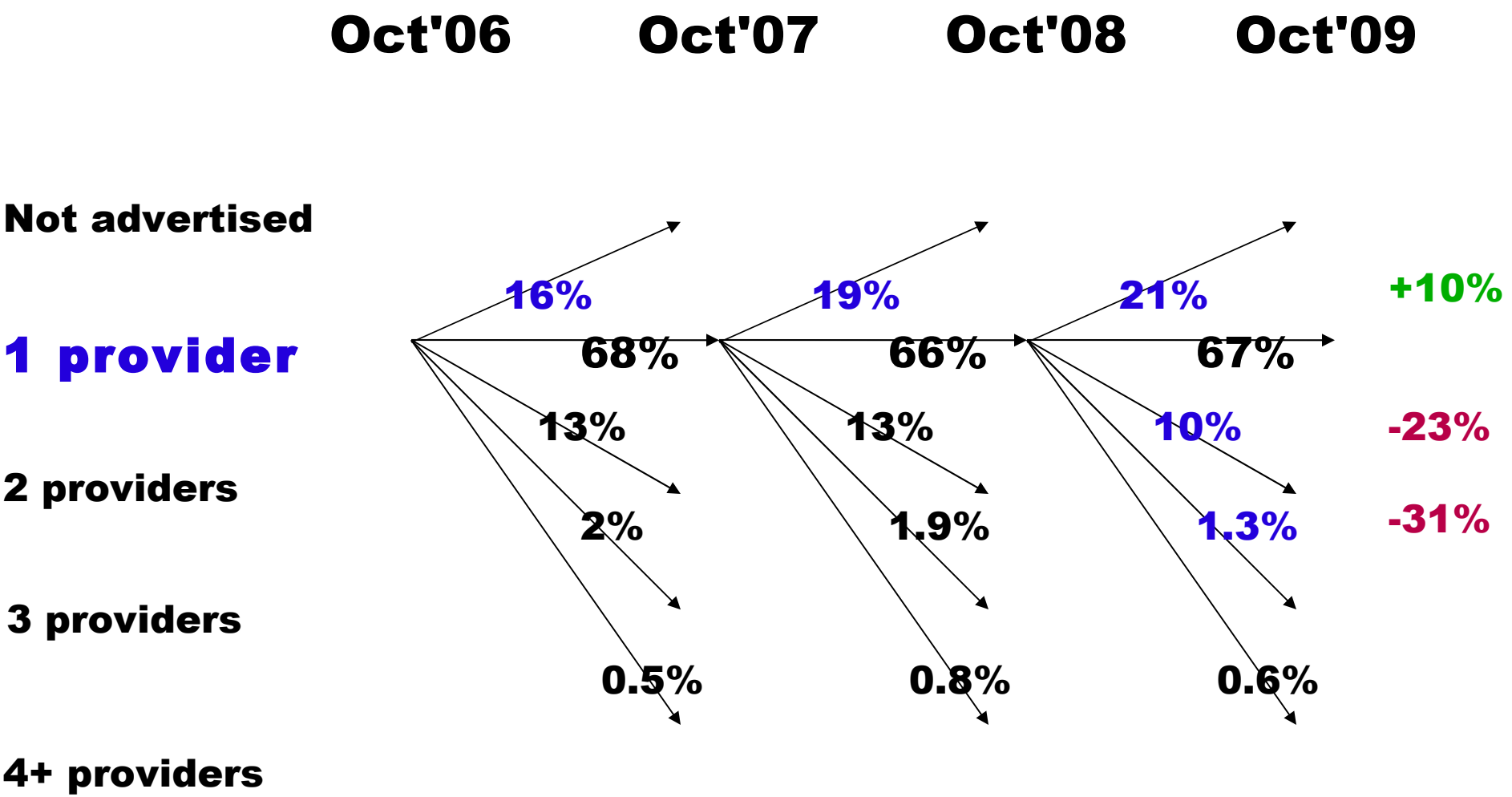
Why the Table Keeps Growing

- Enterprises don't cut costs by leaving the Internet.
- They may cut costs by reducing diversity.
- **Cheap transit** getting cheaper acts like “easy money” in the routing table.
- If you want stimulus, you have to be prepared to eat the inflation.
- The prospect of v4 exhaustion may be creating “use it or lose it” incentives to route your assets.

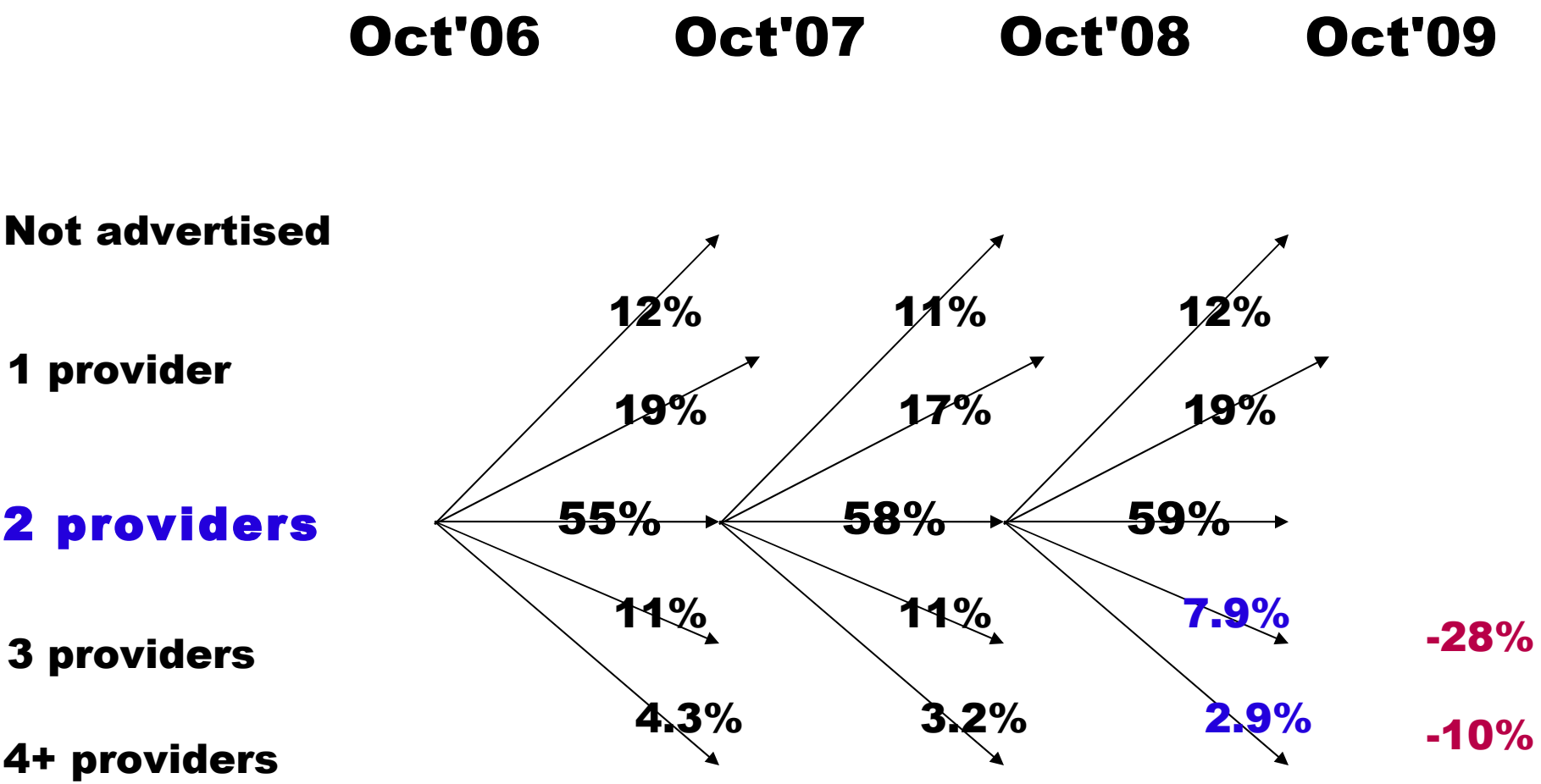
Global Diversity Transitions, 2006-2009

	Oct'06	Oct'07	Oct'08	Oct'09
Total routes	182K	222K	255K	287K
Annual growth		+40K	+33k	+32k
1 provider	55%	55%	52%	52%
2 providers	29%	29%	29%	29%
3 providers	9.5%	9.2%	9.2%	8.7%
4+ providers	6.5%	7.4%	9.0%	9.6%

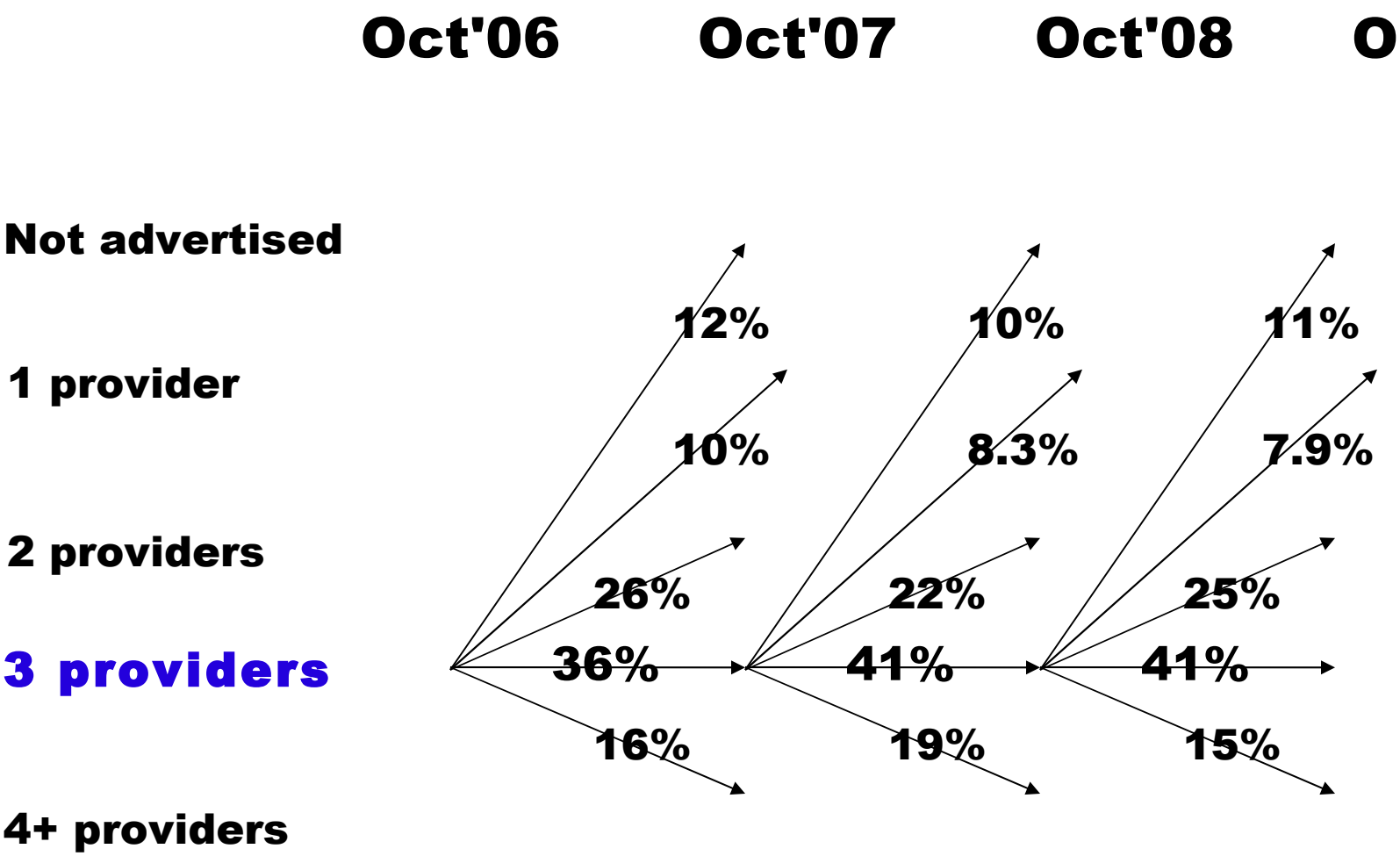
Singlehomed get reclaimed, or go multihomed at lower rates



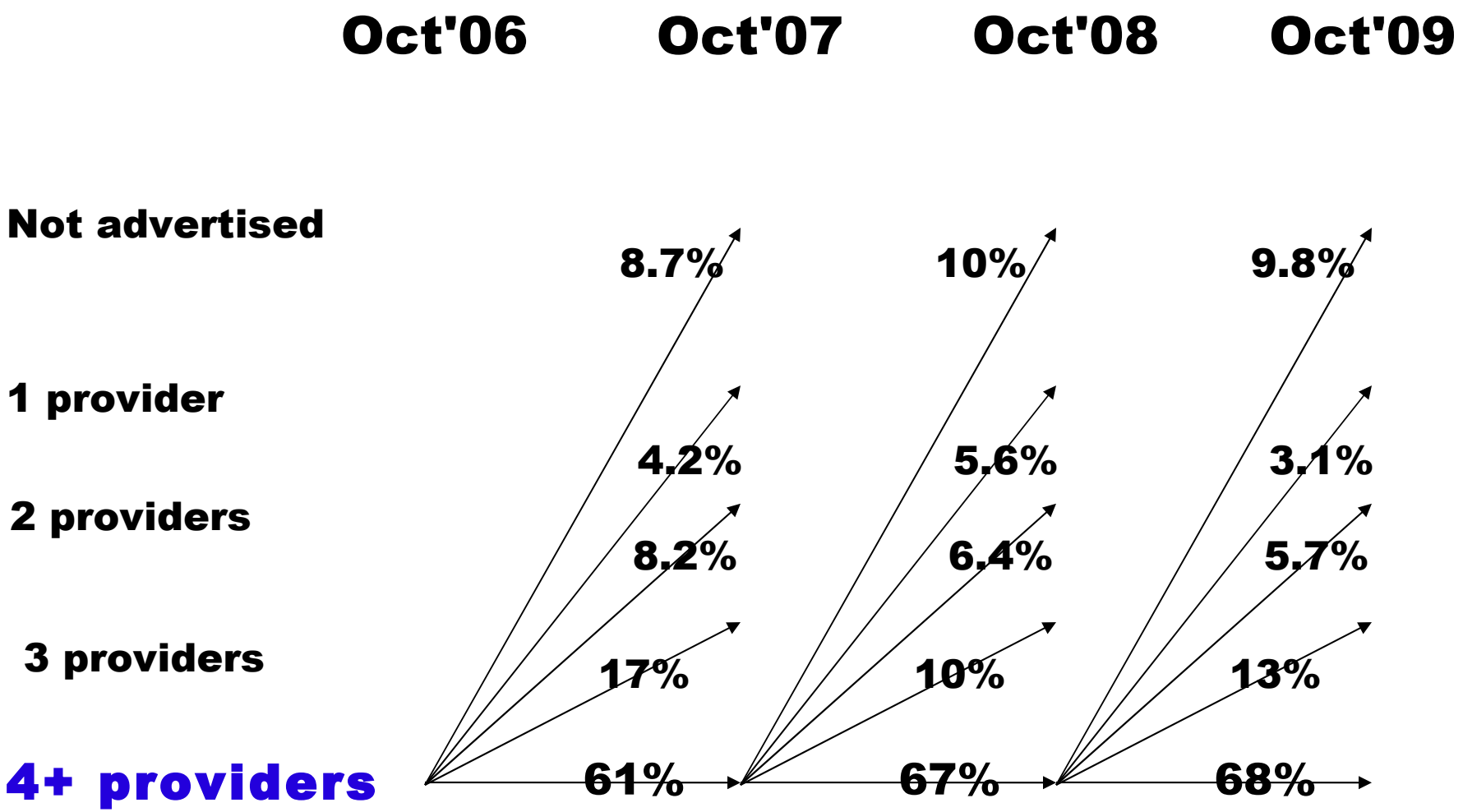
Fewer dual-homed prefixes buying 3rd+ provider



Triply-homed prefixes largely unaffected



Highly multihomed prefixes becoming a larger and more stable class over time



Conclusions

- We thought global recession might give some more breathing space before v4 exhaustion
- Cheap transit appears to have killed that theory
- Some evidence of single- and dual-homed customers putting off the moves to higher transit diversity in 2007-2009
  - *"Obviously practicing for the IPv6 transition, after which, apparently, multihoming becomes unnecessary" --anon*
- Otherwise, growth continues apace
- Bring on the v4 address space aftermarket!

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Corporate Profile

- Renesys provides mission-critical, real-time and analytical information on the state of the Internet to Network Service Providers, e-Commerce companies, cybersecurity organizations
- Patent-pending technologies for real-time global alerts and analytics
- Headquartered in Manchester, NH, USA
  - Data Centers:
    - New Hampshire, USA (Worldpath)
    - Florida, USA (NOTA)
    - California, USA (PAIX and Any2)
    - London, UK (LINX)
    - Amsterdam, the Netherlands (AMS-IX)
    - Tokyo, Japan (Equinix)
- Many data sources on every continent – the **world's largest and most complete view of the Internet** from strategically chosen networks and locations worldwide