

# The Routing Scalability Problem

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# Outline

- The scalability problem
- Solution directions
- Things to think about

# The Scalability Problem



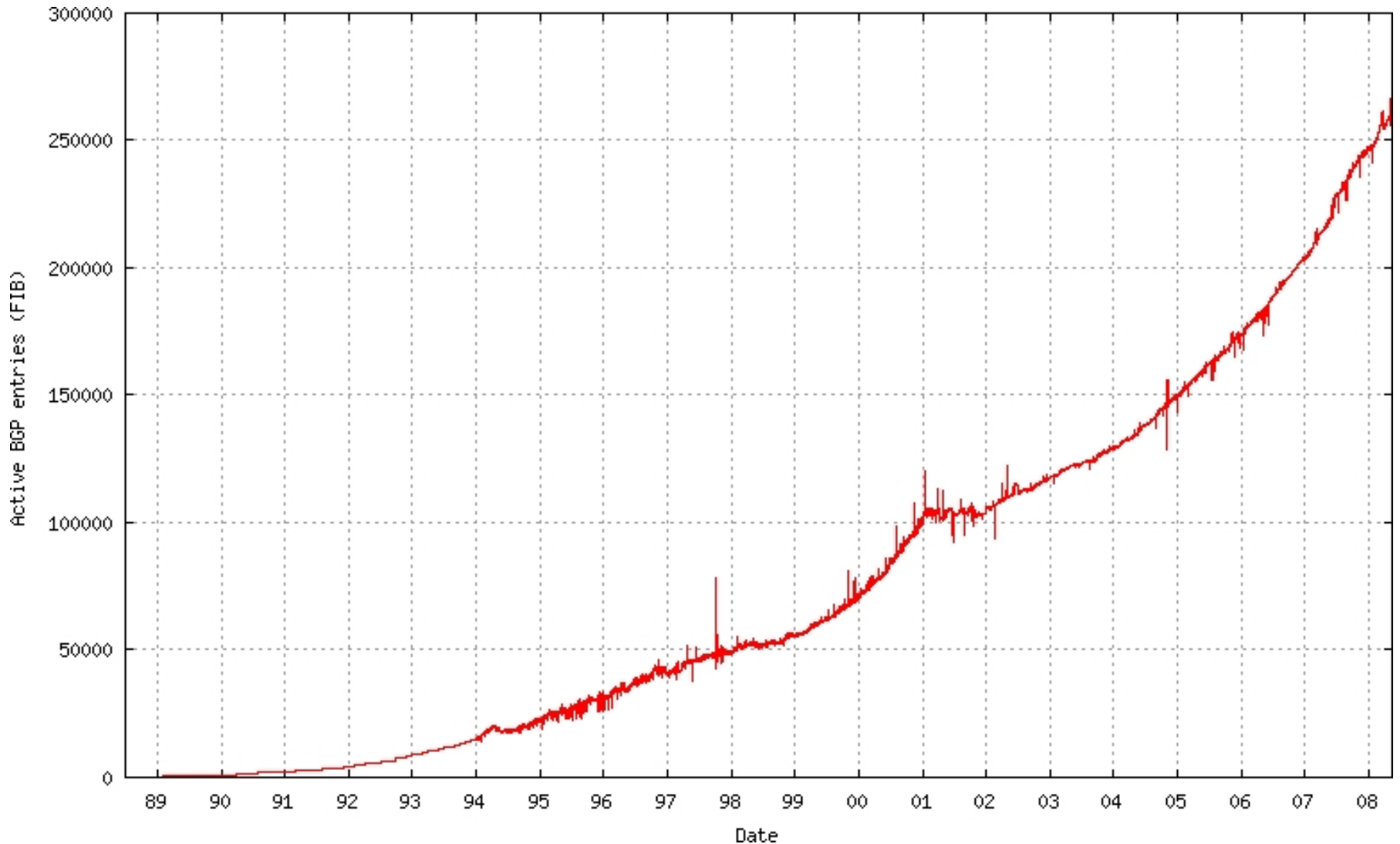
# The Routing Scaling Problem

- The ability of the Internet routing system to cope with the growth of the Internet has been a concern during almost the entire life of the Internet
- The routing and addressing architecture has stayed very similar from the initial days
  - BGP designed in the 1980's
  - CIDR introduced in the 1990's
  - IPv6 designed in the 1990's
- Recent concern from major operators about the growth of the routing problem beyond
  - The growth of the Internet itself
  - Moore's law

# Pressures Facing the Routing System

- Organizations want independence from providers
  - Due to competition, there is a desire to be able to switch providers
  - "Provider Independent" address space
- IPv6
  - Need both IPv4 and IPv6 tables
- Multihoming, traffic engineering
- Errors, fraud

# Measurements – Prefix Growth

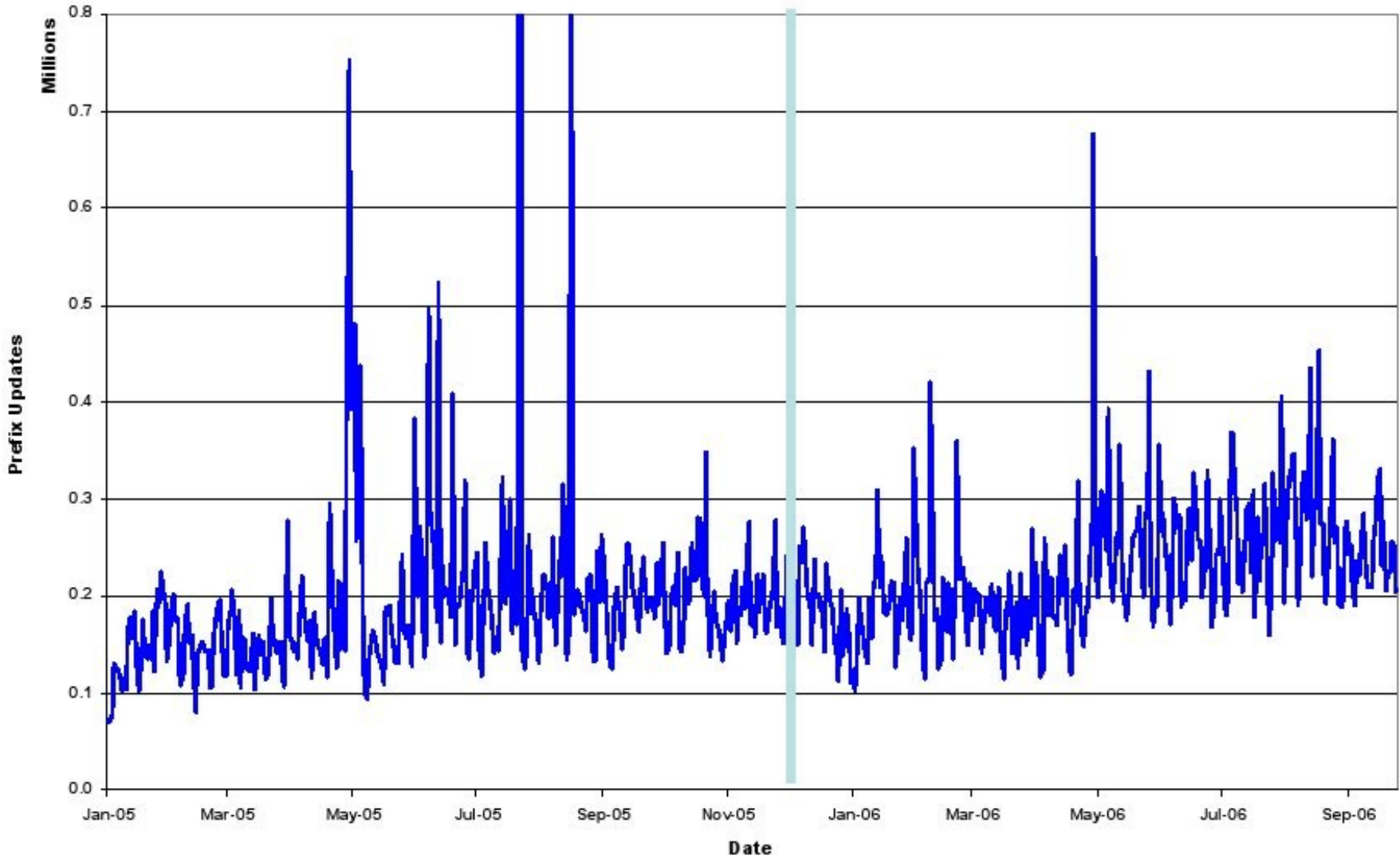


→ Source: Geoff Huston

# Table Size – Main Observations

- Table sizes grow 2x faster than real growth
- One (conservative) analysis predicts 2M entries in 10 years

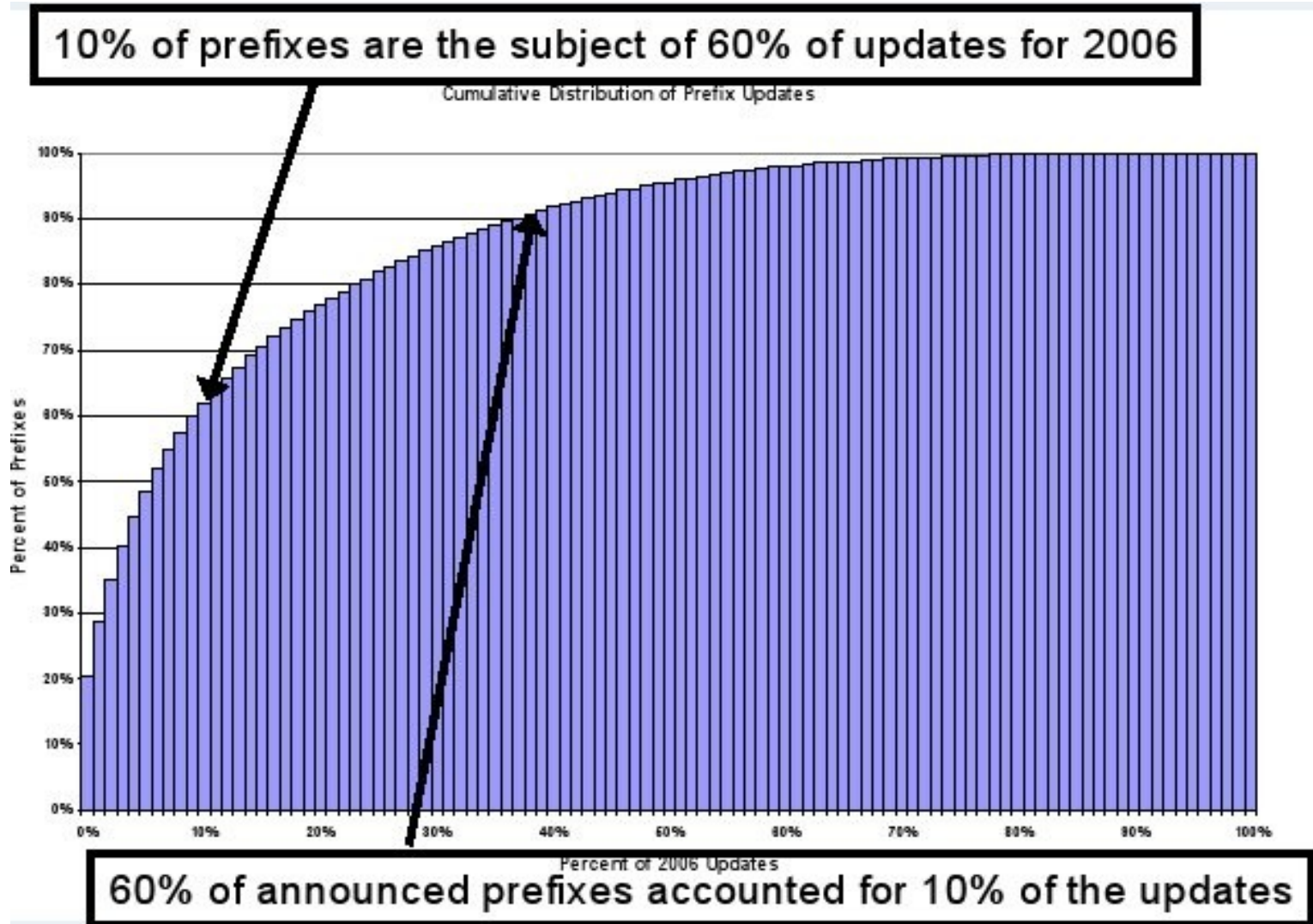
# Measurements – BGP Updates



→ Source: Geoff Huston at IAB RAWS Workshop, 2006



# Distribution of Updates



# Updates – Main Observations

- Most of the net is very stable
- Parts of the net are very unstable
- Everybody pays for the instability
- Problem is getting worse
- Main reasons why the sources are updating:
  - Traffic engineering
  - Unstable configurations
  - New routing applications
  - Address space theft

# Architectural Issue

Architectural principle to uphold:

- A network should be able to implement reasonable internetworking choices without unduly impacting another network's operation

The issue, at an architectural level:

- Some of today's internetworking seem only implementable in ways that threaten this principle.

# How Serious Is This?

- Concern: the growth exceeds what Moore's law can provide for routers
  - Forwarding, routing protocol computations, routing protocol communications, ...
- Power usage, cost, functionality, investment lifecycle will suffer if this is the case
- However, there is reason for optimism
- Forwarding is a small factor in router power usage (power = line speed X per-packet actions)
- Latest routers use parallelism and new memories

# How Serious Is This? (Cont'd)

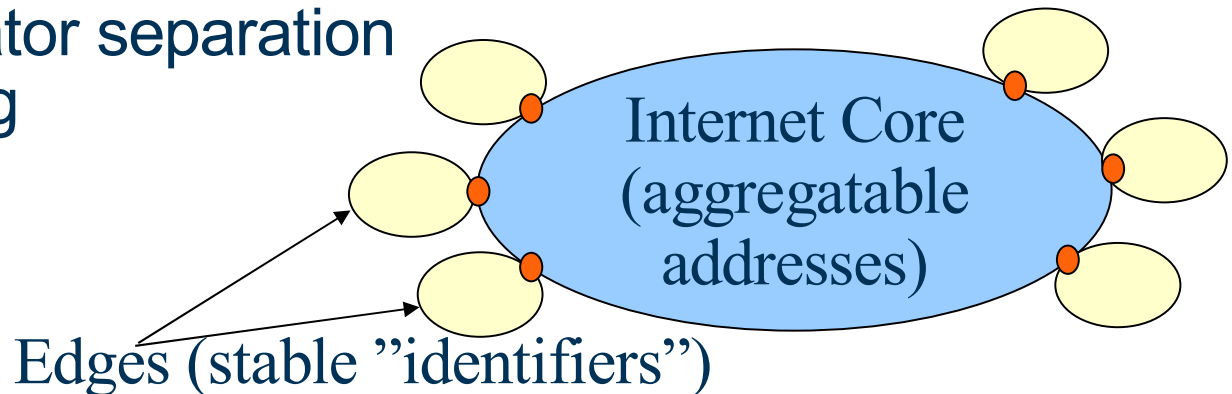
- Punchline: The routing system is not about to fall over; lots of runway
- But the long-term trend is wrong; if we want to change this, the time to start working is now
- And we need an Internet which can scale to hundreds of billions of end hosts and (at least) millions of multihomed, provider independent networks

# Solution Directions



# What Can We Do?

- Faster routers – Engineering by microelectronics and router designers
- Update dynamics - BGP adjustments, better operational practices
- Bigger networks, traffic engineering, multihoming, e2e transparency, and mobility would benefit from architectural changes
  - Identifier/locator separation is a promising approach



# Things to Think About

(while working on architectural changes)





# Some of the Hard Parts...

## Issues with architectural changes:

- Incrementally deployable
  - Connectivity to the "old" Internet
- Part of the reason for the current situation is lack of a "routing economy" and pushback for new entries
  - Will any new technology change that?
  - Incentives for deployment
  - Convincing people to behave differently, even when they have existing tools

# Hard Parts (Cont'd)

- What are the costs (security, complexity, ...)?
  - Are there negative effects to other parts of the Internet?
- What other implications are there?
- Ability to pass addresses in applications
- Caching behaviour
  - Delaying or losing first packets to a site
  - DoS vulnerabilities

# Ongoing Work

- Routing research group (RRG) at the IRTF
- GROW and IDR Wgs
- Possible BOF at the next IETF
- Various research projects

# Summary



# Summary

- In the short term, this is "only" an engineering issue
- But there are architectural problems that should be addressed
- Ongoing work in the IRTF – but many problems remain
- Key issues are deployment incentives and not breaking others parts of the Internet while saving routers



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