2021-7-1

BIERV6 TEST REPORT WHITE PAPER

CHINA UNICOM & HUAWEI

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BIERv6 Introduction

Real-time applications, e.g., 4K/8K TV, online education, cloud games AR/VR, etc., have become more and more important in individual entertainment, work and daily life. Correspondingly, the users have higher demands on the network experience.

The traditional multicast technologies for IPTV and other similar applications are limited by its complexity and multiple issues, for example: maintenance difficulties, slow network failure convergence, difficult to use with SDN, hard to respond to user on demand quickly etc.

Bit Index Explicit Replication (BIER), defined in RFC 8279, is an architecture that provides optimal multicast forwarding, without requiring intermediate routers to maintain per-flow state, through the use of a multicast-specific BIER header. BIERv6(Bit Index Explicit Replication over IPv6) is a BIER solution for IPv6 network with the following features:

IPv6 native: BIERv6, integrating BIER with IPv6, supports IPv6 non-BIER nodes transition and Inter-AS deployment within a unified IPv6 encapsulation.

Easy to deploy: no complex multicast protocols, such as PIM, MLDP, RSVP-TE P2MP, are requested.

High reliability: intermediate nodes are not aware of multicast status; fast convergence of network failures is provided with IGP protection mechanism; one-hop joining of users and fast channel switching.

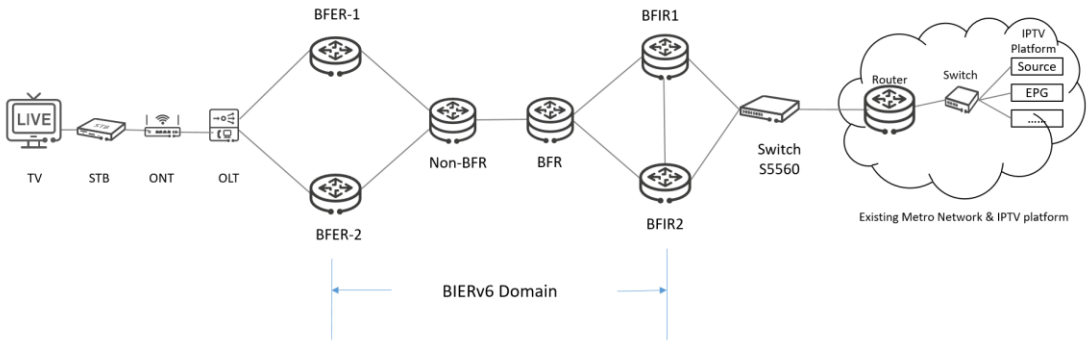
Intelligence: Service information and quality monitoring commands are initiated at the ingress node, and the SRv6-like design facilitates the evolution of the network to SDN and intelligent management.

China Unicom Beijing branch, in conjunction with Huawei, has tested BIERv6 multicast solution with the IPTV service in existing metro network. This test is an end-to-end verification of the actual IPTV video service, proving that BIERv6 solution has the advantages of easy deployment, on-demand access, high reliability and intelligent operation and maintenance This white paper covers the topology, network device and the features that have been tested. The detailed BIERv6 specification could be found in the following IETF documents:

- BIERv6 Encapsulation: draft-xie-bier-ipv6-encapsulation
- BIERv6 ISIS extensions: draft-xie-bier-ipv6-isis-extension
- BIERv6 MVPN: draft-xie-bier-ipv6-mvpn
- BIERv6 Inter domain: draft-geng-bier-ipv6-inter-domain
- BIERv6 YANG: draft-geng-bier-bierv6-yang

Topology and Network Device

- **Network topology, IPTV Head end and Terminal**



- **Network Device**

Device Type	Product Type
BFER	Huawei ATN980C
BFR & BFIR	Huawei NE40E
Non-BFR	Cisco ASR 9006

- **Scenarios**

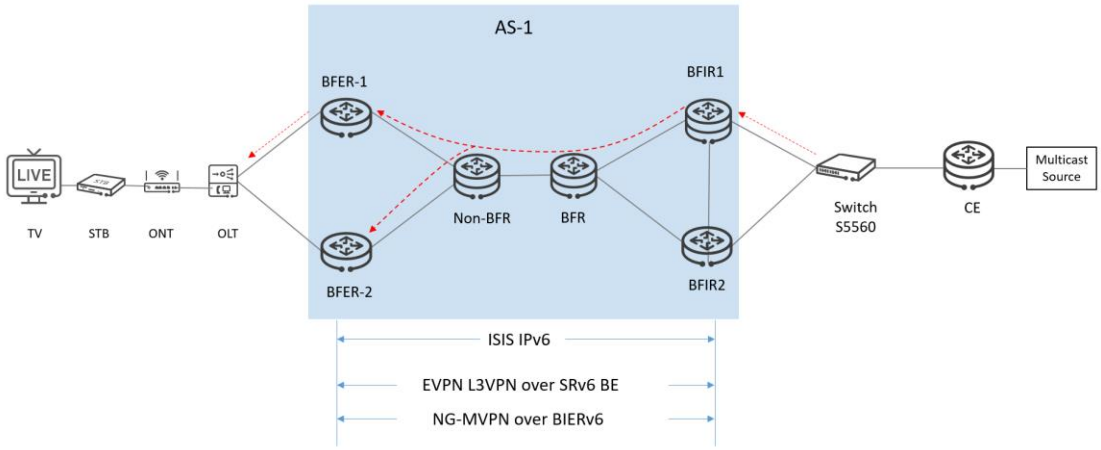
Scenario	Description
Intra-AS BIERv6	Mechanisms defined in draft-xie-bier-ipv6-encapsulation and draft-xie-bier-ipv6-isis-extension are validated
Inter-AS BIERv6	Mechanisms defined in draft-geng-bier-ipv6-inter-domain are validated
IPv4 multicast traffic over BIERv6 MVPN	Mechanisms defined in draft-xie-bier-ipv6-mvpn are validated
BIERv6 Ping	BIERv6 Ping is validated

Service reliability	Protection when BIERv6 source/receiver side link or BFIR/BFER node fails

Case 1 Intra-AS BIERv6

Intra-AS BIERv6: mechanisms defined in this document and [I-D.xie-bier-ipv6-isis-extension] are validated.

- **Topology & Configuration**



- **Pre-configuration**

1. The tested network is in the same AS: AS-1; IS-IS is used as the IGP; BFIR and BFER establish IBGP neighbours with BFR respectively and the BFR in this topology is configured as RR.
2. Multicast source and RP (Rendezvous Point) are in the existing network in the CE side. And route reachability with test networking

devices is achieved by static routes configuration in CE.

- **Test Process**

1. OLT is dual-homed to BFER1 and BFER2, join eth-trunk1, configure e-trunk dual-active on BFER, configure IGMP hot standby and ARP hot standby.
2. In each device supporting BIERv6 (BFR, BFIR and BFER) :

   1) plan BIER sub-domain 0;

   2) configure BFR-prefix by selecting a loopback IPv6 address;

   3) configure End.BIER by another IPv6 address ;

   4) enable BIERv6 in ISIS;
3. In each device not supporting BIERv6(non-BFR) : configure basic ISIS IPv6 capability;
4. MVPN and EVPN neighbors are established between BFIR and BFER. BFER joins the multicast service through MVPN.
5. In BFIR as the root node:

   1) configure VPN instance bier1;

   2) enable underlay ipv6 capability under MVPN;

   3) configure an IPv6 address as Src.dt4 to identify mvpn instances;

   4) configure x-PMSI tunnel type as Bierv6;
6. In BFER as a leaf node:

   1) configure VPN instance bier2;

2) configure bfr-id to identify the leaf node;

3) configure underlay ipv6 capability under mvpn instance.

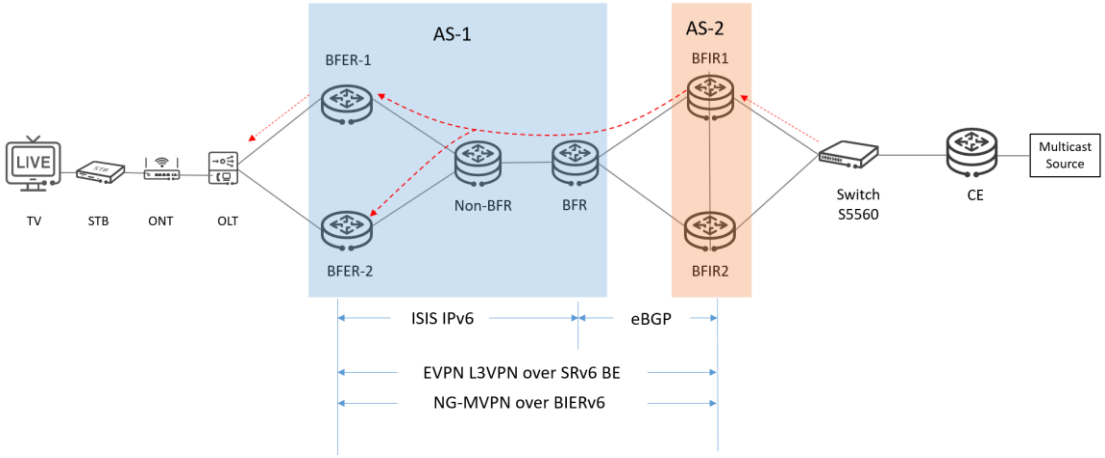
- **Test Result**

1. When connecting the ONT, STB and TV via the OLT, with the STB switched on, it could be observed that (S,G) table entries are generated on the leaf node (BFER), and the live video is visible on the TV.
2. It could be observed that (S,G) table entries are generated on the root node (BFIR).
3. It could be observed that the x-PMSI for multicast MVPN services is a BIERv6 tunnel.

Case 2 Inter-AS BIERv6

Inter-AS BIERv6: mechanisms defined in [I-D.geng-bier-ipv6-inter-domain] are validated.

- **Topology**



- **Pre-configuration**

On the basis of case 1, modify the network planning and make that BFIR belongs to AS-2 and establishes EBGP neighbor with BFR.

In AS-1, BIER routing and forwarding table is established through ISIS protocol.

In AS-2, BIER routing and forwarding table is established through static configuration as descripted in [I-D.geng-bier-ipv6-inter-domain].

- **Test Process**

1. Modify BFIR configuration based on the configuration of case 1, enable static BIER forwarding table mode: specify static BIFT entry to BFER and neighbor of BFIR node as BFR.

- **Test Result**

1. When connecting the ONT, STB and TV via the OLT, with the STB

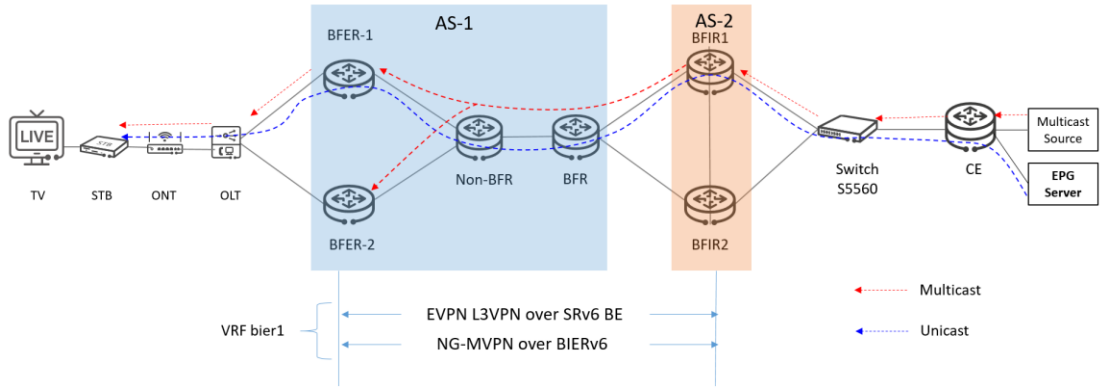
switched on, it could be observed that (S,G) table entries are generated on the leaf node (BFER), and the live video is visible on the TV.

2. It could be observed that (S,G) table entries are generated on the root node (BFIR).
3. It could be observed that the x-PMSI for multicast MVPN services is a BIERv6 tunnel.

Case 3 Unicast and Multicast in the same VPN

Verify the ability to co-deploy unicast multicast services on the same VPN

- **Topology**



- **Pre-configuration**

The same as case 1 and case 2

- **Test Process**

1. In Case 1 and Case 2, except for the multicast support introduced above, the unicast VPN service is also deployed in the same VPN, to support the whole IPTV service from STB to Headend system.
2. In BFIR and BFER:

   1) configure IPv4 unicast address family under the VPN instance

   2) service routes are published through BGP EVPN address family;

   3) VPN unicast traffic is configured to connect to an SRv6 tunnel.
3. Simulate the configuration of the access side interface in the existing network, configure two sub-interfaces bounding to the same VPN instance to access both unicast and multicast services.

- **Test Result**

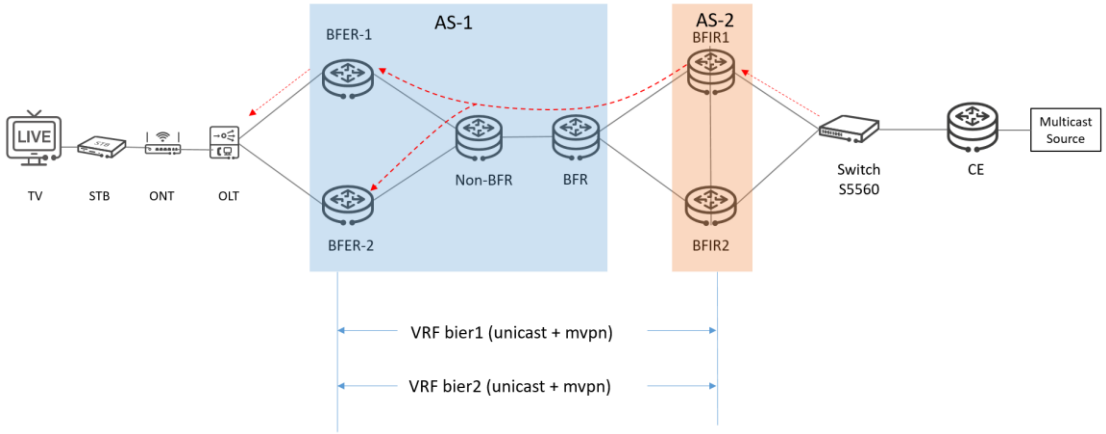
1. When the TV or STB is switched on, the EPG (Electronic Program Guide) contents can be loaded on the TV screen using the button on the remote-control panel.
2. TV programs can be selected through the EPG contents, or through up/down button, or through number button on the remote-control panel.

Case 4 Multiple BIERv6 MVPN instances

IPv4 multicast traffic over BIERv6 MVPN. Mechanisms defined in [I-D.xie-

bier-ipv6-mvpn] are validated.

- **Topology**



- **Pre-configuration**

The same as case 1 and case 2.

- **Test Process**

1. In Case 1 and Case 2, except for the L3VPN with both unicast and multicast support for the whole IPTV service from STB to Headend system, an additional L3VPN instance with both unicast and multicast support is tested in this case.
2. In BFIR:

   1) configure VPN instance bier2;

   2) enable underlay ipv6 capability under MVPN;

   3) configure an IPv6 address as Src.dt4 to identify mvpn instances;

4) configure x-PMSI tunnel type as Bierv6;

3. In BFER:

   1) configure VPN instance bier2;

   2) configure underlay ipv6 capability under mvpn instance.

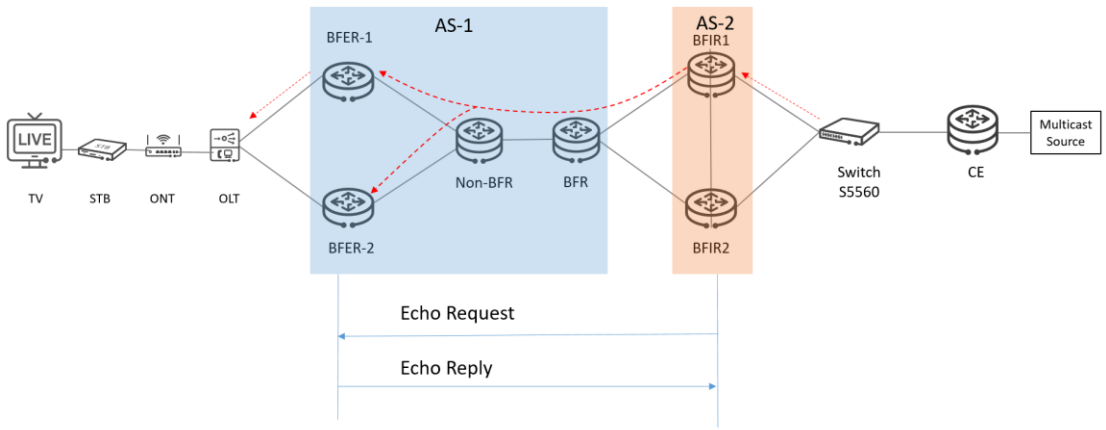
4. BFER access interface is configured to statically join the multicast group.

- **Test Result**

1. The (S,G) table entry could be seen on the leaf node BFER, with multicast traffic visible on the port.
2. The (S,G) table entry is seen on the multicast root node BFIR.
3. The x-PMSI for multicast MVPN services is a BIERv6 tunnel.

Case 5 BIERv6 Ping

- **Topology**



- **Pre-configuration**

The same as case 1 and case 2.

- **Test Process**

1. In Case 1 and Case 2, except for the L3VPN with both unicast and multicast support for the whole IPTV service from STB to Headend system, BIERv6 ping is tested.
2. On BFIR1/BFIR2/BFR, ping BFR-ID 1/2 to check the connectivity of the BIERv6 network and the reachability of the BFR through BIERv6 data plane.

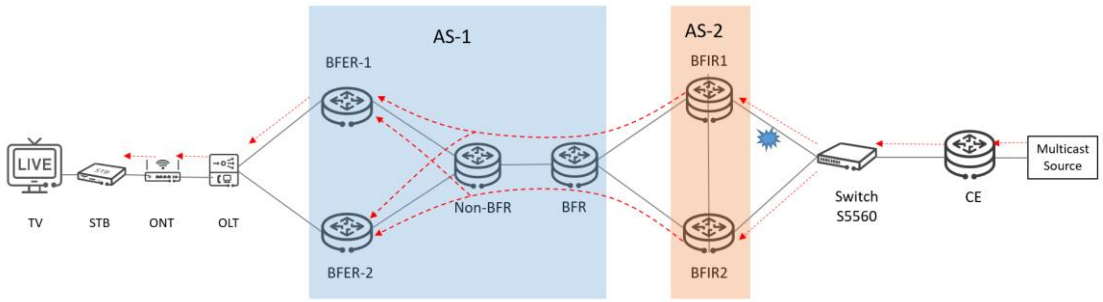
- **Test Result**

1. Echo reply message from the leaf nodes could be received.

Case 6 Dual Root 1+1 Protection

MVPNv4 double root 1+1 fast protection capability is validated.

- **Topology**



- **Pre-configuration**

The same as case 1 and case 2

- **Test Process**

1. Based on the Case 1/2 configuration, including Inter-AS networking BIERv6 capability, with some devices supporting BIERv6
2. In BFER:

   1) enable private network multicast fast reroute function;

   2) enable fast switching based on flow-detection;

- **Test Result**

1. Connecting ONT, STB and TV via OLT, and after the STB is powered on, it could be observed that (S,G) table entries is generated on the leaf node of BFER, which can receive two copies of traffic from the primary and backup links. Live signal is visible on the TV.
2. When BFIR1 fails to connect to the switch AC port, the traffic is switched to be received from the backup ingress PE (BFIR2), with no

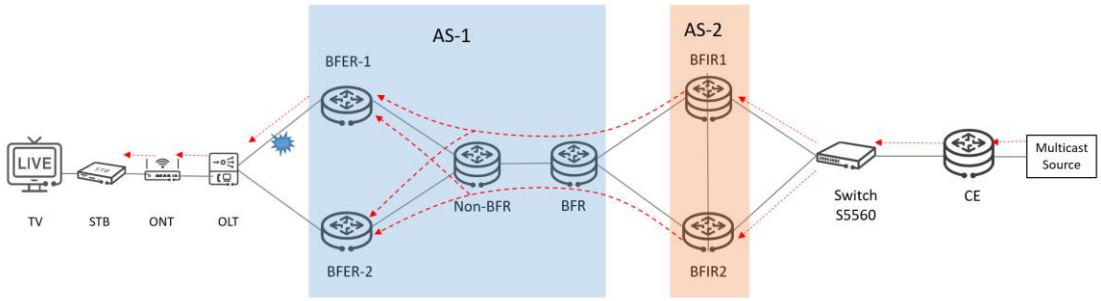
noticeable delay in the live TV video lag.

3. Traffic is switched back with no noticeable delayed lag in live TV video.

Case 7 Receiver Side Dual-home Protection

BIERv6 access-side AC link fault convergence performance is validated. Service reliability includes BIERv6 source side link and BFIR node failure.

- **Topology**



- **Pre-configuration**

Same as case 2

- **Test Process**

1. Based on the Case 2 configuration, including Inter-AS networking BIERv6 capability, with some devices supporting BIERv6
2. Simulate the leaf node BFER to OLT output interface failure by shutting

down the interface.

3. Restore the leaf node BFER to the OLT output interface.

- **Test Result**

1. The BFER-1 access side interface that forwards live TV traffic is shutdown, and the visible traffic is switched to be forwarded by the other BFER-2. There is no significant delay lag in live TV video.
2. The BFER-1 access side interface is restored and the traffic is visible back to the cut. There is no significant delay lag in live TV video.

Editor and Contributor

Test Contribution:

China Unicom (Beijing branch):

Zhao Jinshui, Qin Zhuangzhuang, Han Dong, Wang Peng

Huawei Technologies:

Liu Shuying, Hu Chunyue, Wang Kaichun, Guo Jun

Editor:

China Unicom (Beijing branch):

Qin Zhuangzhuang

Huawei Technologies:

Geng Xuesong, Xie Jingrong, Hu chunyue

References

[1] RFC 8279: https://datatracker.ietf.org/doc/rfc8279/

[2] draft-xie-bier-ipv6-encapsulation:
https://datatracker.ietf.org/doc/draft-xie-bier-ipv6-encapsulation/

[3] draft-xie-bier-ipv6-isis-extension
https://datatracker.ietf.org/doc/draft-xie-bier-ipv6-isis-extension/

[4] draft-xie-bier-ipv6-mvpn
https://datatracker.ietf.org/doc/draft-xie-bier-ipv6-mvpn/

[5] draft-geng-bier-ipv6-inter-domain
https://datatracker.ietf.org/doc/draft-geng-bier-ipv6-inter-domain/

[6] draft-geng-bier-bierv6-yang
https://tools.ietf.org/html/draft-geng-bier-bierv6-yang-00