RIPE/RIS Project BGP Analysis CIDR at Work

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BGP is not perfect!

- Too many catastrophies

  - often due to misconfiguration and bugs

- Known convergence problems

  - up to 30 minutes

- Questionable scaling properties

  - linear?, quadratic?, exponential?, *hyper–exponential?*

- *Understanding BGP's operation is crucial to getting the solution right*

Why care about growth?

- Linear or quadratic growth

  - need to add more memory/cpu power once in a while

- Exponential but slower than Moore's law

  - we can still cope with this, but gets expensive

- Faster than Moore's law

  - next generation hardware costs more

  - need a new EGP, fast!

    - no time to understand all the issues...

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RIPE / RIS Project

- **Massive BGP data collection project**

  - At 7 locations, oldest since September 1999

- **Every single BGP message, state change**

  - in mrt format, using zebra software

  - our analysis uses mrtlib from Merit

- **We use rrc00 at RIPE NCC**

  - peering 13 routers now

  - peered 22 routers over the course of its operation

- **We are extremely grateful to RIPE/RIS project for their efforts and making the data available.**

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BGP Messages vs Snapshots

- We want to understand BGP's operation, not just routing table growth

  - routing table growth

  - churn

  - convergence

  - volatility

- Snapshots are not nearly as powerful even for routing table growth

  - e.g. under–estimates multi–homing, AS topology

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Routing table size

- Total number of prefixes over all active peers

    - not the average routing table size

    - each routing table has prefixes the others dont

- Growth

    - Very slow growth this year

    - Can the growth rates of the past resurface?
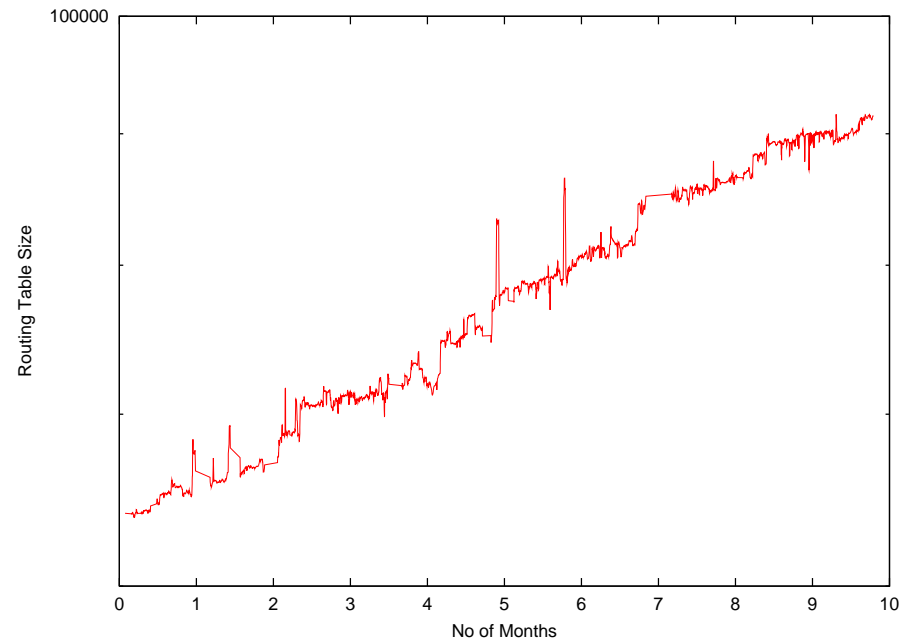
Routing table growth
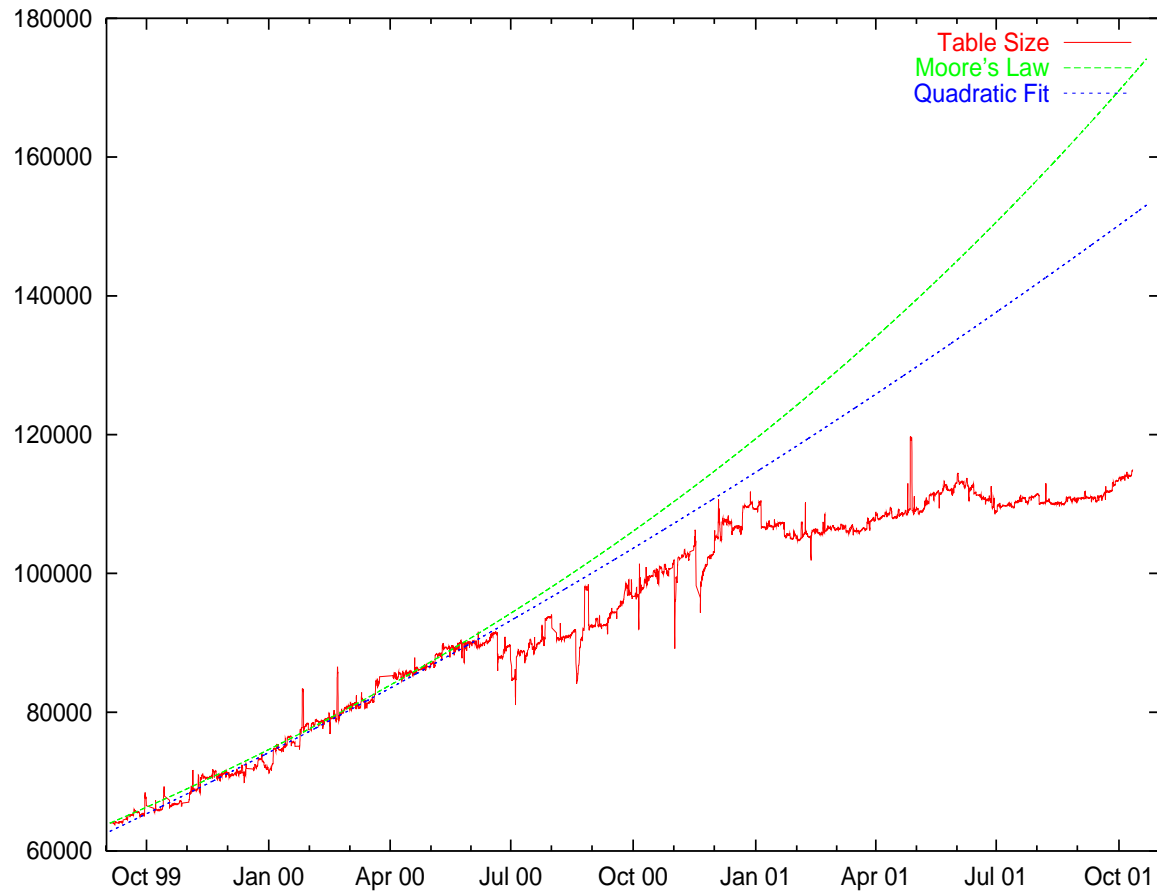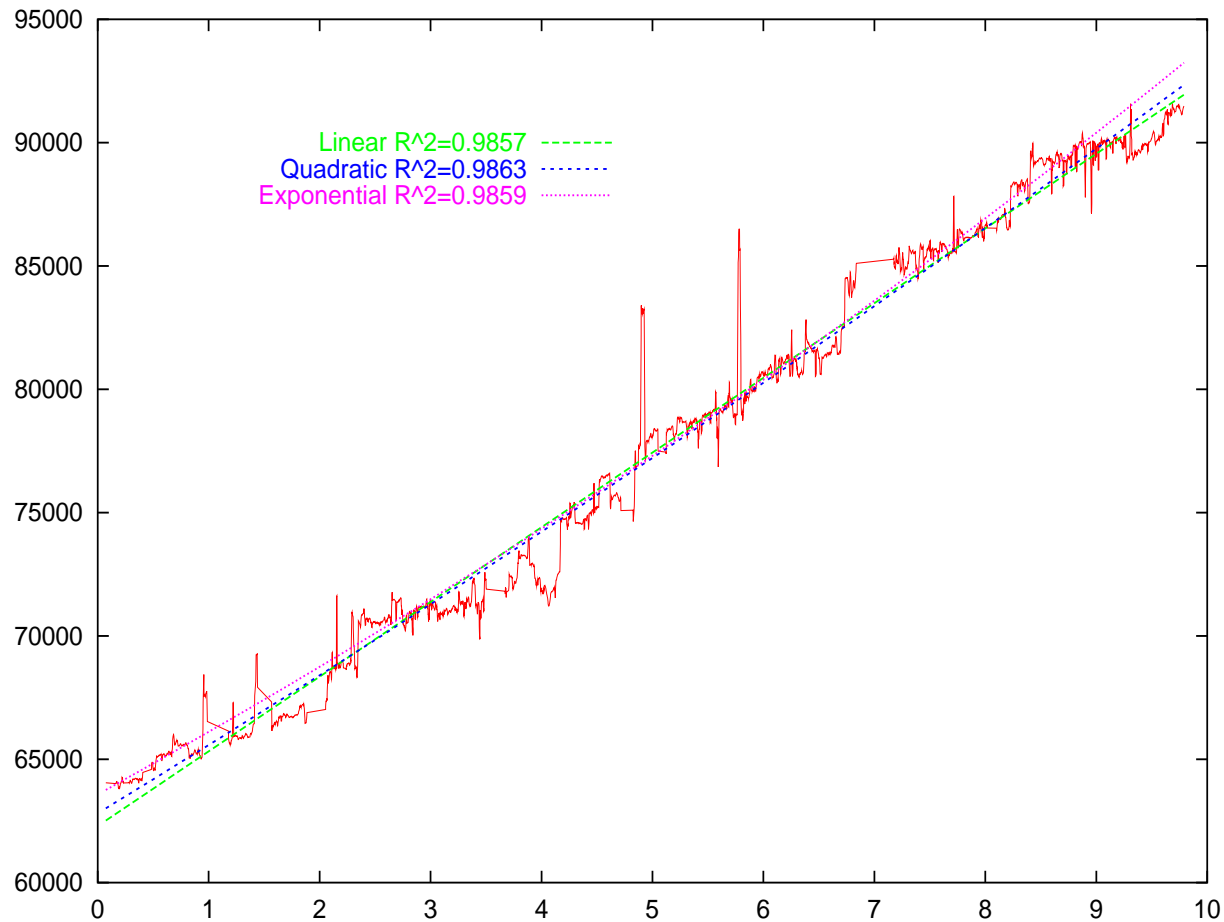

- Smoothed w/ moving average of 5 data points

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First Ten Months
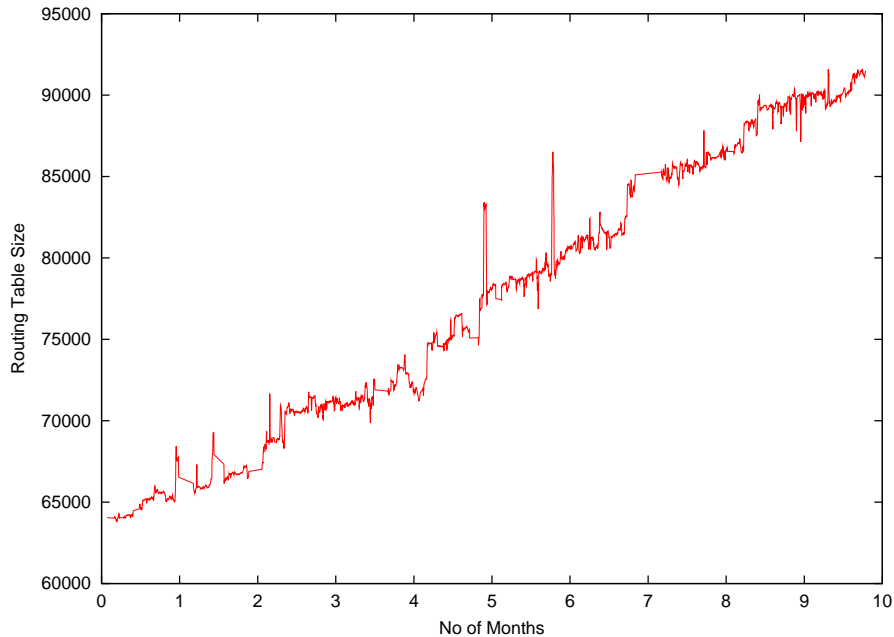
Linear y axis scale

Log y axis scale

- Polynomials and exponentials can look alike
  - depending on coefficients, constants and the x axis range

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The Fit

Legend in chart:
- Linear R^2=0.9857
- Quadratic R^2=0.9863
- Exponential R^2=0.9859

- Linear, quadratic, exponential all fit well
  - thru residual analysis methods

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Under differencing


local fit (lowess)
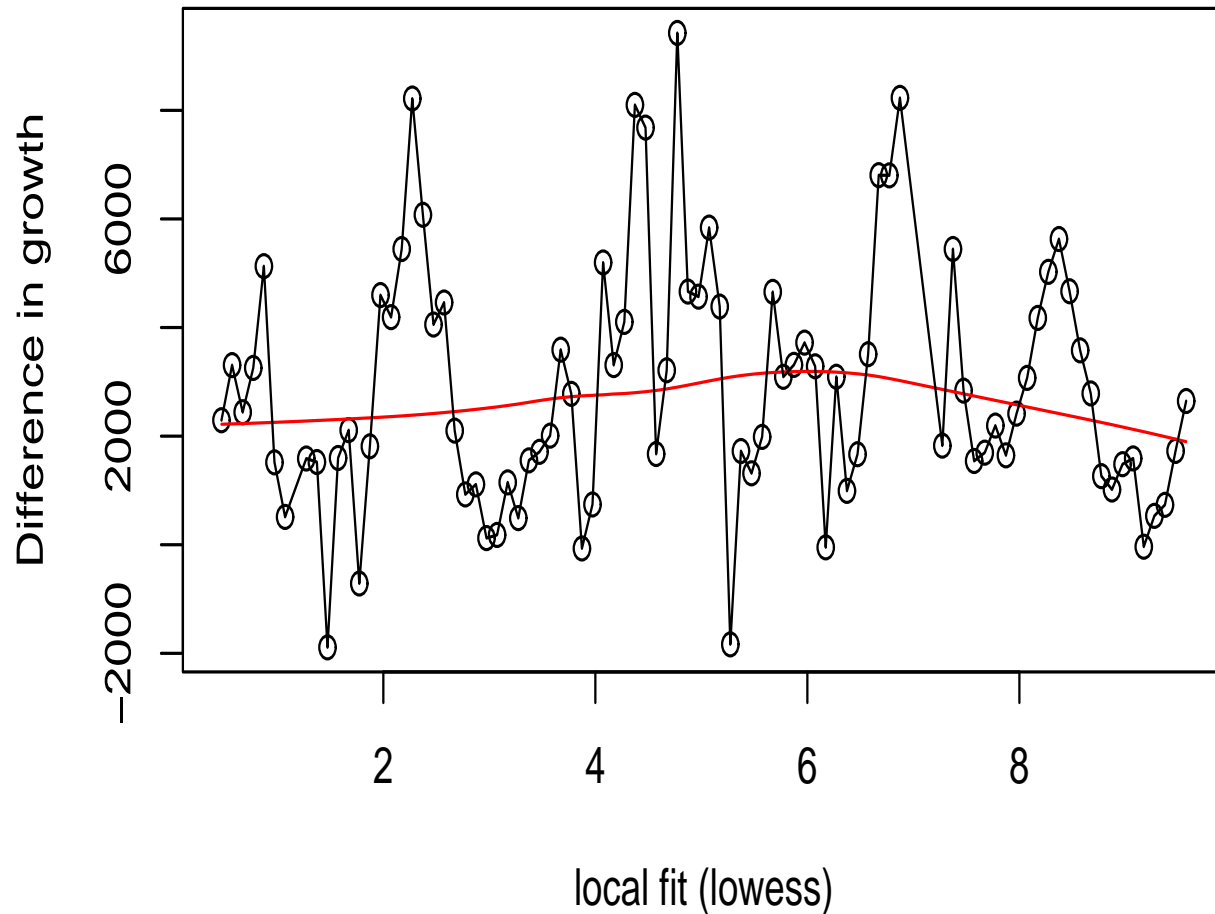
- Local trend analysis shows no evidence of an exponential

CIDR at work

- How effective is CIDR in presence of
    - multi–homing
    - inter–domain traffic engineering

- Historic prefixes
    - Prefixes that were used to be advertised
        - CIDR
        - ISPs leaking their more specifics => CIDR
        - Private address space (fixed number)
        - Un–assigned address space (spammers)

CIDR is working very well
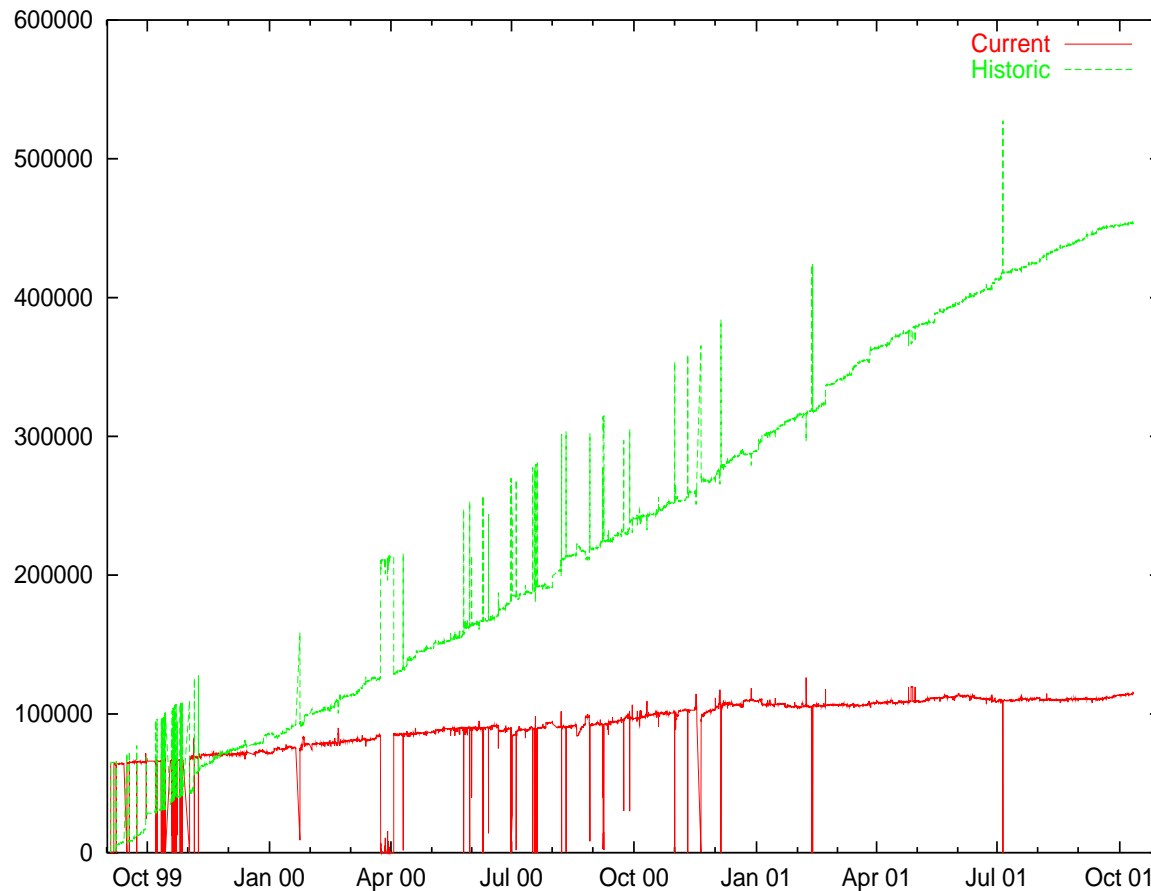
- Without CIDR routing table would have been ~5 times larger

# The total growth
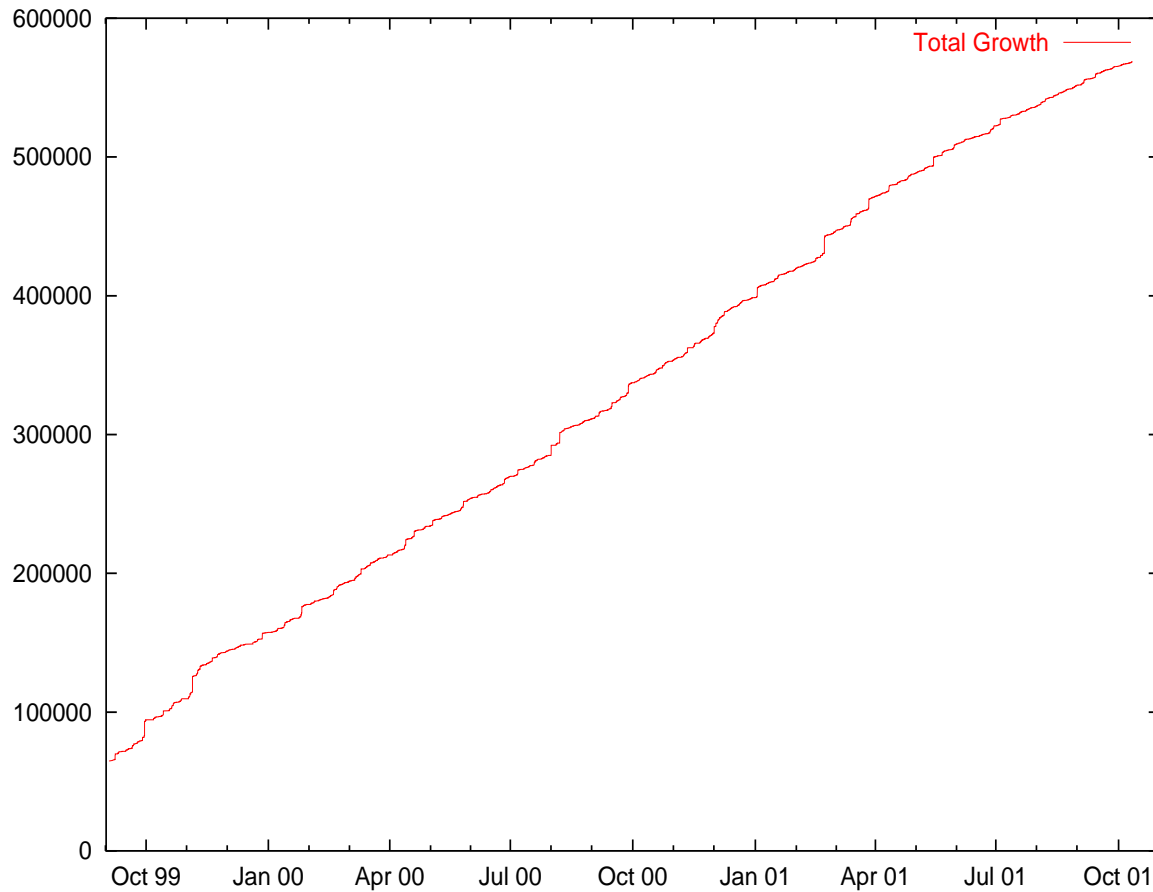
- Exponential does not fit

Where is the growth coming from?

- Classify a prefix into *one* of the following groups:
  - Multi Homing
    - with origin AS doing BGP w/ multiple ISPs
    - with multiple origin ASes
  - Engineered prefixes
    - prefixes and their components w/ the same origin AS
  - Punching holes
    - prefixes and their components w/ no common origin AS
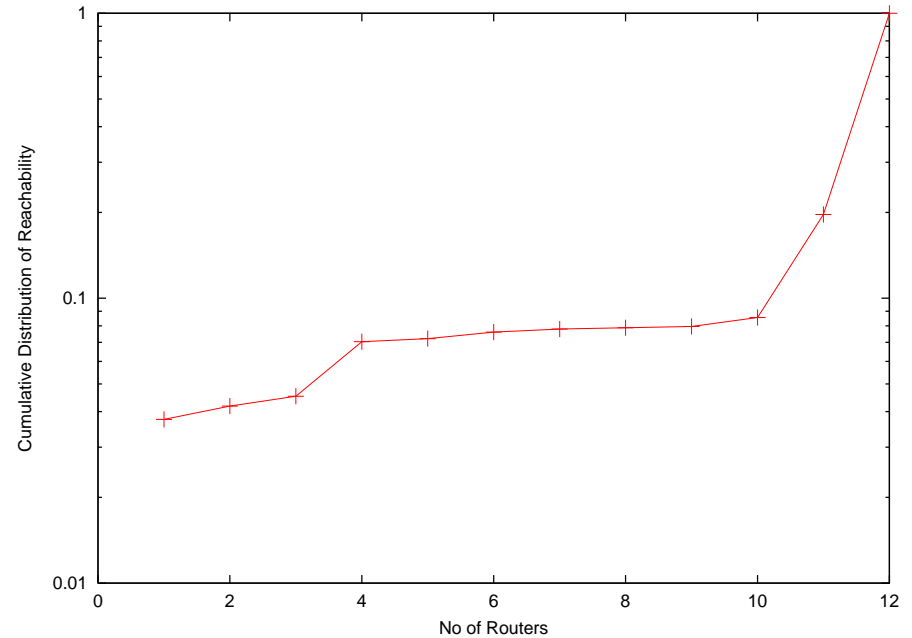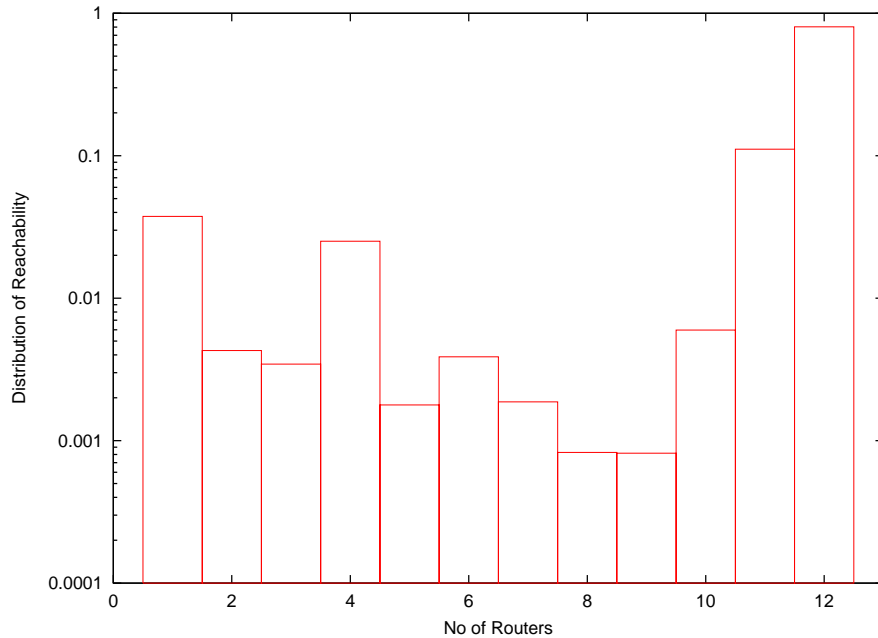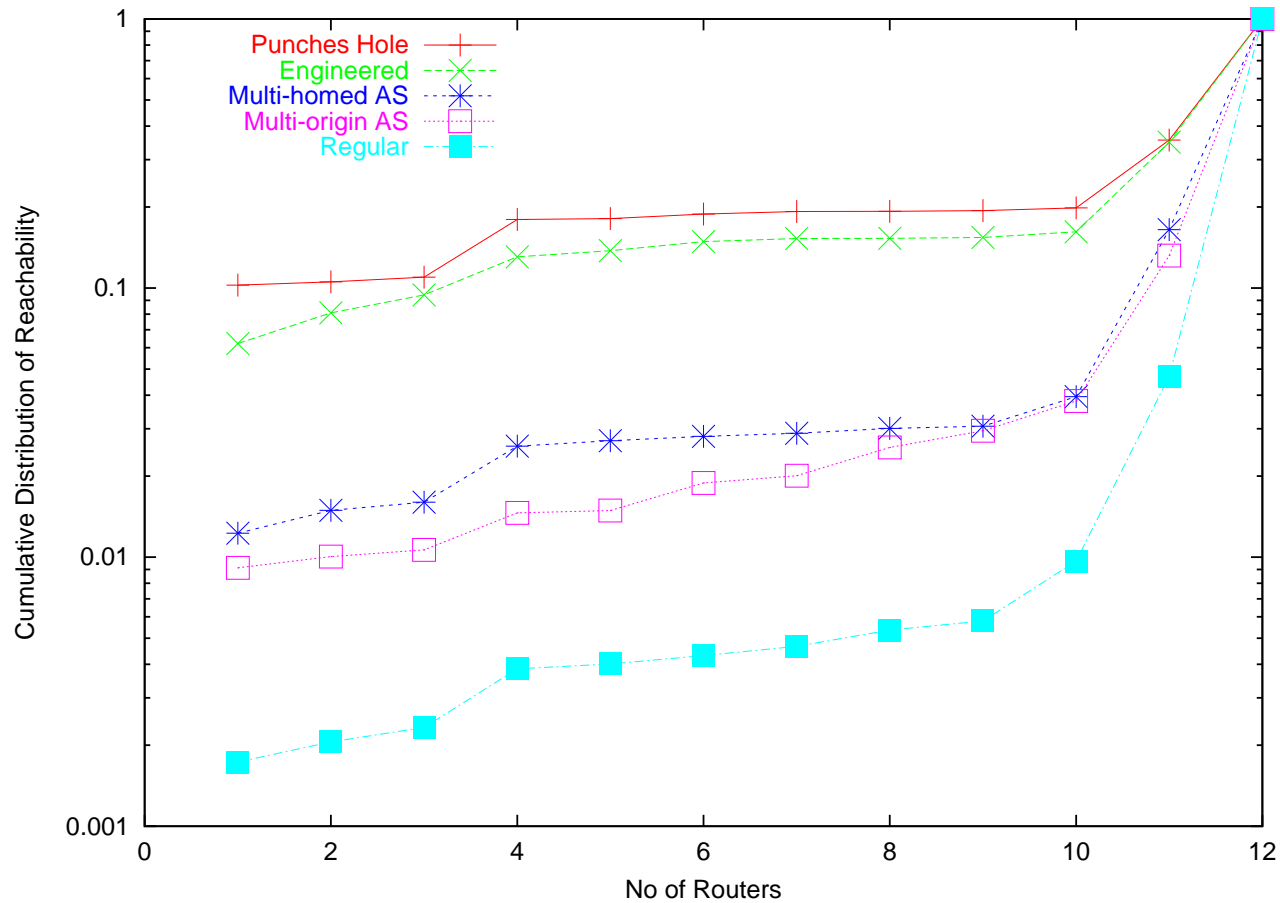   - perhaps some are multi–homed

Components of Growth

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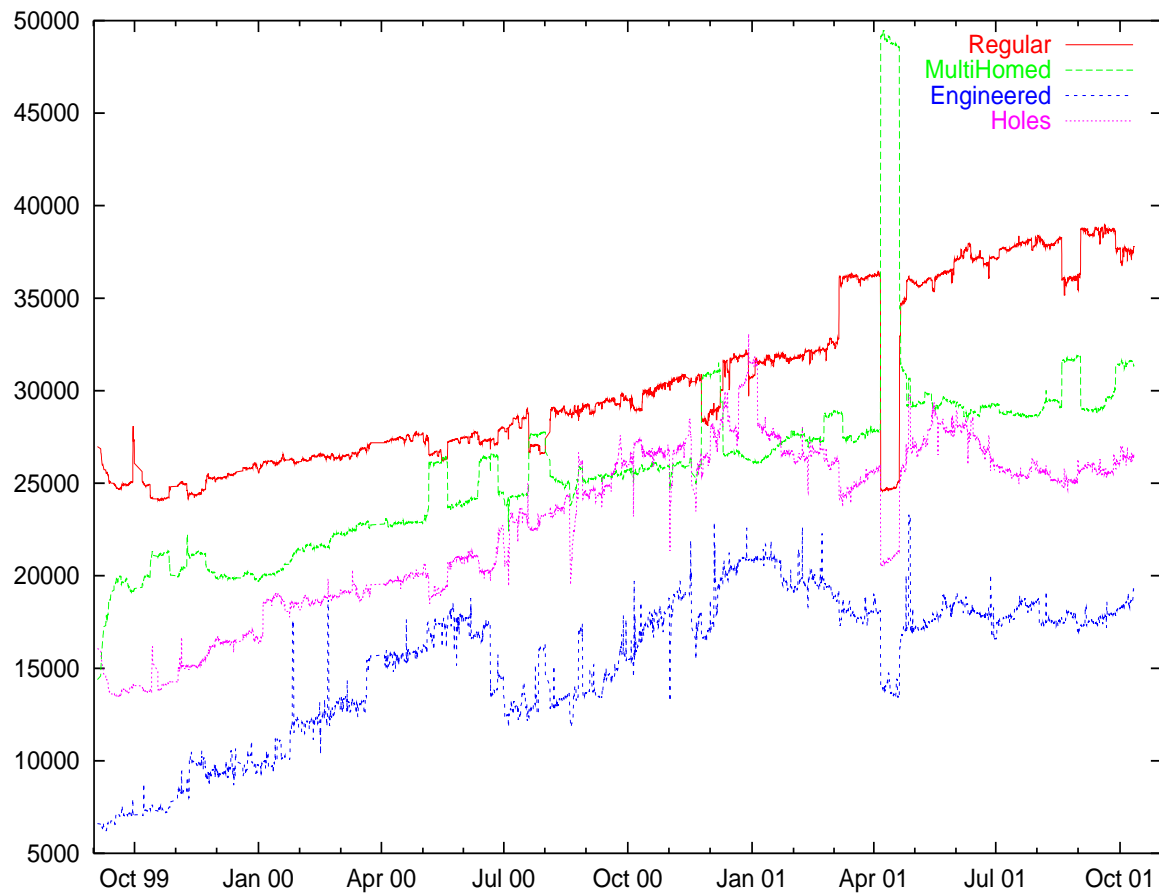
How do People Multi–Home?
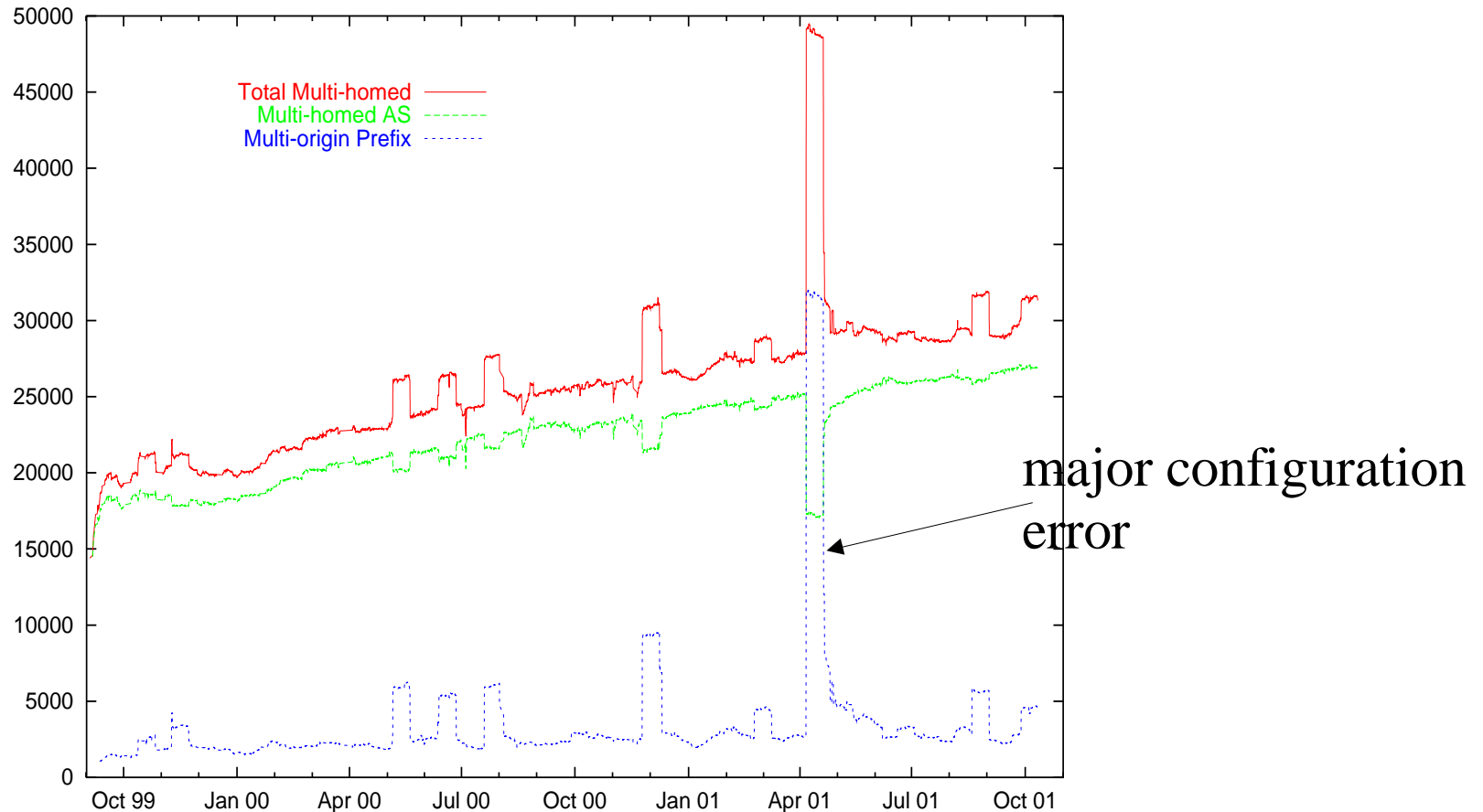
- Dominated by running BGP at the site

- Some do it through their ISP's BGP

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Prefix to Router Distribution

- Only 80% are seen by all 12 routers
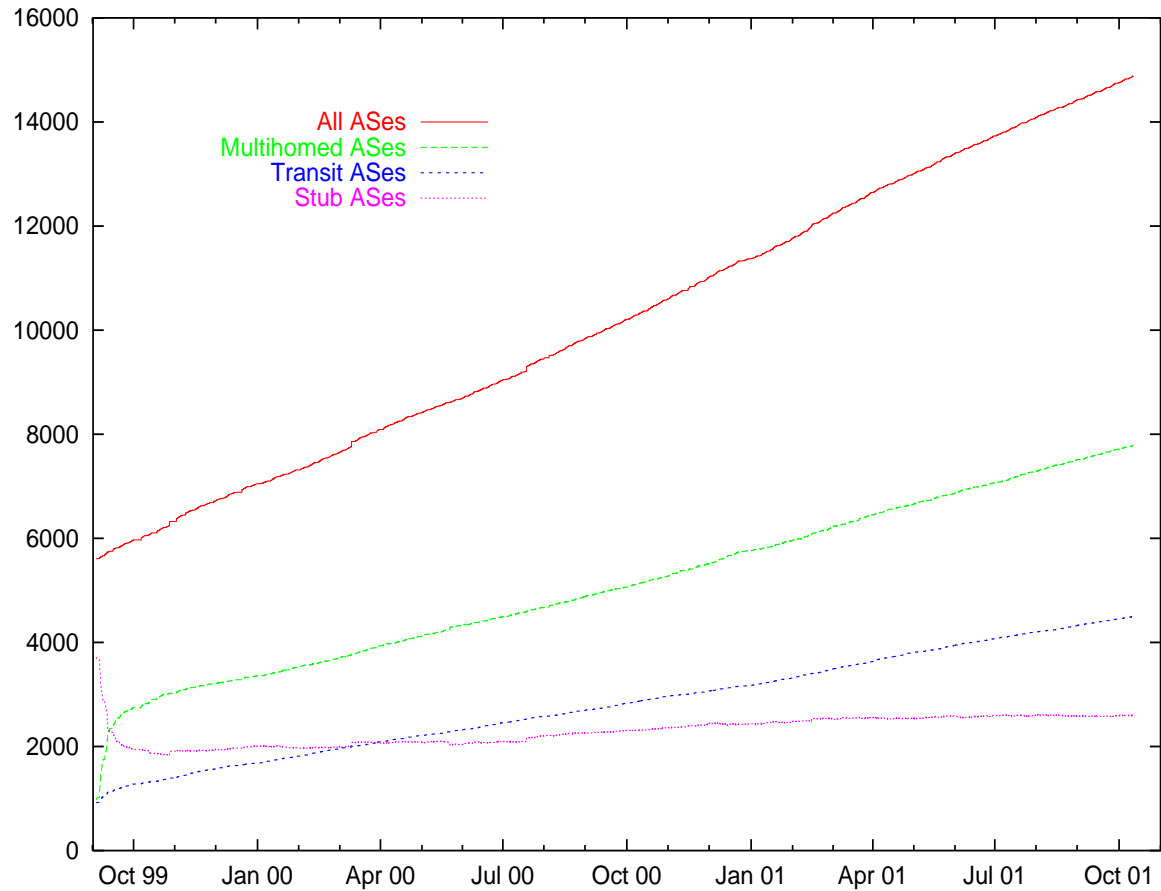 - If you take 2 ISPs, the number is much higher
- Caveat: using a snapshot only

Filtering and Routing Distribution

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Word on AS number growth

- We were told: exponentially growing

- If each of these ASes had 1 prefix, we would have seen exponential multi–homing growth...

AS Growth

- quadratic fits best: R^2=0.9996 (also by Tim Griffin)
- exponential fits very badly (residuals are not stationary)
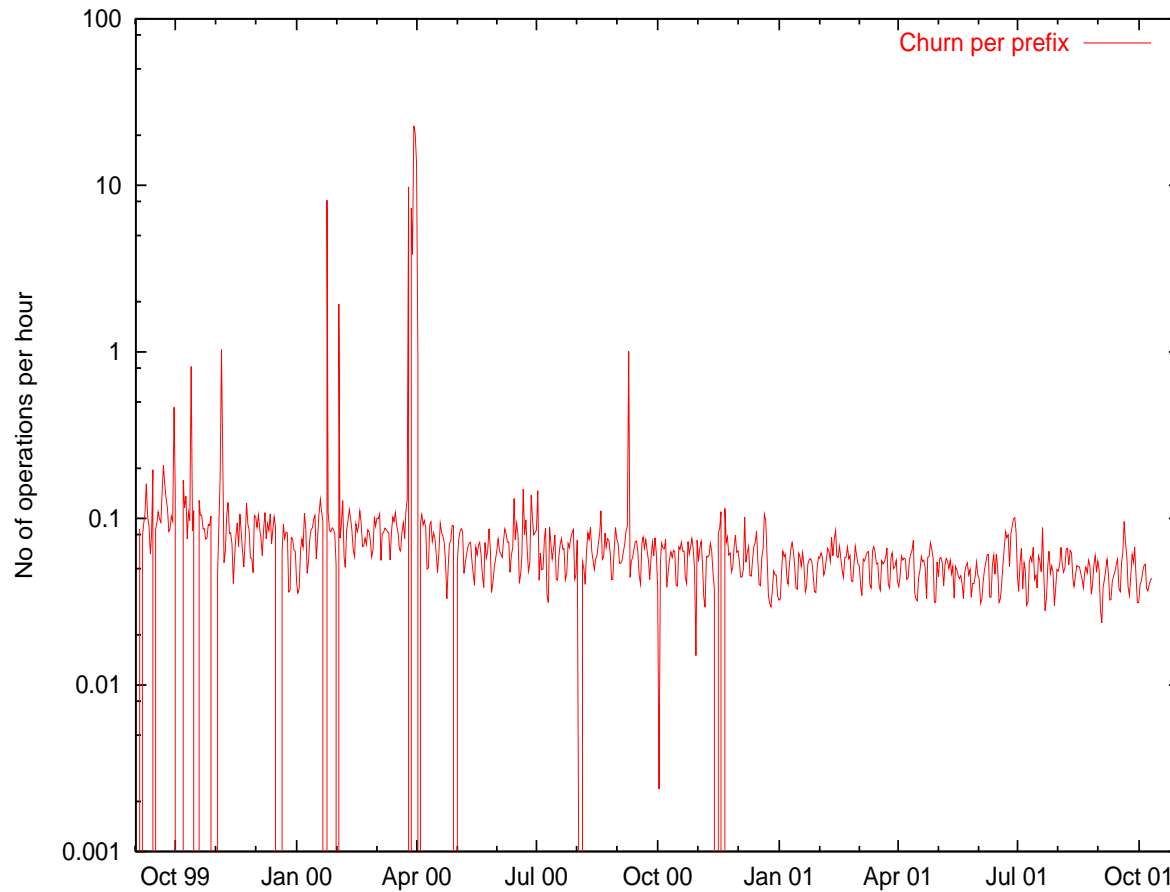
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The churn

- During BGP convergence factorial number of alternate paths are examined

- Churn may be growing faster than the space

- We looked at churn by each router
  - took median/min/max/ave hour to represent the day
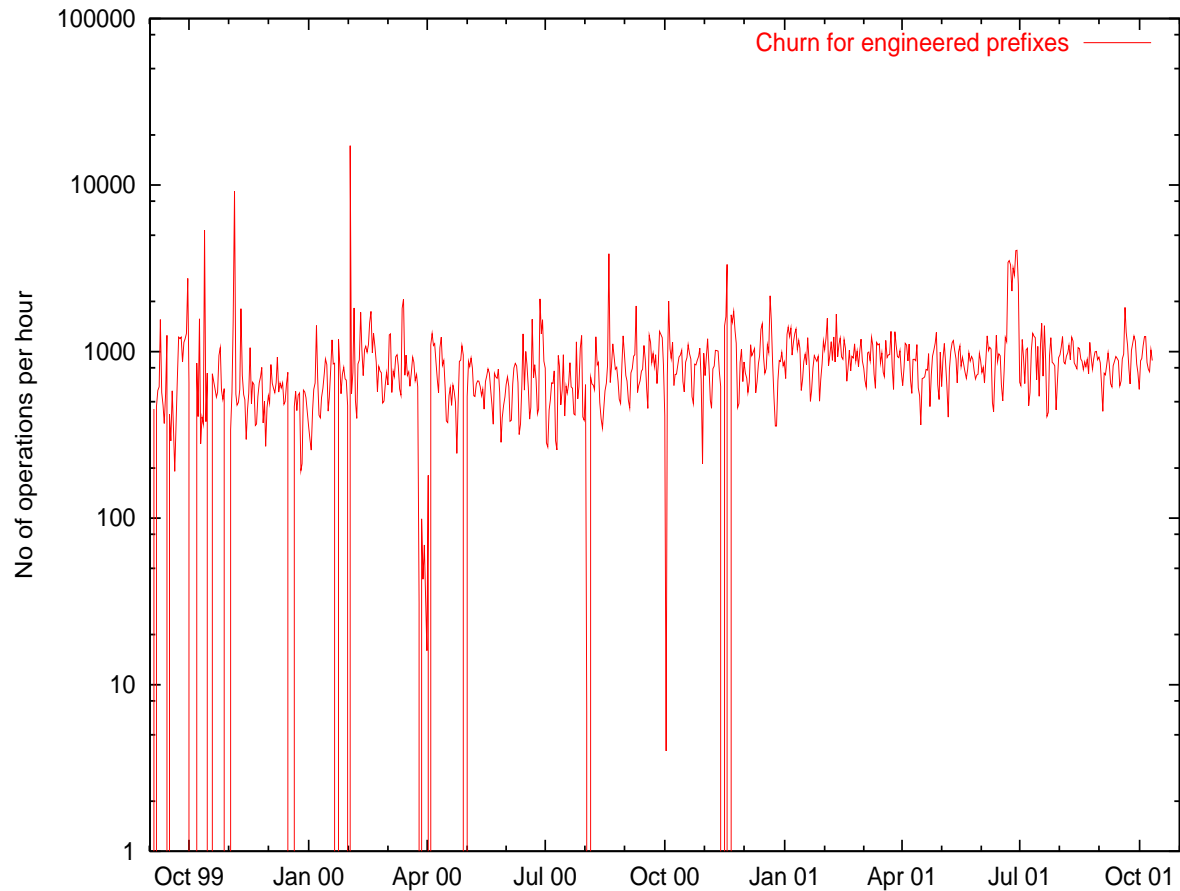 - took the median router
  - for each class of prefixes

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Overall churn is decreasing

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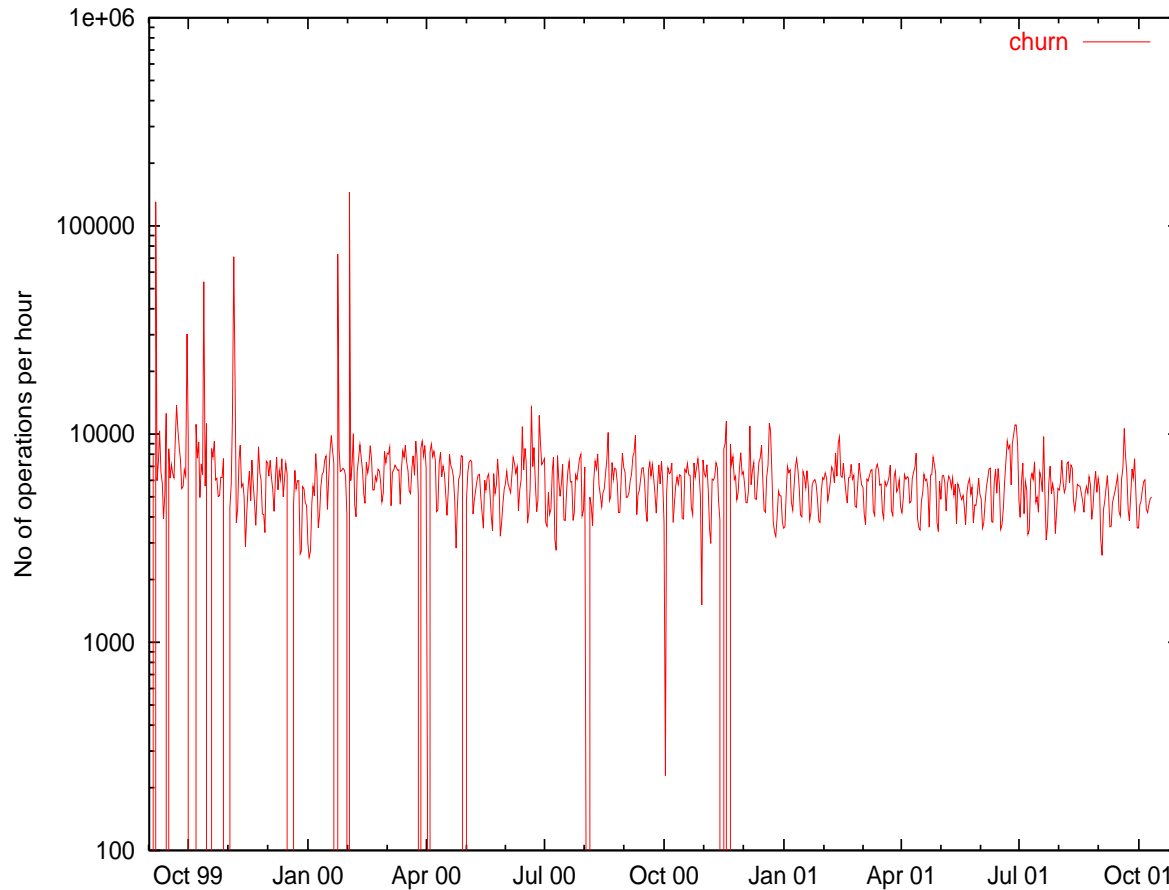
Per prefix churn: stability

Engineered Prefixes behave differently

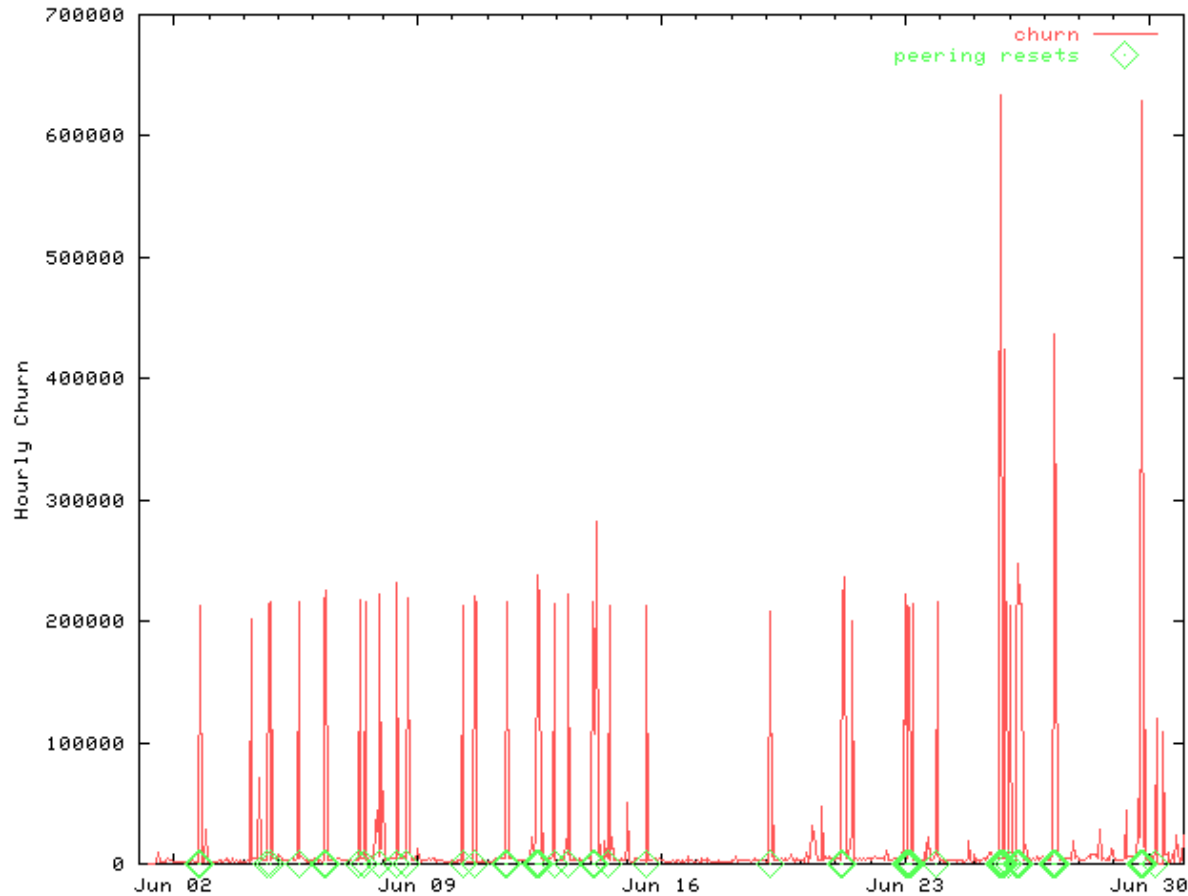- Do people engineer prefixes dynamically?

Churn by Prefix Length
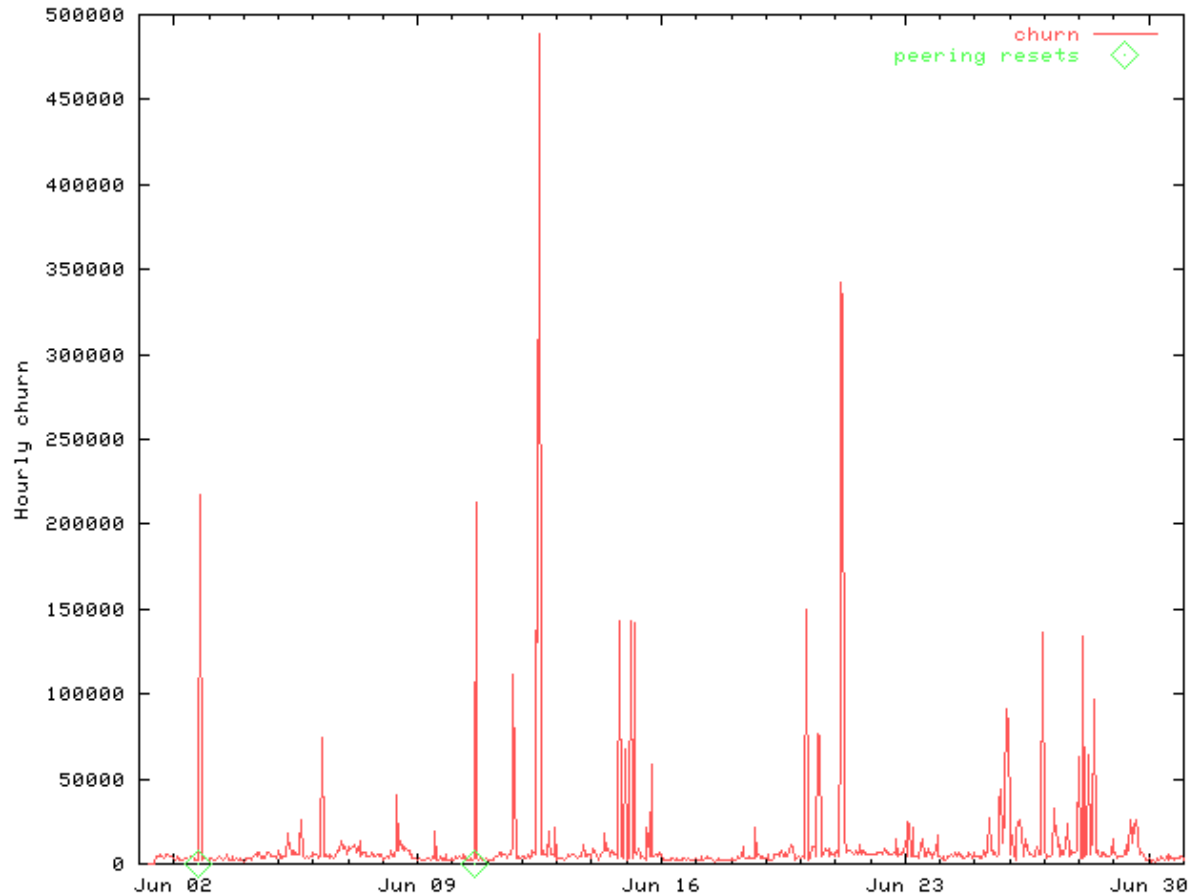
Major cause of churn

- Each time a BGP peering is lost, upto 100K routes are withdrawn and then later re–announced

- For one router, out of 16M churn, at least 12M is because of losing and reestablishing peering
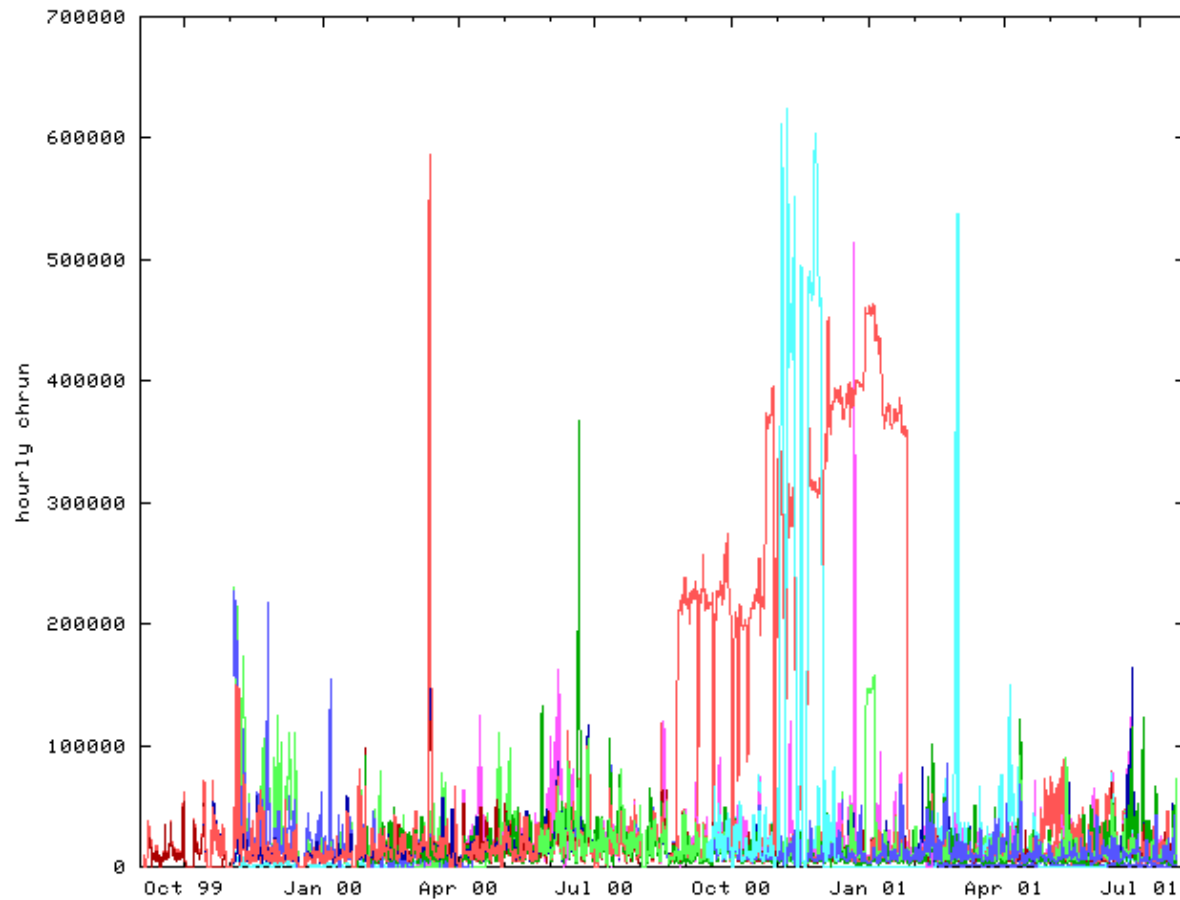
Cause of Churn

- Peering loss/reestablishment is very costly

This is carried multiple ASes away

- High churn due to peering reestablishment is carried multiple hops away

High variance across routers

Summary

- Growth
  - more evidence that it is quadratic than exponential
  - dont blame multi–homing: no evidence of exponential
- Churn
  - overall there is a decrease
  - peering loss/re–establishment needs to improve
  - engineered prefixes churn more
    - peering loss/re–establishment dominates this by 2 orders of magnitude

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Conclusions

- ## Short term issues

  - increase router stability to remove spikes in churn

  - configuration: fewer knobs, more robust filters

- ## Longer term

  - Trends can change (depends on economics/technology)

  - Growth is good but we need to handle it right

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