
Xserver Provider for DTrace

Alan Coopersmith, Oracle Corporation

X Server Version 21.1.99.1

Copyright © 2005, 2006, 2007, 2010, 2020 Oracle and/or its affiliates.

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice (including the next paragraph) shall be included in all copies or substantial portions of the Software.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

Table of Contents

Introduction	3
Available probes	3
Data Available in Probe Arguments	4
Examples	5

Introduction

This page provides details on a [statically defined user application tracing provider](http://dtrace.org/guide/chp-usdt.html) [http://dtrace.org/guide/chp-usdt.html] for the [DTrace](http://dtrace.org/blogs/about/) [http://dtrace.org/blogs/about/] facility in Solaris™ 10, MacOS X™ 10.5, and later releases. This provider instruments various points in the X server, to allow tracing what client applications are up to. DTrace probes may be used with [SystemTap](http://sourceware.org/systemtap/) [http://sourceware.org/systemtap/] on GNU/Linux systems.

The provider was integrated into the X.Org code base with Solaris 10 & OpenSolaris support for the Xserver 1.4 release, released in 2007 with X11R7.3. Support for DTrace on MacOS X was added in Xserver 1.7.

These probes expose the request and reply structure of the X protocol between clients and the X server, so an understanding of that basic nature will aid in learning how to use these probes.

Available probes

Due to the way User-Defined DTrace probes work, arguments to these probes all bear undistinguished names of *arg0*, *arg1*, *arg2*, etc. These tables should help you determine what the real data is for each of the probe arguments.

Table 1. Probes and their arguments

Probe name	Description	arg0	arg1	arg2	arg3	arg4	arg5	arg6
Request Probes								
request-start	Called just before processing each client request.	request	requestName	requestCode	requestLength	requestBuffer		
request-done	Called just after processing each client request.	request	requestName	requestCode	clientName	resultCode		
Event Probes								
send-event	Called just before send each event to a client.	clientId	eventId	eventCode	eventBuffer			
Client Connection Probes								
client-connect	Called when a new connection is opened from a client	clientId	clientFD					
client-auth	Called when client authenticates (normally just after connection opened)	clientId	clientAuthData	clientZoneId				
client-disconnect	Called when a client connection is closed	clientId						
Resource Allocation Probes								
resource-alloc	Called when a new resource (pixmap, gc, colormap, etc.) is allocated	resource	resourceType	resourceValue	resourceTypeName			
resource-free	Called when a resource is freed	resource	resourceType	resourceValue	resourceTypeName			
Input API probes								

Probe name	Description	arg0	arg1	arg2	arg3	arg4	arg5	arg6
input-event	Called when an input event was submitted for processing	deviceid	eventtype	button or keycode or touchid	flags	nvalues	mask	values

Data Available in Probe Arguments

To access data in arguments of type string, you will need to use `copyinstr()` [<http://dtrace.org/guide/chp-actsub.html#chp-actsub-copyinstr>]. To access data buffers referenced via `uintptr_t`'s, you will need to use `copyin()` [<http://dtrace.org/guide/chp-actsub.html#chp-actsub-copyin>].

Table 2. Probe Arguments

Argument name	Type	Description
<i>clientAddr</i>	string	String representing address client connected from
<i>clientFD</i>	int	X server's file descriptor for server side of each connection
<i>clientId</i>	int	Unique integer identifier for each connection to the X server
<i>clientPid</i>	pid_t	Process id of client, if connection is local (from <code>getpeerucred()</code>)
<i>clientZoneId</i>	zoneid_t	Solaris: Zone id of client, if connection is local (from <code>getpeerucred()</code>)
<i>eventBuffer</i>	uintptr_t	Pointer to buffer containing X event - decode using structures in < X11/Xproto.h > and similar headers for each extension
<i>eventCode</i>	uint8_t	Event number of X event
<i>resourceId</i>	uint32_t	X resource id (XID)
<i>resourceTypeId</i>	uint32_t	Resource type id
<i>resourceTypeName</i>	string	String representing X resource type ("PIXMAP", etc.)
<i>resourceValue</i>	uintptr_t	Pointer to data for X resource
<i>resultCode</i>	int	Integer code representing result status of request
<i>requestBuffer</i>	uintptr_t	Pointer to buffer containing X request - decode using structures in < X11/Xproto.h > and similar headers for each extension
<i>requestCode</i>	uint8_t	Request number of X request or Extension
<i>requestName</i>	string	Name of X request or Extension
<i>requestLength</i>	uint16_t	Length of X request
<i>sequenceNumber</i>	uint32_t	Number of X request in in this connection
<i>deviceid</i>	int	The device's numerical ID
<i>eventtype</i>	int	Protocol event type
<i>button, keycode, touchid</i>	uint32_t	The button number, keycode or touch ID
<i>flags</i>	uint32_t	Miscellaneous event-specific server flags
<i>nvalues</i>	int8_t	Number of bits in <i>mask</i> and number of elements in <i>values</i>
<i>mask</i>	uint8_t*	Binary mask indicating which indices in <i>values</i> contain valid data

Argument name	Type	Description
<i>values</i>	double*	Valuator values. Values for indices for which the <i>mask</i> is not set are undefined

Examples

Example 1. Counting requests by request name

This script simply increments a counter for each different request made, and when you exit the script (such as by hitting **Control+C**) prints the counts.

```
#!/usr/sbin/dtrace -s

Xserver*:::request-start
{
    @counts[copyinstr(arg0)] = count();
}
```

The output from a short run may appear as:

QueryPointer	1
CreatePixmap	2
FreePixmap	2
PutImage	2
ChangeGC	10
CopyArea	10
CreateGC	14
FreeGC	14
RENDER	28
SetClipRectangles	40

This can be rewritten slightly to cache the string containing the name of the request since it will be reused many times, instead of copying it over and over from the kernel:

```
#!/usr/sbin/dtrace -s

string Xrequest[uintptr_t];

Xserver*:::request-start
/Xrequest[arg0] == ""/
{
    Xrequest[arg0] = copyinstr(arg0);
}

Xserver*:::request-start
{
    @counts[Xrequest[arg0]] = count();
}
```

Example 2. Get average CPU time per request

This script records the CPU time used between the probes at the start and end of each request and aggregates it per request type.

```
#!/usr/sbin/dtrace -s

Xserver*:::request-start
{
    reqstart = vtimestamp;
}

Xserver*:::request-done
{
    @times[copyinstr(arg0)] = avg(vtimestamp - reqstart);
}
```

The output from a sample run might look like:

ChangeGC	889
MapWindow	907
SetClipRectangles	1319
PolyPoint	1413
PolySegment	1434
PolyRectangle	1828
FreeCursor	1895
FreeGC	1950
CreateGC	2244
FreePixmap	2246
GetInputFocus	2249
TranslateCoords	8508
QueryTree	8846
GetGeometry	9948
CreatePixmap	12111
AllowEvents	14090
GrabServer	14791
MIT-SCREEN-SAVER	16747
ConfigureWindow	22917
SetInputFocus	28521
PutImage	240841

Example 3. Monitoring clients that connect and disconnect

This script simply prints information about each client that connects or disconnects from the server while it is running. Since the provider is specified as `Xserver$1` instead of `Xserver*` like previous examples, it won't monitor all Xserver processes running on the machine, but instead expects the process id of the X server to monitor to be specified as the argument to the script.

```
#!/usr/sbin/dtrace -s

Xserver$1:::client-connect
{
    printf("*** Client Connect: id %d\n", arg0);
}

Xserver$1:::client-auth
{
    printf("*** Client auth'ed: id %d => %s pid %d\n",
```

```
    arg0, copyinstr(arg1), arg2);
}

Xserver$1::client-disconnect
{
    printf("*** Client Disconnect: id %d\n", arg0);
}
```

A sample run:

```
# ./foo.d 5790
dtrace: script './foo.d' matched 4 probes
CPU      ID      FUNCTION:NAME
  0   15774 CloseDownClient:client-disconnect ** Client Disconnect: id 65

  2   15774 CloseDownClient:client-disconnect ** Client Disconnect: id 64

  0   15773 EstablishNewConnections:client-connect ** Client Connect: id 64

  0   15772              AuthAudit:client-auth ** Client auth'ed: id 64 => local h

  0   15773 EstablishNewConnections:client-connect ** Client Connect: id 65

  0   15772              AuthAudit:client-auth ** Client auth'ed: id 65 => local h

  0   15774 CloseDownClient:client-disconnect ** Client Disconnect: id 64
```

Example 4. Monitoring clients creating Pixmaps

This script can be used to determine which clients are creating pixmaps in the X server, printing information about each client as it connects to help trace it back to the program on the other end of the X connection.

```
#!/usr/sbin/dtrace -qs

string Xrequest[uintptr_t];
string Xrestype[uintptr_t];

Xserver$1::request-start
/Xrequest[arg0] == ""/
{
    Xrequest[arg0] = copyinstr(arg0);
}

Xserver$1::resource-alloc
/arg3 != 0 && Xrestype[arg3] == ""/
{
    Xrestype[arg3] = copyinstr(arg3);
}

Xserver$1::request-start
/Xrequest[arg0] == "X_CreatePixmap"/
{
```

```
    printf("-> %s: client %d\n", Xrequest[arg0], arg3);
}

Xserver$1::request-done
/Xrequest[arg0] == "X_CreatePixmap"/
{
    printf("<- %s: client %d\n", Xrequest[arg0], arg3);
}

Xserver$1::resource-alloc
/Xrestype[arg3] == "PIXMAP"/
{
    printf("*** Pixmap alloc: %08x\n", arg0);
}

Xserver$1::resource-free
/Xrestype[arg3] == "PIXMAP"/
{
    printf("*** Pixmap free:  %08x\n", arg0);
}

Xserver$1::client-connect
{
    printf("*** Client Connect: id %d\n", arg0);
}

Xserver$1::client-auth
{
    printf("*** Client auth'ed: id %d => %s pid %d\n",
        arg0, copyinstr(arg1), arg2);
}

Xserver$1::client-disconnect
{
    printf("*** Client Disconnect: id %d\n", arg0);
}
```

Sample output from a run of this script:

```
** Client Connect: id 17
** Client auth'ed: id 17 => local host pid 20273
-> X_CreatePixmap: client 17
** Pixmap alloc: 02200009
<- X_CreatePixmap: client 17
-> X_CreatePixmap: client 15
** Pixmap alloc: 01e00180
<- X_CreatePixmap: client 15
-> X_CreatePixmap: client 15
** Pixmap alloc: 01e00181
<- X_CreatePixmap: client 15
-> X_CreatePixmap: client 14
** Pixmap alloc: 01c004c8
<- X_CreatePixmap: client 14
** Pixmap free: 02200009
** Client Disconnect: id 17
```



```
** Pixmap free: 01e00180
** Pixmap free: 01e00181
```

Example 5. Input API monitoring with SystemTap

This script can be used to monitor events submitted by drivers to the server for enqueueing. Due to the integration of the input API probes, some server-enqueued events will show up too.

```
# Compile+run with
#     stap -g xorg.stp /usr/bin/Xorg
#

function print_valuators:string(nvaluators:long, mask_in:long, valuators_in:long)
{
    int i;
    unsigned char *mask = (unsigned char*)THIS->mask_in;
    double *valuators = (double*)THIS->valuators_in;
    char str[128] = {0};
    char *s = str;

#define BitIsSet(ptr, bit) (((unsigned char*)(ptr))[(bit)>>3] & (1 << ((bit) >> 3)))

    s += sprintf(s, "nval: %d ::", (int)THIS->nvaluators);
    for (i = 0; i < THIS->nvaluators; i++)
    {
        s += sprintf(s, " %d: ", i);
        if (BitIsSet(mask, i))
            s += sprintf(s, "%d", (int)valuators[i]);
    }

    sprintf(THIS->__retvalue, "%s", str);
}%

probe process(@1).mark("input__event")
{
    deviceid = $arg1
    type = $arg2
    detail = $arg3
    flags = $arg4
    nvaluators = $arg5

    str = print_valuators(nvaluators, $arg6, $arg7)
    printf("Event: device %d type %d detail %d flags %#x %s\n",
        deviceid, type, detail, flags, str);
}
```

Sample output from a run of this script:

```
Event: device 13 type 4 detail 1 flags 0x0 nval: 0 ::
Event: device 13 type 6 detail 0 flags 0xa nval: 1 :: 0: 1
Event: device 13 type 6 detail 0 flags 0xa nval: 2 :: 0: 2 1: -1
Event: device 13 type 6 detail 0 flags 0xa nval: 2 :: 0: 2 1: -1
Event: device 13 type 6 detail 0 flags 0xa nval: 2 :: 0: 4 1: -3
Event: device 13 type 6 detail 0 flags 0xa nval: 2 :: 0: 3 1: -3
Event: device 13 type 6 detail 0 flags 0xa nval: 2 :: 0: 3 1: -2
```

```
Event: device 13 type 6 detail 0 flags 0xa nval: 2 :: 0: 2 1: -2
Event: device 13 type 6 detail 0 flags 0xa nval: 2 :: 0: 2 1: -2
Event: device 13 type 6 detail 0 flags 0xa nval: 2 :: 0: 2 1: -2
Event: device 13 type 6 detail 0 flags 0xa nval: 2 :: 0: 1: -1
Event: device 13 type 6 detail 0 flags 0xa nval: 2 :: 0: 1: -1
Event: device 13 type 5 detail 1 flags 0x0 nval: 0 ::
```