

[MS-ICE2BWM]: Interactive Connectivity Establishment (ICE) 2.0 Bandwidth Management Extensions

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1 Introduction

This document specifies the Interactive Connectivity Establishment (ICE) Bandwidth Management Extensions protocol. It is a proprietary extension to the Interactive Connectivity Establishment (ICE) Extensions protocol, as described in [\[MS-ICE2\]](#).

[MS-ICE2] describes how to set up Real-Time Transport Protocol (RTP) streams in a way that allows the streams to traverse network address translation (NAT) and firewalls. The protocol described by [MS-ICE2] is agnostic to bandwidth or other policy constraints and attempts to find the highest priority path for the media session.

This protocol specifies how to determine and enforce bandwidth policy constraints by communicating with a bandwidth policy aware server.

This protocol facilitates:

- Communication with a server based on the [\[MS-TURNBWM\]](#) protocol that supports network bandwidth utilization management and access control. The [MS-TURNBWM] server is known as a bandwidth policy server. The bandwidth policy server uses this protocol to determine any policy constraints that necessitate avoiding viable media paths that could potentially be used for media flow.
- Enforces bandwidth policy constraints and ensures that policy restricted paths are not used for media flow.
- Periodically reports to the bandwidth policy server the path and the bandwidth being utilized by the media session.

1.1 Glossary

The following terms are defined in [\[MS-GLOS\]](#):

Internet Protocol version 4 (IPv4)
network address translation (NAT)
Transmission Control Protocol (TCP)
User Datagram Protocol (UDP)

The following terms are defined in [\[MS-OFCGLOS\]](#):

agent
answer
bandwidth management endpoint
callee
caller
candidate
candidate pair
Check List
component
connectivity check
controlled agent
controlling agent
endpoint
final offer
full
Host Candidate
initial offer

INVITE
local candidate
local transport address
offer
peer
peer-derived candidate
provisional answer
Real-Time Transport Control Protocol (RTCP)
Real-Time Transport Protocol (RTP)
Relayed Candidate
remote candidate
remote endpoint
Server Reflexive Candidate
Session Description Protocol (SDP)
Session Initiation Protocol (SIP)
Simple Traversal of UDP through NAT (STUN)
TCP/IP
transport address
Traversal Using Relay NAT (TURN)
TURN candidate
TURN server

The following terms are specific to this document:

STUN candidate: A candidate whose transport addresses are STUN-derived transport addresses. See also Simple Traversal of UDP through NAT (STUN).

MAY, SHOULD, MUST, SHOULD NOT, MUST NOT: These terms (in all caps) are used as described in [\[RFC2119\]](#). All statements of optional behavior use either MAY, SHOULD, or SHOULD NOT.

1.2 References

1.2.1 Normative References

We conduct frequent surveys of the normative references to assure their continued availability. If you have any issue with finding a normative reference, please contact dochelp@microsoft.com. We will assist you in finding the relevant information. Please check the archive site, <http://msdn2.microsoft.com/en-us/library/E4BD6494-06AD-4aed-9823-445E921C9624>, as an additional source.

[MS-ICE2] Microsoft Corporation, "[Interactive Connectivity Establishment \(ICE\) Extensions 2.0](#)"

[MS-TURN] Microsoft Corporation, "[Traversal Using Relay NAT \(TURN\) Extensions](#)"

[MS-TURNBWM] Microsoft Corporation, "[Traversal using Relay NAT \(TURN\) Bandwidth Management Extensions](#)"

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997, <http://www.rfc-editor.org/rfc/rfc2119.txt>

1.2.2 Informative References

[MS-GLOS] Microsoft Corporation, "[Windows Protocols Master Glossary](#)".

[MS-OFCGLOS] Microsoft Corporation, "[Microsoft Office Master Glossary](#)".

1.3 Protocol Overview (Synopsis)

Managing and controlling utilization of network bandwidth is important for enterprises to reduce cost and also to ensure good quality of service. Media communication traffic has the potential to congest or overuse the available bandwidth on network links unless the utilization is closely monitored and bandwidth policy restrictions are actively enforced. Even if the bandwidth utilization is known, enforcing the bandwidth policy is difficult because the clients involved in the media session could be dispersed across the enterprise and can be in different geographical or network regions.

The Interactive Connectivity Establishment (ICE) Extensions protocol, as described in [MS-ICE2], is used to establish media flow between a **caller endpoint (5)** and a **callee endpoint (5)**. This protocol seamlessly integrates with and extends the protocol described in [MS-ICE2] for bandwidth management.

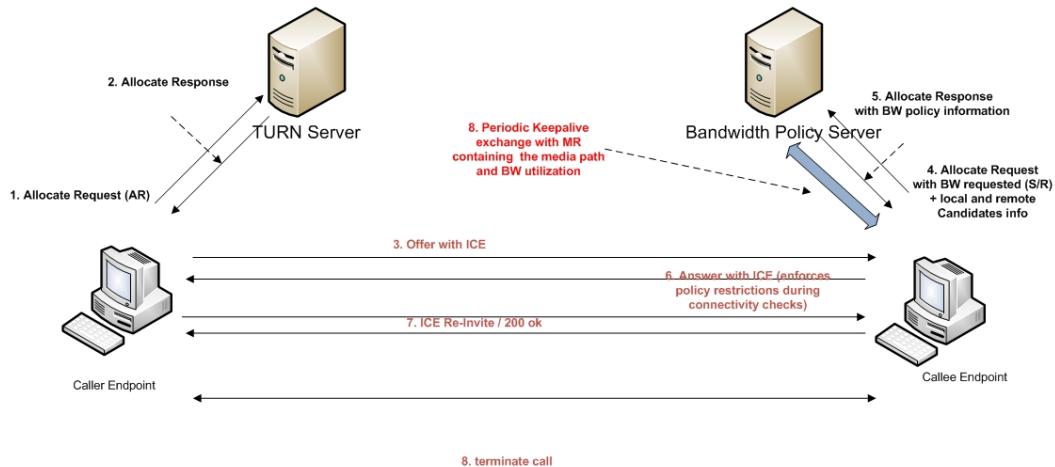


Figure 1: ICE bandwidth management

The preceding figure shows a typical deployment scenario with two endpoints (5) that establish a media session with bandwidth management.

The sequence diagram in the following figure outlines the various phases involved in establishing a session between two endpoints (5) using the [MS-ICE2] protocol and this protocol during the different phases.

The **candidates** gathering phase is the exchange of gathered **transport addresses** between the caller and callee endpoints (5).

The **connectivity checks** phase is the exchange of candidates selected by the candidates gathering phase.

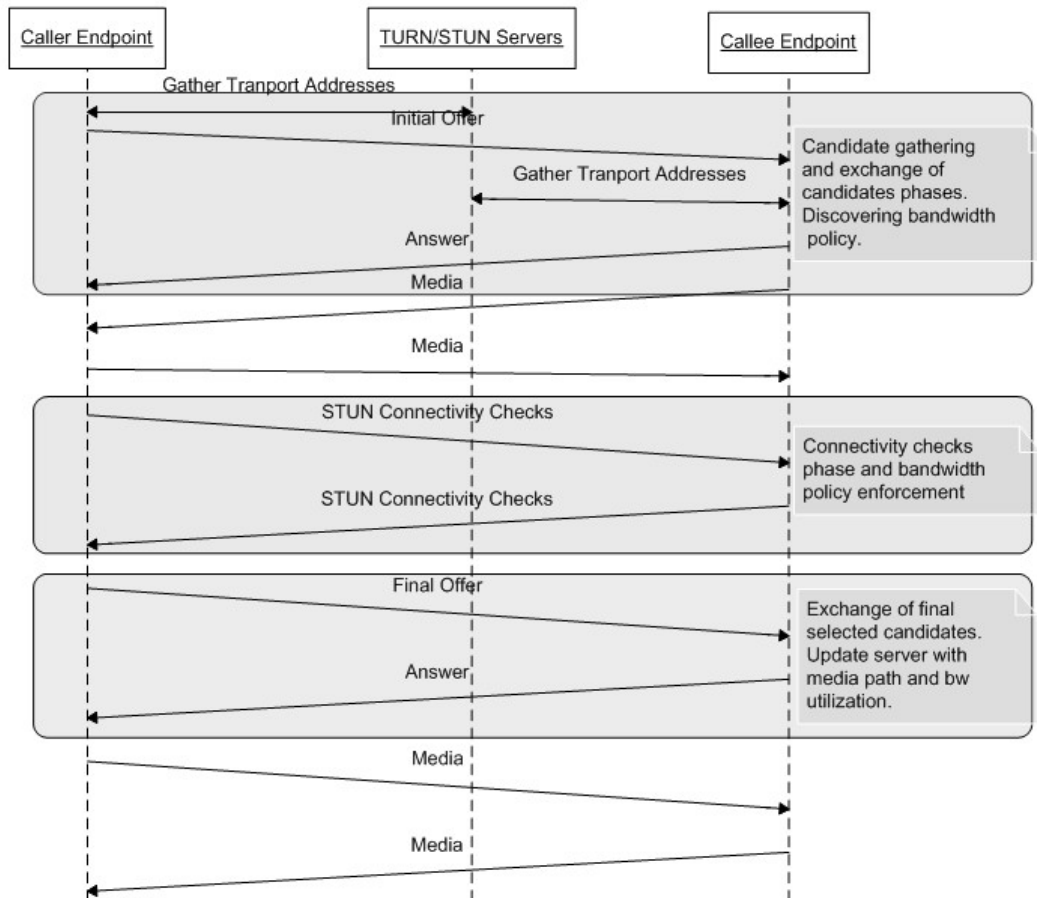


Figure 2: ICE sequence diagram

During the candidates gathering phase, the caller attempts to establish a media session and gathers transport addresses that can potentially be used to communicate with its **peer**.

The gathered transport addresses are used to form candidates. The gathered candidates are then sent to the peer in the **offer**. Typically the caller endpoint (5) serves as the **controlling agent** or endpoint (5) and is responsible for selecting the final candidates for media flow.

The callee endpoint (5) is typically assigned as the **bandwidth management endpoint** by the applications. If the bandwidth management endpoint is aware of the **remote endpoint's** candidates during its candidate gathering phase, it sends the information about the bandwidth requirement for the media session along with the local **Host Candidate** and **remote candidates** to the server that it uses to gather **Relayed Candidates**. The communication between the bandwidth management endpoint and the bandwidth policy server uses the [\[MS-TURNBWM\]](#) protocol. The bandwidth policy server, if capable of bandwidth management, returns the bandwidth policy. At this point, the callee endpoint (5) is aware of the bandwidth policy and can enforce the policy during connectivity checks. The bandwidth policy from the server returns the send and receive bandwidth for local site addresses as described in [\[MS-TURNBWM\]](#) section 2.2.6, local relay site addresses as described in [\[MS-TURNBWM\]](#) section 2.2.7, remote site addresses as described in [\[MS-TURNBWM\]](#) section 2.2.4,

and remote relay site addresses as described in [\[MS-TURNBWM\]](#) section 2.2.5. If the requested bandwidth is not available for a particular site, the candidates belonging to the site are not used for media flow. If no **candidate pairs** can be formed by the bandwidth management endpoint, it fails the media session. If the local relay site candidates cannot be used, the bandwidth management endpoint does not include the local relay site candidates in the offer or **answer**.

The gathered candidates are encoded and sent to the caller in the answer. With the exchange of candidates complete, both the endpoints (5) are now aware of their peer's candidates. The start of the connectivity checks phase is triggered at an endpoint (5) when it is aware of its peer's candidates. Both endpoints (5) pair up the local and remote candidates to form a **Check List** of candidate pairs that are ordered based on the priorities of the candidate pairs. Both endpoints (5) systematically perform connectivity checks starting from the top of the candidate pair Check List to determine the highest priority candidate pair that can be used by the endpoints (5) to establish a media session.

Connectivity checks involve sending peer-to-peer **Simple Traversal of UDP through NAT (STUN)** binding request messages and responses from the **local transport addresses** to the remote transport addresses of each candidate pair in the list. During the connectivity checks, the bandwidth management endpoint does not attempt connectivity checks for candidate pairs that have either the local or remote candidate restricted by the bandwidth policy. In addition, if the bandwidth management endpoint receives connectivity check packets from the peer endpoint (5) for any of the bandwidth policy restricted candidate pairs, it responds with an error response with specific error codes. The peer endpoint (5) based on the error code disables the candidate pair, or all associated candidate pairs, for the **local candidate** for which the error response was received. This ensures that the connectivity checks do not select any of the candidates belonging to sites restricted by the bandwidth policy.

The controlling agent concludes the connectivity checks by nominating a valid candidate pair found by connectivity checks for media flow. At the end of the connectivity checks, the bandwidth management endpoint periodically updates the bandwidth policy server with the path being used for media flow and the bandwidth being utilized. Applications can alternatively also configure the bandwidth management enabled endpoint to skip doing the bandwidth policy checks and to only report the path being used for media flow and bandwidth being utilized at the end of connectivity checks.

1.4 Relationship to Other Protocols

This protocol seamlessly integrates with and extends the ICE extensions described in [\[MS-ICE2\]](#).

This protocol works with implementations of **TURN** protocols that adhere to the specifications in this protocol to create **TURN candidates** and **STUN candidates** for discovering bandwidth and reporting bandwidth utilization.

1.5 Prerequisites/Preconditions

This protocol uses the **TCP/IP** v4 and UDP/IP v4 protocols as transport protocols.

This protocol requires that the endpoints (5) be able to communicate through a signaling protocol, such as the **Session Initiation Protocol (SIP)**, to exchange candidates.

This protocol requires that the bandwidth management endpoint is configured with the bandwidth management policy server IP address and port.

1.6 Applicability Statement

This protocol requires a bandwidth management policy server, as described in [\[MS-TURNBWM\]](#), to discover the bandwidth policy and report the bandwidth utilization.

If a bandwidth management enabled endpoint does not have the peer endpoints candidates available during the candidate gathering phase, bandwidth policy will not be discovered. However, at the end of connectivity checks the bandwidth management enabled endpoint will report the path being used for media flow and the bandwidth utilization to the bandwidth management policy server.

This protocol also works with TURN servers based on the descriptions in [\[MS-TURN\]](#) section 3. In this case, the functioning of this protocol is identical to the protocol described in [\[MS-ICE2\]](#) section 3 because there is no bandwidth policy available.

1.7 Versioning and Capability Negotiation

Currently, this protocol has no versioning and capability negotiation constraints, with the following exception.

Supported Transports: This protocol is implemented on top of the **Transmission Control Protocol (TCP)** (**Internet Protocol version 4 (IPv4)**) and **User Datagram Protocol (UDP)** (IPv4) transport protocols, as described in section [2.1](#).

1.8 Vendor-Extensible Fields

None.

1.9 Standards Assignments

None.

2 Messages

2.1 Transport

This protocol uses the TCP (IPv4) and UDP (IPv4) transport protocols.

2.2 Message Syntax

The following sections specify how the messages for this protocol are transported and the syntax for protocol messages. This protocol follows the restrictions for message size specified in [\[MS-ICE2\]](#) section 2.2.

2.2.1 TURN/TURN Bandwidth Management Extension Messages

This protocol requires a bandwidth management policy server that implements the specifications in [\[MS-TURNBWM\]](#) to discover bandwidth policy, and also to discover **Server Reflexive Candidates** and Relayed Candidates if the server supports it. The message syntax used by the endpoint (5) is specified in [\[MS-TURNBWM\]](#) section 2.

2.2.2 STUN Messages

This protocol uses STUN binding request and response messages for connectivity checks between the two endpoints (5) and STUN binding error responses for enforcing bandwidth policy. The message formats MUST follow the specifications in [\[MS-ICE2\]](#) section 2.2.2.

This protocol adds two new error codes that are sent in the STUN binding error responses to enforce bandwidth policy restrictions. The codes and their reason phrases are defined as follows.

274 Disable Candidate: All associated candidate pairs with the local candidate on which the error response is received are disabled as a result of bandwidth policy restrictions.

275 Disable Candidate Pair: The candidate pair for which the error response is received is disabled as a result of bandwidth policy restrictions.

2.3 Directory Service Schema Elements

None.

3 Protocol Details

3.1 Common Details

The procedures specified apply to both TCP and UDP transport protocols unless the procedures explicitly specify a transport protocol.

3.1.1 Abstract Data Model

This protocol uses the same abstract data model as the one specified in [\[MS-ICE2\]](#) section 3.1.1.

3.1.2 Timers

This protocol adds two new timers in addition to the timers specified in [\[MS-ICE2\]](#) section 3.1.2.

ICE Bandwidth Commit Timer: This timer tracks the spacing of the bandwidth commit message sent to the bandwidth policy server.

ICE Bandwidth Update Timer: This timer tracks the spacing of the bandwidth update message sent to the bandwidth policy server.

3.1.3 Initialization

None.

3.1.4 Higher-Layer Triggered Events

This section outlines the higher-layer events that trigger the start of the various phases of this protocol for bandwidth management. The higher-layer triggered events specified in [\[MS-ICE2\]](#) section 3.1.4 MUST be followed in addition to the specifications in the following sections. Differences in processing from the specifications in [\[MS-ICE2\]](#) section 3.1.4 are specified in the corresponding sections. Discovering the bandwidth policy and enforcing and reporting bandwidth utilization MUST be carried out independently for each media stream.

The callee endpoint (5) is typically configured as the bandwidth management endpoint because the callee endpoint (5), on receiving the **initial offer**, knows the peer endpoint's candidates. However, in cases where the caller is an ICE endpoint (5) and the peer endpoint (5) is a non-ICE endpoint (5), applications can configure the caller endpoint (5) as the bandwidth management endpoint. The bandwidth management endpoint is responsible for the bandwidth policy discovery, policy enforcement, and reporting for that media session. Applications can configure the bandwidth management endpoint to skip the bandwidth policy discovery and policy enforcement and to only do the reporting for that media session.

3.1.4.1 Sending the Initial Offer

The caller attempting to establish a media session with a peer MUST follow the procedures specified in [\[MS-ICE2\]](#) section 3.1.4.1.

In addition, if the caller endpoint (5) is a bandwidth management endpoint and is aware of the peer endpoints (5) site addresses, the caller endpoint (5) MUST perform the checks for bandwidth admission control during its candidate gathering phase, as specified in [\[MS-TURNBWM\]](#) section 3.2.4.1, to determine the bandwidth policy. If the bandwidth policy from the bandwidth policy server restricts all potential paths between the caller and the callee endpoint (5), the attempt to establish the media session MUST fail and the offer MUST NOT be sent.

If the policy received from the bandwidth management policy server restricts the use of the local Relayed Candidate, the local Relayed Candidate MUST NOT be included in the offer.

3.1.4.2 Receiving the Initial Offer and Generation of the Answer

The callee endpoint (5), on receiving the initial offer, MUST follow the procedures specified in [\[MS-ICE2\]](#) section 3.1.4.6.

If the callee endpoint (5) is a bandwidth management endpoint, and has been configured to do bandwidth policy discovery and policy enforcement the callee endpoint (5) MUST perform bandwidth policy checks during its candidate gathering phase, as specified in section [3.1.4.8.1.1](#), using the remote endpoints candidate information received in the offer. If the bandwidth policy from the bandwidth policy server restricts all potential paths between the caller and the callee endpoint (5), the attempt to establish the media session MUST fail. If the policy received from the bandwidth management policy server restricts the use of the local Relayed Candidate, the local Relayed Candidate MUST NOT be included in the answer.

3.1.4.3 Processing of Provisional Answer to Initial Offer

The caller, after receiving the **provisional answer** with the callee's candidates MUST follow the procedures specified in [\[MS-ICE2\]](#) section 3.1.4.3.

3.1.4.4 Processing the Answer to the Initial Offer from Full ICE Peer

The caller, on receiving the answer to its initial offer with the callee's candidates MUST follow the procedures specified in [\[MS-ICE2\]](#) section 3.1.4.4.

3.1.4.4.1 Processing of Answer to Initial Offer from Non-ICE/Lite Peer

If an answer is received from a non-ICE/Lite peer, the procedure specified in [\[MS-ICE2\]](#) section 3.1.4.4.1 MUST be followed.

If the endpoint (5) is a bandwidth management endpoint, the endpoint (5) MUST follow the procedures specified in section [3.1.4.8.2.2](#) and section [3.1.4.8.2.3](#) for committing and sending periodic updates to the bandwidth management policy server.

3.1.4.5 Generating the Final Offer

At the end of the connectivity checks phase, the controlling endpoint (5) MUST follow the procedures specified in [\[MS-ICE2\]](#) section 3.1.4.5.

If the endpoint (5) is a bandwidth management endpoint, it MUST use the procedures specified in section [3.1.4.8.2.2](#) for committing, and in section [3.1.4.8.2.3](#) for sending, periodic updates to the bandwidth management policy server.

3.1.4.6 Receiving the Final Offer and Generation of the Answer

The **controlled agent**, on receiving the **final offer**, MUST follow the procedures specified in [\[MS-ICE2\]](#) section 3.1.4.6.

If the endpoint (5) is a bandwidth management endpoint, it MUST use the procedures specified in section [3.1.4.8.2.2](#) for committing, and in section [3.1.4.8.2.3](#) for sending, periodic updates to the bandwidth management policy server.

3.1.4.7 Processing the Answer to Final Offer

The controlling agent, after receiving the answer to its final offer, MUST follow the procedures specified in [\[MS-ICE2\]](#) section 3.1.4.7.

If the endpoint (5) is a bandwidth management endpoint, it MUST follow the procedures specified in section [3.1.4.8.2.2](#) and section [3.1.4.8.2.3](#) to commit and send periodic updates to the bandwidth management policy server.

3.1.4.8 Common Procedures

Bandwidth management endpoints, when configured with a bandwidth management policy server, follow the specifications in [\[MS-TURNBWM\]](#) section 2.

3.1.4.8.1 Candidates Gathering Phase

The candidates gathering phase MUST follow the specifications in [\[MS-ICE2\]](#) section 3.1.4.8.1. If the endpoint (5) is a bandwidth management endpoint and is aware of the peer's endpoints (5) site addresses, it MUST follow the procedures specified in the following section for the bandwidth policy checks.

3.1.4.8.1.1 Bandwidth Admission Check Request

The bandwidth management endpoint SHOULD perform the policy checks following the procedures specified in [\[MS-TURNBWM\]](#) section 3.2.4.1. The following sections specify the procedures for populating the attributes for the check messages.

The **Local Site Address** attribute MUST be populated with one of the local Host Candidate addresses. The **Remote Site Address** attribute MUST be populated with any one of the peer endpoint's Host Candidate. If the peer endpoint (5) has a Relayed Candidate, **Remote Site Address** MUST be populated with the address of the Relayed Candidate.

If the endpoint (5) is configured with both TCP and UDP bandwidth management policy servers, the checks MUST be sent to both servers. The first valid check response from the server MUST be honored and subsequent check responses from the servers MUST be ignored.

3.1.4.8.2 Connectivity Checks Phase

The procedures specified in [\[MS-ICE2\]](#) section 3.1.4.8.2 for the connectivity checks MUST be followed. The following sections specify additional functionality that MUST be followed for bandwidth management. At the end of the connectivity checks phase, the bandwidth management endpoint MUST commit the candidates selected by connectivity check, and the bandwidth used, to the policy server. For the duration of the media session, the bandwidth management endpoint MUST send periodic updates to the policy server based on the update timer. If both UDP and TCP bandwidth policy servers are available, the UDP bandwidth policy server SHOULD be used for commits and updates unless media is flowing over a TCP Relayed Candidate for the bandwidth management endpoint. In that case, the TCP bandwidth policy server SHOULD be used for commits and updates.

3.1.4.8.2.1 Formation of Candidate Pairs

The candidate pairs MUST be formed as specified in [\[MS-ICE2\]](#) section 3.1.4.8.2.1. If the bandwidth management endpoint has received a policy response from the policy server, candidate pairs that have either the local candidate or remote candidate invalidated by the bandwidth policy MUST be considered invalidated and connectivity check requests MUST NOT be sent for those candidate pairs.

3.1.4.8.2.2 Bandwidth Admission Commit Request

At the end of successful connectivity checks, the bandwidth management endpoint sends the commit request following the procedures specified in [\[MS-TURNBWM\]](#) section 3.2.4.2 when the commit timer fires. The following sections specify the procedures for populating the attributes for the bandwidth admission commit request messages, and for interpreting the policy response received from the policy server.

If the local candidate selected by the connectivity checks is not a Relayed Candidate, the **Local Site Address** attribute MUST be populated with the candidate address of a local candidate selected by the connectivity checks.

If the local candidate selected by connectivity checks is a Relayed Candidate, the **Local Site Address** attribute MUST be populated with the candidate address of any Local Host Candidate. The **Local Relay Site Address** attribute MUST be populated with the relay address of the selected local candidate.

If the remote candidate selected by connectivity checks is not a Relayed Candidate, the **Remote Site Address** attribute MUST be populated with the candidate address of a remote candidate selected by connectivity checks.

If the remote candidate selected by connectivity checks is a Relayed Candidate, the **Remote Site Address** attribute MUST be populated with the candidate address of any any remote Host Candidate. The **Remote Relay Site Address** attribute MUST be populated with the relay address of the selected remote candidate.

3.1.4.8.2.3 Bandwidth Admission Update Request

After receiving a valid commit response, the bandwidth management endpoint MUST send the update request following the procedures specified in [\[MS-TURNBWM\]](#) section 3.2.4.3 when the update timer fires.

The bandwidth management endpoint SHOULD generate an update request if the bandwidth value is different from the bandwidth value that was sent in the commit request, using the update request procedures specified in [\[MS-TURNBWM\]](#) section 3.2.4.3 when the update timer fires.

3.1.4.8.3 Media Flow

The candidate pairs to be used for media flow MUST follow the specifications in [\[MS-ICE2\]](#) section 3.1.4.8.3.

3.1.5 Message Processing Events and Sequencing Rules

The processing of messages and sequencing rules MUST follow the specifications in [\[MS-ICE2\]](#) section 3.1.5. The following sections specify additional procedures that MUST be followed by the endpoints (5) for bandwidth management.

3.1.5.1 Processing TURN Bandwidth Management Extensions Messages

This section specifies the message processing and sequencing rules for the Traversal Using Relay NAT (TURN) bandwidth management extensions.

3.1.5.1.1 Process Bandwidth Check Response

The format of the check response from the server and its attributes are specified in [\[MS-TURNBWM\]](#) section 2. If a site address response does not have the **valid** flag set, the candidates belonging to the site MUST be considered restricted. If the **valid** flag is set, the site address response also provides the send and receive bandwidths that can be used by the candidates belonging to a particular site when the application uses those candidates for media flow.

The local site address response applies to local Host Candidates, Server Reflexive Candidates, and their associated **peer-derived candidates**. The local relay site address response applies to the local Relayed Candidates and their associated Server Reflexive Candidates.

The remote site address response decision applies to remote Host Candidates, remote Server Reflexive Candidates, and their associated peer-derived candidates. The remote relay site address response applies to the remote Relayed Candidates and their associated Server Reflexive Candidates.

3.1.5.1.2 Processing Bandwidth Commit Response

The format of the commit response from the server and its attributes are specified in [\[MS-TURNBWM\]](#) section 2. The reservation identifier provided by the bandwidth policy server MUST be included by the endpoint (5) in subsequent update messages sent to the policy server.

If the server returns a NULL reservation identifier, further bandwidth messages MUST NOT be sent to the bandwidth policy server.

3.1.5.1.3 Processing Bandwidth Update Response

The format of the update response from the server and its processing MUST follow the specifications in [\[MS-TURNBWM\]](#) section 2.

3.1.5.2 Processing STUN Connectivity Check Messages

The processing of STUN connectivity checks MUST follow the specifications in [\[MS-ICE2\]](#) section 3.1.5.2. The following sections specify additional procedures that MUST be followed by the endpoints (5) for bandwidth management.

3.1.5.2.1 Processing STUN Binding Request

If the bandwidth management endpoint receives a STUN binding request from a remote candidate that has been restricted by the bandwidth policy, the endpoint (5) MUST send a STUN binding error response with the error code set to 274 Disable Candidate.

If a STUN binding request is received for a local candidate that is restricted by the bandwidth policy and the remote candidate is not restricted by bandwidth policy, the endpoint (5) MUST send a STUN binding error response with the error code set to 275 Disable Candidate Pair. The remote candidate type can be determined based on the **Candidate Identifier** attribute present in the STUN binding request messages.

3.1.5.2.2 Processing STUN Binding Error Response

If a valid error response is received with a 274 Disable Candidate error code, the endpoint (5) MUST set all candidate pairs associated with the local candidate on which the error response is received to the "Failed" state.

If a valid error response is received with a 275 Disable Candidate Pair error code, the endpoint (5) MUST set the candidate pairs for which the error response is received to the "Failed" state.

3.1.6 Timer Events

All the timer Events specified in [\[MS-ICE2\]](#) section 3.1.6 MUST be followed in addition to the timers specified in this section.

3.1.6.1 Bandwidth Commit Timer

The bandwidth update timer MUST fire every 500ms on the bandwidth management endpoint till a bandwidth commit response is received from the server. When this timer fires the bandwidth commit request MUST be sent out as specified in section [3.1.4.8.2.2](#).

3.1.6.2 Bandwidth Update Timer

The bandwidth update timer MUST fire on the bandwidth management endpoint every 19 seconds or less after the bandwidth has been committed to the policy server. When the timer fires, a bandwidth update message MUST be sent, as specified in section [3.1.4.8.2.3](#) if the bandwidth being updated is same as the bandwidth that was sent in the commit request. This facilitates the bandwidth server to track the bandwidth utilization for the media session.

If the update request is for a bandwidth value that is different from the bandwidth sent in the commit then this timer MUST fire every second till a update response is received from the server. Once the update response is received from the server the timer MUST switch to firing every 19 seconds or less.

3.1.7 Other Local Events

None.

4 Protocol Examples

The following figure shows a sample deployment scenario for bandwidth management.

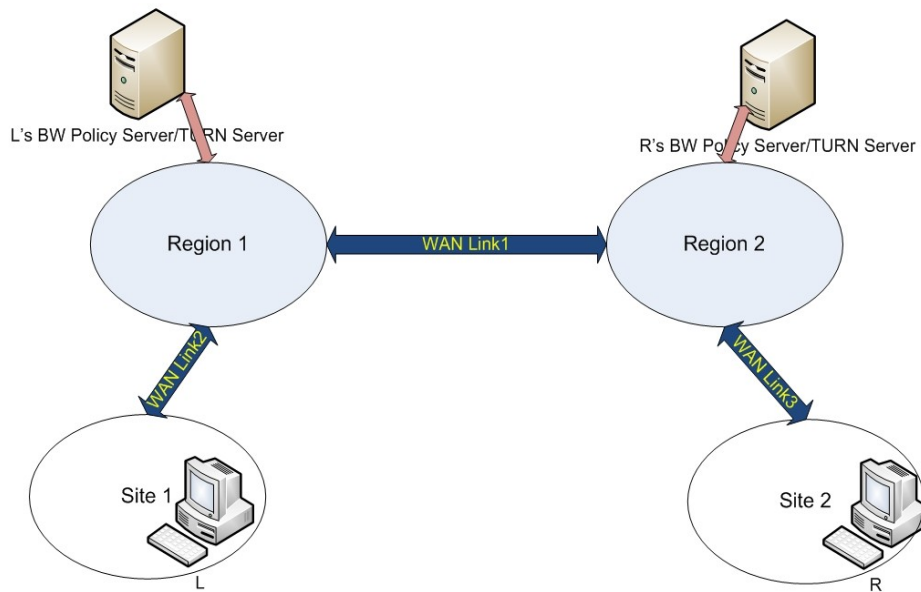


Figure 3: Bandwidth management deployment scenario

In the preceding deployment, Endpoint L and Endpoint R belong to different sites that are connected via WAN links that are under bandwidth management. Both Endpoint L and Endpoint R are configured with their respective UDP bandwidth policy servers that provide TURN functionality, in addition to bandwidth policy management servers, LPS for Endpoint L and RPS for Endpoint R.

Both **agents** are **full** ICE implementations and use regular nominations for selecting the candidates to be used for media flow. In the following example, WAN Link1 is congested and does not have bandwidth available for media flow. WAN Link 2 and WAN Link 3 have bandwidth available for media flow.

The transport address follows a similar naming convention to the sample in [\[MS-ICE2\]](#) section 4.

Transport addresses are referred to using mnemonic names with format entity-type-seqno, where entity refers to the entity whose IP address the transport address is on, and is one of "L", "R", "LPS" or "RPS". The type is either "PUB" for transport addresses that are publicly reachable on the internet or "PRIV" for transport addresses that are not reachable from the internet. The seqno is a number that is different for transport addresses of the same type on an entity.

Endpoint L has a private address L-PRIV-1 (192.168.2.1) and Endpoint R has a private address R-PRIV-1 (192.157.2.1).

LPS has a transport address LPS-PRIV-1 on the private edge (192.170.20.1) and external edge with LPS-PUB-1 (10.101.0.57).

RPS has a transport address RPS-PRIV-1 on the internal edge (192.175.54.2) and external edge with RPS-PUB-1 (10.107.0.37).

Definitions for the call flow are as follows:

- "S=" refers to the source transport address.
- "D=" refers to the destination transport address.
- "SD=" refers to the destination address to which the **TURN server** has to forward the packet.
- "LSA=" refers to the **local site address** attribute.
- "LRA=" refers to the **local relay site address** attribute.
- "RSA=" refers to the **remote site address** attribute.
- "RRA=" refers to the **remote relay site address** attribute.
- "USE-CAND" implies the presence of the **USE-CANDIDATE** attribute.
- "DIS-CAND" implies the presence of the Disable Candidate error code in the message.
- "DIS-LS" implies that the bandwidth policy server disallows usage of candidates belonging to the local site.
- "DIS-RS" implies that the bandwidth policy server disallows usage of candidates belonging to the remote site.
- "BW-CHK-REQ" implies the presence of bandwidth admission check request attributes.
- "BW-CHK-RES" implies the presence of bandwidth admission check response attributes.
- "BW-CMT-REQ" implies the presence of bandwidth admission commit request attributes.
- "BW-CMT-RES" implies the presence of bandwidth admission commit response attributes.
- "RES-ID" implies the presence of the **reservation ID** attribute.
- "BW-UPD-REQ" implies the presence of bandwidth admission update request attributes.
- "MA=" refers to the mapped address in the STUN binding response.
- "RA=" refers to the reflexive address.
- "TA=" refers to the relay transport address.

For clarity, the example does not show the TURN authentication mechanisms and the **Real-Time Transport Control Protocol (RTCP) component**.

The example focuses on the **RTP** component for establishing a media session between Endpoint L and Endpoint R with bandwidth policy management and does not focus on [\[MS-TURNBWM\]](#) protocol details.

Endpoint L initiates the media session and becomes the controlling agent because Endpoint L is a full ICE implementation. Endpoint L gathers its UDP Host Candidate by binding to its local interface and

then gathers a UDP Relayed Candidate from the configured server, LPS. Because no TCP TURN servers are configured, Endpoint L creates a TCP-ACT Server Reflexive Candidate based on the UDP Host Candidate. After gathering the candidates, Endpoint L sends the **INVITE** to Endpoint R. A sample INVITE **Session Description Protocol (SDP)** for Endpoint L's topology is as follows.

v=0

o=- 0 0 IN IP4 10.101.0.57

s=session

c=IN IP4 10.101.0.57

b=CT:99980

t=0 0

m=audio 52732 RTP/AVP 114 111 112 115 116 4 8 0 97 13 118 101

a=ice-ufrag:qkEP

a=ice-pwd:ed6f9GuHjLcoCN6sC/Eh7fVI

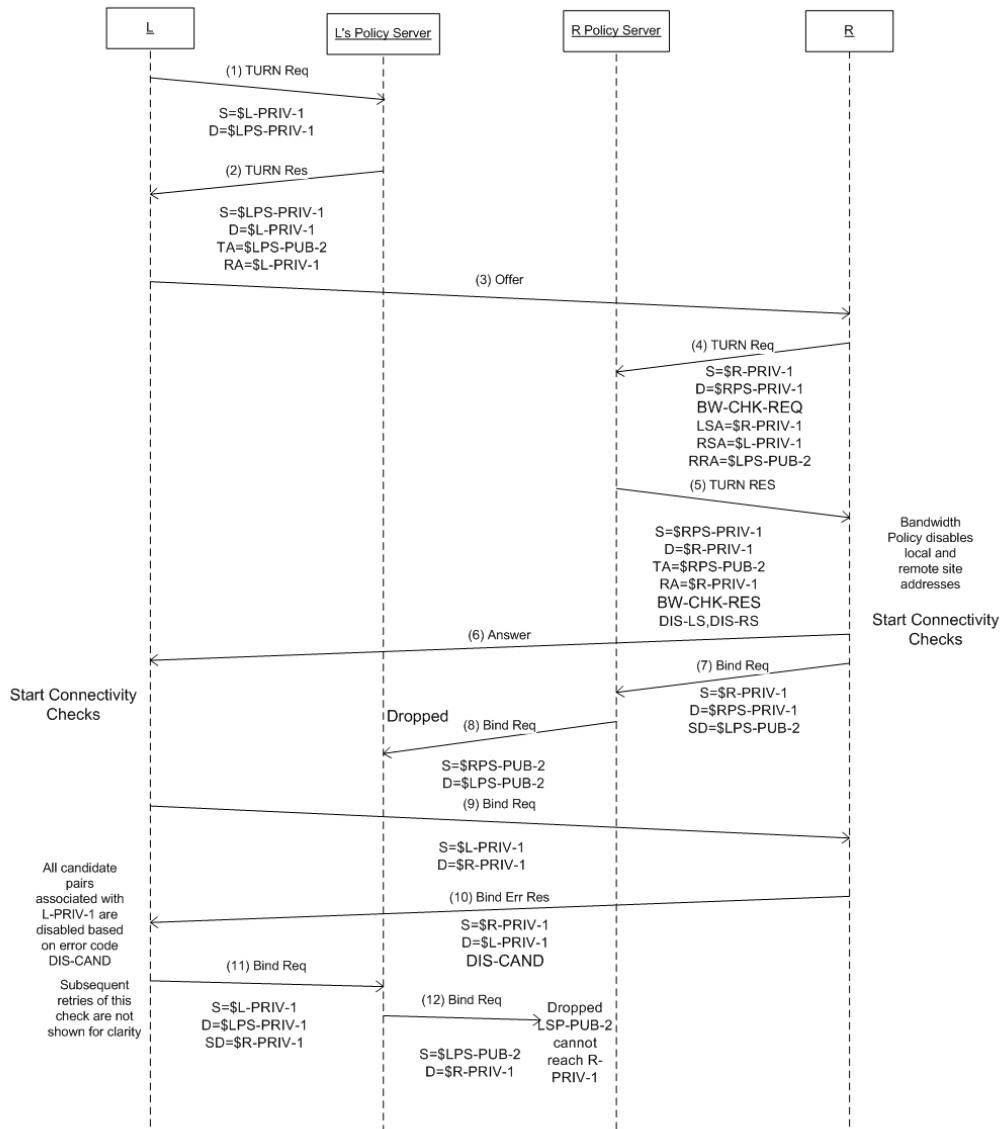
a=candidate:1 1 UDP 2130706431 192.168.2.1 50005 typ host

a=candidate:2 1 UDP 16648703 10.101.0.57 52732 typ relay raddr 192.168.2.1 rport 50033

a=candidate:4 1 TCP-ACT 1684797951 192.168.2.1 50005 typ srflx raddr 192.168.2.1 rport 50005

a=rtpmap:114 x-msrta/16000

The following figure is the call flow for the RTP component for establishing a media session between Endpoint L and Endpoint R with bandwidth policy management.



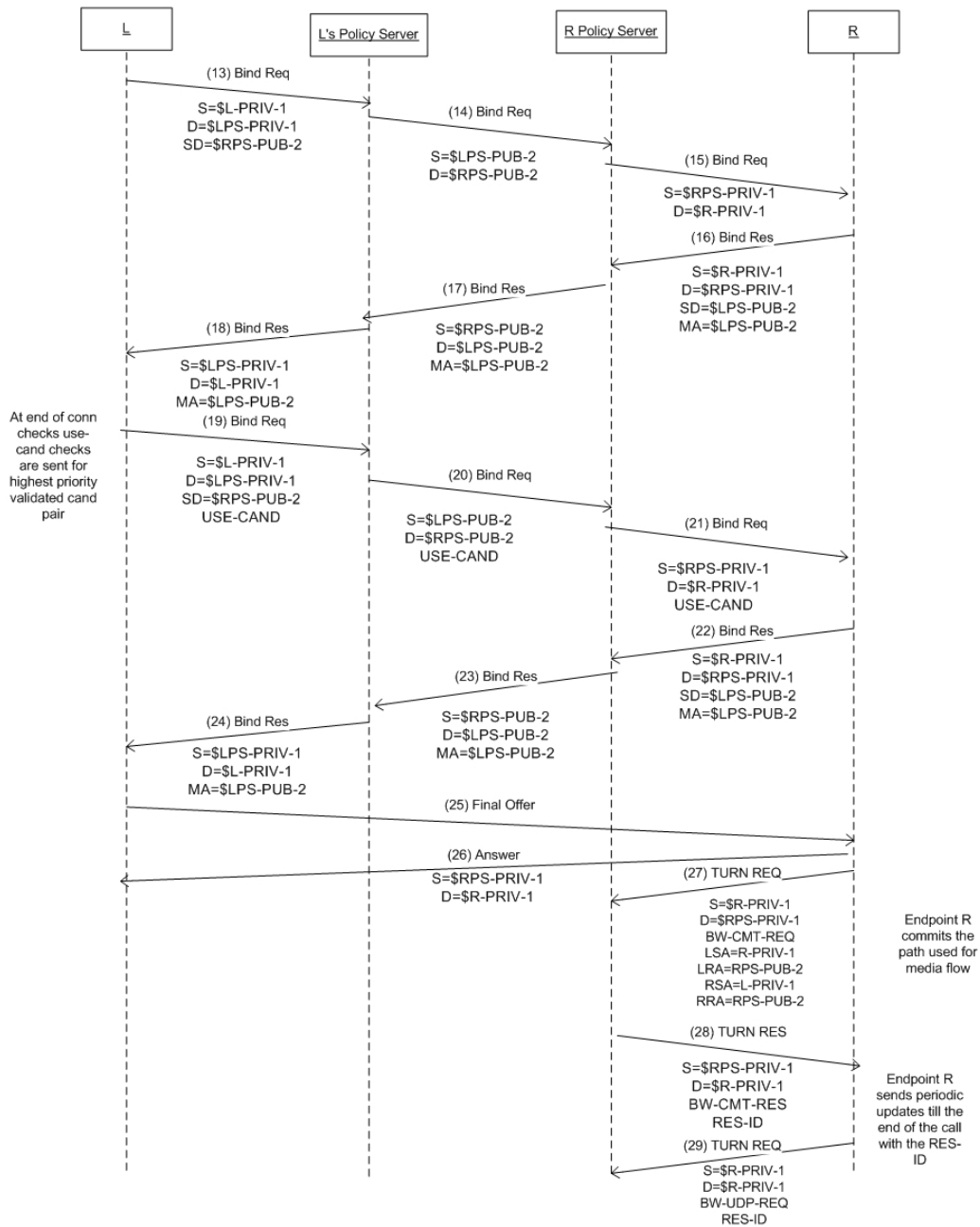


Figure 4: RTP component call flow for bandwidth management

Endpoint R, upon receiving the offer, gathers its candidates. Endpoint R is assigned as the bandwidth management endpoint for this session. At this point, Endpoint R is aware of the peer endpoint's candidates. It gathers its UDP Host Candidate by binding to its local interface and then gathers the UDP Relayed Candidate from the configured bandwidth policy server. In the allocate request sent to the bandwidth policy server endpoint (5) at RPS-PRIV-1, R adds bandwidth management check attributes to perform policy checks, as specified in section 3.1.4.8.1.1. Endpoint R populates the **Local Site Address** attribute with "R-PRIV-1", the **Remote Site Address** attribute with "L-PRIV-1" because endpoint R is not behind a **network address translation (NAT)**, and populates the **Remote Relay Site** attribute with "LPS-PUB-1". Endpoint R specifies the bandwidth needed for this call in the **Bandwidth Reservation Amount** attribute. The bandwidth policy server disables both the local site and remote site address in the allocate response, which includes the **Bandwidth Check Response** attributes, because Wan Link1 does not have available bandwidth for the media session. Endpoint R gathers its Relayed Candidate "RPS-PUB-2" from the allocate response. Because no TURN TCP servers are configured, Endpoint R creates a TCP-ACT Server Reflexive Candidate based on the UDP Host Candidate.

Endpoint R, based on the policy decision received, does not form candidate pairs for candidates that have been disabled by the bandwidth policy. As a result of the bandwidth policy, Endpoint R has only one candidate pair, which is RPS-PUB-2 to LPS-PUB-2. A sample answer SDP for Endpoint R's topology is as follows.

```
v=0
o=- 0 0 IN IP4 10.107.0.37
s=session
c=IN IP4 10.107.0.37
b=CT:99980
t=0 0
m=audio 52714 RTP/AVP 114 111 112 115 116 4 8 0 97 13 118 101
a=ice-ufrag:qkEP
a=ice-pwd:ed6f9GuHjLcoCN6sC/Eh7fVI
a=candidate:1 1 UDP 2130706431 192.175.54.2 50025 typ host
a=candidate:2 1 UDP 16648703 10.107.0.37 52714 typ relay raddr 192.175.54.2 rport 50036
a=candidate:3 1 TCP-ACT 1684797951 192.175.54.2 50025 typ srflx raddr 192.175.54.2 rport 50025
a=rtpmap:114 x-msrta/16000
```

Endpoint R starts connectivity checks for its only candidate pair and sends a STUN binding request to LPS-PUB-2 from its Relayed Candidate RPS-PUB-2, which gets dropped at LPS-PUB-2 because permissions have not been opened for RPS-PUB-2 at LPS-PUB-2. This STUN binding request results in permission being opened for LPS-PUB-2 at RPS-PUB-2.

Endpoint L, on receiving the answer, pairs up its candidates with Endpoint R's candidates received in the answer and starts connectivity checks with the highest priority candidate pair. Endpoint L sends a STUN binding request from L-PRIV-1 to R-PRIV-1. Endpoint R, upon receiving this STUN binding request from L-PRIV-1, sends a STUN binding error response with the Disable Candidate error code because both the local site address and the remote site address have been disabled as a result of bandwidth policy and cannot be used for media flow. Endpoint L, upon receiving the STUN binding

error response, disables all candidate pairs whose local candidates belong to the local site, including Host Candidates, Server Reflexive Candidates, or local peer-derived candidates.

Endpoint L sends a STUN binding request from its Relayed Candidate LPS-PUB-2 to R-PRIV-1, which gets dropped because R-PRIV-1 is not reachable from the public interface. Endpoint L then sends a STUN binding request from its Relayed Candidate LPS-PUB-2 to RPS-PUB-2, which endpoint (5) R receives from its Relayed Candidate because permissions have already been opened on RPS-PUB-2 for LPS-PUB-2. Endpoint L, upon receiving the STUN binding response, validates this candidate pair. At the end of the connectivity checks time-out, Endpoint L nominates its only valid candidate pair and sends a STUN binding request with the **use candidate** attribute set. Upon getting the response, Endpoint L sends the final offer to the endpoint (5) with the final candidates to be used for media flow. A sample SDP for the final offer is as follows.

```
v=0
o=- 0 0 IN IP4 10.101.0.57
s=session
c=IN IP4 10.101.0.57
b=CT:99980
t=0 0
m=audio 52732 RTP/SAVP 114 111 112 115 116 4 8 0 97 13 118 101
a=ice-ufrag:32sD
a=ice-pwd:YF9/OwRcN/pXUglBv1c+5QMu
a=candidate:1 UDP 16648703 10.101.0.57 52732 typ relay raddr 192.168.2.1 rport 50033
a=remote-candidates:1 10.107.0.37 52714
a=rtpmap:114 x-msrta/16000
```

Endpoint R, on receiving the final offer, sends the answer to the final offer. A sample SDP for the final offer is as follows.

```
v=0
o=- 0 0 IN IP4 10.107.0.37
s=session
c=IN IP4 10.107.0.37
b=CT:99980
t=0 0
m=audio 52714 5 RTP/SAVP 114 111 112 115 116 4 8 0 97 13 118 101
a=ice-ufrag:32sD
a=ice-pwd:YF9/OwRcN/pXUglBv1c+5QMu
a=candidate:1 UDP 16648703 10.107.0.37 52714 typ relay raddr 192.175.54.2 rport 50036
```


a=remote-candidates:1 101.0.57 52732

a=rtpmap:114 x-msrta/16000

Endpoint R is the bandwidth management endpoint that also sends a Bandwidth Commit message to the relay to notify the policy server that the candidates are being used for media flow. Endpoint R populates LSA with "R-PRIV-1", LRA with "RPS-PUB-2", RSA with "L-PRIV-1" and RRA with "LPS-PUB-2" because both endpoints (5) are using their Relayed Candidates for media flow.

Endpoint R, on receiving the bandwidth admission commit response with a **reservation ID** from RPS, starts to send periodic bandwidth admission update requests to RPS for the duration of the media session with the **reservation ID** received in the commit response added to every bandwidth admission update request.

5 Security

5.1 Security Considerations for Implementers

This protocol has similar security concerns as those described in [\[MS-ICE2\]](#) section 5. Additional considerations and mitigations for this protocol are listed in this section.

5.1.1 Attacks on Bandwidth Policy Processing

The security considerations with using [\[MS-TURNBWM\]](#) for determining the bandwidth policy are addressed in [\[MS-TURNBWM\]](#) section 5.1.

5.2 Index of Security Parameters

None.

6 Appendix A: Product Behavior

The information in this specification is applicable to the following Microsoft products or supplemental software. References to product versions include released service packs:

- Microsoft® Lync™ Server 2010
- Microsoft® Lync™ 2010

Exceptions, if any, are noted below. If a service pack or Quick Fix Engineering (QFE) number appears with the product version, behavior changed in that service pack or QFE. The new behavior also applies to subsequent service packs of the product unless otherwise specified. If a product edition appears with the product version, behavior is different in that product edition.

Unless otherwise specified, any statement of optional behavior in this specification that is prescribed using the terms SHOULD or SHOULD NOT implies product behavior in accordance with the SHOULD or SHOULD NOT prescription. Unless otherwise specified, the term MAY implies that the product does not follow the prescription.

7 Change Tracking

No table of changes is available. The document is either new or has had no changes since its last release.

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