On the shape of the Internet ... and it's future?

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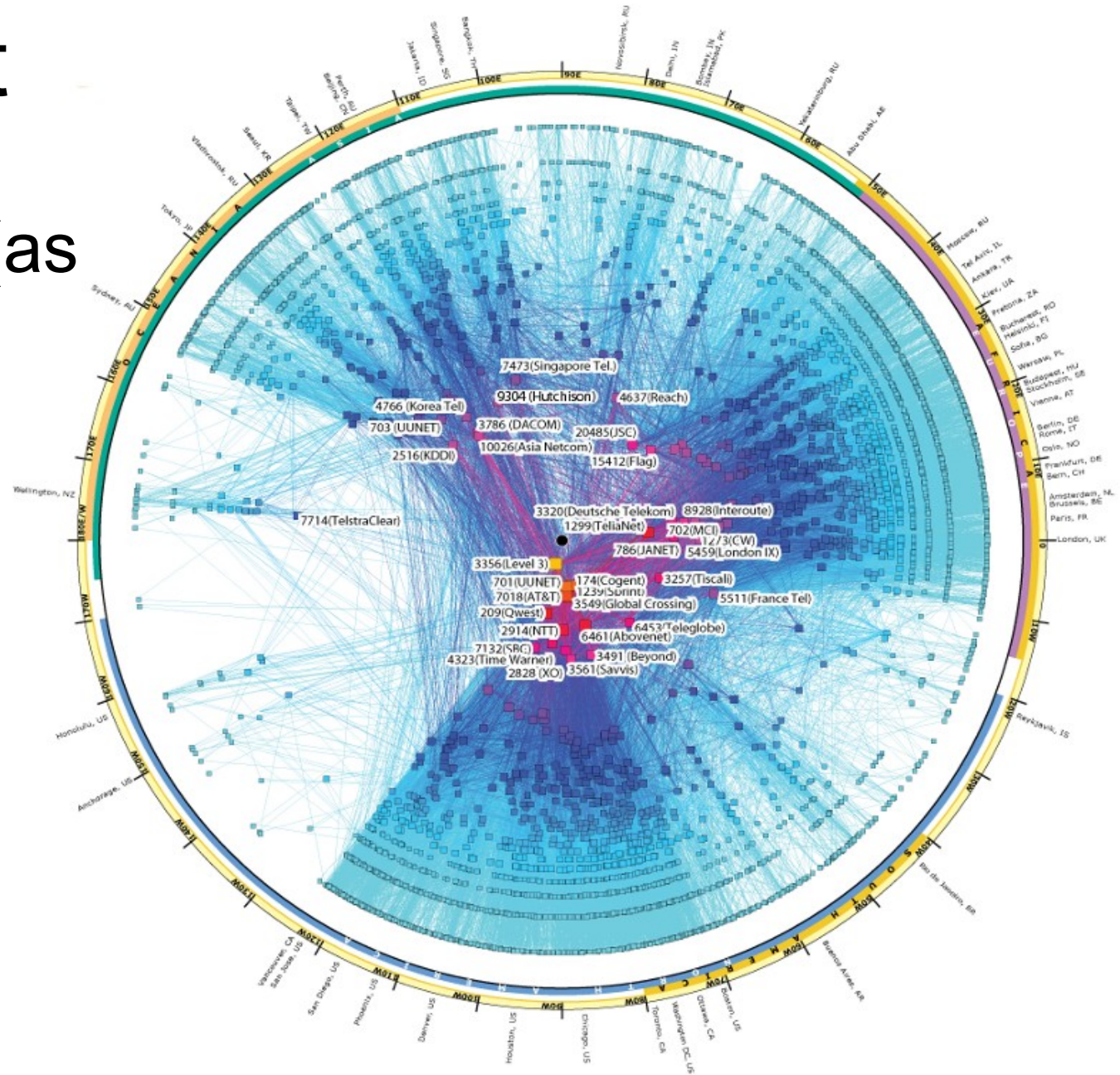
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The Problem

How to achieve scalable routing over
the Internet graph

The Internet

"The Internet... is big. Really big. You just won't believe how vastly, hugely, mind-bogglingly big it is."
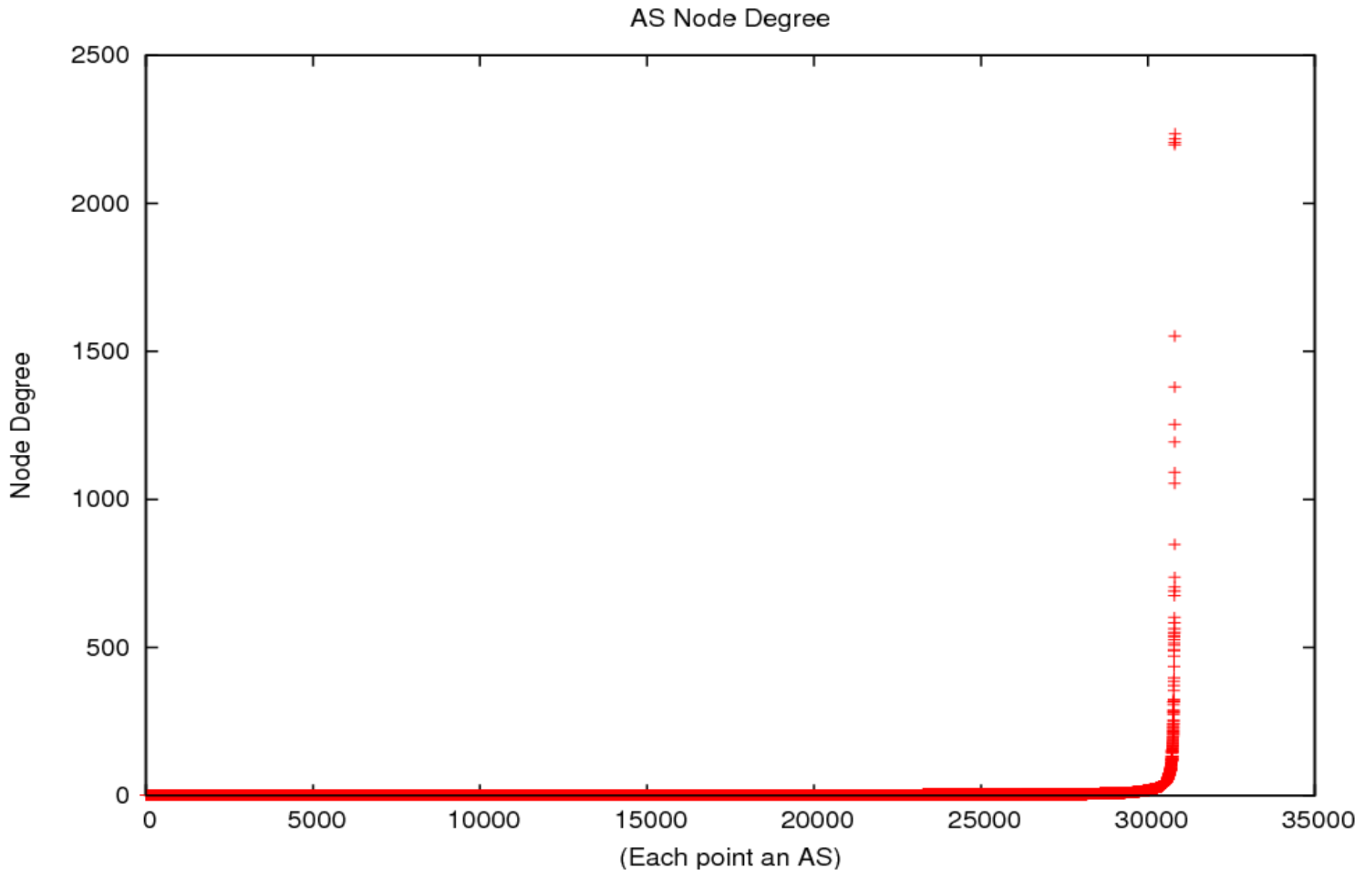
The Internet

- 31,099 ASes (as of yesterday)

- Image: CAIDA
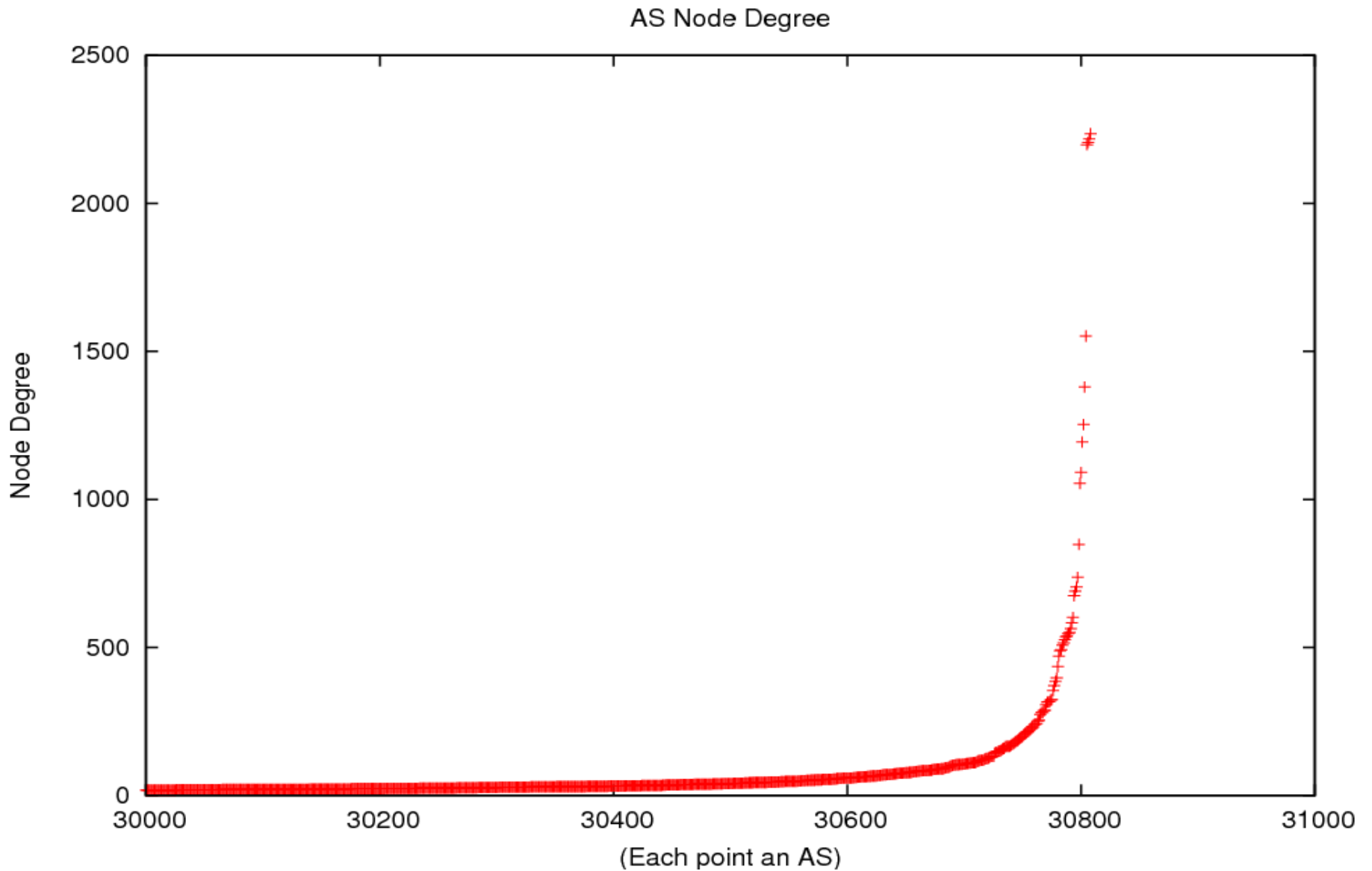
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The Internet

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The Internet

AS Node Degree

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The Internet

AS Node Degree

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The Internet

- There is no (easily definable) core
- Scale-free network (power-law deg. distribution)
- Other factoids:
  - Average AS path length decreasing
  - Average size of address block decreasing
  - Number of CIDR blocks advertised increasing

Why is any of this relevant?

- The Internet must change, in some fundamental way, in the near-ish future

  - IPv4 address exhaustion (3 -- 6(?) years)

  - Concerns on routing table scalability

    - (That's another, longer talk)

Why is any of this relevant?

- Ipv6 is the fix, right?
    - Not quite ... the routing architecture is the same

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Why is any of this relevant?

- In designing a future Internet, how does it scale?

    - We have a pretty good idea of business relationships on the Internet today, from looking at AS relationships

- How to perform good routing with tables that scale well on a graph of this type?

Why is any of this relevant?

- Hierarchical address assignment

  - *Requires* path lengths to increase rapidly with network size (Kleinrock & Kamoun, 1977)

- Clustering algorithms?

  - Compact routing? Often requires total knowledge of the graph to assign names (see: Krioukov & Fall, SIGCOMM 2004)

- Flat routing?

  - Probably do-able on IPv4. But on a larger address space?

Why is any of this relevant?

- But a new architecture requires an analysis of state placement for its chosen addressing scheme

In Conclusion

This is pretty difficult, and nobody has a really good solution yet...

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Questions?

- Answers?

References

- draft-zhang-evolution-01
- RFC4984 for an overview of the problem
- CAIDA, for visualsations and datasets
- Routeviews, for BGP collections
- IRTF RRG