

GREEN PAUWARE



Tools for lower-carbon mobile software

GREEN PAUWARE TEAM

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SUMMER SCHOOL GREEN IT

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Le super logo fait par bibi ;)

(UN)POPULAR OPINIONS

Economiser des microwatts à chaque exécution c'est bien...

...mais ça permet surtout d'allonger la durée de vie des batteries des terminaux mobiles !

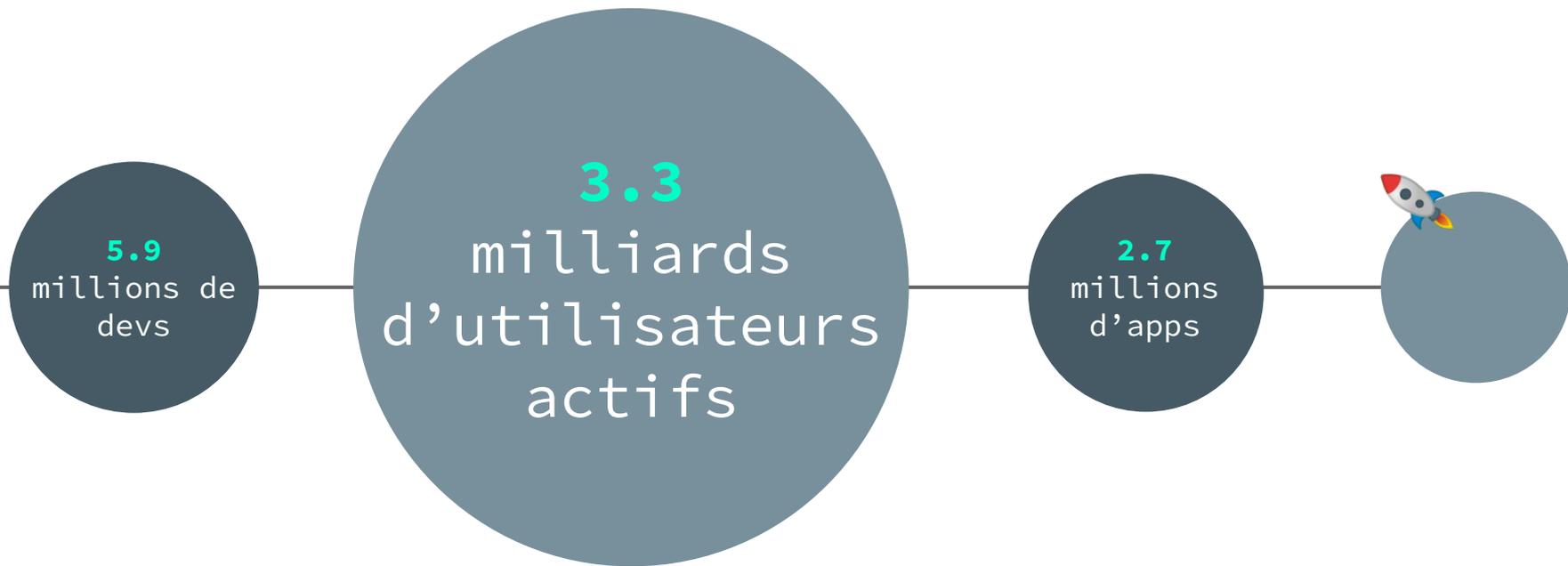
Le code ne fait pas tout certes, mais contribue quand même beaucoup

L'efficacité énergétique ce n'est pas la performance (c-a-d vitesse)

Il y a très peu d'algorithmique en tant que tel dans les apps mobiles

Il faut des solutions actionnables (c-a-d des outils), plus que des bonnes intentions

LA GALAXIE ANDROID



ÉCO-GESTES DU DÉVELOPPEUR

NIVEAUX D'IMPACTS EN GÉNIE LOGICIEL



Feature

API & SDK

Idiom

Language & runtime

"ON NE GÈRE BIEN QUE
CE QUE L'ON MESURE"

– Lord Kelvin

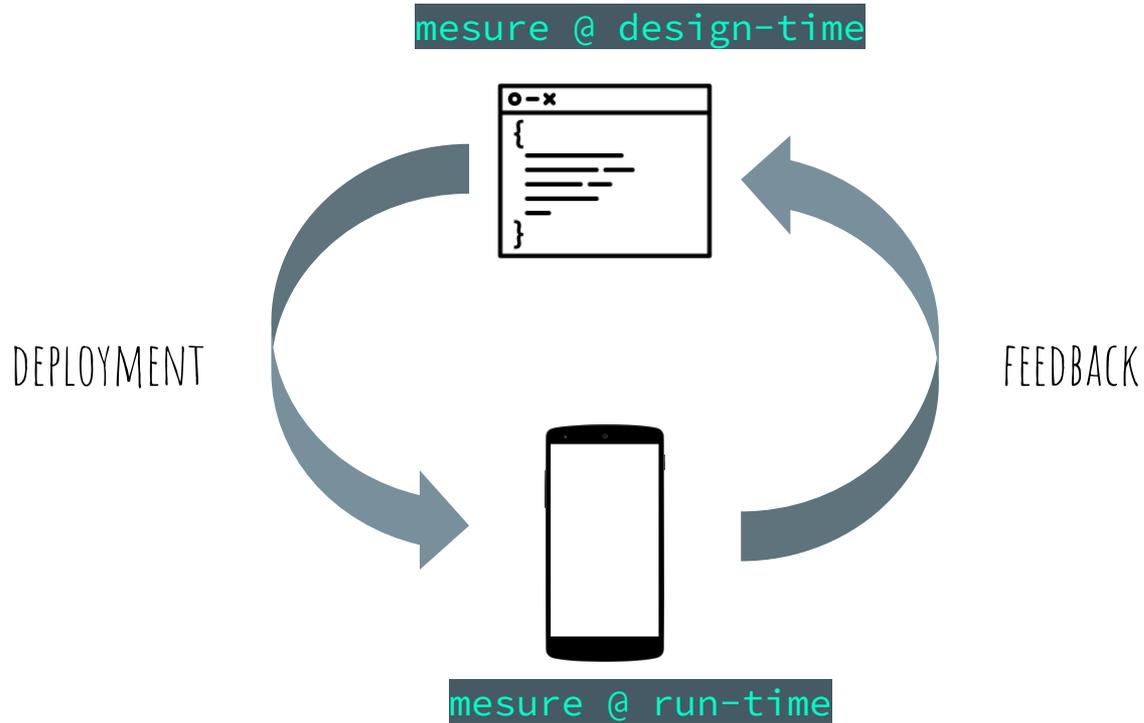
#1 Mesure de la qualité du
code (green code)

Présentation d'**ecoCode**

#2 Mesure de la
consommation en phase
d'usage

Présentation de **PowDroid**

ROUND-TRIP ENGINEERING



MESURE DE LA QUALITÉ DU CODE

(design-time)

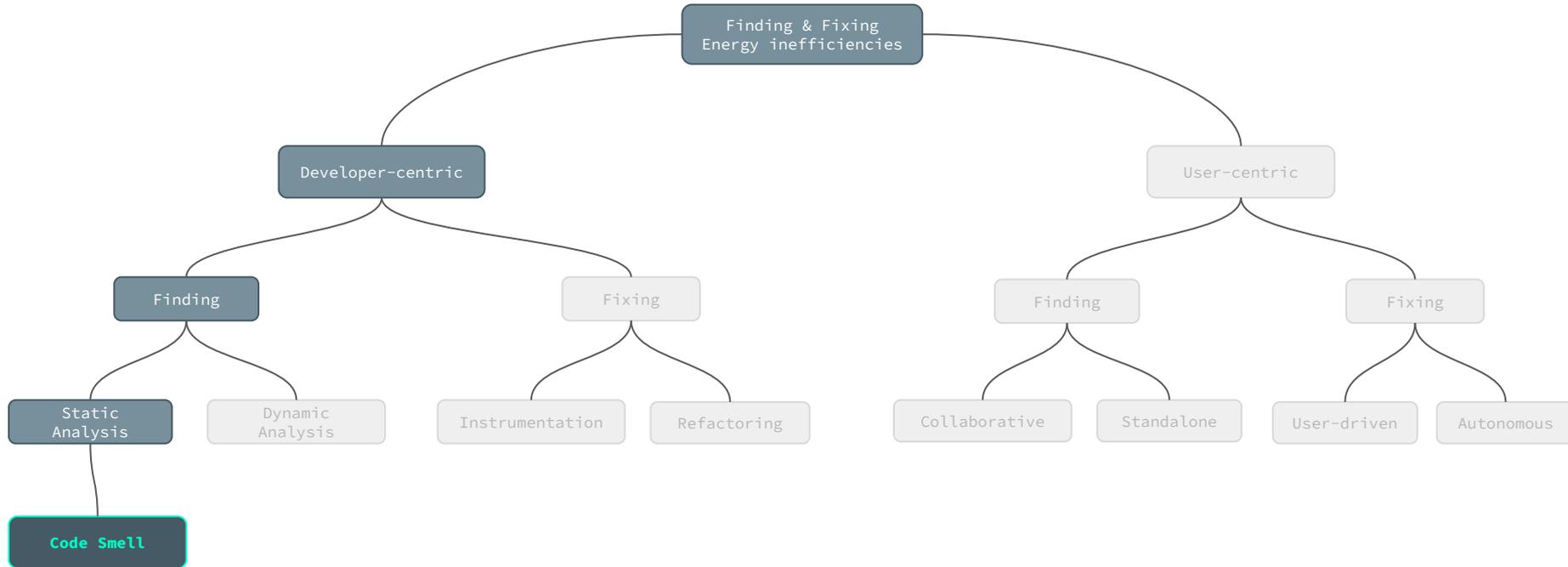
MOTIVATIONS

 Évaluer si une app Android est **verte par construction** (*green by design*), en amont de sa libération sur le store

 Détecter des **code smells** susceptibles d'influencer négativement (ou positivement) l'empreinte carbone

 La densité et la sévérité des smells produisent un **eco-score**, indépendamment de la nature de l'app

TAXONOMIE* DU TRAVAIL



ENVIRONMENTAL CODE SMELLS (ANDROID)

Catalogue ouvert (Licence CC BY-NC-ND) :

<https://github.com/cnumr/best-practices-mobile>

40+

code smells arrangés en

8

catégories

Ils offrent la garantie d'être **statiquement détectables**

CHANGEMENT DE BRAQUET

❤ open source



*Proof Of Concept**
Plugin Android Studio
(2019)

*Minimum Viable Product***
Plugin SonarQube
(2021)

*Olivier Le Goer, "Enforcing Green Code With Android Lint", *The 3rd International Workshop on Advances in Mobile App Analysis @ ASE 2020*.

**Olivier Le Goer and Julien Hertout, "EcoCode: A SonarQube Plugin to Remove Energy Smells from Android Projects". *The 37th IEEE/ACM International Conference on Automated Software Engineering (ASE 2022)*

ENSEIGNER ECOCODE (MOBILE)

Enseigné en TP dans le module NR du Master informatique sur une instance SonarQube auto-hébergée



<https://sonarqube.ecocode.io/>

CAPTURES D'ÉCRAN

The dashboard shows a list of projects with the following details:

Project Name	Status	Environment	Social	Code Size	Last anal
ACME	Failed	C 1	D 2	7,3 k JAVA	October 9, 2020, 3:04
COGIP	Warning	A 14	A 8	XS 214 k JAVA	October 9, 2020, 3:04
Cyberdyne	Passed	A 125	B 89	M 17 k JAVA	October 9, 2020, 3:04
PolarCreed Project	Passed	A 11	A 2	XL 512 k JAVA	October 9, 2020, 3:04
Rekall	Passed	A 122	A 7	M 26 k KOTLIN	October 9, 2020, 3:04
Tricatel	Passed	A 12	B 5	M 31 k	October 9, 2020, 3:04

The issue view for the PolarCreed Project (core) shows the following details:

- Issue title: **Prefer TYPE_GEOMAGNETIC_ROTATION_VECTOR instead of TYPE_ROTATION_VECTOR**
- Location: `src/com/creed/Orientation.java`
- Severity: **Warning**
- Environment: **A**
- Code size: **XS 214 k**
- Code language: **JAVA**

The code snippet shows the following lines:

```
19 private static final int SENSOR_ROTATION_VECTOR = 1016;
20
21 private final WindowManager mWindowManager;
22
23 private final SensorManager mSensorManager;
24
25 @Nullable
26 private final Sensor mRotationSensor;
27
28 private int mLastAccuracy;
29 private Listener mListener;
30
31 public Orientation(Activity activity) {
32     mWindowManager = activity.getWindow().getWindowManager();
33     mSensorManager = (SensorManager) activity.getSystemService(Activity.SENSOR_SERVICE);
34
35     // Can be null if the sensor hardware is not available
36     mRotationSensor = mSensorManager.getDefaultSensor(Sensor.TYPE_ROTATION_VECTOR);
37 }
38
39 public void startListening(Listener listener) {
40     if (mListener == listener) {
41         return;
42     }
43 }
```

The issue description explains the fix:

When using `SensorManager.getDefaultSensor(int type)` always prefer the constant `TYPE_GEOMAGNETIC_ROTATION_VECTOR` which is similar to `TYPE_ROTATION_VECTOR`, but using a magnetometer instead of using a gyroscope. This sensor uses lower power than the other rotation vectors because it does not use the gyroscope. However, it is more noisy and will work best outdoors.

The **Non compliant Code Example** shows the original code:

```
mRotationSensor = mSensorManager.getDefaultSensor(Sensor.TYPE_ROTATION_VECTOR);
```

The **Compliant Solution** shows the corrected code:

```
mRotationSensor = mSensorManager.getDefaultSensor(Sensor.TYPE_GEOMAGNETIC_ROTATION_VECTOR);
```

CUTTING-EDGE

SCALABLE

USER-FRIENDLY



TECHNICAL HURDLES

SMELLS

EMPIRICAL SETTINGS



MESURE DE LA CONSO DE L'APP

(run-time)

MOTIVATIONS

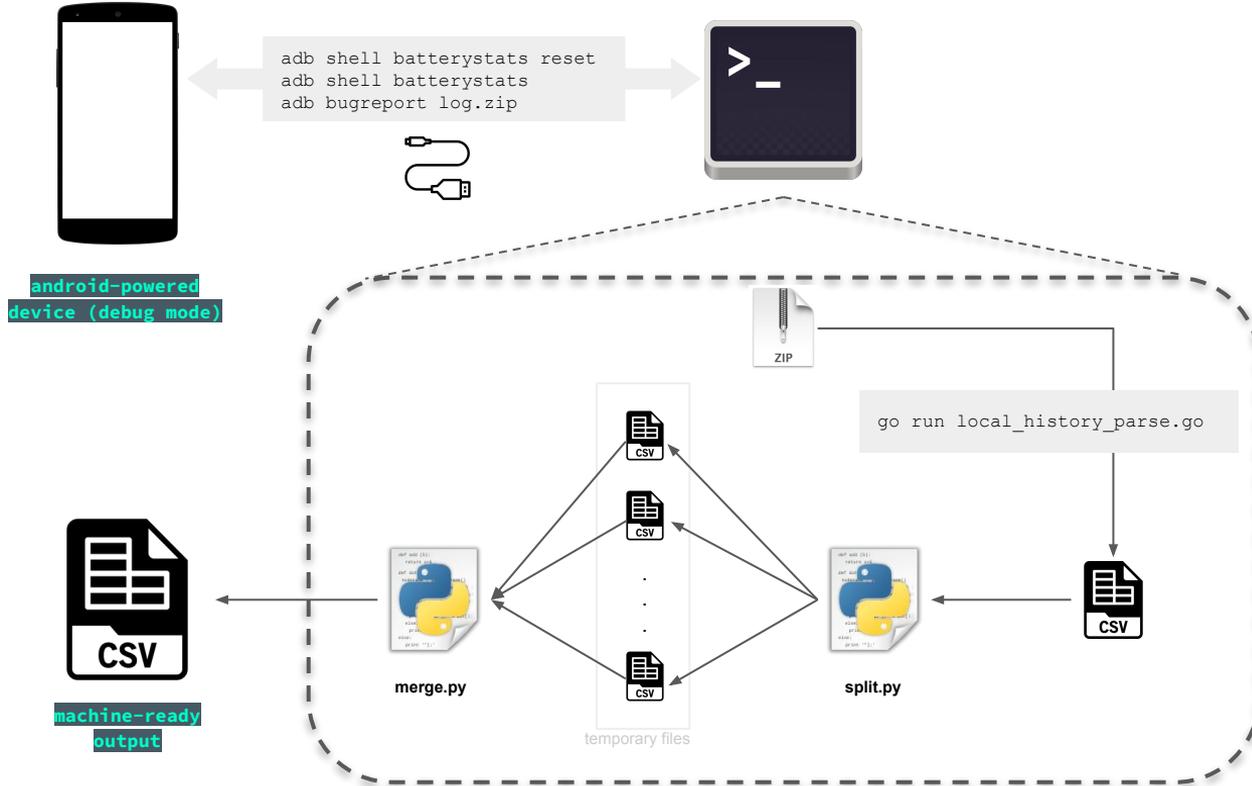
📱 Collecter des métriques énergétiques de n'importe quelle app Android exécutée, **sans avoir accès à son code source**

⚡ Produire un fichier de données permettant, entre autres choses, de calculer l'énergie consommée en **Joules**

👤 L'outil doit être très **simple** d'utilisation (CLI)



<https://gitlab.com/powdroid/>



MÉTRIQUES

Metric	Description	Unit
Start time	when the event start	Timestamp
End time	when the event ends	Timestamp
Duration	duration of the event	Millisecond
Voltage	electric voltage emitted by the battery.	Millivolt
Remaining charge	electric charge remaining in the battery	Milliampere-hour
Intensity	electric intensity calculated from remaining charge	Milliampere
Power	amount of energy during a given time, usually 1 second.	Watt
Consumed charge	amount of charge passing through the cross-section of smartphone	Milliampere-hour
Energy	total energy consumed when the application was run.	Joule
Top app	name of the package running in the foreground.	String
Wakelock	wakelocks acquired by the application.	String
Screen	indicates if the screen is active or not.	Boolean
GPS	indicates if GPS is on or not	Boolean
Mobile radio	indicates if mobile GSM is active for scanning or transmitting data	Boolean
Wifi on	indicates the status of wifi (On/Off)	Boolean
Wifi radio	indicates if the wifi is transferring data	Boolean
Camera	indicates if the camera is active or not	Boolean
Video	indicates if there is a video like video reading or a video call	Boolean
Audio	indicates if the audio component (like speakers) is active	Boolean

	start time	end time	Duration (mS)	Voltage (mV)	Remaining charge (mAh)	Intensity (mA)	Power (W)	Consumed charge(mAh)	Energy (J)
0	1629360761640	1629360761642	2	3807	1311 322.66159968450864	1.228373	0.000179	0.000179	0.002457
1	1629360761642	1629360761646	4	3807	1311 322.66159968450864	1.228373	0.000359	0.000359	0.004913
2	1629360761646	1629360761647	1	3807	1311 322.66159968450864	1.228373	0.000090	0.000090	0.001228
3	1629360761647	1629360761650	3	3807	1311 322.66159968450864	1.228373	0.000269	0.000269	0.003685
4	1629360761650	1629360761651	1	3807	1311 322.66159968450864	1.228373	0.000090	0.000090	0.001228
5	1629360761651	1629360761654	3	3807	1311 322.66159968450864	1.228373	0.000269	0.000269	0.003685
6	1629360761654	1629360761655	1	3807	1311 322.66159968450864	1.228373	0.000090	0.000090	0.001228
7	1629360761655	1629360761657	2	3807	1311 322.66159968450864	1.228373	0.000179	0.000179	0.002457
8	1629360761657	1629360761659	2	3807	1311 322.66159968450864	1.228373	0.000179	0.000179	0.002457
9	1629360761659	1629360761666	7	3807	1311 322.66159968450864	1.228373	0.000627	0.000627	0.008599
10	1629360761666	1629360761667	1	3807	1311 322.66159968450864	1.228373	0.000090	0.000090	0.001228
11	1629360761667	1629360761669	2	3807	1311 322.66159968450864	1.228373	0.000179	0.000179	0.002457
12	1629360761669	1629360761683	14	3807	1311 322.66159968450864	1.228373	0.001255	0.001255	0.017197
13	1629360761683	1629360761685	2	3807	1311 322.66159968450864	1.228373	0.000179	0.000179	0.002457
14	1629360761685	1629360761686	1	3807	1311 322.66159968450864	1.228373	0.000090	0.000090	0.001228
15	1629360761686	1629360761687	1	3807	1311 322.66159968450864	1.228373	0.000090	0.000090	0.001228
16	1629360761687	1629360761688	1	3807	1311 322.66159968450864	1.228373	0.000090	0.000090	0.001228
17	1629360761688	1629360761691	3	3807	1311 322.66159968450864	1.228373	0.000269	0.000269	0.003685
18	1629360761691	1629360761692	1	3807	1311 322.66159968450864	1.228373	0.000090	0.000090	0.001228
19	1629360761692	1629360761693	1	3807	1311 322.66159968450864	1.228373	0.000090	0.000090	0.001228
20	1629360761693	1629360761694	1	3807	1311 322.66159968450864	1.228373	0.000090	0.000090	0.001228
21	1629360761694	1629360761697	3	3807	1311 322.66159968450864	1.228373	0.000269	0.000269	0.003685
22	1629360761697	1629360761699	2	3807	1311 322.66159968450864	1.228373	0.000179	0.000179	0.002457
23	1629360761699	1629360761701	2	3807	1311 322.66159968450864	1.228373	0.000179	0.000179	0.002457
24	1629360761701	1629360761703	2	3807	1311 322.66159968450864	1.228373	0.000179	0.000179	0.002457
25	1629360761703	1629360761757	54	3807	1311 322.66159968450864	1.228373	0.004840	0.004840	0.066332
26	1629360761757	1629360761760	3	3807	1311 322.66159968450864	1.228373	0.000269	0.000269	0.003685
27	1629360761760	1629360761762	2	3807	1311 322.66159968450864	1.228373	0.000179	0.000179	0.002457
28	1629360761762	1629360761763	1	3807	1311 322.66159968450864	1.228373	0.000090	0.000090	0.001228
29	1629360761763	1629360761765	2	3807	1311 322.66159968450864	1.228373	0.000179	0.000179	0.002457
30	1629360761765	1629360761766	1	3807	1311 322.66159968450864	1.228373	0.000090	0.000090	0.001228
31	1629360761766	1629360761768	2	3807	1311 322.66159968450864	1.228373	0.000179	0.000179	0.002457
32	1629360761768	1629360764870	3102	3807	1311 322.66159968450864	1.228373	0.278027	0.278027	3.810412
33	1629360764870	1629360765525	655	3807	1311 322.66159968450864	1.228373	0.058706	0.058706	0.804584
34	1629360765525	1629360767451	1926	3807	1311 322.66159968450864	1.228373	0.172624	0.172624	2.365846

Global structure

Sample output (.csv)

CAPTURES D'ÉCRAN

```
C:\WINDOWS\system32\cmd.exe
[powdroid] Please, plug your smartphone to your computer!
set your smartphone IP address please
10.8.3.39
* daemon not running; starting now at tcp:5037
* daemon started successfully
restarting in TCP mode port: 7777
connected to 10.8.3.39:7777
[powdroid] Wifi connexion established ! unplug your smartphone please !
do you want to install a new application? Y/N
drag and drop your APK file on this window
```

Smartphone connexion

* installation of an APK to test (optional)

```
C:\WINDOWS\system32\cmd.exe
Success
org.mozilla.firefox
Un sous-répertoire ou un fichier org.mozilla.firefox existe
bash arg: -p
bash arg: org.mozilla.firefox
bash arg: -c
bash arg: android.intent.category.LAUNCHER
bash arg: 1
args: [-p, org.mozilla.firefox, -c, android.intent.category.LAUNCHER, 1]
arg: "-p"
arg: "org.mozilla.firefox"
arg: "-c"
arg: "android.intent.category.LAUNCHER"
arg: "1"
data="org.mozilla.firefox"
data="android.intent.category.LAUNCHER"
Events injected: 1
## Network stats: elapsed time=23ms (0ms mobile, 0ms wifi, 23ms not connected)
*****
*****      Welcome to PowDroid V 1.0      *****
*****
[powdroid] Do you want to start your test session now? Y/N
y
Battery stats reset.
162974690839.072
[powdroid] Recording...
[powdroid] Press ENTER once you finished your test session
```

Recording a test session

```
C:\WINDOWS\system32\cmd.exe
WiFi Scan time: 0ms (0.0%)
WiFi Sleep time: 5m 47s 877ms (100.0%)
WiFi Idle time: 0ms (0.0%)
WiFi Rx time: 0ms (0.0%)
WiFi Tx time: 1ms (0.0%)
Background for: 5m 47s 858ms
Total running: 5m 47s 858ms
u0a204:
(nothing executed)
u0a389:
Wi-Fi network: 47.95KB received, 19.91KB sent (packets 112 received, 123 sent)
WiFi Scan time: 0ms (0.0%)
WiFi Sleep time: 5m 47s 745ms (100.0%)
WiFi Idle time: 0ms (0.0%)
WiFi Rx time: 118ms (0.0%)
WiFi Tx time: 15ms (0.0%)
Top Sleeping for: 5m 47s 857ms
Total running: 5m 47s 857ms
Total cpu time: u=474ms s=180ms
Total cpu time per freq: 0 100 80 70 90 30 60 30 150 0 0 0 0 0 0 0 0 0
Total screen-off cpu time per freq: 0 100 80 70 90 30 60 30 150 0 0 0 0 0 0 0 0 0
Proc org.mozilla.firefox:
CPU: 310ms usr + 110ms krn ; 0ms fg

Total cpu time reads: 0
Batched cpu time reads: 0
Batching Duration (min): 2832
All UID cpu time reads since the later of device start or stats reset: 16
UIDs removed since the later of device start or stats reset: 0
[ 0%] generating battery_device.zip
```

Output file generation

COMPARATIF DES NAVIGATEURS WEB*



CONSISTENT

EASY-TO-USE

PLAYGROUND



SYSTEM-WIDE

POORLY SCALABLE

INSTALL



WHAT'S NEXT?

Automated SE → Empirical SE

ecoCode

Étudier l'occurrence des code smells dans les OSS

Nouvelles techniques de détection (ML)

PowDroid

Évaluer chaque code smell unitairement (ranking)

Découvrir de nouvelles bonnes/mauvaises pratiques

MERCI DE VOTRE ATTENTION.

QUESTIONS ?