New inter-domain issues in Research and Education networks

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Internet brings to the end-user an end-to-end connectivity. This concept of "any-to-any" is possible thanks to the interoperability between all operators with the IP[1] protocol, and in particular the usage of BGP[2] routing protocol, which enables IP routes exchange between different domains. Each domain in the Internet corresponds to a zone under the responsibility of one single operator. The notion of "domain" in BGP corresponds to the notion of "Autonomous System (AS)", although in practical there may be several Autonomous Systems managed under the same administrative domain.

The interface between Autonomous Systems is achieved with the MP-BGP[3] protocol, (and also sometimes MSDP[4]). Essentially it permits the distribution of Internet routes, or more generally Internet prefixes. This fundamental interface allows end-to-end connectivity across multiple public operators.

Some operators offer added-value services, like VPNs[5], QoS[6] services; however these services are usually available only in their own domain. Thus all the sites of an enterprise must be connected to the same operator to take advantage of these advanced services. Apparently public operators do not actively extend their advanced services towards other operators, even if now certain initiatives like the Infranet Initiative[7] aims at solving the technical and commercial aspects of these problems.

In the Research and Education networks, the context is very different from the public networks:

1) The network is made up many distinct domains inter-connected. For example, in Croatia, a site (domain 1) will be connect to CARNET (domain 2), the national network. CARNET is connected to GEANT (domain 3) which connects the other National Research and Education Networks (NRENs). In some countries, a university may be first connected to a MAN or regional, and

[1] Internet Protocol
[2] Border Gateway Protocol
[3] Multi-Protocol BGP
[4] Multicast Source Discovery Protocol
[5] Virtual Private Network
[6] Quality Of Service
[7] http://www.infranet.org/

not directly to the NREN. So the traffic between two users of the global network has a very high probability to cross several independent domains.

2) The advanced network services are fundamental. Many services are already available in the research and education networks, e.g. multicast, IPv6, QoS, VPN, and many of them are not widely deployed in commercial networks.

Paradoxically, the interface between the research and education networks remains limited to:

- MP-BGP for the distribution of IPv4 unicast routes;
- MP-BGP for the distribution of IPv6 unicast routes;
- MP-BGP for the distribution of IPv4 multicast routes;
- MP-BGP for the distribution of IPv6 multicast routes (deployment under process);
- MSDP for the exchange of IPv4 multicast sessions.

Whereas a lot of work was performed on advanced services like security, IPv6, Multicast, flow monitoring, QoS, and VPNs (in particular L2 point-to-point), and with successful deployments, the interface between the domains tends to be limited to very small changes, mostly statically case by case. For example, the configuration of a MPLS[8] layer 2 point-to-point circuit between two European universities is today realized by a manual stitching of MPLS circuits at the borders of the domains.

This contribution proposes an investigation of the work undertaken in the standardization bodies, in particular the IETF[9], and which could bring more dynamicity and flexibility in the inter-domain interface, thus facilitating the deployment of end to end advanced services in the research and education community.

This study will focus on services supported on "hop-by-hop" infrastructure (IP) as well as services over circuit-oriented infrastructure (IP/MPLS). In particular following subjects will be addressed:

- evolution of BGP for the exchange of flow specifications rules between Autonomous Systems (domains), for example for intra and inter provider distribution of traffic filtering rules to filter (Distributed) Denial of Service (DoS) attacks[10].
- evolution of multicast services to ensure end-to-end connectivity across unicast domains without the configuration of explicit tunnels (Automatic Multicast Tunnelling)[11];
- L3, L2, and VPLS[12] inter-domain VPNs, with the 2547bis in the context of research and education networks;
- inter-domain GMPLS[13] Traffic Engineering[14];
- Multipoint LSP[15]: circuit-oriented services like MPLS bring significant advantages to the community, but with this model it is challenging to handle

[8] Multi Protocol Label Switching
[9] Internet Engineering Task Force
[10] IETF draft-marques-idr-flow-spec
[11] IETF draft-ietf-mboned-auto-multicast
[12] Virtual Private LAN Service
[13] Generalized MPLS
[14] IETF draft-ayyangar-ccamp-inter-domain-rsvp-te

multicast in a scalable way. The IETF proposes some new solutions based on multipoint LSPs, with concrete applications both for L3 VPNs and VPLS[16].

With a pragmatic and realistic approach, this proposal relates to standardization efforts supported by major industrials of the Internet, and focus on services in harmony with some major objectives expressed by the Research & Education community. This should bring new design elements to the discussions, and perhaps initiate new studies on the network deployments realizable in the short or medium term in current infrastructures.

Vitae

Jean-Marc Uzé is consultant at Juniper Networks since 2001, and his role is focused on Research, Education and Government Networks and Institutions.
Jean-Marc spent 4 years at GIP Renater (the French Academic Research Network). As Project Director, he led the Renater 2 Project, the new generation National Research Network of France. As International Project Manager, he was involved in several projects such as TEN-34, TEN-155 and the US connectivity. In addition, he led and coordinated the MPLS activities of the European technical Task Force TF-TEN and TF-TANT.
Jean-Marc has a Master of Science in Network Engineering, and started his carrier as head of the Data-processing center of INRA, the French Agronomic Research Institute in Versailles, France.

[15] Label Switched Path (circuit MPLS)
[16] IETF draft-rosen-vpn-mcast, draft-raggarwa-l3vpn-2547-mvpn, draft-raggarwa-l3vpn-mvpn-vpls-mcast