Using ezcalDL to connect to EPICS Channel Access from SHADOWVUI for Dynamic X-ray Tracing

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Outline

- Software requirements (what you need)
- Software overview (what it does)
- Simulation model of real-life beamline
  - (caveat *emptor* simulator)
- EPICS and ezcaIDL (connections)
- ezcaSHADOWVUI (dynamic ray tracing)
Software Requirements

- SHADOW (Fortran and C library of subroutines)
  - Ray tracing engine developed at Nanotech Wisconsin (University of Wisconsin)
  - Used to study flashlights to x-ray telescopes and microscopes
- XOP + SHADOWVUI (written in IDL)
  - Visual User Interface for SHADOW
- EPICS with extensions: ezca, ezcaIDL
  - Provides Channel Access (CA) to process variables
- Main program and utilities
- I/O session driven to define system
- SHADOW Structure
  - Data files (usually binary)
  - Parameter files (e.g. START.XX in NAMELIST format)
    
    \[
    \begin{align*}
    &X_{\text{ROT}} = -0.500000000 \\
    &\quad \vdots \\
    &T_{\text{INCIDENCE}} = 75.0000000 \\
    &T_{\text{SOURCE}} = 10.0000000 \\
    &T_{\text{IMAGE}} = 0.000000000 \\
    \end{align*}
    \] 
  - Analysis files (varied)
XOP + SHADOWVUI

Run SHADOW/source

Run SHADOW/trace

command: cmd.exe /c shadowvui.bat
Calculation completed.
- Interfaces with the SHADOW kernel
- Three main steps:
  - Define source and Run SHADOW/source
  - Define optical system and Run SHADOW/trace
  - Visualize results
- Macros (written in IDL) may be used to automate some tasks (i.e. changing energy, moving mirrors, loops, etc.)
The orientation of each element is relative to the previous element, but mirror displacements do not move subsequent components.
In this model
- OFFY corresponds to T2
- OFFZ corresponds to T1

Time to plug and play with EPICS

This is hard to read
EPICS
- real-time control system for beamlines etc.
- process variables indicate positions of optics

ezcaIDL
- allows access to a set of simplified IDL interface commands to connect to Channel Access

Status = caGet(pvname, value, /string, max=max)
Status = caSetMonitor(pvname)
Status = caWidgetSetMonitor(name, widget_id, time=time)
- Initializes ezcaIDL
  
  ```idl```
  caInit
  caSetTimeout, 0.001
  caPendIO, time=0.01, list_time=3.
  caPendEvent, time=0.000001
  add_caPendEvent, timer=5.0
  ```

- Accesses SHADOW variables via SHADOWVUI

- Requires user input that defines relationship between model variables and beamline PVs in an IDL structure
### PV_INFO Structure

<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pv</td>
<td>string</td>
<td>EPICS process variable string</td>
</tr>
<tr>
<td>desc</td>
<td>string</td>
<td>Text to describe process variable</td>
</tr>
<tr>
<td>pv_min</td>
<td>float</td>
<td>Lower limit</td>
</tr>
<tr>
<td>pv_max</td>
<td>float</td>
<td>Upper limit</td>
</tr>
<tr>
<td>oe_num</td>
<td>int</td>
<td>Optical element number (zero otherwise)</td>
</tr>
<tr>
<td>src_num</td>
<td>int</td>
<td>Screen number (zero otherwise)</td>
</tr>
<tr>
<td>pv_2vui</td>
<td>string</td>
<td>Equation(s) to convert value of PV(s) to SHADOWVUI variable</td>
</tr>
<tr>
<td>vui_2pv</td>
<td>string</td>
<td>To convert value of SHADOWVUI variables(s) to PV value</td>
</tr>
<tr>
<td>vui_val</td>
<td>float</td>
<td>Stores SHADOWVUI variable value</td>
</tr>
</tbody>
</table>

- vui_2pv string is executed on widget start-up
- pv_2vui string is executed on PV events
SHADOWVUI variables and PVs

\[
\begin{align*}
\text{OFFY} &= h \sin(\theta) \\
\text{OFFZ} &= h \cos(\theta)
\end{align*}
\]

\[
\begin{align*}
pv\_2vui &= \left(\text{(*ptrOE1).OFFY} = \text{beamline.h.val} \times \sin(\text{beamline.theta.val})\right) \\
&\quad \& \left(\text{(*ptrOE1).OFFZ} = \text{beamline.h.val} \times \cos(\text{beamline.theta.val})\right) \\
vui\_2pv &= \sqrt{\left(\text{(*ptrOE1).OFFY}\right)^2 + \left(\text{(*ptrOE1).OFFZ}\right)^2}
\end{align*}
\]
IDL> reshadowvui, beamline
A problem has been detected and Windows has been shut down to prevent damage to your computer.

DRIVER_IRQL_NOT_LESS_OR_EQUAL

If this is the first time you've seen this stop error screen, restart your computer. If this screen appears again, follow these steps:

Check to make sure any new hardware or software is properly installed. If this is a new installation, ask your hardware or software manufacturer for any Windows updates you might need.

If problems continue, disable BIOS caching or shadowing. If you need to use Safe Mode, press F8 to select Safe Mode.

Technical information:

*** STOP: 0x000000D1 (0x0000000C, 0x00000002, 0x00000000, 0xF86B5A89)

*** gv3.sys - Address F86B5A89 base at F86B5000, DateStamp 3dd991eb

Beginning dump of physical memory
Physical memory dump complete.
Contact your system administrator or technical support group for further assistance.
Dynamic Ray-Tracing
Summary

- SHADOW and XOP + SHADOWVUI
  - Provide ray-tracing engine and user interface
- EPICS extensions ezcaIDL/EZCA
  - allow IDL programs to access PVs
- ezcaSHADOWVUI
  - takes SHADOWVUI model and user defined relationships between PVs and model parameters
  - live positions may be used for dynamic ray tracing
Research described in this paper was performed at the **Canadian Light Source**, which is supported by:

- Natural Sciences and Engineering Research Council of Canada
- National Research Council Canada
- Canadian Institutes of Health Research
- Province of Saskatchewan
- Western Economic Diversification Canada, and
- University of Saskatchewan.
38 supporting University Partners and growing...
Appendix - Prerequisites

- EPICS installed with extensions directory setup
  - /opt/epics/base
    - baseR3.14.9.tar.gz
  - /opt/epics/extensions
    - extensionsTop_20070703.tar.gz
    - extensionsConfigure_20070703.tar.gz
  - /opt/epics/extensions/src/ (ezca,ezcaIDL,EzcaScan)
    - ezca_20070625.tar.gz
    - ezcaIDL_20070625.tar.gz
    - EzcaScan_20090319.tar.gz
Install procedure (libezcaIDL.so)

- cd /opt/epics/extensions && make
  - ln -s /usr/local/bin/g++ /usr/bin
  - ln -s libncurses.so libcurses.so
  - yum install mingw32-readline
  - ln -s /usr/i686-pc-mingw32/sys-root/mingw/include/readline /opt/epics/base/readline

- Set environment variable EZCA_IDL_SHAR
  - /opt/epics/extensions/lib/linux-x86_64/libezcaIDL.so

- /etc/ld.so.conf.d/
  - create ezcaIDL.conf with path to libezcaIDL.so