ICMP Router Discovery Messages

1. Protocol overview

Router Advertisements: *Each router periodically multicasts a router advertsement from each of its multicast interfaces.*

Prefererence Level: *for each advertised router address. Default router chosen from router addresses with highest preference level.*

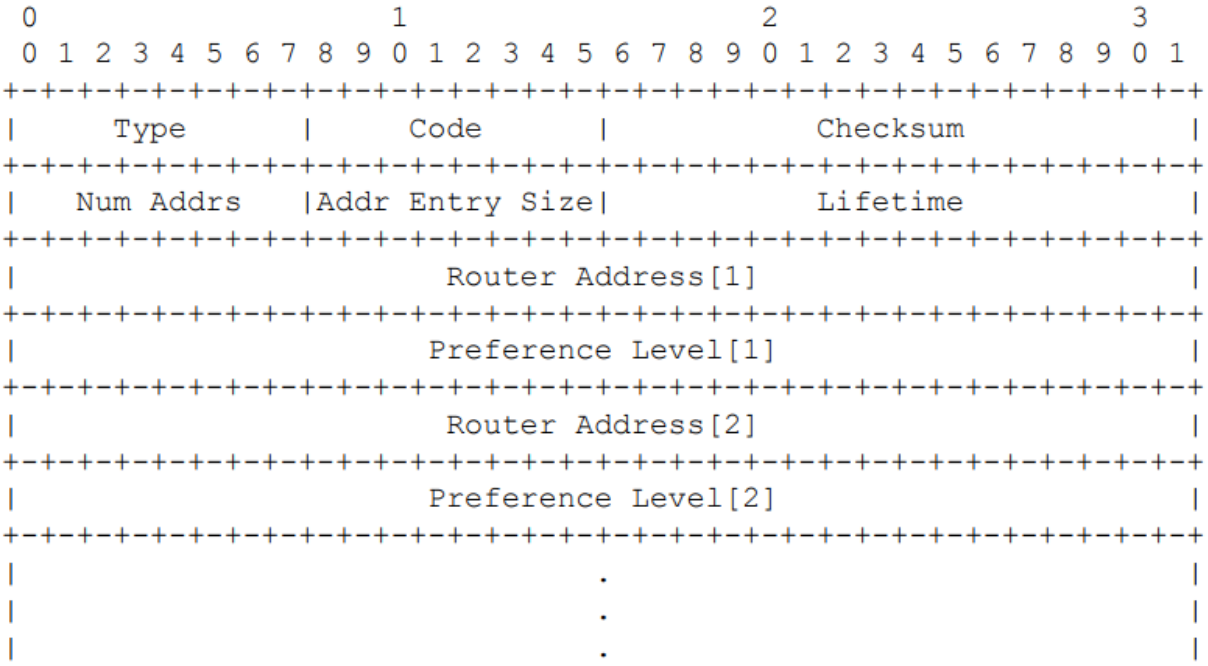
Lifetime: *Max time advertised addresses are considered valid router addresses by hosts.*

Router Solicitation: *When host attached to a multicast link starts up, it may multicast a router solicitation to ask for immediate advertisements. Iff no advertisements forthcoming, it may retransmit it a small number of times.*

Router discovery is not for routing, only for finding neighboring routers.

2. Message formats

ICMP Router Advertisement Message



IP fields:

Source Address: Interface of router

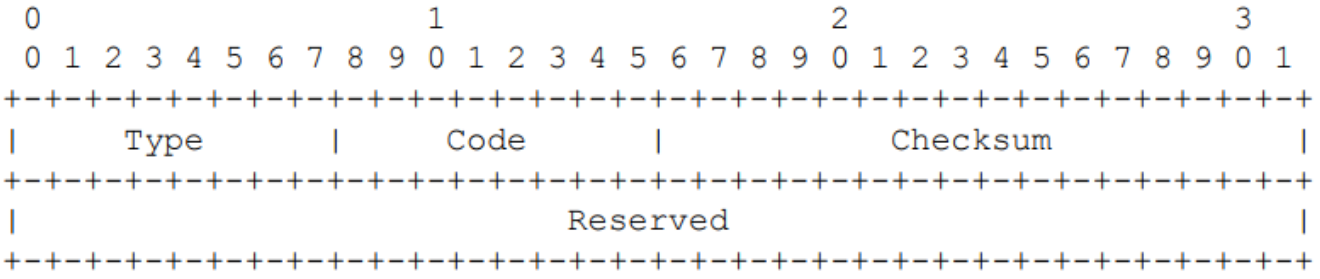
Destination Address: AdvertisementAddress (multicast) or IP address of host (unicast)

Time-to-Live: 1 if Dest is multicast, atleast 1 otherwise

ICMP fields:

Type:	9
Code:	0
Checksum:	16-bit one's complement
Num Addrs:	Number of addresses advertised in this message.
Addr Entry Size:	Number of 32-bit words of information per router address
Lifetime:	Max number of seconds that router addresses considered valid.
Router Address[i]:	Sending router's IP address(es) on the interface.
Preference Level[i]:	Preferability of each router address[i].

ICMP Router Solicitation Message



IP fields:

Source address:	Of interface, or 0.
Destination address:	SolicitationAddress (multicast)
Time-to-Live:	1 if Dest addr is multicast, at least 1 otherwise.

ICMP fields:

Type:	10
Code:	0
Checksum:	16-bit one's complement
Reserved:	Sent as 0, ignored on reception

3. Router specification

For each multicast interface:

AdvertisementAddress:	224.0.0.1/255.255.255.255	
MaxAdvertisementInterval:	Max time allowed between multicast advertisements	
	[4,1800] seconds.	Default: 600 seconds
MinAdvertisementInterval:	Min time allowed between unrequested multicast advertisements.	
	[3,MaxAdvInt] seconds.	Default: 0.75 * MaxAdvInt
AdvertisementLifetime:	Used in lifetime field of advertisements.	
	[MaxAdvInt,9000] seconds.	Default: 3 * MaxAdvInt

For each of router's IP addresses on its multicast interface:

Advertise:	Flag indicating whether address is advertised.	
		Default: TRUE
PreferenceLevel:	32-bit, signed, two's complement integer.	
	Min value: hex 8000 0000	Default: 0

hex 8000 0000 = Advertise True but can't be used as default router.

4. Message validation by Routers

Silently Discard if not valid:

- IP source address is 0 or address of a neighbor
- ICMP checksum is valid
- ICMP code is 0
- ICMP length is 8 or more octets

Ignore:

Contents of ICMP Reserved field + any octets beyond first 8.

Silently Discard:

Router advertisements

5. Router Behavior

- Router joins all-routers IP multicast group 244.0.0.2 on all interfaces that support multicast.
- If not all addresses fit in a single advertisement, multiple can be sent.
- Advertisements not strictly periodic, interval is randomized.
  - Each time multicast sent, timer = uniform_random * [MinAdvInt,MaxAdvInt]
  - Include some unique value (such as IP address) as seed
  - Use units of highest available timer resolution
- For first 0 to *MAX_INITIAL_ADVERTISEMENTS*
  - if interval > *MAX_INITIAL_ADVERT_INTERVAL* then interval is cut to that value.
- Response to valid solicitations, router can choose to
  - Unicast back
    - May delay random interval <= *MAX_RESPONSE_DELAY*
  - Multicast back
    - Reset timer
    - Must delay random interval <= *MAX_RESPONSE_DELAY*
- If router receives solicitation sent to broadcast address on interface whose AdvAddr is multicast address, router may send response to broadcast address. (Configuration incosistency → Log)
- Interface may become advertising interface at times other than startup
  - Enabling interface (if administratively disabled) with addrs that have advertise flag on true
  - Changing from host to router
    - Must join all-routers ip multicast group on all interfaces that support multicast
  - Setting advertise flag of some interfaces to true
- Interface may cease to be advertising interface
  - Administratively disabling interface
  - Shutting down system
  - Changing from router to host
    - Must depart from all-router ip multicast group on all interfaces that support multicast
  - Setting advertise flags of all interface's addresses to FALSE

Recommended but not required to transmit a final multicast advertisement identical to previous but with a Lifetime field of zero.

6. Host specification

For each multicast interface:

PerformRouterDiscovery: Default: True
SolicitationAddress: 224.0.0.2/255.255.255.255
List of default router addresses
RouterAddress
PreferenceLevel

7. Message Validation by Hosts

Silently discard if not valid:

- ICMP Checksum is valid
- ICMP Code is 0
- ICMP Num Addrs >= 1
- ICMP Addr Entry Size >= 2
- ICMP length >= 8 + (Num Addrs * Addr Entry Size * 4) octets

Ignore:

Content other than router address and preference level fields +
contents of any octets beyond the first 8 + (Num Addrs * Addr Entry Size * 4) octets.

Silently discard:

Received router solicitation messages
Router advertisement on interface with PerformRD is False

8. Host behavior

- Host is automatically member of all-systems IP multicast group 224.0.0.1
  on all interfaces on which the host supports IP multicast
- No router solicitation on interface with PerformRD = False
- Host cannot process advertisement until it has determined own IP address for interface.
  But it may save incoming advertisements for later processing
- Process advertisement: Scan list of router address, ignore non-neighboring ones.
  For each neighboring address:
  - If address not present in router list: add new entry (addr, preflevel, timer=advlifetime)
  - If address present: update preflevel + reset timer
  - If address present as a result of system configuration
    - No change in preflevel, there is no timer
- Whenever timer expires: entry is discarded
- Host may choose to not store all router addresses, discard lower preflevels
- May omit hex 8000 0000 from list
- If host redirected to particular router address, it continues to use that router address even if other has higher preflevel
- Host is permitted to transmit up to *MAX_SOLICITATIONS* messages from any of its interfaces after:
  - Interface is initialized at system startup
  - Interface reinitialized after temporary failure/disabled
  - Change from router to host
  - PerformRD flag for interface is changed from False to True
- After event: delay transmission w/ random * [0,*MAX_SOLICITATION_DELAY]* seconds
  - Use IP Address as seed
- Retransmissions should be sent at intervals of *SOLICITATION_INTERVAL* seconds, without randomization
- IP source may contain zero if host has not yet determined an address for the interface
- Host may choose to further postpone solicitation until the first time is needs a router

9. Protocol Constants

Router constants:

MAX_INITIAL_ADVERT_INTERVAL	16 seconds
MAX_INITIAL_ADVERTISEMENTS	3 transmissions
MAX_RESPONSE_DELAY	2 seconds

Host constants:

MAX_SOLICITATON_DELAY	1 second
SOLICITATION_INTERVAL	3 seconds
MAX_SOLICITATIONS	3 transmissions