

A decorative graphic on the left side of the slide, consisting of a network of white lines and small circles on a blue gradient background, resembling a circuit board or a neural network.

GETTING STARTED WITH THE EMP FRAMEWORK – PART 2

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THE MAGIC OF IPBUS/EMP

- The magic of IPbus is that it automagically talks to a PC
 - Assuming that the PC knows how to speak IPbus, of course

PREREQUISITES: XILINX

- Install Xilinx's Voodoo for controlling PCIe from https://github.com/Xilinx/dma_ip_drivers
- plus

```
sudo wget
```

Already installed: Included here for completeness

```
https://github.com/RHSResearchLLC/XilinxAR65444/raw/master/Linux/Xilinx_Answer_65444_Linux_Files/etc/udev/rules.d/xdma-udev-command.sh
```

```
https://github.com/RHSResearchLLC/XilinxAR65444/raw/master/Linux/Xilinx_Answer_65444_Linux_Files/etc/udev/rules.d/60-xdma.rules
```

```
-P /etc/udev/rules.d/
```

```
sudo udevadm control --reload-rules
```

```
sudo udevadm trigger
```

PREREQUISITES: IPBUS & EMP

```
sudo yum install epel-release
```

Already installed: Included here for completeness

```
sudo curl http://serenity.web.cern.ch/serenity/emp-  
fwk/_downloads/emp.centos7.x86_64.repo -o /etc/yum.repos.d/emp.repo
```

```
sudo curl  
http://ipbus.web.cern.ch/ipbus/doc/user/html/_downloads/ipbus-  
sw.centos7.x86_64.repo -o /etc/yum.repos.d/ipbus-sw.repo
```

```
sudo yum clean all
```

```
sudo yum groupinstall uhal emp
```

```
sudo pip install click click_didyousean pytest
```

PREREQUISITES

- The tools are installed in `/opt/cactus`, so add them to the Linux paths to your environment (i.e. in `~/.bashrc`)

```
export PATH=/opt/cactus/bin/emp:$PATH Already installed: Included here for completeness  
export LD_LIBRARY_PATH=/opt/cactus/lib:$LD_LIBRARY_PATH
```

LET'S TALK TO OUR BOARD

- ***In a new terminal***¹
- Create a software directory and move into it

```
mkdir my-software  
cd my-software
```

¹Cannot run EMP software within an IPBB virtual environment

CONNECTING TO A DEVICE

- We need to give the device a name to know how to talk to it
- uHAL uses an XML file to give all known devices names
- Open connections.xml
- Add

```
<connections>
  <connection
    id="my-board"
    uri="ipbuspcie-2.0:///dev/xdma/card0/h2c0,/dev/xdma/card0/c2h0"
    address_table="file:///../my-firmware/proj/my_algo/package/src/addrtab/top_emp_slim.xml"
  />
</connections>
```

CONNECTING TO A DEVICE

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  />
</connections>
```

The name we give our board

CONNECTING TO A DEVICE

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  />
</connections>
```

Protocol **Protocol parameters – in this case PCIe endpoints**
(For IP protocols it is would be the IP address)

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    address_table="file:///..my-firmware/proj/my_algo/package/src/addrtab/top_emp_slim.xml"
  />
</connections>
```

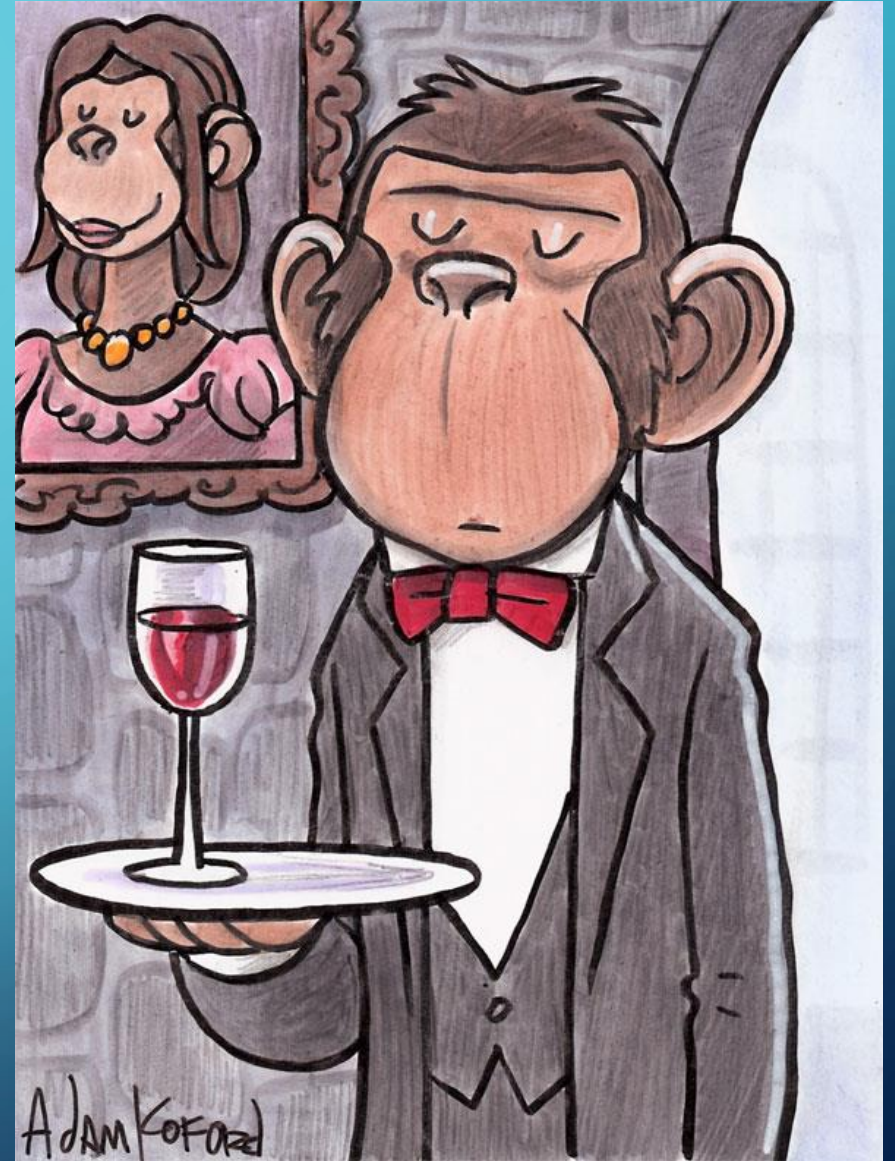
The top-level address table in
the directory created by IPBB

AND WE ARE GOOD-TO-GO

- So how? What now?

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- **EMPbutler**
 - Command-line utility for doing “common” tasks in the EMP infrastructure without having to know anything that is going on under-the-hood



AND WE ARE GOOD-TO-GO

- Can we reset the EMP clocking infrastructure?

```
empbutler -c connections.xml do my-board reset internal
```

AND PLAY DATA THROUGH OUR ALGO!

- Configure inputs to play data through our firmware

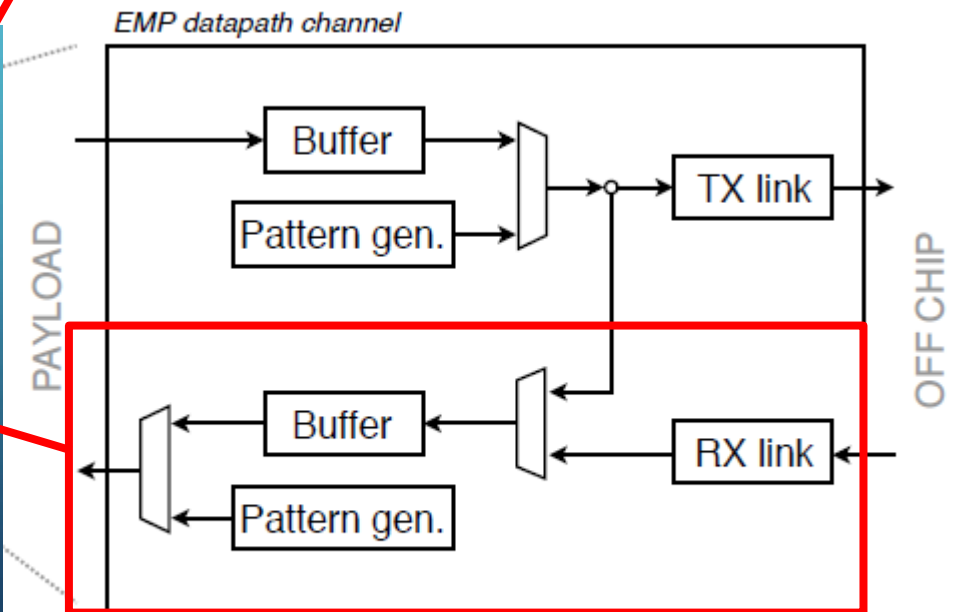
```
empbutler -c connections.xml do my-board buffers rx PlayOnce -c 0-31  
--inject generate://pattern
```

AND PLAY DATA THROUGH OUR ALGO!

- Configure inputs to play data through our firmware

```
empbutler -c connections.xml do my-board buffers rx PlayOnce -c 0-31  
--inject generate://pattern
```

We are pretending the
data is coming off the link



AND PLAY DATA THROUGH OUR ALGO!

- Configure inputs to play data through our firmware

```
empbutler -c connections.xml do my-board buffers rx PlayOnce -c 0-31  
--inject generate://pattern
```

We need to
specify which links

AND PLAY DATA THROUGH OUR ALGO!

- Configure inputs to play data through our firmware

```
empbutler -c connections.xml do my-board buffers rx PlayOnce -c 0-31  
--inject generate://pattern
```

We use the inbuilt pattern generator

- Could also do

```
file://path/to/input_data.txt  
generate://empty  
generate://random
```

AND PLAY DATA THROUGH OUR ALGO!

- Configure outputs to capture data from our firmware

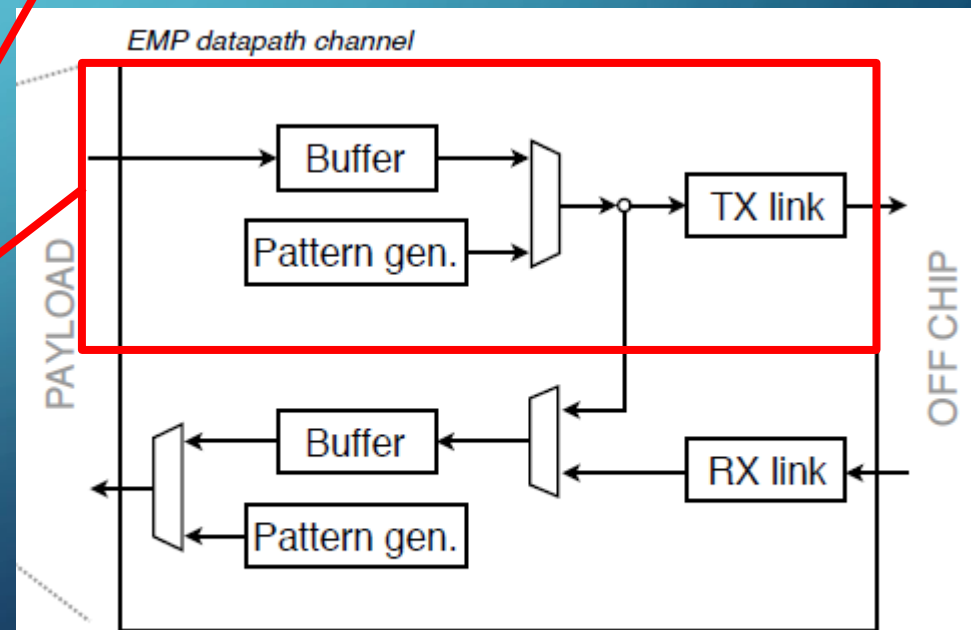
```
empbutler -c connections.xml do my-board buffers tx Capture -c 0-31
```

AND PLAY DATA THROUGH OUR ALGO!

- Configure outputs to capture data from our firmware

```
empbutler -c connections.xml do my-board buffers tx Capture -c 0-31
```

We are capturing the data which
would be going out on the link



AND PLAY DATA THROUGH OUR ALGO!

- Configure outputs to capture data from our firmware

```
empbutler -c connections.xml do my-board buffers tx Capture -c 0-31
```

Again, we need to
specify which links

AND PLAY DATA THROUGH OUR ALGO!

- And then do the capture

```
empbutler -c connections.xml do my-board capture --rx 0-31 --tx 0-31
```

- The captured rx/tx data is written to data/rx_summary.txt and data/tx_summary.txt respectively
 - Although the directory can be changed using the -o argument

IT SHOULD LOOK LIKE

```
Board my-board
Quad/Chan :      q00c0      q00c1      q00c2      q00c3      q01c0      q01c1
Link :          000          001          002          003          004          005
Frame 0000 : 0v0000000000000000 0v00000000000010000 0v00000000000020000 0v00000000000030000 0v00000000000040000 0v00000000000050000
Frame 0001 : 0v0000000000000000 0v00000000000010000 0v00000000000020000 0v00000000000030000 0v00000000000040000 0v00000000000050000
Frame 0002 : 0v0000000000000000 0v00000000000010000 0v00000000000020000 0v00000000000030000 0v00000000000040000 0v00000000000050000
Frame 0003 : 0v0000000000000000 0v00000000000010000 0v00000000000020000 0v00000000000030000 0v00000000000040000 0v00000000000050000
Frame 0004 : 0v0000000000000000 0v00000000000010000 0v00000000000020000 0v00000000000030000 0v00000000000040000 0v00000000000050000
Frame 0005 : 0v0000000000000000 0v00000000000010000 0v00000000000020000 0v00000000000030000 0v00000000000040000 0v00000000000050000
Frame 0006 : 0v0000000000000000 0v00000000000010000 0v00000000000020000 0v00000000000030000 0v00000000000040000 0v00000000000050000
Frame 0007 : 1v0000000000000000 1v00000000000010000 1v00000000000020000 1v00000000000030000 1v00000000000040000 1v00000000000050000
Frame 0008 : 1v00000000000000001 1v00000000000010001 1v00000000000020001 1v00000000000030001 1v00000000000040001 1v00000000000050001
Frame 0009 : 1v00000000000000002 1v00000000000010002 1v00000000000020002 1v00000000000030002 1v00000000000040002 1v00000000000050002
Frame 0010 : 1v00000000000000003 1v00000000000010003 1v00000000000020003 1v00000000000030003 1v00000000000040003 1v00000000000050003
Frame 0011 : 1v00000000000000004 1v00000000000010004 1v00000000000020004 1v00000000000030004 1v00000000000040004 1v00000000000050004
Frame 0012 : 1v00000000000000005 1v00000000000010005 1v00000000000020005 1v00000000000030005 1v00000000000040005 1v00000000000050005
Frame 0013 : 1v00000000000000006 1v00000000000010006 1v00000000000020006 1v00000000000030006 1v00000000000040006 1v00000000000050006
Frame 0014 : 1v00000000000000007 1v00000000000010007 1v00000000000020007 1v00000000000030007 1v00000000000040007 1v00000000000050007
Frame 0015 : 1v00000000000000008 1v00000000000010008 1v00000000000020008 1v00000000000030008 1v00000000000040008 1v00000000000050008
Frame 0016 : 1v00000000000000009 1v00000000000010009 1v00000000000020009 1v00000000000030009 1v00000000000040009 1v00000000000050009
Frame 0017 : 1v0000000000000000a 1v0000000000001000a 1v0000000000002000a 1v0000000000003000a 1v0000000000004000a 1v0000000000005000a
Frame 0018 : 1v0000000000000000b 1v0000000000001000b 1v0000000000002000b 1v0000000000003000b 1v0000000000004000b 1v0000000000005000b
Frame 0019 : 1v0000000000000000c 1v0000000000001000c 1v0000000000002000c 1v0000000000003000c 1v0000000000004000c 1v0000000000005000c
Frame 0020 : 1v0000000000000000d 1v0000000000001000d 1v0000000000002000d 1v0000000000003000d 1v0000000000004000d 1v0000000000005000d
Frame 0021 : 1v0000000000000000e 1v0000000000001000e 1v0000000000002000e 1v0000000000003000e 1v0000000000004000e 1v0000000000005000e
Frame 0022 : 1v0000000000000000f 1v0000000000001000f 1v0000000000002000f 1v0000000000003000f 1v0000000000004000f 1v0000000000005000f
Frame 0023 : 1v00000000000000010 1v00000000000010010 1v00000000000020010 1v00000000000030010 1v00000000000040010 1v00000000000050010
Frame 0024 : 1v00000000000000011 1v00000000000010011 1v00000000000020011 1v00000000000030011 1v00000000000040011 1v00000000000050011
Frame 0025 : 1v00000000000000012 1v00000000000010012 1v00000000000020012 1v00000000000030012 1v00000000000040012 1v00000000000050012
Frame 0026 : 1v00000000000000013 1v00000000000010013 1v00000000000020013 1v00000000000030013 1v00000000000040013 1v00000000000050013
Frame 0027 : 1v00000000000000014 1v00000000000010014 1v00000000000020014 1v00000000000030014 1v00000000000040014 1v00000000000050014
```

IT SHOULD LOOK LIKE

Board name
is included

Quad+Channel
Logical channel

Board my-board							
Quad/Chan :	q00c0	q00c1	q00c2	q00c3	q01c0	q01c1	
Link :	000	001	002	003	004	005	
Frame 0000	0v0000000000000000	0v0000000000001000	0v0000000000002000	0v0000000000003000	0v0000000000004000	0v0000000000005000	
Frame 0001	0v0000000000000000	0v0000000000001000	0v0000000000002000	0v0000000000003000	0v0000000000004000	0v0000000000005000	
Frame 0002	0v0000000000000000	0v0000000000001000	0v0000000000002000	0v0000000000003000	0v0000000000004000	0v0000000000005000	
Frame 0003	0v0000000000000000	0v0000000000001000	0v0000000000002000	0v0000000000003000	0v0000000000004000	0v0000000000005000	
Frame 0004	0v0000000000000000	0v0000000000001000	0v0000000000002000	0v0000000000003000	0v0000000000004000	0v0000000000005000	
Frame 0005	0v0000000000000000	0v0000000000001000	0v0000000000002000	0v0000000000003000	0v0000000000004000	0v0000000000005000	
Frame 0006	0v0000000000000000	0v0000000000001000	0v0000000000002000	0v0000000000003000	0v0000000000004000	0v0000000000005000	
Frame 0007	1v0000000000000000	1v0000000000001000	1v0000000000002000	1v0000000000003000	1v0000000000004000	1v0000000000005000	
Frame 0008	1v0000000000000001	1v0000000000001001	1v0000000000002001	1v0000000000003001	1v0000000000004001	1v0000000000005001	
Frame 0009	1v0000000000000002	1v0000000000001002	1v0000000000002002	1v0000000000003002	1v0000000000004002	1v0000000000005002	
Frame 0010	1v0000000000000003	1v0000000000001003	1v0000000000002003	1v0000000000003003	1v0000000000004003	1v0000000000005003	
Frame 0011	1v0000000000000004	1v0000000000001004	1v0000000000002004	1v0000000000003004	1v0000000000004004	1v0000000000005004	
Frame 0012	1v0000000000000005	1v0000000000001005	1v0000000000002005	1v0000000000003005	1v0000000000004005	1v0000000000005005	
Frame 0013	1v0000000000000006	1v0000000000001006	1v0000000000002006	1v0000000000003006	1v0000000000004006	1v0000000000005006	
Frame 0014	1v0000000000000007	1v0000000000001007	1v0000000000002007	1v0000000000003007	1v0000000000004007	1v0000000000005007	
Frame 0015	1v0000000000000008	1v0000000000001008	1v0000000000002008	1v0000000000003008	1v0000000000004008	1v0000000000005008	
Frame 0016	1v0000000000000009	1v0000000000001009	1v0000000000002009	1v0000000000003009	1v0000000000004009	1v0000000000005009	
Frame 0017	1v000000000000000a	1v000000000000100a	1v000000000000200a	1v000000000000300a	1v000000000000400a	1v000000000000500a	
Frame 0018	1v000000000000000b	1v000000000000100b	1v000000000000200b	1v000000000000300b	1v000000000000400b	1v000000000000500b	
Frame 0019	1v000000000000000c	1v000000000000100c	1v000000000000200c	1v000000000000300c	1v000000000000400c	1v000000000000500c	
Frame 0020	1v000000000000000d	1v000000000000100d	1v000000000000200d	1v000000000000300d	1v000000000000400d	1v000000000000500d	
Frame 0021	1v000000000000000e	1v000000000000100e	1v000000000000200e	1v000000000000300e	1v000000000000400e	1v000000000000500e	
Frame 0022	1v000000000000000f	1v000000000000100f	1v000000000000200f	1v000000000000300f	1v000000000000400f	1v000000000000500f	
Frame 0023	1v0000000000000010	1v0000000000001010	1v0000000000002010	1v0000000000003010	1v0000000000004010	1v0000000000005010	
Frame 0024	1v0000000000000011	1v0000000000001011	1v0000000000002011	1v0000000000003011	1v0000000000004011	1v0000000000005011	
Frame 0025	1v0000000000000012	1v0000000000001012	1v0000000000002012	1v0000000000003012	1v0000000000004012	1v0000000000005012	
Frame 0026	1v0000000000000013	1v0000000000001013	1v0000000000002013	1v0000000000003013	1v0000000000004013	1v0000000000005013	
Frame 0027	1v0000000000000014	1v0000000000001014	1v0000000000002014	1v0000000000003014	1v0000000000004014	1v0000000000005014	

Clock cycles since
the event reset

IT SHOULD LOOK LIKE

Invalid data

Valid data

```
Board my-board
Quad/Chan :      q00c0      q00c1      q00c2      q00c3      q01c0      q01c1
Link :          000          001          002          003          004          005
Frame 0000 : 0v0000000000000000 0v00000000000010000 0v00000000000020000 0v00000000000030000 0v00000000000040000 0v00000000000050000
Frame 0001 : 0v0000000000000000 0v00000000000010000 0v00000000000020000 0v00000000000030000 0v00000000000040000 0v00000000000050000
Frame 0002 : 0v0000000000000000 0v00000000000010000 0v00000000000020000 0v00000000000030000 0v00000000000040000 0v00000000000050000
Frame 0003 : 0v0000000000000000 0v00000000000010000 0v00000000000020000 0v00000000000030000 0v00000000000040000 0v00000000000050000
Frame 0004 : 0v0000000000000000 0v00000000000010000 0v00000000000020000 0v00000000000030000 0v00000000000040000 0v00000000000050000
Frame 0005 : 0v0000000000000000 0v00000000000010000 0v00000000000020000 0v00000000000030000 0v00000000000040000 0v00000000000050000
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```