Sustainable Computing

REGISTER

Monthly newsletter of the IEEE Computer Society Special Technical Community on Sustainable Computing
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Chair's Report – A Year in Review

by Martin Arlitt, University of Calgary/HP Labs

As 2012 comes to an end, it is time to reflect upon the accomplishments of the STC on Sustainable Computing (STC-SC) over the course of the year. Back in January, the inaugural issue of the Register was published. At the time, we did not realize the amount of effort required to create and sustain a monthly publication. While we sprinted to create the first issue, maintaining the Register really requires a marathon effort. I want to thank and congratulate our editor, Chris Stewart, as well as all of the people who contributed content throughout the year, for a job well done.

An equally impressive achievement is the membership growth of our STC. In January 2012, we had a total of 24 members; this consisted primarily of the officers and a few of our colleagues. As of today we have 400 members, a 16X increase. I would like to thank Anirban Mahanti and Sergey Blagodurov, the membership chair and vice-chair, respectively, for their efforts to actively recruit new members. Similarly, I would like to thank everyone else who helped attract new members by advertising our STC.

Our STC is positioned to become even stronger in 2013. In addition to the Register, we have a number of activities in progress. First, we expect to technically co-sponsor several important conferences. Second, we are investigating how we can establish an award to recognize exceptional students working in the area. Third, we are seeking ways to better engage our membership, to capture additional ideas to improve the value our STC provides. Please stay tuned – or better yet, volunteer and actively help out.

This will be my final report as co-chair of the STC-SC. Next month I will become chair of the committee that oversees all STCs. I intend to leverage many of the “best practices” established within our STC to assist other STCs. Giuliano Casale and Raoufeh Hashemian will be joining me in this effort. Anirban Mahanti will replace me as co-chair, while Danilo Ardagna will take over Giuliano’s existing role. Raoufeh will continue to act as the Web master for STC-SC, in addition to filling this role for the STCs committee. I would like to thank everyone in the STC-SC for their contribution in making 2012 so successful.

Seasons Greetings, Martin

STC-SC Officers

Chair:Martin Arlitt, University of Calgary/HP Labs

Chair: Ishfaq Ahmad, Univ. of Texas at Arlington

Secretary/Treasurer: Giuliano Casale,Imperial College

Conferences: Diwakar Krishnamurthy, University of Calgary

Academics: Niklas Carlsson, Linköping University

Membership: Anirban Mahanti, NICTA

Vice Mem.: Sergey Blagodurov, Simon Fraser University

Communications: Abhishek Chandra, University of Minnesota

Policies and Procedures: Stephen Dawson, SAP

Industry Chair: Canturk Isci, IBM

Newsletter: Christopher Stewart, The Ohio State University

Webmaster: Raoufehsadat Hashemian, University of Calgary

Information: David Carrera, UPC BarcelonaTech

Information: Danilo Ardagna, Politecnico di Milano

Information: Fan Dongrui, Institute of Computing Technology

Information: Guillaume Jourjon, NICTA

Energy Packet Networks: Smart Electricity Storage to Meet Surges in Demand

Featured Article by Erol Gelenbe

Energy markets have evolved from having a small number of suppliers to more flexible markets where consumers are able to select energy suppliers, while suppliers themselves may be able to dynamically select the producers and the types of energy sources that they use. These trends are driven by the push from public regulators for more competition in energy supply, by incentives to turn to by renewable energy sources (RES) which are becoming more plentiful, and by the introduction of smart meters and smart grid technologies which allow a far greater flexibility in matching supply and demand. The basic enabling technologies in all of this are data networks and distributed computer based decision systems. The use of RES such as solar panels, wind power, tidal flows, hydroelectric sources and geothermal power all introduce new dynamic time variations which can be unpredictable and sometimes aperiodic. While RES introduce an unpredictable element at the supply side, time varying, but more predictable characteristics are present at the demand side of the energy market. Ideally, one should be able to tune the demand side to meet the supply. To smooth out this interaction between dynamic supply and demand, energy storage systems such as the batteries of electric vehicles, various forms of electronic uninterruptible power supplies (UPS), compressed gas depots (GD), and dams and water towers (WT) can offer new opportunities to provide multiple energy buffers between fluctuating energy supply and demand. Thus in the face of unpredictable and highly variable renewables, storage technologies are an appealing means of smoothing the supply-demand equation and have thus received considerable attention. Pursuing the idea of storing and forwarding energy on demand, we have recently proposed to exploit an interesting analogy between an energy request and distribution system and data networks. Indeed:

• One can think of a consumer's request for energy as a "demand for video" or for a download from a web server, where the content emulates the energy and the flow of data across the computer network emulates the flow of electrical current from the source(s) to the sink(s).
• Intermediate store-and-forward buffers where packets are stored can be viewed as centres where energy is stored, such as batteries or UPSs, or other energy storage devices such as dams or WTs with pumps and water turbine generators or GDs with pumps and gas turbines for energy generation.

Stemming from this, we have recently proposed the concept of an Energy Packet Network (EPN) [1] [2] which is a virtualised dynamic fine-grained energy storage and distribution system based on "energy packets" (EP). An EPN is an integrated adaptive electrical energy storage, distribution and consumption system. In addition to a conventional scheme for distributing energy based on instantaneous flow of current towards points of energy consumption, it offers smart management of requests and dispatching of EPs to meet the demands of individual or commercial consumers and various autonomous electrical devices and appliances, based on smart dynamic generation, storage and dispatching of electric power. Such systems may be particularly well adapted to environments where RES are common, and where effective means for storing energy, such as electric cars and UPS, are available. We can imagine that many of the consumption sinks of a EPN would be coupled at close distance with one or more storage facilities. The flow of energy in the EPN is controlled by Smart Energy Dispatching Centres (SEDCs) which receive requests from both the consumers and storage centres, and optimise the energy flows by making the

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PICK OF THE MONTH
December 2012

<u>Totally Green: Evaluating and Designing Servers for Lifecycle Environmental Impact</u> by Jichuan Chang, Justin Meza, Parthasrathy Ranganathan, Amip Shah, Rocky Shih, and Cullen Bash published in ASPLOS 2012.

Christopher Stewart: Ordinarily, we interview the authors of our Pick of the Month. However, in this issue, we are short on space. So I will summarize the outstanding merits of Totally Green myself. The authors can be contacted by email to get further insights into the paper. Upon the news of receiving the award, the authors said, *"Thanks for the good news! We are honored that our work has been chosen as the Pick of the Month."*

In my humble opinion, Totally Green--- like many of our other Picks of the Month--- represents not just a great paper but foundational effort for future work on sustainable computing systems. The premise of this work is that (computer) system architects already optimize for performance and energy but they should be able to optimize for environmental impact as well. Environment impact differs from operational energy as it includes 1) carbon footprint (modelled here with exergy) and 2) whole life cycle costs, e.g., resources used to produce, package, and deliver products. The paper is multi-disciplinary, teaching systems managers how to apply exergy based life-cycle approaches in their optimizations. Their results show savings around 10% in exergy, and that's just on the production side. At the same time, this only the start. The proposed model can be used to co-design for high renewable energy usage, water conservation, and other environmental concerns. If you haven't already read this paper, you should read it now. If you have, you should read it again. It will probably influence a lot of future work in our field.

Congratulations to all Pick of the Month Winners for 2012

March	Minimizing Data Center SLA Violations and Power Consumption via Hybrid Resource Provisioning	IGCC 2012 (best paper)
April	Capping the Brown Energy Consumption of Internet Services at Low Cost	IGCC 2011 (best paper)
May	Power Budgeting for Virtualized Data Centers	Usenix ATC 2011
June	Blink: Managing Server Clusters on Intermittent Power	ASPLOS 2011
Sep	Leveraging Stored Energy for Handling Power Emergencies in Aggressively Provisioned Datacenters	ASPLOS 2011
Dec	Totally Green: Evaluating and Designing Servers for Lifecycle Environmental Impact	ASPLOS 2012

Big Data and Data-Center Computing

by David Carrera, Barcelona Tech and Barcelona Supercomputing Center

The Parasol: A Solar-Powered Micro-Datacenter

With energy costs of IT infrastructures being every time more important (see report), the creation and management of solar and wind-powered data centers is becoming a very attractive field of research. Renewable energies can be used for data centers as their main power source, but some research challenges are posed by one particular nature of solar and wind-power: their availability is very variable over time. An already large number of companies have started developing prototypes of solar-powered data centers, and in some cases, they already reached production status. Facebook, eBay, Apple, Cisco, Intel, McGraw-Hill are only a few examples of some important companies that have ongoing projects to leverage renewable energies in their datacenters.

But in this entry we will focus on an academic initiative to develop a solar-powered micro-datacenter as a research platform prototype. The Parasol project is conducted by a team led by Prof. Ricardo Bianchini in collaboration with Prof. Thu D. Nguyen at the Department of Computer Science of Rutgers University. The team currently works on topics related to the design and evaluation of complex computer systems, with special focus on energy, availability and performance. Parasol is the research platform in which they will conduct their research on energy-aware computing for the next years. The group has already received more than $1.5 million in U.S. National Science Foundation grants for research into energy efficiency in computing, as well as direct funding from Google to conduct joint research with computer scientists at the U.C. Santa Barbara, the University of Michigan, and the University of Virginia.

The main description of the Parasol project was published by Bianchini's team in EuroSys'2012, with the paper "Parasol: A Solar-Powered µDatacenter" by Ricardo Bianchini, Íñigo Goiri, Kien Le, and Thu D. Nguyen, which received the best poster award at the conference. This work describes the main architectural characteristics of the project. The Parasol prototype is composed of a small container, a set of solar panels, and batteries, all of them located on the roof of one of the building of Rutgers University. The solar panels are located on top of the container to capture as much of solar energy as possible. Batteries are charged with excess energy, and the system can decide to draw energy from the batteries as needed. The container is also plugged to the electrical grid, but Parasol can operate completely off it. Inside the container, two racks of energy-efficient servers are hosted: for the moment, 64 Atom-based half-U servers equipped with solid-state drives, but the maximum capacity of Parasol is around 150 of these servers. As much as possible, the container uses free cooling (an option on a rooftop), but can use air conditioning (HVAC) if required.

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best use of renewable energy sources and existing pricing policies, while satisfying consumer demands and minimising peak energy flows through buffering and scheduling of energy. SEDCs are computer control centres which receive information and make dispatching decisions from/to all other system components via data communication networks. The basic unit of energy in this system, an EP, can be viewed as a pulse of power that lasts a certain time; it constitutes the basic energy delivery unit of our system, say in KWH. The discretised and dynamically buffered nature of this system which integrates Quantised Requests, Generation, Storage and Distribution of Electric Power, motivates our choice of its name: the Energy Packet Network. The aim of an EPN is to provide a flexible, economical and efficient response to dynamic energy needs. An EPN can serve different purposes:

• It can be used to provide real-time information about the requests on the one hand, and the sources of energy on the other, so that an electrical energy network may be managed in real-time to provide lower overall costs, lower overall CO2 imprint, and greater reliability and security, and/or

• It can schedule the flow of current to and from electricity storage units, based on availability and demand,

• It may also be useful for real-time scheduling of energy demand so as to meet certain desirable objectives, e.g. scheduling electric heating in a large building in a round-robin manner among different flats or rooms.

[1] E. Gelenbe "Energy Packet Networks", Keynote Talk, GreenNets 2011: The First ICST International Conference on Green Communications and Networking, Colmar, France, Oct. 5-7, 2011.

[2] E. Gelenbe. Energy Packet Networks: Smart Electricity Storage to Meet Surges in Demand. SIMUTOOLS 2012 , 5th International Conference for Simulation Tools and Techniques, 1-7, ACM Digital Library http://dx.doi.org/10.4108/icst.simutools.2012.247805, European Digital Library: http://eudl.eu/doi/10.4108/icst.simutools.2012.247805

Big Data and Data-Center Computing: Parasol (Continued)

The research team plans has already identified open research questions that need to be addressed, such as:

- What kinds of data center workloads are amenable to green data centers?
- What kinds of techniques can we apply to better match the demand for energy to the variable energy supply?
- Should we allow programmers to specify what types of techniques can be used?
- How well can we predict solar and wind availability? If batteries are available, how should we manage them?
- Can we leverage geographical distribution to maximize our use of green energy?
- If we have a choice, where should be place green data centers to strike a good compromise between high energy generation and data center costs?"

To address some of these questions, the team has already built two load-scheduling prototypes for green data centers: GreenSlot and GreenHadoop. Both systems aim to maximize the use of green energy and work under the assumption that the data center is connected to both a solar array and the electrical grid, and that there are no batteries attached to the compute nodes. GreenSlot builds on top of the SLURM scheduler and aims to maximize the solar energy consumption while meeting the jobs' deadlines. In this scenario, brown energy is only used to avoid deadline violations when no other options are possible, but still tries to only schedule the use of brown energy to the time periods when it is cheap. In more detail, it first predicts the amount of solar energy that will likely be available in the future, using historical data and weather forecasts. Based on its predictions and the information provided by users, it schedules the workload by creating resource reservations into the future. As expected, servers are switched off (sleep mode) when not needed. On the other hand, GreenHadoop focuses on Hadoop framework (Apache's MapReduce runtime). MapReduce workloads are very malleable but they are not usually associated to performance or energy goals as most batch job-schedulers do. But they pose another important challenge in terms of power-managing because MapReduce workloads require guaranteeing that the data to be accessed by the active jobs remains available. Besides managing energy consumption and brown energy costs, GreenHadoop manages the cost of peak brown power consumption.

STC Updates

By Giuliano Casale, Imperial College

Membership: 400

Report from Secretary/Treasurer (Giuliano Casale):
- Collected officers' activity reports and prepared monthly STC report

Report from Conferences Chair (Diwakar Krishnamurthy):
- Coordinated with organizers of MICRO 2012 and ClouCom 2012 to display the STC's poster

Report from Academic Chair (Niklas Carlsson):
- Looking into alternative avenues to reward young researchers in the field, e.g., a student award

Report from Membership Chairs (Anirban Mahanti and Sergey Blagodurov):
- Sent invitations for CloudCom participants to join STC-SC
- We are on track to meet our membership goal (400 members) by the end of 2012
- Investigating how to better leverage "services" provided by Computer Society for our members
- Setting up an STC-SC Google Group and integrating with Computer Society's website

Report from Communications Chair (Abhishek Chandra):
- Updating upcoming call for papers and call for participation
- Bhuvan Urgaonkar accepted to serve as vice communications chair

Report from Policies and Procedures Chair (Stephen Dawson):
- Met with SAP green energy / e-mobility and Green ICT areas to promote STC-SC
- Still looking around to find vice-chair

Report from Industry Chair (Canturk Isci):
- Finally had our first draft for our inaugural STC community highlight feature
- Working with the Academic Chair to have a follow up with the group and to publish in the Register

Report from Information Officers (Danilo Ardagna, Fan Dongrui, Guillaume Jourjon, David Carrera):
- Contributed material for newsletter and blogs.
- Contacted young researchers at the Centre for Energy Efficient Telecommunications (CEET) in Melbourne to more contributors

Report from the Newsletter Editor (Christopher Stewart):
- Enlisted David Chui from Washington State at Pullman as Vice-Editor

Upcoming Events

By Abhishek Chandra, University of Minnesota

The following venues are all requesting submissions on subtopics related to sustainable computing or IT for sustainability.

Conference, Workshop & Symposium Call For Papers

Short Name	Main Topic	Location	Dates	Abstracts Due	Papers Due
SIGMETRICS	*Performance Evaluation*	*Pittsburgh, PA, USA*	*Jun. 17-21, 2013*	*Nov. 2, 2012*	*Nov. 9, 2012*
CCGrid	Cluster, Cloud and Grid Computing	Delft, Netherlands	May 13-16, 2013		Nov. 12, 2012
ICDCS	Distributed Computing Systems	Philadelphia, USA	Jul. 8-11, 2013		Nov. 12, 2012
ENERGY 2013	Smart Grids, Green Communications	Lisbon, Portugal	Mar. 24-29, 2013		Nov. 12, 2012
ISCA	Computer Architecture	Tel Aviv, Israel	Jun. 23-27, 2013	Nov. 14, 2012	Nov. 21, 2012
SEIT 2013	Sustainable Energy IT	Halifax, Canada	Jun. 25-28, 2013	Dec. 20, 2012	
HPDC	High Performance Distributed Computing	New York, USA	Jun. 17-21, 2013	Jan. 14, 2013	Jan. 21, 2013
USENIX ATC	Computer Systems	San Jose, CA, USA	Jun. 26-28, 2013	Jan. 23, 2013	Jan. 30, 2013
GreenMetrics	Sustainable Computing	Pittsburgh, PA, USA	Jun. 17, 2013		Apr. 15, 2013

Journal and Special Issue Call For Papers

Sustainable Computing

Conference, Workshop & Symposium Call for Participation

Short Name	*Main Topic*	*Location*	*Dates*
CGC 2012	*Cloud and Green Computing*	*Xiangtan, China*	*Nov. 1-3, 2012*
UCC 2012	*Utility and Cloud Computing*	*Chicago, IL, USA*	*Nov. 5-8, 2012*
GreeNETS 2012	*Green Communications and Networking*	*Gandia, Spain*	*Oct. 24-26, 2012*
SC'12	*Supercomputing*	*Salt Lake City, USA*	*Nov. 10-16, 2012*
GreenCom	Green Computing and Communications	Besancon, France	Nov. 20-23, 2012

Visit http://stc-sustainable-computing.ieee.net/venues for more information.

To advertise a relevant venue, email Abhishek Chandra at chandra@cs.umn.edu.
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