
# OpenCPI - Open Component Portability Infrastructure

## An Open Source Infrastructure for Heterogeneous/Embedded Component-Based Systems and Applications

## OpenCPI Debugging Tools

# Debugging Techniques

- Use **`ocpihdl`** and **`ocpixml`** to collect HDL application worker and HDL device worker information
- Review the worker lifecycle
- Use **`ocpihdl`** to control the worker state
- Change and view worker properties
- Use the **`ocpi_debug`** built-in worker build configuration property

# Using `ocpihdl`

- You can use **`ocpihdl`** to:
  - Probe the XML of the currently loaded bitstream
  - Display currently loaded workers
  - View/change worker status
  - Set/change worker properties
  - Reset workers
  - Step through an application

- When invoked without options, **`ocpihdl`** lists all of its uses
- See the **`ocpihdl(1)`** man page for command usage details
- You cannot currently use **`ocpihdl`** on simulators (this function may be enabled in a future release)

# Finding Available HDL Devices on an FPGA Platform

- **`ocpihdl search`** – provides information on available HDL devices, such as:
  - Device name
  - Date of bitstream creation
  - HDL platform
  - Part identifier
  - Unique identifier (UUID) of the bitstream

```
ocpihdl search
OpenCPI HDL device found: 'PL:0': bitstream date Fri Jan  7 09:35:37
2022, platform "matchstiq_z1", part "xc7z020", UUID 10226754-2e6e-
11e7-88f7-573bc8e8124c
```

- **`ocpihdl probe`** – similar to search, but you can specify an HDL device

# Loading/Probing the Bitstream

- Examine the XML packaged into *any* artifact (including bitstreams) with **`ocpixml get`**:

  **`ocpixml get <artifact-file>.bitz | <artifact-file>.so`**

  (See the **`ocpixml(1)`** man page for tool usage details)

- Load a bitstream with **`ocpihdl load`**:

  **`ocpihdl load <path-to-bitstream>`**

- Examine the XML packaged into a *currently loaded* bitstream with **`ocpihdl getxml`**:

  **`ocpihdl getxml <output-file>`**

# Loading/Probing the Bitstream (cont.)

**`ocpihdl getxml <output-file>`**

**`grep controlOperation <output-file>`**

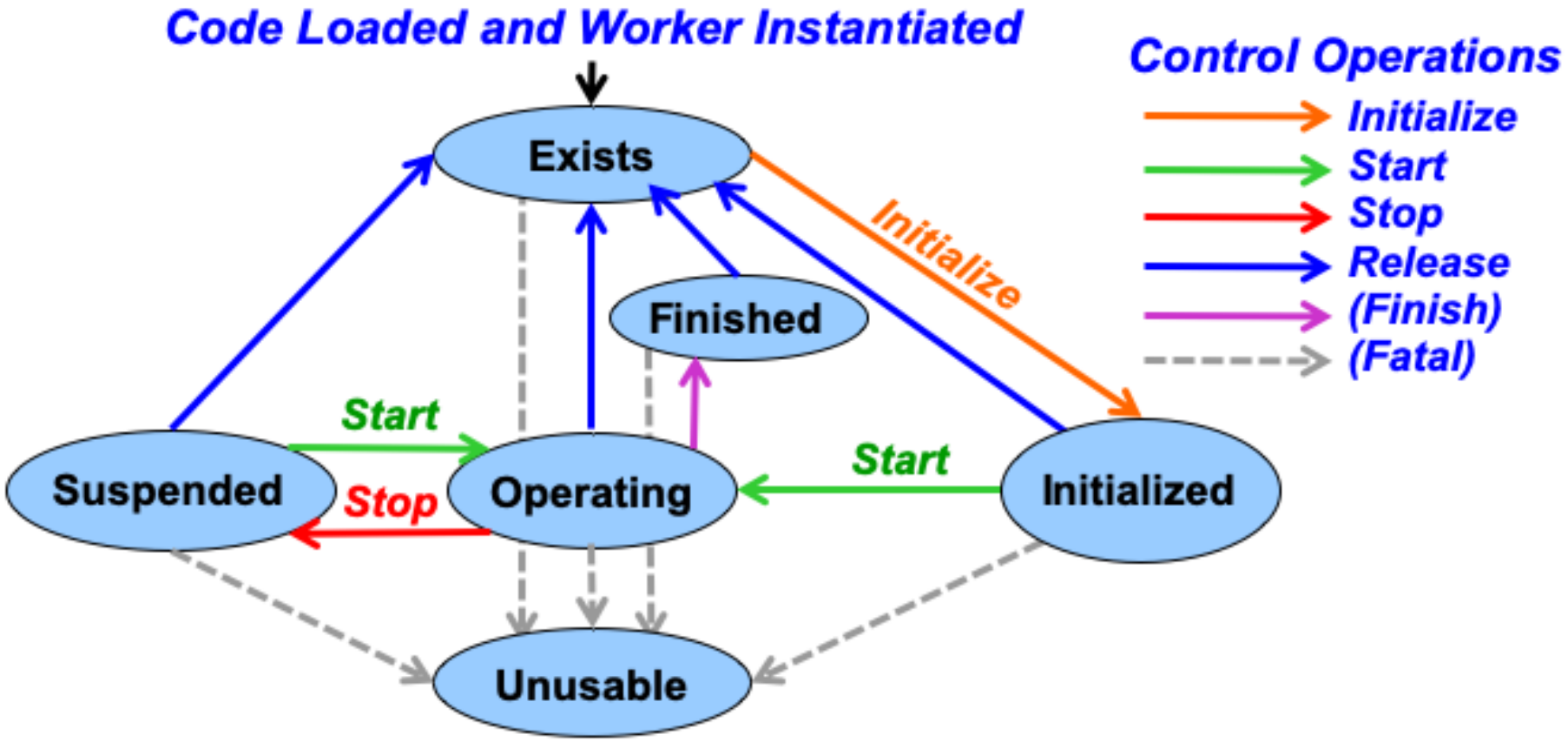
- What controlOperations are implemented by each worker?

```
% grep controlOperation output.xml | tail -4
<worker name="pattern" model="hdl" package="ocpi" specname="ocpi.pattern" sizeOfConfigSpace="21
47483712" controlOperations="initialize">
<worker name="bias" model="hdl" package="ocpi" specname="ocpi.bias" sizeOfConfigSpace="42949672
96" controlOperations="initialize" Timeout="444">
<worker name="capture" model="hdl" package="ocpi" specname="ocpi.capture" sizeOfConfigSpace="21
47487744" controlOperations="initialize">
<worker name="ocscp" model="hdl" package="ocpi" specname="ocpi.ocscp" controlOperations="stop">
```

# Loading/Probing the Bitstream (cont.)

- If you want to remove the bitstream from the FPGA, use **`ocpihdl unload`**
- Most commonly used when the system's processor functions independently from the programmable logic
- **CAUTION**: Unloading an FPGA that implements a PCIe interface may result in the card becoming unusable and may require a system reboot

# Worker Lifecycle




*(Fatal): fatal error from control operation, other transitions based on success: non-fatal errors do not change states.*
*(Finish): is self initiated, not controlled from outside*

# Controlling HDL Workers with `ocpihdl`

- Find the worker index and other information:

  **`ocpihdl get`**

  You can also specify ***`<worker-instance-index>`***, ***`<worker-instance-name>`***, and even **`<worker-property>`** as arguments
- Reset or unreset the control reset signal into workers:

  **`ocpihdl`** [**`wreset`**|**`wunreset`**] ***`<worker-instance-index>`***
- Perform other control operations on workers:

  **`ocpihdl wop`** ***`<worker-instance-index>`*** **`[start|initialize|stop]`**
- Set worker properties:

  **`ocpihdl set [`**<***`worker-instance-index`***>**`|`**<***`worker-instance-name`***>**`] \`**
  **`<property> <value>`**
- Observe worker state:

  **`ocpihdl status [<worker-instance-index>|<worker-instance-name>]`**

  Add the **`-v`** option to see worker properties

# View Worker Information from Bitstream

## ocpihdl get

```
% ocpihdl get
HDL Device: 'PL:0' is platform 'matchstiq_z1' part 'xc7z020' and UUID '10226754-2e6e-1
1e7-88f7-573bc8e8124c'
Platform configuration workers are:
  Instance p/matchstiq_z1 of io worker matchstiq_z1 (spec ocpi.platform) with index 0
  Instance p/time_server of io worker time_server (spec ocpi.devices.time_server) with
 index 1
Container workers are:
  Instance c/ocscp of normal worker ocscp (spec ocpi.ocscp)
  Instance c/unoc_term0_0 of io worker sdp_term (spec ocpi.devices.sdp_term)
  Instance c/unoc_term1_0 of io worker sdp_term (spec ocpi.devices.sdp_term)
  Instance c/unoc_term2_0 of io worker sdp_term (spec ocpi.devices.sdp_term)
  Instance c/unoc_term3_0 of io worker sdp_term (spec ocpi.devices.sdp_term)
  Instance c/tb_bias_wti0_time_client of normal worker time_client (spec ocpi.time_cli
ent)
  Instance c/metadata of normal worker metadata (spec ocpi.metadata)
Application workers are:
  Instance a/pattern of normal worker pattern (spec ocpi.pattern) with index 2
  Instance a/bias of normal worker bias (spec ocpi.bias) with index 3
  Instance a/capture of normal worker capture (spec ocpi.capture) with index 4
```

We can identify the worker instances by their indices

# Controlling HDL Workers

If the worker instance status is “RESET”:

**`ocpihdl unreset <worker-instance-index>`**

```
% ocpihdl status 2
Status of instance 'a/pattern' of worker 'pattern' is 'RESET'
Worker 2 on device pl:0
 Status:     0x00008000
 Control:    0x00000000 not enabled (reset asserted);  timeout value is 1
 ConfigAddr: 0x00000000
 PageWindow: 0x00000000
  Instance a/pattern of normal worker pattern (spec ocpi.pattern) with index 2
% ocpihdl wunreset 2
Worker 2 on device pl:0: reset deasserted, was asserted
% ocpihdl status 2
Status of instance 'a/pattern' of worker 'pattern' is 'EXISTS'
Worker 2 on device pl:0
 Status:     0x00008000
 Control:    0x80000000 enabled (reset not asserted);  timeout value is 1
 ConfigAddr: 0x00000000
 PageWindow: 0x00000000
  Instance a/pattern of normal worker pattern (spec ocpi.pattern) with index 2
```

# Controlling HDL Workers (cont.)

If the worker instance implements the **`initialize`** control option:

**`ocpihdl wop <worker-instance-index> initialize`**

```
% ocpihdl wop 2 initialize
Worker 2 on device pl:0: the 'initialize' control operation was performed with result 'success'
01)
% ocpihdl status 2
Status of instance 'a/pattern' of worker 'pattern' is 'INITIALIZED'
Worker 2 on device pl:0
 Status:     0x00048000 opValid:0x0:init
 Control:    0x80000000 enabled (reset not asserted);  timeout value is 1
 ConfigAddr: 0x00000000
 PageWindow: 0x00000000
  Instance a/pattern of normal worker pattern (spec ocpi.pattern) with index 2
```

Ultimately, to bring the worker instance status to "OPERATING" :

**`ocpihdl wop <worker-instance-index> start`**

# Controlling HDL Workers (cont.)

- Writeable worker properties can be changed:

  **ocpihdl set [<*worker-instance-index*>|<*worker-instance-name*>] **
  **<*property*> <*value*>**

- Volatile properties can be read:

  **ocpihdl status -v [<*worker-instance-index*>|<*worker-instance-name*>]**

```
% ocpihdl set 2 step true
Setting the step property to 'true' on instance 'a/counter'
% ocpihdl status 2 ; ocpihdl get -v 2
Status of instance 'a/counter' of worker 'counter-1' is 'OPERATING'
Worker 2 on device pl:0
 Status:     0x091f0000 addrValid beValid:0x1 opValid:0x1:start wrtValid:1
 Control:    0x80000004 enabled (reset not asserted);  timeout value is 16
 ConfigAddr: 0x00000008
 PageWindow: 0x00000000
  Instance a/counter of normal worker counter-1 (spec local.counter) with index 2
  0              counter: 2
  1                  max: 9
  2           ocpi_debug: true
  3          ocpi_endian: little
  4                 step: true
```

# Using the ocpi_debug "Parameter" Property

- **ocpi_debug** is a framework-generated (built-in) worker build configuration "parameter" property for specifying a "debug" build vs. a "production" build
- **ocpi_debug** is set to **true** in the OpenCPI Worker Description (OWD) before building a worker for debugging
- You add the debugging functionality that depends on **ocpi_debug** to the worker
- In VHDL: **ocpi_debug**

```
debug_gen : if its(ocpi_debug) generate
```

- In C++: **<*WORKER-NAME*>_OCPI_DEBUG**

```
if (COUNTER_OCPI_DEBUG) {
```

# Execution and Debug Utilities

- Log level:

  **`export OCPI_LOG_LEVEL=8`**

  **`ocpirun [-loglevel=8|-l 8]`** (`l` is a lowercase "L")

- **`ocpirun [--list|-C]`** - to find containers, including simulators
- **`ocpiview`** - to view simulation waveform results
- **`printf/cout`** - to display diagnostic output
- **`ocpi_debug`** - for debug builds
- **`gdb`** - GNU Project Debugger