Power, Cooling and Energy Consumption for Petascale and Beyond

SC07 Birds-of-a-Feather
14-Nov-07

Agenda

- ASHRAE TC9.9 Overview (Tim McCann, SGI)
- The Green Grid^{SM} Overview (Tahir Cader, ISR)
- Other Initiatives (Tim McCann, SGI)
- Discussion

American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE)

- Non-profit technical society (formed 1894) specializing in cooling
- Over 50,000 members & 2000 technical committee members
- Focuses on maintaining an unbiased role within the industry
- Actively writes standards, guidelines, model codes, etc.
- Over 100 standards / guidelines & almost 100 technical committees

Ice Cooled System
(Circa 1890)

General Electric Room Cooler
(Circa 1932)

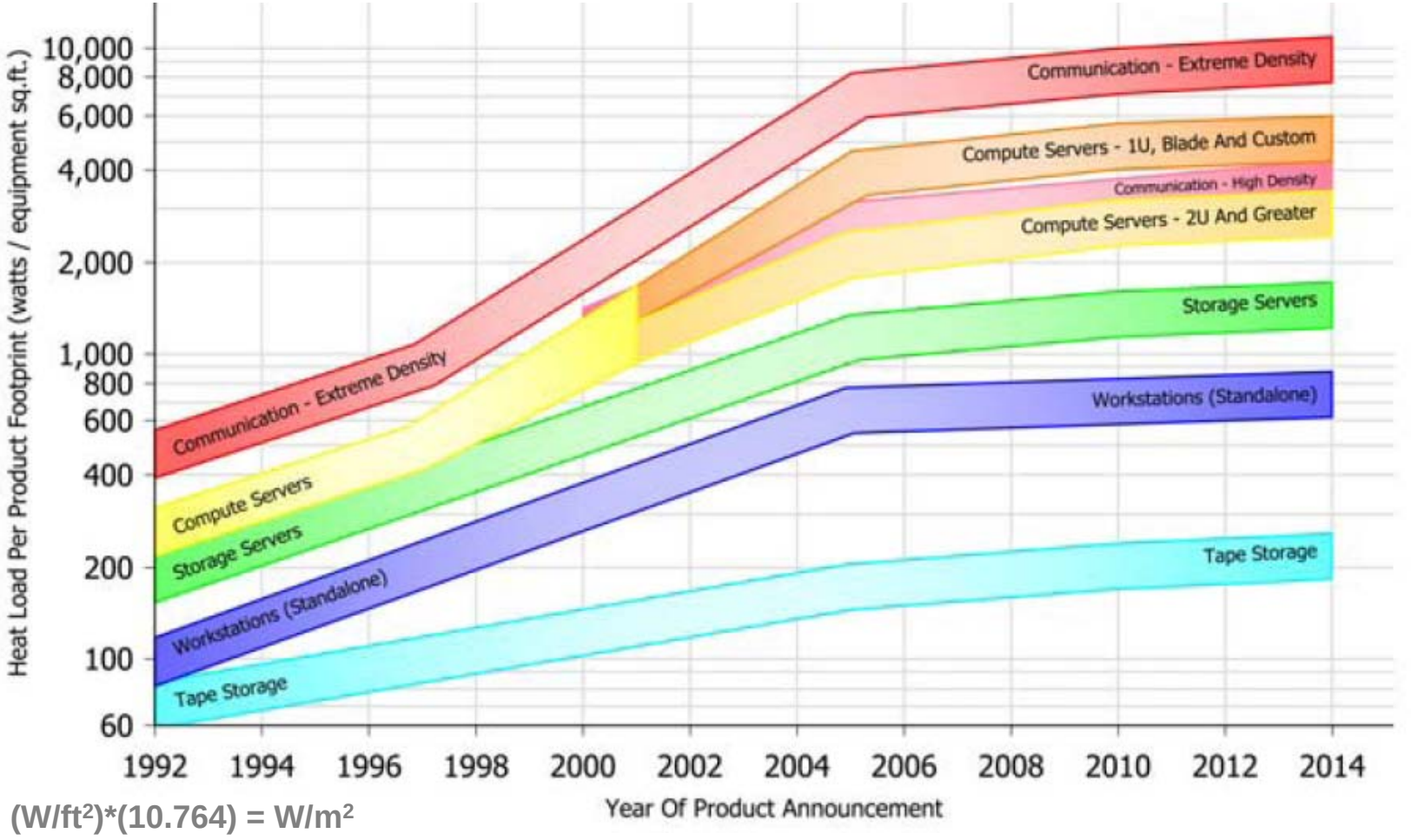
Computer Room Air Conditioner
(Circa 1970)

ASHRAE TC 9.9 “Mission Critical Facilities, Technology Spaces and Electronic Equipment”

- Members (16 voting / 125 corresponding)
  - Vibrant Technical Committee with membership comprised primarily of datacom OEMs, facilities infrastructure manufactures, design & build firms, data center managers, end-users, consultants, academia, etc.
  - Originated in 2001
- Mission Statement
  - To be recognized amongst all areas of the datacom industry as the unbiased engineering leader in HVAC and an effective provider of technical information for the datacom industry
- Scope
  - All datacom facilities (datacom stands for data processing & communications facilities) including rooms, communications closets, computers, or electronic equipment
- http://tc99.ashraetcs.org/

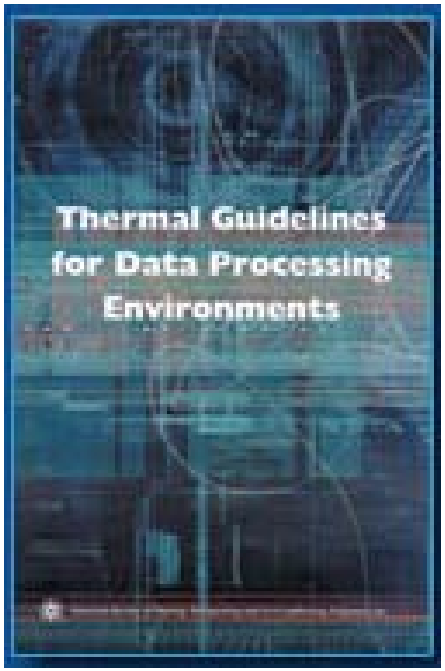
ASHRAE TC 9.9, 2005

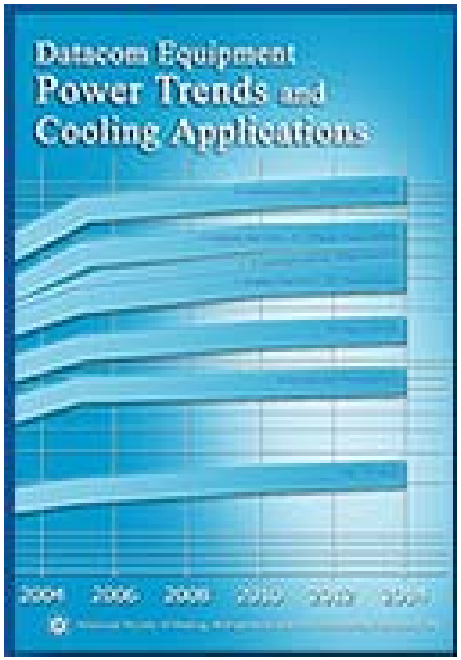
Mission Critical Facilities, Technology Spaces & Electronic Equipment

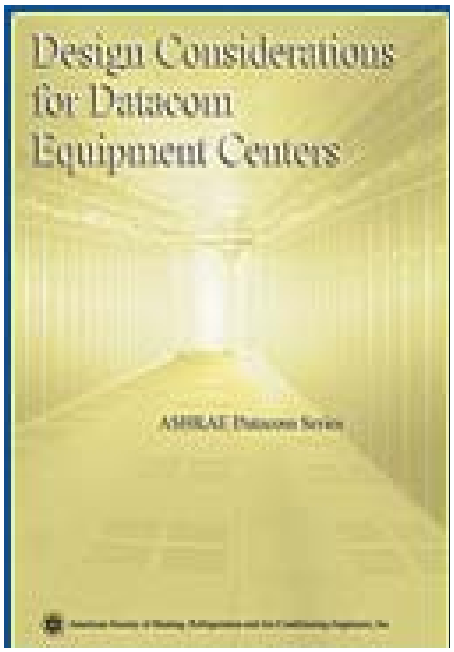


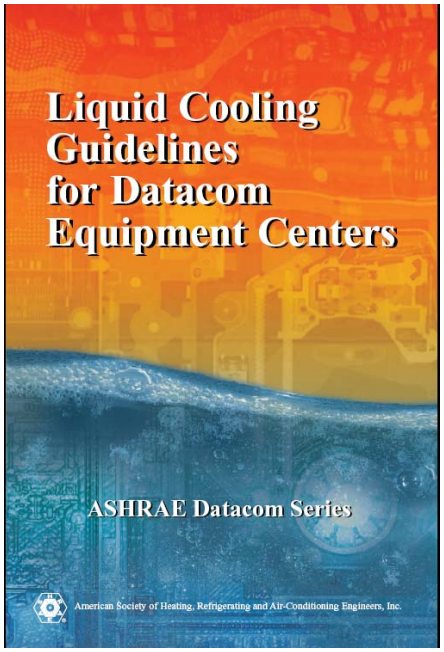
$(W/ft^2)*(10.764) = W/m^2$

ASHRAE TC 9.9 Publications









- Order from http://tc99.ashraetcs.org/

ASHRAE TC 9.9 Items of Interest

- Publications In-Work
  - Best Practices for Datacom Facilities Energy Efficiency
  - Shock and Vibration Guidelines for Datacom Equipment Centers
  - High Density Data Centers - Case Studies and Best Practices
  - Particulate Matter in Datacom Environments
- Considering expansion of recommended Equipment Environmental Specifications
  - Found in “Thermal Guidelines for Data Processing Environments”, 2004
  - Present Class I: 20°C to 25°C, 40% to 55% RH, 17°C dew point max
  - Broader range desired to allow more air-side economizer hours
- Research Topic Acceptance Request to ASHRAE
  - “Effect of Humidity on the Reliability of Data Centers”
- Working collaboratively with The Green Grid^{sm} and others

ASHRAE TC 9.9 Contact Information

- http://tc99.ashraetcs.org/

- Committee Chair:
  Roger Schmidt c28rrs@us.ibm.com

The Journey … From Green Destiny to Green500 (2002 to 2005-2007) List

- Green Destiny (Born February 2002)
  - "Honey, I Shrunk the Beowulf!" *31st Int'l Conf. on Parallel Processing*, August 2002.
- Keynote Address (April 2005)
  - The Evolution of Power-Aware, High-Performance Clusters *IEEE Int'l Parallel & Distributed Symp. Workshop on High-Performance, Power-Aware Computing* --> Generates the initial discussion for Green500 List
- Making a Case for a Green500 List (April 2005 & Sept 2006)
  - *IEEE Workshop on High-Performance, Power-Aware Computing*
  - Jack Dongarra's *CCGSC Workshop* --> "The Final Push"
- Launch of Green500 Web Site and RFC (September 2006)
  - http://www.green500.org --> Generates feedback from hundreds

Source: Dr. Wu-chen Feng, Virginia Tech

Creating a *Green500* List

Ranking the most energy-efficient supercomputers in the world

- Challenges
  - Find a metric*
    - Performance / Measured Power
      - For now, Linpack FLOPS from TOP500 / Measured Power
        - » Use Peak Power, if Measured Power is unavailable.
  - Decide what to measure
    - The largest possible “unit” (excludes facility cooling)
  - How to measure it
    - In-line power measurement
  - Example
    - A Green500 supercomputer using measured power (instead of peak power) jumps up 70 spots on the Green500 List.

* Towards Efficient Supercomputing: Choosing the Right Efficiency Metric, IEEE IPDPS/HPPAC, April 2005.

Source: Dr. Wu-chen Feng, Virginia Tech

80 Plus

- The 80 PLUS program is a unique forum that unites electric utilities, the computer industry and consumers in a groundbreaking effort to bring energy efficient power supplies to desktop computers and servers
- http://www.80plus.org/

Source: http://www.80plus.org/index.htm

Climate Savers Computing Initiative

- Nonprofit group of eco-conscious consumers, businesses and conservation organizations started by Google and Intel
  - The Initiative was started in the spirit of World Wildlife Fund's Climate Savers program which has mobilized over a dozen companies since 1999 to cut carbon dioxide emissions, demonstrating that reducing emissions is good business
- Goal is to promote development, deployment and adoption of smart technologies that can both improve the efficiency of a computer's power delivery and reduce the energy consumed when the computer is in an inactive state
- http://www.climatesaverscomputing.org/

Source: http://www.climatesaverscomputing.org/program/index.html

U. S. Environmental Protection Agency (EPA) ENERGY STAR Program

- Currently developing a new product specification for enterprise servers
  - Partners and other interested parties who would like to participate in this process are encouraged to contact Andrew Fanara, EPA, at Fanara.andrew@epa.gov.
- Whole Building Energy Analysis for Data Centers and Financial Service Centers
  - EPA has been investigating ways of updating the ENERGY STAR Portfolio Manager tool's rating capability for buildings with extensive allocation to data centers and other server equipment
  - For more information on these efforts, please email benchmark-datacenters@energystar.gov.

Source: http://www.energystar.gov/index.cfm?c=prod_development.server_efficiency

U.S. Department of Energy
Energy Efficiency and Renewable Energy

- The Industrial Technologies Program, through Save Energy Now, will work with U.S. computer data centers to reduce their energy consumption
- http://www1.eere.energy.gov/industry/saveenergynow/partnering_data_centers.html

Source: http://www1.eere.energy.gov/industry/saveenergynow/partnering_data_centers.html

What Next?

- Conferences?
  - ISC'08 (June 2008, Dresden)
  - IPDPS (April 2008, Miami)
    - HPPAC
  - SC08 (November 2008, Austin)
  - ?
- Activity?
  - BoFs
  - Panels
  - Workshops
  - Information Portals
  - Special Issue publications
  - Standards coordination
  - ?
- Steering Committee?

References / Legal

80 Plus Program, http://www.80plus.org/index.htm, accessed 11-09-07

American Society of Heating Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 2004, “Thermal Guidelines for Data Processing Environments”, Atlanta, GA

American Society of Heating Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 2005, “Datacom Equipment Power Trends and Cooling Applications”, Atlanta, GA

American Society of Heating Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 2005, “Design Considerations for Datacom Equipment Centers”, Atlanta, GA

American Society of Heating Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 2006, “Liquid Cooling Guidelines for Datacom Equipment Centers”, Atlanta, GA

Climate Savers Computing Initiative, http://www.climatesaverscomputing.org/program/index.html, accessed 11-09-07

Green500, slides courtesy of Dr. Wu-chen Feng, Virginia Tech, 11-14-07, http://www.green500.org/

The Green Grid, “Overview of The Green Grid”, 2007

U.S. Department of Energy (DoE) Energy Efficiency and Renewable Energy (EERE) http://www1.eere.energy.gov/industry/saveenergynow/partnering_data_centers.html, accessed 11-09-07

U.S. Environmental Protection Agency (EPA) ENERGY STAR Program, http://www.energystar.gov/index.cfm?c=prod_development.server_efficiency, accessed 11-08-07