Richard Mortier, Cosener's 2008

SUSTAINABLE INTERNETWORKING
Can we do almost as much, with less?

What?

- Global warming is serious, the planet is dying!
  - Etc.
- Cause is greenhouse gas emission
- Many contributors to address
  - Transport, agriculture, commercial, residential, industry
- Largest of them is (electrical) power generation
  - In the US at least. And Australia.

Why?

- Computer networks are growing and they consume power (really)
  - BT says their network consumes "0.7% of UK power production"
    (BT press release, Oct 17th 2007)
  - ICT equipment is *10%* of UK electricity consumption
    (Barrington, SUN & Gov't advisor)
- So let's turn them off
- Yes, off

Data

- ICT about to exceed aviation in CO2 footprint
  (inefficient truth)
- ICT ~6—10% world energy consumption, 2—3% GHG
  (inefficient truth)
- Data centres are 1.5% of USA power budget, x2 every 5 yrs
  (EPA, 2006)
- A router consumes 370W—40kW   *(Cisco)*
- Even in data centre, network is ~15% of consumption
  (Mogul, ANCS 2007)
- 18—44% ICT power consumption is "network related"
  (ibid.)
- Power increase is super-linear with speed   *(ibid.)*

But…

- Computer networks are an intrinsic part of modern society
- We use them roughly all the time for many, many purposes
  - Communication, entertainment, healthcare, business, finance, government

- So, let's only turn parts of them off, sometimes

So...

- How can we work out what to turn off, and when?

- When should we turn it back on?

- How should we exert this control?

- ...all while not destroying the value in the network

Software, e2e Approach

- Already lots of hardware work
  - Limited in scope and applicability
  - Difficult to control overall system behaviour
- Live topology & traffic modelling & **measurement**
- Router control
  - Centralised control from AT&T/CMU et al (4-D, RCP)
  - Centralised FIB update (Bonaventure et al)
- Router virtualization + migration
  - Bring state up-to-date state faster than current protocols permit

Challenges

- Ubiquitous measurement
  - Scalability
- Data access
  - Privacy, scalability
- Traffic modelling
  - Latency, accuracy
- Centralised router control
  - Correctness, efficiency
- Connecting the loops
  - POP/DC design, routing, traffic engineering