Clouds and Optical Networks

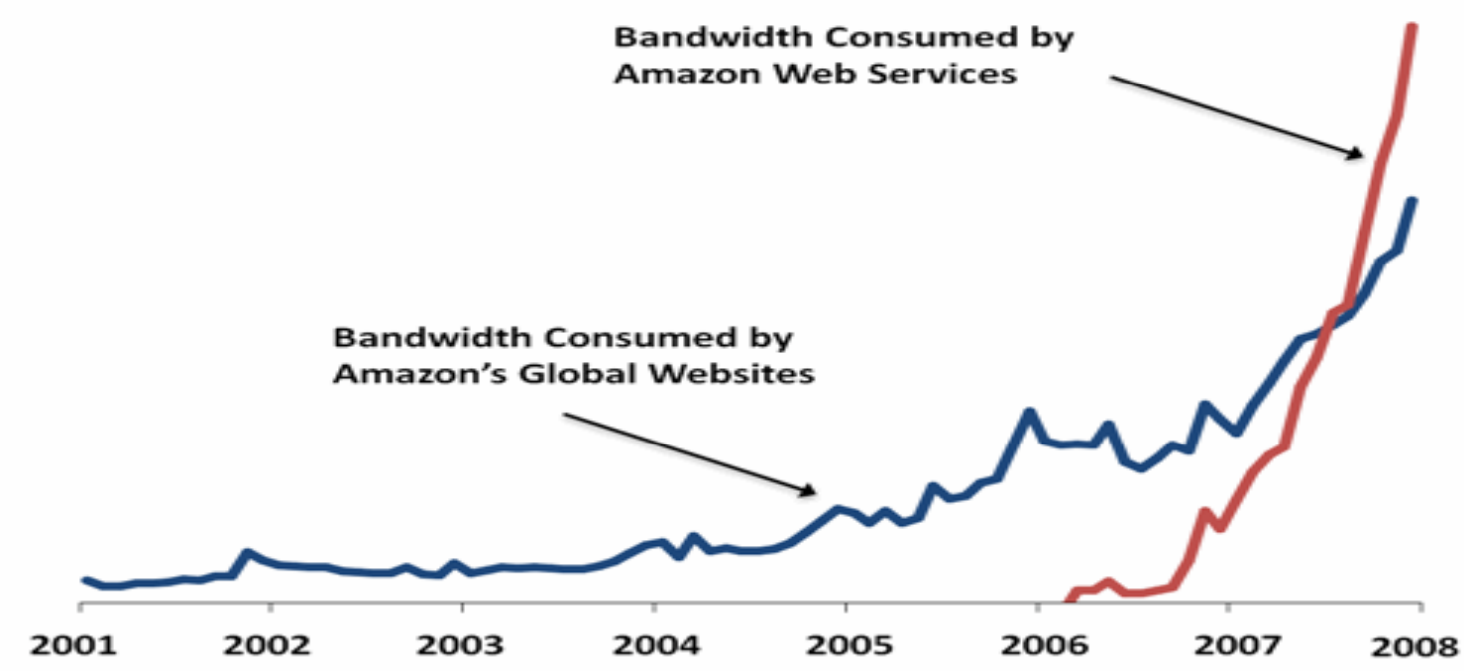
Bill St. Arnaud
CANARIE Inc – www.canarie.ca
Bill.st.arnaud@canarie.ca

Taxonomy of Clouds

- **Application or platform clouds**
  - Google Apps, SalesForce
  - No specific allocation of resources or location
- **Computational Clouds**
  - Amazon EC2
  - Specific allocation of storage and computation – no specific location
- **Private Clouds**
  - VmWare Datagardens, Grids
  - Specific allocation of storage and computation at a specific number of locations

Bandwidth demand for clouds

- In January of 2008 Amazon Web Services consumed more bandwidth than do the entire global network of Amazon.com retail sites.



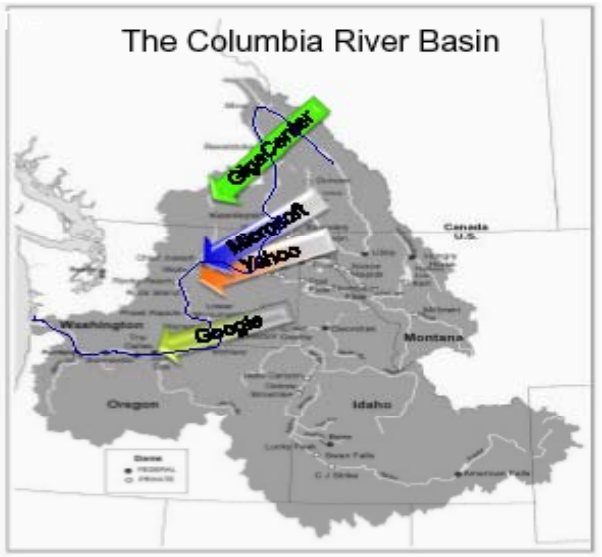
Clouds and Climate Change

- Clouds will be essential as we move to a zero carbon Internet
- Computers will become handheld and solar powered
- Applications and services will be hosted on the cloud that is based on zero carbon infrastructure
- Businesses will move services and applications to zero carbon data centers using clouds
- Optical networks will be critical to sustain a zero carbon cloud

Many examples

Wind powered data centers

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



Hydro-electric powered data centers

Relocation of Nordic HPC facilities to Iceland

Data Islandia
Digital Data Archive

ASIO solar powered data centers

Zero Carbon strategy essential

- **Zero carbon strategy using renewable energy critically important if governments mandate carbon neutrality, or if there is a climate catastrophe**
- **With a zero carbon strategy growth in demand for ICT services will not effect GHG emissions**
  - Anything times zero is always zero
- **Wind and solar power are most likely candidates because of opportunity cost/benefit analysis especially time to deploy**
  - Nuclear has high opportunity cost because of time to deploy
  - http://climateprogress.org/2008/12/14/stanford-study-part-1-wind-solar-baseload-easily-beat-nuclear-and-they-all-best-clean-coal/
- **But renewable energy sites are usually located far from cities and electrical distribution systems are not designed to carry load**
  - http://www.americanprogress.org/issues/2008/12/pdf/renewable_transmission.pdf

“Zero Carbon” ICT

- **Purchasing green power locally is expensive with significant transmission line losses**
  - Demand for green power within cities expected to grow dramatically
- **ICT facilities DON’T NEED TO BE LOCATED IN CITIES**
  - -Cooling also a major problem in cities
- **But most renewable energy sites are very remote and impractical to connect to electrical grid.**
  - Can be easily reached by an optical network
  - Provide independence from electrical utility and high costs in wheeling power
  - Savings in transmission line losses (up to 15%) alone, plus carbon offsets can pay for moving ICT facilities to renewable energy site
- **ICT is only industry ideally suited to relocate to renewable energy sites**
  - Also ideal for business continuity in event of climate catastrophe

Optical networks, SOA and Virtualization are key

- Optical networks (as opposed to electronic routed networks) have much smaller carbon footprint
- Significant reduced CO2 impacts are possible through use of SOA, clouds, web services, virtualization, UCLP, grids, Web 2.0, NGI etc.
- Computer and networks architectures to connect remote computers, databases and instruments will be essential for zero carbon ICT

CANARIE Green-IT Pilot

- **$3m - $4m 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 grid
  - 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

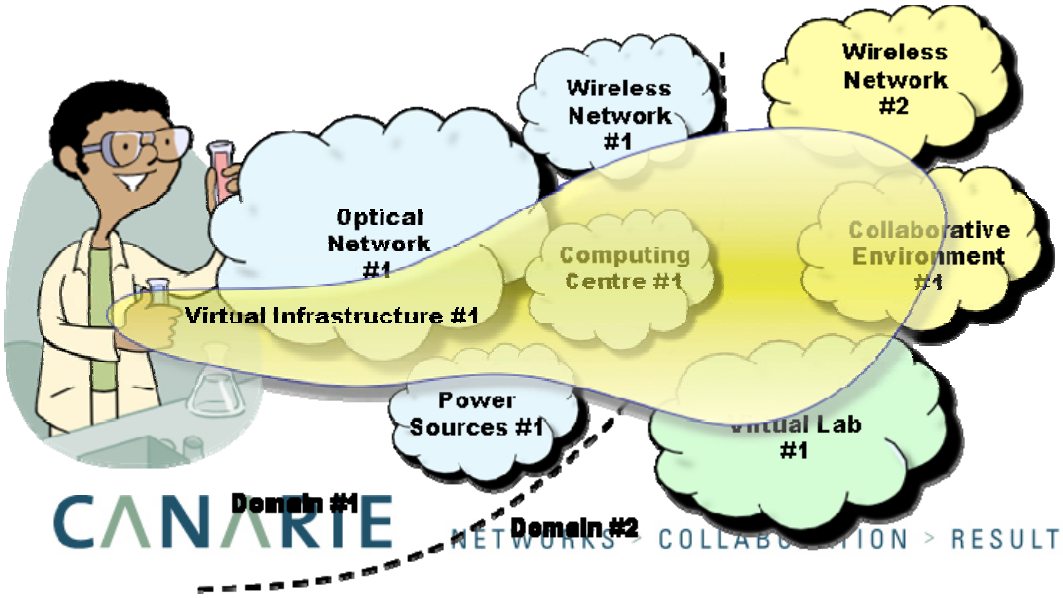
- **International partnership with possible zero carbon nodes using virtual router/computers in Spain, Ireland, California, Australia, British Columbia, Ottawa, Quebec and Nova Scotia**

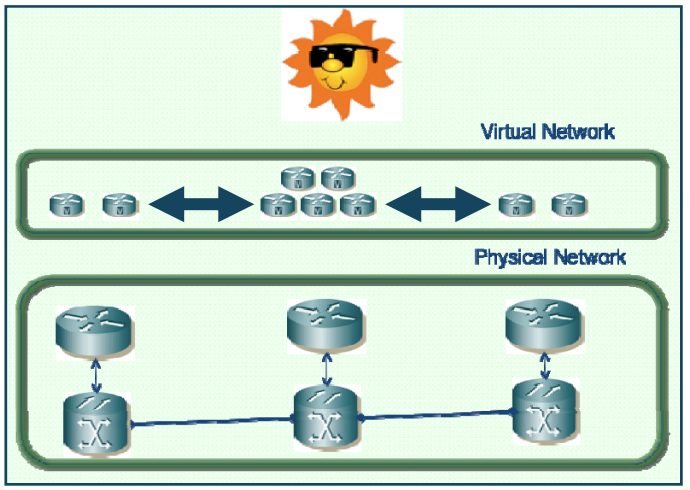
PROMPT – Next Generation Internet to Reduce Global Warming

Technology, Products and R&D

Virtualization, SOA and Hypervisors
Audit and Monitoring
Infrastructure as a Service (IaaS)
Wireless & Optical Networks
Cognitive Networks
IP Multimedia Subsystem
Smart Systems
Lifecycle Management

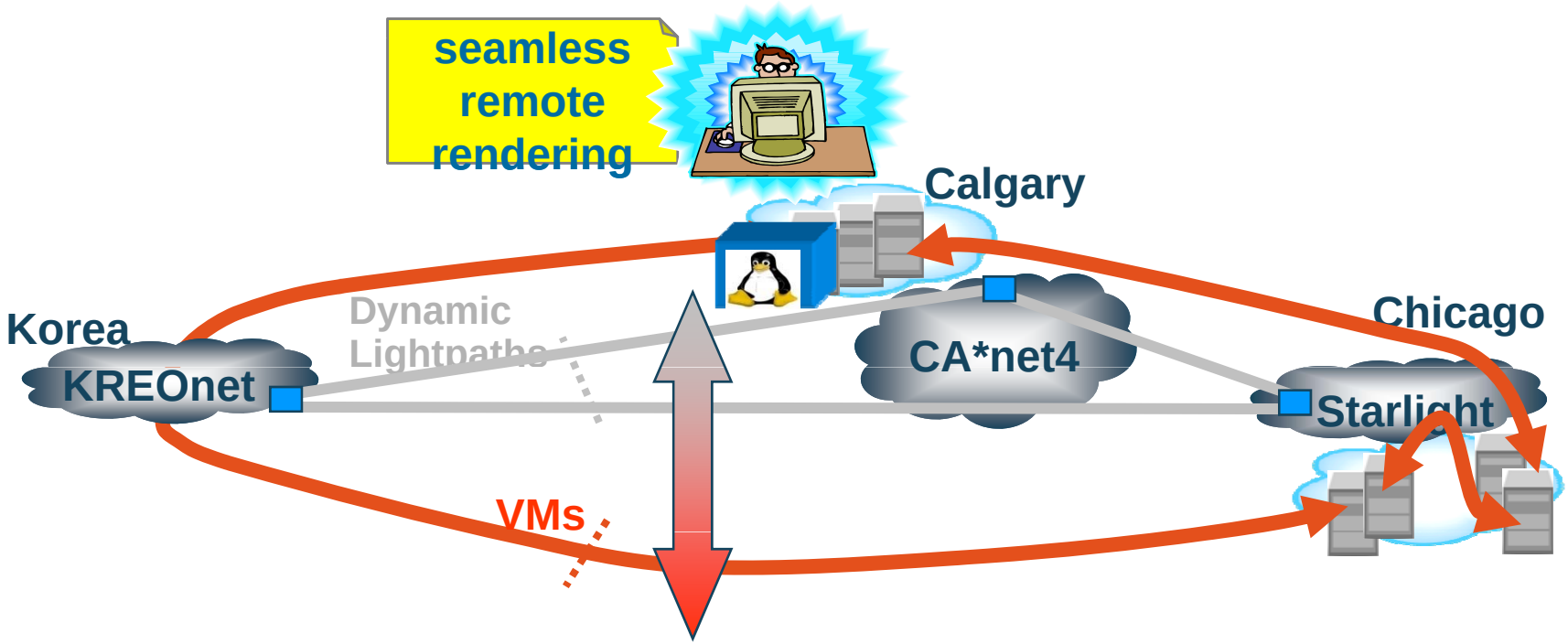
- Research on router, optical, W/W-less and distributed computing architectures, applications, grids, clouds, Web services, virtualization, dematerialization, remote instrumentation and sensors, etc.
- Share infrastructure & maximize lower cost power by "following wind & sun" networks.





Sources: GENI and Inocybe

The “VM Turntable” Demonstrator



APEC TEL 33, Calgary, AL, Apr 24-27 2006

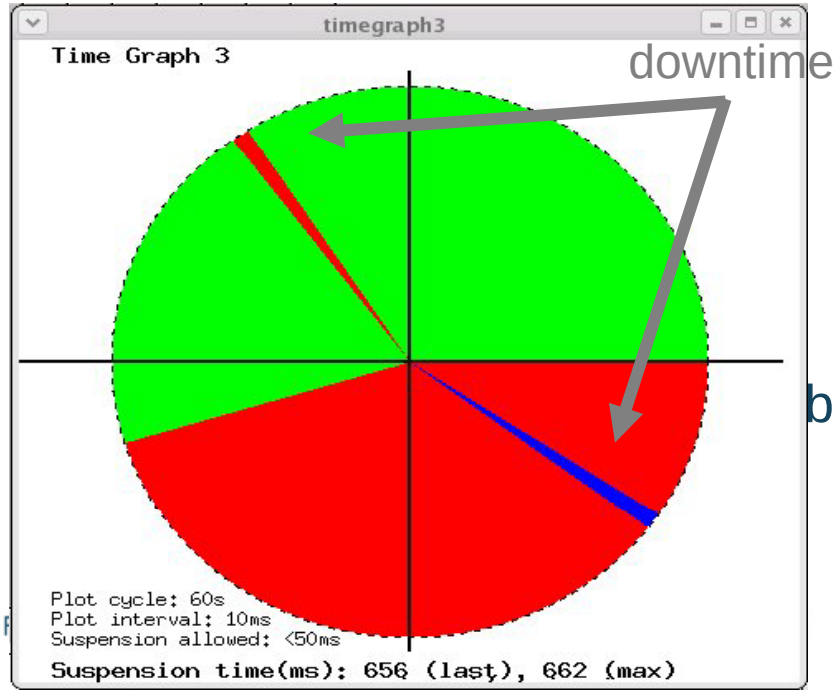
Live VMs migrated from Calgary to Chicago with transit through S. Korea, resulting in just a 1.011 second of application downtime.

DRAC sets up and tears down a lightpath w/ each migration.

In the Blink of an Eye

- Virtual Machine teleported over thousand miles
- Seamless to external clients, w/ just a tiny ~1s glitch
- Downtime is limited despite high RTTs
  - **Calgary–Korea–Chicago, 1GE, RTT = 310 msec, downtime = ~1 sec**
  - **Back to back, 1GE, RTT = 0.2 - 0.5 ms, downtime = ~0.2 sec**

downtime is only ~5x
while RTT is ~1,000x !!!



- Lightpath is a virtualized
- Its determinism (not the bw!) bling technology

Thank you

- **More information**
- http://green-broadband.blogspot.com
- http://free-fiber-to-the-home.blogspot.com/