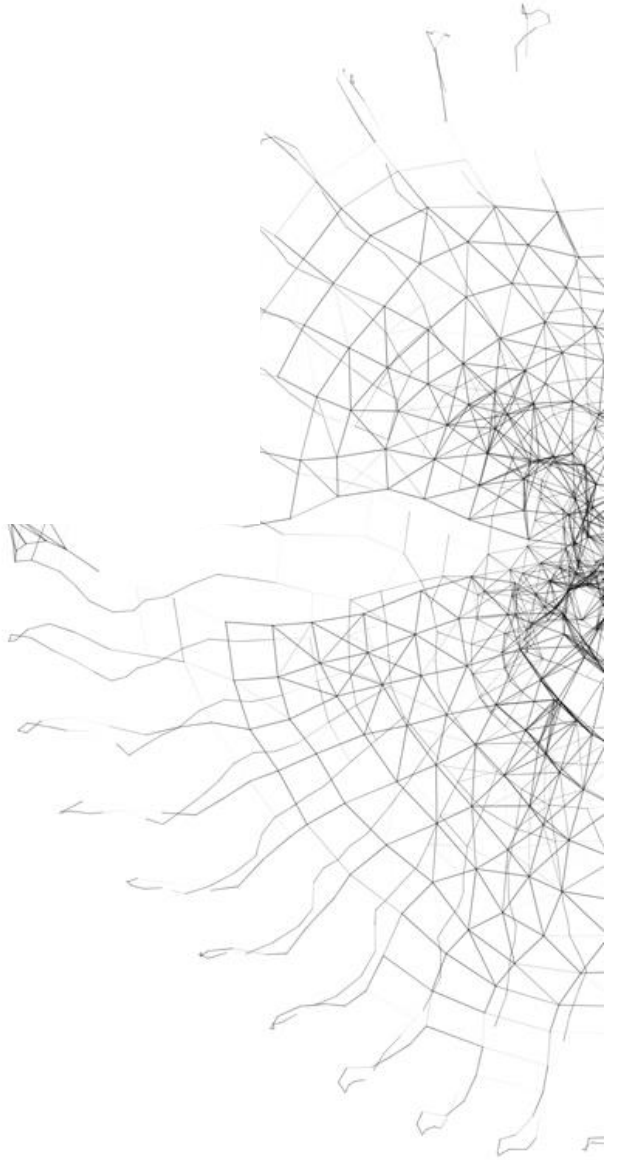
RTC 2017

THRIVING IN TESTING

Testing the Energetic Consumption of Software: Why and How



By Paulo Jose´ Matos

Voting Code

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Me

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32 years

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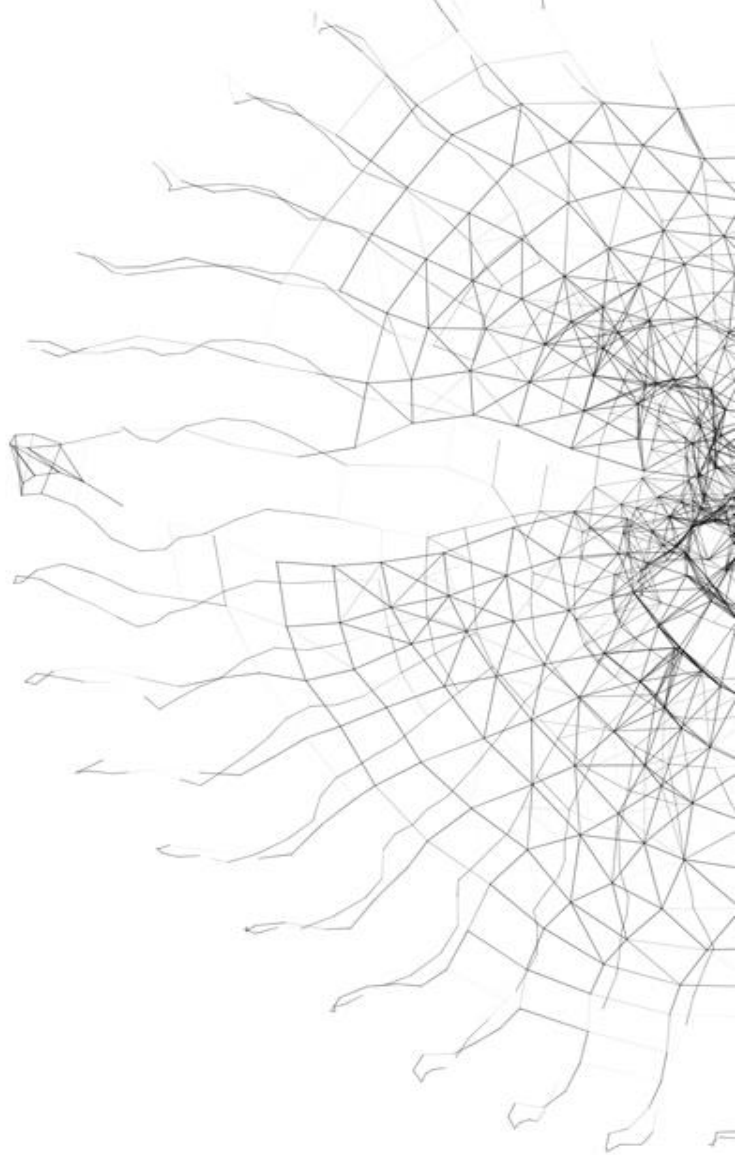
Why

Why Energy (and its consumption) is Important?



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Why Energy is Important?

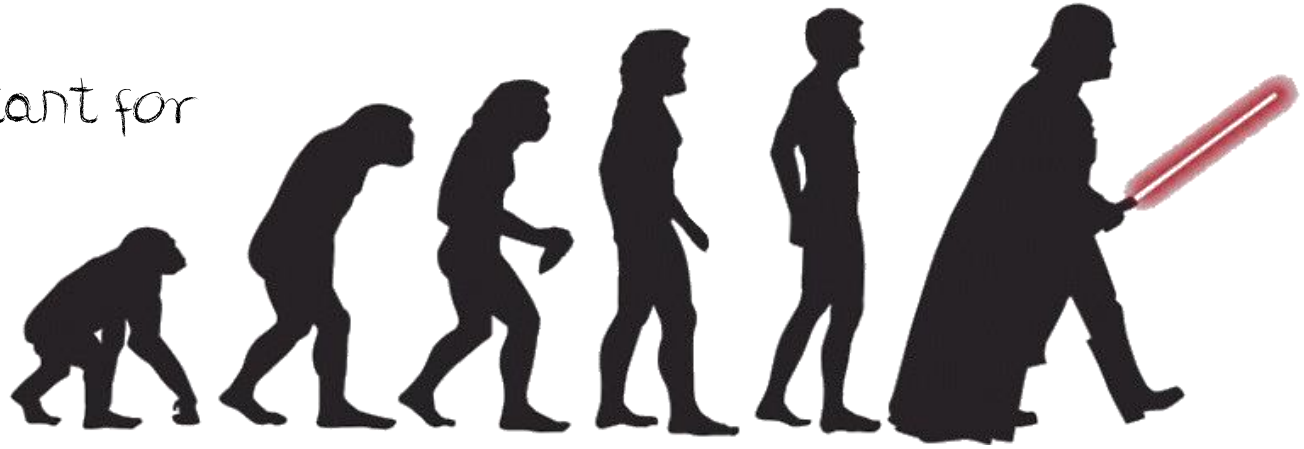
Global Energetic Model

Mankind, has evolved further than in a biological way.
It has also evolved through the increased use of **technology in their habits**, although initially only in **concept hardware**.

The man today is quite distant from nature at point of believes to possess a **virtual existence**, controlled and mediated by the intangible - **the software**.

This evolution is only reachable thanks to a technology called "electricity."

This technology is so important for humanity that it shaped his existence on electricity ecosystem!



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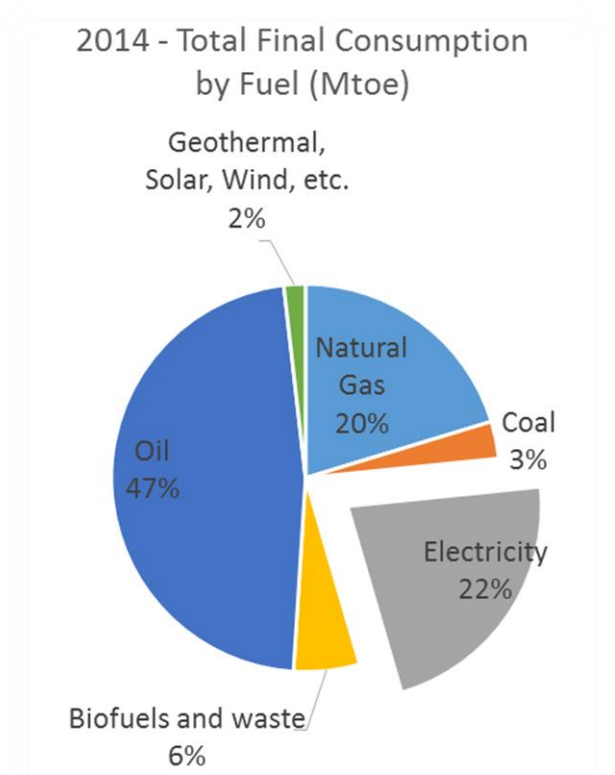
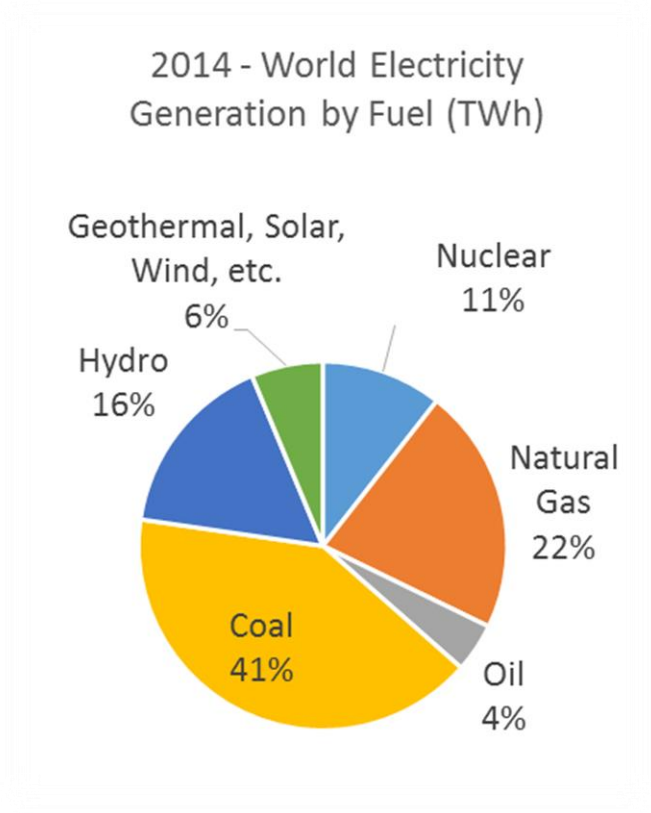
Why Energy is Important?

Global Energetic Model





The specific type of energy called "electricity", in context of the total energy generated, descends on its majority from **non-renewable sources*** (68%) which emit 12,547 million tons of CO_2 per turn, which represents near **40 % of the world total emissions of CO_2.**

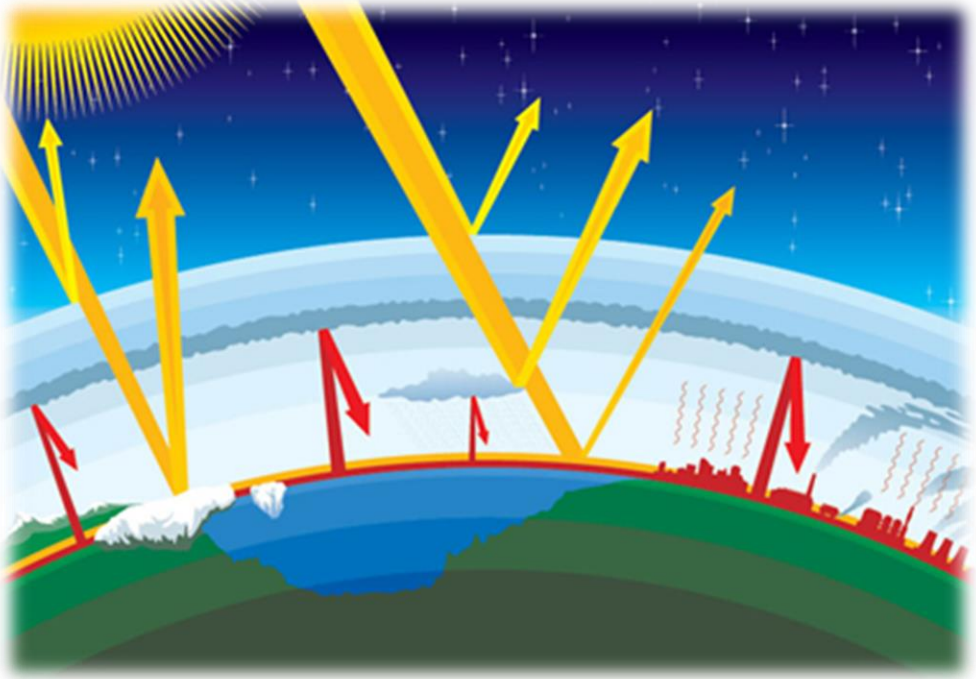
*Considering nuclear energy as renewable

Why Energy is Important?

Challenges: Environment

CO_2 is the main gas causing the greenhouse effect, and today the quantities emitted are excessive. For that we are contribute effectively to the Climate Change.

The United Nations indicate for survival of the species (**including human**) the increase of temperature at planet just old more 2°C, at limit more 4° C.



Why Energy is Important?

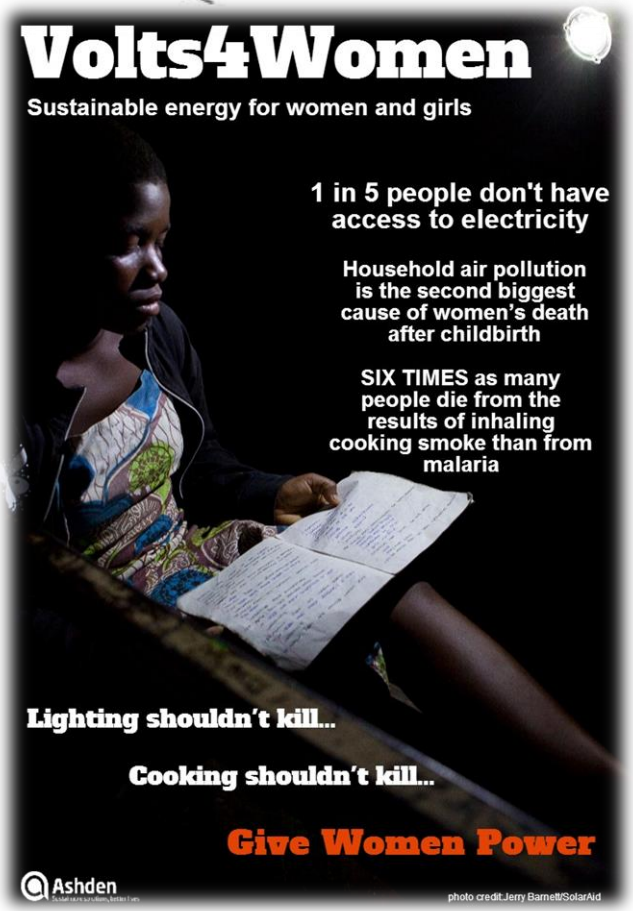
Challenges: Sustainable Development

Urban Populations Growing

In 2014, 1.3 billion people, i.e., 1 in every 5 of the world's population had no access to electricity.

In 2010 more than half the population lived in urban areas and it is expected that in 2050, 7 people in 10 are city residents.

So, demand for electricity in locations where the electrical distribution infrastructure are non-existent or ineffective is increasing.



Why Energy is Important?

Challenges: Sustainable Development

The United Nations alert to the energy paradigm of societies, in particular to the poorest countries, where it was agreed that the "energy" must be provided to all citizens as it's fundamental to the fulfillment of all the "Millennium Development Goals (MDGs)".

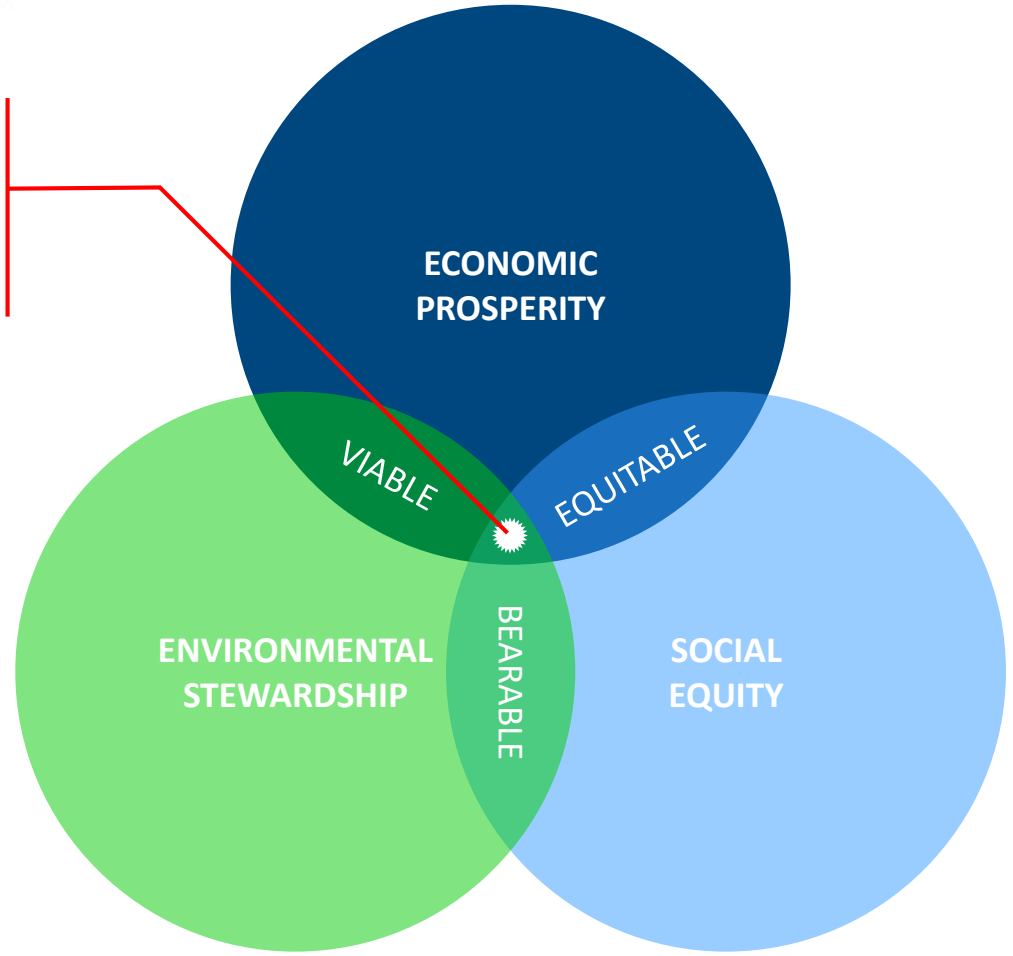
Three UN objectives to be achieved by 2030:

* Ensure universal access to modern energy services.
* Double the global rate of improvement in energy efficiency.
* Double the share of renewable energy in the global energy mix.

Why Energy (and its consumption) is Important?

Resume

New Governance Model:
Sustainable Energy 4All



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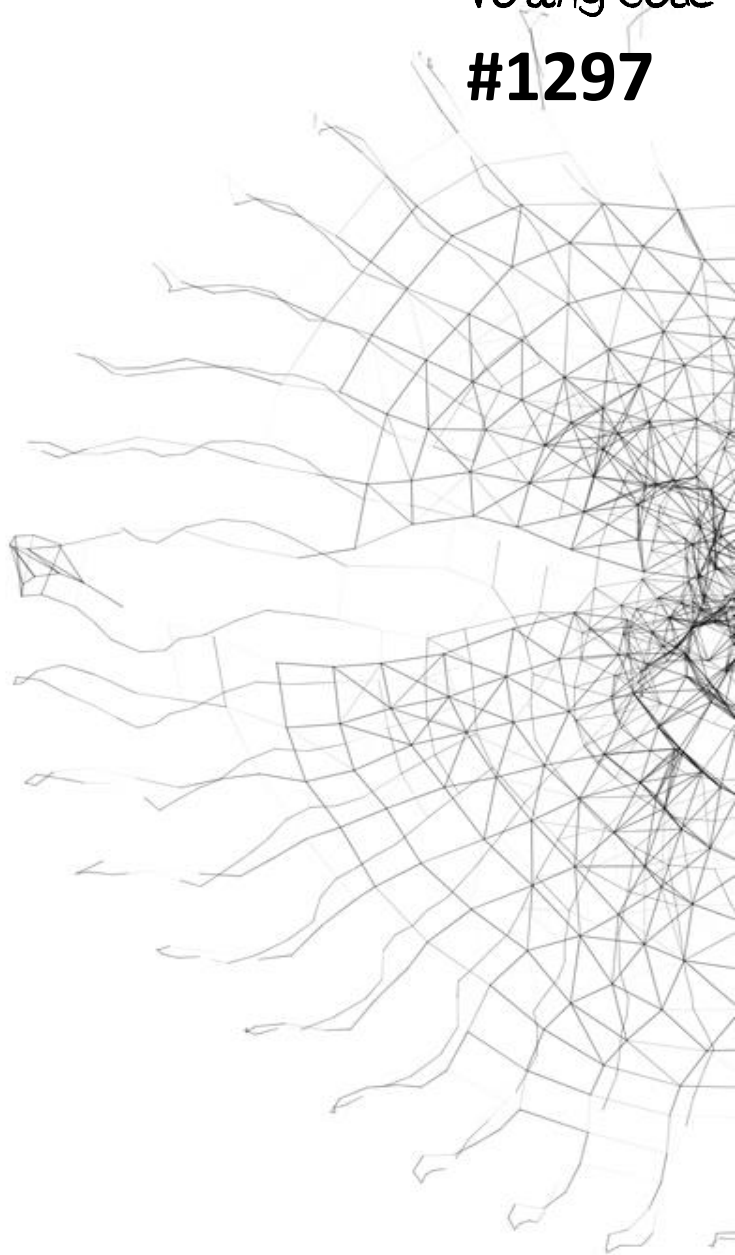
How

How we (testers) can help?



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How we can help?

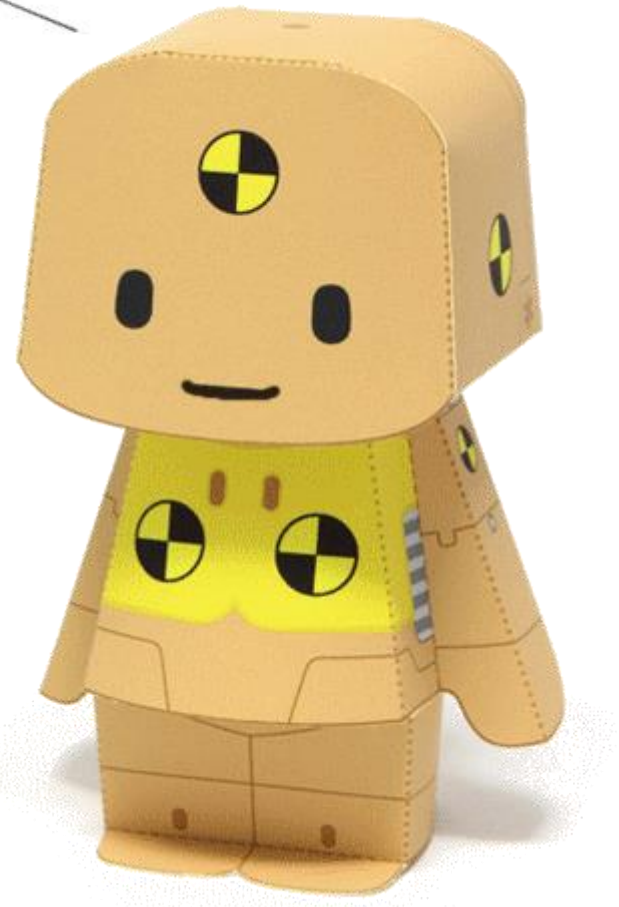
Here we are: Testers!

Software Testers are ready to help

A Software Tester performs an activity all over the software production cycle, from the collection of Requirements, to the support the delivery of the software product to customer or end user.

The Testing activity can be qualitative and quantitative by measurements at the code level, functionality or feature of a software program.

We live for Quality Assurance!



How we can help?

Here we are: Testers!

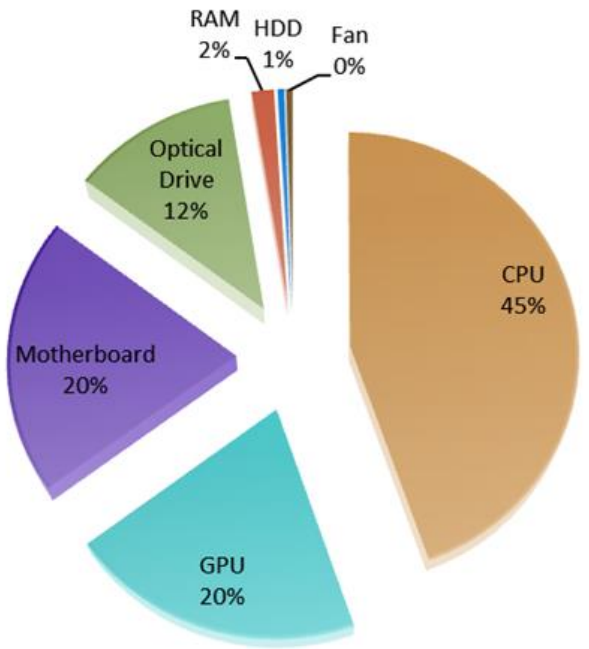
Where can we help?

A computer system, or computer, is the set of physical electronic devices (hardware) capable of performing algorithmic calculations in accordance with certain procedures defined by logical (software).

Actually, a computer consumes more than 65% of power capacity dealing with processing tasks (CPU+CPU).

And is the software that requires processing capability to perform its functions.

Computer's Power Consumption Distribution



How we can help?

Here we are: Testers!

HW + SW as whole

A Software Tester can measure the energy consumption without established barriers between software and hardware.

The ISO 14756:1999 indicates:

> "In order to measure the influence of software on the time behavior of a data processing system it is necessary to measure the time behavior of the whole system.".

This sentence in the context of ISO definition, tells us to test the energy consumption of software you must test the platform as a whole, because for example the software under test only runs if there is an operating system (OS) below that will have an effect.

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How we can help?

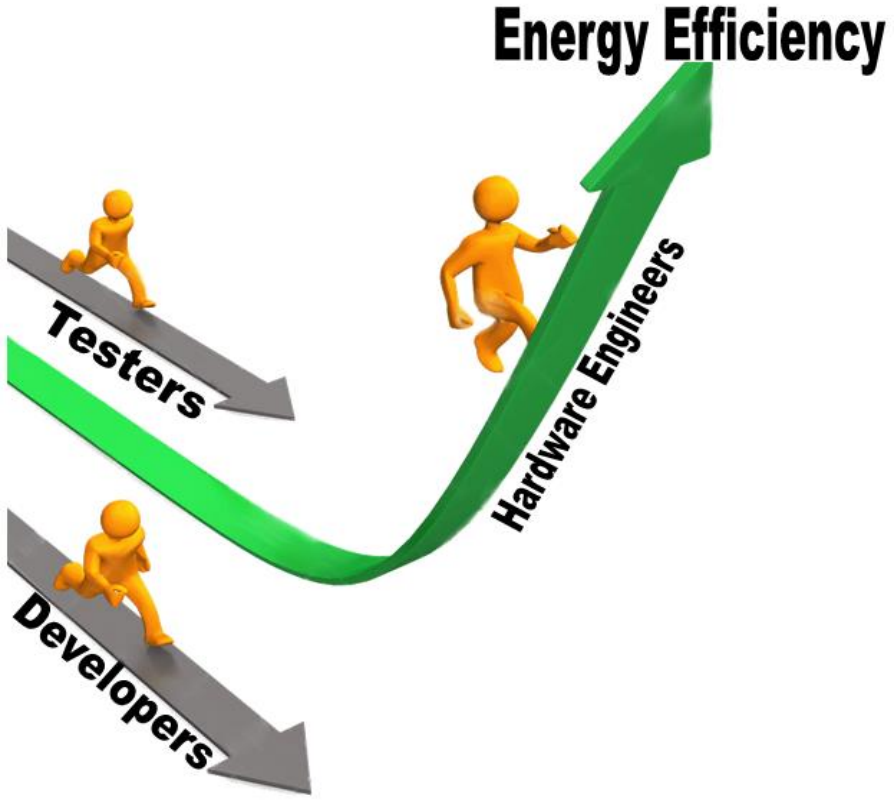
Status Quo

IT Professions Scenario

- For over a decade and a half, hardware engineers (eg, Intel, AMD) have been concerned about energy efficiency (>=2000 year).

- The Programmers, with the evolution of the Software in the mobile devices "was forced" to deal with Energy limitations because the batteries (>=2008).

- So we (testers) are once again started after the race started.



How we can help?

Status Quo

- In the book we can consider the tester's bible "Art of Software Testing" (1979) of Glenford Myers *et al.* it contained the following excerpt "there are programs that may have specific performance targets and efficiency".
- On 2008, we can pick the firsts references on Eurostar Conference by Brennan and Blatt, particularly the second.
- Blatt refers that hardware engineering already had energy efficiency measures implemented and because of that, they knew the benefits of financial savings. He also stated that they have a metric "performance per watt". Blatt also asked the essential question that all software engineers should reflect upon: "Highly efficient code will use less processing power, and Therefore less energy; but is the extra development effort (and energy spent doing it) worth it?"

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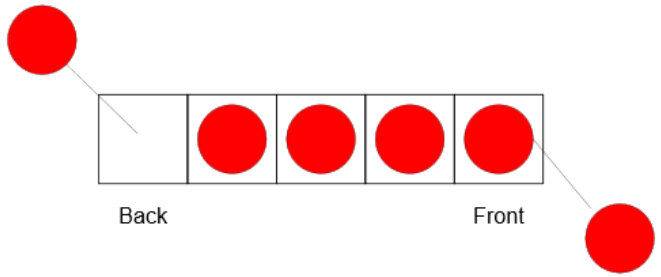
How we can help?

Status Quo

- Beginning at 2010, in Germany, the project Green Software (GE) and the annual conference Energy-Aware High Performance Computing (EAHPC) emerged, and many scientific papers about energy efficiency software were boosted.

  - E.g, in 2011, on EAHPC, Mammel *et al.* demonstrated by an optimization of an algorithm how to distribute work over a set of servers in further 3 years, nicknamed Job Scheduler (see figure), the existence of an increase in energy efficiency of 39%.



How we can help?

Here we are: Testers!

Re-catch attention about Testing Energy Consumption of Software

2015, on the official blog of Belgium Testing Days I get a text successfully approved and on that I present 8 arguments for limited discussion and no progress in methods of testing the energy consumption of software:

1. Lack of demand from the market
2. Negative perception of environmental radicalism
3. Energy consumption is seen as a hardware problem
4. Lack of tools makes it difficult to test
5. Low cost benefit
6. Benefits may affect the consumer rather than the organization
7. Software development mainly occurs in developed countries
8. Exist others debates more exciting

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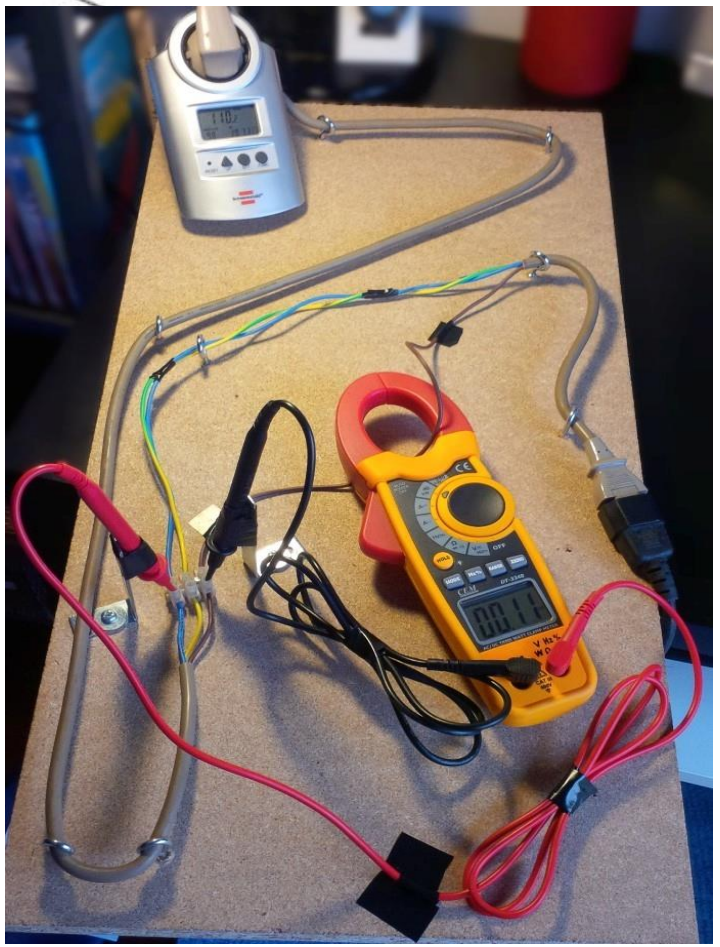
How we can help?

Measure Tools

- We can measure the energy consumption by two ways: physical (direct and indirect) and emulated (simulated).

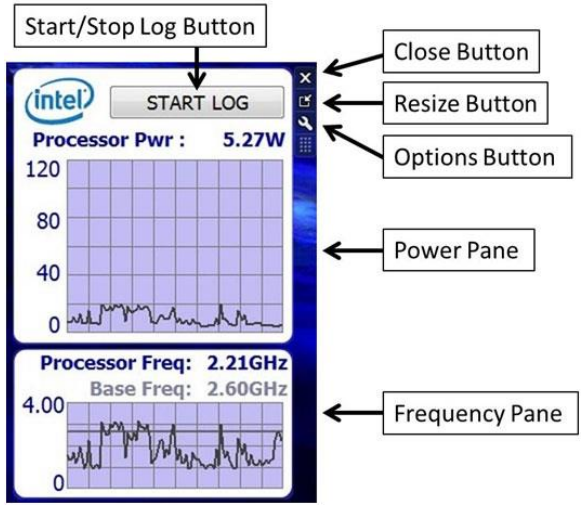
- Physical measurement devices can be done with wattmeter (power meter) or a clamp-on meter.
  - The first is an invasive device in the electrical supply.
  - The second is not invasive in the electrical circuit (so does not influence, positively or negatively, the measured consumption) because the calculation is estimated by magnetic field of the caliper.

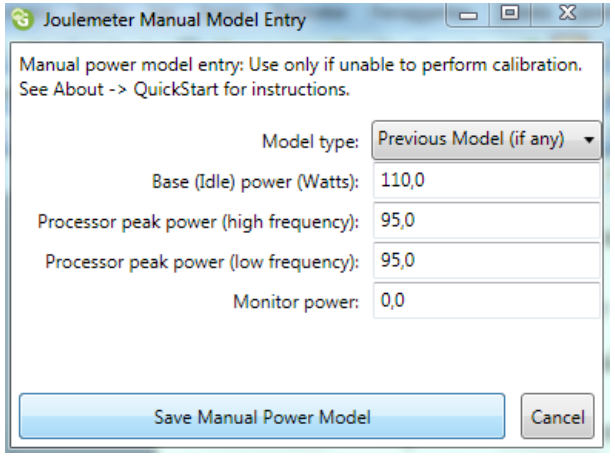


How we can help?

Measure Tools

- There are also the measuring tools who simulated consumption
  - IPPET from Intel
  - Joulemeter from Microsoft
  - and more frequently add-ons for the integration into software development tools like Microsoft Visual Studio Energy Consumption profiler



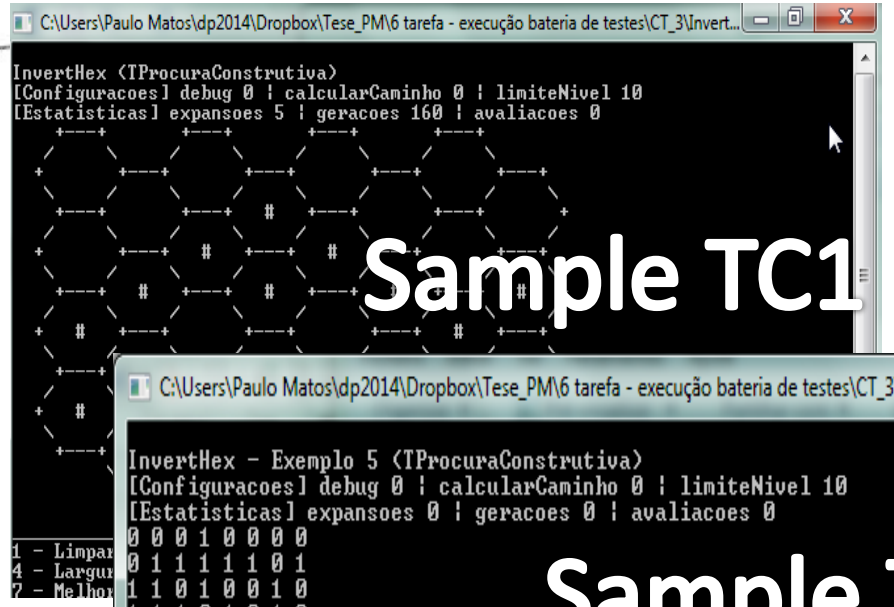


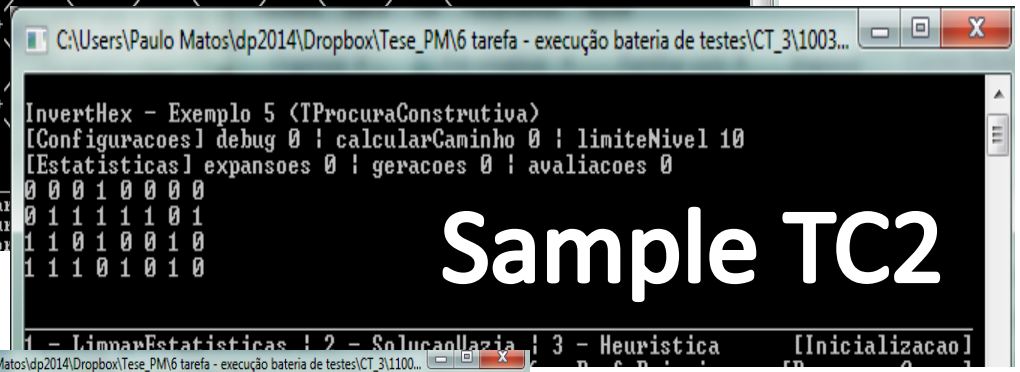
How we can help?

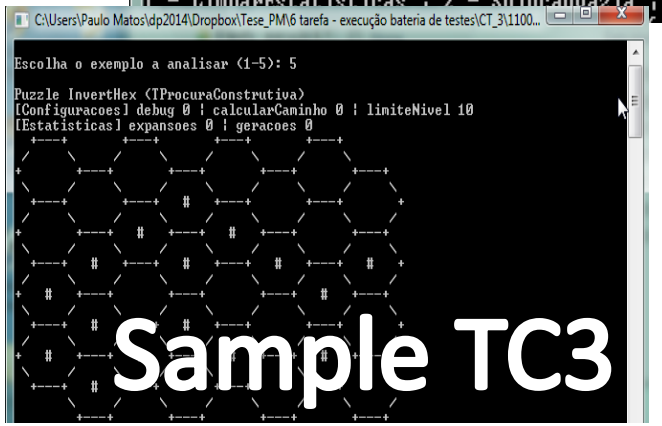
Sharing Results

Case Study A - mathematical algorithm

- A mathematical algorithm that can be
- 3 source code created : Two by students and the third by an academic teacher
- Compile the source code to run on W7
- Testing using Microsoft Joulemeter
- 2 different architecture System Under Testing (Laptop and fixed workstation)



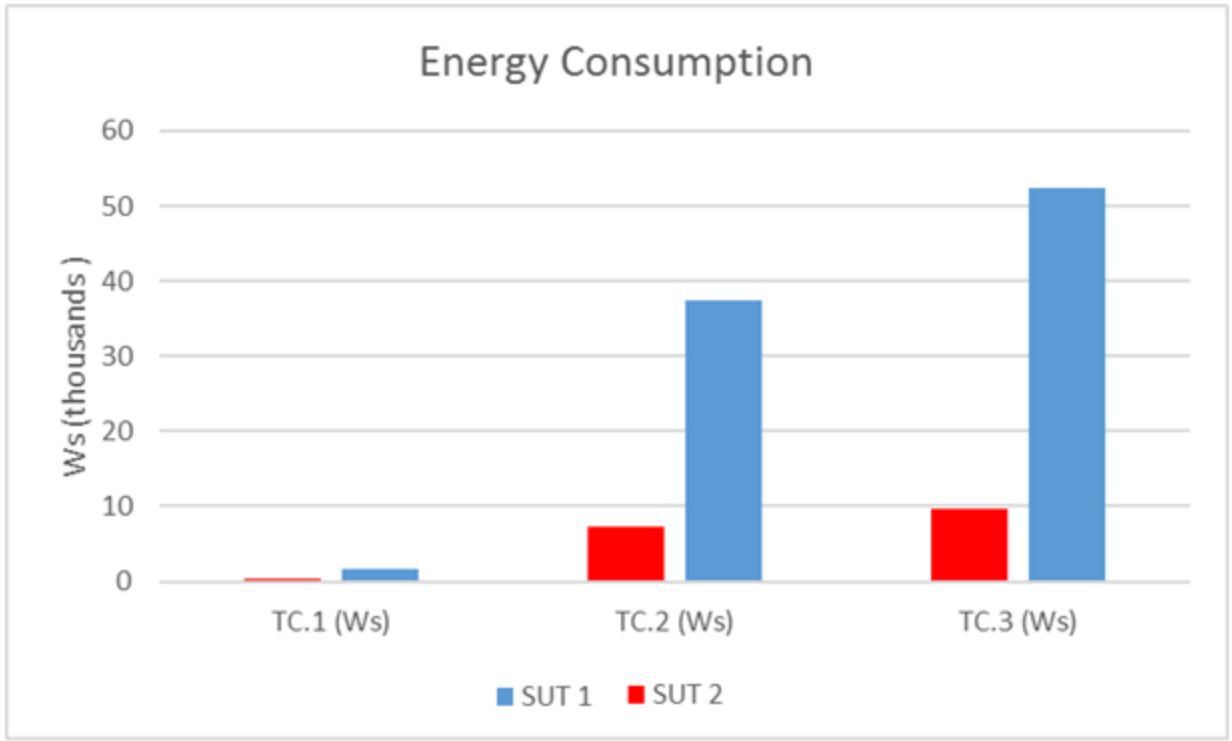




How we can help?

Sharing Results

Case Study A - Mathematical algorithm



	Energy Consumption			Max
SUT	TC.1 (Ws)	TC.2 (Ws)	TC.3 (Ws)	Δ %
1	1555	37330	52462	3274%
2	258	7312	9712	3664%
Δ %	17%	20%	19%	

How we can help?

Sharing Results

Case Study B - Browser Starting

Session-Based Testing:

- find the best browser to start-up with homepage of http://www.romaniatesting.ro/ by the point of view of energy consumption.

Method:

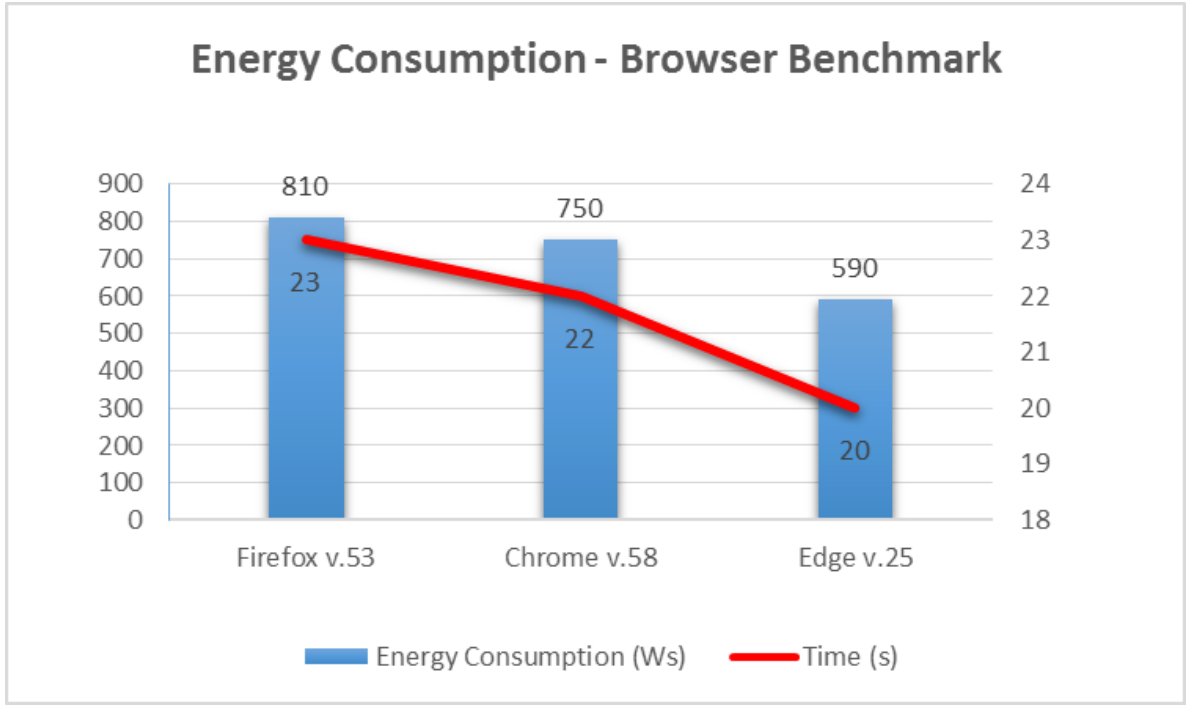
- For each browser make 10 runs to capture the energy consumption and we calculate the average. Between tests we clean cache. The access to internet by using a mobile connection.

Browsers on test:

- Mozilla Firefox 53.0.2 (64bits)
- Microsoft Edge 25.10586.672.0
- Google Chrome Version 58.0.3029.96 (64bits)

Tools used:

- Intel® Power Gadget 3.0
- CrazyClock (for help to monitor the time)



How we (testers) can help?

Resume

- The stakeholders should know that energy consumption can be an important requirement, not only for mobile but also for common use on everything.
- The task of evaluation should be given to the testers because they are the elements of software development that has the mission of worrying about quality assurance.
- The testers should identify the best tool to use in their tests in a methodical way given the variability and risks of imprecision of each, in particular in the emulated ones.
- An important aspect of this type of testing is to understand we compare the our results with what? The comparison is made to an earlier version of a our product, or is with similar product on market, or is only for knowing the performance on different platforms. By this way, our work can only identify optimization situations (<20%) or very bad situations (> 4000%).

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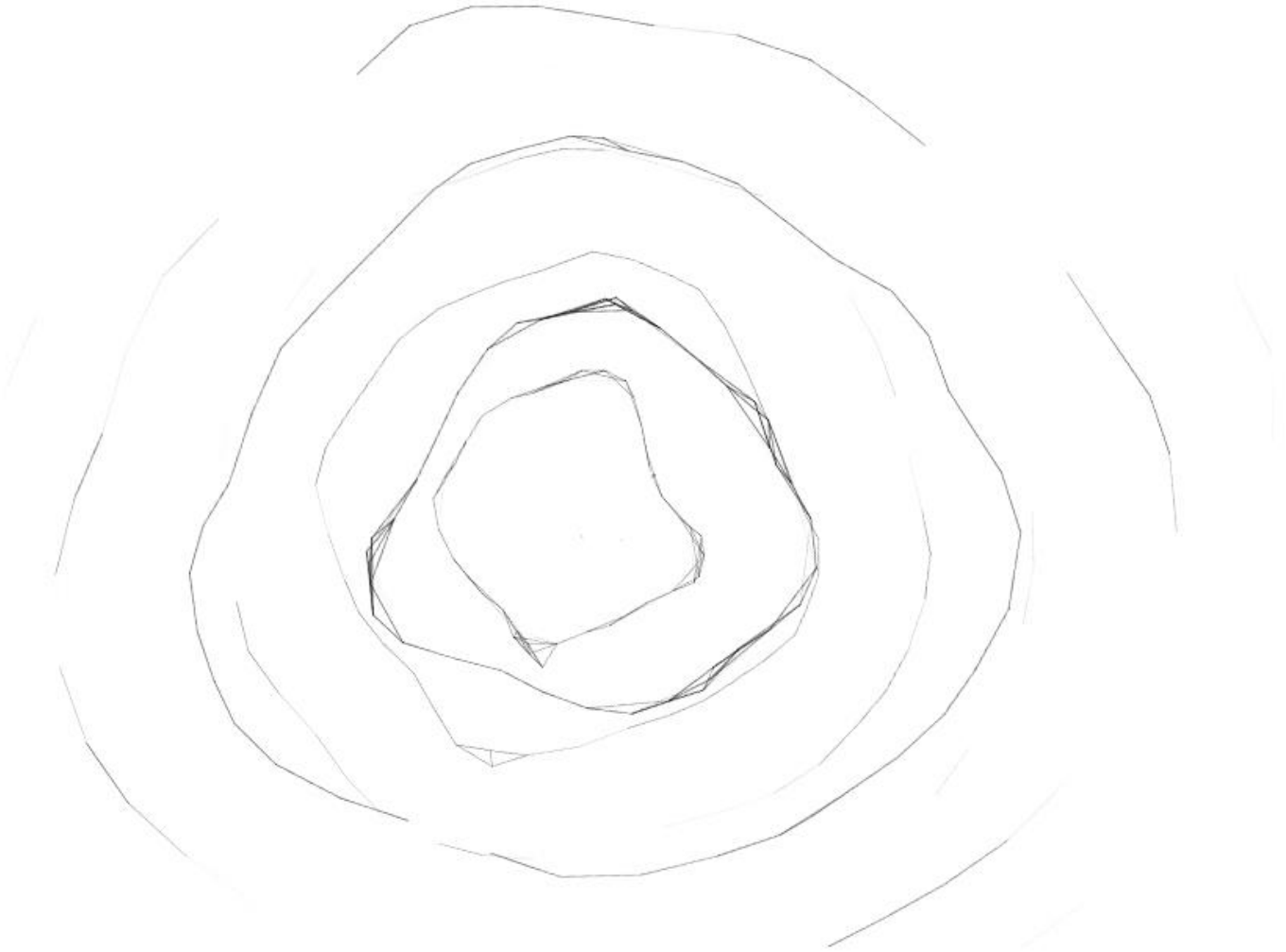
DEMO



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Thanks,

For your presence

Available for questions

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