Measuring the Global Routing System

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***Abstract*—test**

I. Introduction

BGP is the critical infrastructure for the Internet and inter-domain routing. The routing protocol operates in the junction point where independent networks (an AS, or autonomous system) exchange network traffic through proscribed and announced routes of connectivity. Because ASes are separate networking and economic entities, BGP must operate balancing essentially two purposes, which are not entirely orthogonal to each other: the limits of efficient networked traffic and the realities of routing policies, which are governed by cost expenses, some issues of politics, network locality, and multihoming preferences. These have served together, and at times as trade-offs, to add to complexity within BGP and to bring the level of routed Internet traffic – with its number of policy-constrained routing inefficiencies – such as is seen at this time.

As originally envisioned, a hierarchical and scalable routing table was to serve as an efficient and streamlined mechanism. However, not foreseen was how the limited number of IPv4 addresses (2^{32}) and the increasing number of allocations to users would lead to fractionalization and finer segmentation of the IP address space. Fragmentation has effectively flattened portions of the IP address table, rather than preserved the hierarchical IP address-based routing. Reasons for numerous ”special-case” announcements include multihoming demands and Internet customers' implementation of particular traffic engineering to suit any special purposes. Likewise, single institutions have grown to need more IP addresses than originally allocated and have received additional address blocks that are non-adjacent. In either case, it has generated a routing table with more entries than a hierarchical structure would have yielded that strictly worked with consolidated blocks. Correspondingly, the Internet experiences a higher number of transmitted BGP updates to propagate these steadily ongoing changes.

Several issues impact the growth of the BGP routing table. First is the challenge of best guessing

The paper is organized as follows. Section II describes the data sets and methodology used in our study.

II. Data sets and methodology

some words

A. Data sets

5 RIRs (ARIN, RIPE NCC, APNIC, LAPNIC, AfriNIC), 5 sources for BGP data (Oregon from RouteViews, Amsterdam, Tokyo, London, Moscow from RIPE NCC),

B. Methodology

Data is imported to PostgresSQL database for further processing. The total number of collected prefixes is more than 17 000 000.

III. IP address allocation dynamics

A. Allocated IP block sizes

B. Yearly distribution of IP allocations

C. Unaligned allocation

D. Allocation by geographical region

E. Allocation changes by geographical region

There is another dynamic occurring while the BGP table size grows steadily, and that concerns table entries appearing and disappearing, obviously with appearances outnumbering disappearances that account for the table growth. Thus, fourth, we will chart both allocation/deallocations and table prefix appearances/disappearances on a monthly basis.

IV. BGP routing table

A. Announced IP block sizes

B. Age distribution of BGP entries

Finally, eighth, we will provide a cumulative distribution function (CDF) of prefix ages, by which to draw conclusions about the stability of the routing table content. These will give information not so much about what is happening, but who is involved and for how long.

C. BGP announcements by geographical region

One other direction of our BGP routing system study deals with characteristics of the allocations and announcements themselves. These are in the areas of geography and age. Some of the new areas we will examine to monitor where allocation activity is happening, and for how long a time on average. Thus, seventh, we will give a year-on-year comparison of prefix allocations and prefix announcements by major countries, including Russia, Japan, major countries of Asia, and broad regions such as the European Union, North America, and Africa.

D. BGP table growth accelerators

1) IP block fragmentation: Third, we will build a graph showing both the approximated BGP table size and a calculated table size had there been no fragmenting of allocated blocks.

2) Duplicate announcements of IP blocks: Fifth, we will determine the trends of the percentage of covering prefixes that 1) match, 2) fragment, and 3) aggregate allocations. Sixth, we will show the dynamics of "Level 1" and "Level 2+" covered prefixes over time. Plus, we will give a comparison of covering prefixes to the number of allocations. All these measurements concern the overall growth of the BGP routing table.

V. Previous measurements

Past studies have characterized growth of the Border Gateway Protocol routing table in terms of the prevalence of special announcements to suit traffic engineering purposes, longevity of announcements appearing and disappearing, and estimated time left until the IPv4 space is fully allocated. These studies reflect concerns that BGP operates with functions that are not entirely free of conflict with each other (efficiency versus policy priorities, i.e. public good versus self serving choices), that network traffic growth stemming from BGP updates tracking connectivity changes faces scalability limitations, and that the BGP routing table size contributes to routing latency. Since the time of those studies between 2003 and 2005, the BGP routing table has continued its rate of growth. It is helpful to examine the current state of the BGP routing table and quantify how that high-level picture has changed from earlier measurements. It is also worthwhile analyzing whether table fragmentation or aggregation has changed over time and how that affects estimates of the routing table size in the future. But particularly informative and not as well charted in the past is to document where new allocated routing announcements are originating around the world – that is, not necessarily a measure of where most new Internet traffic is occurring but a way to witness the spreading of Internet infrastructure connectivity around the globe. Coupled with an analysis of how long these announcements stay in the routing table – a measure of table stability – it is possible to make some projections how the purposes of connecting to the Internet continue to diversify.

VI. Conclusions

BGP table has more than doubled in 6 years

The BGP table growth outstrips IP allocation rate

Every industrialized nation is participating in BGP table growth

ISPs prefer to fragment large allocated blocks into smaller chunks, e.g., /24 prefixes account for more than 50% of routing table

Demand for IP addresses outpaces the rate IPs are returned to RIRs

Multihoming and traffic engineering techniques introduce redundancy in BGP table (58% in 2009)

BGP table is highly dynamic (only 16% is static)