

CSA Group Computer Real-World Energy Use Test Procedure

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ENERGY STAR

March 12, 2018



Global Footprint For Market Expertise & Access

+2,000 employees

39 offices in
14 countries,

assists in entering
+140 countries



Standards & Codes Drive Trust and Safety

Electrical
and Gas



Healthcare



Power
Generation
and Delivery

Construction
and
Infrastructure

Over **3,000** standards,
codes & related products
in **50+** technology areas

Public and
Workplace
Safety

Petroleum
and
Natural Gas



Environment



Business
Excellence

CSA Group Standards Research & Planning

Funding and Conducting Research:

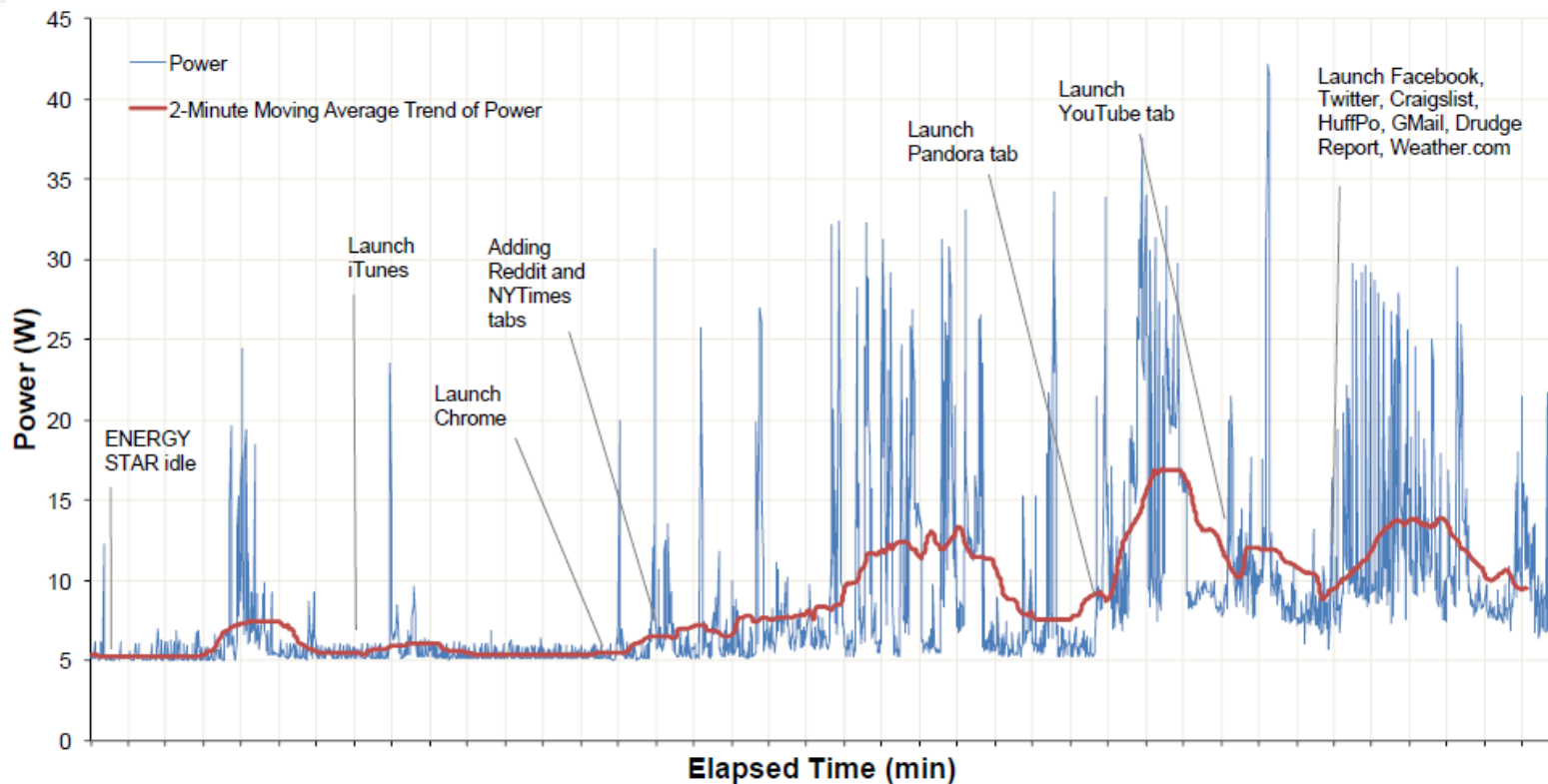
- In areas that address new or emerging industries
- Topics and issues that impact a broad base of current and potential stakeholders
 - *Computing Appliances*

The output of our research programs will:

- Support the development of future standard test and measurement procedures
- Provide interim guidance to industries on the development and adoption of new technologies



Motivating Example: Laptop idles at 5 watts (ENERGY STAR short idle), but consumes significantly more in real-world use



Computer Real-World Energy Use Test Procedure

Computer Energy Test and Measurement

- In mobile devices power consumption in real-life active mode is 10-100x higher than in idle
- Modern computers also heading that way, with increased power scalability and modern standby
- Diminishing policy returns on ENERGY STAR idle. Next frontier for computer energy policy is real-world use, including “browser idle” and “browser active”:
 1. Will help more appropriately report computer real-world energy use
 2. Will enable future policy action on computer energy use

About the Project

- **What?** Evolve the test and measurement procedure for computers to better reflect their real-world energy use, and ensure continued effectiveness of ENERGY STAR and other energy efficiency policies
- **How?** Use established practices for energy testing of mobile devices to define test and measurement procedures for real-world idle and light active mode
- **When?** Start now with computers, leverage for other computing appliances (web & video-enabled) in the future



Approach

- In scope:
 - Web browsing
 - Video + audio streaming
 - Real-world idle (browser windows open, programs loaded...)
- } Large share of typical computer duty cycle
- Out of scope (at least initially):
 - High-intensity active (gaming, video editing, etc.):
- Higher complexity, smaller share of computer energy use

Research Phases

	Duration (Weeks)
Phase 1a - Proof of Concept	
Detailed Specification Dev	8
Execution Environment Dev	12
Proof of Concept Content Definition	6
Proof of Concept Testing	2
Project Management Phase 1a	8
Phase 1b - Production Environment	
Content Definition	10
Validation Test Development	8
Alpha Testing	4
Beta 1 Updates and Testing	6
Beta 2 Updates and Testing	8
Public Release Updates and Testing	6
Documentation Development	16
Project Management Phase 1b	18
Phase 2- Remote Streaming	
Detailed Specification Dev	4
Execution Environment Dev	8
Validation Test Development	6
Alpha Testing	4
Beta Updates and Testing	4

Inception/Timeline

- 2013 Submission by Aggios Inc. during CEC Computer Rulemaking process
 - Discussions unfold with BC Ministry of Energy and Mines, BC Hydro through Pacific Coast Collaborative (PCC)
 - Submission of a project proposal form (PPF) to CSA in 2013; approved in November 2013
 - Goal: Develop horizontal real-world idle and light active state test and measurement procedures for computing appliances based on established energy testing practices for mobile devices
- Technical Sub-Committee (TSC) formed in 2014
 - Some hesitation on industry's part to participate citing concerns around reproducibility, imminent regulation
 - 2015 - 2016: TSC generally in agreement that discussions would re-start after research was complete
 - 2017 (December): Computing Appliances R&D project initiated. Aggios Inc retained as the contractor

Project Governance

Sponsors:



Natural Resources
Canada

Ressources naturelles
Canada



Advisory Committee

- Voytek Gretka, *Chair* (Morrison Hershfield)
- Jovan Cheema (CSA Group)
- Gary Hamer (BC Hydro)
- Pierre Delforge (NRDC)
- Vojin Zivojnovic (Aggios Inc)
- Pat Saxton (CEC)

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CA investor-owned utilities



About AGGIOS

- California business out of Irvine, CA since 2010:
 - Focus: Research and innovation to save energy
 - In depth technical expertise in power optimizations (plug load, mobile, internet of things)
 - Independent, fully employee-owned
- Our vision: EVERY MICRO-JOULE COUNTS!
- Our strategy: Software Defined Energy Management based on technical standards
- Our key product engagements:
 - Power management software/firmware IP, development tools, format and interface standards for leading US semiconductor companies
 - Complete highly specialized power management solutions for US Aerospace and Defense
- Our key energy engagements:
 - California IOUs: California Computer Regulation (official)
 - California EPIC project: “Mobile efficiency for plug load devices” (in progress)
 - IEEE P2415 technical standard: “Unified Hardware Abstraction” (in progress)
 - CSA Computing Appliances (in progress)



Phase 1a – Executive Summary

- 1) Active Mode Test and Measurement (T&M) Specification
 - T&M definition and execution environment
 - Benchmark and content definition
 - T&M procedure specification
- 2) Develop prototype execution environment
- 3) Create proof of concept content

Test & Measurement Definition

- Each T&M procedure defines the sequence of content to be loaded, as well as the user interactions with the content
- The T&M procedure shall perform a fixed set of actions over a pre-determined period of time
- T&M Procedure Requirements:
 - Representative
 - Repeatable
 - Platform Independent
 - Reasonable

Existing T&M Procedures and Benchmarks

EnergyStar T&M procedure

- Single measurement run, sensitive to settling time (maintenance tasks after prolonged off-periods)
- Measurements are often difficult to reproduce, results can vary significantly

Various performance-oriented browser benchmarks

- Basemark Web 3.0
- browserbench.org (Speedometer, JetStream, Ares6, Motionmark)
- Peacekeeper
- Octane
- Sunspider
- PCMark8

Existing energy benchmark:

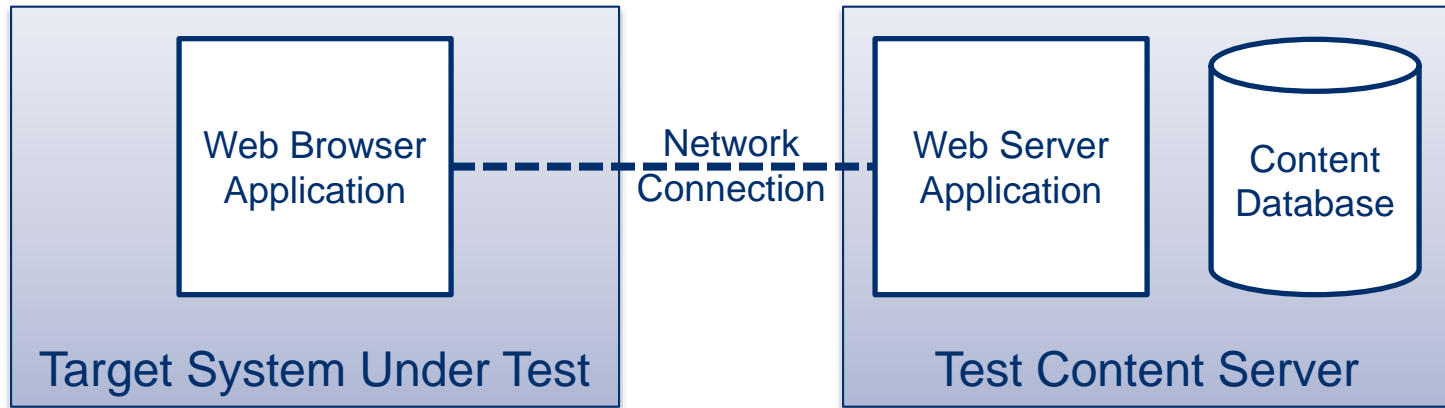
- EEcoMark (BAPCO)

Challenges

- Existing benchmarks either measure the time it takes to perform a fixed task, or they measure how much work can be performed in a fixed amount of time
- Existing benchmarks are performance-oriented, hence browser intensity is much higher than real world usage
- Existing energy benchmarks are not device independent, i.e. they need device-specific code

Execution Environment

- We propose the following setup for active mode and real world idle benchmarking:



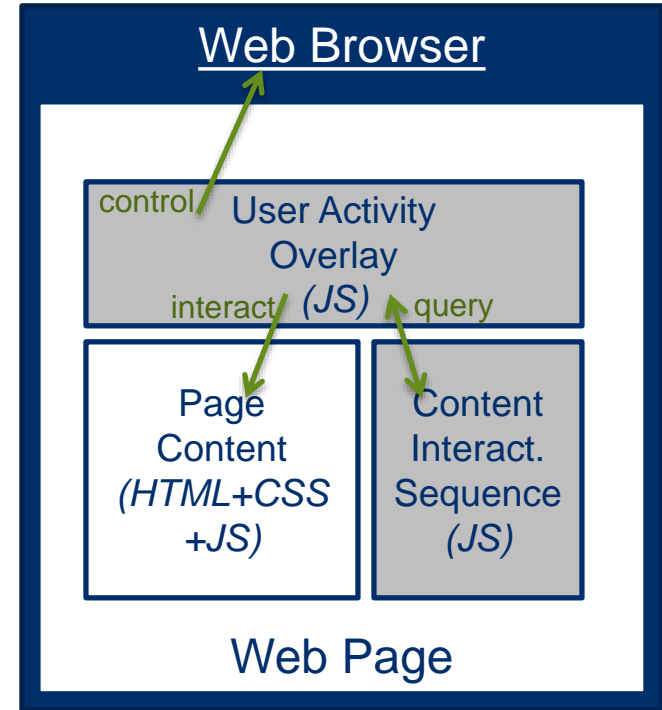
Web Browsing T&M: User Activity

- The following user activities shall be covered by the T&M procedure
 - sequentially visiting multiple different websites
 - scrolling up and down the page
 - moving the mouse over page items triggering dynamic content
 - downloading files
 - clicking on hyperlinks
 - entering data in forms and submitting the data
 - opening new browser tabs and browser windows

Proposed Solution: User Activity Emulation

JavaScript Overlays:

- Emulate user activity in a platform independent manner
- Each web page generated by the test content server shall consist of
 - The content itself (HTML, CSS, JS)
 - Content interaction sequence (JS)
 - Benchmark overlay (generic JS)
- The benchmark overlay JavaScript code will query the content interaction sequence and then emulate user activity by controlling the web browser (e.g. scrolling) and interacting with the web page (e.g. trigger dynamic content).



Content Definition

- Content must be defined for each activity type
 - Web browsing
 - Audio/video streaming
 - Real world idle
- Content must be representative
 - Must include all relevant technologies
 - Reflect content of popular US consumer and business websites
 - Must reflect similar level of complexity and hierarchy
 - Must include HTML5 and CSS3 features
 - Restricted to standardized features supported by all browsers

Website Technologies

- Web Page Technologies (as seen by a web browser)
 - HTML, or HyperText Markup Language, is used to create the basic structure and content of a webpage
 - CSS, or Cascading Style Sheets, is used for the design of a webpage – where everything is placed and how it looks
 - JavaScript is used to define the interactive elements of a webpage
 - Losing relevance: Java, AdobeFlash
- Other Technologies (server side / dev)
 - Programming Languages: PHP, Ruby, Java, C#, VisualBasic, etc
 - Frameworks: Django, TypeScript, Ruby on Rails, etc
 - Libraries: jQuery, Underscore, Zurb, Web Components, etc

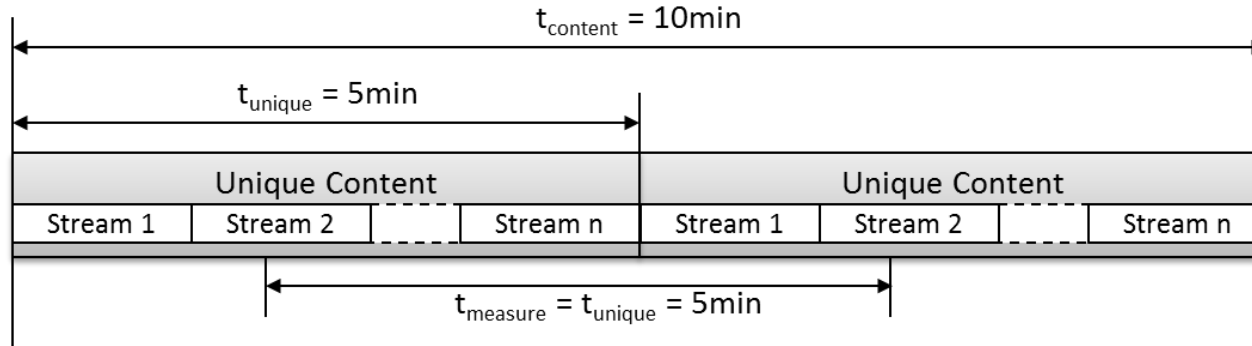
Representative Websites - Overview

Site	Page Size (kB)	Processing Time	JavaScript Size	Lines of JS Code
Google (Search Result)	736 kB	2.0s	372 kB	30k+
Youtube	3,789 kB	9.3s	1,126 kB	100k+
Facebook	3,482 kB	7.9s	2,355 kB	200k+
Amazon	16,384 kB	12.8s	1331 kB	120k+
Yahoo	2,048 kB	10.5s	1229 kB	120k+
Twitter	1,126 kB	9.4s	568 kB	50k+
Microsoft Live.com	4,408 kB	12.62s	370 kB	35k+
LinkedIn	2,560 kB	5.6s	1331 kB	100k+
Google Docs	8,397 kB	14.06s	719 kB	70k+
Salesforce	2,867 kB	6.4s	1946 kB	190k+

- Processing time is dominated by executing JavaScript code
- Download/display of media is not a dominant factor
- 10,000 to 100,000 lines of code is the norm

Video Stream T&M

- To ensure timing independent results the content must be repeated



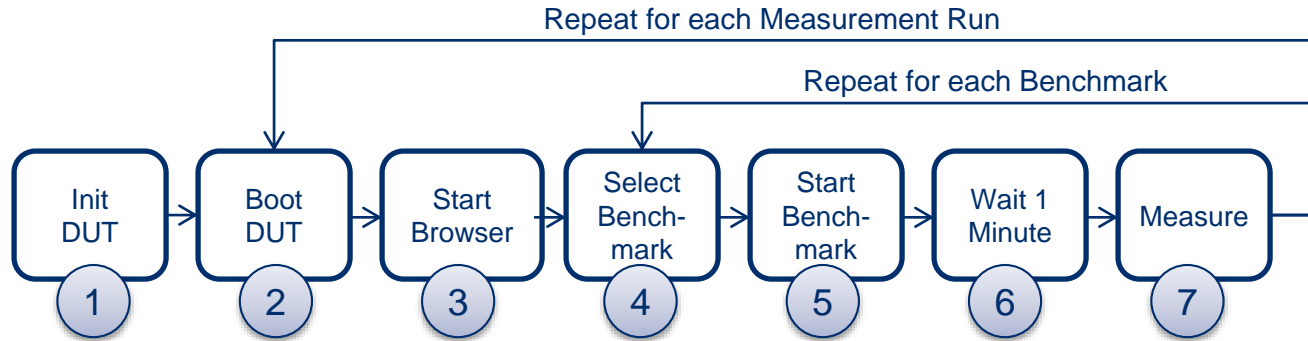
- To avoid unintended caching effects each repetition should have its own unique URL
- Two repetitions should be sufficient as we want each unique content to be covered once
- Unique Content duration is TBD, proposed time is 5 minutes

Power Measurements

- Power Measurement Requirements
 - Relevant
 - Content shall be representative of typical consumer and business websites
 - Reliable
 - Execution environment shall ensure reliability
 - Repeatable
 - Controlled, locally hosted content
 - Well-defined power measurement procedure
 - Reproducible
 - Local hosting of content
 - Well-defined power measurement procedure
 - Reasonable
 - A 5-minute cycle should be sufficient to produce representative results

Power Measurement Procedure

- We propose the following procedure for measuring power during active mode benchmarking:





Questions?



**CSA
Group**