COST 0804 INTL. TRAINING SCHOOL ON ENERGY EFFICIENCY

IN LARGE SCALE DISTRIBUTED SYSTEMS

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Research Issues and Questions Identified during the Presentations and the Q/A Sessions

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SCOPE:

This document summarizes the research issues identified by the trainees during the Training School in connection with each set of lectures, as well as the main questions raised. The Training School goal was to provide Early Stage Researchers from COST member countries with knowledge in the area of energy efficiency in a diversity of large scale systems (computers, computer grids, communications networks, building complexes, etc.).

Day 1, 8th of March 2001

Lecture 1

Methods for Efficient Consumption of Energy in IT Infrastructure (Dr. Andrei Vlad, IBM Romania)

Abstract: *Design of high performance computer systems in terms of hardware: cooling, heat reuse, hybrid technologies, virtualization, monitoring, provisioning, back-up and resource scheduling. Efficient energy reduction techniques in IT infrastructure.*

Research Issues and Questions

- How can we increase confidentiality and security in clouds?
- How can we identify redundant information in clouds and not send the same information back and forth?
- Does producing your own power for an IT datacentre pay off when its power consumption rises to several MW? What is the best option for powering a datacentre: gas turbines or other types of power? Is a hybrid approach viable?
- Through virtualization there can be an increase of up to 40 - 50% of the average utilization of one computer.
- How can software producers be "disciplined" in terms of energy consumption induced by the programming, taking into account that an energy-optimized software could bring up to 40% savings?
- Another idea to reduce the amount of data processed, and thus indirectly the amount of power consumed. The data flow has to be modelled better: can DNA encoding and ontologies be possible solutions?
- Can datacentres, based on smart metering and consumption forecasts, buy energy at a cheaper price in advance? How relevant is it for the entire eco-system?

- How can more tight standards for IT, like those for civilian and industrial appliances, make IT systems more energy efficient?

Lecture 2

Thermal Emissions in Electronic Systems (Dr. Werner Escher, IBM Research, Zurich)

Abstract: Thermal emissions and management in electronic systems.

Research Questions

- Can we make use of information about the previous usage of a data centre to predict its future load and reduce its energy consumption?
- Can we reduce energy consumption in electronic systems by increasing parallelism (similarly to how the human brain works)?

Lecture 3

Direct Waste Heat Utilization from Liquid-Cooled Supercomputers (Dr. Werner Escher, IBM Research, Zurich)

Abstract: Liquid-cooling reduces the conductive and convective resistances; hence it improves the efficiency of data centres by allowing coolant temperatures above the free cooling limit in all climates.

Research Issues and Questions

- How can we make use of nanomaterials for the production of superconductors?
- In view of the high energy savings derived from carbon nanotube circuits and substrates, are we moving towards a carbon era (away from the silicon era)?

Day 2, 9th of March 2011

Lecture 1

Energy Efficiency in Computer Grids (Anne Cecile Orgerie, E.N.S., Lyon)

Abstract: Substantial quantities of electrical power is consumed when a computer is idle, so reductions are to be found from switching on/off techniques, namely EARI (Energy-Aware Reservation Infrastructure), using usage prediction and reservation aggregation.

- How we can improve the energy efficiency of software code on a large scale? Is it possible to have "green programming", and to improve compilers and code in order to be more energy efficient?

- Computer architectures are inherently not built for energy savings. What changes have to be performed on current computer architectures?

- New developments in the field of smart grids include the virtualization of the different types of actors/agents. For all of these actors/agents there is the need to know what amount of energy we are talking about.

Lecture 2

Background lecture on Green ITC Technologies, Business and Regulation (L.F. Pau, Copenhagen Business School and Rotterdam School of Management)

Abstract: *The lecture provides extensive background information for the whole Green ITC area. This includes: physical units, climate policies, ITC component technologies, Green information systems, Green communications networks, Green buildings, Power systems and Smart grids, Economics and Business aspects of emissions, Regulatory aspects. As an introduction it was stated that: the "Cheapest energy is using no energy at all"; "The energy area is a global, but locally regulated market"; "There are other things that affect a green environment than CO_2"*

Research Issues and Questions

- The ITC area is very badly standardized in general, also in terms of energy use and emissions. As the current standards are rather weak, how would reinforced regulations improve the situation?

- Dismantling and doing materials recovery from an ITC system is on average five times more costly than the initial value of the equipment: how can we reduce this discrepancy?

- How can the shift from AC to DC, at least for renewable energy sources, to improve the efficiency of the power grid? How can we use improvements in DC-DC conversion techniques?

- Energy Lifecycle costs is highly different depending on the exact nature of the benchmarks. The variety of real-life scenarios is huge; therefore it is difficult to find an optimal solution for the estimation of energy lifecycle costs. This aspect is like a dynamic mosaic.

- How can we convince end-users to accept the benefits of the use of smart energy meters in their homes, as they end up paying a lot for them? How relevant is the usage profile in reducing the CO2 footprint of a household / small firm?

- In terms of Green ITC technologies it is necessary to make a continuous zoom between the microscopic level and the real world. There is the need to understand the effect of each detail at the macro-level.

Day 3, 10th of March 2011

Lecture 1

Energy Efficiency in Wired Communications Network (Anne Cecile Orgerie, E.N.S., Lyon)

Abstract: State of the art of energy efficient techniques in wired networks. Hardware optimizations, on/off techniques, rate adaptation, and network wide solutions. Proposed Hermes framework.

Research Issues and Questions

- Designing green network protocols: it takes about 15 years to deploy new network protocols in the Internet (from the design to the real usage). How can energy-efficient network protocols be designed fast for future wired applications and traffic?

- It is necessary to design energy-efficient network equipment, with e.g. low power modes, different emission rates, rapid boot up and shut down.

- How can we dynamically adjust wired network infrastructures to the traffic load? Is it possible to have network management infrastructures that for example can turn off network portions, or which are designed to be more adapted to the real traffic and required QoS?

Lecture 2

Energy and Information an Holistic Approach about computers and power Networks (Paul Nicolae Borza, Transilvania University of Brasov, and Dr. Mihai Sanduleac, ECRO, Romania)

Research Questions

- Are bio-systems the source of energy saving paradigms?

Lecture 3

Emissions from wireless networks and services: trade-off and selection methodologies including business and user behaviours. Presentation of a simplified version of proprietary tool for energy efficiency and emissions in wireless public networks taking service demand into account   (Prof. L-F Pau, Copenhagen Business School and Rotterdam School of Management)

Research Issues and Questions

- This case and tool show that a "just use what you need"- like approach, in terms of services and infrastructure for wireless networks, directly impacts the CO_2 emissions. We have to consider that the cheapest energy is the one that we don't use.

- How can we incentivise users to use to a larger extent renewable power in communication networks, terminals and in general?

- How can we make the wireless network node's architectures more "green"? Which new features and functionality can be proposed to the wireless standardization bodies?

- Is it possible to impose or propose a "green tariff "to the users of a wireless network?

- When proposing a viable technology it is very important to validate and verify this technology with end users. We do not have only to "push" technology: someone has to "pull" from the other side to adopt new technologies.

- How can we couple pure technological research with research on user behaviour, in order to have a complete design for a new technology, also in terms of usability? The approaches should be made at all levels (individuals, companies, governments).

- How can the use of femtocells, in a hierarchical coverage organization, make wireless networks more energy efficient?