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AGRIB-BHF: A sustainable and fault tolerant aggregation

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A R T I C L E I N F O

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A B S T R A C T

Growing size of the internet is raising concern to internet designers as the routing table growth leading to the state of difficulty in managing the huge amount of forwarding information on relatively limited memory size of line cards. Aggregation is a method of limiting the volume of data in the forwarding information base. Most of the existing approaches have shown aggressive aggregation tendency that leaves problems of black holes, overburden next hops links, inappropriate path selection in the forwarding information which subsequently degrades the overall performance of the internet. This paper proposes an approach AGRIB-BHF to overcome aforementioned problems of aggregation.

1. Introduction:

Internet is understood as a backbone of today's society. Its importance in our day-to-day living has reached up to a level where we cannot imagine completing even a day of our life without getting help directly or indirectly from internet. Today's backbone i.e. internet also has a backbone without which it cannot exist. That backbone itself is a network of networks consisting of network service providers' networks (NSPs), and internet service providers' networks (ISPs). Aforementioned backbone network is made up of interconnections of NSP's routers, ISP's routers, Universities' routers, etc. connected by high speed links.

These routers are grouped in a single administrative domain called Autonomous Systems (AS). Routers maintain connectivity and reachability information of all the networks in the internet. This reachability information is stored in tables called routing tables. The protocol which connects different autonomous systems is Border Gateway Protocol (BGP). The BGP is the default protocol to establish connectivity in aforementioned networks of NSPs, ISPs, etc.

The reason behind BGP is being used as a default protocol, for the communication among different autonomous systems today, is its potential to handle route aggregation and route propagation among the different domains. BGP came into existence in late 1980s and its first version was BGP-1. Since then it has undergone several phases of improvements. Its latest version which is fourth began in 1993. Earlier versions had no support for aggregation but the fourth version has.

BGP maintains reachability information in routing information base (RIB). As shown in Fig. 1(a) the size of the internet has grown at faster rate than that of expected, the routing table size is reaching at an alarming state (Routing Table Analysis Reports, 2012).

It is not that the efforts were not being put in place to control the growing size of routing tables. Efforts started in early 1990s nearly couple of decades ago (Rekhtar, 1993). The first effort may be seen in the form of Classless Inter-domain Routing (CIDR). The supernetting combines prefixes into one prefix by using variable mask are shown in Fig. 1(b) (Classless Inter-Domain Routing) where three prefixes are combined into 10.10.1.0/25.

The Classless Inter-domain Routing (CIDR) was introduced to control the explosive growth of routing tables on routers in the internet. The importance of CIDR in maintaining traffic stability and traffic behavior is easy to understand.

A routing rule says that any network must not forward the traffic on a less specific route which matches with one of its routes. A situation, when packets keep circulating back and forth among the network elements but never reaches its real destination, is known as routing loops (Sam Halabi, 2000). An evidence of the above mentioned rule is the default route. So the thumb rule states that the default routes must not be used in internet to forward packets. Cisco routers address aforementioned condition by using bit bucket to discard the traffic that may cause looping.

When redistribution is used the IGP entries are redistributed to BGP, and this process has potential to leak some of the

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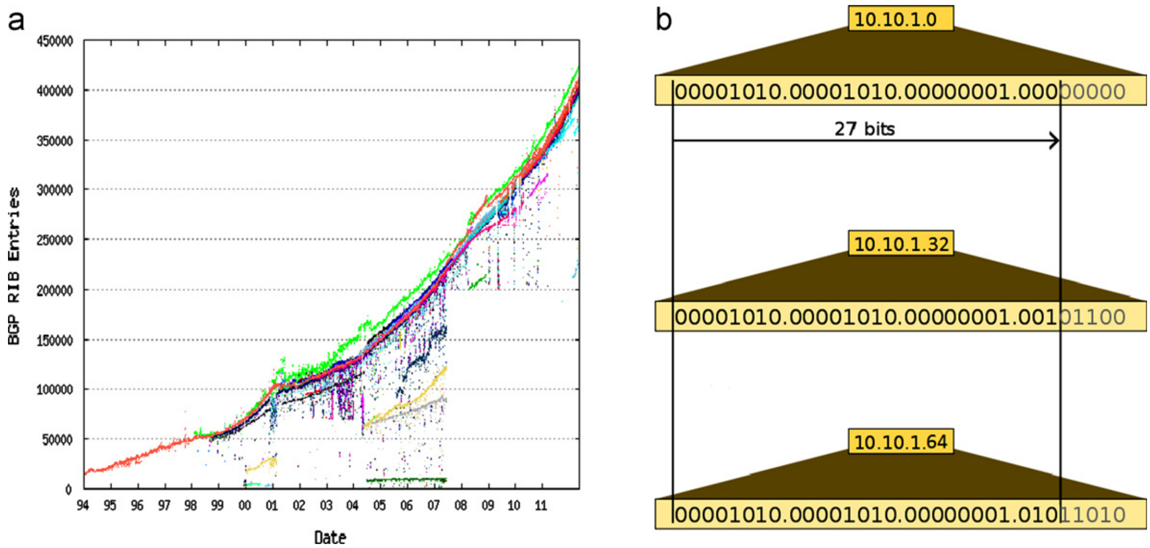

Fig. 1. (a) RIB growth and (b) aggregation process.

undesired entries into BGP routing table. Such entries may be illegitimate addresses, and private addresses which are otherwise not supposed to be there in BGP tables and must not be advertised to other autonomous systems. This may have unwanted consequences therefore utmost care to be exercised in filtering that information (Sam Halabi, 2000).

It is not easy task to control the route instabilities, as it depends on factors which are beyond one's control. These factors are sometimes malfunctioning of hardware, and sometimes links which are not stable. Minimizing instabilities of routes with the help of aggregation could be one approach (Fuller et al., 1993). When any route advertisement, which is aggregated, represents many routes, then single route failure may not cause change in aggregated prefix's route (Sam Halabi, 2000). Prefix aggregation may be done at either of the boundaries, at provider or customer, but it may depend on amount of information exchanged. If the aggregation is performed on the boundary of the customer, it may reduce provider's capacity of looking at the changes in each customer's route. But if the aggregation is performed at the boundary of the provider then the customer's changes would not be propagated to internet but would leak to the provider's network.

Limitation of aggregation may be seen on Multi-Exit Discriminators (MEDs) especially in those cases where providers announce a CIDR block from the different locations of their networks and then shorter routes are suppressed. In such cases if the MEDs are used, it may result in less preferred routes because more specific ones are distributed throughout the autonomous system and the MEDs which are associated with some of the routes, especially those which are more granular may not be available anymore. Suboptimal routes are created as outcomes of the aggregation therefore the MEDs are not welcome by peer routers.

2. Related work

In the beginning of 1990s the internet community started considering the growth rate of the internet as a problem; it has been realized that if this problem is not addressed well in time it would become unmanageable later. In December 1990 internet engineering task force decided to support the idea of restructuring the internet protocol addressing i.e. IPv4 to increase the lifespan of IP addresses.

Between years 1993 and 1995 notion of elimination of class full addressing was conceived and it was proposed to introduce a new idea of classless addresses, this was to be performed with the help of varying subnet mask, which were fixed till now based on the class type, for class A it was first eight bits, for class B it was first sixteen bits, and for class C it was first 24 bits (Li and Fuller, 2006).

The Classless Inter-Domain Routing popularly known as CIDR is to select the number of subnet mask bits based upon the size of the addresses required by the organization. This means that now the subnet masks could range from n-bits to 32-bits. For instance if an organization requires addresses for its network whose capacity was to have only 60 computers then subnet masks bits could be first twenty six bits instead of having first 24 bits (Rekhtar and Li, 1995).

The different networks' addresses allocation based on variable mask bits could be combined to single subnet mask which reduces many entries from routing table of a router to few entries. The process of combining more prefixes into one is known as supernetting, and it is a way to control the growing size of the routing tables in internet as shown in Fig. 1(b).

Rekhtar and Li (1995) explained the routing table structure of BGP, and different blocks of the routing tables which are shown in Fig. 2. It explains the mechanism in which updates received in AdjRib-In are transformed into FIB, and AdjRib-Out.

Uzami and Sana (2010) mentioned in their technical report on aggregation that as the information come from different sources having different attributes aggregation process causes loss of information. As a sign for the loss of information a well known attribute Atomic Aggregation that is discretionary attribute may be observed. So when any router sends an aggregated entry, which is causing information loss, it is necessary for that router to attach attribute Atomic Aggregation along with it.

Sam Halabi (2000) has pointed out that in route aggregation a range of network prefixes are summarized into few aggregated network prefixes by varying the CIDR of the aggregated network prefix which is relatively smaller, here efforts are made to keep it as smaller as possible but this approach has a severe limitation of losing the granularity of more specific routes which exists prior to aggregation.

When two or more routes are aggregated into one route and this aggregated route is then sent to peers as a single advertisement then the path information that was there in many routes is lost. This has potential to lead to routing loops.