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Petascale and Beyond Facility Planning

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Things I have learned about Petascale and Beyond Facility Planning

Initial Key Question(s)

- What is the impact of multi-core chips versus the performance gain?
- What is the impact of the additional power / cooling requirements of having reduced power idle cores?

Impact of Processor Options

- Power & cooling bills for commodity cluster systems are substantial when compared to the up-front cost of the processors
- Data latency becomes more of an issue as processor speed outstrips memory speed
- Network to connect the 1000s of processors requires more power than the processors themselves
  - Richard Walsh AHPCRC

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Note - Review power requirements from HPCwire Steve Scott 7/7/06 article

- Multi-core processors embody the approach of reducing speed and power requirements
- this exacerbates the scaling problem
- The memory wall gets worse, there's more memory contention,
- codes have to be more parallel,
- the communication-to-computation ratio gets worse

Note - Review power requirements from HPCwire Steve Scott 7/7/06 article

- Another alternative is to design processors that have much lower control overhead and use more of their silicon area for performing computations.
- Streaming processors, vector processors and FPGAs are example of this approach, which can result in much faster single processors for the right types of codes
- Microprocessor vendors have a big motive to reduce power consumption because it affects their whole market, not just the relatively small HPC segment.

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HPCwire Editor Notes - 7/7/06

- Gustafson's example of the 5 cents/kilowatt-hours energy cost at the Pacific Northwest National Laboratory versus 23 cents/kilowatt-hours at the Maui High Performance Computing Center is a powerful example of how economic geography is affecting the price of computing.

NEW - Load Trends and Their Application

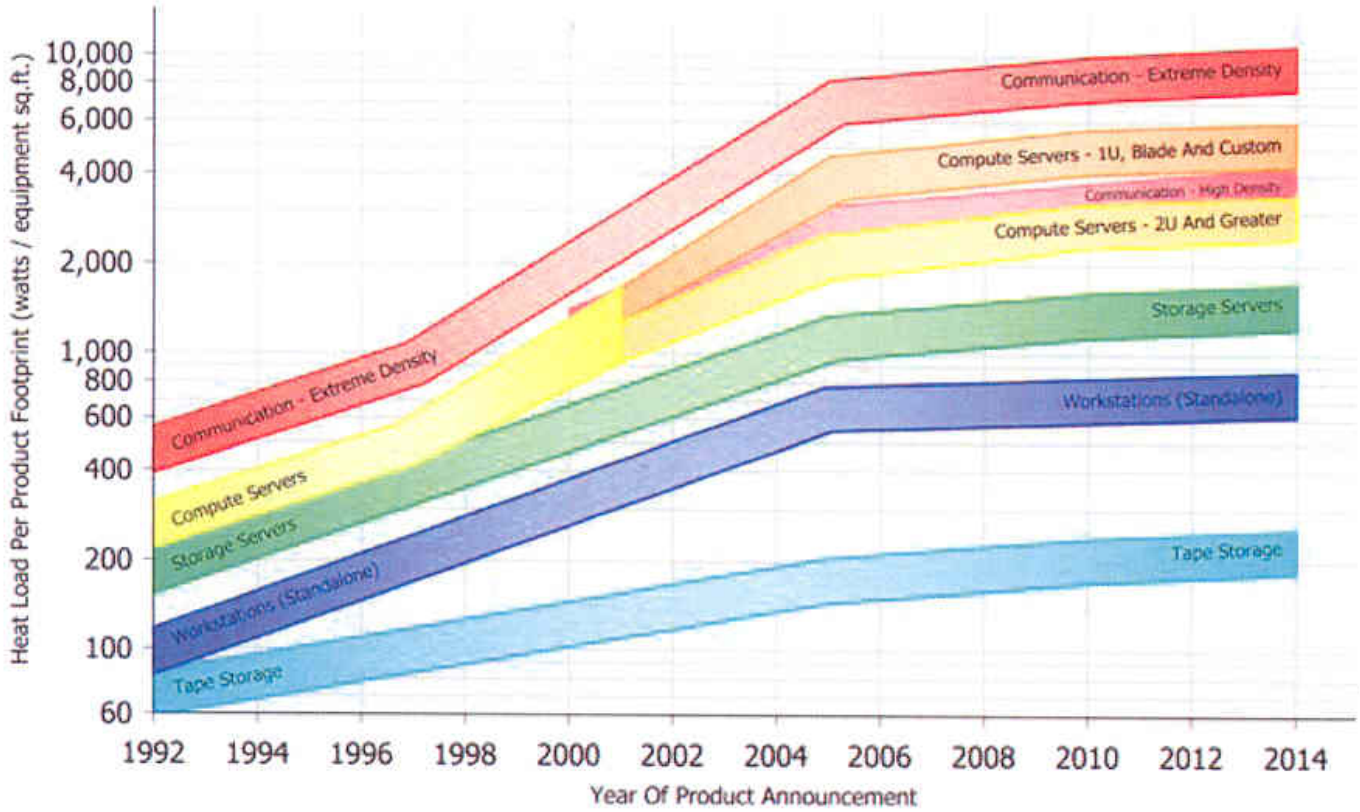


Figure 3-10 New ASHRAE updated and expanded power trend chart.

ASHRAE, Datacom Equipment Power Trends and Cooling Applications, 2005. © American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., www.ashrae.org.

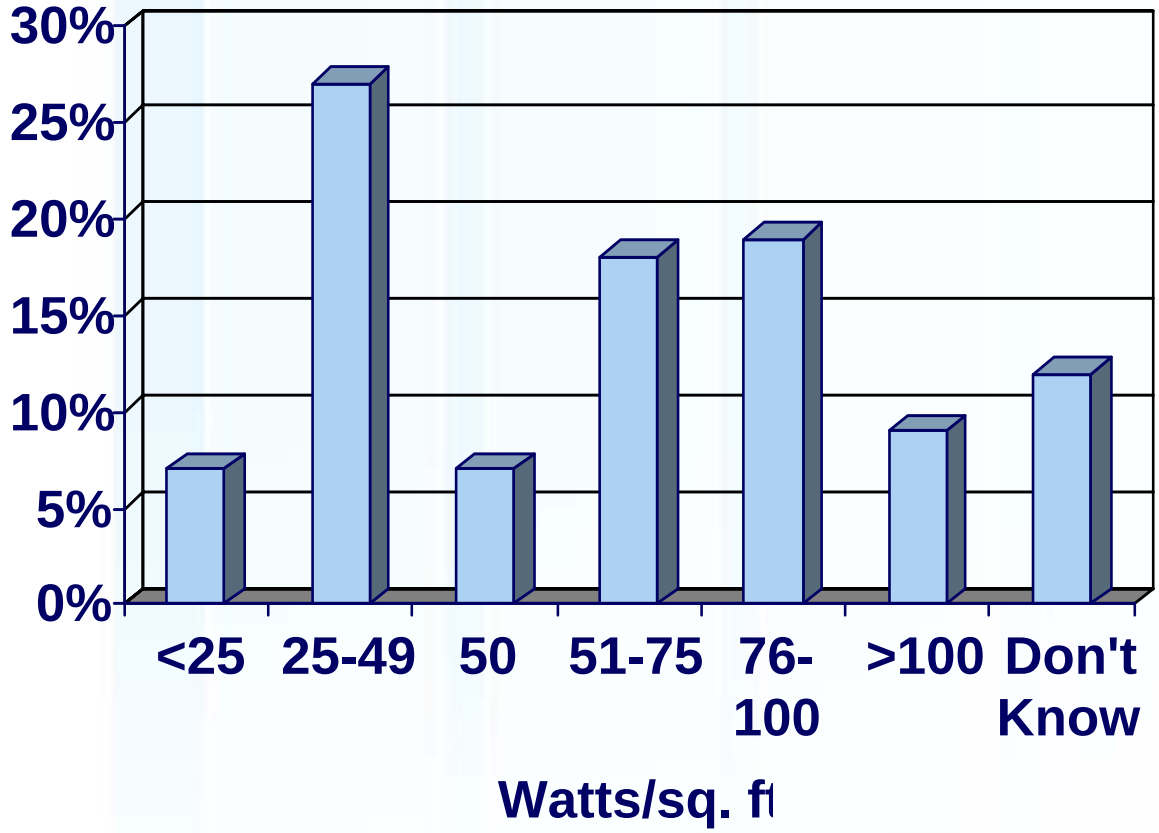
My Thoughts

- The chips, while getting cooler, still impact the computer room facility
- Still need lots of software to take advantage of the multiple cores

Computer Room Needs are Different

- Enterprise computing is more diverse
  - A combination of heat loads ranging from 6 kw / rack to 24 kw/rack
  - This leads to hot spots in the computer room
- Petascale compute facilities are not as diverse
  - This means hot spots in a computer room are becoming hot rooms with cool spots

Design capacities of existing facilities



Power requirement

- Higher density servers increase rack densities and facility power requirements
- Racks are getting hotter
  - 2000 - 28, 2U servers = 2 kw Heat Load
  - 2002 - 42, 1U servers = 6 kw Heat Load
  - 2006 - 6 Blade Centers = 24 kw Heat Load
  - 2008 - ????
    - Not sure, but normal room cooling probably won't work

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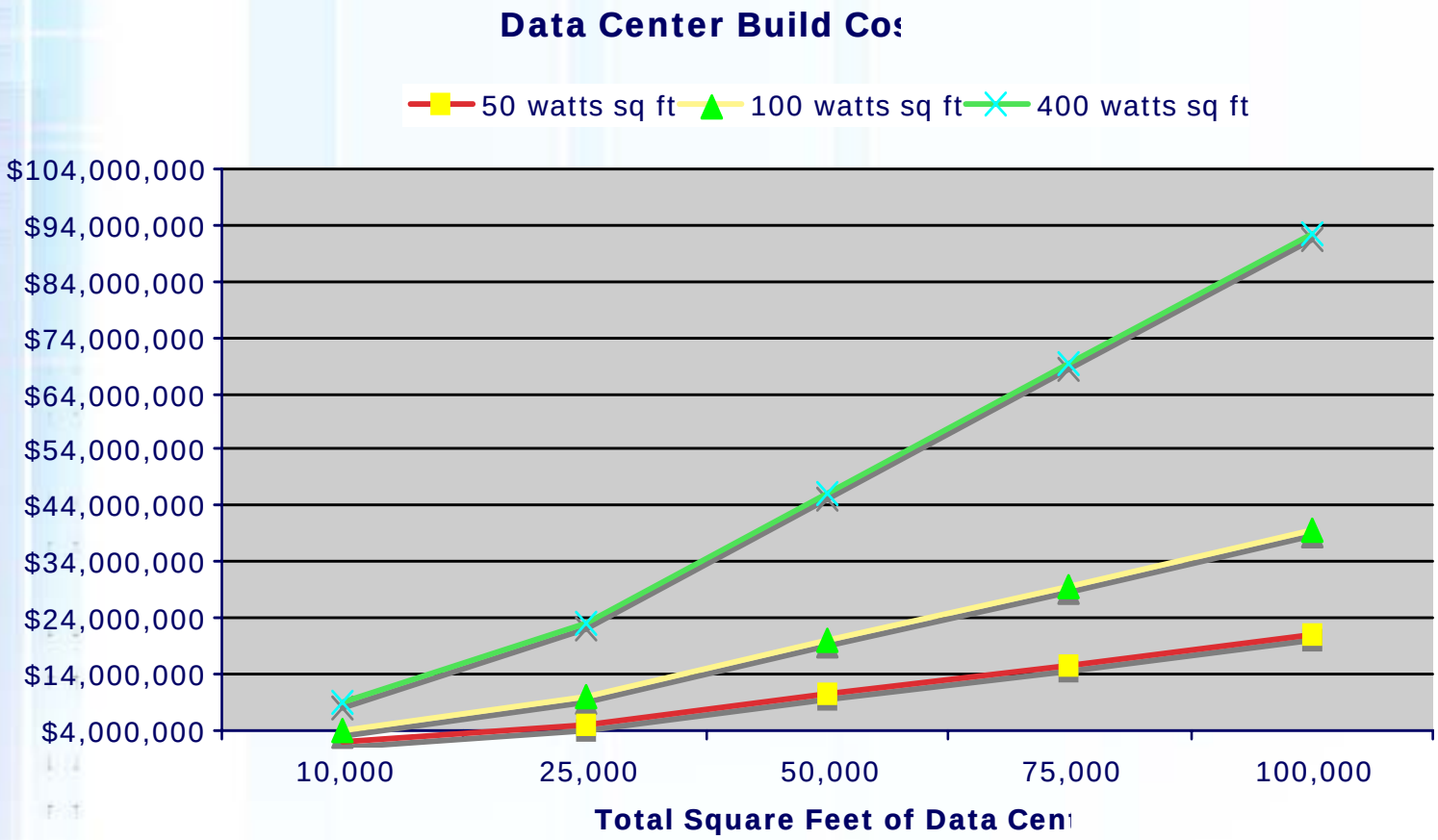
Long term impact

- A 1000 sq. ft. facility, with a cooling capacity of 50 watts / sq. ft. can support 100 1kW racks
- A 1000 sq. ft. facility, with a cooling capacity of 50 watts / sq. ft. can support 20 5kW racks
- A 1000 sq. ft. facility, with a cooling capacity of 50 watts / sq. ft. can support 5 10kW racks

The Impact of dense computing



Must support supplemental Cooling

- Water has a larger thermal capacity versus air
- Raises Water versus refrigerant debate (again)
- Do you really want to use floor space for cooling units?
- Must use Cooling Towers

My thoughts II

- Existing computing facilities not only cannot support a petascale system, they won't be able to support subsets of the petascale environment
- There will not be a trickle down effect
- What about storage?

Some Disk Storage Costs

- Disks are power hogs
- 100 terabyte disk requires 40KWh of power
  - At 5 cents a KWh it costs $48.00 a day
  - Or $17,520 a year to use
  - Plus another $5,732 a year to cool
- So 1 PB would require $232,520 / year
- 10 PBs would require $2,325,200
- A 100 PB storage would need $23,250,000 in power

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Conclusions

- Must look at all costs
  - Energy
  - HVAC
  - Fire Protections / Plumbing
  - Architectural
  - Maintenance of Infrastructure
  - Support Staff

Conclusions

- The availability and costs of power will limit location of petascale facilities
  - Does that mean they become attractive targets?
- Air cooling must be replaced or augmented by water or some other liquid cooling option

My Thoughts III

- Petascale Computer Room $45,000,000
- Petascale System $100,000,000
- Power to run system $25,000,000/year
- Number 1 system on Top 500 list

Priceless