End of the Internet Predicted!

Torrent at 11

The Oracle Bones of IPv4

Some personal divination by
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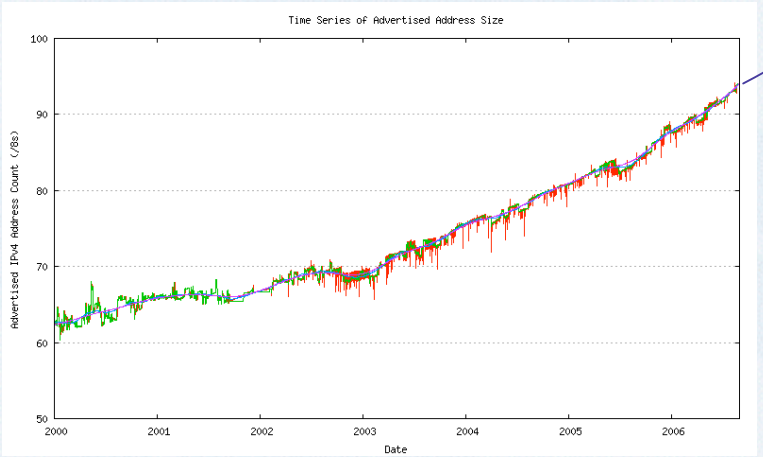
The Art of Divination



The Oracle Bone Questions:

1. When will we ‘exhaust’ IPv4?
2. Why is this a problem?
3. What will happen at the ‘exhaustion’ point?
4. What are the implications for industry players?

1. When will we ‘exhaust” IPv4?

A. When will we stop routing IPv4 in our networks?
   - We will probably still route IPv4 for some decades to come

B. When will the RIRs have no more IPv4 addresses to distribute?
   - Sometime between 2010 and 2013

C. When will IANA have no more IPv4 addresses to pass to the RIRs
   - Sometime between 2009 and 2012

2. Why is this a problem?

- Because the unallocated pool meets growth demand for IPv4-based Internet service deployment
- In the absence of an unallocated address pool to satisfy growth demands:
  - Un-met address demand will increase
  - Placing an escalating scarcity premium on IPv4 addresses

2. Why is this a problem?

- This scarcity may create pricing pressure on IPv4 addresses
  - Where demand exceeds supply then price escalation is a common outcome in classic markets
- This imposes additional costs on industry players
  - These costs may place IPv4 addresses out of reach of some players
- Which, in turn, may cause additional costs for end consumers of Internet services

- These are probably undesireable outcomes that may not be equitable, efficient or effective

3. At the IPv4 Exhaustion Point …

What are our choices?

One or more of:

⇒ **IPv4 + NATs**

⇒ **IPv4 trading markets**

⇒ **IPv6 deployment**

NAT-PT + IPv4?

- Deploy more NAT-PT units within the network
  - How much will it cost? Can the cost be externalized?
  - What services can / cannot be offered? Can these services adapt to NATs?
  - How long / how large can such a NAT strategy last?

Are NATs viable in the short term?

Yes

- Deployment costs are externalized away from network operators
- They support a viable subset of Internet services
- They are already extensively deployed
- They have already influenced application architectures

Are NATs viable in the long term?

Probably not

The major problem with NATs from an application implementation perspective is the non-uniformity of NAT behaviour

– this could be fixed

The major problem with NATs from an application architecture perspective is complexity bloat:

- application-specific identification domains,
- NAT-mediated application-specific rendezvous functions,
- multi-party distributed state application behaviours
- multi-ganged NAT behaviours

– there is no easy fix for this

3. At the IPv4 Exhaustion Point …

What are our choices?

One or more of:

⇒ IPv4 + NATs

⇒ **IPv4 trading markets**

⇒ **IPv6 deployment**

IPv4 Trading?

- Redistribution of IPv4 address blocks through the operation of trading markets?
  - How can such markets operate?
  - How much will IPv4 addresses cost now?
  - How much will IPv4 addresses cost later?
  - Can the outcomes continue to be routed?

IPv4 Trading?

- Balancing supply and demand through an open market with price signals
  - For a seller – the ability to capitalize the value of under-used resources
  - For a buyer – place a utility efficiency value on access to the resource
- Risks:
  - Market distortions
  - Price uncertainty
  - Captive buyers
  - Speculative market players
  - Regulatory intervention
  - Routing load through address block fragmentation

Is an IPv4 trading market viable for the short term?

- Probably yes
  - This is a conventional distribution function which could be undertaken through interactions between address sellers and buyers
  - Price signals could provide motivation for greater levels of efficiency of address deployment
  - Within such a framework there are potential implications for the viability of the routing system which are not well understood

Is an IPv4 trading market viable for the long term?

Unlikely

An IPv4 address trading market can provide a short term incentive to expose unused addresses for reuse, and can provide incentives for high address utilization efficiencies - but the longer term risks of market distortion are high.

An IPv4 market exposes additional risk factors in variability of supply availability and pricing that are expressed as cost elements to the service provider -- that ultimately would be reflected in end user cost escalation.

An IPv4 market does not create new IPv4 addresses. It can create short term economic incentives to increase address utilization efficiencies, or fund the deployment of alternative technologies. But an address trading market cannot fuel network growth indefinitely.

Markets cannot make the finite infinite.

3. At the IPv4 Exhaustion Point …

What are our choices?

One or more of:

⇒ **IPv4 + NATs**

⇒ **IPv4 trading markets**

⇒ **IPv6 deployment**

IPv6 Deployment?

- Deploy IPv6
  - How much will it cost?
  - How long will it take?
  - When will customers and services transition?
  - When can we stop also supporting IPv4?

IPv6 short term viability?

- Still uncertain
  - Few immediate commercial incentives to drive ISP deployment
  - No evident ability to externalize deployment costs
  - No dense service base and few compelling services to drive consumer-level demands

IPv6 – long term viable?

Given the state of the current alternatives - it had better be!

It offers leverage into larger networks with stronger characteristics of utility service models. It has the potential to reduce some of the complexities of network service architectures.

But the gains here are long term outcomes, while the transition cost is short term

4. Implications

- there is no “flag day” for transition
- IPv4 addresses will continue to be in demand beyond the date of exhaustion of the unallocated pool
  - But the mechanisms of management of the address distribution function will change
- coexistence of multiple service models is expensive
  - IPv4 + IPv4 / NATs + IPv6

4. Implications

For network managers:

- Understanding growth requirements and matching this to address accessibility
- Forward planning to minimize disruption risk

For product and service vendors:

- Planning ahead of demand rather than lagging

For regulators and policy makers:

- Phrasing clear and achievable objectives with unambiguous regulatory signals to industry players

4. Implications

It is likely that there will be some disruptive aspects during this exhaustion condition

This will probably not be seamless nor costless

Coping with Crises

Coping with Crises – IPv4 Exhaustion

Thank You