Multicast using PIM-SM in Broadband Satellite Multimedia Systems

Robert J. Mort
Systek Consulting Ltd., UK
robert.mort@etsi.org

Matteo Berioli
DLR, Germany
matteo.berioli@dlr.de

Haitham Cruickshank,
University of Surrey. U.K.
H.Cruickshank@surrey.ac.uk

***Abstract*— The approach currently being taken by ETSI (BSM) to standardisation for Multicast PIM-SM protocols is described. This paper describes methods, architectures and adaptations to support IP-multicast services efficiently across IP-based broadband multimedia satellite systems.**
This work has recently begun and the final objective is to arrive at a consensus for a standard on this subject.

***Keywords*—satellite, BSM, multicast, PIM-SM, IP, multimedia.**

I. Introduction

The need for IP multicast services has been recognised for a considerable period, though they are still not widely implemented. Satellite broadband networks offer efficient solutions for multicast services, owing to their use of the same transmission capacity for many receivers over a very large geographical region. Hence satellites could offer an effective way to introduce multicast on a wider scale for users when the satellite provides access to the wider internet, for example.

There are several IETF protocols that may be used by IP multicast to control and "manage" access, and provide the efficient delivery framework for content, the most suitable and common being PIM and IGMP. PIM-SM (Protocol-Independent Multicast-Sparse Mode) is defined in RFC 2362 [5] and is the mode of PIM most widely used in existing and proposed multicast routing applications today.

The satellite system considered here consists of interconnected terminals (ST's) which act as IP layer devices, and therefore implement IP multicast protocols. The satellite itself is situated at layer 2 (e.g. OBP switching), or below, and is therefore transparent to these protocols.

Figure 1 shows the protocol stack architecture for PIM-SM over the BSM, assuming standard protocols are used. On the downstream side of the BSM, the egress ST may offer either PIM-SM or IGMP externally, without affecting the internal BSM protocols.

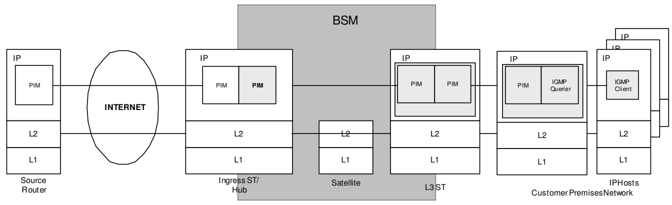

Figure 1: PIM-over-BSM Protocol Architecture without adaptation

IP multicast protocols however are not always well-suited to satellites as the protocols have significant overhead for messaging which wastes satellite capacity, and they require connectivity between adjacent multicast nodes which is not always present.

An adapted version of IGMPv2 for BSM systems has already been defined [3] and this applies to the case when egress ST's act as IGMP clients, or IGMP proxies to external clients in connected hosts.

PIM-SM is used over satellites when there are downstream multicast networks, or when an egress ST has attached receivers (e.g. user PC's), requiring PIM to be operated over the satellite system. Adaptation may be needed for PIM-SM over satellite to improve efficiency and reduce resource usage. This adaptation is described below.

II. PIM-SM Scenarios in BSM

Potential PIM-SM scenarios considered are:

1) The BSM ST's act as PIM routers to external and internal BSM system interfaces (i.e. Native PIM-over-Satellite). The use of PIM-SM over the satellite implies that the ST PIM routers react dynamically and transparently to requests from networks downstream from the BSM, and to other types of PIM messages form both upstream and downstream networks. This also implies that connectionless IP routes are permanently available across the satellite system, or can be set up within a short reaction time.

2) The BSM ST's act as PIM routers to external interfaces, and the PIM-SM protocol would appear externally to transit the BSM system "transparently". Internally to the BSM an adaptation of PIM i.e. Adapted PIM-over-Satellite (S-PIM), or an alternative protocol could be used.

3) No PIM routing is implemented in the BSM ST's, but PIM snooping or proxying may be implemented to influence layer 2 switching etc.

In each of these scenarios, star or mesh satellite link topology can be implemented where the primary difference of the mesh topology compared to the star is that more than one ST can act as ingress nodes.

The focus of this document is on Scenario 2. Also PIM adaptation is especially suitable for the mesh architecture case where the potentially large number of interconnections between ST's needed for correct PIM operation can be advantageously managed.

III. BSM S-PIM Logical Architecture

PIM signalling over satellite mesh architectures introduces potential difficulties: all PIM messages (including Join, Prune, Hello etc.) are sent to the "'ALL-PIM-ROUTERS" multicast address to neighbouring IP devices.

To reduce the total number of PIM messages (for reasons of scalability), a multicast control server is introduced as shown in Figure 2.

In this Scenario therefore, the BSM ST's are configured to act as PIM routers to external interfaces, and to the outside world the PIM-SM protocol acts as though it transits the BSM system "transparently". Internally to the BSM an adaptation of PIM is used.

Hence, for example, when an Egress ST (a client) issues a Join, this must be sent to the PIM server (as part of a more generalised Multicast Control Management Server), which may then decide to issue a Join to only one of the Ingress STs. This involves an adaptation of PIM-SM.

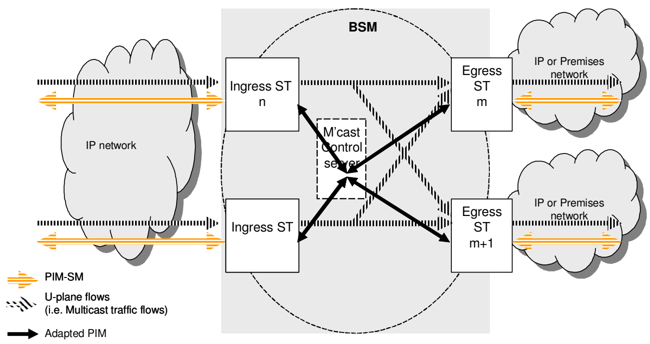

Figure 2: BSM Mesh Scenario – adapted PIM with BSM PIM server

IV. S-PIM over BSM Functional Architecture

The PIM-SM protocol configures forwarding of the multicast flows for multicast groups and sources (in the User Plane) and the focus here is on the Control Plane processes for PIM.

The PIM Server interacts with multicast control functions in lower protocol layers below the BSM SISAP, which in this case are assumed to be located in the NCC and NMC, as shown in Figure 3.

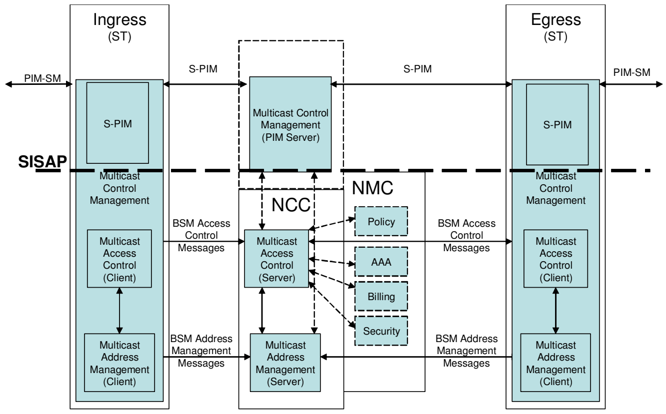

Figure 3: BSM Multicast Control Plane Architecture (with S-PIM)

The PIM Server receives S-PIM messages, extracts PIM messages from them and forwards them according to the S-PIM descriptions below. The PIM Server requires a multicast link to STs for this reason.

The PIM Server interacts with entities below the SI-SAP as indicated in Figure 3 in order to set up and configure resources.

The PIM Server maintains several Timers, as for a normal PIM router (e.g. Join Timer, Prune-Pending Timer etc.)

The PIM Server issues PIM messages depending on the status of these timers as for a standard PIM router. The PIM Server also updates these timers depending on reception of the S-PIM messages as described below.

V. S-PIM Message Processing and Forwarding

All S-PIM messages are passed between ST's and the PIM Server only. The nature of the S-PIM messages depends largely on the method of passing these messages between the entities involved, namely the following options:

1) The PIM Server acts at IP layer and S-PIM packets are forwarded from ST's to the PIM Server.

   a. Native PIM packets from ST's are encapsulated into S-PIM packets

   b. Native PIM packets from ST's are translated into S-PIM packets

2) The PIM Server acts at layer 2 and native PIM packets from ST's are translated into S-PIM frames which are switched from ST's to the PIM Server.

The aim of all of these schemes is to convert native (multicast) PIM messages into unicast messages directed to the PIM Server.

VI. S-PIM Messages

TBD

VII. CONCLUSIONS

PIM-SM protocols over satellite is often needed to support multicast when the satellite system is used to interconnect multicast-enabled networks. Satellite systems can benefit from adaptation of PIM-SM to suit the topology of satellite links between STs, especially for mesh-connected systems. An adaptation of PIM-SM (called S-PIM) has been described for BSM systems.

REFERENCES

[1] IETF RFC 4601: “Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised)”

[2] ETSI TR 101 985: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia; IP over Satellite".

[3] ETSI TS 102 293: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia; IP Interworking over satellite; Multicast Group Management; IGMP adaptation".

[4] ETSI TS 102 461: Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia Services and Architectures: Multicast Source Management