The Regional Internet Registries 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 analysed the roles of the IANA and the RIRs and created an overall model of address consumption.
Modelling the Process – July 2003

IPv4 Model

IANA Pool Exhaustion 2022
RIR Pool Exhaustion 2024

IANA
RIR
BGP
IANA-P
RIR-P
BGP-P
RIR
LIR

Projections
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 (2)
Model Matching

Applying Models to the Data

- Data
- Linear
- Polynomial
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

Least Squares Best Fit
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

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
Exponential Model

- The exponential model assumes a linear 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.
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 past 3 years.
- Assume **linear** best fit model to the announced address space projections and base RIR and IANA pools from the announced address space projections.
Modelling the Process

IPv4 Model

IANA Pool Exhaustion 2030
RIR Pool Exhaustion 2037

IANA
RIR
BGP
IANA-P
RIR-P
BGP-P
RIR
LIR

Unadvertised Address Pool
RIR Holding Pool

Projections
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**.
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)?