UNIVERSITY OF CAMBRIDGE
800 YEARS
1209 ~ 2009

DIGITAL TECHNOLOGY GROUP
COMPUTER LABORATORY

Free Lunch: Exploiting Renewable Energy For Computing

Sherif Akoush

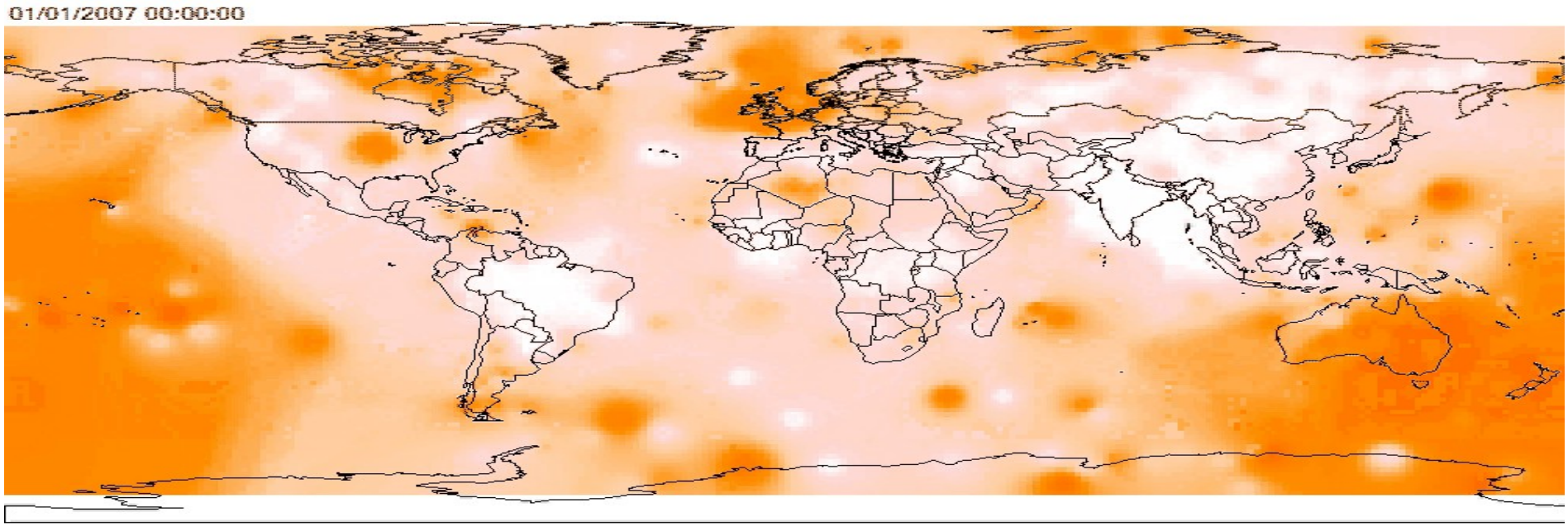
HotOS'11

Greenpeace International
http://www.youtube.com/watch?v=QPty-ZLbJt0

Renewable Energy in Computing

Datacenterknowledge.com

Renewable Energy
Wind+Solar in 2007



Sun Modular Datacentre

Technical Challenges

- Predicting VM migration times

  Predicting the Performance of Virtual Machine Migration, MASCOTS'10

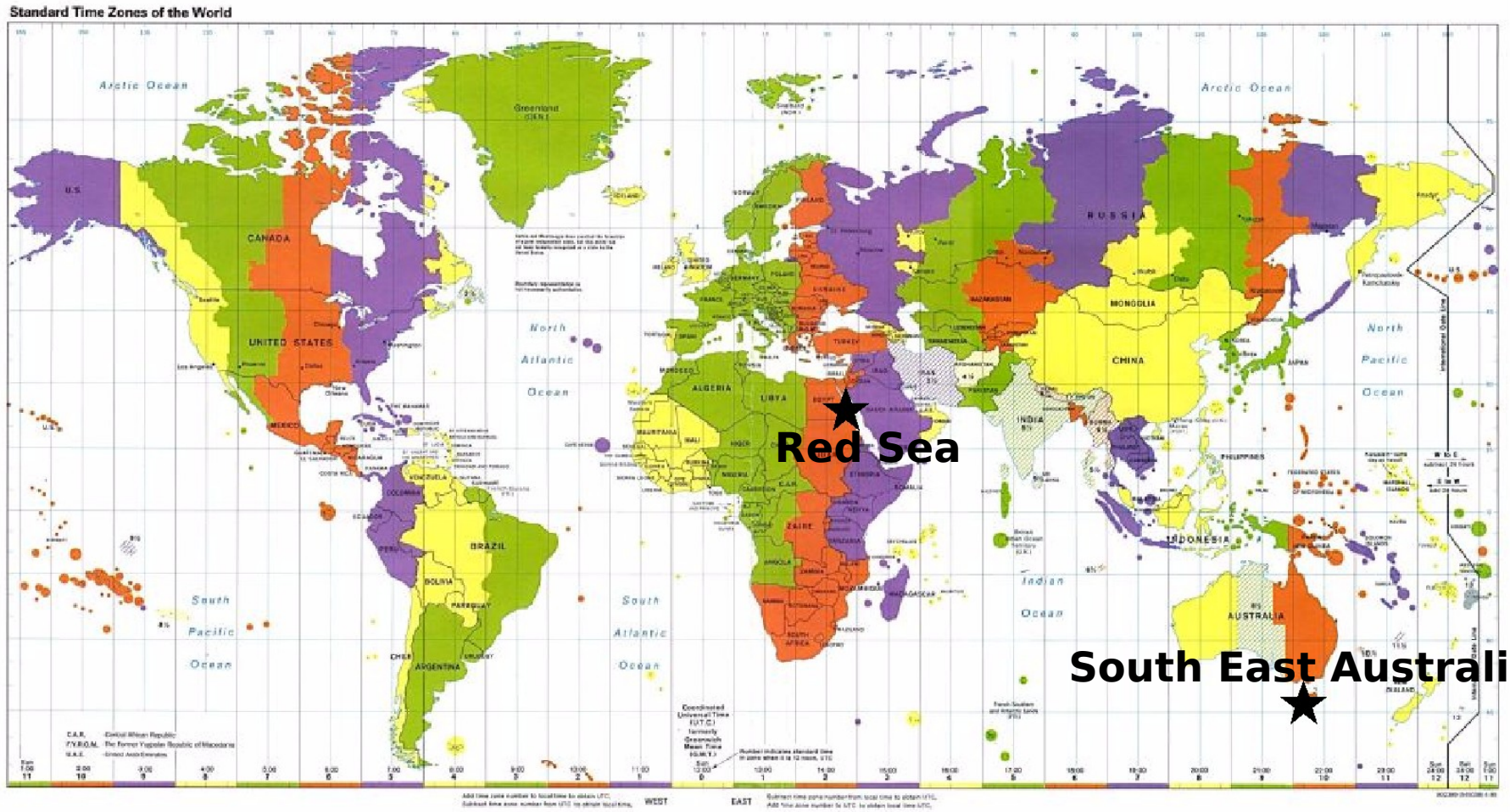
- Storage synchronisation

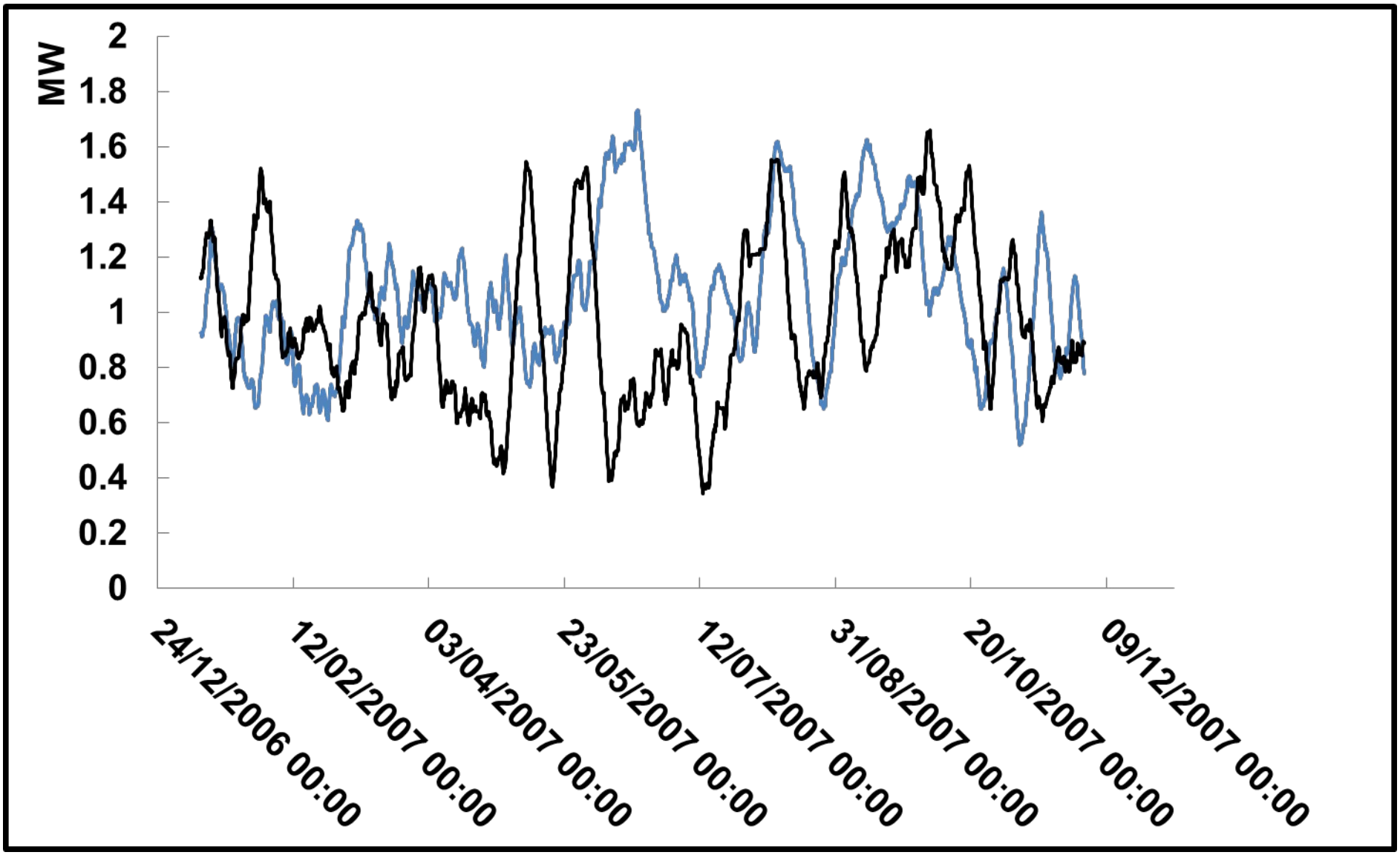
  Activity Based Sector Synchronisation: Efficient Transfer of Disk-State For WAN Live Migration, MASCOTS'11

- Scheduling and placement
  - Stop-Resume vs. migration
  - Capacity planning (slack reserve)
  - Energy mix

Case Study

Datacentre Locations




MW
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
24/12/2006 00:00
12/02/2007 00:00
03/04/2007 00:00
23/05/2007 00:00
12/07/2007 00:00
31/08/2007 00:00
20/10/2007 00:00
09/12/2007 00:00

Impact on Availability (for one VM)

- VM downtime due to memory + disk:
  - ≈ 0.5 seconds (10 Gbps link)
- 615 migrations per year x Downtime:
  - ≈ 415 seconds
- 99.95% SLA: 15,768 seconds allowed

  < 3%

Energy Consumed (for one VM)

- VM Parameters
  - Memory: 7.5 GB
  - Disk: 20 GB (modified)
- Network
  - Network: 10 hops
  - Cisco CRS-1: 3 nJ/bit
- Total energy per migration: 57.5 kJ

  ≈ 0.5 cup of tea

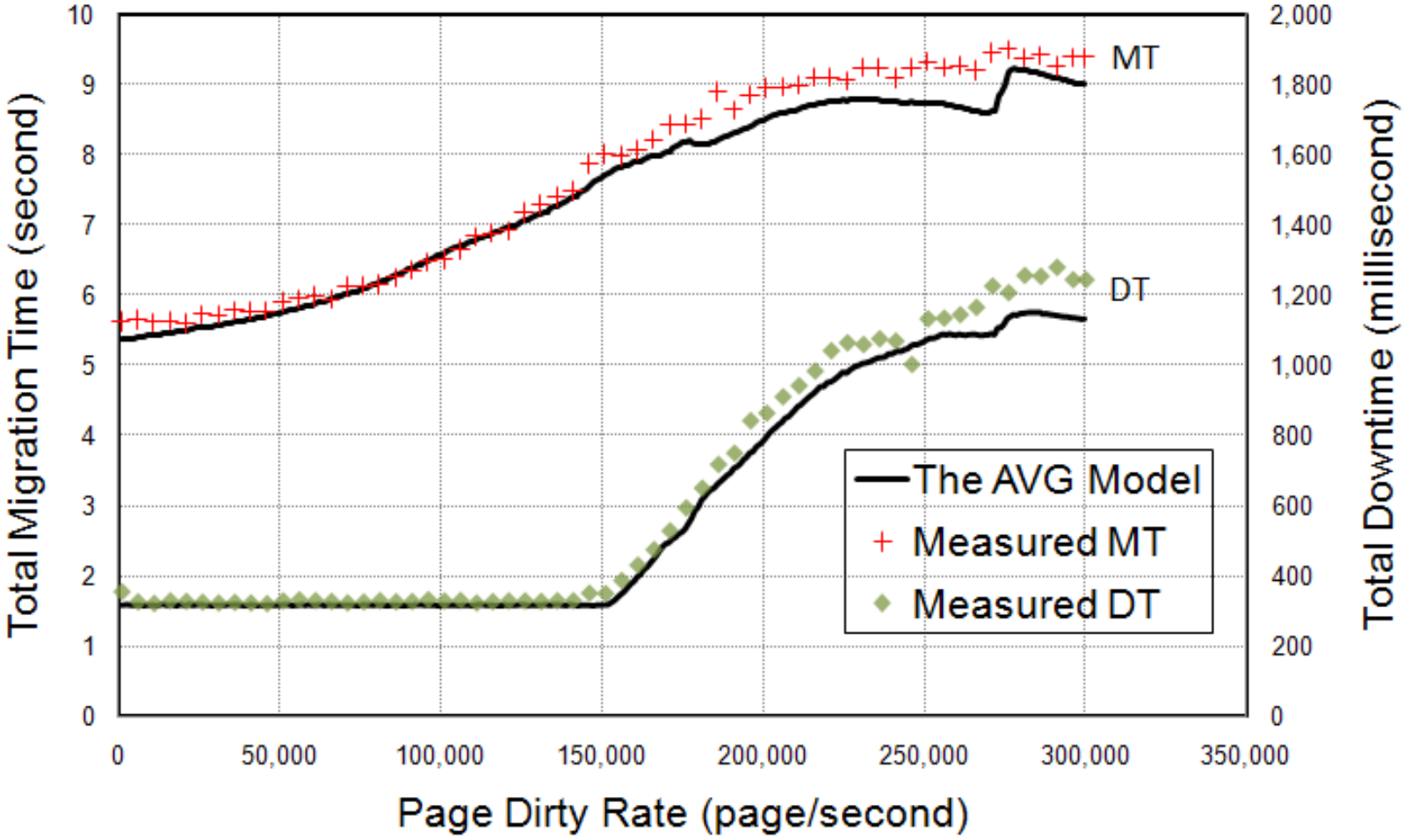
Conclusion

- Exploit remote renewable that is otherwise lost
- Migrate workloads according to power availability
- Transition cost (energy/time) is minimal
- Future work
  - Workload suitability
  - Slack reserve
  - Cost model

- Thanks to: **Ripduman Sohan, Bogdan Roman, Andy Rice, Andrew Moore and Andy Hopper**

DATACENTRES WORKLOAD TRACES PLEASE

Predicting (Memory-state) Migration Times



Storage Synchronisation (Activity-based)

- Synchronise disk-state while the VM is running at the source
- Write rate is relatively low (compared to network speed)
- A few sectors are written many times (for Microsoft production workloads)
- Bandwidth vs. latency
- Adaptive at the sector level
  - Retain hot sectors
  - Transfer cold sectors