Death of the Internet Predicted!

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Purpose of this talk...

- Probably more questions than answers here...

- This is a high-level, question-generating talk, intended to highlight problems usually swept under the carpet...

    - "Somebody else's problem" may soon be everybody's problem if issues are not addressed
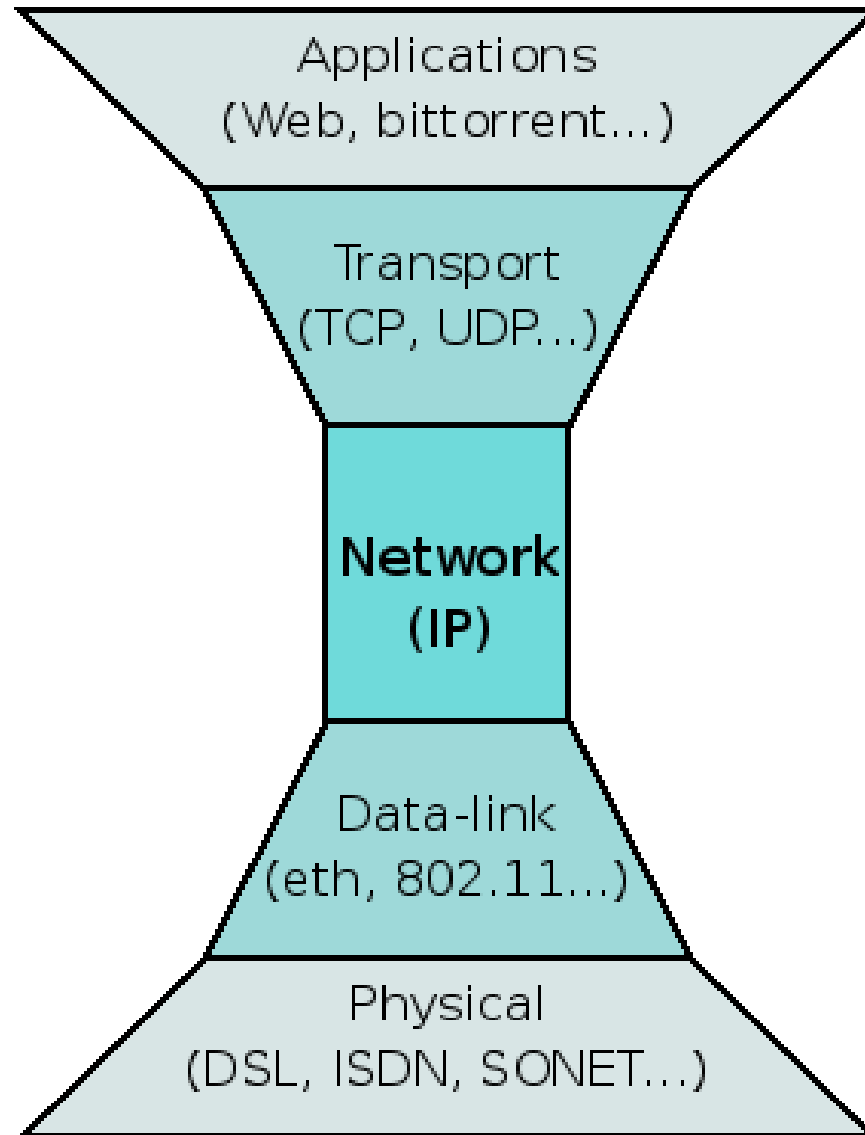
Outline...

- The existing internet architecture

- Issues facing the internet today

- Potential solutions

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The Current Internet Architecture

Applications
(Web, bittorrent...)

Transport
(TCP, UDP...)

Network
(IP)

Data-link
(eth, 802.11...)

Physical
(DSL, ISDN, SONET...)

The Current Internet Architecture

- IPv4 & Classless Inter-Domain Routing (CIDR)
  - IPv4 provides a 32-bit address space offering ~4billion addresses
    - Actually ~3.7 billion: reserved blocks, multicast...
  - CIDR provides variable-length network prefixes and address aggregation
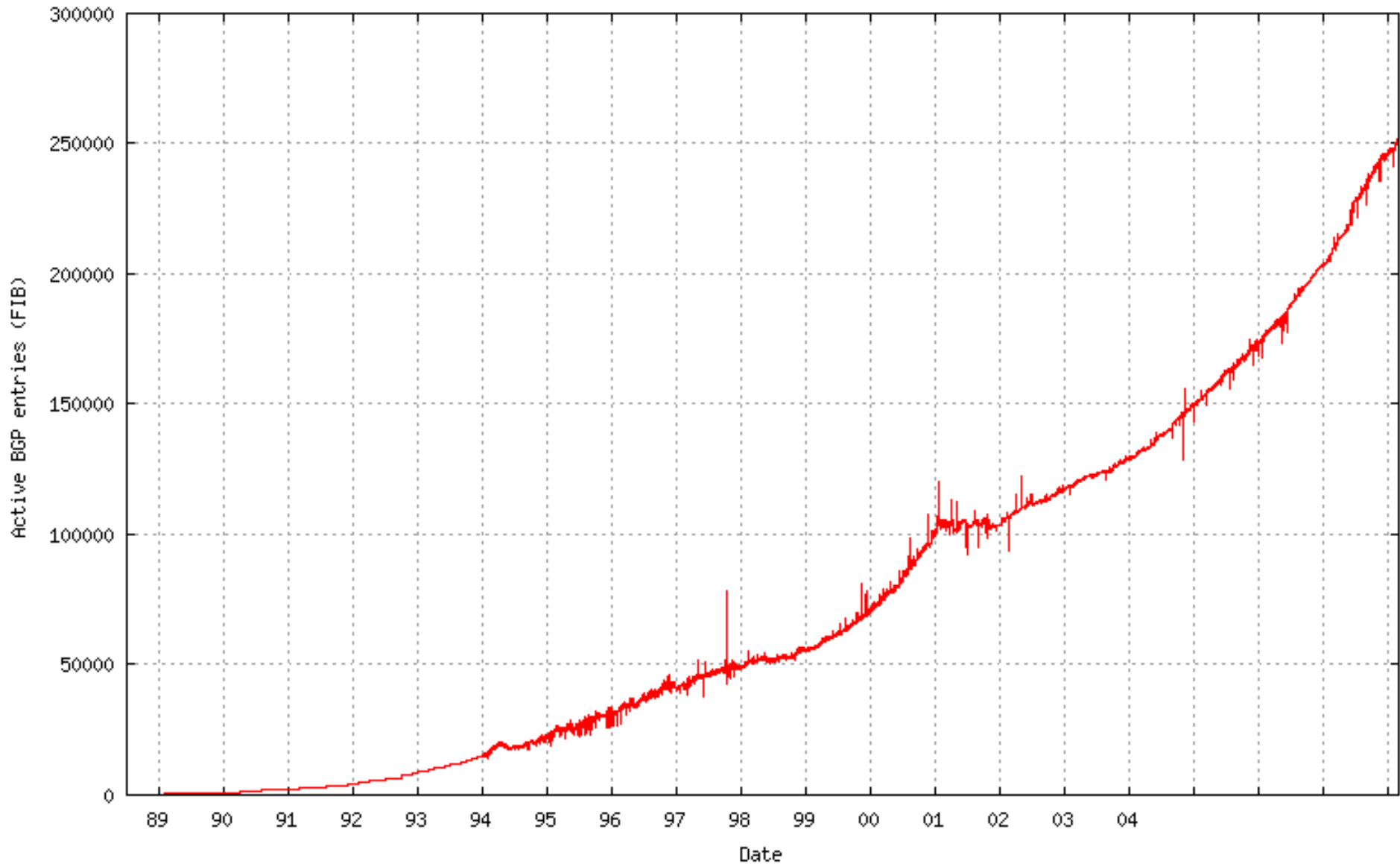
The Current Internet Architecture

- Autonomous Systems
  - Coordinate with BGP
    - Path vector
- Dense mesh of nets in middle
- Aggregatable tree-like structure toward edges
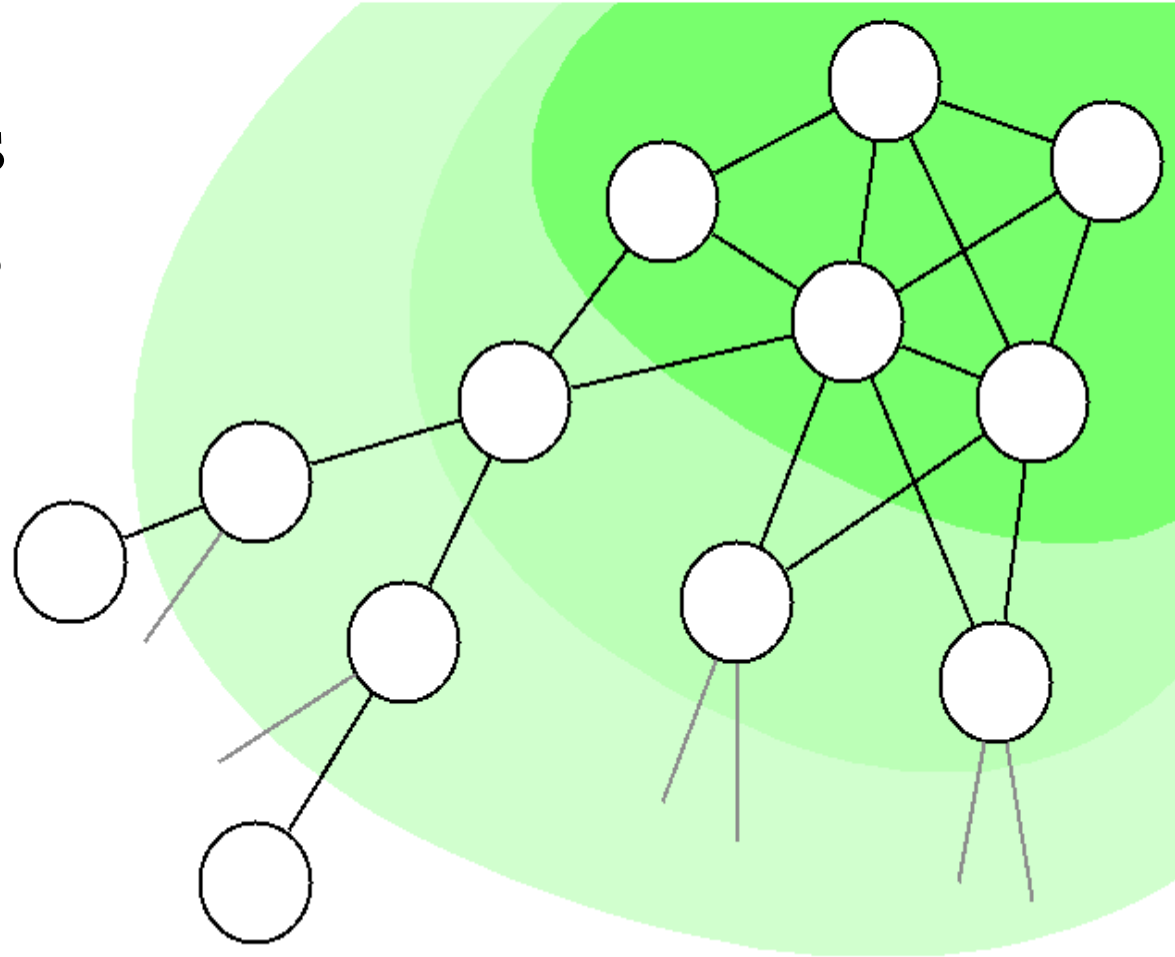
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BGP Scalability: FIB size in DFZ

BGP Scalability: Multihoming

- Why?
  - Gain in reliability
    - Two connections is better than one...

BGP Scalability: Multihoming

- Why?

  - Gain in reliability

    - Two connections is better than one...

- How?

  - Provider independent (PI) addresses

BGP Scalability: Multihoming

- PI address space is more prevalent than we'd like
    - It doesn't aggregate!
    - 59% of address allocations by RIPE over 2005/2006 were PI addresses...
        - But BGP and CIDR attempt to solve scalability issues with aggregation derived from hierarchically-defined addressing!
    - Customers want to retain IP addresses on move
        - Don't want to renumber when changing ISP
        - Don't want to be shoehorned into a technical design decision...

BGP Scalability: Trends

BGP Scalability: Trends

- Average AS-hop distance constant pretty much
  - Aggregatability works if the number of hops from source to destination increases with the network
   - Number of nodes on network continually increasing...

BGP Scalability: Trends

- Average length of advertised prefix is increasing
  - Many advertisements are for small networks
  - Average prefix length is ~/19
    - Advertised ASes are getting smaller
- Why?
  - NAT?
    - Bigger networks buying smaller blocks
  - Traffic engineering: more specific advertisements punch policy holes through existing aggregates for load balancing, policy agreements

BGP Scalability: Trends

- Key point:
  - Even if the network was not growing, BGP tables would increase in size

- BGP tables *could* be smaller... plenty of the entries could be aggregated
  - But we're always going to have bad management of data...

IPv4 Address Exhaustion
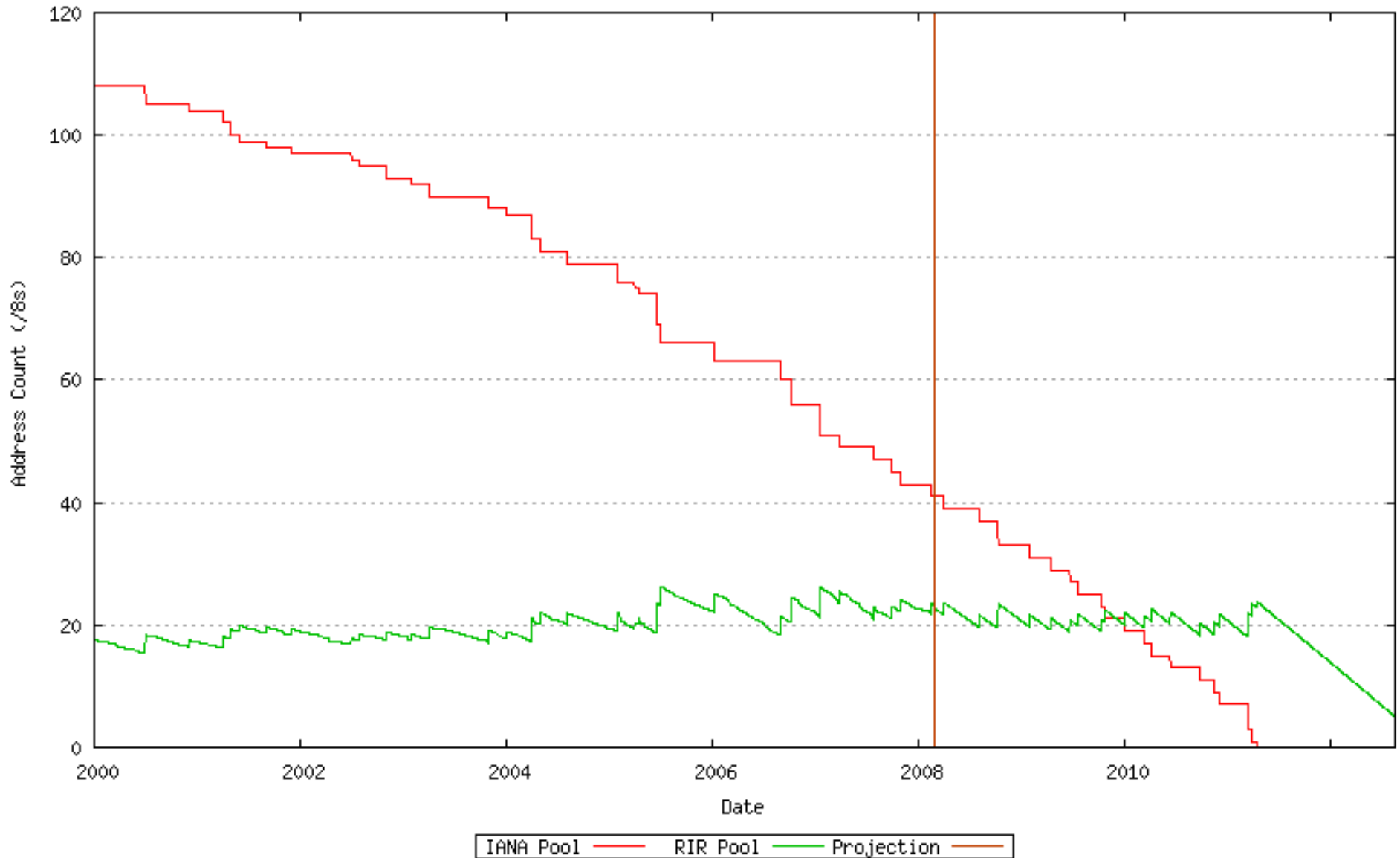
IPv4 Address Exhaustion

- IANA Unallocated Address Pool Exhaustion
  - 10-Apr-2011
- RIR Unallocated Address Pool Exhaustion
  - 13-Aug-2012

  - *Many* assumptions made in these predictions...

IPv4 Address Exhaustion

- IPv4 provides ~3.7 billion addresses

  - There are ~679M unallocated addresses

  - Of the ~3 billion addresses allocated, there are ~1.2 billion unadvertised...

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Fixes?

- Reclaim IPv4 address space?

    - Many organisations have *way* more space than they need.

    - Fragmentation is inevitable...

Fixes?

- IPv6

  - Provides the larger address space to solve the exhaustion problem...

  - But transition has been slow.

    - Size of IPv4 FIB: > 250,000

    - Size of IPv6 FIB: 1,104...

- IPv6 suffers from exactly the same scalability concerns as IPv4...

  - Aggregation *must* be enforced for it to work...

Fixes?

- Identifier/Locator split

    - The increased use of PI space for networks suggests that networks wish to have an identity they can take with them (much like mobile phone numbers)

- LISP: Locator/ID Separation Protocol (Cisco)

Fixes?

140.1.1.0

140.1.0.0

1.2.3.4

2.3.4.5

150.1.1.0

150.1.0.0

End-site

Transit

End-site
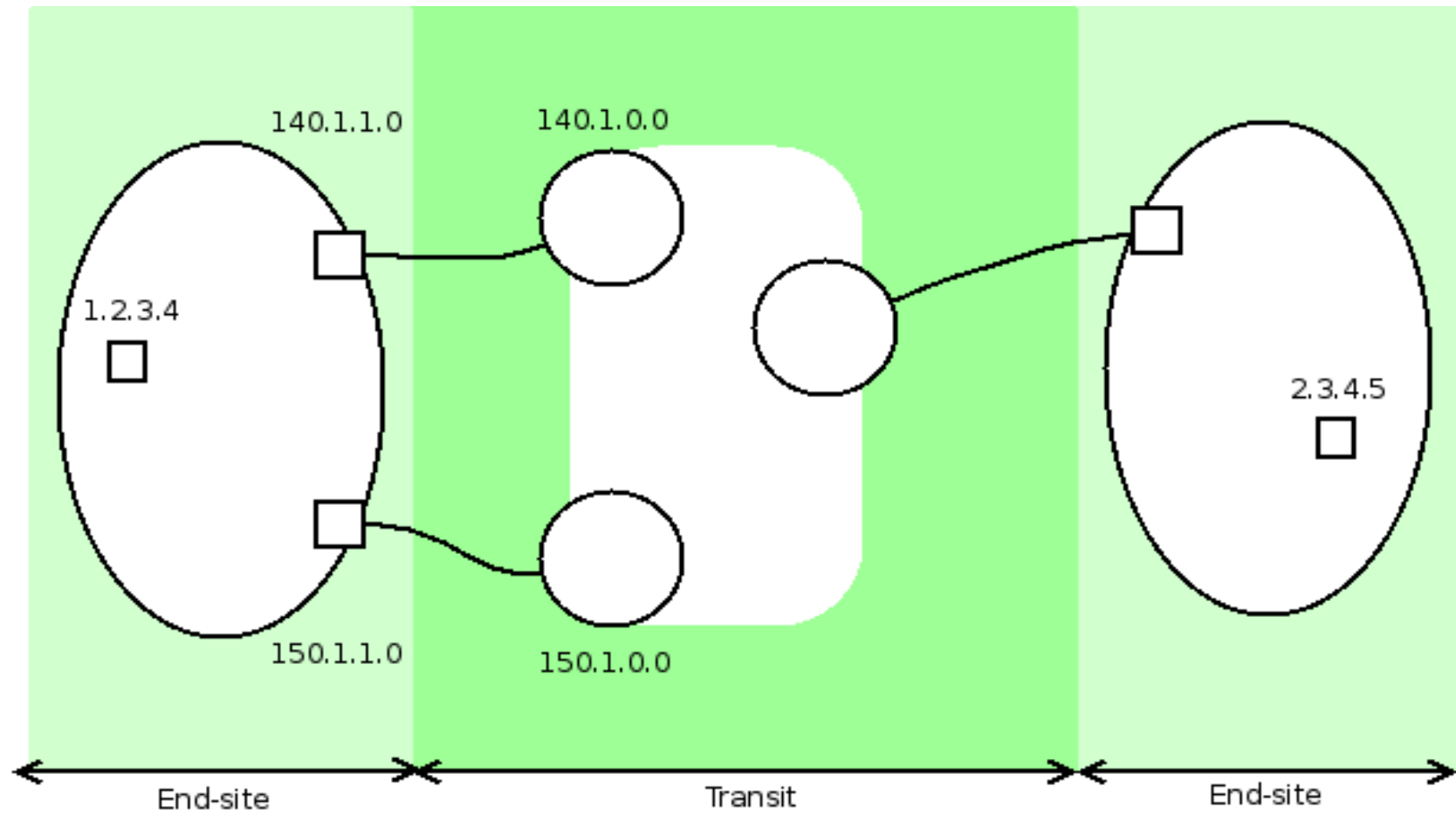
Fixes?

- LISP is considered a short-term fix!
  - NAT was considered by many to be a short-term kludge...

Fixes?

- New architecture?
  - Hierarchies in the IPv4 realm are shallow
  - The network is growing ever denser (peering)
    - For hierarchical routing to work, the distance between nodes must increase as the size of the network increases
    - If the average AS path length is essentially constant (around 3.5), then this is not the case...
  - Do we need a new routing mechanism in the core?
    - Hierarchical routing is the only contender *seriously* considered by the internet community

Fixes?

- Need a new routing algorithm in the core?
  - Lots of work on "compact routing"
  - Currently very theoretical, but refreshingly pessimistic with its claims
  - Would have to abandon shortest path routing
    - Is BGP shortest path?
    - No idea how policy affects compact routing
- Can a scalable routing algorithm even be designed, if policy is to be taken into consideration?

Conclusions...

- Okay, the world isn't ending, but...
    - "The Internet" is clearly not a solved problem
- There are short-term and long-term issues to be addressed:
    - Short:
        - Can we fix the address shortage problem?
        - Can we solve the scalability issues in the DFZ?
    - Long:
        - Can we build a system which is *provably* scalable?
        - Can we solve these problems in an *evolvable* manner?

Questions?

- And, some interesting places for more info:
    - http://bgp.potaroo.net/
    - http://ipv4.potaroo.net/
    - Analysing the Internet's BGP Routing Table, Huston
        - http://www.potaroo.net/papers/ipj/4-1-bgp.pdf
    - Locator/ID Separation Protocol (LISP)
        - http://www.ietf.org/internet-drafts/draft-farinacci-lisp-05.txt
    - "Why the Internet only Just Works", Handley
        - http://www.cs.ucl.ac.uk/staff/M.Handley/papers/
    - "On Compact Routing for the Internet", Krioukov, et al