                        Class A Subnet Experiment
                        Results and Recommendations

Status of this Memo

Discussion/Purpose

   This memo documents some experiences with the RFC 1797 [1] subnet A
   experiment (performed by the Net39 Test Group (see credits)) and
   provides a number of recommendations on future direction for both the
   Internet Registries and the Operations community.

   Not all proposed experiments in RFC 1797 were done. Only the "case
   one" type delegations were made. Additional experimentation was done
   within the DNS service, by supporting a root nameserver and the
   primary for the domain from within the subnetted address space. In
   addition, testing was done on classless delegation [2].

   Internet Services offered over the RFC 1797 experiment were:

        Finger
        HTTP
        Telnet
        FTP server/client
        Gopher
        kerberos
        lpr (and its ilk)
        X
        DNS

   F.Root-Servers.Net, a root name server had an interface defined as
   part of the RFC 1797 experiment. Attached is a report fragment on
   it's performance: "My root server has processed 400,000,000 queries
   in the last 38 days, and well over half of them were to the temporary
   39.13.229.241 address (note that I retained the old 192.5.5.241
   address since I knew a lot of folks would not update their root.cache
   files and I didn't want to create a black hole.)" - Paul Vixie

   Initial predictions [3] seemed to indicate that the safest path for
   an ISP that participates in such a routing system is to have -all- of
   the ISP clients be either:

              a) singly connected to one upstream ISP
        OR
              b) running a classless interior routing protocol

   It is also noted that a network with default route may not notice it
   has potential routing problems until it starts using subnets of
   traditional A's internally.

Problems & Solutions

Operations

   There were initial problems in at least one RIPE181 [4]
   implementation. It is clear that operators need to register in the
   Internet Routing Registry (IRR) all active aggregates and delegations
   for any given prefix. Additionally, there need to be methods for
   determining who is authoritative for announcing any given prefix.

   It is expected that problems identified within the confines of this
   experiment are applicable to some RFC 1597 prefixes or any "natural"
   class "A" space.

   Use of traceroute (LSRR) was critical for network troubleshooting
   during this experiment. In current cisco IOS, coding the following
   statement will disable LSRR and therefore inhibit cross-provider
   troubleshooting:

                 no ip source-route

   We recommend that this statement -NOT- be placed in active ISP cisco
   configurations.

   In general, there are serious weaknesses in the Inter-Provider
   cooperation model and resolution of these problems is outside the
   scope of this document. Perhaps the IEPG or any/all of the national
   or continental operations bodies [5] will take this as an action item
   for the continued health and viability of the Internet.

Routing

   A classic cisco configuration that has the following statements

               ip route 39.1.28.0 255.255.255.0
               router bgp 64000
               redistribute static

   will, by default, promote any classful subnet route to a full
   classful route (supernet routes will be left alone). This behaviour
   can be changed in at least the following two ways:

        1:
               ip route 39.1.28.0 255.255.255.0
               router bgp 64000
               no auto-summary
               redistribute static

        2:
               ip route 39.1.28.0 255.255.255.0
               router bgp 64000
               network 39.1.28.0 mask 255.255.255.0
               redistribute static route-map static-bgp
               ....
               access-list 98 deny 39.1.28.0 0.255.255.255
               access-list 98 permit any
               ....
               route-map static-bgp
               match ip address 98

   Users of cisco gear currently need to code the following two
   statements:

               ip classless
               ip subnet-zero

   The implication of the first directive is that it eliminates the idea
   that if you know how to talk to a subnet of a network, you know how
   to talk to ALL of the network.

   The second is needed since it is no longer clear where the all-ones
   or all-zeros networks are [6].

   Other infrastructure gear exhibited similar or worse behaviour.
   Equipment that depends on use of a classful routing protocol, such a
   RIPv1 are prone to misconfiguration. Tested examples are current
   Ascend and Livingston gear, which continue to use RIPv1 as the
   default/only routing protocol. RIPv1 use will create an aggregate

announcement.

This pernicious use of this classful IGP was shown to impact
otherwise capable systems. When attempting to communicate between an
Ascend and a cisco the promotion problem identified above, was
manifest. The problem turned out to be that a classful IGP (RIPv1)
was being used between the Ascends and ciscos. The Ascend was told to
announce 39.1.28/24, but since RIPv1 can't do this, the Ascend
instead sent 39/8. We note that RIPv1, as with all classful IGPs
should be considered historic.

This validates the predictions discussed in [3].

Cisco Specific Examples

There are actually three ways to solve the unintended aggregation
problem, as described with current cisco IOS. Which of them applies
will depend on what software version is in the router. Workarounds
can be implemented for ancient (e.g., 8.X) version software.

    o Preferred solution: turn on "ip classless" in the
      routers and use a default route inside the AS.
      The "ip classless" command prevents the existence of
      a single "subnet" route from blocking access via the
      default route to other subnets of the same old-style network.
      Default only works with single-homed ISPs.

    o Workaround for 9.1 or later software where the
      "ip classless" command is not available: install a
      "default network route" like this:
      "ip route 39.0.0.0 255.0.0.0 <next-hop>" along the axis
      the default route would normally take. It appears
      an ISP can utilize the "recursive route lookups" so
      the "next-hop" may not actually need to be a directly
      connected neighbour -- the internal router can e.g.,
      point to a loopback interface on the border router.
      This can become "really uncomfortably messy" and it may
      be necessary to use a distribute-list to prevent
      the announcement of the shorter mask.

    o Workaround for 9.0 or older software: create a
      "default subnet route": "ip route 39.x.y.0 <next-hop>"
      combined with "ip default-network 39.x.y.0", otherwise
      as the 9.1 fix.

Both of the latter solutions rely on manual configuration, and in the
long run these will be impossible to maintain. In some topologies
the use of manual configuration can be a problem (e.g., if there is

more than one possible exit point from the AS to choose from).

Recommendations:

   The RFC 1797 experiment appears to have been a success. We believe it
   safe to start carving up "Class A" space, if the spaces are delegated
   according to normal IR conventions [7] and recommend the IANA
   consider this for future address delegations.

Credits:

   Thanks to all the RFC 1797 participants. Particular thanks to Paul
   Vixie, Geert Jan de Groot, and the Staff of the IETF33 Terminal room.
   Other thanks to ACES, MCI, Alternet, IIJ, UUNET-Canada, Nothwestnet,
   BBN-Planet, cisco systems, RIPE, RIPE NCC, ESnet, Xlink, SURFnet,
   STUPI, Connect-AU, INBEnet, SUNET, EUnet, InterPath, VIX.COM,
   MindSpring. Especial thanks to Suzanne Woolf for cleanup.

References:

   [1] IANA, "Class A Subnet Experiment", RFC 1797, USC/Information
       Sciences Institute, April 1995.

   [2] Eidnes, H., and G. J. de Groot, "Classless in-addr.arpa
       delegation", Work in Progress, SINTEF RUNIT, RIPE NCC, May 1995.

   [3] Huston, G., "Observations on the use of Components of the Class A
       Address Space within the Internet", Work in Progress, AARnet, May
       1995.

   [4] Bates, T., et.al, "Representation of IP Routing Policies in a
       Routing Registry", RFC 1786, MCI, March 1995.

   [5] http://info.ra.net/div7/ra/Ops.html, November 1995.

   [6] Baker, F., Editor, "Requirements for IP Version 4 Routers", RFC
       1812, cisco systems, June 1995.

   [7] Hubbard, K., Kosters, M., Conrad, D., and D. Karrenberg,
       "Internet Registry Guidelines", Work in Progress, InterNIC,
       APNIC, RIPE, November 1995.

Security Considerations

    Security issues were not considered in this experiment.

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