IP Multicast using IPOP overlay network

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Background and Motivations

- Current multicast requires routers to maintain additional network state and address translation.
- Secure channel for data transfer between multicast source and destination.
- Need for eliminating packet redundancy within a network.
- IP Multicast supports limited multicast group addresses.
- Need for reconfigurable network depending on amount of data transferred between nodes within a network.
- Improve bandwidth of Video streaming servers by running multicast client systems in a single overlay network.

Key Features

- Secure channel for data dissemination from multicast source to targets.
- Reduce channel overhead and improved network bandwidth.
- ARP and IGMP messages used to build overlay routing table.
- Peer-to-peer links with integrated NAT traversal enabling systems behind private LAN/router to act as a multicast source.
- IPv4 and IPv6 virtual networking – supports existing applications
- Support for unicast/ point to point messaging between nodes in the network as a special case.
- Support for on-demand connection between nodes in the network.

Use Cases and Research Users

- Wireless ad-hoc multicast network for mobile devices, edge devices and sensors.
- Streaming applications
  - Audio/ Video streaming applications
- Act as underlying protocol for multicast technologies like d-PAM, Cache-And-Relay and o-stream.
- Group communication between master and worker nodes in map-reduce applications.
- Distributed computing and file system applications.
- Scalable multicast for data center networks.

Future Work

- Multi-path routing capability.
- Congestion detection within the overlay network for faster message delivery.
- Dynamic client aggregation for video streaming application.
- Create Multicast tree within IPOP node to reduce messages sent through the overlay network.

Architecture Overview

Major modules:

- **Broadcast module**: sends IGMP membership query and report to all the nodes in the network.
- **IP Multicast module** that builds the peer node / client list from the ARP request and IGMP membership report messages.
- **Topology Manager** module that sends multicast data to all members of the group and which also decides creation of on-demand peer to peer overlay link depending on amount of data send to a particular node.
- **Listener module** that receives data from the network interface for e.g. Ethernet, WIFI or Bluetooth.
- **NodeDiscovery** module that captures ARP messages to managed all systems attached to an IPOP node in switch mode.

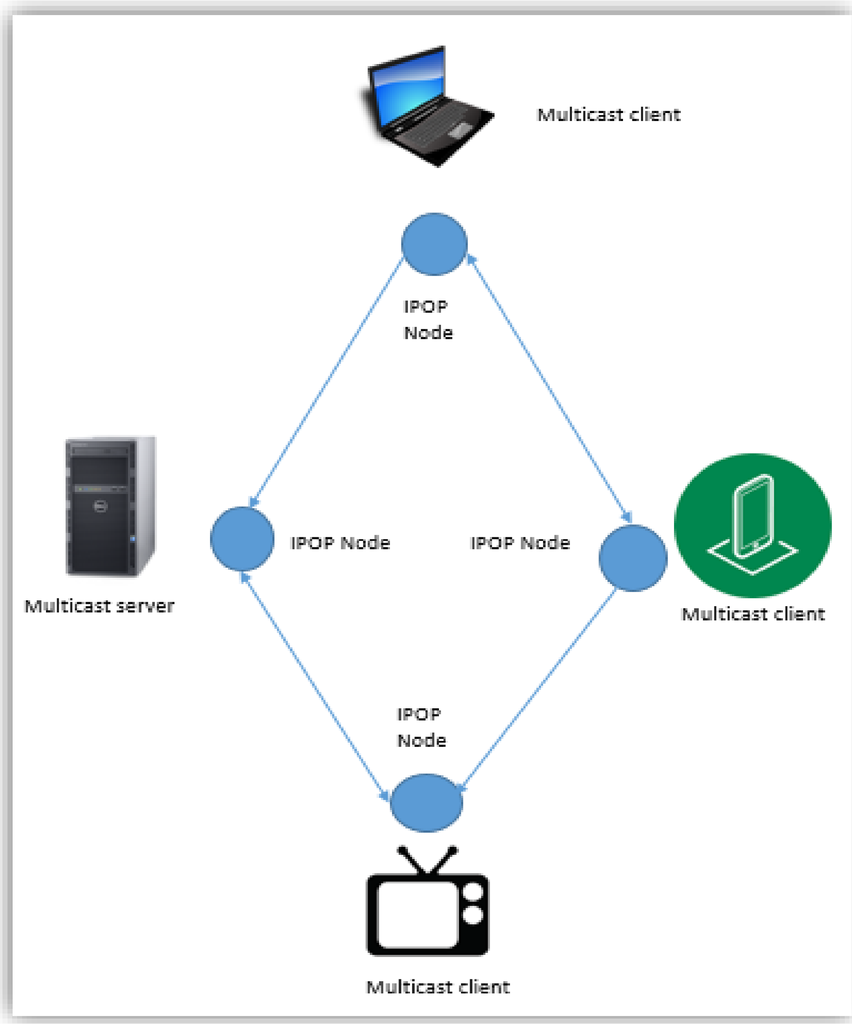

Figure 1: IPOP Multicast Network

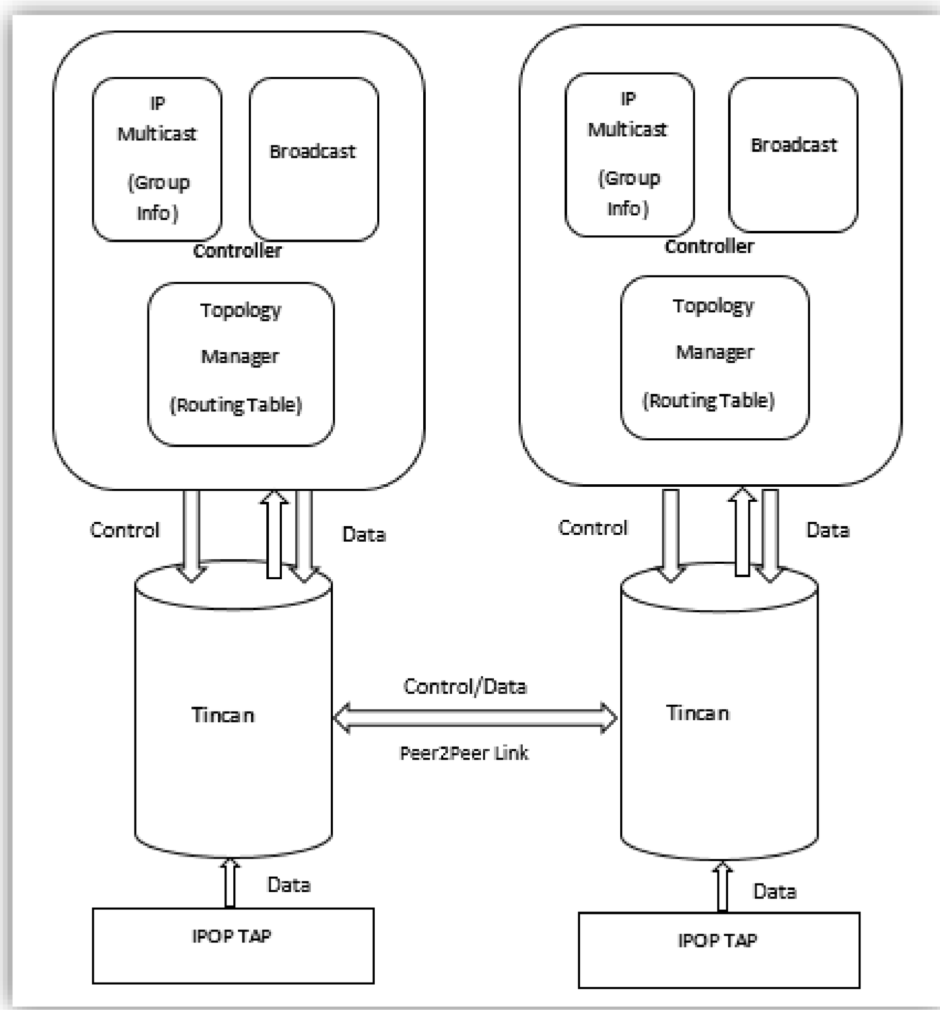

Figure 2: IPOP Multicast Architecture

- Each IPOP node acts as a virtual multicast router broadcasting IGMP membership query messages to retrieve multicast addresses currently in use within the overlay network.
- The IGMP Membership Report messages sent by each IPOP node is used to create Multicast Table. The table contains the information of all the IPOP node subscribing to a multicast address.
- Multicast table enables multiple multicast address to be assigned to a single IPOP node, thereby overcoming scalability issue of traditional IP multicast.
- During data dissemination, multicast address specified in the IP header is used to query the multicast table to obtain the list of IPOP nodes subscribed to the multicast address.
- An IPOP node in switch mode can be made to group together all systems that require information from a common source.
- Supports IGMP version 3 as well as legacy IGMP messaging formats like IGMPv2 and IGMPv1.
- NAT traversal achieved with the help of STUN and TURN servers enables systems within private networks to form multicast network.(Useful for video streaming and IOT applications)
- On-Demand link creation between nodes of the IPOP network depending of the amount of data sent to a multicast destination node enables IPOP network to withstand sudden changes in load.
- Minimum control messages required to maintain multicast and routing tables.

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