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Multicast Transition Overview  
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## Abstract

IPTV providers must serve content to their customers during the period of transition from IPv4 to IPv6. During this period, the content provider may support only one version of IP while the customer's receiver device supports only the other. Likewise, the network between the provider and its customer may include segments supporting only one version of IP or another.

This document provides an overview of the multicast transition problem. It also provides an overview of the solution space. The solution space is characterized by an adaptation function (AF) that provides an interface between IPv4 and IPv6 multicast domains. This document also discusses various multicast use cases which may occur during IPv6 transitioning. These use cases motivate the solution space discussion and the requirements that appear at the end.

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## [1.](#) Introduction

IPTV providers must serve content to their customers during the period of transition from IPv4 to IPv6. During this period, the content provider may support only one version of IP while the customer supports only the other. Likewise, the network between the provider and its customer may include segments supporting only one version of IP or another.

In current deployments, the IP multicast forwarding scheme is used by many service providers to deliver services such as live TV broadcasting. Multiple players intervene in the delivery of these services, including content and service providers. Service providers are responsible for carrying multicast flows from head-ends to receivers. The content can be supplied by a service provider or by other providers (e.g., case of externally paid channels).

Unlike the situation for unicast addresses, the IPv4 multicast address space seems sufficient for most proposed uses. Hence the key motivation for the work described here is to preserve the efficiencies of multicast distribution of content (i.e., by reducing total traffic on the network and minimizing the distance that multicast streams must travel) when both IPv4 and IPv6 segments lie on the path from source to receiver.

This document provides an overview of the multicast transition problem. It also provides an overview of the solution space. The solution space is characterized by an adaptation function (AF) that provides an interface between IPv4 and IPv6 multicast segments. The scope of this document is currently limited to IP transport, and covers both single operator and inter-operator flows.

[Section 2](#) describes the problem space in detail. This section describes an environment that includes a content provider, a customer, and an intervening network. Any component of that environment may support only one version of IP or the other. At

points where IPv4-only devices lie on one side and IPv6-only devices on the other, an adaptation function is required.

[Section 3](#) proposes a framework for the solution. [Section 4](#) defines formal requirements for any proposed solution.

## [2.](#) A Look At the Multicast Transition Problem Space

Historically, IPTV providers have served IPv4 content to receivers over IPv4 multicast networks. CPE has thus until recently supported IPv4 only. As the Internet transitions to IPv6, IPv6-capable

equipment will be deployed by content providers and receivers, as well as the networks that connect them to one another. So long as all of the newly deployed gear supports both IPv4 and IPv6, the transition to IPv6 may not require new IETF protocol specifications in support of multicast deployment. In this case of dual-stack environments, either IP address family can be used end to end for the multicast traffic. However, if some of the newly deployed gear supports IPv6 only, incompatibilities will be introduced. These IPv6-only scenarios are being planned and deployed because the exhaustion of IPv4 unicast address space. Instead of running large NAT and IPv6 all together, some providers prefer to run a single address family that is future proof, which is IPv6. This also brings simpler management of the network. In this unicast case, IPv4 traffic can be either tunneled over IPv6 (e.g. softwire, dslite, 4rd) or translated (NAT64). Therefore, some access networks are IPv6 only.

An incompatibility occurs at a device lying along the path between the source and the receiver when the next device on the path on one side of it supports a different version of IP from the next device on the path on the other side of it (i.e., one device supports IPv4 only and the other supports IPv6 only). For the purposes of this document, we will call these points of incompatibility "IP version transition points". The communication path between source and receiver (which includes both endpoints) can include zero or more IP version transition points.

IP version transition points may be introduced at any point along the path. These IP version transition points may reside in the

subscriber premises, at the CPE, in the intervening network etc. In addition, the Set Top Box (STB) and Electronic Program Guides (EPG) may have different IP versions.

In order to maintain multicast connectivity, one or more adaptation functions (AF) are required. The AF operates in both the forwarding and control planes. Because it provides an interface between the IPv4 and IPv6 domain, it must be both IPv4-capable and IPv6-capable.

In most cases, the adaptation function will mediate between IPv4 and IPv6 on both the control and forwarding planes. However, in scenarios where the path between source and receiver contains multiple IP version transition points, adaptation function instances may tunnel traffic between one another.

## [2.1.](#) Signaling Channels using Multicast Addresses

The receiver is provided the necessary multicast addresses for channel reception by some means such as an Electronic Program Guide

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(EPG). If the source uses the same address family as the receiver, the receiver will subscribe to a multicast address of the appropriate address family. However, If the source uses the other address family, then the signaling must be translated in the path (or at the program guide).

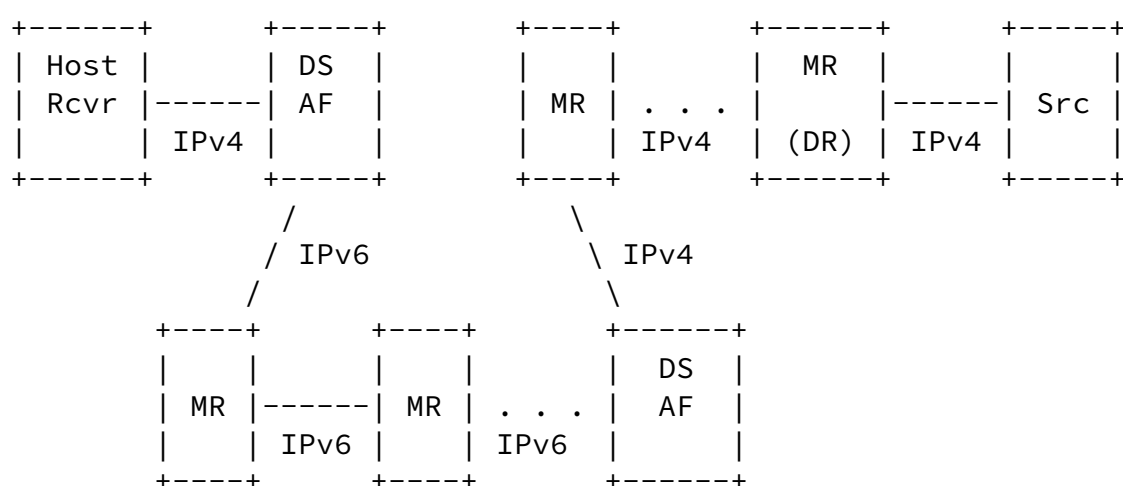
An early assessment of the market seems to suggest that most signaling is done with proprietary protocols, and that most EPG are also proprietary. It remains to be seen if a standardized solution for this issue a need or even a possibility, given these market realities.

## [2.2.](#) Operator View of Use Cases

Discussion with operators has indicated in the first place that the distribution of Electronic Program Guide material is done by proprietary means, and they have no interest in a standardized solution. SSM (Specific Source Multicast) is the technically preferable mode of operation. However, some operators may have to use ASM (Any Source Multicast) because of the limitations of existing receivers (i.e., limitations on the support of IGMP v3 or MLD v2).

In what follows, this document uses the following numeric convention to specify a particular scenario: <receiver version>-<network version(s)>-<source version> (e.g., 6-4-6-4 for the second scenario described below).

For a number of operators, the expected evolution path is to first upgrade the network to IPv6, then upgrade the receivers to IPv6 through a gradual process of replacement, and then add IPv6 sources when a critical mass of IPv6 receivers is reached. This sequence implies that the immediate priority is to support the 4-6-4 scenario shown in Figure 1. One can immediately see that two instances of the AF are needed, one at each side of the IPv6 network. The receiver signals using IGMP. The AF translates the IGMP either to MLD [[RFC3810](#)] or to PIM [[RFC4601](#)] running on IPv6. At the other side, the AF most likely interworks between PIM with IPv6 and PIM with IPv4. In the reverse direction, multicast data packets can either be translated or tunneled between the AF instances, as noted above.

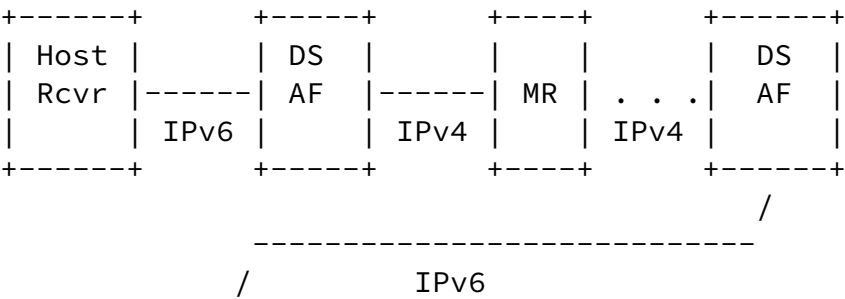


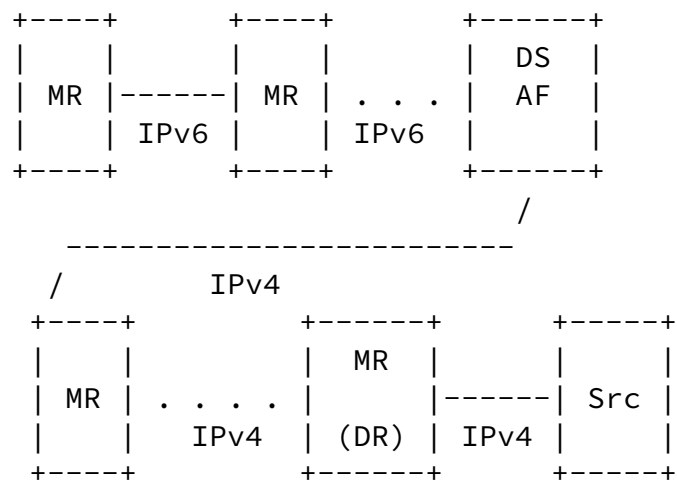
Rcvr: Multicast receiver

DS : Dual Stack  
 AF : Adaptation Function  
 MR : Multicast router  
 DR : Designated Router  
 Src : Multicast source

Figure 1: An Initial Scenario: IPv4 Source and Receiver Via an IPv6 Network

An alternative view of network evolution contemplates a more immediate rollout of IPv6 receivers, but a slow evolution of sources from IPv4 to IPv6. The backbone network will be IPv6 in all cases, but the metro network may be either IPv4 or IPv6. The first case (6-4-6-4), with an IPv4 metro network, is shown in Figure 2. Three AF instances are needed, at the IP version transition points between the source and backbone network, between the backbone and metro network, and between the metro network and the receiver.



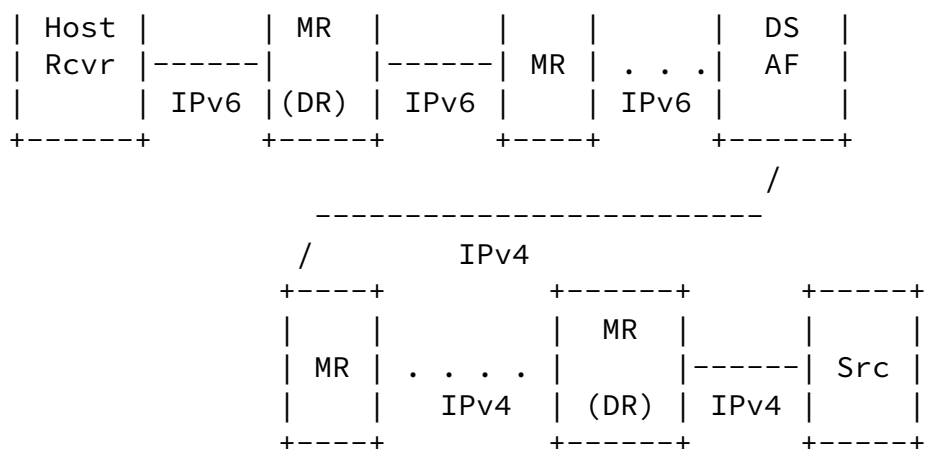


Rcvr: Multicast receiver  
 Src : Multicast source  
 DS : Dual Stack  
 AF : Adaptation function  
 MR : Multicast Router  
 DR : Designated Router

Figure 2: Initial Scenario With IPv6 Host, IPv4 Source, and Both IPv4 and IPv6 Intervening Networks

The case where the metro network has evolved to IPv6 (6-6-4) is shown in Figure 3. Here, only one AF instance is needed. It translates between IPv6 PIM in the receiver network and IPv4 PIM in the content provider network.





Rcvr: Multicast receiver  
Src : Multicast source  
DS : Dual Stack  
AF : Adaptation function  
MR : Multicast Router  
DR : Designated Router

Figure 3: Initial Scenario With IPv6 Host, IPv4 Source, and IPv6 Intervening Network

### 2.3. Requirements From The Use Cases

All three of the immediately relevant scenarios just described feature IPv4 sources. This means that no solution is required in the short term for translation from general IPv6 addresses to IPv4 addresses. In the longer run operators may have the situation of IPv6 sources serving receivers that have remained at IPv4. That presents a more difficult translation problem, but the scenario has low priority.

The three cases illustrate a number of protocol interworking combinations. As indicated below, some combinations can act as a part of others, reducing the total development effort.

In summary, the use cases expose the following gaps for which there are no existing IETF standards:

- o Translating from IPv4 to IPv6 multicast addresses and back again.
- o Translating from IGMP downstream to MLD upstream (4-6-4 case) and from MLD downstream to IGMP upstream (6-4-6-4 case).
- o Interworking between IGMP and PIM with IPv6 (4-6-4 case). This could be synthesized by translating the IGMP to MLD and having MLD

interwork with PIM as usual.

- o Interworking between MLD and PIM with IPv4 (6-4-6-4 case). Again, this could be synthesized, by translating MLD to IGMP and interworking the latter to PIM as usual.
- o Operating PIM with IPv4 downstream and IPv6 upstream (6-4-6-4 case) and with IPv6 downstream and IPv4 upstream (4-6-4 and 6-6-4 cases).

### [3.](#) A Look At the Solution Space For Multicast Transition

The AF operates on both the forwarding and control planes. On the forwarding plane, the AF inserts itself into the forwarding path translating multicast packets from one IP version to the other. On the control plane, the AF receives routing and signaling messages of one protocol and sends out routing and signaling messages of another protocol.[Forward reference to future high-level description of the AF.]

#### [3.1.](#) AF Forwarding Plane Operation

The AF accepts packets from one IP version, removes the IP header, and replaces it with an IP Header of the other version. A significant portion of that task is address translation. Ideally the address translation strategy used by an AF should be algorithmic, stateless and reversible. This should be simple when addresses from one IP version can simply be embedded into another (IPv4 into IPv6), but this may not be possible in the opposite direction. That the translation is reversible means that there is a stateless algorithm for translating back into the original address.

[RFC6052] provides an algorithm for translating unicast addresses between IPv4 and IPv6. Likewise [[I-D.mboned-64-mcast-addr-fmt](#)] provides an algorithm for multicast address conversion between IPv4 and IPv6. Note that using this algorithm, different translators could choose different IPv6 prefixes for embedding the IPv4 addresses. But the format allows for stateless translation back to the original IPv4 addresses.

Other issues associated with IP version translation may arise (e.g., fragmentation and checksums and will be resolved as appropriate in conjunction with appropriate IETF working groups.

### [3.2.](#) AF Control Plane Operation

On the control plane, the AF mediates between:

- o IGMPv3 [[RFC3376](#)] and MLDv2 [[RFC3810](#)];
- o PIM(v4) [[RFC4601](#)] and PIM(v6);
- o IGMPv3 and PIM(v6);
- o MLD and PIM(v4);

The IGMP-to-MLD translation may be configured to use only IGMPv2 features. It is defined in [draft to come].

[[I-D.perreault-mboned-igmp-mld-translation](#)] is a candidate for this specification.

The PIM-to-PIM mediation operates between PIM protocol operations of one IP version with operations of the other version.

[[I-D.taylor-pim-v4v6-translation](#)] is a candidate for this specification.

### [3.3.](#) Source Discovery

Source discovery is out of scope and is left for further study.

[[I-D.tsou-mboned-multtrans-addr-acquisition](#)] provides an informative discussion of the options open to operators.

### [3.4.](#) Transitional Multicast Path Optimization

A mechanism to optimize the path to the multicast source for a combination of IPv4 and IPv6 networks is not immediately required, but is a topic for future work.

[[I-D.zhou-mboned-multtrans-path-optimization](#)] is a candidate for this specification.

## [4.](#) Contributors

Some of the introductory text of this document was drawn from [\[I-D.jaclee-behave-v4v6-mcast-ps\]](#). Figures from [Section 3](#) of that document were the starting point for the figures in [Section 2.1](#) of this document. The strong participation of the authors of [\[I-D.jaclee-behave-v4v6-mcast-ps\]](#) in the work on multicast transition leading up to the creation of this document must be acknowledged. These authors include two co-authors of the present document, plus Mohamed Boucadair, Yiu Lee, Hitoshi Asaeda, and Jacni Qin, who should be considered honorary co-authors.

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## [5.](#) Acknowledgements

Ron Bonica inspired the writing of this memo and shaped its content. Michael McBride and Marc Blanchet provided useful comments on intermediate versions of this document.

## [6.](#) IANA Considerations

This memo includes no request to IANA.

## [7.](#) Security Considerations

To come.

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