The X Keyboard Extension: Protocol Specification

X Consortium Standard

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I truly cannot express my gratitude to all of you, without whom this would not have been possible.

Erik Fortune

Silicon Graphics, Inc.

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Chapter 1. Overview

This extension provides a number of new capabilities and controls for text keyboards.

The core X protocol specifies the ways that the Shift, Control and Lock modifiers and the modifiers bound to the Mode_switch or Num_Lock keysyms interact to generate keysyms and characters. The core protocol also allows users to specify that a key affects one or more modifiers. This behavior is simple and fairly flexible, but it has a number of limitations that make it difficult or impossible to properly support many common varieties of keyboard behavior. The limitations of core protocol support for keyboards include:

• Use of a single, uniform, four-symbol mapping for all keyboard keys makes it difficult to properly support keyboard overlays, PC-style break keys or keyboards that comply with ISO9995 or a host of other national and international standards.
• Use of a modifier to specify a second keyboard group has side-effects that wreak havoc with client grabs and X toolkit translations and limit us to two keyboard groups.
• Poorly specified locking key behavior requires X servers to look for a few "magic" keysyms to determine which keys should lock when pressed. This leads to incompatibilities between X servers with no way for clients to detect implementation differences.
• Poorly specified capitalization and control behavior requires modifications to X library source code to support new character sets or locales and can lead to incompatibilities between system-wide and X library capitalization behavior.
• Limited interactions between modifiers specified by the core protocol make many common keyboard behaviors difficult or impossible to implement. For example, there is no reliable way to indicate whether or not using shift should "cancel" the lock modifier.
• The lack of any explicit descriptions for indicators, most modifiers and other aspects of the keyboard appearance requires clients that wish to clearly describe the keyboard to a user to resort to a mishmash of prior knowledge and heuristics.

This extension makes it possible to clearly and explicitly specify most aspects of keyboard behavior on a per-key basis. It adds the notion of a numeric keyboard group to the global keyboard state and provides mechanisms to more closely track the logical and physical state of the keyboard. For keyboard control clients, this extension provides descriptions and symbolic names for many aspects of keyboard appearance and behavior. It also includes a number of keyboard controls designed to make keyboards more accessible to people with movement impairments.

The X Keyboard Extension essentially replaces the core protocol definition of a keyboard. The following sections describe the new capabilities of the extension and the effect of the extension on core protocol requests, events and errors.

Conventions and Assumptions

This document uses the syntactic conventions, common types, and errors defined in sections two through four of the specification of the X Window System Protocol.
This document assumes familiarity with the fundamental concepts of X, especially those related to the way that X handles keyboards. Readers who are not familiar with the meaning or use of keycodes, keysyms or modifiers should consult (at least) the first five chapters of the protocol specification of the X Window System before continuing.
Chapter 2. Keyboard State

The core protocol description of keyboard state consists of eight modifiers (Shift, Lock, Control, and Mod1 - Mod5). A modifier reports the state of one or modifier keys, which are similar to qualifier keys as defined by the ISO9995 standard:

Qualifier key A key whose operation has no immediate effect, but which, for as long as it is held down, modifies the effect of other keys. A qualifier key may be, for example, a shift key or a control key.

Whenever a modifier key is physically or logically depressed, the modifier it controls is set in the keyboard state. The protocol implies that certain modifier keys lock (i.e. affect modifier state after they have been physically released) but does not explicitly discuss locking keys or their behavior. The current modifier state is reported to clients in a number of core protocol events and can be determined using the QueryPointer request.

The XKB extension retains the eight "real" modifiers defined by the core protocol but extends the core protocol notion of keyboard state to include up to four keysym groups, as defined by the ISO9995 standard:

Group: A logical state of a keyboard providing access to a collection of characters. A group usually contains a set of characters which logically belong together and which may be arranged on several shift levels within that group.

For example, keyboard group can be used to select between multiple alphabets on a single keyboard, or to access less-commonly used symbols within a character set.

Locking and Latching Modifiers and Groups

With the core protocol, there is no way to tell whether a modifier is set due to a lock or because the user is actually holding down a key; this can make for a clumsy user-interface as locked modifiers or group state interfere with accelerators and translations.

XKB adds explicit support for locking and latching modifiers and groups. Locked modifiers or groups apply to all future key events until they are explicitly changed. Latched modifiers or groups apply only to the next key event that does not change keyboard state.

Fundamental Components of XKB Keyboard State

The fundamental components of XKB keyboard state include:

• The locked modifiers and group
• The latched modifiers and group
• The base modifiers and group (for which keys are physically or logically down)
• The effective modifiers and group (the cumulative effect of the base, locked and latched modifier and group states).
• State of the core pointer buttons.

The latched and locked state of modifiers and groups can be changed in response to keyboard activity or under application control using the XkbLatchLockState request. The base modifier, base group and pointer button states always reflect the logical state of the keyboard and pointer and change only in response to keyboard or pointer activity.

**Computing Effective Modifier and Group**

The effective modifiers and group report the cumulative effects of the base, latched and locked modifiers and group respectively, and cannot be directly changed. Note that the effective modifiers and effective group are computed differently.

The effective modifiers are simply the bitwise union of the base, latched and locked modifiers.

The effective group is the arithmetic sum of the base, latched and locked groups. The locked and effective keyboard group must fall in the range $Group1 - Group4$, so they are adjusted into range as specified by the global GroupsWrap control as follows:

• If the RedirectIntoRange flag is set, the four least significant bits of the groups wrap control specify the index of a group to which all illegal groups correspond. If the specified group is also out of range, all illegal groups map to $Group1$.

• If the ClampIntoRange flag is set, out-of-range groups correspond to the nearest legal group. Effective groups larger than the highest supported group are mapped to the highest supported group; effective groups less than $Group1$ are mapped to $Group1$. For example, a key with two groups of symbols uses $Group2$ type and symbols if the global effective group is either $Group3$ or $Group4$.

• If neither flag is set, group is wrapped into range using integer modulus. For example, a key with two groups of symbols for which groups wrap uses $Group1$ symbols if the global effective group is $Group3$ or $Group2$ symbols if the global effective group is $Group4$.

The base and latched keyboard groups are unrestricted eight-bit integer values and are not affected by the GroupsWrap control.

**Computing A State Field from an XKB State**

Many events report the keyboard state in a single state field. Using XKB, a state field combines modifiers, group and the pointer button state into a single sixteen bit value as follows:

• Bits 0 through 7 (the least significant eight bits) of the effective state comprise a mask of type KEYMASK which reports the state modifiers.

• Bits 8 through 12 comprise a mask of type BUTMASK which reports pointer button state.

• Bits 13 and 14 are interpreted as a two-bit unsigned numeric value and report the state keyboard group.
• Bit 15 (the most significant bit) is reserved and must be zero.

It is possible to assemble a state field from any of the components of the XKB keyboard state. For example, the effective keyboard state would be assembled as described above using the effective keyboard group, the effective keyboard modifiers and the pointer button state.

Derived Components of XKB Keyboard State

In addition to the fundamental state components, XKB keeps track of and reports a number of state components which are derived from the fundamental components but stored and reported separately to make it easier to track changes in the keyboard state. These derived components are updated automatically whenever any of the fundamental components change but cannot be changed directly.

The first pair of derived state components control the way that passive grabs are activated and the way that modifiers are reported in core protocol events that report state. The server uses the ServerInternalModifiers, IgnoreLocksModifiers and IgnoreGroupLock controls, described in Server Internal Modifiers and Ignore Locks Behavior, to derive these two states as follows:

• The lookup state is the state used to determine the symbols associated with a key event and consists of the effective state minus any server internal modifiers.

• The grab state is the state used to decide whether a particular event triggers a passive grab and consists of the lookup state minus any members of the ignore locks modifiers that are not either latched or logically depressed. If the ignore group locks control is set, the grab state does not include the effects of any locked groups.

Server Internal Modifiers and Ignore Locks Behavior

The core protocol does not provide any way to exclude certain modifiers from client events, so there is no way to set up a modifier which affects only the server.

The modifiers specified in the mask of the InternalMods control are not reported in any core protocol events, are not used to determine grabs and are not used to calculate compatibility state for XKB-unaware clients. Server internal modifiers affect only the action applied when a key is pressed.

The core protocol does not provide any way to exclude certain modifiers from grab calculations, so locking modifiers often have unanticipated and unfortunate side-effects. XKB provides another mask which can help avoid some of these problems.

The locked state of the modifiers specified in mask of the IgnoreLockMods control is not reported in most core protocol events and is not used to activate grabs. The only core events which include the locked state of the modifiers in the ignore locks mask are key press and release events that do not activate a passive grab and which do not occur while a grab is active. If the IgnoreGroupLock control is set, the locked state of the keyboard group is not considered when activating passive grabs.

Without XKB, the passive grab set by a translation (e.g. Alt<KeyPress>space) does not trigger if any modifiers other than those specified by the translation are set, with the result that many user interface components do not react when either
Num Lock or when the secondary keyboard group are active. The ignore locks mask and the ignore group locks control make it possible to avoid this behavior without exhaustively grabbing every possible modifier combination.

**Compatibility Components of Keyboard State**

The core protocol interpretation of keyboard modifiers does not include direct support for multiple groups, so XKB reports the effective keyboard group to XKB-aware clients using some of the reserved bits in the state field of some core protocol events, as described in Computing A State Field from an XKB State.

This modified state field would not be interpreted correctly by XKB-unaware clients, so XKB provides a *group compatibility mapping* (see Group Compatibility Map) which remaps the keyboard group into a core modifier mask that has similar effects, when possible. XKB maintains three compatibility state components that are used to make non-XKB clients work as well as possible:

- The *compatibility state* corresponds to the effective modifier and effective group state.
- The *compatibility lookup state* is the core-protocol equivalent of the lookup state.
- The *compatibility grab state* is the nearest core-protocol equivalent of the grab state.

Compatibility states are essentially the corresponding XKB state, but with keyboard group possibly encoded as one or more modifiers; Group Compatibility Map describes the group compatibility map, which specifies the modifier(s) that correspond to each keyboard group.

The compatibility state reported to XKB-unaware clients for any given core protocol event is computed from the modifier state that XKB-capable clients would see for that same event. For example, if the ignore group locks control is set and group 2 is locked, the modifier bound to *Mode_switch* is not reported in any event except (Device)KeyPress and (Device)KeyRelease events that do not trigger a passive grab.

**Note**

Referring to clients as “XKB-capable is somewhat misleading in this context. The sample implementation of XKB invisibly extends the X library to use the keyboard extension if it is present. This means that most clients can take advantage of all of XKB without modification, but it also means that the XKB state can be reported to clients that have not explicitly requested the keyboard extension. Clients that directly interpret the state field of core protocol events or that interpret the keymap directly may be affected by some of the XKB differences; clients that use library or toolkit routines to interpret keyboard events automatically use all of the XKB features.

XKB-aware clients can query the keyboard state at any time or request immediate notification of a change to any of the fundamental or derived components of the keyboard state.
Chapter 3. Virtual Modifiers

The core protocol specifies that certain keysyms, when bound to modifiers, affect the rules of keycode to keysym interpretation for all keys; for example, when Num_Lock is bound to some modifier, that modifier is used to choose shifted or unshifted state for the numeric keypad keys. The core protocol does not provide a convenient way to determine the mapping of modifier bits, in particular Mod1 through Mod5, to keysyms such as Num_Lock and Mode_switch. Clients must retrieve and search the modifier map to determine the keycodes bound to each modifier, and then retrieve and search the keyboard mapping to determine the keysyms bound to the keycodes. They must repeat this process for all modifiers whenever any part of the modifier mapping is changed.

XKB provides a set of sixteen named virtual modifiers, each of which can be bound to any set of the eight "real" modifiers (Shift, Lock, Control and Mod1 - Mod5 as reported in the keyboard state). This makes it easier for applications and keyboard layout designers to specify to the function a modifier key or data structure should fulfill without having to worry about which modifier is bound to a particular keysym.

The use of a single, server-driven mechanism for reporting changes to all data structures makes it easier for clients to stay synchronized. For example, the core protocol specifies a special interpretation for the modifier bound to the Num_Lock key. Whenever any keys or modifiers are rebound, every application has to check the keyboard mapping to make sure that the binding for Num_Lock has not changed. If Num_Lock is remapped when XKB is in use, the keyboard description is automatically updated to reflect the new binding, and clients are notified immediately and explicitly if there is a change they need to consider.

The separation of function from physical modifier bindings also makes it easier to specify more clearly the intent of a binding. X servers do not all assign modifiers the same way — for example, Num_Lock might be bound to Mod2 for one vendor and to Mod4 for another. This makes it cumbersome to automatically remap the keyboard to a desired configuration without some kind of prior knowledge about the keyboard layout and bindings. With XKB, applications simply use virtual modifiers to specify the behavior they want, without regard for the actual physical bindings in effect.

XKB puts most aspects of the keyboard under user or program control, so it is even more important to clearly and uniformly refer to modifiers by function.

Modifier Definitions

Use an XKB modifier definition to specify the modifiers affected by any XKB control or data structure. An XKB modifier definition consists of a set of real modifiers, a set of virtual modifiers, and an effective mask. The mask is derived from the real and virtual modifiers and cannot be explicitly changed — it contains all of the real modifiers specified in the definition plus any real modifiers that are bound to the virtual modifiers specified in the definition. For example, this modifier definition specifies the numeric lock modifier if the Num_Lock keysym is not bound to any real modifier:

{ real_mods= None, virtual_mods= NumLock, mask= None }
If we assign \textit{Mod2} to the \textit{Num\_Lock} key, the definition changes to:

\begin{verbatim}
{ real_mods= None, virtual_mods= NumLock, mask= Mod2 }
\end{verbatim}

Using this kind of modifier definition makes it easy to specify the desired behavior in such a way that XKB can automatically update all of the data structures that make up a keymap to reflect user or application specified changes in any one aspect of the keymap.

The use of modifier definitions also makes it possible to unambiguously specify the reason that a modifier is of interest. On a system for which the \textit{Alt} and \textit{Meta} keysyms are bound to the same modifier, the following definitions behave identically:

\begin{verbatim}
{ real_mods= None, virtual_mods= Alt, mask= Mod1 }
{ real_mods= None, virtual_mods= Meta, mask= Mod1 }
\end{verbatim}

If we rebind one of the modifiers, the modifier definitions automatically reflect the change:

\begin{verbatim}
{ real_mods= None, virtual_mods= Alt, mask= Mod1 }
{ real_mods= None, virtual_mods= Meta, mask= Mod4 }
\end{verbatim}

Without the level of indirection provided by virtual modifier maps and modifier definitions, we would have no way to tell which of the two definitions is concerned with \textit{Alt} and which is concerned with \textit{Meta}.

\section*{Inactive Modifier Definitions}

Some XKB structures ignore modifier definitions in which the virtual modifiers are unbound. Consider this example:

\begin{verbatim}
if ( state matches \{ Shift \}) Do OneThing;
if ( state matches \{ Shift+NumLock \}) Do Another;
\end{verbatim}

If the \textit{NumLock} virtual modifier is not bound to any real modifiers, these effective masks for these two cases are identical (i.e. they contain only \textit{Shift}). When it is essential to distinguish between \textit{OneThing} and Another, XKB considers only those modifier definitions for which all virtual modifiers are bound.

\section*{Virtual Modifier Mapping}

XKB maintains a \textit{virtual modifier mapping}, which lists the virtual modifiers associated with each key. The real modifiers bound to a virtual modifier always include all of the modifiers bound to any of the keys that specify that virtual modifier in their virtual modifier mapping.

For example, if \textit{Mod3} is bound to the \textit{Num\_Lock} key by the core protocol modifier mapping, and the \textit{Num\_Lock} virtual modifier is bound to the \textit{Num\_Lock} key by the virtual modifier mapping, \textit{Mod3} is added to the set of modifiers associated with the \textit{Num\_Lock} virtual modifier.
The virtual modifier mapping is normally updated automatically whenever actions are assigned to keys (see Changing the Keyboard Mapping Using the Core Protocol for details) and few applications should need to change the virtual modifier mapping explicitly.
Chapter 4. Global Keyboard Controls

The X Keyboard Extension supports a number of *global key controls*, which affect the way that XKB handles the keyboard as a whole. Many of these controls make the keyboard more accessible to the physically impaired and are based on the AccessDOS package.¹

The RepeatKeys Control

The core protocol only allows control over whether or not the entire keyboard or individual keys should autorepeat when held down. The *RepeatKeys* control extends this capability by adding control over the delay until a key begins to repeat and the rate at which it repeats. *RepeatKeys* is also coupled with the core autorepeat control; changes to one are always reflected in the other.

The *RepeatKeys* control has two parameters. The *autorepeat delay* specifies the delay between the initial press of an autorepeating key and the first generated repeat event in milliseconds. The *autorepeat interval* specifies the delay between all subsequent generated repeat events in milliseconds.

The PerKeyRepeat Control

When *RepeatKeys* are active, the *PerKeyRepeat* control specifies whether or not individual keys should autorepeat when held down. XKB provides the *PerKeyRepeat* for convenience only, and it always parallels the *auto-repeats* field of the core protocol *GetKeyboardControl* request — changes to one are always reflected in the other.

Detectable Autorepeat

The X server usually generates both press and release events whenever an autorepeating key is held down. If an XKB-aware client enables the *DetectableAutorepeat* per-client option for a keyboard, the server sends that client a key release event only when the key is *physically* released. For example, holding down a key to generate three characters without detectable autorepeat yields:


If detectable autorepeat is enabled, the client instead receives:

Press → Press → Press → Release

Note that only clients that request detectable autorepeat are affected; other clients continue to receive both press and release events for autorepeating keys. Also note that support for detectable autorepeat is optional; servers are not required to support detectable autorepeat, but they must correctly report whether or not it is supported.

¹AccessDOS provides access to the DOS operating system for people with physical impairments and was developed by the Trace R&D Center at the University of Wisconsin. For more information on AccessDOS, contact the Trace R&D Center, Waisman Center and Department of Industrial Engineering, University of Wisconsin-Madison WI 53705-2280. Phone: 608-262-6966. e-mail: info@trace.wisc.edu.
Querying and Changing Per-Client Flags describes the XkbPerClientFlags request, which reports or changes values for all of the per-client flags, and which lists the per-client flags that are supported.

The SlowKeys Control

Some users often bump keys accidentally while moving their hand or typing stick toward the key they want. Usually, the keys that are bumped accidentally are hit only for a very short period of time. The SlowKeys control helps filter these accidental bumps by telling the server to wait a specified period, called the SlowKeys acceptance delay, before delivering key events. If the key is released before this period elapses, no key events are generated. The user can then bump any number of keys on their way to the one they want without generating unwanted characters. Once they have reached the key they want, they can then hold it long enough for SlowKeys to accept it.

The SlowKeys control has one parameter; the slow keys delay specifies the length of time, in milliseconds, that a key must be held down before it is accepted.

When SlowKeys are active, the X Keyboard Extension reports the initial press, acceptance, rejection or release of any key to interested clients using AccessXNotify events. The AccessXNotify event is described in more detail in Events.

The BounceKeys Control

Some people with physical impairments accidentally "bounce" on a key when they press it. That is, they press it once, then accidentally press it again immediately. The BounceKeys control temporarily disables a key after it has been pressed, effectively "debouncing" the keyboard.

The BounceKeys has a single parameter. The BounceKeys delay specifies the period of time, in milliseconds, that the key is disabled after it is pressed.

When BounceKeys are active, the server reports the acceptance or rejection of any key to interested clients by sending an AccessXNotify event. The AccessXNotify event is described in more detail in Events.

The StickyKeys Control

Some people find it difficult or impossible to press two keys at once. The StickyKeys control makes it easier for them to type by changing the behavior of the modifier keys. When StickyKeys are enabled, a modifier is latched when the user presses it just once, so the user can first press a modifier, release it, then press another key. For example, to get an exclamation point (!) on a PC-style keyboard, the user can press the Shift key, release it, then press the 1 key.

By default, StickyKeys also allows users to lock modifier keys without requiring special locking keys. The user can press a modifier twice in a row to lock it, and then unlock it by pressing it one more time.

Modifiers are automatically unlatched when the user presses a non-modifier key. For instance, to enter the sequence Shift + Ctrl + Z the user could press and release the Shift key to latch the Shift modifier, then press and release the Ctrl key to
latch the Control modifier — the Ctrl key is a modifier key, so pressing it does not unlatch the Shift modifier, but leaves both the Shift and Control modifiers latched, instead. When the user presses the Z key, it will be as though the user pressed Shift + Ctrl + Z simultaneously. The Z key is not a modifier key, so the Shift and Control modifiers are unlatched after the event is generated.

A locked modifier remains in effect until the user unlocks it. For example, to enter the sequence (“XKB”) on a PC-style keyboard with a typical US/ASCII layout, the user could press and release the Shift key twice to lock the Shift modifier. Then, when the user presses the 9, , x, k, b, , and 0 keys in sequence, it will generate (“XKB”). To unlock the Shift modifier, the user can press and release the Shift key.

Two option flags modify the behavior of the StickyKeys control:

- If the XkbAX_TwoKeys flag is set, XKB automatically turns StickyKeys off if the user presses two or more keys at once. This serves to automatically disable StickyKeys when a user who does not require sticky keys is using the keyboard.

- The XkbAX_LatchToLock controls the locking behavior of StickyKeys; the StickyKeys control only locks modifiers as described above if the XkbAX_LatchToLock flag is set.

The MouseKeys Control

The MouseKeys control lets a user control all the mouse functions from the keyboard. When MouseKeys are enabled, all keys with MouseKeys actions bound to them generate core pointer events instead of normal key press and release events.

The MouseKeys control has a single parameter, the mouse keys default button, which specifies the core pointer button to be used by mouse keys actions that do not explicitly specify a button.

The MouseKeysAccel Control

If the MouseKeysAccel control is enabled, the effect of a pointer motion action changes as a key is held down. The mouse keys delay specifies the amount of time between the initial key press and the first repeated motion event. The mouse keys interval specifies the amount of time between repeated mouse keys events. The steps to maximum acceleration field specifies the total number of events before the key is travelling at maximum speed. The maximum acceleration field specifies the maximum acceleration. The curve parameter controls the ramp used to reach maximum acceleration.

When MouseKeys are active and a SA_MovePtr key action (see Key Actions) is activated, a pointer motion event is generated immediately. If MouseKeysAccel is enabled and if acceleration is enabled for the key in question, a second event is generated after mouse keys delay milliseconds, and additional events are generated every mouse keys interval milliseconds for as long as the key is held down.

Relative Pointer Motion

If the SA_MovePtr action specifies relative motion, events are generated as follows: The initial event always moves the cursor the distance specified in the action; after steps to maximum acceleration events have been generated, all subsequent events
move the pointer the distance specified in the action times the \textit{maximum acceleration}. Events after the first but before maximum acceleration has been achieved are accelerated according to the formula:

\[ d(\text{step}) = \text{action\_delta} \times \left( \frac{\text{max\_accel}}{\text{steps\_to\_max \ curveFactor}} \right) \times \text{step}^{\text{curveFactor}} \]

Where \text{action\_delta} is the offset specified by the mouse keys action, \text{max\_accel} and \text{steps\_to\_max} are parameters to the \textit{MouseKeysAccel} ctrl, and the curveFactor is computed using the \textit{MouseKeysAccel curve} parameter as follows:

\[ \text{curveFactor}(\text{curve}) = 1 + \frac{\text{curve}}{1000} \]

With the result that a \text{curve} of 0 causes the distance moved to increase linearly from \text{action\_delta} to \((\text{max\_accel} \times \text{action\_delta})\), and the minimum legal \text{curve} of -1000 causes all events after the first move at \text{max\_accel}. A negative \text{curve} causes an initial sharp increase in acceleration which tapers off, while a positive \text{curve} yields a slower initial increase in acceleration followed by a sharp increase as the number of pointer events generated by the action approaches \text{steps\_to\_max}.

\section*{Absolute Pointer Motion}

If an \textit{SA\_MovePtr} action specifies an absolute position for one of the coordinates but still allows acceleration, all repeated events contain any absolute coordinates specified in the action.

\section*{The AccessXKeys Control}

If \textit{AccessXKeys} is enabled many controls can also be turned on or off from the keyboard by entering the following standard key sequences:

\begin{itemize}
  \item Holding down a shift key by itself for eight seconds toggles the \textit{SlowKeys} control.
  \item Pressing and releasing a shift key five times in a row without any intervening key events and with less than 30 seconds delay between consecutive presses toggles the state of the \textit{StickyKeys} control.
  \item Simultaneously operating two or more modifier keys deactivates the \textit{StickyKeys} control.
\end{itemize}

Some of these key sequences optionally generate audible feedback of the change in state, as described in \textit{The AccessXFeedback Control}, or cause \textit{XkbAccessXNotify} events as described in \textit{Events}.

\section*{The AccessXTimeout Control}

In environments where computers are shared, features such as \textit{SlowKeys} present a problem: if \textit{SlowKeys} is on, the keyboard can appear to be unresponsive because
Global Keyboard Controls

keys have no effect unless they are held for a certain period of time. To help address this problem, XKB provides an *AccessXTimeout* control to automatically change the value of any global controls or AccessX options if the keyboard is idle for a specified period of time.

The AccessXTimeout control has a number of parameters which affect the duration of the timeout and the features changed when the timeout expires.

The *AccessX Timeout* field specifies the number of seconds the keyboard must be idle before the global controls and AccessX options are modified. The *AccessX Options Mask* field specifies which values in the *AccessX Options* field are to be changed, and the *AccessX Options Values* field specifies the new values for those options. The *AccessX Controls Mask* field specifies which controls are to be changed in the global set of enabled controls, and the *AccessX Controls Values* field specifies the new values for those controls.

**The AccessXFeedback Control**

If *AccessXFeedback* is enabled, special beep-codes indicate changes in keyboard controls (or some key events when *SlowKeys* or *StickyKeys* are active). Many beep codes sound as multiple tones, but XKB reports a single *XkbBellNotify* event for the entire sequence of tones.

All feedback tones are governed by the *AudibleBell* control. Individual feedback tones can be explicitly enabled or disabled using the *accessX options mask* or set to deactivate after an idle period using the *accessX timeout options mask*. XKB defines the following feedback tones:
Global Keyboard Controls

<table>
<thead>
<tr>
<th>Feedback Name</th>
<th>Bell Name</th>
<th>Default Sound</th>
<th>Indicates</th>
</tr>
</thead>
<tbody>
<tr>
<td>FeatureFB</td>
<td>AX_FeatureOn</td>
<td>rising tone</td>
<td>Keyboard control enabled</td>
</tr>
<tr>
<td></td>
<td>AX_FeatureOff</td>
<td>falling tone</td>
<td>Keyboard control disabled</td>
</tr>
<tr>
<td></td>
<td>AX_FeatureChange</td>
<td>two tones</td>
<td>Several controls changed state</td>
</tr>
<tr>
<td>IndicatorFB</td>
<td>AX_IndicatorOn</td>
<td>high tone</td>
<td>Indicator Lit</td>
</tr>
<tr>
<td></td>
<td>AX_IndicatorOff</td>
<td>low tone</td>
<td>Indicator Extinguished</td>
</tr>
<tr>
<td></td>
<td>AX_IndicatorChange</td>
<td>two high tones</td>
<td>Several indicators changed state</td>
</tr>
<tr>
<td>SlowWarnFB</td>
<td>AX_SlowKeysWarning</td>
<td>three high tones</td>
<td>Shift key held for four seconds</td>
</tr>
<tr>
<td>SKPressFB</td>
<td>AX_SlowKeyPress</td>
<td>single tone</td>
<td>Key press while \textit{SlowKeys} are on</td>
</tr>
<tr>
<td>SKReleaseFB</td>
<td>AX_SlowKeyRelease</td>
<td>single tone</td>
<td>Key release while \textit{SlowKeys} are on</td>
</tr>
<tr>
<td>SKAcceptFB</td>
<td>AX_SlowKeyAccept</td>
<td>single tone</td>
<td>Key event accepted by \textit{SlowKeys}</td>
</tr>
<tr>
<td>SKRejectFB</td>
<td>AX_SlowKeyReject</td>
<td>low tone</td>
<td>Key event rejected by \textit{SlowKeys}</td>
</tr>
<tr>
<td>StickyKeysFB</td>
<td>AX_StickyLatch</td>
<td>low tone then high tone</td>
<td>Modifier latched by \textit{StickyKeys}</td>
</tr>
<tr>
<td></td>
<td>AX_StickyLock</td>
<td>high tone</td>
<td>Modifier locked by \textit{StickyKeys}</td>
</tr>
<tr>
<td></td>
<td>AX_StickyUnlock</td>
<td>low tone</td>
<td>Modifier unlocked by \textit{StickyKeys}</td>
</tr>
<tr>
<td>BKRejectFB</td>
<td>AX_BounceKeysReject</td>
<td>low tone</td>
<td>Key event rejected by \textit{BounceKeys}</td>
</tr>
</tbody>
</table>

Implementations that cannot generate continuous tones may generate multiple beeps instead of falling and rising tones; for example, they can generate a high-pitched beep followed by a low-pitched beep instead of a continuous falling tone.

If the physical keyboard bell is not very capable, attempts to simulate a continuous tone with multiple bells can sound horrible. Set the \texttt{DumbBellFB} AccessX option to inform the server that the keyboard bell is not very capable and that XKB should use only simple bell combinations. Keyboard capabilities vary wildly, so the sounds generated for the individual bells when the \texttt{DumbBellFB} option is set are implementation specific.

**The Overlay1 and Overlay2 Controls**

A keyboard overlay allows some subset of the keyboard to report alternate keycodes when the overlay is enabled. For example a keyboard overlay can be used to simulate a numeric or editing keypad on keyboard that does not actually have one by
generating alternate keycodes for some keys when the overlay is enabled. This technique is very common on portable computers and embedded systems with small keyboards.

XKB includes direct support for two keyboard overlays, using the Overlay1 and Overlay2 controls. When Overlay1 is enabled, all of the keys that are members of the first keyboard overlay generate an alternate keycode. When Overlay2 is enabled, all of the keys that are members of the second keyboard overlay generate an alternate keycode.

To specify the overlay to which a key belongs and the alternate keycode it should generate when that overlay is enabled, assign it either the KB_Overlay1 or KB_Overlay2 key behaviors, as described in Key Behavior.

"Boolean" Controls and The EnabledControls Control

All of the controls described above, along with the AudibleBell control (described in Disabling Server Generated Bells) and the IgnoreGroupLock control (described in Server Internal Modifiers and Ignore Locks Behavior) comprise the boolean controls. In addition to any parameters listed in the descriptions of the individual controls, the boolean controls can be individually enabled or disabled by changing the value of the EnabledControls control.

The following non-boolean controls are always active and cannot be changed using the EnabledControls control or specified in any context that accepts only boolean controls: GroupsWrap (Computing Effective Modifier and Group), EnabledControls, InternalMods (Server Internal Modifiers and Ignore Locks Behavior), and IgnoreLockMods (Server Internal Modifiers and Ignore Locks Behavior) and PerKeyRepeat (The RepeatKeys Control)

Automatic Reset of Boolean Controls

The auto-reset controls are a per-client value which consist of two masks that can contain any of the boolean controls (see "Boolean" Controls and The EnabledControls Control). Whenever the client exits for any reason, any boolean controls specified in the auto-reset mask are set to the corresponding value from the auto-reset values mask. This makes it possible for clients to “clean up after themselves” automatically, even if abnormally terminated.

For example, a client that replace the keyboard bell with some other audible cue might want to turn off the AudibleBell control (Disabling Server Generated Bells) to prevent the server from also generating a sound and thus avoid cacophony. If the client were to exit without resetting the AudibleBell control, the user would be left without any feedback at all. Setting AudibleBell in both the auto-reset mask and auto-reset values guarantees that the audible bell will be turned back on when the client exits.
Chapter 5. Key Event Processing

Overview

There are three steps to processing each key event in the X server, and at least three in the client. This section describes each of these steps briefly; the following sections describe each step in more detail.

1. First, the server applies global keyboard controls to determine whether the key event should be processed immediately, deferred, or ignored. For example, the SlowKeys control can cause a key event to be deferred until the slow keys delay has elapsed while the RepeatKeys control can cause multiple X events from a single physical key press if the key is held down for an extended period. The global keyboard controls affect all of the keys on the keyboard and are described in Global Keyboard Controls.

2. Next, the server applies per-key behavior. Per key-behavior can be used to simulate or indicate some special kinds of key behavior. For example, keyboard overlays, in which a key generates an alternate keycode under certain circumstances, can be implemented using per-key behavior. Every key has a single behavior, so the effect of key behavior does not depend on keyboard modifier or group state, though it might depend on global keyboard controls. Per-key behaviors are described in Key Behavior.

3. Finally, the server applies key actions. Logically, every keysym on the keyboard has some action associated with it. The key action tells the server what to do when an event which yields the corresponding keysym is generated. Key actions might change or suppress the event, generate some other event, or change some aspect of the server. Key actions are described in Key Actions.

If the global controls, per-key behavior and key action combine to cause a key event, the client which receives the event processes it in several steps.

1. First the client extracts the effective keyboard group and a set of modifiers from the state field of the event. See Computing A State Field from an XKB State for details.

2. Using the modifiers and effective keyboard group, the client selects a symbol from the list of keysyms bound to the key. Determining the KeySym Associated with a Key Event discusses symbol selection.

3. If necessary, the client transforms the symbol and resulting string using any modifiers that are "left over" from the process of looking up a symbol. For example, if the Lock modifier is left over, the resulting keysym is capitalized according to the capitalization rules specified by the system. See Transforming the KeySym Associated with a Key Event for a more detailed discussion of the transformations defined by XKB.

4. Finally, the client uses the keysym and remaining modifiers in an application-specific way. For example, applications based on the X toolkit might apply translations based on the symbol and modifiers reported by the first three steps.
Chapter 6. Key Event Processing in the Server

This section describes the steps involved in processing a key event within the server when XKB is present. Key events can be generated due to keyboard activity and passed to XKB by the DDX layer, or they can be synthesized by another extension, such as XTEST.

Applying Global Controls

When the X Keyboard Extension receives a key event, it first checks the global key controls to decide whether to process the event immediately or at all. The global key controls which might affect the event, in descending order of priority, are:

- If a key is pressed while the **BounceKeys** control is enabled, the extension generates the event only if the key is active. When a key is released, the server deactivates the key and starts a **bounce keys timer** with an interval specified by the debounce delay.

  If the bounce keys timer expires or if some other key is pressed before the timer expires, the server reactivates the corresponding key and deactivates the timer. Neither expiration nor deactivation of a bounce keys timer causes an event.

- If the **SlowKeys** control is enabled, the extension sets a **slow keys timer** with an interval specified by the slow keys delay, but does not process the key event immediately. The corresponding key release deactivates this timer.

  If the slow keys timer expires, the server generates a key press for the corresponding key, sends an **XkbAccessXNotify** and deactivates the timer.

- The extension processes key press events normally whether or not the **RepeatKeys** control is active, but if **RepeatKeys** are enabled and per-key autorepeat is enabled for the event key, the extension processes key press events normally, but it also initiates an **autorepeat timer** with an interval specified by the autorepeat delay. The corresponding key release deactivates the timer.

  If the autorepeat timer expires, the server generates a key release and a key press for the corresponding key and reschedules the timer according to the autorepeat interval.

Key events are processed by each global control in turn: if the **BounceKeys** control accepts a key event, **SlowKeys** considers it. Once **SlowKeys** allows or synthesizes an event, the **RepeatKeys** control acts on it.

Key Behavior

Once an event is accepted by all of the controls or generated by a timer, the server checks the per-key behavior of the corresponding key. This extension currently defines the following key behaviors:
Key Event Processing in the Server

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>KB_Default</td>
<td>Press and release events are processed normally.</td>
</tr>
<tr>
<td>KB_Lock</td>
<td>If a key is logically up (i.e. the corresponding bit of the core key map is cleared) when it is pressed, the key press is processed normally and the corresponding release is ignored. If the key is logically down when pressed, the key press is ignored but the corresponding release is processed normally.</td>
</tr>
<tr>
<td>KB_RadioGroup flags: CARD8 index: CARD8</td>
<td>If another member of the radio group specified by index is logically down when a key is pressed, the server synthesizes a key release for the member that is logically down and then processes the new key press event normally. If the key itself is logically down when pressed, the key press event is ignored, but the processing of the corresponding key release depends on the value of the RGAllowNone bit in flags. If it is set, the key release is processed normally; otherwise the key release is also ignored. All other key release events are ignored.</td>
</tr>
<tr>
<td>KB_Overlay1 key: KEYCODE</td>
<td>If the Overlay1 control is enabled, events from this key are reported as if they came from the key specified in key. Otherwise, press and release events are processed normally.</td>
</tr>
<tr>
<td>KB_Overlay2 key: KEYCODE</td>
<td>If the Overlay2 control is enabled, events from this key are reported as if they came from the key specified in key. Otherwise, press and release events are processed normally.</td>
</tr>
</tbody>
</table>

The X server uses key behavior to determine whether to process or filter out any given key event; key behavior is independent of keyboard modifier or group state (each key has exactly one behavior).

Key behaviors can be used to simulate any of these types of keys or to indicate an unmodifiable physical, electrical or software driver characteristic of a key. An optional permanent flag can modify any of the supported behaviors and indicates that behavior describes an unalterable physical, electrical or software aspect of the keyboard. Permanent behaviors cannot be changed or set by the XkbSetMap request. The permanent flag indicates a characteristic of the underlying system that XKB cannot affect, so XKB treats all permanent behaviors as if they were KB_Default and does not filter key events described in the table above.

Key Actions

Once the server has applied the global controls and per-key behavior and has decided to process a key event, it applies key actions to determine the effects of the key on the internal state of the server. A key action consists of an operator and some optional data. XKB supports actions which:

- change base, latched or locked modifiers or group
- move the core pointer or simulate core pointer button events
- change most aspects of keyboard behavior
Key Event Processing in the Server

- terminate or suspend the server
- send a message to interested clients
- simulate events on other keys

Each key has an optional list of actions. If present, this list parallels the list of symbols associated with the key (i.e. it has one action per symbol associated with the key). For key press events, the server looks up the action to be applied from this list using the key symbol mapping associated with the event key, just as a client looks up symbols as described in Determining the KeySym Associated with a Key Event; if the event key does not have any actions, the server uses the SA_NoAction event for that key regardless of modifier or group state.

Key actions have essentially two halves; the effects on the server when the key is pressed and the effects when the key is released. The action applied for a key press event determines the further actions, if any, that are applied to the corresponding release event or to events that occur while the key is held down. Clients can change the actions associated with a key while the key is down without changing the action applied next time the key is released; subsequent press-release pairs will use the newly bound key action.

Most actions directly change the state of the keyboard or server; some actions also modify other actions that occur simultaneously with them. Two actions occur simultaneously if the keys which invoke the actions are both logically down at the same time, regardless of the order in which they are pressed or delay between the activation of one and the other.

Most actions which affect keyboard modifier state accept a modifier definition (see Virtual Modifiers) named mods and a boolean flag name useModMap among their arguments. These two fields combine to specify the modifiers affected by the action as follows: If useModMap is True, the action sets any modifiers bound by the modifier mapping to the key that initiated the action; otherwise, the action sets the modifiers specified by mods. For brevity in the text of the following definitions, we refer to this combination of useModMap and mods as the "action modifiers."

The X Keyboard Extension supports the following actions:

<table>
<thead>
<tr>
<th>Action</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA_NoAction</td>
<td>• No direct effect, though SA_NoAction events may change the effect of other server actions (see below).</td>
</tr>
<tr>
<td>SA_SetMods</td>
<td>• Key press adds any action modifiers to the keyboard’s base modifiers.</td>
</tr>
<tr>
<td>mods: MOD_DEF</td>
<td>• Key release clears any action modifiers in the keyboard’s base modifiers, provided that no other key which affects the same modifiers is logically down.</td>
</tr>
<tr>
<td>useModMap: BOOL</td>
<td>• If no keys were operated simultaneously with this key and useModMap is set, release unlocks any action modifiers.</td>
</tr>
<tr>
<td>clearLocks: BOOL</td>
<td>• Key press and release events have the same effect as for SA_SetMods; if no keys were operated simultaneously with the latching modifier key, key release events have the following additional effects:</td>
</tr>
<tr>
<td>SA_LatchMods</td>
<td>• Key press and release events have the same effect as for SA_SetMods; if no keys were operated simultaneously with the latching modifier key, key release events have the following additional effects:</td>
</tr>
</tbody>
</table>
Key Event Processing in the Server

<table>
<thead>
<tr>
<th>Action</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>clearLocks: BOOL</td>
<td>• Modifiers that were unlocked due to clearLocks have no further effect.</td>
</tr>
<tr>
<td>latchToLock: BOOL</td>
<td>• If latchToLock is set, key release locks and then unlatches any remaining action modifiers that are already latched.</td>
</tr>
<tr>
<td></td>
<td>• Finally, key release latches any action modifiers that were not used by the clearLocks or latchToLock flags.</td>
</tr>
<tr>
<td>SA_LockMods</td>
<td>• Key press sets the base and possibly the locked state of any action modifiers. If noLock is True, only the base state is changed.</td>
</tr>
<tr>
<td>mods: MOD_DEF</td>
<td>• For key release events, clears any action modifiers in the keyboard’s base modifiers, provided that no other key which affects the same modifiers is down. If noUnlock is False and any of the action modifiers were locked before the corresponding key press occurred, key release unlocks them.</td>
</tr>
<tr>
<td>useModMap: BOOL</td>
<td>• If groupAbsolute is set, key press events change the base keyboard group to group; otherwise, they add group to the base keyboard group. In either case, the resulting effective keyboard group is brought back into range depending on the value of the GroupsWrap control for the keyboard.</td>
</tr>
<tr>
<td>noLock: BOOL</td>
<td>• If an SA_ISOLock key is pressed while this key is held down, key release has no effect, otherwise it cancels the effects of the press.</td>
</tr>
<tr>
<td>noUnlock: BOOL</td>
<td>• If no keys were operated simultaneously with this key and clearLocks is set, key release also sets the locked keyboard group to Group1.</td>
</tr>
<tr>
<td>SA_SetGroup</td>
<td>• Key press and release events have the same effect as an SA_SetGroup action; if no keys were operated simultaneously with the latching group key and the clearLocks flag was not set or had no effect, key release has the following additional effects:</td>
</tr>
<tr>
<td>group: INT8</td>
<td>• If latchToLock is set and the latched keyboard group is non-zero, the key release adds the delta applied by the corresponding key press to the locked keyboard group and subtracts it from the latched keyboard group. The locked and effective keyboard group are brought back into range according to the value of the global GroupsWrap control for the keyboard.</td>
</tr>
<tr>
<td>groupAbsolute: BOOL</td>
<td>• Otherwise, key release adds the key press delta to the latched keyboard group.</td>
</tr>
<tr>
<td>clearLocks: BOOL</td>
<td>• If groupAbsolute is set, key press sets the locked keyboard group to group. Otherwise, key press adds group to the locked keyboard group. In either case, the resulting locked and effective group is brought back into range de-</td>
</tr>
</tbody>
</table>
# Key Event Processing in the Server

<table>
<thead>
<tr>
<th>Action</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>groupAbsolute:</td>
<td>pending on the value of the <code>GroupsWrap</code> control for the keyboard.</td>
</tr>
<tr>
<td>BOOL</td>
<td>• Key release has no effect.</td>
</tr>
<tr>
<td><code>SA_MovePtr</code></td>
<td>• If <code>MouseKeys</code> are not enabled, this action behaves like <code>SA_NoAction</code>, otherwise this action cancels any pending repeat key timers for this key and has the following additional effects.</td>
</tr>
<tr>
<td>x, y: INT16</td>
<td>x specifies the new pointer X coordinate, otherwise x is added to the current pointer X coordinate; <code>absoluteY</code> and y specify the new Y coordinate in the same way.</td>
</tr>
<tr>
<td>noAccel: BOOL:</td>
<td>• If noAccel is <code>False</code>, and the <code>MouseKeysAccel</code> keyboard control is enabled, key press also initiates the mouse keys timer for this key; every time this timer expires, the cursor moves again. The distance the cursor moves in these subsequent events is determined by the mouse keys acceleration as described in <em>The MouseKeysAccel Control</em>.</td>
</tr>
<tr>
<td>absoluteX: BOOL</td>
<td>• Key press generates a core pointer <code>MotionNotify</code> event instead of the usual <code>KeyPress</code>. If <code>absoluteX</code> is <code>True</code>,</td>
</tr>
<tr>
<td>absoluteY: BOOL</td>
<td>• If <code>count</code> is <code>0</code>, key press generates a single <code>ButtonPress</code> event; if <code>count</code> is greater than <code>0</code>, key press generates <code>count</code> pairs of <code>ButtonPress</code> and <code>ButtonRelease</code> events.</td>
</tr>
<tr>
<td><code>SA_PtrBtn</code></td>
<td>• If <code>MouseKeys</code> are not enabled, this action behaves like <code>SA_NoAction</code>.</td>
</tr>
<tr>
<td>button: CARD8</td>
<td>• If <code>count</code> is <code>0</code>, key release generates a core pointer <code>ButtonRelease</code> which matches the event generated by the corresponding key press; if count is non-zero, key release does not cause a <code>ButtonRelease</code> event. Key release never causes a key release event.</td>
</tr>
<tr>
<td>count: CARD8</td>
<td>If <code>useDfltBtn</code> is set, the event is generated for the current default core button. Otherwise, the event is generated for the button specified by <code>button</code>.</td>
</tr>
<tr>
<td>useDfltBtn: BOOL</td>
<td>If the mouse button specified for this action is logically down, the key press and corresponding release are ignored and have no effect.</td>
</tr>
<tr>
<td><code>SA_LockPtrBtn</code></td>
<td>Otherwise, key press causes one or more core pointer button events instead of the usual key press. If <code>count</code> is <code>0</code>, key press generates a single <code>ButtonPress</code> event; if <code>count</code> is greater than <code>0</code>, key press generates <code>count</code> pairs of <code>ButtonPress</code> and <code>ButtonRelease</code> events.</td>
</tr>
<tr>
<td>button: BUTTON</td>
<td>• If <code>MouseKeys</code> are not enabled, this action behaves like <code>SA_NoAction</code>.</td>
</tr>
</tbody>
</table>
| noLock: BOOL    | • Otherwise, if the button specified by `useDfltBtn` and `button` is not locked, key press causes a `ButtonPress` instead of a key press and locks the button. If the button is already
Key Event Processing in the Server

<table>
<thead>
<tr>
<th>Action</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>noUnlock: BOOL</td>
<td>locked or if noLock is True, key press is ignored and has no effect.</td>
</tr>
<tr>
<td>useDfltBtn: BOOL</td>
<td>• If the corresponding key press was ignored, and if noUnlock is False, key release generates a ButtonRelease event instead of a key release event and unlocks the specified button. If the corresponding key press locked a button, key release is ignored and has no effect.</td>
</tr>
<tr>
<td>SA_SetPtrDflt</td>
<td>• If MouseKeys are not enabled, this action behaves like SA_NoAction.</td>
</tr>
<tr>
<td>affect: CARD8</td>
<td>• Otherwise, both key press and key release are ignored, but key press changes the pointer value specified by affect to value, as follows:</td>
</tr>
<tr>
<td>value: CARD8</td>
<td>• If which is SA_AffectDfltBtn, value and dfltBtnAbs specify the default pointer button used by the various pointer actions as follow: If dfltBtnAbs is True, value specifies the button to be used, otherwise, value specifies the amount to be added to the current default button. In either case, illegal button choices are wrapped back into range.</td>
</tr>
<tr>
<td>dfltBtnAbs: BOOL</td>
<td>• If dfltIsGroup is True, key press sets the base group specified by groupAbsolute and group. Otherwise, key press sets the action modifiers in the keyboard's base modifiers.</td>
</tr>
<tr>
<td>SA_ISOLock</td>
<td>• Key release clears the base modifiers or group that were set by the key press; it may have additional effects if no other appropriate actions occur simultaneously with the SA_ISOLock operation.</td>
</tr>
<tr>
<td>dfltIsGroup: False</td>
<td>• If noAffectMods is False, any SA_SetMods or SA_LatchMods actions that occur simultaneously with the ISOLock action are treated as SA_LockMods instead.</td>
</tr>
<tr>
<td>mods: MOD_DEF</td>
<td>• If noAffectGrp is False, any SA_SetGroup or SA_LatchGroup actions that occur simultaneously with this action are treated as SA_LockGroup actions instead.</td>
</tr>
<tr>
<td>useModMap: BOOL</td>
<td>• If noAffectPtr is False, SA_PtrBtn actions that occur simultaneously with the SA_ISOLock action are treated as SA_LockPtrBtn actions instead.</td>
</tr>
<tr>
<td>noLock: BOOL</td>
<td>• If noAffectCtrls is False, any SA_SetControls actions that occur simultaneously with the SA_ISOLock action are treated as SA_LockControls actions instead.</td>
</tr>
<tr>
<td>noUnlock: BOOL</td>
<td>• If no other actions were transformed by the SA_ISOLock action, key release locks the group or modifiers specified by the action arguments.</td>
</tr>
<tr>
<td>noAffectMods: BOOL</td>
<td></td>
</tr>
<tr>
<td>noAffectGrp: BOOL</td>
<td></td>
</tr>
<tr>
<td>noAffectPtr: BOOL</td>
<td></td>
</tr>
<tr>
<td>noAffectCtrls: BOOL</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>dfltIsGroup: True</td>
<td></td>
</tr>
<tr>
<td>group: INT8</td>
<td></td>
</tr>
<tr>
<td>groupAbsolute: BOOL</td>
<td></td>
</tr>
<tr>
<td>noAffectMods: BOOL</td>
<td></td>
</tr>
<tr>
<td>Action</td>
<td>Effect</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>noAffectGrp: BOOL</td>
<td></td>
</tr>
<tr>
<td>noAffectPtr: BOOL</td>
<td></td>
</tr>
<tr>
<td>noAffectCtrls: BOOL</td>
<td></td>
</tr>
<tr>
<td><strong>SA_TerminateServer</strong></td>
<td>Key press terminates the server. Key release is ignored.</td>
</tr>
<tr>
<td>num: INT8</td>
<td>If the server supports this action and multiple screens or displays (either virtual or real), this action changes to the active screen indicated by <code>num</code> and <code>screenAbs</code>. If <code>screenAbs</code> is <code>True</code>, <code>num</code> specifies the index of the new screen; otherwise, <code>num</code> specifies an offset from the current screen to the new screen.</td>
</tr>
<tr>
<td>switchApp: BOOL</td>
<td>If <code>switchApp</code> is <code>False</code>, it should switch to another screen on the same server. Otherwise it should switch to another X server or application which shares the same physical display.</td>
</tr>
<tr>
<td>screenAbs: BOOL</td>
<td>This action is optional; servers are free to ignore the action or any of its flags if they do not support the requested behavior. If the action is ignored, it behaves like <code>SA_NoAction</code>.</td>
</tr>
<tr>
<td><strong>SA_SwitchScreen</strong></td>
<td></td>
</tr>
<tr>
<td>controls: KB_BOOLCTRLMASK</td>
<td>Key press enables any boolean controls that are specified in <code>controls</code> and not already enabled at the time of the key press. Key release disables any controls that were enabled by the corresponding key press. This action can cause <code>XkbControlsNotify</code> events.</td>
</tr>
<tr>
<td>noLock: BOOL</td>
<td>If <code>noLock</code> is <code>False</code>, key press locks and enables any controls that are specified in <code>controls</code> and not already locked at the time of the key press.</td>
</tr>
<tr>
<td>noUnlock: BOOL</td>
<td>If <code>noUnlock</code> is <code>False</code>, key release unlocks and disables any controls that are specified in <code>controls</code> and were not enabled at the time of the corresponding key press.</td>
</tr>
<tr>
<td><strong>SA_SetControls</strong></td>
<td></td>
</tr>
<tr>
<td>pressMsg: BOOL</td>
<td>If <code>pressMsg</code> is <code>True</code>, key press generates an <code>XkbActionMessage</code> event which reports the keycode, event type and the contents of <code>message</code>.</td>
</tr>
<tr>
<td>releaseMsg: BOOL</td>
<td>If <code>releaseMsg</code> is <code>True</code>, key release generates an <code>XkbActionMessage</code> event which reports the keycode, event type and contents of <code>message</code>.</td>
</tr>
<tr>
<td>genEvent: BOOL</td>
<td>If <code>genEvent</code> is <code>True</code>, both press and release generate key press and key release events, regardless of whether they also cause an <code>XkbActionMessage</code>.</td>
</tr>
</tbody>
</table>
### Key Event Processing in the Server

<table>
<thead>
<tr>
<th>Action</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SA_RedirectKey</strong></td>
<td>• Key press causes a key press event for the key specified by <code>newKey</code> instead of for the actual key. The state reported in this event reports of the current effective modifiers changed as follow: Any real modifiers specified in <code>modsMask</code> are set to corresponding values from <code>mods</code>. Any real modifiers bound to the virtual modifiers specified in <code>vmodsMask</code> are either set or cleared, depending on the corresponding value in <code>vmods</code>. If the real and virtual modifier definitions specify conflicting values for a single modifier, the real modifier definition has priority.</td>
</tr>
<tr>
<td><code>newKey</code>: KEYCODE</td>
<td></td>
</tr>
<tr>
<td><code>modsMask</code>: KEYMASK</td>
<td></td>
</tr>
<tr>
<td><code>mods</code>: KEYMASK</td>
<td></td>
</tr>
<tr>
<td><code>vmodsMask</code>: CARD16</td>
<td></td>
</tr>
<tr>
<td><code>vmods</code>: CARD16</td>
<td></td>
</tr>
<tr>
<td><strong>SA_DeviceBtn</strong></td>
<td>• The <code>SA_RedirectKey</code> action normally redirects to another key on the same device as the key or button which caused the event, unless that device does not belong to the input extension KEYCLASS, in which case this action causes an event on the core keyboard device.</td>
</tr>
<tr>
<td><code>count</code>: CARD8</td>
<td></td>
</tr>
<tr>
<td><code>button</code>: BUTTON</td>
<td></td>
</tr>
<tr>
<td><code>device</code>: CARD8</td>
<td></td>
</tr>
<tr>
<td><strong>SA_LockDeviceBtn</strong></td>
<td>• Otherwise, key press causes one or more input extension device button events instead of the usual key press event. If <code>count</code> is 0, key press generates a single <code>DeviceButtonPress</code> event; if <code>count</code> is greater than 0, key press generates <code>count</code> pairs of <code>DeviceButtonPress</code> and <code>DeviceButtonRelease</code> events.</td>
</tr>
<tr>
<td><code>button</code>: BUTTON</td>
<td></td>
</tr>
<tr>
<td><code>device</code>: CARD8</td>
<td></td>
</tr>
<tr>
<td><code>noLock</code>: BOOL</td>
<td>• If <code>count</code> is 0, key release generates an input extension <code>DeviceButtonRelease</code> which matches the event generated by the corresponding key press; if count is non-zero, key release does not cause a <code>DeviceButtonRelease</code> event. Key release never causes a key release event.</td>
</tr>
<tr>
<td><code>noUnlock</code>: BOOL</td>
<td></td>
</tr>
</tbody>
</table>

- **SA_DeviceBtn** action is used when a device button is pressed or released. It specifies the ID of an extension device and the index of a button on that device. If the button specified by this action is logically down, the key press and corresponding release are ignored and have no effect. If the device or button specified by this action are illegal, this action behaves like **SA_NoAction**.

- **SA_LockDeviceBtn** action is used to lock or unlock a button on a device. It specifies the ID of an extension device and the index of a button on that device. If the specified button is not locked and if `noLock` is False, key press causes an input extension `DeviceButtonPress` event instead of a key press event and locks the button. If the button is already locked or if `noLock` is True, key press is ignored and has no effect.
Key Event Processing in the Server

<table>
<thead>
<tr>
<th>Action</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SA_DeviceValuator</strong></td>
<td>- If the corresponding key press was ignored, and if <em>noUnlock</em> is <em>False</em>, key release generates an input extension <em>DeviceButtonRelease</em> event instead of a core protocol or input extension key release event and unlocks the specified button. If the corresponding key press locked a button, key release is ignored and has no effect.</td>
</tr>
<tr>
<td>device : CARD8</td>
<td>- The <em>device</em> field specifies the ID of an extension device; <em>val1</em> and <em>val2</em> specify valuators on that device. If <em>device</em> is illegal or if neither <em>val1</em> nor <em>val2</em> specifies a legal valuator, this action behaves like <em>SA_NoAction</em>.</td>
</tr>
<tr>
<td>val1What : SA_DVOP</td>
<td>- If <em>valn</em> specifies a legal valuator and <em>valnWhat</em> is not <em>SA_IgnoreVal</em>, the specified value is adjusted as specified by <em>valnWhat</em>:</td>
</tr>
<tr>
<td>val1 : CARD8</td>
<td>- If <em>valnWhat</em> is <em>SA_SetValMin</em>, <em>valn</em> is set to its minimum legal value.</td>
</tr>
<tr>
<td>val1Value : INT8</td>
<td>- If <em>valnWhat</em> is <em>SA_SetValCenter</em>, <em>valn</em> is centered (to (max-min)/2).</td>
</tr>
<tr>
<td>val1Scale : 0...7</td>
<td>- If <em>valnWhat</em> is <em>SA_SetValMax</em>, <em>valn</em> is set to its maximum legal value.</td>
</tr>
</tbody>
</table>
| val2What : BOOL         |   - if *valnWhat* is *SA_SetValRelative*, \[
| val2 : CARD8             |     \[ valnValue \times 2^{\text{valnScale}} \]
| val2Value : INT8         |     is added to *valn*.                                                                                                                   |
| val2Scale : 0...7        |   - If *valnWhat* is *SA_SetValAbsolute*, *valn* is set to \[
|                         |     \[ valnValue \times 2^{\text{valnScale}} \]
|                         |   .                                                                                                                                       |
|                         | - Illegal values for *SA_SetValRelative* or *SA_SetValAbsolute* are clamped into range.                                                  |

If *StickyKeys* are enabled, all *SA_SetMods* and *SA_SetGroup* actions act like *SA_LatchMods* and *SA_LatchGroup* respectively. If the *LatchToLock* AccessX option is set, either action behaves as if both the *SA_ClearLocks* and *SA_LatchToLock* flags are set.

Actions which cause an event from another key or from a button on another device immediately generate the specified event. These actions do not consider the behavior or actions (if any) that are bound to the key or button to which the event is redirected.

Core events generated by server actions contain the keyboard state that was in effect at the time the key event occurred; the reported state does not reflect any changes in state that occur as a result of the actions bound to the key event that caused them.
Events sent to clients that have not issued an XkbUseExtension request contain a compatibility state in place of the actual XKB keyboard state. See Effects of XKB on Core Protocol Events for a description of this compatibility mapping.

Delivering a Key or Button Event to a Client

The window and client that receive core protocol and input extension key or button events are determined using the focus policy, window hierarchy and passive grabs as specified by the core protocol and the input extension, with the following changes:

- A passive grab triggers if the modifier state specified in the grab matches the grab compatibility state (described in Compatibility Components of Keyboard State). Clients can choose to use the XKB grab state instead by setting the GrabsUseXKBState per-client flag. This flag affects all passive grabs that are requested by the client which sets it but does not affect passive grabs that are set by any other client.

- The state field of events which trigger a passive grab reports the XKB or compatibility grab state in effect at the time the grab is triggered; the state field of the corresponding release event reports the corresponding grab state in effect when the key or button is released.

- If the LookupStateWhenGrabbed per-client flag is set, all key or button events that occur while a keyboard or pointer grab is active contain the XKB or compatibility lookup state, depending on the value of the GrabsUseXKBState per-client flag. If LookupStateWhenGrabbed is not set, they include the XKB or compatibility grab state, instead.

- Otherwise, the state field of events that do not trigger a passive grab report is derived from the XKB effective modifiers and group, as described in Computing A State Field from an XKB State.

- If a key release event is the result of an autorepeating key that is being held down, and the client to which the event is reported has requested detectable autorepeat (see Detectable Autorepeat), the event is not delivered to the client.

The following section explains the intent of the XKB interactions with core protocol grabs and the reason that the per-client flags are needed.

XKB Interactions With Core Protocol Grabs

XKB provides the separate lookup and grab states to help work around some difficulties with the way the core protocol specifies passive grabs. Unfortunately, many clients work around those problems differently, and the way that XKB handles grabs and reports keyboard state can sometimes interact with those client workarounds in unexpected and unpleasant ways.

To provide more reasonable behavior for clients that are aware of XKB without causing problems for clients that are unaware of XKB, this extension provides two per-client flags that specify the way that XKB and the core protocol should interact.

- The largest problems arise from the fact that an XKB state field encodes an explicit keyboard group in bits 13-14 (as described in Computing A State Field from
an XKB State), while pre-XKB clients use one of the eight keyboard modifiers to select an alternate keyboard group. To make existing clients behave reasonably, XKB normally uses the compatibility grab state instead of the XKB grab state to determine whether or not a passive grab is triggered. XKB-aware clients can set the `GrabsUseXKBState` per-client flag to indicate that they are specifying passive grabs using an XKB state.

• Some toolkits start an active grab when a passive grab is triggered, in order to have more control over the conditions under which the grab is terminated. Unfortunately, the fact that XKB reports a different state in events that trigger or terminate grabs means that this grab simulation can fail to terminate the grab under some conditions. To work around this problem, XKB normally reports the grab state in all events whenever a grab is active. Clients which do not use active grabs like this can set the `LookupStateWhenGrabbed` per-client flag in order to receive the same state component whether or not a grab is active.

The `GrabsUseXKBState` per-client flag also applies to the state of events sent while a grab is active. If it is set, events during a grab contain the XKB lookup or grab state; by default, events during a grab contain the compatibility lookup or grab state.

The state used to trigger a passive grab is controlled by the setting of the `GrabsUseXKBState` per-client flag at the time the grab is registered. Changing this flag does not affect existing passive grabs.
Chapter 7. Key Event Processing in the Client

The XKB client map for a keyboard is the collection of information a client needs to interpret key events that come from that keyboard. It contains a global list of key types, described in Key Types, and an array of key symbol maps, each of which describes the symbols bound to one particular key and the rules to be used to interpret those symbols.

Notation and Terminology

XKB associates a two-dimensional array of symbols with each key. Symbols are addressed by keyboard group (see Keyboard State) and shift level, where level is defined as in the ISO9995 standard:

Level  One of several states (normally 2 or 3) which govern which graphic character is produced when a graphic key is actuated. In certain cases the level may also affect function keys.

Note that shift level is derived from the modifier state, but not necessarily in the same way for all keys. For example, the Shift modifier selects shift level 2 on most keys, but for keypad keys the modifier bound to Num_Lock (i.e. the NumLock virtual modifier) also selects shift level 2.

Gray symbols on a key

We use the notation $G_n L_n$ to specify the position of a symbol on a key or in memory:

The gray characters indicate symbols that are implied or expected but are not actually engraved on the key.

Note

Unfortunately, the “natural" orientation of symbols on a key and the natural orientation in memory are reversed from one another, so keyboard group refers to a column on the key and a row in memory. There’s no real help for it, but we try to minimize confusion by using "group" and "level" (or "shift level") to refer to symbols regardless of context.
Determining the KeySym Associated with a Key Event

To look up the symbol associated with an XKB key event, we need to know the group and shift level that correspond to the event.

Group is reported in bits 13-14 of the state field of the key event, as described in Computing A State Field from an XKB State. The keyboard group reported in the event might be out-of-range for any particular key because the number of groups can vary from key to key. The XKB description of each key contains a group info field which is interpreted identically to the global groups wrap control (see Computing Effective Modifier and Group) and which specifies the interpretation of groups that are out-of-range for that key.

Once we have determined the group to be used for the event, we have to determine the shift level. The description of a key includes a key type for each group of symbols bound to the key. Given the modifiers from the key event, this key type yields a shift level and a set of "leftover" modifiers, as described in Key Types below.

Finally, we can use the effective group and the shift level returned by the type of that group to look up a symbol in a two-dimensional array of symbols associated with the key.

Key Types

Each entry of a key type’s map field specifies the shift level that corresponds to some XKB modifier definition; any combination of modifiers that is not explicitly listed somewhere in the map yields shift level one. Map entries which specify unbound virtual modifiers (see Inactive Modifier Definitions) are not considered; each entry contains an automatically-updated active field which indicates whether or not it should be used.

Each key type includes a few fields that are derived from the contents of the map and which report some commonly used values so they don’t have to be constantly recalculated. The numLevels field contains the highest shift level reported by any of its map entries; XKB uses numLevels to insure that the array of symbols bound to a key is large enough (the number of levels reported by a key type is also referred to as its width). The modifiers field reports all real modifiers considered by any of the map entries for the type. Both modifiers and numLevels are updated automatically by XKB and neither can be changed explicitly.

Any modifiers specified in modifiers are normally consumed (see Transforming the KeySym Associated with a Key Event), which means that they are not considered during any of the later stages of event processing. For those rare occasions that a modifier should be considered despite having been used to look up a symbol, key types include an optional preserve field. If a preserve list is present, each entry corresponds to one of the key type’s map entries and lists the modifiers that should not be consumed if the matching map entry is used to determine shift level.

For example, the following key type implements caps lock as defined by the core protocol (using the second symbol bound to the key):
Key Event Processing in the Client

type "ALPHABETIC" {
    modifiers = Shift+Lock;
    map[Shift]= Level2;
    map[Lock]= Level2;
    map[Shift+Lock]= Level2;
};

The problem with this kind of definition is that we could assign completely unrelated symbols to the two shift levels, and "Caps Lock" would choose the second symbol. Another definition for alphabetic keys uses system routines to capitalize the keysym:

type "ALPHABETIC" {
    modifiers= Shift;
    map[Shift]= Level2;
};

When caps lock is applied using this definition, we take the symbol from shift level one and capitalize it using system-specific capitalization rules. If shift and caps lock are both set, we take the symbol from shift level two and try to capitalize it, which usually has no effect.

The following key type implements shift-cancels-caps lock behavior for alphabetic keys:

type "ALPHABETIC" {
    modifiers = Shift+Lock;
    map[Shift] = Level2;
    preserve[Lock]= Lock;
};

Consider the four possible states that can affect alphabetic keys: no modifiers, shift alone, caps lock alone or shift and caps lock together. The map contains no explicit entry for None (no modifiers), so if no modifiers are set, any group with this type returns the first keysym. The map entry for Shift reports Level2, so any group with this type returns the second symbol when Shift is set. There is no map entry for Lock alone, but the type specifies that the Lock modifier should be preserved in this case, so Lock alone returns the first symbol in the group but first applies the capitalization transformation, yielding the capital form of the symbol. In the final case, there is no map entry for Shift+Lock, so it returns the first symbol in the group; there is no preserve entry, so the Lock modifier is consumed and the symbol is not capitalized.

Key Symbol Map

The key symbol map for a key contains all of the information that a client needs to process events generated by that key. Each key symbol mapping reports:

• The number of groups of symbols bound to the key (numGroups).

• The treatment of out-of-range groups (groupInfo).

• The index of the key type to for each possible group (kt_index[MaxKbdGroups]).
• The width of the widest type associated with the key (\texttt{groupsWidth}).

• The two-dimensional (\texttt{numGroups} \times \texttt{groupsWidth}) array of symbols bound to the key.

It is legal for a key to have zero groups, in which case it also has zero symbols and all events from that key yield \texttt{NoSymbol}. The array of key types is of fixed width and is large enough to hold key types for the maximum legal number of groups (\texttt{MaxKbdGroups}, currently four); if a key has fewer than \texttt{MaxKbdGroups} groups, the extra key types are reported but ignored. The \texttt{groupsWidth} field cannot be explicitly changed; it is updated automatically whenever the symbols or set of types bound to a key are changed.

If, when looking up a symbol, the effective keyboard group is out-of-range for the key, the \texttt{groupInfo} field of the key symbol map specifies the rules for determining the corresponding legal group as follows:

• If the \texttt{RedirectIntoRange} flag is set, the two least significant bits of \texttt{groupInfo} specify the index of a group to which all illegal groups correspond. If the specified group is also out of range, all illegal groups map to \texttt{Group1}.

• If \texttt{ClampIntoRange} flag is set, out-of-range groups correspond to the nearest legal group. Effective groups larger than the highest supported group are mapped to the highest supported group; effective groups less than \texttt{Group1} are mapped to \texttt{Group1}. For example, a key with two groups of symbols uses \texttt{Group2} type and symbols if the global effective group is either \texttt{Group3} or \texttt{Group4}.

• If neither flag is set, group is wrapped into range using integer modulus. For example, a key with two groups of symbols for which groups wrap uses \texttt{Group1} symbols if the global effective group is \texttt{Group3} or \texttt{Group2} symbols if the global effective group is \texttt{Group4}.

The client map contains an array of key symbol mappings, with one entry for each key between the minimum and maximum legal keycodes, inclusive. All keycodes which fall in that range have key symbol mappings, whether or not any key actually yields that code.

**Transforming the KeySym Associated with a Key Event**

Any modifiers that were not used to look up the keysym, or which were explicitly preserved, might indicate further transformations to be performed on the keysym or the character string that is derived from it. For example, If the \texttt{Lock} modifier is set, the symbol and corresponding string should be capitalized according to the locale-sensitive capitalization rules specified by the system. If the \texttt{Control} modifier is set, the keysym is not affected, but the corresponding character should be converted to a control character as described in Default Symbol Transformations.

This extension specifies the transformations to be applied when the \texttt{Control} or \texttt{Lock} modifiers are active but were not used to determine the keysym to be used:
Key Event Processing in the Client

<table>
<thead>
<tr>
<th>Modifier</th>
<th>Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Report the control character associated with the symbol. This extension defines the control characters associated with the ASCII alphabetic characters (both upper and lower case) and for a small set of punctuation characters (see Default Symbol Transformations). Applications are free to associate control characters with any symbols that are not specified by this extension.</td>
</tr>
<tr>
<td>Lock</td>
<td>Capitalize the symbol either according to capitalization rules appropriate to the application locale or using the capitalization rules defined by this extension (see Default Symbol Transformations).</td>
</tr>
</tbody>
</table>

Interpretation of other modifiers is application dependent.

**Note**

This definition of capitalization is fundamentally different from the core protocol’s, which uses the lock modifier to select from the symbols bound to the key. Consider key 9 in the client map example; the core protocol provides no way to generate the capital form of either symbol bound to this key. XKB specifies that we first look up the symbol and then capitalize, so XKB yields the capital form of the two symbols when caps lock is active.

XKB specifies the behavior of Lock and Control, but interpretation of other modifiers is left to the application.

**Client Map Example**

Consider a simple, if unlikely, keyboard with the following keys (gray characters indicate symbols that are implied or expected but are not actually engraved on the key):

```
Key:          Keycode:  
Q q @         8
è ö           9
A ÅE å æ      10
? ?           11
1 End         12
```

The core protocol represents this keyboard as a simple array with one row per key and four columns (the widest key, key 10, determines the width of the entire array).
The row to be used for a given key event is determined by keycode; the column to be used is determined by the symbols bound to the key, the state of the Shift and Lock Modifiers and the state of the modifiers bound to the Num Lock and Mode_switch keys as specified by the core protocol.

The XKB description of this keyboard consists of six key symbol maps, each of which specifies the types and symbols associated with each keyboard group for one key:

<table>
<thead>
<tr>
<th>Key</th>
<th>Group: Type</th>
<th>L1</th>
<th>L2</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>G1: ALPHABETIC</td>
<td>q</td>
<td>Q</td>
</tr>
<tr>
<td>9</td>
<td>G1: TWO_LEVEL</td>
<td>odiaeresis</td>
<td>egrave</td>
</tr>
<tr>
<td>10</td>
<td>G1: ALPHABETIC</td>
<td>ae</td>
<td>A</td>
</tr>
<tr>
<td>11</td>
<td>G1: TWO_LEVEL</td>
<td>ssharp</td>
<td>question</td>
</tr>
<tr>
<td>12</td>
<td>G1: KEYPAD</td>
<td>KP_End</td>
<td>KP_1</td>
</tr>
<tr>
<td>13</td>
<td>G1: ONE_Level</td>
<td>Num_Lock</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>No Groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>G1: ONE_LEVEL</td>
<td>Return</td>
<td></td>
</tr>
</tbody>
</table>

The keycode reported in a key event determines the row to be used for that event; the effective keyboard group determines the list of symbols and key type to be used. The key type determines which symbol is chosen from the list.

Determining the KeySym Associated with a Key Event details the procedure to map from a key event to a symbol and/or a string.
Chapter 8. Symbolic Names

The core protocol does not provide any information to clients other than that actually used to interpret events. This makes it difficult to write a client which presents the keyboard to a user in an easy-to-understand way. Such applications have to examine the vendor string and keycodes to determine the type of keyboard connected to the server and have to examine keysyms and modifier mappings to determine the effects of most modifiers (the Shift, Lock and Control modifiers are defined by the core protocol but no semantics are implied for any other modifiers).

This extension provides such applications with symbolic names for most components of the keyboard extension and a description of the physical layout of the keyboard.

The keycodes name describes the range and meaning of the keycodes returned by the keyboard in question; the keyboard geometry name describes the physical location, size and shape of the various keys on the keyboard. As an example to distinguish between these two names, consider function keys on PC-compatible keyboards. Function keys are sometimes above the main keyboard and sometimes to the left of the main keyboard, but the same keycode is used for the key that is logically F1 regardless of physical position. Thus, all PC-compatible keyboards might share a keycodes name but different geometry names.

Note

The keycodes name is intended to be a very general description of the keycodes returned by a keyboard; A single keycodes name might cover keyboards with differing numbers of keys provided that the keys that all keys have the same semantics when present. For example, 101 and 102 key PC keyboards might use the same name. Applications can use the keyboard geometry to determine which subset of the named keyboard type is in use.

The symbols name identifies the symbols bound to the keys. The symbols name is a human or application-readable description of the intended locale or usage of the keyboard with these symbols. The physical symbols name describes the symbols actually engraved on the keyboard, which might be different than the symbols currently being used.

The types name provides some information about the set of key types that can be associated with the keyboard keys. The compat name provides some information about the rules used to bind actions to keys changed using core protocol requests.

The compat, types, keycodes, symbols and geometry names typically correspond to the keyboard components from which the current keyboard description was assembled. These components are stored individually in the server’s database of keyboard components, described in The Server Database of Keyboard Components, and can be combined to assemble a complete keyboard description.

Each key has a four-byte symbolic name. The key name links keys with similar functions or in similar positions on keyboards that report different scan codes. Key aliases allow the keyboard layout designer to assign multiple names to a single key, to make it easier to refer to keys using either their position or their "function."

For example, consider the common keyboard customizations:
• Set the "key to the left of the letter a" to be a control key.

• Change the "caps lock" key, wherever it might be, to a control key.

If we specify key names by position, the first customization is simple but the second is impossible; if we specify key names by function, the second customization is simple but the first is impossible. Using key aliases, we can specify both function and position for "troublesome" keys, and both customizations are straightforward.

Key aliases can be specified both in the symbolic names component and in the keyboard geometry (see Keyboard Geometry). Both sets of aliases are always valid, but key alias definitions in the keyboard geometry have priority; if both symbolic names and geometry include aliases, applications should consider the definitions from the geometry before considering the definitions from the symbolic names section.

XKB provides symbolic names for each of the four keyboard groups, sixteen virtual modifiers, thirty-two keyboard indicators, and up to $MaxRadioGroups$ (32) radio groups.

XKB allows keyboard layout designers or editors to assign names to each key type and to each of the levels in a key type. For example, the second position on an alphabetic key might be called the "Caps" level while the second position on a numeric keypad key might be called the "Num Lock" level.
Chapter 9. Keyboard Indicators

Although the core X protocol supports thirty-two LEDs on a keyboard, it does not provide any way to link the state of the LEDs and the logical state of the keyboard. For example, most keyboards have a "Caps Lock" LED, but X does not provide any standard way to make the LED automatically follow the logical state of the modifier bound to the Caps Lock key.

The core protocol also gives no way to determine which bits in the led_mask field of the keyboard state map to the particular LEDs on the keyboard. For example, X does not provide a method for a client to determine which bit to set in the led_mask to turn on the "Scroll Lock" LED, or even if the keyboard has a "Scroll Lock" LED.

Most X servers implement some kind of automatic behavior for one or more of the keyboard LEDs, but the details of that automatic behavior are implementation-specific and can be difficult or impossible to control.

XKB provides indicator names and programmable indicators to help solve these problems. Using XKB, clients can determine the names of the various indicators, determine and control the way that the individual indicators should be updated to reflect keyboard changes, and determine which of the 32 keyboard indicators reported by the protocol are actually present on the keyboard. Clients may also request immediate notification of changes to the state of any subset of the keyboard indicators, which makes it straightforward to provide an on-screen "virtual" LED panel.

Global Information About Indicators

XKB provides only two pieces of information about the indicators as a group.

The physical indicators mask reports which of the 32 logical keyboard indicators supported by the core protocol and XKB corresponds to some actual indicator on the keyboard itself. Because the physical indicators mask describes a physical characteristic of the keyboard, it cannot be directly changed under program control. It is possible, however, for the set of physical indicators to be change if a new keyboard is attached or if a completely new keyboard description is loaded by the XkbGetKeyboardByName request (see Using the Server's Database of Keyboard Components).

The indicator state mask reports the current state of the 32 logical keyboard indicators. This field and the core protocol indicator state (as reported by the led-mask field of the core protocol GetKeyboardControl request) are always identical.

Per-Indicator Information

Each of the thirty-two keyboard indicators has a symbolic name, of type ATOM. The XkbGetNames request reports the symbolic names for all keyboard components, including the indicators. Use the XkbSetNames request to change symbolic names. Both requests are described in Querying and Changing Symbolic Names.

Indicator Maps

XKB also provides an indicator map for each of the thirty-two keyboard indicators; an indicator map specifies:
• The conditions under which the keyboard modifier state affects the indicator.

• The conditions under which the keyboard group state affects the indicator.

• The conditions under which the state of the boolean controls affects the indicator.

• The effect (if any) of attempts to explicitly change the state of the indicator using the core protocol SetKeyboardControl request.

If IM_NoAutomatic is set in the flags field of an indicator map, that indicator never changes in response to changes in keyboard state or controls, regardless of the values for the other fields of the indicator map. If IM_NoAutomatic is not set in flags, the other fields of the indicator map specify the automatic changes to the indicator in response to changes in the keyboard state or controls.

The which_groups and the groups fields of an indicator map determine how the keyboard group state affects the corresponding indicator. The which_groups field controls the interpretation of groups and may contain any one of the following values:

<table>
<thead>
<tr>
<th>Value</th>
<th>Interpretation of the Groups Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM_UseNone</td>
<td>The groups field and the current keyboard group state are ignored.</td>
</tr>
<tr>
<td>IM_UseBase</td>
<td>If groups is non-zero, the indicator is lit whenever the base keyboard group is non-zero. If groups is zero, the indicator is lit whenever the base keyboard group is zero.</td>
</tr>
<tr>
<td>IM_UseLatched</td>
<td>If groups is non-zero, the indicator is lit whenever the latched keyboard group is non-zero. If groups is zero, the indicator is lit whenever the latched keyboard group is zero.</td>
</tr>
<tr>
<td>IM_UseLocked</td>
<td>The groups field is interpreted as a mask. The indicator is lit when the current locked keyboard group matches one of the bits that are set in groups.</td>
</tr>
<tr>
<td>IM_UseEffective</td>
<td>The groups field is interpreted as a mask. The indicator is lit when the current effective keyboard group matches one of the bits that are set in groups.</td>
</tr>
</tbody>
</table>

The which_mods and mods fields of an indicator map determine how the state of the keyboard modifiers affect the corresponding indicator. The mods field is an XKB modifier definition, as described in Modifier Definitions, which can specify both real and virtual modifiers. The mods field takes effect even if some or all of the virtual indicators specified in mods are unbound.

The which_mods field can specify one or more components of the XKB keyboard state. The corresponding indicator is lit whenever any of the real modifiers specified in the mask field of the mods modifier definition are also set in any of the current keyboard state components specified by the which_mods. The which_mods field may have any combination of the following values:
Keyboard Indicators

<table>
<thead>
<tr>
<th>Value</th>
<th>Keyboard State Component To Be Considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM_UseBase</td>
<td>Base modifier state</td>
</tr>
<tr>
<td>IM_UseLatched</td>
<td>Latched modifier state</td>
</tr>
<tr>
<td>IM_UseLocked</td>
<td>Locked modifier state</td>
</tr>
<tr>
<td>IM_UseEffective</td>
<td>Effective modifier state</td>
</tr>
<tr>
<td>IM_UseCompat</td>
<td>Modifier compatibility state</td>
</tr>
</tbody>
</table>

The *controls* field specifies a subset of the boolean keyboard controls (see "Boolean Controls and The EnabledControls Control"). The indicator is lit whenever any of the boolean controls specified in *controls* are enabled.

An indicator is lit whenever any of the conditions specified by its indicator map are met, unless overridden by the *IM_NoAutomatic* flag (described above) or an explicit indicator change (described below).

**Effects of Explicit Changes on Indicators**

If the *IM_NoExplicit* flag is set in an indicator map, attempts to change the state of the indicator are ignored.

If both *IM_NoExplicit* and *IM_NoAutomatic* are both absent from an indicator map, requests to change the state of the indicator are honored but might be immediately superseded by automatic changes to the indicator state which reflect changes to keyboard state or controls.

If the *IM_LEDDrivesKB* flag is set and the *IM_NoExplicit* flag is not, the keyboard state and controls are changed to reflect the other fields of the indicator map, as described in the remainder of this section. Attempts to explicitly change the value of an indicator for which *IM_LEDDrivesKB* is absent or for which *IM_NoExplicit* is present do not affect keyboard state or controls.

The effect on group state of changing an explicit indicator which drives the keyboard is determined by the value of *which_groups* and *groups*, as follows:
### Keyboard Indicators

<table>
<thead>
<tr>
<th>which_groups</th>
<th>New State</th>
<th>Effect on Keyboard Group State</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IM_UseNone</strong>, or <strong>IM_UseBase</strong></td>
<td>On or Off</td>
<td>No Effect</td>
</tr>
<tr>
<td><strong>IM_UseLatched</strong></td>
<td>On</td>
<td>The <code>groups</code> field is treated as a group mask. The keyboard group latch is changed to the lowest numbered group specified in <code>groups</code>; if <code>groups</code> is empty, the keyboard group latch is changed to zero.</td>
</tr>
<tr>
<td><strong>IM_UseLatched</strong></td>
<td>Off</td>
<td>The <code>groups</code> field is treated as a group mask. If the indicator is explicitly extinguished, keyboard group latch is changed to the lowest numbered group not specified in <code>groups</code>; if <code>groups</code> is zero, the keyboard group latch is set to the index of the highest legal keyboard group.</td>
</tr>
<tr>
<td><strong>IM_UseLocked</strong>, or <strong>IM_UseEffective</strong></td>
<td>On</td>
<td>If the <code>groups</code> mask is empty, group is not changed, otherwise the locked keyboard group is changed to the lowest numbered group specified in <code>groups</code>.</td>
</tr>
<tr>
<td><strong>IM_UseLocked</strong>, or <strong>IM_UseEffective</strong></td>
<td>Off</td>
<td>Locked keyboard group is changed to the lowest numbered group that is not specified in the <code>groups</code> mask, or to <code>Group1</code> if the <code>groups</code> mask contains all keyboard groups.</td>
</tr>
</tbody>
</table>

The effect on the keyboard modifiers of changing an explicit indicator which drives the keyboard is determined by the values that are set in of `which_mods` and `mods`, as follows:
### Keyboard Indicators

<table>
<thead>
<tr>
<th>Set in which_mods</th>
<th>New State</th>
<th>Effect on Keyboard Modifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM_USE_BASE</td>
<td>On or Off</td>
<td>No Effect</td>
</tr>
<tr>
<td>IM_USE_LATCHED</td>
<td>On</td>
<td>Any modifiers specified in the mask field of mods are added to the latched modifiers.</td>
</tr>
<tr>
<td></td>
<td>Off</td>
<td>Any modifiers specified in the mask field of mods are removed from the latched modifiers.</td>
</tr>
<tr>
<td>IM_USE_LOCKED</td>
<td>On</td>
<td>Any modifiers specified in the mask field of mods are added to the locked modifiers.</td>
</tr>
<tr>
<td>IM_USE_COMPAT</td>
<td>Off</td>
<td>Any modifiers specified in the mask field of mods are removed from both the locked and latched modifiers.</td>
</tr>
</tbody>
</table>

Lighting an explicit indicator which drives the keyboard also enables all of the boolean controls specified in the controls field of its indicator map. Explicitly extinguishing such an indicator disables all of the boolean controls specified in controls.

The effects of changing an indicator which drives the keyboard are cumulative; it is possible for a single change to affect keyboard group, modifiers and controls simultaneously.

If an indicator for which both the IM_LEDDrivesKB and IM_NoAutomatic flags are specified is changed, the keyboard changes specified above are applied and the indicator is changed to reflect the state that was explicitly requested. The indicator will remain in the new state until it is explicitly changed again.

If the IM_NoAutomatic flag is not set for an indicator which drives the keyboard, the changes specified above are applied and the state of the indicator is set to the values specified by the indicator map. Note that it is possible in this case for the indicator to end up in a different state than the one that was explicitly requested. For example, an indicator with which_mods of IM_USE_BASE and mods of Shift is not extinguished if one of the Shift keys is physically depressed when the request to extinguish the indicator is processed.
Chapter 10. Keyboard Bells

The core protocol provides requests to control the pitch, volume and duration of the keyboard bell and a request to explicitly sound the bell.

The X Keyboard Extension allows clients to disable the audible bell, attach a symbolic name to a bell request or receive an event when the keyboard bell is rung.

Client Notification of Bells

Clients can ask to receive \texttt{XkbBellNotify} event when a bell is requested by a client or generated by the server. Bells can be sounded due to core protocol \texttt{Bell} requests, X Input Extension \texttt{DeviceBell} requests, X Keyboard Extension \texttt{XkbBell} requests or for reasons internal to the server such as the XKB \texttt{AccessXFeedback} control.

Bell events caused by the \texttt{XkbBell} request or by the \texttt{AccessXFeedback} control include an optional window and symbolic name for the bell. If present, the window makes it possible to provide some kind of visual indication of which window caused the sound. The symbolic name can report some information about the reason the bell was generated and makes it possible to generate a distinct sound for each type of bell.

Disabling Server Generated Bells

The global \texttt{AudibleBell} boolean control for a keyboard indicates whether bells sent to that device should normally cause the server to generate a sound. Applications which provide "sound effects" for the various named bells will typically disable the server generation of bells to avoid burying the user in sounds.

When the \texttt{AudibleBell} control is active, all bells caused by core protocol \texttt{Bell} and X Input Extension \texttt{DeviceBell} requests cause the server to generate a sound, as do all bells generated by the XKB \texttt{AccessXFeedback} control. Bells requested via the X \texttt{kbBell} request normally cause a server-generated sound, but clients can ask the server not to sound the default keyboard bell.

When the \texttt{AudibleBell} control is disabled, the server generates a sound only for bells that are generated using the \texttt{XkbBell} request and which specify forced delivery of the bell.

Generating Named Bells

The \texttt{XkbBell} request allows clients to specify a symbolic name which is reported in the bell events they cause. Bells generated by the \texttt{AccessXFeedback} control of this extension also include a symbolic name, but all kinds of feedback cause a single event even if they sound multiple tones.

The X server is permitted to use symbolic bell names (when present) to generate sounds other than simple tones, but it is not required to do so.

Aside from those used by the XKB \texttt{AccessXFeedback} control (see \texttt{The AccessXFeedback Control}), this extension does not specify bell names or their interpretation.
Generating Optional Named Bells

Under some circumstances, some kind of quiet audio feedback is useful, but a normal keyboard bell is not. For example, a quiet “launch effect” can be helpful to let the user know that an application has been started, but a loud bell would simply be annoying.

To simplify generation of these kinds of effects, the XkbBell request allows clients to specify "event only" bells. The X server never generates a normal keyboard bell for "event only" bells, regardless of the setting of the global AudibleBell control.

If the X server generates different sounds depending bell name, it is permitted to generate a sound even for "event only" bells. This field is intended simply to weed out "normal" keyboard bells.

Forcing a Server Generated Bell

Occasionally, it is useful to force the server to generate a sound. For example, a client could "filter" server bells, generating sound effects for some but sounding the normal server bell for others. Such a client needs a way to tell the server that the requested bell should be generated regardless of the setting of the AudibleBell control.

To simplify this process, clients which call the XkbBell request can specify that a bell is forced. A forced bell always causes a server generated sound and never causes a XkbBellNotify event. Because forced bells do not cause bell notify events, they have no associated symbolic name or event window.
Chapter 11. Keyboard Geometry

The XKB description of a keyboard includes an optional keyboard geometry which describes the physical appearance of the keyboard. Keyboard geometry describes the shape, location and color of all keyboard keys or other visible keyboard components such as indicators. The information contained in a keyboard geometry is sufficient to allow a client program to draw an accurate two-dimensional image of the keyboard.

The components of the keyboard geometry include the following:

• A **symbolic name** to help users identify the keyboard.

• The **width** and **height** of the keyboard, in \( \frac{mm}{10} \). For non-rectangular keyboards, the width and height describe the smallest bounding-box that encloses the outline of the keyboard.

• A list of up to **MaxColors** (32) **color names**. A color name is a string whose interpretation is not specified by XKB. Other geometry components refer to colors using their indices in this list.

• The **base color** of the keyboard is the predominant color on the keyboard and is used as the default color for any components whose color is not explicitly specified.

• The **label color** is the color used to draw the labels on most of the keyboard keys.

• The **label font** is a string which describes the font used to draw labels on most keys; XKB does not specify a format or name space for font names.

• A list of **geometry properties**. A geometry property associates an arbitrary string with an equally arbitrary name. Geometry properties can be used to provide hints to programs that display images of keyboards, but they are not interpreted by XKB. No other geometry structures refer to geometry properties.

• A list of **key aliases**, as described in Symbolic Names.

• A list of **shapes**; other keyboard components refer to shapes by their index in this list. A shape consists of a name and one or more closed-polygons called **outlines**. Shapes and outlines are described in detail in Shapes and Outlines.

Unless otherwise specified, geometry measurements are in \( \frac{mm}{10} \) units. The origin (0,0) is in the top left corner of the keyboard image. Some geometry components can be drawn rotated; all such objects rotate about their origin in \( \frac{1^\circ}{10} \) increments.
All geometry components include a *priority*, which indicates the order in which overlapping objects should be drawn. Objects are drawn in order from highest priority (0) to lowest (255).

The description of the actual appearance of the keyboard is subdivided into named *sections* of related keys and *doodads*. A *doodad* describes some visible aspect of the keyboard that is not a key. A section is a collection of keys and doodads that are physically close together and logically related.

## Shapes and Outlines

An outline is a list of one or more points which describes a single closed-polygon, as follows:

- A list with a single point describes a rectangle with one corner at the origin of the shape (0, 0) and the opposite corner at the specified point.

- A list of two points describes a rectangle with one corner at the position specified by the first point and the opposite corner at the position specified by the second point.

- A list of three or more points describes an arbitrary polygon. If necessary, the polygon is automatically closed by connecting the last point in the list with the first.

- A non-zero value for the *cornerRadius* field specifies that the corners of the polygon should be drawn as circles with the specified radius.

All points in an outline are specified relative to the origin of the enclosing shape. Points in an outline may have negative values for the X and Y coordinate.

One outline (usually the first) is the primary outline; a keyboard display application can generate a simpler but still accurate keyboard image by displaying only the primary outlines for each shape. Non-rectangular keys must include a rectangular *approximation* as one of the outlines associated with the shape; the approximation is not normally displayed but can be used by very simple keyboard display applications to generate a recognizable but degraded image of the keyboard.

## Sections

Each section has its own coordinate system — if a section is rotated, the coordinates of any components within the section are interpreted relative to the edges that were on the top and left before rotation. The components that make up a section include:

- A list of *rows*. A row is a list of horizontally or vertically adjacent keys. Horizontal rows parallel the (pre-rotation) top of the section and vertical rows parallel the (pre-rotation) left of the section. All keys in a horizontal row share a common top coordinate; all keys in a vertical row share a left coordinate.

A key description consists of a key *name*, a *shape*, a key *color*, and a *gap*. The key *name* should correspond to one of the keys named in the keyboard names description, the *shape* specifies the appearance of the key, and the key *color* specifies the color of the key (not the label on the key). Keys are normally drawn
immediately adjacent to one another from left-to-right (or top-to-bottom) within a row. The gap field specifies the distance between a key and its predecessor.

- An optional list of doodads; any type of doodad can be enclosed within a section. Position and angle of rotation are relative to the origin and angle of rotation of the sections that contain them. Priority is relative to the other components of the section, not to the keyboard as a whole.

- An optional list of overlay keys. Each overlay key definition indicates a key that can yield multiple scan codes and consists of a field named under, which specifies the primary name of the key and a field named over, which specifies the name for the key when the overlay keycode is selected. The key specified in under must be a member of the section that contains the overlay key definition, while the key specified in over must not.

**Doodads**

Doodads can be global to the keyboard or part of a section. Doodads have symbolic names of arbitrary length. The only doodad name whose interpretation is specified by XKB is "Edges", which describes the outline of the entire keyboard, if present.

All doodads report their origin in fields named left and top. XKB supports five kinds of doodads:

- An indicator doodad describes one of the physical keyboard indicators. Indicator doodads specify the shape of the indicator, the indicator color when it is lit (on_color) and the indicator color when it is dark (off_color).

- An outline doodad describes some aspect of the keyboard to be drawn as one or more hollow, closed polygons. Outline doodads specify the shape, color, and angle of rotation about the doodad origin at which they should be drawn.

- A solid doodad describes some aspect of the keyboard to be drawn as one or more filled polygons. Solid doodads specify the shape, color and angle of rotation about the doodad origin at which they should be drawn.

- A text doodad describes a text label somewhere on the keyboard. Text doodads specify the label string, the font and color to use when drawing the label, and the angle of rotation of the doodad about its origin.

- A logo doodad is a catch-all, which describes some other visible element of the keyboard. A logo doodad is essentially an outline doodad with an additional symbolic name that describes the element to be drawn.

  If a keyboard display program recognizes the symbolic name, it can draw something appropriate within the bounding region of the shape specified in the doodad. If the symbolic name does not describe a recognizable image, it should draw an outline using the specified shape, outline, and angle of rotation.

  The XKB extension does not specify the interpretation of logo names.

**Keyboard Geometry Example**

Consider the following example keyboard:
This keyboard has six sections: The left and right function sections (at the very top) each have one horizontal row with eight keys. The left and right alphanumeric sections (the large sections in the middle) each have six vertical rows, with four or five keys in each row. The left and right editing sections each have three vertical rows with one to three keys per row; the left editing section is rotated 20° clockwise about its origin while the right editing section is rotated 20° counterclockwise.

This keyboard has four global doodads: Three small, round indicators and a rectangular logo. The program which generated this image did not recognize the logo, so it displays an outline with an appropriate shape in its place.
This keyboard has seven shapes: All of the keys in the two function sections use the "FKEY" shape. Most of the keys in the alphanumeric sections, as well as four of the keys in each of the editing sections use the "NORM" shape. The keys in the first column of the left alphanumeric section and the last column of the right alphanumeric section all use the "WIDE" shape. Two keys in each of the editing sections use the "TALL" shape. The "LED" shape describes the three small, round indicators between the function and alphabetic sections. The "LOGO" shape describes the keyboard logo, and the "EDGE" shape describes the outline of the keyboard as a whole.

The keyboard itself is white, as are all of the keys except for the eight keys that make up the home row, which use the "grey20" color. It isn’t really visible in this picture, but the three indicators have an "on" color of "green" and are "green30" when they are turned off. The keys in the alphanumeric and editing sections all have a (vertical) gap of 0.5mm; the keys in the two function sections have a (horizontal) gap of 3mm.

Many of the keys in the right alphanumeric section, and the rightmost key in the right editing section are drawn with two names in this image. Those are overlay keys; the bottom key name is the normal name while the overlay name is printed at the top. For example, the right editing section has a single overlay key entry, which specifies an under name of <SPCE> and an over name of <KP0>, which indicates that the key in question is usually the shift key, but can behave like the 0 key on the numeric keypad when an overlay is active.
Chapter 12. Interactions Between XKB and the Core Protocol

In addition to providing a number of new requests, XKB replaces or extends existing core protocol requests and events. Some aspects of this extension, such as the ability to lock any key or modifier, are visible even to clients that are unaware of the XKB extension. Other capabilities, such as control of keysym selection on a per-key basis, are available only to XKB-aware clients.

Though they do not have access to some advanced extension capabilities, the XKB extension includes compatibility mechanisms to ensure that non-XKB clients behave as expected and operate at least as well with an XKB-capable server as they do today.

There are a few significant areas in which XKB state and mapping differences might be visible to XKB-unaware clients:

- The core protocol uses a modifier to choose between two keyboard groups, while this extension provides explicit support for multiple groups.
- The order of the symbols associated with any given key by XKB might not match the ordering demanded by the core protocol.

To minimize problems that might result from these differences, XKB includes ways to specify the correspondence between core protocol and XKB modifiers and symbols.

This section describes the differences between the core X protocol's notion of a keyboard mapping and XKB and explains the ways they can interact.

Group Compatibility Map

As described in Keyboard State, the current keyboard group is reported to XKB-aware clients in bits 13-14 of the state field of many core protocol events. XKB-unaware clients cannot interpret those bits, but they might use a keyboard modifier to implement support for a single keyboard group. To ensure that pre-XKB clients continue to work when XKB is present, XKB makes it possible to map an XKB state field, which includes both keyboard group and modifier state, into a pre-XKB state field which contains only modifiers.

A keyboard description includes one group compatibility map per keyboard group (four in all). Each such map is a modifier definition (i.e. specifies both real and virtual modifiers) which specifies the modifiers to be set in the compatibility states when the corresponding keyboard group is active. Here are a few examples to illustrate the application of the group compatibility map:
Interactions Between XKB and the Core Protocol

<table>
<thead>
<tr>
<th>Group Map</th>
<th>Effective Modifiers</th>
<th>State for XKB Clients</th>
<th>Compatibility Modifiers</th>
<th>State for non-XKB Clients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Group1=None Shift</td>
<td>x00xxxxx00000000$shift</td>
<td>xxxxxxxxxx00000001</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Group2=Mod3 None</td>
<td>x01xxxxx00000000$Mod3</td>
<td>xxxxxxxxxx00100000</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Group3=Mod2 Shift</td>
<td>x10xxxxx00000000$shift+Mod2</td>
<td>xxxxxxxxxx00010001</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Group4=None Control</td>
<td>x11xxxxx00000100$Control</td>
<td>xxxxxxxxxx00000100</td>
<td></td>
</tr>
</tbody>
</table>

Note that non-XKB clients (i.e. clients that are linked with a version of the X library that does not support XKB) cannot detect the fact that Group4 is active in this example because the group compatibility map for Group4 does not specify any modifiers.

Setting a Passive Grab for an XKB State

The fact that the state field of an event might look different when XKB is present can cause problems with passive grabs. Existing clients specify the modifiers they wish to grab using the rules defined by the core protocol, which use a normal modifier to indicate keyboard group. If we used an XKB state field, the high bits of the state field would be non-zero whenever the keyboard was in any group other than Group1, and none of the passive grabs set by clients could ever be triggered.

To avoid this behavior, the X server normally uses the compatibility grab state to decide whether or not to activate a passive grab, even for XKB-aware clients. The group compatibility map attempts to encode the keyboard group in one or more modifiers of the compatibility state, so existing clients continue to work exactly the way they do today. By default, there is no way to directly specify a keyboard group in a Grabbed or GrabButton request, but groups can be specified indirectly by correctly adjusting the group compatibility map.

Clients that wish to specify an XKB keyboard state, including a separate keyboard group, can set the GrabsUseXKBState per-client flag which indicates that all subsequent key and button grabs from the requesting clients are specified using an XKB state.

Whether the XKB or core state should be used to trigger a grab is determined by the setting of the GrabsUseXKBState flag for the requesting client at the time the key or button is grabbed. There is no way to change the state to be used for a grab that is already registered or for grabs that are set by some other client.

Changing the Keyboard Mapping Using the Core Protocol

An XKB keyboard description includes a lot of information that is not present in the core protocol description of a keyboard. Whenever a client remaps the keyboard using core protocol requests, XKB examines the map to determine likely default values for the components that cannot be specified using the core protocol.

Some aspects of this automatic mapping are configurable, and make it fairly easy to take advantage of many XKB features using existing tools like xmodmap, but
much of the process of mapping a core keyboard description into an XKB description is designed to preserve compatible behavior for pre-XKB clients and cannot be redefined by the user. Clients or users that want behavior that cannot be described using this mapping should use XKB functions directly.

Explicit Keyboard Mapping Components

This automatic remapping might accidentally replace definitions that were explicitly requested by an application, so the XKB keyboard description defines a set of explicit components for each key; any components that are listed in the explicit components for a key are not changed by the automatic keyboard mapping. The explicit components field for a key can contain any combination of the following values:

<table>
<thead>
<tr>
<th>Bit in Explicit Mask</th>
<th>Protects Against</th>
</tr>
</thead>
<tbody>
<tr>
<td>ExplicitKeyType1</td>
<td>Automatic determiniation of the key type associated with Group1 (see Assigning Types To Groups of Symbols for a Key)</td>
</tr>
<tr>
<td>ExplicitKeyType2</td>
<td>Automatic determiniation of the key type associated with Group2 (see Assigning Types To Groups of Symbols for a Key)</td>
</tr>
<tr>
<td>ExplicitKeyType3</td>
<td>Automatic determiniation of the key type associated with Group3 (see Assigning Types To Groups of Symbols for a Key)</td>
</tr>
<tr>
<td>ExplicitKeyType4</td>
<td>Automatic determiniation of the key type associated with Group4 (see Assigning Types To Groups of Symbols for a Key)</td>
</tr>
<tr>
<td>ExplicitInterpret</td>
<td>Application of any of the fields of a symbol interpretation to the key in question (see Assigning Actions To Keys).</td>
</tr>
<tr>
<td>ExplicitAutoRepeat</td>
<td>Automatic determiniation of autorepeat status for the key, as specified in a symbol interpretation (see Assigning Actions To Keys).</td>
</tr>
<tr>
<td>ExplicitBehavior</td>
<td>Automatic assignment of the KB_Lock behavior to the key, if the LockingKey flag is set in a symbol interpretation (see Assigning Actions To Keys).</td>
</tr>
<tr>
<td>ExplicitVModMap</td>
<td>Automatic determiniation of the virtual modifier map for the key based on the actions assigned to the key and the symbol interpretations which match the key (see Assigning Actions To Keys).</td>
</tr>
</tbody>
</table>

Assigning Symbols To Groups

The first step in applying the changes specified by a core protocol ChangeKeyboardMapping request to the XKB description of a keyboard is to determine the number of groups that are defined for the key and the width of each group. The XKB extension does not change key types in response to core protocol SetModifierMapping requests, but it does choose key actions as described in Assigning Actions To Keys.

Determining the number of symbols required for each group is straightforward. If the key type for some group is not protected by the corresponding ExplicitKeyType
Interactions Between XKB and the Core Protocol

component, that group has two symbols. If any of the explicit components for the key include `ExplicitKeyType3` or `ExplicitKeyType4`, the width of the key type currently assigned to that group determines the number of symbols required for the group in the core protocol keyboard description. The explicit type components for `Group1` and `Group2` behave similarly, but for compatibility reasons the first two groups must have at least two symbols in the core protocol symbol mapping. Even if an explicit type assigned to either of the first two keyboard groups has fewer than two symbols, XKB requires two symbols for it in the core keyboard description.

If the core protocol request contains fewer symbols than XKB needs, XKB adds trailing `NoSymbol` keysyms to the request to pad it to the required length. If the core protocol request includes more symbols than it needs, XKB truncates the list of keysyms to the appropriate length.

Finally, XKB divides the symbols from the (possibly padded or truncated) list of symbols specified by the core protocol request among the four keyboard groups. In most cases, the symbols for each group are taken from the core protocol definition in sequence (i.e. the first pair of symbols is assigned to `Group1`, the second pair of symbols is assigned to `Group2`, and so forth). If either `Group1` or `Group2` has an explicitly defined key type with a width other than two, it gets a little more complicated.

**Assigning Symbols to Groups One and Two with Explicitly Defined Key Types**

The server assigns the first four symbols from the expanded or truncated map to the symbol positions `G1L1`, `G1L2`, `G2L1` and `G2L2`, respectively. If the key type assigned to `Group1` reports more than two shift levels, the fifth and following symbols contain the extra keysyms for `Group2`. If the key type assigned to `Group2` reports more than two shift levels, the extra symbols follow the symbols (if any) for `Group1` in the core protocol list of symbols. Symbols for `Group3` and `Group4` are contiguous and follow the extra symbols, if any, for `Group1` and `Group2`.

For example, consider a key with a key type that returns three shift levels bound to each group. The symbols bound to the core protocol are assigned in sequence to the symbol positions:

```
G1L1, G1L2, G2L1, G2L2, G1L3, G2L3, G3L1, G3L2, G3L3, G4L1, G4L2, and G4L3
```

For a key with a width one key type on group one, a width two key type on group two and a width three key type on group three, the symbols bound to the key by the core protocol are assigned to the following key positions:

```
G1L1, (G1L2), G2L1, G2L2, G3L1, G3L2, G3L3
```

Note that the second and fourth symbols (positions `G1L2` and `G2L2`) can never be generated if the key type associated with the group yields only one symbol. XKB accepts and ignores them in order to maintain compatibility with the core protocol.

**Assigning Types To Groups of Symbols for a Key**

Once the symbols specified by `ChangeKeyboardMapping` have been assigned to the four keyboard groups for a key, the X server assigns a key type to each group on
the key from a canonical list of key types. The first four key types in any keyboard map are reserved for these standard key types:

<table>
<thead>
<tr>
<th>Key Type Name</th>
<th>Standard Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ONE_LEVEL</strong></td>
<td>Describes keys that have exactly one symbol per group. Most special or function keys (such as Return) are ONE_LEVEL keys. Any combination of modifiers yields level 0. Index 0 in any key symbol map specifies key type ONE_LEVEL.</td>
</tr>
<tr>
<td><strong>TWO_LEVEL</strong></td>
<td>Describes non-keypad and non-alphabetical keys that have exactly two symbols per group. By default, the TWO_LEVEL type yields column 1 if the Shift modifier is set, column 0 otherwise. Index 1 in any key symbol map specifies key type TWO_LEVEL.</td>
</tr>
<tr>
<td><strong>ALPHABETIC</strong></td>
<td>Describes alphabetic keys that have exactly two symbols per group. The default definition of the ALPHABETIC type provides shift-cancels-caps behavior as described in Key Types. Index 2 in any key symbol map specifies key type ALPHABETIC.</td>
</tr>
<tr>
<td><strong>KEYPAD</strong></td>
<td>Describes numeric keypad keys with two symbols per group. Yields column 1 if either of the Shift modifier or the real modifier bound to the virtual modifier named NumLock are set. Yields column 0 if neither or both modifiers are set. Index 3 in any key symbol map specifies key type KEYPAD.</td>
</tr>
</tbody>
</table>

Users or applications may change these key types to get different default behavior (to make shift cancel caps lock, for example) but they must always have the specified number of symbols per group.

Before assigning key types to groups, the X server expands any alphanumeric symbol definitions as follows:

If the second symbol of either group is NoSymbol and the first symbol of that group is an alphabetic keysym for which both lowercase and uppercase forms are defined, the X server treats the key as if the first element of the group were the lowercase form of the symbol and the second element were the uppercase form of the symbol. For the purposes of this expansion, XKB ignores the locale and uses the capitalization rules defined in Default Symbol Transformations.

For each keyboard group that does not have an explicit type definition, XKB chooses a key type from the canonical key types. If the second symbol assigned to a group is NoSymbol (after alphabetic expansion), the server assigns key type ONE_LEVEL. If the group contains the lowercase and uppercase forms of a single glyph (after alphanumeric expansion), the server assigns key type ALPHABETIC. If either of the symbols in a group is a numeric keypad keysym (KP_*), the server assigns key type KEYPAD. Otherwise, it assigns key type TWO_LEVEL.

Finally, XKB determines the number of groups of symbols that are actually defined for the key. Trailing empty groups (i.e. groups that have NoSymbol in all symbol positions) are ignored.

There are two last special cases for compatibility with the core protocol: If, after trailing empty groups are excluded, all of the groups of symbols bound to the key
Interactions Between XKB and the Core Protocol

have identical type and symbol bindings, XKB assigns only one group to the key. If Group2 is empty and either of Group3 or Group4 are not, and if neither Group1 nor Group2 have explicit key types, XKB copies the symbols and key type from Group1 into Group2.

Assigning Actions To Keys

Once symbols have been divided into groups and key types chosen for the keys affected by a ChangeKeyboardMapping request, XKB examines the symbols and modifier mapping for each changed key and assigns server actions where appropriate. XKB also automatically assigns server actions to changed keys if the client issues a core protocol SetModifierMapping request, and does so optionally in response to XkbSetMap and XkbSetCompatMap requests.

The compatibility map includes a list of symbol interpretations, which XKB compares to each symbol associated with any changed keys in turn, unless the ExplicitInterp component is set for a key. Setting the ExplicitInterp component prevents the application of symbol interpretations to that key.

If the modifiers and keysym specified in a symbol interpretation match the modifier mapping and a symbol bound to a changed key that is not protected by ExplicitInterp, the server applies the symbol interpretation to the symbol position. The server considers all symbol interpretations which specify an explicit keysym before considering any that do not. The server uses the first interpretation which matches the given combination of keysym and modifier mapping; other matching interpretations are ignored.

XKB uses four of the fields of a symbol interpretation to decide if it matches one of the symbols bound to some changed key:

- The symbol field is a keysym which matches if it has the value NoSymbol or is identical to the symbol in question.

- The modifiers specified in the mods field are compared to the modifiers affected by the key in question as indicated by match.

- The match field can specify any of the comparisons: NoneOf, AnyOfOrNone, AnyOf, AllOf or Exactly.

- The levelOneOnly setting, indicates that the interpretation in question should only use the modifiers bound to this key by the modifier mapping if the symbol that matches in level one of its group. Otherwise, if the symbol being considered is not in shift level one of its group, the server behaves as if the modifier map for the key were empty. Note that it is still possible for such an interpretation to apply to a symbol in a shift level other than one if it matches a key without modifiers; the levelOneOnly flag only controls the way that matches are determined and that the key modifiers are applied when an interpretation does match.

Applying a symbol interpretation can affect several aspects of the XKB definition of the key symbol mapping to which it is applied:

- The action specified in the symbol interpretation is bound to the symbol position; any key event which yields that symbol will also activate the new action.

- If the matching symbol is in position G1L1, the autorepeat behavior of the key is set from the autorepeat field of the symbol interpretation. The ExplicitAutoRepeat...
**Interactions Between XKB and the Core Protocol**

*peat* component protects the autorepeat status of a key from symbol interpretation initiated changes.

- If the symbol interpretation specifies an associated virtual modifier, that virtual modifier is added to the virtual modifier map for the key. The *ExplicitVModMap* component guards the virtual modifier map for a key from automatic changes. If the *levelOneOnly* flag is set for the interpretation, and the symbol in question is not in position G1L1, the virtual modifier map is not updated.

- If the matching symbol is in position G1L1, and the *locking key* field is set in the symbol interpretation, the behavior of the key is changed to *KB_Lock* (see *Key Behavior*). The *ExplicitBehavior* component prevents this change.

If no interpretations match a given symbol or key, the server uses: *SA_NoAction*, autorepeat enabled, non-locking key, with no virtual modifiers.

If all of the actions computed for a key are *SA_NoAction*, the server assigns an length zero list of actions to the key.

If the core protocol modifier mapping is changed, the server regenerates actions for the affected keys. The *XkbSetMap* and *XkbSetCompatMap* requests can also cause actions for some or all keyboard keys to be recomputed.

### Updating Everything Else

Changes to the symbols or modifier mapping can affect the bindings of virtual modifiers. If any virtual modifiers change, XKB updates all of its data structures to reflect the change. Applying virtual modifier changes to the keyboard mapping might result in changes to types, the group compatibility map, indicator maps, internal modifiers or ignore locks modifiers.

### Effects of XKB on Core Protocol Events

After applying server actions which modify the base, latched or locked modifier or group state of the keyboard, the X server recomputes the effective group and state. Several components of the keyboard state are reported to XKB-aware clients depending on context (see *Keyboard State* for a detailed description of each of the keyboard state components):

- The effective modifier state is reported in *XkbStateNotify* events and in response to *XkbGetState* requests.

- The symbol lookup state is reported to XKB-aware clients in the state field of core protocol and input extension key press and release events that do not activate passive grabs. Unless the *LookupStateWhenGrabbed* per-client flag is set, the lookup state is only reported in these events when no grabs are active.

- The grab state is reported to XKB-aware clients in the state field of all core protocol events that report keyboard state, except *KeyPress* and *KeyRelease* events that do not activate passive grabs.

- The effective group is the sum of the base, latched and locked keyboard groups. An out of range effective group is wrapped or truncated into range according to the setting of the *groupsWrap* flag for the keyboard.
The server reports compatibility states to any clients that have not issued a successful \textit{XkbUseExtension} request. The server computes the compatibility symbol lookup state and the compatibility effective grab state by applying the compatibility modifier map to the corresponding computed XKB states.

The compatibility symbol lookup state is reported to non-XKB clients whenever an XKB-aware client would receive the XKB lookup state. The compatibility grab state is reported to XKB-unaware clients whenever an XKB client would receive the XKB grab state.

If the \textit{GrabsUseXKBState} per-client option is not set, even XKB-aware clients receive the compatibility grab state in events that trigger or terminate passive grabs. If this flag is not set, XKB clients also receive the compatibility grab or lookup state whenever any keyboard grab is active.

If the \textit{LookupStateWhenGrabbed} per-client option is set, clients receive either the XKB or compatibility lookup state when the keyboard is grabbed, otherwise they receive either the XKB or compatibility grab state. All non-XKB clients receive the compatibility form of the appropriate state component; the form that is sent to an XKB-aware client depends on the setting of the \textit{GrabsUseXKBState} option for that client.

**Effect of XKB on Core Protocol Requests**

Whenever a client updates the keyboard mapping using a core protocol request, the server saves the requested core protocol keyboard mapping and reports it to any clients that issue \textit{GetKeyboardMapping} or \textit{GetModifierMapping} requests. Whenever a client updates the keyboard mapping using XKB requests, the server discards the affected portion of the stored core keyboard description and regenerates it based on the XKB description of the keyboard.

The symbols associated with the XKB keyboard description appear in the order:

\begin{verbatim}
G1L1 G1L2 G2L1 G2L2 G1L3-n G2L3-n G3L* G4L*
\end{verbatim}

If the type associated with \textit{Group1} is width one, the second symbol is \textit{NoSymbol} ; if the type associated with \textit{Group2} is width one, the fourth symbol is \textit{NoSymbol} .

If a key has only one group but the keyboard has several, the symbols for \textit{Group1} are repeated for each group. For example, given a keyboard with three groups and a key with one group that contains the symbols \{ \textit{a A} \}, the core protocol description would contain the six symbols: \{ \textit{a A a A a A} \}. As a slightly more complicated example, an XKB key which had a single width three group with the symbols \{ \textit{a b c} \} would show up in the generated core protocol keyboard description with the symbols \{ \textit{a b a b c c a b c} \} for a keyboard with three groups.

The generated modifier mapping for a key contains all of the modifiers affected by all of the actions associated with the key plus all of the modifiers associated with any virtual modifiers bound to the key by the virtual modifier mapping. If any of the actions associated with a key affect any component of the keyboard group, any modifiers specified in any entry of the group compatibility map (see \textit{Group Compatibility Map}) are reported in the modifier mask. The \textit{SA_ISOLock} action can theoretically affect any modifier, but the modifier map of an \textit{SA_ISOLock} key contains only the modifiers or group state that it sets by default.
The server notifies interested clients of keyboard map changes in one of two ways. It sends \texttt{XkbMapNotify} to clients that have explicitly selected them and core protocol \texttt{MappingNotify} events to clients that have not. Once a client requests \texttt{XkbMapNotify} events, the server stops sending it \texttt{MappingNotify} events to inform it of keyboard changes.

## Sending Events to Clients

XKB normally assumes that events sent to clients using the core protocol \texttt{SendEvent} request contain a core protocol state, if applicable. If the client which will receive the event is not XKB-capable, XKB attempts to convert the core state to an XKB state as follows: if any of the modifiers bound to \texttt{Group2} in the group compatibility map are set in the event state, XKB clears them in the resulting event but sets the effective group in the event state to \texttt{Group2}.

If the \texttt{PCF\_SendEventUsesXKBState} per-client flag is set at the time of the \texttt{SendEvent} request, XKB instead assumes that the event reported in the event is an XKB state. If the receiving client is not XKB-aware, the extension converts the XKB state (which contains the effective state in bits 13-14) to a core state by applying the group compatibility map just as it would for actual key events.
Chapter 13. The Server Database of Keyboard Components

The X server maintains a database of keyboard components and common keyboard mappings. This database contains five kinds of components; when combined, these five components provide a complete description of a keyboard and its behavior.

The X Keyboard Extension provides requests to list the contents of this database, to assemble and complete keyboard descriptions by merging the current keyboard description with the contents of this database, or to replace the current keyboard description with a complete keyboard description assembled as described below.

Component Names

Component and keymap names have the form "class (member)" where class describes a subset of the available components for a particular type and the optional member identifies a specific component from that subset. For example, the name "atlantis(acme)" might specify the symbols used for the atlantis national keyboard layout by the vendor "acme." Each class has an optional default member — references which specify a class but not a member refer to the default member of the class, if one exists.

The class and member names are both specified using characters from the Latin-1 character set. XKB implementations must accept all alphanumeric characters, minus ('-') and underscore ('_') in class or member names, and must not accept parentheses, plus, vertical bar, percent sign, asterisk, question mark or white space. The use of other characters is implementation-dependent.

Partial Components and Combining Multiple Components

Some of the elements in the server database contain describe only a piece of the corresponding keyboard component. These partial components should be combined with other components of the same type to be useful.

For example, a partial symbols map might describe the differences between a common ASCII keyboard and some national layout. Such a partial map is not useful on its own because it does not include those symbols that are the same on both the ASCII and national layouts (such as function keys). On the other hand, this partial map can configure any ASCII keyboard to use a national layout.

Two components can be combined in two ways:

• If the second component overrides the first, any definitions that are present in both components are taken from the second.
• If the second component augments the first, any definitions that are present in both components are taken from the first.

Applications can use a component expression to combine multiple components of some time into a complete description of some aspect of the keyboard. A compo-
Component expression is a string which lists the components to be combined separated by operators which specify the rules for combining them. A complete description is assembled from the listed components, left to right, as follows:

- If the new elements are being merged with an existing map, the special component name ‘%’ refers to the unmodified value of the map.
- The ‘+’ operator specifies that the next specified component should override the current assembled definition.
- The ‘|’ operator specifies that the next specified component should augment the currently assembled definition.
- If the new elements are being merged with an existing map and the component expression begins with an operator, a leading ‘%’ is implied.
- If any unknown or illegal characters appear anywhere in the string, the entire expression is invalid and is ignored.

For example, the component expression "+de" specifies that the default element of the "de" map should be applied to the current keyboard mapping, overriding any existing definitions.

A slightly more involved example: the expression "acme(ascii)+de(basic)|iso9995-3" constructs a German (de) mapping for the ASCII keyboard supplied by the "acme" vendor. The new definition begins with the symbols for the default ASCII keyboard for Acme, overrides them with any keys that are defined for the default German keyboard layout and then applies the definitions from the iso9995-3 to any undefined keys or groups of keys (part three of the iso9995 standard defines a common set of bindings for the secondary group, but allows national layouts to override those definitions where necessary).

### Component Hints

Each component has a set of flags that provide some additional hints about that component. XKB provides these hints for clients that present the keyboard database to users and specifies their interpretation only loosely. Clients can use these hints to constrain the list of components or to control the way that components are presented to the user.

Hints for a component are reported with its name. The least significant byte of the hints field has the same meaning for all five types of keyboard components, and can contain any combination of the following values:

<table>
<thead>
<tr>
<th>Flag</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC_Hidden</td>
<td>Indicates a component that should not normally be presented to the user.</td>
</tr>
<tr>
<td>LC_Default</td>
<td>Indicates a component that is the default member of its class.</td>
</tr>
<tr>
<td>LC_Partial</td>
<td>Indicates a partial component.</td>
</tr>
</tbody>
</table>

The interpretation of the most significant byte of the hints field is dependent on the type of component. The hints defined for each kind of component are listed in the section below that describes that kind of component.
Keyboard Components

The Server Database of Keyboard Components

Keyboard Components

The five types of components stored in the server database of keyboard components correspond to the symbols, geometry, keycodes, compat and types symbolic names associated with a keyboard.

The Keycodes Component

The keycodes component of a keyboard mapping specifies the range and interpretation of the raw keycodes reported by the device. It sets the keycodes symbolic name, the minimum and maximum legal keycodes for the keyboard, and the symbolic name for each key. The keycodes component might also contain aliases for some keys, symbolic names for some indicators, and a description of which indicators are physically present.

The special keycodes component named "computed" indicates that XKB should assign unused keycodes to any unknown keys referenced by name by any of the other components. The computed keycodes component is useful primarily when browsing keymaps because it makes it possible to use the symbols and geometry components without having to find a set of keycodes that includes keycode definitions for all of the keys listed in the two components.

XKB defines no hints that are specific to the keycodes component.

The Types Component

The types component of a keyboard mapping specifies the key types that can be associated with the various keyboard keys. It affects the types symbolic name and the list of types associated with the keyboard (see Key Types). The types component of a keyboard mapping can also optionally contain real modifier bindings and symbolic names for one or more virtual modifiers.

The special types component named "canonical" always contains the types and definitions listed in Canonical Key Types of this document.

XKB defines no hints that are specific to the types component.

The Compatibility Map Component

The compatibility map component of a keyboard mapping primarily specifies the rules used to assign actions to keysyms. It affects the compat symbolic name, the symbol compatibility map and the group compatibility map. The compat component might also specify maps for some indicators and the real modifier bindings and symbolic names of some virtual modifiers.

XKB defines no hints that are specific to the compatibility map component.

The Symbols Component

The symbols component of a keyboard mapping specifies primarily the symbols bound to each keyboard key. It affects the symbols symbolic name, a key symbol mapping for each key, they keyboard modifier mapping, and the symbolic names
The Server Database of
Keyboard Components

for the keyboard symbol groups. Optionally, the *symbols* component can contain explicit actions and behaviors for some keys, or the real modifier bindings and symbolic names for some virtual modifiers.

XKB defines the following additional hints for the symbols component:

<table>
<thead>
<tr>
<th>Flag</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC_AlphanumericKeys</td>
<td>Indicates a symbol component that contains bindings primarily for an alphanumeric section of the keyboard.</td>
</tr>
<tr>
<td>LC_ModifierKeys</td>
<td>Indicates a symbol component that contains bindings primarily for modifier keys.</td>
</tr>
<tr>
<td>LC_KeypadKeys</td>
<td>Indicates a symbol component that contains bindings primarily for numeric keypad keys.</td>
</tr>
<tr>
<td>LC_FunctionKeys</td>
<td>Indicates a symbol component that contains bindings primarily for function keys.</td>
</tr>
<tr>
<td>LC_AltimateGroup</td>
<td>Indicates a symbol component that contains bindings for an alternate keyboard group.</td>
</tr>
</tbody>
</table>

These hints only apply to partial symbols components; full symbols components are assumed to specify all of the pieces listed above.

**Note**

The alphanumeric, modifier, keypad or function keys hints should describe the primary intent of the component designer and should not simply an exhaustive list of the kinds of keys that are affected. For example, national keyboard layouts affect primarily alphanumeric keys, but many affect a few modifier keys too; such mappings should set only *LC_AlphanumericKeys* hint. In general, symbol components should set only one of those four flags (though *LC_AltimateGroup* may be combined with any of the other flags).

**The Geometry Component**

The *geometry* component of a keyboard mapping specifies primarily the geometry of the keyboard. It contains the geometry symbolic name and the keyboard geometry description. The geometry component might also contain aliases for some keys or symbolic names for some indicators and might affect the set of indicators that are physically present. Key aliases defined in the geometry component of a keyboard mapping override those defined in the keycodes component.

XKB defines no hints that are specific to the geometry component.

**Complete Keymaps**

The X server also reports a set of fully specified keymaps. The keymaps specified in this list are usually assembled from the components stored in the rest of the database and typically represent the most commonly used keymaps for a particular system.

XKB defines no hints that are specific to complete keymaps.
Chapter 14. Replacing the Keyboard "On-the-Fly"

XKB supports the `XkbNewKeyboardNotify` event, which reports a change in keyboard geometry or the range of supported keycodes. The server can generate an `XkbNewKeyboardNotify` event when it detects a new keyboard, or in response to an `XkbGetKeyboardByName` request (see Using the Server’s Database of Keyboard Components) which loads a new keyboard description.

When a client opens a connection to the X server, the server reports the minimum and maximum keycodes. If the range of supported keycodes is changed, XKB keeps track of the minimum and maximum keycodes that were reported to each client and filters out any events that fall outside of that range. Note that these events are simply ignored; they are not delivered to some other client.

When the server sends an `XkbNewKeyboardNotify` event to a client to inform it of the new keycode range, XKB resets the stored range of legal keycodes to the keycode range reported in the event. Non-XKB clients and XKB-aware clients that do not request `XkbNewKeyboardNotify` events never receive events from keys that fall outside of the legal range that XKB maintains for that client.

When a client requests `XkbNewKeyboardNotify` events, the server compares the range of keycodes for the current keyboard to the range of keycodes that are valid for the client. If they are not the same, the server immediately sends that client an `XkbNewKeyboardNotify` event. Even if the "new" keyboard is not new to the server, it is new to this particular client.

In addition to filtering out-of-range key events, XKB:

- Adjusts core protocol `MappingNotify` events to refer only to keys that match the stored legal range.

- Reports keyboard mappings for keys that match the stored legal range to clients that issue a core protocol `GetKeyboardMapping` request.

- Reports modifier mappings only for keys that match the stored legal range to clients that issue a core protocol `GetModifierMapping` request.

- Restricts the core protocol `ChangeKeyboardMapping` and `SetModifierMapping` requests to keys that fall inside the stored legal range.

In short, XKB does everything possible to hide the fact that the range of legal keycodes has changed from clients non-XKB clients, which cannot be expected to deal with it. The corresponding XKB events and requests do not pay attention to the legal keycode range in the same way because XKB makes it possible for clients to track changes to the keycode range for a device and respond to them.
Chapter 15. Interactions Between XKB and the X Input Extension

All XKB interactions with the input extension are optional; implementors are free to restrict the effects of the X Keyboard Extension to the core keyboard device. The XkbGetExtensionDeviceInfo request reports whether or not an XKB implementation supports a particular capability for input extension devices.

XKB recognizes the following interactions with the X Input Extension:

<table>
<thead>
<tr>
<th>Name</th>
<th>Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>XI_Keyboard</td>
<td>If set, applications can use all XKB requests and events with extension keyboards.</td>
</tr>
<tr>
<td>XI_ButtonActions</td>
<td>If set, clients can assign key actions to buttons, even on input extension devices that are not keyboards.</td>
</tr>
<tr>
<td>XI_IndicatorNames</td>
<td>If set, clients can assign names to indicators on non-keyboard extension devices.</td>
</tr>
<tr>
<td>XI_IndicatorMaps</td>
<td>If set, clients can assign indicator maps to indicators on non-keyboard extension devices.</td>
</tr>
<tr>
<td>XI_IndicatorState</td>
<td>If set, clients can change the state of device indicators using the XkbSetExtensionDeviceInfo request.</td>
</tr>
</tbody>
</table>

Attempts to use an XKB feature with an extension device fail with a Keyboard error if the server does not support the XkbXI_Keyboard optional feature. If a capability particular capability other than XkbXI_Keyboard is not supported, attempts to use it fail silently. The replies for most requests that can use one of the other optional features include a field to report whether or not the request was successful, but such requests do not cause an error condition.

Clients can also request an XkbExtensionDeviceNotify event. This event notifies interested clients of changes to any of the supported XKB features for extension devices, or if a request from the client that is receiving the event attempted to use an unsupported feature.

Using XKB Functions with Input Extension Keyboards

All XKB requests and events include a device identifier which can refer to an input extension KeyClass device, if the implementation allows XKB to control extension devices. If the implementation does not support XKB manipulation of extension devices, the device identifier is ignored but it must be either 0 or UseCoreKbd.

Implementations which do not support the use of XKB functions with extension keyboards must not set the XkbXI_Keyboard flag. Attempts to use XKB features on an extension keyboard with an implementation that does not support this feature yield a Keyboard error.
Pointer and Device Button Actions

The XKB extension optionally allows clients to assign any key action (see Key Actions) to core pointer or input extension device buttons. This makes it possible to control the keyboard or generate keyboard key events from extension devices or from the core pointer.

XKB implementations are required to support actions for the buttons of the core pointer device, but support for actions on extension devices is optional. Implementations which do not support button actions for extension devices must not set the XkbXI_ButtonActions flag.

Attempts to query or assign button actions with an implementation that does not support this feature report failure in the request reply and might cause the server to send an XkbExtensionDeviceNotify event to the client which issued the request that failed. Such requests never cause an error condition.

Indicator Maps for Extension Devices

The XKB extension allows applications to assign indicator maps to the indicators of non-keyboard extension devices. If supported, maps can be assigned to all extension device indicators, whether they are part of a keyboard feedback or part of an indicator feedback.

Implementations which do not support indicator maps for extension devices must not set the XkbXI_IndicatorMaps flag.

Attempts to query or assign indicator maps with an implementation that does not support this feature report failure in the request reply and might cause the server to send an XkbExtensionDeviceNotify event to the client which issued the request that failed. Such requests never cause an error condition.

If this feature is supported, the maps for the default indicators on the core keyboard device are visible both as extension indicators and as the core indicators. Changes made with XkbSetDeviceInfo are visible via XkbGetIndicatorMap and changes made with XkbSetIndicatorMap are visible via XkbGetDeviceInfo.

Indicator Names for Extension Devices

The XKB extension allows applications to assign symbolic names to the indicators of non-keyboard extension devices. If supported, symbolic names can be assigned to all extension device indicators, whether they are part of a keyboard feedback or part of an indicator feedback.

Implementations which do not support indicator maps for extension devices must not set the XkbXI_IndicatorMaps flag.

Attempts to query or assign indicator names with an implementation that does not support this feature report failure in the request reply and might cause the server to send an XkbExtensionDeviceNotify event to the client which issued the request that failed. Such requests never cause an error condition.

If this feature is supported, the names for the default indicators on the core keyboard device are visible both as extension indicators and as the core indicators.
Changes made with \texttt{XkbSetDeviceInfo} are visible via \texttt{XkbGetNames} and changes made with \texttt{XkbSetName}s are visible via \texttt{XkbGetDeviceInfo}.
Chapter 16. XKB Protocol Requests

This document uses the syntactic conventions and common types defined by the specification of the core X protocol with a number of additions, which are detailed below.

Errors

If a client attempts to use any other XKB request except XkbUseExtension before the extension is properly initialized, XKB reports an Access error and ignores the request. XKB is properly initialized once XkbUseExtension reports that the client has asked for a supported or compatible version of the extension.

Keyboard Errors

In addition to all of the errors defined by the core protocol, the X Keyboard Extension defines a single error, Keyboard, which indicates that some request specified an illegal device identifier or an extension device that is not a member of an appropriate. Unless otherwise noted, any request with an argument of type KB_DEVICESPEC can cause Keyboard errors if an illegal or inappropriate device is specified.

When the extension reports a Keyboard error, the most significant byte of the resource_id is a further refinement of the error cause, as defined in the table below. The least significant byte contains the device, class, or feedback id as indicated:

<table>
<thead>
<tr>
<th>high-order byte</th>
<th>value</th>
<th>meaning</th>
<th>low-order byte</th>
</tr>
</thead>
<tbody>
<tr>
<td>XkbErr_BadDevice</td>
<td>0xff</td>
<td>device not found</td>
<td>device id</td>
</tr>
<tr>
<td>XkbErr_BadClass</td>
<td>0xfe</td>
<td>device found, but is the wrong class</td>
<td>class id</td>
</tr>
<tr>
<td>XkbErr_BadId</td>
<td>0xfd</td>
<td>device found, class ok, but device does not have a feedback with the indicated id</td>
<td></td>
</tr>
</tbody>
</table>

Side-Effects of Errors

With the exception of Alloc or Implementation errors, which might result in an inconsistent internal state, no XKB request that reports an error condition has any effect. Unless otherwise stated, requests which update some aspect of the keyboard description will not apply only part of a request — if part of a request fails, the whole thing is ignored.

Common Types

The following types are used in the request and event definitions in subsequent sections:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LISTofITEMs</td>
<td>The type LISTofITEMs is special. It is similar to the LISTofVALUE defined by the core protocol, but the elements of a LISTofITEMs are not necessarily all the same size. The use of a BITMASK to indicate which</td>
</tr>
<tr>
<td>Name</td>
<td>Value</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------------------------------</td>
</tr>
<tr>
<td>KB_DEVICESPEC</td>
<td>8 bit unsigned integer, UseCoreKbd, or UseCorePtr</td>
</tr>
<tr>
<td>KB_LEDCLASSSPEC</td>
<td>{ KbdFeedbackClass, LedFeedbackClass, DfltXI-Class, AllXIClasses, XINone }</td>
</tr>
<tr>
<td>KB_BELLCLASSSPEC</td>
<td>{ KbdFeedbackClass, BellFeedbackClass, DfltXI-Class, AllXIClasses }</td>
</tr>
<tr>
<td>KB_IDSPEC</td>
<td>8 bit unsigned integer or DfltXIId</td>
</tr>
<tr>
<td>KB_VMODMASK</td>
<td>CARD16, each bit corresponds to a virtual modifier</td>
</tr>
<tr>
<td>KB_GROUPMASK</td>
<td>{ Group1, Group2, Group3, Group4 }</td>
</tr>
<tr>
<td>KB_GROUPSWRAP</td>
<td>{ WrapIntoRange, ClampIntoRange, RedirectIntoRange }</td>
</tr>
<tr>
<td>KB_GROUPINFO</td>
<td>{ groupsWrap: KB_GROUPSWRAP redirectGroup: 1...4, numGroups: 1...4 }</td>
</tr>
<tr>
<td>KB_NKNDETAILSMASK</td>
<td>{ NKN_Keycodes, NKN_Geometry, NKN_DeviceID }</td>
</tr>
<tr>
<td>KB_STATEMASK</td>
<td>KEYBUTMASK or KB_GROUPMASK</td>
</tr>
<tr>
<td>KB_STATEPARTMASK</td>
<td>{ ModifierState, ModifierBase, ModifierLatch, ModifierLock, GroupState, GroupBase, GroupLatch, GroupLock,CompatState, GrabMods,CompatGrabMods, LookupMods,CompatLookupMods, PointerButtons }</td>
</tr>
<tr>
<td>KB_BOOLCTRLMASK</td>
<td>{ RepeatKeys, SlowKeys, BounceKeys, StickyKeys, MouseKeys, MouseKeysAccel, AccessXKeys, AccessXTimesOut, AccessXFeedback, AudibleBell, Overlay1, Overlay2, IgnoreGroupLock }</td>
</tr>
<tr>
<td>KB_CONTROLSDMASK</td>
<td>{ GroupsWrap, InternalMods, IgnoreLock-Mods, PerKeyRepeat, ControlsEnabled } or KB_BOOLCTRLMASK</td>
</tr>
<tr>
<td>KB_MAPPARTMASK</td>
<td>{ KeyTypes, KeySyms, ModifierMap, ExplicitComponents, KeyActions, KeyBehaviors, VirtualMods, VirtualModMap }</td>
</tr>
<tr>
<td>KB_CMDETAILMASK</td>
<td>{ SymInterp, GroupCompat }</td>
</tr>
<tr>
<td>KB_NAMEDETAILMASK</td>
<td>{ KeycodesName, GeometryName, SymbolsName, PhysSymbolsName, TypesName, CompatName, KeyTypeName, KTLevelNames, IndicatorNames, KeyNames, KeyAliases, VirtualModNames, GroupNames, RGNames }</td>
</tr>
<tr>
<td>KB_AXNDETAILMASK</td>
<td>{ AXN_SKPress, AXN_SKAccept, AXN_SKReject, AXN_SKRelease, AXN_BKAccept, AXN_BKReject, AXN_AXKWarning }</td>
</tr>
<tr>
<td>KB_AXSKOPTSMASK</td>
<td>{ AX_TwoKeys, AX_LatchToLock }</td>
</tr>
<tr>
<td>KB_AXFBOPTSMASK</td>
<td>{ AX_SkPressFB, AX_SKAcceptFB, AX_FeatureFB, AX_SlowWarnFB, AX_IndicatorFB, AX_StickyKeysFB, AX_SKReleaseFB }</td>
</tr>
</tbody>
</table>
### XKB Protocol Requests

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AK_SkRejectFB , AX_BkRejectFB , AX_DumbBellFB</td>
<td></td>
</tr>
</tbody>
</table>

KB_AXOPTIONSMASK  
KB_AXFBOPTSMASK or KB_AXSKOPTSMASK

KB_GBNDETAILMASK  
{ GBN_Types , GBN_CompatMap , GBN_ClientSymbols , GBN_ServerSymbols , GBN_IndicatorMap , GBN_KeyNames , GBN_Geometry , GBN_OtherNames }

KB_BELLDETAILMASK  
{ XkbAllBellNotifyEvents }

KB_MSGDETAILMASK  
{ XkbAllActionMessages }

KB_EVENTTYPE  
{ XkbNewKeyboardNotify , XkbMapNotify , XkbStateNotify , XkbControlsNotify , XkbIndicatorStateNotify , XkbIndicatorMapNotify , XkbNamesNotify , XkbCompatMapNotify , XkbBellNotify , XkbActionMessage , XkbAccessXNotify , XkbExtensionDeviceNotify }

KB_ACTION  
[ type: CARD8 data: LISTofCARD8 ]

KB_BEHAVIOR  
[ type: CARD8, data: CARD 8 ]

KB_MODDEF  
[ mask: KEYMASK, mods: KEYMASK, vmods: KB_VMODMASK ]

KB_KTMAPENTRY  
[ active: BOOL, level: CARD8, mods: KB_MODDEF ]

KB_KTSETMAPENTRY  
[ level: CARD8, mods: KB_MODDEF ]

KB_KEYTYPE  
[ mods: KB_MODDEF, numLevels: CARD8, map: LISTofKB_KTMAPENTRY, preserve: LISTofKB_MODDEF ]

KB_SETKEYTYPE  
[ realMods: KEYMASK, vmods: CARD16, numLevels: CARD8, map: LISTofKB_KTSETMAPENTRY, preserve: LISTofKB_MODDEF ]

KB_KEYSYMmapper  
[ ktIndex: LISTofCARD8, width: CARD8 numGroups: 0...4, groupsWrap: KB_GROUPWRAP, redirectGroup: 0...3, sym: LISTofKEYSYM ]

KB_KEYVMODMAP  
[ key: KEYCODE, vmods: CARD16 ]

KB_KEYMODMAP  
[ key: KEYCODE, mods: KEYMASK ]

KB_EXPLICITMASK  
{ ExplicitKeyType1 , ExplicitKeyType2 , ExplicitKeyType3 , ExplicitKeyType4 , ExplicitInterpret , ExplicitAutoRepeat , ExplicitBehavior , ExplicitV-ModMap }

KB_INDICATORMASK  
CARD32, each bit corresponds to an indicator

KB_IMFLAGS  
{ IM_NoExplicit , IM_NoAutomatic , IM_LEDDrivesKB }

KB_IMMODSWHICH  
{ IM_UseNone , IM_UseBase , IM_UseLatched , IM_UseLocked , IM_UseEffective , IM_UseCompat }

KB_IMGROUPSWHICH  
{ IM_UseNone , IM_UseBase , IM_UseLatched , IM_UseLocked , IM_UseEffective }
XKB Protocol Requests

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>KB_INDICATORMAP</td>
<td>[ flags: CARD8, mods: KB_MODDEF, whichMods: groups: KB_GROUPMASK, whichGroups: ctrls: KB_BOOLCTRLMASK ]</td>
</tr>
<tr>
<td>KB_SYMINTERPMATCH</td>
<td>{ SI_NoneOf, SI_AnyOfOrNone, SI_AnyOf, SI_AllOf, SI_Exactly }</td>
</tr>
<tr>
<td>KB_SYMINTERP</td>
<td>[ sym: KEYSYM, mods: KEYMASK, levelOneOnly: BOOL, match: KB_SYMINTERPMATCH, virtualMod: CARD8, autoRepeat: BOOL, lockingKey: BOOL ]</td>
</tr>
<tr>
<td>KB_PCFMASK</td>
<td>{ PCF_DetectableAutorepeat, PCF_GrabsUseXkbState, PCF_AutoResetControls, PCF_LookupStateWhenGrabbed, PCF_SendEventUsesXKBS }</td>
</tr>
<tr>
<td>KB_LCFLAGSMASK</td>
<td>{ LC_Hidden, LC_Default, LC_Partial }</td>
</tr>
<tr>
<td>KB_LCSYMFLAGSMASK</td>
<td>{ LC_AlphanumericKeys, LC_ModifierKeys, LC_KeypadKeys, LC_FunctionKeys, LC_AltKey }</td>
</tr>
</tbody>
</table>

These types are used by the XkbGetGeometry and XkbSetGeometry requests:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>KB_PROPERTY</td>
<td>[ name, value: STRING8 ]</td>
</tr>
<tr>
<td>KB_POINT</td>
<td>[ x, y: CARD16 ]</td>
</tr>
<tr>
<td>KB_OUTLINE</td>
<td>[ cornerRadius: CARD8, points: LISTofKB_POINT ]</td>
</tr>
<tr>
<td>KB_SHAPE</td>
<td>[ name: ATOM, outlines: LISTofKB_OUTLINE primaryNdx, approxNdx: CARD8 ]</td>
</tr>
<tr>
<td>KB_KEYNAME</td>
<td>[ name: LISTofCHAR ]</td>
</tr>
<tr>
<td>KB_KEYALIAS</td>
<td>[ real: LISTofCHAR, alias: LISTofCHAR ]</td>
</tr>
<tr>
<td>KB_KEY</td>
<td>[ name: KB_KEYNAME, gap: INT16, shapeNdx, colorNdx: CARD8 ]</td>
</tr>
<tr>
<td>KB_ROW</td>
<td>[ top, left: INT16, vertical: BOOL, keys LISTofKB_KEY ]</td>
</tr>
<tr>
<td>KB_OVERLAYKEY</td>
<td>[ over, under: KB_KEYNAME ]</td>
</tr>
<tr>
<td>KB_OVERLAYROW</td>
<td>[ rowUnder: CARD8, keys: LISTofKB_OVERLAYKEY ]</td>
</tr>
<tr>
<td>KB_OVERLAY</td>
<td>[ sectionUnder: CARD8, rows: LISTofKB_OVERLAY ]</td>
</tr>
<tr>
<td>KB_TEXTDOODAD</td>
<td>[ name: ATOM, priority: CARD8, top, left: INT16, angle: INT16, width, height: CARD16, colorNdx: CARD8, text: STRING8, font: STRING8 ]</td>
</tr>
<tr>
<td>KB_INDICATORDOODAD</td>
<td>[ name: ATOM, priority: CARD8, top, left: INT16, angle: INT16, shapeNdx, onColorNdx, offColorNdx: CARD8 ]</td>
</tr>
</tbody>
</table>
XKB Protocol Requests

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>KB_LOGODOODAD</td>
<td>[ name: ATOM, priority: CARD8, top, left: INT16, angle: INT16, colorNdx, shapeNdx: CARD8, logoName: STRING8 ]</td>
</tr>
<tr>
<td>KB_DOODAD</td>
<td>KB_SHAPEDOODAD, or KB_TEXTDOODAD, or KB_INDICATORDOODAD, or KB_LOGODOODAD</td>
</tr>
<tr>
<td>KB_SECTION</td>
<td>[ name: ATOM, top, left, angle: INT16, width, height: CARD16, priority: CARD8, rows: LISTofKB_ROW, doodads: LISTofKB_DOODAD, overlays: LISTofKB_OVERLAY ]</td>
</tr>
</tbody>
</table>

These types are used by XkbGetDeviceInfo and XkbSetDeviceInfo:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>KB_XIDEVFEATUREMASK</td>
<td>{ XI_ButtonActions, XI_IndicatorNames, XI_IndicatorMaps, XI_IndicatorState }</td>
</tr>
<tr>
<td>KB_XIFEATUREMASK</td>
<td>{ KB_XIDEVFEATURES or XI_Keyboard }</td>
</tr>
<tr>
<td>KB_XIDETAILMASK</td>
<td>{ KB_XIFEATURES or XI_UnsupportedFeature }</td>
</tr>
<tr>
<td>KB_DEVICELEDINFO</td>
<td>[ ledClass: KB_LEDCLASSSPEC, ledID: KB_IDSPEC, physIndicators: CARD32, state: CARD32, names: LISTofATOM, maps: LISTofKB_INDICATORMAP ]</td>
</tr>
</tbody>
</table>

Requests

This section lists all of the requests supported by the X Keyboard Extension, separated into categories of related requests.

Initializing the X Keyboard Extension

**XkbUseExtension**

- wantedMajor, wantedMinor: CARD16
- supported: BOOL
- serverMajor, serverMinor: CARD16

This request enables XKB extension capabilities for the client that issues the request; the wantedMajor and wantedMinor fields specify the extension version in use by the requesting client. The supported field is True if the server supports a compatible version, False otherwise. The serverMajor and serverMinor fields return the actual version supported by the server.

Until a client explicitly and successfully requests the XKB extension, an XKB capable server reports compatibility state in all core protocol events and requests. Once a client asks for XKB extension semantics by issuing this request, the server reports the extended XKB keyboard state in some core protocol events and requests, as described in the overview section of this specification.

Clients should issue an XkbUseExtension request before using any other extension requests.
Selecting Events

XkbSelectEvents

deviceSpec: KB_DEVICESPEC
affectWhich, clear, selectAll: KB_EVENTTYPE
affectMap, map: KB_MAPPARTMASK
details: LISTofITEMs

Errors: Keyboard, Match, Value

This request updates the event masks of the keyboard indicated by deviceSpec for this client. If deviceSpec specifies an illegal device, a Keyboard error results.

The affectMap and map fields specify changes to the event details mask for the XkbMapNotify event. If any map components are set in map but not in affectMap, a Match error results. Otherwise, any map components that are set in affectMap are set or cleared in the map notify details mask, depending on the value of the corresponding field in map.

The affectWhich, clear, and selectAll fields specify changes to any other event details masks. If any event types are set in both clear and selectAll, a Match error results; if any event types are specified in either clear or selectAll but not in affectWhich, a Match error results. Otherwise, the detail masks for any event types specified in the affectWhich field of this request are changed as follows:

- If the event type is also set in clear, the detail mask for the corresponding event is set to 0 or False, as appropriate.
- If the event type is also set in selectAll, the detail mask for the corresponding event is set to include all legal detail values for that type.
- If the event type is not set in either clear or selectAll, the corresponding element of details lists a set of explicit changes to the details mask for the event, as described below.

Each entry of the details list specifies changes to the event details mask for a single type of event, and consists of an affects mask and a values mask. All details that are specified in affects are set to the corresponding value from values; if any details are listed in values but not in affects, a Match error results.

The details list contains entries only for those event types, if any, that are listed in the affectWhich mask and not in either clear or selectAll. When present, the items of the details list appear in the following order:

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Legal Details</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>XkbNewKeyboardNotify</td>
<td>KB_NKNDETAILSMASK</td>
<td>CARD16</td>
</tr>
<tr>
<td>XkbStateNotify</td>
<td>KB_STATEPARTMASK</td>
<td>CARD16</td>
</tr>
<tr>
<td>XkbControlsNotify</td>
<td>KB_CONTROLMASK</td>
<td>CARD32</td>
</tr>
<tr>
<td>XkbIndicatorMapNotify</td>
<td>KB_INDICATORMASK</td>
<td>CARD32</td>
</tr>
<tr>
<td>XkbIndicatorStateNotify</td>
<td>KB_INDICATORMASK</td>
<td>CARD32</td>
</tr>
<tr>
<td>XkbNamesNotify</td>
<td>KB_NAMEDETAILMASK</td>
<td>CARD16</td>
</tr>
</tbody>
</table>
Detail masks for event types that are not specified in affectWhich are not changed.

If any components are specified in a client’s event masks, the X server sends the client an appropriate event whenever any of those components change state. Unless explicitly modified, all event detail masks are empty. Events describes all XKB events and the conditions under which the server generates them.

**Generating Named Keyboard Bells**

**XkbBell**

deviceSpec: KB_DEVICESPEC
bellClass: KB_BELLCLASSSPEC
bellID: KB_IDSPEC
percent: INT8
forceSound: BOOL
eventOnly: BOOL
pitch, duration: INT16
name: ATOM
window: WINDOW

Errors: Keyboard, Value, Match

This request generates audible bells and/or XkbBellNotify events for the bell specified by the bellClass and bellID on the device specified by deviceSpec at the specified pitch, duration and volume (percent). If deviceSpec specifies a device that does not have a bell or keyboard feedback, a Keyboard error results.

If both forceSound and eventOnly are set, this request yields a Match error. Otherwise, if forceSound is True, this request always generates a sound and never generates an event; if eventOnly is True, it causes an event but no sound. If neither forceSound nor eventOnly are True, this request always generates an event; if the keyboard’s global AudibleBell control is enabled, it also generates a sound.

Any bell event generated by this request contains all of the information about the bell that was requested, including the symbolic name specified by name and the event window specified by window. The name and window are not directly interpreted by XKB, but they must have the value None or specify a legal Atom or Window, respectively. XkbBellNotify events generated in response to core protocol or X input extension bell requests always report None as their name.

The bellClass, bellID, and percent fields are interpreted as for the X input extension DeviceBell request. If pitch and duration are zero, the server uses the corre-
sponding values for that bell from the core protocol or input extension, otherwise
pitch and duration are interpreted as for the core protocol ChangeKeyboardControl request; if they do not include legal values, a Value error results. The window field must specify a legal Window or have the value None, or a Value error results. The name field must specify a legal Atom or have the value None, or an Atom error results. If an error occurs, this request has no other effect (i.e. does not cause a sound or generate an event).

The pitch, volume, and duration are suggested values for the bell, but XKB does not require the server to honor them.

Querying and Changing Keyboard State

XkbGetState
deviceSpec: KB_DEVICESPEC
deviceID: CARD8
mods, baseMods, latchedMods, lockedMods: KEYP\ MASK
group, lockedGroup: KB\ GROUP
baseGroup, latchedGroup: INT16
compatState: KEYP\ MASK
grabMods, compatGrabMods: KB\ GROUP
lookupMods, compatLookupMods: KEYP\ MASK
ptrBtnState: BUTMASK
Errors: Keyboard

This request returns a detailed description of the current state of the keyboard specified by deviceSpec.

The deviceID return value contains the input extension identifier for the specified device, or 0 if the server does not support the input extension.

The baseMods return value reports the modifiers that are set because one or more modifier keys are logically down. The latchedMods and lockedMods return values report the modifiers that are latched or locked respectively. The mods return value reports the effective modifier mask which results from the current combination of base, latched and locked modifiers.

The baseGroup return value reports the group state selected by group shift keys that are logically down. The latchedGroup and lockedGroup return values detail the effects of latching or locking group shift keys and XkbLatchLockState requests. The group return value reports the effective keyboard group which results from the current combination of base, latched and locked group values.

The lookupMods return value reports the lookup modifiers, which consist of the current effective modifiers minus any server internal modifiers. The grabMods return value reports the grab modifiers, which consist of the lookup modifiers minus any members of the ignore locks mask that are not either latched or logically depressed. Keyboard State describes the lookup modifiers and grab modifiers in more detail.
The _ptrBtnState_ return value reports the current logical state of up to five buttons on the core pointer device.

The _compatState_ return value reports the compatibility state that corresponds to the effective keyboard group and modifier state. The _compatLookupMods_ and _compatGrabMods_ return values report the core protocol compatibility states that correspond to the XKB lookup and grab state. All of the compatibility states are computed by applying the group compatibility mapping to the corresponding XKB modifier and group states, as described in Group Compatibility Map.

**XkbLatchLockState**

deviceSpec: KB_DEVICESPEC  
affectModLocks, modLocks: KEYMASK  
lockGroup: BOOL  
groupLock: KB_GROUP  
affectModLatches, modLatches: KEYMASK  
latchGroup: BOOL  
groupLatch: INT16  
Errors: Keyboard, Value

This request locks or latches keyboard modifiers and group state for the device specified by _deviceSpec_. If _deviceSpec_ specifies an illegal or non-keyboard device, a Keyboard error occurs.

The locked state of any modifier specified in the _affectModLocks_ mask is set to the corresponding value from _modLocks_. If _lockGroup_ is True, the locked keyboard group is set to the group specified by _groupLock_. If any modifiers are set in _modLocks_ but not _affectModLocks_, a Match error occurs.

The latched state of any modifier specified in the _affectModLatches_ mask is set to the corresponding value from _modLatches_. If _latchGroup_ is True, the latched keyboard group is set to the group specified by _groupLatch_. If any modifiers are set in _modLatches_ but not in _affectModLatches_, a Match error occurs.

If the locked group exceeds the maximum number of groups permitted for the specified keyboard, it is wrapped or truncated back into range as specified by the global GroupsWrap control. No error results from an out-of-range group specification.

After changing the locked and latched modifiers and groups as specified, the X server recalculates the effective and compatibility keyboard state and generates XkbS-stateNotify events as appropriate if any state components have changed. Changing the keyboard state might also turn indicators on or off which can cause XkbIndicatorStateNotify events as well.

If any errors occur, this request has no effect.
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Querying and Changing Keyboard Controls

**XkbGetControls**

deviceSpec: KB_DEVICESPEC
deviceID: CARD8
mouseKeysDfltBtn: CARD8
numGroups: CARD8
groupsWrap: KB_GROUPINFO
internalMods, ignoreLockMods: KB_MODDEF
repeatDelay, repeatInterval: CARD16
slowKeysDelay, debounceDelay: CARD16
mouseKeysDelay, mouseKeysInterval: CARD16
mouseKeysTimeToMax, mouseKeysMaxSpeed: CARD16
mouseKeysCurve: INT16
accessXOptions: KB_AXOPTIONMASK
accessXTimeout: CARD16
accessXTimeoutOptionsMask, accessXTimeoutOptionValues: CARD16
accessXTimeoutMask, accessXTimeoutValues: CARD32
enabledControls: KB_BOOLCTRLMASK
perKeyRepeat: LISTofCARD8

Errors: *Keyboard*

This request returns the current values and status of all controls for the keyboard specified by `deviceSpec`. If `deviceSpec` specifies an illegal device a *Keyboard* error results. On return, the `deviceID` specifies the identifier of the requested device or zero if the server does not support the input extension.

The `numGroups` return value reports the current number of groups, and `groupsWrap` reports the treatment of out-of-range groups, as described in Key Symbol Map. The `internalMods` and `ignoreLockMods` return values report the current values of the server internal and ignore locks modifiers as described in Keyboard State. Both are modifier definitions (Modifier Definitions) which report the real modifiers, virtual modifiers, and the resulting combination of real modifiers that are bound to the corresponding control.

The `repeatDelay`, `repeatInterval`, `slowKeysDelay` and `debounceDelay` fields report the current values of the for the autorepeat delay, autorepeat interval, slow keys delay and bounce keys timeout, respectively. The `mouseKeysDelay`, `mouseKeysInterval`, `mouseKeysTimeToMax` and `mouseKeysMaxSpeed` return values report the current acceleration applied to mouse keys, as described in The MouseKeysAccel Control. All times are reported in milliseconds.

The `mouseKeysDfltBtn` return value reports the current default pointer button for which events are synthesized by the mouse keys server actions.

The `accessXOptions` return value reports the current settings of the various AccessX options flags which govern the behavior of the *StickyKeys* control and of AccessX feedback.
The `accessXTimeout` return value reports the length of time, in seconds, that the keyboard must remain idle before AccessX controls are automatically changed; an `accessXTimeout` of 0 indicates that AccessX controls are not automatically changed. The `accessXTimeoutMask` specifies the boolean controls to be changed if the AccessX timeout expires; the `accessXTimeoutValues` field specifies new values for all of the controls in the timeout mask. The `accessXTimeoutOptionsMask` field specifies the AccessX options to be changed when the AccessX timeout expires; the `accessXTimeoutOptionValues` return value reports the values to which they will be set.

The `enabledControls` return value reports the current state of all of the global boolean controls.

The `perKeyRepeat` array consists of one bit per key and reports the current autorepeat behavior of each keyboard key; if a bit is set in `perKeyRepeat`, the corresponding key repeats if it is held down while global keyboard autorepeat is enabled. This array parallels the core protocol and input extension keyboard controls, if the autorepeat behavior of a key is changed via the core protocol or input extension, those changes are automatically reflected in the `perKeyRepeat` array.

### XkbSetControls

deviceSpec: KB_DEVICESPEC
affectInternalRealMods, internalRealMods: KEYMASK
affectInternalVirtualMods, internalVirtualMods: KB_VMODMASK
affectIgnoreLockRealMods, ignoreLockRealMods: KB_MODMASK
affectIgnoreLockVirtualMods, ignoreLockVirtualMods: KB_VMODMASK
mouseKeysDfltBtn: CARD8
groupsWrap: KB_GROUPINFO
accessXOptions: CARD16
affectEnabledControls: KB_BOOLCTRLMASK
enabledControls: KB_BOOLCTRLMASK
changeControls: KB_CONTROLMASK
repeatDelay, repeatInterval: CARD16
slowKeysDelay, debounceDelay: CARD16
mouseKeysDelay, mouseKeysInterval: CARD16
mouseKeysTimeToMax, mouseKeysMaxSpeed: CARD16
mouseKeysCurve: INT16
accessXTimeout: CARD16
accessXTimeoutMask, accessXTimeoutValues: KB_BOOLCTRLMASK
accessXTimeoutOptionsMask, accessXTimeoutOptionsValues: CARD16
perKeyRepeat: LISTofCARD8
Errors: Keyboard, Value

This request sets the keyboard controls indicated in `changeControls` for the keyboard specified by `deviceSpec`. Each bit that is set in `changeControls` indicates that one or more of the other request fields should be applied, as follows:
### Bit in `changeControls` | Field(s) to be Applied
--- | ---
`XkbRepeatKeysMask` | `repeatDelay`, `repeatInterval`  
`XkbSlowKeysMask` | `slowKeysDelay`  
`XkbStickyKeysMask` | `accessXOptions` (only the `XkbAX_TwoKeys` and the `XkbAX_LatchToLock` options are affected)  
`XkbBounceKeysMask` | `debounceDelay`  
`XkbMouseKeysMask` | `mouseKeysDfltBtn`  
`XkbMouseKeysAccelMask` | `mouseKeysDelay`, `mouseKeysInterval`, `mouseKeysCurve`, `mouseKeysTimeToMax`, `mouseKeysMaxSpeed`  
`XkbAccessXKeysMask` | `accessXOptions` (all options)  
`XkbAccessXTimeoutMask` | `accessXTimesout`, `accessXTimesoutMask`, `accessXTimesoutValues`, `accessXTimesoutOptionsMask`, `accessXTimesoutOptionsValues`  
`XkbAccessXFeedbackMask` | `accessXOptions` (all options except those affected by the `XkbStickyKeysMask` bit)  
`XkbGroupsWrapMask` | `groupsWrap`  
`XkbInternalModsMask` | `affectInternalRealMods`, `internalRealMods`, `affectInternalVirtualMods`, `internalVirtualMods`  
`XkbIgnoreLockModsMask` | `affectIgnoreLockRealMods`, `ignoreLockRealMods`, `affectIgnoreLockVirtualMods`, `ignoreLockVirtualMods`  
`XkbPerKeyRepeatMask` | `perKeyRepeat`  
`XkbControlsEnabledMask` | `affectEnabledControls`, `enabledControls`

If any other bits are set in `changeControls`, a **Value** error results. If any of the bits listed above are not set in `changeControls`, the corresponding fields must have the value 0, or a **Match** error results.

If applied, `repeatDelay` and `repeatInterval` change the autorepeat characteristics of the keyboard, as described in [The RepeatKeys Control](#). If specified, `repeatDelay` and `repeatInterval` must both be non-zero or a **Value** error results.

If applied, the `slowKeysDelay` field specifies a new delay for the **SlowKeys** control, as defined in [The SlowKeys Control](#). If specified, `slowKeysDelay` must be non-zero, or a **Value** error results.

If applied, the `debounceDelay` field specifies a new delay for the **BounceKeys** control, as described in [The BounceKeys Control](#). If present, the `debounceDelay` must be non-zero or a **Value** error results.

If applied, the `mouseKeysDfltBtn` field specifies the core pointer button for which events are generated whenever a **SA_PtrBtn** or **SA_LockPtrBtn** key action is activated. If present, `mouseKeysDfltBtn` must specify a legal button for the core pointer device, or a **Value** error results. [Key Actions](#) describes the **SA_PtrBtn** and **SA_LockPtrBtn** actions in more detail.

If applied, the `mouseKeysDelay`, `mouseKeysInterval`, `mouseKeysTimeToMax`, `mouseKeysMaxSpeed` and `mouseKeysCurve` fields change the rate at which the
pointer moves when a key which generates a `SA_MovePtr` action is held down. The `MouseKeysAccel Control` describes these `MouseKeysAccel` parameters in more detail. If defined, the `mousekeysDelay`, `mousekeysInterval`, `mousekeysTimeToMax` and `mousekeysMaxSpeed` values must all be greater than zero, or a `Value` error results. The `mousekeysCurve` value must be greater than `-1000` or a `Value` error results.

If applied, the `accessXOptions` field sets the AccessX options, which are described in detail in the `The AccessXKeys Control`. If either one of `XkbStickyKeysMask` and `XkbAccessXFeedbackMask` are set in `changeControls` and `XkbAccessXKeysMask` is not, only a subset of the AccessX options are changed, as described in the table above; if both are set or if the `AccessXKeys` bit is set in `changeControls`, all of the AccessX options are updated. Any bit in `accessXOptions` whose interpretation is undefined must be zero, or a `Value` error results.

If applied, the `accessXTimeout`, `accessXTimeoutMask`, `accessXTimeoutValues`, `accessXTimeoutOptionsMask` and `accessXTimeoutOptionsValues` fields change the behavior of the AccessX Timeout control, as described in `The AccessXTimeout Control`. The `accessXTimeout` must be greater than zero, or a `Value` error results. The `accessXTimeoutMask` or `accessXTimeoutValues` fields must specify only legal boolean controls, or a `Value` error results. The `accessXTimeoutOptionsMask` and `accessXTimeoutOptionsValues` fields must contain only legal AccessX options or a `Value` error results. If any bits are set in either values field but not in the corresponding mask, a `Match` error results.

If present, the `groupsWrap` field specifies the treatment of out-of-range keyboard groups, as described in `Key Symbol Map`. If the `groupsWrap` field does not specify a legal treatment for out-of-range groups, a `Value` error results.

If present, the `affectInternalRealMods` field specifies the set of real modifiers to be changed in the internal modifier definition and the `internalRealMods` field specifies new values for those modifiers. The `affectInternalVirtualMods` and `internalVirtualMods` fields update the virtual modifier component of the modifier definition that describes the internal modifiers in the same way. If any bits are set in either values field but not in the corresponding mask field, a `Match` error results.

If present, the `affectIgnoreLockRealMods` field specifies the set of real modifiers to be changed in the ignore locks modifier definition and the `ignoreLockRealMods` field specifies new values for those modifiers. The `affectIgnoreLockVirtualMods` and `ignoreLockVirtualMods` fields update the virtual modifier component of the ignore locks modifier definition in the same way. If any bits are set in either values field but not in the corresponding mask field, a `Match` error results.

If present, the `perKeyRepeat` array specifies the repeat behavior of the individual keyboard keys. The corresponding core protocol or input extension per-key autorepeat information is updated to reflect any changes specified in `perKeyRepeat`. If the bits that correspond to any out-of-range keys are set in `perKeyRepeat`, a `Value` error results.

If present, the `affectEnabledControls` and `enabledControls` field enable and disable global boolean controls. Any controls set in both fields are enabled; any controls that are set in `affectEnabledControls` but not in `enabledControls` are disabled. Controls that are not set in either field are not affected. If any controls are specified in `enabledControls` but not in `affectEnabledControls`, a `Match` error results. If either field contains anything except boolean controls, a `Value` error results.
XKB Protocol Requests

## Querying and Changing the Keyboard Mapping

**XkbGetMap**

deviceSpec: KB_DEVICESPEC  
full, partial: KB_MAPPARTMASK  
firstType, nTypes: CARD8  
firstKeySym, firstKeyAction: KEYCODE  
nKeySyms, nKeyActions: CARD8  
firstKeyBehavior, firstKeyExplicit: KEYCODE  
nKeyBehaviors, nKeyExplicit: CARD8  
firstModMapKey, firstVModMapKey: KEYCODE  
nModMapKeys, nVModMapKeys: CARD8  
virtualMods: KB_VMODMASK  
deviceID: CARD8  
minKeyCode, maxKeyCode: KEYCODE  
present: KB_MAPPARTMASK  
firstType, nTypes, nTotalTypes: CARD8  
firstKeySym, firstKeyAction: KEYCODE  
nKeySyms, nKeyActions: CARD8  
totalSyms, totalActions: CARD16  
firstKeyBehavior, firstKeyExplicit: KEYCODE  
nKeyBehaviors, nKeyExplicit: CARD8  
totalKeyBehaviors, totalKeyExplicit: CARD8  
firstModMapKey, firstVModMapKey: KEYCODE  
nModMapKeys, nVModMapKeys: CARD8  
totalModMapKeys, totalVModMapKeys: CARD8  
virtualMods: KB_VMODMASK  
typesRtrn: LISTofKB_KEYTYPE  
symsRtrn: LISTofKB_KEYSYMMAP  
actsRtrn: { count: LISTofCARD8, acts: LISTofKB_ACTION }  
behaviorsRtrn: LISTofKB_SETBEHAVIOR  
vmodsRtrn: LISTofKB_SETKEYMASK  
explicitRtrn: LISTofKB_SETEXPLICIT  
modmapRtrn: LISTofKB_KEYMODMAP  
vmodMapRtrn: LISTofKB_KEYVMODMAP  
Errors: Keyboard, Value, Match, Alloc

This request returns the indicated components of the server and client maps of the keyboard specified by *deviceSpec*. The *full* mask specifies the map components to be returned in full; the *partial* mask specifies the components for which some subset of the legal elements are to be returned. The server returns a *Match* error.
if any component is specified in both full and partial, or a Value error if any undefined bits are set in either full or partial.

Each bit in the partial mask controls the interpretation of one or more of the other request fields, as follows:

<table>
<thead>
<tr>
<th>Bit in the Partial Mask</th>
<th>Type</th>
<th>Corresponding Field(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>XkbKeyTypesMask</td>
<td>key types</td>
<td>firstType, nTypes</td>
</tr>
<tr>
<td>XkbKeySymsMask</td>
<td>keycodes</td>
<td>firstKeySym, nKeySyms</td>
</tr>
<tr>
<td>XkbKeyActionsMask</td>
<td>keycodes</td>
<td>firstKeyAction, nKeyActions</td>
</tr>
<tr>
<td>XkbKeyBehaviorsMask</td>
<td>keycodes</td>
<td>firstKeyBehavior, nKeyBehaviors</td>
</tr>
<tr>
<td>XkbExplicitComponentsMask</td>
<td>keycodes</td>
<td>firstKeyExplicit, nKeyExplicit</td>
</tr>
<tr>
<td>XkbModifierMapMask</td>
<td>keycodes</td>
<td>firstModMapKey, nModMapKeys</td>
</tr>
<tr>
<td>XkbVirtualModMapMask</td>
<td>keycodes</td>
<td>firstVModMapKey, nVModMapKeys</td>
</tr>
<tr>
<td>XkbVirtualModsMask</td>
<td>virtual modifiers</td>
<td>virtualMods</td>
</tr>
</tbody>
</table>

If any of these keyboard map components are specified in partial, the corresponding values must specify a valid subset of the requested components or this request reports a Value error. If a keyboard map component is not specified in partial, the corresponding fields must contain zeroes, or a Match error results.

If any error is generated, the request aborts and does not report any values.

On successful return, the deviceID field reports the X input extension device ID of the keyboard for which information is being returned, or 0 if the server does not support the X input extension. The minKeyCode and maxKeyCode return values report the minimum and maximum keycodes that are legal for the keyboard in question.

The present return value lists all of the keyboard map components contained in the reply. The bits in present affect the interpretation of the other return values as follows:

If XkbKeyTypesMask is set in present:

- firstType and nTypes specify the types reported in the reply.
- nTotalTypes reports the total number of types defined for the keyboard
- typesRtrn has nTypes elements of type KB_KEYTYPE which describe consecutive key types starting from firstType.

If XkbKeySymsMask is set in present:

- firstKeySym and nKeySyms specify the subset of the keyboard keys for which symbols will be reported.
- totalSyms reports the total number of keysyms bound to the keys returned in this reply.
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• symsRtrn has nKeySyms elements of type KB_KEYSYMMAP, which describe the symbols bound to consecutive keys starting from firstKeySym.

If XkbKeyActionsMask is set in present:

• firstKeyAction and nKeyActions specify the subset of the keys for which actions are reported.

• totalActions reports the total number of actions bound to the returned keys.

• The count field of the actsRtrn return value has nKeyActions entries of type CARD8, which specify the number of actions bound to consecutive keys starting from firstKeyAction. The acts field of actsRtrn has totalActions elements of type KB_ACTION and specifies the actions bound to the keys.

If XkbKeyBehaviorsMask is set in present:

• The firstKeyBehavior and nKeyBehaviors return values report the range of keyboard keys for which behaviors will be reported.

• The totalKeyBehaviors return value reports the number of keys in the range to be reported that have non-default values.

• The behaviorsRtrn value has totalKeyBehaviors entries of type KB_BEHAVIOR. Each entry specifies a key in the range for which behaviors are being reported and the behavior associated with that key. Any keys in that range that do not have an entry in behaviorsRtrn have the default behavior, KB_Default.

If XkbExplicitComponentsMask is set in present:

• The firstKeyExplicit and nKeyExplicit return values report the range of keyboard keys for which the set of explicit components is to be returned.

• The totalKeyExplicit return value reports the number of keys in the range specified by firstKeyExplicit and nKeyExplicit that have one or more explicit components.

• The explicitRtrn return value has totalKeyExplicit entries of type KB_KEYEXPLICIT. Each entry specifies a key in the range for which explicit components are being reported and the explicit components that are bound to it. Any keys in that range that do not have an entry in explicitRtrn have no explicit components.

If XkbModifierMapMask is set in present:

• The firstModMapKey and nModMapKeys return values report the range of keyboard keys for which the modifier map is to be reported.

• The totalModMapKeys return value reports the number of keys in the range specified by firstModMapKey and nModMapKeys that are bound with to one or more modifiers.

• The modmapRtrn return value has totalModMapKeys entries of type KB_KEYMODMAP. Each entry specifies the a key in the range for which the mod-
ifier map is being reported and the set of modifiers that are bound to that key. Any keys in that range that do not have an entry in modmapRtrn are not associated with any modifiers by the modifier mapping.

If XkbVirtualModMapMask is set in present:

- The firstVModMapKey and nVModMapKeys return values report the range of keyboard keys for which the virtual modifier map is to be reported.

- The totalVModMapKeys return value reports the number of keys in the range specified by firstVModMapKey and nVModMapKeys that are bound with to or more virtual modifiers.

- The vmodmapRtrn return value has totalVModMapKeys entries of type KB_KEYVMODMAP. Each entry specifies the a key in the range for which the virtual modifier map is being reported and the set of virtual modifiers that are bound to that key. Any keys in that range that do not have an entry in vmodmapRtrn are not associated with any virtual modifiers,

If XkbVirtualModsMask is set in present:

- The virtualMods return value is a mask with one bit per virtual modifier which specifies the virtual modifiers for which a set of corresponding real modifiers is to be returned.

- The vmodsRtrn return value is a list with one entry of type KEYBUTMASK for each virtual modifier that is specified in virtualMods. The entries in vmodsRtrn contain the real modifier bindings for the specified virtual modifiers, beginning with the lowest-numbered virtual modifier that is present in virtualMods and proceeding to the highest.

If any of these bits are not set in present, the corresponding numeric fields all have the value zero, and the corresponding lists are all of length zero.
**XkbSetMap**

deviceSpec: KB_DEVICESPEC

flags: { SetMapResizeTypes, SetMapRecomputeActions }

present: KB_MAPPARTMASK

minKeyCode, maxKeyCode: KEYCODE

firstType, nTypes: CARD8

firstKeySym, firstKeyAction: KEYCODE

nKeySyms, nKeyActions: CARD8

totalSyms, totalActions: CARD16

firstKeyBehavior, firstKeyExplicit: KEYCODE

nKeyBehaviors, nKeyExplicit: CARD8

totalKeyBehaviors, totalKeyExplicit: CARD8

firstModMapKey, firstVModMapKey: KEYCODE

nModMapKeys, nVModMapKeys: CARD8

totalModMapKeys, totalVModMapKeys: CARD8

virtualMods: VMODMASK

types: LISTofKB_KEYTYPE

syms: LISTofKB_KEYSYM

actions: { count: LISTofCARD8, actions: LISTofKB_ACTION }

behaviors: LISTofKB_BEHAVIOR

vmods: LISTofKEYMASK

explicit: LISTofKB_EXPLICIT

modmap: LISTofKB_KEYMODMAP

vmodmap: LISTofKB_KEYVMODMAP

Errors: Keyboard, Value, Match, Alloc

This request changes the indicated parts of the keyboard specified by `deviceSpec`. With XKB, the effect of a key release is independent of the keyboard mapping at the time of the release, so this request can be processed regardless of the logical state of the modifier keys at the time of the request.

The `present` field specifies the keyboard map components contained to be changed. The bits in `present` affect the interpretation of the other fields as follows:

If `XkbKeyTypesMask` is set in `present`, `firstType` and `nTypes` specify a subset of the key types bound to the keyboard to be changed or created. The index of the first key type to be changed must be less than or equal to the unmodified length of the list of key types or a Value error results.

If `XkbKeyTypesMask` is set in `present` and `SetMapResizeTypes` is set in `flags`, the server resizes the list of key types bound to the keyboard so that the last key type specified by this request is the last element in the list. If the list of key types is shrunk, any existing key definitions that use key types that eliminated are automatically assigned key types from the list of canonical key types as described in Assigning Types To Groups of Symbols for a Key. The list of key types bound to a keyboard must always include the four canonical types and cannot have more
than \textit{XkbMaxTypesPerKey} (32) types; any attempt to reduce the number of types bound to a keyboard below four or above \textit{XkbMaxTypesPerKey} causes a \textit{Value} error. Symbolic names for newly created key types or levels within a key type are initialized to \textit{None}.

If \textit{XkbKeyTypesMask} is set in \textit{present}, the types list has \textit{nTypes} entries of type \texttt{KB\_KEYTYPE}. Each key type specified in \textit{types} must be valid or a \textit{Value} error results. To be valid a key type definition must meet the following criteria:

- The \textit{numLevels} for the type must be greater than zero.
- If the key type is \textit{ONE\_LEVEL} (i.e. index zero in the list of key types), \textit{numLevels} must be one.
- If the key type is \textit{TWO\_LEVEL} or \textit{KEYPAD}, or \textit{ALPHABETIC} (i.e. index one, two, or three in the list of key types) group width must be two.

Each key type in \textit{types} must also be internally consistent, or a Match error results. To be internally consistent, a key type definition must meet the following criteria:

- Each map entry must specify a resulting level that is legal for the type.
- Any real or virtual modifiers specified in any of the map entries must also be specified in the \textit{mods} for the type.

If \textit{XkbKeySymsMask} is set in \textit{present}, \textit{firstKeySym} and \textit{nKeySyms} specify a subset of the keyboard keys to which new symbols are to be assigned and \textit{totalSyms} specifies the total number of symbols to be assigned to those keys. If any of the keys specified by \textit{firstKeySym} and \textit{nKeySyms} are not legal, a \textit{Match} error results. The \textit{syms} list has \textit{nKeySyms} elements of type \texttt{KB\_KEYSYMMAP}. Each key in the resulting key symbol map must be valid and internally consistent or a \textit{Value} error results. To be valid and internally consistent, a key symbol map must meet the following criteria:

- The key type indices must specify legal result key types.
- The number of groups specified by \textit{groupInfo} must be in the range \texttt{0...4}.
- The \textit{width} of the key symbol map must be equal to \textit{numLevels} of the widest key type bound to the key.
- The number of symbols, \textit{nSyms}, must equal the number of groups times \textit{width}.

If \textit{XkbKeyActionsMask} is set in \textit{present}, \textit{firstKeyAction} and \textit{nKeyActions} specify a subset of the keyboard keys to which new actions are to be assigned and \textit{totalActions} specifies the total number of actions to be assigned to those keys. If any of the keys specified by \textit{firstKeyAction} and \textit{nKeyActions} are not legal, a \textit{Match} error results. The \textit{count} field of the \textit{actions} return value has \textit{nKeyActions} elements of type \texttt{CARD8}; each element of \textit{count} specifies the number of actions bound to the corresponding key. The \textit{actions} list in the \textit{actions} field has \textit{totalActions} elements of type \texttt{KB\_ACTION}. These actions are assigned to each target key in turn, as specified by \textit{count}. The list of actions assigned to each key must either be empty or have exactly as many actions as the key has symbols, or a \textit{Match} error results.

If \textit{XkbKeyBehaviorsMask} is set in \textit{present}, \textit{firstKeyBehavior} and \textit{nKeyBehaviors} specify a subset of the keyboard keys to which new behaviors are to be assigned, and
totalKeyBehaviors specifies the total number of keys in that range to be assigned non-default behavior. If any of the keys specified by firstKeyBehavior and nKeyBehaviors are not legal, a Match error results. The behaviors list has totalKeyBehaviors elements of type KB_BEHAVIOR; each entry of behaviors specifies a key in the specified range and a new behavior for that key; any key that falls in the range specified by firstBehavior and nBehaviors for which no behavior is specified in behaviors is assigned the default behavior, KB_Default. The new behaviors must be legal, or a Value error results. To be legal, the behavior specified in the XkbSetMap request must:

- Specify a key in the range indicated by firstKeyBehavior and nKeyBehaviors.
- Not specify the permanent flag; permanent behaviors cannot be set or changed using the XkbSetMap request.
- If present, the KB_Overlay1 and KB_Overlay2 behaviors must specify a keycode for the overlay key that is valid for the current keyboard.
- If present, the KB_RadioGroup behavior must specify a legal index (0…31) for the radio group to which the key belongs.

Key behaviors that are not recognized by the server are accepted but ignored. Attempts to replace a “permanent” behavior are silently ignored; the behavior is not replaced, but not error is generated and any other components specified in the XkbSetMap request are updated, as appropriate.

If XkbVirtualModsMask is set in present, virtualMods is a mask which specifies the virtual modifiers to be rebound. The vmods list specifies the real modifiers that are bound to each of the virtual modifiers specified in virtualMods, starting from the lowest numbered virtual modifier and progressing upward. Any virtual modifier that is not specified in virtualMods has no corresponding entry in vmods, so the vmods list has one entry for each bit that is set in virtualMods.

If XkbExplicitComponentsMask is set in present, firstKeyExplicit and nKeyExplicit specify a subset of the keyboard keys to which new explicit components are to be assigned, and totalKeyExplicit specifies the total number of keys in that range that have at least one explicit component. The explicit list has totalKeyExplicit elements of type KB_KEYEXPLICIT; each entry of explicit specifies a key in the specified range and a new set of explicit components for that key. Any key that falls in the range specified by firstKeyExplicit and nKeyExplicit that is not assigned some value in explicit has no explicit components.

If XkbModifierMapMask is set in present, firstModMapKey and nModMapKeys specify a subset of the keyboard keys for which new modifier mappings are to be assigned, and totalModMapKeys specifies the total number of keys in that range to which at least one modifier is bound. The modmap list has totalModMapKeys elements of type KB_KEYMODMAP; each entry of modmap specifies a key in the specified range and a new set of modifiers to be associated with that key. Any key that falls in the range specified by firstModMapKey and nModMapKeys that is not assigned some value in modmap has no associated modifiers.

If the modifier map is changed by the XkbSetMap request, any changes are also reflected in the core protocol modifier mapping. Changes to the core protocol modifier mapping are reported to XKB-unaware clients via MappingNotify events and can be retrieved with the core protocol GetModifierMapping request.
If XkbVirtualModMapMask is set in present, firstVModMapKey and nVModMapKeys specify a subset of the keyboard keys for which new modifier mappings are to be assigned, and totalVModMapKeys specifies the total number of keys in that range to which at least one virtual modifier is bound. The vmodmap list has totalVModMapKeys elements of type KB_KEYVMODMAP; each entry of vmodmap specifies a key in the specified range and a new set of virtual modifiers to be associated with that key. Any key that falls in the range specified by firstVModMapKey and nVModMapKeys that is not assigned some value in vmodmap has no associated virtual modifiers.

If the resulting keyboard map is legal, the server updates the keyboard map. Changes to some keyboard components have indirect effects on others:

If the XkbSetMapRecomputeActions bit is set in flags, the actions associated with any keys for which symbol or modifier bindings were changed by this request are recomputed as described in Assigning Actions To Keys. Note that actions are recomputed after any actions specified in this request are bound to keys, so the actions specified in this request might be clobbered by the automatic assignment of actions to keys.

If the group width of an existing key type is changed, the list of symbols associated with any keys of the changed type might be resized accordingly. If the list increases in size, any unspecified new symbols are initialized to NoSymbol.

If the list of actions associated with a key is not empty, changing the key type of the key resizes the list. Unspecified new actions are calculated by applying any keyboard symbol interpretations to the corresponding symbols.

The number of groups global to the keyboard is always equal to the largest number of groups specified by any of the key symbol maps. Changing the number of groups in one or more key symbol maps may change the number of groups global to the keyboard.

Assigning key behavior KB_RadioGroup to a key adds that key as a member of the specified radio group. Changing a key with the existing behavior KB_RadioGroup removes that key from the group. Changing the elements of a radio group can cause synthetic key press or key release events if the key to be added or removed is logically down at the time of the change.

Changing a key with behavior KB_Lock causes a synthetic key release event if the key is logically but not physically down at the time of the change.

This request sends an XkbMapNotify event which reflects both explicit and indirect map changes to any interested clients. If any symbolic names are changed, it sends a XkbNamesNotify reflecting the changes to any interested clients. XKB-unaware clients are notified of keyboard changes via core protocol MappingNotify events.

Key press and key release events caused by changing key behavior may cause additional XkbStateNotify or XkbIndicatorStateNotify events.
Querying and Changing the Compatibility Map

**XkbGetCompatMap**

devicespec: KB_DEVICESPEC
groups: KB_GROUPMASK
getAllSI: BOOL
firstSI, nSI: CARD16
deviceID: CARD8
groupsRtrn: KB_GROUPMASK
firstSIRtrn, nSIRtrn, nTotalSI: CARD16
siRtrn: LISTofKB_SYMINTERP
groupRtrn: LISTofKB_MODDEF
Errors: Keyboard, Match, Alloc

This request returns the listed compatibility map components for the keyboard specified by *deviceSpec*. If *deviceSpec* does not specify a valid keyboard device, a Keyboard Error results. On return, *deviceID* reports the input extension identifier of the keyboard device or 0 if the server does not support the input extension.

If *getAllSI* is False, *firstSI* and *nSI* specify a subset of the symbol interpretations to be returned; if used, *nSI* must be greater than 0 and all of the elements specified by *firstSI* and *nSI* must be defined or a Value error results. If *getAllSym* is True, the server ignores *firstSym* and *nSym* and returns all of the symbol interpretations defined for the keyboard.

The *groups* mask specifies the groups for which compatibility maps are to be returned.

The *nTotalSI* return value reports the total number of symbol interpretations defined for the keyboard. On successful return, the *siRtrn* return list contains the definitions for *nSIRtrn* symbol interpretations beginning at *firstSIRtrn*.

The *groupRtrn* return values report the entries in the group compatibility map for any groups specified in the *groupsRtrn* return value.

**XkbSetCompatMap**

devicespec: KB_DEVICESPEC
recomputeActions: BOOL
truncateSI: BOOL
groups: KB_GROUPMASK
firstSI, nSI: CARD16
si: LISTofKB_SYMINTERPRET
groupMaps: LISTofKB_MODDEF
Errors: Keyboard, Match, Value, Alloc

This request changes a specified subset of the compatibility map of the keyboard indicated by *deviceSpec*. If *deviceSpec* specifies an invalid device, a Keyboard error results and nothing is changed.
The \textit{firstSI} and \textit{nSI} fields specify a subset of the keyboard symbol interpretations to be changed. The \textit{si} list specifies new values for each of the interpretations in that range.

The first symbol interpretation to be changed, \textit{firstSI}, must be less than or equal to the unchanged length of the list of symbol interpretations, or a \textit{Value} error results. If the resulting list would be larger than the unchanged list, it server list of symbol interpretations is automatically increased in size. Otherwise, if \textit{truncateSyms} is \textit{True}, the server deletes any symbol interpretations after the last element changed by this request, and reduces the length of the list accordingly.

The \textit{groupMaps} fields contain new definitions for a subset of the group compatibility map; \textit{groups} specifies the group compatibility map entries to be updated from \textit{groupMaps}.

All changed compatibility maps and symbol interpretations must either ignore group state or specify a legal range of groups, or a \textit{Value} error results.

If the \textit{recomputeActions} field is \textit{True}, the server regenerates recalculates the actions bound to all keyboard keys by applying the new symbol interpretations to the entire key symbol map, as described in \textit{Assigning Actions To Keys}.

\section*{Querying and Changing Indicators}

\begin{description}
\item[XkbGetIndicatorState]
\begin{verbatim}
deviceSpec: KB_DEVICESPEC
deviceID: CARD8 state: KB_INDICATORMASK
\end{verbatim}
\end{description}

This request reports the current state of the indicators for the keyboard specified by \textit{deviceSpec}. If \textit{deviceSpec} does not specify a valid keyboard, a \textit{Keyboard} error results.

On successful return, the \textit{deviceID} field reports the input extension identifier of the keyboard or 0 if the server does not support the input extension. The \textit{state} return value reports the state of each of the thirty-two indicators on the specified keyboard. The least-significant bit corresponds to indicator 0, the most significant bit to indicator 31; if a bit is set, the corresponding indicator is lit.

\begin{description}
\item[XkbGetIndicatorMap]
\begin{verbatim}
deviceSpec: KB_DEVICESPEC
which: KB_INDICATORMASK
deviceID: CARD8
which: KB_INDICATORMASK
realIndicators: KB_INDICATORMASK
nIndicators: CARD8
maps: LISTofKB_INDICATORMAP
\end{verbatim}
\end{description}

Errors: \textit{Keyboard}, \textit{Value}
This request returns a subset of the maps for the indicators on the keyboard specified by `deviceSpec`. If `deviceSpec` does not specify a valid keyboard device, a `Keyboard` error results.

The `which` field specifies the subset to be returned; a set bit in the which field indicates that the map for the corresponding indicator should be returned.

On successful return, the `deviceID` field reports the input extension identifier of the keyboard or 0 if the server does not support the input extension. Any indicators specified in `realIndicators` are actually present on the keyboard; the rest are virtual indicators. Virtual indicators do not directly cause any visible or audible effect when they change state, but they do cause `XkbIndicatorStateNotify` events.

The `maps` return value reports the requested indicator maps. Indicator maps are described in `Indicator Maps`.

### XkbSetIndicatorMap

deviceSpec: KB_DEVICESPEC
which: KB_INDICATORMASK
maps: LISTofKB_INDICATORMAP

Errors: `Keyboard`, `Value`

This request changes a subset of the maps on the keyboard specified by `deviceSpec`. If `deviceSpec` does not specify a valid keyboard device, a `Keyboard` error results.

The `which` field specifies the subset to be changed; the `maps` field contains the new definitions.

If successful, the new indicator maps are applied immediately. If any indicators change state as a result of the new maps, the server generates `XkbIndicatorStateNotify` events as appropriate.

### XkbGetNamedIndicator

deviceSpec: KB_DEVICESPEC
ledClass: KB_LEDCLASSSPEC
ledID: KB_IDSPEC
indicator: ATOM
deviceID: CARD8
supported: BOOL
found: BOOL
on: BOOL
realIndicator: BOOL
ndx: CARD8
map: KB_INDICATORMAP

Errors: `Keyboard`, `Atom`, `Value`

This request returns information about the indicator specified by `ledClass`, `ledID`, and `indicator` on the keyboard specified by `deviceSpec`. The `indicator` field specifies the name of the indicator for which information is to be returned.
If \textit{deviceSpec} does not specify a device with indicators, a \textit{Keyboard} error results. If \textit{ledClass} does not have the value \textit{DfltXIClass}, \textit{LedFeedbackClass}, or \textit{KbdFeedbackClass}, a \textit{Value} error results. If \textit{ledID} does not have the value \textit{DfltXIId} or specify the identifier of a feedback of the class specified by \textit{ledClass} on the device specified by \textit{deviceSpec}, a \textit{Match} error results. If \textit{indicator} is not a valid ATOM other than \textit{None}, a \textit{Atom} error results.

This request is always supported with default class and identifier on the core keyboard device. If the request specifies a device other than the core keyboard device or a feedback class and identifier other than the defaults, and the server does not support indicator names or indicator maps for extension devices, the \textit{supported} return value is \textit{False} and the values of the other fields in the reply are undefined. If the client which issued the unsupported request has also selected to do so, it will also receive an \textit{XkbExtensionDeviceNotify} event which reports the attempt to use an unsupported feature, in this case one or both of \textit{XkbXI_IndicatorMaps} or \textit{XkbXI_IndicatorNames}.

Otherwise, \textit{supported} is \textit{True} and the \textit{deviceID} field reports the input extension identifier of the keyboard or 0 if the server does not support the input extension. The \textit{indicator} return value reports the name for which information was requested and the \textit{found} return value is \textit{True} if an indicator with the specified name was found on the device.

If a matching indicator was found:

- The \textit{on} return value reports the state of the indicator at the time of the request.
- The \textit{realIndicator} return value is \textit{True} if the requested indicator is actually present on the keyboard or \textit{False} if it is virtual.
- The \textit{ndx} return value reports the index of the indicator in the requested feedback.
- The \textit{map} return value reports the indicator map used by to automatically change the state of the specified indicator in response to changes in keyboard state or controls.

If no matching indicator is found, the \textit{found} return value is \textit{False}, and the \textit{on}, \textit{realIndicator}, \textit{ndx}, and \textit{map} return values are undefined.

\textbf{XkbSetNamedIndicator}

\begin{itemize}
  \item deviceSpec: KB_DEVICESPEC
  \item ledClass: KB_LEDCLASSSPEC
  \item ledID: KB_IDSPEC
  \item indicator: ATOM
  \item setState: BOOL
  \item on: BOOL
  \item setMap: BOOL
  \item createMap: BOOL
  \item map: KB_SETINDICATORMAP
\end{itemize}

\textit{Errors: Keyboard, Atom, Access}
This request changes various aspects of the indicator specified by \textit{ledClass}, \textit{ledID}, and \textit{indicator} on the keyboard specified by \textit{deviceSpec}. The \textit{indicator} argument specifies the name of the indicator to be updated.

If \textit{deviceSpec} does not specify a device with indicators, a \textit{Keyboard} error results. If \textit{ledClass} does not have the value \textit{DfltXIClass}, \textit{LedFeedbackClass}, or \textit{KbdFeedbackClass}, a \textit{Value} error results. If \textit{ledID} does not have the value \textit{DfltXIId} or specify the identifier of a feedback of the class specified by \textit{ledClass} on the device specified by \textit{deviceSpec}, a \textit{Match} error results. If \textit{indicator} is not a valid ATOM other than \textit{None}, an \textit{Atom} error results.

This request is always supported with default class and identifier on the core keyboard device. If the request specifies a device other than the core keyboard device or a feedback class and identifier other than the defaults, and the server does not support indicator names or indicator maps for extension devices, the \textit{supported} return value is \textit{False} and the values of the other fields in the reply are undefined. If the client which issued the unsupported request has also selected to do so, it will also receive an \textit{XkbExtensionDeviceNotify} event which reports the attempt to use an unsupported feature, in this case one or both of \textit{XkbXI_IndicatorMaps} and \textit{XkbXI_IndicatorNames}.

Otherwise, \textit{supported} is \textit{True} and the \textit{deviceID} field reports the input extension identifier of the keyboard or \textit{0} if the server does not support the input extension. The \textit{indicator} return value reports the name for which information was requested and the \textit{found} return value is \textit{True} if an indicator with the specified name was found on the device.

If no indicator with the specified name is found on the specified device, and the \textit{createMap} field is \textit{True}, XKB assigns the specified name to the lowest-numbered indicator that has no name (i.e. whose name is \textit{None}) and applies the rest of the fields in the request to the newly named indicator. If no unnamed indicators remain, this request reports no error and has no effect.

If no matching indicator is found or new indicator assigned this request reports no error and has no effect. Otherwise, it updates the indicator as follows:

If \textit{setMap} is \textit{True}, XKB changes the map for the indicator (see \textit{Indicator Maps}) to reflect the values specified in \textit{map}.

If \textit{setState} is \textit{True}, XKB attempts to explicitly change the state of the indicator to the state specified in \textit{on}. The effects of an attempt to explicitly change the state of an indicator depend on the values in the map for that indicator and are not guaranteed to succeed.

If this request affects both indicator map and state, it updates the indicator map before attempting to change its state, so the success of the explicit change depends on the indicator map values specified in the request.

If this request changes the indicator map, it applies the new map immediately to determine the appropriate state for the indicator given the new indicator map and the current state of the keyboard.
Querying and Changing Symbolic Names

XkbGetNames

deviceSpec: KB DEVICESEPEC
which: KB NAMEDETAILMASK
deviceID: CARD8 which: KB NAMESMASK minKeyCode, maxKeyCode: KEYCODE nTypes: CARD8 nKTLevels: CARD16 groupNames: KB GROUPMASK virtualMods: KB VMODMASK firstKey: KEYCODE nKeys: CARD8 indicators: KB INDICATORMASK nRadioGroups, nKeyAliases: CARD8 present: KB NAMEDETAILMASK valueList: LISTofITEMs

Errors: Keyboard , Value

This request returns the symbolic names for various components of the keyboard mapping for the device specified by deviceSpec. The which field specifies the keyboard components for which names are to be returned. If deviceSpec does not specify a valid keyboard device, a Keyboard error results. If any undefined bits in which are non-zero, a Value error results.

The deviceID return value contains the X Input Extension device identifier of the specified device or 0 if the server does not support the input extension. The present and valueList return values specify the components for which names are being reported. If a component is specified in present, the corresponding element is present in the valueList, otherwise that component has length 0. The components of the valueList appear in the following order, when present:

<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>XkbKeycodesName</td>
<td>1</td>
<td>ATOM</td>
</tr>
<tr>
<td>XkbGeometryName</td>
<td>1</td>
<td>ATOM</td>
</tr>
<tr>
<td>XkbSymbolsName</td>
<td>1</td>
<td>ATOM</td>
</tr>
<tr>
<td>XkbPhysSymbolsName</td>
<td>1</td>
<td>ATOM</td>
</tr>
<tr>
<td>XkbTypesName</td>
<td>1</td>
<td>ATOM</td>
</tr>
<tr>
<td>XkbCompatName</td>
<td>1</td>
<td>ATOM</td>
</tr>
<tr>
<td>XkbKeyTypeNames</td>
<td>nTypes</td>
<td>LISTofATOM</td>
</tr>
<tr>
<td>XkbKTLevelNames</td>
<td>nTypes , nKTLevels</td>
<td>{ count: LISTofCARD8, names: LISTofATOM }</td>
</tr>
<tr>
<td>XkbIndicatorNames</td>
<td>One per bit set in indicators</td>
<td>LISTofATOM</td>
</tr>
<tr>
<td>XkbVirtualModNames</td>
<td>One per bit set in virtualMods</td>
<td>LISTofATOM</td>
</tr>
<tr>
<td>XkbGroupNames</td>
<td>One per bit set in groupNames</td>
<td>LISTofATOM</td>
</tr>
<tr>
<td>XkbKeyNames</td>
<td>nKeys</td>
<td>LISTofKB_KEYNAME</td>
</tr>
<tr>
<td>XkbKeyAliases</td>
<td>nKeyAliases</td>
<td>LISTofKB_KEYALIAS</td>
</tr>
<tr>
<td>XkbRGNames</td>
<td>nRadioGroups</td>
<td>LISTofATOM</td>
</tr>
</tbody>
</table>

If type names are reported, the nTypes return value reports the number of types defined for the keyboard, and the list of key type names in valueList has nTypes elements.
If key type level names are reported, the list of key type level names in the valueList has two parts: The count array has nTypes elements, each of which reports the number of level names reported for the corresponding key type. The names array has nKTLLevels atoms and reports the names of each type sequentially. The nKTLLevels return value is always equal to the sum of all of the elements of the count array.

If indicator names are reported, the indicators mask specifies the indicators for which names are defined; any indicators not specified in indicators have the name None. The list of indicator names in valueList contains the names of the listed indicators, beginning with the lowest-numbered indicator for which a name is defined and proceeding to the highest.

If virtual modifier names are reported, the virtualMods mask specifies the virtual modifiers for which names are defined; any virtual modifiers not specified in virtualMods have the name None. The list of virtual modifier names in valueList contains the names of the listed virtual modifiers, beginning with the lowest-numbered virtual modifier for which a name is defined and proceeding to the highest.

If group names are reported, the groupNames mask specifies the groups for which names are defined; any groups not specified in groupNames have the name None. The list of group names in valueList contains the names of the listed groups, beginning with the lowest-numbered group for which a name is defined and proceeding to the highest.

If key names are reported, the firstKey and nKeys return values specify a range of keys which includes all keys for which names are defined; any key that does not fall in the range specified by firstKey and nKeys has the name NullKeyName. The list of key names in the valueList has nKeys entries and specifies the names of the keys beginning at firstKey.

If key aliases are reported, the nKeyAliases return value specifies the total number of key aliases defined for the keyboard. The list of key aliases in valueList has nKeyAliases entries, each of which reports an alias and the real name of the key to which it corresponds.

If radio group names are reported, the nRadioGroups return value specifies the number of radio groups on the keyboard for which names are defined. The list of radio group names in valueList reports the names of each group and has nRadioGroups entries.
**XkbSetNames**

deviceSpec: KB_DEVICESPEC  
which: KB_NAMEDETAILEDMASK  
virtualMods: KB_VMODMASK  
firstType, nTypes: CARD8  
firstKTLevel, nKTLevels: CARD8  
totalKTLevelNames: CARD16  
indicators: KB_INDICATORDETAILEDMASK  
groupNames: KB_GROUPDETAILEDMASK  
nRadioGroups: CARD8  
firstKey: KEYCODE  
nKeys, nKeyAliases: CARD8  
valueList: LISTofITEMs  

**Errors:** Keyboard, Atom, Value, Match, Alloc

This request changes the symbolic names for the requested components of the keyboard specified by `deviceSpec`. The `which` field specifies the components for which one or more names are to be updated. If `deviceSpec` does not specify a valid keyboard device, a Keyboard error results. If any undefined bits in `which` are non-zero, a Value error results. If any error (other than Alloc or Implementation) occurs, this request returns without modifying any names.

The `which` and `valueList` fields specify the components to be changed; the type of each `valueList` entry, the order in which components appear in the `valueList` when specified, and the correspondence between components in `which` and the entries in the `valueList` are as specified for the XkbGetNames request.

If keycodes, geometry, symbols, physical symbols, types or compatibility map names are to be changed, the corresponding entries in the `valueList` must have the value None or specify a valid ATOM, else an Atom error occurs.

If key type names are to be changed, the `firstType` and `nTypes` fields specify a range of types for which new names are supplied, and the list of key type names in `valueList` has `nTypes` elements. Names for types that fall outside of the range specified by `firstType` and `nTypes` are not affected. If this request specifies names for types that are not present on the keyboard, a Match error results. All of the type names in the `valueList` must be valid ATOMs or have the value None, or an Atom error results.

The names of the first four keyboard types are specified by the XKB extension and cannot be changed; including any of the canonical types in this request causes an Access error, as does trying to assign the name reserved for a canonical type to one of the other key types.

If key type level names are to be changed, the `firstKTLevel` and `nKTLevels` fields specify a range of key types for which new level names are supplied, and the list of key type level names in the `valueList` has two parts: The count array has `nKTLevels` elements, each of which specifies the number of levels for which names are supplied on the corresponding key type; any levels for which no names are specified are assigned the name None. The names array has `totalKTLevels` atoms and specifies
the names of each type sequentially. The totalKTLevels field must always equal the sum of all of the elements of the count array. Level names for types that fall outside of the specified range are not affected. If this request specifies level names for types that are not present on the keyboard, or if it specifies more names for a type than the type has levels, a Match error results. All specified type level names must be None or a valid ATOM or an Atom error results.

If indicator names are to be changed, the indicators mask specifies the indicators for which new names are specified; the names for indicators not specified in indicators are not affected. The list of indicator names in valueList contains the new names for the listed indicators, beginning with the lowest-numbered indicator for which a name is defined and proceeding to the highest. All specified indicator names must be a valid ATOM or None, or an Atom error results.

If virtual modifier names are to be changed, the virtualMods mask specifies the virtual modifiers for which new names are specified; names for any virtual modifiers not specified in virtualMods are not affected. The list of virtual modifier names in valueList contains the new names for the specified virtual modifiers, beginning with the lowest-numbered virtual modifier for which a name is defined and proceeding to the highest. All virtual modifier names must be valid ATOMs or None, or an Atom error results.

If group names are to be changed, the groupNames mask specifies the groups for which new names are specified; the name of any group not specified in groupNames is not changed. The list of group names in valueList contains the new names for the listed groups, beginning with the lowest-numbered group for which a name is defined and proceeding to the highest. All specified group names must be a valid ATOM or None, or an Atom error results.

If key names are to be changed, the firstKey and nKeys fields specify a range of keys for which new names are defined; the name of any key that does not fall in the range specified by firstKey and nKeys is not changed. The list of key names in the valueList has nKeys entries and specifies the names of the keys beginning at firstKey.

If key aliases are to be changed, the nKeyAliases field specifies the length of a new list of key aliases for the keyboard. The list of key aliases can only be replaced in its entirety; it cannot be replaced. The list of key aliases in valueList has nKeyAliases entries, each of which reports an alias and the real name of the key to which it corresponds.

XKB does not check key names or aliases for consistency and validity, so applications should take care not to assign duplicate names or aliases.

If radio group names are to be changed, the nRadioGroups field specifies the length of a new list of radio group names for the keyboard. There is no way to edit the list of radio group names; it can only be replaced in its entirety. The list of radio group names in valueList reports the names of each group and has nRadioGroups entries. If the list of radio group names specifies names for more radio groups than XKB allows (32), a Match error results. All specified radio group names must be valid ATOMs or have the value None, or an Atom error results.
Querying and Changing Keyboard Geometry

**XkbGetGeometry**

deviceSpec: KB_DEVICESPEC
nname: ATOM
deviceID: CARD8
nname: ATOM
found: BOOL
widthMM, heightMM: CARD16
baseColorNdx, labelColorNdx: CARD8
properties: LISTofKB_PROPERTY
colors: LISTofSTRING8
shapes: LISTofKB_SHAPE
sections: LISTofKB_SECTION
doodads: LISTofKB_DOODAD
keyAliases: LISTofKB_KEYALIAS
Errors: Keyboard

This request returns a description of the physical layout of a keyboard. If the *name* field has the value *None*, or if name is identical to the name of the geometry for the keyboard specified by *deviceSpec*, this request returns the geometry of the keyboard specified by *deviceSpec*; otherwise, if *name* is a valid atom other than *None*, the server returns the keyboard geometry description with that name in the server database of keyboard components (see The Server Database of Keyboard Components) if one exists. If *deviceSpec* does not specify a valid keyboard device, a Keyboard error results. If *name* has a value other than *None* or a valid ATOM, an Atom error results.

On successful return, the *deviceID* field reports the X Input extension identifier of the keyboard device specified in the request, or 0 if the server does not support the input extension.

The *found* return value reports whether the requested geometry was available. If *found* is False, no matching geometry was found and the remaining fields in the request reply are undefined; if *found* is True, the remaining fields of the reply describe the requested keyboard geometry. The interpretation of the components that make up a keyboard geometry is described in detail in Keyboard Geometry.
XkbSetGeometry

deviceSpec: KB_DEVICESPEC
name: ATOM
widthMM, heightMM, CARD16
baseColorNdx, labelColorNdx: CARD8
shapes: LISTofKB_SHAPE
sections: LISTofKB_SECTION
properties: LISTofKB_PROPERTY
colors: LISTofSTRING8
doodads: LISTofKB_DOODAD
keyAliases: LISTofKB_KEYALIAS

Errors: Keyboard, Atom, Value

This request changes the reported description of the geometry for the keyboard specified by deviceSpec. If deviceSpec does not specify a valid keyboard device, a Keyboard error results.

The name field specifies the name of the new keyboard geometry and must be a valid ATOM or an Atom error results. The new geometry is not added to the server database of keyboard components, but it can be retrieved using the XkbGetGeometry request for as long as it is bound to the keyboard. The keyboard geometry symbolic name is also updated from the name field, and an XkbNamesNotify event is generated, if necessary.

The list of colors must include at least two definitions, or a Value error results. All color definitions in the geometry must specify a legal color (i.e. must specify a valid index for one of the entries of the colors list) or a Match error results. The baseColorNdx and the labelColorNdx must be different or a Match error results.

The list of shapes must include at least one shape definition, or a Value error results. If any two shapes have the same name, a Match error result. All doodads and keys which specify shape must specify a valid index for one of the elements of the shapes list, or a Match error results.

All section, shape and doodad names must be valid ATOMs or an Atom error results; the constant None is not permitted for any of these components.

All doodads must be of a known type; XKB does not support "private" doodad types.

If, after rotation, any keys or doodads fall outside of the bounding box for a section, the bounding box is automatically adjusted to the minimum size which encloses all of its components.

If, after adjustment and rotation, the bounding box of any section or doodad extends below zero on either the X or Y axes, the entire geometry is translated so that the minimum extent along either axis is zero.

If, after rotation and translation, any keyboard components fall outside of the rectangle specified by widthMM and heightMM, the keyboard dimensions are automatically resized to the minimum bounding box that surrounds all components. Otherwise, the width and height of the keyboard are left as specified.
The `under` field of any overlay key definitions must specify a key that is in the section that contains the overlay key, or a `Match` error results. This request does not check the value of the `over` field of an overlay key definition, so applications must be careful to avoid conflicts with actual keys.

This request does not verify that key names or aliases are unique. It also does not verify that all key names specified in the geometry are bound to some keycode or that all keys that are named in the keyboard definition are also available in the geometry. Applications should make sure that keyboard geometry has no internal conflicts and is consistent with the other components of the keyboard definition, but XKB does not check for or guarantee it.

**Querying and Changing Per-Client Flags**

**XkbPerClientFlags**

deviceSpec: KB_DEVICESPEC
change: KB_PCFMASK
value: KB_PCFMASK
ctrlsToChange: KB_BOOLCTRLMASK
autoCtrls: KB_BOOLCTRLMASK
autoCtrlValues: KB_BOOLCTRLMASK
deviceID: CARD8 supported: KB_PCFMASK value: KB_PCFMASK autoCtrls: KB_BOOLCTRLMASK autoCtrlValues: KB_BOOLCTRLMASK

**Errors:** Keyboard, Value, Match, Alloc

Changes the client specific flags for the keyboard specified by `deviceSpec` . Reports a `Keyboard` error if `deviceSpec` does not specify a valid keyboard device.

Any flags specified in `change` are set to the corresponding values in `value` , provided that the server supports the requested control. Legal per-client-flags are:

<table>
<thead>
<tr>
<th>Flag...</th>
<th>Described in...</th>
</tr>
</thead>
<tbody>
<tr>
<td>XkbPCF_DetectableAutorepeat</td>
<td>Detectable Autorepeat</td>
</tr>
<tr>
<td>XkbPCF_GrabsUseXKBStateMask</td>
<td>Setting a Passive Grab for an XKB State</td>
</tr>
<tr>
<td>XkbPCF_AutoResetControlsMask</td>
<td>Automatic Reset of Boolean Controls</td>
</tr>
<tr>
<td>XkbPCF_LookupStateWhenGrabbed</td>
<td>Effects of XKB on Core Protocol Events</td>
</tr>
<tr>
<td>XkbPCF_SendEventUsesXKBState</td>
<td>Sending Events to Clients</td>
</tr>
</tbody>
</table>

If `PCF_AutoResetControls` is set in both `change` and `value` , the client’s mask of controls to be changed is updated from `ctrlsToChange` , `autoCtrls` , and `autoCtrlValues` . Any controls specified in `ctrlsToChange` are modified in the auto-reset controls mask for the client; the corresponding bits from the `autoCtrls` field are copied into the auto-reset controls mask and the corresponding bits from `autoCtrlValues` are copied into the auto-reset controls state values. If any controls are specified in `autoCtrlValues` but not in `autoCtrls` , a `Match` error results. If any controls are specified in `autoCtrls` but not in `ctrlsToChange` , a `Match` error results.
If `PCF_AutoResetControls` is set in `change` but not in `value`, the client’s mask of controls to be changed is reset to all zeroes (i.e. the client does not change any controls when it exits).

This request reports a `Match` error if a bit is set in any of the value masks but not in the control mask that governs it or a `Value` error if any undefined bits are set in any of the masks.

On successful return, the `deviceId` field reports the X Input extension identifier of the keyboard, or 0 if the server does not support the X Input Extension.

The `supported` return value reports the set of per-client flags that are supported by the server; in this version of XKB, only the `XkbPCF_DetectableAutorepeat` per-client flag is optional; all other per-client flags must be supported.

The `value` return value reports the current settings of all per-client flags for the specified keyboard. The `autoCtrls` return value reports the current set of controls to be reset when the client exits, while the `autoCtrlValues` return value reports the state to which they should be set.

### Using the Server’s Database of Keyboard Components

**XkbListComponents**

deviceSpec: KB_DEVICESPEC
maxNames: CARD16
keymapsSpec: STRING8
keycodesSpec: STRING8
typesSpec: STRING8
compatMapSpec: STRING8
symbolsSpec: STRING8
geometrySpec: STRING8
deviceID: CARD8
extra: CARD16
keymaps,keycodes,types,compatMaps: LISTofKB_COMPONENTNAME
symbols, geometries: LISTofKB_COMPONENTNAME

Where:

KB_COMPONENTNAME { hints: CARD8, name: STRING8 }

Errors: `Keyboard`, `Alloc`

This request returns one or more lists of keyboard components that are available from the X server database of keyboard components for the device specified by `deviceSpec`. The X server is allowed, but not required or expected, to maintain separate databases for each keyboard device. A `Keyboard` error results if `deviceSpec` does not specify a valid keyboard device.

The `maxNames` field specifies the maximum number of component names to be reported, in total, by this request.

The `keymapsSpec`, `keycodesSpec`, `typesSpec`, `compatMapSpec`, `symbolsSpec` and `geometrySpec` request fields specify a pattern to be matched against the names
of all components of the corresponding type in the server database of keyboard components.

Each pattern uses the ISO Latin-1 encoding and should contain only parentheses, the wildcard characters "?" and "*" or characters that are permitted in a component class or member name (see Component Names). Illegal characters in a pattern are simply ignored; no error results if a pattern contains illegal characters.

Comparison is case-sensitive and, in a pattern, the "?" wildcard character matches any single character except parentheses while the "*" character matches any number of characters except parentheses. If an implementation accepts characters other than those required by XKB, whether or not those characters match either wildcard is also implementation dependent. An empty pattern does not match any component names.

On successful return, the deviceID return value reports the X Input Extension device identifier of the specified device, or 0 if the server does not support the X input extension. The extra return value reports the number of matching component names that could not be returned due to the setting of the maxNames field in the request.

The keymaps, keycodes, types, compatMaps, symbols and geometries return the hints (see Component Hints) and names of any components from the server database that match the corresponding pattern.

The Server Database of Keyboard Components describes the X server database of keyboard components in more detail.

XkbGetKbdByName
deviceSpec: KB_DEVICESPEC
need, want: KB_GBNDETAILMASK
load: BOOL
keymapsSpec: STRING8
keycodesSpec, typesSpec: STRING8
compatMapSpec, symbolsSpec: STRING8
geometrySpec: STRING8
deviceID: CARD8
minKeyCode, maxKeyCode: KEYCODE
loaded, newKeyboard: BOOL
found, reported: KB_GBNDETAILMASK
map: optional XkbGetMap reply
compat: optional XkbGetCompatMap reply
indicators: optional XkbGetIndicatorMap reply
names: optional XkbGetNames reply
geometry: optional XkbGetGeometry reply
Errors: Keyboard, Access, Alloc

Assembles and returns a keymap from the current mapping and specified elements from the server database of keymap components for the keyboard specified by de-
viceSpec, and optionally replaces the current keyboard mapping with the newly generated description. If deviceSpec does not specify a valid keyboard device, a Keyboard error results.

The keymapsSpec, keycodesSpec, typesSpec, compatMapSpec, symbolsSpec and geometrySpec component expressions (see Partial Components and Combining Multiple Components) specify the database components to be used to assemble the keyboard description. The want field lists the pieces of the keyboard description that the client wants to have reported for the newly constructed keymap. The need field lists all of the pieces that must be reported. If any of the pieces in need cannot be loaded from the specified names, no description of the keyboard is returned.

The want and need fields can include any combinations of these XkbGetMapByName (GBN) components:

<table>
<thead>
<tr>
<th>XkbGetMapByName</th>
<th>Database Component...</th>
<th>Components of Keyboard Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XkbGBN_Types</td>
<td>types</td>
<td>key types</td>
</tr>
<tr>
<td>XkbGBN_CompatMap</td>
<td>compat</td>
<td>symbol interpretations, group compatibility</td>
</tr>
<tr>
<td>XkbGBN_ClientSymbols</td>
<td>symbols, types, keycodes</td>
<td>key types, key symbol mappings</td>
</tr>
<tr>
<td>XkbGBN_ServerSymbols</td>
<td>symbols, types, keycodes</td>
<td>key behaviors, key actions, key explicit components, virtual modifiers, virtual modifier mapping</td>
</tr>
<tr>
<td>XkbGBN_IndicatorMap</td>
<td>compat</td>
<td>indicator maps, indicator names</td>
</tr>
<tr>
<td>XkbGBN_KeyNames</td>
<td>keycodes</td>
<td>key names, key aliases</td>
</tr>
<tr>
<td>XkbGBN_Geometry</td>
<td>geometry</td>
<td>keyboard geometry</td>
</tr>
<tr>
<td>XkbGBN_OtherNames</td>
<td>all</td>
<td>key types, symbol interpretations, indicator maps, names, geometry</td>
</tr>
</tbody>
</table>

If either field contains a GBN component that depends on some database component for which the request does not supply an expression, XKB automatically substitutes the special pattern "%" which copies the corresponding component from the current keyboard description, as described in Partial Components and Combining Multiple Components.

The load flag asks the server to replace the current keyboard description for deviceSpec with the newly constructed keyboard description. If load is True, the request must include component expressions for all of the database components; if any are missing, XKB substitutes "%" as described above.

If all necessary components are both specified and found, the new keyboard description is loaded. If the new keyboard description has a different geometry or keycode range than the previous keyboard description, XKB sends XkbNewKeyboardNotify.
events to all interested clients. See Replacing the Keyboard “On-the-Fly” for more information about the effects of replacing the keyboard description on the fly.

If the range of keycodes changes, clients that have requested XkbNewKeyboardNotify events are not sent any other change notification events by this request. Clients that do not request XkbNewKeyboardNotify events are sent other XKB change notification events (e.g. XkbMapNotify, XkbNamesNotify) as necessary to alert them to as many of the keyboard changes as possible.

If no error occurs, the request reply reports the GBN components that were found and sends a description of any of the resulting keyboard that includes and of the components that were requested.

The deviceID return value reports the X Input extension device identifier of the keyboard that was used, or 0 if the server does not support the X input extension.

The minKeyCode and maxKeyCode return values report the legal range of keycodes for the keyboard description that was created. If the resulting keyboard description does not include at least one of the key names, client symbols or server symbols components, minKeyCode and maxKeyCode are both 0.

The loaded return value reports whether or not the existing keyboard definition was replaced with the newly created one. If loaded is True, the newKeyboard return value reports whether or not the new map changed the geometry or range of keycodes and caused XkbNewKeyboardNotify events for clients that have requested them.

The found return value reports the GBN components that were present in the keymap that was constructed by this request. The reported return value lists the subset of those components for which descriptions follow. if any of the components specified in the need field of the request were not found, reported is empty, otherwise it contains the intersection of the found return value with the union of the need and want request fields.

If any of GBN_Types, GBN_ClientSymbols or GBN_ServerSymbols are set in reported, the map return value has the same format as the reply to an XkbGetMap request and reports the corresponding pieces of the newly constructed keyboard description.

If GBN_CompatMap is set in reported, the compat return value has the same format as the reply to an XkbGetCompatMap request and reports the symbol interpretations and group compatibility map for the newly constructed keyboard description.

If GBN_IndicatorMap is set in reported, the indicators return value has the same format as the reply to an XkbGetIndicatorMap request and reports the physical indicators and indicator maps for the newly constructed keyboard description.

If GBN_KeyNames or GBN_OtherNames are set in reported, the names return value has the same format as the reply to an XkbGetNames reply and reports the corresponding set of symbolic names for the newly constructed keyboard description.

If GBN_Geometry is set in reported, the geometry return value has the same format as the reply to an XkbGetGeometryMap request and reports the keyboard geometry for the newly constructed keyboard description.
Querying and Changing Input Extension Devices

**XkbGetDeviceInfo**

deviceSpec: KB_DEVICESPEC
wanted: KB_XIDEVFEATUREMASK
ledClass: KB_LEDCLASSSPEC
ledID: KB_IDSPEC
allButtons: BOOL
firstButton, nButtons: CARD8
deviceID: CARD8
present: KB_XIDEVFEATUREMASK
supported: KB_XIFEATUREMASK
unsupported: KB_XIFEATUREMASK
firstBtnWanted: CARD8
nBtnsWanted: CARD8
firstBtnRtrn: CARD8
nBtnsRtrn: CARD8
totalBtns: CARD8
hasOwnState: BOOL
dfltKbdFB, dfltLedFB: KB_IDSPEC
devType: ATOM
name: STRING
btnActions: LISTofKB_ACTION
leds: LISTofKB_DEVICELEDINFO

Errors: Device, Match, Access, Alloc

Reports a subset of the XKB-supplied information about the input device specified by `deviceSpec`. Unlike most XKB requests, the device specified for `XkbGetDeviceInfo` need not be a keyboard device. Nonetheless, a *Keyboard* error results if `deviceSpec` does not specify a valid core or input extension device.

The `wanted` field specifies the types of information to be returned, and controls the interpretation of the other request fields.

If the server does not support assignment of XKB actions to extension device buttons, the `allButtons`, `firstButton` and `nButtons` fields are ignored.

Otherwise, if the `XkbXI_ButtonActions` flag is set in `wanted`, the `allButtons`, `firstButton` and `nButtons` fields specify the device buttons for which actions should be returned. Setting `allButtons` to `True` requests actions for all device buttons; if `allButtons` is `False`, `firstButton` and `nButtons` specify a range of buttons for which actions are requested. If the device has no buttons or if `firstButton` and `nButtons` specify illegal buttons, a *Match* error results. If `allButtons` is `True`, `firstButton` and `nButtons` are ignored.

If the server does not support XKB access to any aspect of the indicators on extension devices, or if the `wanted` field does not include any of the indicator flags, the
ledClass and ledID fields are ignored. Otherwise, ledClass and ledID specify one or more feedback(s) for which indicator information is requested. If ledClass or ledID have illegal values, a Value error results. If they have legal values but do not specify a keyboard or indicator class feedback for the device in question, a Match error results.

The ledClass field can specify either KbdFeedbackClass, LedFeedbackClass, XkbDfltXIClass, or XkbAllXIClasses. If at least one keyboard feedback is defined for the specified device, XkbDfltXIClass is equivalent to KbdFeedbackClass, otherwise it is equivalent to LedFeedbackClass. If XkbAllXIClasses is specified, this request returns information about both indicator and keyboard class feedbacks which match the requested identifier, as described below.

The ledID field can specify any valid input extension feedback identifier, XkbDfltXIID, or XkbAllXIIIds. The default keyboard feedback is the one that is affected by core protocol requests; the default led feedback is implementation-specific. If XkbAllXIIIds is specified, this request returns indicator information about all feedbacks of the class(es) specified by ledClass.

If no error results, the deviceID return value reports the input extension device identifier of the device for which values are being returned. The supported return value reports the set of optional XKB extension device features that are supported by this implementation (see Interactions Between XKB and the X Input Extension) for the specified device, and the unsupported return value reports any unsupported features.

If hasOwnProperty is True, the device is also a keyboard, and any indicator maps bound to the device use the current state and control settings for this device to control automatic changes. If hasOwnProperty is False, the state and control settings of the core keyboard device control automatic indicator changes.

The name field reports the X Input Extension name for the device. The devType field reports the X Input Extension device type. Both fields are provided merely for convenience and are not interpreted by XKB.

The present return value reports the kinds of device information being returned, and controls the interpretation of the remaining fields. The present field consists of the wanted field from the original request minus the flags for any unsupported features.

If XkbXI_ButtonActions is set in present, the totalBtns return value reports the total number of buttons present on the device, firstBtnWanted and nBtnsWanted specify the range of buttons for which actions were requested, and the firstBtnRtrn and nBtnsRtrn values specify the range of buttons for which actions are reported. The actionsRtrn list has nButtonsRtrn entries which contain the actions bound to the specified buttons on the device. Any buttons for which actions were requested but not returned have the action NoAction().

If any indicator information is reported, the leds list contains one element for each requested feedback. For example, if ledClass is XkbAllXIClasses and ledID is XkbAllXIIIds, leds describes all of the indicators on the device and has one element for each keyboard or led class feedback defined for the device. If any information at all is reported about a feedback, the set of physical indicators is also reported in the physIndicators field of the corresponding element of leds.
If the server supports assignment of indicator maps to extension device indicators, and if the \texttt{XkbXI\_IndicatorMaps} flag is set in \texttt{wanted}, each member of \texttt{leds} reports any indicators on the corresponding feedback to which names have been assigned. Any indicators for which no map is reported have the default map, which allows explicit changes and does not request any automatic changes.

If the server supports assignment of indicator names to extension device indicators, and the \texttt{XkbXI\_IndicatorNames} flag is set in \texttt{wanted}, each member of \texttt{leds} reports any indicators on the corresponding feedback to which names have been assigned. Any indicators for which no name is reported have the name \texttt{None}.

If the server supports XKB access to the state of extension device indicators, and the \texttt{XkbXI\_IndicatorState} flag is set in \texttt{wanted}, each member of \texttt{leds} reports the state of the indicators on the corresponding feedback.

If any unsupported features are requested, and the requesting client has selected for them, the server sends the client an \texttt{XkbExtensionDeviceNotify} event which indicates that an unsupported feature was requested. This event is only generated if the client which issued the unsupported request has selected for it and, if generated, is not sent to any other clients.

**XkbSetDeviceInfo**

\texttt{deviceSpec: KB\_DEVICESPEC}

\texttt{change: KB\_XIDEVFEATUREMASK}

\texttt{firstBtn, nBtns: CARD8}

\texttt{btnActions: LISTofKB\_ACTION}

\texttt{leds: LISTofKB\_DEVICELEDINFO}

Errors: \texttt{Device}, \texttt{Match}, \texttt{Access}, \texttt{Alloc}

Changes a subset of the XKB-supplied information about the input device specified by \texttt{deviceSpec}. Unlike most XKB requests, the device specified for \texttt{XkbGetDeviceInfo} need not be a keyboard device. Nonetheless, a \texttt{Keyboard} error results if \texttt{deviceSpec} does not specify a valid core or input extension device.

The \texttt{change} field specifies the features for which new values are supplied, and controls the interpretation of the other request fields.

If the server does not support assignment of XKB actions to extension device buttons, the \texttt{firstButton} and \texttt{nButtons} fields are ignored.

Otherwise, if the \texttt{XkbXI\_ButtonActions} flag is set in \texttt{change}, the \texttt{firstBtn} and \texttt{nBtns} fields specify a range of buttons for which actions are specified in this request. If the device has no buttons or if \texttt{firstBtn} and \texttt{nBtns} specify illegal buttons, a \texttt{Match} error results.

Each element of the \texttt{leds} list describes the changes for a single keyboard or led feedback. If the \texttt{ledClass} field of any element of \texttt{leds} contains any value other than \texttt{KbdFeedbackClass}, \texttt{LedFeedbackClass} or \texttt{XkbDfltXIClass}, a \texttt{Value} error results. If the \texttt{ledId} field of any element of \texttt{leds} contains any value other than a valid input extension feedback identifier or \texttt{XkbDfltXIId}, a \texttt{Value} error results. If both fields are valid, but the device has no matching feedback, a \texttt{Match} error results.

The fields of each element of \texttt{leds} are interpreted as follows:
• If XkbXI_IndicatorMaps is set in `change` and the server supports XKB assignment of indicator maps to the corresponding feedback, the maps for all indicators on the corresponding feedback are taken from `leds`. If the server does not support this feature, any maps specified in `leds` are ignored.

• If XkbXI_IndicatorNames is set in `change`, and the server supports XKB assignment of names to indicators for the corresponding feedback, the names for all indicators on the corresponding feedback are taken from `leds`. If the server does not support this feature, any names specified in `leds` are ignored. Regardless of whether they are used, any names be a valid Atom or `None`, or an `Atom` error results.

• If XkbXI_IndicatorState is set in `change`, and the server supports XKB changes to extension device indicator state, the server attempts to change the indicators on the corresponding feedback as specified by `leds`. Any indicator maps bound to the feedback are applied, so state changes might be blocked or have side-effects.

If any unsupported features are requested, and the requesting client has selected for them, the server sends the client an XkbExtensionDeviceNotify event which indicates that an unsupported feature was requested. This event is only generated if the client which issued the unsupported request has selected for it and, if generated, is not sent to any other clients.

### Debugging the X Keyboard Extension

**XkbSetDebuggingFlags**

- `affectFlags`, `flags`: CARD32
- `affectCtrls`, `ctrls`: CARD32
- `message`: STRING
- `currentFlags`, `supportedFlags`: CARD32
- `currentCtrls`, `supportedCtrls`: CARD32

This request sets up various internal XKB debugging flags and controls. It is intended for developer use and may be disabled in production servers. If disabled, `XkbSetDebuggingFlags` has no effect but returns `Success`.

The `affectFlags` field specifies the debugging flags to be changed, the `flags` field specifies new values for the changed flags. The interpretation of the debugging flags is implementation-specific, but flags are intended to control debugging output and should not otherwise affect the operation of the server.

The `affectCtrls` field specifies the debugging controls to be changed, the `ctrls` field specifies new values for the changed controls. The interpretation of the debugging controls is implementation-specific, but debugging controls are allowed to affect the behavior of the server.

The `message` field provides a message that the X server can print in any logging or debugging files before changing the flags. The server must accept this field but it is not required to actually display it anywhere.

The X Test Suite makes some assumptions about the implementation of locking modifier keys that do not apply when XKB is present. The `XkbDF_DisableLocks` debugging control provides a simple workaround to these test suite problems by simply
disabling all locking keys. If XkbDF_DisableLocks is enabled, the SA_LockMods and SA_LockGroup actions behave like SA_SetMods and SA_LockMods, respectively. If it is disabled, SA_LockMods and SA_LockGroup actions behave normally.

Implementations are free to ignore the XkbDF_DisableLocks debugging control or to define others.

The currentFlags return value reports the current setting for the debugging flags, if applicable. The currentCtrls return value reports the setting for the debugging controls, if applicable. The supportedFlags and supportedCtrls fields report the flags and controls that are recognized by the implementation. Attempts to change unsupported fields or controls are silently ignored.

If the XkbSetDebuggingFlags request contains more data than expected, the server ignores the extra data, but no error results. If the request has less data than expected, a Length error results.

If the XkbSetDebuggingFlags reply contains more data than expected, the client just ignores any uninterpreted data without reporting an error. If the reply has less data than expected, a Length error results.

**Events**

All XKB events report the time at which they occurred in a field named time and the device on which they occurred in a field named deviceID. XKB uses a single X event code for all events and uses a common field to distinguish XKB event type.

**Tracking Keyboard Replacement**

XkbNewKeyboardNotify
time: TIMESTAMP
deviceID: CARD8
changed: KB_NKNDetailMask
minKeyCode, maxKeyCode: KEYCODE
oldDeviceID: CARD8
oldMinKeyCode, oldMaxKeyCode: KEYCODE
requestMajor, requestMinor: CARD8

An XkbNewKeyboardNotify event reports that a new core keyboard has been installed. New keyboard notify events can be generated:

- When the X server detects that the keyboard was changed.
- When a client installs a new extension device as the core keyboard using the X Input Extension ChangeKeyboardDevice request.
- When a client issues an XkbGetMapByName request which changes the keycodes range or geometry.

The changed field of the event reports the aspects of the keyboard that have changed, and can contain any combination of the event details for this event:
The server sends an `XkbNewKeyboardNotify` event to a client only if at least one of the bits that is set in the `changed` field of the event is also set in the appropriate event details mask for the client.

The `minKeyCode` and `maxKeyCode` fields report the minimum and maximum keycodes that can be returned by the new keyboard. The `oldMinKeyCode` and `oldMaxKeyCode` fields report the minimum and maximum values that could be returned before the change. This event always reports all four values, but the old and new values are the same unless `NKN_Keycodes` is set in `changed`.

Once a client receives a new keyboard notify event which reports a new keycode range, the X server reports events from all keys in the new range to that client. Clients that do not request or receive new keyboard notify events receive events only from keys that fall in the last range for legal keys reported to that client. See Replacing the Keyboard "On-the-Fly" for a more detailed explanation.

If `NKN_Keycodes` is set in `changed`, the `XkbNewKeyboardNotify` event subsumes all other change notification events (e.g. `XkbMapNotify`, `XkbNamesNotify`) that would otherwise result from the keyboard change. Clients who receive an `XkbNewKeyboardNotify` event should assume that all other aspects of the keyboard mapping have changed and regenerate the entire local copy of the keyboard description.

The `deviceId` field reports the X Input Extension device identifier of the new keyboard device; `oldDeviceID` reports the device identifier before the change. This event always includes both values, but they are the same unless `NKN_DeviceID` is set in `changed`. If the server does not support the X Input Extension, both fields have the value 0.

The `requestMajor` and `requestMinor` fields report the major and minor opcode of the request that caused the keyboard change. If the keyboard change was not caused by some client request, both fields have the value 0.
Tracking Keyboard Mapping Changes

**XkbMapNotify**

time: TIMESTAMP
deviceID: CARD8
ptrBtnActions: CARD8
changed: KB_MAPPARTMASK
minKeyCode, maxKeyCode: KEYCODE
firstType, nTypes: CARD8
firstKeySym, firstKeyAction: KEYCODE
nKeySyms, nKeyActions: CARD8
firstKeyBehavior, firstKeyExplicit: KEYCODE
nKeyBehaviors, nKeyExplicit: CARD8
virtualMods: KB_VMODMASK
firstModMapKey, firstVModMapKey: KEYCODE
nModMapKeys, nVModMapKeys: CARD8

An *XkbMapNotify* event reports that some aspect of XKB map for a keyboard has changed. Map notify events can be generated whenever some aspect of the keyboard map is changed by an XKB or core protocol request.

The *deviceID* field reports the keyboard for which some map component has changed and the *changed* field reports the components with new values, and can contain any of the values that are legal for the *full* and *partial* fields of the *XkbGetMap* request. The server sends an *XkbMapNotify* event to a client only if at least one of the bits that is set in the *changed* field of the event is also set in the appropriate event details mask for the client.

The *minKeyCode* and *maxKeyCode* fields report the range of keycodes that are legal on the keyboard for which the change is being reported.

If *XkbKeyTypesMask* is set in *changed*, the *firstType* and *nTypes* fields report a range of key types that includes all changed types. Otherwise, both fields are 0.

If *XkbKeySymsMask* is set in *changed*, the *firstKeySym* and *nKeySyms* fields report a range of keycodes that includes all keys with new symbols. Otherwise, both fields are 0.

If *XkbKeyActionsMask* is set in *changed*, the *firstKeyAction* and *nKeyActions* fields report a range of keycodes that includes all keys with new actions. Otherwise, both fields are 0.

If *XkbKeyBehaviorsMask* is set in *changed*, the *firstKeyBehavior* and *nKeyBehaviors* fields report a range of keycodes that includes all keys with new key behavior. Otherwise, both fields are 0.

If *XkbVirtualModsMask* is set in *changed*, *virtualMods* contains all virtual modifiers to which a new set of real modifiers is bound. Otherwise, *virtualMods* is 0.
If \texttt{XkbExplicitComponentsMask} is set in \texttt{changed}, the \texttt{firstKeyExplicit} and \texttt{nKeyExplicit} fields report a range of keycodes that includes all keys with changed explicit components. Otherwise, both fields are 0.

If \texttt{XkbModifierMapMask} is set in \texttt{changed}, the \texttt{firstModMapKey} and \texttt{nModMapKeys} fields report a range of keycodes that includes all keys with changed modifier bindings. Otherwise, both fields are 0.

If \texttt{XkbVirtualModMapMask} is set in \texttt{changed}, the \texttt{firstVModMapKey} and \texttt{nVModMapKeys} fields report a range of keycodes that includes all keys with changed virtual modifier mappings. Otherwise, both fields are 0.

\section*{Tracking Keyboard State Changes}

\textbf{XkbStateNotify}
\begin{itemize}
  \item \texttt{time}: TIMESTAMP
  \item \texttt{deviceID}: CARD8
  \item \texttt{mods}, \texttt{baseMods}, \texttt{latchedMods}, \texttt{lockedMods}: KEYMASK
  \item \texttt{group}, \texttt{lockedGroup}: CARD8
  \item \texttt{baseGroup}, \texttt{latchedGroup}: INT16
  \item \texttt{compatState}: KEYMASK
  \item \texttt{grabMods}, \texttt{compatGrabMods}: KEYMASK
  \item \texttt{lookupMods}, \texttt{compatLookupMods}: KEYMASK
  \item \texttt{ptrBtnState}: BUTMASK
  \item \texttt{changed}: KB\_STATEPARTMASK
  \item \texttt{keycode}: KEYCODE
  \item \texttt{eventType}: CARD8
  \item \texttt{requestMajor}, \texttt{requestMinor}: CARD8
\end{itemize}

An \texttt{XkbStateNotify} event reports that some component of the XKB state (see Keyboard State) has changed. State notify events are usually caused by key or pointer activity, but they can also result from explicit state changes requested by the \texttt{XkbLatchLockState} request or by other extensions.

The \texttt{deviceID} field reports the keyboard on which some state component changed. The \texttt{changed} field reports the XKB state components (see Keyboard State) that have changed and contain any combination of:
XKB Protocol Requests

<table>
<thead>
<tr>
<th>Bit in changed</th>
<th>Event field</th>
<th>Changed component</th>
</tr>
</thead>
<tbody>
<tr>
<td>ModifierState</td>
<td>mods</td>
<td>The effective modifiers</td>
</tr>
<tr>
<td>ModifierBase</td>
<td>baseMods</td>
<td>The base modifiers</td>
</tr>
<tr>
<td>ModifierLatch</td>
<td>latchedMods</td>
<td>The latched modifiers</td>
</tr>
<tr>
<td>ModifierLock</td>
<td>lockedMods</td>
<td>The locked modifiers</td>
</tr>
<tr>
<td>GroupState</td>
<td>group</td>
<td>The effective keyboard group</td>
</tr>
<tr>
<td>GroupBase</td>
<td>baseGroup</td>
<td>The base keyboard group</td>
</tr>
<tr>
<td>GroupLatch</td>
<td>latchedGroup</td>
<td>The latched keyboard group</td>
</tr>
<tr>
<td>GroupLock</td>
<td>lockedGroup</td>
<td>The locked keyboard group</td>
</tr>
<tr>
<td>PointerButtons</td>
<td>ptrBtnState</td>
<td>The state of the core pointer buttons</td>
</tr>
<tr>
<td>GrabMods</td>
<td>grabMods</td>
<td>The XKB state used to compute grabs</td>
</tr>
<tr>
<td>LookupMods</td>
<td>lookupMods</td>
<td>The XKB state used to look up symbols</td>
</tr>
<tr>
<td>CompatState</td>
<td>compatState</td>
<td>Default state for non-XKB clients</td>
</tr>
<tr>
<td>CompatGrabMods</td>
<td>compatGrabMods</td>
<td>The core state used to compute grabs</td>
</tr>
<tr>
<td>CompatLookup-Mods</td>
<td>compatLookup-Mods</td>
<td>The core state used to look up symbols</td>
</tr>
</tbody>
</table>

The server sends an `XkbStateNotify` event to a client only if at least one of the bits that is set in the `changed` field of the event is also set in the appropriate event details mask for the client.

A state notify event reports current values for all state components, even those with unchanged values.

The `keycode` field reports the key or button which caused the change in state while the `eventType` field reports the exact type of event (e.g. `KeyPress`). If the change in state was not caused by key or button activity, both fields have the value 0.

The `requestMajor` and `requestMinor` fields report the major and minor opcodes of the request that caused the change in state and have the value 0 if it was resulted from key or button activity.

Tracking Keyboard Control Changes

`XkbControlsNotify`

time: TIMESTAMP
deviceID: CARD8
numGroups: CARD8
changedControls: KB_CONTROLMASK
enabledControls,enabledControlChanges: KB_BOOLCTRLMASK
keycode: KEYCODE
eventType: CARD8
requestMajor: CARD8
requestMinor: CARD8

An `XkbControlsNotify` event reports a change in one or more of the global keyboard controls (see Global Keyboard Controls) or in the internal modifiers or ignore locks.
masks (see Server Internal Modifiers and Ignore Locks Behavior). Controls notify events are usually caused by and XkbSetControls request, but they can also be caused by keyboard activity or certain core protocol and input extension requests.

The `deviceId` field reports the keyboard for which some control has changed, and the `changed` field reports the controls that have new values.

The `changed` field can contain any of the values that are permitted for the `changeControls` field of the XkbSetControls request. The server sends an XkbControlsNotify event to a client only if at least one of the bits that is set in the `changed` field of the event is also set in the appropriate event details mask for the client.

The `numGroups` field reports the total number of groups defined for the keyboard, whether or not the number of groups has changed.

The `enabledControls` field reports the current status of all of the boolean controls, whether or not any boolean controls changed state. If `EnabledControls` is set in `changed`, the `enabledControlChanges` field reports the boolean controls that were enabled or disabled; if a control is specified in `enabledControlChanges`, the value that is reported for that control in `enabledControls` represents a change in state.

The `keycode` field reports the key or button which caused the change in state while the `eventType` field reports the exact type of event (e.g. KeyPress). If the change in state was not caused by key or button activity, both fields have the value 0.

The `requestMajor` and `requestMinor` fields report the major and minor opcodes of the request that caused the change in state and have the value 0 if it was resulted from key or button activity.

## Tracking Keyboard Indicator State Changes

**XkbIndicatorStateNotify**

time: TIMESTAMP

deviceID: CARD8

stateChanged, state: KB_INDICATORMASK

An XkbIndicatorStateNotify event indicates that one or more of the indicators on a keyboard have changed state. Indicator state notify events can be caused by:

- Automatic update to reflect changes in keyboard state (keyboard activity, XkbLatchLockState requests).

- Automatic update to reflect changes in keyboard controls (XkbSetControls, keyboard activity, certain core protocol and input extension requests).

- Explicit attempts to change indicator state (core protocol and input extension requests, XkbSetNamedIndicator requests).

- Changes to indicator maps (XkbSetIndicatorMap and XkbSetNamedIndicator requests).

The `deviceId` field reports the keyboard for which some indicator has changed, and the `state` field reports the new state for all indicators on the specified keyboard. The `stateChanged` field specifies which of the values in `state` represent a new state for
the corresponding indicator. The server sends an XkbIndicatorStateNotify event to a client only if at least one of the bits that is set in the stateChanged field of the event is also set in the appropriate event details mask for the client.

Tracking Keyboard Indicator Map Changes

XkbIndicatorMapNotify
time: TIMESTAMP
deviceID: CARD8
state: KB_INDICATORMASK
mapChanged: KB_INDICATORMASK

An XkbIndicatorMapNotify event indicates that the maps for one or more keyboard indicators have been changed. Indicator map notify events can be caused by XkbSetIndicatorMap and XkbSetNamedIndicator requests.

The deviceID field reports the keyboard for which some indicator map has changed, and the mapChanged field reports the indicators with changed maps. The server sends an XkbIndicatorMapNotify event to a client only if at least one of the bits that is set in the mapChanged field of the event is also set in the appropriate event details mask for the client.

The state field reports the current state of all indicators on the specified keyboard.

Tracking Keyboard Name Changes

XkbNamesNotify
time: TIMESTAMP
deviceID: CARD8
changed: KB_NAMEDETAILMASK
firstType, nTypes: CARD8
firstLevelName, nLevelNames: CARD8
firstKey: KEYCODE
nKeys, nKeyAliases, nRadioGroups: CARD8
changedGroupNames: KB_GROUPMASK
changedVirtualMods: KB_VMODMASK
changedIndicators: KB_INDICATORMASK

An XkbNamesNotify event reports a change to one or more of the symbolic names associated with a keyboard. Symbolic names can change when:

• Some client explicitly changes them using XkbSetNames.
• The list of key types or radio groups is resized
• The group width of some key type is changed

The deviceID field reports the keyboard on which names were changed. The changed mask lists the components for which some names have changed and can
have any combination of the values permitted for the which field of the XkbGetNames request. The server sends an XkbNamesNotify event to a client only if at least one of the bits that is set in the changed field of the event is also set in the appropriate event details mask for the client.

If KeyTypeNames is set in changed, the firstType and nTypes fields report a range of types that includes all types with changed names. Otherwise, both fields are 0.

If KTLevelNames is set in changed, the firstLevelName and nLevelNames fields report a range of types that includes all types with changed level names. Otherwise, both fields are 0.

If IndicatorNames is set in changed, the changedIndicators field reports the indicators with changed names. Otherwise, changedIndicators is 0.

If VirtualModNames is set in changed, the changedVirtualMods field reports the virtual modifiers with changed names. Otherwise, changedVirtualMods is 0.

If GroupNames is set in changed, the changedGroupNames field reports the groups with changed names. Otherwise, changedGroupNames is 0.

If KeyNames is set in changed, the firstKey and nKeys fields report a range of keycodes that includes all keys with changed names. Otherwise, both fields are 0.

The nKeyAliases field reports the total number of key aliases associated with the keyboard, regardless of whether KeyAliases is set in changed.

The nRadioGroups field reports the total number of radio group names associated with the keyboard, regardless of whether RGNames is set in changed.

**Tracking Compatibility Map Changes**

XkbCompatMapNotify

time: TIMESTAMP

deviceID: CARD8

changedGroups: KB_GROUPMASK

firstSI, nSI: CARD16

nTotalSI: CARD16

An XkbCompatMapNotify event indicates that some component of the compatibility map for a keyboard has been changed. Compatibility map notify events can be caused by XkbSetCompatMap and XkbGetMapByName requests.

The deviceID field reports the keyboard for which the compatibility map has changed; if the server does not support the X input extension, deviceID is 0.

The changedGroups field reports the keyboard groups, if any, with a changed entry in the group compatibility map. The firstSI and nSI fields specify a range of symbol interpretations in the symbol compatibility map that includes all changed symbol interpretations; if the symbol compatibility map is unchanged, both fields are 0. The nTotalSI field always reports the total number of symbol interpretations present in the symbol compatibility map, regardless of whether any symbol interpretations have been changed.
The server sends an `XkbCompatMapNotify` event to a client only if at least one of the following conditions is met:

- The `nSI` field of the event is non-zero, and the `XkbSymInterpMask` bit is set in the appropriate event details mask for the client.
- The `changedGroups` field of the event contains at least one group, and the `Xkb-GroupCompatMask` bit is set in the appropriate event details mask for the client.

### Tracking Application Bell Requests

**XkbBellNotify**

time: TIMESTAMP
deviceID: CARD8
bellClass: { KbdFeedbackClass, BellFeedbackClass }
bellID: CARD8
percent: CARD8
pitch: CARD16
duration: CARD16
eventOnly: BOOL
name: ATOM
window: WINDOW

An `XkbBellNotify` event indicates that some client has requested a keyboard bell. Bell notify events are usually caused by `Bell`, `DeviceBell`, or `XkbBell` requests, but they can also be generated by the server (e.g. if the `AccessXFeedback` control is active).

The server sends an `XkbBellNotify` event to a client if the appropriate event details field for the client has the value `True`.

The `deviceID` field specifies the device for which a bell was requested, while the `bellClass` and `bellID` fields specify the input extension class and identifier of the feedback for which the bell was requested. If the reporting server does not support the input extension, all three fields have the value 0.

The `percent`, `pitch` and `duration` fields report the volume, tone and duration requested for the bell as specified by the `XkbBell` request. Bell notify events caused by core protocol or input extension requests use the pitch and duration specified in the corresponding bell or keyboard feedback control.

If the bell was caused by an `XkbBell` request or by the X server, `name` reports an optional symbolic name for the bell and the `window` field optionally reports the window for which the bell was generated. Otherwise, both fields have the value `None`.

If the `eventOnly` field is `True`, the server did not generate a sound in response to the request, otherwise the server issues the beep before sending the event. The `eventOnly` field can be `True` if the `AudibleBell` control is disabled or if a client explicitly requests `eventOnly` when it issues an `XkbBell` request.
Tracking Messages Generated by Key Actions

XkbActionMessage
- time: TIMESTAMP
- deviceID: CARD8
- keycode: KEYCODE
- press: BOOL
- mods: KEYMASK
- group: KB_GROUP
- keyEventFollows: BOOL
- message: LISTofCARD8

An XkbActionMessage event is generated when the user operates a key to which an SA_ActionMessage message is bound under the appropriate state and group. The server sends an XkbActionMessage event to a client if the appropriate event details field for the client has the value True.

The deviceID field specifies the keyboard device that contains the key which activated the event. The keycode field specifies the key whose operation caused the message and press is True if the message was caused by the user pressing the key. The mods and group fields report the effective keyboard modifiers and group in effect at the time the key was pressed or released.

If keyEventFollows is True, the server will also send a key press or release event, as appropriate, for the key that generated the message. If it is False, the key causes only a message. Note that the key event is delivered normally with respect to passive grabs, keyboard focus, and cursor position, so that keyEventFollows does not guarantee that any particular client which receives the XkbActionMessage notify event will also receive a key press or release event.

The message field is NULL-terminated string of up to ActionMessageLength (6) bytes, which reports the contents of the message field in the action that caused the message notify event.

Tracking Changes to AccessX State and Keys

XkbAccessXNotify
- time: TIMESTAMP
- deviceID: CARD8
- detail: KB_AXNDETAILMASK
- keycode: KEYCODE
- slowKeysDelay: CARD16
- debounceDelay: CARD16

An XkbAccessXNotify event reports on some kinds of keyboard activity when any of the SlowKeys, BounceKeys or AccessXKeys controls are active. Compatibility map notify events can only be caused by keyboard activity.
The *deviceID* and *keycode* fields specify the keyboard and key for which the event occurred. The *detail* field describes the event that occurred and has one of the following values:

<table>
<thead>
<tr>
<th>Detail</th>
<th>Control</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>AXN_SKPress</td>
<td>SlowKeys</td>
<td>Key pressed</td>
</tr>
<tr>
<td>AXN_SKAccept</td>
<td>SlowKeys</td>
<td>Key held until it was accepted.</td>
</tr>
<tr>
<td>AXN_SKReject</td>
<td>SlowKeys</td>
<td>Key released before it was accepted.</td>
</tr>
<tr>
<td>AXN_SKRelease</td>
<td>SlowKeys</td>
<td>Key released after it was accepted.</td>
</tr>
<tr>
<td>AXN_BKAccept</td>
<td>BounceKeys</td>
<td>Key pressed while it was active.</td>
</tr>
<tr>
<td>AXN_BKReject</td>
<td>BounceKeys</td>
<td>Key pressed while it was still disabled.</td>
</tr>
<tr>
<td>AXN_AXKWarning</td>
<td>AccessXKeys</td>
<td>Shift key held down for four seconds</td>
</tr>
</tbody>
</table>

Each subclass of the AccessX notify event is generated only when the control specified in the table above is enabled. The server sends an *XkbAccessXNotify* event to a client only if the bit which corresponds to the value of the *detail* field for the event is set in the appropriate event details mask for the client.

Regardless of the value of *detail*, the *slowKeysDelay* and *debounceDelay* fields always reports the current slow keys acceptance delay (see The SlowKeys Control) and debounce delay (see The BounceKeys Control) for the specified keyboard.

### Tracking Changes To Extension Devices

**XkbExtensionDeviceNotify**

time: TIMESTAMP
deviceID: CARD16
ledClass: { KbdFeedbackClass, LedFeedbackClass }
ledID: CARD16
reason: KB_XIDETAILMASK
supported: KB_XIFEATUREMASK
unsupported: KB_XIFEATUREMASK
ledsDefined: KB_INDICATORMASK
ledState: KB_INDICATORMASK
firstButton, nButtons: CARD8

An *XkbExtensionDeviceNotify* event reports:

- A change to some part of the XKB information for an extension device.
- An attempt to use an XKB extension device feature that is not supported for the specified device by the current implementation.

The *deviceID* field specifies the X Input Extension device identifier of some device on which an XKB feature was requested, or *XkbUseCorePtr* if the request affected the core pointer device. The *reason* field explains why the event was generated in response to the request, and can contain any combination of *XkbXI_UnsupportedFeature* and the values permitted for the change field of the *XkbSetDeviceInfo* request.
If `XkbXI_ButtonActions` is set in `reason`, this event reports a successful change to the XKB actions bound to one or more buttons on the core pointer or an extension device. The `firstButton` and `nButtons` fields report a range of device buttons that include all of the buttons for which actions were changed.

If any combination of `XkbXI_IndicatorNames`, `XkbXI_IndicatorMaps`, or `XkbXI_IndicatorState` is set in either `reason` or `unsupported`, the `ledClass` and `ledID` fields specify the X Input Extension feedback class and identifier of the feedback for which the change is reported. If this event reports any changes to an indicator feedback, the `ledsDefined` field reports all indicators on that feedback for which either a name or a indicator map are defined, and `ledState` reports the current state of all of the indicators on the specified feedback.

If `XkbXI_IndicatorNames` is set in `reason`, this event reports a successful change to the symbolic names bound to one or more extension device indicators by XKB. If `XkbXI_IndicatorMaps` is set in `reason`, this event reports a successful change to the indicator maps bound to one or more extension device indicators by XKB. If `XkbXI_IndicatorState` is set in `reason`, this event reports that one or more indicators in the specified device and feedback have changed state.

If `XkbXI_UnsupportedFeature` is set in `reason`, this event reports an unsuccessful attempt to use some XKB extension device feature that is not supported by the XKB implementation in the server for the specified device. The `unsupported` mask reports the requested features that are not available on the specified device. See Interactions Between XKB and the X Input Extension for more information about possible XKB interactions with the X Input Extension.

The server sends an `XkbExtensionDeviceNotify` event to a client only if at least one of the bits that is set in the `reason` field of the event is also set in the appropriate event details mask for the client.

Events that report a successful change to some extension device feature are reported to all clients that have expressed interest in the event; events that report an attempt to use an unsupported feature are reported only to the client which issued the request. Events which report a partial success are reported to all interested clients, but only the client that issued the request is informed of the attempt to use unsupported features.
Appendix A. Default Symbol Transformations

Interpreting the Control Modifier

If the Control modifier is not consumed by the symbol lookup process, routines that determine the symbol and string that correspond to an event should convert the symbol to a string as defined in the table below. Only the string to be returned is affected by the Control modifier; the symbol is not changed.

This table lists the decimal value of the standard control characters that correspond to some keysyms for ASCII characters. Control characters for symbols not listed in this table are application-specific.

<table>
<thead>
<tr>
<th>Keysyms</th>
<th>Value</th>
<th>Keysyms</th>
<th>Value</th>
<th>Keysyms</th>
<th>Value</th>
<th>Keysyms</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>atsign</td>
<td>0</td>
<td>h, H</td>
<td>8</td>
<td>p, P</td>
<td>16</td>
<td>x, X</td>
<td>24</td>
</tr>
<tr>
<td>a, A</td>
<td>1</td>
<td>i, I</td>
<td>9</td>
<td>q, Q</td>
<td>17</td>
<td>y, Y</td>
<td>25</td>
</tr>
<tr>
<td>b, B</td>
<td>2</td>
<td>j, J</td>
<td>10</td>
<td>r, R</td>
<td>18</td>
<td>z, Z</td>
<td>26</td>
</tr>
<tr>
<td>c, C</td>
<td>3</td>
<td>k, K</td>
<td>11</td>
<td>s, S</td>
<td>19</td>
<td>left_bracket</td>
<td>27</td>
</tr>
<tr>
<td>d, D</td>
<td>4</td>
<td>l, L</td>
<td>12</td>
<td>t, T</td>
<td>20</td>
<td>backslash</td>
<td>28</td>
</tr>
<tr>
<td>e, E</td>
<td>5</td>
<td>m, M</td>
<td>13</td>
<td>u, U</td>
<td>21</td>
<td>right_bracket</td>
<td>29</td>
</tr>
<tr>
<td>f, F</td>
<td>6</td>
<td>n, N</td>
<td>14</td>
<td>v, V</td>
<td>22</td>
<td>asciicircum</td>
<td>30</td>
</tr>
<tr>
<td>g, G</td>
<td>8</td>
<td>o, O</td>
<td>15</td>
<td>w, W</td>
<td>23</td>
<td>underbar</td>
<td>31</td>
</tr>
</tbody>
</table>

Interpreting the Lock Modifier

If the Lock modifier is not consumed by the symbol lookup process, routines that determine the symbol and string that correspond to an event should capitalize the result. Unlike the transformation for Control, the capitalization transformation changes both the symbol and the string returned by the event.

Locale-Sensitive Capitalization

If Lock is set in an event and not consumed, applications should capitalize the string and symbols that result from an event according to the capitalization rules in effect for the system on which the application is running, taking the current state of the user environment (e.g. locale) into account.

Locale-Insensitive Capitalization

XKB recommends but does not require locale-sensitive capitalization. In cases where the locale is unknown or where locale-sensitive capitalization is prohibitively expensive, applications can capitalize according to the rules defined in this extension.
The following tables list all of the keysyms for which XKB defines capitalization behavior. Any keysyms not explicitly listed in these tables are not capitalized by XKB when locale-insensitive capitalization is in effect and are not automatically assigned the \textit{ALPHABETIC} type as described in the Alphabetic Key Type.

### Capitalization Rules for Latin-1 Keysyms

This table lists the Latin-11 keysyms for which XKB defines upper and lower case:

<table>
<thead>
<tr>
<th>Lower Case</th>
<th>Upper Case</th>
<th>Lower Case</th>
<th>Upper Case</th>
<th>Lower Case</th>
<th>Upper Case</th>
<th>Lower Case</th>
<th>Upper Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>A</td>
<td>o</td>
<td>O</td>
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<td>Oacute</td>
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<td>E</td>
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<td>S</td>
<td>ae</td>
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<tr>
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<td>G</td>
<td>u</td>
<td>U</td>
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<td>Egrave</td>
<td>odiaeresis</td>
<td>Odiaeresis</td>
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<td>V</td>
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<td>Eacute</td>
<td>oslash</td>
<td>Ooblique</td>
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<td>I</td>
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<td>W</td>
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<td>Ecircumflex</td>
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<td>Ugrave</td>
</tr>
<tr>
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<td>J</td>
<td>x</td>
<td>X</td>
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<td>Ediaeresis</td>
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<td>Uacute</td>
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<tr>
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<td>K</td>
<td>y</td>
<td>Y</td>
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<td>Igrave</td>
<td>ucircumflex</td>
<td>Ucircumflex</td>
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<td>Iacute</td>
<td>udiaeresis</td>
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### Capitalization Rules for Latin-2 Keysyms

This table lists the Latin-2 keysyms for which XKB defines upper and lower case:

<table>
<thead>
<tr>
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<th>Lower Case</th>
<th>Upper Case</th>
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<th>Upper Case</th>
</tr>
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</tr>
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<td>Abreve</td>
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<td>Ncaron</td>
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<td>Odoubleacute</td>
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<td>Cacute</td>
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<td>Rcaron</td>
</tr>
<tr>
<td>scedilla</td>
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<td>ccaron</td>
<td>Ccaron</td>
<td>uabovering</td>
<td>Uabovering</td>
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<tr>
<td>tcaron</td>
<td>Tcaron</td>
<td>eogonek</td>
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<td>Udoubleacute</td>
</tr>
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<td>Zacute</td>
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<th>Upper Case</th>
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<td>Hcircumflex</td>
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<td>Cabovedot</td>
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<td>Ubreve</td>
</tr>
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<td>Ccircumflex</td>
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## Capitalization Rules for Latin-4 Keysyms

This table lists the Latin-4 keysyms for which XKB defines upper and lower case:

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<td>Amacron</td>
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<td>Uogonek</td>
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<td>eabovedot</td>
<td>utilde</td>
<td>Utilde</td>
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## Capitalization Rules for Cyrillic Keysyms

This table lists the Cyrillic keysyms for which XKB defines upper and lower case:
### Capitalization Rules for Greek Keysyms

This table lists the Greek keysyms for which XKB defines upper and lower case:

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<th>Upper Case</th>
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### Default Symbol Transformations

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<th>Upper Case</th>
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<td>Greek_LAMDA</td>
</tr>
<tr>
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</tr>
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<td>Greek_IOTADIERESIS</td>
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<td>Greek_TAU</td>
</tr>
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<td>Greek_CHI</td>
</tr>
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<td>GreekETA</td>
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<td>Greek PSI</td>
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<td>Greek_THETA</td>
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<td>Greek_OMEGA</td>
</tr>
</tbody>
</table>

### Capitalization Rules for Other Keysyms

XKB defines no capitalization rules for symbols in any other set of keysyms provided by the consortium. Applications are free to apply additional rules for private keysyms or for other keysyms not covered by XKB.
Appendix B. Canonical Key Types

Canonical Key Types

The ONE_LEVEL Key Type

The "ONE_LEVEL" key type describes groups that have only one symbol. The default "ONE_LEVEL" type has no map entries and does not pay attention to any modifiers.

The TWO_LEVEL Key Type

The "TWO_LEVEL" key type describes groups that have two symbols but are neither alphabetic nor numeric keypad keys. The default "TWO_LEVEL" type uses only the Shift modifier. It returns level two if Shift is set, level one if it is not.

The ALPHABETIC Key Type

The "ALPHABETIC" key type describes groups that consist of two symbols — the lowercase form of a symbol followed by the uppercase form of the same symbol. The default "ALPHABETIC" type implements locale-sensitive "shift cancels caps lock" behavior using both the Shift and Lock modifiers as follows:

- If Shift and Lock are both set, the default "ALPHABETIC" type yields level one.
- If Shift alone is set, it yields level two.
- If Lock alone is set, it yields level one but preserves the Lock modifier.
- If neither Shift nor Lock are set, it yields level one.

The KEYPAD Key Type

The "KEYPAD" key type describes that consist of two symbols, at least one of which is a numeric keypad symbol. The default "KEYPAD" type implements "shift cancels numeric lock" behavior using the Shift modifier and the real modifier bound to the virtual modifier named "NumLock" (the "NumLock" modifier) as follows:

- If Shift and the "NumLock" modifier are both set, the default "KEYPAD" type yields level one.
- If either Shift or the "NumLock" modifier alone are set, it yields level two.
- If neither Shift nor the "NumLock" modifier are set, it yields level one.
Appendix C. New KeySyms

New KeySyms

KeySyms Used by the ISO9995 Standard

<table>
<thead>
<tr>
<th>Byte 3</th>
<th>Byte 4</th>
<th>Character</th>
<th>Name</th>
</tr>
</thead>
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</tr>
<tr>
<td>254</td>
<td>2</td>
<td>ISO LATCHING LEVEL TWO SHIFT</td>
<td></td>
</tr>
<tr>
<td>254</td>
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</tr>
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<td>ISO LATCHING LEVEL THREE SHIFT</td>
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<td>ISO LEVEL THREE SHIFT LOCK</td>
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<td>254</td>
<td>6</td>
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<td>MOVE LINE DOWN</td>
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<td>254</td>
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<td>PARTIAL LINE DOWN</td>
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<tr>
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</tr>
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<td>254</td>
<td>38</td>
<td>PARTIAL SPACE RIGHT</td>
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<td>39</td>
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<td>SET MARGIN RIGHT</td>
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<td>RELEASE MARGIN RIGHT</td>
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</tr>
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<td>254</td>
<td>43</td>
<td>RELEASE MARGIN LEFT AND RIGHT</td>
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<td>44</td>
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### New KeySyms

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<th>Name</th>
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<td>51</td>
<td></td>
<td>CENTER OBJECT</td>
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<td>52</td>
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### KeySyms Used to Control The Core Pointer

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</tr>
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<tr>
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<td>DEFAULT POINTER BUTTON</td>
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<td>DRAG POINTER BUTTON THREE</td>
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<td>DRAG POINTER BUTTON FOUR</td>
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<td>254</td>
<td>249</td>
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<td>ENABLE POINTER FROM KEYBOARD</td>
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<tr>
<td>254</td>
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<td>ENABLE KEYBOARD POINTER ACCEL</td>
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New KeySyms

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<td>SET DEFAULT POINTER BUTTON NEXT</td>
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<td>252</td>
<td></td>
<td>SET DEFAULT POINTER BUTTON PREVIOUS</td>
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KeySyms Used to Change Keyboard Controls

<table>
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<tr>
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<tr>
<td>254</td>
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<td></td>
<td>ENABLE ACCESSX KEYS</td>
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<td>254</td>
<td>113</td>
<td></td>
<td>ENABLE ACCESSX FEEDBACK</td>
</tr>
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<td>254</td>
<td>114</td>
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<td>TOGGLE REPEAT KEYS</td>
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<tr>
<td>254</td>
<td>115</td>
<td></td>
<td>TOGGLE SLOW KEYS</td>
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<td>254</td>
<td>116</td>
<td></td>
<td>ENABLE BOUNCE KEYS</td>
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<td>254</td>
<td>117</td>
<td></td>
<td>ENABLE STICKY KEYS</td>
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<td>254</td>
<td>118</td>
<td></td>
<td>ENABLE MOUSE KEYS</td>
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<td>254</td>
<td>119</td>
<td></td>
<td>ENABLE MOUSE KEYS ACCELERATION</td>
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<td>254</td>
<td>120</td>
<td></td>
<td>ENABLE OVERLAY1</td>
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<td>254</td>
<td>121</td>
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<td>ENABLE OVERLAY2</td>
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<td>254</td>
<td>122</td>
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<td>ENABLE AUDIBLE BELL</td>
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KeySyms Used To Control The Server

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<td>FIRST SCREEN</td>
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<td></td>
<td>PREVIOUS SCREEN</td>
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<td>NEXT SCREEN</td>
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<td>LAST SCREEN</td>
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<td>254</td>
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<td>TERMINATE SERVER</td>
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KeySyms for Non-Spacing Diacritical Keys

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<td>DEAD ACUTE ACCENT</td>
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<td>DEAD CIRCUMFLEX</td>
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<td>DEAD TILDE</td>
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<td>DEAD MACRON</td>
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<td>254</td>
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<td>DEAD BREVE</td>
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<td>254</td>
<td>86</td>
<td></td>
<td>DEAD DOT ABOVE</td>
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<tr>
<td>254</td>
<td>87</td>
<td></td>
<td>DEAD DIAERESIS</td>
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<td>254</td>
<td>88</td>
<td></td>
<td>DEAD RING ABOVE</td>
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<td>89</td>
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<td>DEAD DOUBLE ACUTE ACCENT</td>
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<td>90</td>
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<td>DEAD CARON</td>
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<td>DEAD OGONEK</td>
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<td></td>
<td>DEAD IOTA</td>
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<td>254</td>
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<td></td>
<td>DEAD VOICED SOUND</td>
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<td>254</td>
<td>95</td>
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<td>DEAD SEMI VOICED SOUND</td>
</tr>
<tr>
<td>254</td>
<td>96</td>
<td></td>
<td>DEAD DOT BELOW</td>
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</table>
Appendix D. Protocol Encoding

Syntactic Conventions

This document uses the same syntactic conventions as the encoding of the core X protocol, with the following additions:

A LISTofITEMs contains zero or more items of variable type and size. The encode form for a LISTofITEMs is:

\[
\begin{array}{ll}
\text{v} & \text{LISTofITEMs} \quad \text{NAME} \\
\text{TYPE} & \text{MASK-EXPRESSION} \\
\text{value1} & \text{corresponding field(s)} \\
\ldots & \\
\text{valuen} & \text{corresponding field(s)}
\end{array}
\]

The MASK-EXPRESSION is an expression using C-style boolean operators and fields of the request which specifies the bitmask used to determine whether or not a member of the LISTofITEMs is present. If present, TYPE specifies the interpretation of the resulting bitmask and the values are listed using the symbolic names of the members of the set. If TYPE is blank, the values are numeric constants.

It is possible for a single bit in the MASK-EXPRESSION to control more than one ITEM — if the bit is set, all listed ITEMS are present. It is also possible for multiple bits in the MASK-EXPRESSION to control a single ITEM — if any of the bits associated with an ITEM are set, it is present in the LISTofITEMs.

The size of a LISTofITEMs is derived from the items that are present in the list, so it is always given as a variable in the request description, and the request is followed by a section of the form:

\[
\begin{array}{l}
\text{ITEMs} \\
\text{encode-form} \\
\ldots \\
\text{encode-form}
\end{array}
\]

listing an encode-form for each ITEM. The NAME in each encode-form keys to the fields listed as corresponding to each bit in the MASK-EXPRESSION. Items are not necessarily the same size, and the size specified in the encoding form is the size that the item occupies if it is present.

Some types are of variable size. The encode-form for a list of items of a single type but variable size is:

\[
\begin{array}{ll}
\text{S0+..Ss} & \text{LISTofTYPE} \quad \text{name}
\end{array}
\]

Which indicates that the list has \( s \) elements of variable size and that the size of the list is the sum of the sizes of all of the elements that make up the list. The notation \( S_n \) refers to the size of the \( n \)th element of the list and the notation \( S^* \) refers to the size of the list as a whole.
Protocol Encoding

The definition of a type of variable size includes an expression which specifies the size. The size is specified as a constant plus a variable expression; the constant specifies the size of the fields that are always present and the variables which make up the variable expression are defined in the constant portion of the structure. For example, the following definition specifies a counted string with a two-byte length field preceding the string:

```
TYPE             2+n+p
2     n          length
n     STRING8    string
p                unused, p=pad(n)
```

Some fields are optional. The size of an optional field has the form: "[ expr ]" where expr specifies the size of the field if it is present. An explanation of the conditions under which the field is present follows the name in the encode form:

```
1       BOOL          more
3                     unused
[4]     CARD32        optData, if more==TRUE
```

This portion of the structure is four bytes long if more is FALSE or eight bytes long if more is TRUE. This notation can also be used in size expressions; for example, the size of the previous structure is written as "4+[4]" bytes.

Common Types

```
SETofKB_EVENTTYPE
  #x0001     XkbNewKeyboardNotify
  #x0002     XkbMapNotify
  #x0004     XkbStateNotify
  #x0008     XkbControlsNotify
  #x0010     XkbIndicatorStateNotify
  #x0020     XkbIndicatorMapNotify
  #x0040     XkbNamesNotify
  #x0080     XkbCompatMapNotify
  #x0100     XkbBellNotify
  #x0200     XkbActionMessage
  #x0400     XkbAccessXNotify
  #x0800     XkbExtensionDeviceNotify

SETofKB_NKNDETAIL
  #x01        XkbNKN_Keycodes
  #x02        XkbNKN_Geometry
  #x04        XkbNKN_DeviceID

SETofKB_AXNDETAIL
  #x01        XkbAXN_SKPress
  #x02        XkbAXN_SKAccept
  #x04        XkbAXN_SKReject
  #x08        XkbAXN_SKRelease
  #x10        XkbAXN_BKAccept
  #x20        XkbAXN_BKReject
```
#x40  XkbAXN_AXKWarning

SETofKB_MAPPART
#x0001  XkbKeyTypes
#x0002  XkbKeySymms
#x0004  XkbModifierMap
#x0008  XkbExplicitComponents
#x0100  XkbKeyActions
#x0200  XkbKeyBehaviors
#x0400  XkbVirtualMods
#x0800  XkbVirtualModMap

SETofKB_STATEPART
#x0001  XkbModifierState
#x0002  XkbModifierBase
#x0004  XkbModifierLatch
#x0008  XkbModifierLock
#x0100  XkbGroupState
#x0200  XkbGroupBase
#x0400  XkbGroupLatch
#x0800  XkbGroupLock
#x1000  XkbCompatState
#x2000  XkbGrabMods
#x4000  XkbCompatGrabMods
#x8000  XkbLookupMods
#x10000  XkbCompatLookupMods
#x20000  XkbPointerButtons

SETofKB_BOOLCTRL
#x00000001  XkbRepeatKeys
#x00000002  XkbSlowKeys
#x00000004  XkbBounceKeys
#x00000008  XkbStickyKeys
#x00000010  XkbMouseKeys
#x00000020  XkbMouseKeysAccel
#x00000040  XkbAccessXKeys
#x00000080  XkbAccessXTimesoutMask
#x00000100  XkbAccessXFeedbackMask
#x00000200  XkbAudibleBellMask
#x00000400  XkbOverlay1Mask
#x00000800  XkbOverlay2Mask
#x00001000  XkbIgnoreGroupLockMask

SETofKB_CONTROL
Encodings are the same as for SETofKB_BOOLCTRL, with the addition of:
#x080000000  XkbGroupsWrap
#x100000000  XkbInternalMods
#x200000000  XkbIgnoreLockMods
#x400000000  XkbPerKeyRepeat
#x800000000  XkbControlsEnabled

SETofKB_AXFBOPT
#x0001  XkbAX_SKPressFB
#x0002  XkbAX_SKAcceptFB
#x0004  XkbAX_FeatureFB
Protocol Encoding

#x0008                  XkbAX_SlowWarnFB
#x0010                  XkbAX_IndicatorFB
#x0020                  XkbAX_StickyKeysFB
#x0100                  XkbAX_SKReleaseFB
#x0200                  XkbAX_SKRejectFB
#x0400                  XkbAX_BKRejectFB
#x0800                  XkbAX_DumbBell

SETofKB_AXSKOPT
#x0040                  XkbAX_TwoKeys
#x0080                  XkbAX_LatchToLock

SETofKB_AXOPTION
  Encoding same as the bitwise union of:
  SETofKB_AXFBOPT
  SETofKB_AXSKOPT

KB_DEVICESPEC
  0..255     input extension device id
#x100      XkbUseCoreKbd
#x200      XkbUseCorePtr

KB_LEDCLASSRESULT
  0     KbdFeedbackClass
  4     LedFeedbackClass

KB_LEDCLASSSPEC
  Encoding same as KB_LEDCLASSRESULT, with the addition of:
#x0300     XkbDfltXIClass
#x0500     XkbAllXIClasses

KB_BELLCLASSRESULT
  0     KbdFeedbackClass
  5     BellFeedbackClass

KB_BELLCLASSSPEC
  Encoding same as KB_BELLCLASSRESULT, with the addition of:
#x0300     XkbDfltXIClass

KB_IDSPEC
  0..255     input extension feedback id
#x0400     XkbDfltXIIId

KB_IDRESULT
  Encoding same as KB_IDSPEC, with the addition of:
#xff00     XkbXINone

KB_MULTIIDSPEC
  encodings same as KB_IDSPEC, with the addition of:
#x0500     XkbAllXIIIds

KB_GROUP
  0     XkbGroup1
  1     XkbGroup2
  2     XkbGroup3
  3     XkbGroup4
Protocol Encoding

KB_GROUPS

Encoding same as KB_GROUP, with the addition of:
254  XkbAnyGroup
255  XkbAllGroups

SETofKB_GROUP

#x01  XkbGroup1
#x02  XkbGroup2
#x04  XkbGroup3
#x08  XkbGroup4

SETofKB_GROUPS

Encoding same as SETofKB_GROUP, with the addition of:
#x80  XkbAnyGroup

KB_GROUPSWRAP

#x00  XkbWrapIntoRange
#x40  XkbClampIntoRange
#x80  XkbRedirectIntoRange

SETofKB_VMODSHIGH

#x80  virtual modifier 15
#x40  virtual modifier 14
#x20  virtual modifier 13
#x10  virtual modifier 12
#x08  virtual modifier 11
#x04  virtual modifier 10
#x02  virtual modifier 9
#x01  virtual modifier 8

SETofKB_VMODSLOW

#x80  virtual modifier 7
#x40  virtual modifier 6
#x20  virtual modifier 5
#x10  virtual modifier 4
#x08  virtual modifier 3
#x04  virtual modifier 2
#x02  virtual modifier 1
#x01  virtual modifier 0

SETofKB_VMOD

#x8000  virtual modifier 15
#x4000  virtual modifier 14
#x2000  virtual modifier 13
#x1000  virtual modifier 12
#x0800  virtual modifier 11
#x0400  virtual modifier 10
#x0200  virtual modifier 9
#x0100  virtual modifier 8
#x0080  virtual modifier 7
#x0040  virtual modifier 6
#x0020  virtual modifier 5
#x0010  virtual modifier 4
#x0008  virtual modifier 3
#x0004  virtual modifier 2
Protocol Encoding

#x0002 virtual modifier 1
#x0001 virtual modifier 0

SETofKB_EXPLICIT
#x80 XkbExplicitVModMap
#x40 XkbExplicitBehavior
#x20 XkbExplicitAutoRepeat
#x10 XkbExplicitInterpret
#x08 XkbExplicitKeyType4
#x04 XkbExplicitKeyType3
#x02 XkbExplicitKeyType2
#x01 XkbExplicitKeyType1

KB_SYMINTERPMATCH
#x80 XkbSI_LevelOneOnly
#x7f operation, one of the following:
  0 XkbSI_NoneOf
  1 XkbSI_AnyOfOrNone
  2 XkbSI_AnyOf
  3 XkbSI_AllOf
  4 XkbSI_Exactly

SETofKB_IMFLAG
#x80 XkbIM_NoExplicit
#x40 XkbIM_NoAutomatic
#x20 XkbIM_LEDDrivesKB

SETofKB_IMMODSWHICH
#x10 XkbIM_UseCompat
#x08 XkbIM_UseEffective
#x04 XkbIM_UseLocked
#x02 XkbIM_UseLatched
#x01 XkbIM_UseBase

SETofKB_IMGROUPSWHICH
#x10 XkbIM_UseCompat
#x08 XkbIM_UseEffective
#x04 XkbIM_UseLocked
#x02 XkbIM_UseLatched
#x01 XkbIM_UseBase

KB_INDICATORMAP
1 SETofKB_IMFLAGS flags
1 SETofKB_IMGROUPSWHICH whichGroups
1 SETofKB_GROUP groups
1 SETofKB_IMMODSWHICH whichMods
1 SETofKEYMASK mods
1 SETofKEYMASK realMods
2 SETofKB_VMOD vmods
4 SETofKB_BOOLCTRL ctrls

SETofKB_CMDETAIL
#x01 XkbSymInterp
#x02 XkbGroupCompat

SETofKB_NAMEDETAIL
Protocol Encoding

#x0001 XkbKeycodesName
#x0002 XkbGeometryName
#x0004 XkbSymbolsName
#x0008 XkbPhysSymbolsName
#x0010 XkbTypesName
#x0020 XkbCompatName
#x0040 XkbKeyTypeNames
#x0080 XkbKTLevelNames
#x0100 XkbIndicatorNames
#x0200 XkbKeyNames
#x0400 XkbKeyAliases
#x0800 XkbVirtualModNames
#x1000 XkbGroupNames
#x2000 XkbRGNames

SETofKB_GBNDETAIL
#x01 XkbGBN_Types
#x02 XkbGBN_CompatMap
#x04 XkbGBN_ClientSymbols
#x08 XkbGBN_ServerSymbols
#x10 XkbGBN_IndicatorMaps
#x20 XkbGBN_KeyNames
#x40 XkbGBN_Geometry
#x80 XkbGBN_OtherNames

SETofKB_XIEXTDEVFEATURE
#x02 XkbXI_ButtonActions
#x04 XkbXI_IndicatorNames
#x08 XkbXI_IndicatorMaps
#x10 XkbXI_IndicatorState

SETofKB_XIFEATURE
Encoding same as SETofKB_XIEXTDEVFEATURE, with the addition of:
#x01 XkbXI_Keyboards

SETofKB_XIDETAIL
Encoding same as SETofKB_XIFEATURE, with the addition of:
#x8000 XkbXI_UnsupportedFeature

SETofKB_PERCLIENTFLAG
#x01 XkbDetectableAutorepeat
#x02 XkbGrabsUseXKBState
#x04 XkbAutoResetControls
#x08 XkbLookupStateWhenGrabbed
#x10 XkbSendEventUsesXKBState

KB_MODDEF
1 SETofKEYMASK mask
1 SETofKEYMASK realMods
2 SETofVMOD vmods

KB_COUNTED_STRING8
1 1 length
1 STRING8 string

KB_COUNTED_STRING16
2  1     length
1  STRING8     string

KB_COUNTED_STRING16
p     unused,p=pad(2+1)

Errors

1  0     Error
2  ??    code
2  CARD16     sequence
4  CARD32    error value

most significant 8 bits of error value have the meaning:
0xff     XkbErrBadDevice
0xfe     XkbErrBadClass
0xfd     XkbErrBadId

the least significant 8 bits of the error value contain the device id,
class, or feedback id which failed.
2  CARD16     minor opcode
1  CARD8     major opcode
21    unused

Key Actions

1  0     type
7    unused

1  1     type
1  BITMASK   flags
 #x01     XkbSA_ClearLocks
 #x02     XkbSA_LatchToLock
 #x04     XkbSA_UseModMapMods
1  SETofKEYMASK   mask
1  SETofKEYMASK   real modifiers
1  SETofKB_VMODSHIGH   virtual modifiers high
1  SETofKB_VMODSLOW    virtual modifiers low
2    unused

1  2     type
1  BITMASK   flags
 #x01     XkbSA_ClearLocks
 #x02     XkbSA_LatchToLock
 #x04     XkbSA_UseModMapMods
1  SETofKEYMASK   mask
1  SETofKEYMASK   real modifiers
1  SETofKB_VMODSHIGH   virtual modifiers high
1  SETofKB_VMODSLOW    virtual modifiers low
2    unused

1  3     type
1  BITMASK   flags
 #x01     XkbSA_LockNoLock
 #x02     XkbSA_LockNoUnlock
Protocol Encoding

#x04 XkbSA_UseModMapMods
1 SETofKEYMASK mask
1 SETofKEYMASK real modifiers
1 SETofKB_VMODSHIGH virtual modifiers high
1 SETofKB_VMODSLOW virtual modifiers low
2 unused

1 4 type
1 BITMASK flags
#x01 XkbSA_ClearLocks
#x02 XkbSA_LatchToLock
#x04 XkbSA_GroupAbsolute
1 INT8 group
5 unused

1 5 type
1 BITMASK flags
#x01 XkbSA_ClearLocks
#x02 XkbSA_LatchToLock
#x04 XkbSA_GroupAbsolute
1 INT8 group
5 unused

1 6 type
1 BITMASK flags
#x01 XkbSA_LockNoLock
#x02 XkbSA_LockNoUnlock
#x04 XkbSA_GroupAbsolute
1 INT8 group
5 unused

1 7 type
1 BITMASK flags
#x01 XkbSA_NoAcceleration
#x02 XkbSA_MoveAbsoluteX
#x04 XkbSA_MoveAbsoluteY
1 INT8 x high
1 CARD8 x low
1 INT8 y high
1 CARD8 y low
2 unused

1 8 type
1 BITMASK flags
1 CARD8 count
1 CARD8 button
4 unused

1 9 type
1 BITMASK flags
1 unused
1 CARD8 button
4 unused

1 10 type
Protocol Encoding

1 BITMASK  flags
  #x02  XkbSA_DfltBtnAbsolute
1 BITMASK  affect
  #x01  XkbSA_AffectDfltBtn
1 INT8  value
4 unused

1 11  type
1 BITMASK  flags
  #x01  XkbSA_LockNoLock
  #x02  XkbSA_LockNoUnlock
  #x04  XkbSA_UseModMapMods (if SA_ISODfltIsGroup is 0)
  #x04  XkbSA_GroupAbsolute (if SA_ISODfltIsGroup is 1)
  #x80  XkbSA_ISODfltIsGroup
1 SETofKEYMASK  mask
1 SETofKEYMASK  real modifiers
1 INT8  group
1 BITMASK  affect
  #x08  XkbSA_ISONoAffectCtrls
  #x10  XkbSA_ISONoAffectPtr
  #x20  XkbSA_ISONoAffectGroup
  #x40  XkbSA_ISONoAffectMods
1 SETofKB_VMODSHIGH  virtual modifiers high
1 SETofKB_VMODSLOW  virtual modifiers low

1 12  type
7 unused

1 13  type
1 BITMASK  flags
  #x01  XkbSA_SwitchApplication
  #x04  XkbSA_SwitchAbsolute
1 INT8  new screen
5 unused (must be 0)

1 14  type
3 unused (must be 0)
1 BITMASK  boolean controls high
  #x01  XkbAccessXFeedbackMask
  #x02  XkbAudibleBellMask
  #x04  XkbOverlay1Mask
  #x08  XkbOverlay2Mask
  #x10  XkbIgnoreGroupLockMask
1 BITMASK  boolean controls low
  #x01  XkbRepeatKeys
  #x02  XkbSlowKeys
  #x04  XkbBounceKeys
  #x08  XkbStickyKeys
  #x10  XkbMouseKeys
  #x20  XkbMouseKeysAccel
  #x40  XkbAccessXKeys
  #x80  XkbAccessXTtimeoutMask
2 unused (must be 0)

1 15  type
Protocol Encoding

3       unused (must be 0)
1       BITMASK  boolean controls high
#x01   XkbAccessXFeedbackMask
#x02   XkbAudibleBellMask
#x04   XkbOverlay1Mask
#x08   XkbOverlay2Mask
#x10   XkbIgnoreGroupLockMask
1       BITMASK  boolean controls low
#x01   XkbRepeatKeys
#x02   XkbSlowKeys
#x04   XkbBounceKeys
#x08   XkbStickyKeys
#x10   XkbMouseKeys
#x20   XkbMouseKeysAccel
#x40   XkbAccessXKeys
#x80   XkbAccessXTimeoutMask

1       16      type
2       unused (must be 0)

1       16      type
1       BITMASK  flags
#x01   XkbSA_MessageOnPress
#x02   XkbSA_MessageOnRelease
#x04   XkbSA_MessageGenKeyEvent
6       STRING  message

1       17      type
1       KEYCODE  new key
1       SETofKEYMASK  mask
1       SETofKEYMASK  real modifiers
1       SETofKB_VMODSHIGH  virtual modifiers mask high
1       SETofKB_VMODSLOW  virtual modifiers mask low
1       SETofKB_VMODSHIGH  virtual modifiers high
1       SETofKB_VMODSLOW  virtual modifiers low

1       18      type
1       0       flags
1       CARD8  count
1       CARD8  button
1       CARD8  device
3       unused (must be 0)

1       19      type
1       BITMASK  flags
#x01   XkbSA_LockNoLock
#x02   XkbSA_LockNoUnlock
1       unused
1       CARD8  button
1       CARD8  device

1       20      type
1       CARD8  device
1       KB_SA_VALWHAT  valuator 1 what
#x00   XkbSA_IgnoreVal
Protocol Encoding

#x01      XkbSA_SetValMin
#x02      XkbSA_SetValCenter
#x03      XkbSA_SetValMax
#x04      XkbSA_SetValRelative
#x05      XkbSA_SetValAbsolute

1     CARD8          valuator 1 index
1     CARD8          valuator 1 value
1     KB_SA_VALWHAT          valuator 2 what

Encodings as for "valuator 1 what" above
1     CARD8          valuator 2 index
1     CARD8          valuator 2 value

Key Behaviors

1     #x00          type
1          unused

1     #x01          type
1          unused

1     #x02          type
1        0..31          group

1     #x03          type
1        KEYCODE          key

1     #x04          type
1        CARD8          key

1     #x81          type
1          unused

1     #x82          type
1        0..31          group

1     #x83          type
1        KEYCODE          key

1     #x84          type
1        KEYCODE          key

Requests

1     ??          opcode
1     0          xkb-opcode
2     2          request-length
2     CARD16          wantedMajor
2     CARD16          wantedMinor

1     1          Reply
1     BOOL          supported
2     CARD16          sequence number
4     0          reply length
2     1          serverMajor
2     0          serverMinor
Protocol Encoding

20 unused

1 ?? opcode
1 1 xkb-opcode
2 4+(V+p)/4 request-length
2 KB_DEVICESPEC deviceSpec
2 SETofKB_EVENTTYPE affectWhich
2 SETofKB_EVENTTYPE clear
2 SETofKB_EVENTTYPE selectAll
2 SETofKB_MAPDETAILS affectMap
2 SETofKB_MAPDETAILS map
V LISTofITEMs details
\(\text{SETofKB_EVENTTYPE} \) (affectWhich&(~clear)&(~selectAll))
\(\text{XkbNewKeyboardNotify} \) affectNewKeyboard, newKeyboardDetails
\(\text{XkbStateNotify} \) affectState, stateDetails
\(\text{XkbControlsNotify} \) affectCtrls, ctrlDetails
\(\text{XkbIndicatorStateNotify} \) affectIndicatorState, indicatorStateDetails
\(\text{XkbIndicatorMapNotify} \) affectIndicatorMap, indicatorMapDetails
\(\text{XkbNamesNotify} \) affectNames, namesDetails
\(\text{XkbCompatMapNotify} \) affectCompat, compatDetails
\(\text{XkbBellNotify} \) affectBell, bellDetails
\(\text{XkbActionMessage} \) affectMsgDetails, msgDetails
\(\text{XkbExtensionDeviceNotify} \) affectExtDev, extdevDetails

ITEMs
p unused, p=pad(V)

ITEMs
2 SETofKB_NKNDetail affectNewKeyboard
2 SETofKB_NKNDetail newKeyboardDetails
2 SETofKB_STATEPART affectState
2 SETofKB_STATEPART stateDetails
4 SETofKB_CONTROL affectCtrls
4 SETofKB_CONTROL ctrlDetails
4 SETofKB_INDICATOR affectIndicatorState
4 SETofKB_INDICATOR indicatorStateDetails
4 SETofKB_INDICATOR affectIndicatorMaps
4 SETofKB_INDICATOR indicatorMapDetails
2 SETofKB_NAME_DETAIL affectNames
2 SETofKB_NAME_DETAIL namesDetails
1 SETofKB_CMDETAIL affectCompat
1 SETofKB_CMDETAIL compatDetails
1 SETofKB_BELLDETAIL affectBell
1 SETofKB_BELLDETAIL bellDetails
1 SETofKB_MSGDETAIL affectMsgDetails
1 SETofKB_MSGDETAIL msgDetails
2 SETofKB_AXNDETAIL affectAccessX
2 SETofKB_AXNDETAIL accessXDetails
2 SETofKB_XIDETAIL affectExtDev
2 SETofKB_XIDETAIL extdevDetails

1 ?? opcode
1 3 xkb-opcode
2 7 request-length
Protocol Encoding

2 KB_DEVICESPEC       deviceSpec
2 KB_BELLCLASSSPEC    bellClass
2 KB_IDSPEC           bellID
1 INT8                percent
1 BOOL                forceSound
1 BOOL                eventOnly
1 unused
2 INT16               pitch
2 INT16               duration
2 unused
4 ATOM                name
4 WINDOW              window
1 ??                  opcode
1 4                  xkb-opcode
2 2                  request-length
2 KB_DEVICESPEC       deviceSpec
2 unused
1 1                  Reply
1 CARD8               deviceID
2 CARD16              sequence number
4 0                  length
1 SETofKEYMASK        mods
1 SETofKEYMASK        baseMods
1 SETofKEYMASK        latchedMods
1 SETofKEYMASK        lockedMods
1 KP_GROUP            group
1 KP_GROUP            lockedGroup
2 INT16               baseGroup
2 INT16               latchedGroup
1 SETofKEYMASK        compatState
1 SETofKEYMASK        grabMods
1 SETofKEYMASK        compatGrabMods
1 SETofKEYMASK        lookupMods
1 SETofKEYMASK        compatLookupMods
1 unused
2 SETofBUTMASK        ptrBtnState
6 unused
1 ??                  opcode
1 5                  xkb-opcode
2 4                  request-length
2 KB_DEVICESPEC       deviceSpec
1 SETofKEYMASK        affectModLocks
1 SETofKEYMASK        modLocks
1 BOOL                lockGroup
1 KB_GROUP            groupLock
1 SETofKEYMASK        affectModLatches
1 SETofKEYMASK        modLatches
1 unused
1 BOOL                latchGroup
2 INT16               groupLatch
1 ??                  opcode
### Protocol Encoding

```
<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>xkb-opcode</td>
</tr>
<tr>
<td>2</td>
<td>request-length</td>
</tr>
<tr>
<td>2</td>
<td>KB_DEVICESPEC deviceSpec</td>
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<td>unused</td>
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<tr>
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<td>sequence number</td>
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<td>groupsWrap</td>
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<td>internalMods.mask</td>
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<tr>
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<td>ignoreLockMods.mask</td>
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<tr>
<td>1</td>
<td>internalMods.realMods</td>
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<tr>
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<td>ignoreLockMods.vmods</td>
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<td>perKeyRepeat</td>
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<td>KB_DEVICESPEC deviceSpec</td>
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<tr>
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<td>affectIgnoreLockVirtualMods</td>
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<tr>
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<tr>
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<td>accessXOptions</td>
</tr>
<tr>
<td>2</td>
<td>unused</td>
</tr>
</tbody>
</table>
```
Protocol Encoding

```
4     SETofKB_BOOLCTRL          affectEnabledControls
4     SETofKB_BOOLCTRL          enabledControls
4     SETofKB_CONTROL          changeControls
2     CARD16          repeatDelay
2     CARD16          repeatInterval
2     CARD16          slowKeysDelay
2     CARD16          debounceDelay
2     CARD16          mouseKeysDelay
2     CARD16          mouseKeysInterval
2     CARD16          mouseKeysTimeToMax
2     CARD16          mouseKeysMaxSpeed
2     INT16          mouseKeysCurve
2     CARD16          accessXTimeout
4     SETofKB_BOOLCTRL          accessXTimeoutMask
4     SETofKB_BOOLCTRL          accessXTimeoutValues
2     SETofKB_AXOPTION          accessXTimeoutOptionsMask
2     SETofKB_AXOPTION          accessXTimeoutOptionsValues
32     LISTofCARD8          perKeyRepeat
1     CARD8          opcode
8     xkb-opcode
2     7          request-length
2     KB_DEVICESPEC          deviceSpec
2     SETofKB_MAPPART          full
2     SETofKB_MAPPART          partial
1     CARD8          firstType
1     CARD8          nTypes
1     KEYCODE          firstKeySym
1     CARD8          nKeySyms
1     KEYCODE          firstKeyAction
1     CARD8          nKeyActions
1     KEYCODE          firstKeyBehavior
1     CARD8          nKeyBehaviors
2     SETofKB_VMOD          virtualMods
1     KEYCODE          firstKeyExplicit
1     CARD8          nKeyExplicit
1     KEYCODE          firstModMapKey
1     CARD8          nModMapKeys
1     KEYCODE          firstVModMapKey
1     CARD8          nVModMapKeys
2     unused
1     1          Reply
1     CARD8          deviceID
2     CARD16          sequence number
4     2+(I/4)          length
2     unused
1     KEYCODE          minKeyCode
1     KEYCODE          maxKeyCode
2     SETofKB_MAPPART          present
1     CARD8          firstType
1     t          nTypes
1     CARD8          totalTypes
1     KEYCODE          firstKeySym
```
Protocol Encoding

2     S          totalSyms
1     s          nKeySyms
1     KEYCODE          firstKeyAction
2     A          totalActions
1     a          nKeyActions
1     KEYCODE          firstKeyBehavior
1     b          nKeyBehaviors
1     B          totalKeyBehaviors
1     KEYCODE          firstKeyExplicit
1     e          nKeyExplicit
1     E          totalKeyExplicit
1     KEYCODE          firstModMapKey
1     m          nModMapKeys
1     M          totalModMapKeys
1     KEYCODE          firstVModMapKey
1     0          nVModMapKeys
1     V          totalVModMapKeys
1               unused
2     SETofKB_VMOD          virtualMods (has v bits set to 1)
I     LISTofITEMs          map
SETofKB_MAPPART               (present)
XkbKeyTypes     typesRtrn
XkbKeySyms     symsRtrn
XkbKeyActions     actsRtrn.count, actsRtrn.acts
XkbKeyBehaviors     behaviorsRtrn
XkbVirtualMods     vmodsRtrn
XkbExplicitComponents     explicitRtrn
XkbModifierMap     modmapRtrn
XkbVirtualModMap     vmodMapRtrn

ITEMs
T1+..Tt     LISTofKB_KEYTYPE          typesRtrn
8s+4S     LISTofKB_KEYSYMMAP          symsRtrn
a     LISTofCARD8          actsRtrn.count
p               unused, p=pad(a)
8A     LISTofKB_ACTION          actsRtrn.acts
4B     LISTofKB_SETBEHAVIOR          behaviorsRtrn
v     LISTofSETofKEYMASK          vmodsRtrn
p               unused, p=pad(v)
2E     LISTofKB_SETEXPLICIT          explicitRtrn
p               unused, p=pad(2E)
2M     LISTofKB_KEYMODMAP          modmapRtrn
p               unused, p=pad(2M)
4V     LISTofKB_KEYVMODMAP          vmodMapRtrn

KB_KEYTYPE     8+8m+[4m]
1     SETofKEYMASK          mods.mask
1     SETofKEYMASK          mods.mods
2     SETofKB_VMOD          mods.vmods
1     CARD8          numLevels
1     m          nMapEntries
1     BOOL          hasPreserve
1               unused
8m     LISTofKB_KTMAPENTRY          map
Protocol Encoding

```plaintext
LIST of KB_MODDEF

KB_KTMAPENTRY
1  BOOL active
1  SET of KEYMASK mods.mask
1  CARD8 level
1  SET of KEYMASK mods.mods
2  SET of KB_VMOD mods.vmods
2    unused

KB_KEYSYMMP
8+4n
4  LIST of CARD8 ktIndex
1  CARD8 groupInfo
1  CARD8 width
2  n nSyms
4n  LIST of KEYSYM syms

KB_SETBEHAVIOR
1  KEYCODE keycode
2  KB_BEHAVIOR behavior
1    unused

KB_SETEXPLICIT
1  KEYCODE keycode
1  SET of KB_EXPLICIT explicit

KB_KEYMODMAP
1  KEYCODE keycode
1  SET of KB KEYMASK mods

KB_KEYVMODMAP
1  KEYCODE keycode
1    unused
2  SET of KB_VMOD vmods
1  CARD8 opcode
1  9 xkb-opcode
2  9+(I/4) request-length
2  KB_DEVICESPEC deviceSpec
2  SET of KB_MAPPART present
2  SET of KB_SETMAPFLAGS flags
#0001  SetMapResizeTypes
#0002  SetMapRecomputeActions
1  KEYCODE minKeyCode
1  KEYCODE maxKeyCode
1  CARD8 firstType
1  t nTypes
1  KEYCODE firstKeySym
1  s nKeySyms
2  S totalSyms
1  KEYCODE firstKeyAction
1  a nKeyActions
2  A totalActions
1  KEYCODE firstKeyBehavior
1  b nKeyBehaviors
```
Protocol Encoding

1  B  totalKeyBehaviors
1  KEYCODE  firstKeyExplicit
1  e  nKeyExplicit
1  E  totalKeyExplicit
1  KEYCODE  firstModMapKey
1  m  nModMapKeys
1  M  totalModMapKeys
1  KEYCODE  firstVModMapKey
1  v  nVModMapKeys
1  V  totalVModMapKeys
2  SETofKB_VMOD  virtualMods (has n bits set to 1)
I  LISTofITEMs  values
   SETofKB_MAPPART  (present)
   XkbKeyTypes  types
   XkbKeySymbols  syms
   XkbKeyActions  actions.count, actions.actions
   XkbKeyBehaviors  behaviors
   XkbVirtualMods  vmods
   XkbExplicitComponents  explicit
   XkbModifierMap  modmap
   XkbVirtualModMap  vmodmap

ITEMs
T0+...Tt  LISTofKB_SETKEYTYPE  types
8s+4S  LISTofKB_KEYSYMMAP  syms
   a  LISTofCARD8  actions.count
   p  unused, p=pad(a)
8A  LISTofKB_ACTION  actions.actions
4B  LISTofKB_SETBEHAVIOR  behaviors
   v  LISTofSETofKEYMASK  vmods
   p  unused, p=pad(v)
2E  LISTofKB_SETEXPLICIT  explicit
   p  unused, p=pad(2E)
2M  LISTofKB_KEYMODMAP  modmap
   P  unused, p=pad(2M)
4V  LISTofKB_KEYVMODMAP  vmodmap

KB_SETKEYTYPE  8+4m+[4m]
1  SETofKEYMASK  mask
1  SETofKEYMASK  realMods
2  SETofKB_VMOD  virtualMods
1  CARD8  numLevels
1  m  nMapEntries
1  BOOL  preserve
1  unused
4m  LISTofKB_KTSETMAPENTRY  entries
[4m]  LISTofKB_MODDEF  preserveEntries (if preserve==TRUE)

KB_KTSETMAPENTRY
1  CARD8  level
1  SETofKEYMASK  realMods
2  SETofKB_VMOD  virtualMods
1  ??  opcode
1  10  xkb-opcode
Protocol Encoding

2     3          request-length
2     KB_DEVICESPEC           deviceSpec
1     SETofKB_GROUP          groups
1     BOOL          getAllSI
2     CARD16          firstSI
2     CARD16          nSI

1     1          Reply
1     CARD8          deviceID
2     CARD16          sequence number
4     (16n+4g)/4          length
1     SETofKB_GROUP          groupsRtrn (has g bits set to 1)
1     unused
2     CARD16          firstSIRtrn
2     n               nSIRtrn
2     CARD16          nTotalSI
16    unused
16n   LISTofKB_SYMINTERPRET           siRtrn
4g    LISTofKB_MODDEF          groupRtrn

1     ??          opcode
1     11          xkb-opcode
2     4+(16n+4g)          request-length
2     KB_DEVICESPEC           deviceSpec
1     unused
1     BOOL          recomputeActions
1     BOOL          truncateSI
1     SETofKB_GROUP          groups (has g bits set to 1)
2     CARD16          firstSI
2     n               nSI
2     unused
16n   LISTofKB_SYMINTERPRET           si
4g    LISTofKB_MODDEF          groupMaps

1     ??          opcode
1     12          xkb-opcode
2     2          request-length
2     KB_DEVICESPEC           deviceSpec

ITEMs
2     unused

1     1          Reply
1     CARD8          deviceID
2     CARD16          sequence number
4     0          length
4     SETofKB_INDICATOR          state
20    unused

1     ??          opcode
1     13          xkb-opcode
2     3          request-length
2     KB_DEVICESPEC           deviceSpec
2     unused
4     SETofKB_INDICATOR          which
1     1          Reply
1     CARD8          deviceID
2     CARD16          sequence number
4     12n/4          length
4     SETofKB_INDICATOR which (has n bits set to 1)
4     SETofKB_INDICATOR realIndicators
1     n          nIndicators
15               unused
12n     LISTofKB_INDICATORMAP          maps

1     ??          opcode
1     14          xkb-opcode
2     3+3n          request-length
2     KB_DEVICESPEC           deviceSpec
2               unused
4     SETofKB_INDICATOR which (has n bits set to 1)
12n     LISTofKB_INDICATORMAP          maps

1     CARD8          opcode
1     15          xkb-opcode
2     4          request-length
2     KB_DEVICESPEC           deviceSpec
2     KB_LEDCLASSSPEC          ledClass
2     KB_IDSPEC          ledID
2               unused
4     ATOM          indicator
1     1          Reply
1     CARD8          deviceID
2     CARD16          sequence number
4     0          length
4     ATOM          indicator
1     BOOL          found
1     BOOL          on
1     BOOL          realIndicator
1     KB_INDICATOR          ndx
1     SETofKB_IMMFLAGS          map.flags
1     SETofKB_IMGROUPSWHICH          map.whichGroups
1     SETofKB_GROUPS          map.groups
1     SETofKB_IMMODSWHICH          map.whichMods
1     SETofKEYMASK          map.mods
1     SETofKEYMASK          map.realMods
2     SETofKB_VMOD          map.vmods
4     SETofKB_BOOLCTRL          map.ctrls
1     BOOL          supported
3               unused
1     ??          opcode
1     16          xkb-opcode
2     8          request-length
2     KB_DEVICESPEC           deviceSpec
2     KB_LEDCLASSSPEC          ledClass
2     KB_IDSPEC          ledID
2               unused
4     ATOM          indicator
Protocol Encoding

1  BOOL          setState
1  BOOL          on
1  BOOL          setMap
1  BOOL          createMap
1     unused
1  SETofKB_IMFLAGS          map.flags
1  SETofKB_IGROUPSWHICH     map.whichGroups
1  SETofKB_GROUP           map.groups
1  SETofKB_IMMODSWHICH      map.whichMods
1  SETofKEYMASK            map.realMods
2  SETofKB_VMOD            map.vmods
4  SETofKB_BOOLCTRL        map.ctrls

1  CARD8          opcode
1     17          xkb-opcode
2     3          request-length
2     KB_DEVICESPEC   deviceSpec
2     unused
4  SETofKB_NAMEDETAIL   which

1  1          Reply
1     CARD8     deviceID
2     CARD16     sequence number
4     V/4        length
4  SETofKB_NAMEDETAIL   which
1     KEYCODE    minKeyCode
1     KEYCODE    maxKeyCode
1     t          nTypes
1  SETofKB_GROUP    groupNames (has g bits set to 1)
2  SETofKB_VMOD     virtualMods (has v bits set to 1)
1     KEYCODE     firstKey
1     k          nKeys
4  SETofKB_INDICATOR   indicators (has i bits set to 1)
1     r          nRadioGroups
1     a          nKeyAliases
2     l          nKTLevels
4     unused
V  LISTofITEMs        valueList
SETofKB_NAMEDETAIL     (which)
XkbKeycodesName        keycodesName
XkbGeometryName        geometryName
XkbSymbolsName         symbolsName
XkbPhysSymbolsName     physSymbolsName
XkbTypesName           typesName
XkbCompatName          compatName
XkbKeyTypeNames        typeNames
XkbKTLevelNames        nLevelsPerType, ktLevelNames
XkbIndicatorNames      indicatorNames
XkbVirtualModNames     virtualModNames
XkbGroupNames          groupNames
XkbKeyName             keyNames
XkbKeyAliases          keyAliases
XkbRGName              radioGroupNames

ITEMs
Protocol Encoding

4 ATOM keycodesName
4 ATOM geometryName
4 ATOM symbolsName
4 ATOM physSymbolsName
4 ATOM typesName
4 ATOM compatName
4t LISTofATOM typeNames
1 LISTofCARD8 nLevelsPerType, sum of all elements=L
  p unused, p=pad(1)
4L LISTofATOM ktLevelNames
4i LISTofATOM indicatorNames
4v LISTofATOM virtualModNames
4g LISTofATOM groupNames
4k LISTofKB_KEYNAME keyNames
8a LISTofKB_KEYALIAS keyAliases
4r LISTofATOM radioGroupNames

1 CARD8 opcode
1 18 xkb-opcode
2 7+(V/4) request-length
2 KB_DEVICESPEC deviceSpec
2 SETofKB_VMOD virtualMods
4 SETofKB_NAMEDETAIL which
1 CARD8 firstType
1 t nTypes
1 CARD8 firstKTLevel
1 l nKTLevels
4 SETofKB_INDICATOR indicators (has i bits set to 1)
1 SETofKB_GROUP groupNames (has g bits set to 1)
1 r nRadioGroups
1 KEYCODE firstKey
1 k nKeys
1 a nKeyAliases
1 unused
2 L totalKTLevelNames
V LISTofITEMs values
  SETofKB_NAMEDETAIL (which)
  XkbKeycodesName keycodesName
  XkbGeometryName geometryName
  XkbSymbolsName symbolsName
  XkbPhysSymbolsName physSymbolsName
  XkbTypesName typesName
  XkbCompatName compatName
  XkbKeyTypeNames typeNames
  XkbKTLevelNames nLevelsPerType, ktLevelNames
  XkbIndicatorNames indicatorNames
  XkbVirtualModNames virtualModNames
  XkbGroupName groupNames
  XkbKeyName keyNames
  XkbKeyAlias keyAliases
  XkbRGName radioGroupNames

ITEMs
4 ATOM keycodesName
Protocol Encoding

4 ATOM geometryName
4 ATOM symbolsName
4 ATOM physSymbolsName
4 ATOM typeName
4 ATOM compatName
4t LISTofATOM typeNames
1 LISTofCARD8 nLevelsPerType
p unused, p=pad(l)
4L LISTofATOM ktLevelNames
4l LISTofATOM indicatorNames
4v LISTofATOM virtualModNames
4g LISTofATOM groupNames
4k LISTofKB_KEYNAME keyNames
8a LISTofKB_KEYALIAS keyAliases
4r LISTofATOM radioGroupNames

1 CARD8 opcode
1 19 xkb-opcode
2 3 request-length
2 KB_DEVICESPEC deviceSpec
2 unused
4 ATOM name

1 1 Reply
1 CARD8 deviceID
2 CARD16 sequence number
4 (f+8p+C*+H*+S*+D*+A*)/4 length
4 ATOM name
1 BOOL found
1 unused
2 CARD16 widthMM
2 CARD16 heightMM
2 p nProperties
2 c nColors
2 h nShapes
2 s nSections
2 d nDoodads
2 a nKeyAliases
1 CARD8 baseColorNdx
1 CARD8 labelColorNdx
f KB_COUNTED_STRING16 labelFont
8p LISTofKB_PROPERTY properties
C0+..Cc LISTofKB_COUNTED_STRING16 colors
H0+..Hh LISTofKB_SHAPE shapes
S0+..Ss LISTofKB_SECTION sections
D0+..Dd LISTofKB_DOODAD doodads
A0+..Aa LISTofKB_KEYALIAS keyAliases

KB_PROPERTY 4+n+v
2 n nameLength
n STRING8 name
2 v valueLength
v STRING8 value

KB_SHAPE 8+0*
Protocol Encoding

4 ATOM name
1 o nOutlines
1 CARD8 primaryNdx
1 CARD8 approxNdx
1 unused
00+.Oo LISTofKB_OUTLINE outlines

KB_OUTLINE 4+4p
1 p nPoints
1 CARD8 cornerRadius
2 unused
4p LISTofKB_POINT points

KB_POINT
2 INT16 x
2 INT16 y

KB_SECTION 20+R*+D*+O*
4 ATOM name
2 INT16 top
2 INT16 left
2 CARD16 width
2 CARD16 height
2 INT16 angle
1 CARD8 priority
1 r nRows
1 d nDoodads
1 o nOverlays
2 unused
R0+.Rr LISTofKB_ROW rows
D0+.Dd LISTofKB_DOODAD doodads
00+.Oo LISTofKB_OVERLAY overlays

KB_ROW 8+8k
2 INT16 top
2 INT16 left
1 k nKeys
1 BOOL vertical
2 unused
8k LISTofKB_KEY keys

KB_KEY
4 STRING8 name
2 INT16 gap
1 CARD8 shapeNdx
1 CARD8 colorNdx

KB_OVERLAY 8+R*
4 ATOM name
1 r nRows
3 unused
R0+.Rr LISTofKB_OVERLAYROW rows

KB_OVERLAYROW 4+8k
1 CARD8 rowUnder
Protocol Encoding

1  k      nKeys
2  unused
8k  LISTofKB_OVERLAYKEY   keys

KB_OVERLAYKEY
4  STRING8  over
4  STRING8  under

KB_SHAPEDOODAD
4  ATOM     name
1  CARD8    type

KB_SHAPEDOODAD
#1  XkbOutlineDoodad
#2  XkbSolidDoodad
1  CARD8    priority
2  INT16    top
2  INT16    left
2  INT16    angle
1  CARD8    colorNdx
1  CARD8    shapeNdx
6  unused

KB_TEXTDOODAD   20+t+f
4  ATOM     name
1  CARD8    type
#3  XkbTextDoodad
1  CARD8    priority
2  INT16    top
2  INT16    left
2  INT16    angle
2  CARD16   width
2  CARD16   height
1  CARD8    colorNdx
3  unused
t  KB_COUNTED_STRING16   text
f  KB_COUNTED_STRING16   font

KB_INDICATORDOODAD
4  ATOM     name
1  CARD8    type
#4  XkbIndicatorDoodad
1  CARD8    priority
2  INT16    top
2  INT16    left
2  INT16    angle
1  CARD8    shapeNdx
1  CARD8    onColorNdx
1  CARD8    offColorNdx
5  unused

KB_LOGODOODAD   20+n
4  ATOM     name
1  CARD8    type
#5  XkbLogoDoodad
Protocol Encoding

1  CARD8          priority
2  INT16          top
2  INT16          left
2  INT16          angle
1  CARD8          colorNdx
1  CARD8          shapeNdx
6               unused
n     KB_COUNTED_STRING16          logoName

KB_DOODAD:
  KB_SHAPEDOODAD, or KB_TEXTDOODAD, or
  KB_INDICATORDOODAD, or KB_LOGODOODAD

1  CARD8          opcode
1  20          xkb-opcode
2  \(7+(f+8p+C\ast H\ast S\ast D\ast A)/4\)          request-length
2  KB_DEVICESPEC           deviceSpec
1  h          nShapes
1  s          nSections
4     ATOM          name
2  CARD16          widthMM
2  CARD16          heightMM
2  p          nProperties
2  c          nColors
2  d          nDoodads
2  a          nKeyAliases
1  CARD8          baseColorNdx
1  CARD8          labelColorNdx
2               unused
f     KB_COUNTED_STRING16          labelFont
8p     LISTofKB_PROPERTY          properties
C0+..Cc     LISTofKB_COUNTED_STRING16           colors
H0+..Hh     LISTofKB_SHAPE          shapes
S0+..Ss     LISTofKB_SECTION          sections
D0+..Dd     LISTofKB_DOODAD          doodads
A0+..Aa     LISTofKB_KEYALIAS          keyAliases

1  CARD8          opcode
1  21          xkb-opcode
2  7          request-length
2  KB_DEVICESPEC           deviceSpec
2               unused
4     SETofKB_PERCLIENTFLAG          change
4     SETofKB_PERCLIENTFLAG          value
4     SETofKB_BOOLCTRL          ctrlsToChange
4     SETofKB_BOOLCTRL          autoCtrls
4     SETofKB_BOOLCTRL          autoCtrlValues

1  1          Reply
1  CARD8          deviceID
2  CARD16          sequence number
4  0          length
4     SETofKB_PERCLIENTFLAG          supported
4     SETofKB_PERCLIENTFLAG          value
4     SETofKB_BOOLCTRL          autoCtrls
Protocol Encoding

4     SETofKB_BOOLCTRL          autoCtrlValues
8     unused
1     CARD8          opcode
2     22          xkb-opcode
2     2+(6+m+k+t+c+s+g+p)/4          request-length
2     KB_DEVICESPEC           deviceSpec
2     CARD16          maxNames
1     m          keymapsSpecLen
m     STRING          keymapsSpec
1     k          keycodesSpecLen
k     STRING          keycodesSpec
1     t          typesSpecLen
t     STRING          typesSpec
1     c          compatMapSpecLen
c     STRING          compatMapSpec
1     s          symbolsSpecLen
s     STRING          symbolsSpec
1     g          geometrySpecLen
g     STRING          geometrySpec
p               unused,p=pad(6+m+k+t+c+s+g)

1     1          Reply
1     CARD8          deviceID
2     CARD16          sequence number
4     (M*+K*+T*+C*+S*+G*+p)/4          length
2     m          nKeymaps
2     k          nKeycodes
2     t          nTypes
2     c          nCompatMaps
2     s          nSymbols
2     g          nGeometries
2     CARD16          extra
10    unused
M0+..Mm     LISTofKB_LISTING          keymaps
K0+..Kk     LISTofKB_LISTING          keycodes
T0+..Tt     LISTofKB_LISTING          types
C0+..Cc     LISTofKB_LISTING          compatMaps
S0+..Ss     LISTofKB_LISTING          symbols
G0+..Gg     LISTofKB_LISTING          geometries
p               unused,p=pad(M*+K*+T*+C*+S*+G*)

KB_LISTING          4+n+p
2     CARD16          flags
2     n          length
n     STRING8          string
p               unused,p=pad(n) to a 2-byte boundary

1     CARD8          opcode
1     23          xkb-opcode
2     3+(6+m+k+t+c+s+g+p)/4          request-length
2     KB_DEVICESPEC           deviceSpec
2     SETofKB_GBNDETAILMASK          need
2     SETofKB_GBNDETAILMASK          want
1     BOOL          load
Protocol Encoding

1 unused
1 m keymapsSpecLen
m STRING8 keymapsSpec
1 k keycodesSpecLen
k STRING8 keycodesSpec
1 t typesSpecLen
t STRING8 typesSpec
1 c compatMapSpecLen
c STRING8 compatMapSpec
1 s symbolsSpecLen
s STRING8 symbolsSpec
1 g geometrySpecLen
g STRING8 geometrySpec
p unused, p = pad(6 + m + k + t + c + s + g)

1 1 Reply
1 CARD8 deviceID
2 CARD16 sequence number
4 V/4 length
1 KEYCODE minKeyCode
1 KEYCODE maxKeyCode
1 BOOL loaded
1 BOOL newKeyboard
2 SETofKB_GBNDETAILMASK found
2 SETofKB_GBNDETAILMASK reported
16 unused
V LISTofITEMs replies
SETofKB_GBNDETAILMASK (reported)
XkbGBN_Types map
XkbGBN_CompatMap compat
XkbGBN_ClientSymbols map
XkbGBN_ServerSymbols map
XkbGBN_IndicatorMap indicators
XkbGBN_KeyNames names
XkbGBN.OtherNames names
XkbGBN_Geometry geometry

ITEMs
M XkbGetMap reply map
C XkbGetCompatMap reply compat
I XkbGetIndicatorMap reply indicators
N XkbGetNames reply names
G XkbGetGeometry reply geometry

1 CARD8 opcode
1 24 xkb-opcode
2 4 request-length
2 KB_DEVICESPEC deviceSpec
2 SETofKB_DEVFEATURE wanted
1 BOOL allButtons
1 CARD8 firstButton
1 CARD8 nButtons
1 unused
2 KB_LEDCLASSSPEC ledClass
Protocol Encoding

2 KB_IDSPEC ledID

1 1  Reply
1 CARD8 deviceID
2 CARD16 sequence number
4 \((2+n+p+8b+L*)/4\) length
2 SETofKB_DEVFEATURE present
2 SETofKB_FEATURE supported
2 SETofKB_FEATURE unsupported
2 l nDeviceLedFBs
1 CARD8 firstBtnWanted
1 CARD8 nBtnsWanted
1 CARD8 firstBtnRtrn
1 b nBtnsRtrn
1 CARD8 totalBtns
1 BOOL hasOwnState
2 SETofKB_IDRESULT dfltKbdFB
2 SETofKB_IDRESULT dfltLedFB
2 unused
4 ATOM devType
2 n nameLen
n STRING8 name
p unused,p=pad(2+n)
8b LISTofKB_ACTION btnActions
L0+..Ll LISTofKB_DEVICELEDINFO leds

KB_DEVICELEDINFO 20+4n+12m
2 KB_LEDCLASSSPEC ledClass
2 KB_IDSPEC ledID
4 SETofKB_INDICATOR namesPresent (has n bits set to 1)
4 SETofKB_INDICATOR mapsPresent (has m bits set to 1)
4 SETofKB_INDICATOR physIndicators
4 SETofKB_INDICATOR state
4n LISTofATOM names
12m LISTofKB_INDICATORMAP maps

1 ?? opcode
1 25 xkb-opcode
2 3+(8b+L*)/4 request-length
2 KB_DEVICESPEC deviceSpec
1 CARD8 firstBtn
1 b nBtns
2 SETofKB_DEVFEATURE change
2 l nDeviceLedFBs
8b LISTofKB_ACTION btnActions
L0+..Ll LISTofKB_DEVICELEDINFO leds

Encoding of KB_DEVICELEDINFO is as for XkbGetDeviceInfo

1 ?? opcode
1 101 xkb-opcode
2 6+(n+p)/4 request-length
2 n msgLength
2 unused
4 CARD32 affectFlags
4 CARD32 flags
Protocol Encoding

4     CARD32     affectCtrls
4     CARD32     ctrls
n     STRING8    message
p     unused, p=pad(n)

1     1     Reply
1     unused
2     CARD16   sequence number
4     0     length
4     CARD32   currentFlags
4     CARD32   currentCtrls
4     CARD32   supportedFlags
4     CARD32   supportedCtrls
8     unused

Events

1     ??    code
1     0     xkb code
2     CARD16  sequence number
4     TIMESTAMP  time
1     CARD8    deviceID
1     CARD8    oldDeviceID
1     KEYCODE  minKeyCode
1     KEYCODE  maxKeyCode
1     KEYCODE  oldMinKeyCode
1     KEYCODE  oldMaxKeyCode
1     CARD8    requestMajor
1     CARD8    requestMinor
2     SETofKB_MAPPART  ptrBtnActions
14    unused

1     ??    code
1     1     xkb code
2     CARD16  sequence number
4     TIMESTAMP  time
1     CARD8    deviceID
1     SETofBUTMASK ptrBtnActions
1     SETofKB_MAPPART  changed
1     KEYCODE  minKeyCode
1     KEYCODE  maxKeyCode
1     CARD8    firstType
1     CARD8    nTypes
1     KEYCODE  firstKeySym
1     CARD8    nKeySyms
1     KEYCODE  firstKeyAct
1     CARD8    nKeyActs
1     KEYCODE  firstKeyBehavior
1     CARD8    nKeyBehaviors
1     KEYCODE  firstKeyExplicit
1     CARD8    nKeyExplicit
1     KEYCODE  firstModMapKey
1     CARD8    nModMapKeys
 Protocol Encoding

1  KEYCODE         firstVModMapKey
1  CARD8           nVModMapKeys
2  SETofKB_VMOD    virtualMods
   unused

1  ??              code
1  2               xkb code
2  CARD16          sequence number
4  TIMESTAMP       time
1  CARD8           deviceID
1  SETofKEYMASK    mods
1  SETofKEYMASK    baseMods
1  SETofKEYMASK    latchedMods
1  SETofKEYMASK    lockedMods
1  KB_GROUP        group
2  INT16           baseGroup
2  INT16           latchedGroup
1  KB_GROUP        lockedGroup
1  SETofKEYMASK    compatState
1  SETofKEYMASK    grabMods
1  SETofKEYMASK    compatGrabMods
1  SETofKEYMASK    lookupMods
1  SETofKEYMASK    compatLookupMods
2  SETofBUTMASK    ptrBtnState
2  SETofKB_STATEPART changed
1  KEYCODE         keycode
1  CARD8           eventType
1  CARD8           requestMajor
1  CARD8           requestMinor

1  ??              code
1  3               xkb code
2  CARD16          sequence number
4  TIMESTAMP       time
1  CARD8           deviceID
1  CARD8           numGroups
2   unused
4  SETofKB_CONTROL changedControls
4  SETofKB_BOOLCTRL enabledControls
4  SETofKB_BOOLCTRL enabledControlChanges
1  KEYCODE         keycode
1  CARD8           eventType
1  CARD8           requestMajor
1  CARD8           requestMinor
4   unused

1  ??              code
1  4               xkb code
2  CARD16          sequence number
4  TIMESTAMP       time
1  CARD8           deviceID
3   unused
4  SETofKB_INDICATOR state
4  SETofKB_INDICATOR stateChanged
Protocol Encoding

12               unused
1       ??       code
1       5       xkb code
2       CARD16   sequence number
4       TIMESTAMP  time
1       CARD8    deviceID
3               unused
4       SETofKB_INDICATOR  state
4       SETofKB_INDICATOR  mapChanged
12               unused
1       ??       code
1       6       xkb code
2       CARD16   sequence number
4       TIMESTAMP  time
1       CARD8    deviceID
1               unused
2       SETofKB_NAMEDETAIL  changed
1       CARD8    firstType
1       CARD8    nTypes
1       CARD8    firstLevelName
1       CARD8    nLevelNames
1               unused
1       CARD8    nRadioGroups
1       CARD8    nKeyAliases
1       SETofKB_GROUP  changedGroupNames
2       SETofKB_VMOD   changedVirtualMods
1       KEYCODE   firstKey
1       CARD8    nKeys
4       SETofKB_INDICATOR  changedIndicators
4               unused
1       ??       code
1       7       xkb code
2       CARD16   sequence number
4       TIMESTAMP  time
1       CARD8    deviceID
1       SETofKB_GROUP  changedGroups
2       CARD16   firstSI
2       CARD16   nSI
2       CARD16   nTotalSI
16               unused
1       ??       code
1       8       xkb code
2       CARD16   sequence number
4       TIMESTAMP  time
1       CARD8    deviceID
1       KB_BELLCLASSRESULT   bellClass
1       CARD8    bellClass
1       CARD8    percent
2       CARD16   pitch
2       CARD16   duration
4       ATOM     name
<table>
<thead>
<tr>
<th>Protocol Encoding</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 WINDOW window</td>
</tr>
<tr>
<td>1 BOOL eventOnly</td>
</tr>
<tr>
<td>7 unused</td>
</tr>
<tr>
<td>1 ?? code</td>
</tr>
<tr>
<td>9 xkb code</td>
</tr>
<tr>
<td>2 CARD16 sequence number</td>
</tr>
<tr>
<td>4 TIMESTAMP time</td>
</tr>
<tr>
<td>1 CARD8 deviceID</td>
</tr>
<tr>
<td>1 KEYCODE keycode</td>
</tr>
<tr>
<td>1 BOOL press</td>
</tr>
<tr>
<td>1 BOOL keyEventFollows</td>
</tr>
<tr>
<td>1 SETofKEYMASK mods</td>
</tr>
<tr>
<td>1 KB_GROUP group</td>
</tr>
<tr>
<td>8 STRING8 message</td>
</tr>
<tr>
<td>10 unused</td>
</tr>
<tr>
<td>1 ?? code</td>
</tr>
<tr>
<td>10 xkb code</td>
</tr>
<tr>
<td>2 CARD16 sequence number</td>
</tr>
<tr>
<td>4 TIMESTAMP time</td>
</tr>
<tr>
<td>1 CARD8 deviceID</td>
</tr>
<tr>
<td>1 KEYCODE keycode</td>
</tr>
<tr>
<td>2 SETofKB_AXNDETAIL detail</td>
</tr>
<tr>
<td>2 CARD16 slowKeysDelay</td>
</tr>
<tr>
<td>2 CARD16 debounceDelay</td>
</tr>
<tr>
<td>1 ?? code</td>
</tr>
<tr>
<td>16 unused</td>
</tr>
<tr>
<td>1 ?? code</td>
</tr>
<tr>
<td>11 xkb code</td>
</tr>
<tr>
<td>2 CARD16 sequence number</td>
</tr>
<tr>
<td>4 TIMESTAMP time</td>
</tr>
<tr>
<td>1 CARD8 deviceID</td>
</tr>
<tr>
<td>1 unused</td>
</tr>
<tr>
<td>2 SETofKB_XIDETAIL reason</td>
</tr>
<tr>
<td>2 KB_LEDCLASSRESULT ledClass</td>
</tr>
<tr>
<td>2 CARD8 ledID</td>
</tr>
<tr>
<td>4 SETofKB_INDICATOR ledsDefined</td>
</tr>
<tr>
<td>4 SETofKB_INDICATOR ledState</td>
</tr>
<tr>
<td>1 CARD8 firstButton</td>
</tr>
<tr>
<td>1 CARD8 nButtons</td>
</tr>
<tr>
<td>2 SETofKB_XIFEATURE supported</td>
</tr>
<tr>
<td>2 SETofKB_XIFEATURE unsupported</td>
</tr>
<tr>
<td>2 unused</td>
</tr>
</tbody>
</table>