IGMP and MLD Optimization in Wireless and Mobile Networks

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Aims

* Optimize IGMP and MLD to meet wireless or mobile multicast network requirements:
  * Adaptive to link conditions
  * Minimal group Join/Leave latency
  * Robust to packet loss
  * Reducing packet exchange
  * Avoiding packet burst

* Limit the changes within the protocol framework without introducing interoperability issues

* Possibly used in wired network where efficiency and robustness are required
Option List

* Switching between unicast and multicast Queries
* General Query supplemented with unicast Query
* Retransmission of General Query
* General Query suppression with no receiver
* Tuning Response Delay according to link type
* Triggering Report and Query quickly during handover
Switching Between Unicast and Multicast General Queries

- Add the capability of a router to query just 1 receiver by setting the destination as unicast address

- Enable the router to switch between unicast and multicast Queries according to actual network conditions
  - Use unicast Query to each receiver when number of valid receivers is small, while using multicast Query as normal when receiver number is large
  - A threshold is predefined to enable the switching
  - Explicit tracking is required to know the link state

- Benefits
  - Take advantages of both unicast and multicast Query
  - Unicast Query has less effect on non-members and helps improve batter-saving
General Query Supplemented with Unicast General Query

* Send unicast Query to non-respondent valid receivers after a run of normal General Query, presumably the scale of non-respondent receiver is small
* Reasons of non-responding valid receivers
  * Receiver silently leaves the network without notification
  * Reports are lost due to unstable link condition and etc.
* Trigger unicast Query at the end of the [Maximum Response Delay], and retransmit for [Last Member Query Count] times
* Require explicit tracking to be enabled
* Benefit
  * Improve Robustness without influencing other normal receivers
General Query Suppression with no Receiver

- Suppress General Query if there is no valid multicast receiver on an interface
- Example Scenarios
  - When last member reports its leave, by an explicit tracking router checking its membership database, or by a non-explicit-tracking router getting no response after sending Group-(and-Source-) Specific Queries
  - When the (only) member on a PTP link reports its leave
  - When a router after retransmitting General Queries on startup fails to get any response
  - When a router previously has valid members but fails to get any response after several rounds of General Queries.

- Benefit
  - Eliminate unnecessary continuous General Query have benefits for all terminal on the link for battery saving
Retransmission of General Query

* If after a General Query no response can be collected from all valid receivers, for one of the reasons of:
  * All valid receivers leave the group silently or moved out of range
  * All the responses of the receivers happen to be lost
  * Query does not arrive at the other side of the link to the receivers.
* Retransmit General Queries for [Last Member Query Count] times before deciding to stop General Query finally
* Require explicit tracking to be enabled
* Benefit
  * Improve robustness of General Query if there are valid members
  * Realize fast leave if all the receivers quit.
Tuning Response Delay according to link type and status

* Tuning maximum response delay according to link type and status to reduce message burst and leave latency, according to the expected number of responders, and link type and status:
  * If the expected number of reporters is large and/or link condition is bad, select larger [Maximum Response Delay]
  * If the expected number of reporters is small and/or the link condition is good, select smaller Delay
  * If link mode is PTP, choose smaller Delay; if link mode is PTMP or broadcast, configure larger Delay.
Triggering Reports and Queries during handover

* Access router triggers a Query (General Query or unicast General Query) as it detects a new terminal on its link.

* Terminal triggers a Report as soon as it detects connection to new network, if it is just in multicast reception state

* Benefits
  * During handover, new access network acquire terminal’s membership and deliver the content to the receiver quickly to help reducing disruption or performance deterioration.