



# Towards Greener Datacenters

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# Outline



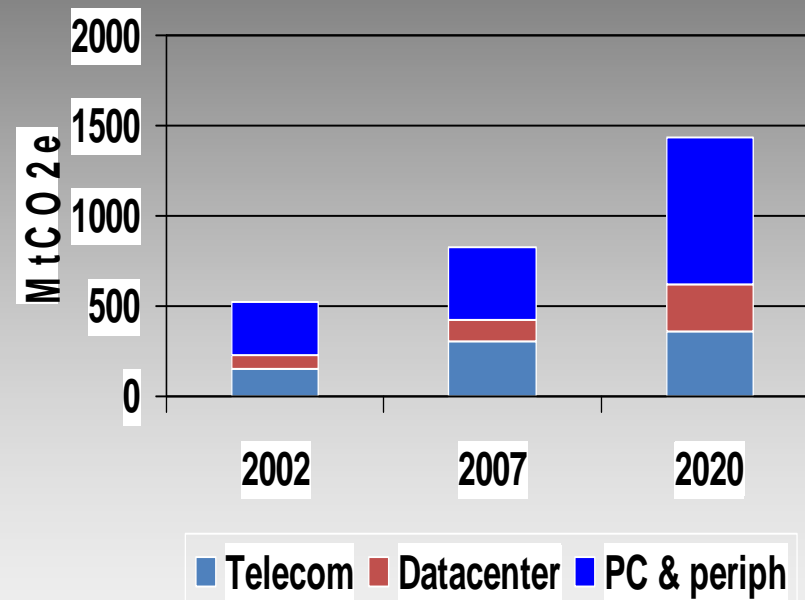
- Drivers towards greener datacenters
- Anatomy of a datacenter
- Current Practice
- Issues and opportunities
- Futures

# Drivers



- Cost
  - Datacenter consolidation
  - IT operations
- Increase resource utilisation
  - Improved efficiency
  - Flexibility
- Limits of current datacenters
  - Compute density
  - Power density >10Kw/Rack
  - Cooling
- Datacenter footprint CAGR 7%

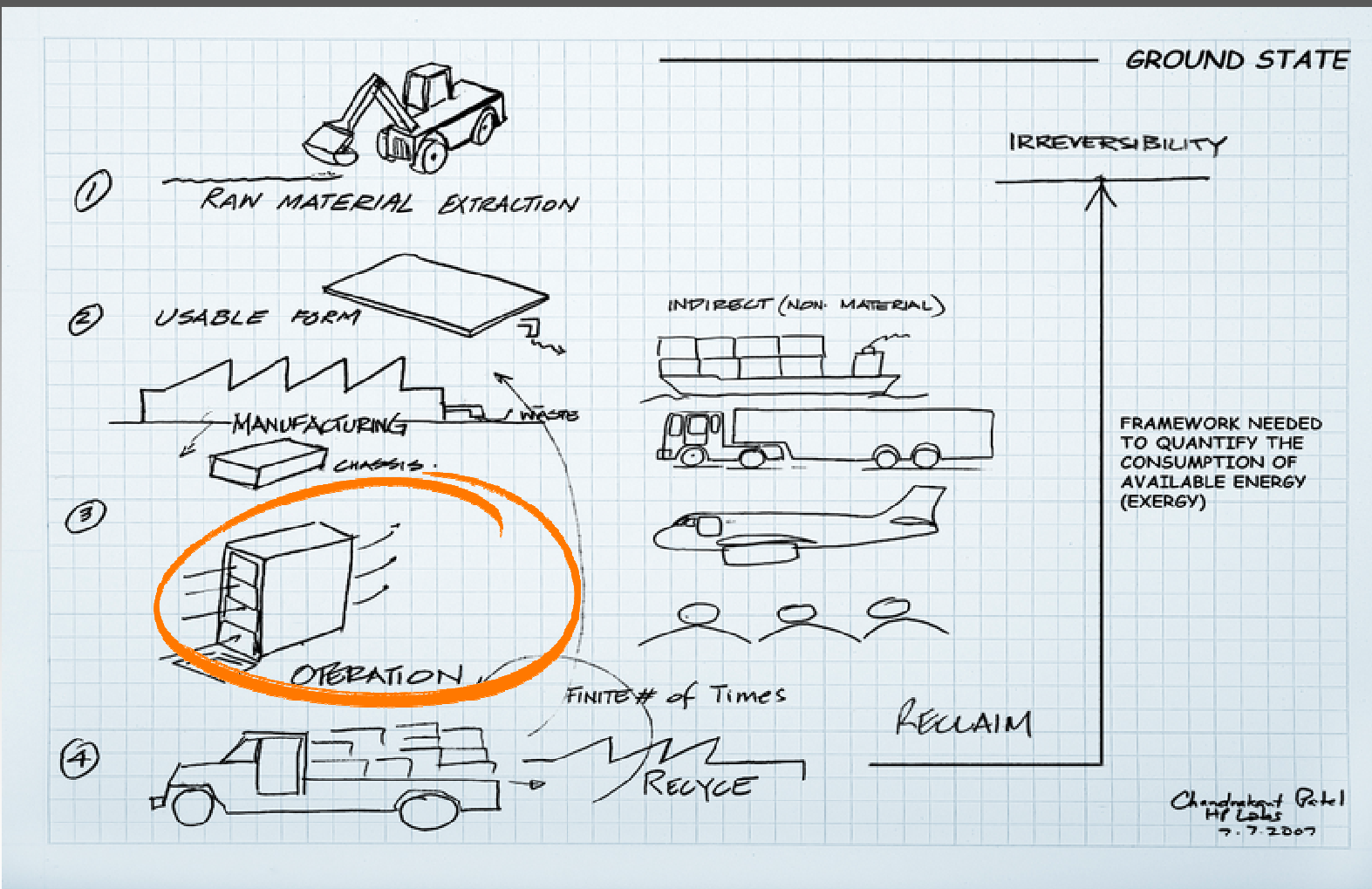
Global Carbon Emission Footprint by sector



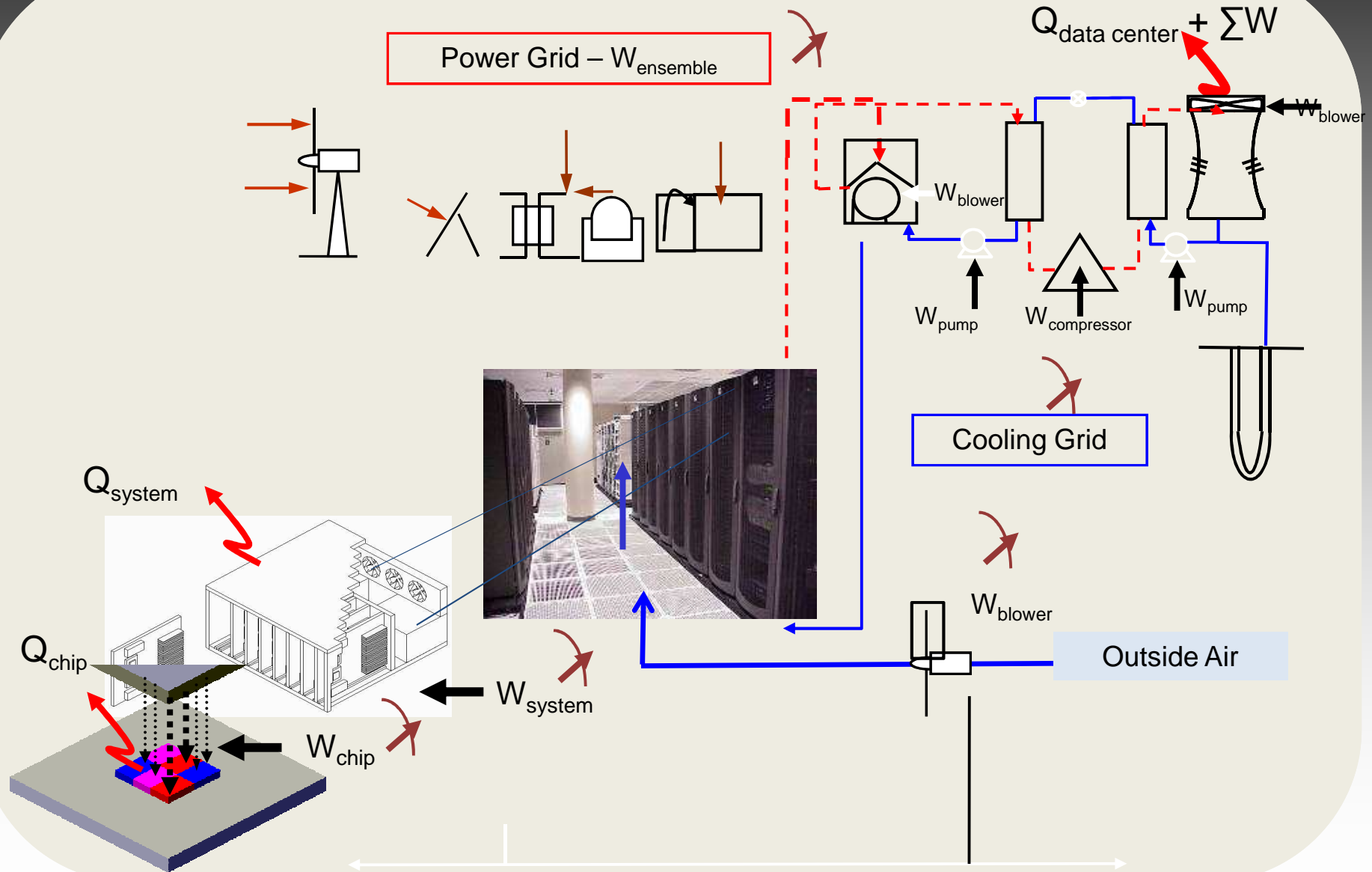
From "SMART 2020 Enabling the low carbon economy in the information age"  
The CLIMATE GROUP Global eSustainability Initiative (GeSI)

# End to End Perspective

Datacenter scale life cycle engineering and management



# Anatomy of a datacenter

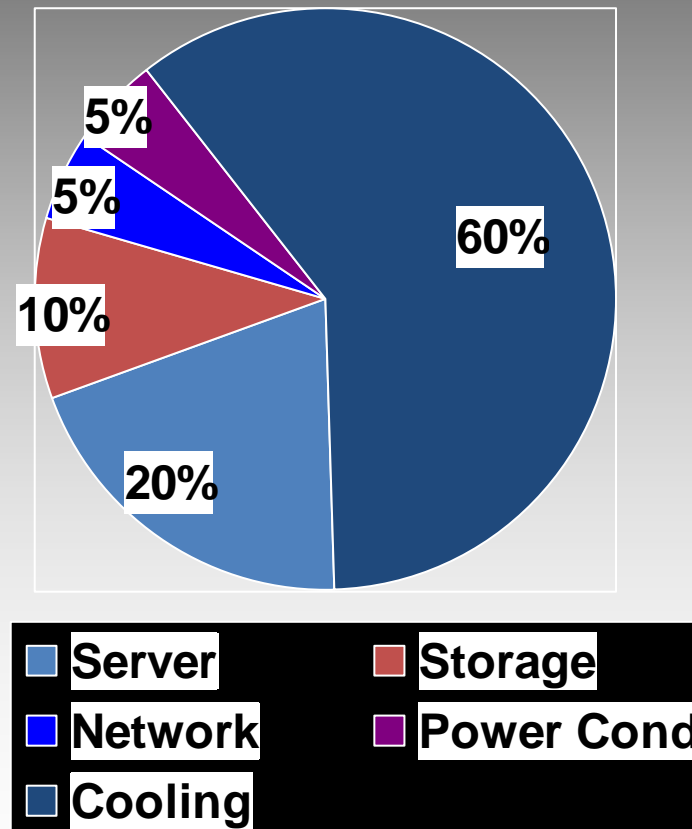


# Current Situation



- Static design tools
- Few controls
  - Power
  - Cooling
  - Workload management
- Emerging TCO tools
- Benchmarks (SpecPower)
- Virtualisation
- Server processors designed for speed on general purpose workloads rather than efficiency for any particular type

Energy distribution



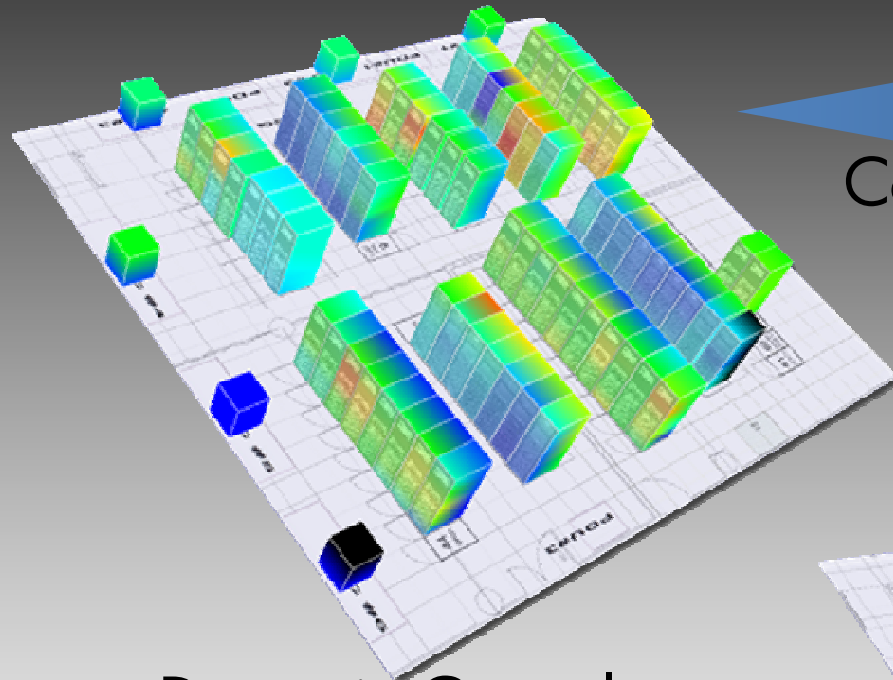
# Issues and Opportunities



- Uncoordinated procurement of components
- Energy benefits of Moore's law not realised
- Lack of standardised measures and controls
  - Measuring useful work
- Smart dynamic cooling
  - Sensors + controls + algorithms
- Intelligent workload management
  - Workload classification and prioritisation
  - Energy cost based service pricing for cloud services
  - Energy cost based workload scheduling
- Location: Renewable energy
  - economic, political , geological & meteorological stability

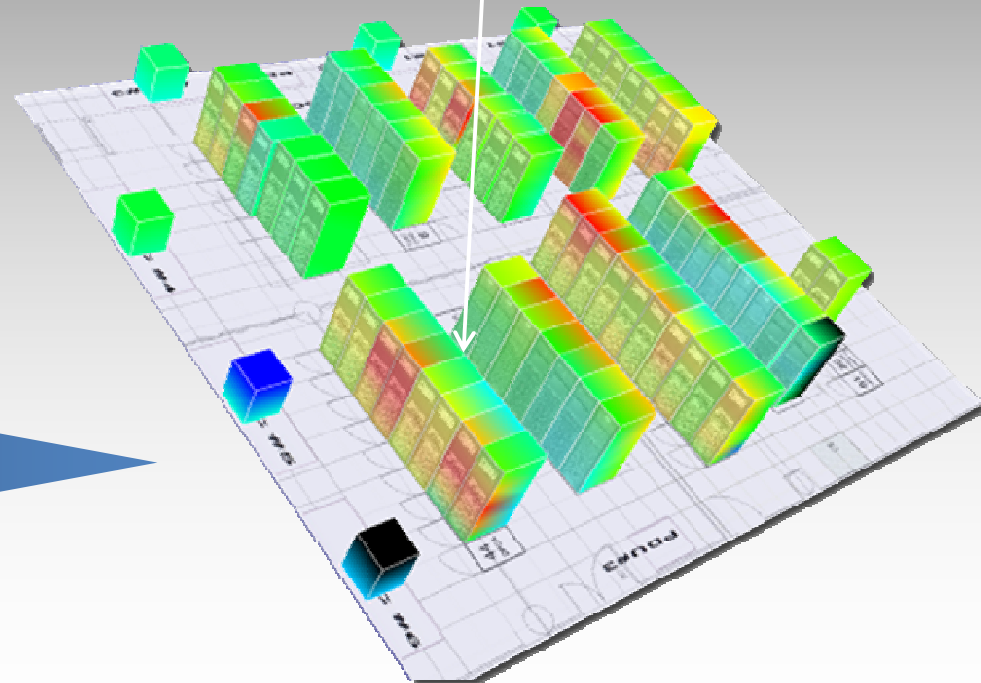
# Control of Cooling Resources

HP Laboratories, Palo Alto Data Center Demonstrator



Conventional Mode

Inlet temperature  
at 25 °C



Dynamic Control  
air flow rate and  
temperature

35% Energy Savings  
Improved reliability



# Standardisation



greengrid.org: a global consortium dedicated to developing and promoting energy efficiency for data centers and business computing ecosystems by:

- Defining meaningful, user-centric models and metrics
- Promoting the adoption of energy efficient standards, processes, measurement methods and technologies
- Developing standards, measurement methods, processes and new technologies to improve performance against the defined metrics

– 9 Board, 37 Contributor and > 100 general members

–  $PUE = (\text{Total facility power}) / (\text{IT equipment power}) = 100/35 = 2.85$   
= (Cooling Load Factor) + (Power Load Factor) + 1.0  
CLF = (Cooling power) / (IT equipment power)

– Datacenter productivity  $DCP = (\text{Useful Work}) / (\text{Total Facility Power})$

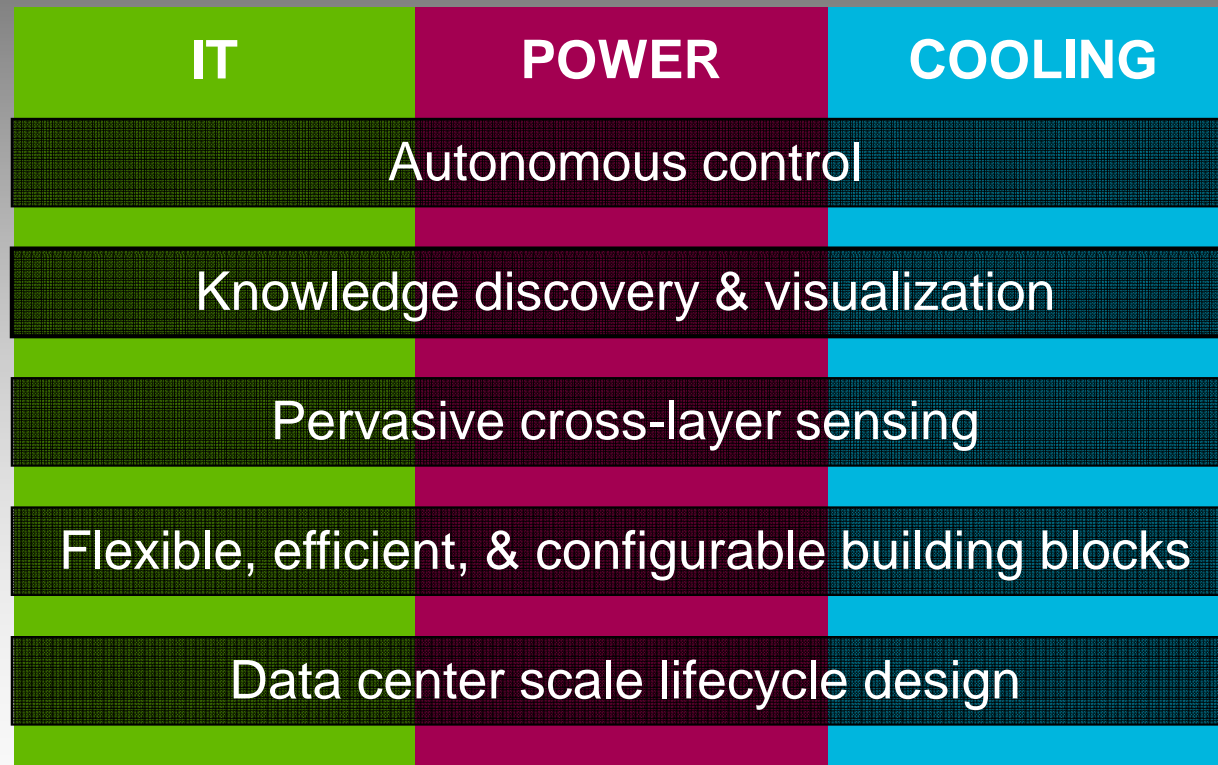
– Datacenter component efficiency Standards



# Greener Data Center



Transparent, efficient and light by end-to-end design and management



# Futures



- Datacenter is the computer
  - dematerialisation
  - direct cooling
  - OS manages Compute, Storage, Network, Power & Cooling resources
- Upside technology improvements
  - Optical interconnects
    - board, chassis and rack level
  - Solid state storage
  - High speed nonvolatile memories
    - memristor, MRAM  $10^{-12}$  Joules/Bit op (Theoretical limit  $10^{-21}$ )
    - 0 idle power consumption
  - Reconfigurable processors
  - Reversible computing



Thank You