IMAP Extension for Conditional STORE operation

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Abstract

Often, multiple IMAP (RFC 3501) clients need to coordinate changes to
a common IMAP mailbox. Examples include different clients working on behalf
of the same user, and multiple users accessing shared mailboxes. These
clients
need a mechanism to synchronize state changes for messages within the
mailbox. They must be able to guarantee that only one client can change
message state (e.g., message flags or annotations) at any time. An
example of such an application is use of an IMAP mailbox as a message
queue with multiple dequeueing clients.

The Conditional Store facility provides a protected update mechanism for
message state information that can detect and resolve conflicts between
multiple writing mail clients.

This document defines an extension to IMAP (RFC 3501).

Table of Contents

[1]. 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 [KEYWORDS].

  In examples, lines beginning with "S:" are sent by the IMAP server, and
  lines beginning with "C:" are sent by the client. Line breaks may appear
  in example commands solely for editorial clarity; when present in
  the actual message they are represented by "CRLF".

  Formal syntax is defined using ABNF [ABNF] as modified by [IMAP4].

  The term "metadata" or "metadata item" is used throughout this document.
  It refers to any system or user defined keyword or an annotation
  [ANNOTATE].

  Some IMAP mailboxes are private, accessible only to the owning user.
  Other mailboxes are not, either because the owner has set an ACL
  [ACL] which permits access by other users, or because it is a

shared mailbox. Let's call a metadata item "shared" for the mailbox
if any changes to the metadata items are persistent and visible to all
other users accessing the mailbox. Otherwise the metadata item is called
"private". Note, that private metadata items are still visible to all
sessions accessing the mailbox as the same user. Also note, that different
mailboxes may have different metadata items as shared.

See the next section for the definition of a "CONDSTORE-aware client"
and a "CONDSTORE enabling command".

2. Introduction and Overview

The Conditional STORE extension is present in any IMAP4 implementation
which returns "CONDSTORE" as one of the supported capabilities in the
CAPABILITY command response.

Every IMAP message has an associated positive unsigned 64-bit value called
a
modification sequence (mod-sequence). This is an opaque value updated by
the server whenever a metadata item is modified. The value is intended to
be used only for comparisons within a server. However, the server MUST
guarantee that each STORE command performed on the same mailbox, including
simultaneous stores to different metadata items from different connections,
will get a different mod-sequence value. Also, for any two successful
STORE operations performed in the same session on the same mailbox,
the mod-sequence of the second completed operation MUST be greater than
the mod-sequence of the first completed. Note that the latter rule
disallows
the use of the system clock as a mod-sequence, because if system time
changes
(e.g., a NTP [NTP] client adjusting the time), the next generated value
might
be less than the previous one.

Mod-sequences allow a client that supports the CONDSTORE extension to
determine if a message metadata has changed since some known
moment. Whenever the state of a flag changes (i.e., the flag is added and
before it wasn't set, or the flag is removed and before it was set) the
value of the modification sequence for the message MUST be updated.
Adding the flag when it is already present or removing when it is not
present SHOULD NOT change the mod-sequence.

When a message is appended to a mailbox (via the IMAP APPEND command,
COPY to the mailbox or using an external mechanism) the server
generates a new modification sequence that is higher than the highest
modification sequence of all messages in the mailbox and assigns it to
the appended message.

When an annotation [ANNOTATE] is added, modified or removed the
corresponding

message mod-sequence MUST be updated.

The server MAY store separate (per message) modification sequence values
for
different metadata items. If the server does so, per message mod-sequence
is
the highest mod-sequence of all metadata items for the specified message.

The server that supports this extension is not required to be able to store
mod-sequences for every available mailbox. Section 3.1.2 describes how
the server may act if a particular mailbox doesn't support the persistent
storage of mod-sequences.

This extension makes the following changes to the IMAP4 protocol:

    a) extends the syntax of the STORE command to allow STORE
       modifiers

    b) adds the MODIFIED response code which should be used with
       an OK response to the STORE command

    c) adds a new MODSEQ message data item for use with the FETCH command

    d) extends the syntax of the FETCH command to allow FETCH
       modifiers

    e) adds a new MODSEQ search criterion

    f) extends the syntax of untagged SEARCH responses to include mod-
sequence

    g) adds new OK untagged responses for the SELECT and EXAMINE commands

    h) defines an additional parameter to SELECT/EXAMINE commands

    i) adds the HIGHESTMODSEQ status data item to the STATUS command

A client supporting CONDSTORE extension indicates its willingness to
receive
mod-sequence updates in all untagged FETCH responses by issuing a SELECT or
EXAMINE command with the CONDSTORE parameter, or a FETCH, SEARCH, or SORT
(if it also supports SORT=MODSEQ extension, see below) command that
includes
the MODSEQ message data item, a FETCH command with the CHANGEDSINCE
modifier,
or a STORE command with the UNCHANGEDSINCE modifier.
The server will include mod-sequence data in all FETCH responses, whether
they
were caused by a regular STORE, STORE with UNCHANGEDSINCE modifier, or an
external
agent, until the connection is closed.

This document uses the term "CONSTORE-aware client" to refer to a client
that announces its willingness to receive mod-sequence updates as described
above. The term "CONDSTORE enabling command" will refer any of the commands
listed above. A first CONDSTORE enabling command executed in the session
MUST cause the server to return HIGHESTMODSEQ (section 3.1.1) unless the
server has sent NOMODSEQ (section 3.1.2) response code when the currently
selected mailbox was selected.

This document also defines a new SORT extension with a capability name
"SORT=MODSEQ". This extension is upwards compatible with the SORT extension
defined in [SORT]. Server implementations that support both the CONDSTORE
and
SORT extensions SHOULD also support the SORT=MODSEQ extension. The
SORT=MODSEQ extension makes the following additions to the SORT extension:

> a) extends syntax of untagged SORT responses to include mod-sequence
>   (see section 3.6)

> b) adds a new MODSEQ sort criterion (see sections 3.4 and 3.5)

The rest of this document describes the protocol changes more rigorously.

3. IMAP Protocol Changes

3.1. New OK untagged responses for SELECT and EXAMINE

This document adds two new response codes HIGHESTMODSEQ and NOMODSEQ.
One of those response codes MUST be returned in the OK untagged
response for a successful SELECT and EXAMINE commands.

When opening a mailbox the server must check if the mailbox supports
the persistent storage of mod-sequences. If the mailbox supports
the persistent storage of mod-sequences and mailbox open operation
succeeds,
the server MUST send the OK untagged response including HIGHESTMODSEQ
response code. If the persistent storage for the mailbox is not supported,
the server MUST send the OK untagged response including NOMODSEQ response
code instead.

3.1.1. HIGHESTMODSEQ response code

This document adds a new response code that is returned in the OK
untagged response for the SELECT and EXAMINE commands. A server
supporting the persistent storage of mod-sequences for the mailbox MUST
send the OK untagged response including HIGHESTMODSEQ response code with
every successful SELECT or EXAMINE command:

  OK [HIGHESTMODSEQ <mod-sequence-value>]

  Where <mod-sequence-value> is the highest mod-sequence value of all

messages in the mailbox. When the server changes UIDVALIDITY for a
mailbox, it doesn't have to keep the same HIGHESTMODSEQ for the
mailbox.

A disconnected client can use the value of HIGHESTMODSEQ to check if
it has to refetch flags and/or annotations from the server. If the
UIDVALIDITY value has changed for the selected mailbox, the client
MUST delete the cached value of HIGHESTMODSEQ. If UIDVALIDITY for
the mailbox is the same and if the HIGHESTMODSEQ value stored in
the client's cache is less than the value returned by the server,
then some metadata items on the server have changed since the last
synchronization, and the client needs to update its cache. The client
MAY use SEARCH MODSEQ as described in section 3.4 to find out exactly
which metadata items have changed. Alternatively the client MAY issue
FETCH with CHANGEDSINCE modifier (section 3.3.1) in order to fetch data
for all messages that have metadata items changed since some known
modification sequence.

```
Example:    C: A142 SELECT INBOX
            S: * 172 EXISTS
            S: * 1 RECENT
            S: * OK [UNSEEN 12] Message 12 is first unseen
            S: * OK [UIDVALIDITY 3857529045] UIDs valid
            S: * OK [UIDNEXT 4392] Predicted next UID
            S: * FLAGS (\Answered \Flagged \Deleted \Seen \Draft)
            S: * OK [PERMANENTFLAGS (\Deleted \Seen \*)] Limited
            S: * OK [HIGHESTMODSEQ 20010715194045007]
            S: A142 OK [READ-WRITE] SELECT completed
```

3.1.2 NOMODSEQ response code

A server that doesn't support the persistent storage of mod-sequences for
the mailbox MUST send the OK untagged response including NOMODSEQ response
code with every successful SELECT or EXAMINE command.

```
Example:    C: A142 SELECT INBOX
            S: * 172 EXISTS
            S: * 1 RECENT
            S: * OK [UNSEEN 12] Message 12 is first unseen
            S: * OK [UIDVALIDITY 3857529045] UIDs valid
            S: * OK [UIDNEXT 4392] Predicted next UID
            S: * FLAGS (\Answered \Flagged \Deleted \Seen \Draft)
            S: * OK [PERMANENTFLAGS (\Deleted \Seen \*)] Limited
            S: * OK [NOMODSEQ] Sorry, this mailbox format doesn't support
modsequences
            S: A142 OK [READ-WRITE] SELECT completed
```

3.2. STORE and UID STORE Commands

```
     Arguments:   message set
                  OPTIONAL store modifiers
                  message data item name
                  value for message data item


     Responses:   untagged responses: FETCH


     Result:      OK - store completed
                  NO - store error: can't store that data
                  BAD - command unknown or arguments invalid
```

This document extends the syntax of the STORE and UID STORE
commands (see section 6.4.6 of [IMAP4]) to include an optional STORE
modifier. The document defines the following modifier:

  UNCHANGEDSINCE <mod-sequence>
      For each message specified in the message set the server performs
      the following. If the mod-sequence of any metadata item of the
      message is equal or less than the specified UNCHANGEDSINCE value,
      then the requested operation (as described by the
      message data item) is performed. If the operation is successful
      the server MUST update the mod-sequence attribute of the message.
      An untagged FETCH response MUST be sent (even if the .SILENT suffix
      is specified or ANNOTATION message data item is used; the latter
      changes the behavior described in Section 9.4 of [ANNOTATE])
      and the response MUST include the MODSEQ message data
      item. This is required to update the client's cache with the
correct
      mod-sequence values. See section 3.3.2 for more details.

      However, if the mod-sequence of any metadata item of the
      message is greater than the specified UNCHANGEDSINCE value, than
      the requested operation MUST NOT be performed. In this case,
      the mod-sequence attribute of the message is not updated, and the
      message number (or unique identifier in the case of the UID STORE
      command) is added to the list of messages that failed the
UNCHANGESINCE test.

      When the server finished performing the operation on all the
messages
      in the message set, it checks for a non-empty list of messages that
      failed the UNCHANGESINCE test. If this list is non-empty, the
server MUST
      return in the tagged response a MODIFIED response code. The
MODIFIED
      response code includes the message set (for STORE) or set of UIDs
      (for UID STORE) of all messages that failed the UNCHANGESINCE test.

      Example :

```
    All messages pass the UNCHANGESINCE test.

  C: a103 UID STORE 6,4,8 (UNCHANGEDSINCE 200012121230045)
       +FLAGS.SILENT (\Deleted)
  S: * 1 FETCH (UID 4 MODSEQ (200012121231000))
  S: * 2 FETCH (UID 6 MODSEQ (200012101230852))
  S: * 4 FETCH (UID 8 MODSEQ (200012121130956))
  S: a103 OK Conditional Store completed

Example:

  C: a104 STORE * (UNCHANGEDSINCE 200012121230045) +FLAGS.SILENT
       (\Deleted $Processed)
  S: * 50 FETCH (MODSEQ (200012111230047))
  S: a104 OK Store (conditional) completed

Example:
  C: c101 STORE 1 (UNCHANGEDSINCE 200012121230045) ANNOTATION
       ("/message/comment" ("value.priv" "My new comment"))
  S: * OK [HIGHESTMODSEQ 200012111230047]
  S: * 50 FETCH (MODSEQ (200012111230048))
  S: c101 OK Store (conditional) completed

  HIGHESTMODSEQ response code was sent by the server
  presumably because this was the first CONDSTORE enabling
  command.

Example:

  In spite of the failure of the conditional STORE operation
  for message 7, the server continues to process the conditional
  STORE in order to find all messages which fail the test.

  C: a105 STORE 7,5,9 (UNCHANGEDSINCE 20000320162338)
       +FLAGS.SILENT (\Deleted)
  S: * 5 FETCH (MODSEQ (20000320162350))
  S: a105 OK [MODIFIED 7,9] Conditional STORE failed


Example:

  Same as above, but the server follows SHOULD recommendation
  in section 6.4.6 of [IMAP4].

  C: a105 STORE 7,5,9 (UNCHANGEDSINCE 20000320162338)
       +FLAGS.SILENT (\Deleted)
  S: * 7 FETCH (MODSEQ (20000320162342) FLAGS (\Seen \Deleted))
  S: * 5 FETCH (MODSEQ (20000320162350))
  S: * 9 FETCH (MODSEQ (20000320162349) FLAGS (\Answered))
  S: a105 OK [MODIFIED 7,9] Conditional STORE failed
```

Use of UNCHANGEDSINCE with a modification sequence of 0
always fails if the metadata item exists. A system flag
MUST always be considered existent, whether it was set or not.

Example:

```
C: a102 STORE 12 (UNCHANGEDSINCE 0)
     +FLAGS.SILENT ($MDNSent)
S: a102 OK [MODIFIED 12] Conditional STORE failed
```

  The client has tested the presence of the $MDNSent user defined
  keyword.

Note: A client trying to make an atomic change to the state of a
particular
metadata item (or a set of metadata items) should be prepared
to deal with the case when the server returns MODIFIED response
code
if the state of the metadata item being watched hasn't changed (but
the state of some other metadata item has). This is necessary,
because
some servers don't store separate mod-sequences for different
metadata
items. However, a server implementation SHOULD avoid generating
spurious MODIFIED responses for +FLAGS/-FLAGS STORE operations,
even when the server stores a single mod-sequence per message.
[Section](#)
[5](#) describes how this can be achieved.

Unless the server has included an unsolicited FETCH to update
client's
knowledge about message(s) that has failed UNCHANGEDSINCE test,
upon the
receipt of MODIFIED response code the client SHOULD try to
figure out if the required metadata items have indeed changed by
issuing
FETCH or NOOP command. It is RECOMMENDED that the server avoids the
need for the client to do that by sending an unsolicited FETCH
response
(see two following examples).

If the required metadata items haven't changed the client SHOULD
retry
the command with the new modsequence. The client SHOULD allow for a
configurable but reasonable number of retries (at least 2).

Example:
  In the example below the server returns MODIFIED response code
  without sending information describing why the STORE
UNCHANGEDSINCE
  operation has failed.

```
C: a106 STORE 100:150 (UNCHANGEDSINCE 200212030000000)
       +FLAGS.SILENT ($Processed)
S: * 100 FETCH (MODSEQ (200303181230852))
S: * 102 FETCH (MODSEQ (200303181230852))
 ...
S: * 150 FETCH (MODSEQ (200303181230852))
S: a106 OK [MODIFIED 101] Conditional STORE failed
```

the flag $Processed was set on the message 101 ...
```
C: a107 NOOP
S: * 101 FETCH (MODSEQ (200303011130956) FLAGS ($Processed))
S: a107 OK
```

Or the flag hasn't changed, but another has (note, that this
server behaviour is discouraged. Server implementors should also see

[section 5](#)) ...

```
C: b107 NOOP
S: * 101 FETCH (MODSEQ (200303011130956) FLAGS (\Deleted
\Answered))
S: b107 OK
```

... and the client retries the operation for the message 101
    with the updated UNCHANGEDSINCE value

```
C: b108 STORE 101 (UNCHANGEDSINCE 200303011130956)
       +FLAGS.SILENT ($Processed)
S: * 101 FETCH (MODSEQ (200303181230852))
S: b108 OK Conditional Store completed
```

Example:
    Same as above, but the server avoids the need for the client to
    poll for changes.

the flag $Processed was set on the message 101 by another
client ...

```
C: a106 STORE 100:150 (UNCHANGEDSINCE 200212030000000)
       +FLAGS.SILENT ($Processed)
S: * 100 FETCH (MODSEQ (200303181230852))
S: * 101 FETCH (MODSEQ (200303011130956) FLAGS ($Processed))
S: * 102 FETCH (MODSEQ (200303181230852))
 ...
S: * 150 FETCH (MODSEQ (200303181230852))
S: a106 OK [MODIFIED 101] Conditional STORE failed
```

Or the flag hasn't changed, but another has (note, that this
server behaviour is discouraged. Server implementors should also see

[section 5](#)) ...

```
          C: a106 STORE 100:150 (UNCHANGEDSINCE 200212030000000)
             +FLAGS.SILENT ($Processed)
          S: * 100 FETCH (MODSEQ (200303181230852))
          S: * 101 FETCH (MODSEQ (200303011130956) FLAGS (\Deleted
\Answered))
          S: * 102 FETCH (MODSEQ (200303181230852))
          ...
          S: * 150 FETCH (MODSEQ (200303181230852))
          S: a106 OK [MODIFIED 101] Conditional STORE failed

          ... and the client retries the operation for the message 101
             with the updated UNCHANGEDSINCE value

          C: b108 STORE 101 (UNCHANGEDSINCE 200303011130956)
             +FLAGS.SILENT ($Processed)
          S: * 101 FETCH (MODSEQ (200303181230852))
          S: b108 OK Conditional Store completed

          Or the flag hasn't changed, but another has (nice server
behaviour.
          Server implementors should also see section 5) ...

          C: a106 STORE 100:150 (UNCHANGEDSINCE 200212030000000)
             +FLAGS.SILENT ($Processed)
          S: * 100 FETCH (MODSEQ (200303181230852))
          S: * 101 FETCH (MODSEQ (200303011130956) FLAGS ($Processed
\Deleted \Answered))
          S: * 102 FETCH (MODSEQ (200303181230852))
          ...
          S: * 150 FETCH (MODSEQ (200303181230852))
          S: a106 OK Conditional STORE completed

       Example:

          The following example is based on the example from the
section 4.2.3 of
          [RFC-2180] and demonstrates that the MODIFIED response code may
be also
          returned in the tagged NO response.

          Client tries to conditionally STORE flags on a mixture of
expunged
          and non-expunged messages, one message fails the UNCHANGEDSINCE
test.

          C: B001 STORE 1:7 (UNCHANGEDSINCE 20000320172338) +FLAGS (\SEEN)
          S: * 1 FETCH (MODSEQ (20000320172342) FLAGS (\SEEN))
          S: * 3 FETCH (MODSEQ (20000320172342) FLAGS (\SEEN))
          S: B001 NO [MODIFIED 2] Some of the messages no longer exist.

          C: B002 NOOP
```

```
S: * 4 EXPUNGE
S: * 4 EXPUNGE
S: * 4 EXPUNGE
S: * 4 EXPUNGE
S: * 2 FETCH (MODSEQ (20000320172340) FLAGS (\Deleted \Answered))
S: B002 OK NOOP Completed.
```

By receiving FETCH responses for messages 1 and 3, and EXPUNGE
responses that indicate that messages 4:7 have been expunged,
the client retries the operation only for the message 2. The
updated UNCHANGEDSINCE value is used.

```
C: b003 STORE 2 (UNCHANGEDSINCE 20000320172340) +FLAGS (\Seen)
S: * 2 FETCH (MODSEQ (20000320180050))
S: b003 OK Conditional Store completed
```

Note: If a message is specified multiple times in the message
set, and the server doesn't internally eliminate duplicates from
the message set, it MUST NOT fail the conditional STORE
operation for the second (or subsequent) occurrence of the message
if the operation completed successfully for the first occurrence.
For example, if the client specifies:

```
a105 STORE 7,3:9 (UNCHANGEDSINCE 200012121230045)
 +FLAGS.SILENT (\Deleted)
```

the server must not fail the operation for message 7 as part of
processing "3:9" if it succeeded when message 7 was processed
the first time.

Once the client specified the UNCHANGEDSINCE modifier in a STORE
command,
the server MUST include the MODSEQ fetch response data items in all
subsequent unsolicited FETCH responses.

This document also changes the behaviour of the server when it has
performed
a STORE or UID STORE command and the UNCHANGEDSINCE modifier is not
specified.
If the operation is successful for a message, the server MUST update
the mod-sequence attribute of the message. The server is REQUIRED to
include the mod-sequence value whenever it decides to send the
unsolicited FETCH response to all CONDSTORE-aware clients that have
opened
the mailbox containing the message.

3.3 FETCH and UID FETCH Commands

3.3.1 FETCH modifiers

```
Arguments:  sequence set
            message data item names or macro

Responses:  untagged responses: FETCH

Result:     OK - fetch completed
            NO - fetch error: can't fetch that data
            BAD - command unknown or arguments invalid
```

This document extends the syntax of the FETCH and UID FETCH
commands (see section 6.4.5 of [IMAP4]) to include an optional FETCH
modifier. The document defines the following modifier:

   CHANGEDSINCE <mod-sequence>

      CHANGEDSINCE FETCH modifier allows to further subset the list of
      messages described by sequence set. The information described by
      message data items is only returned for messages that have
      mod-sequence bigger than <mod-sequence>.

      When CHANGEDSINCE FETCH modifier is specified, it implicitly adds
      MODSEQ FETCH message data item (section 3.3.2).

      Example:

        C: s100 UID FETCH 1:* (FLAGS) (CHANGEDSINCE 12345)
        S: * 1 FETCH (UID 4 MODSEQ (65402) FLAGS (\Seen))
        S: * 2 FETCH (UID 6 MODSEQ (75403) FLAGS (\Deleted))
        S: * 4 FETCH (UID 8 MODSEQ (29738) FLAGS ($NoJunk $AutoJunk
$MDNSent))
        S: s100 OK FETCH completed

3.3.2 MODSEQ message data item in FETCH Command

This extension adds a MODSEQ message data item to the FETCH command.
The MODSEQ message data item allows clients to retrieve mod-sequence
values for a range of messages in the currently selected mailbox.

Once the client specified the MODSEQ message data item in a FETCH request,
the server MUST include the MODSEQ fetch response data items in all
subsequent unsolicited FETCH responses.

```
Syntax:  MODSEQ
```

The MODSEQ message data item causes the server to return MODSEQ fetch
response data items.

```
Syntax:  MODSEQ ( <permsg-modsequence> )
```

MODSEQ response data items contain per-message mod-sequences.

The MODSEQ response data item is returned if the client issued FETCH with
MODSEQ message data item. It also allows the server to notify the client
about mod-sequence changes caused by conditional STOREs (section 3.2) and/or
changes caused by external sources.

Example:

```
C: a FETCH 1:3 (MODSEQ)
S: * 1 FETCH (MODSEQ (20000624140003))
S: * 2 FETCH (MODSEQ (20000624140007))
S: * 3 FETCH (MODSEQ (20000624140005))
S: a OK Fetch complete
```

 In this example the client requests per message mod-sequences for a
 set of messages.

When a flag for a message is modified in a different session, the server
sends an unsolicited FETCH response containing the mod-sequence for the
message.

Example:

 (Session 1, authenticated as a user "alex"). The user adds a shared
 flag \Deleted:

```
C: A142 SELECT INBOX
...
S: * FLAGS (\Answered \Flagged \Deleted \Seen \Draft)
S: * OK [PERMANENTFLAGS (\Answered \Deleted \Seen \*)] Limited
...

C: A160 STORE 7 +FLAGS.SILENT (\Deleted)
S: * 7 FETCH (MODSEQ (200012121231000))
S: A160 OK Store completed
```

(Session 2, also authenticated as the user "alex"). Any changes to flags
 are always reported to all sessions authenticated as the same user as in
 the session 1.

```
C: C180 NOOP
S: * 7 FETCH (FLAGS (\Deleted \Answered) MODSEQ (200012121231000))
S: C180 OK Noop completed
```

(Session 3, authenticated as a user "andrew"). As \Deleted is a shared

flag, changes in the session 1 are also reported in the session 3:

             C: D210 NOOP
             S: * 7 FETCH (FLAGS (\Deleted \Answered) MODSEQ (200012121231000))
             S: D210 OK Noop completed

        The user modifies a private flag \Seen in the session 1 ...

             C: A240 STORE 7 +FLAGS.SILENT (\Seen)
             S: * 7 FETCH (MODSEQ (200012121231777))
             S: A240 OK Store completed

        ... which is only reported in the session 2 ...

             C: C270 NOOP
             S: * 7 FETCH (FLAGS (\Deleted \Answered \Seen) MODSEQ
(200012121231777))
             S: C270 OK Noop completed

        ... but not in the session 3.

             C: D300 NOOP
             S: D300 OK Noop completed

        And finally the user removes flags \Answered (shared) and \Seen
(private)
          in the session 1.

             C: A330 STORE 7 -FLAGS.SILENT (\Answered \Seen)
             S: * 7 FETCH (MODSEQ (200012121245160))
             S: A330 OK Store completed

        Both changes are reported in the session 2 ...

             C: C360 NOOP
             S: * 7 FETCH (FLAGS (\Deleted) MODSEQ (200012121245160))
             S: C360 OK Noop completed

        ... and only changes to shared flags are reported in session 3.

             C: D390 NOOP
             S: * 7 FETCH (FLAGS (\Deleted) MODSEQ (200012121245160))
             S: D390 OK Noop completed

3.4. **MODSEQ search criterion in SEARCH**

     The MODSEQ criterion for the SEARCH command allows a client to search
     for the metadata items that were modified since a specified moment.

     Syntax: MODSEQ [<entry-name> <entry-type-req>] <mod-sequence-valzer>

Messages that have modification values which are equal to or
greater than <mod-sequence-valzer>. This allows a client,
for example, to find out which messages contain metadata items
that have changed since the last time it updated its disconnected
cache. The client may also specify <entry-name> (name of metadata
item) and <entry-type-req> (type of metadata item) before
<mod-sequence-valzer>. <entry-type-req> can be one of "shared",
"priv" (private) or "all". The latter means that the server should
use
the biggest value among "priv" and "shared" mod-sequences for the
metadata item. If the server doesn't store internally separate
mod-sequences for different metadata items, it MUST ignore
<entry-name> and <entry-type-req>. Otherwise the server should
use them to narrow down the search.

For a flag <flagname> the corresponding <entry-name> has a form
"/flags/<flagname>" as defined in [ANNOTATE]. Note, that
the leading "\" character that denotes a system flag has to be
escaped as per Section 4.3 of [IMAP4], as the <entry-name> uses
syntax for quoted strings.

If client specifies a MODSEQ criterion in a SEARCH command and
the server returns a non-empty SEARCH result, the server MUST also
append (to the end of the untagged SEARCH response) the highest
mod-sequence for all messages being returned. See also section 3.6.

Example:
    C: a SEARCH MODSEQ "/flags/\\draft" all 20010320162338
             ANNOTATION "/comment" "value" "IMAP4"
    S: * SEARCH 2 5 6 7 11 12 18 19 20 23 (MODSEQ 20010917162500)
    S: a OK Search complete

    In the above example, the message numbers of any messages
    containing the string "IMAP4" in the "value" attribute of the
    "/comment" entry and having a mod-sequence equal to or
    greater than 20010320162338 for the "\Draft" flag are returned in
    the search results.

Example:
    C: a SEARCH OR NOT MODSEQ 20010320162338 LARGER 50000
    S: * SEARCH
    S: a OK Search complete, nothing found

3.5. MODSEQ Sort Criterion

If a server implementing CONDSTORE also implements the SORT
extension as defined by [SORT], it SHOULD implement the
SORT=MODSEQ extension that allows for sorting on per-message
mod-sequence. SORT=MODSEQ extension adds MODSEQ sort criterion
that allows to sort the matching messages based on their mod-sequence.

If client specifies a MODSEQ search (as per [section 3.4](#)) or sort criterion in the SORT command and the server returns a non-empty SORT result, the server MUST also append (to the end of the untagged SORT response) the highest mod-sequence for all messages being returned. See also [section 3.6](#).

Example (MODSEQ search criterion):

```
C: A282 SORT (SUBJECT MODSEQ) UTF-8 SINCE 1-Feb-2001
S: * SORT 2 81 83 84 82 882 (MODSEQ 117)
S: A282 OK SORT completed
```

Example (MODSEQ sort criterion):

```
C: A283 SORT (SUBJECT REVERSE DATE) UTF-8 MODSEQ 21
S: * SORT 6 3 4 5 2 (MODSEQ 125)
S: A283 OK SORT completed
```

Example (MODSEQ search criterion and MODSEQ SORT criterion,
        but no messages matching the search criteria):

```
C: A284 SORT (MODSEQ) KOI8-R OR NOT MODSEQ 20010320162338
        SUBJECT "Privet"
S: * SORT
S: A284 OK Sort complete, nothing found
```

[3.6](#). Modified SEARCH and SORT untagged responses

Data: zero or more numbers
             mod-sequence value (omitted if no match)

This document extends syntax of the untagged SEARCH and SORT responses to include mod-sequence for all messages being returned.

If a client specifies a MODSEQ criterion in a SEARCH (or UID SEARCH) command and the server returns a non-empty SEARCH result, the server MUST also append (to the end of the untagged SEARCH response) the highest mod-sequence for all messages being returned. See [section 3.4](#) for examples.

If client specifies a MODSEQ search or sort criterion in a SORT (or UID SORT) command and the server returns a non-empty SORT result, the server MUST also append (to the end of the untagged SORT response) the highest mod-sequence for all messages being returned. See [section 3.5](#) for examples.

[3.7](#). HIGHESTMODSEQ status data items

This document defines a new status data item:

HIGHESTMODSEQ
            The highest mod-sequence value all messages
            in the mailbox. This is the same value that is returned by the server
            in the HIGHESTMODSEQ response code in OK untagged response
            (see section 3.1.1).

    Example: C: A042 STATUS blurdybloop (UIDNEXT MESSAGES HIGHESTMODSEQ)
                S: * STATUS blurdybloop (MESSAGES 231 UIDNEXT 44292
                     HIGHESTMODSEQ 200201011231777)
                S: A042 OK STATUS completed

3.8. CONDSTORE parameter to SELECT and EXAMINE

    The CONDSTORE extension defines a single optional select parameter
    "CONDSTORE", which tells the server that it MUST include the MODSEQ
    fetch response data items in all subsequent unsolicited FETCH responses.

    The CONDSTORE parameter to SELECT/EXAMINE helps to avoid a race condition
    that might arise when a metadata item(s) is(are) modified in another
session
    after the server has sent the HIGHESTMODSEQ response code and before the
    client was able to issue a CONDSTORE enabling command.

    Example: C: A142 SELECT INBOX (CONDSTORE)
                S: * 172 EXISTS
                S: * 1 RECENT
                S: * OK [UNSEEN 12] Message 12 is first unseen
                S: * OK [UIDVALIDITY 3857529045] UIDs valid
                S: * OK [UIDNEXT 4392] Predicted next UID
                S: * FLAGS (\Answered \Flagged \Deleted \Seen \Draft)
                S: * OK [PERMANENTFLAGS (\Deleted \Seen *)] Limited
                S: * OK [HIGHESTMODSEQ 20010715194045007]
                S: A142 OK [READ-WRITE] SELECT completed, CONDSTORE is now
enabled

4. Formal Syntax

    The following syntax specification uses the Augmented Backus-Naur
    Form (ABNF) notation as specified in [ABNF].

    Non-terminals referenced but not defined below are as defined by
    [IMAP4] or [ANNOTATE].

    Except as noted otherwise, all alphabetic characters are case-
    insensitive. The use of upper or lower case characters to define token
    strings is for editorial clarity only. Implementations MUST accept
    these strings in a case-insensitive fashion.

    capability   =/ "CONDSTORE" / "SORT=MODSEQ"

```
status                = "STATUS" SP mailbox SP
                         "(" status-att-req *(SP status-att-req) ")"
                         ;; redefine STATUS command syntax defined in [IMAP4]

status-att-req        = status-att / "HIGHESTMODSEQ"

status-rsp-info       = status-att SP number /
                         "HIGHESTMODSEQ" SP mod-sequence-value

store                 = "STORE" SP sequence-set store-modifiers SP store-att-
flags

store-modifiers       = [ SP "(" store-modifier *(SP store-modifier) ")" ]

store-modifier        = "UNCHANGEDSINCE" SP mod-sequence-valzer
                         ;; Only a single "UNCHANGEDSINCE" may be specified
                         ;; in a STORE operation

fetch                 = "FETCH" SP sequence-set SP ("ALL" / "FULL" /
                         "FAST" / fetch-att /
                         "(" fetch-att *(SP fetch-att) ")") [SP fetch-
modifiers]

                         ;; modifies the original IMAP4 fetch command to
                         ;; accept optional modifiers

fetch-modifiers       = "(" fetch-modifier *(SP fetch-modifier) ")"

fetch-modifier        = fetch-modifier-name / fetch-modifier-name SP
astring /
                         fetch-modifier-name SP "(" fetch-modif-params ")"
                         ;; modifiers to FETCH may contain a modifier name
                         ;; followed by zero or more atoms or strings -
multiple
                         ;; items are always parenthesised, nesting is
allowed

fetch-modif-params    = astring *(SP astring) /
                         "(" fetch-modif-params *(SP fetch-modif-params) ")"

fetch-modifier-name   = atom

chgsince-fetch-mod    = "CHANGEDSINCE" SP mod-sequence-value
                         ;; CHANGEDSINCE FETCH modifier conforms to
                         ;; the fetch-modifier syntax

fetch-att             =/ fetch-mod-sequence
                         ;; modifies original IMAP4 fetch-att

fetch-mod-sequence    = "MODSEQ"

fetch-mod-resp        = "MODSEQ" SP "(" permsg-modsequence ")"
```

```
      search-key         =/ search-modsequence
                            ;; modifies original IMAP4 search-key
                            ;;
                            ;; This change applies to all command referencing
   this
                            ;; non-terminal, in particular SEARCH and SORT.

      search-modsequence = "MODSEQ" [search-modseq-ext] SP mod-sequence-valzer

      search-modseq-ext  = SP entry-name SP entry-type-req

      resp-text-code     =/ "HIGHESTMODSEQ" SP mod-sequence-value /
                            "NOMODSEQ" /
                            "MODIFIED" SP set

      entry-name         = entry-flag-name / entry-annotate-name
                            ;; The server MUST understand entry-flag-name.
                            ;; If the server also supports [ANNOTATE], it MUST
                            ;; also support entry-annotate-name.

      entry-flag-name    = DQUOTE "/flags/" attr-flag DQUOTE
                            ;; each system or user defined flag <flag>
                            ;; is mapped to "/flags/<flag>".
                            ;;
                            ;; <entry-flag-name> follows the escape rules used
                            ;; by "quoted" string as described in Section
                            ;; 4.3 of [IMAP4], e.g. for the flag \Seen
                            ;; the corresponding <entry-name> is
                            ;; "/flags/\\seen", and for the flag
                            ;; $MDNSent, the corresponding <entry-name>
                            ;; is "/flags/$mdnsent".

      entry-annotate-name = entry
                            ;; <entry> is defined in [ANNOTATE]

      entry-type-resp    = "priv" / "shared"
                            ;; metadata item type

      entry-type-req     = entry-type-resp / "all"
                            ;; perform SEARCH operation on private
                            ;; metadata item, shared metadata item or both

      permsg-modsequence = mod-sequence-value
                            ;; per message mod-sequence

      mod-sequence-value = 1*DIGIT
                            ;; Positive unsigned 64-bit integer (mod-sequence)
                            ;; (1 <= n < 18,446,744,073,709,551,615)

      mod-sequence-valzer = "0" / mod-sequence-value
```

```
search-sort-mod-seq = "(" "MODSEQ" SP mod-sequence-value ")"

sort-key            =/ "MODSEQ"

condstore-param     = "CONDSTORE"
                        ;; defines the select parameter used with
                        ;; CONDSTORE extension

mailbox-data        =/ "STATUS" SP mailbox SP "("
                        [status-rsp-info *(SP status-rsp-info)] ")" /
                        "SEARCH" [1*(SP nz-number) SP search-sort-mod-seq] /
                        "SORT" [1*(SP nz-number) SP search-sort-mod-seq]

attr-flag           = "\\Answered" / "\\Flagged" / "\\Deleted" /
                        "\\Seen" / "\\Draft" / attr-flag-keyword /
                        attr-flag-extension
                        ;; Does not include "\\Recent"

attr-flag-extension = "\\" atom
                        ;; Future expansion.  Client implementations
                        ;; MUST accept flag-extension flags.  Server
                        ;; implementations MUST NOT generate
                        ;; flag-extension flags except as defined by
                        ;; future standard or standards-track
                        ;; revisions of [IMAP4].

attr-flag-keyword   = atom
```

5. Server implementation considerations

This section describes how a server implementation that
doesn't store separate per-metadata modsequences for different metadata
items can avoid sending MODIFIED response to any of the following
conditional STORE operations:
   +FLAGS
   -FLAGS
   +FLAGS.SILENT
   -FLAGS.SILENT

Note, that the optimization described in this section can't be performed
in case of a conditional STORE FLAGS operation.

Let's use the following example. The client has issued

   C: a106 STORE 100:150 (UNCHANGEDSINCE 20021203000000)
      +FLAGS.SILENT ($Processed)

When the server receives the command and parses it successfully it
iterates through the message set and tries to execute the conditional
STORE command for each message.

Each server internally works as a client, i.e. it has to cache the
current state of all IMAP flags as it is known to the client.
In order to report flag changes to the client the server compares the
cached values with the values in its database for IMAP flags.

Imagine that another client has changed the state of a flag \Deleted on
message 101 and the change updated the modsequence for the message.
The server knows that the modsequence for the mailbox has changed, however
it also knows that

  a) The client is not interested in \Deleted flag, as it hasn't included
     it in +FLAGS.SILENT operation.
  b) The state of the flag $Processed hasn't changed (server can determine
     this by comparing cached flag state with the state of the flag in the
     database),
so the server doesn't have to report MODIFIED to the client. Instead the
server may set $Processed flag, update the modsequence for the message 101
once again and send an untagged FETCH response with new modsequence and
flags:

    S: * 101 FETCH (MODSEQ (200303011130956) FLAGS ($Processed \Deleted
\Answered))

6. Security Considerations

It is believed that the Conditional STORE extension doesn't raise
any new security concerns that are not already discussed in [IMAP4].
However, the availability of this extension may make it possible
for IMAP4 to be used in critical applications it could not be used
for previously, making correct IMAP server implementation and
operation even more important.

7. References

7.1. Normative References

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7.2. Informative References

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8. IANA Considerations

IMAP4 capabilities are registered by publishing a standards track or
IESG approved experimental RFC. The registry is currently located
at:

    http://www.iana.org/assignments/imap4-capabilities

This document defines the CONDSTORE and SORT=MODSEQ IMAP capabilities.
IANA should add them to the registry accordingly.

9. Acknowledgments

Some text was borrowed from "IMAP ANNOTATE Extension" by Randall Gellens
and Cyrus Daboo, and "ACAP -- Application Configuration Access Protocol"
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Acknowledgement

Appendix A. Open Issues and Change History

Note that this appendix will be removed before publication.

0.1. Change History

Changes from draft-ietf-imapext-condstore-04
1. Fixed typo in an example, added more examples.
2. Clarified client behavior regarding retrying the request
    when the server returns MODIFIED (IESG comment)
3. Added new section describing how a CONDSTORE server implementation
    should avoid sending MODIFIED when the client has requested
    a conditional store on a flag A and a flag B was modified
    by another client. (IESG comment)

Changes from draft-ietf-imapext-condstore-03
1. ABNF corrections from Ned Freed.
2. Minor spelling/wording corrections from Ned Freed.

Changes from draft-ietf-imapext-condstore-02
1. Added FETCH modifiers.
2. Added example for using ANNOTATE with UNCHANGEDSINCE STORE
    modifier.
3. Added a new requirement to send HIGHESTMODSEQ response code
    when implicit enabling is used.
4. Fixed syntax in an example in section 3.2.

Changes from draft-ietf-imapext-condstore-01
1. Fixed missing \\ in one example.
2. Added explanatory comment that search-key modifications apply at
    least to SEARCH and SORT command.
3. Don't require from a conditional store operation to be atomic accross

message set, updated text and examples.
     4.   Added SORT=MODSEQ extension and reworked text in the Introduction
section.
     5.   Added Conditional STORE example based on suggestions from [RFC 2180](#).
     6.   Removed the paragraph about DOS attack from the Security
considerations
          section, as it doesn't apply anymore.
     7.   Updated entry-name ABNF.
     8.   Added an optional CONDSTORE parameter to SELECT/EXAMINE.

     Changes from [draft-ietf-imapext-condstore-00](#)
     1.   Dropped "/message" prefix in entry names as per decision in San
Francisco.
     2.   Fixed ABNF for SEARCH and SORT untagged responses.
     3.   Changed "private" to "priv" to be consistent with ANNOTATE.
     4.   MODIFIED response code is now returned in OK response, not NO.
     5.   Added NOMODSEQ response code.

     Changes from [draft-melnikov-imap-condstore-09](#):
     1.   Some text clarifications based on suggestions by Harrie Hazewinkel
     2.   Added paragraph about mailbox locking and DOS when conditional STORE
          operation is performed on a large mailbox.
     3.   Fixed syntax of <entry-name> to match the ANNOTATE extension.
     4.   Added sentence that a system flag MUST always be considered existent,
          when UNCHANGEDSINCE 0 is used. Is this a good idea?
     5.   Clarified client behavior upon receipt of MODIFIED response code.
     6.   Updated ABNF to clarify where 0 is allowed as mod-sequence and where
          it is not.
     7.   Got rid of MODSEQ response code and return this data in the untagged
          SEARCH/SORT responses.
     8.   Updated RFC number for the IMAP4rev1 document.

     Changes from -08 to -09:
     1.   Added an extended example about reporting regular (non-conditional)
flag
          changes to other sessions.
     2.   Simplified FETCH MODSEQ syntax by removing per-metadata requests and
          responses.

     Changes from -07 to -08:
     1.   Added note saying the change to UIDVALIDITY also invalidates
HIGHESTMODSEQ.
     2.   Fixed several bugs in ABNF for STATUS and STORE commands.

     Changes from -06 to -07:
     1.   Added clarification that when a server does command reordering, the
second
          completed operation gets the higher mod sequence.
     2.   Renamed annotation type specifier "both" to "all" as per suggestion
          from Minneapolis meeting.
     3.   Removed PERFLAGMODSEQ capability, as it doesn't buy anything: a

client
       has to work with both types of servers (i.e. servers that support per
       message per flag modseqs and servers that support only per message
       modseqs) anyway.
    4. Per flag mod-sequences are optional for a server to return. Updated
syntax.
    5. Allow MODSEQ response code only as a result of SEARCH/SORT as
suggested
       by John Myers. MODSEQ response code is not allowed after FETCH or
STORE.

    Changes from -05 to -06:
     1. Replaced "/message/flags/system" with "/message/flags" to
        match ANNOTATE draft.
     2. Extended FETCH/SEARCH/SORT syntax to allow for specifying
        whether an operation should be performed on a shared or a private
        annotation (or both).
     3. Corrected some examples.

    Changes from -04 to -05:
     1. Added support for SORT extension.
     2. Multiple language/spelling fixes by Randall Gellens.

    Changes from -03 to -04:
     1. Added text saying that MODSEQ fetch data items cause server
        to include MODSEQ data response in all subsuquent unsolicited FETCH
        responses.
     2. Added "authors address" section.

    Changes from -02 to -03:
     1. Changed MODTIME untagged response to MODTIME response code.
     2. Added MODTIME response code to the tagged OK response for SEARCH.
        Updated examples accordingly.
     3. Changed rule for sending untagged FETCH response as a result of
        STORE when .SILENT prefix is used. If .SILENT prefix is used,
        server doesn't have to send untagged FETCH response, because
        MODTIME response code already contains modtime.
     4. Renamed MODTIME to MODSEQ to make sure there is no confusion
        between mod-sequence and ACAP modtime.
     5. Minor ABNF changes.
     6. Minor language corrections.

    Changes from -01 to -02:
     1. Added MODTIME data item to STATUS command.
     2. Added OK untagged response to SELECT/EXAMINE.
     3. Clarified that MODIFIED response code contains list of UIDs for
        conditional UID STORE and message set for STORE.
     4. Added per-message modtime.
     5. Added PERFLAGMODTIME capability.
     6. Fixed several bugs in examples.
     7. Added more comments to ABNF.

Changes from -00 to -01:
1.   Refreshed the list of Open Issues.
2.   Changed "attr-name" to "entry-name", because modtime applies to
     entry, not attribute.
3.   Added MODTIME untagged response.
4.   Cleaned up ABNF.
5.   Added "Acknowledgments" section.
6.   Fixed some spelling mistakes.