e-vigr:
ekt's - Virtual Infrastructure GReen meteR

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The **Ekt's - Virtual Infrastructure Green metreR** is a set of scripts for estimating, in real time, and with appropriate assumptions, the power savings a virtualization/cloud computing infrastructure achieved in comparison to an non-virtualized equivalent system.

- **E-vigr** can calculate power consumption savings over **XEN** and **VMWARE** based virtual infrastructures, independently of specific h/w vendors.

- It applies **real time power metering** of the physical servers, comprising the virtual/cloud infrastructure, virtualized infrastructure platform information, a **projected power consumption of virtualized servers**, based on collected performance metrics.
- Can work over

● Cloud Computing

1. Meaning lots of different things to different people – iaas, saas, grid etc.
2. Core in most of these is virtualization
3. Scalability and savings of scale can be important

● Cloud & Green IT

- IT consumes **lots of energy** (Koomey >2% power consumed in the US)
- Green IT: cloud infrastructures and virtualization one of the solutions to make “things better”
- Large scale infrastructures can be more efficient - but also can consume lot of energy
- Lots of different metrics - forums, previously overlooked, not clear always definition of parameters, need for a interdisciplinairy approach

EKT/NHRF: who we are

- EKT is the national infrastructure for scientific documentation, online information and support services on research, science and technology.
- Provides digital content (scientific, cultural, research and technology) services to the greek academic community,
  - [www.openaccess.gr](http://www.openaccess.gr)
  - The Greek PhD theses dissertation archive [phdtheses.ekt.gr](http://phdtheses.ekt.gr)
  - [Helios-eie.ekt.gr](http://helios-eie.ekt.gr), the NHRF institutional repository
  - [Pandektis.ekt.gr](http://pandektis.ekt.gr), the NHRF digital cultural collection
  - 5 peer reviewed open access journals for the humanities and science ([www.byzsym.org](http://www.byzsym.org), …)
  - [Parthenonfrieze.gr](http://parthenonfrieze.gr), the digital Parthenon frieze online
  - The ABEKT library automation tool ([abekt.ekt.gr](http://abekt.ekt.gr))
  - [www.enterprise-hellas.gr](http://www.enterprise-hellas.gr), connecting research and innovating enterprises

- Expertise in IT systems and s/w for providing and organizing **large volumes of structured and unstructured digital content** for science, technology and research
- Supporting **open source, open access, open standards** and **environmental responsibility**
- Operates (since 1991) one of the most important **Datacenters** in the greek academic community providing:
  - content services (EKT’s IT systems)
  - computation: hosts one HellasGrid node
  - network connectivity and services: hosts GR-IX, GEANT GRNET node, etc.
  - > 120 m2 raised floor space, 100s of KWs consumed

Since 2007 we have introduced virtualization infrastructure for providing our services to our end users:

- **ELLAK 2008 conference (Athens)**: presented the feasibility of providing production grade services using open source virtualisation infrastructures, calculated energy savings of our consolidation project.

- **Open Source Systems 2009 (Skovde, Sweden)**: Demonstrated that virtualisation infrastructures are most agile, cost effective and scalable when open source software is used on top of them.

- Next step (**ELLAK 2010 conference**): calculate in real time the power saving our virtualization infrastructure offers

**power savings, green it and metrics:**

- Green IT: not mature metrics/KPIs, not ready made s/w, should employ an interdisciplinary problem

http://code.google.com/p/e-vigr/
Ekt's - Virtual Infrastructure Green meteR (e-vigr) is a set of scripts for estimating, in real time, and with appropriate assumptions, the power savings a virtualization/cloud computing infrastructure achieved in comparison to an non-virtualized equivalent system.

- We have made our s/w and we give it as open source s/w
- operates on Linux (CentOS – RHEL) written on TCL (rapid prototyping)
- requires certain infrastructure enhancements but not specific vendors equipment
- Simple, manageable and independent of specific monitoring systems in order to reduce complexity
- Operates on XEN and on VMWARE platforms
- Result : live monitoring of the power savings, environmental and economic footprint

http://code.google.com/p/e-vigr/
Prerequisites

Steps (simplified):

1. Measure the actual consumption of the virtualisation infrastructure servers
   - SNMP based, requires to enable an appropriate server-based ILOM, or alternatively metered PDU socket

2. Dynamically read the virtual servers that run over the virtualisation infrastructure
   - Depends on the virtualisation management, bare metal s/w MIB
   - Requires some SNMP specific enhancements on XEN infrastructures

3. Then model the projected power consumption of the virtual servers using valid assumptions

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Basic output

*Graph created using cacti

http://code.google.com/p/e-vigr/
Modeling the power consumption of virtual servers:

- How can we model something that is virtual?
- Safe side: estimate the worst case scenario, i.e. the least power consumption savings

Valid assumptions:

1. Find the main factors that contribute to power consumption: server architecture, memory, cpus, etc
2. Lots of work has been done on this field

http://code.google.com/p/e-vigr/
Assumptions

- **Vendor example**
  - Sun X4150 power calculator
    - What matters: CPU types, number of CPUs, memory, extension cards

- **Vendors & Bibliography**: what actually matters is the processor load for a given server

- **US department of Energy**: 
  - $P = (P_{\text{max}} - P_{\text{idle}}) \times n/100 + P_{\text{idle}}$, $n =$ CPU utilization
Implementing assumptions

- Select a base server as the basic reference model & be on the safe side
- measure virtual server processor load and based on this equivalent server calculate the projected power
- The script “crawls’ all of the virtual servers and based on their load calculates the projected power savings.
  - It can recover from non responding servers, malformed SNMP answers, etc
- Now we are having the actual power consumed and the projected power consumed.
- It refers on the server h/w does takes into account no networking, or storage

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Based on the instantaneous power consumption benefits e-vigr estimates:

- The saved Energy over a period of time
- Cost savings (Kwh to Euro, source [http://www.energy.eu/](http://www.energy.eu/))
- CO2 emissions reduction
  - different for each country/installation (source greenpeace.gr)

For different PUEs ([http://www.thegreengrid.org/](http://www.thegreengrid.org/))

- So far we have calculated only the server-side savings
- Real datacenters need cooling, have UPS/PDUs power losses

**PUE**: indicates how much more energy we need in order to cool the equipment and count for the losses in UPS power, lines etc.

- PUE = Total Facility Power / IT Equipment power
- It depends on datacenter technology, season external environmental factors, load of the datacenter etc.
- Calculates for PUE from 1.0 to 2.5

Virtualisation platform - Total energy savings

- Energy savings (PUE 2.5): 209.06 k
- Energy savings (PUE=2.0): 167.25 k
- Energy savings (PUE=1.5): 125.44 k
- Energy savings (PUE=1.0, IT only): 83.62 k

Virtualisation Platform - CO2 emissions reduction

- CO2 reduction, (PUE=2.5): 209.06
- CO2 reduction, (PUE=2.0): 167.25
- CO2 reduction, (PUE=1.5): 125.44
- CO2 reduction, (PUE=1.0, IT only): 83.62

Virtualisation platform - Energy cost reduction

- Cost reduction (PUE 2.5): 18063
- Cost reduction (PUE 2.0): 14.45 k
- Cost reduction (PUE 1.5): 10.84 k
- Cost reduction (PUE=1.0, IT only): 7.23 k

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EKT’s power savings

- What was achieved by EKT since 2008 (2nd version of our virtualization platform initiated):
  - 167,000 Kwh consumed less.
  - 167 tons of reduced CO2 emissions
  - 15,000€ less
  - 16KW average power savings

- but also, e-vigr is:
  - Readily available as OSS and simple (room for lots of improvements)
  - initiated as an internal need but also can cover similar needs in other organisations
  - Raise awareness to infrastructure managers, policy makers, etc.
  - Tool for further implementing and evaluating Green IT technologies
  - Real graphs available in real time at http://code.google.com/p/e-vigr/