IPv6 support for WebRTC

IPv6 support for WebRTC is added since build 5.2.660. This led to some changes in configuration settings and connection establishing procedure.

Configuration

By default, IPv6 support is disabled. To enable this feature, the following should be done:

- in flashphoner.properties file set the external IPv6 server address and allow IPv6 candidates

  ```
  ip_v6=2a03:b0c0:3:e0::42e:c002
  ice_add_ipv6_candidate=true
  ```

- in wcs-core.properies file allow IPv6 stack

  ```
  -Djava.net.preferIPv4Stack=false
  ```

The following settings can be used to set comma separated IPv4 and IPv6 interfaces to bind

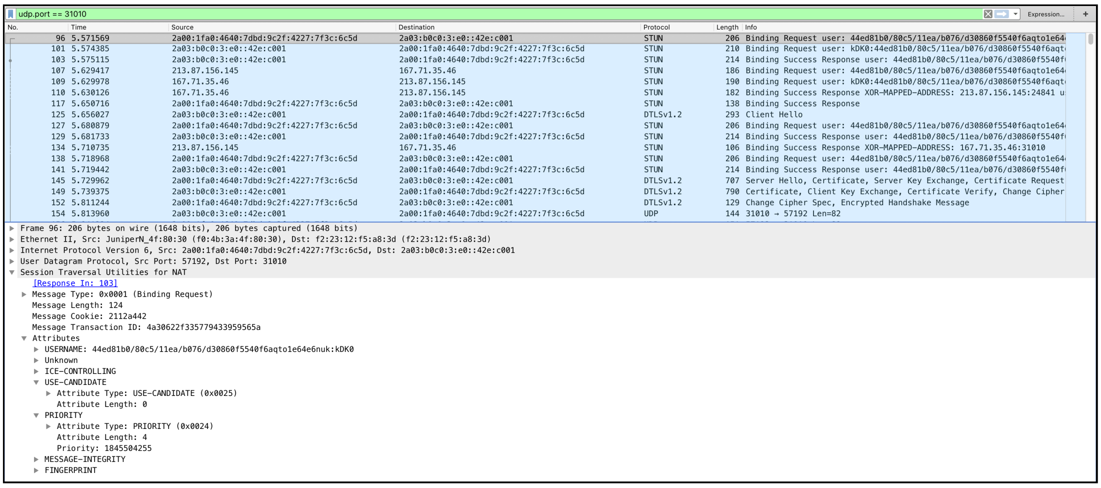
- `hls.address`
- `http.address`
- `https.address`
- `rtmfp.address`
- `rtmp.address`
- `rtsp.address`
- `rtsp_client_address`
- `ws.address`
- `wss.address`

Connection establishing procedure

Connection establishing to exchange WebRTC media traffic now looks as follows:

1. Server waits for incoming Binding Request queries to IPv4 and IPv6 interfaces.

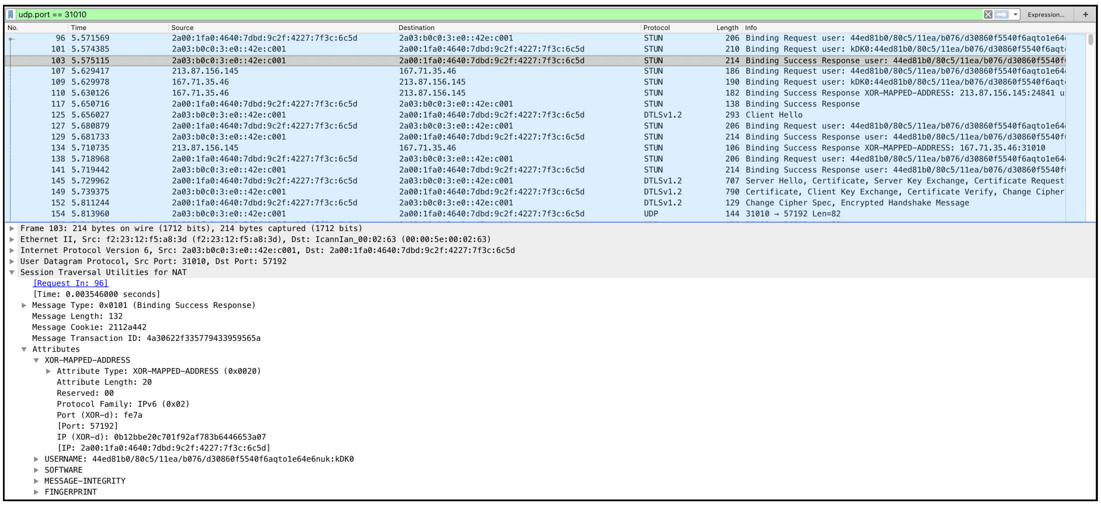
2. When a query with `USE-CANDIDATE` attribute is received, the candidate is marked as nominated to use, if `Binding Response` would be received



```
udp.port == 31010
No.   Time      Source                                 Destination                            Protocol  Length Info
   96 5.571569  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      206 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
  101 5.574385  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      210 Binding Request user: kDK0:44ed81b0/80c5/11ea/b076/d30860f5540f6aqt
  103 5.575115  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      214 Binding Success Response user: 44ed81b0/80c5/11ea/b076/d30860f5540f
  107 5.629417  213.87.156.145                         167.71.35.46                           STUN      186 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
  109 5.629978  167.71.35.46                           213.87.156.145                         STUN      190 Binding Request user: kDK0:44ed81b0/80c5/11ea/b076/d30860f5540f6aqt
  110 5.630126  167.71.35.46                           213.87.156.145                         STUN      182 Binding Success Response XOR-MAPPED-ADDRESS: 213.87.156.145:24841 u
  117 5.650716  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      138 Binding Success Response
  125 5.656027  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d DTLSv1.2  293 Client Hello
  127 5.680879  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      206 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
  129 5.681733  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      214 Binding Success Response user: 44ed81b0/80c5/11ea/b076/d30860f5540f
  134 5.710735  213.87.156.145                         167.71.35.46                           STUN      106 Binding Success Response XOR-MAPPED-ADDRESS: 167.71.35.46:31010
  138 5.718968  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      206 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
  141 5.719442  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      214 Binding Success Response user: 44ed81b0/80c5/11ea/b076/d30860f5540f
  145 5.729962  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               DTLSv1.2  707 Server Hello, Certificate, Server Key Exchange, Certificate Request
  149 5.739375  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d DTLSv1.2  790 Certificate, Client Key Exchange, Certificate Verify, Change Cipher
  152 5.811244  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               DTLSv1.2  129 Change Cipher Spec, Encrypted Handshake Message
  154 5.813960  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d UDP       144 31010 → 57192 Len=82

▶ Frame 96: 206 bytes on wire (1648 bits), 206 bytes captured (1648 bits)
▶ Ethernet II, Src: JuniperN_4f:80:30 (f0:4b:3a:4f:80:30), Dst: f2:23:12:f5:a8:3d (f2:23:12:f5:a8:3d)
▶ Internet Protocol Version 6, Src: 2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d, Dst: 2a03:b0c0:3:e0::42e:c001
▶ User Datagram Protocol, Src Port: 57192, Dst Port: 31010
▼ Session Traversal Utilities for NAT
    [Response In: 103]
  ▶ Message Type: 0x0001 (Binding Request)
    Message Length: 124
    Message Cookie: 2112a442
    Message Transaction ID: 4a30622f335779433959565a
  ▼ Attributes
    ▶ USERNAME: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64e6nuk:kDK0
    ▶ Unknown
    ▶ ICE-CONTROLLING
    ▼ USE-CANDIDATE
      ▶ Attribute Type: USE-CANDIDATE (0x0025)
        Attribute Length: 0
    ▼ PRIORITY
      ▶ Attribute Type: PRIORITY (0x0024)
        Attribute Length: 4
        Priority: 1845504255
    ▶ MESSAGE-INTEGRITY
    ▶ FINGERPRINT
```

3. For every browser `Binding Request` server sends `Binding Response`

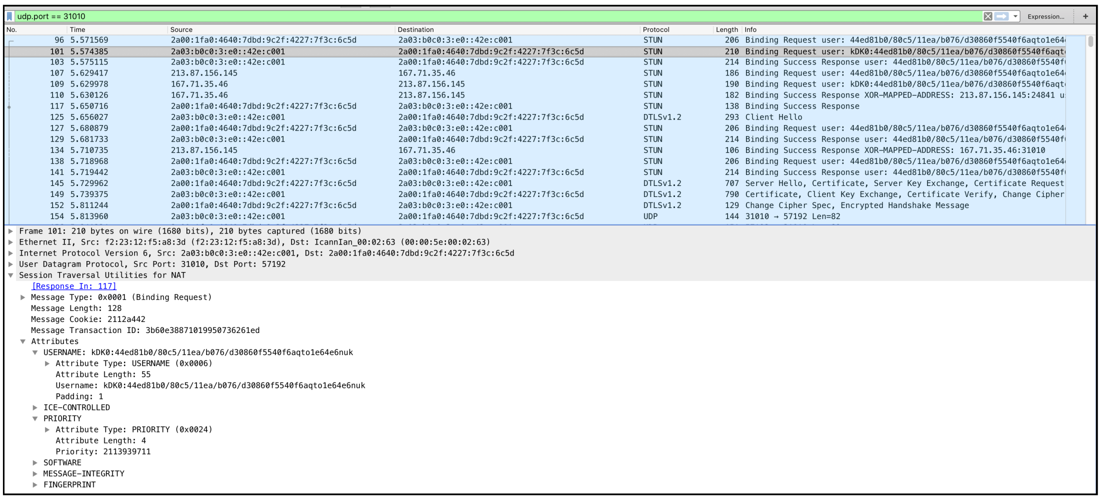


```
udp.port == 31010
No.   Time      Source                                 Destination                            Protocol  Length Info
   96 5.571569  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      206 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
  101 5.574385  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      210 Binding Request user: kDK0:44ed81b0/80c5/11ea/b076/d30860f5540f6aqt
  103 5.575115  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      214 Binding Success Response user: 44ed81b0/80c5/11ea/b076/d30860f5540f
  107 5.629417  213.87.156.145                         167.71.35.46                           STUN      186 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
  109 5.629978  167.71.35.46                           213.87.156.145                         STUN      190 Binding Request user: kDK0:44ed81b0/80c5/11ea/b076/d30860f5540f6aqt
  110 5.630126  167.71.35.46                           213.87.156.145                         STUN      182 Binding Success Response XOR-MAPPED-ADDRESS: 213.87.156.145:24841 u
  117 5.650716  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      138 Binding Success Response
  125 5.656027  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d DTLSv1.2  293 Client Hello
  127 5.680879  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      206 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
  129 5.681733  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      214 Binding Success Response user: 44ed81b0/80c5/11ea/b076/d30860f5540f
  134 5.710735  213.87.156.145                         167.71.35.46                           STUN      106 Binding Success Response XOR-MAPPED-ADDRESS: 167.71.35.46:31010
  138 5.718968  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      206 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
  141 5.719442  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      214 Binding Success Response user: 44ed81b0/80c5/11ea/b076/d30860f5540f
  145 5.729962  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               DTLSv1.2  707 Server Hello, Certificate, Server Key Exchange, Certificate Request
  149 5.739375  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d DTLSv1.2  790 Certificate, Client Key Exchange, Certificate Verify, Change Cipher
  152 5.811244  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               DTLSv1.2  129 Change Cipher Spec, Encrypted Handshake Message
  154 5.813960  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d UDP       144 31010 → 57192 Len=82

▶ Frame 103: 214 bytes on wire (1712 bits), 214 bytes captured (1712 bits)
▶ Ethernet II, Src: f2:23:12:f5:a8:3d (f2:23:12:f5:a8:3d), Dst: IcannIan_00:02:63 (00:00:5e:00:02:63)
▶ Internet Protocol Version 6, Src: 2a03:b0c0:3:e0::42e:c001, Dst: 2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d
▶ User Datagram Protocol, Src Port: 31010, Dst Port: 57192
▼ Session Traversal Utilities for NAT
    [Request In: 96]
    [Time: 0.003546000 seconds]
  ▶ Message Type: 0x0101 (Binding Success Response)
    Message Length: 132
    Message Cookie: 2112a442
    Message Transaction ID: 4a30622f335779433959565a
  ▼ Attributes
    ▼ XOR-MAPPED-ADDRESS
      ▶ Attribute Type: XOR-MAPPED-ADDRESS (0x0020)
        Attribute Length: 20
        Reserved: 00
        Protocol Family: IPv6 (0x02)
        Port (XOR-d): fe7a
        [Port: 57192]
        IP (XOR-d): 0b12bbe20c701f92af783b6446653a07
        [IP: 2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d]
    ▶ USERNAME: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64e6nuk:kDK0
    ▶ SOFTWARE
    ▶ MESSAGE-INTEGRITY
    ▶ FINGERPRINT
```

4. At the same time, server sends `Binding Request` to browser. Requests will be repeated if necessary with the following period (1500 ms by default)

```
stun_freshness_period=1500
```



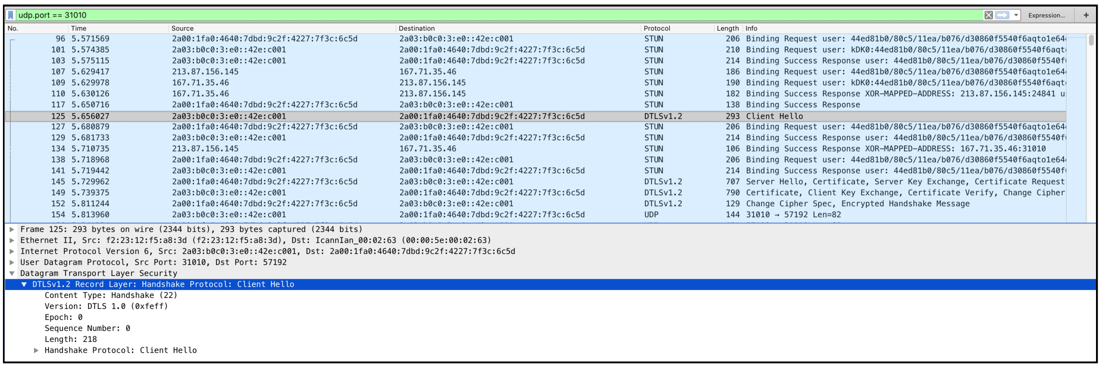
```
udp.port == 31010
No.   Time      Source                                 Destination                            Protocol  Length Info
   96 5.571569  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      206 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
  101 5.574385  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      210 Binding Request user: kDK0:44ed81b0/80c5/11ea/b076/d30860f5540f6aqt
  103 5.575115  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      214 Binding Success Response user: 44ed81b0/80c5/11ea/b076/d30860f5540f
  107 5.629417  213.87.156.145                         167.71.35.46                           STUN      186 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
  109 5.629978  167.71.35.46                           213.87.156.145                         STUN      190 Binding Request user: kDK0:44ed81b0/80c5/11ea/b076/d30860f5540f6aqt
  110 5.630126  167.71.35.46                           213.87.156.145                         STUN      182 Binding Success Response XOR-MAPPED-ADDRESS: 213.87.156.145:24841 u
  117 5.650716  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      138 Binding Success Response
  125 5.656027  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d DTLSv1.2  293 Client Hello
  127 5.680879  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      206 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
  129 5.681733  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      214 Binding Success Response user: 44ed81b0/80c5/11ea/b076/d30860f5540f
  134 5.710735  213.87.156.145                         167.71.35.46                           STUN      106 Binding Success Response XOR-MAPPED-ADDRESS: 167.71.35.46:31010
  138 5.718968  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      206 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
  141 5.719442  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      214 Binding Success Response user: 44ed81b0/80c5/11ea/b076/d30860f5540f
  145 5.729962  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               DTLSv1.2  707 Server Hello, Certificate, Server Key Exchange, Certificate Request
  149 5.739375  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d DTLSv1.2  790 Certificate, Client Key Exchange, Certificate Verify, Change Cipher
  152 5.811244  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               DTLSv1.2  129 Change Cipher Spec, Encrypted Handshake Message
  154 5.813960  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d UDP       144 31010 → 57192 Len=82

▶ Frame 101: 210 bytes on wire (1680 bits), 210 bytes captured (1680 bits)
▶ Ethernet II, Src: f2:23:12:f5:a8:3d (f2:23:12:f5:a8:3d), Dst: IcannIan_00:02:63 (00:00:5e:00:02:63)
▶ Internet Protocol Version 6, Src: 2a03:b0c0:3:e0::42e:c001, Dst: 2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d
▶ User Datagram Protocol, Src Port: 31010, Dst Port: 57192
▼ Session Traversal Utilities for NAT
    [Response In: 117]
  ▶ Message Type: 0x0001 (Binding Request)
    Message Length: 128
    Message Cookie: 2112a442
    Message Transaction ID: 3b60e38871019950736261ed
  ▼ Attributes
    ▼ USERNAME: kDK0:44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64e6nuk
      ▶ Attribute Type: USERNAME (0x0006)
        Attribute Length: 55
        Username: kDK0:44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64e6nuk
        Padding: 1
    ▶ ICE-CONTROLLED
    ▼ PRIORITY
      ▶ Attribute Type: PRIORITY (0x0024)
        Attribute Length: 4
        Priority: 2113939711
    ▶ SOFTWARE
    ▶ MESSAGE-INTEGRITY
    ▶ FINGERPRINT
```

5. When `Bindind Response` is received from the first candidate, the timeout is started to wait for another candidates as set in the following parameter (1000 ms by default)

```
stun_wait_candidate_timeout=1000
```

6. When timeout is finished, server sends DTLS `Client Hello` to the priority candidate



```
udp.port == 31010
No.  Time      Source                                 Destination                            Protocol Length Info
  96 5.571569  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      206 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
 101 5.574385  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      210 Binding Request user: kDK0:44ed81b0/80c5/11ea/b076/d30860f5540f6aqt
 103 5.575115  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      214 Binding Success Response user: 44ed81b0/80c5/11ea/b076/d30860f5540f
 107 5.629417  213.87.156.145                         167.71.35.46                           STUN      186 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
 109 5.629978  167.71.35.46                           213.87.156.145                         STUN      190 Binding Request user: kDK0:44ed81b0/80c5/11ea/b076/d30860f5540f6aqt
 110 5.630126  167.71.35.46                           213.87.156.145                         STUN      182 Binding Success Response XOR-MAPPED-ADDRESS: 213.87.156.145:24841 u
 117 5.650716  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      138 Binding Success Response
 125 5.656027  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d DTLSv1.2  293 Client Hello
 127 5.680879  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      206 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
 129 5.681733  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      214 Binding Success Response user: 44ed81b0/80c5/11ea/b076/d30860f5540f
 134 5.710735  213.87.156.145                         167.71.35.46                           STUN      106 Binding Success Response XOR-MAPPED-ADDRESS: 167.71.35.46:31010
 138 5.718968  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               STUN      206 Binding Request user: 44ed81b0/80c5/11ea/b076/d30860f5540f6aqto1e64
 141 5.719442  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d STUN      214 Binding Success Response user: 44ed81b0/80c5/11ea/b076/d30860f5540f
 145 5.729962  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               DTLSv1.2  707 Server Hello, Certificate, Server Key Exchange, Certificate Request
 149 5.739375  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d DTLSv1.2  790 Certificate, Client Key Exchange, Certificate Verify, Change Cipher
 152 5.811244  2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d 2a03:b0c0:3:e0::42e:c001               DTLSv1.2  129 Change Cipher Spec, Encrypted Handshake Message
 154 5.813960  2a03:b0c0:3:e0::42e:c001               2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d UDP       144 31010 → 57192 Len=82

▶ Frame 125: 293 bytes on wire (2344 bits), 293 bytes captured (2344 bits)
▶ Ethernet II, Src: f2:23:12:f5:a8:3d (f2:23:12:f5:a8:3d), Dst: IcannIan_00:02:63 (00:00:5e:00:02:63)
▶ Internet Protocol Version 6, Src: 2a03:b0c0:3:e0::42e:c001, Dst: 2a00:1fa0:4640:7dbd:9c2f:4227:7f3c:6c5d
▶ User Datagram Protocol, Src Port: 31010, Dst Port: 57192
▼ Datagram Transport Layer Security
  ▼ DTLSv1.2 Record Layer: Handshake Protocol: Client Hello
      Content Type: Handshake (22)
      Version: DTLS 1.0 (0xfeff)
      Epoch: 0
      Sequence Number: 0
      Length: 218
    ▶ Handshake Protocol: Client Hello
```

When establishing connection with Safari browser, IPv4 candidates are preferred unless some problem in STUN-DTLS procedure occur with such candidate. Therefore, in Safari IPv4 will be used if client has both IPv4 and IPv6 interfaces working and traffic between client and server is not blocked. In other browsers (see example pictures above) IPv6 candidates are preferred.

Known issues

1. WebRTC publishing/playback does not work in any browser on IPv6 only host

Symptoms

Stream publishing or playback fails with `Failed by ICE timeout` error

✓ **Solution**

If a host has only IPv6 address (and localhost), ICE candidates exchange does not work, `RTCPeerConnection.onicecandidate` event is nor fired in most browsers. Use RTMP to publish and RTSP, RTMP, HLS to play.