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SIP (Session Initiation Protocol) Usage of Offer/Answer Model
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Abstract

SIP utilizes offer/answer model to establish and update multimedia sessions. The descriptions on how to use offer/answer in SIP are dispersed in the multiple RFCs. This document summarizes all the current usage of offer/answer model in SIP communication.

Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC-2119 [1].

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1. Summary of SIP usage of Offer/Answer Model

Offer/answer model itself is independent from the higher layer application protocols which utilize it. SIP is one of the applications using offer/answer model. In RFC 3264 [4], which defines offer/answer model, which SIP message should convey an offer or an answer is not defined. This should be defined in the SIP core and extensions RFCs.

In theory, any SIP message can include session description in its body. But not all the session description in a SIP message is an offer or an answer. Only the session description that conforms to the rules described in the standard track RFCs can be interpreted as an

offer or an answer. The rules how to handle offer/answer model are currently defined in several RFCs. Unless defined in an RFC explicitly as an offer or an answer, except ones in non-reliable provisional response to INVITE request, a session description should not be included in SIP messages to avoid confusions.

Offer/answer model defines the update of sessions. In SIP, dialog is used to match the offer/answer exchange to the session which is to be updated with it. In other words, only the offer/answer exchange in the SIP dialog can update the session which is managed with it.

1.1. Offer/Answer Exchange Pairs in SIP Messages

Currently, the rules on offer/answer model are defined in RFC 3261, RFC 3262 and RFC 3311. In these RFCs, only the six patterns shown in Table 1 are defined for exchanging an offer and an answer with SIP messages.

Note that an offer/answer exchange initiated by an INVITE request must follow exactly one of the patterns 1, 2, 3, 4. Only one of them, one for each dialog if multiple dialogs are created, must occur in an INVITE 3-way handshake process. Pattern 2 and pattern 4 can occur only when INVITE request does not include an offer. 'The first reliable non-failure message' must have an offer if there is no offer in the INVITE request. This means that UA which receives the INVITE request without an offer must include an offer in the first reliable response with 100rel extension. If no reliable provisional response has been sent, UAS must include an offer when sending 2xx response.

In pattern 3, the first reliable provisional response may or may not have an answer. When a reliable provisional response contains a session description, and is the first to do so, then that session description is the answer to the offer in the INVITE request.

In pattern 5, PRACK request can contain an offer only if the non-reliable response which it acknowledges contains an answer in the previous offer/answer exchange.

Offer	Answer	RFC	Ini	Est	Early
1. INVITE Req.	2xx INVITE Resp.	RFC 3261	O	O	X
2. 2xx INVITE Resp.	ACK Req.	RFC 3261	O	O	X
3. INVITE Req.	1xx-rel INVITE Resp.	RFC 3262	O	O	X
4. 1xx-rel INVITE Resp.	PRACK Req.	RFC 3262	O	O	X
5. PRACK Req.	200 PRACK Resp.	RFC 3262	X	O	O
6. UPDATE Req.	2xx UPDATE Resp.	RFC 3311	X	O	O

Table 1. Summary of SIP Usage of Offer/Answer Model

In Table 1, '1xx-rel' corresponds to the reliable provisional response which applies 100rel option defined in RFC 3262 [3].

'Ini' column shows the ability to exchange the offer/answer to initiate the session. 'O' indicates that the pattern can be used in the initial offer/answer exchange, while 'X' indicates that it can not. Only the initial INVITE request can be used to exchange the offer/answer to establish multimedia session.

'Est' column shows the ability to update the established session.

'Early' column shows the ability to be used to modify the established session in an early dialog. There are two ways to exchange subsequent offer/answer in an early dialog.

1.2. Rejection against an Offer

How to reject an offer when it can not be accepted is not so clear and some method can not allow explicit rejection against an offer. Corresponding to the patterns in Table 1, how to reject an offer is shown in Table 2.

When a UA receives an INVITE request with an offer which it can not accept, it should respond with a 488 response preferably with Warning header field indicating the reason of the rejection unless other response code is more appropriate to reject it. (Pattern 1 and Pattern 3)

When a UA receives an UPDATE request with an offer which it can not accept, it should respond with a 488 response preferably with Warning header field indicating the reason of the rejection unless other response code is more appropriate to reject it. (Pattern 6)

When a UA receives a PRACK request with an offer which it can not accept, it may respond with a 200 response with a syntactically correct session description followed by an UPDATE request possibly to rearrange the session parameters if both ends support UPDATE method. A UA may simply give up continuing the dialog and send error response to INVITE request. (Pattern 5)

When a UA receives a response with an offer which it can not accept, a UA does not have the way to reject it explicitly. Therefore, an UA should respond to the offer with the correct session description and rearrange the session parameters by initiating a new offer/answer exchange. (Pattern 2 and Pattern 4)

Offer	Rejection
1. INVITE Req.	488 INVITE Response
2. 2xx INVITE Resp.	Answer in ACK Req. followed by new offer
3. INVITE Req.	488 INVITE Response (same as Pattern 1.)
4. 1xx-rel INVITE Resp.	Answer in PRACK Req. followed by new offer
5. PRACK Req. (*)	200 PRACK Resp. followed by new offer
6. UPDATE Req.	488 UPDATE Response

Table 2. Rejection against an Offer

(*) UA should only use PRACK to send an offer when it has strong reasons to assume the receiver will accept.

1.3. Session Description which is not Offer nor Answer

As it is stated, not all the session description in a SIP message is an offer or an answer. For example, SIP can use the session description to describe the capabilities apart from offer/answer exchange. Examples of these messages are 200 OK responses for OPTIONS and 488 responses for INVITE.

2. Detailed Discussion on Offer/Answer Model for SIP

2.1. Offer/Answer for INVITE method with 100rel extension

INVITE method is the basic procedure for offer/answer exchange in SIP. Without 100rel option, the rules are simple as described in RFC 3261 [2]. If an INVITE request includes a session description, pattern 1 is applied and if an INVITE request does not include a session description, pattern 2 is applied.

With 100rel, pattern 3 and pattern 4 are added and this makes the rules complicated. An INVITE request may cause multiple responses. Note that even if both UAs support 100rel extension, not all the provisional responses are sent reliably. Note also that a reliable provisional response is allowed not to include a session description even when UAS does not send the answer yet. Unreliable provisional response may include a session description in its body until an UAC receives the answer, but its session description is not an offer nor an answer. All the session descriptions in the unreliable responses to the INVITE request must be identical to the answer which is included in the reliable response. Session description in an unreliable response that precedes a reliable response can be considered a "preview" of the session description that will be coming, and hence may be treated like an offer or an answer until the actual one arrives.

2.1.1. INVITE Request with SDP

When UAC includes an SDP in the INVITE request as an offer, it expects the answer to be received with one of the reliable responses. Other than that, no offer/answer exchanges can occur in the INVITE 3-way handshake process.

```
    UAC                   UAS
     | F1  INVITE (SDP)    | <- The offer in offer/answer model
     |-------------------->|
     | F2     1xx (SDP)    | <- The SDP is not an official answer but
     |<--------------------|    UAC act as if it receives the answer.
     |                     | ^
     | F3 1xx-rel (no SDP) | |<- a 1xx-rel may be sent without answer
     |<--------------------| |   SDP.
     | F4   PRACK (no SDP) | |
     |-------------------->| | UAC must not send a new offer.
     | F5 2xx PRA (no SDP) | |
     |<--------------------| v
     |                     |
     | F6 1xx-rel (SDP)    | <- The answer in offer/ answer model
     |<--------------------| -
     | F7   PRACK          | | UAC can send a new offer in a PRACK
     |-------------------->| | request to acknowledge F6.
     | F8 2xx PRA          | | After F6 UAC and UAS can send a new offer
     |<--------------------| v in an UPDATE request.
     |                     |
     | F9 1xx-rel          | <- SDP should not be included in the
     |<--------------------|    subsequent 1xx-rel once offer/answer
     | F10  PRACK          |    has been completed.
     |-------------------->|
     | F11 2xx PRA         |
     |<--------------------|
     |                     |
     | F12 2xx INV         | <- SDP should not be included in the final
     |<--------------------|    response once offer/answer has been
     | F13    ACK          |    completed.
     |-------------------->|
```

Figure 1 Example of Offer/Answer with 100rel Extension (1)

For example, in Figure 1, only the SDP in F6 is the answer. The SDP in the non-reliable response (F3) must be the same as the answer in F6 but is not the answer. Receiving F3, UAC should act as if it receives the answer. However, offer/answer exchange is not completed yet and UAC must not send a new offer until it receives the same SDP in the first reliable response, which is the real answer. After

sending the SDP in F6, UAS must prepare to receive new offer from UAC with an UPDATE request or a PRACK request.

UAS should not include an SDP in the responses F9 and F12. However, UAC should prepare to receive an SDP in F9 and/or F12, and just ignore them for the case that the peer does not conform to the recommended implementation.

2.1.2. INVITE request without SDP

When UAC does not include an SDP in the INVITE request, it expects the offer to be received with the first reliable response. UAC will send the answer in the request to acknowledge the response, i.e. PRACK request for the reliable response. Other than that, no offer/answer exchanges can occur in the INVITE 3-way handshake process.

For example, in Figure 2, only the SDP in F3 is the answer. The SDP in the non-reliable response (F2) must be the same as the offer in F3 but is not the offer. Receiving F2, UAC can act as if it receives the offer. However, the official offer is not received until it receives the first reliable response. The first reliable response (F3) must include an SDP as an offer.

UAS should not include an SDP in the responses F6 and F9. However, UAC should prepare to receive an SDP in F6 and/or F9, and just ignore them for the case that the peer does not conform to the recommended implementation.

```
    UAC                   UAS
     | F1  INVITE (no SDP) |
     |-------------------->|
     | F2     1xx (SDP)    | <- SDP may be included but it is not the
     |<--------------------|    offer. UAC may act as if it receives
     |                     |    the offer.
     | F3 1xx-rel (SDP)    | <- The first 1xx-rel must contain an SDP
     |<--------------------|    as the offer.
     | F4   PRACK (SDP)    | <- An PRACK request to the first 1xx-rel
     |-------------------->|    must contain an SDP as the answer.
     | F5 2xx PRA (no SDP) | -
     |<--------------------| |
     |                     | |
     | F6 1xx-rel (no SDP) | <- The subsequent 1xx-rel should not
     |<--------------------| |  contain an SDP.
     | F7   PRACK          | |
     |-------------------->| | UAC can send a new offer in an UPDATE
     | F8 2xx PRA          | | request after F4.
     |<--------------------| v
     |                     |
     | F9 2xx INV (no SDP) | <- The final response should not
     |<--------------------|    contain an SDP.
     | F10    ACK          |
     |-------------------->|
```

Figure 2 Example of Offer/Answer with 100rel Extension (2)

2.2. Offer/Answer Exchange in Early Dialog

When both UAs support 100rel extension, they can update the session in the early dialog once the first offer/answer exchange has been completed.

From UA sending an INVITE request:

UA can send an UPDATE request with a new offer if both ends support UPDATE method. Whether UPDATE method is supported must be declared in Allow header in some prior messages in the dialog.

UA can send a PRACK request with a new offer when acknowledging the reliable provisional response with the answer to the offer in the INVITE request. Compared to UPDATE method, using PRACK can save messages to be exchanged between the UAs. However, as a PRACK request should not be rejected, UA is recommended to send a PRACK request only when it has strong reasons to assume the receiver will accept it. For example, the procedure used in precondition extension[6] is the case that a PRACK request should be used for updating the session status in the early dialog.

From UA receiving an INVITE request:

UA can send an UPDATE request with a new offer if both ends support UPDATE method. UAS can not send new offer in the reliable provisional response. So UPDATE method is the only method for UAS to update the early session.

2.3. Offer/Answer Exchange in Established Dialog

Re-INVITE method and UPDATE method can be used in the established dialog to update the session.

UPDATE method is simpler and can save at least one message compared with INVITE method. But both ends must support UPDATE method to use UPDATE.

INVITE method needs at least three messages to complete but no extensions are needed. Additionally, INVITE method allows the peer to take time to decide whether it accept session update or not by sending provisional responses. That is, re-INVITE allows the UAS to interact with the user at the peer, while UPDATE needs to be answered automatically by the UAS. It is noted that re-INVITE should be answered immediately unless such a user interaction is needed. Otherwise, some 3pcc flows would break.

3. Exceptional Case Handling

In RFC 3264 [4], the following restrictions are defined with regard to sending a new offer.

> "It MUST NOT generate a new offer if it has received an offer which it has not yet answered or rejected. It MUST NOT generate a new offer if it has generated a prior offer for which it has not yet received an answer or a rejection."

Assuming that the above rules are guaranteed, there seems to be two possible 'exceptional' cases to be considered in SIP offer/answer usage, which are 'message crossing' case and 'glare' case. One of the reasons why the usage of a SIP method to exchange offer/answer needs to be carefully restricted in the RFCs is to make sure that UA can detect and handle appropriately the 'exceptional' cases to avoid the confusion.

3.1. Message Crossing Case Handling

When message packets are crossed in the transport network, an offer may reach before the answer for the previous offer/answer exchange as

described in Figure 3. In such a case, UA A must detect the session description of the offer2 is not the answer to the offer1.

```
 A                  B
 |offer1            |
 |----------------->|
 |           answer1|
 |<------\  /-------|
 |        \/        |
 |        /\  offer2|
 |<------/  \-------|
```

Figure 3 Message Crossing Case

When offer2 is in an UPDATE request or a re-INVITE request, a session description can never be the answer. Then UA A must reject the message including offer2 with a 500 response with Retry-After header field.

When offer2 is in a PRACK request, that is, when PRACK request to acknowledge the reliable provisional response with an answer to the offer in the INVITE request contains a session description, UA A knows it is an offer. As a PRACK request should not be rejected, UA A is recommended to wait for the answer1 until sending a PRACK response with the answer to the offer2. Note that if UA A does not send a new offer until the reliable provisional response with an answer to the offer in the INVITE request is acknowledged with a PRACK request, this case never happens. Therefore, to make implementations simple, a UA acting as a UAS for INVITE transaction is recommended not to send a UPDATE request with an offer until the reliable response with an answer to the offer in the INVITE request is acknowledged with PRACK request.

When offer2 is in a reliable provisional response or a successful final response, UA A knows it is not the answer to the offer1. For a reliable response to an initial INVITE request, this case never happens. For a reliable response to a re-INVITE request, UA A can detect the offer2 is not the answer1. In this case, UA A can not reject offer2 in a reliable response, it is recommended to wait for the answer1 until sending a PRACK request with the answer to the offer2. Note that if UA A does not send an INVITE request without session description if it has sent the offer which has not yet received the answer to it, this case never happens.

3.2. Glare Case Handling

When both ends in a dialog send an offer at nearly the same time, UA may receive a new offer before it receives the answer to the offer

itsends as described in Figure 4. This case is called 'glare' case in general.

```
 A                  B
 |offer1      offer2|
 |-------\  /-------|
 |        \/        |
 |        /\        |
 |<------/  \------>|
```

Figure 4 Glare Case

When offer2 is in an UPDATE request or (re-)INVITE request, it must be rejected with a 491 response.

When offer2 is in a PRACK request, it may be accepted with 200 or may be rejected with a 491 response. A 491 response may be adequate for offer/answer model but it may delay the completion of the reliable response transfer mechanism or, in worst case, may result in the failure to complete SIP transaction because there is no clear retry rule when a PRACK request is rejected with a 491 response. To avoid this glare condition, UA is recommended not to send an offer, which currently must be in an UPDATE request, if it has generated the reliable provisional response with the answer to the offer in the INVITE request which is not acknowledged with a PRACK request.

To avoid glare condition for offer2 in the response, UA A is recommended not to send a new offer if it has generated (re)INVITE request without session description which it has not received the reliable response with the offer.

4. Add New Offer/Answer Usage in SIP

It is not recommended to add new SIP methods for the offer/answer exchange beyond the ways described in this document. However, it may be requested to have new offer/answer exchange methods as SIP extensions evolve. In this clause, what should be taken into considerations is noted in this section.

4.1. Explicit Usage

New method should define the usage explicitly without any ambiguity.

4.2. Rejection against an Offer

New method should define how to reject an offer where possible.

4.3. Backward Compatibility

New method must keep backward compatibility.

4.4. Exceptional Case Handling

New method should take care of how to handle exceptional cases, message crossing case and glare case.

5. Security Considerations

There are not any security issues beyond the referenced RFCs.

6. References

6.1. Normative References

[1] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[2] Rosenberg, J., Schulzrinne, H., Camarillo, G., Johnston, A., Peterson, J., Sparks, R., Handley, M. and E. Schooler, "SIP: Session Initiation Protocol", RFC 3261, June 2002.

[3] Rosenberg, J. and H. Schulzrinne, "Reliability of Provisional Responses in the Session Initiation Protocol (SIP)", RFC 3262, June 2002.

[4] Rosenberg, J. and H. Schulzrinne, "An Offer/Answer Model with SDP", RFC 3264, June 2002.

[5] Rosenberg, J., "The Session Initiation Protocol (SIP) UPDATE Method", RFC 3311, September 2002.

[6] Camarillo, G., Marshall, W., and J. Rosenberg, "Integration of Resource Management and Session Initiation Protocol (SIP)", RFC 3312, October 2002.

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