SWINBURNE UNIVERSITY OF TECHNOLOGY

Internet Energy Efficiency and the Smart Grid

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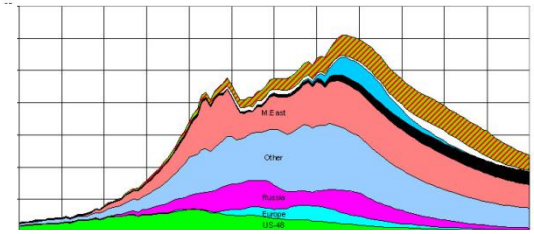
CAIA's "GREEN" project

FICT's EMRC

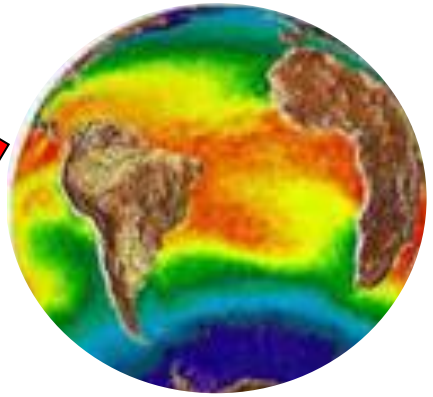
The greatest challenge of our generation

Peak oil



Energy use

Internet 2% and rising



Outline

- Scope (projects)
- Flavour (tools used)
- Collaborators
- Outcomes

Dynamic server provisioning

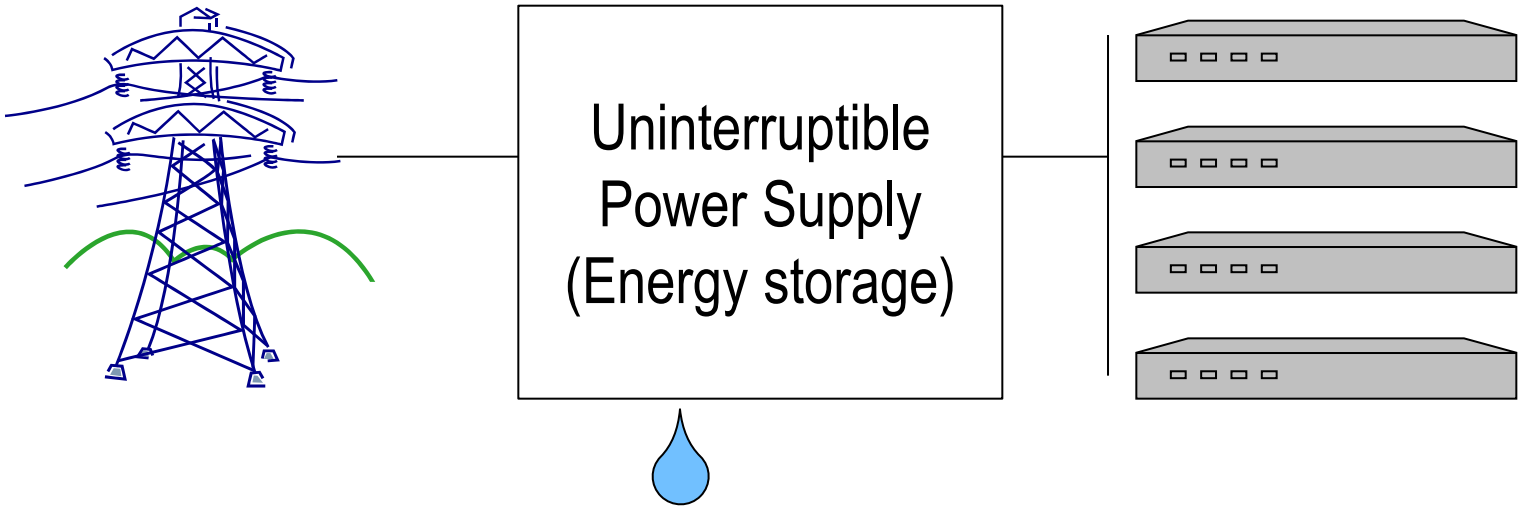
Turn off subsystems / servers when load is low

Cost for turning on / off

Optimal strategy depends on future workload

Need “on-line” algorithms

Optimal UPS management



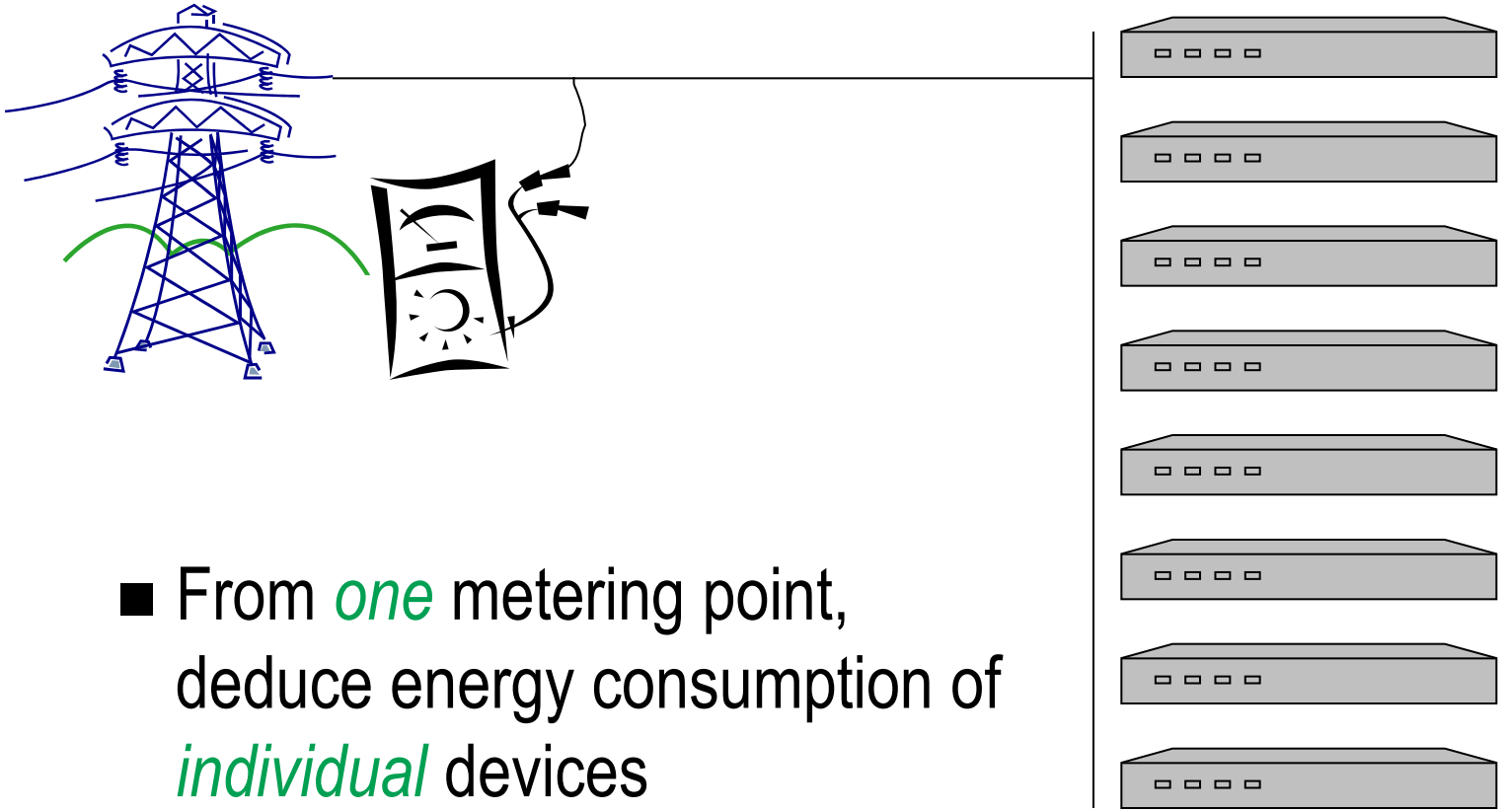
Data centres charged by *peak* energy draw

Store energy when load is low, release when load high

What is the optimal charge/discharge pattern?

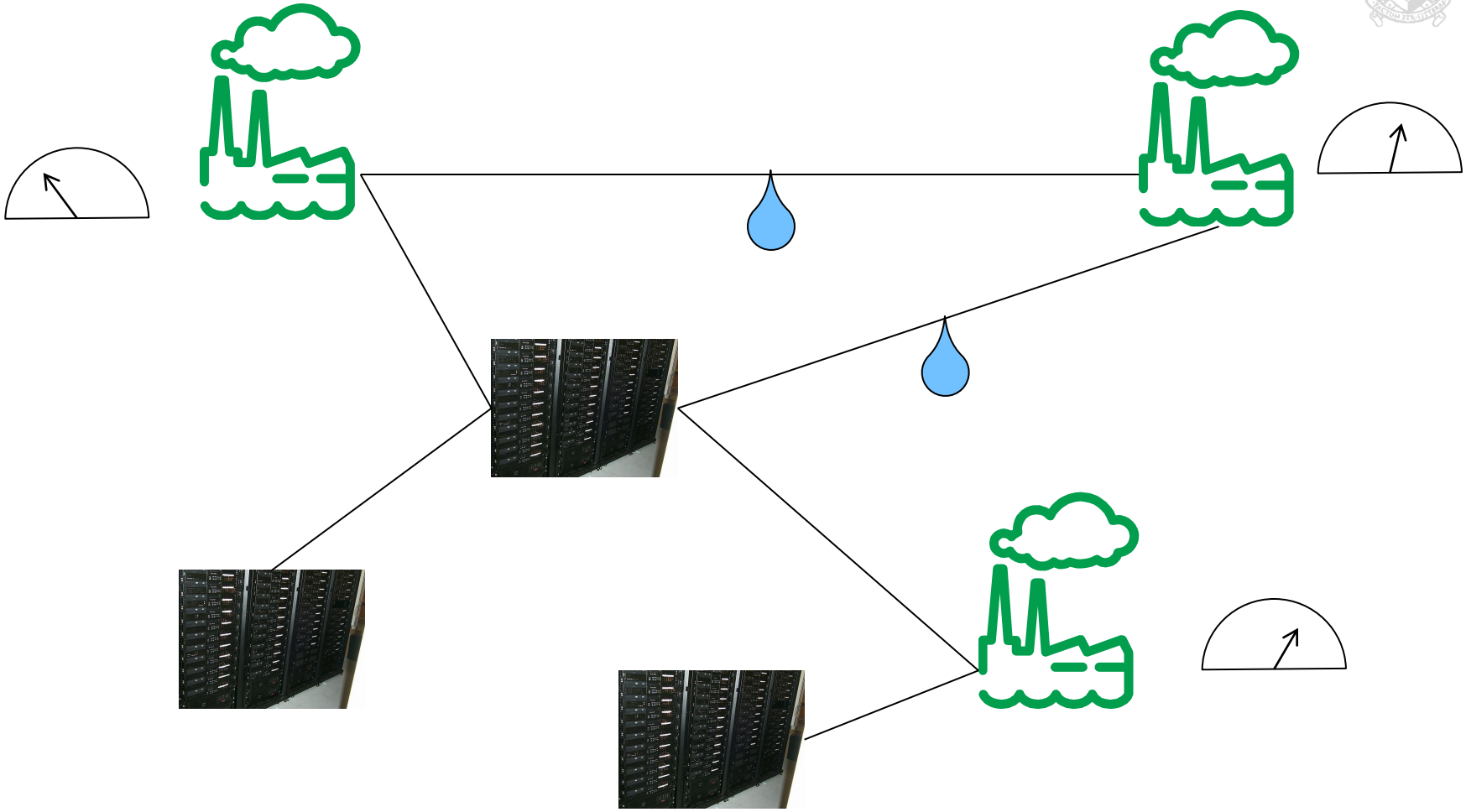
How does loss in the UPS affect this?

Cognitive metering



- From *one* metering point, deduce energy consumption of *individual* devices
- Signal processing / clustering / AI

Congestion control for power networks



Tools

- Convex optimization / relaxation of non-convex problems
- Dynamic programming

Develop new tools

"Smoothed online convex optimization"

Cost for "jumps" in decision variables, $x(t) - x(t-1)$.

Constraints revealed progressively. Must choose some decision variables before all constraints are known

Tools – exploring limits

Worst case analysis measures "competitive ratio", *CR*

= Maximum over all inputs of $\frac{\text{Cost of my algorithm}}{\text{Cost of optimal solution}}$

Learning theory measures "regret", *R*

= Maximum over all inputs of
(Cost of my algorithm) – (Cost of best *static* solution)

Result: If an algorithm performs "well" according to *CR*,
it must perform "poorly" according to *R*

Collaborators

- Adam Wierman's team at Caltech
  - Minghong Lin, Zhenhua Liu, Steven Low, …
- Minghua Chen's team at CUHK
- Mung Chiang's team at Princeton

- Hai Vu, Philip Branch, Yoni Nazarathy, Dragi Klimovski, Rozanna Jesudasan, Tuan Dinh

Outcomes

- Work related to this project has been incorporated in HP's "zero net energy" data centre

- Best paper awards at IEEE INFOCOM, IGCC
  - Student best paper award at ACM GreenMetrics