SDN-assisted IP Multicast

IP multicast is a distribution paradigm that sends IP packets to multiple receivers in a single transmission, in a one-to-many or many-to-many fashion. Multicast employs in-network techniques to duplicate packets only in key network locations and hence reduce the number of identical flows carrying the same data from the source server(s) to the destinations. This allows reducing source server load and increasing network capacity savings. IP multicast supports a variety of applications such as IPTV streaming, video conferencing, multi-location backups or online multi-player gaming.

Despite the good intentions behind the design of IP Multicast [1, 2], its current service model and architecture does not efficiently provide adequate features and support for large scale real-world deployment. Some key deployment problems are [3, 4] :

1. Lack of **authentication, authorisation and accounting** of clients wanting to send or receive multicast traffic. For example, if multiple clients transmit data to the same multicast address then streams will collide. Additionally, unauthorised clients should not be able to receive multicast traffic if they have not paid to receive the relevant traffic.
2. Lack of efficient and scalable **group management and membership access control**. For example, not all clients should be able to create new multicast groups.
3. Lack of **security protection** against attacks on routing and the integrity of multicast packets. For example, flooding multicast IP addresses would cause network congestion and packet loss.
4. Increased **complexity** due to the **creation and maintenance of multicast distribution trees** by routers. To carry out multicast routing, routers have to be able to run a variety of different multicast distribution protocols (each suited to a different network scale) that introduce a high network communication overhead. This overhead is attributed first, to the way multicast protocols discover neighbours and create multicast trees (which sometimes requires flooding) and secondly, to the high number of communication messages that neighbouring routers have to exchange in order to update their multicast trees, every time a client joins or leaves a multicast group. In addition, routers on a multicast tree have to process a large number of packets and keep states for each multicast group they route packets for, despite their limited processing and storage resources. The problem of creating and updating multicast distribution trees becomes larger if multi-domain or multi-source scenarios are considered.
5. Lack of efficient **multicast support on hardware** on routers. If edge devices support multicast, they usually process multicast packets on their slower software path, leading to increased CPU load and in turn occasional dropping of non-multicast packets. On the other end, in many scenarios core routers do not want to process multicast packets that require special treatment, so that they can unintelligently handle higher-capacity traffic.
6. Lack of an efficient mechanism for **unique allocation** of multicast IP addresses on a worldwide (i.e. Internet) scale [5].

Software Dened Networking (SDN) is a new, very promising, networking approach that facilitates the decoupling of the control plane in a network (i.e. the decision making entity) from the data plane (i.e. the underlying forwarding system). OpenFlow [6], currently the prominent SDN protocol, defines the communication between the Layer 2 networking devices (i.e. switches) and the controller of the network. With the centralised network perspective that OpenFlow provides through its controller, a network administrator has an overarching view of the current status of the network and can interact with its network devices.

The two aforementioned reasons (i.e. the decoupling of the control and data planes of a network and the centralised view that an SDN controller provides) make SDN a potential solution to some of the deployment problems that IP multicast currently entails [7, 8]. With the use of SDN, we can afford to move the processing, managenent and control overhead centrally (to the SDN controller) and alleviate this burden from the network equipment. This approach would essentially allow the network switches and routers to eventually perform their one key task: fast forwarding of packets.

This project aims to examine the applicability of SDN to address part of the aforementioned IP multicast deployment problems. In particular, the student should identify one (or more) key multicast deployment problems and leverage SDN to address it (them). The outcome of this project should be a prototype SDN-assisted IP multicast implementation.

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