IPv4 Address Lifetime Expectancy Revisited - Revisited

Geoff Huston
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Presentation to the IEPG

Research activity
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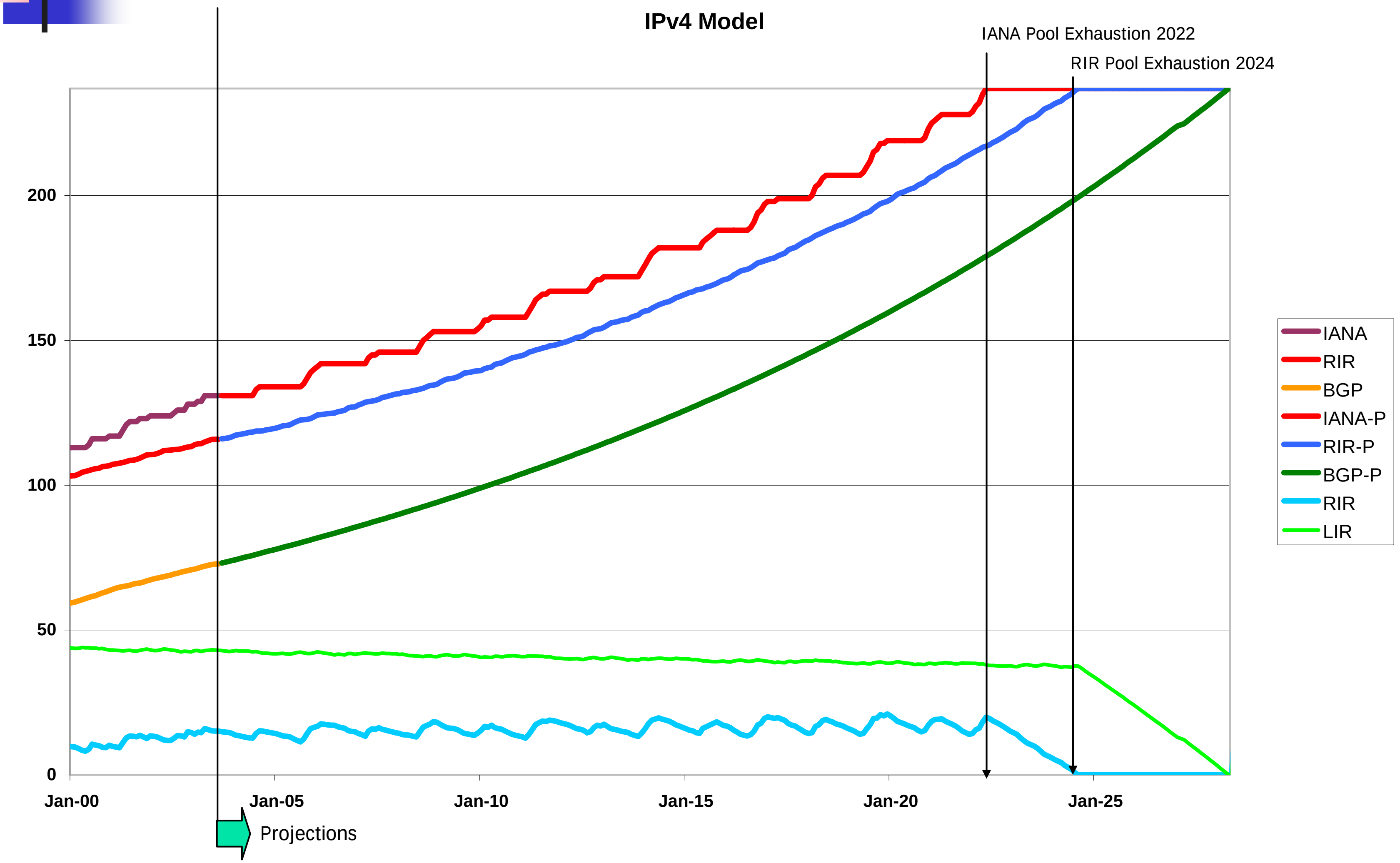
The Regional Internet Registries s do not make forecasts or predictions about number resource lifetimes. The RIRs provide statistics of what has been allocated. The following presentation is a personal contribution based on extrapolation of RIR allocation data.

IPv4 Address Lifetime Expectancy

- In July the IEPG presentation on address lifetime expectancy used the rate of growth of BGP advertised address space as the overall address consumption driver

- The presentation analyzed the roles of the IANA and the RIRs and created an overall model of address consumption

Modelling the Process – July 2003

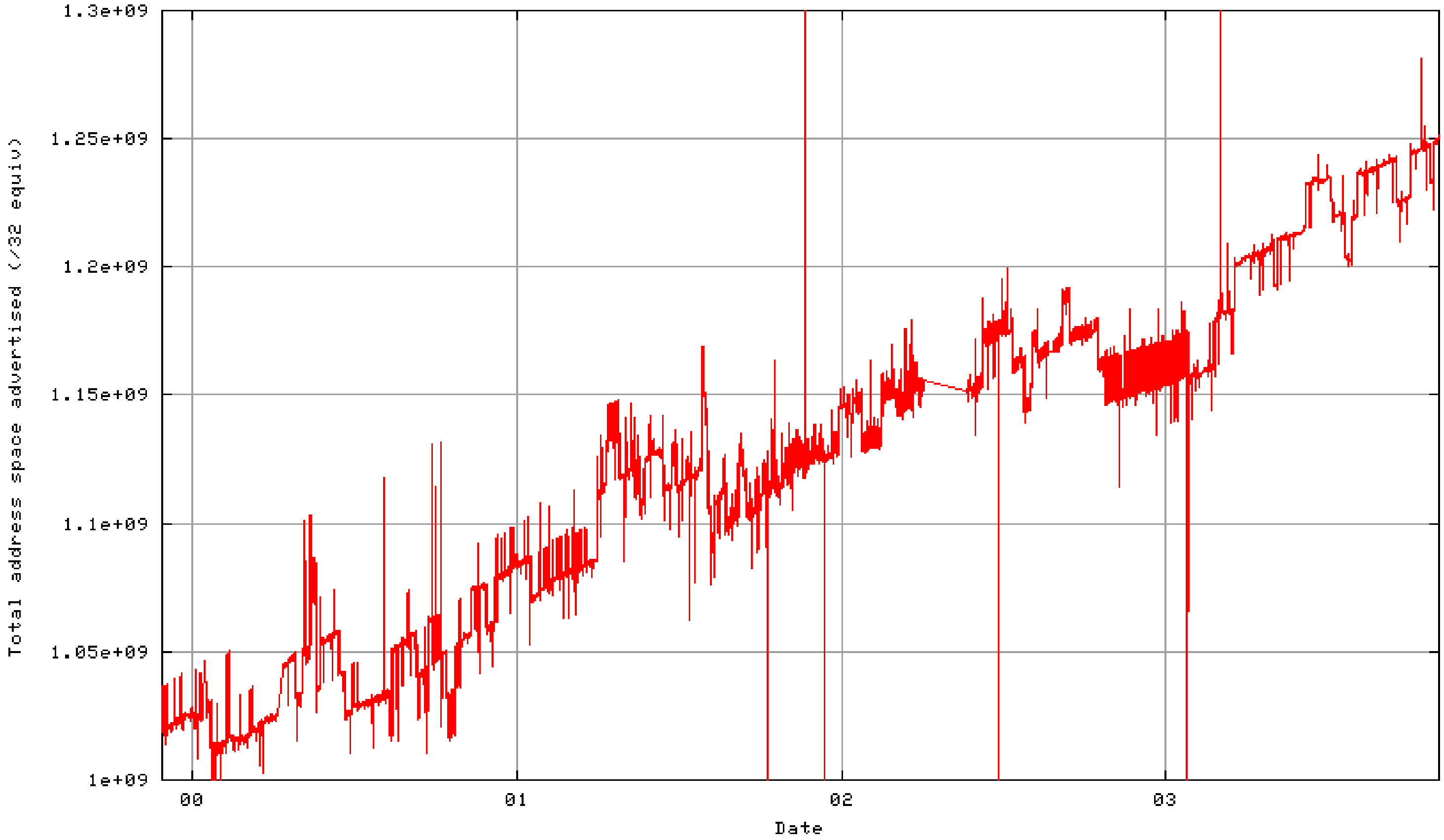


Address Consumption Models

- The basic assumption was that continued growth will remain at a constant proportion of the total advertised address space (compound growth), and that as a consequence address exhaustion was predicted to occur sometime around 2025

- Does the advertised address data support this view of the address growth model?

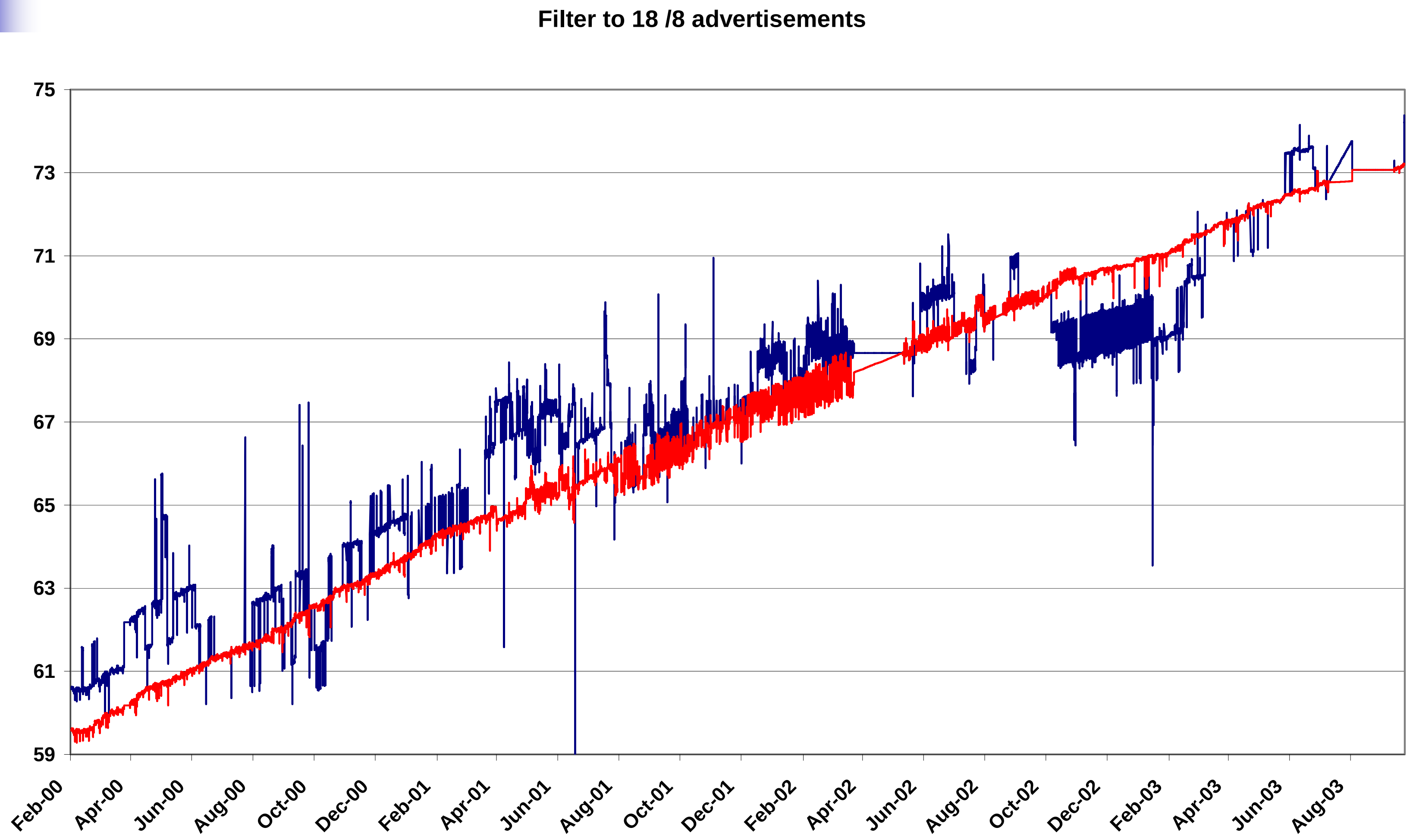
The Advertised Address Space



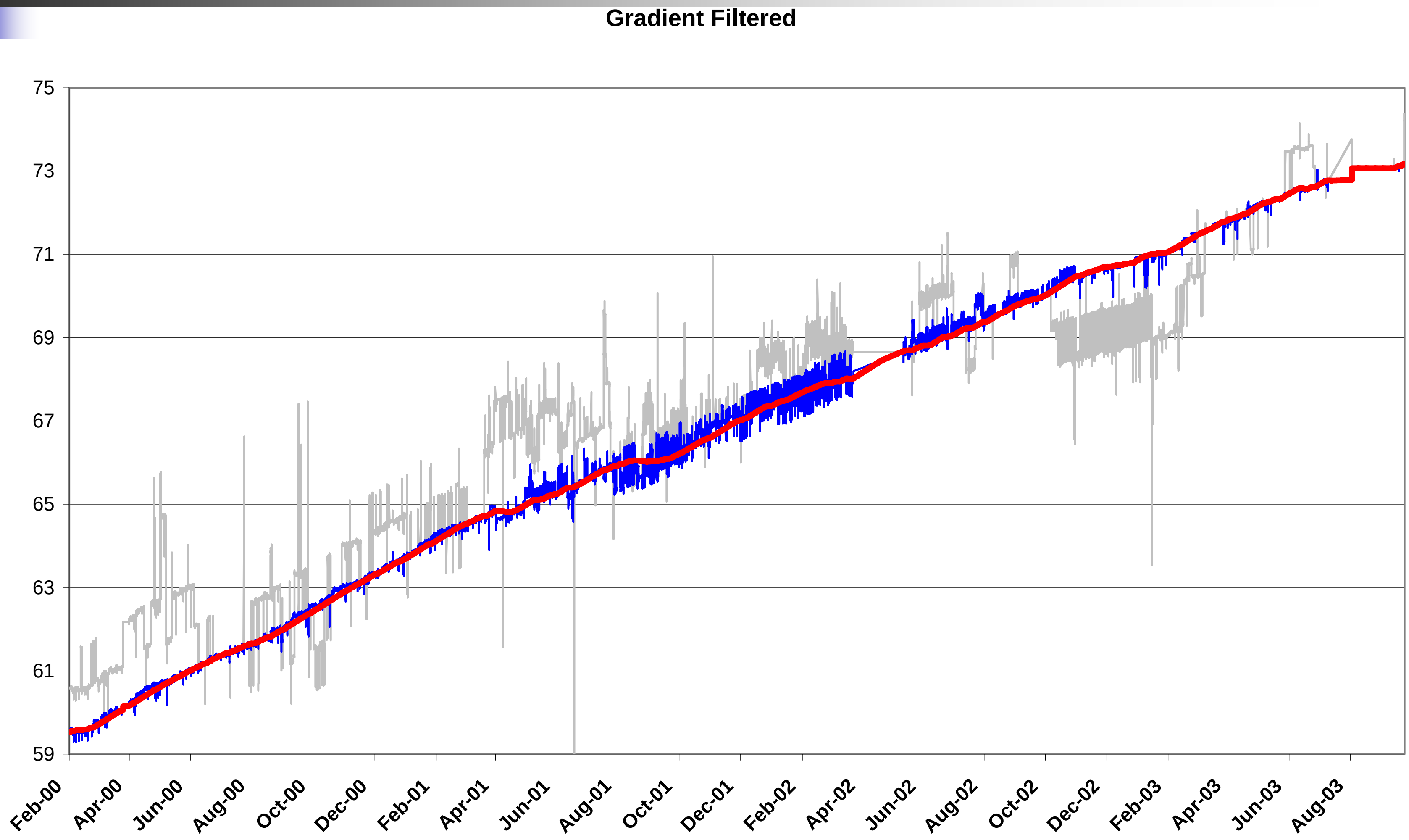
Notes

- It's noisy data
  - There are 3 /8 prefixes that flap on a multi-day cycle
  - There are shorter term flaps of smaller prefixes
- Reduce the noise by:
  - Removing large steps
  - Applying gradient filter
  - Apply averaging to smooth the data

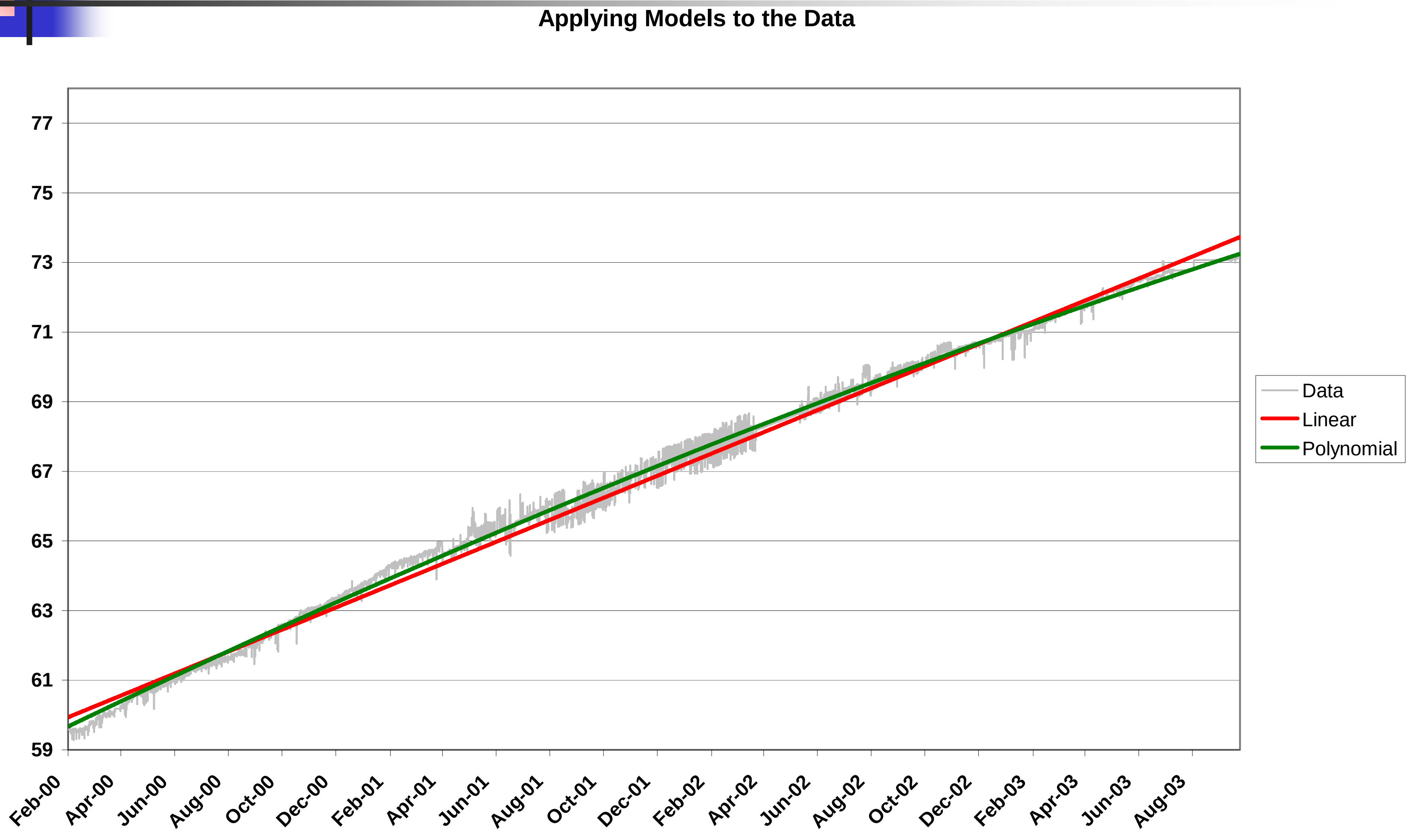
Smoothed Data (1)



Smoothed Data (2)



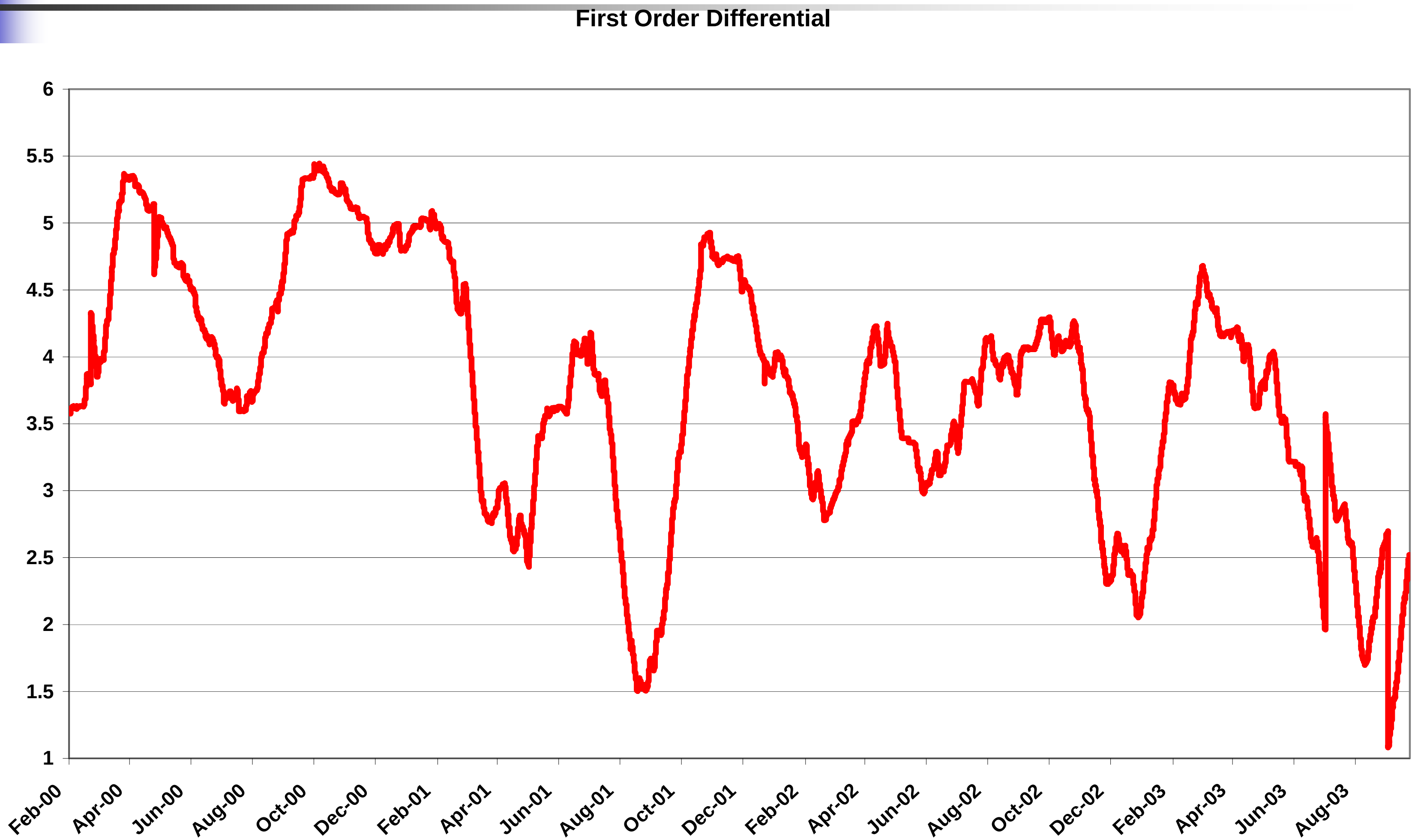
Model Matching



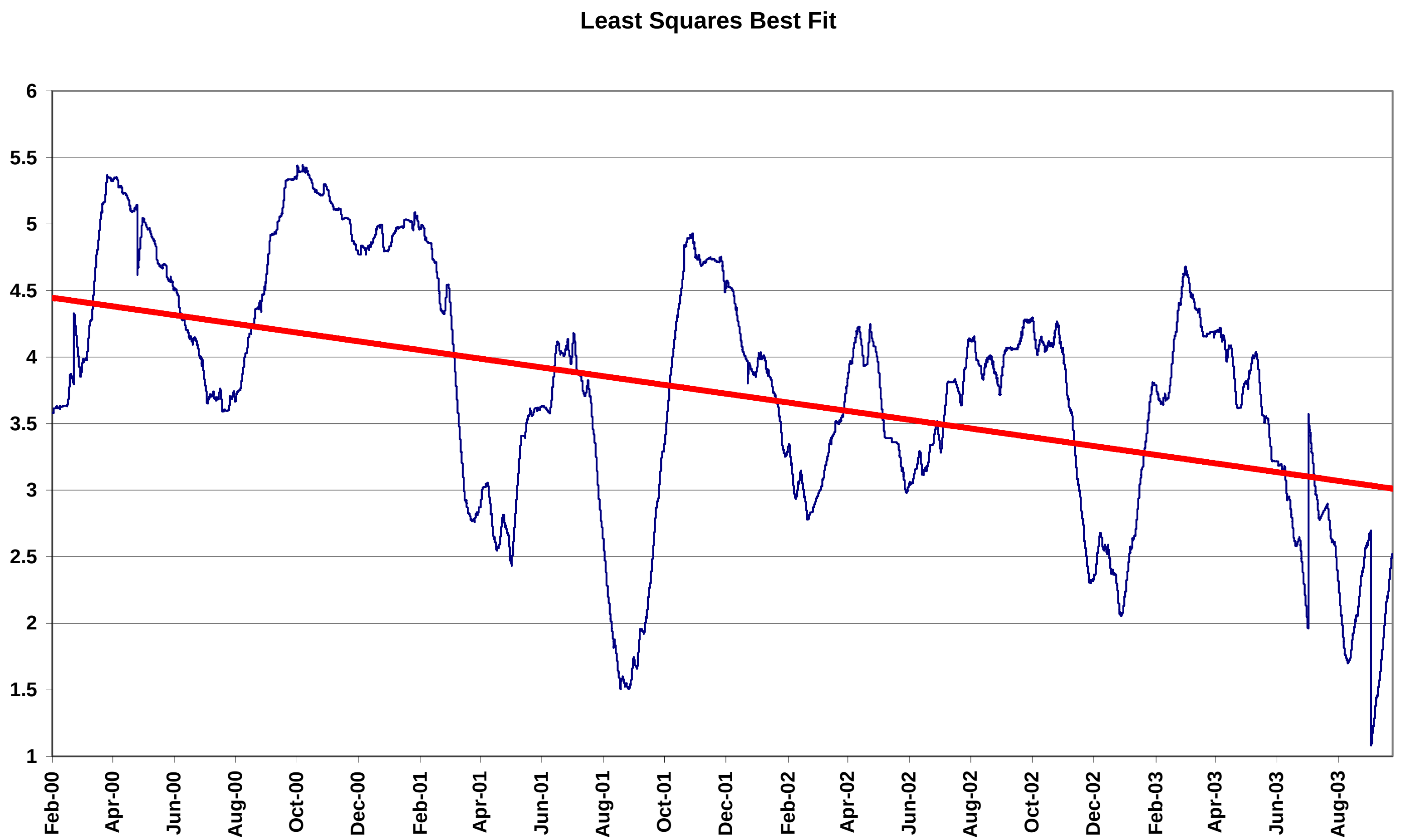
But Which Model?

- A number of models can be applied to this data:
  - Linear model, assuming a constant rate of growth
  - Polynomial model, assuming a constant rate of change of growth
  - Exponential model, assuming a geometric growth with a constant doubling period

First Order Differential of the data



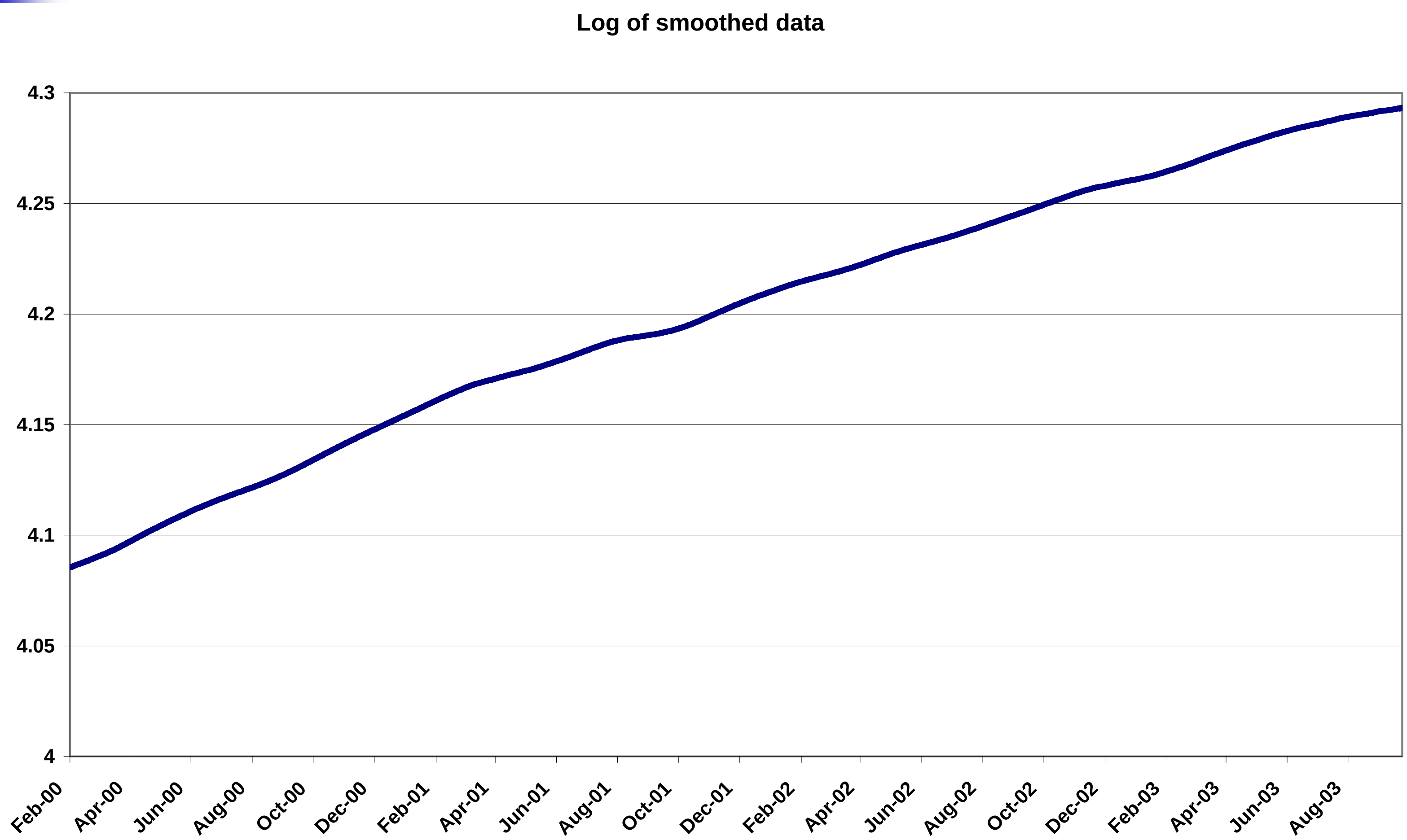
Linear Best Fit to Differential



Growth Rate

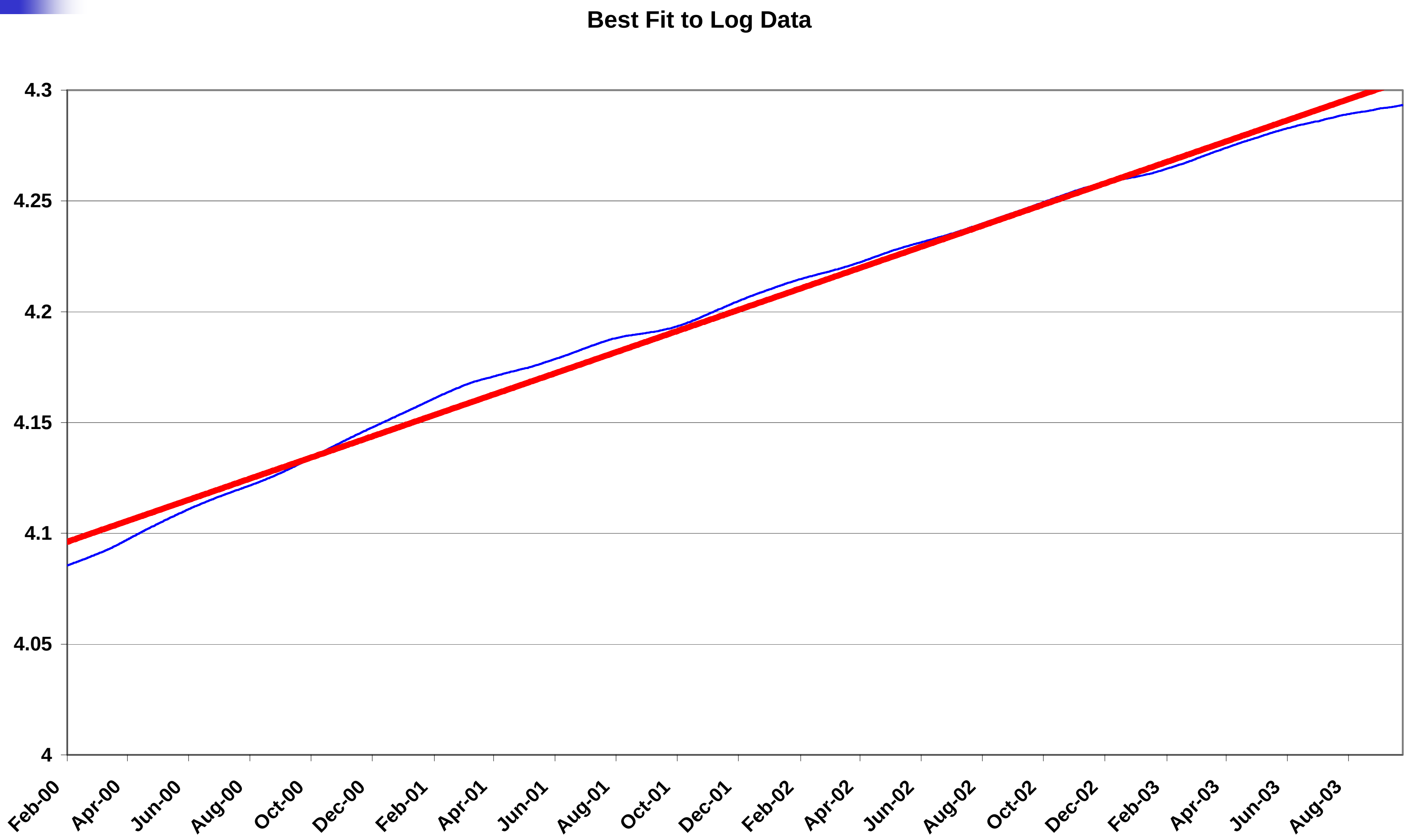
- The growth rate of 4 – 5 /8 blocks per year in 99-00 is now approximately half that, at 2 – 3 /8 blocks per year
- A constant growth model has a best fit of 3.5 /8 blocks per year
- The change in growth over the period is a decline in growth rate by 0.4 /8 blocks per year

Log of Data



Log of smoothed data
4.3
4.25
4.2
4.15
4.1
4.05
4
Feb-00
Apr-00
Jun-00
Aug-00
Oct-00
Dec-00
Feb-01
Apr-01
Jun-01
Aug-01
Oct-01
Dec-01
Feb-02
Apr-02
Jun-02
Aug-02
Oct-02
Dec-02
Feb-03
Apr-03
Jun-03
Aug-03

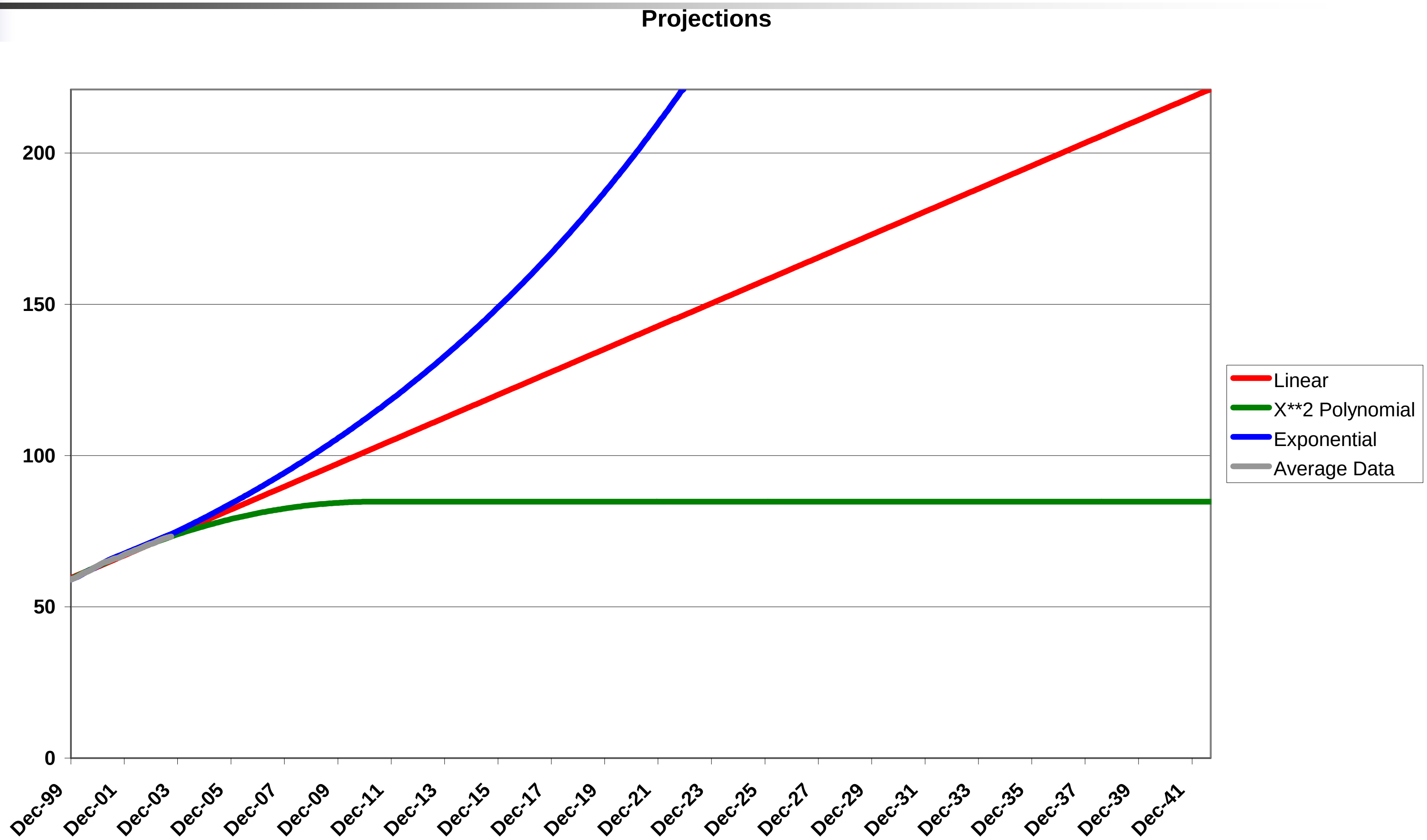
Best Fit to Log



Exponential Model

- The exponential model assumes a liner best fit to the log of the data series
- This linear fit is evident across 2000
- More recent data shows a negative declining rate in growth of the log of the data.

Projections



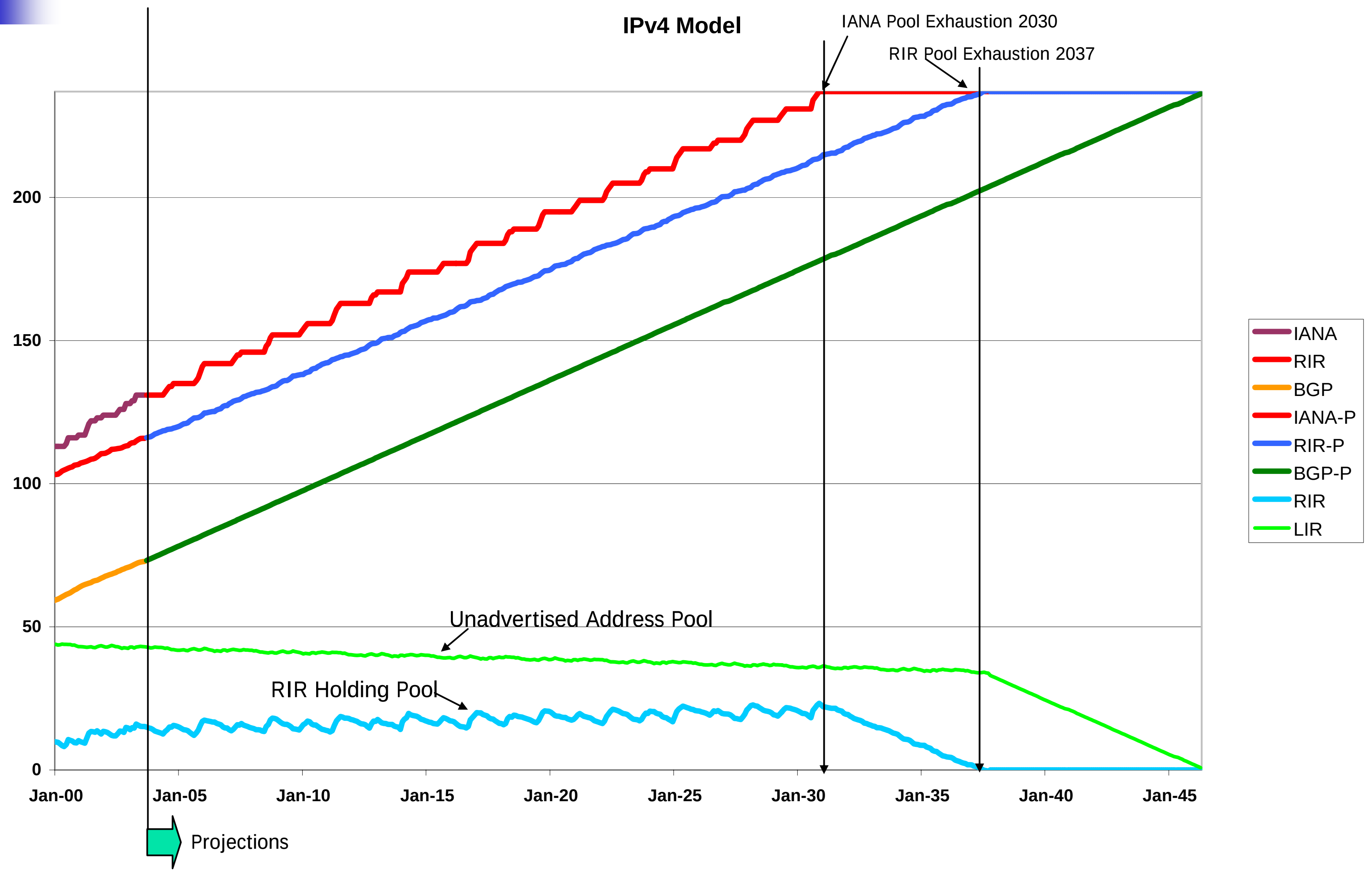
Observations

- Polynomial best fit sees a continuing decline in growth until growth reaches zero in 2010
  - Matches a model of market saturation
- Exponential best fit sees continuing increase in growth until exhaustion occurs in 2021
  - Matches a model of uniform continued growth in all parts of the network
- Linear best fit sees constant growth until exhaustion occurs in 2042
  - Matches a model of progressive saturation in existing markets offset by demands in new markets

Modelling the Process

- Assume that the RIR efficiency in allocation slowly declines, then the amount of RIR-held space increases over time
- Assume that the Unannounced space shrinks at the same rate as shown over the past3 years
- Assume <u>linear</u> best fit model to the announced address space projections and base RIR and IANA pools from the announced address space projections

Modelling the Process



Observations

- Extrapolation of current allocation practices and current demand models using an exponential growth model derived from a 2000 – 2003 data would see RIR IPv4 space allocations being made for the next 2 decades, with the unallocated draw pool lasting until 2018 - 2020
- The use linear growth model sees RIR IPv4 space allocations being made for the next 3 decades, with the unallocated draw pool lasting until 2030 – 2037
- Re-introducing the held unannounced space into the routing system over the coming years would extend this point by a further decade, prolonging the useable lifetime of the unallocated draw pool until 2038 – 2045
- This is just a model

Questions

- Externalities:
  - What are the underlying growth drivers and how are these best modeled?
  - What forms of disruptive events would alter this model?
  - What would be the extent of the disruption (order of size of the disruptive address demand)?