X Record Extension Library

X Consortium Standard

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Chapter 1. Record Extension Overview

The purpose of this extension is to support the recording and reporting of all core
X protocol and arbitrary X extension protocol. This first section gives an overview
of the Record extension. The following sections describe how to use the Record
extension library.

Synchronous Playback

Environment information is generally provided to an X-based playback mechanism,
which might use the XTest extension to synthesize input events. This synchronization
information defines the X state prior to event synthesis (for example, location
of the cursor, window locations and sizes, installed colormap, window manager running, and so on) and the consequences that occur after the playback mechanism
synthesizes the event. If the user moves the mouse into the icon window and presses
and releases a mouse button, the device events PositionNotify, ButtonPress, and
ButtonRelease are generated by the X server. Because X follows an event-driven
model, there are consequences that follow from the user actions, or device events,
that are in the form of X protocol. As a result of the previous user actions, the client
could generate requests such as ImageText8 and PolyLine to the X server, or the
X server could send non-device events such as Expose and MapNotify to the client
window. Both the requests and non-device events that result from user actions are
known as consequences, which can be used as a synchronization, or control point,
during playback. That is, the playback mechanism does not generate a specific syn-
thesized event until its matching synchronization condition occurs (for example, the
window is mapped or unmapped, the cursor changes, a text string displays, and
so on)

Because it cannot be predicted what synchronization information is required during
playback, the Record extension makes no assumptions about the intended use of the
recorded data. Facilities exist to record any core X protocol or X extension protocol.
Therefore, Record does not enforce a specific synchronization methodology.

Design Approach

The design approach of the extension is to record core X protocol and arbitrary X
extension protocol entirely within the X server itself. When the extension has been
requested to record specific protocol by one or more recording clients, the protocol
data is formatted and returned to the recording clients. The extension provides a
mechanism for capturing all events, including input device events that do not go
to any clients.

Record Clients

The recommended communication model for a Record application is to open two
connections to the server—one connection for recording control and one connection
for reading recorded protocol data.

Information about recording (for example, what clients to record, what protocol to
record for each client, and so on) is stored in resources called record contexts (type
XRecordContext). Most Record extension functions take a record context as an ar-
argument. Although in theory it is possible to share record contexts between applications, it is expected that applications will use their own context when performing recording operations.

A client that wishes to record X protocol does so through the library functions defined in *Library Extension Requests* A typical sequence of requests that a client would make is as follows:

- **XRecordQueryVersion**
  query the extension protocol version.

- **XRecordCreateContext**
  request that the server create a record context for access by this client, and express interest in clients and protocol to be recorded. This request returns an XRecord-Context, which is an XID that is used by most other extension requests to identify the specified context.

- **XRecordEnableContext**
  begin the recording and reporting of protocol data.

- **XRecordDisableContext**
  end the recording and reporting of protocol data.

- **XRecordFreeContext**
  free the record context.

The header for this library is `<X11/extensions/record.h>`. All identifiers defined in the interface are supplied by this header and are prefixed with "XRecord". The Xtst library contains the XRecord functions.
Chapter 2. Common Arguments

The Record extension functions `XRecordCreateContext` and `XRecordRegisterClients` allow applications to specify the following:

- Individual clients or sets of clients to record
- Ranges of core X protocol and X extension protocol to record for each client

Protocol in the ranges specified by the recording client will be recorded by the server. The device_events protocol type can be specified by a recording client although it may not be sent to a recorded client. The device_events type differs from delivered_events, which also can be specified by a recording client; delivered_events are actually delivered to one or more clients. These event types are discussed in Protocol Ranges.

The Record extension functions `XRecordCreateContext` and `XRecordRegisterClients` have the common arguments datum_flags, clients, and ranges, which specify whether server time and/or client sequence number should precede protocol elements, the clients or client set to record, and the protocol ranges to record, respectively. These are discussed in the following sections.

Datum Flags

The datum_flags argument is a set of flags OR’ed together to specify options for the record context. Specify zero to disable all the options.

- The `XRecordFromServerTime` flag specifies that `XRecordInterceptData` structures with a category of `XRecordFromServer` will have a server_time field specific to each protocol element.
- The `XRecordFromClientTime` flag specifies that `XRecordInterceptData` structures with a category of `XRecordFromClient` will have a server_time field specific to each protocol element.
- The `XRecordFromClientSequence` flag specifies that `XRecordInterceptData` structures with a category of `XRecordFromClient` or `XRecordClientDied` will have a valid client_seq field.

Selecting Clients

The clients argument is a pointer to an array of `XRecordClientSpec`. `XRecordClientSpec` is an integral type that holds a resource ID, a client resource ID base, or one of the client set constants defined below.

Duplicate elements in the array are ignored by the functions, and if any element in the array is not valid, a BadMatch error results. A resource ID references the client that created that resource. The client set may be one of the following constants: `XRecordCurrentClients`, `XRecordFutureClients`, or `XRecordAllClients`.

If the element in the array identifies a particular client, protocol specified by the ranges argument will be recorded by the server. The recorded protocol data will not be returned to the recording client until the record context has been enabled. This is described in Data Transfer.
If the element is `XRecordCurrentClients`, the protocol ranges specified by the
ranges argument, except for `device_events`, are associated with each current client
connection. If the element is `XRecordFutureClients`, the protocol ranges specified
by the ranges argument are associated with each new client connection. If the ele-
ment is `XRecordAllClients`, the protocol ranges specified by the ranges argument
are associated with each current client connection and with each new client connec-
tion. When the context is enabled, the data connection is unregistered if it was reg-
istered. If the context is enabled, `XRecordCurrentClients` and `XRecordAllClients`
silently exclude the recording data connection. It is an error to explicitly register
the data connection.

## Protocol Ranges

The functions `XRecordCreateContext` and `XRecordRegisterClients` have another
common argument, ranges, which is an array of pointers to `XRecordRange` struc-
tures. Each structure contains ranges of numeric values for each of the proto-
col types that can be specified and recorded individually by the Record exten-
sion. An `XRecordRange` structure must be allocated by the Record library using the
`XRecordAllocRange` function.

The `XRecordRange` typedef is a structure with the following members:

```c
struct XRecordRange8 {
    unsigned char first;
    unsigned char last;
} XRecordRange;
```

The types used in `XRecordRange` members are defined as follows. The `XRecor-
dRange8` typedef is a structure with the following members:

```c
struct XRecordRange8 {
    unsigned char first;
    unsigned char last;
} XRecordRange8;
```

The `XRecordRange16` typedef is a structure with the following members:

```c
struct XRecordRange16 {
    unsigned short first;
    unsigned short last;
} XRecordRange16;
```

The `XRecordExtRange` typedef is a structure with the following members:

```c
struct XRecordExtRange {
    XRecordRange8 ext_major;
} XRecordExtRange;
```
XRecordRange16 ext_minor

If any of the values specified in XRecordRange is invalid, a BadValue error results.

The core_requests member specifies the range of core X protocol requests to record. Core X protocol requests with a major opcode that is between first and last, inclusive, will be recorded. A BadValue error results if the value of first is greater than the value of last. If the values of both first and last are zero, no core X protocol requests will be recorded.

The core_replies member specifies the range of replies resulting from core X protocol requests to record. Replies that result from core X protocol requests with a major opcode between first and last, inclusive, will be recorded. A BadValue error results if the value of first is greater than the value of last. If the values of both first and last are zero, no core X protocol replies will be recorded.

The ext_requests member specifies the range of X extension requests to record. X extension requests with a major opcode between ext_major.first and ext_major.last, and with a minor opcode between ext_minor.first and ext_minor.last, inclusive, will be recorded. A BadValue error results if the value of ext_major.first is greater than the value of ext_major.last or if the value of ext_minor.first is greater than the value of ext_minor.last. If the values of both ext_major.first and ext_major.last are zero, no X extension requests will be recorded.

The ext_replies member specifies the range of replies resulting from X extension requests to record. Replies that result from an X extension request with a major opcode between ext_major.first and ext_major.last, and a minor opcode that is between ext_minor.first and ext_minor.last will be recorded. A BadValue error results if the value of ext_major.first is greater than the value of ext_major.last or if the value of ext_minor.first is greater than the value of ext_minor.last. If the values of both ext_major.first and ext_major.last are zero, no X extension replies will be recorded.

The delivered_events member specifies the range of both core X events and X extension events to record. These events are delivered to at least one client. Core X events and X extension events with a code value between first and last inclusive will be recorded. A BadValue error results if the value of first is greater than the value of last. If the values of first and last are zero, no events will be recorded.

The device_events member specifies the range of both core X device events and X extension device events to record. These events may or may not be delivered to a client. Core X device events and X extension device events with a code value between first and last inclusive that are not delivered to any clients will be recorded. A BadValue error results if the value of first is greater than the value of last. A BadValue error results if first is less than two or last is less than two, except that if first and last are zero, no events will be recorded.

The errors member specifies the range of both core X errors and X extension errors to record. Core X errors and X extension errors with a code value between first and last inclusive will be recorded. A BadValue error results if the value of first is greater than the value of last. If the values of first and last are zero, no errors will be recorded.

A value of True for the client_started member specifies the connection setup reply from the server to new clients. If False the connection setup reply is not specified by this XRecordRange.
A value of True for the client_died member specifies notification when a client disconnects. If False notification when a client disconnects is not specified by this XRecordRange.
Chapter 3. Library Extension Requests

Recording operations are accessed by programs through the use of new protocol requests. The following functions are provided as extensions to Xlib. An Xlib error results if an extension request is made to an X server that does not support the Record extension. Note that any of the extension protocol requests may generate BadAlloc or BadLength errors.

Query Extension Version

An application uses the XRecordQueryVersion function to determine the version of the Record extension protocol supported by an X server.

```
Status XRecordQueryVersion( *display, cmajor_return, cminor_return);
```

display
Returns the connection to the X server.

cmajor_return
Returns the extension protocol major version in use.

cminor_return
Returns the extension protocol minor version in use.

The XRecordQueryVersion function returns the major and minor protocol version numbers supported by the server. XRecordQueryVersion returns nonzero (success) only if the returned version numbers are common to both the library and the server; otherwise, it returns zero.

Create and Modify Context

An application uses the XRecordCreateContext function to create a record context. At the time the record context is created by the recording client, the clients to be recorded and the protocol to record for each client may be specified.

```
XRecordContext XRecordCreateContext( *display, datum_flags, *clients, nclients, *ranges, nranges);
```

display
Returns the connection to the X server.

datum_flags
Specifies whether detailed time or sequence info should be sent.

clients
Specifies the clients to record.

nclients
Specifies the number of clients.

ranges
Specifies the protocol ranges to record.

nranges
Specifies the number of protocol ranges.

The XRecordCreateContext function creates a record context and returns an XRecordContext which is then used in the other Record library calls. This request is typically executed by the recording client over its control connection to the X server. The datum_flags specifies whether server time and/or client sequence number should precede protocol elements recorded by context (Datum Flags). When a clients element identifies a particular client, the client is added to the context and
the protocol to record for that client is set to the union of all ranges. When a clients element is XRecordCurrentClients XRecordFutureClients or XRecordAllClients the actions described in Selecting Clients are performed.

XRecordCreateContext returns zero if the request failed. XRecordCreateContext can generate BadIDChoice BadMatch and BadValue errors.

The ranges argument is an XRecordRange array, that is, an array of pointers. The structures the elements point to shall be allocated by calling XRecordAllocRange

XRecordRange *
XRecordAllocRange(void)

The XRecordAllocRange function allocates and returns an XRecordRange structure. The structure is initialized to specify no protocol. The function returns NULL if the structure allocation fails. The application can free the structure by calling XFree

Additions

An application uses the XRecordRegisterClients function to modify a previously created record context, by adding clients or modifying the recorded protocol, typically over its control connection to the X server.

Status XRecordRegisterClients( *display, context, datum_flags, *clients, nclients, *ranges, nranges);

display Returns the connection to the X server.

context Specifies the record context to modify.

datum_flags Specifies whether detailed time or sequence info should be sent.

clients Specifies the clients to record.

nclients Specifies the number of clients.

ranges Specifies the protocol ranges to record.

nranges Specifies the number of protocol ranges.

The datum_flags specifies whether server time and/or client sequence number should precede protocol elements for all clients recorded by context (See Datum Flags ). When a clients element identifies a particular client and the client is not yet targeted for recording in the given context, the client is added to the set of clients to record, and the protocol to record for that client is set to the union of all ranges. When the client is already targeted for recording, the protocol to record for that client is set to the union of all ranges. When the element is XRecordCurrentClients XRecordFutureClients or XRecordAllClients the actions described in Selecting Clients are performed.

XRecordRegisterClients returns zero if the request failed; otherwise, it returns nonzero.

XRecordRegisterClients can generate XRecordBadContext BadMatch and BadValue errors.
Deletions

An application uses the `XRecordUnregisterClients` function to delete clients from a previously created record context, typically over its control connection to the X server.

```
Status XRecordUnRegisterClients( *display, context, *clients, nclients);
```

display Returns the connection to the X server.
context Specifies the record context to modify.
clients Specifies the clients to stop recording.
nclients Specifies the number of clients.

When an element in clients identifies a particular client, and the specified client is already targeted for recording in the given context, the client and the set of protocol to record for that client are deleted from the context. If the specified client is not targeted for recording, then no action is performed.

When the element is `XRecordCurrentClients` all clients currently targeted for recording in context and their corresponding sets of protocol to record are deleted from context.

When the item is `XRecordFutureClients` any future client connections will not automatically be targeted for recording in context.

When the element is `XRecordAllClients` all clients currently targeted for recording in context and their corresponding sets of protocol to record are deleted from context. Any future client connections will not automatically be targeted for recording in context.

`XRecordUnregisterClients` returns zero if the request failed; otherwise, it returns nonzero.

`XRecordUnregisterClients` can generate `XRecordBadContext` BadMatch and BadValue errors.

Query Context State

An application uses the `XRecordGetContext` function to query the current state of a record context, typically over its control connection to the X server.

```
Status XRecordGetContext( *display, context, **state_return);
```

display Specifies the connection to the X server.
context Specifies the record context to query.
state_return Specifies the address of a variable into which the function stores a pointer to the current state of the record context.

The `XRecordState` typedef returned by `XRecordGetContext` is a structure with the following members:
XRecordState:
  Bool  enabled
  int   datum_flags
  unsigned long  nclients
  XRecordClientInfo **client_info

The enabled member is set to the state of data transfer and is True when the
recording client has asked that recorded data be sent; otherwise it is False. The
datum_flags member is set to the value of these flags for this context. The nclients
member is set to the number of XRecordClientInfo structures returned. The
client_info member is an array of pointers to XRecordClientInfo structures that
contain the protocol to record for each targeted client. The XRecordClientInfo
typedef is a structure with the following members:

XRecordClientInfo:
  XRecordClientSpec client
  unsigned long  nranges
  XRecordRange **ranges

The client member either identifies a client targeted for recording or is set to
XRecordFutureClients to describe how future clients will be automatically target-
ed for recording. The nranges member is set to the number of protocol ranges to
be recorded for the specified client. The ranges member is an array of pointers to
XRecordRange structures, which specify the protocol ranges to record.

XRecordGetContext returns zero if the request failed; otherwise, it returns nonze-
ro. The context argument must specify a valid XRecordContext or a XRecordBad-
Context error results.

Recording clients should use the XRecordFreeState function to free the state data
returned by XRecordGetContext

void XRecordFreeState( *state);

state  Specifies the structure that is to be freed.

XRecordFreeState frees the data pointed to by state. If the argument does not
match an XRecordState pointer returned from a successful call to XRecordGetCon-
text or if XRecordFreeState has already been called with it, the behavior is unde-
defined.

Data Transfer

An application uses the XRecordEnableContext and XRecordDisableContext func-
tions to change the state of data transfer between the X server and the recording
client. These functions allow the application to start recording and reporting of pro-
tocol data and to stop recording and reporting of protocol data, respectively.

Enable Context

To direct the X server to record and report protocol, a program uses XRecordEn-
ableContext typically over its data connection to the X server. The reporting of
recorded protocol back to the recording client is handled by the following data structures and procedure definitions. Each recorded protocol element is reported to the recording client through an XRecordInterceptData typedef, a structure with the following members:

XRecordInterceptData:

- XID id_base
- Time server_time
- unsigned long client_seq
- int category
- Bool client_swapped
- unsigned char *data
- unsigned long data_len

The id_base member is set to the resource identifier base sent to the client in the connection setup reply and therefore identifies the client being recorded, except when the recorded protocol data is a device event that may have not been delivered to a client. In this case, id_base is set to zero. The server_time member is set to the time of the server when the protocol was recorded. It is the time that was attached to this protocol element in the reply, if so specified by datum_flags, or else the time from the header of the reply that contained this protocol element. The client_seq member is the sequence number of the recorded client's most recent request processed by the server at the time this protocol element was recorded, if this information were included in the recorded data; otherwise client_seq is 0. The category member is set to one of the following values: XRecordStartOfData XRecordFromServer XRecordFromClient XRecordClientStarted XRecordClientDied or XRecordEndOfData XRecordStartOfData is immediately sent as the first reply to confirm that the context is enabled. XRecordFromClient indicates the protocol data is from the recorded client to the server (requests). XRecordFromServer indicates the protocol data is from the server to the recorded client (replies, errors, events, or device events). XRecordClientStarted indicates that the protocol data is the connection setup reply from the server. XRecordClientDied indicates that the recorded client has closed its connection to the X server; there is no protocol data. XRecordEndOfData indicates that the context has been disabled and that this is the last datum. It does not correspond to any protocol or state change in a recorded client. There is no protocol data.

The client_swapped member is set to True if the byte order of the client being recorded is swapped relative to the recording client; otherwise, it is set to False. All recorded protocol data is returned in the byte order of the recorded client. Therefore, recording clients are responsible for all byte swapping, if required. Device events are in the byte order of the recording client. For replies of category XRecordStartOfData and XRecordEndOfData client_swapped is set according to the byte order of the server relative to the recording client.

The data member contains the actual recorded protocol data. When category is set to XRecordStartOfData XRecordClientDied or XRecordEndOfData no protocol data are contained in data.

For the core X events KeyPress KeyRelease ButtonPress and ButtonRelease, the fields of a device event that contain valid information are time and detail. For the core X event MotionNotify the fields of a device event that contain valid information are time, root, root-x and root-y. The time field refers to the time the event was generated by the device.
For the extension input device events DeviceKeyPress, DeviceKeyRelease, DeviceButtonPress, and DeviceButtonRelease the fields of a device event that contain valid information are device, time, and detail. For DeviceMotionNotify the valid device event fields are device and time. For the extension input device events ProximityIn and ProximityOut the fields of a device event that contain valid information are device and time. For the extension input device event DeviceValuator the fields of a device event that contain valid information are device, num_valuators, first_valuator, and valuators. The time field refers to the time the event was generated by the device.

The data_len member is set to the length of the actual recorded protocol data in 4-byte units.

When the context has been enabled, protocol data the recording client has previously expressed interest in is recorded and returned to the recording client via multiple replies. Because the X server batches the recorded data, more than one protocol element may be contained in the same reply packet. When a reply is received, a procedure of type XRecordInterceptProc is called for each protocol element in the reply.

```c
typedef void (*XRecordInterceptProc)( closure, *recorded_data);
```

closure Pointer that was passed in when the context was enabled.

recorded_data A protocol element recorded by the server extension.

This callback may use the control display connection (or any display connection other than the data connection).

Recording clients should use the XRecordFreeData function to free the XRecordInterceptData structure.

```c
Status XRecordEnableContext( *display, context, callback, closure);
```

display Specifies the connection to the X server.

context Specifies the record context to enable.

callback Specifies the function to be called for each protocol element received.

closure Specifies data passed to callback.

XRecordEnableContext enables data transfer between the recording client and the X server. All core and extension protocol received from or sent to targeted clients that the recording client has expressed interest in will be recorded and reported to the recording client.

XRecordEnableContext returns zero if the request failed; otherwise, it returns nonzero. The context argument must specify a valid XRecordContext or a XRecordBadContext error results. The error BadMatch results when data transfer is already enabled on the given context.

**Enable Context Asynchronously**

Because XRecordEnableContext does not return until XRecordDisableContext is executed on the control connection, a nonblocking interface in addition to XRecor-
**Library Extension Requests**

**dEnableContext** is provided. This interface also enables data transfer; however, it does not block.

This interface is defined as follows:

```c
Status XRecordEnableContextAsync( *display, context, callback, closure);
```

- **display** Specifies the connection to the X server.
- **context** Specifies the record context to enable.
- **callback** Specifies the function to be called for each protocol element received.
- **closure** Specifies data passed to callback.

`XRecordEnableContextAsync` enables data transfer between the recording client and the X server just as `XRecordEnableContext` does. Unlike `XRecordEnableContext`, it does not wait for the context to be disabled before returning; `XRecordEnableContextAsync` returns as soon as the `XRecordStartOfData` reply has been received and processed.

`XRecordEnableContextAsync` returns zero if it could not allocate the necessary memory and nonzero if it sent the request successfully to the server. The context argument must specify a valid `XRecordContext` or a `XRecordBadContext` error results. The error `BadMatch` results when data transfer is already enabled.

Each time it reads data from the server connection, Xlib will check for incoming replies and call `callback` as necessary. The application may direct Xlib explicitly to check for Record data with the `XRecordProcessReplies` function.

```c
void XRecordProcessReplies( *display);
```

- **display** Specifies the connection to the X server.

`XRecordProcessReplies` will check for any replies that have not yet been processed by the application. The asynchronous callback will be called as appropriate. `XRecordProcessReplies` returns when all immediately available replies have been processed. It does not block.

To free the data passed to the `XRecordInterceptProc` callback, use `XRecordFreeData`.

```c
void XRecordFreeData( *data);
```

- **data** Specifies the structure that is to be freed.

`XRecordFreeData` frees the data pointed to by data. If the argument does not match an `XRecordInterceptData` pointer earlier passed to an `XRecordInterceptProc` callback or if `XRecordFreeData` has already been called with it, the behavior is undefined.

**Disable Context**

To direct the X server to halt the reporting of recorded protocol, the program executes `XRecordDisableContext` typically over its control connection to the X server.
Status `XRecordDisableContext`( *display, context);

`display` Specifies the connection to the X server.
`context` Specifies the record context to disable.

The `XRecordDisableContext` function disables context, stopping all recording over its data connection. Any complete protocol elements for context that were buffered in the server will be sent to the recording client rather than being discarded. If a program attempts to disable an `XRecordContext` that has not been enabled, no action will take place.

`XRecordDisableContext` returns zero if the request failed; otherwise, it returns nonzero. The context argument must specify a valid `XRecordContext` or an `XRecordBadContext` error results.

### ID Base Mask

To determine the mask the server uses for the client ID base, use `XRecordIdBaseMask`.

`XID XRecordIdBaseMask`( *display);

`display` Specifies the connection to the X server.

The `XRecordIdBaseMask` function returns the resource ID mask passed to the client by the server at connection setup.

### Free Context

Before terminating, the program should request that the server free the record context. This is done with the `XRecordFreeContext` function, typically over the record client's control connection to the X server.

Status `XRecordFreeContext`( *display, context);

`display` Specifies the connection to the X server.
`context` Specifies the record context to free.

The `XRecordFreeContext` function frees the given context for the requesting client. Freeing a record context releases the clients targeted for recording and their respective protocol ranges to record. If protocol data is being reported to the recording client, generally over the data connection to the X server, the reporting ceases as if `XRecordDisableContext` had been called on the given context. When a program terminates without freeing its record context, the X server will automatically free that context on behalf of the client.

`XRecordFreeContext` returns zero if the request failed; otherwise, it returns nonzero. The context argument must specify a valid `XRecordContext` or an `XRecordBadContext` error results.