



IGMPv3 Proxy

For BCM963xx DSL Linux

Version 1.1

October 28, 2013

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IGMPv3 Proxy How To

REVISION HISTORY

| <i>Revision Number</i> | <i>Date</i> | <i>Change Description</i> |
|-------------------------------|--------------------|---|
| V1.0 | 02/15/2007 | Initial Release. |
| V1.1 | 10/28/2013 | Add description of CMS internal configuration details |

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1.0 BACKGROUND

Multicast forwarding in edge CPE equipment like xDSL systems is based on simple tree topology. It is not necessary to run a multicast routing protocol. It is sufficient to learn and proxy group membership information and simply forward multicast packets based upon that information. Broadcom xDSL CPE equipment already supports IGMPv2 based proxy feature for multicast forwarding information. IGMPv2 had some limitations that were enhanced by IGMPv3 (RFC3376) standard track RFC to support applications like IPTV through Source Specific Multicast (SSM). IGMPv3 also reduces host side complexity and enhances the state change (group change) operation performance.

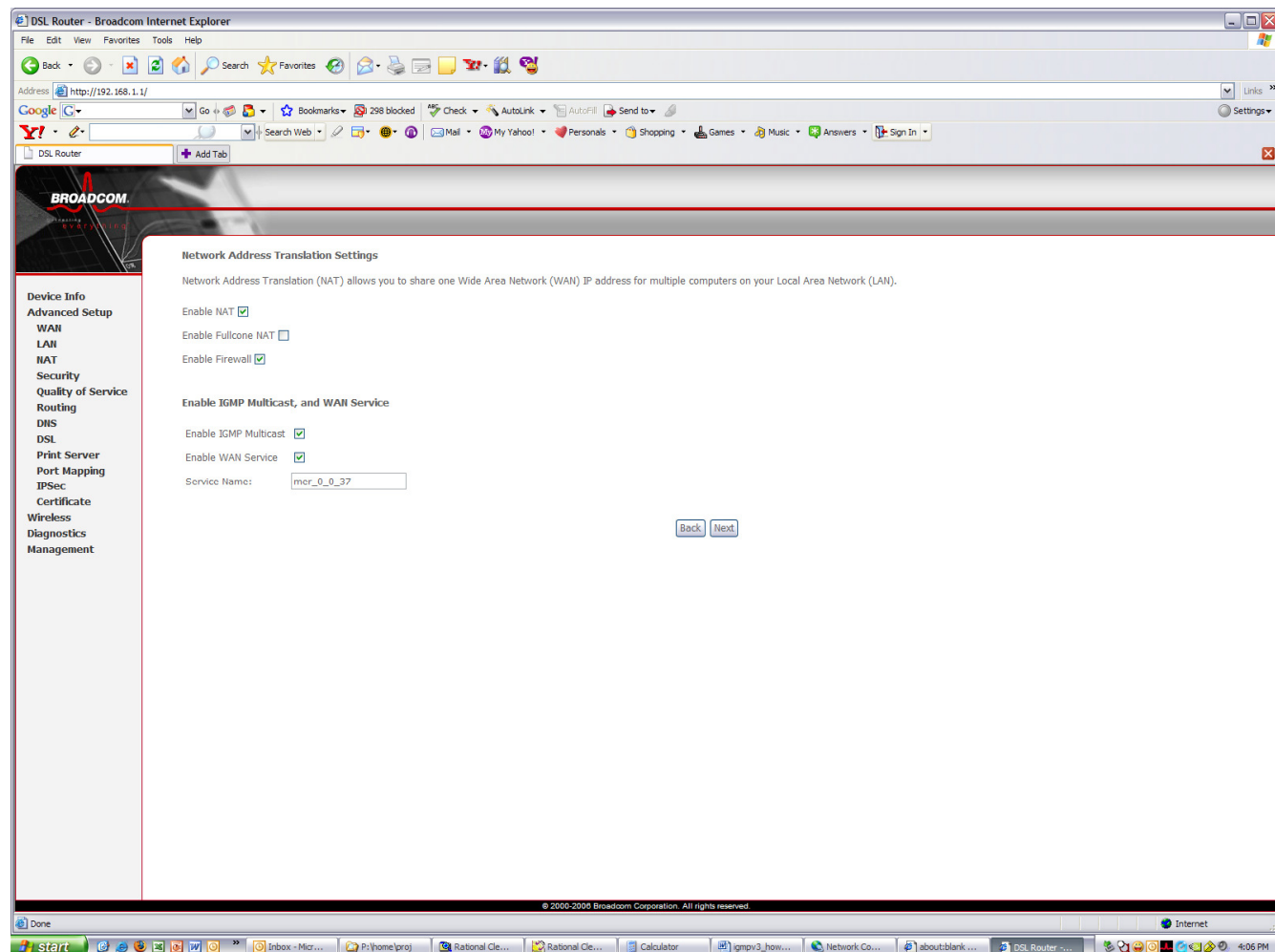
2.0 IGMPv3 FEATURES

IGMPv3 (RFC3376) brings following enhancements

1. IGMPv3 membership state is maintained as group multicast address and list of sources, not simply as group multicast address. i.e., user can select the multicast sources instead of just group as in version 2. This enables re-using group multicast address for different multicast sources.
2. Membership report has been enhanced to support new message types. IGMP client specify their filter options through following options.
 - i. CURRENT STATE RECORD (CSR) is either INCLUDE() or EXCLUDE()
 - ii. FILTER MODE CHANGE RECORD is either TO_IN() or TO_EX
 - iii. SOURCE LIST CHANGE RECORD is either ALLOW() or BLOCK()
3. A single report message can have information about multiple group multicast memberships
4. Membership queries can be of three types
 - i. General Query without group multicast address
 - ii. Group-Specific Query based on group multicast address
 - iii. Group-and-Source-Specific Query based on group multicast address and multicast source address
5. Leave group message in version 2 is enhanced to be as part of membership report. This enables leaving and joining new group message can be single one instead of two messages in case of version 2. So, switching between groups should be faster.
6. All IGMPv3 report messaging is destined to multicast address 224.0.0.22 instead of group address in version 2. This avoids the host side processing of multicast reports thereby reduces host side complexity.
7. IGMPv3 proxy merges all downstream filters for a group and issues a single filter request upstream.
8. Socket interface has been changed to support source specific multicast operations
9. New timers have been added with for group-source state
10. Backward compatible with previous versions

3.0 HOW TO CREATE IGMPv3 ENABLED SERVICES

While creating any non-bridge wan service, user has to select “Enable IGMP”. This is start the IGMP on that wan interface for multicast forwarding. If IGMP snooping has to be enabled then, it should be done under LAN section.



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4.0 IGMPv3 COMPATIBILITY AND RESTRICTIONS

IGMPv3 is compatible is backward compatible with earlier versions. It is advised that IGMP proxy should have only one wan interface enabled with IGMP to avoid any problems with upstream router looping. Currently, IGMPv3 snooping support for xDSL systems is there based on group multicast address. Future releases will enhance the IGMPv3 snooping to handle source specific multicast.

5.0 IGMPv3 TEST PLAN

IGMPv3 feature in details can be verified using the following test plan.

5.1 IGMP Proxy Join

Purpose: To verify the LAN client joins in the multicast group.

Discussion: Client connects directly to server through proxy.

Test Setup:



Procedure:

1. In shell, run "*vlc udp://<VLC-S>@<MCAST IP>:<port>*".
2. Start video LAN client with SSM option to play video from a video server.
3. Verify the LAN client joins in the multicast group through `MODE_IS_INCLUDE` filter and it plays the video.
4. Stop the video IGMP, it should stop playing the video and IGMPv3 membership expiry should happen with `BLOCK_OLD_SOURCES` filter.

Observable Results:

- LAN client joins in the multicast group.
- IGMPv3 membership expiry should happen.

5.2 LAN client without SSM

Purpose: To verify the LAN client joins in the multicast group.

Discussion: Client connects directly to server through proxy.

Test Setup:

**Procedure:**

1. In shell, run "*vlc udp://<VLC-S>@<MCAST IP>:<port>*".
2. Start the video LAN client without SSM option, i.e., just multicast group and make sure the video is playing from whichever video server is broadcast in that group.
3. IGMPv3 Proxy should have `MODE_IS_EXCLUDE` = null filter sending to the upstream router.
4. Stop the video to make sure the membership expires.

Observable Results:

- LAN client joins in the multicast group.
- IGMPv3 membership expiry should happen.

5.3 Continuous Regression Mode

Purpose: To verify the LAN client joins in the multicast group.

Discussion: Client connects directly to server through proxy.

Test Setup:

Same as in Test IGMP 6.1 and 6.2

Procedure:

1. In shell, run "*vlc udp://<VLC-S>@<MCAST IP>:<port>*".
2. Test either Test IGMP.1.1 or Test IGMP.1.2 in continuous regression mode, i.e., start and stop the video.
3. Set Leave Latency 10 sec.

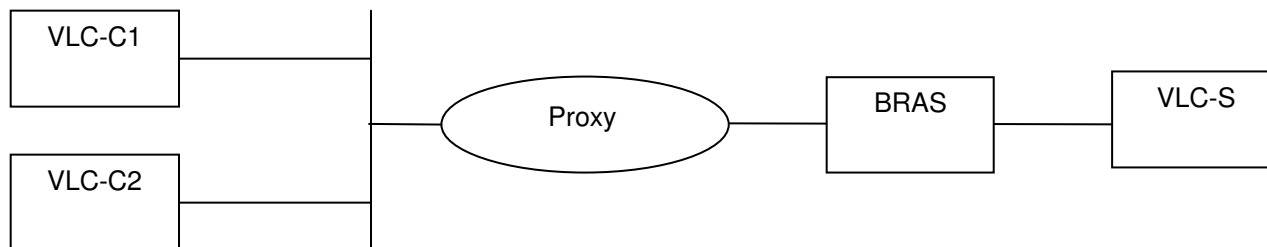
Observable Results:

- Make sure you the leave latency is achieved as configured.

5.4 Two different LAN clients with SSM

Purpose: To verify the LAN client joins in the multicast group.

Discussion: Two different clients connect to server through proxy.

Test Setup:**Procedure:**

1. In shell, run "*vlc udp://<VLC-S>@<MCAST IP>:<port>*".
2. Request same video from the two different LAN clients with SSM option in `MODE_IS_INCLUDE`.
3. IGMPv3 proxy should have one `MODE_IS_INCLUDE` filter with one source in `INCLUDE` mode.
4. Stop the video and make sure IGMPv3 membership expires.

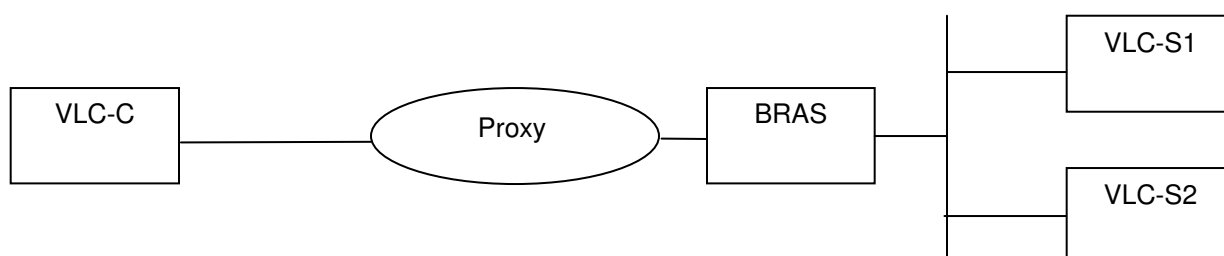
Observable Results:

- LAN client joins in the multicast group.
- IGMPv3 membership expiry should happen.
- Stops when one video clip stops.

5.5 Request two videos from the same LAN client with SSM

Purpose: To verify the LAN client joins in the multicast group.

Discussion: Client connects to two servers through proxy.

Test Setup:**Procedure:**

1. In shell, run "*vlc udp://<VLC-S>@<MCAST IP>:<port>*".
2. Request two videos from the same LAN client with SSM option in which each video stream is running from different servers.
3. IGMPv3 proxy should have two sources with `MODE_IS_INCLUDE` filter.
4. Stop the video and make sure IGMPv3 membership expires.

Observable Results:

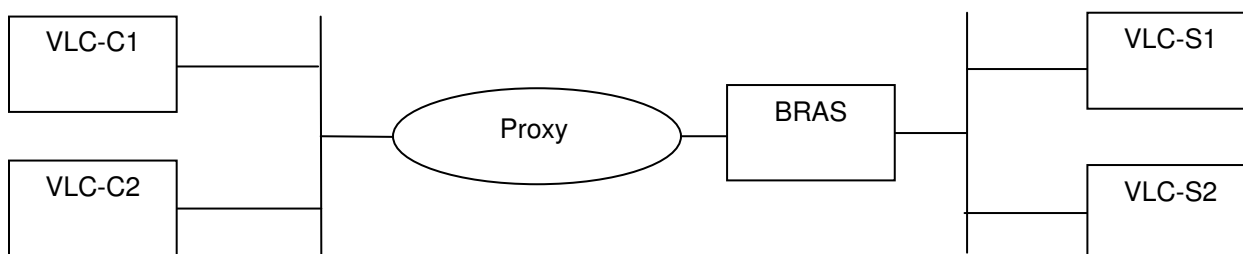
- LAN client joins in the multicast group.
- IGMPv3 membership expiry should happen.
- Stops when one video clip stops.

5.6 Request two videos from different LAN client with SSM

Purpose: To verify the LAN client joins in the multicast group.

Discussion: Two clients connect to two servers through proxy.

Test Setup:



Procedure:

1. In shell, run "*vlc udp://<VLC-S>@<MCAST IP>:<port>*".
2. Request two videos from the different LAN clients with SSM option in which each video stream is running from different servers.
3. IGMPv3 proxy should have two `MODE_IS_INCLUDE` with different sources in `INCLUDE` mode.
4. Stop the video and make sure IGMPv3 membership expires.

Observable Results:

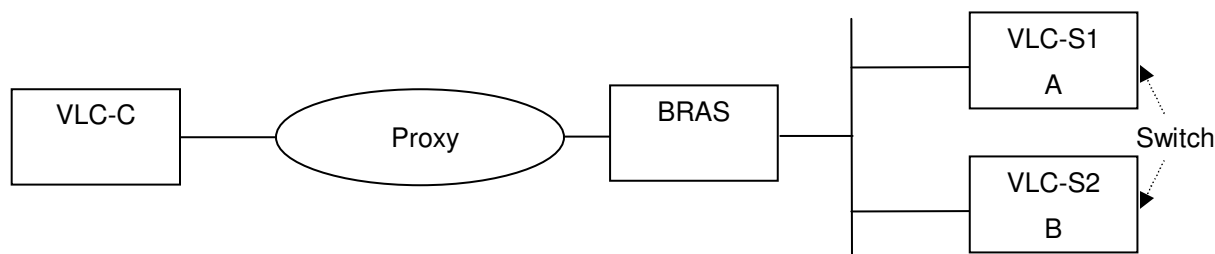
- LAN client joins in the multicast group.
- IGMPv3 membership expiry should happen.
- Stops when one video clip stops.

5.7 Request a video from LAN client with SSM from server A, then switch to server B

Purpose: To verify the LAN client joins in the multicast group.

Discussion: Client connects to a server, and then switches to another server through proxy. This is to test that switching between the video streams takes place.

Test Setup:

**Procedure:**

1. In shell, run "*vlc udp://<VLC-S>@<MCAST IP>:<port>*".
2. Request a video from a LAN client with SSM option from server A.
3. IGMPv3 proxy should have MODE_IS_INCLUDE filter with the source in INCLUDE mode.
4. Then, stop the video client and re-start the video client for video from different server B.
5. Stop the video and make sure IGMPv3 membership expires.

Observable Results:

- LAN client joins in the multicast group.
- IGMPv3 membership expiry should happen.
- Make sure you the leave latency is achieved as configured.

5.8 Request a video in IGMPv1/2

Purpose: To verify the LAN client joins in the multicast group.

Discussion: Client connects to a server through proxy. To test that IGMPv3 is backward compatible during start/stop video.

Test Setup:**Procedure:**

1. In shell, run "*vlc udp://<VLC-S>@<MCAST IP>:<port>*".
2. Request a video in IGMPv1/2 mode.
3. Make sure IGMPv3 proxy is backward compatible during start/stop video.
4. IGMPv3 Proxy should have the EXCLUDE filter as NULL while in this mode.

Observable Results:

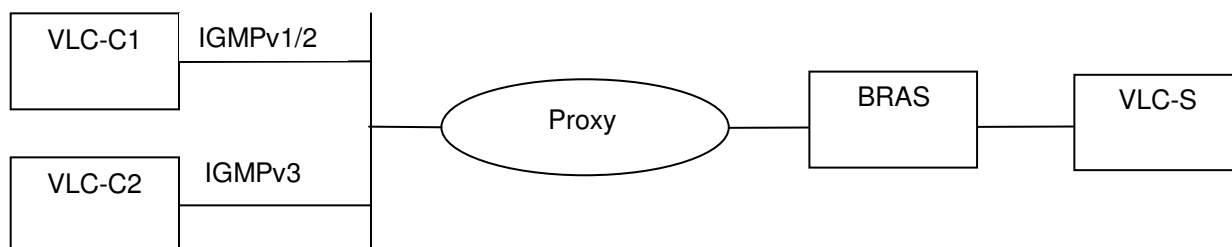
- LAN client joins in the multicast group.

5.9 Merge a request of a video in IGMPv1/2 and a video in IGMPv3

Purpose: To verify the LAN client joins in the multicast group.

Discussion: Two clients connect to a server through proxy. To test IGMPv3 proxy module is able to merge both IGMPv3 and IGMPv1/2 requests into IGMPv3 mode.

Test Setup:



Procedure:

1. In shell, run "*vlc udp://<VLC-S>@<MCAST IP>:<port>*".
2. Request a video in IGMPv1/2 mode and at the same time request the same video from a different LAN client in IGMPv3 mode.
3. Make sure IGMPv3 proxy module is able to merge both the requests into IGMPv3 mode while requesting the video from the upstream interface.
4. IGMPv3 Proxy should have the EXCLUDE filter as NULL while in this mode as the merging takes place from v2 to v3.

Observable Results:

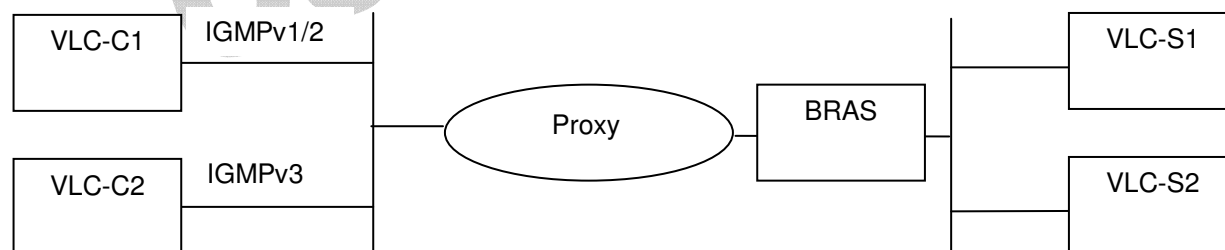
- LAN client joins in the multicast group.

5.10 Request a video in IGMPv1/2 and a different video in IGMPv3

Purpose: To verify the LAN client joins in the multicast group.

Discussion: Two different clients connect to two different servers through proxy. To test IGMPv3 is able to keep IGMPv1/2 and IGMPv3 request separate.

Test Setup:



Procedure:

1. In shell, run "*vlc udp://<VLC-S>@<MCAST IP>:<port>*".
2. Request a video in IGMPv1/2 mode and at the same time request a different video from a different LAN client from a different server in IGMPv3 mode.
3. IGMPv3 Proxy should have the EXCLUDE filter as NULL for v2 group and INCLUDE with source for v3 group.

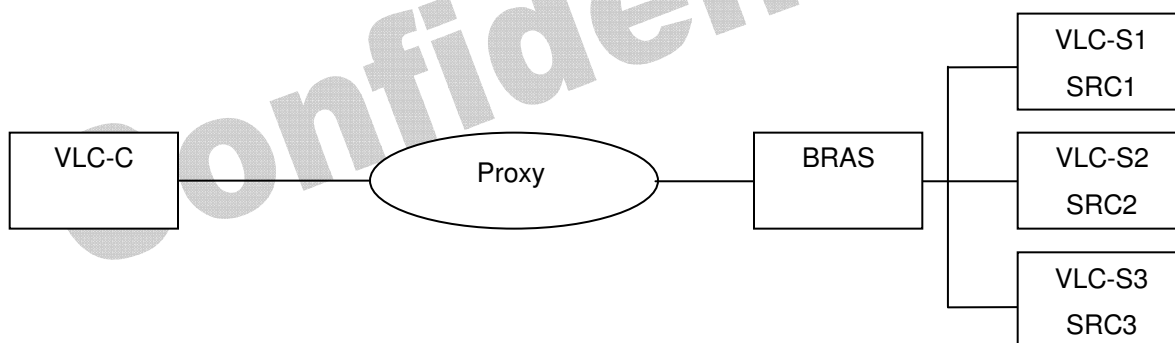
Observable Results:

- LAN client joins in appropriate multicast group.

5.11 Switching modes

Purpose: To verify the multicast group switches modes.

Discussion: One client is connected to three servers through a proxy.

Test Setup:**Procedure:**

1. In shell, run "*vlc udp://<VLC-S>@<MCAST IP>:<port>*".
2. Request two videos (SRC1 and SRC2) in MODE_IS_INCLUDE.
3. Request third video (SRC3) in MODE_IS_EXCLUDE.

Observable Results:

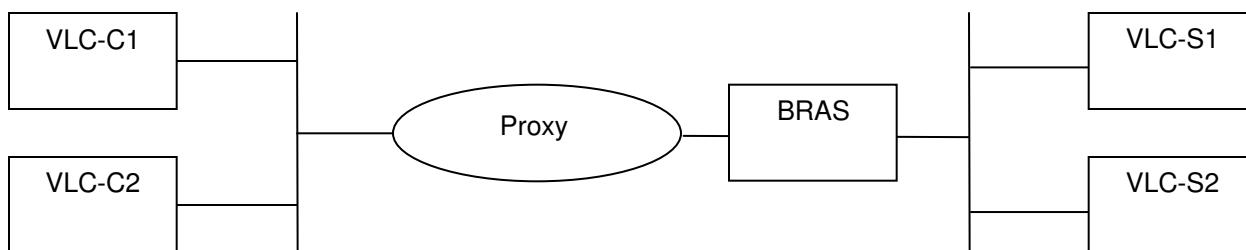
- Make sure the group switches to MODE_IS_EXCLUDE with SRC3 as EXCLUDE mode.

5.12 Retaining appropriate mode

Purpose: To verify the multicast group retains appropriate mode.

Discussion: Two clients are connected to two servers through a proxy.

Test Setup:

**Procedure:**

1. In shell, run "*vlc udp://<VLC-S>@<MCAST IP>:<port>*".
2. Request two videos (SRC1 and SRC2) in MODE_IS_INCLUDE from one host.
3. Request SRC2 in MODE_IS_EXCLUDE from different host.

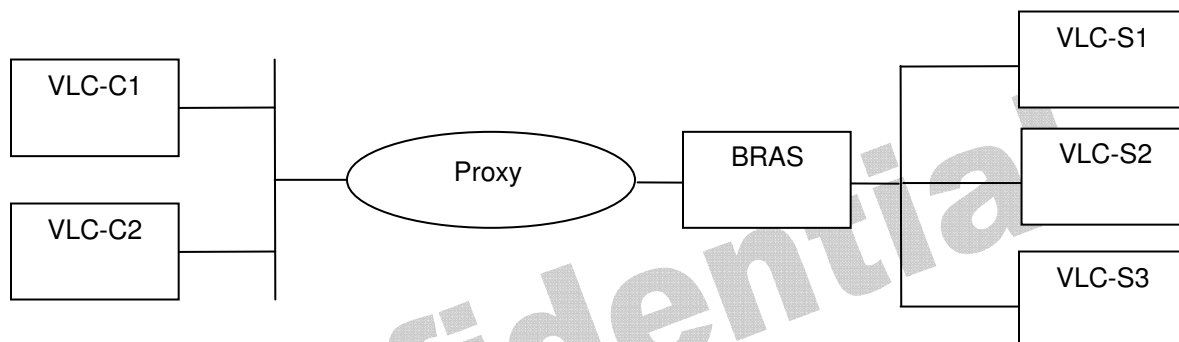
Observable Results:

- Make sure the group is in MODE_IS_INCLUDE with SRC1, SRC2.

5.13 Switching modes after source timer expiry

Purpose: To verify the multicast group switches modes after source timer expiry.

Discussion: Two clients are connected to three servers through a proxy.

Test Setup:**Procedure:**

1. In shell, run "*vlc udp://<VLC-S>@<MCAST IP>:<port>*".
2. Request SRC1, SRC2 in MODE_IS_EXCLUDE from one host.
3. Request SRC3 in MODE_IS_INCLUDE from a different host.
4. Stop the SRC1, SRC2 request.

Observable Results:

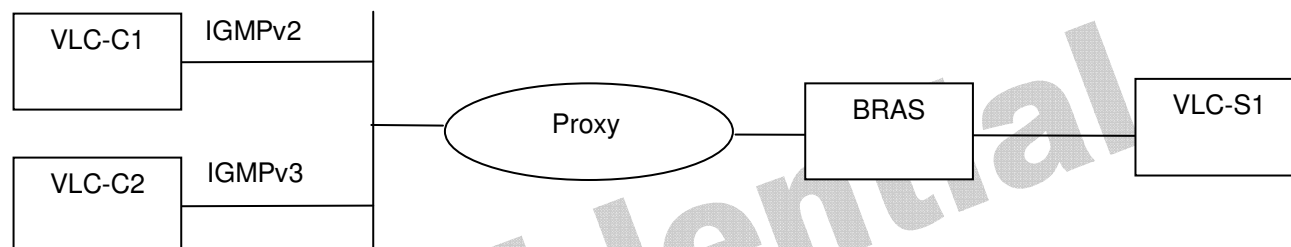
- The group should switch to MODE_IS_INCLUDE after the source timer expiry of SRC1, SRC2 with SRC3 as its source.

5.14 Keeping and switching the appropriate mode among different IGMP versions

Purpose: To verify the multicast group keeps or switches modes among different IGMP versions.

Discussion: Two clients connected to a server through a proxy.

Test Setup:



Procedure:

1. In shell, run "vlc udp://<VLC-S>@<MCAST IP>:<port>".
2. Two LAN clients make video requests with different IGMP versions (2 &3). Version 2 request for a group, and version 3 request for a SRC1 with MODE_IS_INCLUDE filter.
3. Stop the request from version 2 LAN clients, then the proxy should switch to version 3 mode with MODE_IS_INCLUDE filter and SRC1.

Observable Results:

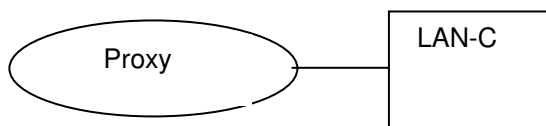
- The v2/v3 request will be merged as MODE_IS_EXCLUDE = null.

5.15 IGMP message types

Purpose: To determine whether the returned IGMP message types are valid.

Discussion: IGMPv3 protocol should accept message types that are new in this version of IGMP, as well as support message types of previous versions.

Test Setup:



Procedure:

Part A: Message Name & Type

1. Restart IGMP on the RUT.
2. Determine the IGMP message type on the multicast group 224.0.6.130

Observable Results:

- In Part A, the message types that should be returned are:
IGMPv3 protocol message types:

0x11 Membership Query

0x22 IGMPv3 Membership Report

Previous versions of IGMP:

0x12 IGMPv1 Membership Report [RFC-1112]

0x16 IGMPv2 Membership Report [RFC-2236]

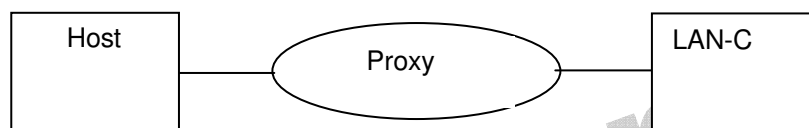
0x17 IGMPv2 Leave Group [RFC-2236]

Possible Problems: Unrecognized message types may appear, and they should be silently ignored. Other message types may be used by new versions or extensions of IGMP.

5.16 Membership Query Message

Purpose: To determine whether the membership queries follow the correct format.

Discussion: Membership Queries are sent by IP multicast routers to query the multicast reception state of neighboring interfaces. The queries are composed of the following fields: Max Resp Code (Max Response Code), Checksum, Group Address, Resv (Reserved), S Flag (Suppress Router-Side Processing), QRV (Querier's Robustness Variable), QQIC (Querier's Query Interval Code), Number of Sources (N), and Source Address [i].

Test Setup:**Procedure:**

Look at the following fields using a network analyzer to determine the components of the body of the Membership Query Message.

Part A: Max Resp Code

Part B: Checksum

Part C: Group Address

Part D: Resv (Reserved)

Part E: S Flag (Suppress Router-Side Processing)

Part F: QRV (Querier's Robustness Variable)

Part G: QQIC (Querier's Query Interval Code)

Part H: Number of Sources (N)

Part I: Source Address [i]

Observable Results:

- In Part A, the RUT shall accept a query with a Max Resp Code:
 Small Response Time: Max Resp Code < 128, Max Resp Time = Max Resp Code
 Large Response Time: Max Resp Code >=128,

$$\text{Max Resp Time} = (\text{mant} \mid 0x10) \ll (\text{exp} + 3)$$

$$\begin{array}{cccccccc} & 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ & |1| & \text{exp} & | & \text{mant} & | & & & \end{array}$$
- In Part B, the value of this field is the 16-bit one's complement of the one's complement sum of the whole IGMP message (the entire IP payload).
- In Part C, the Group Address field will either be set to zero when sending a General Query, or set to the IP multicast address being queried when sending a Group-Specific Query or Group-and-Source-Specific Query.
- In Part D, this field is set to zero on transmission, and ignored on reception.
- In Part E, when set to one, the S Flag indicates to any receiving multicast routers that they are to suppress the normal timer updates they perform upon hearing a Query.
- In Part F, if non-zero, the QRV field contains the [Robustness Variable] value used by the querier, i.e., the sender of the Query. If the querier's Robustness Variable] exceeds 7, the maximum value of the QRV field, the QRV is set to zero.
- In Part G, the actual interval, called the Querier's Query Interval (QQI), is represented in units of seconds and is derived from the QQI Code as follows:
 If QQIC < 128, QQI = QQIC
 If QQIC >= 128, QQIC represents a floating-point value as follows:

$$\begin{array}{cccccccc} & 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ & |1| & \text{exp} & | & \text{mant} & | & & & \end{array}$$

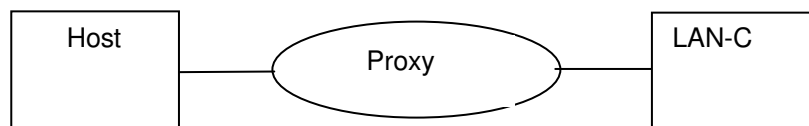
$$\text{QQI} = (\text{mant} \mid 0x10) \ll (\text{exp} + 3)$$
- In Part H, this field is zero in a General Query or a Group-Specific Query, and non-zero in a Group-and-Source-Specific Query. This number is limited by the MTU of the network over which the Query is transmitted.
- In Part I, this field will contain a vector of n IP unicast addresses, where n is the value in the Number of Sources (N) field.

5.17 Query Message Variants.

Purpose: To check whether the Query message falls within a valid category

Discussion: There are three variants of the Query message: General, Group-Specific, and Group-and-Source-Specific.

Test Setup:



Procedure:

For the following tests:

1. Ensure that the RUT is in Querier state on the network.
2. Determine value of fields using network analyzer.

Part A: General Query

Part B: Group-Specific Query

Part C: Group-and-Source-Specific Query

Observable Results:

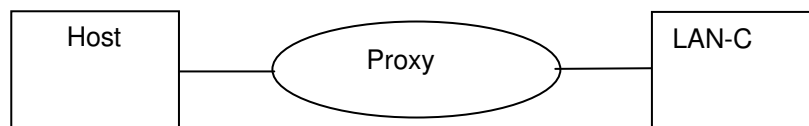
Refer to the field of the message body from *Test IGMP.2.2*.

- In Part A, the Group Address field and the Number of Sources (N) field are zero.
- In Part B, the Group Address field contains the multicast address of interest and the Number of Sources (N) field contains zero.
- In Part C, the Group Address field contains the multicast address of interest, and the Source Address [i] field contains the source address(es) of interest.

5.18 Version 3 Membership Report Message

Purpose: To check to see whether the components of the report message are valid.

Discussion: Version 3 Membership Report Messages are sent by IP systems to report (to neighboring routers) the current multicast reception state, or changes in the multicast reception state, of their interface. The reports are composed of the following fields: Reserved, Checksum, Number of Group Records (M), Group Record, Record Type, Aux Data Len, Number of Sources (N), Multicast Address, Source Address [i], and Auxiliary Data.

Test Setup:**Procedure:**

Look at the following fields using a network analyzer to determine the components of the body of the Membership Report Message.

Part A: Reserved

Part B: Checksum

Part C: Number of Group Records (M)

Part D: Group Record

Part E: Record Type

Part F: Aux Data Len

Part G: Number of Sources (N)

Part H: Multicast Address

Part I: Source Address [i]

Part J: Auxiliary Data

Observable Results:

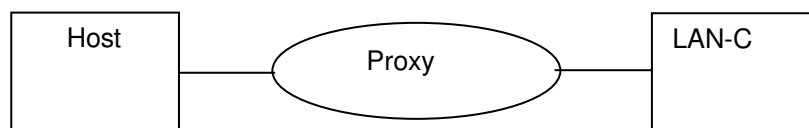
- In Part A, the reserved fields are set to zero on transmission, and ignored on reception.
- In Part B, the value of this field is the 16-bit one's complement of the one's complement sum of the whole IGMP message (the entire IP payload).
- In Part C, this field will specify how many Group Records are present in this Report.
- In Part D, a block of fields will contain information pertaining to the sender's membership in a single multicast group on the interface from which the Report is sent.
- In Part E, see Test IGMP.2.5 below.
- In Part F, this field contains the length of the Auxiliary Data field in this Group Record, in units of 32-bit words. It may contain zero, to indicate the absence of any auxiliary data.
- In Part G, this field specifies how many source addresses are present in this Group Record.
- In Part H, this field contains the IP multicast address to which this Group Record pertains.
- In Part I, this field contains a vector of n IP unicast addresses, where n is the value in this record's Number of Sources (N) field.
- In Part J, this field is irrelevant. The protocol specified in this document, IGMPv3, does not define any auxiliary data. Therefore, implementations of IGMPv3 **MUST NOT** include any auxiliary data (i.e., **MUST** set the Aux Data Len field to zero) in any transmitted Group Record, and **MUST** ignore any auxiliary data present in any received Group Record.

5.19 Group Record Types

Purpose: To test group records found in report messages.

Discussion: A query message can trigger the generation of an IGMPv3 report message by a host. The “Current-State Record” reports the current reception state of an interface. A “Filter-Mode-Change Record” is sent on the interface, when a local invocation of IPMulticastListen causes a change of the filter mode. A “Source-List-Change Record” is sent by a system whenever a local invocation of IPMulticastListen causes a change of source list that is *not* coincident with a change of filter mode, of the interface-level state entry for a particular multicast address.

Test Setup:



Procedure:

Look at the Group Record field (from Test IGMP.2.4) using a network analyzer to determine the type of Group Record that is included in the Membership Report Message.

Part A: Current-State Record

Part B: Filter-Mode-Change Record

Part C: Source-List-Change Record

Observable Results:

- In Parts A, the value may be either MODE_IS_INCLUDE or MODE_IS_EXCLUDE.
- In Parts B, the value may be either CHANGE_TO_INCLUDE_MODE or CHANGE_TO_EXCLUDE_MODE.
- In Parts C, the value may be either ALLOW_NEW_SOURCES or BLOCK_OLD_SOURCES.

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6.0 SUPPORTING UTILITIES

Protocol Analyzer:

| | |
|-----------|--|
| Ethereal | www.ethereal.com |
| WireShark | www.wireshark.org |

Media Players:

| | |
|----------------------|--|
| VLC Media Player | www.videolan.org/vlc |
| Windows Media Player | |

Internet Group Management Protocol, Version 3

www.ietf.org/rfc/rfc3376.txt

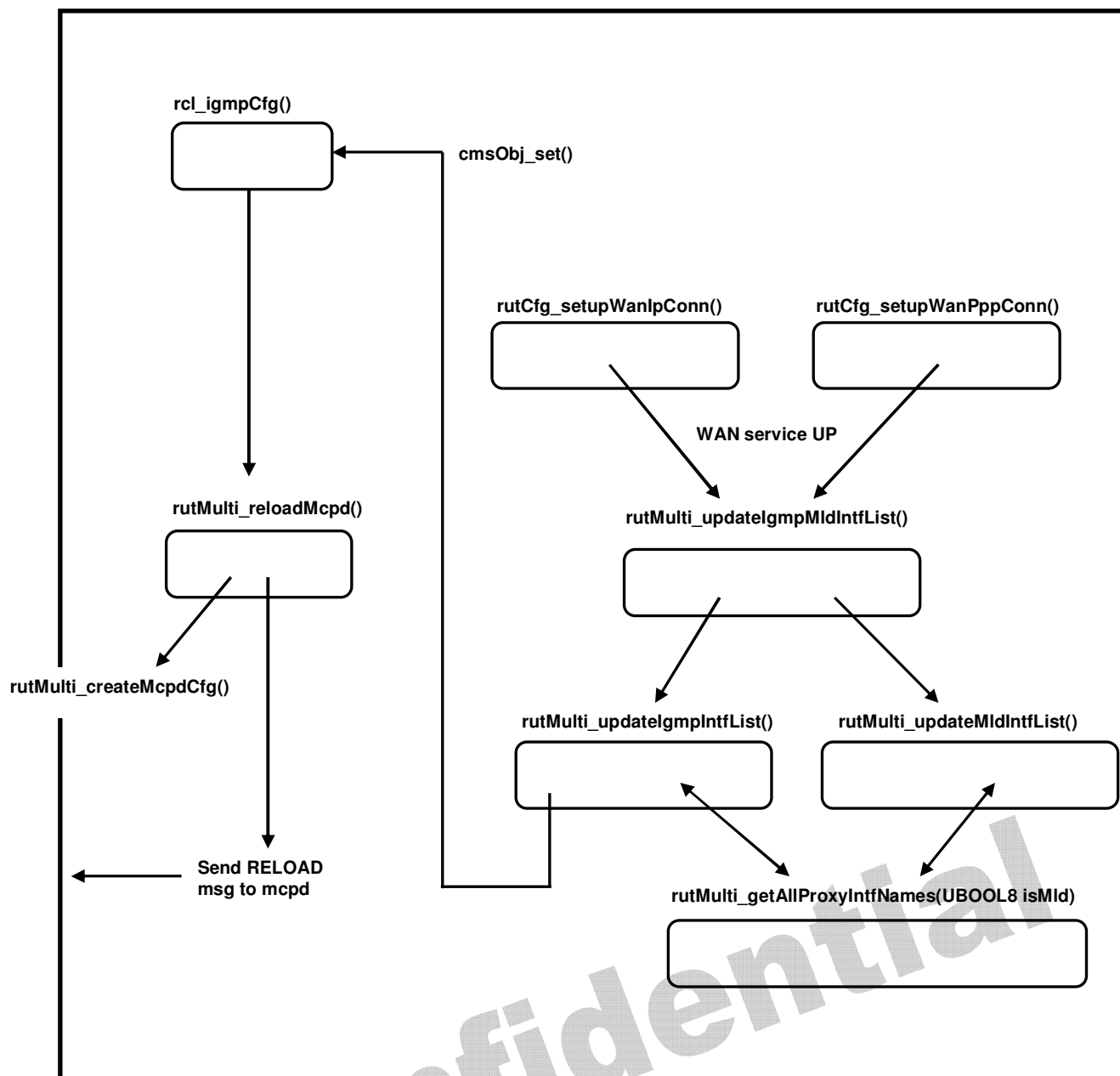
7.0 GLOSSARY

| | |
|-------|---------------------------------|
| C1 | Client 1 |
| S1 | Server 1 |
| SSM | Source Specific Multicast |
| VNC | Virtual Network Connection |
| LAN-C | Local Area Network – Client |
| VLC | Video LAN Player (Video player) |
| VLC-C | Video LAN Player – Client |
| VLC-S | Video LAN Player - Server |

8.0 CMS INTERNALS

The following section contains a brief description of the CMS internals which support IGMP proxying and snooping configuration. This description only shows the legacy TR98 implementation for IGMP, but the implementation for MLD and Pure TR181 are very similar.

In the figure below, only the major functions involved in igmp proxying is shown. Not all functions are shown.



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