ASHRAE IT Power Trends

ASHRAE’s Datacom Series’ IT Equipment Power Trends, third edition, published earlier this year brought about three significant tools to help data center owners and design engineers better estimate the current and future power demands in data center designs as follows:

1. Power trends as a function of workload (software applications);
2. Compound annual growth rate (CAGR) metric to estimate future growth needs; and
3. Boundary conditions (typical vs maximum configurations).

Next to the Thermal Guidelines, the IT Power Trends is one of the most significant and impactful publications for the data center industry. The updates to this third edition help to solve one of the most misunderstood publications by HVAC engineers by attempting to quantify power consumption as a function of workload and how it can deviate significantly from maximum configurations (i.e., below them).

The original publications sought to raise awareness about the increasing power demands of the IT equipment as a function of the product class and year released. The trends aimed to provide a consensus of the IT manufacturers peak power demands, assuming maximum configuration, and fully utilized. This was an attempt to define the worst possible condition or extreme for power requirements for a given data center.

Each subsequent edition of Power Trends has attempted to further expand and clarify the diversity in the product classes, configurations, and utilizations as a function of software applications. Updates to IT Power Trends have been adapted to consider how the industry is evolving including taking into account the increasingly common practice to use purpose-built servers tailored to specific software applications.

This trend has led to the next evolution server power trends reflected in the third edition of Power Trends. The trends now reflect the power of these purpose-built servers when being used to perform specific workloads.

This column serves as an introduction to the updates in Power Trends.

Power Trend Evolution

As with previous editions, the intended use for the book is as a reference for making current and future server power usage projections. These projections

Donald L. Beaty, P.E., is president, David Quirk, P.E., is vice president, and Jeff Jaworski is an engineer at DLB Associates Consulting Engineers, in Eatontown, N.J.
are particularly useful when planning the design and construction of new, expanded, or renovated data centers. Keep in mind that the trend data represents a consensus opinion of representatives from participating IT manufacturers. The data is not intended to be utilized as a baseline for making product comparisons. They are also not intended as the only reference for the design of a new data center. A new design should begin with an understanding of the company’s goals, both now and in the future.

*Power Trends* has evolved with a focus on becoming easier to understand and apply. The following is a recap of the timeline of changes:

**Uptime Institute, 2000:**
Four trend bands presented graphically and categorized by equipment type (Figure 1).

**First edition, 2005:**
Seven trend bands presented graphically and categorizing by equipment type (Figure 2).

**Second edition, 2012:**
Nine compute server trend bands presented graphically over multiple charts and categorized by equipment type and the number of CPU sockets deployed within its servers. Figure 3 shows one of the six compute server charts with four of the nine compute server trend bands.

**Third edition, 2018** (Figure 4):
- Seven workload types defined
- Workload types correlated with their typical server configurations
- CAGR introduced with values assigned to each server configuration associated with a workload type.
Trends presented for each workload type and bounded by “Maximum Expected” and “Typical Expected.”

The above is best represented with graphics to depict the evolution of changes to the main power trends. The following figures and descriptions help to paint the historic picture.

As shown in Figure 1, the original trends chart published by the Uptime Institute had the equipment types divided into four broad categories. At this point in time, the communications equipment was noted as the highest density based on the commonly smaller footprint frames used at the time.

This began to lead to confusion for the industry as many argued that communications equipment was not the most dense, particularly when configured in larger cabinets. This is an important item to note later in the third edition and part of the reason why the product footprint was ultimately abandoned.

First Edition

These equipment types were further divided into seven categories when published in the first edition of Power Trends as noted and shown below in Figure 2. This was in response to the industry developing a broader range of hardware configurations (e.g., blade servers) that expanded the range of potential density for a given type.

Equipment Types

- Communication equipment
  - High density
  - Extreme density
- Compute Servers
  - 1U, Blade, custom
  - 2U and higher
- Storage Servers (disk storage systems)
- Workstations (stand-alone)
- Tape storage systems

Second Edition

The second edition stayed with the same seven equipment type classifications for the hardware, but further expanded the sub-types by more granularity with the applications as noted below:

- Scientific
- Analytics
- Business Processing
- Cloud/IPDC (Internet Portal Data Center)
- Visualization & Audio
- Communications/Telco
- Storage

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<table>
<thead>
<tr>
<th>Table 1. Workload Types.</th>
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<tbody>
<tr>
<td><strong>Workload Type</strong></td>
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<tr>
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</tbody>
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Note: Web Hosting & Cloud/IPDC is a defined workload, examples include wikis, portals, social media, video-sharing websites, search engines, and online auctions. This should not be confused with cloud service providers.

Third Edition

In the current edition, the evolution and development of methods for projecting future power consumption took another fundamental leap. Workload types have been introduced as a means of reflecting server configurations and utilization.

Trends were modified to be based on a 42U cabinet instead of using cabinet footprint. This was done to make the information easier to use and apply in application since cabinet footprints were largely variable and customer dependent.

Trends for custom servers, blade servers and workstations were eliminated as there was too much variation
and inability to gain consensus on the data.

Server configurations and their utilization for each workload were also identified.

**Workload Types**

The transition to using workload type was brought about by the recognition that “software is the real load in data centers.” These workloads and their software drive server energy usage composed of a mix of both transient and steady-state components.

At the high end of the energy usage trends is the scientific workload. This is composed primarily of steady-state server utilization at a high level since they are continuously “crunching numbers.”

Toward the lower end is the Business Processing Workload, where processor utilization is composed of longer idle periods during data entry followed by spikes after the data has been entered.

**Future Growth Trends Using CAGR**

Compound annual growth rate (CAGRs) has also been introduced in the current edition with actual values for each workload type and their common server configurations. These values represent a consensus of the participating IT equipment manufacturers and strive to take into account:

- Historic growth rates;
- Economic factors;
- Market demands;
- Projections of computational performance improvement via: hardware advances and optimization and software refinements and tuning; and
- Projections of new application development.

These CAGRs are intended to serve as a technical reference for estimating future power usage. The equation for using the CAGRs is:

\[
\text{Future load} = \text{Current Load} \times (1 + \text{CAGR})^{(t-t_0)}
\]

Upon review of this equation, the following observations became apparent:

**Highest CAGRs**

- **CAGR:** 4.7%
- **Workload:** Analytics
- **Form Factor:** 1U ½-width

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**When commercial grade isn’t enough.**
• Sockets: 2 CPUs
  CAGR: 4.1%,
• Workload: Scientific
• Form Factor: 1U
• Sockets: 2 CPUs
  CAGR: 2.9%,
• Workload: Visualization & Audio
• Form Factor: 1U ½-width
• Sockets: 2 CPUs (Non GPU)

One of the conclusions that can be drawn from this is that significant focus is being placed on these three workload types and the IU & 1U 1/2-width servers.

It is reasonable to expect that the CAGR values reflect market demand for a server configuration and thus the IT industry’s focus on continued development of that configuration. In other words, high CAGR values are for Workloads where demand for cutting edge servers is highest.

Boundary Conditions

Trends by workload type are provided with boundaries for maximum expected and typical expected rack power levels based on the year of project introduction (Figure 5).

Historically, the biggest misconception of Power Trends was that the forecasted maximums were the typical. Arguably, this lead to many over-provisioned data centers as many engineers designed to these forecasted maximums. The delta between the typical expected and maximum expected is significant as shown in Figure 5.

The range between typical expected and maximum expected requires some iteration and understanding of how a client configures their equipment in a rack, how much utilization is expected, and the workloads of the software on that configured hardware.

Conclusions

This third edition of Power Trends provides much more detailed information that can be utilized by data center owners and design engineers to develop realistic power growth projections for use in planning their data centers. The challenge now becomes acquiring the detailed insight into the IT plans and strategies to utilize this new trend information to is full potential.

The software applications running on the equipment will dictate power densities and they will never be the same as these published hardware trends. The published values are based on actual power measurements of servers performing each workload. These measurements were then adjusted to correspond with 42U cabinets fully provisioned with servers.

Each data center has a unique combination of the following that ultimately dictates the real power trends in a given data center:

• Equipment types;
• Equipment configurations;
• Equipment utilizations (how much of the cabinet is populated, how much of the row is populated, etc.);
• Software applications;
• Software utilizations; and
• Technology refresh rates (how often is equipment changed out).

The evolution of ASHRAE Power Trends helps demonstrate some of the factors that have gone into further clarifying the combination of hardware and software trends that have driven the power increases in data centers over the years.

Armed with the third edition of Power Trends, and a deeper understanding of the intended applications, data center owners and design engineers are better equipped to plan their next data center growth project.

References


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WHAT’S INSIDE MATTERS

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