

Hard-state Protocol Independent Multicast-Source Specific Multicast (HPIM-SSM) State Machines

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A HPIM-SSMv2 State Machines

In this appendix, we describe rigorously the state machines needed for the correct operation of the HPIM-SSMv2 protocol.

To simplify the state machine tables, we refer to interfaces just as root or non-root. When we say that a root/non-root receives interest from a neighbor, this can mean one of two things: either an IGMP report was received from a host that intends to join a (S,G) multicast group, or a (S,G) Join message was received from a router. When we say that an interface receives no interest from a neighbor, this can mean one of three things: either an IGMP report was received from a host that intends to leave a (S,G) multicast group, a (S,G) Prune message was received from a router, or a neighbor has failed.

A.1 Interface Interest State Machine

There are four states in the (S,G) Downstream Interest state machine, two for each type of interface:

1. Non-root:

- **DOWNSTREAM INTERESTED (DI):** Non-root interface I has downstream interested neighbors in (S,G) multicast traffic.
- **NOT DOWNSTREAM INTERESTED (NDI):** Non-root interface I has no downstream interested neighbors in (S,G) multicast traffic.

2. Root:

- **UPSTREAM INTERESTED (UI):** Root interface I has interested neighbors in (S,G) multicast traffic.
- **NOT UPSTREAM INTERESTED (NUI):** Root interface I has no interested neighbors in (S,G) multicast traffic.

Event	State Transition	Action
Non-root interface receives interest from a neighbor	NDI/DI \Rightarrow DI	Stores the interest of the neighbor
Root interface receives interest from a neighbor	NUI/UI \Rightarrow UI	
Non-root interface receives no interest from a neighbor and it is not the last one interested	DI \Rightarrow DI	Drops the interest of the neighbor
Non-root interface receives no interest from a neighbor and it is the last one interested	DI \Rightarrow NDI	
Root interface receives no interest from a neighbor and it is not the last one interested	UI \Rightarrow UI	
Root interface receives no interest from a neighbor and it is the last one interested	UI \Rightarrow NUI	
Non-root interface becomes root	NDI \Rightarrow NUI	-
	DI \Rightarrow UI	-
Root interface becomes non-root	NUI \Rightarrow NDI	-
	UI \Rightarrow DI	-

Table 1: *DOWNSTREAM INTERESTED State Machine*

A.2 Assert State Machine

There are three states in the (S,G) Assert state machine:

- **Assert Winner (AW):** Interface I has won a (S,G) assert election. It is now responsible for forwarding traffic from S destined for G.
- **Assert Loser (AL):** Interface I has lost a (S,G) assert election. It must not forward traffic from S destined for G.
- **Not Available (NA):** Interface I is a root interface or is a non-root interface that is in the NDI state, so it is not available to forward traffic from S destined for G.

Event	State Transition	Action
Non-root becomes DI	NA \Rightarrow AW	Send Assert message
	NA \Rightarrow AL	
Non-root becomes NDI	AW/AL \Rightarrow NA	Send AssertCancel message
Non-root receives Assert message that does not affect the AW	AW \Rightarrow AW	Stores RPC received
	AL \Rightarrow AL	
Non-root receives Assert message with better RPC than AW	AW \Rightarrow AL	Stores RPC received
	AL \Rightarrow AL	
Non-root receives Assert message from AW and becomes AW	AL \Rightarrow AW	Stores RPC received
Non-root receives AssertCancel and it is not from AW	AL \Rightarrow AL	Drops RPC of the sender
	AW \Rightarrow AW	
Non-root receives AssertCancel and it is from AW and becomes AW	AL \Rightarrow AW	Drops RPC of the sender
Non-root receives AssertCancel and it is from AW and continues AL	AL \Rightarrow AL	Drops RPC of the sender
RPC changess but interface type stays the same and does not affect AW	AL \Rightarrow AL	Send Assert message
	AW \Rightarrow AW	
RPC changess but interface type stays the same and becomes AW	AL \Rightarrow AW	Send Assert message
RPC changess but interface type stays the same and becomes AL	AW \Rightarrow AL	Send Assert message
Root receives Assert message	NA \Rightarrow NA	Stores RPC received
Root receives AssertCancel	NA \Rightarrow NA	Drops RPC of the sender

Table 2: Assert State Machine

A.3 Forward State Machine

There are two states in the (S,G) Forward state machine:

- **FORWARDING (F)**: Interface I is both in the DI state and in the AW state for (S,G) multicast traffic. It must not forward traffic from S destined for G.
- **PRUNED (P)**: Interface I is not in the DI state and in the AW state simultaneous for (S,G) multicast traffic. It must not forward traffic from S destined for G.

Event	State transition	Action
Non-root interface becomes DI and AW	P/F \Rightarrow F	-
Non-root interface is no longer both DI and AW	P/F \Rightarrow P	-

Table 3: FORWARD State Machine

A.4 Interest State Machine

There are two states in the (S,G) Interest state machine:

- **INTERESTED (I)**: Interface I is interested in receiving (S,G) multicast traffic.
- **NOT INTERESTED (NI)**: Interface I is not interested in receiving (S,G) multicast traffic.

Event	State Transition	Action
Non-root becomes F or root becomes UI	NI \Rightarrow I	Unicasts a Join message to the Potential AW
	I \Rightarrow I	-
Non-root becomes P and it was not the last one in F	I \Rightarrow I	-
Non-root becomes P and it was the last one in F and root is NUI	I \Rightarrow NI	Unicasts a Prune message to the Potential AW
Root becomes NUI and all non-root are P	I \Rightarrow NI	Unicasts a Prune message to the Potential AW
Potential AW changes	NI \Rightarrow NI	-
	I \Rightarrow I	Unicasts a Prune message to the previous Potential AW; Unicasts a Join message to the new Potential AW

Table 4: *INTERESTED State Machine*