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Achieving Carbon & Cost Accounting Per Service or Task, through Data Collection and Simulation Modelling

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Why we need per-service accounting

Why implementing it is hard

How simulation and grid may be a solution

Where we are now

A lot of work has been done on improving the energy efficiency of data centres

- Better cooling strategies
- More efficient, multicore servers
- Virtualisation & grid
- Modular UPS systems
- Energy supply (CHP, Hydro, …)
- More efficient storage (flash / optical)

Just two problems…

Problem 1: Exponential increase in demand

Science, Engineering and Financial Markets now depend on IT

- Platform: customers planning for 50x increase in 3 years (OGF23)
- EU CoC: 56TWh - 2007 to 104TWh – 2020
- Energy saving technologies (virtualisation, more efficient coolers, etc) win only once.

Energy efficient IT is not enough

- Energy efficient IT is cheaper, unlocking demand
- Rebound effect

"If we build it, they will come"

Problem 2: How do we measure efficiency?

Efficiency = Output / Input

Input = energy cost

Output = ???

IT values: SPECint, FLOPS, TPS

How do these relate to “useful work”?

Business value: no global definition

Only the business concerned can decide

The answer: per-service energy accounting

“For each Watt my data centre consumes, what output do I get?”

vs.

“For each service I deliver, how much energy do I use?”

The answer: per-service energy accounting

Macro Scale restriction or targeting of 'IT Energy Use' is not an effective approach

- We need to examine each system on a case by case basis
- In the context of what benefit the system delivers

Instead we should ask;

"What is the marginal environmental or economic benefit of this IT system?"

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Advantages

Enables energy optimisation of business processes

- "Do I really need to run that job?"

Supports business planning

- "How can I best use my CO^2 allocation?"

Introduces demand management

- "If we build it, can they afford the CO^2 to use it?"

Allows informed allocation of CO^2 credits to services and companies

- Many IT services cut energy use elsewhere in the economy
- Per-service accounting is one part of a larger CO^2 market

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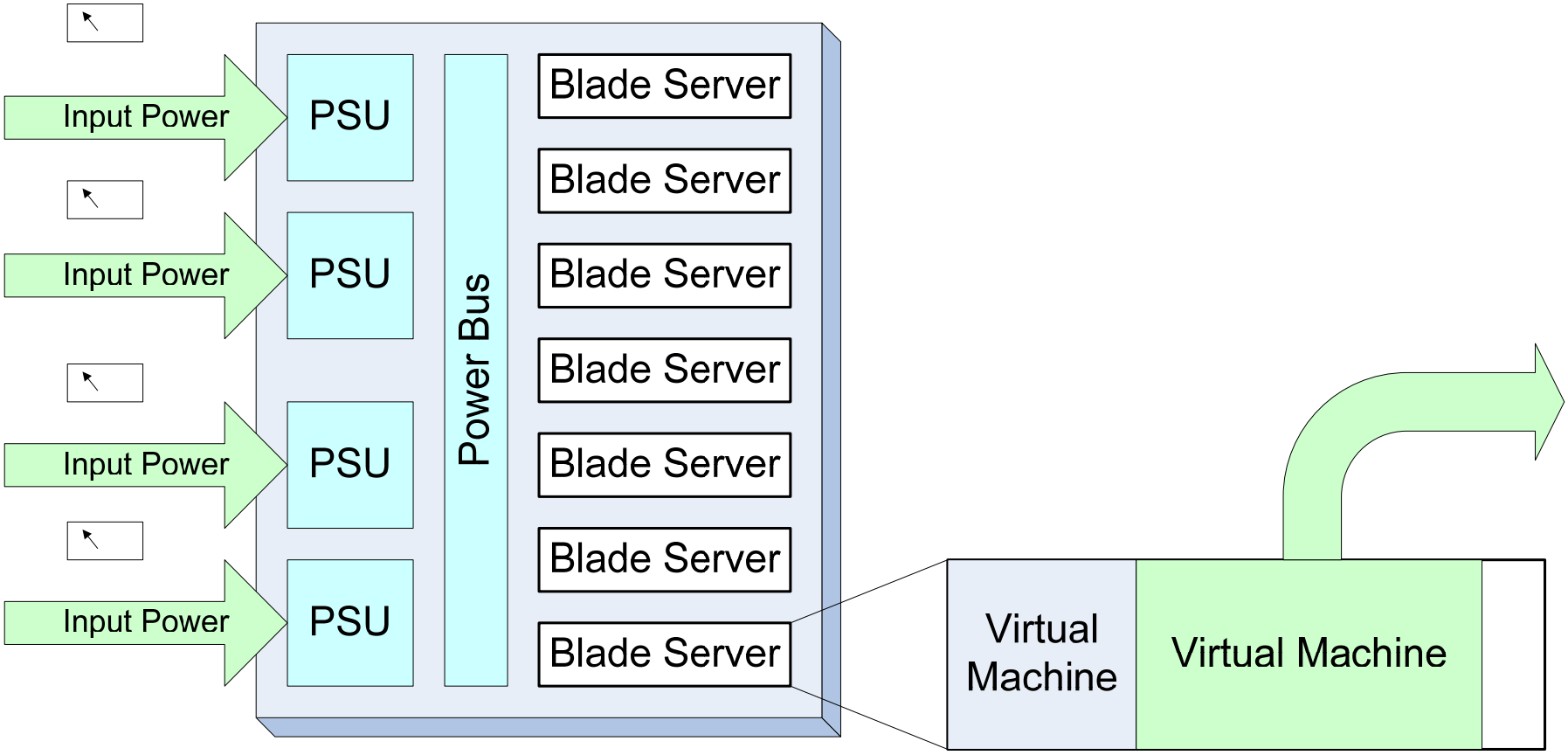
Metering fails for modern IT infrastructure



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BCS Data Centre Model

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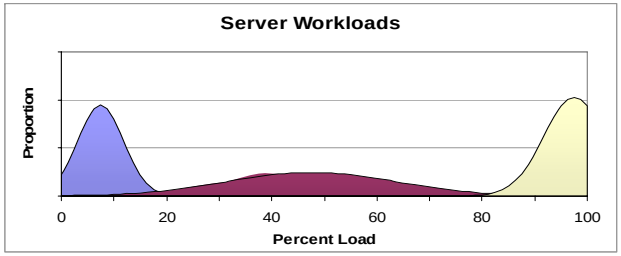
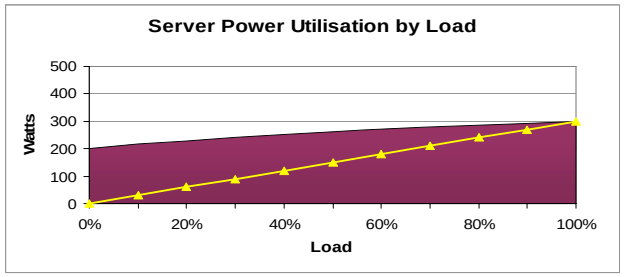
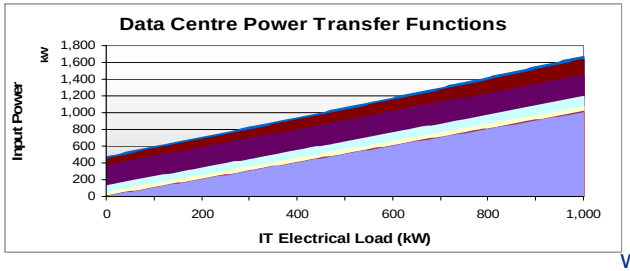


IT Workload



Server Load to Power Function



Data Centre Power Transfer Function

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Proposal: Grid infrastructure and data centre simulation

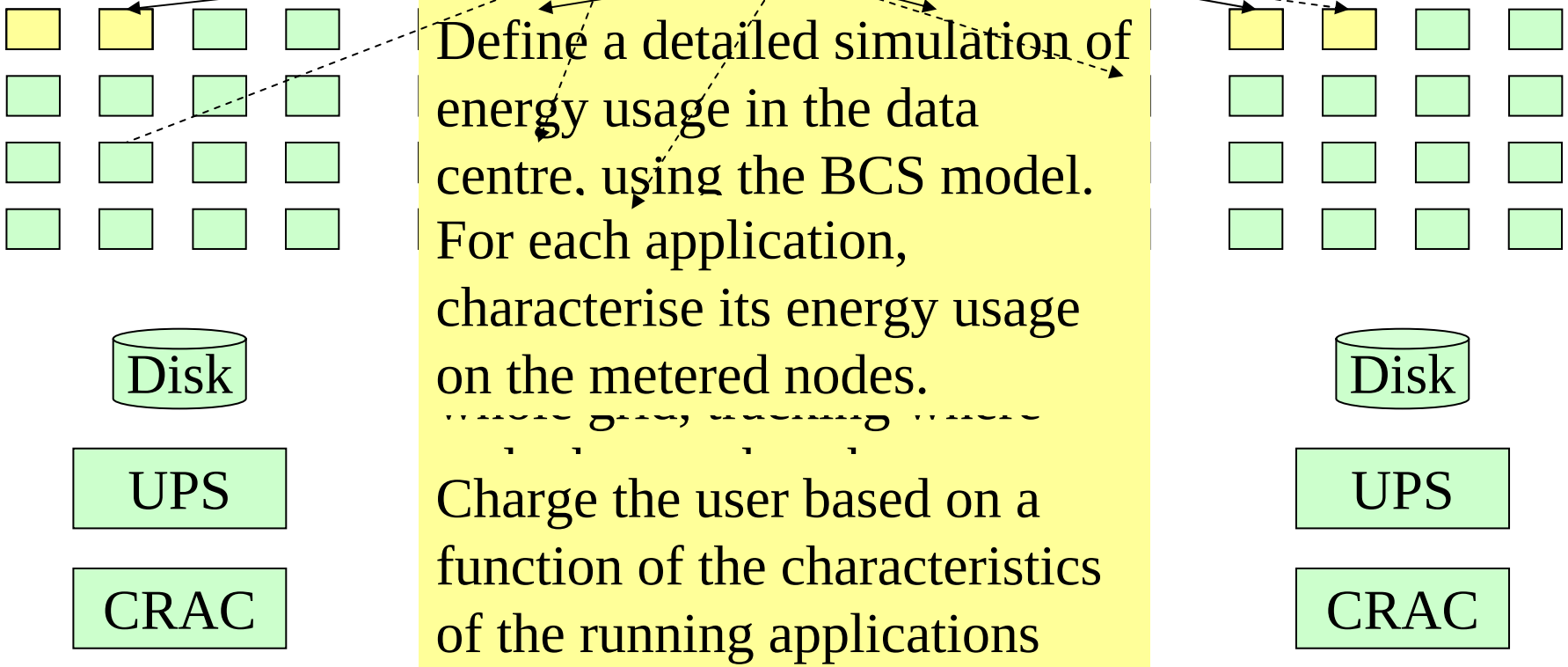
Assume a modular infrastructure of sub-grids

In each sub-grid, install detailed metering for a small set of server nodes.

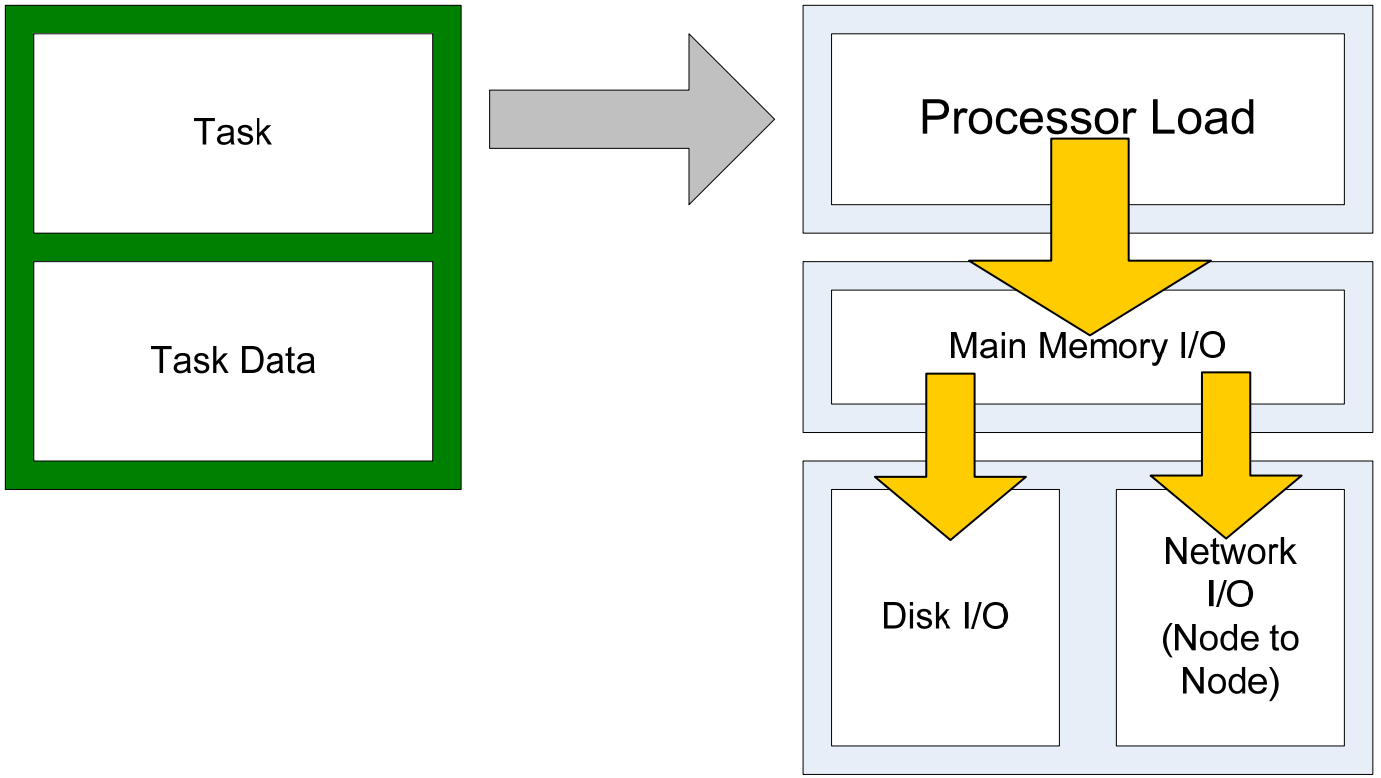
Define a detailed simulation of energy usage in the data centre, using the BCS model.

For each application, characterise its energy usage on the metered nodes.

Charge the user based on a function of the characteristics of the running applications and the overall power drawn.



Characterising workloads



The scheduler is key

- Grid schedulers actively allocate workload to nodes
- Therefore can collect data of which tasks execute where

Workload characterisations are approximations

- Hypothesis: Accurate enough to predict usage for purposes of cost allocation

Production accounting & calibration system

- Divides cost of actual power among workloads
- Warns if predicted and actual power diverge significantly

Take home message

Per-service accounting is essential to enable informed business decisions

Implementation is hard

Grid and simulation may be a solution

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Thank you

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http://www.gridcomputingnow.org

http://dcsg.bcs.org

http://projects.oucs.ox.ac.uk/lowcarbonict

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