The Second Workshop on HPC Power Management: Knowledge Discovery

Power API Collaborations, Community, and What's Next

25 August 2016

James H. Laros III
Principal Member of Technical Staff
Sandia National Laboratories
http://powerapi.sandia.gov

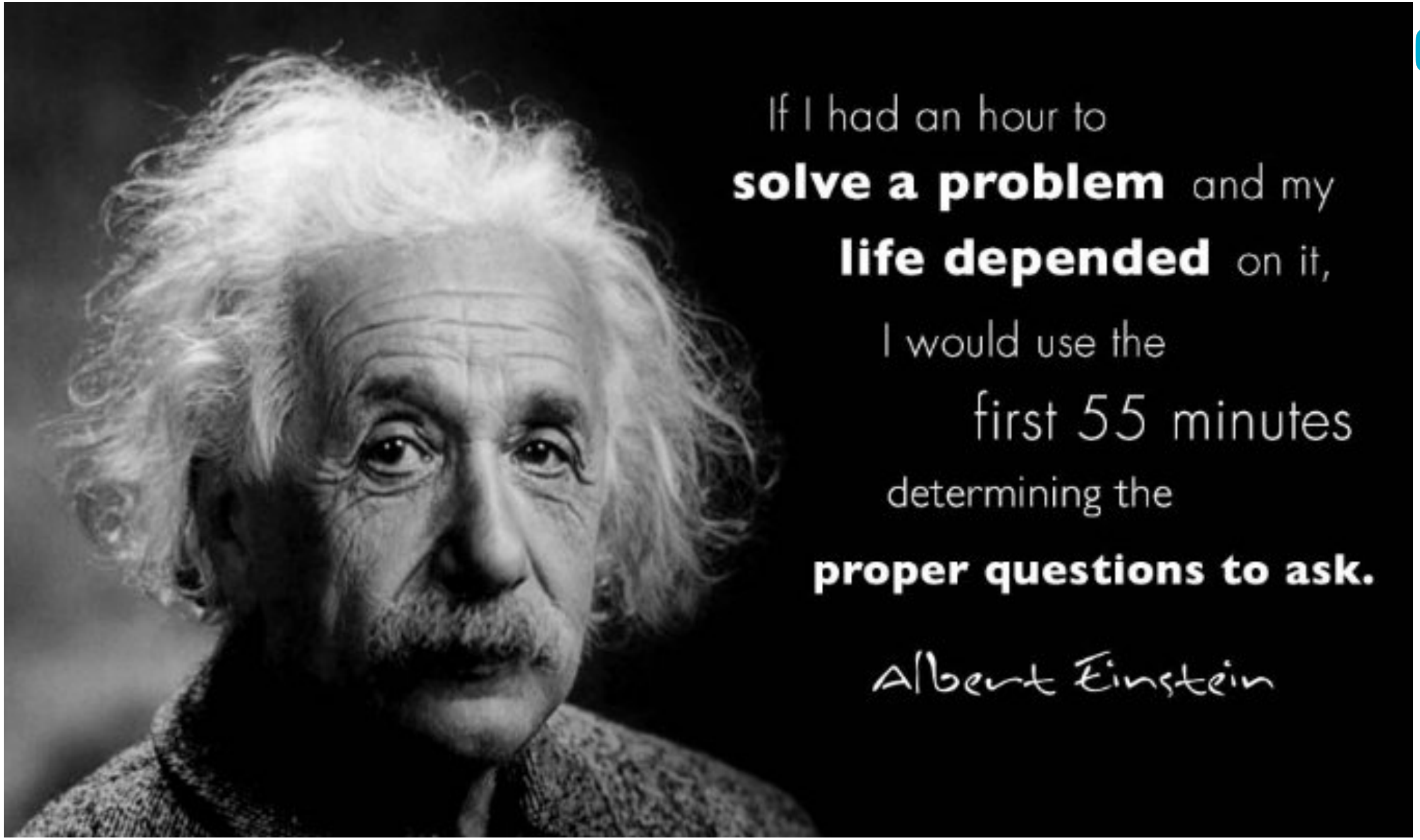
Sandia National Laboratories

Exceptional service in the national interest

U.S. DEPARTMENT OF ENERGY

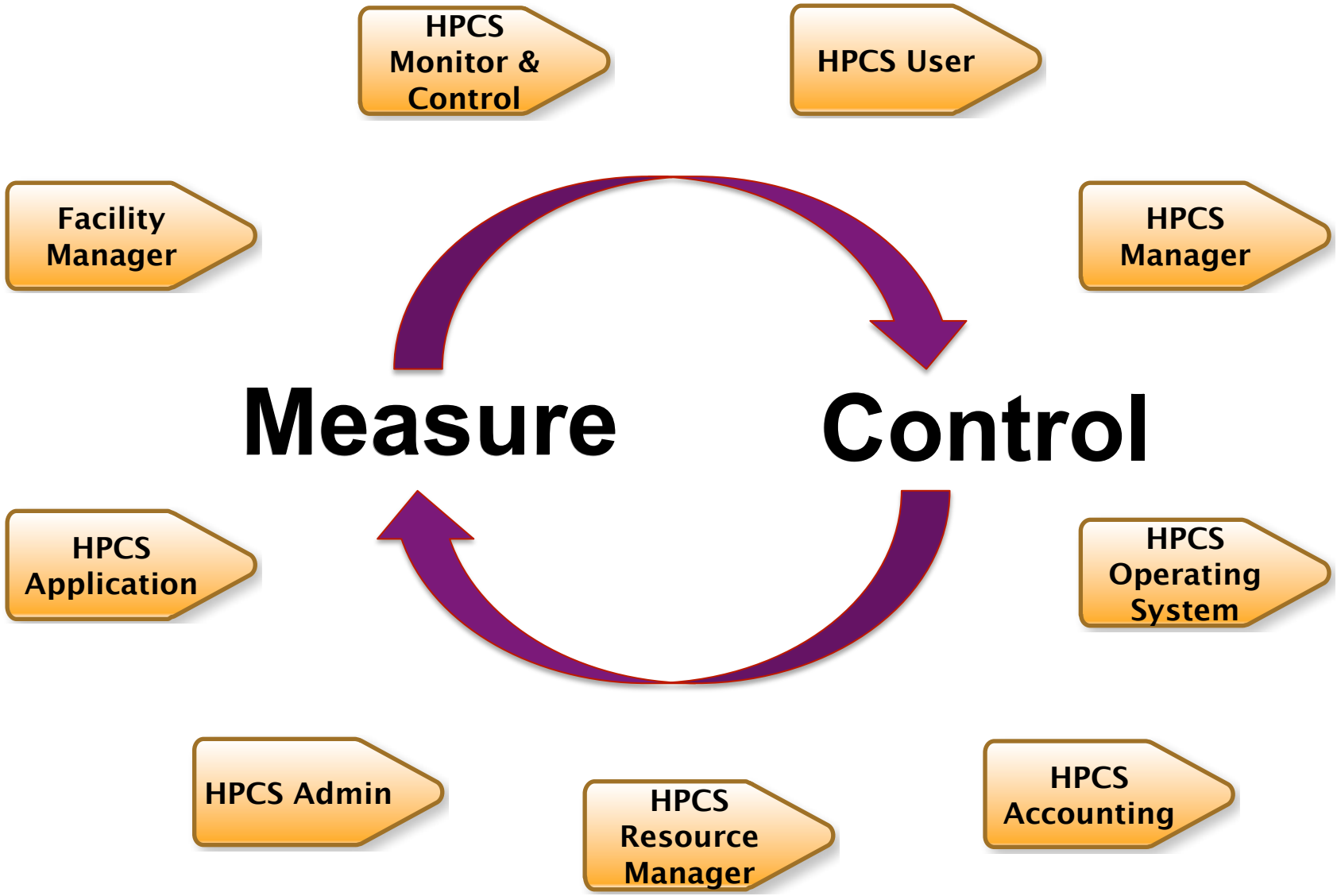
NNSA National Nuclear Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND2016-8184 C



Sandia National Laboratories

2004-2006: Initial Research



2012/2013: Use Case Study

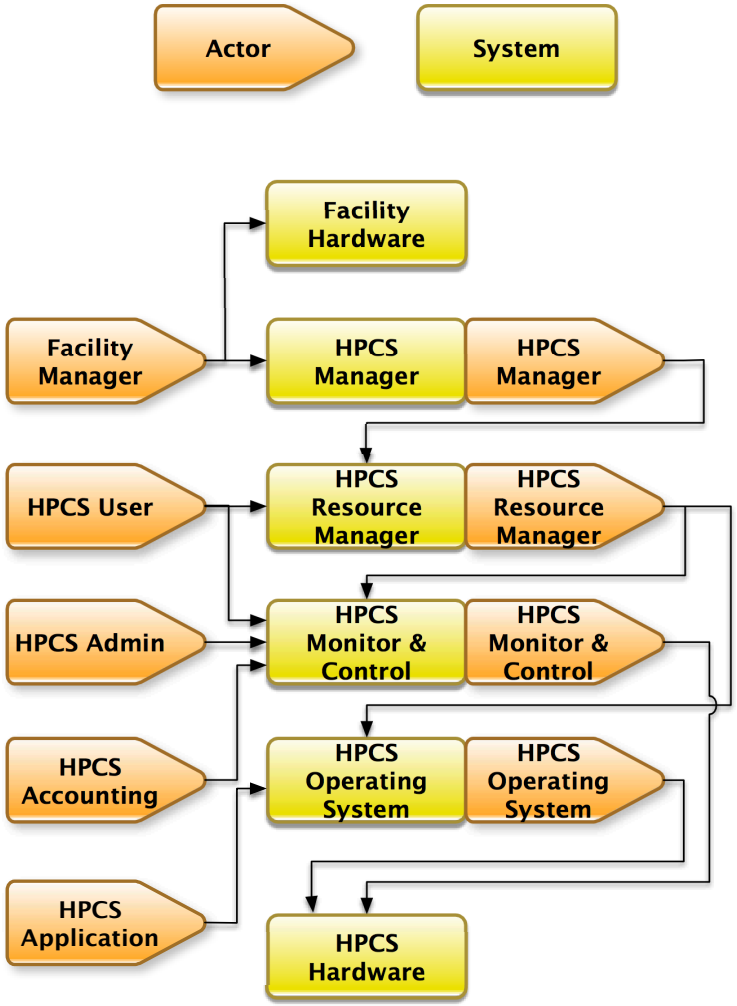
Diagram is the result of a UML study of the target space

- Goal: Define Scope, Roles and Interfaces

Arrows indicate interfaces or interaction between an Actor (Role) and System

- Each interaction represents an interface that is defined in the specification
- Specification is structured from the user or Role perspective

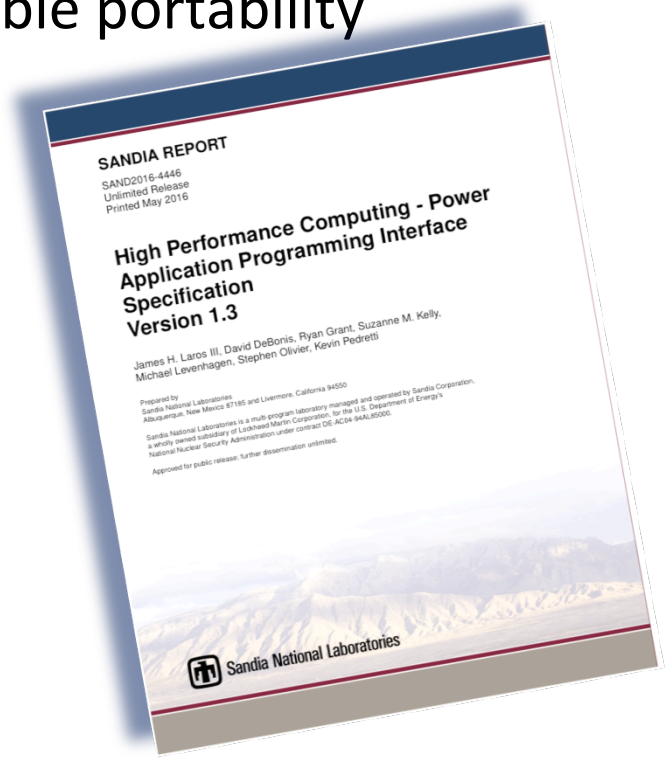
Notice that an Actor (Role) can also be a System



https://cfwebprod.sandia.gov/cfdocs/CompResearch/docs/UseCase-powapi.pdf

2014: Initial Version Power API Specification

- Versions 1.0, 1.1, 1.1a, 1.2 and 1.3 delivered
- Community needed a portable API for measuring and controlling power and energy
- Sandia developed Power API specification to fill this gap
- Provides measurement and control interfaces designed to enable portability
  - Covers full spectrum of facility to component
- First production implementation will be Trinity (ATS1)
- Continued (increasing) community involvement and influence
  - This is what we are here to promote!


SANDIA REPORT
SAND2016-4446
Unlimited Release
Printed May 2016

High Performance Computing - Power Application Programming Interface Specification
Version 1.3

James H. Laros III, David DeBonis, Ryan Grant, Suzanne M. Kelly, Michael Levenhagen, Stephen Olivier, Kevin Pedretti

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Approved for public release; further dissemination unlimited.

Sandia National Laboratories

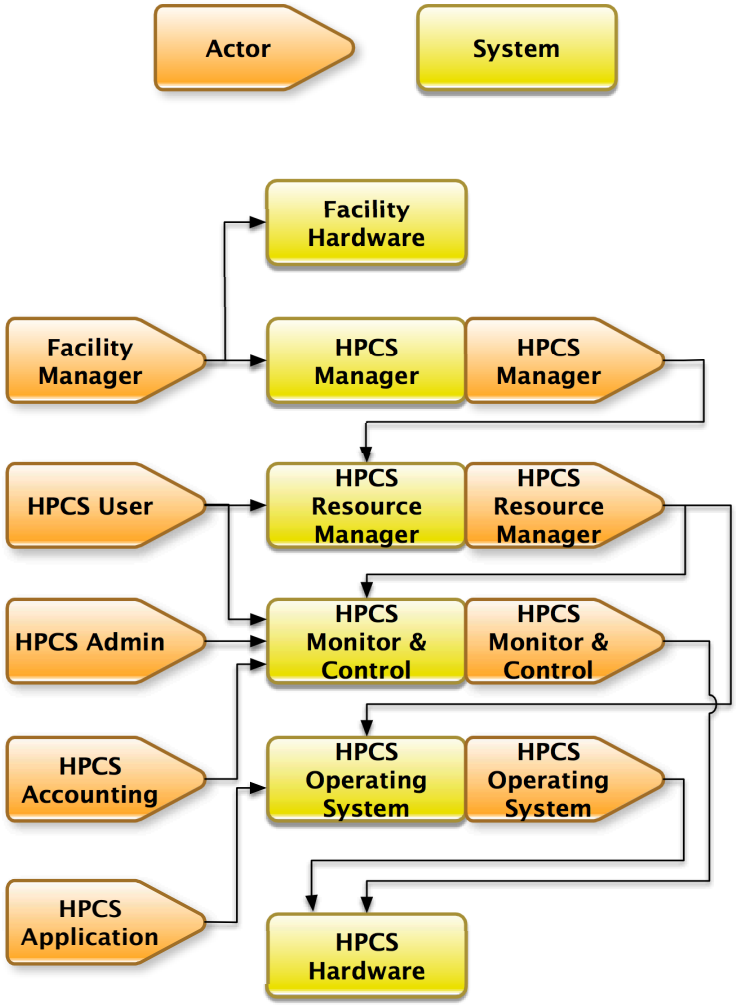
http://powerapi.sandia.gov

The *"High Performance Computing – Power Application Programming Interface Specification"* a.k.a. Power API

Sandia National Laboratories

- Broad Scope
  - High-level: end user and applications
  - Low-level: hardware and operating system
- Roles (actors)
- Systems
- Interfaces
  - Roles interacting with Systems

```
typedef enum {
        PWR_ROLE_APP,  /* Application */
        PWR_ROLE_MC,   /* Monitor and Control */
        PWR_ROLE_OS,   /* Operating System */
        PWR_ROLE_USER, /* User */
        PWR_ROLE_RM,   /* Resource Manager */
        PWR_ROLE_ADMIN, /* Administrator */
        PWR_ROLE_MGR,  /* HPCS Manager */
        PWR_ROLE_ACC   /* Accounting */
} PWR_Role;
```



Power API Goals

- Portability for the HPC community
  - Wouldn't it be nice to develop tools that worked on all your machines with little to no modification?
  - Same desire exists no matter what Role you play
- Forecast emerging needs of HPC community
  - As a group, inform the vendors of how we want to use systems now and in the future
  - Specification acts as a basis of collaboration
- **Expose new capabilities developed by vendors and community**
  - **Leverage vendor and community innovations in this and related spaces**
  - **E.g. Geo and Redfish**
- Most important, want something out there to throw stones at
  - Need a starting point!

What is the Power API?

Sandia National Laboratories

- A comprehensive API for power MEASUREMENT and CONTROL of HPC platforms
  - Comprehensive = Facility to Component
  - API = Define the interface not the mechanism
  - HPC platforms = Facility (or datacenter) and all the platforms within
- Core (Common) among all "users" Includes:
  - Roles, Initialization, Navigation, Objects and Groups,
  - Attributes (Get/Set), Metadata and Statistics
- High-Level Common
  - Higher level of abstraction but still potentially common among multiple Roles
- Role/System Specific
  - Higher level abstraction specific to how Role interfaces with system

So what have we been doing since last year?

- Two new versions released this year with a big one coming
  - Versions 1.2 and 1.3 largely changes resulting from NRE collaborations
  - Version 1.4 possible
  - Version 2.0 will include Python bindings
- 2nd BoF at SC15 – standing room only!
- Hopefully a 3rd at SC16
  - Focus on how to move to a more community influenced/driven paradigm
  - We want your great ideas now and at the BoF!!
- RNET
  - Efficient large scale sampling
  - Reporting power along side performance data

Must be doing something it takes two slides!

- Intel
  - Working closely with the goal of compatibility between GEO and Power API
  - API focus has been our Application->OS interface
    - Since theirs is largely a runtime effort
  - In particular the AppTuningHint() interface
    - Multiple nested phases (Version 1.4 or 2.0)
- Continuing to work with Cray Inc. (Trinity NRE)
  - Cray's Power Management Data Base (PMDB)
    - Python implementation of Power API (Version 2.0)
  - Compute Node Interface
    - C implementation of Power API
- Began work with Adaptive Computing (Trinity NRE)
  - Power aware scheduling use cases for Trinity
  - Exercise portions of Cray Power API implementation

We would like to involve more HPC community members in driving these (and new) efforts forward

Python Implementation of Power API

```
>>> cntxt = pwr.Cntxt(pwr.Role.ACC, "System Accounting")
>>> entryPoint = cntxt.GetEntryPoint()
>>> entryPoint.GetName()
's0'
>>> entryPoint.AttrGetValue(pwr.AttrName.POWER)
InfoFromGet(attr=6, value=26839, obj=<cray.obj.ObjPlatform object at 0x7f4fc3805ed0>,
timestamp=1471899692.880717, rc=0)
>>> entryPoint.AttrGetValue(pwr.AttrName.POWER).value
26839
>>> entryPoint.AttrGetValue(pwr.AttrName.ENERGY)
InfoFromGet(attr=12, value=139260873, obj=<cray.obj.ObjPlatform object at
0x7f4fc3805ed0>, timestamp=1471899709.188973, rc=0)
>>> entryPoint.AttrGetValue(pwr.AttrName.ENERGY).value
139325195
```

Python Implementation of Power API (cont.)

```
>>> now = time.time()
>>> tempTimePeriod = pwr.TimePeriod(now - 300.0, now)
>>> entryPoint.GetStat(pwr.AttrName.POWER, pwr.AttrStat.AVG, tempTimePeriod).value
16144.03
>>> entryPoint.GetStat(pwr.AttrName.POWER, pwr.AttrStat.MAX, tempTimePeriod).value
16630
>>> entryPoint.GetStat(pwr.AttrName.POWER, pwr.AttrStat.MIN, tempTimePeriod).value
15696
>>> myNode = cntxt.GetObjByName("c0-0c2s12n0")
>>> myNode.GetStat(pwr.AttrName.POWER, pwr.AttrStat.AVG, tempTimePeriod).value
48.671140939597315
>>> myNode.GetStat(pwr.AttrName.POWER, pwr.AttrStat.MAX, tempTimePeriod).value
81
>>> myNode.GetStat(pwr.AttrName.POWER, pwr.AttrStat.MIN, tempTimePeriod).value
38
```

Who is Behind PowerAPI?

Sandia National Laboratories

IBM

Los Alamos NATIONAL LABORATORY EST. 1943

intel

Lawrence Livermore National Laboratory

NREL NATIONAL RENEWABLE ENERGY LABORATORY

PENGUIN COMPUTING EXPERTS IN HIGH PERFORMANCE COMPUTING SOLUTIONS

NERSC

Adaptive COMPUTING

Sandia National Laboratories

AMD

UNM

Hewlett Packard Enterprise

CRAY THE SUPERCOMPUTER COMPANY

RNET Technologies, Inc.

OAK RIDGE National Laboratory

<Your logo here!>

EEHPC ENERGY EFFICIENT HIGH PERFORMANCE COMPUTING

Wish List

Sandia National Laboratories

"My job" defined as: HPC User, Administrator, Application, etc.

- A standard way of interfacing with HPC systems to measure and control power!
- Adoption of this (aforementioned) standard by the HPC vendor community
- A growing set of tools that use these standard interfaces (portable)
- Integration of app libraries and runtimes that utilize these interfaces
- Minimum standards for measurement and control
  - Node, component, etc.
  - Sample frequency
  - Quality of sample
  - Time-stamp accuracy

Questions?

- http://powerapi.sandia.gov
- Register on the reflector
- Get the current version of the spec
- Get the prototype/reference implementation source
- Other information as it develops
- Please get involved and help us (the community) improve the specification
- Sandia TEAM:

James Laros, Suzanne Kelly, Kevin Pedretti, Michael Levenhagen, Ryan Grant, Stephen Olivier