Network Working Group
Request for Comments: 2036
Category: Informational

G. Huston
Telstra Internet

October 1996

Observations on the use of Components of the Class A Address Space within the Internet

Status of this Memo

Abstract

This document is a commentary on the recommendation that IANA commence allocation of the presently unallocated components of the Class A address space to registries, for deployment within the Internet as class-less address blocks.

The document examines the implications for service providers and end clients within this environment. The document notes the major conclusion that widespread adoption of class-less routing protocols is required, within a relatively rapid timeframe for this recommendation to be effective.

Introduction

The Address Lifetime Expectancy (ALE) Working Group of the IETF has recorded the allocation of Internet addresses from the unallocated address pool. ALE has noted that the existing practice of drawing addresses from the Class C space (192/3 address prefix) will result in near to medium term exhaustion of this section of the unallocated address pool. The largest remaining pool is in the Class A space, where some 25% of Internet addresses (the upper half of the Class A space) remain, to date, unallocated.

This document is a commentary on the potential recommendation that the Internet Assigned Numbers Authority (IANA), through delegated registries, commence allocation of the presently unallocated components of the Class A address space to registries, for deployment within the Internet through the mechanism of allocation of class-less address prefixes.

The deployment of class-less address prefixes from the Class A space within the Internet will require some changes to the routing structure within Internet component network domains. The motivation

for, and nature of, such changes as they effect network domains and network service providers are outlined in this document.

Current Practice with Address Allocations

To date the allocation of class-less network prefixed address blocks has followed a conservative practice of using address allocations which are compatible superblocks of Class C addresses, while the allocation of addresses within the space of Class A and Class B networks has continued to be aligned with the class-based prefix structure.

Within this address allocation environment for non-transit network domains there is accordingly the option to continue to use address deployment strategies which involve fixed subnet address structures within contiguous areas, and use Class-full interior routing protocols. In the situation where variable length subnet masks or disconnected subnets are deployed within the network domain's routing structure, interior routing protocols which use subnet-based routing of Class-full networks can still be successfully deployed and the end network has the option of using an explicit or implicit sink subnet default route. Where such non-transit network domains are connected to the Internet infrastructure the boundary exchange between the non-transit network and the network service provider (this term is used as a synonym for a transit network domain, which provides a traffic transit service to other non-transit and peer transit network domains) is either a class-full advertisement of routes, or an aggregated address advertisement where the aggregate is a superblock of the deployed component class-full networks. At the boundary points of the non-transit network it is a requirement that the non-transit network's subnet default route (if used explicitly) not be directed to the network service provider's domain, to avoid a routing loop at the domain boundary point.

For network service providers the interior routing protocol can use either aggregated routing or explicit class-full routing within this environment. At the network service provider's boundary peering points the strongly recommended practice is to advertise aggregated routes to transit peers, which in turn may be further aggregated across the Internet, within the parameters of permissible policies.

Implications of Address Allocation from the Class A space

Network Service Providers Must Use Class-less Routing

For network service providers within the deployed Internet the implications from this recommendation to deploy prefixes from the Class A address space add more pressure to the requirement to uniformly deploy class-less routing protocols. While this is already a mandatory requirement for any domain which operates without a default route (ie. the provider carries full Internet routing and effectively calculates default), other providers currently can use an imported default route and operate within a class-full routing configuration. This mode of operation is sub-optimal, in so far as the task of aggregating routes falls on peer network service providers performing proxy aggregation of contiguous class-full address blocks.

In deploying components of the Class A the use of proxy aggregation is no longer sufficient. Where a domain sees a default route and a subnet of a Class A route the routing structure, in a class-full configuration, may not necessarily follow the default route to reach other parts of the Class A network not covered by the advertised Class A subnet route.

Accordingly for Network Service Providers operating within the Internet domain the deployment of components of the Class A space entails a requirement to deploy class-less routing protocols, even in the presence of a default route. It is noted that this absolute requirement is not the case at present.

Consideration of Non-Transit Network Configurations

For disconnected network environments, where the network domain is operated with no links to any peer networking domain, such networks can continue to use class-full interior routing protocols with subnet support. Allocation of addresses using prefix blocks from the Class A space within such environments is possible without adding any additional routing or address deployment restrictions on the network domain.

For non-transit network domains which are connected to one or more peer network domains the situation does involve consideration of additional factors. The observation which is made in the context of this consideration is that there are at present relatively few non-transit networks operating a fully class-less interior routing protocol, as there has been no absolute requirement for this functionality when using single class-full network addresses, or when using block prefixed address allocations which are clusters of class-full network addresses.

For non-transit network domains which support external peer connections to a network service provider, deployment of a component of the Class A space would be supportable using a fully class-less interior routing protocol.

In this case there is an additional constraint placed on the external connection such that the non-transit domain either agrees that the network service will undertake proxy aggregation of the advertised class-less address components, or the network domain is configured to advertise to the provider an aggregate route. In both cases the aggregate route must be either the allocated address block, or a fully contained sub-block. Advertising aggregatable address blocks without proxy aggregation permission, or advertising multiple sub-blocks of the registry allocated address block is considered overly deleterious to the provider’s internetworking environment due to considerations of consequent growth in routing table size.

If the externally connected non-transit network domain uses class-full interior routing protocols then deployment of Class A address space prefixes implies that the domain must configure the Class A subnet default route along the same path as the default route to the network service provider (which is noted to be the exact opposite of the necessary routing configuration for those address prefixes which are either aligned to class-full address boundaries or are super blocks of such class-full address blocks). The network service provider may also receive leaked explicit subnet reachability information in such a routing configuration, potentially placing the responsibility for advertising the correct aggregate address block with the network service provider as a case of proxied aggregation.

Within this configuration model, even when explicit subnet default routing is deployed, there is the risk of unintentional traffic leakage and routing loops. If the network service provider is undertaking proxy aggregation using the registry allocated address block then traffic originating within the non-transit domain which is (mis)directed to non-deployed components of the address block will loop at the interface between the network domain and the provider. If the network service provider is configured to explicitly route only

those address components which are also explicitly routed within the non-transit domain, such (mis)directed traffic will be passed through the internetworking environment along the default route until a default-less routing point is encountered, where it can then be discarded. The outcome of this consideration is that the non-transit network domain should explicitly configure sink subnet routes for all non-deployed components of the allocated address block, and conservative operational practice would be to configure the proxy aggregation undertaken by the network service provider to aggregate according to the registry allocated address block.

There is an additional constraint placed on the non-transit network domain using class-full interior routing protocols, such that the domain has no other exterior peer connections to other network domains which deploy class-full routing interior routing protocols.

There is the further constraint placed on the of use of interior class-full routing protocols within a non-transit network domain. In the case where the non-transit network domain has multiple exterior connections to Network Service Providers (ie the network domain is multiply homed within a number of network providers) there is the possibility that each provider may wish to announce components of the same Class A parent. Accordingly the network domain must use a class-less interior routing protocol in the case where the network domain is multiply homed within network service providers.

There are also additional constraints placed on the non-transit network domain where the network has exterior connections to other peer networks. Even in the case where the network domain uses a class-less interior routing protocol, there is the additional consideration that this requirement for use of a class-less routing domain is transitive to other connected network domains. An second network domain, externally connected to the class-less domain routing part of the Class A space, will interpret the boundary reachability advertisement as a complete Class A network advertisement, if using class-full routing. Even if both network domains are connected to the same network provider the provider’s default routing advertisement default to the class-full domain will be overridden by the assumed class A advertisement through the domain-to-domain connection, leading to unintended traffic diversion. The diversion occurs in this case as the traffic directed to parts of the Class A network which are not deployed within the first domain will transit the first domain before entering the network service provider’s domain.

It is also possible to have configurations with unintended routing holes. An example of such a configuration is two stub clients of different network service providers, both using class-less interior routing (X and Y), both directly connected to a third network domain

(Z), which uses class-full interior routing, which is configured as a transit between X and Y. X's advertisement of a component of a Class A to Z will be assumed by Z to be a complete Class A network, and as such will be advertised to Y, overriding Y's default route received from the network service provider. Y will pass all Class A addressed traffic to Z, who will in turn pass it to X. As X is configured as a non-transit stub network X must discard all non-locally addressed traffic.

Thus reasonable operational practice would be to ensure that if a network domain deploys a component of the Class A address space, the network domain is configured to use class-less interior routing protocols, and the network has a single exterior connection to a class-less network provider domain, with the boundary configured as a class-less routing exchange. Multiply homed network domains do infer a common requirement of class-less routing exchanges and interior class-less routing protocols across all peer connected network domains.

It is possible to propose that multi homed network domains should probably not get subnets of a class A for these reasons, although with an increasing diversity of network service providers instances of multi-homed network domains may become more prevalent, and the requirement to transition to an interior class-less routing structure as a consequence of moving to a multi-homed configuration may not be explicitly apparent to all network domains.

Potential Guidelines for Allocation of an Address Prefix from the Class A Address Space

To summarise the possible guidelines for allocation from the Class A space, such addresses should only be assigned to network domains which:

- have no exterior connection (in which case the domain can use either class-full or class-less interior routing protocols without further implication),

or

- are a component of a private internet domain which uses class-full routing exchanges and no other part of the same Class A is assigned into the domain (this is probably an unlikely scenario given a probable direction to use the Class A space as the major resource for the unallocated pool of addresses for allocation),

or

- have a single default exterior connection to a class-less routing domain, use class-full routing protocols and explicitly direct a subnet default route to the exterior connection,

or

- use class-less interior routing protocols and connect only to other network domains which also use class-less interior routing protocols.

It is a reasonable objective to nominate a transition objective to the final configuration (uniform use of class-less routing domains within the Internet) which would enable deployment of components of the Class A space uniformly across the Internet.

Related Potential Activities

Given the pressures on the remaining Class C address space in the unallocated address pool, it is noted that there would be widespread deployment of components of the remaining Class A space in class-less allocation guidelines. There is a consequent requirement for widespread deployment of class-less interior routing protocols in order to ensure continued correct operation of the routed Internet. This is a more significant transition than that deployed to date with the network service providers' deployment of Class-less Inter-Domain Routing (CIDR) protocols, in that there is a necessary transition to deploy Class-less Interior Routing Protocols (CIRP) within a large number of network domains which are currently configured with class-full routing.

However this would appear to be a necessary task if we wish to continue to utilise a pool of globally unique Internet addresses to allocate to new systems and networks, but one requiring significant effort considering the space of the routing transition required to make this work.

There are a number of directed activities which can assist in this transition:

- The network registries commence initial class-less allocation from the unallocated Class A space to those entities who either:

  o operate a CIRP environment, and either have no external connectivity, or are singly homed to a network service provider using a CIDR environment, with no other exterior connections,

or

- operate a class-full routing protocol, and either have no external connectivity, or are singly homed to a network service provider using a CIDR environment, with no other exterior connections, and are willing to point the subnet default route towards the network service provider.

- In deploying the Class A space there is a requirement within the vendors' product sets to allow explicit configuration of whether the router operates in a class-less or class-full mode, with correct behaviour of the default route in each case. Class-full mode of operation must also allow explicit configuration of subnet default behaviour as to whether to follow the default route, or to operate a subnet default sink.

- There is a similar, but longer term, activity within the host configuration environment to support a mode of address configuration which uses a local network prefix and host address, possibly in addition to the current configuration mode of class-full network, subnet and host address

- Internet Service Providers also must support full class-less configurations in both interior routing configurations and interdomain peering routing exchanges, and provide support to client network domains operating a class-less boundary routing exchange configuration and be able to undertake proxy aggregation as permitted.

Security Considerations

Correct configuration of the routing environment of the Internet is essential to the secure operation of the Internet.

The potential use of the Class A space raises no additional considerations in this area.

References

[CIDR]
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Author’s Address

Geoff Huston
Telstra Internet
Locked Bag 5744
Canberra ACT 2601
Australia

phone: +61 6 208 1908
email: gih@telstra.net