

The Binary Floor Control Protocol (BFCP)

Status of This Memo

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Abstract

Floor control is a means to manage joint or exclusive access to shared resources in a (multiparty) conferencing environment. Thereby, floor control complements other functions -- such as conference and media session setup, conference policy manipulation, and media control -- that are realized by other protocols.

This document specifies the Binary Floor Control Protocol (BFCP). BFCP is used between floor participants and floor control servers, and between floor chairs (i.e., moderators) and floor control servers.

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1. Introduction

Within a conference, some applications need to manage the access to a set of shared resources, such as the right to send media to a particular media session. Floor control enables such applications to provide users with coordinated (shared or exclusive) access to these resources.

The Requirements for Floor Control Protocol [9] list a set of requirements that need to be met by floor control protocols. The Binary Floor Control Protocol (BFCP), which is specified in this document, meets these requirements.

In addition, BFCP has been designed so that it can be used in low-bandwidth environments. The binary encoding used by BFCP achieves a small message size (when message signatures are not used) that keeps the time it takes to transmit delay-sensitive BFCP messages to a minimum. Delay-sensitive BFCP messages include FloorRequest, FloorRelease, FloorRequestStatus, and ChairAction. It is expected that future extensions to these messages will not increase the size of these messages in a significant way.

The remainder of this document is organized as follows: Section 2 defines the terminology used throughout this document, Section 3 discusses the scope of BFCP (i.e., which tasks fall within the scope of BFCP and which ones are performed using different mechanisms), Section 4 provides a non-normative overview of BFCP operation, and subsequent sections provide the normative specification of BFCP.

2. Terminology

In this document, the key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" are to be interpreted as described in BCP 14, RFC 2119 [1] and indicate requirement levels for compliant implementations.

Media Participant: An entity that has access to the media resources of a conference (e.g., it can receive a media stream). In floor-controlled conferences, a given media participant is typically colocated with a floor participant, but it does not need to be. Third-party floor requests consist of having a floor participant request a floor for a media participant when they are not colocated. The protocol between a floor participant and a media participant (that are not colocated) is outside the scope of this document.

Client: A floor participant or a floor chair that communicates with a floor control server using BFCP.

Floor: A temporary permission to access or manipulate a specific shared resource or set of resources.

Floor Chair: A logical entity that manages one floor (grants, denies, or revokes a floor). An entity that assumes the logical role of a floor chair for a given transaction may assume a different role (e.g., floor participant) for a different transaction. The roles of floor chair and floor participant are defined on a transaction-by-transaction basis. BFCP transactions are defined in Section 8.

Floor Control: A mechanism that enables applications or users to gain safe and mutually exclusive or non-exclusive input access to the shared object or resource.

Floor Control Server: A logical entity that maintains the state of the floor(s), including which floors exist, who the floor chairs are, who holds a floor, etc. Requests to manipulate a floor are directed at the floor control server. The floor control server of a conference may perform other logical roles (e.g., floor participant) in another conference.

Floor Participant: A logical entity that requests floors, and possibly information about them, from a floor control server. An entity that assumes the logical role of a floor participant for a given transaction may assume a different role (e.g., a floor chair) for a different transaction. The roles of floor participant and floor chair are defined on a transaction-by-transaction basis. BFCP transactions are defined in Section 8. In floor-controlled conferences, a given floor participant is typically colocated with a media participant, but it does not need to be. Third-party floor requests consist of having a floor participant request a floor for a media participant when they are not colocated.

Participant: An entity that acts as a floor participant, as a media participant, or as both.

3. Scope

As stated earlier, BFCP is a protocol to coordinate access to shared resources in a conference following the requirements defined in [9]. Floor control complements other functions defined in the XCON conferencing framework [10]. The floor control protocol BFCP defined in this document only specifies a means to arbitrate access to floors. The rules and constraints for floor arbitration and the results of floor assignments are outside the scope of this document and are defined by other protocols [10].

Figure 1 shows the tasks that BFCP can perform.

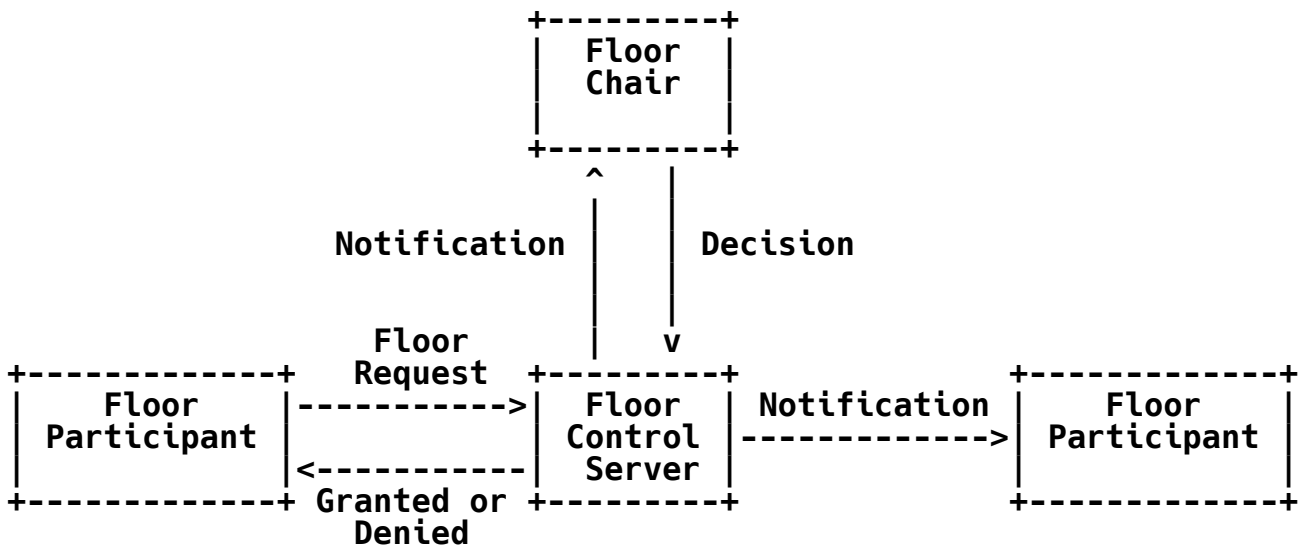


Figure 1: Functionality provided by BFCP

BFCP provides a means:

- o for floor participants to send floor requests to floor control servers.
- o for floor control servers to grant or deny requests to access a given resource from floor participants.
- o for floor chairs to send floor control servers decisions regarding floor requests.
- o for floor control servers to keep floor participants and floor chairs informed about the status of a given floor or a given floor request.

Even though tasks that do not belong to the previous list are outside the scope of BFCP, some of these out-of-scope tasks relate to floor control and are essential for creating floors and establishing BFCP connections between different entities. In the following subsections, we discuss some of these tasks and mechanisms to perform them.

3.1. Floor Creation

The association of a given floor with a resource or a set of resources (e.g., media streams) is out of the scope of BFCP as described in [10]. Floor creation and termination are also outside the scope of BFCP; these aspects are handled using the conference control protocol for manipulating the conference object. Consequently, the floor control server needs to stay up to date on changes to the conference object (e.g., when a new floor is created).

3.2. Obtaining Information to Contact a Floor Control Server

A client needs a set of data in order to establish a BFCP connection to a floor control server. These data include the transport address of the server, the conference identifier, and a user identifier.

Clients can obtain this information in different ways. One is to use an SDP offer/answer [8] exchange, which is described in [7]. Other mechanisms are described in the XCON framework [10] (and other related documents).

3.3. Obtaining Floor-Resource Associations

Floors are associated with resources. For example, a floor that controls who talks at a given time has a particular audio session as its associated resource. Associations between floors and resources are part of the conference object.

Floor participants and floor chairs need to know which resources are associated with which floors. They can obtain this information by using different mechanisms, such as an SDP offer/answer [8] exchange. How to use an SDP offer/answer exchange to obtain these associations is described in [7].

Note that floor participants perform SDP offer/answer exchanges with the conference focus of the conference. So, the conference focus needs to obtain information about associations between floors and resources in order to be able to provide this information to a floor participant in an SDP offer/answer exchange.

Other mechanisms for obtaining this information, including discussion of how the information is made available to a (SIP) Focus, are described in the XCON framework [10] (and other related documents).

3.4. Privileges of Floor Control

A participant whose floor request is granted has the right to use (in a certain way) the resource or resources associated with the floor that was requested. For example, the participant may have the right to send media over a particular audio stream.

Nevertheless, holding a floor does not imply that others will not be able to use its associated resources at the same time, even if they do not have the right to do so. Determination of which media participants can actually use the resources in the conference is discussed in the XCON Framework [10].

4. Overview of Operation

This section provides a non-normative description of BFCP operations. Section 4.1 describes the interface between floor participants and floor control servers, and Section 4.2 describes the interface between floor chairs and floor control servers.

BFCP messages, which use a TLV (Type-Length-Value) binary encoding, consist of a common header followed by a set of attributes. The common header contains, among other information, a 32-bit conference identifier. Floor participants, media participants, and floor chairs are identified by 16-bit user identifiers.

BFCP supports nested attributes (i.e., attributes that contain attributes). These are referred to as grouped attributes.

There are two types of transactions in BFCP: client-initiated transactions and server-initiated transactions. Client-initiated transactions consist of a message from a client to the floor control server and a response from the floor control server to the client. Both messages can be related because they carry the same Transaction ID value in their common headers. Server-initiated transactions consist of a single message, whose Transaction ID is 0, from the floor control server to a client.

4.1. Floor Participant to Floor Control Server Interface

Floor participants request a floor by sending a FloorRequest message to the floor control server. BFCP supports third-party floor requests. That is, the floor participant sending the floor request need not be colocated with the media participant that will get the floor once the floor request is granted. FloorRequest messages carry the identity of the requester in the User ID field of the common header, and the identity of the beneficiary of the floor (in third-party floor requests) in a BENEFICIARY-ID attribute.

Third-party floor requests can be sent, for example, by floor participants that have a BFCP connection to the floor control server but that are not media participants (i.e., they do not handle any media).

FloorRequest messages identify the floor or floors being requested by carrying their 16-bit floor identifiers in FLOOR-ID attributes. If a FloorRequest message carries more than one floor identifier, the floor control server treats all the floor requests as an atomic package. That is, the floor control server either grants or denies all the floors in the FloorRequest message.

Floor control servers respond to FloorRequest messages with FloorRequestStatus messages, which provide information about the status of the floor request. The first FloorRequestStatus message is the response to the FloorRequest message from the client, and therefore has the same Transaction ID as the FloorRequest.

Additionally, the first FloorRequestStatus message carries the Floor Request ID in a FLOOR-REQUEST-INFORMATION attribute. Subsequent FloorRequestStatus messages related to the same floor request will carry the same Floor Request ID. This way, the floor participant can associate them with the appropriate floor request.

Messages from the floor participant related to a particular floor request also use the same Floor Request ID as the first FloorRequestStatus Message from the floor control server.

Figure 2 shows how a floor participant requests a floor, obtains it, and, at a later time, releases it. This figure illustrates the use, among other things, of the Transaction ID and the FLOOR-REQUEST-ID attribute.

Floor Participant

Floor Control
Server

```

(1) FloorRequest
Transaction ID: 123
User ID: 234
FLOOR-ID: 543
----->

(2) FloorRequestStatus
Transaction ID: 123
User ID: 234
FLOOR-REQUEST-INFORMATION
    Floor Request ID: 789
    OVERALL-REQUEST-STATUS
        Request Status: Pending
    FLOOR-REQUEST-STATUS
        Floor ID: 543
<-----

(3) FloorRequestStatus
Transaction ID: 0
User ID: 234
FLOOR-REQUEST-INFORMATION
    Floor Request ID: 789
    OVERALL-REQUEST-STATUS
        Request Status: Accepted
        Queue Position: 1st
    FLOOR-REQUEST-STATUS
        Floor ID: 543
<-----

(4) FloorRequestStatus
Transaction ID: 0
User ID: 234
FLOOR-REQUEST-INFORMATION
    Floor Request ID: 789
    OVERALL-REQUEST-STATUS
        Request Status: Granted
    FLOOR-REQUEST-STATUS
        Floor ID: 543
<-----

(5) FloorRelease
Transaction ID: 154
User ID: 234
FLOOR-REQUEST-ID: 789
----->

```

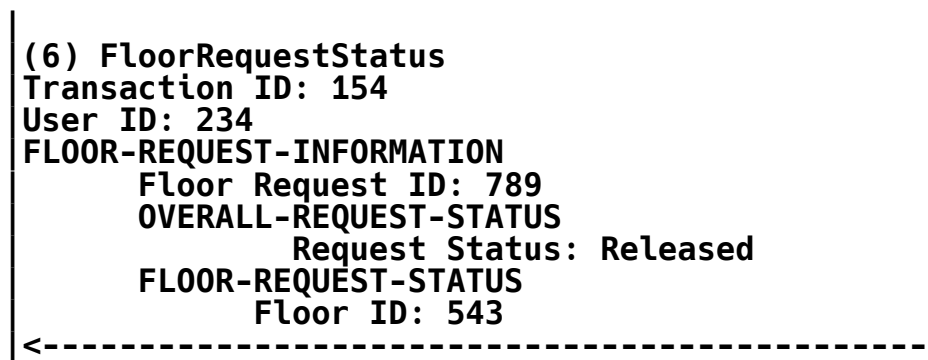


Figure 2: Requesting and releasing a floor

Figure 3 shows how a floor participant requests to be informed on the status of a floor. The first FloorStatus message from the floor control server is the response to the FloorQuery message and, as such, has the same Transaction ID as the FloorQuery message.

Subsequent FloorStatus messages consist of server-initiated transactions, and therefore their Transaction ID is 0. FloorStatus message (2) indicates that there are currently two floor requests for the floor whose Floor ID is 543. FloorStatus message (3) indicates that the floor requests with Floor Request ID 764 has been granted, and the floor request with Floor Request ID 635 is the first in the queue. FloorStatus message (4) indicates that the floor request with Floor Request ID 635 has been granted.

Floor Participant

Floor Control
Server



```
(2) FloorStatus
Transaction ID: 257
User ID: 234
FLOOR-ID:543
FLOOR-REQUEST-INFORMATION
    Floor Request ID: 764
    OVERALL-REQUEST-STATUS
        Request Status: Accepted
        Queue Position: 1st
    FLOOR-REQUEST-STATUS
        Floor ID: 543
    BENEFICIARY-INFORMATION
        Beneficiary ID: 124
FLOOR-REQUEST-INFORMATION
    Floor Request ID: 635
    OVERALL-REQUEST-STATUS
        Request Status: Accepted
        Queue Position: 2nd
    FLOOR-REQUEST-STATUS
        Floor ID: 543
    BENEFICIARY-INFORMATION
        Beneficiary ID: 154
```

```
<-----
(3) FloorStatus
Transaction ID: 0
User ID: 234
FLOOR-ID:543
FLOOR-REQUEST-INFORMATION
    Floor Request ID: 764
    OVERALL-REQUEST-STATUS
        Request Status: Granted
    FLOOR-REQUEST-STATUS
        Floor ID: 543
    BENEFICIARY-INFORMATION
        Beneficiary ID: 124
FLOOR-REQUEST-INFORMATION
    Floor Request ID: 635
    OVERALL-REQUEST-STATUS
        Request Status: Accepted
        Queue Position: 1st
    FLOOR-REQUEST-STATUS
        Floor ID: 543
    BENEFICIARY-INFORMATION
        Beneficiary ID: 154
<-----
```

```
(4) FloorStatus
Transaction ID: 0
User ID: 234
FLOOR-ID:543
FLOOR-REQUEST-INFORMATION
    Floor Request ID: 635
OVERALL-REQUEST-STATUS
    Request Status: Granted
FLOOR-REQUEST-STATUS
    Floor ID: 543
BENEFICIARY-INFORMATION
    Beneficiary ID: 154
<-----
```

Figure 3: Obtaining status information about a floor

FloorStatus messages contain information about the floor requests they carry. For example, FloorStatus message (4) indicates that the floor request with Floor Request ID 635 has as the beneficiary (i.e., the participant that holds the floor when a particular floor request is granted) the participant whose User ID is 154. The floor request applies only to the floor whose Floor ID is 543. That is, this is not a multi-floor floor request.

A multi-floor floor request applies to more than one floor (e.g., a participant wants to be able to speak and write on the whiteboard at the same time). The floor control server treats a multi-floor floor request as an atomic package. That is, the floor control server either grants the request for all floors or denies the request for all floors.

4.2. Floor Chair to Floor Control Server Interface

Figure 4 shows a floor chair instructing a floor control server to grant a floor.

Note, however, that although the floor control server needs to take into consideration the instructions received in ChairAction messages (e.g., granting a floor), it does not necessarily need to perform them exactly as requested by the floor chair. The operation that the floor control server performs depends on the ChairAction message and on the internal state of the floor control server.

For example, a floor chair may send a ChairAction message granting a floor that was requested as part of an atomic floor request operation that involved several floors. Even if the chair responsible for one of the floors instructs the floor control server to grant the floor, the floor control server will not grant it until the chairs responsible for the other floors agree to grant them as well. In another example, a floor chair may instruct the floor control server to grant a floor to a participant. The floor control server needs to revoke the floor from its current holder before granting it to the new participant.

So, the floor control server is ultimately responsible for keeping a coherent floor state using instructions from floor chairs as input to this state.

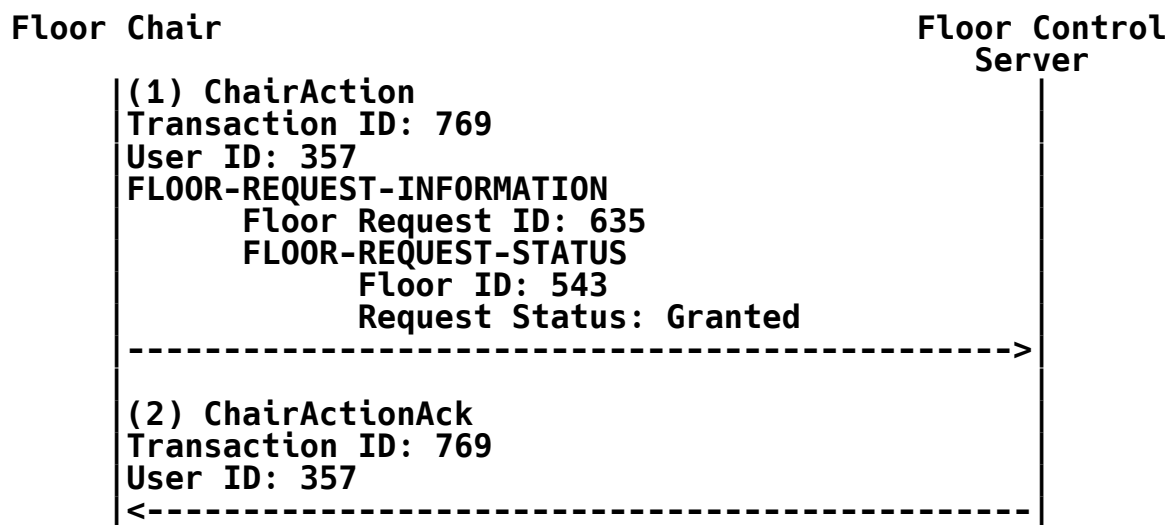


Figure 4: Chair instructing the floor control server

5. Packet Format

BFCP packets consist of a 12-octet common header followed by attributes. All the protocol values **MUST** be sent in network byte order.

5.1. COMMON-HEADER Format

The following is the format of the common header.

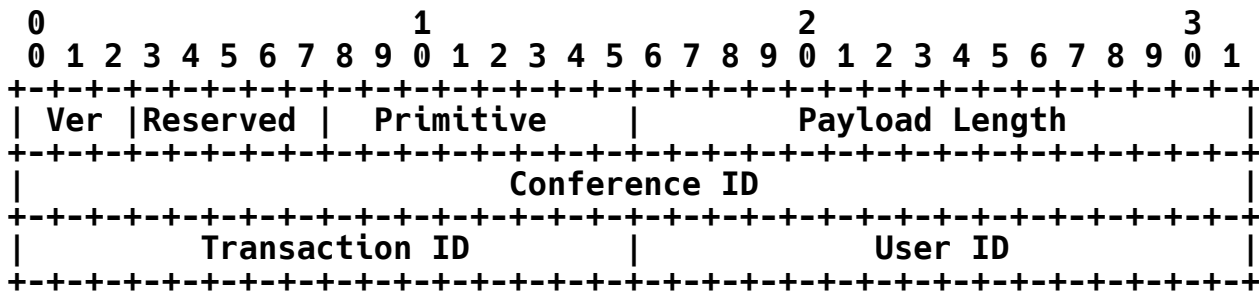


Figure 5: COMMON-HEADER format

- Ver: The 3-bit version field MUST be set to 1 to indicate this version of BFCP.
- Reserved: At this point, the 5 bits in the reserved field SHOULD be set to zero by the sender of the message and MUST be ignored by the receiver.
- Primitive: This 8-bit field identifies the main purpose of the message. The following primitive values are defined:

Value	Primitive	Direction
1	FloorRequest	P -> S
2	FloorRelease	P -> S
3	FloorRequestQuery	P -> S ; Ch -> S
4	FloorRequestStatus	P <- S ; Ch <- S
5	UserQuery	P -> S ; Ch -> S
6	UserStatus	P <- S ; Ch <- S
7	FloorQuery	P -> S ; Ch -> S
8	FloorStatus	P <- S ; Ch <- S
9	ChairAction	Ch -> S
10	ChairActionAck	Ch <- S
11	Hello	P -> S ; Ch -> S
12	HelloAck	P <- S ; Ch <- S
13	Error	P <- S ; Ch <- S

S: Floor Control Server
P: Floor Participant
Ch: Floor Chair

Table 1: BFCP primitives

Payload Length: This 16-bit field contains the length of the message in 4-octet units, excluding the common header.

Conference ID: This 32-bit field identifies the conference the message belongs to.

Transaction ID: This field contains a 16-bit value that allows users to match a given message with its response. The value of the Transaction ID in server-initiated transactions is 0 (see Section 8).

User ID: This field contains a 16-bit value that uniquely identifies a participant within a conference.

The identity used by a participant in BFCP, which is carried in the User ID field, is generally mapped to the identity used by the same participant in the session establishment protocol (e.g., in SIP). The way this mapping is performed is outside the scope of this specification.

5.2. Attribute Format

BFCP attributes are encoded in TLV (Type-Length-Value) format. Attributes are 32-bit aligned.

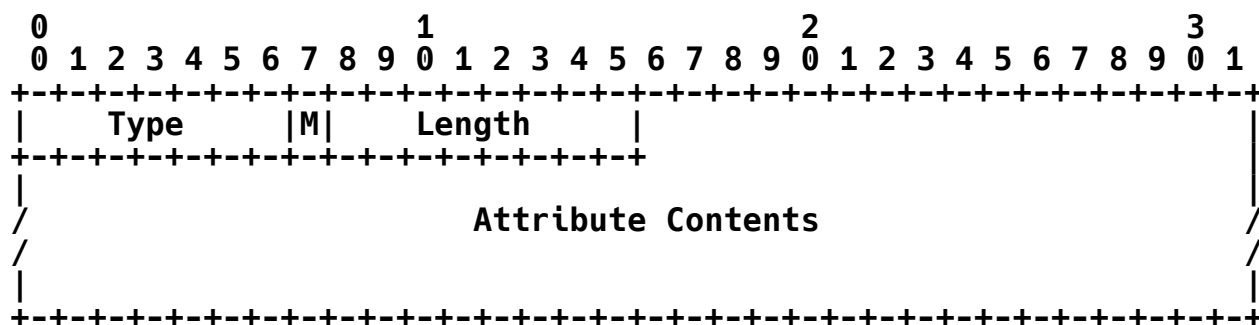


Figure 6: Attribute format

Type: This 7-bit field contains the type of the attribute. Each attribute, identified by its type, has a particular format. The attribute formats defined are:

Unsigned16: The contents of the attribute consist of a 16-bit unsigned integer.

OctetString16: The contents of the attribute consist of 16 bits of arbitrary data.

OctetString: The contents of the attribute consist of arbitrary data of variable length.

Grouped: The contents of the attribute consist of a sequence of attributes.

Note that extension attributes defined in the future may define new attribute formats.

The following attribute types are defined:

Type	Attribute	Format
1	BENEFICIARY-ID	Unsigned16
2	FLOOR-ID	Unsigned16
3	FLOOR-REQUEST-ID	Unsigned16
4	PRIORITY	OctetString16
5	REQUEST-STATUS	OctetString16
6	ERROR-CODE	OctetString
7	ERROR-INFO	OctetString
8	PARTICIPANT-PROVIDED-INFO	OctetString
9	STATUS-INFO	OctetString
10	SUPPORTED-ATTRIBUTES	OctetString
11	SUPPORTED-PRIMITIVES	OctetString
12	USER-DISPLAY-NAME	OctetString
13	USER-URI	OctetString
14	BENEFICIARY-INFORMATION	Grouped
15	FLOOR-REQUEST-INFORMATION	Grouped
16	REQUESTED-BY-INFORMATION	Grouped
17	FLOOR-REQUEST-STATUS	Grouped
18	OVERALL-REQUEST-STATUS	Grouped

Table 2: BFCP attributes

M: The 'M' bit, known as the Mandatory bit, indicates whether support of the attribute is required. If an unrecognized attribute with the 'M' bit set is received, the message is rejected. The 'M' bit is significant for extension attributes defined in other documents only. All attributes specified in this document **MUST** be understood by the receiver so that the setting of the 'M' bit is irrelevant for these. In all other cases, the unrecognized attribute is ignored but the message is processed.

Length: This 8-bit field contains the length of the attribute in octets, excluding any padding defined for specific attributes. The length of attributes that are not grouped includes the Type, 'M' bit,

and Length fields. The Length in grouped attributes is the length of the grouped attribute itself (including Type, 'M' bit, and Length fields) plus the total length (including padding) of all the included attributes.

Attribute Contents: The contents of the different attributes are defined in the following sections.

5.2.1. BENEFICIARY-ID

The following is the format of the BENEFICIARY-ID attribute.

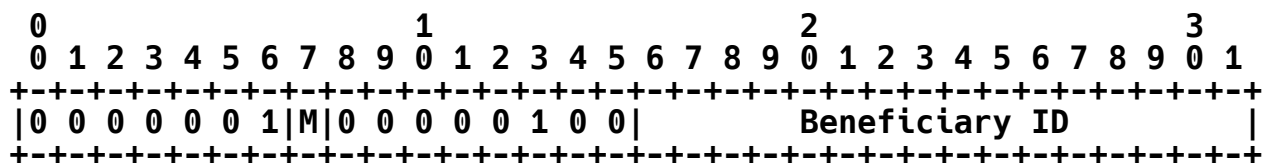


Figure 7: BENEFICIARY-ID format

Beneficiary ID: This field contains a 16-bit value that uniquely identifies a user within a conference.

Note that although the formats of the Beneficiary ID and of the User ID field in the common header are similar, their semantics are different. The Beneficiary ID is used in third-party floor requests and to request information about a particular participant.

5.2.2. FLOOR-ID

The following is the format of the FL00R-ID attribute.

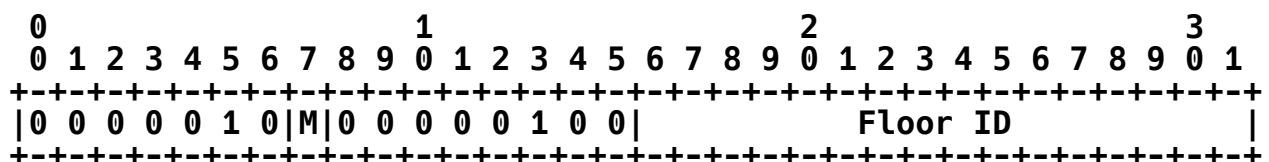


Figure 8: FL00R-ID format

Floor ID: This field contains a 16-bit value that uniquely identifies a floor within a conference.

5.2.3. FLOOR-REQUEST-ID

The following is the format of the FLOOR-REQUEST-ID attribute.

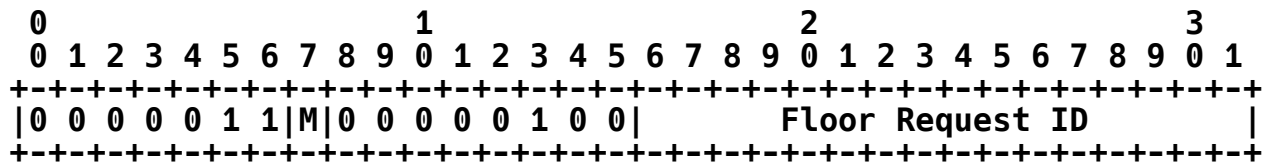


Figure 9: FL00R-REQUEST-ID format

Floor Request ID: This field contains a 16-bit value that identifies a floor request at the floor control server.

5.2.4. PRIORITY

The following is the format of the **PRIORITY** attribute.

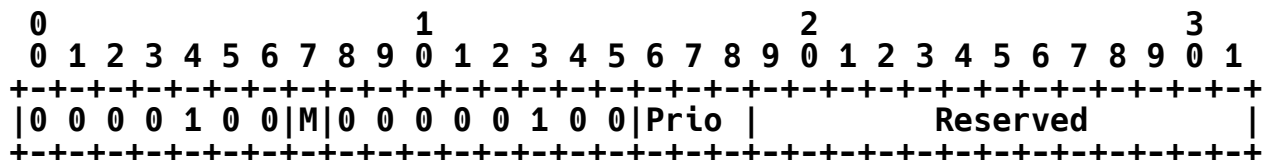


Figure 10: PRIORITY format

Prio: This field contains a 3-bit priority value, as shown in Table 3. Senders **SHOULD NOT** use values higher than 4 in this field. Receivers **MUST** treat values higher than 4 as if the value received were 4 (Highest). The default priority value when the PRIORITY attribute is missing is 2 (Normal).

Value	Priority
0	Lowest
1	Low
2	Normal
3	High
4	Highest

Table 3: Priority values

Reserved: At this point, the 13 bits in the reserved field **SHOULD** be set to zero by the sender of the message and **MUST** be ignored by the receiver.

5.2.5. REQUEST-STATUS

The following is the format of the REQUEST-STATUS attribute.

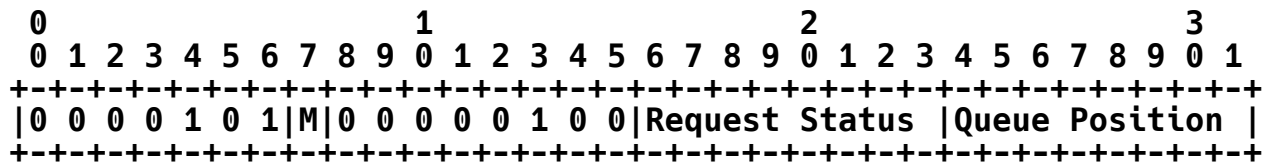


Figure 11: REQUEST-STATUS format

Request Status: This 8-bit field contains the status of the request, as described in the following table.

Value	Status
1	Pending
2	Accepted
3	Granted
4	Denied
5	Cancelled
6	Released
7	Revoked

Table 4: Request Status values

Queue Position: This 8-bit field contains, when applicable, the position of the floor request in the floor request queue at the server. If the Request Status value is different from Accepted, if the floor control server does not implement a floor request queue, or if the floor control server does not want to provide the client with this information, all the bits of this field **SHOULD** be set to zero.

A floor request is in Pending state if the floor control server needs to contact a floor chair in order to accept the floor request, but has not done it yet. Once the floor control chair accepts the floor request, the floor request is moved to the Accepted state.

5.2.6. ERROR-CODE

The following is the format of the ERROR-CODE attribute.

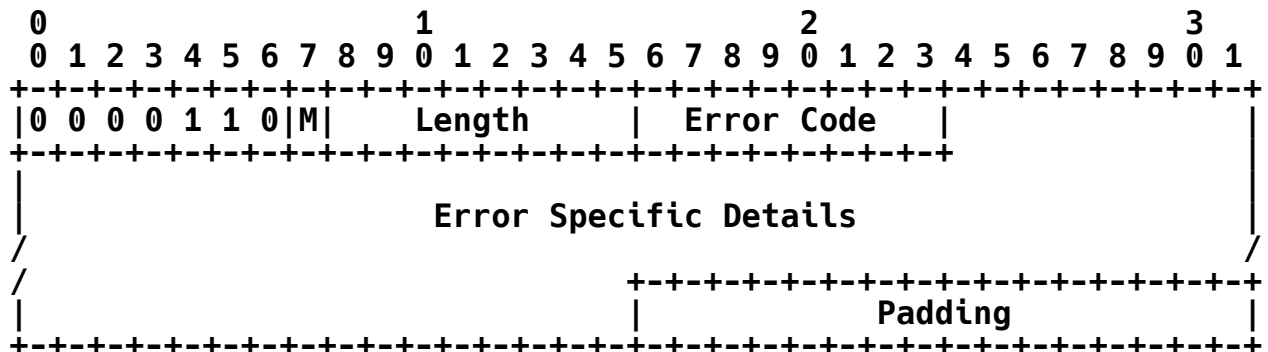


Figure 12: ERROR-CODE format

Error Code: This 8-bit field contains an error code from the following table. If an error code is not recognised by the receiver, then the receiver **MUST** assume that an error exists, and therefore that the message is processed, but the nature of the error is unclear.

Value	Meaning
1	Conference does not Exist
2	User does not Exist
3	Unknown Primitive
4	Unknown Mandatory Attribute
5	Unauthorized Operation
6	Invalid Floor ID
7	Floor Request ID Does Not Exist
8	You have Already Reached the Maximum Number of Ongoing Floor Requests for this Floor
9	Use TLS

Table 5: Error Code meaning

Error Specific Details: Present only for certain Error Codes. In this document, only for Error Code 4 (Unknown Mandatory Attribute). See Section 5.2.6.1 for its definition.

Padding: One, two, or three octets of padding added so that the contents of the ERROR-CODE attribute is 32-bit aligned. If the attribute is already 32-bit aligned, no padding is needed.

The Padding bits **SHOULD** be set to zero by the sender and **MUST** be ignored by the receiver.

5.2.6.1. Error-Specific Details for Error Code 4

The following is the format of the Error-Specific Details field for Error Code 4.

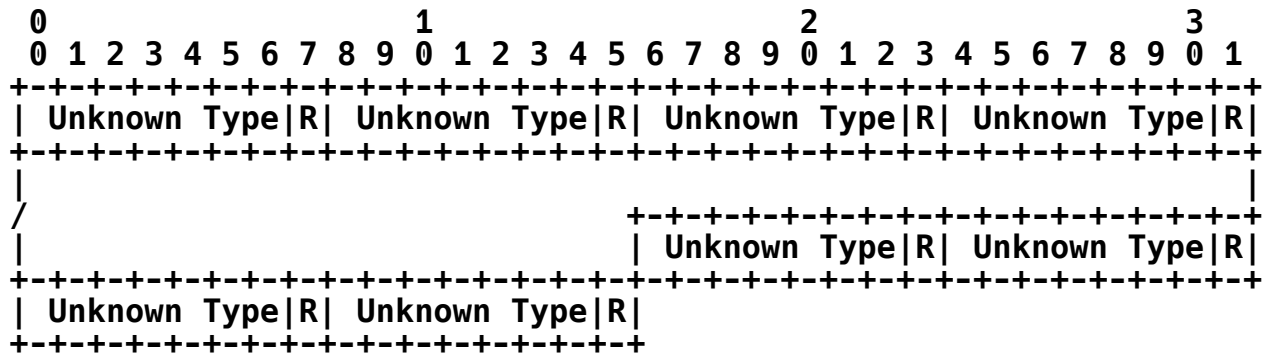


Figure 13: Unknown attributes format

Unknown Type: These 7-bit fields contain the Types of the attributes (which were present in the message that triggered the Error message) that were unknown to the receiver.

R: At this point, this bit is reserved. It **SHOULD** be set to zero by the sender of the message and **MUST** be ignored by the receiver.

5.2.7. ERROR-INFO

The following is the format of the ERROR-INFO attribute.

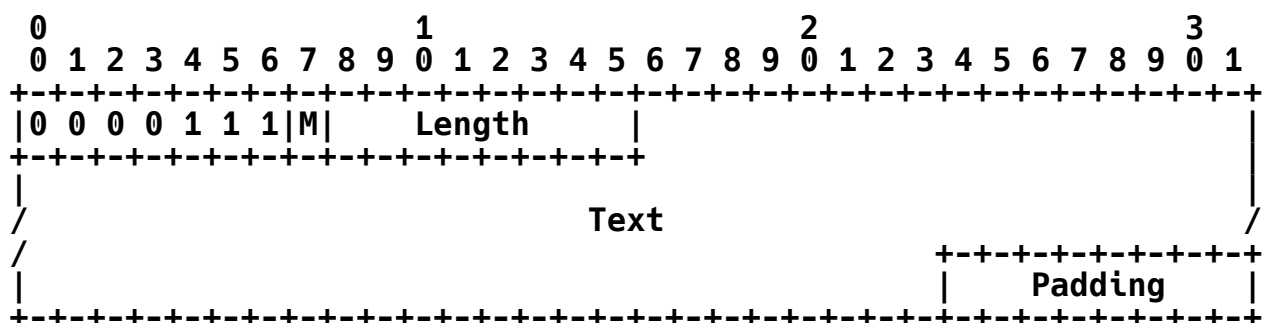


Figure 14: ERROR-INFO format

Text: This field contains UTF-8 [6] encoded text.

In some situations, the contents of the Text field may be generated by an automaton. If this automaton has information about the preferred language of the receiver of a particular ERROR-INFO attribute, it MAY use this language to generate the Text field.

Padding: One, two, or three octets of padding added so that the contents of the ERROR-INFO attribute is 32-bit aligned. The Padding bits SHOULD be set to zero by the sender and MUST be ignored by the receiver. If the attribute is already 32-bit aligned, no padding is needed.

5.2.8. PARTICIPANT-PROVIDED-INFO

The following is the format of the PARTICIPANT-PROVIDED-INFO attribute.

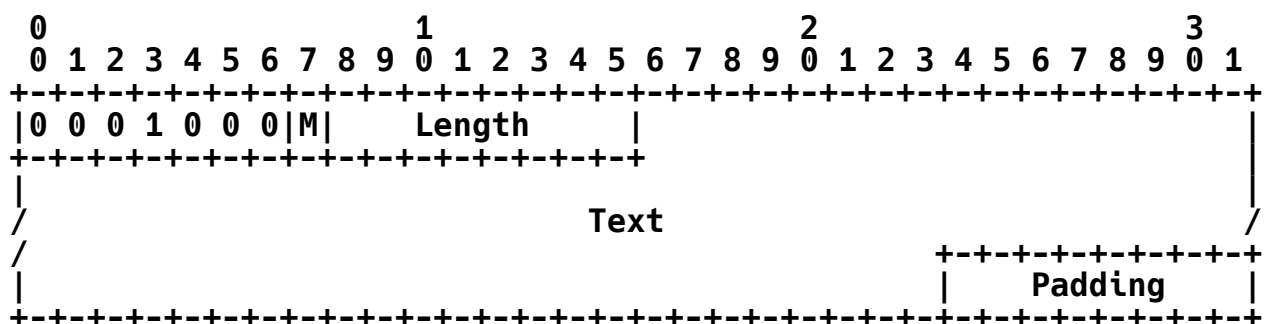


Figure 15: PARTICIPANT-PROVIDED-INFO format

Text: This field contains UTF-8 [6] encoded text.

Padding: One, two, or three octets of padding added so that the contents of the PARTICIPANT-PROVIDED-INFO attribute is 32-bit aligned. The Padding bits SHOULD be set to zero by the sender and MUST be ignored by the receiver. If the attribute is already 32-bit aligned, no padding is needed.

5.2.9. STATUS-INFO

The following is the format of the STATUS-INFO attribute.

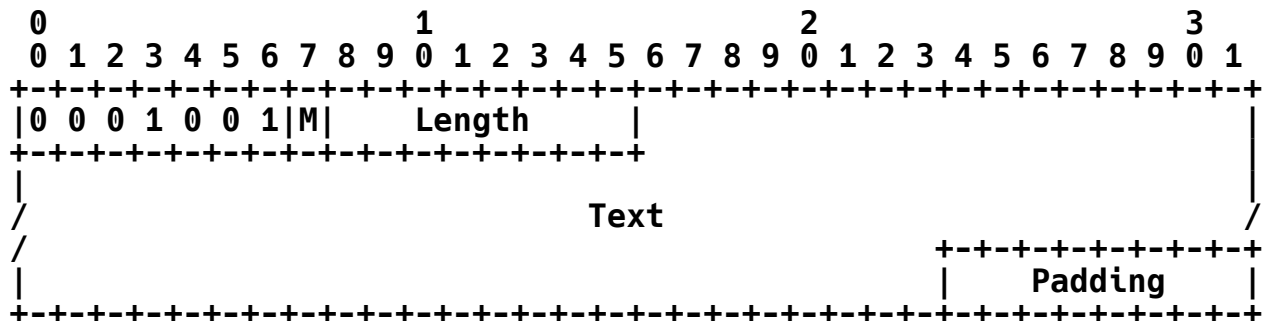


Figure 16: STATUS-INFO format

Text: This field contains UTF-8 [6] encoded text.

In some situations, the contents of the Text field may be generated by an automaton. If this automaton has information about the preferred language of the receiver of a particular STATUS-INFO attribute, it MAY use this language to generate the Text field.

Padding: One, two, or three octets of padding added so that the contents of the STATUS-INFO attribute is 32-bit aligned. The Padding bits SHOULD be set to zero by the sender and MUST be ignored by the receiver. If the attribute is already 32-bit aligned, no padding is needed.

5.2.10. SUPPORTED-ATTRIBUTES

The following is the format of the SUPPORTED-ATTRIBUTES attribute.

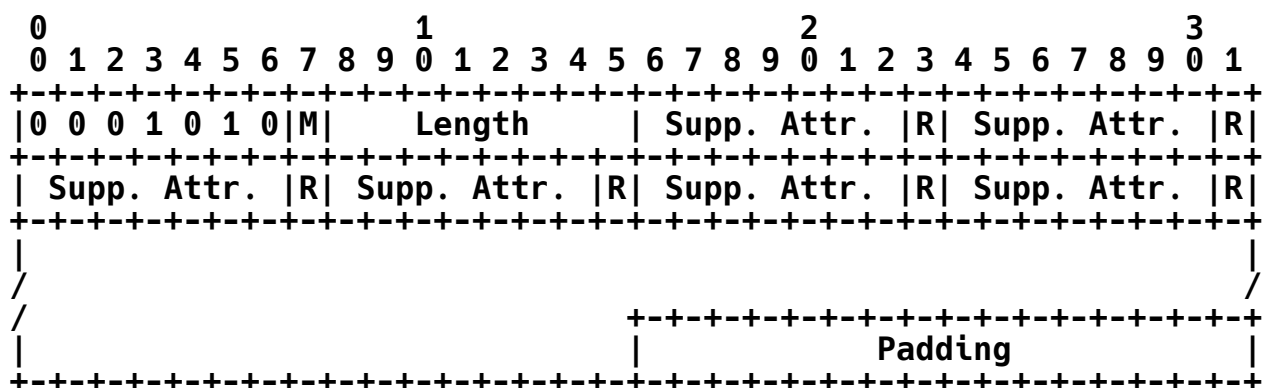


Figure 17: SUPPORTED-ATTRIBUTES format

Supp. Attr.: These fields contain the Types of the attributes that are supported by the floor control server in the following format:

R: Reserved: This bit MUST be set to zero upon transmission and MUST be ignored upon reception.

Padding: Two octets of padding added so that the contents of the SUPPORTED-ATTRIBUTES attribute is 32-bit aligned. If the attribute is already 32-bit aligned, no padding is needed.

The Padding bits SHOULD be set to zero by the sender and MUST be ignored by the receiver.

5.2.11. SUPPORTED-PRIMITIVES

The following is the format of the `SUPPORTED-PRIMITIVES` attribute.

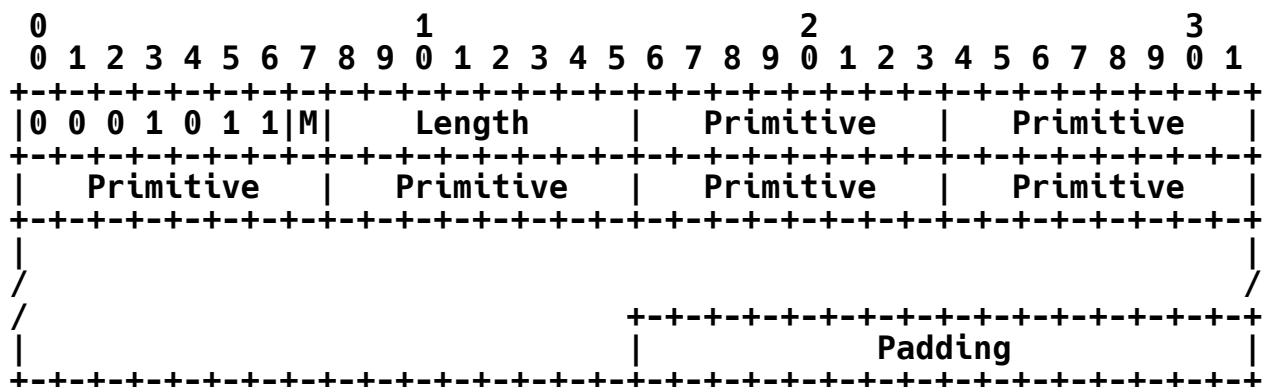


Figure 18: SUPPORTED-PRIMITIVES format

Primitive: These fields contain the types of the BFCP messages that are supported by the floor control server. See Table 1 for the list of BFCP primitives.

Padding: One, two, or three octets of padding added so that the contents of the SUPPORTED-PRIMITIVES attribute is 32-bit aligned. If the attribute is already 32-bit aligned, no padding is needed.

The Padding bits SHOULD be set to zero by the sender and MUST be ignored by the receiver.

5.2.12. USER-DISPLAY-NAME

The following is the format of the USER-DISPLAY-NAME attribute.

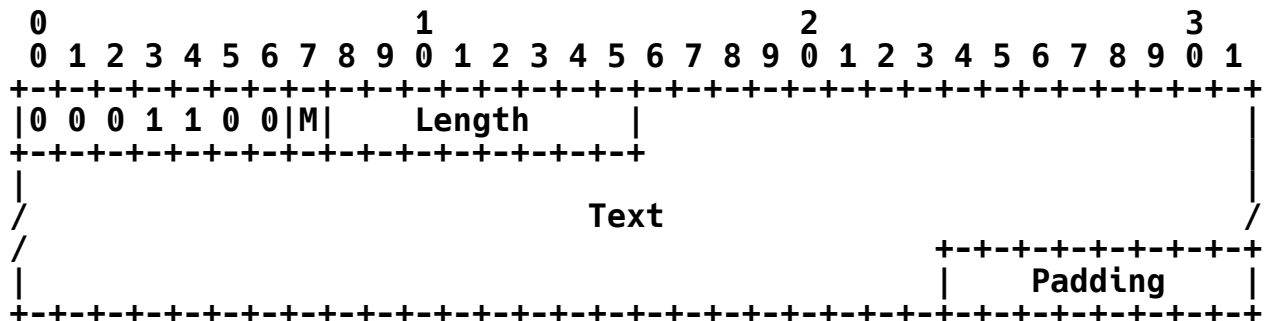


Figure 19: USER-DISPLAY-NAME format

Text: This field contains the UTF-8 encoded name of the user.

Padding: One, two, or three octets of padding added so that the contents of the USER-DISPLAY-NAME attribute is 32-bit aligned. The Padding bits **SHOULD** be set to zero by the sender and **MUST** be ignored by the receiver. If the attribute is already 32-bit aligned, no padding is needed.

5.2.13. USER-URI

The following is the format of the USER-URI attribute.

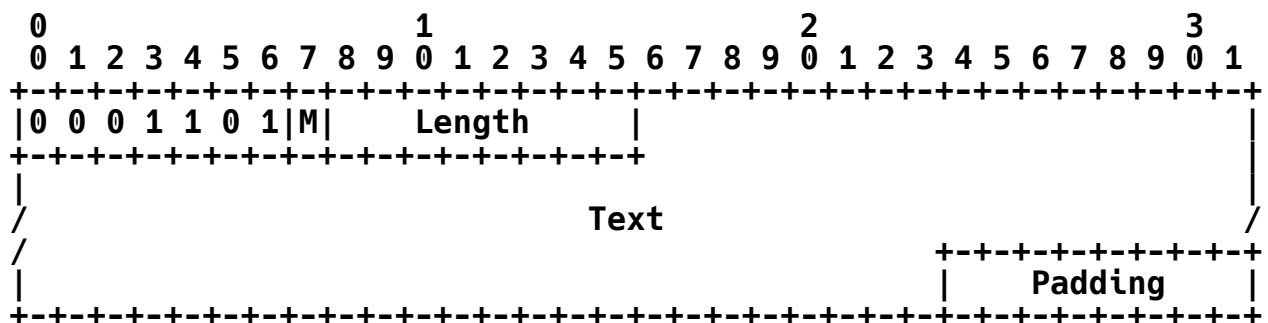


Figure 20: USER-URI format

Text: This field contains the UTF-8 encoded user's contact URI, that is, the URI used by the user to set up the resources (e.g., media streams) that are controlled by BFCP. For example, in the context of a conference set up by SIP, the USER-URI attribute would carry the SIP URI of the user.

Messages containing a user's URI in a USER-URI attribute also contain the user's User ID. This way, a client receiving such a message can correlate the user's URI (e.g., the SIP URI the user used to join a conference) with the user's User ID.

Padding: One, two, or three octets of padding added so that the contents of the USER-URI attribute is 32-bit aligned. The Padding bits **SHOULD** be set to zero by the sender and **MUST** be ignored by the receiver. If the attribute is already 32-bit aligned, no padding is needed.

5.2.14. BENEFICIARY-INFORMATION

The **BENEFICIARY-INFORMATION** attribute is a grouped attribute that consists of a header, which is referred to as **BENEFICIARY-INFORMATION-HEADER**, followed by a sequence of attributes. The following is the format of the **BENEFICIARY-INFORMATION-HEADER**:

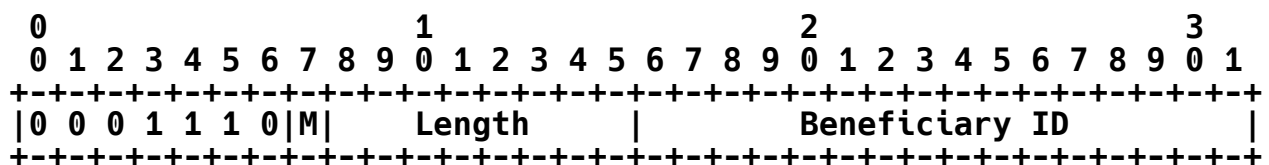


Figure 21: BENEFICIARY-INFORMATION-HEADER format

Beneficiary ID: This field contains a 16-bit value that uniquely identifies a user within a conference.

The following is the ABNF (Augmented Backus-Naur Form) [2] of the BENEFICIARY-INFORMATION grouped attribute. (EXTENSION-ATTRIBUTE refers to extension attributes that may be defined in the future.)

```

BENEFICIARY-INFORMATION = (BENEFICIARY-INFORMATION-HEADER)
                           [USER-DISPLAY-NAME]
                           [USER-URI]
                           * [EXTENSION-ATTRIBUTE]

```

Figure 22: BENEFICIARY-INFORMATION format

5.2.15. FLOOR-REQUEST-INFORMATION

The FLOOR-REQUEST-INFORMATION attribute is a grouped attribute that consists of a header, which is referred to as FLOOR-REQUEST-INFORMATION-HEADER, followed by a sequence of attributes. The following is the format of the FLOOR-REQUEST-INFORMATION-HEADER:

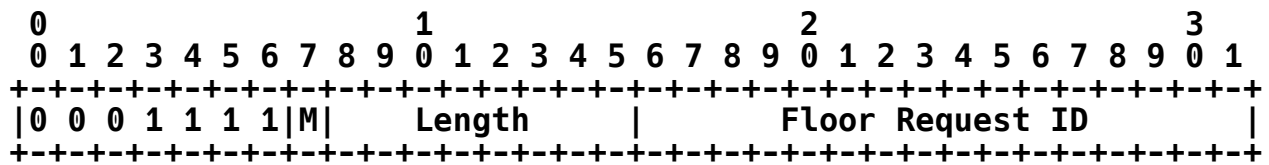


Figure 23: FLOOR-REQUEST-INFORMATION-HEADER format

Floor Request ID: This field contains a 16-bit value that identifies a floor request at the floor control server.

The following is the ABNF of the FLOOR-REQUEST-INFORMATION grouped attribute. (EXTENSION-ATTRIBUTE refers to extension attributes that may be defined in the future.)

```

FLOOR-REQUEST-INFORMATION = (FLOOR-REQUEST-INFORMATION-HEADER)
                             [OVERALL-REQUEST-STATUS]
                             1*(FLOOR-REQUEST-STATUS)
                             [BENEFICIARY-INFORMATION]
                             [REQUESTED-BY-INFORMATION]
                             [PRIORITY]
                             [PARTICIPANT-PROVIDED-INFO]
                             *[EXTENSION-ATTRIBUTE]

```

Figure 24: FLOOR-REQUEST-INFORMATION format

5.2.16. REQUESTED-BY-INFORMATION

The REQUESTED-BY-INFORMATION attribute is a grouped attribute that consists of a header, which is referred to as REQUESTED-BY-INFORMATION-HEADER, followed by a sequence of attributes. The following is the format of the REQUESTED-BY-INFORMATION-HEADER:

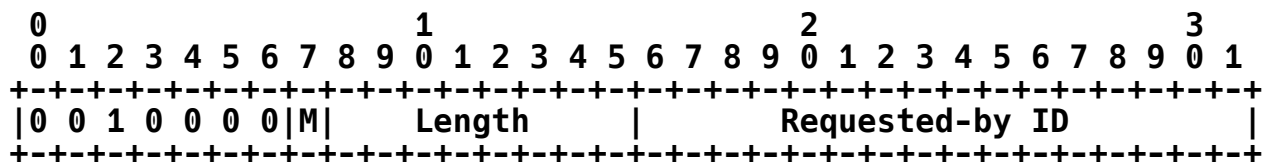


Figure 25: REQUESTED-BY-INFORMATION-HEADER format

Requested-by ID: This field contains a 16-bit value that uniquely identifies a user within a conference.

The following is the ABNF of the REQUESTED-BY-INFORMATION grouped attribute. (EXTENSION-ATTRIBUTE refers to extension attributes that may be defined in the future.)

```

REQUESTED-BY-INFORMATION = (REQUESTED-BY-INFORMATION-HEADER)
                             [USER-DISPLAY-NAME]
                             [USER-URI]
                             *[EXTENSION-ATTRIBUTE]

```

Figure 26: REQUESTED-BY-INFORMATION format

5.2.17. FLOOR-REQUEST-STATUS

The FLOOR-REQUEST-STATUS attribute is a grouped attribute that consists of a header, which is referred to as FLOOR-REQUEST-STATUS-HEADER, followed by a sequence of attributes. The following is the format of the FLOOR-REQUEST-STATUS-HEADER:

0										1										2										3									
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1								
0 0 1 0 0 0 1 M										Length										Floor ID																			

Figure 27: FLOOR-REQUEST-STATUS-HEADER format

Floor ID: this field contains a 16-bit value that uniquely identifies a floor within a conference.

The following is the ABNF of the FLOOR-REQUEST-STATUS grouped attribute. (EXTENSION-ATTRIBUTE refers to extension attributes that may be defined in the future.)

```

FLOOR-REQUEST-STATUS      = (FLOOR-REQUEST-STATUS-HEADER)
                             [REQUEST-STATUS]
                             [STATUS-INFO]
                             *[EXTENSION-ATTRIBUTE]

```

Figure 28: FLOOR-REQUEST-STATUS format

5.2.18. OVERALL-REQUEST-STATUS

The OVERALL-REQUEST-STATUS attribute is a grouped attribute that consists of a header, which is referred to as OVERALL-REQUEST-STATUS-HEADER, followed by a sequence of attributes. The following is the format of the OVERALL-REQUEST-STATUS-HEADER:

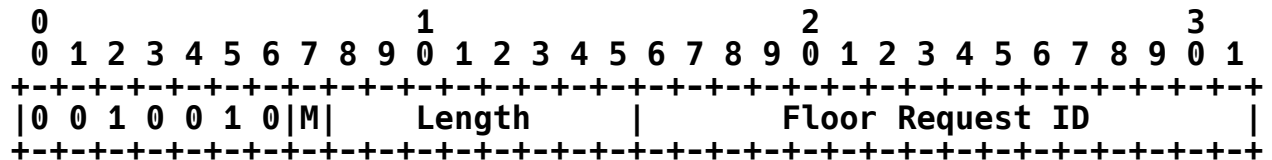


Figure 29: OVERALL-REQUEST-STATUS-HEADER format

Floor Request ID: this field contains a 16-bit value that identifies a floor request at the floor control server.

The following is the ABNF of the OVERALL-REQUEST-STATUS grouped attribute. (EXTENSION-ATTRIBUTE refers to extension attributes that may be defined in the future.)

```
OVERALL-REQUEST-STATUS = ( OVERALL-REQUEST-STATUS-HEADER )
                        [ REQUEST-STATUS ]
                        [ STATUS-INFO ]
                        * [ EXTENSION-ATTRIBUTE ]
```

Figure 30: OVERALL-REQUEST-STATUS format

5.3. Message Format

This section contains the normative ABNF (Augmented Backus-Naur Form) [2] of the BFCP messages. Extension attributes that may be defined in the future are referred to as EXTENSION-ATTRIBUTE in the ABNF.

5.3.1. FloorRequest

Floor participants request a floor by sending a FloorRequest message to the floor control server. The following is the format of the FloorRequest message:

```
FloorRequest = (COMMON-HEADER)
                1*(FLOOR-ID)
                [BENEFICIARY-ID]
                [PARTICIPANT-PROVIDED-INFO]
                [PRIORITY]
                *[EXTENSION-ATTRIBUTE]
```

Figure 31: FloorRequest format

5.3.2. FloorRelease

Floor participants release a floor by sending a FloorRelease message to the floor control server. Floor participants also use the FloorRelease message to cancel pending floor requests. The following is the format of the FloorRelease message:

```
FloorRelease = (COMMON-HEADER)
                (FLOOR-REQUEST-ID)
                *[EXTENSION-ATTRIBUTE]
```

Figure 32: FloorRelease format

5.3.3. FloorRequestQuery

Floor participants and floor chairs request information about a floor request by sending a FloorRequestQuery message to the floor control server. The following is the format of the FloorRequestQuery message:

```
FloorRequestQuery = (COMMON-HEADER)
                    (FLOOR-REQUEST-ID)
                    *[EXTENSION-ATTRIBUTE]
```

Figure 33: FloorRequestQuery format

5.3.4. FloorRequestStatus

The floor control server informs floor participants and floor chairs about the status of their floor requests by sending them FloorRequestStatus messages. The following is the format of the FloorRequestStatus message:

```
FloorRequestStatus = (COMMON-HEADER)
                     (FLOOR-REQUEST-INFORMATION)
                     *[EXTENSION-ATTRIBUTE]
```

Figure 34: FloorRequestStatus format

5.3.5. UserQuery

Floor participants and floor chairs request information about a participant and the floor requests related to this participant by sending a UserQuery message to the floor control server. The following is the format of the UserQuery message:

```
UserQuery = (COMMON-HEADER)
             [BENEFICIARY-ID]
             *[EXTENSION-ATTRIBUTE]
```

Figure 35: UserQuery format

5.3.6. UserStatus

The floor control server provides information about participants and their related floor requests to floor participants and floor chairs by sending them UserStatus messages. The following is the format of the UserStatus message:

```
UserStatus = (COMMON-HEADER)
              [BENEFICIARY-INFORMATION]
              *(FLOOR-REQUEST-INFORMATION)
              *[EXTENSION-ATTRIBUTE]
```

Figure 36: UserStatus format

5.3.7. FloorQuery

Floor participants and floor chairs request information about a floor or floors by sending a FloorQuery message to the floor control server. The following is the format of the FloorRequest message:

```
FloorQuery = (COMMON-HEADER)
              *(FLOOR-ID)
              *[EXTENSION-ATTRIBUTE]
```

Figure 37: FloorQuery format

5.3.8. FloorStatus

The floor control server informs floor participants and floor chairs about the status (e.g., the current holder) of a floor by sending them FloorStatus messages. The following is the format of the FloorStatus message:

```
FloorStatus      =  (COMMON-HEADER)
                   *1(FLOOR-ID)
                   *[FLOOR-REQUEST-INFORMATION]
                   *[EXTENSION-ATTRIBUTE]
```

Figure 38: FloorStatus format

5.3.9. ChairAction

Floor chairs send instructions to floor control servers by sending ChairAction messages. The following is the format of the ChairAction message:

```
ChairAction      =  (COMMON-HEADER)
                   (FLOOR-REQUEST-INFORMATION)
                   *[EXTENSION-ATTRIBUTE]
```

Figure 39: ChairAction format

5.3.10. ChairActionAck

Floor control servers confirm that they have accepted a ChairAction message by sending a ChairActionAck message. The following is the format of the ChairActionAck message:

```
ChairActionAck   =  (COMMON-HEADER)
                   *[EXTENSION-ATTRIBUTE]
```

Figure 40: ChairActionAck format

5.3.11. Hello

Floor participants and floor chairs check the liveness of floor control servers by sending a Hello message. The following is the format of the Hello message:

```
Hello           =  (COMMON-HEADER)
                   *[EXTENSION-ATTRIBUTE]
```

Figure 41: Hello format

5.3.12. HelloAck

Floor control servers confirm that they are alive on reception of a Hello message by sending a HelloAck message. The following is the format of the HelloAck message:

```
HelloAck      = (COMMON-HEADER)
                  (SUPPORTED-PRIMITIVES)
                  (SUPPORTED-ATTRIBUTES)
                  *[EXTENSION-ATTRIBUTE]
```

Figure 42: HelloAck format

5.3.13. Error

Floor control servers inform floor participants and floor chairs about errors processing requests by sending them Error messages. The following is the format of the Error message:

```
Error          = (COMMON-HEADER)
                  (ERROR-CODE)
                  [ERROR-INFO]
                  *[EXTENSION-ATTRIBUTE]
```

Figure 43: Error format

6. Transport

BFCP entities exchange BFCP messages using TCP connections. TCP provides an in-order reliable delivery of a stream of bytes. Consequently, message framing is implemented in the application layer. BFCP implements application-layer framing using TLV-encoded attributes.

A client **MUST NOT** use more than one TCP connection to communicate with a given floor control server within a conference. Nevertheless, if the same physical box handles different clients (e.g., a floor chair and a floor participant), which are identified by different User IDs, a separate connection per client is allowed.

If a BFCP entity (a client or a floor control server) receives data from TCP that cannot be parsed, the entity **MUST** close the TCP connection, and the connection **SHOULD** be reestablished. Similarly, if a TCP connection cannot deliver a BFCP message and times out, the TCP connection **SHOULD** be reestablished.

The way connection reestablishment is handled depends on how the client obtains information to contact the floor control server (e.g., using an SDP offer/answer exchange [7]). Once the TCP connection is reestablished, the client MAY resend those messages for which it did not get a response from the floor control server.

If a floor control server detects that the TCP connection towards one of the floor participants is lost, it is up to the local policy of the floor control server what to do with the pending floor requests of the floor participant. In any case, it is RECOMMENDED that the floor control server keep the floor requests (i.e., that it does not cancel them) while the TCP connection is reestablished.

If a client wishes to end its BFCP connection with a floor control server, the client closes (i.e., a graceful close) the TCP connection towards the floor control server. If a floor control server wishes to end its BFCP connection with a client (e.g., the Focus of the conference informs the floor control server that the client has been kicked out from the conference), the floor control server closes (i.e., a graceful close) the TCP connection towards the client.

7. Lower-Layer Security

BFCP relies on lower-layer security mechanisms to provide replay and integrity protection and confidentiality. BFCP floor control servers and clients (which include both floor participants and floor chairs) MUST support TLS [3]. Any BFCP entity MAY support other security mechanisms.

BFCP entities MUST support, at a minimum, the TLS TLS_RSA_WITH_AES_128_CBC_SHA ciphersuite [5].

Which party, the client or the floor control server, acts as the TLS server depends on how the underlying TCP connection is established. For example, when the TCP connection is established using an SDP offer/answer exchange [7], the answerer (which may be the client or the floor control server) always acts as the TLS server.

8. Protocol Transactions

In BFCP, there are two types of transactions: client-initiated transactions and server-initiated transactions (notifications). Client-initiated transactions consist of a request from a client to a floor control server and a response from the floor control server to the client. The request carries a Transaction ID in its common header, which the floor control server copies into the response. Clients use Transaction ID values to match responses with previously issued requests.

Server-initiated transactions consist of a single message from a floor control server to a client. Since they do not trigger any response, their Transaction ID is set to 0.

8.1. Client Behavior

A client starting a client-initiated transaction **MUST** set the Conference ID in the common header of the message to the Conference ID for the conference that the client obtained previously.

The client **MUST** set the Transaction ID value in the common header to a number that is different from 0 and that **MUST NOT** be reused in another message from the client until a response from the server is received for the transaction. The client uses the Transaction ID value to match this message with the response from the floor control server.

8.2. Server Behavior

A floor control server sending a response within a client-initiated transaction **MUST** copy the Conference ID, the Transaction ID, and the User ID from the request received from the client into the response. Server-initiated transactions **MUST** contain a Transaction ID equal to 0.

9. Authentication and Authorization

BFCP clients **SHOULD** authenticate the floor control server before sending any BFCP message to it or accepting any BFCP message from it. Similarly, floor control servers **SHOULD** authenticate a client before accepting any BFCP message from it or sending any BFCP message to it.

BFCP supports TLS-based mutual authentication between clients and floor control servers, as specified in Section 9.1. This is the **RECOMMENDED** authentication mechanism in BFCP.

Note that future extensions may define additional authentication mechanisms.

In addition to authenticating BFCP messages, floor control servers need to authorize them. On receiving an authenticated BFCP message, the floor control server checks whether the client sending the message is authorized. If the client is not authorized to perform the operation being requested, the floor control server generates an Error message, as described in Section 13.8, with an Error code with a value of 5 (Unauthorized Operation). Messages from a client that cannot be authorized **MUST NOT** be processed further.

9.1. TLS-Based Mutual Authentication

BFCP supports TLS-based mutual authentication between clients and floor control servers. BFCP assumes that there is an integrity-protected channel between the client and the floor control server that can be used to exchange their self-signed certificates or, more commonly, the fingerprints of these certificates. These certificates are used at TLS establishment time.

The implementation of such an integrity-protected channel using SIP and the SDP offer/answer model is described in [7].

BFCP messages received over an authenticated TLS connection are considered authenticated. A floor control server that receives a BFCP message over TCP (no TLS) can request the use of TLS by generating an Error message, as described in Section 13.8, with an Error code with a value of 9 (Use TLS). Clients SHOULD simply ignore unauthenticated messages.

Note that future extensions may define additional authentication mechanisms that may not require an initial integrity-protected channel (e.g., authentication based on certificates signed by a certificate authority).

As described in Section 9, floor control servers need to perform authorization before processing any message. In particular, the floor control server SHOULD check that messages arriving over a given authenticated TLS connection use an authorized User ID (i.e., a User ID that the user that established the authenticated TLS connection is allowed to use).

10. Floor Participant Operations

This section specifies how floor participants can perform different operations, such as requesting a floor, using the protocol elements described in earlier sections. Section 11 specifies operations that are specific to floor chairs, such as instructing the floor control server to grant or revoke a floor, and Section 12 specifies operations that can be performed by any client (i.e., both floor participants and floor chairs).

10.1. Requesting a Floor

A floor participant that wishes to request one or more floors does so by sending a FloorRequest message to the floor control server.

10.1.1. Sending a FloorRequest Message

The ABNF in Section 5.3.1 describes the attributes that a FloorRequest message can contain. In addition, the ABNF specifies normatively which of these attributes are mandatory, and which ones are optional.

The floor participant sets the Conference ID and the Transaction ID in the common header following the rules given in Section 8.1.

The floor participant sets the User ID in the common header to the floor participant's identifier. This User ID will be used by the floor control server to authenticate and authorize the request. If the sender of the FloorRequest message (identified by the User ID) is not the participant that would eventually get the floor (i.e., a third-party floor request), the sender **SHOULD** add a BENEFICIARY-ID attribute to the message identifying the beneficiary of the floor.

Note that the name space for both the User ID and the Beneficiary ID is the same. That is, a given participant is identified by a single 16-bit value that can be used in the User ID in the common header and in several attributes: BENEFICIARY-ID, BENEFICIARY-INFORMATION, and REQUESTED-BY-INFORMATION.

The floor participant must insert at least one FLOOR-ID attribute in the FloorRequest message. If the client inserts more than one FLOOR-ID attribute, the floor control server will treat all the floor requests as an atomic package. That is, the floor control server will either grant or deny all the floors in the FloorRequest message.

The floor participant may use a PARTICIPANT-PROVIDED-INFO attribute to state the reason why the floor or floors are being requested. The Text field in the PARTICIPANT-PROVIDED-INFO attribute is intended for human consumption.

The floor participant may request that the server handle the floor request with a certain priority using a PRIORITY attribute.

10.1.2. Receiving a Response

A message from the floor control server is considered a response to the FloorRequest message if the message from the floor control server has the same Conference ID, Transaction ID, and User ID as the FloorRequest message, as described in Section 8.1. On receiving such a response, the floor participant follows the rules in Section 9 that relate to floor control server authentication.

The successful processing of a FloorRequest message at the floor control server involves generating one or several FloorRequestStatus messages. The floor participant obtains a Floor Request ID in the Floor Request ID field of a FLOOR-REQUEST-INFORMATION attribute in the first FloorRequestStatus message from the floor control server. Subsequent FloorRequestStatus messages from the floor control server regarding the same floor request will carry the same Floor Request ID in a FLOOR-REQUEST-INFORMATION attribute as the initial FloorRequestStatus message. This way, the floor participant can associate subsequent incoming FloorRequestStatus messages with the ongoing floor request.

The floor participant obtains information about the status of the floor request in the FLOOR-REQUEST-INFORMATION attribute of each of the FloorRequestStatus messages received from the floor control server. This attribute is a grouped attribute, and as such it includes a number of attributes that provide information about the floor request.

The OVERALL-REQUEST-STATUS attribute provides information about the overall status of the floor request. If the Request Status value is Granted, all the floors that were requested in the FloorRequest message have been granted. If the Request Status value is Denied, all the floors that were requested in the FloorRequest message have been denied. A floor request is considered to be ongoing while it is in the Pending, Accepted, or Granted states. If the floor request value is unknown, then the response is still processed. However, no meaningful value can be reported to the user.

The STATUS-INFO attribute, if present, provides extra information that the floor participant MAY display to the user.

The FLOOR-REQUEST-STATUS attributes provide information about the status of the floor request as it relates to a particular floor. The STATUS-INFO attribute, if present, provides extra information that the floor participant MAY display to the user.

The BENEFICIARY-INFORMATION attribute identifies the beneficiary of the floor request in third-party floor requests. The REQUESTED-BY-INFORMATION attribute need not be present in FloorRequestStatus messages received by the floor participant that requested the floor, as this floor participant is already identified by the User ID in the common header.

The PRIORITY attribute, when present, contains the priority that was requested by the generator of the FloorRequest message.

If the response is an Error message, the floor control server could not process the FloorRequest message for some reason, which is described in the Error message.

10.2. Cancelling a Floor Request and Releasing a Floor

A floor participant that wishes to cancel an ongoing floor request does so by sending a FloorRelease message to the floor control server. The FloorRelease message is also used by floor participants that hold a floor and would like to release it.

10.2.1. Sending a FloorRelease Message

The ABNF in Section 5.3.2 describes the attributes that a FloorRelease message can contain. In addition, the ABNF specifies normatively which of these attributes are mandatory, and which ones are optional.

The floor participant sets the Conference ID and the Transaction ID in the common header following the rules given in Section 8.1. The floor participant sets the User ID in the common header to the floor participant's identifier. This User ID will be used by the floor control server to authenticate and authorize the request.

Note that the FloorRelease message is used to release a floor or floors that were granted and to cancel ongoing floor requests (from the protocol perspective, both are ongoing floor requests). Using the same message in both situations helps resolve the race condition that occurs when the FloorRelease message and the FloorGrant message cross each other on the wire.

The floor participant uses the FLOOR-REQUEST-ID that was received in the response to the FloorRequest message that the FloorRelease message is cancelling.

Note that if the floor participant requested several floors as an atomic operation (i.e., in a single FloorRequest message), all the floors are released as an atomic operation as well (i.e., all are released at the same time).

10.2.2. Receiving a Response

A message from the floor control server is considered a response to the FloorRelease message if the message from the floor control server has the same Conference ID, Transaction ID, and User ID as the FloorRequest message, as described in Section 8.1. On receiving such a response, the floor participant follows the rules in Section 9 that relate to floor control server authentication.

If the response is a FloorRequestStatus message, the Request Status value in the OVERALL-REQUEST-STATUS attribute (within the FLOOR-REQUEST-INFORMATION grouped attribute) will be Cancelled or Released.

If the response is an Error message, the floor control server could not process the FloorRequest message for some reason, which is described in the Error message.

It is possible that the FloorRelease message crosses on the wire with a FloorRequestStatus message from the server with a Request Status different from Cancelled or Released. In any case, such a FloorRequestStatus message will not be a response to the FloorRelease message, as its Transaction ID will not match that of the FloorRelease.

11. Chair Operations

This section specifies how floor chairs can instruct the floor control server to grant or revoke a floor using the protocol elements described in earlier sections.

Floor chairs that wish to send instructions to a floor control server do so by sending a ChairAction message.

11.1. Sending a ChairAction Message

The ABNF in Section 5.3.9 describes the attributes that a ChairAction message can contain. In addition, the ABNF specifies normatively which of these attributes are mandatory, and which ones are optional.

The floor chair sets the Conference ID and the Transaction ID in the common header following the rules given in Section 8.1. The floor chair sets the User ID in the common header to the floor participant's identifier. This User ID will be used by the floor control server to authenticate and authorize the request.

The ChairAction message contains instructions that apply to one or more floors within a particular floor request. The floor or floors are identified by the FLOOR-REQUEST-STATUS attributes and the floor request is identified by the FLOOR-REQUEST-INFORMATION-HEADER, which are carried in the ChairAction message.

For example, if a floor request consists of two floors that depend on different floor chairs, each floor chair will grant its floor within the floor request. Once both chairs have granted their floor, the floor control server will grant the floor request as a whole. On the other hand, if one of the floor chairs denies its floor, the floor

control server will deny the floor request as a whole, regardless of the other floor chair's decision.

The floor chair provides the new status of the floor request as it relates to a particular floor using a FLOOR-REQUEST-STATUS attribute. If the new status of the floor request is Accepted, the floor chair MAY use the Queue Position field to provide a queue position for the floor request. If the floor chair does not wish to provide a queue position, all the bits of the Queue Position field SHOULD be set to zero. The floor chair SHOULD use the Status Revoked to revoke a floor that was granted (i.e., Granted status) and SHOULD use the Status Denied to reject floor requests in any other status (e.g., Pending and Accepted).

The floor chair MAY add an OVERALL-REQUEST-STATUS attribute to the ChairAction message to provide a new overall status for the floor request. If the new overall status of the floor request is Accepted, the floor chair MAY use the Queue Position field to provide a queue position for the floor request.

Note that a particular floor control server may implement a different queue for each floor containing all the floor requests that relate to that particular floor, a general queue for all floor requests, or both. Also note that a floor request may involve several floors and that a ChairAction message may only deal with a subset of these floors (e.g., if a single floor chair is not authorized to manage all the floors). In this case, the floor control server will combine the instructions received from the different floor chairs in FLOOR-REQUEST-STATUS attributes to come up with the overall status of the floor request.

Note that, while the action of a floor chair may communicate information in the OVERALL-REQUEST-STATUS attribute, the floor control server may override, modify, or ignore this field's content.

The floor chair may use STATUS-INFO attributes to state the reason why the floor or floors are being accepted, granted, or revoked. The Text in the STATUS-INFO attribute is intended for human consumption.

11.2. Receiving a Response

A message from the floor control server is considered a response to the ChairAction message if the message from the server has the same Conference ID, Transaction ID, and User ID as the ChairAction message, as described in Section 8.1. On receiving such a response, the floor chair follows the rules in Section 9 that relate to floor control server authentication.

A ChairActionAck message from the floor control server confirms that the floor control server has accepted the ChairAction message. An Error message indicates that the floor control server could not process the ChairAction message for some reason, which is described in the Error message.

12. General Client Operations

This section specifies operations that can be performed by any client. That is, they are not specific to floor participants or floor chairs. They can be performed by both.

12.1. Requesting Information about Floors

A client can obtain information about the status of a floor or floors in different ways, which include using BFCP and using out-of-band mechanisms. Clients using BFCP to obtain such information use the procedures described in this section.

Clients request information about the status of one or several floors by sending a FloorQuery message to the floor control server.

12.1.1. Sending a FloorQuery Message

The ABNF in Section 5.3.7 describes the attributes that a FloorQuery message can contain. In addition, the ABNF specifies normatively which of these attributes are mandatory, and which ones are optional.

The client sets the Conference ID and the Transaction ID in the common header following the rules given in Section 8.1. The client sets the User ID in the common header to the client's identifier. This User ID will be used by the floor control server to authenticate and authorize the request.

The client inserts in the message all the Floor IDs it wants to receive information about. The floor control server will send periodic information about all of these floors. If the client does not want to receive information about a particular floor any longer, it sends a new FloorQuery message removing the FLOOR-ID of this floor. If the client does not want to receive information about any floor any longer, it sends a FloorQuery message with no FLOOR-ID attribute.

12.1.2. Receiving a Response

A message from the floor control server is considered a response to the FloorQuery message if the message from the floor control server has the same Conference ID, Transaction ID, and User ID as the

FloorRequest message, as described in Section 8.1. On receiving such a response, the client follows the rules in Section 9 that relate to floor control server authentication.

On reception of the FloorQuery message, the floor control server will respond with a FloorStatus message or with an Error message. If the response is a FloorStatus message, it will contain information about one of the floors the client requested information about. If the client did not include any FLOOR-ID attribute in its FloorQuery message (i.e., the client does not want to receive information about any floor any longer), the FloorStatus message from the floor control server will not include any FLOOR-ID attribute either.

FloorStatus messages that carry information about a floor contain a FLOOR-ID attribute that identifies the floor. After this attribute, FloorStatus messages contain information about existing (one or more) floor requests that relate to that floor. The information about each particular floor request is encoded in a FLOOR-REQUEST-INFORMATION attribute. This grouped attribute carries a Floor Request ID that identifies the floor request, followed by a set of attributes that provide information about the floor request.

After the first FloorStatus, the floor control server will continue sending FloorStatus messages, periodically informing the client about changes on the floors the client requested information about.

12.2. Requesting Information about Floor Requests

A client can obtain information about the status of one or several floor requests in different ways, which include using BFCP and using out-of-band mechanisms. Clients using BFCP to obtain such information use the procedures described in this section.

Clients request information about the current status of a floor request by sending a FloorRequestQuery message to the floor control server.

Requesting information about a particular floor request is useful in a number of situations. For example, on reception of a FloorRequest message, a floor control server may choose to return FloorRequestStatus messages only when the floor request changes its state (e.g., from Accepted to Granted), but not when the floor request advances in its queue. In this situation, if the user requests it, the floor participant can use a FloorRequestQuery message to poll the floor control server for the status of the floor request.

12.2.1. Sending a FloorRequestQuery Message

The ABNF in Section 5.3.3 describes the attributes that a FloorRequestQuery message can contain. In addition, the ABNF specifies normatively which of these attributes are mandatory, and which ones are optional.

The client sets the Conference ID and the Transaction ID in the common header following the rules given in Section 8.1. The client sets the User ID in the common header to the client's identifier. This User ID will be used by the floor control server to authenticate and authorize the request.

The client must insert a FLOOR-REQUEST-ID attribute that identifies the floor request at the floor control server.

12.2.2. Receiving a Response

A message from the floor control server is considered a response to the FloorRequestQuery message if the message from the floor control server has the same Conference ID, Transaction ID, and User ID as the FloorRequestQuery message, as described in Section 8.1. On receiving such a response, the client follows the rules in Section 9 that relate to floor control server authentication.

If the response is a FloorRequestStatus message, the client obtains information about the status of the FloorRequest the client requested information about in a FLOOR-REQUEST-INFORMATION attribute.

If the response is an Error message, the floor control server could not process the FloorRequestQuery message for some reason, which is described in the Error message.

12.3. Requesting Information about a User

A client can obtain information about a participant and the floor requests related to this participant in different ways, which include using BFCP and using out-of-band mechanisms. Clients using BFCP to obtain such information use the procedures described in this section.

Clients request information about a participant and the floor requests related to this participant by sending a UserQuery message to the floor control server.

This functionality may be useful for floor chairs or floor participants interested in the display name and the URI of a particular floor participant. In addition, a floor participant may find it useful to request information about itself. For example, a

floor participant, after experiencing connectivity problems (e.g., its TCP connection with the floor control server was down for a while and eventually was re-established), may need to request information about all the floor requests associated to itself that still exist.

12.3.1. Sending a UserQuery Message

The ABNF in Section 5.3.5 describes the attributes that a UserQuery message can contain. In addition, the ABNF specifies normatively which of these attributes are mandatory, and which ones are optional.

The client sets the Conference ID and the Transaction ID in the common header following the rules given in Section 8.1. The client sets the User ID in the common header to the client's identifier. This User ID will be used by the floor control server to authenticate and authorize the request.

If the floor participant the client is requesting information about is not the client issuing the UserQuery message (which is identified by the User ID in the common header of the message), the client **MUST** insert a BENEFICIARY-ID attribute.

12.3.2. Receiving a Response

A message from the floor control server is considered a response to the UserQuery message if the message from the floor control server has the same Conference ID, Transaction ID, and User ID as the UserQuery message, as described in Section 8.1. On receiving such a response, the client follows the rules in Section 9 that relate to floor control server authentication.

If the response is a UserStatus message, the client obtains information about the floor participant in a BENEFICIARY-INFORMATION grouped attribute and about the status of the floor requests associated with the floor participant in FLOOR-REQUEST-INFORMATION attributes.

If the response is an Error message, the floor control server could not process the UserQuery message for some reason, which is described in the Error message.

12.4. Obtaining the Capabilities of a Floor Control Server

A client that wishes to obtain the capabilities of a floor control server does so by sending a Hello message to the floor control server.

12.4.1. Sending a Hello Message

The ABNF in Section 5.3.11 describes the attributes that a Hello message can contain. In addition, the ABNF specifies normatively which of these attributes are mandatory, and which ones are optional.

The client sets the Conference ID and the Transaction ID in the common header following the rules given in Section 8.1. The client sets the User ID in the common header to the client's identifier. This User ID will be used by the floor control server to authenticate and authorize the request.

12.4.2. Receiving Responses

A message from the floor control server is considered a response to the Hello message by the client if the message from the floor control server has the same Conference ID, Transaction ID, and User ID as the Hello message, as described in Section 8.1. On receiving such a response, the client follows the rules in Section 9 that relate to floor control server authentication.

If the response is a HelloAck message, the floor control server could process the Hello message successfully. The SUPPORTED-PRIMITIVES and SUPPORTED-ATTRIBUTES attributes indicate which primitives and attributes, respectively, are supported by the server.

If the response is an Error message, the floor control server could not process the Hello message for some reason, which is described in the Error message.

13. Floor Control Server Operations

This section specifies how floor control servers can perform different operations, such as granting a floor, using the protocol elements described in earlier sections.

On reception of a message from a client, the floor control server **MUST** check whether the value of the Primitive is supported. If it does not, the floor control server **SHOULD** send an Error message, as described in Section 13.8, with Error code 3 (Unknown Primitive).

On reception of a message from a client, the floor control server **MUST** check whether the value of the Conference ID matched an existing conference. If it does not, the floor control server **SHOULD** send an Error message, as described in Section 13.8, with Error code 1 (Conference does not Exist).

On reception of a message from a client, the floor control server follows the rules in Section 9 that relate to the authentication of the message.

On reception of a message from a client, the floor control server **MUST** check whether it understands all the mandatory ('M' bit set) attributes in the message. If the floor control server does not understand all of them, the floor control server **SHOULD** send an Error message, as described in Section 13.8, with Error code 2 (Authentication Failed). The Error message **SHOULD** list the attributes that were not understood.

13.1. Reception of a FloorRequest Message

On reception of a FloorRequest message, the floor control server follows the rules in Section 9 that relate to client authentication and authorization. If while processing the FloorRequest message, the floor control server encounters an error, it **SHOULD** generate an Error response following the procedures described in Section 13.8.

BFCP allows floor participants to have several ongoing floor requests for the same floor (e.g., the same floor participant can occupy more than one position in a queue at the same time). A floor control server that only supports a certain number of ongoing floor requests per floor participant (e.g., one) can use Error Code 8 (You have Already Reached the Maximum Number of Ongoing Floor Requests for this Floor) to inform the floor participant.

13.1.1. Generating the First FloorRequestStatus Message

The successful processing of a FloorRequest message by a floor control server involves generating one or several FloorRequestStatus messages, the first of which **SHOULD** be generated as soon as possible. If the floor control server cannot accept, grant, or deny the floor request right away (e.g., a decision from a chair is needed), it **SHOULD** use a Request Status value of Pending in the OVERALL-REQUEST-STATUS attribute (within the FLOOR-REQUEST-INFORMATION grouped attribute) of the first FloorRequestStatus message it generates.

The policy that a floor control server follows to grant or deny floors is outside the scope of this document. A given floor control server may perform these decisions automatically while another may contact a human acting as a chair every time a decision needs to be made.

The floor control server **MUST** copy the Conference ID, the Transaction ID, and the User ID from the FloorRequest into the

FloorRequestStatus, as described in Section 8.2. Additionally, the floor control server **MUST** add a FLOOR-REQUEST-INFORMATION grouped attribute to the FloorRequestStatus. The attributes contained in this grouped attribute carry information about the floor request.

The floor control server **MUST** assign an identifier that is unique within the conference to this floor request, and **MUST** insert it in the Floor Request ID field of the FLOOR-REQUEST-INFORMATION attribute. This identifier will be used by the floor participant (or by a chair or chairs) to refer to this specific floor request in the future.

The floor control server **MUST** copy the Floor IDs in the FLOOR-ID attributes of the FloorRequest into the FLOOR-REQUEST-STATUS attributes in the FLOOR-REQUEST-INFORMATION grouped attribute. These Floor IDs identify the floors being requested (i.e., the floors associated with this particular floor request).

The floor control server **SHOULD** copy (if present) the contents of the BENEFICIARY-ID attribute from the FloorRequest into a BENEFICIARY-INFORMATION attribute inside the FLOOR-REQUEST-INFORMATION grouped attribute. Additionally, the floor control server **MAY** provide the display name and the URI of the beneficiary in this BENEFICIARY-INFORMATION attribute.

The floor control server **MAY** provide information about the requester of the floor in a REQUESTED-BY-INFORMATION attribute inside the FLOOR-REQUEST-INFORMATION grouped attribute.

The floor control server **MAY** copy (if present) the PARTICIPANT-PROVIDED-INFO attribute from the FloorRequest into the FLOOR-REQUEST-INFORMATION grouped attribute.

Note that this attribute carries the priority requested by the participant. The priority that the floor control server assigns to the floor request depends on the priority requested by the participant and the rights the participant has according to the policy of the conference. For example, a participant that is only allowed to use the Normal priority may request Highest priority for a floor request. In that case, the floor control server would ignore the priority requested by the participant.

The floor control server **MAY** copy (if present) the PARTICIPANT-PROVIDED-INFO attribute from the FloorRequest into the FLOOR-REQUEST-INFORMATION grouped attribute.

13.1.2. Generation of Subsequent FloorRequestStatus Messages

A floor request is considered to be ongoing as long as it is not in the Cancelled, Released, or Revoked states. If the OVERALL-REQUEST-STATUS attribute (inside the FLOOR-REQUEST-INFORMATION grouped attribute) of the first FloorRequestStatus message generated by the floor control server did not indicate any of these states, the floor control server will need to send subsequent FloorRequestStatus messages.

When the status of the floor request changes, the floor control server SHOULD send new FloorRequestStatus messages with the appropriate Request Status. The floor control server MUST add a FLOOR-REQUEST-INFORMATION attribute with a Floor Request ID equal to the one sent in the first FloorRequestStatus message to any new FloorRequestStatus related to the same floor request. (The Floor Request ID identifies the floor request to which the FloorRequestStatus applies.)

The floor control server MUST set the Transaction ID of subsequent FloorRequestStatus messages to 0.

The rate at which the floor control server sends FloorRequestStatus messages is a matter of local policy. A floor control server may choose to send a new FloorRequestStatus message every time the floor request moves in the floor request queue, while another may choose only to send a new FloorRequestStatus message when the floor request is Granted or Denied.

The floor control server may add a STATUS-INFO attribute to any of the FloorRequestStatus messages it generates to provide extra information about its decisions regarding the floor request (e.g., why it was denied).

Floor participants and floor chairs may request to be informed about the status of a floor following the procedures in Section 12.1. If the processing of a floor request changes the status of a floor (e.g., the floor request is granted and consequently the floor has a new holder), the floor control server needs to follow the procedures in Section 13.5 to inform the clients that have requested that information.

The common header and the rest of the attributes are the same as in the first FloorRequestStatus message.

The floor control server can discard the state information about a particular floor request when this reaches a status of Cancelled, Released, or Revoked.

13.2. Reception of a FloorRequestQuery Message

On reception of a FloorRequestQuery message, the floor control server follows the rules in Section 9 that relate to client authentication and authorization. If while processing the FloorRequestQuery message, the floor control server encounters an error, it **SHOULD** generate an Error response following the procedures described in Section 13.8.

The successful processing of a FloorRequestQuery message by a floor control server involves generating a FloorRequestStatus message, which **SHOULD** be generated as soon as possible.

The floor control server **MUST** copy the Conference ID, the Transaction ID, and the User ID from the FloorRequestQuery message into the FloorRequestStatus message, as described in Section 8.2. Additionally, the floor control server **MUST** include information about the floor request in the FLOOR-REQUEST-INFORMATION grouped attribute to the FloorRequestStatus.

The floor control server **MUST** copy the contents of the FLOOR-REQUEST-ID attribute from the FloorRequestQuery message into the Floor Request ID field of the FLOOR-REQUEST-INFORMATION attribute.

The floor control server **MUST** add FLOOR-REQUEST-STATUS attributes to the FLOOR-REQUEST-INFORMATION grouped attribute identifying the floors being requested (i.e., the floors associated with the floor request identified by the FLOOR-REQUEST-ID attribute).

The floor control server **SHOULD** add a BENEFICIARY-ID attribute to the FLOOR-REQUEST-INFORMATION grouped attribute identifying the beneficiary of the floor request. Additionally, the floor control server **MAY** provide the display name and the URI of the beneficiary in this BENEFICIARY-INFORMATION attribute.

The floor control server **MAY** provide information about the requester of the floor in a REQUESTED-BY-INFORMATION attribute inside the FLOOR-REQUEST-INFORMATION grouped attribute.

The floor control server **MAY** provide the reason why the floor participant requested the floor in a PARTICIPANT-PROVIDED-INFO.

The floor control server **MAY** also add to the FLOOR-REQUEST-INFORMATION grouped attribute a PRIORITY attribute with the Priority value requested for the floor request and a STATUS-INFO attribute with extra information about the floor request.

The floor control server **MUST** add an **OVERALL-REQUEST-STATUS** attribute to the **FLOOR-REQUEST-INFORMATION** grouped attribute with the current status of the floor request. The floor control server **MAY** provide information about the status of the floor request as it relates to each of the floors being requested in the **FLOOR-REQUEST-STATUS** attributes.

13.3. Reception of a UserQuery Message

On reception of a UserQuery message, the floor control server follows the rules in Section 9 that relate to client authentication and authorization. If while processing the UserQuery message, the floor control server encounters an error, it **SHOULD** generate an Error response following the procedures described in Section 13.8.

The successful processing of a UserQuery message by a floor control server involves generating a UserStatus message, which **SHOULD** be generated as soon as possible.

The floor control server **MUST** copy the Conference ID, the Transaction ID, and the User ID from the UserQuery message into the UserStatus message, as described in Section 8.2.

The sender of the UserQuery message is requesting information about all the floor requests associated with a given participant (i.e., the floor requests where the participant is either the beneficiary or the requester). This participant is identified by a **BENEFICIARY-ID** attribute or, in the absence of a **BENEFICIARY-ID** attribute, by a the User ID in the common header of the UserQuery message.

The floor control server **MUST** copy, if present, the contents of the **BENEFICIARY-ID** attribute from the UserQuery message into a **BENEFICIARY-INFORMATION** attribute in the UserStatus message. Additionally, the floor control server **MAY** provide the display name and the URI of the participant about which the UserStatus message provides information in this **BENEFICIARY-INFORMATION** attribute.

The floor control server **SHOULD** add to the UserStatus message a **FLOOR-REQUEST-INFORMATION** grouped attribute for each floor request related to the participant about which the message provides information (i.e., the floor requests where the participant is either the beneficiary or the requester). For each **FLOOR-REQUEST-INFORMATION** attribute, the floor control server follows the following steps.

The floor control server **MUST** identify the floor request the **FLOOR-REQUEST-INFORMATION** attribute applies to by filling the Floor Request ID field of the **FLOOR-REQUEST-INFORMATION** attribute.

The floor control server **MUST** add FLOOR-REQUEST-STATUS attributes to the FLOOR-REQUEST-INFORMATION grouped attribute identifying the floors being requested (i.e., the floors associated with the floor request identified by the FLOOR-REQUEST-ID attribute).

The floor control server **SHOULD** add a BENEFICIARY-ID attribute to the FLOOR-REQUEST-INFORMATION grouped attribute identifying the beneficiary of the floor request. Additionally, the floor control server **MAY** provide the display name and the URI of the beneficiary in this BENEFICIARY-INFORMATION attribute.

The floor control server **MAY** provide information about the requester of the floor in a REQUESTED-BY-INFORMATION attribute inside the FLOOR-REQUEST-INFORMATION grouped attribute.

The floor control server **MAY** provide the reason why the floor participant requested the floor in a PARTICIPANT-PROVIDED-INFO.

The floor control server **MAY** also add to the FLOOR-REQUEST-INFORMATION grouped attribute a PRIORITY attribute with the Priority value requested for the floor request.

The floor control server **MUST** include the current status of the floor request in an OVERALL-REQUEST-STATUS attribute to the FLOOR-REQUEST-INFORMATION grouped attribute. The floor control server **MAY** add a STATUS-INFO attribute with extra information about the floor request.

The floor control server **MAY** provide information about the status of the floor request as it relates to each of the floors being requested in the FLOOR-REQUEST-STATUS attributes.

13.4. Reception of a FloorRelease Message

On reception of a FloorRelease message, the floor control server follows the rules in Section 9 that relate to client authentication and authorization. If while processing the FloorRelease message, the floor control server encounters an error, it **SHOULD** generate an Error response following the procedures described in Section 13.8.

The successful processing of a FloorRelease message by a floor control server involves generating a FloorRequestStatus message, which **SHOULD** be generated as soon as possible.

The floor control server **MUST** copy the Conference ID, the Transaction ID, and the User ID from the FloorRelease message into the FloorRequestStatus message, as described in Section 8.2.

The floor control server **MUST** add a **FLOOR-REQUEST-INFORMATION** grouped attribute to the **FloorRequestStatus**. The attributes contained in this grouped attribute carry information about the floor request.

The **FloorRelease** message identifies the floor request it applies to using a **FLOOR-REQUEST-ID**. The floor control server **MUST** copy the contents of the **FLOOR-REQUEST-ID** attribute from the **FloorRelease** message into the **Floor Request ID** field of the **FLOOR-REQUEST-INFORMATION** attribute.

The floor control server **MUST** identify the floors being requested (i.e., the floors associated with the floor request identified by the **FLOOR-REQUEST-ID** attribute) in **FLOOR-REQUEST-STATUS** attributes to the **FLOOR-REQUEST-INFORMATION** grouped attribute.

The floor control server **MUST** add an **OVERALL-REQUEST-STATUS** attribute to the **FLOOR-REQUEST-INFORMATION** grouped attribute. The **Request Status** value **SHOULD** be **Released**, if the floor (or floors) had been previously granted, or **Cancelled**, if the floor (or floors) had not been previously granted. The floor control server **MAY** add a **STATUS-INFO** attribute with extra information about the floor request.

13.5. Reception of a FloorQuery Message

On reception of a **FloorQuery** message, the floor control server follows the rules in Section 9 that relate to client authentication. If while processing the **FloorRelease** message, the floor control server encounters an error, it **SHOULD** generate an **Error** response following the procedures described in Section 13.8.

A floor control server receiving a **FloorQuery** message from a client **SHOULD** keep this client informed about the status of the floors identified by **FLOOR-ID** attributes in the **FloorQuery** message. Floor Control Servers keep clients informed by using **FloorStatus** messages.

An individual **FloorStatus** message carries information about a single floor. So, when a **FloorQuery** message requests information about more than one floor, the floor control server needs to send separate **FloorStatus** messages for different floors.

The information **FloorQuery** messages carry may depend on the user requesting the information. For example, a chair may be able to receive information about pending requests, while a regular user may not be authorized to do so.

13.5.1. Generation of the First FloorStatus Message

The successful processing of a FloorQuery message by a floor control server involves generating one or several FloorStatus messages, the first of which **SHOULD** be generated as soon as possible.

The floor control server **MUST** copy the Conference ID, the Transaction ID, and the User ID from the FloorQuery message into the FloorStatus message, as described in Section 8.2.

If the FloorQuery message did not contain any FLOOR-ID attribute, the floor control server sends the FloorStatus message without adding any additional attribute and does not send any subsequent FloorStatus message to the floor participant.

If the FloorQuery message contained one or more FLOOR-ID attributes, the floor control server chooses one from among them and adds this FLOOR-ID attribute to the FloorStatus message. The floor control server **SHOULD** add a FLOOR-REQUEST-INFORMATION grouped attribute for each floor request associated to the floor. Each FLOOR-REQUEST-INFORMATION grouped attribute contains a number of attributes that provide information about the floor request. For each FLOOR-REQUEST-INFORMATION attribute, the floor control server follows the following steps.

The floor control server **MUST** identify the floor request the FLOOR-REQUEST-INFORMATION attribute applies to by filling the Floor Request ID field of the FLOOR-REQUEST-INFORMATION attribute.

The floor control server **MUST** add FLOOR-REQUEST-STATUS attributes to the FLOOR-REQUEST-INFORMATION grouped attribute identifying the floors being requested (i.e., the floors associated with the floor request identified by the FLOOR-REQUEST-ID attribute).

The floor control server **SHOULD** add a BENEFICIARY-ID attribute to the FLOOR-REQUEST-INFORMATION grouped attribute identifying the beneficiary of the floor request. Additionally, the floor control server **MAY** provide the display name and the URI of the beneficiary in this BENEFICIARY-INFORMATION attribute.

The floor control server **MAY** provide information about the requester of the floor in a REQUESTED-BY-INFORMATION attribute inside the FLOOR-REQUEST-INFORMATION grouped attribute.

The floor control server MAY provide the reason why the floor participant requested the floor in a PARTICIPANT-PROVIDED-INFO.

The floor control server MAY also add to the FLOOR-REQUEST-INFORMATION grouped attribute a PRIORITY attribute with the Priority value requested for the floor request.

The floor control server MUST add an OVERALL-REQUEST-STATUS attribute to the FLOOR-REQUEST-INFORMATION grouped attribute with the current status of the floor request. The floor control server MAY add a STATUS-INFO attribute with extra information about the floor request.

The floor control server MAY provide information about the status of the floor request as it relates to each of the floors being requested in the FLOOR-REQUEST-STATUS attributes.

13.5.2. Generation of Subsequent FloorStatus Messages

If the FloorQuery message carried more than one FLOOR-ID attribute, the floor control server SHOULD generate a FloorStatus message for each of them (except for the FLOOR-ID attribute chosen for the first FloorStatus message) as soon as possible. These FloorStatus messages are generated following the same rules as those for the first FloorStatus message (see Section 13.5.1), but their Transaction ID is 0.

After generating these messages, the floor control server sends FloorStatus messages, periodically keeping the client informed about all the floors for which the client requested information. The Transaction ID of these messages MUST be 0.

The rate at which the floor control server sends FloorStatus messages is a matter of local policy. A floor control server may choose to send a new FloorStatus message every time a new floor request arrives, while another may choose to only send a new FloorStatus message when a new floor request is Granted.

13.6. Reception of a ChairAction Message

On reception of a ChairAction message, the floor control server follows the rules in Section 9 that relate to client authentication and authorization. If while processing the ChairAction message, the floor control server encounters an error, it SHOULD generate an Error response following the procedures described in Section 13.8.

The successful processing of a ChairAction message by a floor control server involves generating a ChairActionAck message, which SHOULD be generated as soon as possible.

The floor control server **MUST** copy the Conference ID, the Transaction ID, and the User ID from the ChairAction message into the ChairActionAck message, as described in Section 8.2.

The floor control server needs to take into consideration the operation requested in the ChairAction message (e.g., granting a floor) but does not necessarily need to perform it as requested by the floor chair. The operation that the floor control server performs depends on the ChairAction message and on the internal state of the floor control server.

For example, a floor chair may send a ChairAction message granting a floor that was requested as part of an atomic floor request operation that involved several floors. Even if the chair responsible for one of the floors instructs the floor control server to grant the floor, the floor control server will not grant it until the chairs responsible for the other floors agree to grant them as well.

So, the floor control server is ultimately responsible for keeping a coherent floor state using instructions from floor chairs as input to this state.

If the new Status in the ChairAction message is Accepted and all the bits of the Queue Position field are zero, the floor chair is requesting that the floor control server assign a queue position (e.g., the last in the queue) to the floor request based on the local policy of the floor control server. (Of course, such a request only applies if the floor control server implements a queue.)

13.7. Reception of a Hello Message

On reception of a Hello message, the floor control server follows the rules in Section 9 that relate to client authentication. If while processing the Hello message, the floor control server encounters an error, it **SHOULD** generate an Error response following the procedures described in Section 13.8.

The successful processing of a Hello message by a floor control server involves generating a HelloAck message, which **SHOULD** be generated as soon as possible. The floor control server **MUST** copy the Conference ID, the Transaction ID, and the User ID from the Hello into the HelloAck, as described in Section 8.2.

The floor control server **MUST** add a SUPPORTED-PRIMITIVES attribute to the HelloAck message listing all the primitives (i.e., BFCP messages) supported by the floor control server.

The floor control server **MUST** add a **SUPPORTED-ATTRIBUTES** attribute to the HelloAck message listing all the attributes supported by the floor control server.

13.8. Error Message Generation

Error messages are always sent in response to a previous message from the client as part of a client-initiated transaction. The ABNF in Section 5.3.13 describes the attributes that an Error message can contain. In addition, the ABNF specifies normatively which of these attributes are mandatory and which ones are optional.

The floor control server **MUST** copy the Conference ID, the Transaction ID, and the User ID from the message from the client into the Error message, as described in Section 8.2.

The floor control server **MUST** add an **ERROR-CODE** attribute to the Error message. The **ERROR-CODE** attribute contains an Error Code from Table 5. Additionally, the floor control server may add an **ERROR-INFO** attribute with extra information about the error.

14. Security Considerations

BFCP uses TLS to provide mutual authentication between clients and servers. TLS also provides replay and integrity protection and confidentiality. It is **RECOMMENDED** that TLS with non-null encryption always be used. BFCP entities **MAY** use other security mechanisms as long as they provide similar security properties.

The remainder of this section analyzes some of the threats against BFCP and how they are addressed.

An attacker may attempt to impersonate a client (a floor participant or a floor chair) in order to generate forged floor requests or to grant or deny existing floor requests. Client impersonation is avoided by having servers only accept BFCP messages over authenticated TLS connections. The floor control server assumes that attackers cannot hijack the TLS connection and, therefore, that messages over the TLS connection come from the client that was initially authenticated.

An attacker may attempt to impersonate a floor control server. A successful attacker would be able to make clients think that they hold a particular floor so that they would try to access a resource (e.g., sending media) without having legitimate rights to access it. Floor control server impersonation is avoided by having servers only accept BFCP messages over authenticated TLS connections.

Attackers may attempt to modify messages exchanged by a client and a floor control server. The integrity protection provided by TLS connections prevents this attack.

An attacker may attempt to fetch a valid message sent by a client to a floor control server and replay it over a connection between the attacker and the floor control server. This attack is prevented by having floor control servers check that messages arriving over a given authenticated TLS connection use an authorized user ID (i.e., a user ID that the user that established the authenticated TLS connection is allowed to use).

Attackers may attempt to pick messages from the network to get access to confidential information between the floor control server and a client (e.g., why a floor request was denied). TLS confidentiality prevents this attack. Therefore, it is RECOMMENDED that TLS be used with a non-null encryption algorithm.

15. IANA Considerations

The IANA has created a new registry for BFCP parameters called "Binary Floor Control Protocol (BFCP) Parameters". This new registry has a number of subregistries, which are described in the following sections.

15.1. Attribute Subregistry

This section establishes the Attribute subregistry under the BFCP Parameters registry. As per the terminology in RFC 2434 [4], the registration policy for BFCP attributes shall be "Specification Required". For the purposes of this subregistry, the BFCP attributes for which IANA registration is requested MUST be defined by a standards-track RFC. Such an RFC MUST specify the attribute's type, name, format, and semantics.

For each BFCP attribute, the IANA registers its type, its name, and the reference to the RFC where the attribute is defined. The following table contains the initial values of this subregistry.

Type	Attribute	Reference
1	BENEFICIARY-ID	[RFC 4582]
2	FLOOR-ID	[RFC 4582]
3	FLOOR-REQUEST-ID	[RFC 4582]
4	PRIORITY	[RFC 4582]
5	REQUEST-STATUS	[RFC 4582]
6	ERROR-CODE	[RFC 4582]
7	ERROR-INFO	[RFC 4582]
8	PARTICIPANT-PROVIDED-INFO	[RFC 4582]
9	STATUS-INFO	[RFC 4582]
10	SUPPORTED-ATTRIBUTES	[RFC 4582]
11	SUPPORTED-PRIMITIVES	[RFC 4582]
12	USER-DISPLAY-NAME	[RFC 4582]
13	USER-URI	[RFC 4582]
14	BENEFICIARY-INFORMATION	[RFC 4582]
15	FLOOR-REQUEST-INFORMATION	[RFC 4582]
16	REQUESTED-BY-INFORMATION	[RFC 4582]
17	FLOOR-REQUEST-STATUS	[RFC 4582]
18	OVERALL-REQUEST-STATUS	[RFC 4582]

Table 6: Initial values of the BFCP Attribute subregistry

15.2. Primitive Subregistry

This section establishes the Primitive subregistry under the BFCP Parameters registry. As per the terminology in RFC 2434 [4], the registration policy for BFCP primitives shall be "Specification Required". For the purposes of this subregistry, the BFCP primitives for which IANA registration is requested MUST be defined by a standards-track RFC. Such an RFC MUST specify the primitive's value, name, format, and semantics.

For each BFCP primitive, the IANA registers its value, its name, and the reference to the RFC where the primitive is defined. The following table contains the initial values of this subregistry.

Value	Primitive	Reference
1	FloorRequest	[RFC 4582]
2	FloorRelease	[RFC 4582]
3	FloorRequestQuery	[RFC 4582]
4	FloorRequestStatus	[RFC 4582]
5	UserQuery	[RFC 4582]
6	UserStatus	[RFC 4582]
7	FloorQuery	[RFC 4582]
8	FloorStatus	[RFC 4582]
9	ChairAction	[RFC 4582]
10	ChairActionAck	[RFC 4582]
11	Hello	[RFC 4582]
12	HelloAck	[RFC 4582]
13	Error	[RFC 4582]

Table 7: Initial values of the BFCP primitive subregistry

15.3. Request Status Subregistry

This section establishes the Request Status subregistry under the BFCP Parameters registry. As per the terminology in RFC 2434 [4], the registration policy for BFCP request status shall be "Specification Required". For the purposes of this subregistry, the BFCP request status for which IANA registration is requested MUST be defined by a standards-track RFC. Such an RFC MUST specify the value and the semantics of the request status.

For each BFCP request status, the IANA registers its value, its meaning, and the reference to the RFC where the request status is defined. The following table contains the initial values of this subregistry.

Value	Status	Reference
1	Pending	[RFC 4582]
2	Accepted	[RFC 4582]
3	Granted	[RFC 4582]
4	Denied	[RFC 4582]
5	Cancelled	[RFC 4582]
6	Released	[RFC 4582]
7	Revoked	[RFC 4582]

Table 8: Initial values of the Request Status subregistry

15.4. Error Code Subregistry

This section establishes the Error Code subregistry under the BFCP Parameters registry. As per the terminology in RFC 2434 [4], the registration policy for BFCP error codes shall be "Specification Required". For the purposes of this subregistry, the BFCP error codes for which IANA registration is requested **MUST** be defined by a standards-track RFC. Such an RFC **MUST** specify the value and the semantics of the error code, and any Error Specific Details that apply to it.

For each BFCP primitive, the IANA registers its value, its meaning, and the reference to the RFC where the primitive is defined. The following table contains the initial values of this subregistry.

Value	Meaning	Reference
1	Conference does not Exist	[RFC 4582]
2	User does not Exist	[RFC 4582]
3	Unknown Primitive	[RFC 4582]
4	Unknown Mandatory Attribute	[RFC 4582]
5	Unauthorized Operation	[RFC 4582]
6	Invalid Floor ID	[RFC 4582]
7	Floor Request ID Does Not Exist	[RFC 4582]
8	You have Already Reached the Maximum Number of Ongoing Floor Requests for this Floor	[RFC 4582]
9	Use TLS	[RFC 4582]

Table 9: Initial Values of the Error Code subregistry

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