Multicast on 802.11

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History

- IP predominantly over 802.3 wired networks
- Low packet loss
- Broadcast/multicast efficient
- Uni-/Multi-/Broadcast similar packet loss

Ethernet

- In most (IETF) minds, “Ethernet” anything with 802.2 frame type over any link layer
- Still same expectation on low packet loss for uni-/multi-/broadcast because of 802.3 history
- Packet loss expected to be less than 1%

End user expectation

- Users purchase devices with wired and wireless technology and expects “Internet” to “just work”

Broadcast/Multicast use

- Control plane for IPv4 and IPv6
- Service discovery
- Applications (video delivery, stock data etc)
- Other L3 protocols (non-IP)

IPv4

- IPv4 uses ARP/DHCP as control plane
- ARP/DHCP uses broadcast, but mainly at initial discovery phase, not steady-state
- ARP requests only for new stations or stations we haven’t heard from for a long time
- Only frequent broad-/multicast is for service discovery (mDNS)

IPv6

- IPv6 makes extensive use of multicast for its control plane (ND and DHCPv6), more packets than IPv4 broadcast control plane
- Control plane does some liveliness detection both actively and passively over multicast (RA), services are announced and discovered over multicast
- Expectation that multicast packet loss is low (less than 1%), a few consecutive losses of packets might mean resource considered gone and resources based on service announcement are deconfigured (addresses/routes for instance)
- Control plane packets for IPv6 are generally delay tolerant, but sensitive to packet loss and RTT in excess of 1s (DAD) and even less delay sensitive for other types of control packets

Other multicast

- There are other L3 protocols that make extensive use of Ethernet multicast
- OSI IS-IS is one example (not transported over IP), all traffic sent to multicast address.
- IS-IS mostly used in ISP backbones over wired links, but has also seen use for L2 control plane (TRILL) and also considered for home networking (HOMENET) where routers might be connected using 802.11
- There is no MLD/IGMP for non-IP L2 multicast group subscription

802.11 Reality

- In its basic form, 802.11 treats unicast differently from multicast/broadcast, there is no retransmission of multicast/broadcast
- Reports of 20% multicast/broadcast loss in certain congested/marginal cases (where unicast still works due to retransmits) making IPv6 resources time out and getting deconfigured intermittently
- Reports that frequent multicast (after IPv6 enablement) is not energy efficient on 802.11, causes battery drain on terminals
- This has caused people to voice opinions in the IETF to severely limit use of broadcast/multicast except in case of discovery of new resources.
- IPv6 is more adversely affected by multi-/broadcast packet loss compared to IPv4 (in steady-state IPv4 uses mainly unicast to keep its control plane information after initial startup)

802.11 properties - 1

- 802.11 operates in unlicensed frequency bands. There are no guarantees that any traffic gets through.
- 802.11 MAC layer packets can be lost due to collision, interference, poor rate adaptation decisions, changes in the radio channel (e.g. walking behind a steel-reinforced pillar).
- A 10% “packet error ratio” is not unreasonable, but this is metric with a *lot* of noise in it.
- Unicast traffic is retried up to some limit (typically 4-12 times). This improves reliability, but it’s still subject to higher-layer packet loss

802.11 properties - 2

- Multicast / broadcast traffic is generally not retransmitted, because there is no acknowledgement
- Multicast / broadcast traffic is generally sent at a “lowest common denominator” rate, known as a basic rate. This might be as low as 6 Mbps, when unicast links are operating at 600 Mbps.
- There are options, that are not commonly implemented or certified to improve reliability – GCR (groupcast with retries).
- There’s also the flexible multicast service that allows a multicast rate to be selected that is higher than a basic rate.

802.11 properties - 3

- Both unicast and multicast traffic can be delayed by power-saving mechanisms.
- Unicast is delayed until a STA wakes up and asks for it. Additionally, unicast traffic may be delayed to improve efficiency and increase probability of aggregation.
- Multicast traffic is delayed in a wireless network if any of the STAs in that network are power savers. All STAs are awake at a known time to receive multicast traffic. This interval is, by default, around 500ms.
- Higher layer packets can be discarded due to buffer limitations in the AP and non-AP.

802.11 implementer's option

- An 802.11 AP manufacturer might optimize certain multicast-related behaviours
- There's nothing in the standard to stop them turning multicast into unicast traffic
- There is support in the standard for ARP proxying