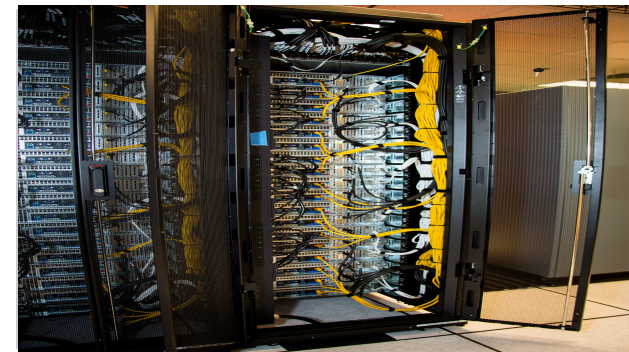
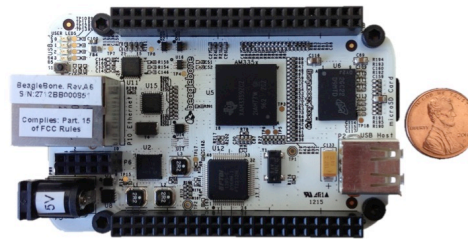


Exceptional service in the national interest

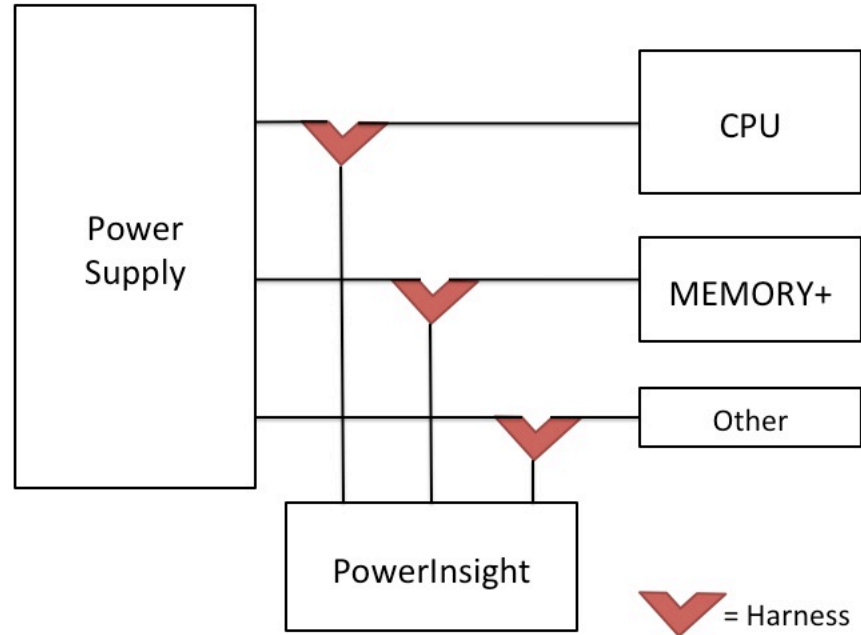


A Prototype of a Power API

using PowerInsight on Teller

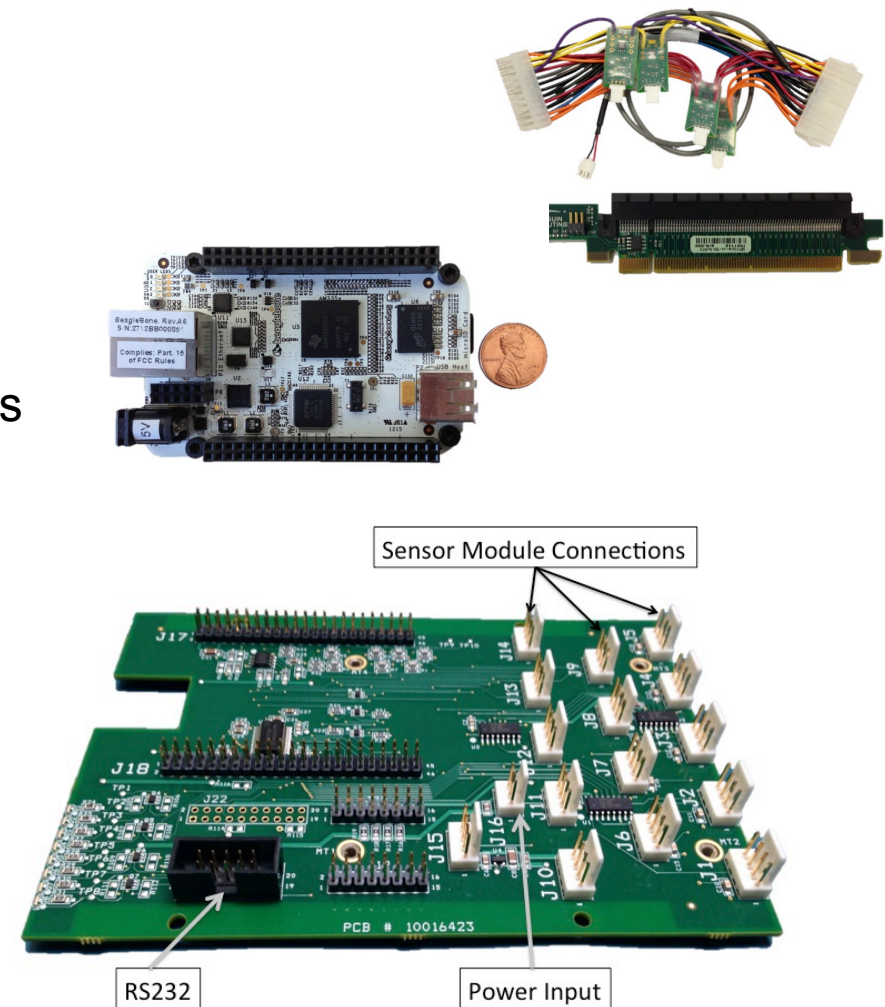
Overview

- Prototype Power API
 - Hardware support
 - Library based calls
 - Modes of operation
- Experiment
 - Tools for collection
 - Data reduction / analysis
 - Code instrumentation
- Tiered Power Collection
 - Application Level
 - OS Level
 - Cluster Level
- Future Work



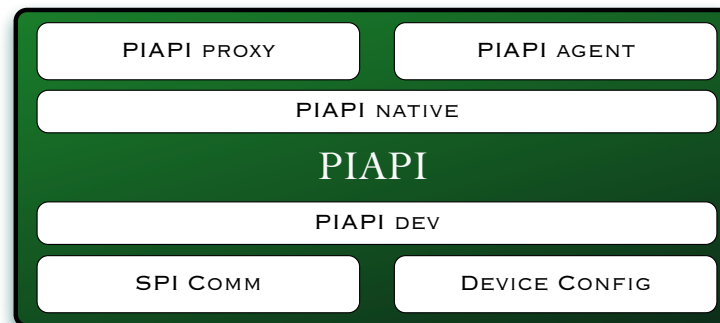
Hardware Support

- Emulating Current / Future Hardware
 - Postulating foundation
 - Discovering system needs
- Component level analysis (Ideal)
 - CPU, memory, storage, peripherals
- PowerInsight (Actual)
 - BeagleBone ARM-based Platform
 - ATX Harness
 - Hall effect sensors on voltage
 - 10-bit ADC per channel
 - Optional PCIe Harness
 - SPI communication
 - Up to 1000 samples per second



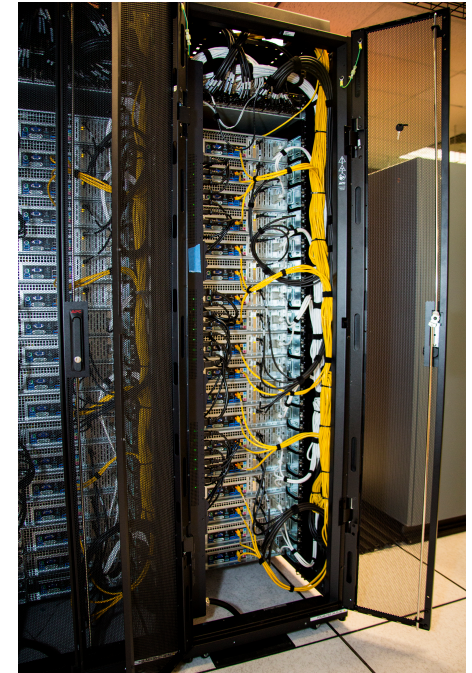
Library Support

- User space raw device interface (pidev)
 - Device level interface from Penguin
- Power API for emulating device features (piapi)
 - C-based library
 - Running counters on all channels
 - Reset counter
 - Read cumulative energy since reset
 - Push or pull mode of operation
 - Subscribe to a collection request
 - Poll instantaneous power data
- Operates in three different modes
 - Native calls to the device
 - Agent hosted native calls
 - Proxy calls to the agents



Power Collection Utilities

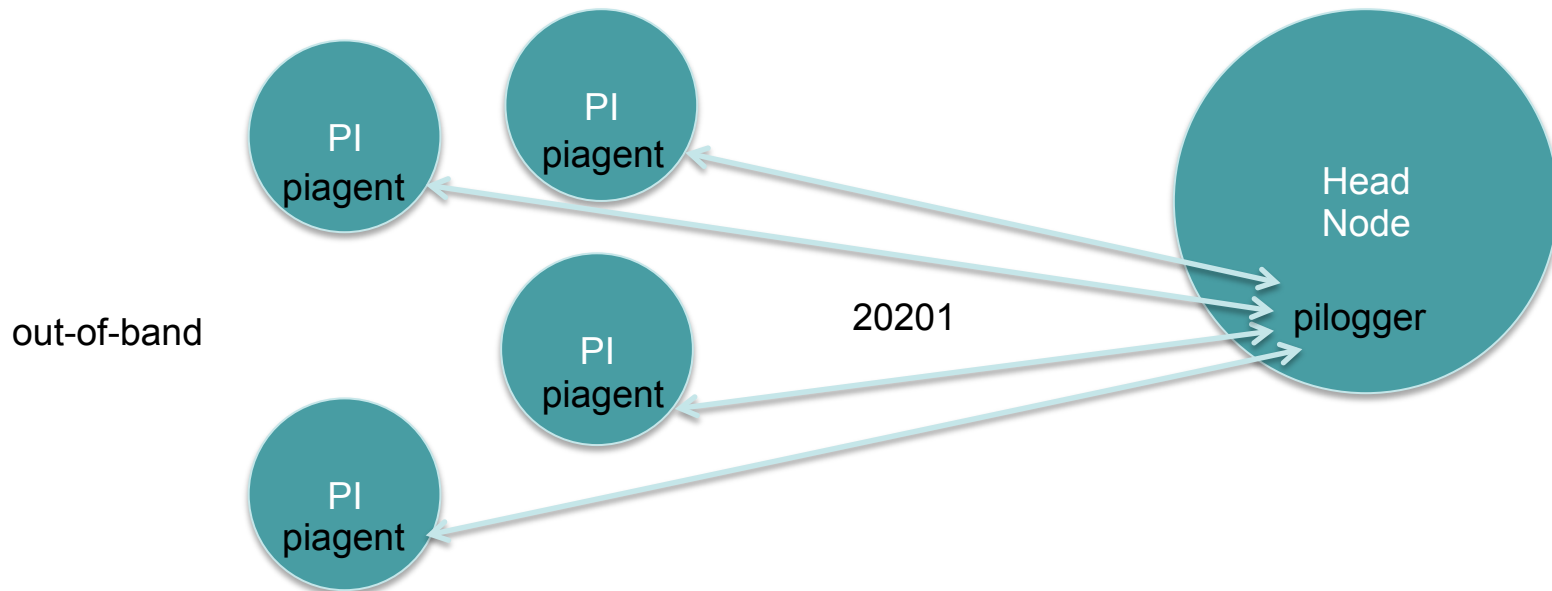
- Embedded Tools (under-the-hood)
 - Native (piapi)
`./piapi -t 1 -s 1000 -f 100`
 - Agent (piagent)
 - Running on port 20201 upon system boot
- Command Line Tools
 - Proxy (piproxy)
`./piproxy -a 10.54.21.10 -t 1 -s 1000 -f 100`
 - Logger (pillogger)
`./pillogger -l 10 -u 29 -t 1 -s 1000 -f 100 -p results`



(show example collection)

```
1:1000:1377619836:88064:1:12.212000:0.585000:7.144000:12.212000:0.585000:7.144000:12.212000:0.585000:7.144000:12.212000:0.585000:7.144000:0.000000:7.144000
2:1000:1377619836:99020:1:12.212000:0.558000:6.814000:12.212000:0.571500:6.979000:12.212000:0.558000:6.814000:12.212000:0.585000:7.144000:0.010956:7.218654
3:1000:1377619836:109701:1:12.212000:0.504000:6.154000:12.212001:0.549000:6.704000:12.212000:0.504000:6.154000:12.212000:0.585000:7.144000:0.021637:7.351808
4:1000:1377619836:120321:1:12.212000:0.531000:6.484000:12.212000:0.544500:6.649000:12.212000:0.504000:6.154000:12.212000:0.585000:7.144000:0.032257:7.560963
5:1000:1377619836:130941:1:12.212000:0.558000:6.814000:12.212000:0.547200:6.682000:12.212000:0.504000:6.154000:12.212000:0.585000:7.144000:0.042877:7.853127
6:1000:1377619836:141561:1:12.212000:0.640000:7.815000:12.211999:0.562667:6.870833:12.212000:0.504000:6.154000:12.212000:0.640000:7.815000:0.053497:8.271206
7:1000:1377619836:152182:1:12.212000:0.585000:7.144000:12.211999:0.565857:6.909857:12.212000:0.504000:6.154000:12.212000:0.640000:7.815000:0.064118:8.729265
8:1000:1377619836:162802:1:12.212000:0.585000:7.144000:12.211999:0.568250:6.939125:12.212000:0.504000:6.154000:12.212000:0.640000:7.815000:0.074738:9.263193
9:1000:1377619836:173452:1:12.196000:0.558000:6.805000:12.210221:0.567111:6.924222:12.196000:0.504000:6.154000:12.212000:0.640000:7.815000:0.085388:9.844258
```

Method : System-Monitor



On system launch collect samples:

callback for each sample at a given rate

OR

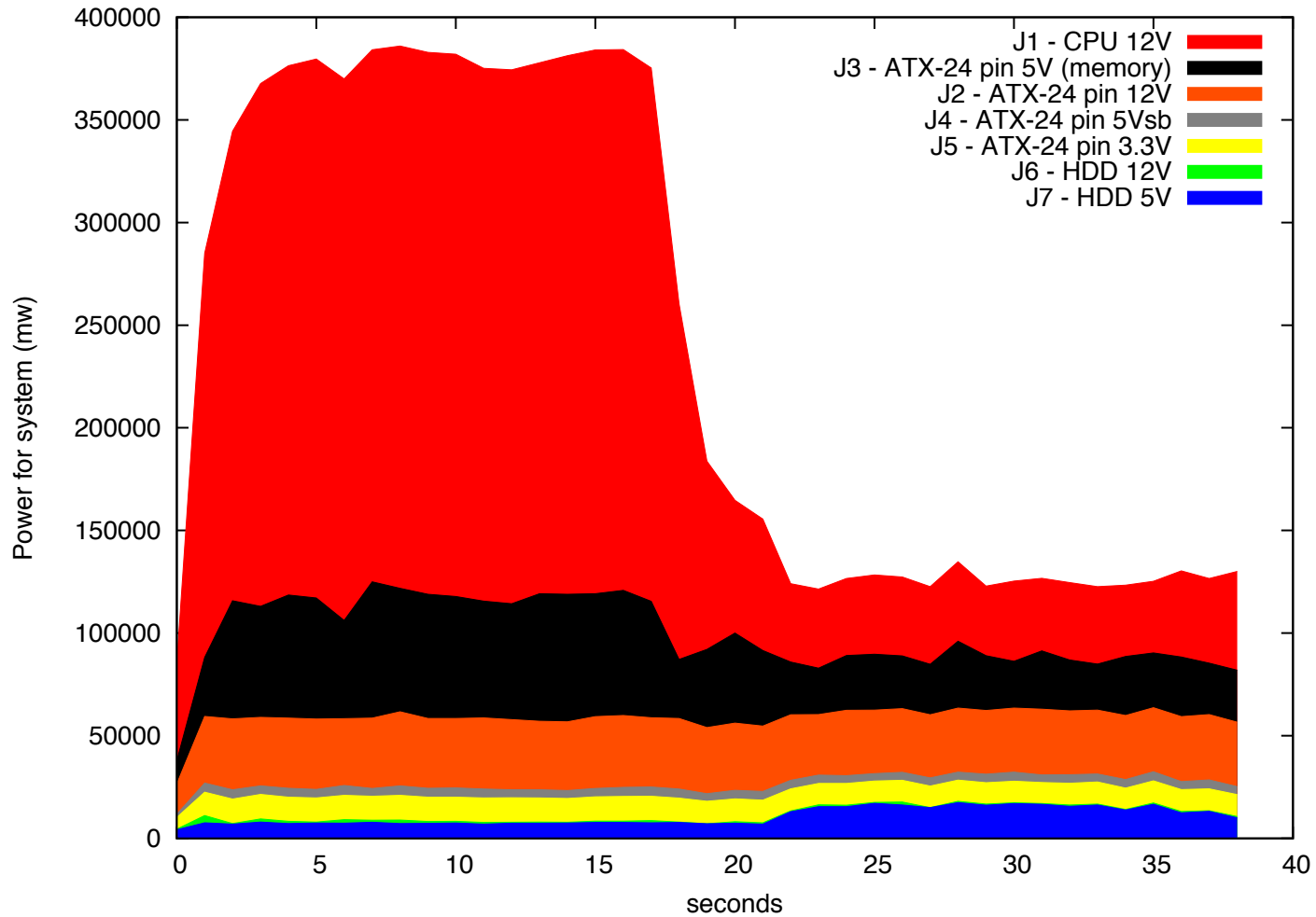
counter difference between start / finish

Data Reduction / Analysis

- Node results saved to file (i.e. teller10.out, teller11.out, ...)
- Each file contains one reading per line
 - Sample number
 - Sample timestamp
 - Sensor port
 - For Voltage, Current, Power:
 - Raw / Average value over collection
 - Minimum / Maximum value over collection
 - Running Total Energy
- Various Python and Perl scripts exist to extract key info

```
1:1000:1377619836:88064:1:12.212000:0.585000:7.144000:12.212000:0.585000:7.144000:12.212000:0.585000:7.144000:12.212000:0.585000:7.144000:0.000000:7.144000
2:1000:1377619836:99020:1:12.212000:0.558000:6.814000:12.212000:0.571500:6.979000:12.212000:0.558000:6.814000:12.212000:0.585000:7.144000:0.010956:7.218654
3:1000:1377619836:109701:1:12.212000:0.504000:6.154000:12.212001:0.549000:6.704000:12.212000:0.504000:6.154000:12.212000:0.585000:7.144000:0.021637:7.351808
4:1000:1377619836:120321:1:12.212000:0.531000:6.484000:12.212000:0.544500:6.649000:12.212000:0.504000:6.154000:12.212000:0.585000:7.144000:0.032257:7.560963
5:1000:1377619836:130941:1:12.212000:0.558000:6.814000:12.212000:0.547200:6.682000:12.212000:0.504000:6.154000:12.212000:0.585000:7.144000:0.042877:7.853127
6:1000:1377619836:141561:1:12.212000:0.640000:7.815000:12.211999:0.562667:6.870833:12.212000:0.504000:6.154000:12.212000:0.640000:7.815000:0.053497:8.271206
7:1000:1377619836:152182:1:12.212000:0.585000:7.144000:12.211999:0.565857:6.909857:12.212000:0.504000:6.154000:12.212000:0.640000:7.815000:0.064118:8.729265
8:1000:1377619836:162802:1:12.212000:0.585000:7.144000:12.211999:0.568250:6.939125:12.212000:0.504000:6.154000:12.212000:0.640000:7.815000:0.074738:9.263193
9:1000:1377619836:173452:1:12.196000:0.558000:6.805000:12.210221:0.567111:6.924222:12.196000:0.504000:6.154000:12.212000:0.640000:7.815000:0.085388:9.844258
```


Experiment Results



Code Instrumentation

- Initialize API

```
void piapi_callback( piapi_sample_t *sample );  
void *cntx;  
piapi_init( &cntx, PIAPI_MODE_PROXY, piapi_callback, saddr, sport );
```

- Start Collection

```
piapi_collect( cntx, PIAPI_PORT_CPU, 1000, 100 );
```

OR

- Reset / Poll Counter

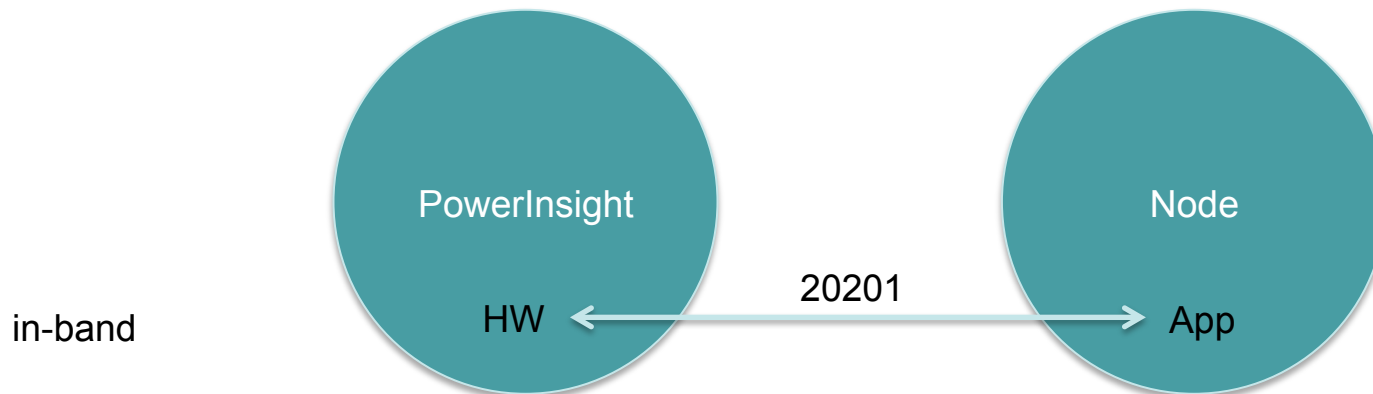
```
piapi_reset( cntx, PIAPI_PORT_CPU );  
piapi_counter( cntx, PIAPI_PORT_CPU );
```

- Cleanup

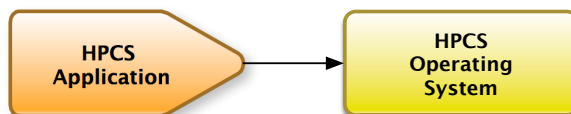
```
piapi_destroy( &cntx );
```

(show example code)

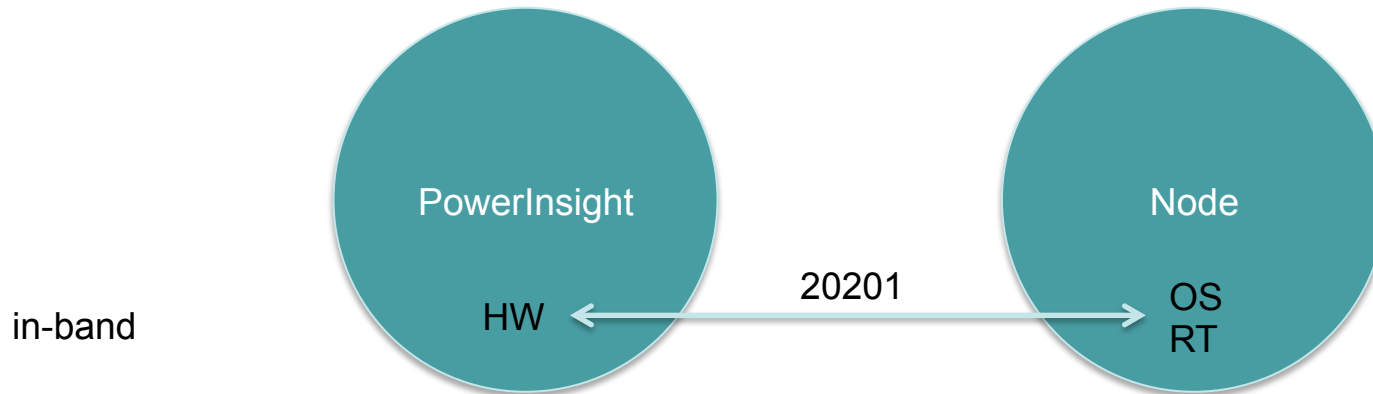
Method : Introspection



On application launch collect samples:
callback for each sample at a given rate
OR
counter difference between start / finish

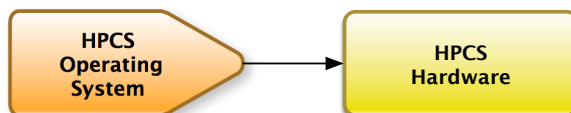


Method : Self-Reflection

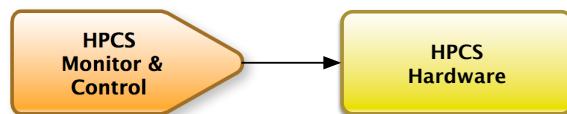
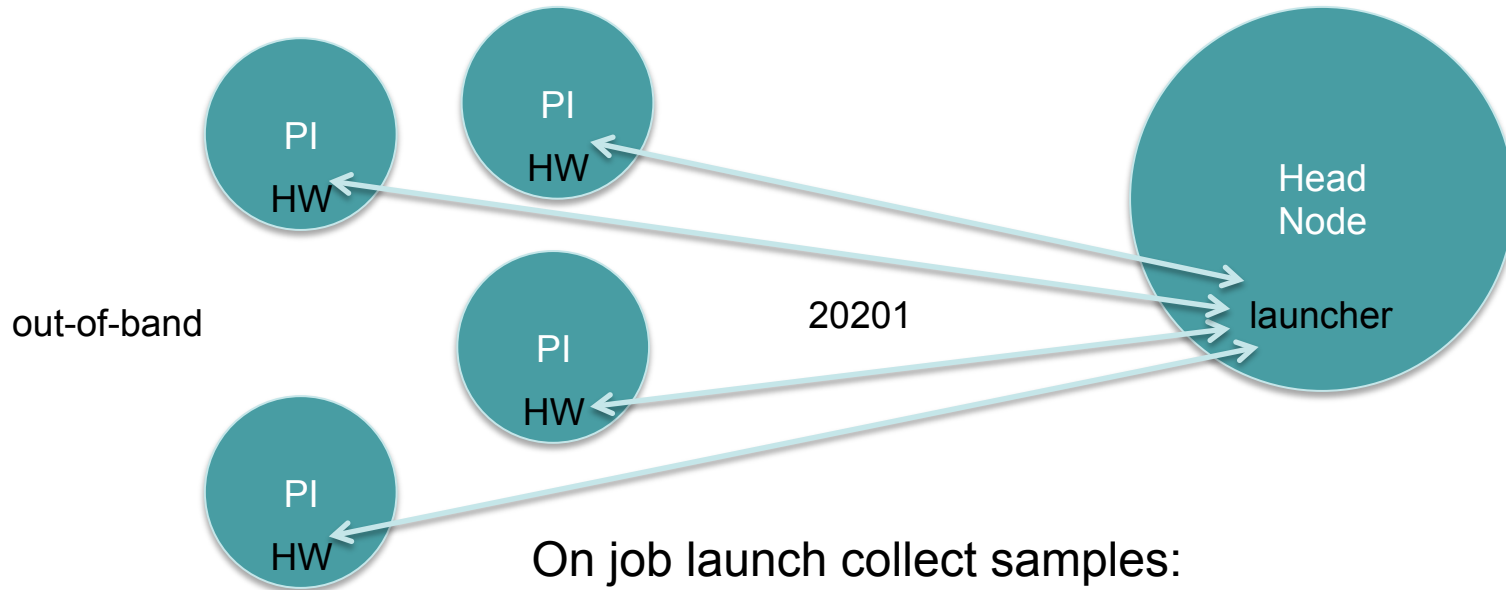


On job launch collect samples:

callback for each sample at a given rate
OR
counter difference between start / finish



Method : Collective-Monitor



Future Work

- Trinity power features
- Prototype PIAPI control features
 - DVFS, etc.
- Integrate with Kitten LWK
- Port PIAPI to Cray Cascade (Volta – XC30)

