Climate Change: Challenges and Opportunities for R&E networks

Bill St. Arnaud

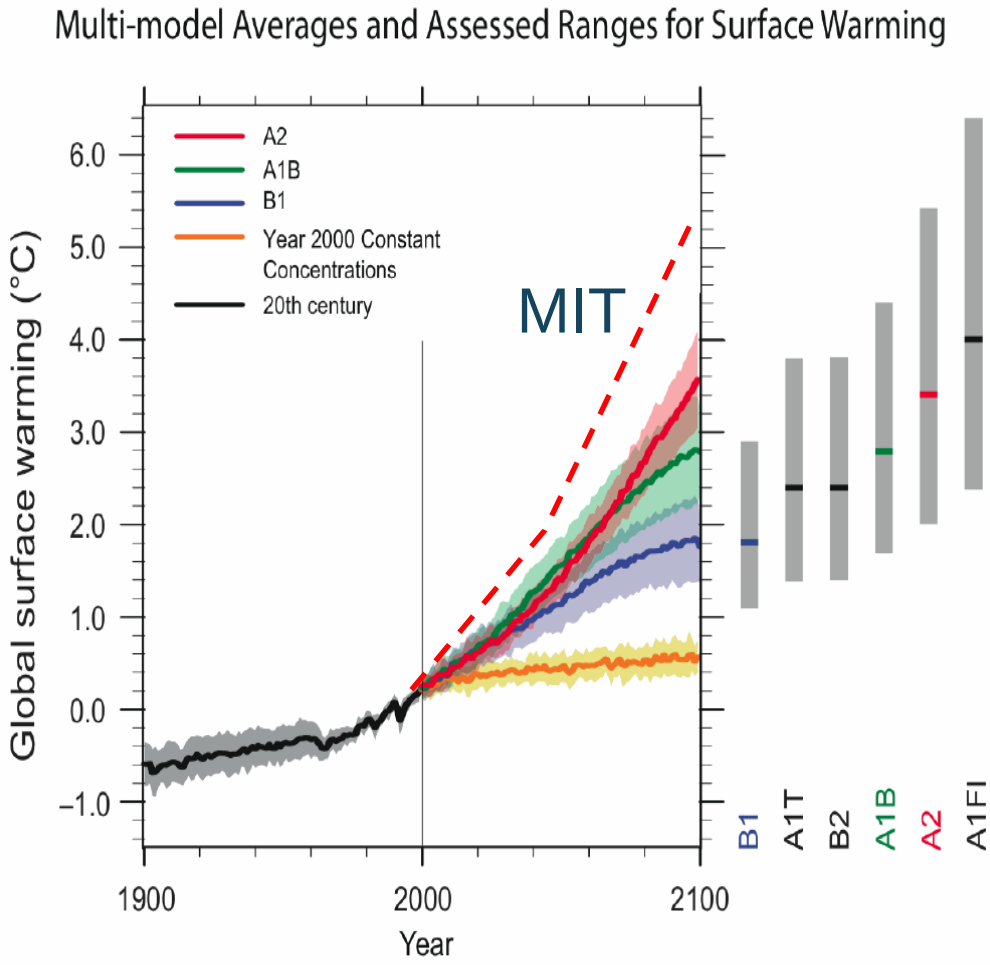
CANARIE Inc – www.canarie.ca

Bill.st.arnaud@canarie.ca

Climate Forecasts

- MIT report predicts median temperature forecast of 5.2C
  - 11C increase in Northern Canada
  - http://globalchange.mit.edu/pubs/abstract.php?publication_id=990

- Last Ice age average global temperature was 5-6C cooler than today
  - Most of Canada was under 2-3 km ice
  - With BAU we are talking about 5-6C change in temperature in the opposite direction in less than 80 Years

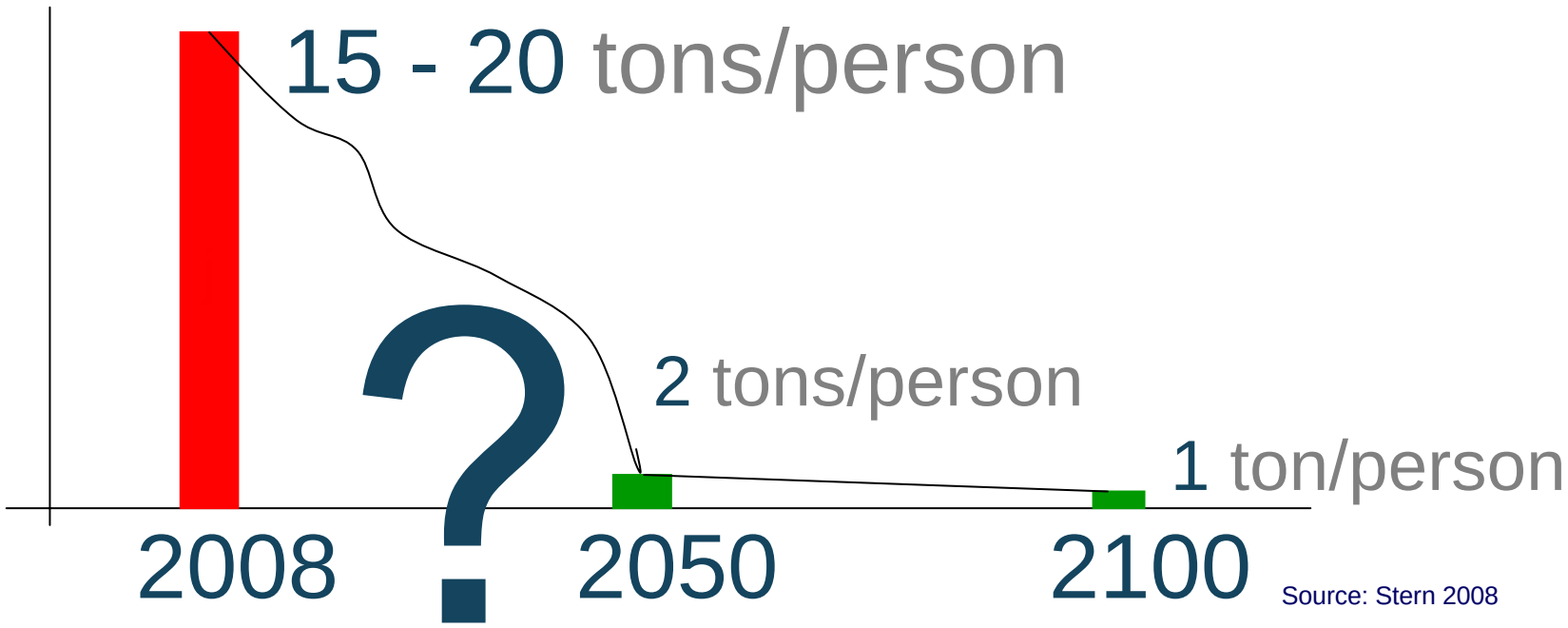


2008 second warmest year

Our Challenge

80/50 rule – 80% reduction in CO2 by 2050

(Commitment made by G8 countries)



Source: Stern 2008

MIT to build zero carbon data center in Holyoke MA

- The data center will be managed and funded by the four main partners in the facility: the Massachusetts Institute of Technology, Cisco Systems, the University of Massachusetts and EMC.

- It will be a high-performance computing environment that will help expand the research and development capabilities of the companies and schools in Holyoke
  - http://www.greenercomputing.com/news/2009/06/11/cisco-emc-team-mit-launch-100m-green-data-center
  -

Many examples already

Wind powered data centers

Ecotricity in UK builds windmills at data center locations with no capital cost to user

Hydro-electric powered data centers

Data Islandia
Digital Data Archive

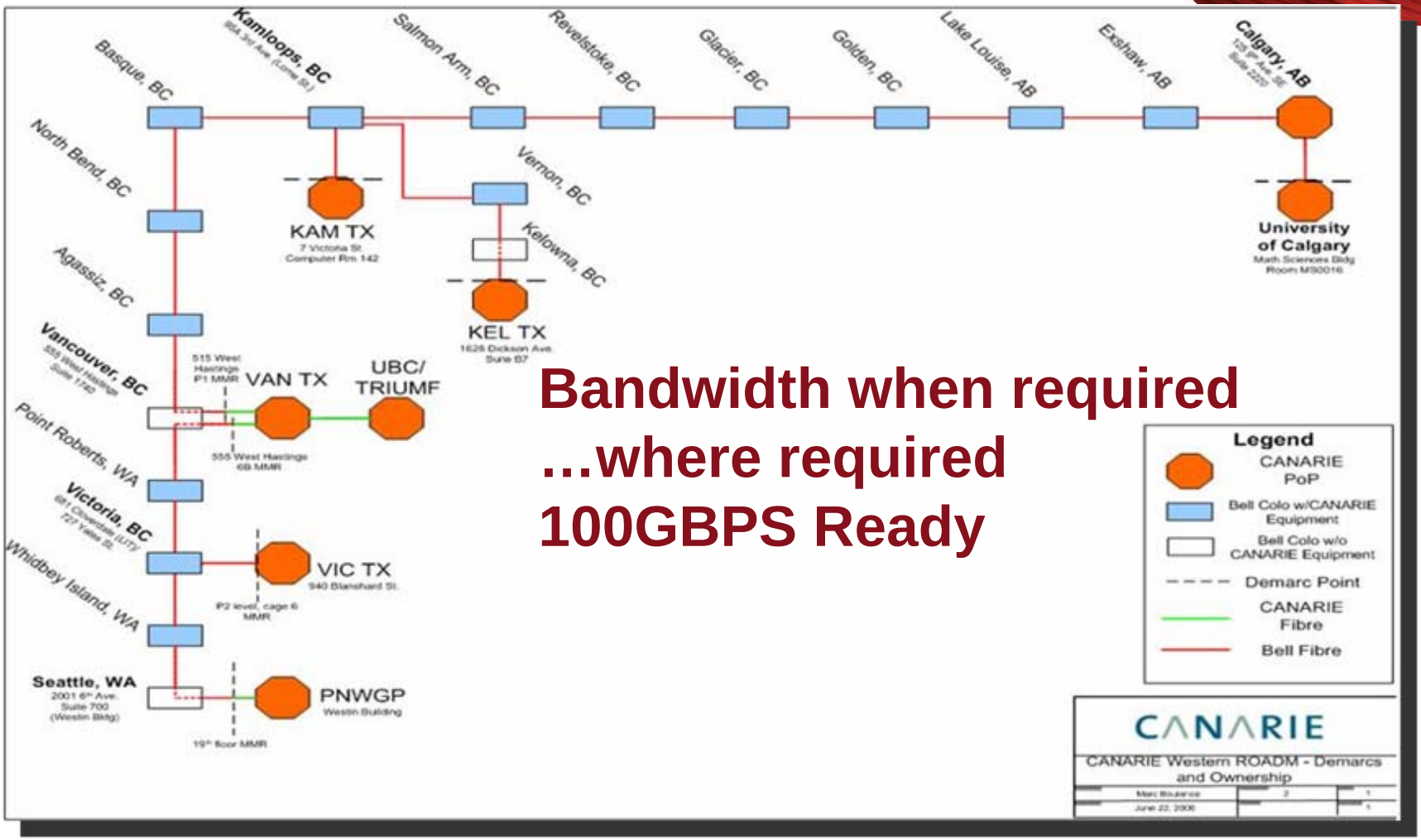
ASIO solar powered data centers

British Columbia BCnet Leadership

The Concept

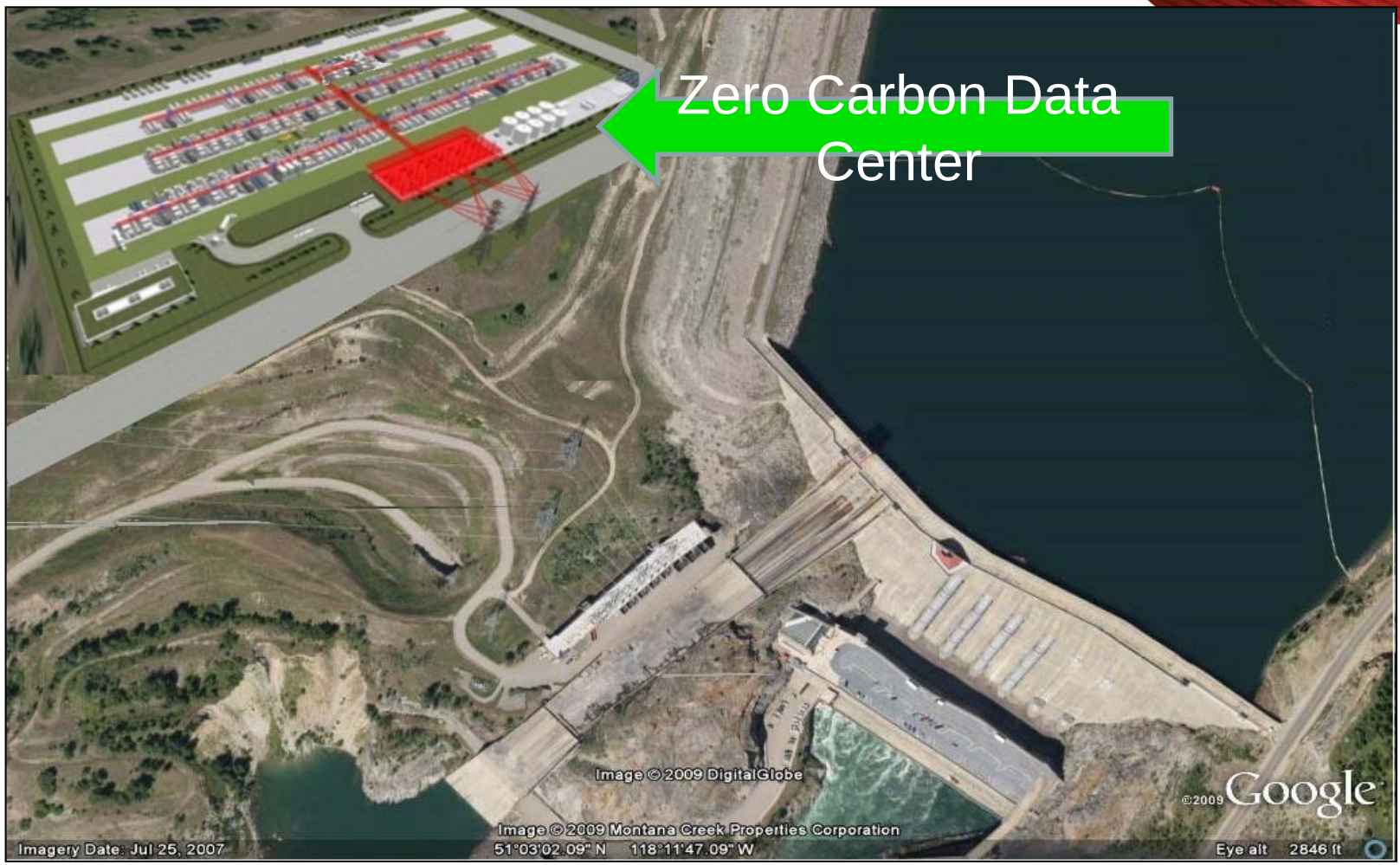
- Use cyber infrastructure to combat global warming by reducing computing infrastructure's carbon footprint
- Find efficient ways to share computing facilities that are close to sources of green power by utilizing BCNET's advanced network infrastructure within the Province
- Make it possible for BC's Universities to reduce their carbon footprint by relocating their existing ICT infrastructure to "greener facilities"
- Build a **zero carbon data centre** and use the BCNET/CANARIE ROADM network to connect users to it

Optical Network as Enabler



SOURCE: Eric Bernier, CTO
CANARIE

BC's Green Data Centre MUST be in Proximity to a Clean Source of Power



source: Dan Gillard
BCnet 04/09

Grand Challenge – Building robust ICT services using renewable energy only

- 30% of electrical power will come from renewable sources
- How do you provide mission critical ICT services when energy source is unreliable?
  - Ebbing wind or setting sun
- Back up diesel and batteries are not an option because they are not zero carbon and power outages can last for days or weeks
- Need new network architectures and business models to ensure reliable service delivery by quickly moving compute jobs and data sets around the world to sites that have available power
  - Will require high bandwidth networks and routing architectures to quickly move jobs and data sets from site to site

Impact on networks

- Need to avoid using more fossil based energy consumption in transmission facilities (versus reduction at data centers)
- Optical networks will have modest increase in power consumption especially with new 100G and 1000G waves
- Electronic equipment such as routers and aggregators will have much larger impact
- Future Broadband- Internet alone is expected to consume 5% of all electricity
  - http://www.ee.unimelb.edu.au/people/rst/talks/files/Tucker_Green_Plenary.pdf

CANARIE Green-IT Pilot

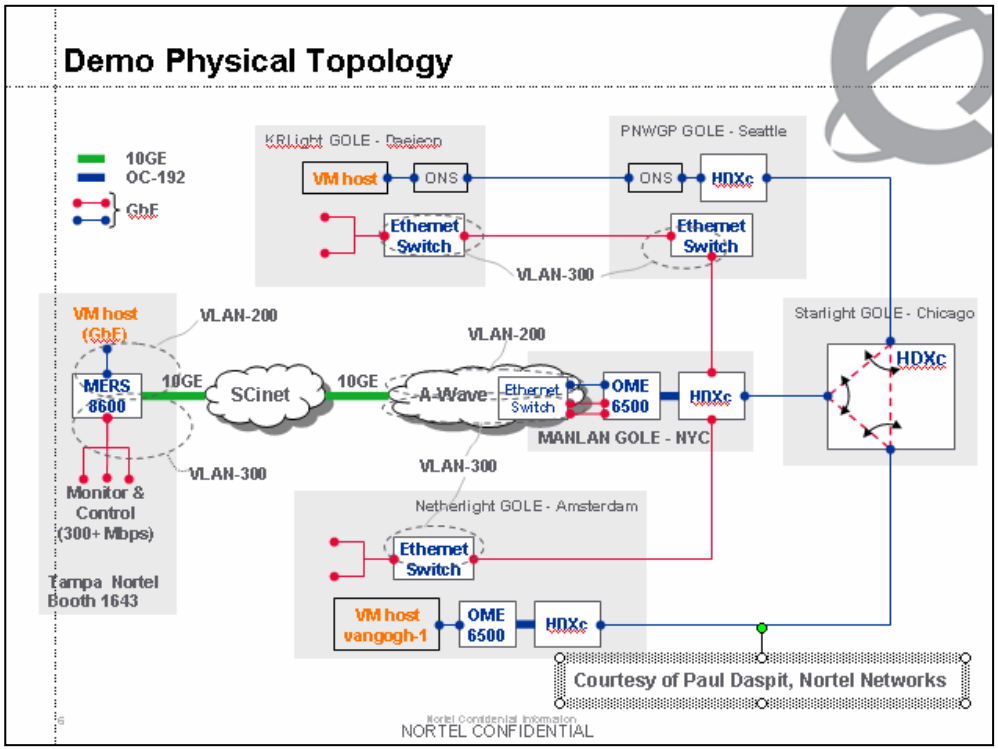
- $3m allocation for Green cyber-infrastructure-IT pilot testbed

- Two objectives:
  - Technical viability and usability for relocating computers to zero carbon data centers and follow the sun/follow the wind network
  - Business case viability of offering carbon offsets (and or equivalent in services) to IT departments and university researchers who reduce their carbon footprint by relocating computers and instrumentation to zero carbon data centers

- International partnership with possible zero carbon nodes using virtual router/computers in Spain, Ireland, California, Australia, British Columbia, Ottawa, Quebec and Nova Scotia

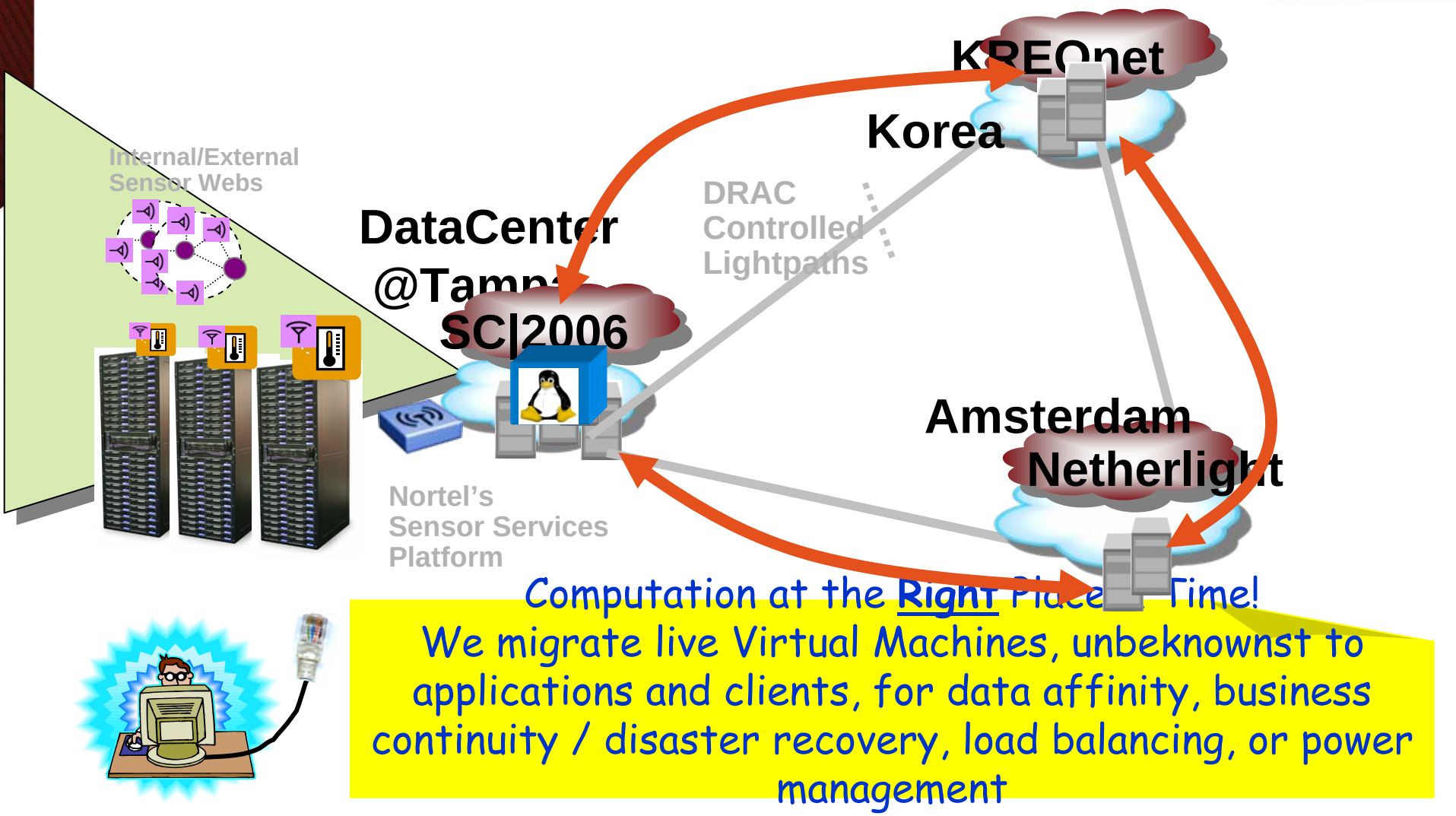
Emerging “Follow the Sun” Technologies

- The ability to migrate entire virtual machines (routers and computers) to alternate data centres exists.
- Over HS networks the latency is tiny and transfer is invisible to the user.
- Happens instantly without user knowledge, action or intervention



Nortel’s research labs developed and conceived the “Virtual Machine Turntable in 2006 and through collaboration with R&E networks in the US, Canada, Netherlands, and South Korea proved viability.

The SC06 VMT Demonstrator



Economic benefits of follow the wind/sun architectures

- Cost- and Energy-Aware Load Distribution Across Data Centers
  - http://www.cs.rutgers.edu/~ricardob/papers/hotpower09.pdf
  - Green data centers can decrease brown energy consumption by 35% by leveraging the green data centers at only a 3% cost increase
- Cutting the Electric Bill for Internet-Scale Systems
  - Companies can shift computing power to a data center in a location where it's an off-peak time of the day and energy prices are low
  - Cassatt a product that dynamically shifts loads to find the cheapest energy prices
  - 45% maximum savings in energy costs
  - http://ccr.sigcomm.org/online/files/p123.pdf
  - http://earth2tech.com/2009/08/19/how-data-centers-can-follow-energy-prices-to-save-millions/
- Computing for the future of the planet
  - http://www.cl.cam.ac.uk/research/dtg/~ah12/
  - http://earth2tech.com/2008/07/25/data-centers-will-follow-the-sun-and-chase-the-wind

Thank you

- More information
- List server on Green IT
  - Send e-mail to bill.st.arnaud@canarie.ca
- http://green-broadband.blogspot.com
- http://free-fiber-to-the-home.blogspot.com/