Multicast address

A **multicast address** is a logical identifier for a group of hosts in a computer network that are available to process datagrams or frames intended to be multicast for a designated network service. Multicast addressing can be used in the link layer (layer 2 in the OSI model), such as Ethernet multicast, and at the internet layer (layer 3 for OSI) for Internet Protocol Version 4 (IPv4) or Version 6 (IPv6) multicast.

Contents

IPv4

IPv4 multicast addresses are defined by the most-significant bit pattern of *1110*. This originates from the classful network design of the early Internet when this group of addresses was designated as *Class D*. The CIDR notation for this group is *224.0.0.0/4*. The group includes the addresses from *224.0.0.0* to *239.255.255.255*. Address assignments from within this range are specified in RFC 5771, an Internet Engineering Task Force (IETF) *Best Current Practice* document (BCP 51).

The address range is divided into blocks each assigned a specific purpose or behavior.

IP multicast address range	Description	Routable
224.0.0.0 to 224.0.0.255	Local subnetwork[1]	No
224.0.1.0 to 224.0.1.255	Internetwork control	Yes
224.0.2.0 to 224.0.255.255	AD-HOC block 1[2]	Yes
224.3.0.0 to 224.4.255.255	AD-HOC block 2[3]	Yes
232.0.0.0 to 232.255.255.255	Source-specific multicast[1]	Yes
233.0.0.0 to 233.251.255.255	GLOP addressing[4]	Yes
233.252.0.0 to 233.255.255.255	AD-HOC block 3[5]	Yes
234.0.0.0 to 234.255.255.255	Unicast-prefix-based	Yes
239.0.0.0 to 239.255.255.255	Administratively scoped[1]	Yes

Local subnetwork
Addresses in the range of *224.0.0.0* to *224.0.0.255* are individually assigned by IANA and designated for multicasting on the local subnetwork only. For example, the Routing Information Protocol (RIPv2) uses *224.0.0.9*, Open Shortest Path First (OSPF) uses *224.0.0.5* and *224.0.0.6*, and Multicast DNS uses *224.0.0.251*. Routers must not forward these messages outside the subnet from which they originate.

Internetwork control block
Addresses in the range *224.0.1.0* to *224.0.1.255* are individually assigned by IANA and designated as the *internetwork control block*. This block of addresses is used for traffic that must be routed through the public Internet, such as for applications of the Network Time Protocol using *224.0.1.1*.

AD-HOC block
Addresses in three separate blocks are not individually assigned by IANA. These addresses are globally routed and are used for applications that don't fit either of the previously described purposes.[6]

Source-specific multicast
The *232.0.0.0/8* (IPv4) and *ff3x::/32* (IPv6) blocks are reserved for use by source-specific multicast.

GLOP

The *233.0.0.0/8* range was originally assigned by RFC 2770 (https://tools.ietf.org/html/rfc2770) as an experimental, public statically-assigned multicast address space for publishers and Internet service providers that wished to source content on the Internet. The allocation method is termed GLOP addressing and provides implementers a block of 255 addresses that is determined by their 16-bit autonomous system number (ASN) allocation. In a nutshell, the middle two octets of this block are formed from assigned ASNs, giving any operator assigned an ASN 256 globally unique multicast group addresses.[7] The method is not applicable to the newer 32-bit ASNs. RFC 3180 (https://tools.ietf.org/html/rfc3180), superseding RFC 2770 (https://tools.ietf.org/html/rfc2770), envisioned the use of the range for many-to-many multicast applications. Unfortunately, with only 256 multicast addresses available to each autonomous system, GLOP is not adequate for large-scale broadcasters.

Unicast-prefix-based

The *234.0.0.0/8* range is assigned by RFC 6034 (https://tools.ietf.org/html/rfc6034) as a range of global IPv4 multicast address space provided to each organization that has */24* or larger globally routed unicast address space allocated; one multicast address is reserved per */24* of unicast space. A resulting advantage over GLOP is that the unicast-prefix mechanism resembles the unicast-prefix capabilities of IPv6 as defined in RFC 3306 (https://tools.ietf.org/html/rfc3306).

Administratively scoped

The *239.0.0.0/8* range is assigned by RFC 2365 for private use within an organization. Per the RFC, packets destined to administratively scoped IPv4 multicast addresses do not cross administratively defined organizational boundaries, and administratively scoped IPv4 multicast addresses are locally assigned and do not have to be globally unique. The RFC also discusses structuring the *239.0.0.0/8* range to be loosely similar to the scoped IPv6 multicast address range described in RFC 1884 (https://tools.ietf.org/html/rfc1884).

Notable addresses

The following table is a list of notable well-known IPv4 addresses that are reserved for IP multicasting and that are registered with the Internet Assigned Numbers Authority (IANA).[8]

IP multicast address	Description	Routable
224.0.0.0	Base address (reserved)	No
224.0.0.1	The *All Hosts* multicast group addresses all hosts on the same network segment.	No
224.0.0.2	The *All Routers* multicast group addresses all routers on the same network segment.	No
224.0.0.4	This address is used in the Distance Vector Multicast Routing Protocol (DVMRP) to address multicast routers.	No
224.0.0.5	The Open Shortest Path First (OSPF) *All OSPF Routers* address is used to send Hello packets to all OSPF routers on a network segment.	No
224.0.0.6	The OSPF *All Designated Routers* ""(DR)"" address is used to send OSPF routing information to designated routers on a network segment.	No
224.0.0.9	The Routing Information Protocol (RIP) version 2 group address is used to send routing information to all RIP2-aware routers on a network segment.	No
224.0.0.10	The Enhanced Interior Gateway Routing Protocol (EIGRP) group address is used to send routing information to all EIGRP routers on a network segment.	No
224.0.0.13	Protocol Independent Multicast (PIM) Version 2	No
224.0.0.18	Virtual Router Redundancy Protocol (VRRP)	No
224.0.0.19–21	IS-IS over IP	No
224.0.0.22	Internet Group Management Protocol (IGMP) version 3[9]	No
224.0.0.102	Hot Standby Router Protocol version 2 (HSRPv2) / Gateway Load Balancing Protocol (GLBP)	No
224.0.0.107	Precision Time Protocol (PTP) version 2 peer delay measurement messaging	No
224.0.0.251	Multicast DNS (mDNS) address	No
224.0.0.252	Link-local Multicast Name Resolution (LLMNR) address	No
224.0.0.253	Teredo tunneling client discovery address[10]	No
224.0.1.1	Network Time Protocol clients listen on this address for protocol messages when operating in multicast mode.	Yes
224.0.1.22	Service Location Protocol version 1 general	Yes
224.0.1.35	Service Location Protocol version 1 directory agent	Yes
224.0.1.39	The Cisco multicast router *AUTO-RP-ANNOUNCE* address is used by RP mapping agents to listen for candidate announcements.	Yes
224.0.1.40	The Cisco multicast router *AUTO-RP-DISCOVERY* address is the destination address for messages from the RP mapping agent to discover candidates.	Yes
224.0.1.41	H.323 Gatekeeper discovery address	Yes
224.0.1.129–132	Precision Time Protocol (PTP) version 1 messages (Sync, Announce, etc.) except peer delay measurement	Yes
224.0.1.129	Precision Time Protocol (PTP) version 2 messages (Sync, Announce, etc.) except peer delay measurement	Yes
239.255.255.250	Simple Service Discovery Protocol address	Yes
239.255.255.253	Service Location Protocol version 2 address	Yes

IPv6

Multicast addresses in IPv6 use the prefix *ff00::/8*. IPv6 multicast addresses can be structured using the old format (RFC 2373) or the new format (RFC 3306, updated by RFC 7371).

General multicast address format (old)

Bits	8	4	4	112
Field	*prefix*	*flags*	*scope*	*group ID*

General multicast address format (new)

Bits	8	4	4	4	4	8	64	32
Field	*prefix*	*ff1*	*scope*	*ff2*	*reserved*	*plen*	*network prefix*	*group ID*

The *prefix* holds the value *ff* for all multicast addresses.

Currently, 3 of the 4 flag bits in the *flags* field (*ff1*) are defined;[11] the most-significant flag bit is reserved for future use. The other three flags are known as *R*, *P* and *T*.

Multicast address flags[12]

Bit[note 1]	Flag	0	1
0 (MSB)	Reserved	(Reserved)	(Reserved)
1	R (Rendezvous)[13]	Rendezvous point not embedded	Rendezvous point embedded
2	P (Prefix)[14]	Without prefix information	Address based on network prefix
3 (LSB)	T (Transient)[15]	Well-known multicast address	Dynamically assigned multicast address

Similar to a unicast address, the *prefix* of an IPv6 multicast address specifies its scope, however, the set of possible scopes for a multicast address is different. The 4-bit *sc* (or scope) field (bits 12 to 15) is used to indicate where the address is valid and unique.

Multicast address scope

IPv6 address[note 2]	IPv4 equivalent[16]	Scope	Purpose
`ff00::/16`, `ff0f::/16`		Reserved	
`ffx1::/16`	`127.0.0.0/8`	Interface-local	Packets with this destination address may not be sent over any network link, but must remain within the current node; this is the multicast equivalent of the unicast loopback address.
`ffx2::/16`	`224.0.0.0/24`	Link-local	Packets with this destination address may not be routed anywhere.
`ffx3::/16`	`239.255.0.0/16`	IPv4 local scope	
`ffx4::/16`		Admin-local	The smallest scope that must be administratively configured.
`ffx5::/16`		Site-local	Restricted to the local physical network.
`ffx8::/16`	`239.192.0.0/14`	Organization-local	Restricted to networks used by the organization administering the local network. (For example, these addresses might be used over VPNs; when packets for this group are routed over the public internet (where these addresses are not valid), they would have to be encapsulated in some other protocol.)
`ffxe::/16`	`224.0.1.0`–`238.255.255.255`	Global scope	Eligible to be routed over the public internet.

The service is identified in the *group ID* field. For example, if *ff02::101* refers to all Network Time Protocol (NTP) servers on the local network segment, then *ff08::101* refers to all NTP servers in an organization's networks. The *group ID* field may be further divided for special multicast address types.

The following table is a list notable IPv6 multicast addresses that are registered with IANA.[17]

Notable IPv6 multicast addresses

Address	Description
ff02::1	All nodes on the local network segment
ff02::2	All routers on the local network segment
ff02::5	OSPFv3 All SPF routers
ff02::6	OSPFv3 All DR routers
ff02::8	IS-IS for IPv6 routers
ff02::9	RIP routers
ff02::a	EIGRP routers
ff02::d	PIM routers
ff02::16	MLDv2 reports (defined in RFC 3810)
ff02::1:2	All DHCP servers and relay agents on the local network segment (defined in RFC 3315)
ff02::1:3	All LLMNR hosts on the local network segment (defined in RFC 4795)
ff05::1:3	All DHCP servers on the local network site (defined in RFC 3315)
ff0x::c	Simple Service Discovery Protocol
ff0x::fb	Multicast DNS
ff0x::101	Network Time Protocol
ff0x::108	Network Information Service
ff0x::181	Precision Time Protocol (PTP) version 2 messages (Sync, Announce, etc.) except peer delay measurement
ff02::6b	Precision Time Protocol (PTP) version 2 peer delay measurement messages
ff0x::114	Used for experiments

Ethernet

Ethernet frames with a value of 1 in the least-significant bit of the first octet[note 3] of the destination MAC address are treated as multicast frames and are flooded to all points on the network. While frames with ones in all bits of the destination address (FF-FF-FF-FF-FF-FF) are sometimes referred to as broadcasts, Ethernet network equipment generally does not distinguish between multicast and broadcast frames. Modern Ethernet controllers filter received packets to reduce CPU load, by looking up the hash of a multicast destination address in a table, initialized by software, which controls whether a multicast packet is dropped or fully received.

The IEEE has allocated the address block 01-80-C2-00-00-00 to 01-80-C2-FF-FF-FF for group addresses for use by standard protocols. Of these, the MAC group addresses in the range of 01-80-C2-00-00-00 to 01-80-C2-00-00-0F are not relayed by MAC bridges conforming to 802.1D.[18]

Some well known Ethernet multicast addresses[19]

Ethernet multicast address	Type Field	Usage
01-00-0C-CC-CC-CC		CDP (Cisco Discovery Protocol), VTP (VLAN Trunking Protocol), UDLD (Unidirectional Link Detection)
01-00-0C-CC-CC-CD		Cisco Shared Spanning Tree Protocol Address
01-80-C2-00-00-00		Spanning Tree Protocol (for bridges) IEEE 802.1D
01-80-C2-00-00-00, 01-80-C2-00-00-03 or 01-80-C2-00-00-0E	0x88CC	Link Layer Discovery Protocol
01-80-C2-00-00-08	0x0802	Spanning Tree Protocol (for provider bridges) IEEE 802.1ad
01-80-C2-00-00-01	0x8808	Ethernet flow control (Pause frame) IEEE 802.3x
01-80-C2-00-00-02	0x8809	"Slow protocols" including Ethernet OAM Protocol (IEEE 802.3ah) and Link Aggregation Control Protocol (LACP)
01-80-C2-00-00-21	0x88f5	GARP VLAN Registration Protocol (also known as IEEE 802.1q GVRP)
01-80-C2-00-00-30 through 01-80-C2-00-00-3F	0x8902	Ethernet CFM Protocol IEEE 802.1ag
01-00-5E-00-00-00 through 01-00-5E-7F-FF-FF	0x0800	IPv4 Multicast (RFC 1112), insert the low 23 Bits of the multicast IPv4 Address into the Ethernet Address (RFC 7042 2.1.1.)
33-33-00-00-00-00 through 33-33-FF-FF-FF-FF	0x86DD	IPv6 Multicast (RFC 2464), insert the low 32 Bits of the multicast IPv6 Address into the Ethernet Address (RFC 7042 2.3.1.)
01-0C-CD-01-00-00 through 01-0C-CD-01-01-FF	0x88B8	IEC 61850-8-1 GOOSE Type 1/1A
01-0C-CD-02-00-00 through 01-0C-CD-02-01-FF	0x88B9	GSSE (IEC 61850 8-1)
01-0C-CD-04-00-00 through 01-0C-CD-04-01-FF	0x88BA	Multicast sampled values (IEC 61850 8-1)
01-1B-19-00-00-00 or 01-80-C2-00-00-0E	0x88F7	Precision Time Protocol (PTP) version 2 over Ethernet (layer-2)

802.11

802.11 wireless networks use the same 01:00:5E:xx:xx:xx and 33:33:xx:xx:xx:xx MAC addresses for multicast as Ethernet.

See also

- Broadcast address
- Reserved IP addresses

Notes

1. The recommended style for Request for Comments (RFC) documents is "MSB 0" bit numbering.
2. *x* is a place holder indicating that the value of the *flags* field is unimportant in the current discussion.
3. On Ethernet, the least-significant bit of an octet is the first to be transmitted. A multicast is indicated by the first transmitted bit of the destination address being 1.

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