JPL "Standard Rack" Project

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Jet Propulsion Laboratory
California Institute of Technology

Background Info

- The Jet Propulsion Laboratory (JPL) is a federally funded research and development center and NASA field center located in La Cañada Flintridge, California and Pasadena, California, United States.
- The JPL is managed by the nearby California Institute of Technology (Caltech) for NASA. The laboratory's primary function is the construction and operation of planetary robotic spacecraft, though it also conducts Earth-orbit and astronomy missions. It is also responsible for operating NASA's Deep Space Network.
- Among the laboratory's current major active projects are the Mars Science Laboratory mission (which includes the Curiosity rover), the Cassini–Huygens mission orbiting Saturn, the Mars Exploration Rover Opportunity, the Mars Reconnaissance Orbiter, the Dawn mission to the dwarf planet Ceres and asteroid Vesta, the Juno spacecraft orbiting Jupiter, the NuSTAR X-ray telescope, and the Spitzer Space Telescope. They are also responsible for managing the JPL Small-Body Database, and provides physical data and lists of publications for all known small Solar System bodies.
- The JPL's Space Flight Operations Facility and Twenty-Five-Foot Space Simulator are designated National Historic Landmarks.

Wikipedia contributors. "Jet Propulsion Laboratory." Wikipedia, The Free Encyclopedia. Wikipedia, The Free Encyclopedia, 10 Oct. 2016. Web. 10 Oct. 2016.

How Federal is Different than Commercial IT Compute

- Federal IT / Compute is funded differently than commercial IT / Compute.
- Federal funding cycles are typically *far* longer than their commercial equivalents.
  - Project cycles can be measured in years.
    - This causes Federal IT to '*chase*' Moore's Law rather than be ahead of it (reactive v proactive).
    - Projects typically last longer than design goals. Voyager is in it's 39th year of operation; Opportunity had a 90 day target and has been running for 10 years.
- Federal IT typical has a mix of in-house IT assets and contractor IT assets.
- At JPL, we have all of that **plus** the additional requirement of '*mission-based*' needs
  - In this case, mission really does mean '***Space Flight Missions***'!
- JPL has been robust in capturing the '***soft***' infrastructure; software and IT rollouts as well as internal and external support.
- Up until five years ago, where JPL lagged their commercial equivalents was in the '***hard***' infrastructure; managing the data center.

JPL's "**OCIO**"

The Information Technology (IT) Directorate – also known as the Office of the Chief Information Officer (OCIO) is the organization at JPL that is chartered to protect and enable optimal use of this asset, including associated technologies collectively abbreviated as "IT". The IT Directorate is responsible for architecting, engineering, managing, implementing and provisioning, and operating and supporting this key Laboratory asset and the processes, policies, guidelines, and procedures associated with it.

All three presenters represent work in Divisions within the Office of the Chief Information Officer, the "**OCIO**" (the "*IT Directorate*")

JPL’s **OCIO** Managed Data Centers

- The OCIO manages14 data centers of various age and size
  - ~ 500 racks
  - ~1,000 active fiber ports
  - ~2,000 active copper ports
- 2 data centers house the majority of our mission data uplink/downlink
  - Building 600 and Building 230

Managing the Data Center

- B600 (Building 600) — was the starting point of JPL's next generation of managed data center infrastructure.
- B600 initiated the marriage of mission-centric IT (which we did very well) to commercial data center equivalency (which we did haphazardly up to that point).
- Current industry best practices in the commercial data center industry were introduced and, most importantly, *enforced* at this data center. This represented a paradigm shift in the thinking of IT infrastructure at JPL as we had the ubiquitous mission-centric thinking coupled with a '*server hugger*' attitude, which as we all know in this room, is prevalent within our industry.
- B600 started the infrastructure movement towards utilizing industry '***Best Practices***' and it rolled into our B230 Phase I data center.

Managing the Data Center (con't)

B230 Phase 1—housed within a National Historic Building (SFOF) this data center utilized the very best of industry best practices including:

- Chimney cabinets
- Higher density cabinets / kw per rack
- No raised floor
- Clean agent suppression with HVAC mods to the SOO during discharge (no mechanical shutdown)
- Iso-bases for seismic events
- Modular, row-based construction with RPP on each end row.

Managing the Data Center (con't)

- B230 taught the OCIO that we had gotten '*close*' to commercial equivalency but we still had issues on timing and duration of project timelines.
- B230 Phase II will be an even greater density layout that incorporates rear-door heat exchanger (RDHx) technology that is **utterly** on-par with COTS Best Practices.
- The OCIO is adding a DCIM implementation that actually *exceeds* COTS Best Practices and ties into the DCOI, which is one vehicle that has leap-frogged Federal computing past their commercial equivalents and will likely trickle down to the commercial IT sector.

DCOI

- The Data Center Optimization Initiative (**DCOI**) was signed into law on August 1, 2016.
- DCOI **<u>mandates</u>** **PUE** (Power Utilization Effectiveness) metrics of 1.2 for new data centers and 1.4 for legacy data centers, combined with environmental monitoring along with **DCEP** (Data Center Energy Practitioner) involvement in all federal data centers.
- Those targets **<u>must</u>** be met by end of fiscal year 2018 (Sep. 2018) and, if not met, no new dc expansions nor upfits nor builds.
- Commercial data centers have tried to meet PUE metrics for Energy Star and power company and/or carbon footprint reporting for several years…the new Federal DCOI ensures that we do it in our data centers.
- The OCIO's approach to this was to marry our DCIM implementation into energy metrics to achieve a '*single-pane-of-glass*' dashboard and reporting mechanism.

JPL Data Centers Today

- Today, JPL's data centers are undergoing upfit to comply with DCOI as well as incorporate commercial '*Best Practices*' throughout.
- DCIM for JPL has been not so much a methodology as another paradigm shift in how we operate data centers.
- It allows us to achieve our CIO's vision of '***One Data Center***' that incorporates legacy as well as new data centers, outsourced as well as in-house managed data centers and cloud integration.
- This allows easy entry into the '*Converged Infrastructure*' topic of today.

Converged Infrastructure

The term '*Converged Infrastructure*' incorporates all of the back office with the front office in IT, marrying the latest in **BYOS** (Bring Your Own Server) with the **IOT** (Internet of Things).

At JPL, we've deployed BYOS and IOT, literally, for years. It's part of our DNA in the OCIO to utilize the latest technologies and allow authorized users to access with a variety of technologies. This hasn't been a problem, per se.

What *has* been a problem is the back office infrastructure that is necessary to **allow** this to happen; i.e. standards in racking, standards in footprint, standards in topology, standards in low-voltage, etc.

B600, B230 Phase I and B230 Phase II allowed us to re-engineer our data centers to incorporate industry best practices while allowing us to still be JPL and offer our highest level of mission support.

Converged Infrastructure (con't)

- One of the first things that Jim Chu did as a new data center manager was to embrace (or more accurately: **develop**) a new racking / cabinet standard.

- This new rack, now called '*The JPL Standard Rack*' will be used at all future JPL data centers, mission projects and facilities (where appropriate).

- There may be instances where a mission and/or project will not be able to use the new rack but it will **always** be offered and deployed when it can.

- Currently this new rack is being deployed (or planned to be) in 2 newly configured OCIO managed Data Centers.
  - Bldg230/Phase II as a RDHx environment and Bldg126 as cold isle containment.
  - Deep Space Network (DSN) in a still TBD configuration

- It marries industry best practices with JPL's '***Lessons Learned***' and incorporates several features that marry it into a rack that can be configured and deployed in a multitude of environments.

- It is our firm belief that unless you have a standardized back office infrastructure, Converged Infrastructure will be painful to deploy.

The JPL Standard Rack

Features of the JPL Standard Rack include:

- Higher U count (more U, less racks needed).
  - At JPL we enforce a '*Needed U*' mentality over a '*Needed Rack*' mentality.
- Configurable as stand-alone, hot-aisle, cold-aisle, chimney, RDHx and others.
- Robust static and dynamic loads (4000 lbs. / 4000 lbs.).
- Robust square tubing so that it can survive setup (techs standing inside, etc.)
- Side breather accommodation / side 'wells' and enhanced use of vertical space within.
- PDU configuration that can include up to 8 standard internal PDUs.
- A compilation of many racks used over the years with emphasis on modularity and extensibility.

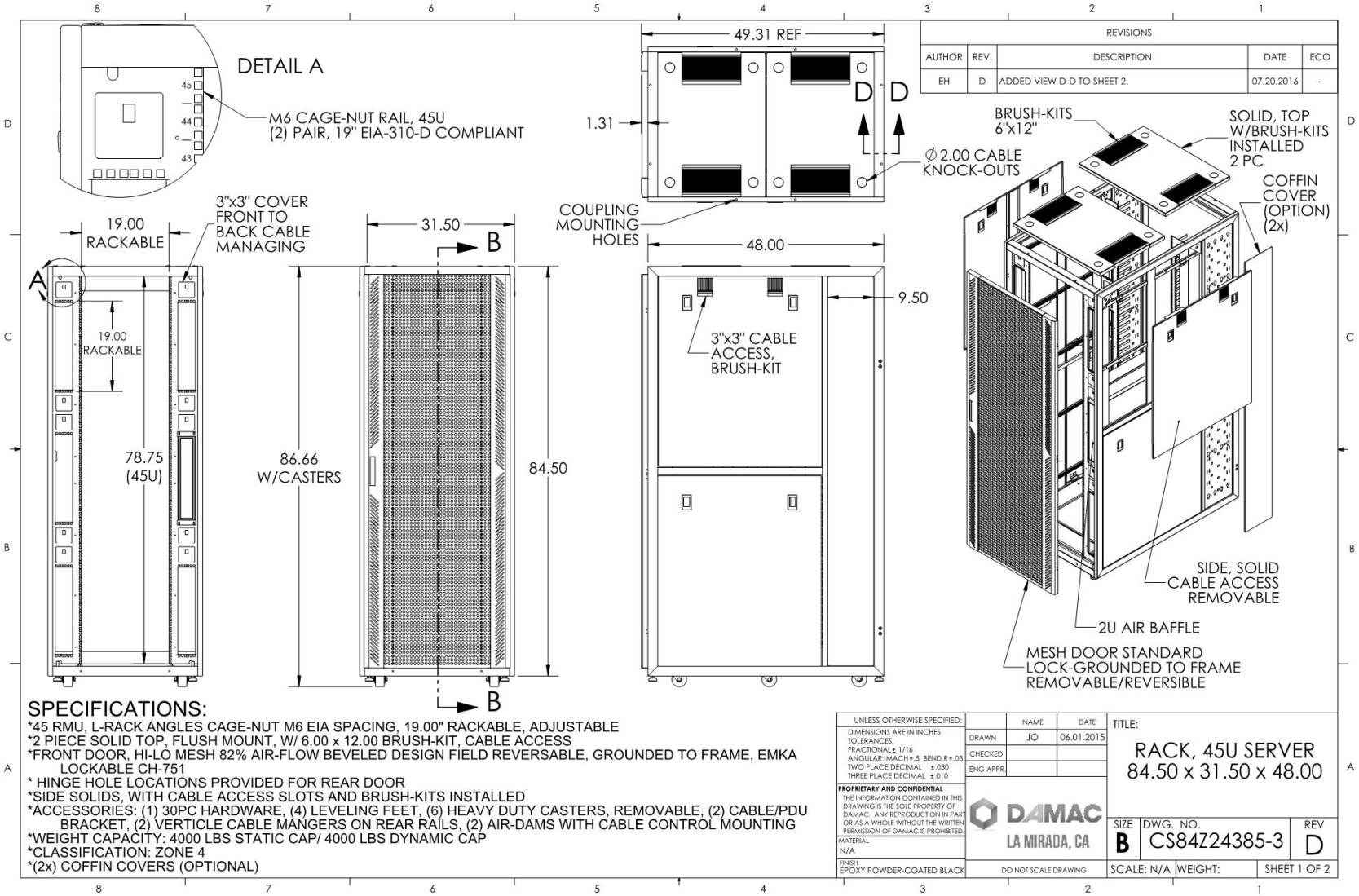
The JPL Standard Rack (con’t)

The JPL Standard Rack is part of a standardization that includes:

- Universal racking
- Universal DCIM and Environmentals
- Universal Fire Suppression and Monitoring
- Standards and Policies for the Data Center
- Standards for Provisioning

The JPL Standard Rack will allow ease of deployment in numerous HVAC and Electrical configurations as well as meeting our infrastructure and seismic goals.

The JPL Standard Rack (con't)



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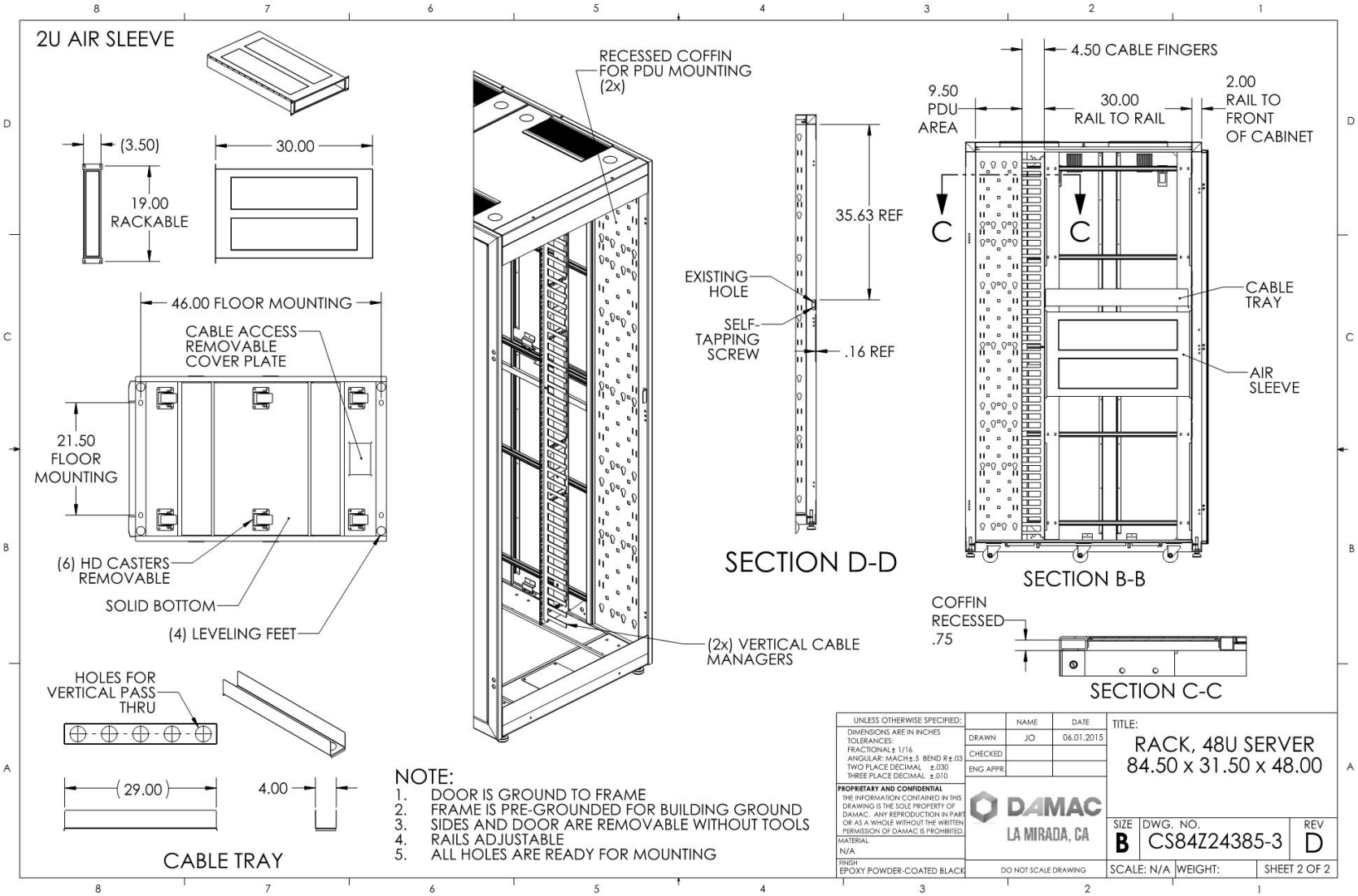

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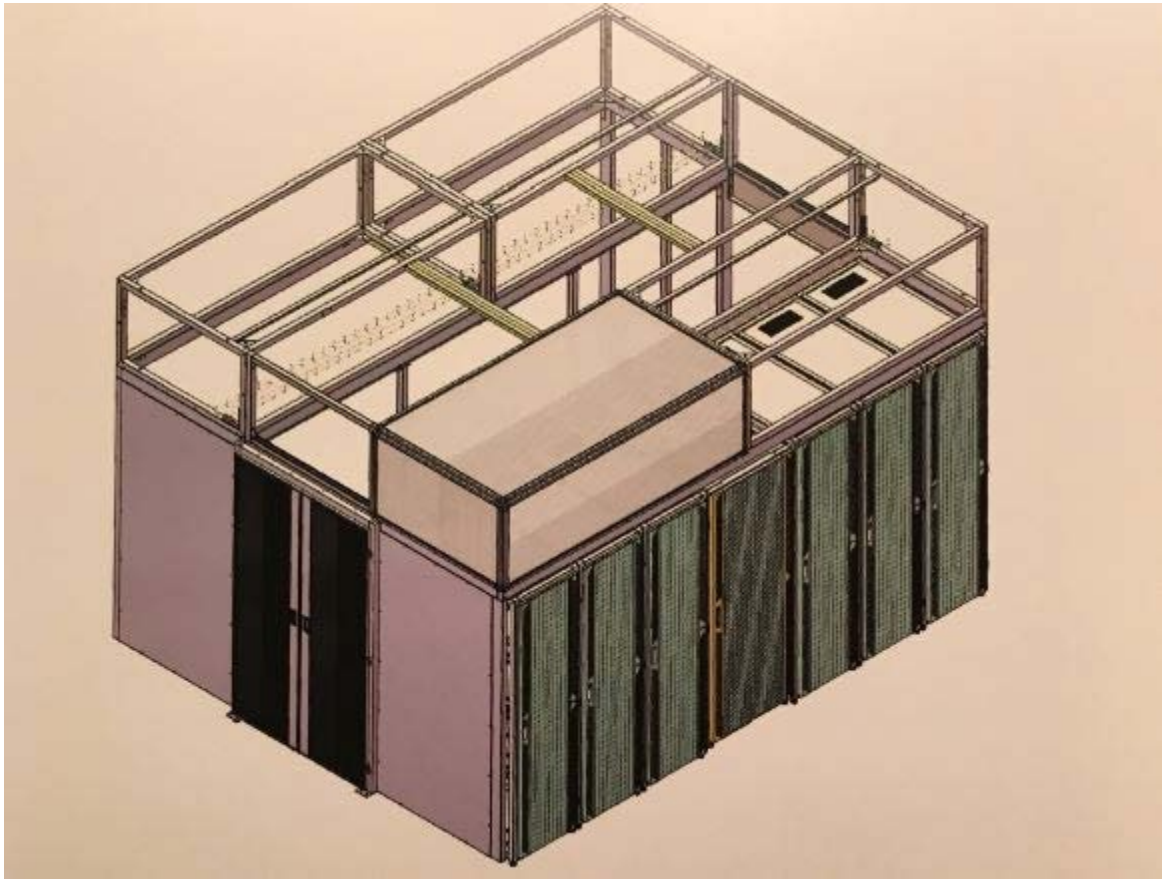

The JPL Standard Rack (con’t)

Thank You

Questions?